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THE INTERNATIONAL TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE
(C.C.I.T.T.)

RED BOOK

VOLUME I

Ist PLENARY ASSEMBLY

GENEVA, 10-20 DECEMBER 1956

List of participants
Minutes of the meetings of the First Plenary Assembly
Resolutions issued by the First Plenary Assembly
Questions to be studied in 1957-1960
Study Groups and Sub-Study Groups in 1957, 1958 and 1959

Published by the
INTERNATIONAL TELECOMMUNICATION UNION
JUNE 1957

THE INTERNATIONAL TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE
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ORGANIZATION

OF THE FIRST PLENARY ASSEMBLY OF THE INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE

(GENEVA, DECEMBER 1956)

10, 11 and 12 December: Meetings of Heads of Delegations, with Mr. GNEME (Italy) in the Chair, to draw up a list of study groups and working procedures for submission to the Assembly.

15 to 20 December, 1956: Meetings of the Plenary Assembly and its committees.

All meetings took place in the SALLE DU CONSEIL GÉNÉRAL (Bâtiment Electoral) in GENEVA.

The Chairman of the Assembly was Mr. VAN DER TOORN (Head of the Dutch Delegation), assisted by Mr. NESBITT (Head of the United States Delegation) and Mr. AFANASIEV (Head of the Delegation of the Bielorussian Soviet Socialist Republic).

The following committees were set up :

Election Committee: Mr. STERKY (Sweden), Chairman.

Finance Committee: Mr. RAUS (Luxembourg), Chairman.

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LIST OF PARTICIPANTS
TO THE
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Mr. NGUYEN-TUONG-THUY	Directeur des Télécommunications. SAÏGON
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Mr. R. CHAPUIS Mr. J. LALOU	Counsellors
Mr. H. TOWNSHEND	Interim Director of the C.C.I.T.
Mr. J. BESSEYRE	Senior Counsellor.

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LIST OF DOCUMENTS

OF THE FIRST PLENARY ASSEMBLY OF THE C.C.I.T.T.

AP I/1 Report on the meeting of C.C.I.F. and C.C.I.T. Chairmen and Vice-Chairmen on Study Groups and working methods for the C.C.I.T.T.

AP I/2 Views of the C.C.I.R. on whether the C.C.I.T. Study Group on phototelegraphy and facsimile telegraphy should be amalgamated with the C.C.I.R.-C.C.I.T. Joint Study Group on phototelegraphy.

AP I/3 Report on Technical Assistance.

AP I/4 Report on relations between the Union (with particular reference to the C.C.I.T.) and E.C.A.F.E. (Economic Commission for Asia and the Far East).

AP I/5 Procedure for the election of a Director of the C.C.I.T.T.

AP I/6 Material for the report on the financial needs of the C.C.I.T.T. until the second Plenary Assembly.

AP I/7 Technical Assistance (VIIIth Plenary Assembly of the C.C.I.R., Warsaw, 1956).

AP I/8 Future activities of the amalgamated C.C.I.T. to meet the needs of those countries which find their telecommunication systems insufficiently developed — Some suggestions by the Interim Director of the C.C.I.T., submitted for consideration by the First Plenary Assembly of the C.C.I.T.T.

AP I/9 Comments on report drawn up by the meeting of C.C.I.F. and C.C.I.T. Chairmen and Vice-Chairmen on Study Groups and working procedures of the C.C.I.T.T.

AP I/10 Abbreviation to designate the C.C.I.T.T.

AP I/11 Proposal for the organization of the study groups of the C.C.I.T.T. submitted by the Swiss Administration.

GP I/12 The International Consultative Committees and Technical Assistance.

AP I/13 Minutes of the Meeting of Heads of Delegations.

AP I/14 Tunisia — Assistance to countries whose telecommunication networks are insufficiently developed.

AP I/15 Minutes of the second meeting of Heads of Delegations.

AP I/16 Minutes of the Third and final meeting of Heads of Delegations.

AP I/17 Statement by the delegate of the P.R. of Bulgaria.

AP I/18 Organization of Study Groups and working procedures of the C.C.I.T.T. adopted by the Meeting of the Heads of Delegations.

AP I/19 List of questions which the VIIIth Plenary Assembly of the C.C.I.T. requests the First Plenary Assembly of the C.C.I.T.T. to continue or begin studying.

AP I/20 Statement by the Delegation of the Roumanian People's Republic.

AP I/21 Statement by the Delegations of the U.S.S.R., the Ukrainian S.S.R., and the Biélorussian S.S.R. to the 1st Plenary Assembly of the C.C.I.T.T.

AP I/22 Statement by the delegate of the Republic of China.

AP I/23 Statement by the Delegation of Czechoslovakia.

AP I/24 Minutes of the First Plenary Meeting.

AP I/25 Statement by the Delegation of Tunisia.

AP I/26 Report of the Committee on the election of the Director of the C.C.I.T.T.

AP I/27 Suggestions and proposals from the VIIIth Plenary Assembly of the C.C.I.T. to the 1st Plenary Assembly of the C.C.I.T.T.

AP I/28 Recapitulation of the opinions and suggestions submitted by the XVIIIth Plenary Assembly of the C.C.I.F. to the 1st Plenary Assembly of the C.C.I.T.T.

AP I/29 List of questions which the XVIIIth Plenary Assembly of the C.C.I.F. requests the First Plenary Assembly of the C.C.I.T.T. to begin or continue studying.

AP I/30 Statement by the Delegation of the United States of America.

PA I/31 Statement by the Delegation of the People's Republic of Poland to be included in the minutes of the First Plenary Assembly of the C.C.I.T.T.

AP I/32 Spain : Use of Spanish.

AP I/33 Ethiopia : Draft Recommendation on Technical Assistance.

AP I/34 Ethiopia : Draft Recommendation on a Special Committee for Plans and Projects.

AP I/35 Proposals of the Working Group on the designation of Study Groups and Sub-Study Groups of the C.C.I.T.T.

AP I/36 Minutes of the Third Plenary Meeting.

AP I/37 Minutes of the Second Plenary Meeting.

AP I/38 Minutes of the Fourth Plenary Meeting.

AP I/39 Proposals by the Chairmen of Study Groups for the meetings in 1957 and 1958.

AP I/40 Minutes of the Fifth Plenary Meeting.

AP I/41 Minutes of the Sixth Plenary Meeting.

AP I/42 Table showing the correspondence between the index numbers of the study groups in documents AP I/18 and AP I/35.

AP I/43 Resolution — Technical Assistance.

AP I/44 Proposal by the French Administration — examination of a " documentary " question.

AP I/45 Report by the Budget Commission.

AP I/46 List of Administrations and private Recognized Operating Agencies which have expressed the wish to participate in the work of Study Groups and Sub-Groups.

AP I/47 List of Delegates, representatives and observers present at the First Plenary Assembly of the C.C.I.T.T.

AP I/48 Minutes of the Seventh Plenary Meeting.

AP I/49 Minutes of the Eighth and Final Plenary Meeting.

AP I/50 Corrigendum to the Minutes of the Sixth Plenary Meeting.

MINUTES
OF THE Ist PLENARY ASSEMBLY

MEETINGS OF THE HEADS OF DELEGATIONS

FIRST MEETING

Monday, 10 December 1956, at 5 p.m.

Chairman: Mr. GNEME (Italy)

The meeting was opened by Mr. TOWNSHEND, Interim Director of the C.C.I.T., who explained the purpose of the meeting : to make a preliminary examination of the report drawn up in Geneva, March 1956, by the Meeting of Chairmen and Vice-Chairmen of the C.C.I.F. and the C.C.I.T. on study groups and working methods for the new C.C.I.T. (Document AP I/1); further documents to be examined were Documents AP I/2, 9 and 11, submitted respectively by the C.C.I.R., the Chile Telephone Company and the Swiss Administration, containing comments and counter-proposals with respect to Document AP I/1.

Following a proposal by Mr. Townshend, Mr. Gneme (Italy), the senior Head of Delegation, was elected Chairman of the meeting by acclamation.

The CHAIRMAN invited the Heads of Delegations to comment on the documents under examination.

Mr. BAST (Netherlands), who was Chairman of the Meeting of Chairmen and Vice-Chairmen in February-March 1956, said that the report prepared by that meeting had been prepared in the same way as a recommendation; the proposals contained in it had been unanimously adopted as the result of a joint study, with the exception of a special matter referred to in Annex III of the report.

The delegate of the U.S.S.R. was of the opinion that neither of the two documents under examination (AP I/1 and AP I/11) constituted a wholly satisfactory solution, but that they nevertheless contained many constructive proposals. He therefore proposed that a working party should be set up for the purpose of studying both documents and submitting in the near future a single proposal on the structure of the C.C.I.T.T.

The delegate of BELGIUM asked the Heads of Delegations to voice their opinions on the two working procedures proposed, so that the working party in question might, if constituted, be acquainted with their feelings on the matter.

The delegate of FRANCE shared this view : the working party under consideration should receive clear directives from the present meeting. The French delegation felt that the draft established in Geneva in March 1956 (Document No. 1) comprised too many Study Groups, especially in respect of telegraph Study Groups; it considered the draft submitted by the Swiss Administration (Document No. 11) to be preferable, although it ought to be further improved.

The delegate of CZECHOSLOVAKIA recalled that the draft prepared by the Geneva meeting was certainly the result of a compromise between the opinions of the representatives of telegraph services and telephone services, but that in addition various considerations of a practical nature (the number of questions to be studied, the size of delegations in each study group, etc.) had affected the final draft. Furthermore, it would be difficult to change the whole of such a complete proposal in a short period of time. The delegate of Czechoslovakia therefore suggested that, while recognizing the advantages of the Swiss proposal, the Meeting of the Heads of Delegations should take Document AP I/11 (Switzerland) as a basis and examine just how far the organisational plan proposed in Document No. 1 might be amended, bearing in mind at the same time that Document No. 1 contained a proposed distribution of questions among the new Study Groups.

The delegate of the PEOPLE'S REPUBLIC OF BULGARIA thought that the draft submitted by the Swiss Administration was preferable to that of the Geneva meeting, from the point of view both of efficiency and economy. He therefore supported the proposal by the Russian delegate for the setting up of a working party, and suggested that this working party should take the Swiss draft as a basis for its work.

The delegate of the UNITED KINGDOM fully appreciated the arguments put forward by the Swiss Administration in submitting its draft : simplicity, economy, flexibility and efficiency of organisation. But those very same arguments had been taken into account by the Chairmen and Vice-Chairmen at their meeting in Geneva in March, and the result of their work, which reflected an almost unanimous opinion, had been guided by them.

The British delegate therefore favoured the draft contained in Document No. 1. He feared that the draft submitted by the Swiss Administration would turn out to be less simple in practice than it appeared to be on paper. He concluded by asking that the draft submitted by the Chairmen and Vice-Chairmen should be put into effect, and that its value should be judged in the light of actual experience.

The delegate of INDIA approved of the principles which had guided the Chairmen and Vice-Chairmen in the establishment of their report. The Swiss proposal also contained some valuable points. He thought it could be used as a guide with a view to reducing the number of study groups.

The delegate of the UNITED STATES OF AMERICA shared the view of the British delegate. His delegation would not oppose adoption of the Swiss draft, but it considered that the draft contained in Document No. 1 constituted a good compromise and that it would be desirable to test by actual experience the organisational plan outlined therein.

The delegate of SWITZERLAND drew the attention of the meeting to the financial considerations on which the proposal by his country had been founded. An increase in the number of study groups would oblige the Administrations to send officials on

mission fairly often, thus increasing the expenditure of the secretariat. The ordinary budget of the Union was limited and that limit would be exceeded. That was why the Swiss Administration, considering that the plan proposed in Document No. 1 would lead to excessive expenditure, had, after a very detailed study, submitted a constructive draft to combine the views of all the Administrations which were concerning themselves in an ever increasing number with the activities of the C.C.I.F. and the C.C.I.T.

The delegate of BELGIUM disagreed, as the ideal solution did not lie in having few study groups. Or course both drafts under consideration had their advantages and drawbacks. It might be possible to bridge the gap; for example, in the organisational plan in Document 1 Study Groups J, O, and P *, dealing with tariff and operational questions, might be suppressed, providing Study Group F ** with several Sub-Study Groups in the same way as had been proposed for Study Group G *** on transmission.

The meeting rose at 6.50 p.m.

SECOND MEETING

Tuesday, 11 December 1956, at 5 p.m.

Chairman: Mr. GNEME (Italy)

At the opening of the meeting, a document entitled " Proposal by the Belgian Delegation concerning the organisation of the C.C.I.T.T. " was distributed.

The discussion begun at the previous meeting was resumed.

The Delegate of SPAIN said that, in view of the two organisation plans contained in Documents AP I/1 and AP I/11, it would be reasonable to take that of Document I/1 as a basis for discussion, since it had met with general approval when it was prepared. It might be necessary, however, to amend it slightly to take account of the general ideas expressed in the Swiss draft (AP I/11) and the comments of the Chile Telephone Company.

The operation of the amalgamated C.C.I.T. would certainly give rise to increased expense, but that was not due to the existence of a more or less greater number of Study Groups. Caution was required if the continuity of the work of the C.C.I.s was not to be affected and it would really be the Second Plenary Assembly of the C.C.I.T.T. which could best assess the necessity of a more or less close amalgamation.

Notes from Secretariat:

* Study Group J, in the plan of the meeting of Chairmen, corresponds to Sub-Study Group 2/2 of the C.C.I.T.T.
Study Groups O and P have been amalgamated into Sub-Study Group 2/1.

** Study Group F corresponds to Study Group 2 of the C.C.I.T.T.

*** Study Group G corresponds to Study Group 1.

He consequently supported the proposal made by the United Kingdom Delegation at the previous meeting which consisted in (1) adopting Document AP I/1, and (2) instructing the Director of the C.C.I.T.T. to apply the standards appearing in that document so as to effect amalgamation in the most reasonable form.

The Delegate of the ROUMANIAN PEOPLE'S REPUBLIC felt that, for the sake of efficiency, the amalgamation of the two Committees should be more thorough than the organisation plan given in Document AP I/1. He was in favour of setting up a Working Party to find a compromise solution between Documents AP I/1 and AP I/11 on the basis of the present debates.

In connection with the Swiss proposal, he thought it quite reasonable to have given questions of telephone and telegraph operation and tariffs to a single Study Group, but it seemed less sensible for a single Group to deal with protection against disturbance and corrosion as indicated in the plan.

The Delegate of the BIELORUSSIAN S.S.R. considered that the Swiss proposal was the better. It could be taken as a basis and perhaps further improved. The structure of the C.C.I.T.T. should be simplified so as to expedite treatment of questions and drafting of recommendations, as experience had shown that considerable delay arose from the existence of too many Study Groups and the transfer of questions from one Consultative Committee to another. Such delay would be avoided if there were fewer Study Groups and if Administrations could send their replies to a Committee that had been efficiently amalgamated.

The Delegate of the NETHERLANDS thought that the problem under discussion was not really as serious as it seemed. It is not a matter of finding a structure corresponding to the minimum number of Study Groups, but of considering the number of questions under study and the time during which the Groups should meet and which the experts of Administrations should devote to the meetings of the C.C.I.s.

Some slight amendments could perhaps be made to the organization envisaged by the Chairmen and Vice-Chairmen, for instance :

— Study Groups A * and B * could be amalgamated, as proposed by the Swiss Administration.

— Study Groups K ** and L ** could be combined, as suggested by Mr. Mikhailov.

It would be unwise to go further for the time being. Prudence was required and no radical change should be made at the delicate moment of the birth of the C.C.I.T.T.

The Delegate of AUSTRALIA said that, with all due respect for the authority of the Chairmen and Vice-Chairmen who had drafted Document AP I/1, he agreed with the Swiss Administration that it was possible to decrease the number of Study Groups.

Notes from Secretariat:

* Study Groups A and B in the plan of the meeting of Chairmen correspond to Study Groups 5 and 6 of the C.C.I.T.T.

** Study Groups K and L ase those which correspond to Study Groups 8 and 9 of the C.C.I.T.T.

Without proposing any drastic change, he quoted one or two cases in which such a reduction could be effected :

1. Study Groups A * and B * could easily be combined; in the last few years, they had never met separately and their work was always in common.

2. Study Group E ** could easily be a Sub-Group of Study Group C **; the work of Study Group 5 of the C.C.I.F. had apparently always been done by some invisible working party of Study Group 3 of the C.C.I.F.

The delegate of CANADA thought it unlikely that a Working Party could find a more satisfactory solution than that proposed by the meeting of Chairmen and Vice-Chairmen, who had most experience in the matter. He favoured the organization set out in Document AP I/1, which could, of course, be improved by amendments of details such as those proposed by the delegate of the Netherlands.

The delegate of LEBANON recalled the motives which had led the Buenos Aires Plenipotentiary Conference to recommend amalgamation of the two Committees. One was economic and the sponsors of amalgamation had certainly intended it to be as complete as possible. The Swiss plan went even further in that direction than the Chairmen and Vice-Chairmen who seemed somewhat to have lost sight of the economic aspect.

Among the Members of the Union there were a growing number of small countries wishing to participate more actively in the work of the C.C.I.s. They could not succeed if the C.C.I.T. were to have such a complex structure as that in Document AP VIII/1. In conclusion, he asked for the proposed Working Party to base its work on the above considerations in order to reach a compromise between the two solutions submitted.

The delegate of the PEOPLE'S REPUBLIC OF POLAND preferred the Swiss plan which achieved closer amalgamation by reducing the number of Study Groups. However, he felt that too much diversity in the structure of the Study Groups should be avoided and that a general organization plan should not mention working groups, essentially temporary, but only Study Groups and Sub-Groups. It should finally be possible to find a compromise between the two plans in Documents AP VIII/1 and 11.

The Delegate of CHILE mentioned some points in Document AP 1/9 submitted by the Chile Telephone Company, especially those referring to Study Group 4 of the C.C.I.F. and Study Group H, envisaged in Document AP I/1 and to the need for having small temporary working parties. His long personal experience had shown him that the number of delegates taking part in the work of a Study Group rapidly increased

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Notes from Secretariat:

* Study Groups A and B in the plan of the meeting of Chairmen, correspond to Study Groups 5 and 6 of the C.C.I.T.T.

** Study Groups E and C correspond to Study-Groups 3 and 1 of the C.C.I.T.T.

as the years went by, so that what was originally a small group of qualified experts became a real assembly in which discussion was practically impossible. That was why it was necessary to envisage small groups of selected experts.

The Delegate of BELGIUM explained that the draft submitted by his Delegation was a plan which endeavoured to conciliate the different views that had been put forward. For instance, for operating and tariff questions, the draft proposed an organization similar to that of Study Group C (Coordination of transmission studies) in Document AP I/1. For switching and signalling questions on the other hand, it had been thought useless to set up a Study Group for the coordination of two bodies which had almost no real affinities, but the connection shown between Study Group I (telephone switching) and Study Group N (telegraph and telex switching) meant that the two Groups should collaborate to solve questions that seemed to have aspects of common interest.

Mr. TOWNSHEND wished to clarify certain statements on some important points which might give rise to misunderstanding concerning the financial effects of amalgamation.

Although staff expenditure accounted for 83 % of the total ordinary expenses of the I.T.U., it should not be forgotten that the expenses of the C.C.I.T.T. would represent only some 8 % of those expenses. It should also be borne in mind, when assessing the financial effects of amalgamation, that the C.C.I.T. had never had the Director it should normally have had. Moreover, the cost of the work of the C.C.I. did not so much depend on how the duties were apportioned between the Study Groups as on the number and complexity of the questions on the programme of work.

In any event, the Administrations had been warned (he had made a point of this) both at the Plenipotentiary Conference and in the Administrative Council and during the Plenary Assemblies of the two C.C.I's that they must not expect to make any economies on the amalgamation. The issue was one of efficiency, not of economy.

It was fortunate that, as Mr. Kayata had remarked, more and more countries were expressing a desire to take part in the work of the C.C.Is. That fact did not create difficulties of organization for the study of the question; but it did increase the size of the Study Groups quite apart from increase in size which might be caused by amalgamation.

The CHAIRMAN, summing up, said that three documents were before the meeting (Document AP I/1, Document AP I/11, draft submitted by Belgium), together with three proposals, as follows :

1. the proposal of the United Kingdom to adopt Document AP I/1 as it stood, instructing the Director of the C.C.I.T.T. to implement the organization described therein, and possibly to submit to the Administrations for referendum any amendments that experience might show to be required;

2. The Swiss proposal, as in Document AP I/11.

3. The U.S.S.R. proposal that the documents under consideration should be submitted to a working party.

The Chairman pointed out that such a working party would have only two days in which to complete its work.

The Delegate of FRANCE observed that the proposed working party, which he had favoured the previous day, would not have enough time in which to work. He therefore asked the meeting to choose between the United Kingdom proposal and the Belgian draft, which seemed to be a satisfactory compromise between the plans in Docs. AP I/1 and 11.

The Delegate of SWITZERLAND said that his Administration would support the Belgian proposal and would not insist on discussion of its own proposal in Document AP I/11.

Thus, only two proposals remained before the meeting; that of the Chairmen and Vice-Chairmen and that of Belgium. To enable the delegates to study the latter more thoroughly, the CHAIRMAN adjourned the discussion to the following day at 5 p.m.

After a short exchange of views, this was *agreed.*

The meeting rose at 6.15 p.m.

THIRD AND FINAL MEETING

Wednesday, 12 December 1956, at 5 p.m.

Chairman: Mr. GNEME (Italy)

The meeting continued with the examination of the organizational plan of the C.C.I.T.T.

The CHAIRMAN recalled that they had two plans before them : the one proposed by the meeting of Chairmen and Vice-Chairmen, and the one proposed by the Belgian delegation.

The delegate of the BIELORUSSIAN S.S.R., while regretting the withdrawal of the Swiss proposal which he had fully supported, expressed his preference for the Belgian plan.

The delegate of the NETHERLANDS proposed the following amendments to the Belgian plan :

1. Study Group K in the Belgian plan was very large, being charged with the study of 51 questions. It would therefore be desirable to split it into two Study Groups; the first would be Study Group L of the plan submitted by the meeting of Chairmen and Vice-Chairmen, and the second would be a combination of Study Groups K *, M * and M*bis* ** of that same plan.

Notes from Secretariat:

* The merging of K and M in the Chairmens' plan gave rise to Study Group 8 of the C.C.I.T.T.

** M*bis* has become joint Study Group MP for phototelegraphy.

2. The Sub-Study Group mentioned on page 3 of the Belgian plan, entitled " Sub-Study Group for telegraph and telex operation and tariffs " should be sub-divided into two Sub-Study Groups, one to deal with telegraph operation and tariffs and the other with telex operation and tariffs; these two Sub-Study Groups would in fact be Study Groups O and P of the plan submitted by the meeting of Chairmen and Vice-Chairmen *.

The delegate of the UNITED KINGDOM supported the above proposals.

The delegate of FRANCE suggested it might be possible to meet the wishes of the Dutch delegation without amending the plan proposed by Belgium, but by distributing the terms of reference of Study Group L of Document No. 1 between the Sub-Study Group on the Use of International Lines for Telegraphy and the Study Group on Maintenance.

A vote was taken on the *first part of the Dutch proposal.* It was *adopted* by 22 votes against 7, with 4 abstentions.

A vote was then taken on the *second part of the Dutch proposal.* It was rejected by 17 votes against 14, with 5 abstentions.

A vote was finally taken on the *whole of the Belgian proposal,* taking into account the amendment which had just been adopted, and it was *adopted* by 34 votes against 1, with 3 abstentions.

After a brief discussion it was decided that the secretariat should publish a document containing the organizational plan which had been finally agreed upon; it was not considered necessary to introduce this plan by an explanatory note since the minutes of the three Meetings of the Heads of Delegations already contained explanations pertinent to the matter.

The CHAIRMAN then introduced for discussion the " Draft Additional Rules of Procedure of the C.C.I.T." which appear on pages 13 to 16 of Document AP I/1, preceded by a section entitled " Working Procedures for the C.C.I.T.T. " on pages 7 to 11 of the same document.

The delegate of the UNITED KINGDOM proposed that the Draft Additional Rules of Procedure of the C.C.I.T. together with the comments preceding it should be adopted as they stood.

In the absence of comment it was so *decided.*

Replying to a comment by the delegate of BELGIUM on the nature of the meeting of the Heads of Delegations, Mr. TOWNSHEND, Interim Director of the C.C.I.T., explained that its role was different from that usually played by meetings of the same kind which limited themselves to settling certain classic points such as the designation of a chairman, the setting up of committees, the establishment of working time-tables, etc. On the present occasion it constituted a semi-official preliminary meeting which was being held at the request of the head of a delegation in order to discuss questions of organization before the Plenary Assembly met, the latter having a limited amount of time at its disposal.

Mr. VALENSI, Director of the C.C.I.F., stressed the value of the meeting, adding that the C.C.I.F. would transmit two documents to the C.C.I.T.T. after the close of

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Notes from Secretariat:

* The amalgamation of Study Groups O and P was finally approved and gave rise to Sub-Study Group 2/1 of the C.C.I.T.T.

the Plenary Assembly of the C.C.I.F.; one would consist of a list of questions to be studied by the C.C.I.T.T., accompanied by some Resolutions to aid it in this study, and the other would be a table summarizing the questions under study with an indication of the responsible Study Groups. It was therefore essential to know how the C.C.I.T.T. would be organized, as soon as possible.

Before declaring the meeting closed, the CHAIRMAN recalled that the Secretariat would publish the organizational plan of the C.C.I.T.T. which had just been adopted by the semi-official Meeting of the Heads of Delegations. The Draft Additional Rules of Procedure would not be published as they had been adopted without amendment as they stood in Document AP I/1. Finally, the two existing C.C.I.s would each prepare the documents which had just been mentioned by Mr. Valensi, namely, the list of questions to be studied by the C.C.I.T.T. and a table showing the Study Groups of the C.C.I.T.T. entrusted with the study of these questions.

The meeting rose at 5.50 p.m.

MINUTES OF THE PLENARY MEETING

FIRST MEETING

Saturday, 15 December 1956, at 11 a.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

The meeting was opened by Dr. ANDRADA, Secretary-General of the International Telecommunication Union, who welcomed the numerous delegates present; their presence was proof of the interest aroused throughout the world in telegraph and telephone problems. The Secretary-General of the I.T.U. announced that a meeting of the Heads of Delegations held that morning had proposed Mr. van der Toorn, Director-General of the Dutch Telecommunication Administration, as Chairman of the First Plenary Assembly of the International Telegraph and Telephone Consultative Committee.

The Assembly approved this proposal by acclamation and the Secretary-General asked Mr. van der Toorn to take the chair. *(Applause.)*

Mr. VAN DER TOORN (Netherlands) expressed his gratitude to the delegates and said how honoured he felt to have been chosen as Chairman of the First Plenary Assembly of the International Telegraph and Telephone Consultative Committee. He announced that the meeting of the Heads of Delegations had proposed Mr. NESBITT, head of the delegation of the United States of America, and Mr. AFANASIEV, head of the delegation of the Bielorussian S.S.R., as Vice-Chairmen.

These proposals were *approved* unanimously; Mr. Nesbitt (United States of America) and Mr. Afanasiev (Bielorussian S.S.R.) were thus made Vice-Chairmen of the First Plenary Assembly of the C.C.I.T.T.

The CHAIRMAN then recalled that the last Plenary Assemblies of the C.C.I.F. and the C.C.I.T. had been concluded the day before. Those two organs, which had carried out their tasks so admirably, were now to be combined and the Committee resulting from this combination was about to be launched. The new Committee would have to ensure within its framework cooperation between telegraph and telephone engineers and operators from all over the world. There were numerous problems which had to be solved and it was to be expected that their number and difficulty would continue to increase ; the C.C.I.T.T. would have ample opportunity of demonstrating its efficiency in a sphere in which technology was developing at least as rapidly nowadays as it had thirty years beforehand when the consultative committees which were being combined had been originally set up.

The Chairman mentioned some of the technical developments which were to become realities in the near future and which would demand an ever-increasing measure of work, imagination and mutual cooperation by those taking part in C.C.I.T.T. meetings; such developments included electronic switching, the development of a network of trans-oceanic telephone cables, machines for handling data etc. It was quite certain that the need for international cooperation would become pressing in the years to come. It was the duty of those present at that First Plenary Assembly of the C.C.I.T.T. to ensure that the new organization, based on the solid foundations of its two predecessors, would accomplish all that was expected of it, not only for this generation but for future generations of technicians and scientists in the field of telecommunications.

The Chairman concluded his address by expressing the hope that, in a world which was becoming more and more complex, as it embarked on an age which could be termed atomic and electronic, the International Telegraph and Telephone Consultative Committee would prove to be a worthy servant of mankind.

The SECRETARY-GENERAL then delivered the following address :

" Mr. Chairman, Ladies and Gentlemen,

The birth of the new International Telegraph and Telephone Consultative Committee, marked by the opening of this first Plenary Assembly, will be a milestone in the history of the Union.

You are all aware that although the C.C.I.T. and C.C.I.F. were magnificently well adapted to a major phase in the development of international telegraphy and telephony, the differences between the engineering procedures peculiar to these two branches of telecommunication have been becoming ever less clearly defined, and this had led to complications. And for a variety of reasons—historical, geographical and economic—there were appreciable differences in the constitutions and operating methods of these two praise-worthy organizations.

The idea of a merger of the two was first seriously mooted ten years or so ago. The question was on the agenda of the Plenipotentiary Conference which met in Buenos Aires in 1952. After lengthy deliberation, that Conference, in its Protocol II, defined the ways and means of amalgamation. You all know what action was taken on Buenos Aires Protocol II. You know that the Telegraph and Telephone Conference having been postponed since 1954, it was the Administrative Council which, at its 1955 session, recommended Members of the Union to effect this amalgamation as from 1 January 1957.

I shall not here go into the arguments that have been adduced for and against in recent years. By deciding in favour of amalgamation, the majority of Union Members most certainly acted in the higher interests of the Union, and more especially, in the interests of telegraphy and telephony.

But I shall try to analyse what this amalgamation in fact signifies and represents.

First of all—and here I shall refer to the fears entertained by some of the most fervent champions of telegraphic or telephonic independence, who have felt that the merger might well be prejudicial to the proper developments of their particular fields—let me say straight away that it was never the intention of the Buenos Aires Conference, or of the Council, that amalgamation should betoken simply a merger of telegraphy and telephony, or that there should be any absorption of one by the other, and this is in fact made clear by the very terms of the decision taken by the Council. In reality, the C.C.I.T. and C.C.I.F. will cease to exist on 1 January next, and not all their constituent elements will be resurrected in the C.C.I.T.T. in its original form. Amalgamation will affect more the specialized secretariats of the present C.C.I.T. and C.C.I.F., the officials of which (to begin with, at least, and subject to any action that may be taken later as a result of any recommendations this Plenary Assembly may make) will together constitute the specialized secretariat of the new body. On the other hand, this Assembly and the study groups you are going to set up are new entities, which it will be for you to conceive, to organize and to foster in the joint interests of telegraphy and telephony.

Clearly, it is none of my business as Secretary-General to make any suggestions here, but in that capacity, I think it might be desirable for me to outline certain considerations which you might, I think, usefully bear in mind when you come to take your decisions.

Firstly, then, it is doubtless true that the creation of the C.C.I.T.T. has been inspired by a concern for efficiency rather than economy. But you are, I am certain, anxious to see that its organization is as economical as possible and in this connection I would remind you that there is no water-tight partition between the General Secretariat and the C.C.I. Secretariats. All I.T.U. organs are under an obligation to go as far as they can in saving money by pushing cooperation as far it will go, without, of course, carrying matters to such a pitch that efficiency is affected. Hence the senior officials of the Union will gladly help you to consider how cooperation between these organs of our Union can be made most effective.

Secondly, I would mention the interest displayed in the C.C.I.T.T. by I.T.U. Administrations. As you know, forty-nine Administrations and eighteen Recognized Private Operating Agencies have already announced their wish to participate. Hence the new body promises to be practically world-wide in scope. I think we are justified in explaining this state of affairs by the general tendency to ever closer international cooperation. But we may, I feel, legitimately assume that the increased activities of this new body will redound to the advantage of all countries, no matter what sort of telecommunication networks they may have or how far those networks have developed. This brings me, by a natural transition, to what is known as Technical Assistance, a form of international cooperation which has been greatly extended these last few years. The matter is one which appears on your agenda, and I have taken the liberty of attaching a brief report to those submitted by Mr. Townshend and Mr. Valensi on this question. It is not, of course, any business of mine—nor is it my intention—to try to give you any guidance in this matter. But it is, I feel, part of my duty to draw your attention to a subject which is very complicated and may well become increasingly important within the I.T.U.

Mr. Chairman, Ladies and Gentlemen, there is one wish to which I must, I think, give expression, namely, that the International Telegraph and Telephone Consultative Committee should be as successful as its two predecessors, the C.C.I.T. and the C.C.I.F. And when I say successful, by that I mean even more efficient, because the advocates of amalgamation felt that a combination of the two C.C.I.s would produce results over and above those that might have been attained by a mere addition of the continuous activities hitherto carried on almost independently by telegraph specialists, on the one hand, and by telephone experts, on the other.

On the purely human level, I cannot help feeling that nothing but good can come of the amalgamation. By bringing the telegraph and telephone experts together in a common cause, it cannot but lead to better mutual understanding and more fruitful personal contacts. In fact, the atmosphere prevailing here and now encourages me to say that ' amalgamation ' exists already in intention and in spirit. This augurs very well indeed for the future of the C.C.I.T.T.".

The CHAIRMAN thanked the Secretary-General for his comments and advice, which would certainly be kept in mind by all the delegates in the course of the meetings of the present Assembly.

The Chairman then described the suggestions that had been made that morning by the meeting of the Heads of Delegations, and asked the Plenary Assembly to give its views on them.

1. *Procedure for electing the Director of the C.C.I.T.T.*

The Assembly *approved* the following suggestions made by the Meeting of the Heads of Delegations :

The procedure for electing the Director of the C.C.I.T.T. should be the same as that followed at Warsaw in August, 1956, when the new Director of the C.C.I.R. had been elected. That procedure was described in Document AP I/5.

An Election Committee would be set up to examine the validity of the candidatures submitted and to establish the list of delegations entitled to vote in accordance with the provisions of the International Telecommunication Convention.

Mr. STERKY (Sweden) would be Chairman of the Election Committee, which would be composed of the delegates of Belgium, Canada, Japan, Lebanon and Czechoslovakia. It would meet that same day and would prepare its report in the course of the day.

The future Director would be elected on Monday morning, 17 December. If a second ballot were necessary, it would be taken at 3 p.m. on the same day, and if a third were required, it would be taken at 6 p.m. If a fourth ballot proved to be necessary, it would be taken 24 hours after the third one, in accordance with the provisions of Document AP I/5.

2. *Setting up of a Finance Committee.*

The Assembly *approved* the following suggestions by the Meeting of the Heads of Delegations :

A Finance Committee should be set up; it should have the same make-up as that which had sat during the XVIIIth Plenary Assembly of the C.C.I.F. and the VIIIth Plenary Assembly of the former C.C.I.T., namely : Chairman : Mr. Raus (Luxembourg); members : the delegates of Spain, France, India, Italy, the Federal German Republic, the United Kingdom and Switzerland. This Committee would have the job of examining the accounts of the First Plenary Assembly, and of discussing Document AP I/6 concerning the financial needs of the C.C.I.T.T. until its Second Plenary Assembly.

3. *Working time-table.*

It was decided that the meetings should be held at the following time :

— Mornings : 9.30 a.m. to 12.30 p.m.
— Afternoons : 3 p.m. to 6 p.m.

4. *Technical Assistance.*

Mr. MIRZA (Pakistan) drew the attention of the Assembly to Documents AP I/12 and AP I/14, the first submitted by the General Secretariat and the second by the Dele-

gation of Tunisia. They both dealt with participation by the new International Consultative Committee in the Expanded Programme of Technical Assistance to countries whose telecommunications were insufficiently developed. He wondered if the Assembly did not consider it desirable to set up a committee to study the question and the two documents just mentioned.

The CHAIRMAN replied that the subject of technical assistance had been discussed by the heads of delegations and they had felt that the best procedure would be to deal with the matter in the Plenary Meeting itself, it being understood that working parties could be set up if the need arose to examine special points in detail.

The Chairman gave a brief outline of various other questions which would have to be solved by the Plenary Assembly; the chief of these were : organization and working procedures of the Committee, appointment of Chairmen and Vice-Chairmen for the Study Groups, approval of the report by the Finance Committee and decision on a date for the Second Plenary Assembly of the C.C.I.T.T.

The meeting rose at 11.45 a.m.

SECOND MEETING

Monday, 17 December 1956, at 9.30 a.m., 3 p.m., and 6 p.m.
Tuesday, 18 December at 6 p.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

Election of the Director of the C.C.I.T.T.

The CHAIRMAN opened the meeting at 9.30 a.m. He pointed out that the delegates had to take a very important decision and wished them the necessary wisdom in their choice.

Referring to Document AP I/26 (Report by the Election Committee), he thanked the Committee for its expeditious work.

He had been informed by the General Secretariat that no further delegations had arrived since the list in Annex 2 to Doc. AP I/26 had been closed at mid-day on 15 December.

The Delegate of the FEDERAL PEOPLE'S REPUBLIC OF YUGOSLAVIA made a statement on the representation of China and asked for it to be annexed to the minutes.

The Delegate of CHINA raised a point of order. The question of the representation of China could not be discussed at a meeting of an International Consultative Committee.

The CHAIRMAN ruled that the matter was out of order, since the Plenary Assemblies of the C.C.Is were not entitled to discuss problems of membership, under the provisions of the Convention. He realised that the problem existed but it should be taken up at the proper time and place.

The Report by the Election Committee (Document AP I/26) *was unanimously approved.*

The CHAIRMAN reminded the Assembly of the voting procedure.

Three scrutiners were appointed : Mr. Beltramino (Argentine Republic), Mr. Nicotera (Italy) and Mr. Kayata (Lebanon).

The scrutineers took their places.

Mr. LEWIS, Senior Counsellor, then called the roll and the delegates voted in due form.

Result of the first ballot :

Mr. Besseyre	12
Mr. Mirza	9
Mr. Batra	11
Mr. Laursen	1
Mr. Rouvière	10

As no candidate had obtained an absolute majority, the CHAIRMAN adjourned the meeting until 3 p.m., when the second ballot would be taken.

*

The Assembly met at 3 p. m. for the second ballot.

The CHAIRMAN announced that since the publication of the Report by the Election Committee, one further delegation had registered—Israel.

Mr. TOWNSHEND, in reply to the Chairman, stated that Israel had ratified the Buenos Aires Convention on 10 June 1954 and was therefore fully entitled to vote. The number of delegations entitled to vote thus became 44 and the absolute majority 23.

The scrutineers then took their places, Mr. LEWIS called the roll and the delegates voted in due form.

Result of the second ballot :

Mr. Besseyre	15
Mr. Mirza	6
Mr. Batra	11
Mr. Laursen	1
Mr. Rouvière	11

As no candidate had obtained an absolute majority, the CHAIRMAN adjourned the meeting until 6 p.m., when the third ballot would be taken.

*

The meeting resumed at 6 p.m. for the third ballot.

The CHAIRMAN read out a letter from Mr. Hans Laursen to the Secretary-General of the Union, withdrawing his candidacy.

The scrutineers took their places, Mr. LEWIS called the roll and the delegates voted in due form.

Result of the third ballot:

Mr. Besseyre	16
Mr. Mirza	3
Mr. Batra	8
Mr. Rouvière	17

As no candidate had obtained an absolute majority, the CHAIRMAN announced that the meeting would adjourn until 6 p.m. on the following day, Tuesday, 18 December, when a fourth ballot would be taken. He reminded the Assembly that the choice would be between the two leading candidates, Mr. Besseyre and Mr. Rouvière, and that at least 23 votes must be cast for the election to be valid, although neither candidate would be required to obtain the absolute majority.

*

The Assembly met at 6 p.m. on Tuesday, 18 December, for the fourth ballot.

After the CHAIRMAN had reminded the Assembly of the voting procedure, the scrutineers took their place and Mr. LEWIS called the roll. The delegates voted in due form.

Result of the fourth ballot:

Mr. Besseyre	18
Mr. Rouvière	25

There was one blank voting slip.

Mr. Jean ROUVIÈRE was thus elected Director of the C.C.I.T.T.

The CHAIRMAN made the following statement :

" I have the pleasure of declaring you, Jean Rouvière, elected Director of the C.C.I.T.T. This will be confirmed by a letter signed by me on behalf of the Plenary Assembly and countersigned by the Secretary-General of the I.T.U. I request you to let me know on what date you can assume your new duties, since, should there be an interim period, the Plenary Assembly would have to decide how to assure continuity in the Directorate.

Mr. Rouvière, it is my privilege as Chairman to be the first to congratulate you on your election. You have been appointed to a high office. This has certainly been influenced by the fact that your experience as Director-General of Telecommunications in France has given you an opportunity of covering the whole field of telecommunications, of developing wide views and acquiring executive capacities and administrative abilities of a high order. All this will be

of importance for your work in the C.C.I.T.T. Your task in this new amalgamated body will cover a considerably wider scope than that covered by either of the preceding organs; moreover, the process of knitting together the two previous C.C.I.s, the real fusing into unity will not be easy. It will require experience, tact and patience. You will also have to uphold the high standards set by the retiring Director, Mr. Valensi. He himself, in his closing speech, has already given good advice to the new Director. We are looking forward to close cooperation with you as Director of the C.C.I.T.T. with the same feeling of friendship and esteem as we had for the Head of the French Delegation.

I hope you will find much personal satisfaction in the execution of your new duties. In the interest of this important organization and in your own personal interest, I wish you every success as Director of the C.C.I.T.T. Once more, my hearty congratulations ".

Dr. ANDRADA, Secretary-General of the I.T.U., congratulated the new Director and welcomed him to the Union.

" Everyone knew his sterling qualities—a guarantee that the new organ would begin its work under the guidance of a clever and steady hand and successfully face the ever-growing problems to which the Chairman had referred."

He wished to assure the new Director that the General Secretariat would not be sparing in its efforts to increase the cooperation which naturally existed between the General Secretariat and an International Consultative Committee to solve the new problems that would be raised by the birth of the C.C.I.T.T.

Prof. Balthazar VAN DER POL, Director of the C.C.I.R., said that he would like to be among the first to congratulate Mr. Rouvière on his election. He was sure that he was voicing the wishes of the new Director of the C.C.I.R., Dr. Metzler, in associating him with the congratulations. His own personal experience had taught him that the new Director's task would not be easy, but the difficulty was compensated by the understanding and the appreciation of the Administrations.

He was very sorry that he would be unable to work personally with the new Director of the C.C.I.T.T.—which he was tempted to call the C.C.I.T. squared—but the C.C.I.R. has always been interested in telegraph and telephone questions, to such a point that it might be well to begin by clearly delimiting the fields of the two Committees so as to avoid overlapping.

He once again congratulated Mr. Rouvière on the great distinction that had been conferred on him.

Mr. ROUVIÈRE (France), newly elected Director of the C.C.I.T.T., said that he was touched by the confidence the Assembly had shown in him, and he thanked everyone from the bottom of his heart. He was particularly sensitive to the remarks made by the Chairman, Dr. Andrada and Prof. van der Pol and would certainly keep in mind the advice they had given him. It was common knowledge that he had hesitated to apply for the post, not because he underestimated its importance and interest, but because he felt himself inadequately prepared for the new task and, at the same time, felt deep regret at leaving work that had been so enthralling. He had, however, yielded to friendly insistence.

Now the dice were cast and his only aim was to throw himself body and soul into his new task. He wished to pay a tribute to the Directors of the two previous Committees —the C.C.I.T. and the C.C.I.F.—especially to Mr. Valensi who had so amply merited the praise that had been bestowed on him at the close of the XVIIIth Plenary Assembly of the C.C.I.F. He would try always to follow Mr. Valensi's example, although his methods might be difficult. Mr. Valensi, apart from his other qualities, was a great scientist, while he himself was more of a practical man.

He would not presume to define a programme at the present stage, but he would strive to adopt a firm, realistic policy. During the Plenary Assembly, he had sometimes been dismayed at the enormous mass of documents. No doubt he would soon realise that they were all indispensable, but perhaps it would not be too much presumption to suggest that in future they might be reduced to the strict minimum and given fuller and more thorough treatment.

It had been said that Mr. Valensi was like radar or a parabolic mirror. He would prefer to choose a chemical simile and say that the Director of the C.C.I. was like a catalyst provoking the synthesis of all the members' ideas.

He would like to do his very best to succeed in his modest contribution to the progress of telecommunication and closer links between the countries of the world. Mutual understanding was easier in technical fields than in other spheres and progress in telecommunication technique was a great step towards that peace and fraternity which was the profound aspiration of all thinking men.

The meeting rose at 6.50 p.m.

ANNEX

Statement by the Delegation of the Federal People's Republic of Yugoslavia

The Report by the Committee for the election of the Director of the C.C.I.T.T. (Document AP I/26) shows that the right to vote has been granted to the Delegation of Formosa on behalf of China. The Delegation of the Federal People's Republic of Yugoslavia accordingly wishes to express the following opinion :

The Yugoslav Delegation considers that it is of very great importance for qualified telecommunication specialists from as many countries as possible to take an active part in the studies and solution of problems submitted to the C.C.I.T. This—as everyone knows—is one of the primary aims of the I.T.U.

However, we see that a great country such as the Chinese People's Republic is not allowed to follow the work of the I.T.U. and C.C.I.T. Committees and thus cannot make its contribution to international cooperation in the field of telecommunication.

In the opinion of the Yugoslav Delegation, membership of the United Nations should not be a criterion for a country to be entitled to participate in the work of the I.T.U. and its Committees since, under the terms of the International Telecommunication Convention, the Members of the I.T.U. can be the Administrations of countries which are Members, or not, of the United Nations.

Furthermore, the principle of universality—one of the basic principles of the I.T.U.—should, in future, militate against the present practice of excluding representatives of the Chinese People's Republic from participation in the work of the I.T.U.

In the opinion of the Yugoslav Delegation, it is incompatible with the above-mentioned principles for the I.T.U. to be guided by political considerations, since the Union is a specialized agency almost purely technical in nature.

For these reasons, the Delegation of the Federal People's Republic of Yugoslavia considers that the Delegation of Formosa cannot represent China, since the only legitimate representative of the Chinese people is the Government of the Chinese People's Republic at Pekin, which alone is competent to appoint representatives to the I.T.U. and the C.C.I.T.

(Signed) S. MARKON.

THIRD MEETING

Tuesday, 18 December 1956, at 9.30 a.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

Subjects discussed:

1. Approval of the Minutes of the First Plenary Meeting (Doc. AP I/24).
2. Abbreviation to designate the International Telegraph and Telephone Consultative Committee (Doc. AP I/10).
3. Organization of the Study Groups of the C.C.I.T.T. (Docs. AP I/18, 13, 15, 16 and AP I/1).
4. Additional rules of procedure (Doc. AP I/1, Section B).
5. Distribution of questions among the Study Groups (Docs. AP I/19 and 29).

1. *Approval of the Minutes of the First Plenary Meeting* (Doc. AP I/24).

2. *Abbreviation to Designate the International Telegraph and Telephone Consultative Committee* (Doc. AP I/10).

The delegate of AUSTRALIA explained the arguments developed in Document AP I/10 in favour of the initials C.C.I.T.T. to designate the International Telegraph and Telephone Consultative Committee. Recognising, however, that the abbreviation " C.C.I.T. " appeared in Protocol II to the Buenos Aires Convention and henceforth, therefore, in the Convention itself, he made the following proposal :

1. The Plenary Assembly should issue a statement to the effect that it considered the use of the abbreviation " C.C.I.T. " as a not very desirable designation for the new Committee and that it preferred the abbreviation " C.C.I.T.T. ";

2. It should draw the attention of the Administrative Council of the I.T.U. to this opinion, and decide to use the abbreviation " C.C.I.T.T. " provisionally, pending its ratification and the amendment of the relevant articles of the Convention by the next Plenipotentiary Conference.

This proposal was supported by the delegations of BELGIUM, INDIA, CZECHOSLOVAKIA, and the U.S.S.R. and no objection was raised.

Replying to a question from the Chairman, Mr. TOWNSHEND, Interim Director of the C.C.I.T., said that it seemed to him the proposal could be accepted without any great danger.

The proposal by the Australian delegation was thus *adopted unanimously.* (See Resolution No. 2.)

3. *Organization of the Study Groups of the C.C.I.T.T.* (Docs. AP I/18, 13, 15, 16 and AP I/1)

The CHAIRMAN recalled that the organization of the Study Groups of the C.C.I.T.T. had already been studied in detail on two occasions: first of all by the meeting of Chairmen and Vice-Chairmen, February-March 1956, which has adopted the report contained in Document AP I/1, and then by a meeting of the Heads of Delegations which had met three times in the previous week to examine Document AP I/1, some comments by the Chile Telephone Company (Document AP I/9), and a draft organization submitted by the Swiss Administration (Document AP I/11); the meeting of the Heads of Delegations now submitted the draft organization appearing in Document AP I/18 to the Assembly. The Chairman invited the delegates to give their views on the last-mentioned document.

The delegates of BELGIUM and the NETHERLANDS proposed some amendments to the titles of Study Groups L and D *.

The delegates of FRANCE felt that the Assembly would save time by setting up a small working party, which would in fact amount to a drafting committee, to review the titles of the various Study Groups and Sub-Study Groups given in Document AP I/18 and to improve them and make any necessary corrections.

The Assembly *decided* to set up such a working party, with Mr. HAEMERS (Belgium) as Chairman, comprising the delegates of Spain, France, Italy, the Netherlands, the United Kingdom, Switzerland and Russia, and Mr. Besseyre and Mr. Lalou.

The delegate of the BIELORUSSIAN S.S.R. drew attention to the difficulties which might arise from the fact that the Study Groups were designated by letters (there were different alphabets in the different countries, various ways of pronouncing the same letter, etc.). It was therefore *decided* that the aforementioned working party should examine the question of designating the Study Groups by means of numbers.

The delegate of DENMARK raised two points. In Document AP I/18, Study Group " Z " was described as dealing with the " General plan for the development of the international network "; it should be borne in mind that it was not a Study Group of the C.C.I.T.T., but a joint Committee, working in cooperation with the C.C.I.R., which would henceforth come under the C.C.I.T.T. In the plan given in the Annex to Document AP I/1, Committee " Z " appeared outside the dotted line which included all the

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Note from Secretariat:

* Study Group L corresponds to Study Group 9 of the C.C.I.T.T. and Study Group D to Study Group 4 of the C.C.I.T.T.

Study Groups. The second point mentioned by the delegate of Denmark was that it should be clearly understood that adoption by the present Plenary Assembly of the organizational plan given in Document AP I/18 was of a purely provisional nature and that the Administrations would be invited to submit draft amendments, which might appear desirable in the light of experience on the occasion of the Second Plenary Assembly.

The delegate of SWEDEN recalled that in Document AP I/9 it was proposed to abolish the Sub-Study Group of Study Group H (formerly the Sub-Study Group of Study Group 4 of the C.C.I.F.). The Chairman of Study Group 4 of the C.C.I.F., Mr. Swedenborg, replying to the Swedish delegate, expressed his support for such action for the reasons given in Document AP I/9. But it seemed, on examining the plan on page 3 of AP I/18, that the Sub-Study Group in question was being maintained. The delegate of Sweden therefore formally proposed that it should be abolished.

The delegate of the UNITED KINGDOM supported the proposal, mentioning the question of the telephone laboratory which was attached to Study Group H; he recalled that the last Session of the Administrative Council had authorized the Secretary-General to approve plans for the future building of the Union and it was therefore important for Study Group H to meet as soon as possible in order to verify what premises would be required for the telephone laboratory; the Secretary-General and the Director of the C.C.I.T.T. would then be able to take those requirements into account in their assessments.

Mr. LALOU, Counsellor, affirmed that Study Group 4 of the C.C.I.F. had already made a study of what premises would be required for the laboratory in the future building of the Union, but of course this did not mean that the new Study Group H should not make a fresh and more detailed study in the near future. Mr. Lalou went on to point out that the exact title of Study Group H (see Document AP I/1) should be : " Telephone transmission quality (local telephone networks)", and that, in a document transmitted to the present Assembly (Document AP I/28) the XVIIIth Plenary Assembly of the C.C.I.F. had insisted that a distinction should be made between the terms of reference of Study Group H and those of its Sub-Study Group. If, therefore, the Sub-Study Group were to be abolished, the terms of reference of the Study Group itself ought not to be affected.

As no objection was raised it was *decided* to abolish the Sub-Study Group H (Document AP I/18, page 3). The question of a fairly early meeting of Study Group H would be examined when the appropriate item of the agenda was tackled.

The organization of Study Groups appearing in Document AP I/18 was *approved* by the Assembly, subject to the amendment just indicated. The CHAIRMAN expressed the hope that the delegates taking part in the activities of the C.C.I.T.T. would find this organization to be efficient.

4. *Additional Rules of Procedure* (Document AP I/1, Section B).

The CHAIRMAN introduced for discussion the Draft Additional Rules of Procedure, appearing in Section B of Document AP I/1, and drew the attention of the Assembly to Document AP I/32, submitted by the Spanish delegation, which proposed that all documents serving as a basis for discussion in the Plenary Assembly should be prepared in the three working languages of the Union.

Mr. TOWNSHEND, Interim Director of the C.C.I.T., explained the practice of that organ when publishing documents in the various languages since the Arnhem Plenary Assembly (1953) : the working documents of the Study Groups had been published in English and French, while documents to be examined by the Plenary Assembly had also been published in Spanish, apart from a few exceptions where the translation or reproduction of documents in Spanish would have been too difficult. The same procedure had been followed by the VIIIth Plenary Assembly ; of the documents submitted to the Plenary Assembly itself, there had been only a few longish technical reports which had not been translated into Spanish, and the delegation of Spain had agreed to those omissions. Such an arrangement, which did not involve any question of principle and was of a purely practical nature, had proved to be completely satisfactory for several years; Mr. Townshend trusted that the Spanish delegation would accept that this arrangement should be continued for a further period.

The delegate of SPAIN thanked Mr. Townshend for his explanations, but firmly maintained the proposal contained in Document AP I/32. The Additional Rules of Procedure which the Assembly intended to adopt would contain provisions which were likely to remain in force for many years, and it was of prime importance that they should not conflict with the provisions of the Convention and the General Regulations annexed thereto. The Spanish delegate then quoted Chapter 14 of the General Regulations, according to which the languages used in the official documents of the Consultative Committees were those specified in Article 14 of the Convention, namely, English, French and Spanish. By restricting the working languages in fact to English and French, the basic rules of the Union would be contravened, diffusion of information by the C.C.I.T.T. would not be effected in a homogeneous manner, and it would be different from the practice followed by the C.C.I.R. which used all three working languages for documents transmitted to Administrations.

The delegate of Spain further recalled how the Secretary-General had said that efficiency was not to be sacrificed for economy. He concluded by asking the Assembly to accept his proposal, otherwise an unfortunate precedent would be created in the language arrangements of the Union.

The delegate of the ARGENTINE REPUBLIC supported the Spanish proposal, pointing to the large number of Spanish-speaking countries which were Members of the Union. He asked that the proposal should be completed by the addition of the word " working " to read : " ... will be drawn up in the three *working* languages (English, French and Spanish)."

The delegate of CUBA supported the preceding proposals and suggested further that the last sentence of paragraph 3 *c)* on page 15 of Document AP I/1 should be deleted.

After an exchange of views between the delegates of the UNITED KINGDOM and SWEDEN and Mr. TOWNSHEND, the proposal by the Spanish delegation was *adopted*, with the amendment proposed by the Argentine delegation, while the Cuban delegation withdrew its proposal.

The CHAIRMAN invited further comment on the Draft Additional Rules of Procedure of the Committee.

Mr. TOWNSHEND thereupon pointed out that paragraph 1 *d)*, page 13, ought to be amended by the insertion of a reference to the United Nations Organization in lines 1, 2 and 5, which would then read as follows :

(line 1) : " ... of the C.C.I.R., the United Nations, the specialized agencies in relation with the United Nations... ".

(line 5) : " ... an advisory capacity. The United Nations, the specialized agencies...".

These amendments were *approved.*

The delegate of AUSTRALIA touched on the difficulties mentioned under paragraph 1.10 (page 10 of Document AP I/1) deriving from the use of the words " Rapporteur principal " and " vice-Rapporteur principal " in French.

Subject to the foregoing comments and adoption of the Spanish proposal as amended by the Argentine proposal, Section B of Document AP I/1, including the Draft Additional Rules of Procedure of the Committee, was *approved* by the Plenary Assembly. (See Resolution No. 1.)

5. *Distribution of questions among the Study Groups* (Documents AP I/1, 19 and 29).

The delegate of the P.R. OF POLAND felt that it would be difficult to carry out a detailed examination of this matter in the Plenary and he suggested it might be preferable to entrust it to a small working party.

After a brief discussion it was recognized that in most instances the distribution of questions among Study Groups as proposed in Documents AP I/19 and 29 did not raise any difficulties and could be decided upon by the Plenary Assembly, apart from a few delicate cases; the Assembly could decide to set up a working party to deal with such cases if it should think fit.

The Assembly then examined question by question the proposed distribution of questions given in Document AP I/19. It was agreed that the study of certain questions would call for cooperation between several Study Groups, whereas Document AP I/19 indicated only one Study Group for each question.

After a discussion between the delegates of SPAIN, ITALY, the UNITED KINGDOM and FRANCE, the Assembly decided that as a general rule it was desirable to indicate only one Study Group for each question; this would be the Study Group chiefly responsible for study of a particular question. It was obvious that if a Study Group wanted the opinion of another Study Group to help it in its work, the Chairman of the first Study Group would get into touch with the Chairman of the second. On that subject Mr. TOWNSHEND observed that, according to the General Regulations, it was the responsibility of the Director of an International Consultative Committee to coordinate the activities of Study Groups; the Plenary Assembly should not fix in advance details of cooperation between Study Groups except in certain very special cases. The delegates of the UNITED KINGDOM and FRANCE pointed out that in the C.C.I.F. it has been the rule to indicate, in addition to the Study Group more especially concerned with a given question, either the Sub-Study Group or if necessary the other Study Group or Groups concerned with it.

Further to this suggestion, some amendments were made to Document AP I/19 : the distribution of the questions between the Study Groups.

The list of questions at the end of this book takes account of these amendments.

The meeting rose at 12.30 a.m.

FOURTH MEETING

Tuesday, 18 December 1956, at 3.30 p.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

Subjects discussed:

1. Distribution of Questions (Documents AP I/19 and 29);
2. Composition of Study Groups (List of participants);
3. Suggestions and proposals by the C.C.I.T. and C.C.I.F. to the C.C.I.T.T. (Documents AP I/27 and 28);
4. Designation of Chairmen and Vice-Chairmen of Study Groups and Sub-Groups.

1. *Distribution of Questions* (Documents AP I/19 and 29).

Consideration of Document AP I/19 was continued from the previous meeting. The proposed distribution of the questions between the Study Groups was slightly amended. The list of questions in this book takes account of these amendments.

2. *Composition of Study Groups (List of Participants).*

The CHAIRMAN announced that a pink sheet had been distributed to indicate which delegations wished to participate in which Study Groups. It was understood that all members of the C.C.I.T.T. could participate in the work of the Study Groups as of right, but it would be useful for the Group Chairmen to have a list prepared as an indication. Any member deciding at a later date to participate in the work could always do so by sending a letter to that effect to the Director of the C.C.I.T.T.

3. *Suggestions and Proposals by the C.C.I.T. and the C.C.I.F. to the C.C.I.T.T.* (Documents AP I/27 and 28).

Documents AP I/27 and 28, which had already been approved by the Plenary Assemblies of the C.C.I.T. and the C.C.I.F., were examined and *approved.*

During the discussion, the following points arose :

With reference to Section B.2 on page 5, Mr. STERKY (Sweden) suggested that the Directors of the C.C.I.T.T. and the C.C.I.R. should be authorized to act in close cooperation with the International Electrotechnical Commission, through the Secretary-General of the I.T.U.

Agreed.

In connection with Section B.3, it was *agreed* to authorize the Director of the C.C.I.T.T., in collaboration with the competent Study Group, to take the necessary action, in cooperation with the C.C.I.R., as the case might be.

The following amendments were made to Document AP I/28 :

Page 1 — Last line but one, for " Study Group F " read " Study Group E ".

It was *agreed* to convey the wish of the C.C.I.T.T. to the C.C.I.R. and leave to the Director of the C.C.I.T.T. and the Group Chairmen the appointment of representatives.

Page 2, Section 1.2 — The Assembly *agreed* to the setting up of the Joint Group and asked the Director of the C.C.I.T.T. to take the necessary action.

Page 3, Section 1.3 — The Delegate of ITALY asked for his country to be added to the list of members of the working party.

Agreed.

Page 7 — It was *agreed* to delete Section 2. " Transmission (apparatus) ". The rest of Document AP I/28 was *approved* without amendment.

4. *Designation of chairmen and vice-chairmen of Study Groups and Sub-Groups.*

The CHAIRMAN made the following proposals :

Study Group or Sub-Group	*Chairman*	*Vice-Chairman*
A	Mr. Collet (France)	Mr. Mikhailov (U.S.S.R.)
B	Mr. Halström (Denmark)	Mr. Gagliardi (Italy)
C	Mr. Bast (Netherlands)	Mr. Franklin (United Kingdom)
C1	Mr. Sueur (France)	Mr. Jacot (Switzerland)
C2	Mr. Franklin (United Kingdom)	Mr. Claeys (Belgium)
C3	Mr. Bassole (France)	Mr. Fijałkowski (P. R. of Poland)
C4	Mr. Müller (Federal German Republic)	Mr. Lewis (United Kingdom)
D	Mr. Valloton (Switzerland)	Mr. Billen (United Kingdom)
E	Mr. Gori (Italy)	Mr. Boroditch (U.S.S.R.)
F	Mr. Langenberger (Switzerland)	Mr. Garrido (Spain)
F1	Mr. Lambiotte (Belgium)	Mr. Chovet (France)
F2	Mr. Terras (France)	Mr. van Dijk (Netherlands)
F3	Mr. Bornemann (Federal German Republic)	Mr. Heimburger (Sweden)
F4	Mr. Perry (Netherlands)	Mr. Vargues (France)
G	Mr. Gella (Spain)	Mr. Bigi (Italy)
H	Mr. Swedenberg (Sweden)	Mr. Kroutl (Czechoslovakia)
I	Mr. Barron (United Kingdom)	Mr. Vassilieff (U.S.S.R.)
K	Mr. Pellé (France)	Mr. Amarantov (U.S.S.R.)
L	Mr. van Lommel (Netherlands)	Mr. Roquet (France)
N	Mr. Jolley (United Kingdom)	Mr. Faugeras (France)
Z	Mr. Antinori (Italy)	Mr. Mirza (Pakistan)

Joint C.C.I.R./C.C.I.T.T. Study Group on phototelegraphy : Chairman Mr. Pellé.

The CHAIRMAN invited the Assembly to study those suggestions at their leisure. They would be discussed at the following meeting.

The meeting rose at 6 p.m.

FIFTH MEETING

Wednesday, 19 December 1956, at 9.30 a.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

Subjects discussed:

1. Organization of the Study Groups (Document AP I/35).
2. Designation of Chairmen and Vice-Chairmen for the Study and Sub-Study Groups.
3. Calendar of Study Group meetings (Documents AP I/27 and 28).

1. *Organization of the Study Groups* (Document AP I/35).

Mr. HAEMERS (Belgium) introduced the report which had been prepared the day before by the working party of which he was chairman. The working party had had a twofold task : on the one hand it had replaced the letters used to denote the various Study Groups in former plans by numbers; on the other hand it had slightly altered the titles of Study or Sub-Study Groups in certain cases. On the subject of the numbers chosen to denote the Study Groups (and Sub-Study Groups attached to them) the working party had felt it wise to break completely with the numbers that had existed formerly, even though they were familiar to everybody; such a policy was guided by the desire to avoid any possible confusion and also to avoid giving the slightest impression that one of the two former C.C.I.s was trying to absorb the other.

The Delegate of the UNITED KINGDOM proposed on the contrary the adoption of a numbering system in which most of the Study Groups would keep the number they had always had and to which many delegates were accustomed.

The proposal was supported by the delegate of the NETHERLANDS, but the Delegate of FRANCE pointed out the drawbacks involved.

The proposed numbering plan given in Document AP I/35 was then put to the vote and *adopted* by 22 votes to 11, with 2 abstentions.

Mr. BESSEYRE explained the advantage of using Roman numerals to designate the Study Groups; however, after an intervention by the Delegate of CUBA the Assembly DECIDED to keep the Arabic numerals.

It also DECIDED, after having considered various possibilities, to designate by " MP " the " Joint C.C.I.R.-C.C.I.T. Committee for phototelegraphy " attached to Study Group 8 (page 3 of Document AP I/35) and by " PLAN " the " Committee on the general plan for the development of the international network " (page 6 of Document AP I/35).

The Assembly then examined Document AP I/35 page by page, and the following comments were made.

Page 3:

Study Group 12.

The Delegate of SWEDEN considered that the title proposed in Document AP I/35 was not satisfactory and that it should be replaced by : " Telephone transmission quality

on local telephone networks ". The Delegate of the UNITED KINGDOM expressed a similar point of view, and the Delegate of SWEDEN went on to propose the following wording : " Transmission quality of telephone apparatus and local telephone networks ". The Delegate of CUBA spoke in a similar vein and also requested that the word " quality " should be replaced by " performance " in the English version.

The Delegate of CZECHOSLOVAKIA explained that Study Group 4 of the C.C.I.F which was to be succeeded by Study Group 12, had studied transmission quality on the international network, but as the local network played an important part in the transmission quality of a complete link, the Study Group had naturally been obliged to deal with the local part of each communication. Therefore, if they accepted the wording proposed by the Delegate of Sweden they would be unnecessarily restricting the terms of reference of Study Group 12.

Mr. LALOU referred, as he had already done so in the 3rd Plenary Meeting, to the opinion appearing on page 8 of Document AP I/28 in which were mentioned the functions of Study Group 4 of the C.C.I.F. and of its Sub-Study Group. That Study Group was entrusted with " problems concerning the specification of telephone transmission quality *and* with the local systems that connect the subscribers to the trunk exchanges on which they depend ".

The Delegate of MEXICO associated himself with the explanations supplied by the Delegate of Czechoslovakia.

The CHAIRMAN proposed that the wording given in Document AP I/35 should not be amended since the preceding discussion had cleared up the matter sufficiently. It was thus *decided*.

Study Group 5.

The Delegate of NORWAY wondered if it would not be better to replace the word " electromagnetic " by " electrostatic ".

Mr. COLLET (France), Chairman of Study Group 1 of the C.C.I.F. replied that " disturbances of electromagnetic origin " should be taken to mean disturbances caused by the various magnetic or electrostatic disturbances as a whole.

It was finally *decided* to retain the existing wording.

Study Group 6.

The Delegate of the UNITED KINGDOM felt that it was not desirable to mention only poles, but that a more general term such as " overhead plant " ought to be used.

The Delegate of SPAIN likewise thought that the term proposed was of too limited a nature; if it were maintained Study Group 6 would not have the study of phenomena of metallic corrosion within its terms of reference.

The Delegate of SWEDEN expressed a similar opinion; to make the title of Study Group 6 more general in scope it would be desirable to speak simply of " protection against corrosion ".

The Delegate of BELGIUM suggested that, in order to satisfy the preceding speakers, the word " Corrosions " could simply be added to the title of Study Group 6.

Mr. CHAPUIS explained that the working party had mentioned only specifications of poles and not of " overhead plant " in general because it had thought that a more general designation would also have covered the arming of overhead lines, which was a matter for a Sub-Study Group of Study Group 1.

Mr. VALENSI, Director of the C.C.I.F., recalled the scope of Study Group 2 of the C.C.I.F., the predecessor of Study Group 6 : it had studied protection against corrosion, the composition of cable sheaths and questions relative to poles. If Study Group 6 was to carry on the work of the 2nd S.G. it was sufficient for it to preserve its title; in any case, it was difficult and dangerous to try to say too much in too few words.

The Delegate of SPAIN emphasized that the distinction which ought to be made between " dangers " and " disturbances " in the title of Study Group 5 was not clear enough in the existing title of the Study Group.

Mr. COLLET (France), speaking as Chairman of the 1st S.G. of the C.C.I.F., gave a historical sketch of how the work of that Study Group had increased in scope since its constitution, and described the difficulties which might arise if it was attempted to lay down the terms of reference of Study Groups in too rigid a manner. For example, if a new question were to arise between two Plenary Assemblies and if the existing Study Groups had terms of reference that were too rigid, it might be found necessary to set up a new Study Group to study that question. The history of the development of the 1st Study Group of the C.C.I.F. over the last thirty years showed that in many cases the most recent character of each Study Group had been fashioned by a chain of circumstances, certain questions leading on to others in related spheres, Mr. Collet concluded by saying that the various Study Groups should perhaps not even have official designations, for their terms of reference were fixed by the list of questions which they had to study.

The CHAIRMAN concluded from the example just given that it was not desirable to give more precise definitions of the Study Groups than those indicated in Document AP I/35. Consequently, the titles of Study Groups 5 and 6 would not be amended.

Page 4 :

Sub-Study Group I/4.

The English version of the title of Sub-Study Group I/4 would read " Use of international lines for transmission of sound and television programmes " as suggested by the Delegate of Sweden.

In the absence of further comment, Document AP I/35 was *adopted* by the Assembly. The CHAIRMAN recalled that two new questions (II/8 and III/6) had been left in abeyance

pending final adoption of the organizational plan of the Study Groups. It was thereupon decided that those questions should be allotted as follows :

Question II/8 to Study Group 9
Question III/6 to Study Group 8 (in cooperation with Study Group 9).

2. *Designation of Chairmen and Vice-Chairmen for the Study and Sub-Study Groups.*

The CHAIRMAN asked the Assembly if it accepted the proposals he had submitted at the plenary meeting on the previous day.

The Delegate of the ARGENTINE REPUBLIC was sorry to observe that, with one exception, all the Chairmen and Vice-Chairmen of the C.C.I.T.T. were from European countries. He realized that the choice had been made for technical reasons and acknowledged the part played by European countries in the two Committees that were now combined. However, the members of the C.C.I.T.T. came from all continents and, in future, it would be advisable to consider fair geographical representation in addition to personal qualifications.

The CHAIRMAN confirmed that the choice proposed was based on practical considerations. He also felt that, in future, it would be desirable to give posts of responsibility in the C.C.I.T.T. to a greater number of experts from non-European countries. He was relying on those experts to take a very active part in the work of the Committee. That would be their best opportunity to make themselves known to their colleagues who had been working for a long time in the C.C.I.T. and the C.C.I.F.

He pointed out that many of the Chairmen and Vice-Chairmen of the former Study Groups were still in the Chair of a Study Group or Sub-Group of the new Committee. He thanked them for having accepted that responsibility and wished them every success in the continuation of their work. One of the results of amalgamation was that some of the Chairmen or Vice-Chairmen were now without a seat. They were :

For the C.C.I.F. : Mr. West (United Kingdom), Mr. Marzin (France), Mr. Visser (Netherlands), Mr. Clara Corellano (Spain) and Mr. Albanese (Italy);

For the C.C.I.T. : Mr. Albanese (Italy), Mr. Wyss (Switzerland), Mr. Gneme (Italy) and Mr. Weninger (Austria).

On behalf of the Assembly, the Chairman heartily thanked them for the excellent services they had rendered in the two former Committees. In particular, he wished to thank the Doyen, Mr. Gneme. He expressed his admiration for Mr. Gneme's continued dynamism, his great competence and the qualities which had endeared him to all who knew him. *(Applause.)*

Mr. GNEME (Italy) thanked the Chairman. He expressed his best wishes for the improvement and development of telecommunication services. *(Applause.)*

The Delegate of SPAIN made the following statement :

" On behalf of the Administration of Spain, I should like to express my entire confidence in the success of the future work of the C.C.I.T.T. as constituted since the election of its Director yesterday and the adoption of its organizational plan at this meeting.

The Spanish Administration expresses its gratitude to the C.C.I.T. and the C.C.I.F. which have just been amalgamated—and its higher authorities have asked me to say this on their behalf—for thirty years of work on the standardization of technical principles, the unification from many standpoints of telegraph and telephone operational methods, especially since the creation of telex, and the bringing into line of services which formerly seemed incompatible.

I must also convey to you the greetings of Mr. José M. Clara Corellano, Executive Director of the Compañía Telefónica Nacional de España, to whom the Chairman has just referred and who is well known for his ability and for his contribution to the work of the C.C.I.s over more than 25 years; he wishes the new Committee every success in its future activities.

Finally, I should like to thank the Chairman and the Assembly for the two posts of Chairman and Vice-Chairman that have been allotted to Spain. My country will in return give proof of its desire to cooperate in the widest sense of the word ".

The CHAIRMAN thanked the Delegate of Spain and asked him to convey his best wishes to Mr. Clara.

The Delegate of DENMARK, making a general comment, wished to remind the Assembly that the organization of the new Committee should be flexible in sufficient degree to enable the next Plenary Assembly to introduce any improvements that might be dictated by experience. In addition, he insisted on the importance of the point raised by the Delegate of the Argentine Republic. In view of the fact that the General Regulations, Chapter 15, laid down procedure for the replacement of a Chairman in the interval between two Plenary Assemblies, it might be possible to envisage provisional nominations to meet such contingencies; these provisional nominations would have to be ratified by the next Plenary Assembly and they should guarantee a fairer geographical distribution.

The CHAIRMAN said that the Assembly would take note of the comments that had just been made; he himself recognized and stressed their importance. In the absence of further discussion the proposals for Chairmen and Vice-Chairmen (see the Minutes of the 4th Plenary Meeting, Document AP I/38, section 4) were *approved* by the Assembly.

3. *Calendar of Study Group meetings* (Documents AP I/27 and 28).

Recognizing the difficulty of drawing up such a calendar in a plenary meeting, the Assembly *decided*, on a proposal by the Chairman, that the Chairmen and Vice-Chairmen should meet during the day to prepare a draft which would be examined by the Plenary Assembly on the following day.

Several delegates announced that their countries would be happy to welcome meetings of various Study Groups or working parties of the C.C.I.T.T. :

The Delegate of BELGIUM wished to extend an invitation to the working party of Study Group 4 to meet in Brussels, in May 1957, and to Sub-Study Group 2/4 and Study Group 11 to meet in Brussels in May-June 1957;

the Delegate of the P.R. OF POLAND wished to extend an invitation to the working parties of Study Groups 8, 9 and 10, to meet in Warsaw at the end of September 1957;

the Delegate of FRANCE wished to extend an invitation to the working party entrusted with the study of Questions 34, 37 and 38, to meet in Paris in June 1957.

The meeting rose at 12.30 p.m.

SIXTH MEETING

Wednesday, 19 December 1956, at 3 p.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

Subject discussed:

Technical Assistance (Documents AP I/3, 4, 7, 8, 12, 14, 33, 34).

Mr. TOWNSHEND, Interim Director of the C.C.I.T., considered that the subject under discussion, namely, Technical Assistance in the widest sense of the term in the field of telecommunications, constituted one of the most important matters before the Plenary Assembly. He recalled Resolutions Nos. 345 and 346 which had been adopted in May, 1956, by the Administrative Council;

— the first dealt with the cooperation that ought to exist between the I.T.U. and the Economic Commission for Asia and the Far East (E.C.A.F.E.), and
— the second related to Technical Assistance itself.

He then introduced Documents AP I/3, I/4, I/7 and I/12 which had been drawn up by the Secretary-General of the I.T.U., the Director of the C.C.I.F. and himself.

With regard to Document AP I/4, he noted that seven countries (Afghanistan, Burma, Cambodia, Korea, Indonesia, the Philippines and Thailand), which belonged to E.C.A.F.E. and were Members of the Union, had not yet declared their intention of taking part in the activities of the C.C.I.T.T.; he trusted that those countries would also join the C.C.I.T.T. in due course.

The four documents referred to above were simply factual accounts describing procedures which were in force at the time. Four further documents had been submitted to the Assembly (Doc. AP I/8, 14, 33 and 34). Document AP I/8 contained suggestions by Mr. Townshend and the other three contained proposals by Tunisia and Ethiopia.

Mr. Townshend was taking the liberty of making some suggestions, the sole purpose of which was to serve as a basis for discussion, although no proposals had yet been made by Members of the Union.

Mr. Townshend gave some general information on a very important point, namely, the financial implications of proposals. He classified proposals in three categories according to their financial implications; in order to fix the limits of those categories he referred to the annual budget of the I.T.U. (which was of the order of six or seven million Swiss francs a year, for the ordinary and extraordinary conference budgets).

The first category of proposals involved expenditure of a few thousand Swiss francs. Such proposals could be dealt with by the Director of the C.C.I.T.T.

The second category involved outlays of roughly 10,000 to 60,000 Swiss francs which represented less than 1 % of the I.T.U. budget. Such proposals could be settled by the Administrative Council.

The third category included proposals involving greater expenditure (more than 100,000 Swiss francs). Such proposals could be considered only after the Plenipotentiary Conference (provisionally fixed for 1959) had raised the ceiling of the I.T.U. budget.

Mr. Townshend noted with pleasure that some of the proposals submitted coincided with the suggestions he had made in Document AP 1/8. He thought that the proposal by Ethiopia to the effect that the I.T.U. should make arrangements for fellowship holders when the countries concerned were prepared to pay for the fellowships should not raise financial difficulties. The proposal to set up ad hoc Study Groups to advise on projects might, on the other hand, involve expenditure and the despatch of experts to distant countries and that could not be covered by the existing budget of the I.T.U.

Mr. Townshend concluded by saying that their task was to make a contribution to what was one of the most important problems of the world. It was necessary to do something to satisfy the demands of so many countries whose standard of living was too low. It was essential to take action to improve that position by making use of the available resources of science which were fortunately increasing every year.

The Delegate of the UNITED STATES said that he had listened to the excellent account given by Mr. Townshend with the greatest interest. He thanked Mr. Townshend for having summed up the position so clearly at the beginning of the meeting.

The delegation of the United States supported the proposal of having a temporary C.C.I.R.-C.C.I.T.T. Joint Committee to study methods of applying Technical Assistance. The Committee ought to meet as soon as possible, and the date of the meeting ought to coincide with the date fixed for the talks between representatives of E.C.A.F.E. and representatives of the I.T.U. mentioned in Administrative Council Resolution 345 (Spring, 1957).

It was desirable to insist on the need for good coordination of Technical Assistance work in both the national and the international spheres. The Government of the United States would strive towards that aim. It would be desirable for the other delegations taking part in the Plenary Assembly to draw the attention of their governments to the advantages of making full use of the very efficient services that the I.T.U. could provide in that respect.

The Delegate of ETHIOPIA introduced the two proposed recommendations which he has submitted to the Plenary Assembly.

DOCUMENT AP I/33

Arrangements for the placing of fellowship-holders by the I.T.U. would be similar to those followed for the United Nations Technical Assistance Programme. Very little expenditure for the I.T.U. would be involved and such action would be most efficient.

The proposal that the C.C.I.T.T. should prepare technical and administrative documents in a fairly simplified form approached the point of view expressed by the Tunisian delegation in Document AP I/14.

The proposal did not entail the setting up of special study groups to draw up plans for networks or working projects; it simply suggested that an *ad hoc* group might be asked to give an expert opinion on plans or projects that had already been established. That should not involve excessive expenditure.

The Delegate of JAPAN felt it very desirable that all the countries of Asia and the Far East belonging to E.C.A.F.E. and which were Members of the I.T.U. should take part in the activities of the C.C.I.T.T.

He analyzed the reasons why countries whose telecommunications were insufficiently developed might hesitate to join in C.C.I. activities, which to them might appear too lofty; such countries were often up against problems which were more down to earth. The greatest obstacle to the development of telecommunications consisted in the difficulties encountered by responsible technicians in approaching their governments for the money necessary to set up telecommunication networks. The I.T.U. should therefore back up the technical services when they approached their governments. E.C.A.F.E. and other organisations of the United Nations in a position to make similar recommendations could also play a very useful role.

The Delegate of SPAIN considered, like the previous speakers, that Technical Assistance was of capital importance. It was not the moment to go into the substance of the matter; details should be studied so that the mission of the C.C.I.s as regards technical assistance could provide material for improving the form of such assistance.

He would first draw attention to the fact that since the decision of the Plenary Assembly regarding the preparation in English, French and Spanish of the documents used as a basis for discussion in the C.C.I.T.T. and which were to be sent to all administrations, amendments should be made to paragraph A.3 on page 3 of Document AP I/8 and that the languages for the working documents to be distributed could not be limited to French and English because, in accordance with the additional rules of procedure, the chosen working languages should be used. In those conditions, it was worth pointing out that the use of Spanish in the working documents of the C.C.I.T.T. would enable more wide-spread dissemination of its recommendations.

Since many of the delegates present had attended the VIIIth Plenary Assembly of the C.C.I.R. in Warsaw, he drew attention to the position taken up there by the Spanish Delegation as regards the plan to create a Joint C.C.I.T./C.C.I.R. Group. As soon as this was agreed, there was a movement to set up the Group at the Warsaw Plenary Assembly itself. The Spanish Delegation considered that, since the Group was a joint C.C.I.T./C.C.I.R. matter, it could not be set up without the prior consent of the other Committee. The Spanish Delegation maintained the stand it took in Warsaw, namely, that the Group could be reduced to the Directors of the C.C.I.s, assisted by some of the competent officials of the I.T.U. and there would be no necessity for other members of the Union to take part. From the economic standpoint, often mentioned in the Assembly, it would be of considerable advantage to set up the Group in such a form.

Mr. VALENSI, Director of the C.C.I.F., wished to describe some of the results achieved with the practice followed at the I.T.U. in Technical Assistance. Four types of machinery existed at the I.T.U. and they worked very well; they were :

— machinery to deal with documentation,
— machinery for selecting experts,
— machinery for allocating fellowship-holders, and
— machinery for coordinating activities through the Committee for the General Interconnection Plan.

Referring to documentation supplied by the I.T.U., he explained that it consisted chiefly in C.C.I. Recommendations. But it could also include the dissemination of specially prepared documents on given subjects which were not actually covered by any Recommendation. That was the case in the C.C.I.F. for example, for the setting up of overhead lines designed for modern carrier systems with few channels, and for methods of impregnating wooden poles. Such documentation could be published at a fairly low cost and could be extremely efficient if it was worded clearly and concisely.

Mr. Valensi recalled certain simple and commonsense rules to make the machinery for sending experts and fellowship-holders fully efficient. He did not think that a committee could make a constructive contribution on the subject of network projects or plans, if the latter had not been studied on the spot by competent technicians in the first place.

The delegate of the UNITED KINGDOM shared the viewpoint already expressed that problems of Technical Assistance were among the most important matters before the Plenary Assembly. He agreed with Mr. Valensi that it was preferable to enlist the aid of specially recruited competent experts working on the spot rather than to entrust the study of projects to *ad hoc* committees. The selection of experts by the I.T.U. had given excellent results. In the proposal submitted by Ethiopia (Document AP I/34) the value of " advice by an expert of repute recruited through the good offices of the C.C.I.T.T. " should therefore be particularly stressed. With that reservation he expressed his full agreement with the two draft recommendations submitted by Ethiopia. He also agreed with the Tunisian proposal, but he believed that the I.T.U., under its existing constitution, was not qualified to intervene in favour of a given country with organizations such as the International Bank.

The delegate of FRANCE approved of that viewpoint.

He found the suggestion that the C.C.I.T.T. should publish instructional manuals in a condensed form very interesting but he wondered who would write those manuals. It would normally be the job of the General Secretariat of the C.C.I.T.T. Some expenditure would be involved, but it should be fairly small.

The delegate of INDIA expressed his agreement with the proposals submitted by Ethiopia and Tunisia, subject to the reservation already mentioned by the delegate of the United Kingdom with regard to the role that might be played by the I.T.U. with the International Bank. He drew attention to the following points in the E.C.A.F.E. Resolution mentioned at the top of page 3 of Document AP 1/4 :

(a) the setting up of a regional telecommunication organization.

As Mr. Valensi had pointed out the only efficient course was to carry out studies on the spot:

(b) the setting up of national or regional training centres. The Indian Administration had organized training centres for its services which had been used to train technicians from neighbouring countries, under the Colombo Plan. India was prepared to organize a regional centre if the Administrative Council should so desire.

The delegate of TUNISIA thought that the last paragraph of his proposal in Document AP I/14 had perhaps been misunderstood. What had been meant was that it was desirable if the I.T.U. could, where necessary, indicate to the International Bank that action by the latter would be useful for the implementation of a given project under the General Interconnection Plan.

Mr. HAYES, Vice-Director of the C.C.I.R., considered that two factors determined the efficiency of Technical Assistance; they were the time necessary to take action and financial resources. In the existing Expanded Programme of Technical Assistance it was up to the government of each country to decide whether telecommunications should receive priority.

The delegate of the U.S.S.R. was in full agreement with all the proposals that had been submitted; he also agreed on the prime importance of Technical Assistance it should have in C.C.I.T.T. work. But it was necessary that the requirements of the various countries should be better known. The Administration of the U.S.S.R. was ready to extend as much aid as possible to countries whose telecommunication networks were insufficiently developed; it was also prepared to place its technical experience at the disposal of those countries, more especially by sending experts to study projects.

Mr. GROSS, Assistant Secretary-General, who had had the privilege of representing the I.T.U. at a good many of the meetings of the Technical Assistance Board held since 1950, briefly reviewed the past history of technical assistance in the I.T.U. Because the I.T.U. was not among the original Specialized Agencies who, with the United Nations, set up the first Technical Assistance Board, its programme at the beginning was somewhat handicapped. Since then it had become one of the regular members of the Board. Under the terms of Resolution No. 542 (XVIII) of the Economic and Social Council, the old system of percentage allocations to organizations was replaced by a system which depended essentially on priorities by countries, and the programme of the I.T.U. began to expand. Since then it had continued to develop, and could be expected to continue to develop still further within the total thirty million dollar expanded programme available for technical assistance, if, in each country desiring technical assistance, the telecommunication authorities could arrange to have their countries give a high priority to telecommunication projects.

The I.T.U. did not have a regularly operating programme as did organizations such as the World Health Organization, UNESCO, and the Food and Agricultural Organization, and consequently, since the I.T.U. budget had been fixed by the last Plenipotentiary Conference, the only real funds available for technical assistance projects in telecommu-

nications must come from the overall budget of the expanded programme administered by the Technical Assistance Board. The situation on that Board was obviously competitive and if the I.T.U. representative was to be successful in defending the interests of telecommunications, the backing of the Member Administrations was necessary.

Mr. Gross referred to the report by the Secretary-General of the Union, summarizing the I.T.U. position (Document AP I/12), as well as to the proposals contained in the other documents before the Plenary Assembly, and suggested that the discussion seemed to indicate general agreement on most of the proposals made. Consequently, he suggested the setting up of a small working party to present a consolidated Resolution, embodying these proposals, to the Plenary Assembly.

The delegate of PAKISTAN stressed that the basic difficulties in the implementation of telecommunication projects were financial. E.C.A.F.E. could therefore play an efficient role by recommending the governments of Members States to give priority to telecommunications. Such priority was justified, for efficient telecommunications were essential for the implementation of other development programmes in those countries. It was nevertheless desirable to examine the best ways of implementing Technical Assistance; the contribution of the C.C.I.s should not merely consist in turning out a mass of documents.

After an intervention by the delegate of the F.P.R. OF YUGOSLAVIA in support of the proposals by Tunisia and Ethiopia, the Chairman noted the general agreement of the Assembly on the substance of the various proposals submitted to it. He entrusted a Working Party composed of the delegates of the UNITED KINGDOM, the UNITED STATES, ETHIOPIA, INDIA, TUNISIA and the U.S.S.R. with the task of submitting a draft resolution on Technical Assistance to the Assembly.

The meeting rose at 5 p.m.

SEVENTH MEETING

Thursday, 20 December 1956, at 10 a.m.

Chairman: Mr. J. D. H. VAN DER TOORN (Netherlands)

Subjects discussed:

1. Approval of the Minutes of the 2nd, 3rd and 4th Plenary Meetings (Documents AP I/36, 37 and 38);
2. Calendar of meetings of Study Groups, Sub-Groups and working parties in 1957 and 1958;
3. Decisions concerning organization;
4. Technical Assistance — Resolution drafted by the working party (Document AP I/43).

1. *Approval of the Minutes of the Second, Third and Fourth Plenary Meetings* (documents AP I/37, 36 and 38).

Concerning the statement of the Federal People's Republic of Yugoslavia annexed to the Minutes of the 2nd Plenary Meeting (statement on the representation of China

at the 1st Plenary Assembly of the C.C.I.T.T.), the CHAIRMAN reminded the Assembly that it had been the intention to annex all the statements on the same subject to the Minutes of the first meeting. As this could not be done for practical reasons, they would be annexed to the present Minutes (See Annex 2).

2. *Calendar of meetings of Study Groups, Sub-Groups and Working Parties in 1957 and 1958* (Document AP I/39)

The final calendar, as *approved*, is annexed to these Minutes (Annex 1),

The following points emerged from the discussion :

In connection with the meeting of Study Group 12 in March 1957, it was *agreed* to ask the Chairman of the Study Group, in collaboration with the Director of the C.C.I.T.T., to find the best way of carrying out the work. Perhaps much of the preliminary work could be done by correspondence and it might not be necessary to hold the meeting. The Study Group Chairman and his collaborators could make a draft plan and send it as soon as possible to other members for their comments, after receipt of which the preliminary draft plan could be handed over to Prof. Furrer. As the report of the working party should be sent for information to the Administrative Council meeting in May, it was *agreed* that it should be prepared and sent to the Secretary-General for 1 April 1957.

Mr. ROUVIÈRE, Director-elect of the C.C.I.T.T., pointed out the difficulties that would arise for the Secretariat on account of the accumulation of meetings in May-June 1958.

It was *agreed* that the Director of the C.C.I.T.T. would be given latitude to arrange the dates of the metings concerned so as to avoid secretarial difficulties.

3. *Decisions concerning organization.*

Since certain activities might have been overlooked in the planning for the following two years, the Plenary Assembly *issued a general directive* to the effect that, as the successor of the C.C.I.T. and the C.C.I.F., the C.C.I.T.T. should take all necessary action in all cases in which the previous organs were actively involved, especially with other international organizations.

The CHAIRMAN pointed out that Mr. Rouvière would assume his duties on 1 March. It would be unnecessary to take special steps to cover the interim period, which was short.

It was therefore *agreed* that the General Secretariat would be requested to provide the necessary direction during that period, with the proviso that no decisions of principle were taken. Any measures concerning fusion would be left in abeyance and the General Secretariat would merely handle the routine business.

4. *Technical Assistance : Resolution drafted by the working party* (Document AP I/43).

Document AP I/43 was *approved* with some minor amendments. (See Resolution 3.)

The CHAIRMAN drew attention to paragraph 1 on page 2 and the C.C.I.R. Resolution on Technical Assistance. Should the Assembly select its two representatives forthwith ? Perhaps Mr. Hayes would explain what the C.C.I.R. had done.

Mr. HAYES, Vice-Director of the C.C.I.R., explained that the Plenary Assembly of the C.C.I.R. in Warsaw had not elected representatives since it had not known what the C.C.I.T.T. was going to do in the matter. The choice had been left to the Director in collaboration with the Administrations. If the C.C.I.T.T. Plenary Assembly were to decide forthwith, the C.C.I.R. could act immediately afterwards.

The CHAIRMAN asked for suggestions.

The two representatives of the C.C.I.T.T. on the Joint C.C.I.T.T.—C.C.I.R. Study Group for Technical Assistance chosen were TUNISIA and the PEOPLE'S REPUBLIC OF POLAND, both of which delegations expressed their consent.

The CHAIRMAN, before closing the meeting, explained that he had to leave in the afternoon. Before departing, he wished to say that it had been a great pleasure for him to direct the debates and he thanked the delegates for their indulgence. He wished them all a very Happy Christmas and the best of luck for 1957. It was a suitable time of year to express once more his faith in the message of peace they were giving the world and his fervent hope that fraternity and good-will between all peoples of the earth would thereby be promoted. *(Applause.)*

Mr. WOLVERSON (United Kingdom) was sure that he was speaking for the Assembly as a whole in saying that it had also been a great pleasure to work under the Chairmanship of Mr. van der Toorn. He had brought to the discharge of a difficult task his great wisdom, a keen sense of perception, a desire to help and a welcome touch of humour. He conveyed his best wishes for Mr. van der Toorn's future success and happiness. *(Applause).*

The meeting rose at 12.20 p.m.

ANNEX 1

List of meetings of Study Groups, Sub-Groups and working parties in 1957 and 1958, as approved by the Plenary Assembly

1957

February 1957	Joint C.C.I.T.T.-C.C.I.R. working party on circuit noise : preparatory meeting prior to asking the Administrations for information : working party of Study Group 1, ex-3rd S.G. of the C.C.I.F.
February 1957 (Frankfurt-am-Main)	Working party of Sub-Group 2/3 (it was understood that some phototelegraph technicians of Study Group 8 would have to be included in this working party) : working party of Sub-Groups 2/1 and 2/2 to draft operational regulations for phototelegraphy (Mr. Bitter).

March 1957 (The Hague)	Working party of Sub-Group 2/1.
March 1957	Study Group 12 or working party, to investigate the future need for a laboratory for determination of telephone transmission performance and to draw up a long-term plan for the premises, equipment and staff of such a laboratory.
March 1957 (Subject to the agreement of the C.C.I.R.)	Joint C.C.I.T.T.-C.C.I.R. Group on vocabulary : working party of Study Group 7, ex-11th S.G. of the C.C.I.F. and ex-Study Group VI of the C.C.I.T.
March 1957	Joint C.C.I.T.T.-C.C.I.R. Committee on Technical Assistance.
April 1957	Working party (maximum of 3 persons) for wooden poles : working party of Study Group 6, ex-2nd S.G. of the C.C.I.F.
April 1957 (Paris)	Working party for the revision of old recommendations on telephone operation and tariffs : working party of Sub-Group 2/2, ex-6th and 7th S.G.s of the C.C.I.F.
May 1957 (Brussels)	Working party on transmission stability in the European network (Mr. Billen) : working party of Study Group 4, ex-9th S.G. of the C.C.I.F.
June 1957	Meeting of Sub-Group 2/4 for semi-automatic and automatic telephone operation : Sub-Group 2/4, ex-Sub-Committee on Rapid Operating Methods of the C.C.I.F. Possible setting up of one or two working parties which would function between the first two meetings of Sub-Group 2/4.
June 1957	First meeting of Sub-Group 2/1.
Date uncertain (for information)	(Meeting of the Joint C.C.I.T.T.-C.C.I.R. Group for television — date and place to be decided by the C.C.I.R.).
September 1957 (The Hague)	Meeting of the working party of Mr. Claeys for the study of multi-circuit systems (first meeting with members of Study Group 1 : working party of Study Group 1, ex-3rd S.G. of the C.C.I.F.).
Late September 1957	Meeting of Sub-Group 5/1 for the revision of the Directives : Sub-Group 5/1, ex-Committee for the revision of Directives of the 1st Study Group of the C.C.I.F.
Late September 1957	Two working parties of Study Group 8, two working parties of Study Group 9, one working party of Study Group 10.
October 1957	Meeting of Study Group 4, Study Group on Maintenance (Study Group 4, ex-9th Study Group of the C.C.I.F.).
November 1957 (The Hague)	Meeting of Sub-Group 2/4 (ex-Sub-Group on Rapid Operating Methods of the C.C.I.F.) (second meeting after the First Plenary Assembly) and Study Group 11.
November 1957	Second meeting of Sub-Group 2/1.
Immediately afterwards	Meeting of Sub-Group 2/2 (ex-6th Study Group of the C.C.I.F.) (as Sub-Group for questions requiring cooperation with 2/4, then as Committee for the Revision of the Telephone Regulations).

1958

January 1958	Sub-Group for the Revision of the Recommendations : Sub-Group 6/1, ex-Committee for the Revision of the Recommendations of the 2nd Study Group of the C.C.I.F.
March 1958 (Munich)	Working party on multi-circuit systems (Mr. Claeys) : second meeting with representatives of Study Group 3 (ex-5th Study Group of the C.C.I.F.) and the C.C.I.R. : working party of Study Group 1, ex-3rd Study Group of the C.C.I.F.

April 1958	Second meeting of the Joint C.C.I.T.T.-C.C.I.R. working party on circuit noise : working party of Study Group 1, ex-3rd Study Group of the C.C.I.F.
**May 1958* (Warsaw)	A working party of Study Group 8 for the new alphabet.
**May-June 1958* (not before) (Brussels)	Sub-Group 2/4 for semi-automatic and automatic telephone operation (ex-Sub-Committee on Rapid Operating Methods of the C.C.I.F.). Study Group 11 on telephone switching and signalling (ex-8th Study Group of the C.C.I.F.).
**May-June 1958*	Study Groups on operation and tariffs. Sub-Groups 2/1, 2/2, 2/3, then Study Group 2 (ex-6th and 7th Study Groups of the C.C.I.F.).
**May-June 1958*	Sub-Groups 1/1, 1/2, 1/3, 1/4, then Study Group 1 (ex-3rd S.G. of the C.C.I.F.), Study Group 3 (ex-5th S.G. of the C.C.I.F.) and Study Group 12 (ex-4th S.G. of the C.C.I.F.).
July 1958	Meeting of Study Group 7 on symbols.
September 1958	Second meeting of Sub-Group 5/1 (ex-Committee for the Revision of the Directives of the C.C.I.F.), Study Group 5 and Study Group 6.
Before the T.T. Administrative Conference	Committee for the Plan.
(For information, second half of 1958)	Administrative Telegraph and Telephone Conference.
October 1958 (date dependent on that of the T.T. Administrative Conference)	Study Group 8, Study Group 9, Study Group 10.
October 1958 (Munich)	Mr. Billen's working party, then Study Group 4.

ANNEX 2

Statements concerning the representation of China at the first Plenary Assembly of the C.C.I.T.T. made by the delegations of :

The Union of Soviet Socialist Republics,
The Ukrainian Soviet Socialist Republic,
The Bielorussian Soviet Socialist Republic,
Czechoslovakia,
The People's Republic of Poland,
The People's Republic of Bulgaria,
The Roumanian People's Republic,
China,
The United States of America.

A statement on the same subject by the Delegation of the Federal People's Republic of Yugoslavia is annexed to the Minutes of the second meeting (Document AP I/37).

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* Dates to be reviewed by the Director of the C.C.I.T.T. in collaboration with the Chairmen, or Administrations, as the case may be.

STATEMENT BY THE DELEGATIONS OF THE U.S.S.R., THE UKRANIAN S.S.R., AND THE BIELORUSSIAN S.S.R.

The delegations of the U.S.S.R., the Ukrainian S.S.R., and the Bielorussian S.S.R. wish to express their satisfaction at the unification of the International Telegraph and Telephone Consultative Committees into a single International Consultative Committee, on the occasion of the opening of the 1st Plenary Assembly of the new Consultative Committee.

However, our delegations are unfortunately obliged to draw the attention of all the delegates at the Plenary Assembly to the fact that such a great country as the Chinese People's Republic, with a quarter of the world's total population and having communications with very many countries, is unjustly excluded from the activities of the International Telecommunication Union.

We consider that this situation is abnormal and in contradiction with the principles of the I.T.U. which aim at extending international cooperation so as to make better use of all means of telecommunication.

In our opinion the question of participation by the Chinese People's Republic in the organs of the I.T.U. should be settled as soon as possible, thus enabling it to add its contribution to technical progress in the field of international telecommunications.

The delegations of the U.S.S.R., the Ukranian S.S.R., and the Bielorussian S.S.R. request this statement be included in the minutes of the 1st Plenary Assembly of the unified C.C.I.T.T.

STATEMENT BY THE DELEGATION OF CZECHOSLOVAKIA

The delegation of Czechoslovakia expresses, on behalf of its Administration, its deepest regret at the absence of representatives of China in the First Plenary Assembly of the C.C.I.T.T.; it formally declares that only the delegates sent by the central government of the Chinese People's Republic can be recognized as representatives of that country.

The delegation of Czechoslovakia considers that the absence of the legitimate representatives of China can only be detrimental to the international cooperation which is necessary, if the work entrusted to the C.C.I.T.T. is to be carried out efficiently.

(Signed) KROUTL,

For the Delegation of Czechoslovakia

STATEMENT BY THE DELEGATION OF THE ROUMANIAN PEOPLE'S REPUBLIC

The delegation of the Roumanian People's Republic considers it unjust, prejudicial to international cooperation in the field of telecommunications, and contrary to the aims of the International Telecommunication Union that representatives of the Chinese People's Republic are not able to take part in our work. This state of affairs is particularly lamentable in view of the size of this country, which has more than 600 million inhabitants and many international telegraph and telephone relations.

The delegation of the Roumanian People's Republic trusts that the problem of representation of the Chinese People's Republic will be solved in the near future and that the representatives of this great country will be invited to take part in the activities of the C.C.I.T.T.

P. POSTELNICU,

The Head of the Delegation of the Roumanian People's Republic

STATEMENT BY THE DELEGATE OF THE REPUBLIC OF CHINA

In view of the statement by the Delegate of Bulgaria (C.C.I.T.T. Document I/17) the Delegation of the Republic of China wishes to state that in accordance with Article Seven (7) of the International Telecommunication Convention of Buenos Aires, 1952, only Administrations

of Members and Associate Members of the Union, and Private Operating Agencies recognized and approved by Members or Associate Members of the Union may be admitted to the Plenary Assemblies of the C.C.I.s.

The Government of the Republic of China is the only legitimate government of China, a signatory of the International Telecommunication Convention, Buenos Aires, 1952; hence only this government has the right to represent China at the C.C.I.T.T.

It is clear, therefore, that the question raised in Document I/17 is incompatible with the relevant stipulations of the International Telecommunication Convention of Buenos Aires and the said Document I/17, and/or any similar documents should be summarily disregarded.

The Chinese Delegation requests that this statement be included in the minutes of the First Plenary Assembly of the C.C.I.T.T.

SHUJEN CHEN

Head of the Delegation of the Republic of China

STATEMENT BY THE DELEGATION OF THE P. R. OF BULGARIA

The delegation of the People's Republic of Bulgaria considers it unjust from every point of view that the Telegraph and Telephone Administration of the Chinese People's Republic should not be represented in the C.C.I.T.T.; in view of the purely technical nature and the organization of this Committee it is highly desirable that the Administrations of all sovereign countries should be represented in it. Since the Chinese People's Republic under its central government has made great progress in the development of its telecommunications and in telecommunication technology in the last few years, it is in a position to make an appreciable contribution to the work of the C.C.I.T.T. and could at the same time benefit from the constructive work of the Committee.

For the above reasons the delegation of the People's Republic of Bulgaria insists that the question of participation by the Telegraph and Telephone Administration of the Chinese People's Republic in the activities of the C.C.I.T. should be settled.

V. HARIZANOV

Head of the Delegation of the People's Republic of Bulgaria

STATEMENT BY THE DELEGATION OF THE UNITED STATES OF AMERICA

The Delegation of the United States of America considers the statements circulated by the Delegations of Bulgaria, Czechoslovakia, Roumania and the U.S.S.R., the Ukrainian S.S.R. and the Bielorussian S.S.R., as well as any other statements of similar content which may be circulated, to be out of order and inadmissible in this meeting.

Under Article Seven of the International Telecommunication Convention of Buenos Aires, 1952, the sole duty of the C.C.I.T. is to study technical, operating and tariff questions in the area of its work and to issue recommendations on them. It is not empowered to discuss or decide political questions.

The Government of the Republic of China alone has the right to represent China at the C.C.I.T.

It is, moreover, unthinkable that any agency associated with the United Nations should even consider the representation of the Chinese Communist regime, whose actions have departed so radically from normally accepted standards of international conduct.

T.H.E. NESBITT

Chief, U.S. Delegation

STATEMENT BY THE DELEGATION OF THE PEOPLE'S REPUBLIC OF POLAND

The delegation of the People's Republic of Poland wishes to draw attention to the fact that a great country like the Chinese People's Republic, whose importance in the field of telecommunications in Asia and in the whole world cannot be denied, should be excluded from taking part in the activities of the International Telegraph and Telephone Consultative Committee.

The Polish delegation wishes to express its firm and deep conviction that the question of participation by the Telegraph and Telephone Administration of the Chinese People's Republic in the work of the C.C.I.T. must be settled in favour of that Administration in the near future; this will contribute in large measure to the development and standardization of the world telecommunication network.

L. SZPIGLER

Head of the delegation of the People's Republic of Poland

EIGHTH AND FINAL MEETING

Thursday, 20 December 1956, at 4 p.m.

Chairman: Mr. T. H. E. NESBITT (United States of America)

then : Mr. P. V. AFANASIEV (Bielorussian S.S.R.)

Subjects discussed:

1. Setting up of working parties (Document AP I/39).
2. Question proposed by the French Administration (Document AP I/44).
3. Date and place of the IInd Plenary Assembly of the C.C.I.T.T.
4. Report by the Budget Committee (Document AP I/45).
5. Approval of the Minutes of the 5th Plenary Meeting (Document AP I/40).
6. Closing of the 1st Plenary Assembly of the C.C.I.T.T.

The meeting opened at 4 p.m. under the chairmanship of Mr. NESBITT (United States of America), Vice-Chairman of the Assembly.

1. *Setting up of working parties* (Document AP I/39).

The Assembly reached the following decisions on the setting up of working parties which would be meeting fairly soon.

1. *Working party on wooden poles.*
   This working party, which was due to meet in April 1957, would be formed on the initiative of the Chairman of S.G. 6, Mr. Halstrøm.

2. *C.C.I.T.T./C.C.I.R. Joint Working Party on circuit noise.*
   This working party, which was due to meet in February 1957, would be formed on the initiative of the Chairman of S.G. 1, Mr. Bast.

3. *Working parties of S.S.G. 2/3 (with members of S.G. 8) and S.S.G.s 2/2 and 2/1.*
   These working parties were due to meet in Frankfurt in February 1957. The first, responsible for drafting a questionnaire on costs in the phototelegraph service, would include the following experts from the Study Group on the

revision of tariffs and phototelegraphy specialists; Messrs. Bornemann, Terras, Gill, van Dijk, Schenk, Jolley, Pellé, Bitter, Heimbürger and a delegate from Italy would take part in the work. The second party, which was to study operational rules for phototelegraphy, would also include Mr. Fernau.

4. *Working party of S.S.G. 2/1.*
This party, which was due to meet in March 1957, would comprise Messrs. Perry, Vargues, Fernau, Wyss, Fei, Vandehove, Busak, Lawrence and Garrido.

5. *Working party of S.G. 7.*
This party, which was due to meet in March 1957, would comprise Messrs. Collet and Bigi and some delegates from the United Kingdom. It would have the task of combining the Draft Lists of Essential Terms prepared by the C.C.I.T. and the C.C.I.F.; it would also have to examine the proposals at present before the International Electrotechnical Commission concerning its draft vocabulary. It was to be hoped that representatives of C.C.I.R. Study Group XIV (Vocabulary) would be able to join this working party.

6. *Working party of S.S.G. 2/2.*
This party, which was due to meet in April or May 1957, was responsible for the revision of old recommendations on telephone operation and rates. Representatives of Spain, France, Italy, the Netherlands, the United Kingdom and Switzerland would take part. It was to be hoped that countries where advance preparation operating was still in force would send their representatives.

7. *Working party of S.G. 4 (Transmission stability in the European network).*
Countries that had expressed their desire to take part in the meeting, due to be held in Brussels in May 1957, were listed in the Report by the 9th S.G. of the C.C.I.F.

8. *Meeting of S.S.G. 2/4.*
The delegate of the NETHERLANDS announced that it was not the meeting of June 1957 of this Sub-Study Group that was to be held in The Hague, but the meeting of November 1957. It would be held at the same time as a meeting of S.G. 11.

2. *Question proposed by the French Administration* (Document AP I/44).

Document AP I/44 was *approved* without comment.

3. *Date and Place of the IInd Plenary Assembly of the C.C.I.T.T.*

Mr. TOWNSHEND, Assistant Secretary-General, said that under the terms of the Convention, the IInd Plenary Assembly of the C.C.I.T.T. was to be held three years after the Ist, in other words in 1959. However, it was intended to hold two important meetings of the I.T.U. in 1959; they were the Administrative Radio Conference and the Plenipotentiary Conference. Moreover, the Administrative Telegraph and Telephone Conference was to be held in the second half of 1958. In those circumstances it would no doubt be best to leave it to the Administrative Council to fix the exact date of the IInd Plenary Assembly of the C.C.I.T.T., making allowances for the dates on which those other conferences were to be held and taking into account the interests of the Union.

In the absence of discussion, the Assembly *decided* to leave it to the Administrative Council to fix the date of the IInd Plenary Assembly of the C.C.I.T.T.

Since no proposal was made as to where the IInd Plenary Assembly should meet, it was *decided* that it should be held in Geneva.

The meeting adjourned at 4.45 p.m.

The meeting continued at 5 p.m. under the chairmanship of Mr. P.V. AFANASIEV (Bielorussian S.S.R.), Vice-Chairman of the Assembly.

4. *Report by the Budget Committee* (Document AP I/45).

Mr. KNAF (Luxembourg) introduced the report by the Budget Committee with the following speech :

" I should like to inscribe the following phrase in our report on the financial needs of the C.C.I.T.T. up to its IInd Plenary Assembly : " We are surrounded by darkness, we are looking for a gleam of light. "

When preparing the similar report concerning the C.C.I.F. and the former C.C.I.T., we could base ourselves on experience, routine and the knowhow of professionals such as Mr. Valensi and Mr. Townshend.

But when your Committee prepared the report you have before you after two long meetings, in which many interesting and useful points were discussed, it emerged that if the C.C.I.T.T. were to be successfully launched it was not sufficient simply to add together the annual expenditures of the C.C.I.F. and the C.C.I.T. It was essential above all to consider the working procedure adopted by the C.C.I.T.T. But the certain necessary elements for a fairly accurate appraisal of costs were not yet available.

For this reason, your Committee has been obliged to seek the advice of Mr. Valensi and Mr. Townshend, and to have recourse to the financial knowledge of Messrs. Weber and Prélaz of the General Secretariat and the organisational experience of Mr. Fritz, also of the General Secretariat.

I should like to take this opportunity to thank them all for the valuable help they have given.

Gentlemen, the figures you have before you are very careful *estimates* which we trust will correspond to reality as closely as possible. Here I should like to thank Mr. Barron, representative from the United Kingdom on your Committee, for the valuable advice and warnings which he did not hesitate to give in the interests of the most economical possible management of funds, without of course, jeopardizing the efficiency of the C.C.I.T.T.

Later on, when the new Committee gets under way and is in a position to show us the initial results of its work, when we are able to appreciate its working procedures, we shall have the right to expect the Budget Committee to supply reasoned explanations for the figures they submit to us for approval.

But for the moment, Gentlemen, we should only have one aim, and that is to avoid hampering the work of the C.C.I.T.T. at the outset by the lack of confidence in it, which we would be expressing indirectly by providing it with insufficient tools in the form of too close and rigid an estimate of its initial expenses.

In this connection we should have unbounded trust in Mr. Rouvière, Director of the C.C.I.T.T., who will not use funds unnecessarily. Furthermore, we should not forget that actual expenditure of the C.C.I.T.T. will in due course be passed through the finest sieve available to the Administrative Council of the I.T.U.

I therefore have the honour, Gentlemen, of proposing that you should adopt the Report which the Finance Committee is submitting to you. "

The CHAIRMAN invited comments on the Report by the Finance Committee.

The delegate of the UNITED KINGDOM wanted to know what was meant by " Restricted Plenary Assembly " mentioned in Column 4 of Annex 2.

Mr. VALENSI explained that, as the task of the Administrative Telegraph and Telephone Conference was to revise the Telegraph and Telephone Regulations, the C.C.I.F. has followed the practice of convening a Plenary Assembly towards the end of such a Conference for the purpose of reviewing recommendations on operating and rates with a view to bringing them into harmony with the new Regulations. Such a practice had been followed in 1938 after the Cairo Conference and in 1949 after the Paris Conference. A further advantage of such a Plenary Assembly, with a programme restricted to questions of operating and rates, if it were to be held in 1958 after the next Administrative and Telegraph and Telephone Conference was that it would enable a review to be made of the financial requirements of the C.C.I.T.T. in the light of the experience gained.

The delegate of the UNITED KINGDOM accepted these explanations, but nevertheless thought it might be best to avoid using the term " Plenary Assembly " which, according to the Convention, had a clearly defined meaning.

After a brief discussion the Assembly decided to *approve* the Report by the Budget Committee as it stood (Document AP I/45).

5. *Approval of the minutes of the 5th Plenary Meeting* (Document AP I/40).

The Minutes of the 5th Plenary Meeting (Document AP I/40) were *approved.*

6. *Closing of the 1st Plenary Assembly of the C.C.I.T.T.*

Mr. NESBITT (United States of America) expressed his gratitude to the secretariat staff for its contribution to the preparation of the 1st Plenary Assembly. The work of the staff had greatly facilitated and accelerated that of the delegates themselves *(Applause.)*

The CHAIRMAN thanked all those whose work had contributed to the smooth running of the 1st Plenary Assembly of the C.C.I.T.T.; they included officials in the secretariat, engineers, technicians, translators, interpreters and typists. The amalgamation of the two C.C.I.s was a great step forward. The new Committee and its Director had already received many wishes for its future success, and he was convinced that, backed up by the experience gained with its predecessors and by the active cooperation of the Administrations, the C.C.I.T.T. would be among the most efficient organs for the improvement of telecommunications in the whole world.

The Chairman concluded by thanking all the delegates present and by wishing them God-speed to their respective countries, every success in their future work and a happy New Year. *(Applause.)*

Mr. CHOVET (France), speaking on behalf of the delegates, congratulated the two Vice-Chairmen, Mr. Nesbitt and Mr. Afanasiev for the skill with which they had chaired that last Plenary Meeting in the absence of Mr. van der Toorn. He thanked Mr. Afanasiev for his kind words, and addressed his heartiest wishes to him and to Mr. Nesbitt on behalf of the Plenary Assembly. *(Applause.)*

The meeting rose at 5.35 p.m.

REPORT BY THE BUDGET COMMITTEE

(Document AP I/45)

The Budget Committee of the C.C.I.T.T. met under the Chairmanship of Mr. Knaf (Luxembourg) in the *Bâtiment Electoral*, Geneva, on 19 and 20 December 1956. The following delegates were present :

Messrs. DEL RIEGO, FOZ	Spain
Messrs. DREVET, TERRAS	France
Messrs. BATRA, MUKERJEE	India
Mr. SACCO	Italy
Mr. RAUS	Luxembourg
Mr. ZERBEL	Federal German Republic
Mr. BARRON	United Kingdom
Mr. LANGENBERGER	Switzerland

The following were also present : Mr. ROUVIÈRE, Director Elect of the new C.C.I.T.T., Mr. TOWNSHEND, Interim Director of the C.C.I.T., Messrs. LEWIS, WEBER, FRITZ, PRÉLAZ, of the I.T.U. General Secretariat and Mr. Wolf, of the C.C.I.F. specialized secretariat.

As specified in the Minutes of the 1st Plenary Meeting of the C.C.I.T.T. (Document C.C.I.T. AP I/24-E) the terms of reference of the Finance Committee were :

1. To examine the accounts of the Plenary Assembly;
2. To examine C.C.I.T. Document AP I/6-E entitled " Report on the financial needs of the C.C.I.T.T., until the 2nd Plenary Assembly ".

In accordance with Resolution No. 83 of the Administrative Council, the Committee also had to appraise the organization and means placed at the disposal of delegates to the Plenary Assembly.

*

The Committee approved the estimate of expenditure for the 1st Plenary Assembly (Annex 1) which totalled 40,400.— Swiss francs, whereas the budget estimates amounted to 65,000.— Swiss francs. The estimate of 8,800,— Swiss francs appearing under sub-head II-5 (Premises, furniture, machines), would be explained in a footnote to the effect that the sum was made up of 8.600,— Swiss francs for premises and 200,— francs for furniture and machines. The extra expenses mentioned under this sub-head were partly compensated by the credit balance under sub-head II-8, as the rental of the *Bâtiment Electoral* also included the cost of the simultaneous interpretation apparatus.

To estimate the extraordinary expenses for the years 1957 to 1959, the Committee had two documents : C.C.I.T.T. Document AP I/39 containing the proposals of the

Study Group Chairmen for the meetings in 1957 and 1958 and a table entitled " Estimates of extraordinary Expenditure of the C.C.I.T. for the years 1956 to 1959 ". This table, prepared by the I.T.U. Finance Section, will be found in Annex 2 to this Report.

Three figures were proposed for the consideration of the Committee as regards the extraordinary expenses for 1957 :

— An estimate of 196,500.— francs for the extraordinary expenses in 1957. This figure was obtained by adding together the budgets separately prepared by the C.C.I.F. and the C.C.I.T. and approved by the Administrative Council.

— A figure rounded to 120,000.— francs obtained by adding together the extraordinary expenses of the C.C.I.T. in 1954 and of the C.C.I.F. in 1955, these years being respectively for each of the two organs the 1st year after a Plenary Assembly.

— Lastly, addition of the 1956 extraordinary expenses of the C.C.I.F. and the C.C.I.T. gives a total of 160,140.— francs.

The Committee, realizing that one of the arguments in favour of amalgamating the two C.C.I.s had been the possibility of saving money, wondered whether the figures of 120,000.— francs and 196,600.— francs should be compared. If so, the margin of more than 50% between the expenses and the budget would seem too high. After discussion, the committee considered that the figure of 120,000.— francs could not be taken as a basis for discussion and would merely serve as an indication.

By comparing the figures of 196,000 and 160,140 francs it could be seen that the increase of 35,000 francs (approximately 25%) was solely due to the working methods imposed on the C.C.I.T.T. by the Plenary Assembly. The Committee considered that on account of the directives given by the Plenary Assembly, the expenses would be inevitably higher in the future than they were in the past.

In connection with the restricted Plenary Assembly planned for 1958, it was made clear that it would be rather a Study-Group Meeting; in spite of its name, it would not have the status of a Plenary Assembly under the terms of the Convention. For example, the date of that meeting would have no influence on the end of the accounting period beginning on 1 January 1957.

Furthermore, the credit of 400.000,— francs, estimated for the Study Groups and the Plenary Assembly in 1959, included only Study Groups meeting immediately before the Plenary Assembly and in the same place.

*

The CHAIRMAN thanked all the delegates for their useful contributions to the debates. He also thanked Mr. TOWNSHEND and the other officials of the General Secretariat for their valuable help and the full details they had supplied.

ANNEX 1

Estimate of expenditure for the Ist Plenary Assembly of the C.C.I.T.T.

	Items and subheads	1956 Budget	Estimated expenditure	Difference
	Sub. I. Staff expenses.			
1.	Administration	9,000.—	3,800.—	+ 5,200.—
2.	Languages	37,000.—	18,500.—	+18,500.—
3.	Roneo	1,300.—	2,400.—	— 1,100.—
4.	Insurance	2,000.—	100.—	+ 1,900.—
	Sub. II. Premises and equipment.			
5.	Premises, furniture, machines	3,000.—	8,800.—*	— 5,800.—
6.	Document production	4,000.—	2,300.—	+ 1,700.—
7.	Office supplies and overheads	4,000.—	2,100.—	+ 1,900.—
8.	Simultaneous interpretation and other technical equipment	2,000.—	700.—	+ 1,300.—
9.	Unforeseen	1,700.—	1,400.—	+ 300.—
	Sub. III. Cash expenses.			
10.	Interest on advances	1,000.—	300.—	+ 700.—
		65,000.—	40,400.—	+24,600.—

Statement of the Members, Associate Members, Recognized Private Operating Agencies, scientific or industrial Organizations, and International Organizations which are to contribute to the extraordinary expenditure of the C.C.I.T.T. for the period between the Ist and the IInd Plenary Assemblies

(The list given below will serve for the apportionment of expenses of the C.C.I.T.T. as they will appear when the accounts of the IInd Plenary Assembly are closed, subject to new statements which may be received before the IInd Plenary Assembly.)

(a) *Members.*	Represented at the Ist P.A.	Number of units
Saudi Arabia (Kingdom of)	x	1
Argentine (Republic)	x	25
Australia (Commonwealth of)	x	20
Austria	x	½
Belgium	x	8
Bielorussian Soviet Socialist Republic	x	3
Bulgaria (People's Republic of)	x	1
Canada	x	20
Ceylon		1
China	x	15
Denmark	x	5
Egypt		5
Ethiopia	x	1
Spain	x	3
United States of America	x	30
Finland		3
France	x	30

* Premises 8,600,—; Furniture, machines 200,—.

	Represented at the Ist P.A.	Number of units
Hungarian People's Republic		1
India (Republic of)	x	20
Iran	x	1
Ireland	x	3
Israel (State of)	x	1
Italy	x	20
Japan	x	25
Laos (Kingdom of)	x	½
Lebanon	x	½
Liberia	x	3
Luxembourg	x	½
Monaco	x	½
Morocco		1
Norway	x	5
New Zealand		5
Pakistan	x	15
Netherlands, Surinam, Netherlands Antilles, New Guinea	x	10
Poland (People's Republic of)	x	10
Portugal	x	8
Federal German Republic	x	20
Federal People's Republic of Yugoslavia	x	1
Ukrainian Soviet Socialist Republic	x	5
Roumanian People's Republic	x	1
United Kingdom of Great Britain and Northern Ireland	x	30
Sweden	x	10
Switzerland (Confederation)	x	10
Syrian Republic		1
Czechoslovakia	x	8
Overseas Territories of the French Republic, and Territories administered as such	x	20
Tunisia	x	1
Turkey	x	5
Union of South Africa and Territory of South-West Africa		13
Union of Soviet Socialist Republics	x	30
Viet-Nam (Republic of)	x	1

(b) *Recognized Private Operating Agencies.*

American Cable and Radio Corporation	x	½
American Telephone and Telegraph Co.	x	½
Cable and Wireless Ltd.		3
Compagnie française de câbles sous-marins	x	½
Compagnie générale de T.S.F.	x	½
Companhia Portuguesa Radio Marconi	x	½
Compañía de Teléfonos de Chile	x	3
Compañía Telefónica Nacional de España	x	2
Cuban Telephone Company	x	5
Deutsch-Atlantische Telegraphengesellschaft	x	½
Grande compagnie des télégraphes du Nord	x	1
Kokusai Denshin Denwa Company, Ltd.	x	½
Nippon Telegraph and Telephone Public Corporation		1
Radio Austria A. G.	x	½
RCA Communications Inc.	x	½
Societa Italcable	x	½
Teléfonos de México, S. A.	x	5
Telephone Association of Canada	x	10

	Represented at the Ist P.A.	Number of units
(c) *Scientific or industrial Organizations.*		
Automatic Telephone and Electric Company, Ltd.	x	2
Felten & Guilleaume, Carlswerk		1
Felten & Guilleaume, Fernmeldeanlagen		1
N. V. Philip's Telecommunicatie Industrie		1
Siemens & Halske A. G.		3
Telefunken G.m.b.H.		1
(d) *International Organizations.*		
International Air Transport Association (I.A.T.A.)		*
World Meteorological Organization (W.M.O.)	x	*
International Railway Union (I.R.U.)		*
Total units . . .		501½

* Organization exempted from contributing to expenses, under the terms of Administrative Council Resolution No. 222 (amended).

ANNEX 2

Estimate of extraordinary expenditure of the C.C.I.T.T. for 1956 to 1959

Items and sub-heads	1956	1957	1958		1959	
	Ist P.A. Geneva	S.G.s	S.G.s	Restricted P.A.	S.Gs.	IInd P.A
	1	2	3	4	5	6
Sub. I. — Staff expenses.						
1. Administration	9,000	25,000				
2. Languages	37,000	115,000				
3. Roneo	1,300	6,000				
4. Insurance	2,000	4,000				
Sub. II. — Premises and equipment.						
5. Premises, furniture, machines	3,000	3,500	[1]			
6. Document production	4,000	14,000		(assuming		
7. Office supplies and overheads	4,000	6,000		that the		
8. Simultaneous interpretation and other technical equipm.	2,000	1,500		Telegraph		
9. Unforeseen	1,700	2,100		and		
Sub. III. — Cash expenses.				Telephone		
10. Interest on advances	1,000	7,400		Conference		
				is held in		
EXPENSES OF AN EXCEPTIONAL NATURE.				1958)		
Sub. IV. — Representation expenses.						
11. Participation in meetings of a C.C.I. or of other International Organizations	—	10,000				
Sub. V. — Preparatory work.						
12. Publication and distribution of reports	—	2,000				
Total : Swiss francs	65,000*) [2]	196,500*) [3]	200,000°) [3]	50,000°) [4] [5]	400,000°) [3] [6]	

*) Budget approved by the Administrative Council.
°) Estimated expenses.
[1]) It is understood that distribution under the various subheads will be approximately the same as for the 1957 budget.
[2]) Estimated expenses : 40,400.— Swiss francs.
[3]) Including a sum of 50,500.— Swiss francs for participation by the C.C.I.T.T. in expenditure for the linguistic service (income in the ordinary budget); this sum can be modified for 1958 and 1959 according to the services which may be requested of the Linguistic section by the General Secretariat.
[4]) Restricted Plenary Assembly (after the Telegraph and Telephone Conference).
[5]) Estimated expenses on the basis of the 1st Plenary Assembly.
[6]) Assuming that the Plenary Assembly will be held at the beginning of 1959. If this Assembly is held later in the same year, 50,000.— Swiss francs would have to be added to this sum to cover Study Groups.

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RESOLUTIONS

RESOLUTION 1

Additional Rules of Procedure of the C.C.I.T.T.

The First Plenary Assembly of the INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE,

In view of Article 7, paragraph 6 (2) of the International Telecommunication Convention, Buenos Aires, 1952.

RESOLVES :

That the General Regulations annexed to the Buenos Aires Convention (1952) shall be amplified as follows regarding the organization of the C.C.I.T.T.

I. *Plenary Assembly (P.A.)*

1. *(a)* If the P.A. meets at the seat of the Union, the precise date of this meeting shall be decided by the Director of the Committee in agreement with the Secretary-General of the Union. If the P.A. does not meet at the seat of the Union, the exact date of the meeting shall be decided by the inviting Government in agreement with the Director of the Committee.

(b) The Director of the Committee shall send an invitation to participate in the meeting of the P.A. to all Members and Associate Members of the Union. If a country which is a Member or Associate Member has already officially notified that a Recognized Private Operating Agency of its country will participate in the work of the C.C.I.T.T., the invitation will also be addressed to this Recognized Private Operating Agency. Otherwise it shall rest with the Member or Associate Member to communicate this invitation to the Recognized Private Operating Agencies of its country. If the P.A. does not meet at the seat of the Union, the Director shall send the above-mentioned invitation in the name of the inviting Government. The invitation shall indicate that participation in the P.A. involves participation in the extraordinary expenses of the C.C.I.T.T.

(c) Members or Associate Members of the Union which wish to participate in the meeting are required to advise the Director of the Committee, by letter or telegram, at least a month before the meeting, of the names of the Delegates of Administrations and Representatives of Recognized Private Operating Agencies who will attend meetings of the preparatory Study Groups and meetings of the P.A. (and especially, of the names of the Heads of their Delegations) as well as the names of experts of the scientific and

industrial Organizations who will attend meetings of the preparatory Study Groups only. The Director of the C.C.I.T.T. shall forward this information to the Administration of the inviting government, if any.

(d) The Director of the C.C.I.T.T. shall invite the Director and Vice-Director of the C.C.I.R., the United Nations, the Specialized Agencies of the United Nations which reciprocally allow representatives of the Union to attend their conferences, and the other International Organizations whose work the Administrative Council considers should be coordinated with the work of the Union and whose activities are similar, to attend the P.A. in an advisory capacity. The United Nations, the Specialized Agencies and other International Organizations are required to notify the names of their observers in the same way as specified in paragraph *(c)* for Members of the Union.

2. *(a)* Before the opening meeting of the P.A., the Heads of Delegations shall meet :

(i) to prepare the programme of work for the P.A., on a proposal by the Director of the C.C.I.T.T. This shall be submitted to the P.A. at its first meeting. (This programme may contain proposals for the setting-up of committees for the duration of the P.A.);

(ii) to designate the persons who will be proposed as Vice-Chairmen and if necessary (meeting of the P.A. at the seat of the Union) as Chairman of the meeting of the P.A. (Chapter 13, Article 4 of the General Regulations annexed to the Buenos Aires Convention, 1952) ;

(iii) to make proposals to the P.A. for the constitution of the " Budget Committee " called upon to examine the " Report on the financial needs of the Committee until the next P.A. " and the expenses incurred by the current P.A.

(b) Before the closing meeting of the P.A. the Heads of Delegations shall meet to prepare proposals for the P.A. concerning :

(i) the constitution of Study Groups;

(ii) the designation of Study Group Chairmen and Vice-Chairmen and Sub-Study Group Chairmen and Vice-Chairmen;

(iii) the programme of meetings for the Study Groups and Sub-Study Groups until the next meeting of the P.A.

3. *(a)* Recommendations submitted to a vote in the course of a P.A. shall be considered as adopted if they obtain a majority of votes; the minutes of the P.A. shall indicate the results of the vote without mentioning the Delegations which voted for or against, unless a Delegation expressly asks that its vote should be mentioned;

(b) The corresponding Recommendations shall also mention these results, in the form :

" The C.C.I.T.T. unanimously issues the Recommendation..." or " The C.C.I.T.T. issues, by a majority (... votes to..., with... abstentions), the Recommendation..."

(c) It is not admissible for a Delegation to vote on behalf of an Administration which has not sent a delegation to the P.A.; however, when a country is not represented by an Administration, the representatives of the Recognized Private Operating Agencies of that country shall, as a whole, regardless of their number, be entitled to a single vote.

4. *(a)* The Plenary Assembly shall draw up lists of questions the study of which should be undertaken or pursued until the next Plenary Assembly.

If a question is of interest to several Study Groups, the Plenary Assembly shall decide which one is to undertake the study and which Study Groups shall be represented in the study;

(b) The Plenary Assembly shall indicate which of the questions to be studied are particularly urgent.

5. At its closing meeting, the P.A. shall draw up the initial list of Administrations and Recognized Private Operating Agencies which are to take part in the work of the various S.G.s and S.S.G.s; it shall take decisions on the proposals of the meeting of the Heads of Delegations concerning

— the designation of Chairmen and Vice-Chairmen;

— the programme of meetings for the Study Groups and Sub-Study Groups until the next meeting of the P.A.

II. *The Director*

1. The Director of the C.C.I.T.T. is empowered to enter into direct contact with the Chairmen and Rapporteurs of the Study Groups and Sub-Study Groups.

2. In order that the Director and his assistants may keep up to date on technical progress, Administrations and Private Operating Agencies (as far as circumstances permit) may authorize him to visit their installations and to obtain all necessary information; the expenses incurred in this connection are chargeable to the C.C.I.T.T.

3. The Director shall take all the necessary preparatory measures for meetings of the P.A., Study Groups and Sub-Study Groups, the work of which he should coordinate.

4. *(a)* In his " Report on the Financial Needs of the Committee until the next P.A.", the Director shall communicate to the P.A. (for information) a summary of the accounts for the years which have elapsed since the preceding P.A. and " Estimated Ordinary Expenses of the C.C.I.T.T. " to cover the financial requirements of the Committee until the next P.A.

(b) These " Estimated Ordinary Expenses of the C.C.I.T.T. " shall first be submitted to a preliminary examination by the " Budget Committee "; the Chairman of this Committee shall prepare a report on this subject for the P.A. After approval, these " Estimated Ordinary Expenses of the C.C.I.T.T." shall be sent by the Director of the C.C.I.T.T. to the Secretary-General of the Union, for the information of the Administrative Council.

(c) After the meeting of the P.A., the Director shall supply the Secretary-General of the Union (for the information of the I.T.U. Administrative Council) with a list of Study Group meetings scheduled up to the time of the next Plenary Assembly, with an estimate of the probable costs of those Study Group meetings.

(d) The Director of the C.C.I.T.T. shall submit, for a preliminary examination by the " Budget Committee " and thereafter for approval by the P.A., the account for extraordinary expenditure incurred for the current P.A.

5. Within the limitations of the Regulations of the Union, the Director may submit to the P.A. any report or proposal which he considers would help to improve the work of the C.C.I.T.T., so that the P.A. may decide what action to take.

6. *(a)* After the closure of a meeting of the P.A., the Director shall send to all Administrations and Recognized Private Operating Agencies which have expressed a desire to take part in C.C.I.T.T. activities, and International Organizations which will cooperate therein, lists of Questions the study of which should be undertaken or continued by each Study Group and Sub-Study Group.

(b) He shall mention that they may forward any comments they may have to offer, including the particulars of their experiments and the drafts of any replies they intend to make to the questions.

III. *Study Groups (and Sub-Study Groups)*

1. *(a)* The Administrations and Private Operating Agencies shall be represented by rapporteurs, appointed by name and chosen by them as experts qualified to collaborate in the search for technically and economically satisfactory solutions to the questions under study.

(b) To study questions of common interest to the C.C.I.T. and the C.C.I.R.' Administrations and Private Operating Agencies may also appoint rapporteurs from the C.C.I.R. to a Study Group of the C.C.I.T.T. ; such an appointment does not carry with it the obligation to participate in the extraordinary expenses of the C.C.I.T.T.

(c) To facilitate their work, the Administrations and Recognized Private Operating Agencies, members of any study groups, shall be kept as few as possible.

2. *(a)* The Administrations and Private Operating Agencies, members of a study group, and Chairmen and Rapporteurs, shall send their contributions, comments, results of experiments and proposals relating to the studies being made, to the Director of the C.C.I.T.T.

(b) This documentation shall be sent to the Director of the C.C.I.T.T. in three copies, in one of the working languages of the C.C.I.T.T. (English, French, or Spanish). It would be of great assistance to the C.C.I.T.T. Secretariat if these contributions, comments, particulars of experiments, and proposals could be sent in at least two of the C.C.I.T.T. working languages.

3. *(a)* The Director shall immediately forward one copy of the contributions received, in the working language used in the original document, to the Chairmen and Vice-Chairmen.

(b) He shall arrange for the necessary translations to be made, and as soon as possible shall send the documentation thus prepared to the Rapporteurs of the Study Groups concerned, in the working language desired by them.

(c) However, if a Chairman, in agreement with the Rapporteurs of his Study Group, states that his Study Group (or Sub-Study Group) is willing to work with the

documents in the working language used in the original, the Director shall merely send on the documents received without having them translated. This procedure cannot be changed during the period between two Plenary Assemblies.

4. To prepare a plan for the meetings of Study Groups, each Group Chairman shall advise the Director, in good time, as to how many days his Study Group will have to meet, and, if he intends to hold common meetings with one or several other Study Groups, he shall indicate how many days will be required for this purpose.

5. *(a)* The Chairman shall direct the debates during the meeting, with the assistance of the Secretariat.

(b) The drafts of recommendations and resolutions shall be prepared by the Chairman, whenever possible with the assistance of the specialized Secretariat or temporary working parties. These texts must be approved in their final form before the meeting disbands.

6. *(a)* A report on the work done during a meeting shall be prepared by the Secretariat.

(b) This report shall be submitted to the Study Groups and Sub-Study Groups for approval before the end of the meeting.

7. Administrations and Private Operating Agencies are authorized to communicate study group reports and documents to any experts they consider it expedient to consult, except where the Study Group concerned has specifically decided that its report, or document, is to be treated as confidential.

8. A Study Group may pass on to its Sub-Study Group any question assigned to it by the P.A., and may entrust that Sub-Study Group with any question which has to be studied in order that the work of the Study Group may continue.

9. *(a)* The Director of the C.C.I.T.T. shall send a report on the work of each Study Group, as a report preliminary to the P.A., to all Administrations and Recognized Private Operating Agencies which have participated or expressed a desire to participate in C.C.I.T.T. activities.

(b) The report shall be submitted as soon as possible, and in the working languages used by the P.A.

10. *(a)* All Study Groups shall meet simultaneously at the meeting place of the Plenary Assembly, before its opening meeting, in order to prepare final versions of the draft recommendations to be submitted to the Plenary Assembly for approval.

(b) The programme for the whole of the Study Group meeting (during the days preceding the Plenary Assembly) shall be sent in good time to the Administrations and to Recognized Private Operating Agencies of countries which are Members or Associate Members of the Union and which participate or have expressed a desire to participate in the work of the C.C.I.T.T., in order to enable them to attend these meetings. The programme shall also be sent to the scientific and industrial Organizations authorized to attend the meetings of Study Groups and Sub-Study Groups.

(c) The final report by each Study Group, prepared in accordance with paragraphs 6 and 9 *(b)* above, shall be forwarded to the P.A.

11. While the P.A. is in session, Study Group Chairmen shall hold themselves at the disposal of the P.A., to supply information on matters which concern their Study Groups.

Annex. — Extract from Report on the Meeting of C.C.I.F. and C.C.I.T. Chairmen and Vice-Chairmen on Working Procedures of the C.C.I.T.T.

ANNEX

(to Resolution 1 of the Ist P.A.)

Extract from report by the meeting of C.C.I.F. and C.C.I.T. chairmen and vice-chairmen on the Study Groups and working procedures of the C.C.I.T.T.

(Geneva, 29 February-8 March, 1956)

(C.C.I.T.T. Document-P.A. I/1)

. . . . . .

B. Working Procedures for the C.C.I.T.T.

The organization of the C.C.I.F. and of the C.C.I.T. and the working methods of these two committees are closely similar in very many respects.

Their working methods are governed by the additional regulations supplementing the International Telecommunication Convention (Buenos Aires, 1952) and in both cases these additional regulations are almost parallel.

For example, if we consider how one Plenary Assembly organizes work to be done, up to the following Plenary Assembly, we see that both the C.C.I.F. and C.C.I.T. Plenary Assemblies (PA) :

— draft the questions to be studied up to the date of the next Plenary Assembly,

— set up Study Groups and Sub-Study Groups to examine these questions,

— apportion questions between the various Study Groups and Sub-Study Groups,

and the only difference is that the Plenary Assembly of the C.C.I.F. makes a programme fixing the approximate dates or places for the meetings of Study Groups and Sub-Study Groups over a period of three years until the following Plenary Assembly, whereas the C.C.I.T. Plenary Assembly does not.

* * *

The meeting of Chairmen tried above all to bring out the essential differences between the C.C.I.F. and C.C.I.T. working procedures, and attempted to define a general method reconciling the advantages of both. These essential differences apply principally to :

(a) The role of the Chairman and of the C.C.I. specialized Secretariat.

(b) The drafting of documents in one or more languages.

1. *The role of the Chairman*

1.1. The powers and duties of the Chairman on the one hand, and of the specialized Secretariat on the other, are not the same in the C.C.I.F. and in the C.C.I.T. These differences were very great before the C.C.I.T. Plenary Assembly, Brussels, 1948, but since then they have been

narrowed down. The differences in working methods are, in fact, due to historical reasons. Since 1924, the C.C.I.F. has been fortunate enough to possess a specialized Secretariat, with which it was in a position to prepare Study Group meetings and take on all the secretariat work. On the other hand, the C.C.I.T. (like the C.C.I.R.) did not have a permanent Secretariat before the Atlantic City Convention (1947), and the files of these C.C.I.s. passed from one Administration to the next, leaving all the work of drafting the reports to the Chairmen of the Study Groups. Since the C.C.I.T. Plenary Assembly (Paris, 1949) set up a specialized Secretariat, working methods of the C.C.I.F. and C.C.I.T. Study Groups have become more similar; at present, since the role of the Chairmen of Study Groups varies within the same C.C.I. according to the Chairman, it can be said that some C.C.I.F. and C.C.I.T. Study Groups use very similar working methods, although in some extreme cases rather noticeable differences still exist.

1.2. *In the C.C.I.T.*, the Chairman is responsible for conducting the whole business of his particular Study Group : he analyzes contributions received, discusses them with the " rapporteurs " of his Study Group by letter or telephone, draws up a preliminary report summarizing the contributions received before a meeting of his Study Group, analyzing them and emphasizing points on which agreement may be possible and, if necessary, explaining differences of opinion. The Chairman conducts business during a meeting, moves draft recommendations, puts comments and resolutions of the Study Group to the vote, after they have been drafted by " *rapporteurs de séance* " drawn from the Study Group, one for the English language, and one for the French. These " *rapporteurs de séance* " also draw up a summary report for each meeting.

After the meeting, the Chairman, with the help of the working documents issued during the meeting, drafts the final report, containing any proposals made, and, in some cases, his own comments to serve as a guide to further study. This report is not approved by the Study Group, as it is only drawn up a few days after the meeting, but the conclusions contained in it have been approved by the meeting.

1.3. *In the C.C.I.F.*, the Chairman has the same powers and duties with regard to the conduct of meetings, but the specialized Secretariat of the C.C.I.F. prepares the documents and reports for the Study Group.

No preliminary report is drawn up as in the case of the C.C.I.T. and the Chairman analyzes the documents and suggests possible solutions orally, during the meeting of the Study Group. The Chairman is helped by the Secretary of the meeting, an engineer from the Secretariat, who unofficially prepares comparative summaries, tables, etc., with a view to speeding up the business of the meeting.

There is no summary report for each meeting of the session, but rough provisional working documents are drawn up by the C.C.I.F. Secretariat, and submitted to the Study Group for approval, for each item and each question considered.

At the end of the session, usually at the last meeting of the session, a draft summary report is submitted to the Study Group, which the latter approves with the requisite amendments. This draft summary report is prepared by the C.C.I.F. Secretariat, following the general directives by the Chairman, who usually examines it before it is submitted to the Study Group.

1.4. Thus, although the role of the Chairman is the same in the C.C.I.F. and in the C.C.I.T., there are two important differences :

— the C.C.I.T. Chairman has to draw up a preliminary Report;

— the C.C.I.F. Chairman has to draw up a final Report a few days after the meeting.

1.5. The meeting feels that measures tending to lighten the burden on Chairmen should be taken, because Chairmen generally have very onerous duties in their national Administrations. Moreover, it is only reasonable that a specialized secretarial staff of Union officials should take over the task of drawing up reports, rather than a national official who must do so without any

kind of remuneration. The same applies to the " *rapporteurs de séance* " whose services are called upon at meetings of C.C.I.T. Study Groups. /

1.6. Hence working methods for the Study Groups and Sub-Study Groups of the C.C.I.T.T. would be as follows :

Work prior to the meeting, such as comparative tables, summaries of certain contributions, etc., to be carried out by a specialized Secretariat, if needed.

The Chairman would conduct business during meetings with the assistance of the Secretariat. The Chairman would draw up draft recommendations or resolutions, wherever possible with the help of the specialized Secretariat or temporary working parties. These texts would have to be approved in their final form before the meeting is adjourned. The final report of the meeting would be prepared by the Secretariat and submitted to the Study Group before the conclusion of the meeting.

1.7. The distribution of Study Group meetings over the period between two Plenary Assemblies will make it easier to send an official from the C.C.I.T.T. Secretariat to these meetings. If it is not possible to send an official, the Director of the C.C.I. may temporarily apply for the services of an official from a national Administration to serve as secretary of a Study Group, to be paid from the C.C.I.T.T. budget and placed for a short period under the authority of the C.C.I.T.T. Director. However, because of the working methods indicated above (paragraph 1.6.) and owing to the simultaneous meeting of an increased number of Study Groups, the specialized Secretariat of the C.C.I.T.T. would have to be sufficiently large to prepare the work of each Study Group in an appropriate manner and to keep in close touch with this work.

1.8. The adoption by the C.C.I.T.T. of C.C.I.F. working methods, i.e. the drafting of reports by the specialized Secretariat, will naturally not affect in any way the right of the Group Chairman to correspond with other " *Rapporteurs* ", to prepare meetings of his Study Group or to submit any proposal or report to the Study Group.

Hence it seems desirable for the Chairman and Vice-Chairman to be able to acquaint themselves with contributions from Administrations, and with all other documents concerning their Study Group, as soon as these are received by the C.C.I.T.T. Secretariat. To facilitate quick distribution, Administrations should send three copies of documents (possibly four) to the Secretariat.

The meeting also feels that all contributions received by the Secretariat should be transmitted as soon as possible (after the necessary translations and duplications have been made) to all the Rapporteurs of the Study Group concerned.

1.9. The duties of the Chairman and Vice-Chairman of a Sub-Study Group are exactly the same as those of the Chairman and Vice-Chairman of a Study Group. In both cases appointments should be made directly by the Plenary Assembly, which might find it advisable, in the case of some Sub-Study Groups, to appoint as Chairman and Vice-Chairman persons other than those presiding over the parent Study Group. For example, this will no doubt be the case with the Sub-Study Groups of Study Group C (transmission) and with the Sub-Study Group on rapid methods of operation. In other cases, however, it may seem preferable to have the same Chairman for the parent Study Group and for the Sub-Study Group engaged on special work; this was generally the practice with the Sub-Study Groups of Study Groups A and B (Protection and Corrosion).

1.10. The French term " *Rapporteur principal* " is used in the Telecommunication Convention. Although this term is always used in the C.C.I.T., the C.C.I.F. has often used " *Président* ". The distinction applies in French only, as the English equivalent used is " Chairman ".

The term " *Rapporteur principal* " is fully justified in designating the person who writes his Study Group's reports. " *Président* " seems a better term for someone who is called upon to direct and lead debates. The meeting of Chairmen and Vice-Chairmen therefore hopes that at the appropriate time—perhaps at the next Plenipotentiary Conference—the French terminology will be reviewed.

2. *Programme of meetings of Study Groups and Sub-Study Groups*

2.1. In the *C.C.I.F.*, the Plenary Assembly decides on the approximate dates and places of all meetings of Study Groups, Sub-Study Groups and Working Parties for the next three years.

In the *C.C.I.T.*, meetings are arranged at the discretion of the Chairmen.

2.2. The meeting considers it advisable to follow the practice adopted in the C.C.I.F. because :

(a) the I.T.U. authorities would find it easier to prepare the draft budget for the extraordinary expenses occasioned by such meetings;

(b) Administrations and Private Operating Agencies would then know exactly at what time, and for how long, their officials would be absent for attendance at C.C.I.T.T. meetings.

2.3. Nevertheless, upon a request from the Chairman of a Study Group or Sub-Study Group, or Working Party, the Director of the C.C.I.T.T. should have power :

— either to change the place fixed for a meeting by the Plenary Assembly;

— or, when necessary, to convene a meeting not previously arranged by the Plenary Assembly.

3. *Preparation of documents for the meetings*

The practical preparation of documents for meetings is identical in the C.C.I.F. and the C.C.I.T., except in the matter of language.

3.1. In the *C.C.I.T.* all documents :

— preparatory documents, i.e. contributions received from Administrations before the meetings,

— documents of the meeting, records of the meeting, draft texts, etc.,

— final reports of meetings are systematically issued in English and French.

The C.C.I.T. considers that, according to the Convention, if the " *Rapporteur* " of an Administration should ask for a document in a working language of the Union, he must be supplied with that document in the language desired.

3.2. In the *C.C.I.F.*, on the contrary, it has been considered advisable to vary the procedure according to the importance of the document.

Contributions from Administrations (preparatory documents) are issued by the Secretariat in French, whether they be submitted in French or English, but they are issued in English too, when that is the original language.

Documents issued during the meetings are also prepared in one language only (usually French) and, if desired, are translated verbally during the meeting.

Important documents on topics to be discussed at Plenary Assemblies, which include, among other things, the records of the Study Group meetings, are all issued in English and French. The English translations are made later by English-speaking engineers who took part in the discussions.

3.3. The meeting considers that a uniform procedure should be applied for the distribution of the documents of the C.C.I.T.T. It would be preferable if, in principle, all documents were issued in two languages.

However, on occasions it might be possible to restrict publication to one language, provided the Members of the Study Group were agreeable, and the matter could be left to the discretion of the Chairman of the Study Group, the Sub-Study Group, or the Working Party and the Director

of the C.C.I.T.T. The documents would then be submitted either in English or French depending on the language in which they were drafted and forwarded to the Secretariat of the C.C.I.T.T. Any decision reached in the matter would of course be valid for the entire period between two Plenary Assemblies, which would mean that translation of all the documents of that particular Study Group could not be requested a few weeks before the Plenary Assembly. Documents serving as a basis for discussions in the Plenary Assembly, which would be sent to all Administrations, will be drawn up in three working languages (English, French and Spanish).

The attention of the Administrations should be drawn to the fact that the work of the specialized Secretariat would be considerably lightened if contributions were sent to it in two working languages.

The meeting recommends acceptance of this procedure, but does not think it necessary to draw up a set of rules and regulations on the subject.

4. *Interpretation at meetings*

The meeting considers that the requirements in the sphere of interpretation are very variable, depending on how many people are present and the degree of technicality of the subject matter. The organization of the meeting (simultaneous interpretation, consecutive interpretation, interpretation by an official of the Specialized Secretariat of the C.C.I.T.T.) should be left to the Director of the C.C.I.T.T., acting in consultation with the Chairman of the Study Group, Sub-Study Group, or Working Party.

5. *Presentation of Recommendations by the C.C.I.T.T.*

At present the C.C.I.T. and the C.C.I.F. have different methods of presenting the recommendations published after a Plenary Assembly.

Those published by the *C.C.I.F.* after a Plenary Assembly are sometimes in the form of numbered Recommendations with " consideranda ", but technical recommendations tend to take the form of " didactic " comments or specifications.

In the *C.C.I.T.* all the texts are in the form of numbered Recommendations with " consideranda ".

The meeting of Chairmen thinks it would be advantageous to adopt the C.C.I.F. practice of including " didactic " comment in the texts, particularly for Administrations of countries not participating in the work of the C.C.I.T.T. Nevertheless it would be helpful if the different sections of the C.C.I.T.T. publications were numbered in the same manner as the existing Recommendations of the C.C.I.T., so that references could be easily quoted.

6. *Procedure for adopting a recommendation between Plenary Assemblies*

The meeting of Chairmen considers that some provisional procedure should exist when reports or recommendations have to be adopted between Plenary Assemblies. Such arrangements have frequently been used in the C.C.I.F. and the C.C.I.T., and one of the following methods may be chosen :

- the Plenary Assembly may delegate authority to a Study Group or Working Group, time being allowed for the Administrations to send in their comments, if any;
- there might be a system of " Provisional Recommendations " which would allow Administrations to study the draft recommendation and state by letter whether or not they approved it;
- some other form of postal vote might be used.

* * *

In view, then, of the above, the meeting of Chairmen has proposed the additional draft Regulations attached hereto *.

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* Resolution 1 of the Ist P.A. of the C.C.I.T.T.

RESOLUTION 2

Abbreviation to Designate the International Telegraph and Telephone Consultative Committee

The first Plenary Assembly of the International Telegraph and Telephone Consultative Committee,

On the proposal by the Australian Delegation,

Recognizing

That the abbreviation " C.C.I.T." appeared in Protocol II to the Buenos Aires Convention and henceforth, therefore, in the Convention itself,

Considering

That the use of these initials could lead to ambiguity, since the International Telegraph Consultative Committee has always adopted the same initials.

That the possible ambiguity which might arise in this respect appears to be recognized in correspondence and documents received from the General Secretariat, wherein it has recently been the practice to refer to the " old C.C.I.T." and the " new C.C.I.T.".

That it would therefore seem preferable to avoid any such ambiguity by using such appropriate initials for the new combined body as would differentiate from those adopted by the old C.C.I.T.

That a distinction of this kind would be of considerable practical assistance to Administrations in the filing of papers and in making references to recommendations issued by the old C.C.I.T. and by the new combined Telegraph and Telephone Consultative Committee, respectively.

1. *Declares* that it considers the use of the abbreviation " C.C.I.T." as a not very desirable designation for the new Committee and that it prefers the abbreviation " C.C.I.T.T.".

2. *Draws* the attention of the Administrative Council of the I.T.U. to this opinion, and decides to use the abbreviation " C.C.I.T.T." provisionally, pending its ratification and the amendment of the relevant articles of the Convention by the next Plenipotentiary Conference.

RESOLUTION 3

Technical Assistance

The first Plenary Assembly of the International Telegraph and Telephone Consultative Committee,

In view of Resolution 346 adopted by the Administrative Council at its 11th Session;

In view of Resolution 38 passed by the Plenary Assembly of the International Radio Consultative Committee in Warsaw, August 1956;

Considering

That, while Technical Assistance in the field of telecommunications has so far made encouraging progress, in particular since the I.T.U. began to participate in the Expanded

Programme of Technical Assistance carried out in common by the United Nations and the Specialized Agencies, the Members of the Union as a whole—and more particularly those playing an effective part in the activities of the C.C.I.T.T.—nevertheless wish to make every effort within their power to develop mutual aid still further, particularly for the benefit of those countries whose telecommunications have not yet reached a sufficient stage of development;

That the International Consultative Committees of the I.T.U. seem to be in a position to increase still further the substantial contribution they are already making in this sphere;

That additional action in this respect should be taken as soon as possible;

Recognizing

That the mutual technical aid which is at present carried on within the I.T.U. might be extended, for example,

— by the dissemination of C.C.I. documentation in a form that could be used more directly by the Administrations of countries whose telecommunications are less developed;

— by the coordination and implementation of the General Interconnection Plan in its different phases and in the various regions;

— by a study of the questions raised individually by certain countries which do not possess sufficient technical means to solve them completely by themselves;

Recommends

1. That the temporary Joint C.C.I.R./C.C.I.T. Committee mentioned in Resolution 38 by the Plenary Assembly of the C.C.I.R., Warsaw, 1956, should be set up as soon as possible so that its conclusions may be examined in May, 1957, by the Administrative Council to which they will be submitted direct;

2. That the recommendations of this Committee should be of such a nature as to lead to action that will be as practical, as efficient and as early as possible, while remaining within the financial possibilities of the Union which are at present limited (on the one hand by the limit on ordinary expenditure fixed by the Plenipotentiary Conference, and on the other by the maximum credit that can be made available to the I.T.U. under the Expanded Programme of Technical Assistance);

3. That the terms of reference of the said Committee should cover the following items in addition to the questions mentioned in the Annex to C.C.I.R. Resolution 38 :

(a) which is the best way of making available to those countries which may make a request to this effect, and more especially those whose telecommunications are insufficiently developed :

(i) the practical information contained in the documentation published by the C.C.I.s ?

(ii) documentation concerning telecommunications published in various countries and more especially in those where telecommunication services are best organized ?

(b) in which conditions and according to what methods could the Directors of the C.C.I.s assist coordinate the implementation of the General Interconnection Plan in its various phases and in the different regions on the basis of written reports supplied by the countries concerned ?

(c) how could the permanent organs of the I.T.U. and more especially the C.C.I.s cooperate in making arrangements for the holders of scholarships and fellowships of the various branches of telecommunication which certain countries might wish to send, at their own expense, and outside the Expanded Programme of Technical Assistance, for training periods in countries whose telecommunications are more developed, where they could complete or perfect their technical training ?

(d) in which conditions and according to what procedure could *ad hoc* Study Groups, composed of experts recruited from the normal C.C.I. Study Groups or elsewhere, be entrusted with the examination of the special problems submitted by Administrations or groups of Administrations and concerning the improvement of their telecommunication networks ?

and declares

That the organization which already exists for participation by the I.T.U. in the Expanded Programme of Technical Assistance can here and now be used by those countries whose telecommunications are insufficiently developed for the purpose of obtaining, at their own expense, and outside the Expanded Programme of Technical Assistance either the despatch of holders of scholarships or fellowships to appropriate countries or the services of experts from more developed countries.

Annex : Resolution 38 of the C.C.I.R.

RESOLUTION 38 OF THE C.C.I.R.

Technical assistance

The C.C.I.R., (Warsaw 1956)

Considering :

(a) Resolution 346 adopted by the 11th Session of the Administrative Council, reproduced in part in Document No. 491 of Warsaw;

(b) the growing importance of Technical Assistance in the sphere of telecommunications;

(c) the desirability of more effective collaboration in Technical Assistance on the part of the C.C.I.'s;

(d) that additional technical information which could be given by the I.T.U. to the Technical Assistance Administration (T.A.A.) may improve ways and means of granting technical assistance;

(e) the advisability of keeping the countries concerned rapidly and fully informed of all the work carried out under the auspices of the I.T.U.;

Resolves :

1. That a temporary joint C.C.I.R.-C.C.I.T. Committee be promptly established to study the present ways and means employed in granting Technical Assistance and to prepare for the

Administrative Council suggestions to improve them in respect of telecommunications. The detailed terms of reference of this Committee are given in the Annex;

2. That membership in the Committee proposed in paragraph 1. above should include the Director or the Vice-Director of the C.C.I.R., the Director of the C.C.I.T., two members of the C.C.I.R. and two members of the C.C.I.T., of countries which are not members of the Administrative Council of the I.T.U.;

3. That the Director of the C.C.I.R. should bring this Resolution to the attention of the C.C.I.T., the Secretary General of the I.T.U. and the Administrative Council.

ANNEX

1. Thorough study of the existing Technical Assistance procedure on the basis of the documentation supplied by U.N.O. and the I.T.U. and the answers to a Questionnaire which should be sent to the members of the I.T.U.

2. To study methods of improving and accelerating this procedure.

3. The most advantageous method whereby countries requiring Technical Assistance could obtain such assistance in the following forms, which are given as an example.

3.1 Consultations regarding plans for the development of telecommunication systems.

3.2 Expert study of telecommunication projects in various spheres (broadcasting stations, television stations, radio relay links, etc.).

3.3 Expert assistance in the planning, construction, assembly, and in the final adjustment of equipment.

3.4 Exchange of specialists in the sphere of radiocommunications, sound broadcasting and television, so that the experience acquired may be shared.

3.5 The sending of consultants and consulting-engineers at the request of a country receiving Technical Assistance.

3.6 Assistance in the training of technical personnel of a country receiving Technical Assistance —in the country receiving such Assistance or in the countries granting Technical Assistance— at the request of the country receiving Assistance.

4. Organization of a more extensive information service on the work carried out by the organs of the I.T.U.

QUESTIONS ENTRUSTED
TO
STUDY GROUPS AND SUB-STUDY GROUPS

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Line Transmission Questions

entrusted to

Study Group 1 and its Sub-Study Groups *

in 1957-1960

Question 1.

(Sub-Group 1/2, then Study Group 1)

(Continuation of Question 1 of C.C.I.F. Study Group 3, 1955-1956)

What limits should be recommended for the general characteristics given below for intercontinental circuits routed mainly in land cables with one or more short submarine sections where necessary and exceeding 2500 km in length ?

A. For variation of equivalent with frequency.

B. For variation of equivalent with time.

C. For non-linear distortion.

D. For internal noise of the transmission system irrespective of its origin.

Note. — For information see the following annex.

ANNEX

(to Question 1 of Study Group 1)

Proposals made in 1952-1954 and 1954-1956 by various Administrations on the subject of limits to be recommended for the general characteristics of intercontinental circuits routed mainly in land cables

I. — *Proposals by the French Administration (1952-1954).*

The French Telephone Administration thinks that the recommendations for planning purposes, based on the definition of the " Coaxial type nominal maximum circuit ", should be applicable to land circuits with one or more submarine sections.

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* The tables on pp. 313-318 summarize the Questions of which the preliminary study has been entrusted to Sub-Groups 1/1, 1/2, 1/3 and 1/4.

II. — *Proposals by the United Kingdom Administration (1955-1956).*

(A) The United Kingdom considers that only in exceptional instances would an international route be specially built for intercontinental circuits. Normally an intercontinental circuit would be routed over plant which is provided for use within a continent. Such plant is built to existing C.C.I.F. standards, i.e. circuits have a bandwidth of 300 c/s to 3400 c/s and this bandwidth would therefore be available for the intercontinental circuit. However, a long intercontinental circuit routed over a number of national networks would generally pass through more demodulating stages to audio frequency than a continental circuit and some relaxation in the C.C.I.F. recommended frequency characteristic may be necessary.

In exceptional cases where a long route is specially constructed, such as the provision of a long submarine cable, the bandwidth of each circuit is dependent on economic factors concerning the particular route. It should be the aim, wherever it is economically possible, to provide circuits with modern bandwidth.

(B) With regard to the variation of the equivalent as a function of time, it is the aim of the C.C.I.F. —not yet realized,— to achieve a maximum variation of $\pm 0{\cdot}2$ Neper on a 2500 km circuit. It is suggested that the aim for the longer inter-continental circuit should be a maximum variation of

$$\pm 0{\cdot}2\sqrt{\frac{L}{2500}} \text{ neper.}$$

(C) It is considered unnecessary to specify the non-linearity of an intercontinental circuit.

(D) The United Kingdom considers that the total circuit noise should correspond, with appropriate adjustment in relation to the length of the circuit, to the value recommended by the C.C.I.F. for international circuits within the same continent.

III — *Proposals by the Administration of the Federal German Republic in 1955-1956, for circuits routed entirely on land.*

A. *Variation of equivalent with frequency for an intercontinental circuit.*

In multi-channel carrier systems, attenuation distortion in the frequency band 300-3400 c/s is mainly determined by the channel filters. It is only in the case of very long circuits that the inevitable defects of equalization at the intermediate repeater stations contribute appreciably to attenuation distortion on a channel. In such cases it is useful to arrange for the insertion of a special equalizer in the channel, so that the variation of the equivalent, as a function of the frequency, conforms with the diagram given in the C.C.I.F. *Green Book*, Volume III, page 40.

In the case of very long circuits it can be expected that the curve (loss/frequency) will vary with time, in particular when the variation of cable attenuation with temperature (a variation which is not the same at all frequencies) is not entirely corrected by temperature equalizers at intermediate stations. It is not possible at present to say at what distance this influence becomes important for very long circuits. Nevertheless it can be expected that these variations with time could be corrected without difficulty during maintenance tests at several frequencies which should be made at suitable intervals.

The Federal German Administration proposes that the recommendations published in Volume III of the *Green Book*, page 40, should provisionally be applicable to intercontinental circuits, in particular, at first, to those up to 2500 km long. It will be useful if Administrations and private operating companies will study and indicate the way in which the curve of variation of equivalent with frequency varies with time in the case of very long circuits. The conditions for international and intercontinental circuits longer than 2500 km could then be fixed on this basis.

B. *Variation of equivalent with time for an intercontinental circuit.*

For the circuits considered here it may be supposed that a number of carrier circuits forming one or more basic 12-channel groups are required with a channel translation only at the ends. For this reason the use of a group reference pilot and an automatic level control for each group is assumed.

Experience to date obtained by the Federal German Administration on national circuits only, on carrier systems with manual regulation, shows that longer circuits (up to 2500 km) with a group pilot and automatic regulation, meet the requirements set up by the C.C.I.F. in the *Green Book*, Volume III, page 41, i.e. the variation of equivalent with time is $\pm 0{\cdot}2$ neper maximum. For circuits longer than 2500 km it is not yet possible to indicate the variations occurring in practice.

To be sure in every case of the stability of very long circuits, it appears useful to increase the equivalent and its tolerance a little and to accept provisionally the following recommendations.

TABLE 1

Equivalent and its variation with time in relation to the length of the circuit

Length (kilometers)	Equivalent (neper)
up to 2 500	0.8 ± 0.2
up to 5 000	0.9 ± 0.3
up to 10 000	1.0 ± 0.4

The application of such a measure would only slightly increase the total reference equivalent between subscribers. Nevertheless in view of the efforts being made in all countries to reduce the reference equivalents in national networks, a slight increase of equivalent in the exceptional cases of very long circuits appears to be justified.

C. *Non-linear distortion.*

Non-linear distortion for carrier circuits is mainly produced by the channel amplifiers. Distortion in modulators and line amplifiers can, on the other hand, be neglected. For this reason the C.C.I.F. recommendations in the *Green Book*, Volume III, page 51, can be extended without change to international and intercontinental circuits of any length.

D. *Internal noise of the system irrespective of its origin.*

For economic reasons it is necessary to use for intercontinental circuits the same cables, line amplifiers and translation equipment as are used for the international and national networks. Under these conditions the psophometric noise power (referred to a point of zero level) is necessarily a function of length.

$$P_{ps} = 10\,000 \times \frac{l \text{ km}}{2\,500 \text{ km}} \text{ pW}.$$

Table 2 shows the values of psophometric power and voltage corresponding to various lengths of circuit.

TABLE 2

Psophometric power at a point of zero relative level, and psophometric voltage at the end of a circuit, as a function of the length of circuit

Length	Psophometric power (pW in 600 ohms at a point of zero relative level)	Psophometric voltage	
		mV	at relative level (see Table 1)
2 500	10 000	1·1	— 0·8 N
5 000	20 000	1·4	— 0·9 N
10 000	40 000	1·8	— 1·0 N

The psophometric voltages shown in table 2 cause, as given in the information published by the C.C.I.F., *Yellow Book*, Volume VI, page 133 et seq., a reduction in the quality of transmission of 0·15 to 0·3 nepers. This can still be accepted for circuits of these lengths.

In normal carrier systems, the low frequency channels have psophometric powers smaller than those at high frequencies. For this reason, it is desirable to choose, if possible, telephone channels corresponding to the lowest frequencies for long international and intercontinental circuits. It can then be expected that the psophometric voltages would be less than those in table 2.

IV. — *Proposal made by the American Telephone and Telegraph Company in 1955-1956.*

The American Telephone and Telegraph Company does not opérate any intercontinental land-line cable circuits at present and does not foresee any such circuits in its future services. If introduced later they might well involve transmission designs different from any now used and make detailed recommendations arrived at now of little practical importance. In general terms, however, the lengths contemplated in the question (2500 km or greater) do not present problems different from those now encountered in this country or Europe, and we do not see why such circuits should not have the same objectives as present high-grade international circuits. It seems that a realistic recommendation would be one along the lines we suggested in 1953, namely,

" To the extent technically and economically feasible the objective should be to engineer intercontinental land-line circuits to the same standards considered desirable for circuits of continental type. Decisions to depart from such standards, whether because of the circuit length, the inclusion of short or long submarine sections, or for any other reason are a matter of agreement between the interested parties."

Question 2.

(Study Group 1 in co-operation with Study Groups 3 and 5 and with the C.C.I.R.; preliminary study by Working Party on " Noises ")

(Continuation of Question 2 of C.C.I.F. Study Group 3, 1955-1956)

Considering that it is desirable that all intercontinental circuits should, in the future, transmit effectively the band of frequencies from 300 to 3400 c/s, will it be possible to fix, for these circuits, an allowable limit for the psophometric electromotive force measured at the incoming switchboard jack ?

Note 1. — Noise on radio relay links (using frequencies above 30 Mc/s approximately) is studied in Questions 6 and 7 below.

Note 2. — A distinction should be made between these categories of intercontinental circuits :

1. Entirely land circuits.

2. Land circuits with one or more submarine sections :

   (a) the case of a short submarine cable,
   (b) the case of a long deep-sea cable.

3. Radio telephony circuits :

   (a) the case of a circuit routed wholly on ultra-high frequencies,
   (b) the case of a circuit routed wholly on long or short waves.

As regards categories 1, 2*a* and 3*a*, the present state of the techniques leads it to be expected that the standards of the C.C.I.F. may always be satisfied in the future. (The case of a long intercontinental line on open wire should be the object of special consideration—see especially Question 38 below.)

As regards category 2*b*, if the development of submerged repeaters is continued as expected, it would appear technically possible that the standards of the C.C.I.F. might be satisfied for each telephone channel of an intercontinental line including a long submarine section. Economic consideration might modify this viewpoint in certain cases.

As regards category 3*b* (long or short wave radio telephony circuits) there are uncontrollable factors : but the attention of interested Administrations and/or Private Operating Companies should be drawn to the importance of the best possible auxiliary equipment.

Note 3. — The following Annex contains the reply by the American Telephone and Telegraph Company made in 1955-56 to Question 2 of C.C.I.F. Study Group 3; the reply by the United Kingdom Administration is given above in the Annex to Question 1.

ANNEX

(to Question 2 of Study Group 1)

Reply of the American Telephone and Telegraph Company in 1955-1956 to Question 2 of C.C.I.F. Study Group 3

We believe that intercontinental telephony would be better served if the concept of a " permissible limit " were changed to one of a " design objective ". This latter has proved to be workable in the Bell System network and a suitable recommendation would be :

" In so far as it is practicable and economic to do so, the noise at the terminal of intercontinental circuits in terminal service condition should be kept to such values that will not contribute an assignable noise transmission impairment. At the present state of the art this condition will be fulfilled if the noise does not exceed 29 dba." *

Question 3.

(Study Group 4 in co-operation with Sub-Group 1/3, then Study Group 1)

(Question 3 of Study Group 4) (New Question)

What are the actual service values of

(a) frequency deviations,

(b) sudden phase-changes

observed on carrier telephone circuits used for voice-frequency telegraphy ?

Note 1. — This question is in response to a request made by the telegraph services for the purpose of forming recommendations for the use of frequency-modulated systems of voice-frequency telegraphy. This request is the subject of the following Note by the C.C.I.T. issued during its VIIIth Plenary Assembly, Geneva, December 1956 (Annex 1).

Note 2. — Annex 2 below contains results of frequency deviation measurements carried out by the Swiss Administration in 1956.

ANNEX 1

(to Question 3 of Study Group 1)

Note by the C.C.I.T.

The C.C.I.T.,

Considering

That there is need to introduce, particularly for international telegraph circuits of great length operating under adverse conditions, frequency-shift modulated voice-frequency telegraph systems;

That the standardization of the characteristics of such systems has been recommended and that studies of this subject are in progress;

Tha the frequency deviation and channel spacing of such systems will be largely determined by the frequency stability of the telephone circuits over which they work;

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* *Note by C.C.I.T.T. Secretariat.* — The American psophometer has the same characteristic curve as the psophometer standardized by the XVIth Plenary Assembly of the C.C.I.F. Indications are given in adjusted decibels (dba) above a reference point corresponding to a sine wave calibrated in 1000 c/s and having an absolute power level of — 85 db. It is pointed out that frequency 1000 c/s has a weight of + 1 db (in relation to the reference frequency of 800 c/s) with the C.C.I.F. psophometer graduation.

That the lengths of circuit over which such systems will operate make it highly desirable to obtain as many channels as possible from each telephone circuit and, for this reason, the recommended frequency deviation of the frequency-shift channels may be as little as ±30 c/s;

That the present limits for frequency error in carrier telephone channels have been set by considering the requirements of amplitude modulated telegraphy and phototelegraphy;

Requests

1. That Administrations should undertake measurements to determine what frequency errors do exist in the carrier telephone channels at present used for voice-frequency telegraphy;

2. That Administrations should undertake measurements to determine in typical cases what transient frequency errors occur in carrier telephone channels used for voice-frequency telegraphy in consequence of a change-over of carrier supplies, loose connections, discontinuity of resonance frequency in piezo-electric crystals, irregular working of thermal controls, sudden variation of power supplies, etc., and that these measurements should not be limited only to variations in master oscillators, but should include also the effects introduced in the actual carrier supplies.

Remark. — Attention is drawn to the fact that a difference of phase existing between carrier supplies at the moment of change-over from one to another may produce an adverse effect on any voice-frequency telegraph system. It would be useful to determine the maximum phase difference which might exist at the instant of change-over, if precautions were to be taken to make a voluntary change-over at the optimum moment.

ANNEX 2

(to Question 3 of Study Group 1)

Frequency deviations on telephone circuits

(Measurements carried out by the Swiss Administration)

Below are given some results of measurements of frequency deviations on carrier telephone systems, carried out on the network of the Swiss Administration.

In order to determine these deviations we compared, every day except Sundays, the frequency of 10 master oscillators for coaxial pair telephone systems with :

(a) the carrier frequency (200 kc/s) of the Droitwich transmitter (making allowances for monthly corrections),

(b) the standard frequency of the Neuchâtel Observatory.

Leaving aside short-term variations, a steady rise in the frequency was noted due to the ageing of the crystal.

There was an average increase of $8{\cdot}9 \times 10^{-5}$ c/s per day for an oscillator frequency of 100,000 c/s or $8{\cdot}9 \times 10^{-10}$ per day and per c/s. The least stable of the oscillators under observation gave a value of 26×10^{-10} c/s while the most stable gave 4×10^{-10} c/s. Only one of the oscillators showed a slight steady frequency decrease of $2{\cdot}4 \times 10^{-10}$ c/s per day and per c/s.

By taking the basic stability of $\pm 1 \times 10^{-7}$ recommended by the C.C.I.F. on page 85 of Volume III of the C.C.I.F. *Green Book* (and leaving aside once again the short-term variations) it is possible to determine the maximum optimum period during which oscillators do not need to be readjusted. It is sufficient to divide the maximum admissible variation by the daily variation. In our specific case we obtain

$$\frac{2 \times 10^{-7}}{8{\cdot}9 \times 10^{-10}} = 225 \text{ days}$$

for average oscillators. For extreme cases we obtain 77 and 830 days respectively.

But to these steady variations due to ageing of the crystal we must add irregular variations caused by changes of temperature, variations of the supply voltage, inaccurate measurements, etc. The curves for frequency variations as a function of time then become jagged and the theoretical period between two consecutive adjustments is reduced.

The average of this reduced period for the ten oscillators is 141 days, while for the extreme cases we obtained about 60 and 360 days.

We may therefore conclude that if adjustments are carried out at shorter intervals than those determined above, the stability of $\pm 1 \times 10^{-7}$ recommended by the C.C.I.F. can be satisfied.

Measurements carried out over a much shorter period on master oscillators for symmetrical pair carrier systems produced similar results.

No information on abrupt phase changes can be given for the time being.

Question 4.

(Sub-Group 1/2, then Study Group 1 in co-operation with Study Group 11)

(Question 4 of Study Group 11) (New Question)

Considering :

That international automatic or semi-automatic calls are at present restricted to routing comprising not more than two international circuits in tandem;

That such a restriction constitutes a grave handicap for the complete development of the European Interconnection Plan;

That studies are proceeding to see whether variations in circuit-equivalent, as a function of time, will enable this equivalent to be kept within limits sufficiently narrow so that three international circuits could be connected in tandem.

Is the position of the European network as regards variation in circuit-equivalent sufficiently improved so that when using signalling equipment conforming to the specifications in Vol. V, routings which comprise three international circuits connected in tandem may be permitted ?

Note 1. — The quality of telephone transmission, during speech, on the chain of national and international circuits forms the subject of Question 9.

Note 2. — The Annex to Question 1 of Study Group 4 contains the results for variations of equivalent in international circuits, obtained in 1955-1956 during the 5th series of C.C.I.F. tests.

Question 5.

(Sub-Group 1/2 and Study Group 1 in co-operation with Study Groups 5, 11 and 12)

(Continuation of Question 5 of C.C.I.F. Study Group 3, 1955-1956)

(a) Determination of a curve of general application giving the transmission impairment due to circuit noise as a function of the readings of the C.C.I.F. standard psophometer connected across the end of the chain of international and trunk circuits.

(b) What means should be recommended for reducing the different types of circuit noise, other than induced noise, to such values that they no longer produce any appreciable impairment of the quality of telephone transmission ?

(c) What is the value of the psophometric voltage produced by power lines which can be considered as admissible at the terminal group centre serving a subscriber ?

Note 1. — Part *(a)* of this Question will first be studied by Study Group 12 (Question 4 of Study Group 12), which will report to Study Group 1. Part *(b)* will be studied by Sub-Group 1/2 in co-operation with Study Group 11. Part *(c)* will first be studied by Study Group 12 (Question 5 of Study Group 12) as regards the normally admissible limit; action to be taken when the limit is exceeded is considered in Question 5 of Study Group 5.

Note 2. — The following Appendix reproduces the joint report of the Working Parties of the C.C.I.F. Study Groups 3 and 4 (which met in November 1956) charged with the study of questions of noise. Appendix 2 below concerns a provisional recommendation given in *Directives concerning the protection of telecommunication lines against the adverse effects of power lines* and which relates to part *(c)* of this question.

ANNEX 1

(to Question 5 of Study Group 1)

Report of the joint meeting of the Working Groups of the C.C.I.F. Study Groups 3 and 4 for the study of questions concerning noise

This joint meeting took place on Tuesday, 20th November 1956, under the Chairmanship of Mr. H. Williams (United Kingdom).

Consideration was given at the meeting to Questions 5 and 6 of C.C.I.F. Study Group 4 and Questions 5 and 23 of C.C.I.F. Study Group 3. Study Group 4 had presented proposals which it thought would lead eventually to final replies to all these questions. These proposals were presented in the form of a report by the Working Group of Study Group 4 for its questions 5 and 6. (This report has provided material for Annexes 2, 3 and 4 to Question 4 of Study Group 12, and for Annex 2 to Question 6 of Study Group 12).

The Working Group of the Study Group 3 declared itself to be in full agreement with the principles of the method proposed in this document for dealing with the problems involved in these questions. The method consisted of collecting under specified testing conditions the opinions of typical telephone users.

The Joint Working Group agreed with the proposed manner of presenting the results of such tests but a choice may later need to be made as to whether the quality of transmission should be expressed in terms of the " mean opinion score ", as in figures 3*a*, *b*, *c*, *d* and *e*, or as a percentage of " satisfied users ", as in figure 4 of the report quoted (Annex 2 to Question 4 of Study Group 12).

Some consideration was given to Annex 4 to Question 4 of Study Group 12 which suggested improvements which should be incorporated in any future tests made on these lines. It was agreed that these suggestions be adopted.

Specifically the reply to part *a* of Question 5 of C.C.I.F. Study Group 4 would be that the recommended method for determining the effect on transmission of circuit noise is the method based on users' opinions. No reply can be made to part *b* of Question 5 of C.C.I.F. Study Group 4 until the opinion tests are completed and a decision can be made concerning what is considered a reasonable quality of service with the " mean opinion score " or the percentage of " satisfied users ".

Concerning part *a* of Question 5 of C.C.I.F. Study Group 3, it was noted that as the noise transmission impairment for a given level and type of noise is dependent on the loss of the circuit, the reply to this part of the question will take the form of a family of curves instead of a single curve.

It is noted that provisional limits of circuit noise have been adopted by C.C.I.F. Study Groups 1 and 3 as follows :

(a) At the end of an International Circuit, i.e. at a point of −7 db relative level : 2 mV e.m.f. This is equivalent to a level of 10 000 pW at the point of 0 relative level. This applies for noise originating in the telephone system (Volume III of the *Green Book*, page 42, § 1.3.8 refers).

(*b*) At the terminals of a subscribers set for the case of noise induced from sources outside the telephone system : 1 mV e.m.f. (see Annex 2 below).

The noise is measured in either case with the C.C.I.F. psophometer having commercial telephone circuit weighting.

The availability of the opinions data referred to above will enable the effect upon the quality of transmission of these levels of noise to be studied.

A reply to Question 6 of C.C.I.F. Study Group 4 dealing with noise on radio relay links, can be made when Study Group 4 has completed the opinion testing programme and has selected a suitable family of curves relating transmission quality with circuit noise level and circuit loss. When this has been done it will be possible to consider statistical distribution curves of circuit noise with time that are submitted by Study Group 3 and to estimate the corresponding grades of service.

The form of presentation of the noise distribution curve will depend on the purpose for which it is intended. For speech studies the basis should be the proportion of time intervals of one minute for which the mean noise power (psophometrically weighted) does not exceed each of a number of levels.

Other durations appropriate for studies in connection with voice-frequency telegraphy or signalling should be decided by the C.C.I.T. or C.C.I.F. Study Group 8 accordingly.

It was decided that Study Group 3 would select several hypothetical noise distributions for radio relay links and submit them to Study Group 4 in order that the grades of service might be determined and hence lead eventually to a final reply to Questions 6 of C.C.I.F. Study Group 4 and 23 of C.C.I.F. Study Group 3.*

ANNEX 2

(to Question 5 of Study Group 1)

Passages in the Directives referring to inducted noises in telephone circuits

The XVIIIth Plenary Assembly of the C.C.I.F. approved a new text for the first two parts of the *Directives concerning the protection of telecommunication lines against the adverse effects of power lines.* The passages of this new text relative to the limit of induced psophometric e.m.f. in audio-frequency telephone circuits (open-wire or cable) are reproduced below. These passages replace in particular paragraphs 93 and 100 of the *Directives* (Geneva revision, 1952).

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* Annex 4 to Question 7 of Study Group 1 (see hereafter) gives more recent and detailed information on this subject.

" § 15. *Comments on calculation of interference*

. . . . . .

225. Resulting from these considerations, the values of calculated psophometric electromotive force are not so exact as the values of electrically induced currents or induced electromotive forces calculated in connection with the assessment of the risk of danger. They only represent an order of values, and even then, are not very precise. However, carefully interpreted, the results of the calculation do indicate, for example, if a proposed situation entails any risk of inadmissible interference, or, in other cases, if a particular special simple arrangement would be sufficient to eliminate the noises, or even if it would be better to consider a major modification to the project.

§ 16. *General Principle.*

226. The psophometric e.m.f. corresponding to the noise due to magnetic and/or electric induction from a group of electric lines, arising in one or more parts of a chain of lines connecting a subscriber's station to its international exchange should not exceed 1 millivolt, this value being measured at the " line " terminals of the subscribers set (when receiving) and for the case when the telecommunications installations in the chain are perfectly symmetrical with respect to earth. *

227. With regard to the resulting noise, it is generally possible in practice to determine, for each national network, the switching centres which correspond, for long distance national communications, with the international exchange in international communications.

228. It is then sufficient to determine the psophometric electromotive forces arising from the whole of the electric lines in one or more sections of the chain of lines which connect such a centre to the subscriber's station.

§ 17. *Overhead open-wire telephone lines.*

229. In certain cases where it would be too difficult or onerous to have adequate spacing between an electric line and an overhead open-wire telephone line, keeping within the limit of 1 mV for the psophometric e.m.f., conforming to sub-paragraph 226 (a limit which must be respected if it is desired to include an audio circuit in the make up of a long distance communication), can necessitate, in exceptional circumstances, the introduction of certain special arrangements, consisting, for example, of adding certain devices to the overhead open-wire line or having recourse to another type of construction or method of operation.

230. In order to assess the risks of interference of a permanent or lasting character which would arise from a projected approach of an electric line to a telephone line, it is necessary to determine by calculation, the values of the psophometric e.m.f. likely to appear in the most unfavourable circumstances.

231. From the point of view of calculations, it is possible to separate the components of the resulting noise into those due to electric induction and those due to magnetic induction. When it has been possible to foresee, that certain of these components are negligible when compared with others, and that consequently, it is unnecessary to calculate them, this is indicated in the following sub-paragraphs. Where it has been recommended that the noise components be calculated, the resulting e.m.f. is obtained by quadratic addition of the e.m.f. components.

Note by C.C.I.T.T. Secretariat. — § 18 (" Cable telephone lines ") of the new text mentions no exceptions to the general principle stated in § 16 which can hence be applied completely to this type of line.

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* Even if the limit fixed for the psophometric e.m.f. determined in this case is respected, the noise which is heard in the subscriber's receiver can be inadmissible if the installations forming the chain of circuits considered are not sufficiently symmetrical with respect to earth.

Information on the effects of dissymmetry on lines and equipment is given in chapter...

Question 6.

(Study Group 1 in co-operation with Study Groups 3 and 12; preliminary study by Working Party on "Noises")

(Question 6 of Study Group 3) (Continuation of Question 23 of C.C.I.F. Study Group 3, 1955-1956)

What is the variation (as a function of time) of the ratio between the signal and noise that might be allowed in an international telephone communication ?

Note. — Study of this question should be continued, as non-urgent, assuming :

(1) Study Group 1 will continue to study the subject of permissible noise on carrier systems during brief periods, within the framework of its Question 27;

(2) Study Group 1 will be able to supply useful information to Study Group 12 on the tests suggested in the new text of Question 6 of Study Group 12.

Question 7.

(Study Groups 1, 3 and 9 in co-operation with the C.C.I.R.; preliminary study by a joint C.C.I.T.T./C.C.I.R. Group)

(Question 7 of Study Group 5) (Continuation of Question 24 of C.C.I.F. Study Group 3, 1955-1956)

Will it be possible to have a clause concerning the total noise which is common to all systems of wideband carrier transmissions (coaxial cable systems, systems of symmetrical pair cable and systems on radio relay links) ?

Note 1. — In its reply to this question in Geneva, 1956, the C.C.I.F. Study Group 3 has agreed a common clause noise for carrier systems on symmetrical pairs, coaxial pairs and also on radio relay links. This is in the form of a mean noise clause in conjunction with a hypothetical reference circuit.

Administrations are now asked to consider whether it is also desirable to agree, as an objective for the design of carrier systems :

(a) a distribution of noise with time;

(b) how this distribution should be divided for the shorter sections of the hypothetical reference circuit.

Note 2. — Study Group 12 should provide results of opinion tests which may be useful for the study of this question. (See also Question 5.)

Note 3. — Annexes 1, 2 and 3 below reproduce respectively the observations of the Administrations of Italy, the United Kingdom and France on the subject of Question 24 studied in 1956 by the C.C.I.F. Study Group 3. Annex 4 gives a report of the first meeting

(February 1957) of a Working Party which drew up a programme of measurements to be taken for the study of this question. The Appendix below reproduces the recommendations made by the VIIIth Plenary Assembly of the C.C.I.R. (Warsaw, 1956) on the subject of admissible noise in the hypothetical reference circuits for radio links.

ANNEX 1

(to Question 7 of Study Group 1)

Reply made in 1956 by Italian Telephone Administration to Question 24 of C.C.I.F. Study Group 3

The Italian Administration feels that the question can be interpreted in two different ways according to whether the noise is : (1) at the end of the nominal maximum circuits adopted or which are to be adopted for the various wide-band carrier telecommunication systems; or (2) at the end of physical circuits which have actually been built.

1. With regard to noise at the end of the nominal maximum circuit for multichannel wide-band carrier systems, the Italian Administration feels it would be desirable to have a common clause which would apply for coaxial pair, symmetrical pair, and radio relay systems. This clause might be worded as follows :

> " The noise at the end of the nominal maximum circuit of 2500 km, ignoring the contribution from channel, group and super group modulation and demodulation, should be below or equal to 7500 pW, when load conditions of the system are those to be expected during the busy hour."

In the case of radio relay systems it would also be necessary, so that this clause may be applicable and constitute a really efficient guide for designing the manufacture of equipment, to specify the make-up of the nominal maximum circuit; proposals for this purpose are given in the reply to Question 34*bis* of Study Group 3 (which led to Question 32 of Study Group 1).

2. Recommendations concerning noise at the end of physical circuits should, in general, be established in the light of two considerations. The first is that transmission performance on all telephone circuits should be satisfactory and should afford good intelligibility irrespective of the type of transmission used. For this reason noise characteristics on this circuit, such as the average value and the value exceeded only for a fairly small and clearly determined percentage of time (for example, of the order of 0·01 %), should satisfy the same recommendations for all transmission systems.

Moreover, it should not be forgotten that for the same geographical distance telephone circuits using differing transmission systems may be subject to noises having differing characteristics and volumes, even if they have been carefully studied.

ANNEX 2

(to Question 7 of Study Group 1)

Supplementary reply made in 1956 by the Administration of the United Kingdom of Great Britain and Northern Ireland to Question 24 of C.C.I.F. Study Group 3

1. C.C.I.F. Study Group 3 has already made certain proposals based on the mean value of the psophometric noise power taken over periods of one hour. (Doc. 49 of Study Group 3, p. 78.) The C.C.I.R., at its meeting in Warsaw, made a provisional recommendation that for radio circuits the psophometric noise power at zero level on the hypothetical reference circuit (excluding noise

due to frequency-division-multiplex equipment) should not exceed 7500 pW in any hour (see the Appendix below).

The United Kingdom Administration considers that these proposals and this recommendation might form the basis for a general recommendation for a design objective applying to all types of broad-band systems, whether cable or radio.

The United Kingdom Administration therefore suggests that the C.C.I.F. recommendation for all types of systems might take the following form :

> " The design objective for broad-band telephony links of all types, whether cable or radio, should be such that circuits intended for international service could form part of a 2500 km hypothetical reference circuit appropriate to the type of system *, in which the mean value over any hour of the psophometrically-weighted noise power, from all sources, at a point of zero relative level, should not exceed 10 000 pW."

In the application of this recommendation to the design of a particular system, it must be recognized that in practice the noise on a circuit may be not only a function of the total noise power (contributed by many channels) on the individual links, but also a function of time, for causes not related to signal power—e.g., to fading on radio systems.

Thus, in assessing performance in relation to the recommendations, it would strictly be necessary to assume a variation of total signal power in some manner from hour to hour during the day, week, month and year. In order to avoid the difficulty of prescribing such a variation, it is therefore suggested that the C.C.I.F. Recommendation should include the following provision :

> " It is to be assumed that, for every channel on every link over which the hypothetical reference circuit is routed, the mean signal power over every hour is equal to the nominal busy-hour signal power ** adopted by the C.C.I.F. for design purposes."

2. The preceding recommendation refers to the coarse structure of the noise on a circuit, i.e. the hour-to-hour variations. It remains to specify the finer structure of the noise, in so far as it may affect the transmission performance for telephony and telegraphy. The questions to be answered are :

(a) Assuming that the most convenient measure of the noise is the power averaged over some period of time, what period of time should be taken ? Periods that merit consideration are :

(i) A period comparable with the duration of a telephone call;

(ii) 5 seconds;

(iii) 200 milliseconds, corresponding to measurements made with a psophometer and to the duration of syllables in speech;

(iv) 20 milliseconds, which would be relevant in the case of telegraphy.

(*b*) What recommendation should be made in relation to the variation of the noise power from one such period to another ?

The United Kingdom Administration proposes for consideration that the noise, as measured on a 2500-km hypothetical reference circuit by means of the psophometer standardized by the C.C.I.F., should not exceed 100 000 pW for more than 0·01 % of any month.

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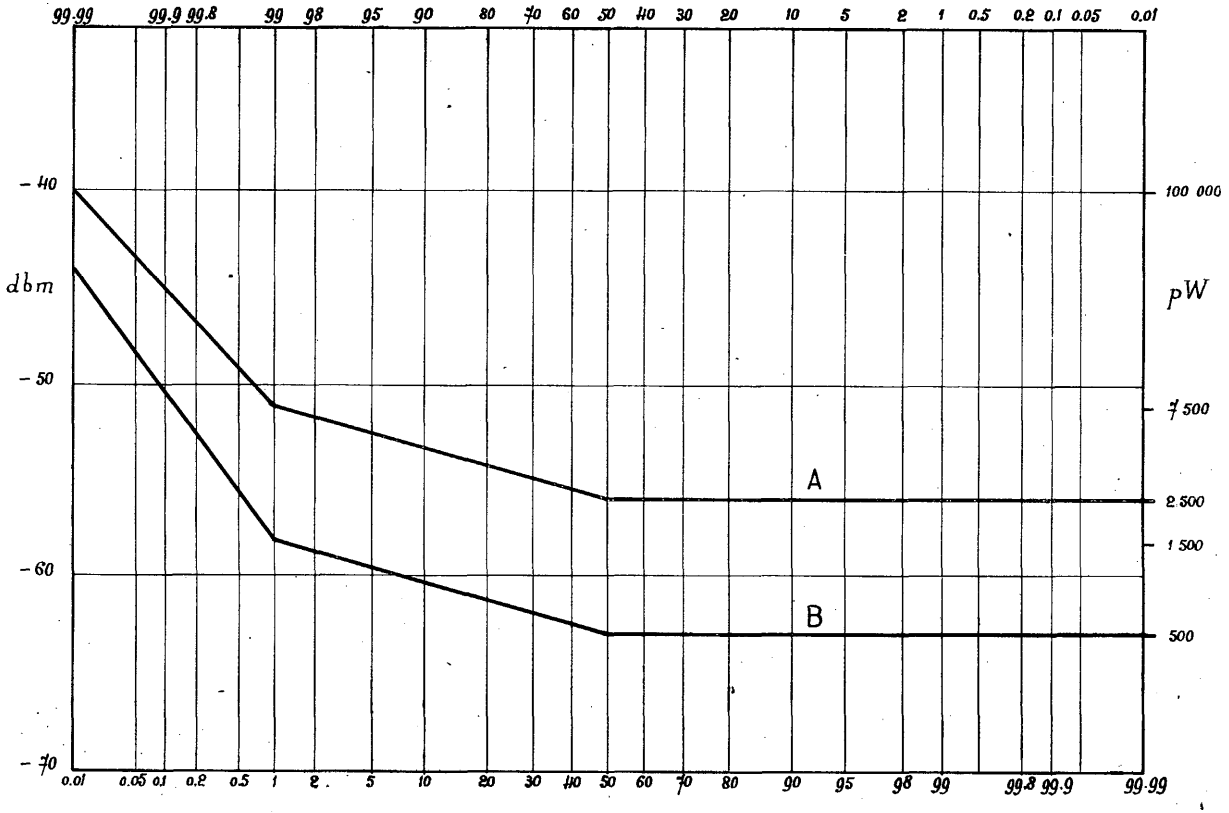
* See C.C.I.F. *Green Book*, Volume III, sections 3.4.1*(d)* and 3.3*(a)*, and the Appendix to Question 32 of Study Group 1.

** i.e. 31.6 microwatts (—15 dbm or —1.73 nepers) at a point of zero relative level.

Allowable weighted noise power at zero level, excluding noise due to F.D.M. terminal equipments

A. — Suggested for 2500 km hypothetical reference circuit

B. — Assumed for 500 km circuit



Percentage of any month

United Kingdom — Distributions for noise on radio circuits

3. In order to facilitate the subdivision of the noise for a hypothetical reference circuit comprising N equal sections, the following principles might be followed :

(1) The mean psophometric noise power over any hour allowed on each section should not exceed

$$\frac{10\,000}{N} \text{ pW}$$

(2) The period of time during which a psophometric noise power of 100 000 pW must not be exceeded is

$$\frac{0{\cdot}01}{N}\,\% \text{ of any month.}$$

Information supplementary to previous contributions by the United Kingdo m Administration to the study of the Question 24 of C.C.I.F. Study Group 3

The United Kingdom Administration considers that the performance of a telephony network is best assessed in terms of the opinions expressed by subscribers concerning the degree of satisfaction afforded by their telephone calls. The United Kingdom Administration made a statistical study, from this point of view, for a distribution of noise as a function of time that might be representative of noise on radio circuits (see diagram above). The statistical study is contained in Annex 2 to Question 6 of Study Group 12. In this study a subscriber is said to be satisfied if he declares that he has had to use no more than moderate effort in conversing. It should be mentioned that the results are considered to give guidance useful in the comparison of different noise distributions, but that calculations to give absolute results for any particular distribution depend on data which are still under consideration by C.C.I.F. Study Group 4.

ANNEX 3

(to Question 7 of Study Group 1)

Contribution made in 1956 by the French Administration in reply to Question 24 of C.C.I.F. Study Group 3

The French Administration feels that this question can be interpreted in two different ways according to whether :

(1) the admissible noise is *measured* at the end of the physical international circuit,

(2) the admissible noise is *calculated* at the end of the nominal maximum circuit.

1. *Admissible noise measured at the end of an international circuit.*

The limits to be considered refer to the noise which it is thought desirable not to exceed in order to ensure satisfactory quality for the subscriber. These limits are obviously common to all systems; values for these limits were fixed as the result of subjective tests carried out by the 4th C.C.I.F. Study Group.

They form the subject of the recommendation in the *Green Book* Volume III, § 1, 3 and 8, page 42 amended in March 1956 by Annex 3 of the common reply by the Study Groups 3 and 5 to Question 24 of Study Group 3, page 82 of document " C.C.I.F. — 1955/1956 — 3rd S.G. — Document No. 49 ". It is desirable that total circuit noise (including non-linear cross-talk), *measured* at the end of a circuit by means of a C.C.I.F. level recorder, should not exceed a value corresponding to a psophometric e.m.f. of two millivolts at a point of relative level of $-0{\cdot}8$ nepers of -2 decibels.

It appeared nevertheless that the reduction in telephone quality was a function of noise voltage fluctuations over a period of time, and C.C.I.F. Study Group 4 examined subjective tests which should enable a recommendation to be made on the matter in the form of an admissible noise voltage distribution curve.

2. *Admissible noise calculated at the end of a nominal maximum circuit.*

The values fixed for this noise should serve as a basis for the establishment of clauses specifying equipment to be used on the system corresponding to the nominal maximum circuit under consideration. These values should derive from the common recommendation relative to noise in physical circuits but they should not be embodied in recommendations if they are of no direct use for plans; it is, therefore, very desirable that they should be expressed in a form adapted to such use for each type of system considered. In these circumstances recommendations relative to the different types of nominal maximum circuits may differ even though they derive from the common clause relative to physical circuits.

It is with this in mind that, for the purposes of cable circuits, the Study Group 3 makes the recommendations relative to the nominal maximum circuit apply to the average psophometric force " during the busy hour ".

The corresponding recommendations are shown on page 81 of Document No. 49 of Study Group 3; to make these recommendations usable, it remains for Question 34 *bis* to be re-examined.

With regard to the radio relay link, the study being made by the C.C.I.R. for the purpose of fixing recommendations, taking account of attenuation fluctuations due to the path, should be based on the considerations mentioned above.

ANNEX 4

(to Question 7 of Study Group 1)

Report on the meeting of the Working Party on Noise of C.C.I.T.T. Study Group 1

(Geneva, February 25-27, 1957)

The C.C.I.T.T. Working Party on Noise met in the Maison des Congrès, Geneva, Switzerland, from 25 to 27 February, 1957. The Chairman was Mr. H. Williams (United Kingdom).

Papers for this meeting were contributed by :

The United Kingdom Administration;
the Bulgarian Administration;
the Federal German Administration;
the Cuban Telephone Company.

The Working Party's terms of reference were limited to :

1. Determination of the four critical elementary durations for :
   (a) telegraphy;
   (b) telephone signalling;
   (c) telephone conversation;
   (d) television.
2. Information to be given to Administrations, so that curves showing noise variation on radio relay systems in service may be uniformly plotted.
3. Decision as to the types of test to be undertaken later to determine the admissible noise limits for telegraphy and signalling; if necessary, points to be settled in order that, in telephony, the method of observing the opinions of telephone users defined by the C.C.I.F. Study Group 4 may be applied (noise limits in television are, of course, a matter for the joint C.C.I.R./C.C.I.T.T. Study Group on television transmission).
4. An estimate of how long such tests would take.

The replies given by the Working Party to these four points appear below, a section being devoted to each point.

The Working Party's recommendations can be summed up in the three proposals which follow :

1. Permanent noise observations should be effected on a telephone channel of a radio relay system. A minute-by-minute analysis would give a noise distribution curve. A detailed study of the outcome of these observations would be made at a meeting attended by representatives of the Administrations taking part in the tests.

2. Administrations and Private Operating Agencies might consider it useful for a choice to be made of representative magnetic-tape recordings of high noise encountered on radio relay systems, so that tests could be made to determine the effect of such noise on :

(a) telephone calls (by sounding the views of typical telephone users);

(b) telephone signalling and telegraph transmission.

The choice of these recordings and responsibility for studying the effect of such noise on the type of transmission under consideration would be left entirely to the initiative of the Administrations and Private Operating Agencies wishing to undertake tests of this kind.

3. Metering should be undertaken to shew how many times in a month a certain high noise level is exceeded. Such metering would be designed to define the conditions in which radio relay systems are used for telegraphy, and for automatic telephony, if desired. The outcome of such metering, like the outcome of the observations described in § 1 above, would be referred to the C.C.I.T.T. Secretariat.

SECTION I

Determination of the critical elementary durations

(a) As regards telegraphy, the critical elementary durations extend from a few milliseconds to several dozen milliseconds. If a figure has to be quoted, then perhaps five milliseconds might serve for further study.

(b) As regards telephone signalling, the position is somewhat similar to that obtaining in telegraphy.

(c) As regards telephone calls, in accordance with the opinion expressed by C.C.I.F. Study Group 4 (see Question 6 of Study Group 12), the noise conditions defining transmission performance are those encountered throughout the entire call, and it is reasonable to perform the measurements on the basis of average noise power throughout one minute.

(d) As regards television, the Working Party cannot lay down precise figures, adequately justified. But it feels that if consideration be given to noise likely to entail a deterioration in transmission performance (graininess), the noise which might be considered as disturbing might be taken as lasting from two to five seconds.

(e) The Bulgarian Administration has asked that consideration be also given to circuits for programme transmissions. Here again, the Working Party had little data to work on. For the time being, it may be taken that noise lasting from two to five seconds would probably cause an appreciable falling-off in quality music programmes.

From these various figures, it will be seen that analysis of noise in radio relay systems ought in certain cases to be a very detailed one, bearing on durations of several milliseconds, and that, in the case of telephone calls, the duration of interest would be about one minute.

Furthermore, it seems very unlikely that, in radio relay systems, fading will be encountered lasting less than one second (in certain kinds of radio relay systems, two hundred milliseconds). It is also very unlikely that there will be more than one high peak of noise in the course of a minute.

Hence the Working Party recommends the following procedure :

(a) Detailed measurements, minute by minute, of the average noise power, to determine the noise distribution curve.

(b) For the time being, no closer analysis of the nature of the noise met with is to be made.

(c) Use of specimen recordings of noise on magnetic tape, in order to undertake tests of the influence of great noise on modes of transmission, such as telegraphy and telephone switching.

SECTION II

Determination of the curve of noise distribution on a telephone channel in a radio relay system

2.1. *Aim. Type of measurements made.*

The curve to be obtained is of the type shown in figure 1, giving the distribution of the noise on a telephone channel in a radio relay system. The most interesting part of the curve is the left-hand side corresponding to probabilities of occurrence of great noise, probabilities lower than 1 % for instance.

This curve will be determined by making measurements on a telephone channel in a radio relay system *every minute* for a period of several months, considered in principle as equal to one year.

The measurement will give a value representing, if not the mean noise power during the minute under consideration, at least a figure very close to that power.

2.2. *Measuring set used.*

2.2.1. The set will show the noise power on the telephone channel during an interval of one minute, the measurement being made with a *time constant* for the set equal to one minute (time constant for the indication of power).

2.2.2. An apparatus that might be used for these tests would be an amplifier followed by a thermo-couple with a voltage output high enough to operate a " dot recorder " (see figure 2). The characteristics of this apparatus are described in the Note of the German Federal Administration which forms the subject of Appendix 1 below.

Since the only interesting part of the curve, as we have seen, is the left-hand side, two sensitivities must be arranged for the set :

— a sensitivity of about 3 000/30 000 picowatts,

— a sensitivity of about 30 000/300 000 picowatts.

Analysis of the paper tape bearing the recordings can be carried out fairly quickly since accurate analysis is required for only 1 % of the time.

2.2.3. Other types of equipment can also be used, e.g. Miller integrators. If the results obtained with different equipment are to be comparable, it will suffice for the time constant of each measurement set to be adjusted to exactly *one minute*.

2.2.4. Use may also be made of an apparatus giving a direct measurement of the mean power over the period of one minute (picowatt-second counting device with motor integration). An apparatus of this type is described in a Note by the British Administration which forms the subject of Appendix 2 to this document.

An apparatus of this type will not give results which are directly comparable to those obtained with the apparatus mentioned in the two preceding paragraphs, but it is not likely to result in important differences for the establishment of a noise distribution curve.

2.3. *Measurement conditions.*

2.3.1. The tests will be made on a radio relay system, and if possible on several such systems corresponding to the different types used by Administrations (radio links using carrier frequencies between 1000 and 8000 Mc/s) *. If enough equipment is available, it would also be interesting to record mean noise power in both directions of a radio relay system, comparing the recordings in order to determine the correlation existing in the noise variations in the two directions.

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* Measurements will not be made on radio links using scattering.

2.3.2. The measurements will be made :

— either on one or more ordinary telephone channels suitably selected in the frequency band of the radio relay system (in particular on the channel which is the least favoured from the point of view of noise),

— or on a special maintenance channel. (This second alternative will make it possible to take account in the measurements solely of noise due to the terminal equipment of the carrier systems, which may be regarded as constant in time. However, this second alternative will not be adopted if the maintenance channel is situated in a favoured position from the point of view of noise.)

When the radio relay system includes diversity reception equipment or a reserve radio channel, the measurements obtained on an ordinary telephone channel will thus be the measurements corresponding to the most favoured radio channel.

The measurements will be made on a standardized channel corresponding to a carrier spacing of 4 kc/s, i.e. in the band 300/3400 kc/s. These measurements will be measurements of *unweighted* noise.

The measurements will be expressed in power units, i.e. in picowatts at a point of zero relative level on the telephone channel.

They will be made between two demodulation points in the carrier system, separated if possible by a distance of 250 to 300 km (280 km is the distance which corresponds to a section of hypothetical reference circuits for radio relay systems, $280 = \frac{2500}{9}$).

2.3.3. The measurement results will be presented :

(a) as obtained,

(b) in the form of a corresponding power for the 2500 km hypothetical reference circuit.

The determination of the noise to be expected for the 2500 km hypothetical reference circuit will be carried out :

— for the flat part of the curve (corresponding to low noise level), assuming a square low addition (for the addition of powers in the various sections of the radio link),

— for the left-hand side of the distribution curve, i.e. at least as far as 1 % probability, assuming a compound probability resulting from independent events,

— the determination of this noise for the 2500 km circuit will not be carried out for the middle part of the curve (between 1 % and 25 or 50 %).

2.3.4. From measurements corresponding to 60 consecutive unfavourable minutes a determination can also be made of the mean value of the noise power during an *unfavourable hour*. This value is in effect that mentioned in the Recommendations of the C.C.I.F. and the C.C.I.R. and it is useful to have exact data concerning this value.

2.4. *Information to be communicated together with the noise distribution curve.*

2.4.1. The principal characteristics of the radio relay system are to be given i.e. :—

Designation of the radio link
Capacity of the system (number of telephone channels)
Number of stations
Distance between stations
Type of path : clearing of the Fresnel zone (perhaps, a graph showing the profile of the path)
Frequencies used
Polarization

Frequency deviation
Power at emission
Antenna gains
Noise factor of receiving equipment
Calculated path loss
Measured path loss
Limits of operation of the limiters.

2.4.2. An indication is to be given of the noise power under propagation conditions when fading does not occur (noise value corresponding to the flat part of the distribution curve). This noise value will not be ascertained by means of recording devices mentioned in § 2.2 above but, for example, by means of a standard psophometer without its weighting network.

2.4.3. Every two months, the results should be communicated to the C.C.I.T.T. Secretariat. There should be a meeting attended by the representatives of the Administrations taking part in these tests, within one year, i.e., in February, 1958, to analyze the data transmitted to the C.C.I.T.T. Secretariat. This meeting would precede the meeting of the C.C.I.T.T./C.C.I.R. joint Working Party to meet in April, 1958.

2.5. *Choice of magnetic-tape recordings representative of the noise met with on radio relay systems*

For the study of Question 6 (C.C.I.T.T. Study Group 12), Administrations should start tests on the reduction of transmission performance due to noise on radio relay systems. These tests should be made by assembling the opinions of typical subscribers. The specimens of noise on radio relay systems should be chosen by these Administrations among magnetic-tape recordings made at the time when noise is at its peak. It will not be very hard to obtain some recordings of this kind, for the periods of intense fading on radio circuits are (generally speaking) well known.

The recordings so made should include, at the beginning and at the end, the recording of a 800 c/s frequency at a given power so as to characterize the noise conditions of the recording, and so that, later, the chosen noise may be attached to a probability of occurrence on the noise distribution curve, when this curve has been defined.

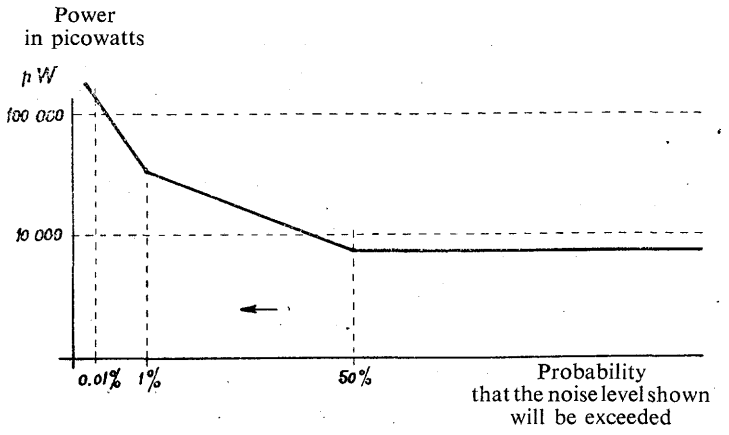


FIGURE 1

The choice of these recordings is left entirely to the initiative of the Administrations and Private Operating Agencies wishing to undertake tests of the type described in Question 6 of Study Group 12.

These recordings may also be used for studies of the effect of noise on telegraph transmission performance (increase in telegraph distortion), or on signal receivers used for long-distance automatic telephone signalling.

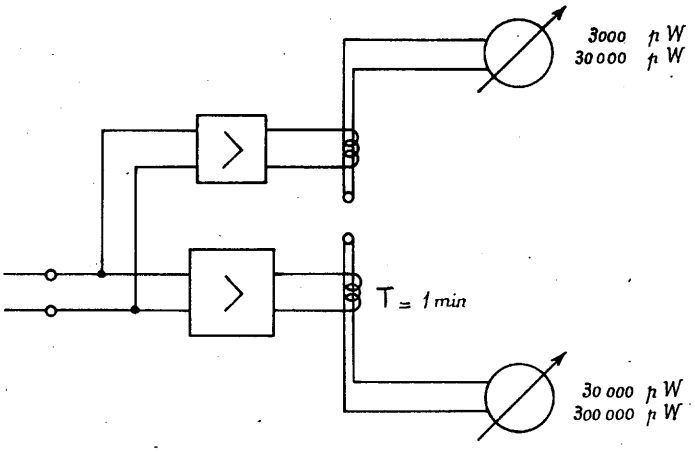


FIGURE 2

APPENDIX 1
(to section II of Annex 4)

Recording apparatus with large time constant proposed by the Federal German Administration of Posts and Telecommunications

To act as a recording apparatus with a large time constant (about 1 minute), the Federal German Administration of Posts and Telecommunications has often used a falling-bar six-colour recorder associated with an inert multiple thermocouple. The millivoltmeter of the six-colour recorder requires 3.5 mV for full swing when its internal resistance is 130 ohms. Since a copper-constantan thermocouple supplies a voltage of 0·04 mV per degree centrigrade and as several (e.g. 10) are used in series, heating the thermo-couples by about 10° C, by means of a special heater winding, carrying the current to be measured, is enough to cause full swing of the meter pointer.

To build the thermocouples, copper and constantan wire 0.15 mm in diameter was used. One copper wire and one constantan wire twisted together, soldered at their open ends and inserted into a flexible insulating tube as narrow as possible. Ten of these thermocouples were bunched together and fitted with another constantan wire about 1 cm long acting as the heater winding, in such a way that the thermocouples were placed just underneath the heater winding. All the thermocouples were then connected in series by twisting them and soldering their free ends. Finally, the multiple thermocouple was housed in a flat iron box fitted with terminals.

The resistance of the heater winding is about 4 ohms. This provides satisfactory matching to the output of a normal broadcast amplifier, as the working resistance of loud-speaker moving coils is roughly the same.

The time constant of such a multiple thermocouple, which is slightly less than 1 minute if a sufficiently thin flexible insulating tube is used, can easily be increased by covering the heater winding with another winding of tinfoil tape which increases the heat capacity of the whole. To check the time constant, one way would be to measure a permanent uniform power just sufficient to produce full swing of the meter pointer. When the time constant is 1 minute, 63% full swing is obtained 1 minute after this permanent power is applied, and 86% 2 minutes after. When this heating power is eventually removed,

the meter pointer falls to 37% of full swing after 1 minute, and 14% after 2 minutes. For the multiple thermocouple described in this annex, a heater power of about 100 mW is required to obtain full swing. The output of a normal broadcast amplifier, e.g., 5 W, is thus adequate even for high power peaks of short duration. The thermocouple must be carefully protected against too much power permanently applied. To do this, use can be made, for instance, of a relay with rectifier, which operates in the case of a psophometric power corresponding to double full swing and, by an additional thermocontact, prevents subsequent heating of the multiple thermocouple when such a psophometric power is applied for a fairly long period.

APPENDIX 2
(to section II of Annex 4)

Suggestion of the United Kingdom Administration for a Method of Measurement of One-Minute Mean Noise Powers

It is suggested that the value of noise power varying with time, averaged over successive periods of one minute (or other convenient periods) can be measured by means of a square-law rectifier, a magnetic amplifier, and an integrating motor which operates a mechanical or electronic counter.

A suitable square-law rectifier consists of a group of thermocouples with heaters connected in parallel with each other and with the source of noise and with couple elements connected in series to deliver an output to a magnetic amplifier. In the experiments which have been carried out, 5 thermocouples were used, each taking a maximum heater current of 10 mA. and having a time constant of 5 milliseconds. The maximum output from the 5 couples together was 15 mV and the total resistance was 50 ohms. This output voltage was fed into a magnetic amplifier which ideally would be designed for a 50 ohm input and to give an output suitable for driving the integrating motor; such a magnetic amplifier is in course of design.

A type of low-inertia permanent-magnet motor with a built-in mechanical revolution counter is available. Between certain values of input power representing a range of about 25 db to 30 db the speed is closely proportional to the input power (maximum error 10% at low values of power) and the number of revolutions in a given period is therefore very close to the mean input power during the period. The motor with counter could be described as a " picowatt second meter " similar in function to a watt hour meter. The motor and mechanical counter are contained in a box measuring about $15 \times 7 \times 7$ cm.

If a mechanical revolution counter is used, it is necessary to photograph the readings at the chosen time intervals, e.g. 1 minute. Sequential counter readings would be subtracted using a calculating machine which prints the differences on a strip of paper; the numbers on this strip of paper would then represent the successive values of one-minute mean power. As an alternative, an electronic device which would count the revolutions and would record the 1-minute mean powers on teleprinter paper might be considered.

SECTION III

Influence of noise on telegraphy and telephone signalling

The noise powers of importance for telegraph transmission should be deduced from detailed studies showing the influence of the following parameters on telegraph distortion and the transmission of telegraph switching signals :

— noise power
— probability of occurrence of noise
— duration of noise
— distribution of noise in the telegraph channels
— modulation systems.

The programme of these studies is within the province of the specialized Study Groups and Sub-Groups of the C.C.I.T.T., i.e., Study Group 9 and Sub-Group 1/3 which have questions for study in this connection (Question 6 of Study Group 9).

To assemble useful statistics for telegraph transmissions passing over a radio circuit, the Working Party recommends that for the moment observations should be made of the probability of occurrence of noise exceeding a given level and, if possible, the corresponding duration.

This probability will be determined by metering apparatus and the results will be expressed as the number of times per month (30 days) where the noise power (measured with apparatus having an integration time of about 5 ms) for the telephone channel exceeds :

(a) 100 000 picowatts
(b) 1 000 000 picowatts

at a point of zero relative level.

It would also be desirable to determine, if possible, the time during which these noise levels are reached, but this may involve installing complicated equipment and is thus left to the discretion of Administrations.

Lastly, specimen magnetic tape recordings will be assembled of noise exceeding 100 000 picowatts (see previous section, end of paragraph 2.5). These specimens will be used in tests showing the influence of noise on telegraph distortion.

These specimen magnetic recordings could also be used for determining the influence of noise on signal receivers used for semi-automatic or automatic telephone operation.

SECTION IV

Schedule of tests

It is unlikely that the equipment can be ready before early in the summer of 1957.

Recordings should begin as soon as possible, but it is unlikely that this will be before September or October, 1957.

The outcome of the tests will be communicated to the C.C.I.T.T. Secretariat every two months. There will have to be a meeting attended by representatives of the Administrations which have taken part in the tests, in February, 1958, to analyze the data so assembled. This meeting would precede the meeting of the Joint C.C.I.R./C.C.I.T.T. Working Party in April, 1958.

APPENDIX

(to Question 7 of Study Group 1)

Recommendations issued by the VIIIth Plenary Assembly of the C.C.I.R. (Warszawa 1956) concerning the allowable noise at the end of hypothetical reference circuits for telephony over radio-relay links

Note by the C.C.I.T.T. Secretariat. — The VIIIth Plenary Assembly of the C.C.I.R., in the Recommendations reproduced in the Appendix to Question 32 of Study Group 1, has defined hypothetical reference circuits for telephony over radio-relay links,

— with time division multiplex and having at least 60 telephone channels (Recommendation 201),
— with frequency division multiplex and having a capacity of 12 to 60 telephone channels (Recommendation 202),
— with frequency division multiplex and having a capacity greater than 60 telephone channels (Recommendation 203).

Concerning the allowable noise at the end of these hypothetical reference circuits, Recommendation 201 (reproduced below) contains some details regarding the hypothetical reference circuit defined in this Recommendation. Recommendation 200 indicates the values already recommended and the values that are still to be fixed for the case of hypothetical reference circuits on radio-relay links with frequency division multiplexing defined in Recommendations 202 and 203. C.C.I.R. Study programme No. 105 (reproduced below) sets out studies which the C.C.I.R. intends to make in a field similar to that covered by Question 7 of Study Groups 1 and 3.

C.C.I.R. Recommendation 201

Hypothetical reference circuit for time-division multiplex radio-relay systems with 60 or less telephone channels

(C.C.I.R. Question 97, Warszawa 1956)

The C.C.I.R.,

Considering

(a) That it is desired to define hypothetical reference circuits for radio-relay systems in order to offer guidance to the designers of equipment and systems for use in international telecommunication networks;

(b) That time-division radio-relay systems may form a part of an international circuit;

(c) That the C.C.I.F. has established a hypothetical reference circuit for the similar case of 60 and 120 telephone channels on symmetrical pairs (Volume III of the *Green Book* of the C.C.I.F., Geneva 1954, page 68);

Unanimously recommends :

1. That a hypothetical reference circuit for time-division multiplex radio-relay systems with a capacity of 60 or less telephone channels per radio channel should be 2500 km long;

2. That this reference circuit should be constituted by 9 sections approximately 280 km long with voice-channel modulation and demodulation at each terminal of a section;

3. That in any hour the mean psophometric noise in a telephone channel at the ends of the overall circuit should not exceed 10 000 pW at a point of zero relative level;

4. That the allocation of this noise power to the single sections and the time distribution of the noise power should be further studied;

5. That the method of specification and permissible values of the psophometric noise for a small percentage of time should be defined, but that a precise answer cannot be given at the present time.

C.C.I.R. Recommendation 200

Allowable noise power in the hypothetical reference circuit for radio-relay systems with frequency-division multiplexing

(C.C.I.R. Question 97, Warszawa 1956)

The C.C.I.R.,

Considering

(a) That the hypothetical reference circuit is intended as a guide to designers and constructors of actual systems;

(b) That the noise power in a radio-relay system is dependent on the one hand on a number of factors concerned with equipment design and on the other hand, on the path attenuation and the variation of path attenuation with time which is dependent on factors such as spacing of stations and the nature of the intervening terrain;

(c) That it is desirable to fix nominal values for propagation conditions in the hypothetical reference circuit, but at present there is insufficient information to enable this to be done precisely (see C.C.I.R. Question 136);

(d) That typical values of the factors concerned with equipment design and path attenuation are given in Annex I;

(e) That the total noise may be calculated by methods such as those given in Annex II, which gives also the numerical results of typical calculations;

(f) That the total noise power in the hypothetical reference circuit should not be so great as to cause serious hindrance to the transmission of telegraph signals or to conversation in a substantial proportion of telephone calls;

(g) That, in the opinion of the C.C.I.R. based on evidence so far available from the C.C.I.F. and other sources, a distribution of noise power with time in a month such as that given in Annex III is considered provisionally to be unlikely to cause serious hindrance to telephone conversations;

(h) That it is convenient to specify the total noise power in the hypothetical reference circuit in a manner suitable for sub-division into the noise power in each of the 6 or 9 homogeneous sections;

(i) That the noise power in actual radio-relay systems may differ from that in the hypothetical reference circuit due for example to the use of equipment designed for association with a given station spacing in the hypothetical reference circuit but used in an actual system with much greater spacings;

(j) That it is advisable that in view of the application of the data of the hypothetical reference circuit to physical circuits, the method of specification and permissible values of psophometric noise for short percentages of the time should be stated;

Unanimously recommends :

1. That the total psophometric noise power at a point of zero relative level in any telephone channel in the 2500 km hypothetical reference circuit for frequency division multiplex radio-relay systems with 12 to 60 channels and in the 2500 km hypothetical reference circuit for radio-relay systems with more than 60 channels, should not exceed the provisional values * ** :

(a) 5000 pW mean value in the busy hours, in the absence of fading,

(b) 7500 pW mean value in any hour;

2. That the method of specification and permissible values of the psophometric noise for short percentages of the time should be defined, but that a precise answer cannot be given at the present time. Proposals under consideration are given in Annex II and in Annex III.

Annexes I to IV
(to C.C.I.R. Recommendation 200)

[Annex III reproduces curve A of the diagram in Annex 2 to Question 7 of Study Group 1. Annexes I, II and IV are contained in the Appendix to Question 7 of Study Group 3].

C.C.I.R. Study Programme No. 105

Wideband radio-relay systems. Noise tolerable during very short periods of time

(C.C.I.R. Question 97, Warszawa 1956)

The C.C.I.R.,

Considering

(a) That for radio relay links, it is necessary to clarify how high noise levels occurring for short periods of time should be taken into consideration;

(b) That consideration must be given not only to the percentage of time during which high noise levels occur, but also to the duration of each burst of noise;

(c) That account should be taken of the fact that in radio-relay systems high noise often occurs at night when the traffic is particularly light;

(d) That examples of the distribution of noise with time in radio-relay systems are given in the Annexes to C.C.I.R. Recommendation 200 and that these Annexes also contain examples of the values of noise power likely to be experienced for short periods of time;

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* Noise in the frequency division multiplex equipment is excluded. The C.C.I.F. allows 2500 pW for this noise.

** It is emphasised that these values are provisional and may be revised later to take account of additional information on path attenuation (C.C.I.R. Question 136, Study Group V) and of the later opinions of the C.C.I.T.T.

Unanimously decides that the following studies should be carried out :

1. In what way should the maximum value of noise be specified when considering transmission on radio-relay systems ?

2. What should be the time constant of the noise measuring apparatus ?

3. Should a limit be set to the number of high noise bursts, of a duration exceeding a given value, occurring in a given time ?

4. In considering this problem, should account be taken of the fact that traffic loading is greater during the day than during the night ?

5. In what way can the maximum tolerable noise power for a part of a radio link be deduced from the maximum value of noise power tolerable for the complete radio link ?

Question 8.

(Study Group 4, in co-operation with Sub-Group 1/2)

(Question 8 of Study Group 4) (New Question)

The present recommendations for the equivalent of an international telephone circuit given in Volume III of the C.C.I.F. *Green Book* apply to the circuit between two-wire points.

However, where circuits are used in automatic working, and the circuits terminate on automatic switches or relay sets and do not have a four-wire terminating set, would it not be better to specify the overall loss of a circuit as a four-wire loss between the points where the circuit is switched, and to test the circuit between these points ?

Question 9.

(Sub-Group 1/2, then Study Group 1, in co-operation with Study Groups 4 and 12)

(New Question)

For manually operated international circuits, the C.C.I.F. at present recommends that the nominal equivalent of a single circuit or of two circuits connected in tandem should be *not more* than 0.8 N (7 db) in each direction of transmission. For semi-automatic international circuits, the recommended nominal equivalent *in the present state of knowledge* is 0.8 N (7 db) in each direction of transmission, for a single circuit and for two circuits connected in tandem (*Green Book*, Tome III, page 39).

Is it desirable that these recommendations of the C.C.I.F. be modified, and, if so :

(a) What should be the new transmission switching plan for Europe (and perhaps other territories outside N. America) ?

(b) What should be the transmission switching plan for global communication ?

(c) What should be the rules governing the control of echoes, including the use of echo-suppressors in long-distance connections where these devices may be needed ?

Note 1. — A recommendation concerning the insertion of echo-suppressors appears on page 30 of Vol. III of the *Green Book*. This may have to be reconsidered.

Note 2. — Details of the national networks of certain Administrations are given in the replies to Question 9 of C.C.I.F. Study Group 4 (" CCIF — 1955/1956 — 3rd SG — Document No. 49 ", pages 229-253). Attention is drawn to page 244 of this document, which indicates that the Federal German Republic proposes to insert different gains in the " go " and " return " channels at a point of interconnection between an international circuit and one of their national circuits.

Question 10.

(Sub-Group 1/2, then Study Group 1, in co-operation with Study Group 11)

(Question 10 of Study Group 11) (New Question)

The results of the 5th series of tests, carried out from October 1955 to January 1956, prove that the standard deviation of the variations of equivalent with time of international circuits is sufficiently low.

Considering that the stability of telephone circuits is now improved, is it possible to reduce the fixed value of 7 db which was laid down (page 39 of Volume III of the C.C.I.F. *Green Book*) for the equivalent of international semi-automatic circuits, and if so by how much ?

Question 11.

(Sub-Group 1/3, then Study Group 1 in co-operation with Study Group 8)

(Question 11 of Study Group 8) (Continuation of Question 44 studied by the C.C.I.T. in 1955-1956)

Study of the transmission of half-tone pictures over combined radio and metallic circuits when direct frequency modulation of the radio frequency carrier is used.

Question 12.

(Sub-Group 1/3, then Study Group 1 in co-operation with Study Group 8)

(Question 12 of Study Group 8) (New Question)

Study of the possibility of increasing the speed of transmission for facsimile (including phototelegraphy) systems in the international service by the use of equipment for correcting delay distortion on the carrier telephone circuits utilised.

Note. — Information on phase distortion encountered in practice is given on pages 160-165 of Volume III of the C.C.I.F. *Green Book* and in Annex 1 below. Annex 2 below contains a study of phase compensation submitted by the Administration of the U.S.S.R.

ANNEX 1

(to Question 12 of Study Group 1)

Phase distortion measured in France on telephone channels in symmetrical-pair cable carrier systems

The French Administration has undertaken propagation time measurements on unloaded symmetrical-pair carrier systems (quads already defined 9/10).

Paris-Limoges (802A + 803A channel 1
(802M + 503M channel 12

The measurements were made by loop.

On the curves given in diagram on the opposite page, it will be seen that the group delay distortion does not exceed :

In the band 1000-3000 c/s	±0·35 ms. for channel 2
	±0·40 ms. for channel 2
In the band 1000-2350 c/s	±0·15 ms. for channel 1
	± 0·20 ms. for channel 2

The minimum distortion appears in the band around 1800 to 2000 c/s.

These figures, which refer to two circuits in tandem, are very liberal. Theory indicates and practice confirms that the transmission of a picture is still satisfactory when the group delay distortion is equal to the duration of the elementary spot.

In the present case let us recall the figures :

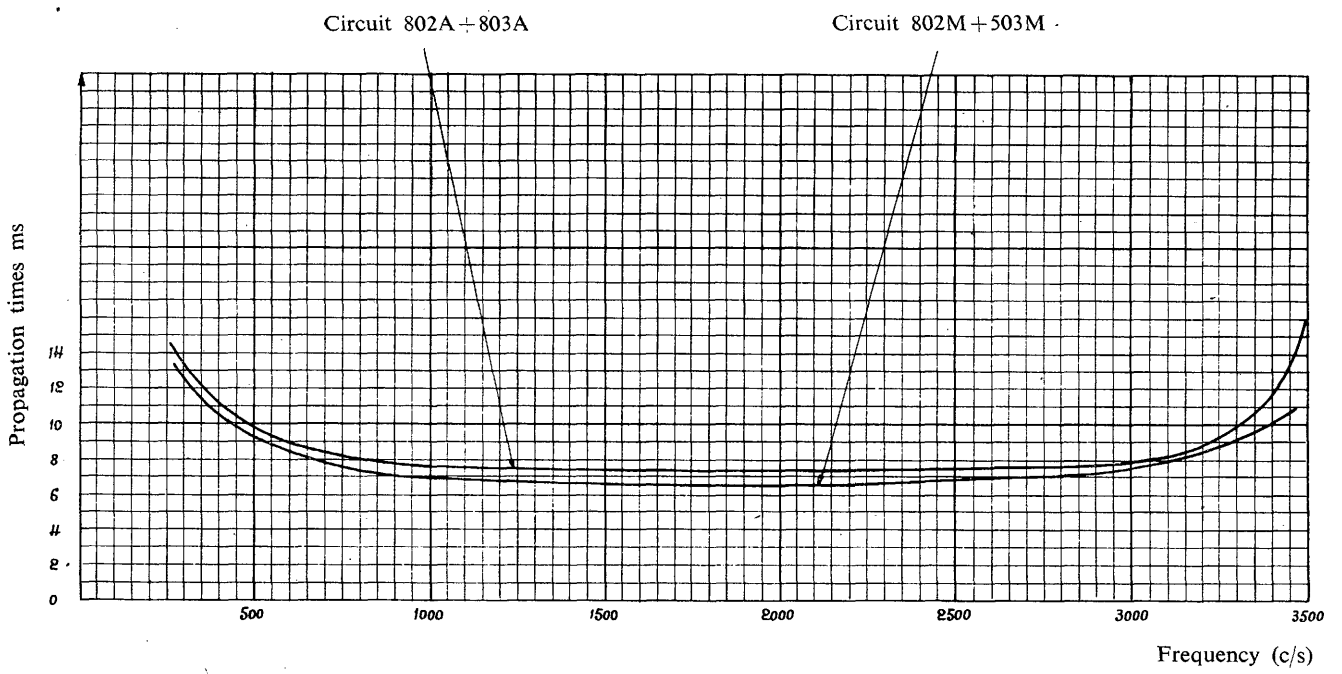
at index 352, speed 60 r.p.m., the duration of the scanning spot is about 0·9 ms. and the band occupied is 1100 c/s.

at index 352, speed 120 r.p.m., the duration of the scanning spot is about 0·45 ms. and the band occupied 2200 c/s.

It therefore seems that by centering the carrier around 1800 to 2000 c/s.—for example at 1900 c/s.—it should be possible in most cases to operate at 120 r.p.m. with satisfactory results.

These figures should nevertheless be given a reasonable test, and it would be advisable to check that the noise level of the carrier circuits permits correct transmission in every case, bearing in mind the desire of the C.C.I.F. to lower the transmission levels.

Comment: If it is desired to increase the transmission speed, the solution would seem to be to use index 264 at a speed of 180 r.p.m. The French Administration has carried out successful tests in this direction.



Propagation times in relation to frequency of circuits on 12 channels carrier systems

ANNEX 2

(to Question 12 of Study Group 1)

Equalization of the delay characteristics of carrier communication channels intended for the transmission of phototelegrams

by G. B. Davidov

(submitted by the Administration of the U.S.S.R.)

Delay distortion within telephone channels (deviations of delay as a function of frequency from a constant value) is one of the main factors limiting the speed of transmission of phototelegrams.

Any increase of transmission speed is limited primarily by delay distortion rather than by the finite width of the channel transmission band.

This is especially evident in the operation of communication channels with several retransmissions. In this case, the width of the frequency band remaining unchanged, delay distortion increases to an extent which is prohibitive to the transmission of phototelegrams even at low speeds.

In standard carrier communication channels (K-12, K-24, K-60 channels etc.), having a band of effectively transmitted frequencies of 300-3400 c/s, delay distortion is introduced mainly by crystal filters used in channel units.

Every channel is equipped with two crystal filters, one at the transmitting, and the other at the receiving end.

The number of filters used in the circuit is increased if retransmission is effected at intermediate points.

It must be indicated that additional delay distortion may be contributed by any group equipment filters provided. However, this distortion affects only the channels occupying extreme positions in basic 12-channel groups.

The system of phototelegram transmission used at present depends upon transmission speeds which correspond to a comparatively narrow frequency band of a phototelegraph signal occupying the middle of a channel transmission band where delay distortion is small. Accordingly, even less than a half of the effectively transmitted frequency band is used.

If delay equalization is provided, transmission speed may be at least doubled. Using delay equalization conjointly with the vestigial side band transmission principle, it is possible to increase

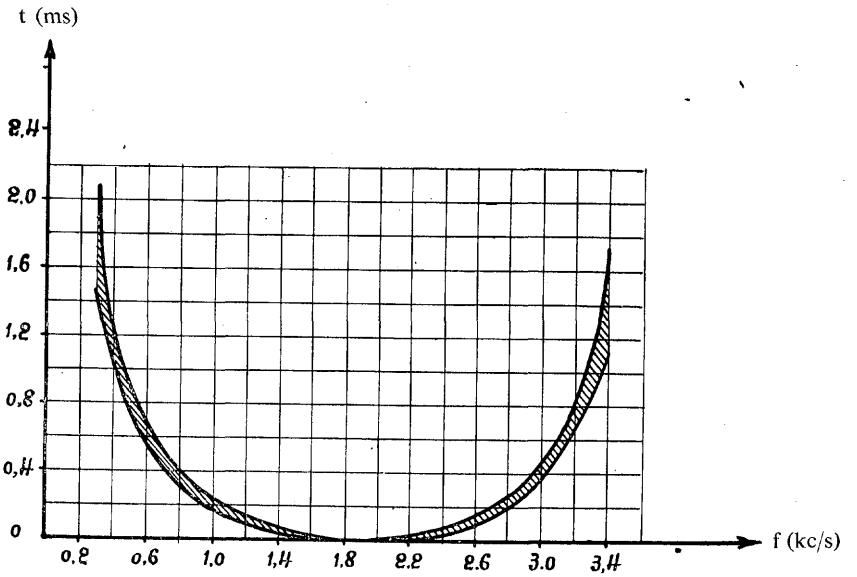


FIGURE 1. — *Spread of "delay-frequency" characteristics*

transmission speed additionally at least 1·6-1·7 times. The total increase of transmission speed will, therefore, be 3·2-3·4 times the value used at present.

Considering that a substantial part of phototelegram cost is contributed by channel costs, it is reasonable to introduce delay equalization of channels to achieve more effective operation. The provision of delay equalization naturally calls for a certain capital investment for the production and installation of necessary delay equalizers.

The study of this question has shown that standard delay equalizers may be used mostly for the equalization of standard carrier communication channels.

Owing to this fact the costs of delay equalizers may be considerably reduced, and their operation simplified.

To determine delay distortion on carrier communication channels, many of these channels were tested on different long-distance routes.

The results of measurements have shown a relatively narrow spread of " delay-frequency " characteristics (see Figure I, hatched area).

Hence, equalization is feasible, if a standard delay equalizer is used providing for the correction of characteristics with an accuracy equivalent to the limit of the virtual deviation of characteristics from the average value.

To evaluate the effect of unequalized residual distortion, the admissible value of distortion has to be determined.

Theoretical computations and practical experience in the field of phototelegraphy, as well as television, have shown that maximum admissible values of continuous deviations of a delay-frequency characteristic from constant value should not exceed the transmission time of a picture element.

This may be stated mathematically as follows :

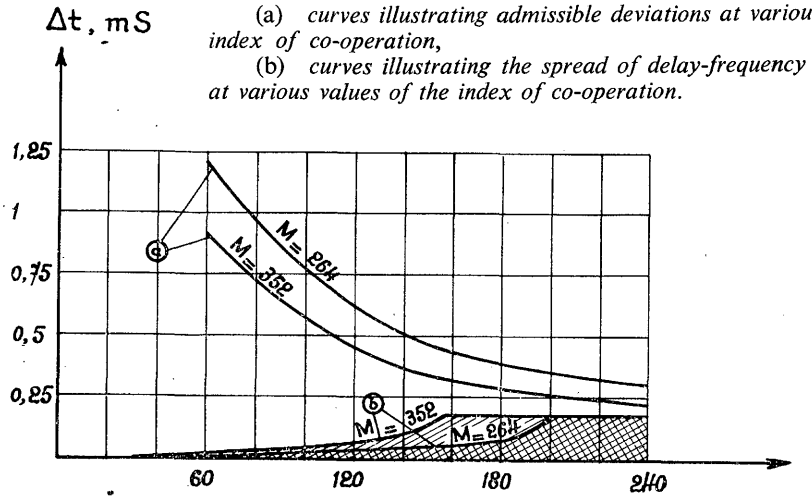
$$\Delta t \leqslant \tau = \frac{60}{\pi MN} \text{ sec} \qquad (1)$$

where :

Δt = maximum admissible value of continuous delay deviation for a given number of r.p.m., N, and for an index of co-operation M;

τ = transmission time of a picture element.

In Figure 2 curve *a*, $\Delta t = f(N)$, which is a plot of (1), is compared with the maximum spread of delay characteristics (curves *b*) which are plotted in accordance with characteristics of Figure I, allowing for the value of the index of co-operation as a function of r.p.m. value used in the transmission.



(a) *curves illustrating admissible deviations at various values of the index of co-operation,*

(b) *curves illustrating the spread of delay-frequency characteristics at various values of the index of co-operation.*

FIGURE 2. — *Comparison of the spread of delay-frequency characteristics with admissible delay deviations at various transmission speeds*

It must be pointed out that for a value of $M = 352$ the maximum number of revolutions is about 160 r.p.m., while for $M = 264$ it is about 210 r.p.m.

The speed may be further increased only if vestigial side band transmission is used. However, in this case no further extension of the frequency band takes place, and the spread of characteristics is not, consequently, increased but remains constantly at its maximum. This latter circumstance is demonstrated by horizontal sections of the curves.

Referring to characteristics given in Figure 2, it is evident that the use of a standard delay equalizer is fully justified because, if there are no retransmissions, even the maximum spread of characteristics remains within admissible deviation limits.

If retransmission is effected, deviations will add statistically. Hence, it is to be assumed that deviations will remain within standard limits even with 2 or 3 channels connected in tandem.

Therefore, delay equalization of carrier telephone channels is feasible using standard delay equalizers inserted in the communication path.

These standard delay equalizers may be cut into line directly by an operator in charge of a phototelegraph apparatus.

It must be indicated, however, that only the channels occupying middle positions in a basic 12-channel group may be equalized. The channels at the extremes of this group should not be used for the transmission of phototelegrams. Moreover, when any channels are allowed to be used, the operator must be informed about the number of retransmissions for each particular channel.

We have designed, produced, and tested a standard delay equalizer. The results of its test are shown in Figure 3. This device equalizes the delay characteristic of a channel within a frequency

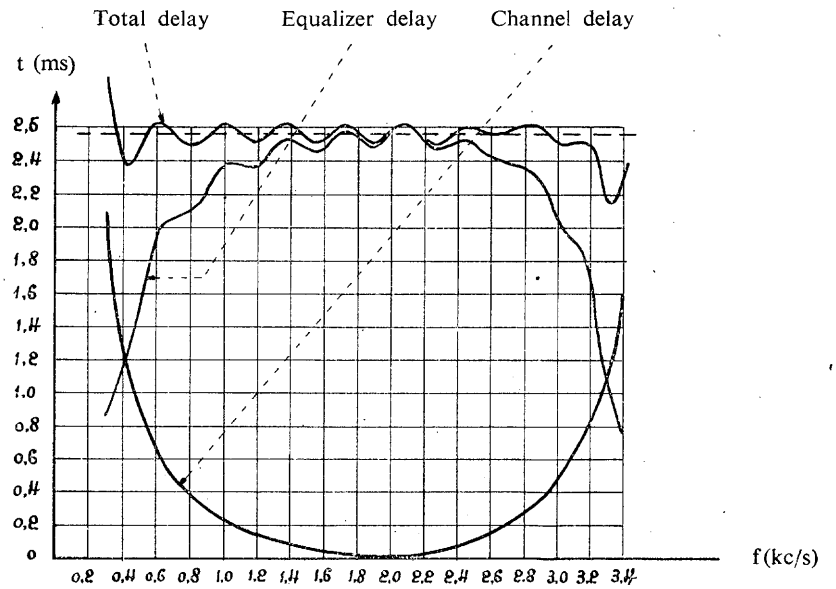


FIGURE 3

range of 450-3250 c/s with an accuracy equivalent to oscillatory delay deviations (" ripples ") of $\pm 0{\cdot}08$ mc/s from constant value.

It is known **[2]** that oscillatory deviations result in the appearance of positive and negative secondary images (" ghosts ").

The delay equalizer was designed with an objective to minimize the number of sections. Another design objective was that a secondary image resulting from systematic oscillatory deviations (which add arithmetically if several delay equalizers are connected in tandem) was to be at least 20 times weaker than a primary image, even if 3 retransmissions were effected. This was achieved with a minimum of 8 sections. (see Appendix).

APPENDIX

(to Annex 2 to Question 12)

Selection of the number of delay equalizer sections

In the design of a delay equalizer the approximation of a given characteristic is the more accurate, the greater the number of equalizer sections. From economic considerations, however, it is desirable to minimize the number of sections.

In choosing the number of sections considerations given below should be taken into account.

Every phase section (Figure 4) is characterized by the following parameters.

$$\omega_0 = \frac{1}{\sqrt{L_1 C_1}} = \frac{1}{\sqrt{L_2 C_2}} \quad \text{resonance frequency} \tag{2}$$

$$m = \sqrt{\frac{L_2}{L_1}} = \sqrt{\frac{C_1}{C_2}} \quad \text{parameter determining the slope} \tag{3}$$

$$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}} \quad \text{characteristic impedance} \tag{4}$$

Moreover, there are some parameters determining the co-ordinates of zeroes and poles of the transfer ratio of a section on a complex frequency plane (see Figure 5), viz :

$$K_n = \frac{\omega_0}{2m} \tag{5}$$

$$\omega_n = \omega_0 \sqrt{1 - \frac{1}{4m^2}} \tag{6}$$

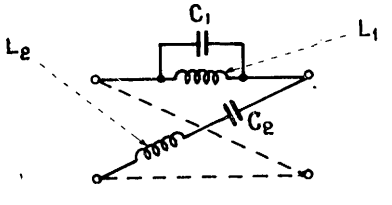


FIGURE 4. — *Phase section*

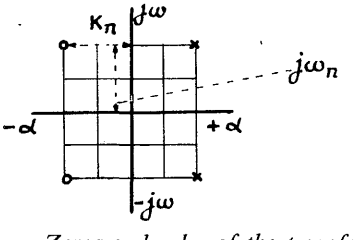


FIGURE 5. — *Zeros and poles of the transfer ratio of phase section*

For a given value of R the above values characterize amply every section.

If there is a sufficient number of sections having the same value of K_n, their resonance frequencies being equally distributed along the frequency axis with intervals of $\Delta\omega$ between them, the total phase delay, **[1]**, will be

$$t \approx \frac{2\pi}{\Delta\omega}\left(1 - 2\exp\frac{-2\pi K_n}{\Delta\omega}\cos\frac{2\pi}{-\Delta\omega}\omega\right) = t_0 - \Delta t\cos t_0\omega = t_0\left(1 - \frac{\Delta t}{t_0}\cos t_0\omega\right) \tag{7}$$

where $t_0 = \frac{2\pi}{\Delta\omega} = \frac{1}{\Delta f}$ average delay (8)

$\Delta t = 2 t_0 e^{-K_n t_0}$ amplitude of cosine delay deviations (" ripples ") (9)

It is known **[2]** that small cosine delay deviations result in signal distortion appearing in the form of paired echoes; the ratio of the paired echo amplitude to the main signal amplitude is given by

$$x = \frac{\Delta t\,\Delta f}{2} \tag{10}$$

Assuming that a delay equalizer is approximately analogous to a delay line with a sufficient number of sections, it is possible to determine the relation between K_n and $\Delta\omega$ for a given value of echo resulting in the appearance of " ghosts " on a phototelegram.

It results from (8), (9) and (10) that, to obtain $x < x_1$ where x_1 is the admissible secondary image, we should have

$$K_n > \frac{\Delta\omega}{2\pi} \ln \frac{1}{x_1} \tag{11}$$

Hence, admissible delay deviations are a determining factor for the minimum value of K_n.

In practice we have to deal with a finite number of delay equalizer sections defining a delay characteristic within the given frequency range $\omega_1 - \omega_2$. This number of sections will be

$$N \approx \frac{\omega_2 - \omega_1}{\Delta\omega} \tag{12}$$

as a first approximation.

The greater the value of K_n for a given section number, the smaller the slope of a delay characteristic at the edge of a frequency range. From the theory of potential analogy **[2]**, **[3]**, phase delay may be derived as

$$t \approx \frac{2}{\Delta\omega} [\varphi_1(\omega) + \varphi_2(\omega)] \tag{13}$$

for a group of phase sections having zeroes and poles of the transfer ratio (corresponding to a constant value of K_n (Figure 6)) equally distributed at intervals $\Delta\omega$ from each other.

Such group of phase sections may be chosen as a first approximation to be a reference group for the design of a delay equalizer. The sections are to be selected in such a way that the values of maximum delay introduced (T_0) and maximum slope $\left(\frac{dt}{d\omega}\right)$ max at the edge of the frequency range would be greater than those of a delay equalizer required.

It is important in this case that the condition of maximum slope be fulfilled at the lower edge of the transmission band, the slope being always smaller at this edge.

Maximum slope of a " delay-frequency " characteristic is determined **[3]** as

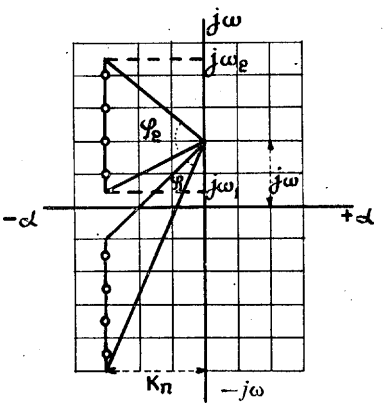


FIGURE 6. — *Zeros of the transfer ratio of a group of phase sections*

$$\left(\frac{dt}{d\omega}\right) \max \approx \frac{2}{\Delta\omega K_n} \left[1 - \frac{1}{4}\left(\frac{K_n}{\omega_1}\right)^2\right] \tag{14}$$

It has been mentioned above that the value of slope for a reference group of sections should not be smaller than that of a delay characteristic of a channel being equalized. Hence, the value of K_n should not exceed

$$K_n < 2\omega_1 \sqrt{1 + \left[\frac{\Delta\omega}{2}\omega_1\left(\frac{dt}{d\omega}\right)\max\right]^2} - \omega_1^2 \Delta\omega \left(\frac{dt}{d\omega}\right) \max \tag{15}$$

In Figure 7 the representative curves of formulae (11) and (15) are plotted defining the delay characteristic of a typical carrier communication channel.

For design purposes, the extreme lower frequency is assumed to be $f = 450$ c/s, i.e. $\omega_1 = 2\pi 450$.

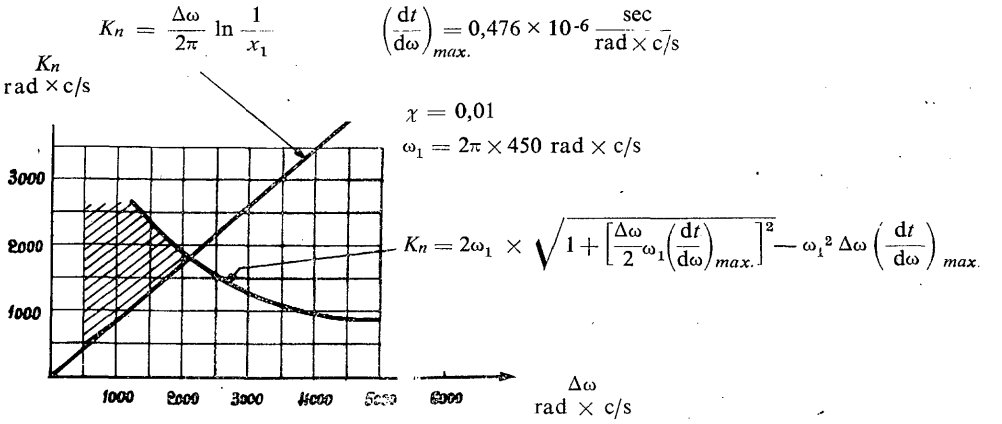


FIGURE 7. — *Determination of optimum values of* K_n *and* $\Delta\omega$

The slope of delay characteristic calculated graphically for this frequency is

$$\left(\frac{dt}{d\omega}\right) \max = \frac{3 \times 10^{-6}}{2\pi}$$

The relative value of secondary image was assumed to be 0·015 considering that with 3 retransmissions the secondary image should not exceed 5% of the primary image. Such secondary image should not be visible.

The admissible value of Kt must remain within the hatched area. The optimum value of K_n is to be found at the crossing of the curves, $\Delta\omega$ reaching in this case its maximum value and the section number being, therefore, at a minimum.

The values of K_n and $\Delta\omega$ are thus selected as a first approximation.

The number of sections is derived from (12). The value of ω_2 for a carrier channel is assumed to be 150 c/s lower than the extreme upper frequency of the channel frequency band

$$\omega_2 = 3400 - 150 = 3250 \text{ c/s}$$

$$N \approx \frac{\omega_2 - \omega_1}{\Delta\omega} = \frac{3250 - 450}{2100} = 8{,}3 \approx 8$$

In Figure 3 a characteristic is plotted of a delay equalizer having 8 sections.

Parameter values of every section are chosen according to calculation data derived from the groups of Figure 7, and subsequently estimated more accurately using the nomographs of reference **[3]**.

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[2] H. A. WHEELER, The Interpretation of Amplitude and Phase Distortion in Terms of Paired Echoes *Proceedings of the Institute of Radio Engineers*, June 1939.

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Question 13.

(Sub-Group 1/3, in co-operation with Sub-Group 1/2, then with Study Group 1)

(New Question)

(a) Is it desirable to recommend unweighted noise voltage limits for telephone circuits which may be used as main or reserve circuits for V.F. telegraph systems ?

(b) In the affirmative :

1. What will be the limits of noise voltage to recommend for such circuits ?
2. What methods and what apparatus should be recommended for the measurements of unweighted noise voltage on these circuits ?

Remark 1. — The annex below reproduces a C.C.I.T. recommendation which has led to this question.

Remark 2. — At present it can only be pointed out to the telegraph services that the unweighted noise electromotive force at the end of a telephone circuit should not exceed in principle a value around 7 millivolts referred to a point of zero relative level.

ANNEX 1

(to Question 13 of Study Group 1)

C.C.I.T. recommendation B.54 — Measurement of noise in circuits used for voice-frequency telephony

The C.C.I.T.,

considering

1. that, although the noise voltage present on a telephone line may not exceed the recommended psophometric limit, relatively strong interfering voltages may be present, particularly at the lowest and highest frequencies used for voice-frequency telegraphy;

2. that, in voice-frequency telegraph systems every channel receiving a signal of given strength is equally sensitive to noise voltages in its own allotted frequency range and that the signals received on telephone circuits tend to be weakest for the highest and lowest voice-frequency telegraph channels. The limitation of psophometric voltage on a telephone circuit therefore gives little protection to the highest and lowest telegraph channels;

3. that the measurements of noise voltages as " signal-to-noise ratios " for equal signal inputs at all frequencies within the normal range of telephonic frequencies, though ideal for voice-frequency telegraph purposes, would be inconvenient as a test;

4. that the measurement of unweighted noise voltage by means of an instrument equally sensitive to voltages of all frequencies within the telephone band, 300-3400 c/s, is easy and that suitable instruments are available;

5. that a limitation upon the unweighted noise voltage in a telephone circuit would conform more nearly to telegraph requirements than a limitation upon psophometric voltage;

unanimously declares the view

that a measurement of unweighted noise voltage in the telephone band of 300-3400 c/s should be made when these circuits are used for voice-frequency telegraphy.

Question 14.

(Sub-Group 1/3, then Study Group 1)

(New Question)

In view of the fact that, when a telephone circuit is used for voice-frequency telegraphy, near-end crosstalk, corresponding to a ratio of 4 nepers, produces an undesirable degree of telegraph distortion (whether the telegraph transmission be duplex or half-duplex), will it be possible, in the future, to improve the near-end crosstalk ratio of telephone circuits used for voice-frequency telegraphy by increasing it from 4 nepers minimum to 5 nepers minimum (35 db to 43 db).

Question 15.

(Sub-Group 1/3, then Study Group 1)

(Question 15 of Study Group 8) (continuation of Question 47, studied by the C.C.I.T. in 1955/56)

(a) Is there a need to envisage the use of frequency modulation for facsimile apparatus working over international metallic telephone circuits ?

(b) If so, what characteristics are to be recommended ?

Note. — C.C.I.T. Study Group IV made some comments on this question; they are contained in the following annex.

ANNEX

(to Question 15 of Study Group 1)

Comments on question 47 studied by the C.C.I.T. in 1955/56

C.C.I.T. Study Group IV has studied the proposals issued by the XVIIth Plenary Assembly of the C.C.I.F. on the use of frequency modulation for phototelegraphy on metallic circuits and agreed to their incorporation in Recommendation D.3.

A statement concerning possible interference with V.F. signalling receivers has also been included in that Recommendation. The Study Group noted, nevertheless, that this would become of importance only if at any time the C.C.I.T.T. proposed the adoption of automatic switching in the establishment of phototelegraph calls, but considered that Study Group 8 of the C.C.I.F. * would be better able to pronounce on this point.

The information on experience with F.M. supplied by various administrations was also studied, but it has been agreed that it was not yet possible to issue positive recommendations as to the circumstances in which F.M. should be used on metallic circuits. Frequency modulation has, however, been included as an alternative to amplitude modulation in Recommendation D.1.

The Study Group, therefore, recommends that the Question should be left open for further study with a view to acquiring practical experience.

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* The work of this Study Group is being carried on by C.C.I.T.T. Study Group 11.

Question 16.

(Sub-Group 1/3, then Study Group 1, in co-operation with Study Group 8)

(Question 16 of Study Group 8) (New Question)

Is there a need to envisage the use of asymmetric sideband operation for permitting higher operating speeds on facsimile (including phototelegraph) apparatus working over international metallic telephone circuits ? If so, what characteristics are to be recommended ?

Note. — The annex below contains a contribution from the Administration of the U.S.S.R.

ANNEX

(to Question 16 of Study Group 1)

The use of asymmetric limitation of sidebands for facsimile transmission * on carrier telephone circuits

by S. CLICOV and G. TICHANOV

(Submitted by the Administration of the U.S.S.R.)

Existing methods for facsimile signal transmission on carrier telephone channels do not make the best use of the channels, which are engaged for quite a long time for the transmission of each facsimile telegram. Speeding-up of transmission time is especially important for the facsimile transmission of meteorological charts of large size over carrier channels.

This increase in speed may be brought about by means similar to those used for carrier telephone transmission on one sideband. The fact that some facsimile signals are present in the modulated band on frequencies close to the carrier (the difference is 1 c/s) makes it impossible to separate the band modulated by the facsimile signal from one of the sidebands. Hence, in facsimile telegraphy, unlike telephony, we can proceed by partially reducing one of the sidebands. This is called the method of asymmetric sideband limitation of sidebands. The basis of this method is as follows. The modulated facsimile signal containing the carrier frequency as well as the upper and lower side frequencies is applied to a filter with slopes symmetrical around the carrier (F_H) and with linear phase characteristic (see Figure 3). In this filter, unlike the normal lowpass filter, the attenuation curve in the transient region meets the condition,

$$e^{-b_1} + e^{-b_2} = 1, \qquad (1)$$

where b_1 and b_2 are the composite attenuations at adjacent frequencies equidistant to the right and left of the middle frequency (F_H) in the transient region. The phase characteristic of this filter is linear in the passband as well as in the transient region. This filter provides partial reduction of the upper sideband and transmission of the side frequencies equidistant to right and left of the carrier, where the sum of the amplitudes of these two frequencies at the output of the filter will be equal to the overall amplitude. Through this limitation of the sidebands, amplitude and attenuation distortion and phase distortion are eliminated in the neighbourhood of the lower picture frequencies.

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* The expression " facsimile " is used here in the meaning defined in the draft Glossary of Definitions of Essential Telegraph Terms, July, 1955, pages 8-9.

This is because the lower frequencies, from 0 to 300 c/s approximately, are transmitted over the modulated channel on the lower and upper side frequencies at the partial amplitudes e^{-b1} and e^{-b2} and the picture frequencies, from 300 c/s upwards, are transmitted over the modulated channel on a lower side frequency at the amplitude $e^{-b} \approx 1$. Since at the output of the detector (in the receiver) the upper and lower side frequencies are added together, if condition (1) is fulfilled, the complete picture frequency band from 0 to the maximum picture frequency (f max. im.) will have no attenuation distortion.

Since at the output of the symmetrical filter the modulated facsimile signal is applied to the carrier telephone channel, we shall transmit the carrier widened to 2800 c/s, over this channel, together with the lower sideband and the 10% residue of the upper one. Thanks to the widened spectrum of the lower sideband up to 2800 c/s, this method enables us to increase by 1·8 times the facsimile transmission speed in relation to the maximum possible transmission rate with double sideband.

Asymmetric limitation of sidebands inevitably involves quadrature distortion, the origin of which is illustrated by the vectorial diagram in Figure 1, *a* and *b*.

With symmetric limitation of the sidebands (Figure 1*a*), the resultant vector coincides with the vector of the carrier in direction, whereas when the side frequencies are asymmetrically limited the resultant vector does not coincide with that of the carrier. The geometrical figure described by the point of the resultant vector is an ellipse. In this case, we shall have not only amplitude modulation, but also disturbing phase modulation. The distortions in quadrature increase as the residue of the upper sideband is reduced.

A study of the influence of quadrature distortion on facsimile transmission shows that in transmitting pictures with much detail, i.e., when short group pulses are transmitted with small intervals between them, and when long pulses are transmitted with small intervals, the components in quadrature of the two successive pulses are mutually offset and the distortion they produce is not apparent when the group details and finer points of the picture are reproduced. When isolated white lines are reproduced, that is to say, isolated pulses, or the " unit step " pulse, the distortions in quadrature appear as widened pulses, i.e. as a decrease in the steepness of the leading and trailing edges.

Since the first group of details predominates in facsimile telegrams, quadrature distortion does not introduce any appreciable reduction in the quality of transmission. Quadrature distortion can be reduced by cutting down the modulation rate. The vectorial diagram in Figure 1*b* shows there is a decrease in the argument (φ_2) characterizing the rate of undesired modulation as the desired modulation rate is reduced, or (the same thing) as the vector of the carrier undergoes a relative increase.

The above-mentioned increase in the speed of facsimile transmission due to asymmetric reduction of the sidebands can be obtained only on carrier telephone channels corrected in accordance with the argument.

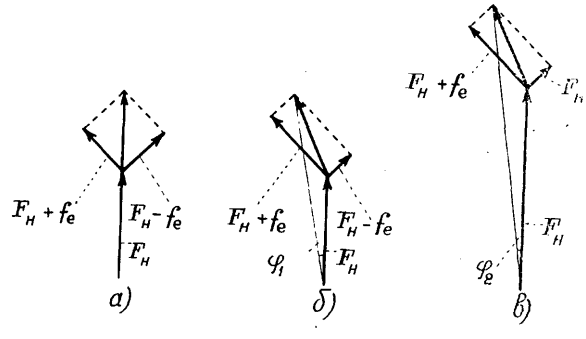


FIGURE 1. — *Vector diagrams showing symmetrical* (a) *and asymmetrical side-band limits*

In the Soviet Union, we have perfected an instrument for facsimile recording on photographic paper or film which enables transmission to take place on carrier telephone channels with a band

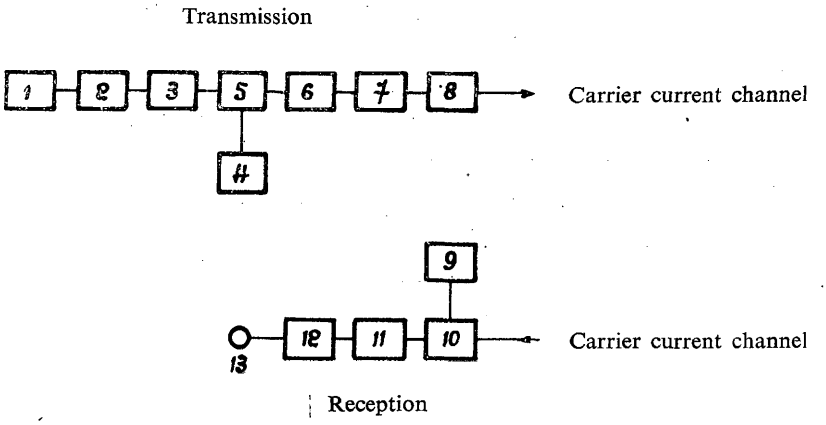


FIGURE 2. — *Diagram of facsimile apparatus*

from 300 to 3400 c/s by the method of asymmetric limitation of sidebands for transmission speeds of 240 and 360 lines per minute. Figure 2 represents this diagrammatically. It shows :

1. Photoelectronic multiplier with ten-stage electronic multiplication.
2. Cathodyne.
3. Lowpass filter for elimination of the picture frequencies higher than the carrier, otherwise the higher picture frequencies after frequency transformation might penetrate the frequency band of the modulated signal and create distortion.
4. A carrier oscillator of 3100 c/s for transmission of modulated facsimile signals on the carrier channels. This particular frequency is chosen because of the transmission of the lower sideband at a width of 2800 c/s and 10% of the residue of the second sideband.

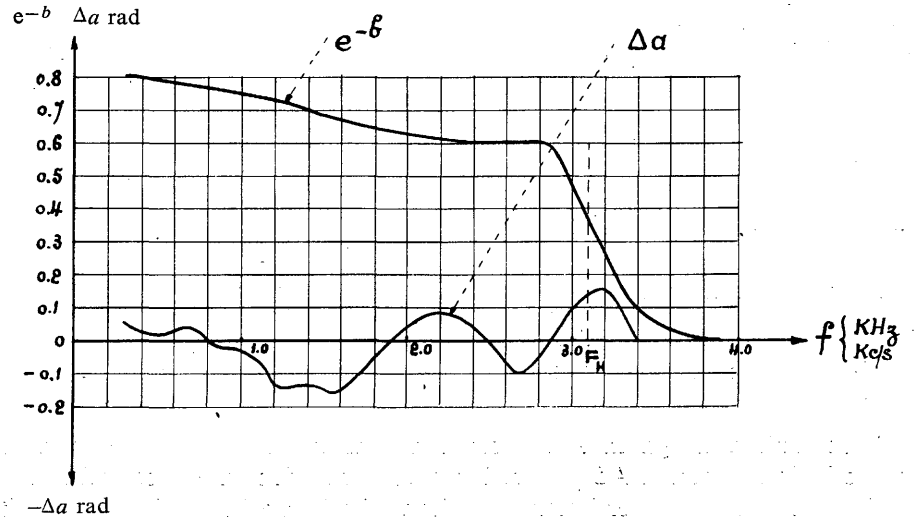


FIGURE 3. — *Frequency characteristics of the relative conductivity (e^{-b}) and the dephase linearity (Δa) of the filter for asymmetrical side-band limits*

5. A balanced modulator designed for modulation of the carrier by the picture signals. The modulated signal at the output of the balanced modulator contains the following frequencies : the carrier, and the lower and upper sidebands. The picture frequency band is balanced in the balanced modulator.

6. To reduce quadrature distortion the modulation rate is fixed at 70%. As from the output of the balanced modulator the modulated signals after appropriate amplification in the amplifier (6) are applied to the filter (7).

7. A lowpass filter with symmetric slopes and linear phase characteristics (see Figure 3) provides partial reduction of the upper sideband.

On leaving the filter, the facsimile signal after the amplifier (8) is transmitted over the carrier telephone channel, corrected in accordance with the argument towards the facsimile receiver (Figure 2). In the facsimile receiver the signal passes from the channel output to the modulator (10) where the linear carrier amounts to 12.7 kc/s. This increase in the carrier is designed to restore the envelope before detection, which in its turn should help to increase the picture's definition. After eliminating the useless products of transformation by means of a filter (11), the facsimile signal enters the photographic recording receiver (12), where the discharge tube (13) is used as a light modulator.

Delay distortion in the channel of the facsimile apparatus and in the carrier telephone channel is corrected with an accuracy of up to 300 microseconds.

Tests of this apparatus under line conditions have shown that the asymmetric limitation of the sidebands makes it possible to transmit facsimile telegrams on carrier telephone channels (300-3400 c/s) with phase compensation, at speeds of 240 and 360 lines a minute.

Question 17.

(Sub-Group 1/4, then Study Group 1, on co-operation with Study Groups 5 and 12, the C.C.I.R., I.B.O. and E.B.U.)

(continuation of Question 9 of C.C.I.F. Study Group 3, 1955/56) (Documentary Question)

Administrations are asked to carry out tests, in co-operation with the Broadcasting Organizations of their own countries, with the object of verifying whether the modifications to the weighting network of the psophometer for broadcast programme circuits and the relative tolerances as proposed in Annex 1 below can be recommended. These tests should be carried out in accordance with Annex 2 below.

Remark 1. — Unless there are very good reasons, it is not desirable to change this curve. It is understood that until tests have shown the need for such a change the curve now recommended should be retained.

Remark 2. — The following contributions to the study of Question 9 of the 3rd C.C.I.F. SG were made in 1955/56 :—

1. The Swedish Administration feels that the proposed change should not take place.

2. The United Kingdom Administration consider that the Annex contributed by the Federal German Administration does not at this stage justify the changing of the C.C.I.F. recommendations. It should be borne in mind that any change in the recommendations would involve the building of new weighting networks. Consequently it is recommended that the question be continued for further study.

ANNEX 1

(to Question 17 of Study Group 1)

Proposals for the modification of the curve of the weighting network of the psophometer for international music circuits

(Note from the Telephone Administration of the Federal German Republic)

1. *Introduction. Modifications proposed.*

1.1 The results of tests made by the broadcasting authority " Nordwestdeutscher Rundfunk " are given below. To facilitate the consideration of the problem the results are given as they were obtained during the tests. For this reason the characteristic curves of the psophometer weighting network obtained with the disturbing tones and test programs are only shown with their relative slopes and are not referred to 1000 c/s (= calculation factor : 1). The curve given in Figure 3 for a " silent period between transmissions " in a room having a noise of 30 phones agrees relatively well with the characteristic curve of the weighting network of the psophometer used for measurements on circuits for music transmissions (published in 1949). The difference at the low frequencies is without doûbt due to the influence of the audibility characteristics of the observers. The difference at the high frequencies is also just within the major part of subjective dispersal. (Also as shown in Figure 12 the characteristic curve of the weighting network of the psophometer which was published in 1949 is from 10 kc/s to the limit below the zone of dispersion of the tests made here.) The object of these tests was not to determine the signal-to-noise ratio necessary for programme circuits.

1.2. From the results of these tests it would appear necessary to modify the provisional curve for the weighting network of the psophometer to be used on international music circuits in such a way that the frequencies between 6 and 12 kc/s receive a greater weighting than with the curve of the weighting network of the 1949 psophometer (see § 3.6 and § 4 and also figures 10 and 11 below). Nevertheless before modifying in the manner indicated the provisional curve of the psophometer weighting network and considering that the curve has already been modified a number of times it is recommended that the proposed new curve should be examined in the light of new tests.

An investigation should be made if the indication of the R.M.S. values recommended by the C.C.I.F. gives a reading which properly corresponds to the true impression of the subjective disturbances. The observations made up to the present have indicated that it is necessary to rate impulsive noise higher than continuous noise. For this reason the psophometer used by the Federal German Republic for measurements on music circuits is arranged to indicate the peaks of impulses with a time constant of some milliseconds ($<$ 10 m.s.). The tests have proved that the indications of impulsive noise given by this equipment correspond better to the subjective impression of disturbance than an indication reading the R.M.S. values. The dynamic properties of this equipment are so chosen that impulses of 20 milliseconds duration are indicated as 80% of their value if permanent. The equipment, therefore, on this point, fulfils the recommendation published in the *Green Book*. (see Vol. IV under 3.2.3.).

1.3. In the *Green Book* the attenuation of the weighting network above 60 c/s and below 10 kc/s is not fixed. In order to avoid falsifying the reading by extraneous voltages outside the band of frequencies 60 to 10 000 c/s the Posts and Telecommunications Administration of the Federal German Republic proposes to add the following to the recommendations concerning the weighting network.

> " At 20 c/s and below and also at 15 000 c/s and above, the attenuation relative to 1000 c/s should be at least 4·6 nepers (40 db). The attenuation should rise in a straight line between 60 and 20 c/s and between 10 000 and 15 000 c/s."

1.4. Volume IV page 129 of the *Green Book* gives no indication of the tolerances allowed for the weighting network. The Posts and Telecommunications Administration of the Federal German Republic proposes the following tolerances :

60	c/s to	100	c/s	± 3·0 decibels
100	c/s to	1 000	c/s	± 1·5 decibels
1000	c/s			± 0·2 decibels
1000	c/s to	8 000	c/s	± 1·5 decibels
8000	c/s to	10 000	c/s	± 3·0 decibels

Note. — When considering the results of the tests mentioned in § 1 it should be considered if, for the frequency band 8000 to 10 000 c/s, a smaller tolerance is possible or if it should only be + 3 db.

2. *Conditions of test.*

The tests were carried out in accordance with " The conditions for tests to determine the characteristics to be adopted for the psophometer for music transmissions " published in the *Yellow Book.* Vol. 1 *ter* (Annex 2 to Question 15, page 291) and brought up to date in Annex 2 below. The measurements taken to this effect are described in § 2·1 to 2·7 below in the order of § 3 to 9 of Annex 2 below. Fig 1 shows the arrangement of the tests.

2.1. " The observations should be made during the silent intervals of a radio program or during the times when the signal is very small ".

The observations have been made when no program was transmitted and with musical passages of low amplitude. Subjects were chosen having the smallest dynamic range possible in order to keep small the difference between observations due to variation of acoustic intensity of the modulation.

2.2. " Normal radio programs or special records of equivalent quality (recordings of music, speech etc.) should be used. All the reproductions should be as free from background noise as possible."

The programs used had a low amplitude (piano, organ, and musical instruments of high tone quality) and were amplified about 15 db, recorded on high quality magnetic tape and attenuated by 15 db on reproduction. By this means the background noise of the tapes was practically imperceptible.

2.3 " Each observer should adjust the volume of sound from the loudspeaker as he wishes. The values thus fixed for the sound volume should be given. The operators should adjust this volume to the level at which they normally listen to radio programs."

The observers were allowed to adjust the sound volume at they wished by means of a potentiometer LR (see Fig. 1). With a low-level program of small dynamic range there is a risk that observers who are not aware of this condition will adjust the sound level too high.

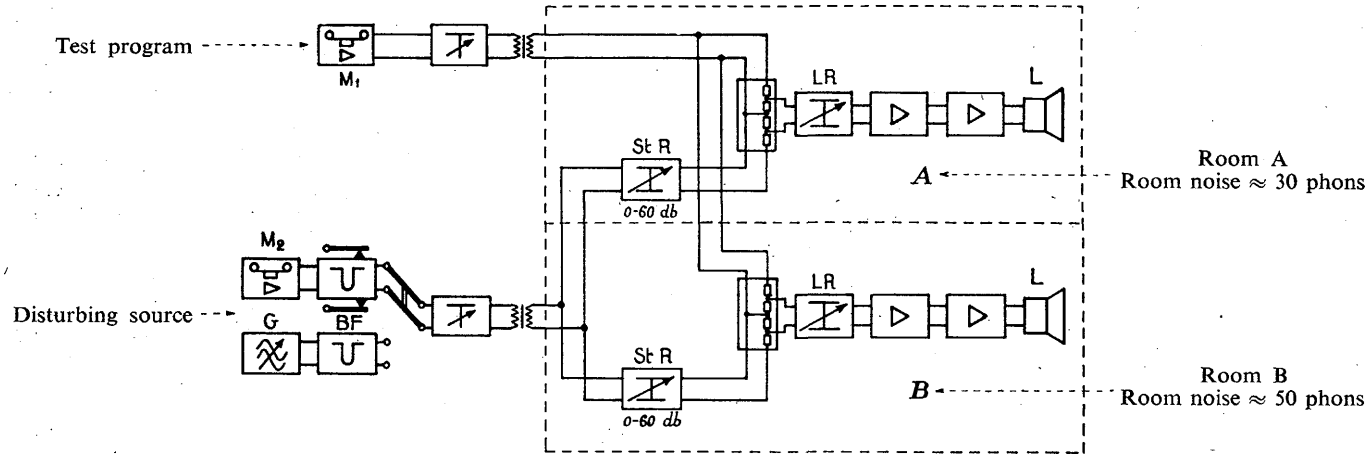
For this reason the test modulation was preceded by a short passage of the same piece of music with a large dynamic ratio during which the observers adjusted the sound volume to normal. The low-level program which followed was then fixed relative to the level they normally hear.

2.4. " The sound reproducing systems should be free from distortion throughout the frequency band at all amplitudes used in the tests " Since there was in each case a ratio of at least 5 db between the test modulation and total modulation, the non-linear distortions produced by the recorder did not exceed the threshold of audibility. For the reproduction a high-quality loudspeaker was used with a spherical radiator for high frequencies *.

The attenuation distortion of the loudspeaker and the audition room was corrected electrically. The remaining distortion was measured by means of thermal agitation noise used in the tests (bandwidth : one third; frequency band from 50 c/s to 12·5 kc/s) and by amplitude modulated sinusoidal tones for the high frequencies (frequency band 3·5 to 16 kc/s) in such a way as to take

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* See Dr. H. HARZ and Dr. H. KOSTERS : " Ein neuer Gesichtspunkt für die Entwicklung von Lautsprechern ", *Technische Hausmitteilungen des Nordwestdeutschen Rundfunks*, No. 12/1951, pages 205 to 208 and Dr. H. HARZ and Dr. H. KOSTERS : " Kugelstrahler als Lautsprecher für Musikwiedergabe ". *Radio Mentor*, No. 7/1952, pages 320 and onwards.



M_1 = Tape Recorder (test program)
M_2 — Tape Recorder (Thermal noise and sinusoidal tones 0.05 to 12.5 kc/s)
G = Generator (amplitude modulated sounds 3.5 to 16 kc/s)
BF = Band Pass filter
StR = Regulator for adjusting the disturbing noise
LR = Regulator for adjusting the listening volume
L = Loudspeaker system (test loudspeaker of high quality with spherical radiator for high frequencies)

FIGURE 1. — *Arrangement of tests*

into account the whole test equipment. Since the attenuation distortion was subject to close variations (around ± 3 db) the position of the microphones and the observer were interchanged and an average of 6 measurements taken. The results obtained by this means (see Figure 2) were used to correct the characteristic curves of the psophometer weighting network.

2.5. " The disturbing noise should be composed of a small band of frequencies (for example, sinusoidal currents periodically interrupted, frequency bands extracted from thermal agitation noise etc.). Narrow bands of frequencies should be used of average values 50, 10, 200, 400, 800, 1600, 3200, 6400, 8000 c/s.

Other types of noise may be used but they should be capable of being accurately described."

In the tests the disturbing frequencies described above were used and also the frequency of 22·5 kc/s. The disturbing noise (thermal agitation *, and sinusoidal sounds periodically interrupted at a frequency of 2 c/s) were recorded on magnetic tape at a level of −12 db (relative to 0 db = 100% modulation). Thus the non-linear distortion and the tape noise was held below the limit of perceptibility. The disturbing noise of 50 c/s was also reproduced by means of a band filter (width of band : one third) since small components at high frequencies may otherwise have been audible and would have affected the result. Since the sensitivity to the high frequencies is greater than was assumed up to this stage, a second series of tests was made with frequencies 3·5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 kc/s. In these limits the measurements were made with amplitude modulated tones (wobble frequency 6·25 c/s; frequency deviation 100 c/s) because at the high frequencies the bands of thermal noise are too large for a good measurement of the impairment and because with pure sinusoidal tones the frequency characteristic is locally subject to too large a variation.

The amplitude modulated tones were applied via band pass filters of bandwidth one third in order to suppress undesirable sounds (arising from the signal generator) which might appear in the band of frequencies at a higher level than the disturbing source.

The observers were able to adjust the disturbing noises by a regulator StR (see Figure 1) to a value they thought tolerable. The observers were not able to see the amount of attenuation so as not to influence the result.

Preliminary tests have shown that 15 seconds was sufficient time for the adjustment of the level of the disturbing noise. If longer, the concentration of the observers was affected.

2.6. " The level of room noise should correspond to conditions normally encountered in rooms when listening to radio programs : it should have a value in the region of 30 to 50 phons for a quiet or noisy room respectively."

The observations were made in two rooms, one having a normal level of room noise of around 30 phons and the other a higher level of room noise of average 43 phons.

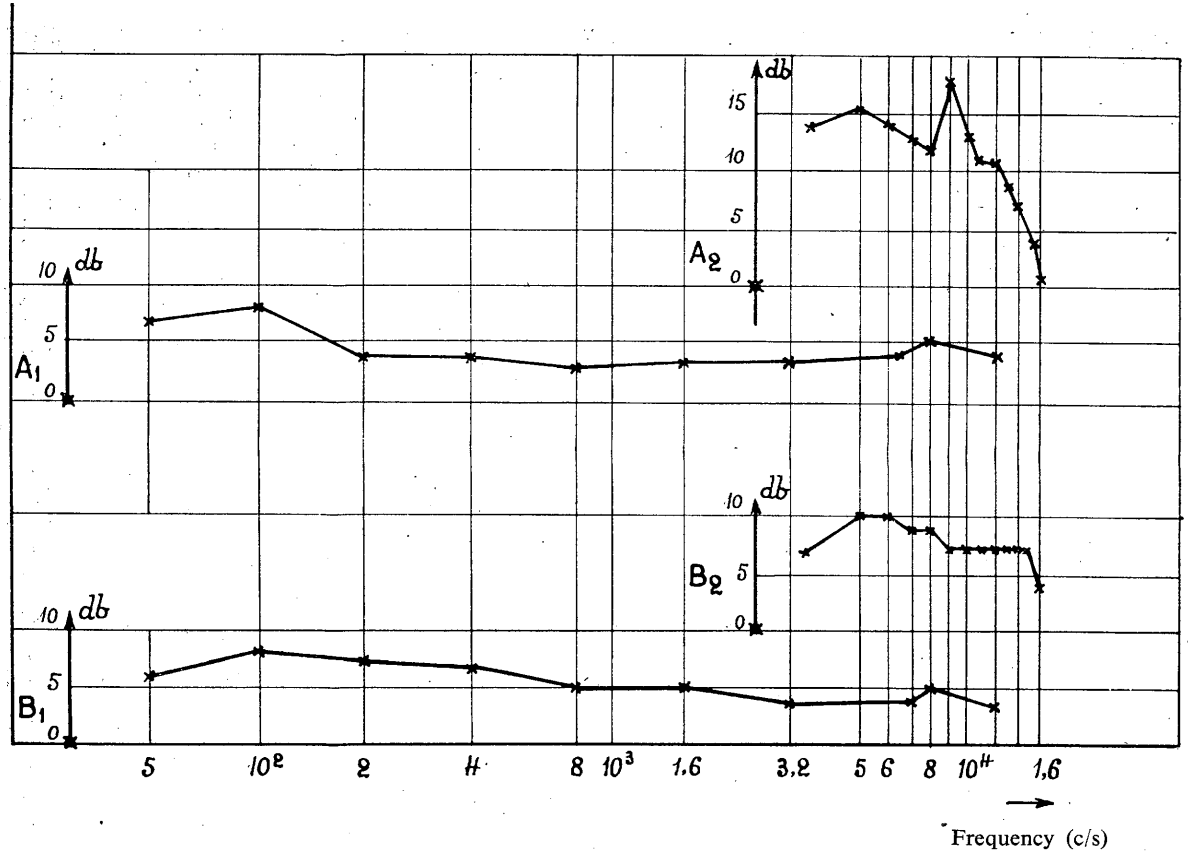
The level of room noise of 50 phons was obtained by means of a second loudspeaker, which was installed at a different angle to the principal loudspeaker and which reproduced street noise with heavy traffic (recorded on magnetic tape). The high frequency band was attenuated electrically corresponding to a reduction in sound with the windows closed.

2.7. " For these measurements about ten observers should be employed of average age (20 to 30 years). People with defective hearing should be excluded. Musical experts only should not be chosen but also amateurs."

The observations were made by 20 people, men and women, 20 to 30 years of age; non musical experts were amongst those chosen. Their audibility curves were first verified by means of an audiometer and those with defective hearing were eliminated. For the high frequencies an audio-

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* Bandwidth : one third.



A_1 Quiet room (30 phons) measured with thermal agitation noise
A_2 Quiet room (30 phons) measured with amplitude modulated tones
B_1 Noisy room (50 phons) measured with thermal agitation noise
B_2 Noisy room (50 phons) measured with amplitude modulated noise

FIGURE 2. — *Acoustic pressure-frequency characteristic at the listening point (average of 6 positions adjacent to the measuring microphone)*

meter was improvised by a resistance generator and a dynamic receiver. The frequencies used later in the tests (see § 2·5) were used to verify the ear sensitivities.

2.8. *Various.* — It has been stated in the preliminary tests that the observers may not have confidence in what they heard but that they could be considerably influenced by extraneous factors. For example they had a tendency to turn the regulator StR to a position which did not differ much from the preceding setting. The observers were not able to read the amount of attenuation inserted but they were able to judge the angle turned through and tended at the next frequency to adjust to a similar position. This tended to give equal acoustic pressure at all frequencies and a flattening of the curve. It was, therefore, necessary to make a preliminary approximate adjustment of the attenuation as known from the existing curve and from preliminary tests and only required the observers to correct these values.

Furthermore it was found that the observers had more tolerance with regard to the first disturbing sounds of an audition than to the disturbing sounds which followed. The same sound occurring at the commencement of an audition could be given about 3 db less attenuation than later in the audition. In order to determine the error the disturbing noises were not always reproduced in the same order.

3. *Results.*

3.1. The results of the tests are reproduced in Figures 3 to 12. In these the ordinates represent the arithmetic mean of the amount of attenuation as adjusted by 20 observers (the curves include a correction to eliminate the frequency characteristics of the testing equipment as chosen in Figure 2).

The scale in decibels refers to the testing apparatus. It should only be read as a relative value and does not represent for example the ratio relative to the level used or to the modulation limit.

3.2. Figure 3 shows the characteristic curve of the psophometer weighting network for thermal agitation noise * and for various forms of signals in a quiet room (30 phons). It will be appreciated that the sensitivity is greater in a silent interval, it is not much less with piano music due to the intervals between different sounds. With organ music, on the contrary, it is much worse and with stringed instruments it is also worse since they both partially mask the disturbing source due to their notes following one another without interval. This effect is particularly noticeable at the middle frequencies which generally contain most of the tones used and in the adjacent higher frequencies. The disturbing effect of the highest and lowest frequencies is not seriously influenced by the program source.

Figure 4 shows for the same test program and disturbing noise the effect of a high room noise (50 phons). The room noise influences in the same way as the disturbing tones, particularly in the absence of disturbing tones or in the case of a " transparent " disturbing source and is much worse than with organ music and stringed instruments which already produce a strong masking effect.

3.3. Figure 5 differs from Figure 3 by the type of disturbing source. This is also the difference between Figure 6 and 4. The effect, known from previous tests and due to the fact that the ear is more sensitive to sinusoidal sounds than to thermal agitation noise is confirmed.

3.4. Figure 7 represents the general average of Figures 3 to 6 for the different disturbing sources used and for the room noises of 30 to 50 phons.

3.5. The upper frequency band measured with the test program but with an amplitude modulated tone ** as disturbing source, is represented in Figure 8 (room noise : 50 phons) and Figure 9 (room noise : 30 phons). Here also the masking effect of room noise is always less as one proceeds to the maximum frequencies.

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* Bandwidth : one third.

** See paragraph 2.5.

3.6. In Figure 10 are assembled the curves of Figure 7 (0·05 to 3·2 kc/s) and the average of Figures 8 and 9 (3·5 to 16 kc/s). They have been placed on the ' y ' axis relative to each other so as to be as coincident as possible in the range 3·5 to 12·5 kc/s.

In Figure 10 the characteristic curve of the psophometer weighting network used for measurements on program circuits published by the C.C.I.F. in 1949 (see the *Green Book*, Volume IV page 130) is drawn in such a way as to agree with the other curves. A comparison with the curves obtained in the tests gives satisfactory agreement in the low and mean frequency bands whilst according to the tests the frequencies about 6 kc/s should receive a much greater weighting than in the C.C.I.F. curve. For this band of frequencies the shape of the curve would be approximately that indicated by the dotted line. The difference between the two curves might, therefore, be explained as follows : — The old tests (which have served as the basis for the C.C.I.F. curve in 1949) were made by observers having another audibility curve and also the transmission quality of the testing apparatus (particularly the loudspeaker systems) might perhaps have been different.

The shape of the curve for the mean and lower frequencies may perhaps be represented with a good approximation by a line with a slope of 6 db per octave.

From the results of the tests the curve represented by the C.C.I.F. in 1949 corresponds in this frequency band to the conditions existing in the silent intervals in a quiet room *, whilst the line shows the effects in the rooms with average noise for music susceptible to disturbance (piano).

3.7. So as to be able to judge the increase in weighting at the higher frequencies, which were represented in the test by thermal agitation noise (white noise) the square of the voltage subjective effect has been plotted as a function of frequency (both linear). The new curve has given a surface which is approximately double, i.e. a noise power greater than 3 db.

3.8. To check the accuracy of the values obtained in the tests, the normal error calculations have been used, it being understood that one does not mean an " error " in the ordinary sense of the word. The values have been obtained as follows :—

Measurement	Average error (in decibels) in the band of frequencies		
	Lower	Middle	Upper
Single measurements	5,3	6,8	8,0
Average of curves 3 to 6	1,3	1,6	2,2
General average from Figure 10 . . .	0,7	0,8	1,1

Figure 12 shows very approximately the dispersion in the example " piano music " in a quiet room (room noise : 30 phons) with thermal agitation noise of a bandwidth of one third or with amplitude modulated sound.

The sound pressure of the test program having a small amplitude as adjusted by the observers was on the average 54 phons with a standard deviation of 2·4 phons in the quiet room (room noise 30 phons) and 63 phons with a standard deviation of 3 phons in the noisy room (room noise 50 phons).

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* The hypothesis (see " Remark " to the old Question No. 15) that the 1949 curve did not take into account the disturbing effect during the silent intervals is not, therefore, confirmed by the tests.

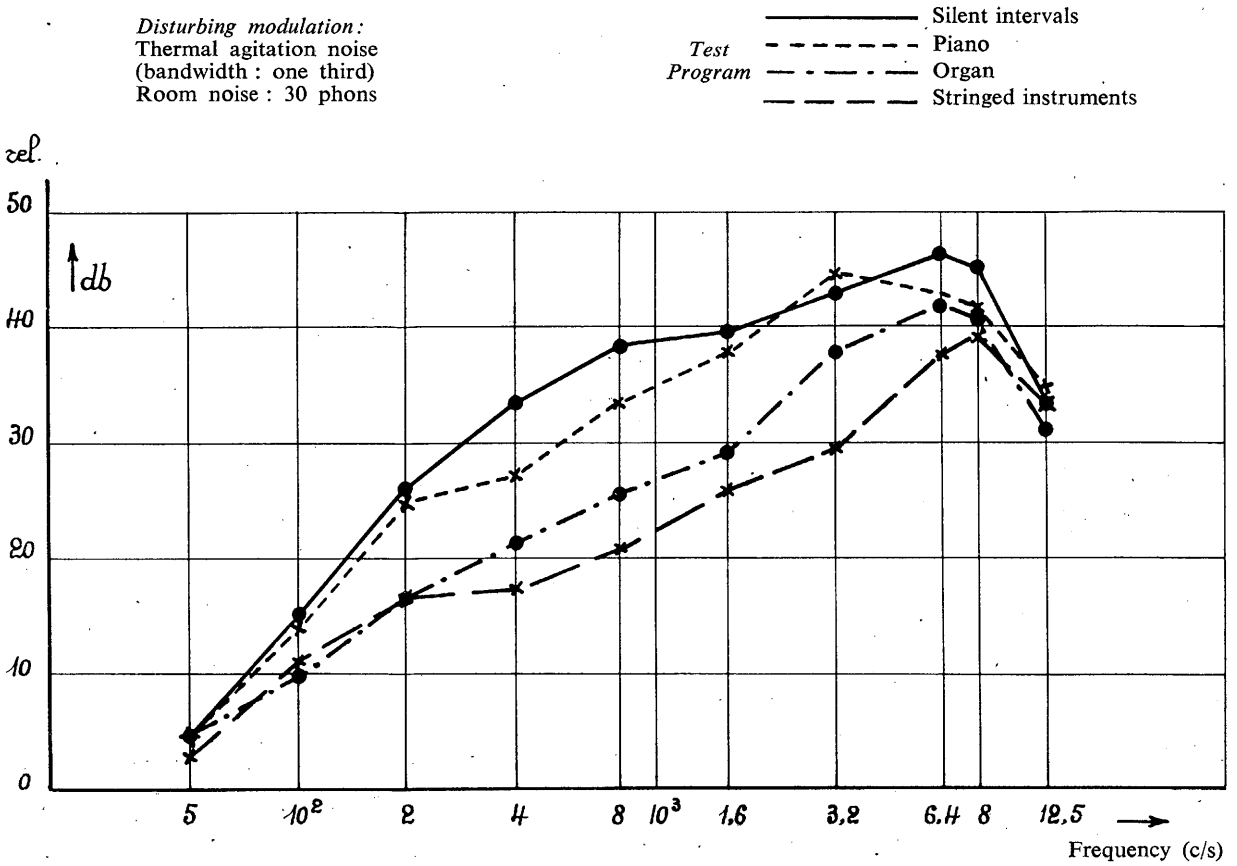


FIGURE 3. — *Characteristic curves pertaining to the psophometer weighting network used for the tests*

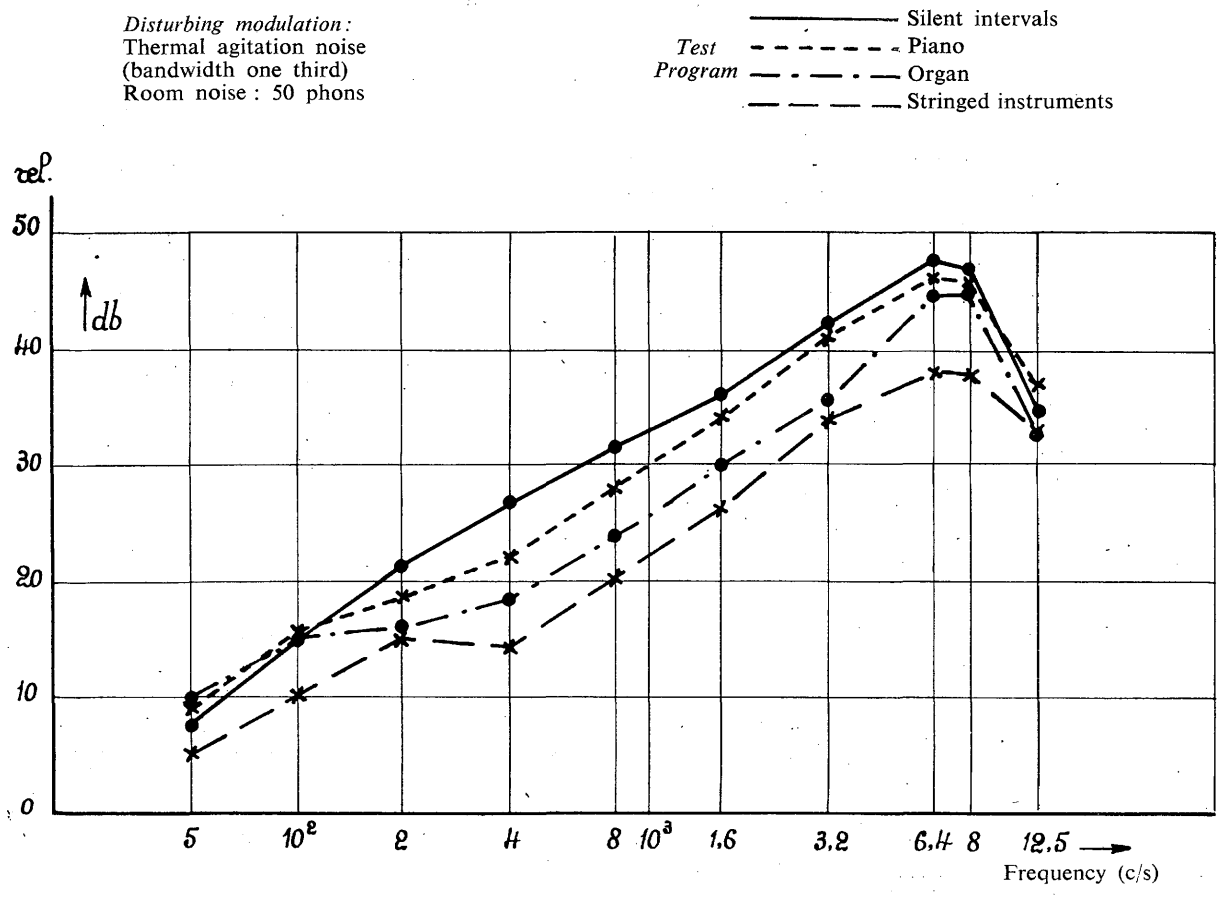


FIGURE 4. — *Characteristic curves pertaining to the psophometer weighting network used for the tests*

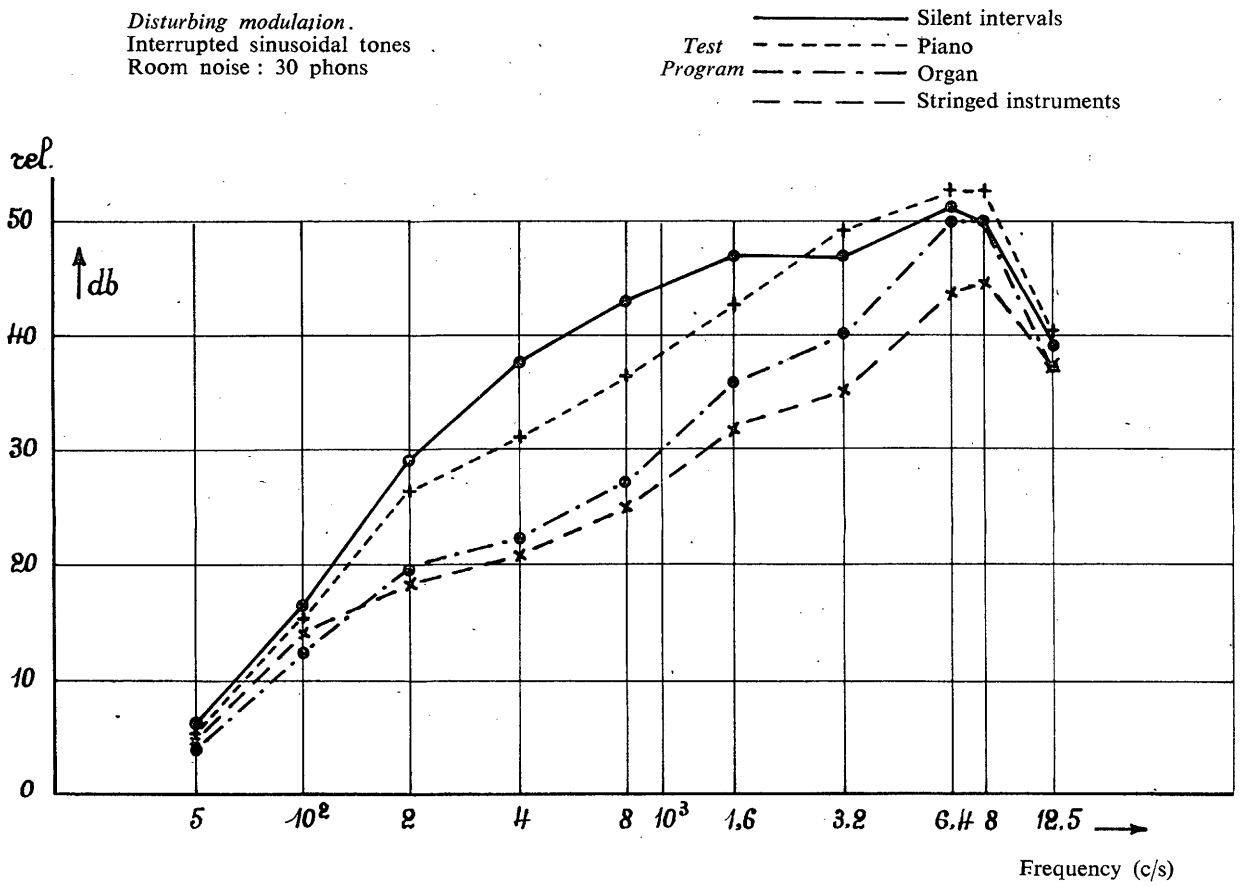


FIGURE 5. — *Characteristic curves pertaining to the psophometer weighting network used for the tests*

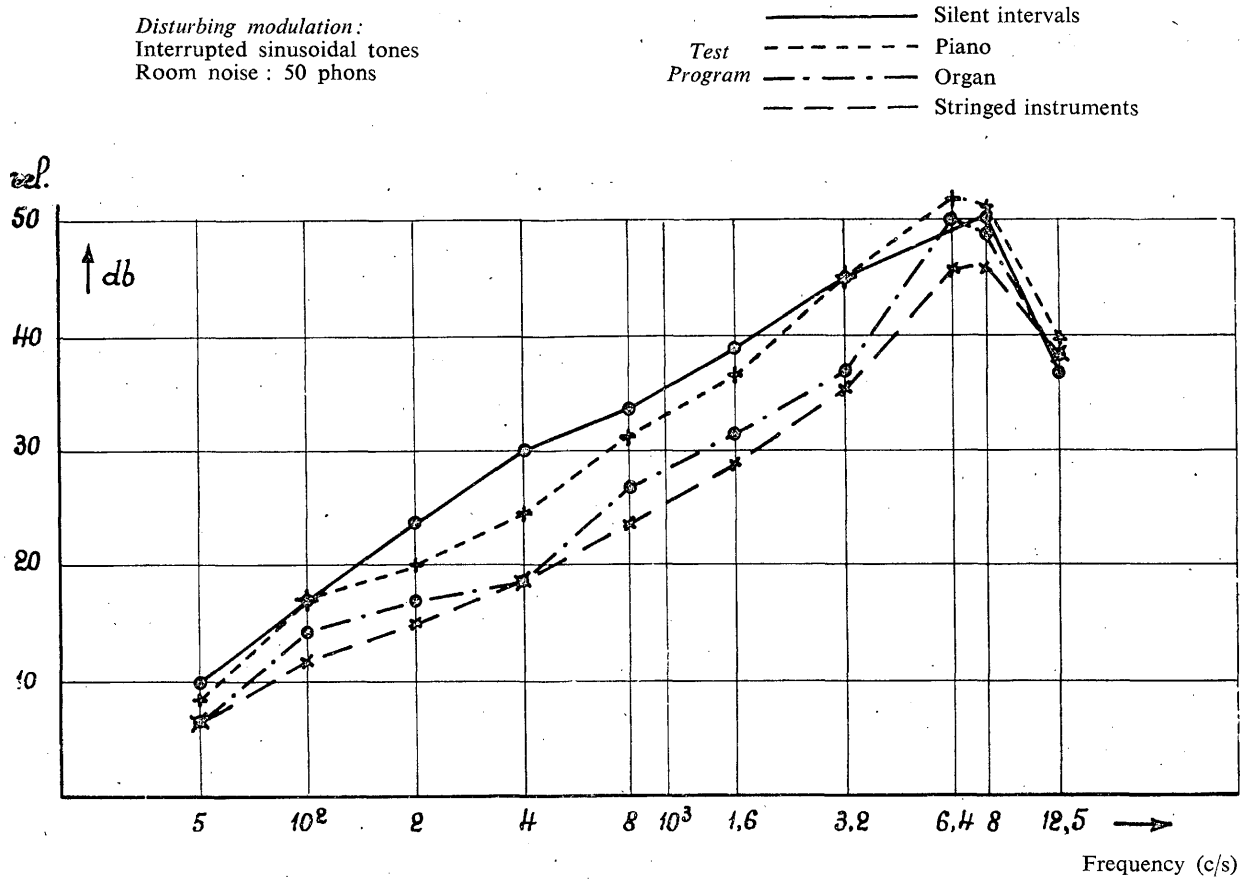


FIGURE 6. — *Characteristic curves pertaining to the psophometer weighting network used for the tests*

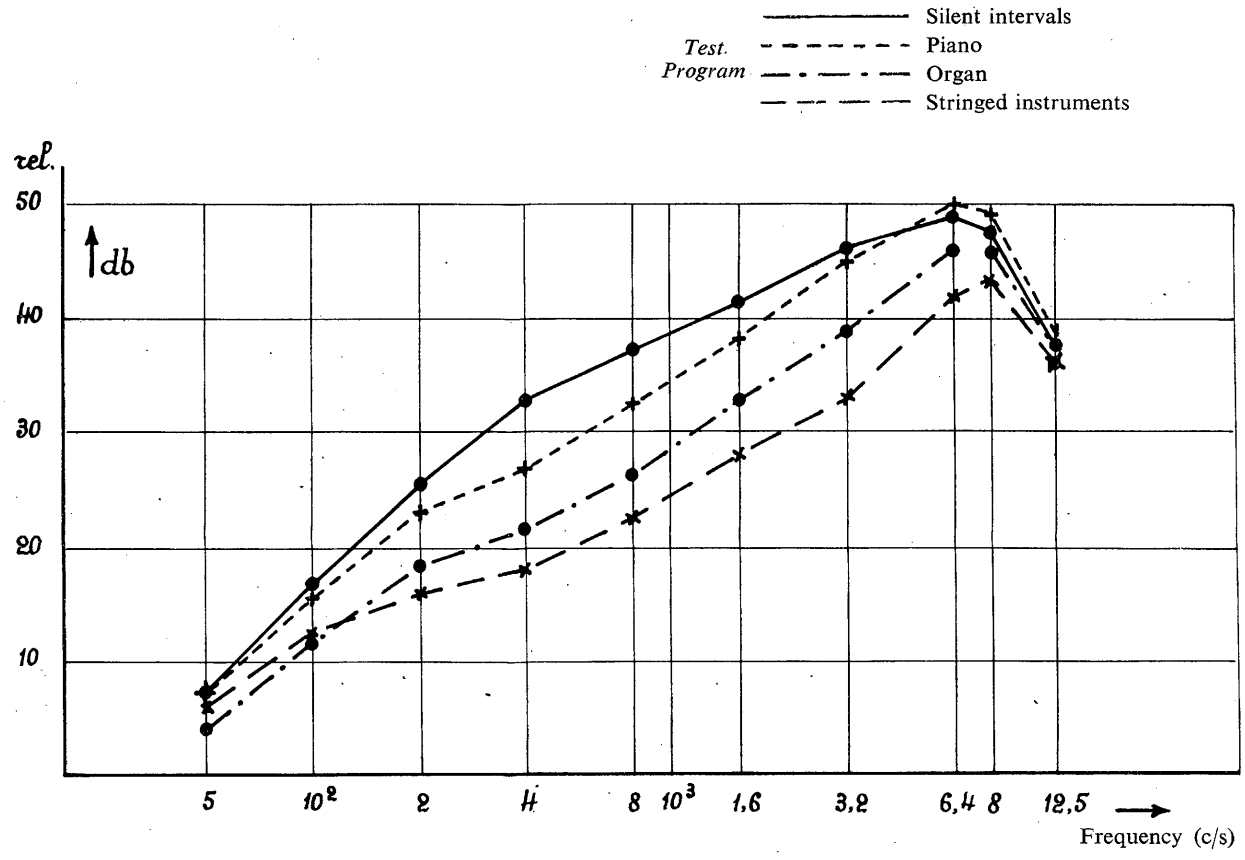


FIGURE 7. — *Curves of average values taken from characteristic curves pertaining to the psophometer weighting network for thermal agitation noise and interrupted sinusoidal tones for room noise 30 and 50 phons*

Characteristic curves pertaining to the psophometer weighting network used for the tests with amplitude modulated tones

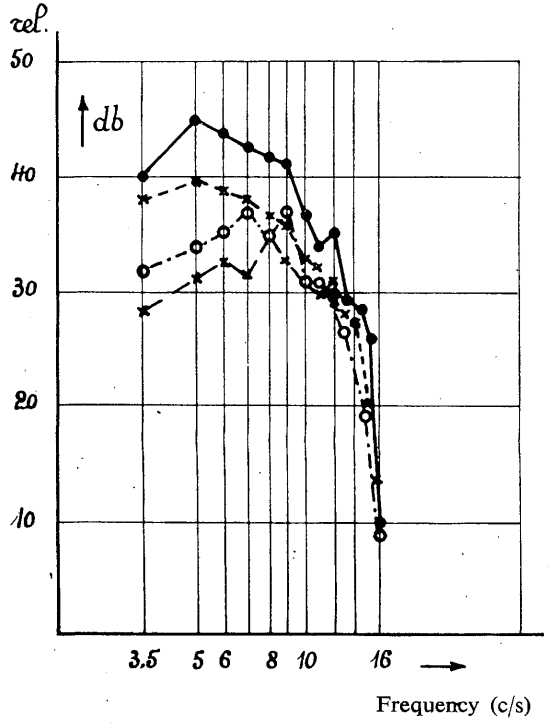


FIGURE 8. — *Room noise: 50 phons*

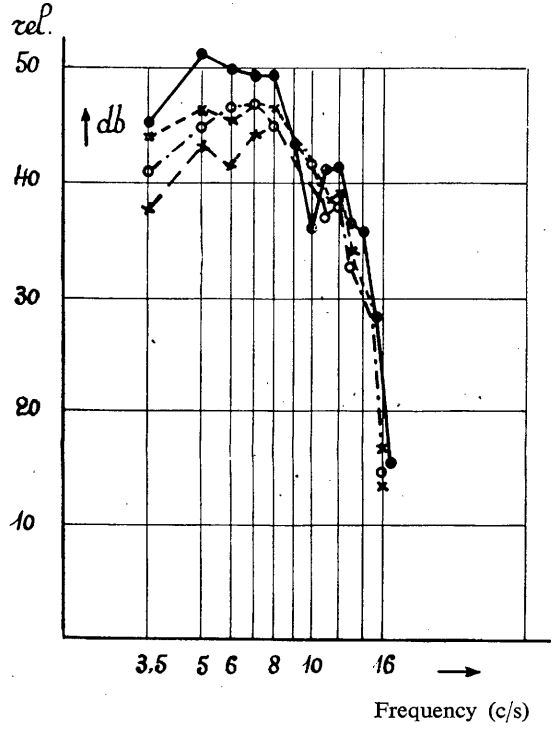


FIGURE 9. — *Room noise: 30 phons*

Disturbing modulation:
Amplitude modulated tones
(Wobble frequency 6.25 c/s;
deviation frequency of wobble 100 c/s)

Test Program
- Silent intervals
- Piano
- Organ
- Stringed instruments

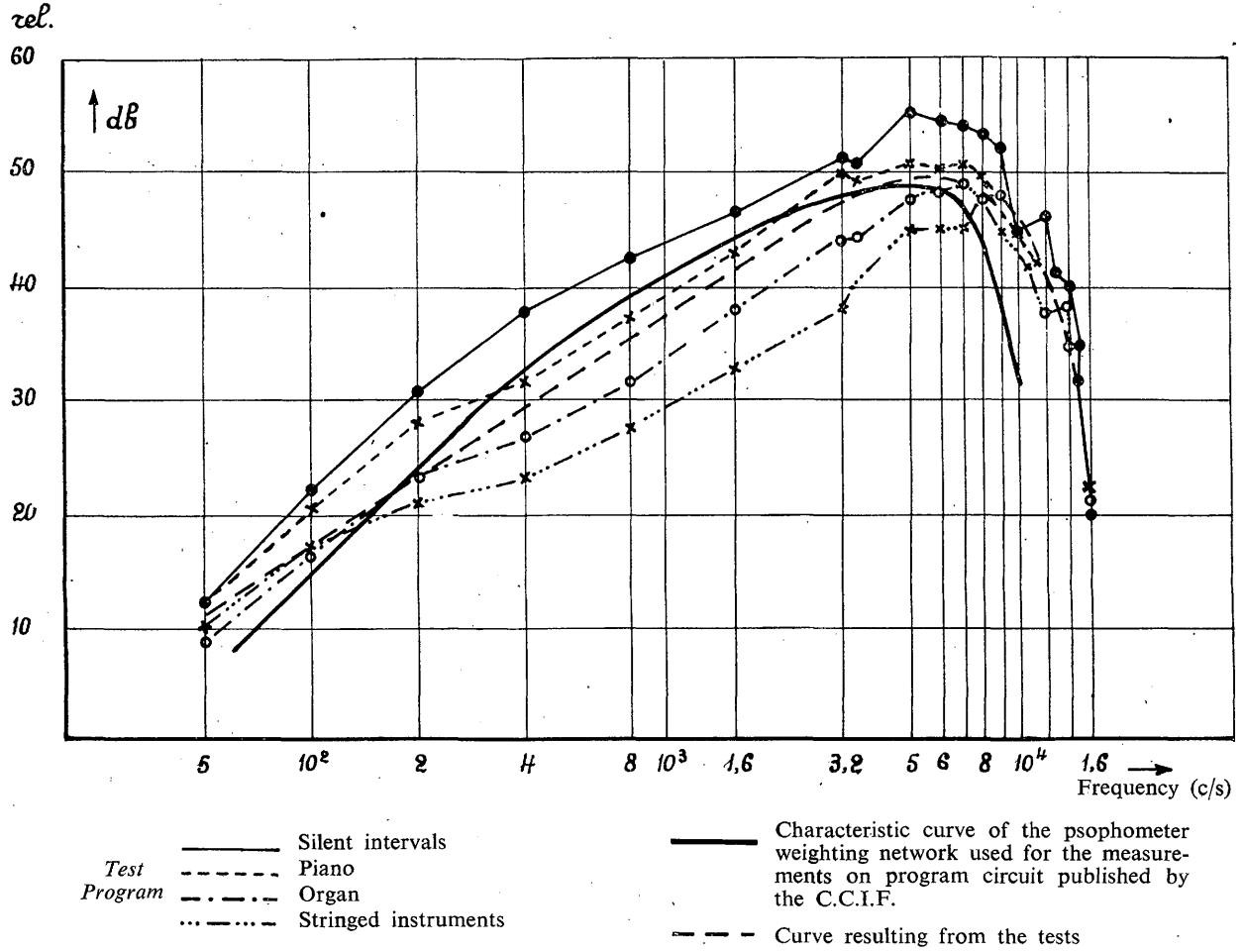


FIGURE 10. — *Curves of average values combining Figure 7 (0·05 to 3·2 kc/s) and Figures 8 and 9 (3·5 to 16 kc/s) compared with the characteristic curve of the psophometer weighting network used for measurements on program circuits published by the C.C.I. in 1949*

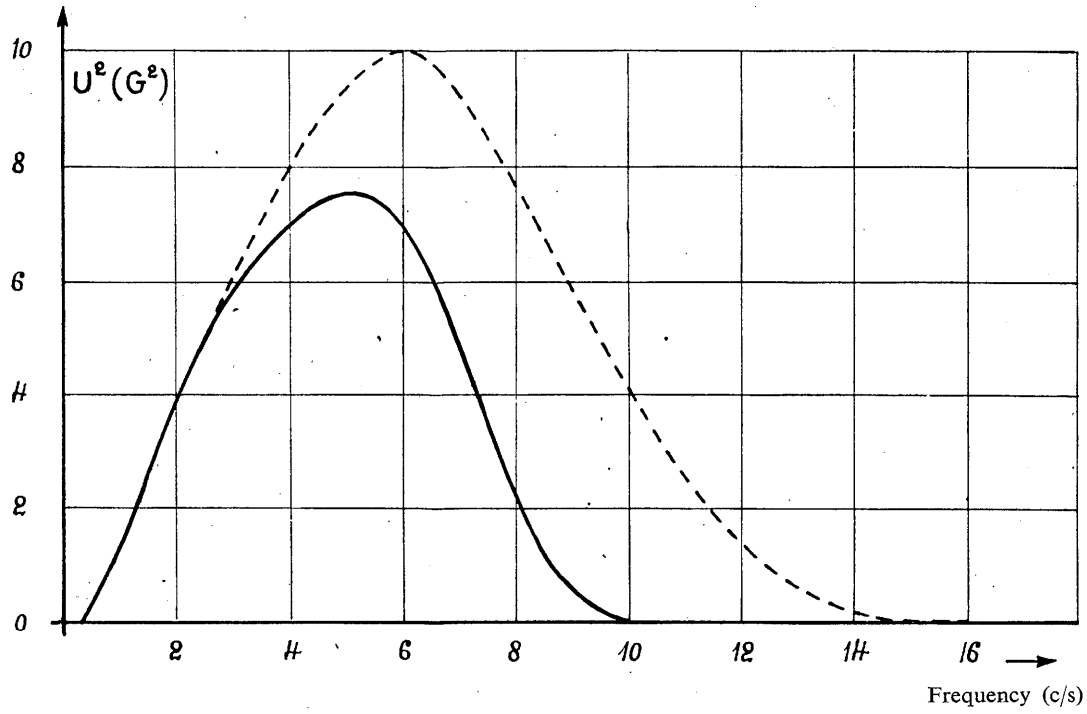


FIGURE 11. — *Linear Graph of* $U^2 = F$ (b) *for the characteristic curve of the psophometer weighting network used for measurement on program circuits published by the C.C.I.F. in 1949* ═══ *and the new curve obtained from the tests* – – – – – –

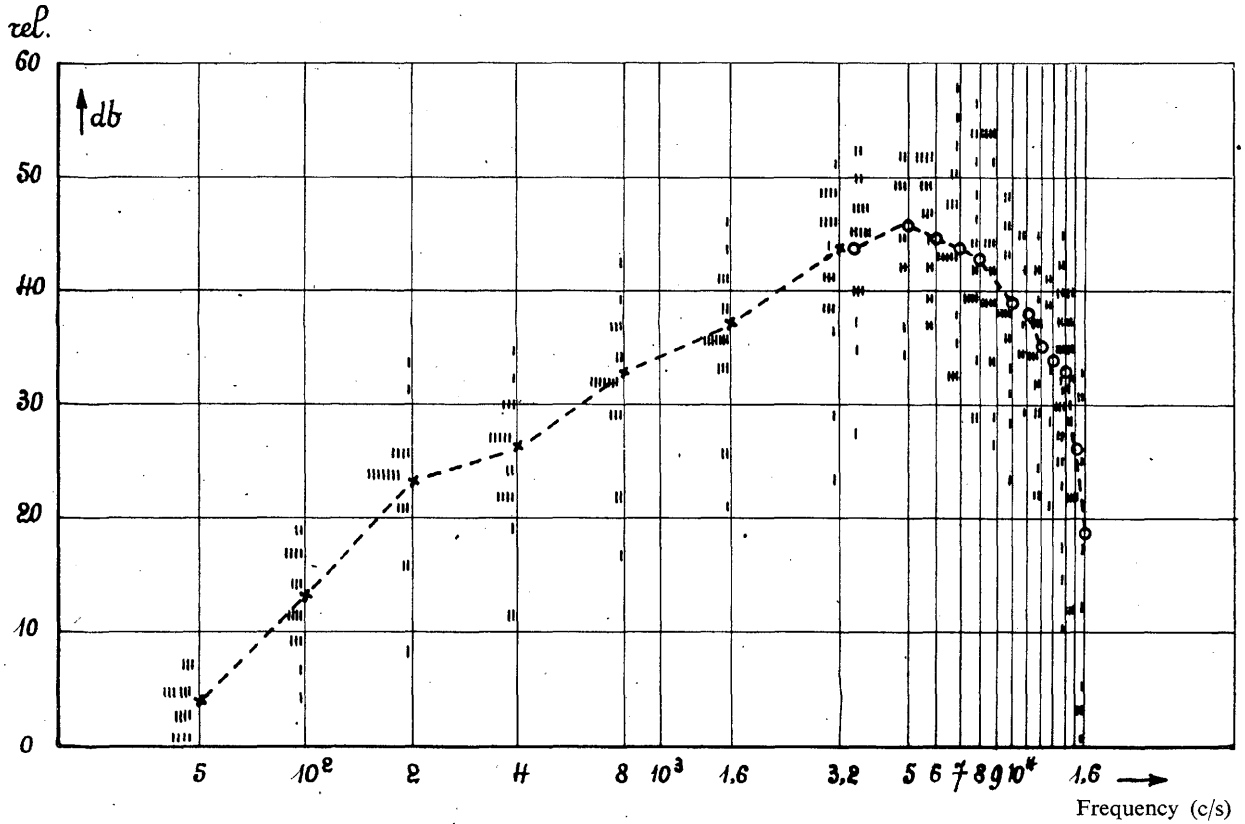


FIGURE 12. — *Measured points and average values for piano music and thermal agitation noise (50 c/s to 3·2 kc/s) or amplitude modulated tones (3·5 to 16 kc/s) for a room noise of 30 phons*

4. *Conclusions.*

According to the characteristic curve of the psophometer weighting network used for the tests (see Figure 10) the frequency of 10 kc/s should receive a greater weighting of 10 db than that recommended by the C.C.I.F. in 1949. Furthermore the new curve takes into account the frequency band between 10 and 16 kc/s which is not the case with the curve published by the C.C.I.F. in the *Green Book*, Volume IV, page 130. If for the frequency band below 3·2 kc/s the shape of the present curve is preserved, the psophometric weighting at 12 kc/s (at 8·5 kc/s in the 1949 curve) is the same as at 1000 c/s. This increased weighting gives twice the power where wideband thermal agitation noise is measured (an increase of 3 db).

The Posts and Telecommunications Administration of the Federal German Republic proposes that the results of the tests should form a basis for an examination of the new curve suggested for the psophometer weighting network.

ANNEX 2

(to Question 17 of Study Group 1)

Conditions to be observed in the tests having as their aim the final fixing of the characteristics to be adopted for the psophometer for programme transmissions

It has been decided to adopt the following procedure, in respect of the tests to be undertaken to determine the curve of the filter network to be used in psophometers for programme transmissions :

1. Each observer, seated in a room reproducing the listening conditions of a relatively quiet private house, is asked to imagine that he is listening to a wireless programme. This programme should have a little circuit noise, the volume of which can be varied, and the listener is asked to adjust this noise so that it just fails to interfere with his enjoyment of the programme.

2. Before each test the hearing of each observer should be checked to ensure it is normal, special attention should be given to hearing at high frequencies, because there is a greater variation of people's hearing at high frequencies than at low frequencies.

3. Tests should be made during silent periods of the wireless transmission, or when the amplitude of the transmitted signal is very small.

4. Normal radio programmes should be used or, alternatively, special recordings of equal quality (of voices, music, etc.). All these should, as far as possible, be free from any background noise.

5. Each observer should be ableto regulate, to his own liking, the volume of the loudspeaker. The values thus fixed for the volume of these sounds should be recorded. The operators should adjust the sound level to that to which they are accustomed when listening to radio programmes.

6. The systems of sound reproduction should be without distortion throughout the frequency band and throughout the whole range of amplitude used during the tests.

7. The disturbing noise should consist of a small frequency band (e.g. sinusoidal current periodically interrupted, or a band extracted from thermal agitation noise, etc...). Narrow frequency bands should be used with mean values successively of :— 50, 100, 200, 400, 800, 1600, 3200, 6400, 8000 c/s.

Other types of noise may be used, but it will be necessary to describe them exactly—for example a noise with a distributed spectrum corresponding to the background noise of carrier systems, and perhaps also intermodulation noise which occurs when there is overloading of a repeater in a multichannel carrier system.

8. The room noise should correspond to the conditions ordinarily met with in rooms used for listening to radio programmes; it should have values of about 30 or 50 phons, corresponding respectively to the conditions of a quiet or noisy room.

9. For these tests about 10 observers of average age (20 to 30 years) should be used; persons suffering from hearing disabilities should be eliminated from the tests. Subjects should not be chosen exclusively from musical experts but also from ordinary music lovers.

Question 18.

(Sub-Group 1/4, then Study Group 1)

(continuation of Question L of C.C.I.F. Study Group 3, 1955/1956) (background question)

The existing recommendation of the C.C.I.F. concerning non-linear distortion on programme circuits is based on considerations of harmonic distortion. It is possible that this criterion does not correspond completely with the harmful effect produced on high-quality music by non-linearity, particularly since it does not take account of differential tones which may considerably affect musical harmony.

Tests should therefore be made on working programme circuits of second and third order distortion such as are described in Appendix 1 following, which reproduces a passage from a C.C.I.F. document (Oslo, 1938) which has not been included in the C.C.I.F. publications since 1945.

(a) Administrations are requested to communicate to the C.C.I.T.T. Secretariat the results of tests of second and third order distortion made on various types of national programme circuits (old type circuits, special rediffusion pairs, phantom circuits on non-loaded symmetrical pairs, circuits set-up on carrier systems), these tests being made in accordance with Annex 1 below.

(b) If it is envisaged that the present C.C.I.F. recommendation, based on harmonic distortion, should be replaced by a recommendation based on second or third order distortion, what are the limits which could be guaranteed in the present state of technique?

Note. — Appendices 2 and 3 following give, by way of information, results of tests made by the Administrations of the Netherlands and of the Federal German Republic.

ANNEX 1

(to Question 18 of Study Group 1)

Definitions and methods of measurement relating to non-linear distorsion

Coefficient of differential tones of a non-linear quadripole is the ratio (measured at the output of the quadripole), of the sum of the r.m.s. values of the differential frequencies to the sum of the r.m.s. values of the two fundamental frequencies.

According to whether the differential tone of the first order, or the two differential tones of the second order, are considered, the coefficient is either quadratic distortion or cubic distortion.

Note 1. — In the expression " coefficient of differential tones ", the word " tone " is used in its general sense to mean a sound wave or an electric wave, and the quadripole considered could be an electric quadripole, and electro-acoustic quadripole, or a purely acoustic quadripole.

Note 2. — The sum of the r.m.s. values of the component frequencies considered here should not be confused with the r.m.s. value of the two frequencies taken together. The sum of the r.m.s. values of the two component frequencies of an amplitude a and of different frequencies is $a\sqrt{2}$ while the r.m.s. value of the two frequencies considered here when taken together is a

Measurement of the coefficient of quadratic distortion. — In order to measure the coefficient of quadratic distortion, for example of an electric quadripole, for a frequency f, and for an input level p, at the input of the quadripole are simultaneously applied two sinusoidal waves of equal amplitude, the frequencies of which are $f + 30$ c/s and $f - 30$ c/s differing the one from the other by 60 c/s, so that the sum of the r.m.s. values of the two fundamental frequencies is equal to the r.m.s. value of a sinusoidal voltage of level p. The value of the peak applied to the quadripole is thus the same as if it were a sinusoidal voltage of which the r.m.s. value corresponded to the level p. The quadripole should be terminated, during the measurement, under service conditions. The measuring apparatus connected to the terminals of the terminating impedance, should have a relatively high input impedance. At the output of the quadripole, a differential frequency of the first order is received amongst others, and this has a frequency of 60 c/s. After passing through a band-pass filter with a very narrow pass-band, which extends from $60-\varepsilon$ to $60+\varepsilon$, E being a small quantity, the amplitude of this differential frequency of 60 c/s is measured at this point (see Figure 1 opposite). Let U_1 represent the value of the voltage thus received. If a sinusoidal wave of

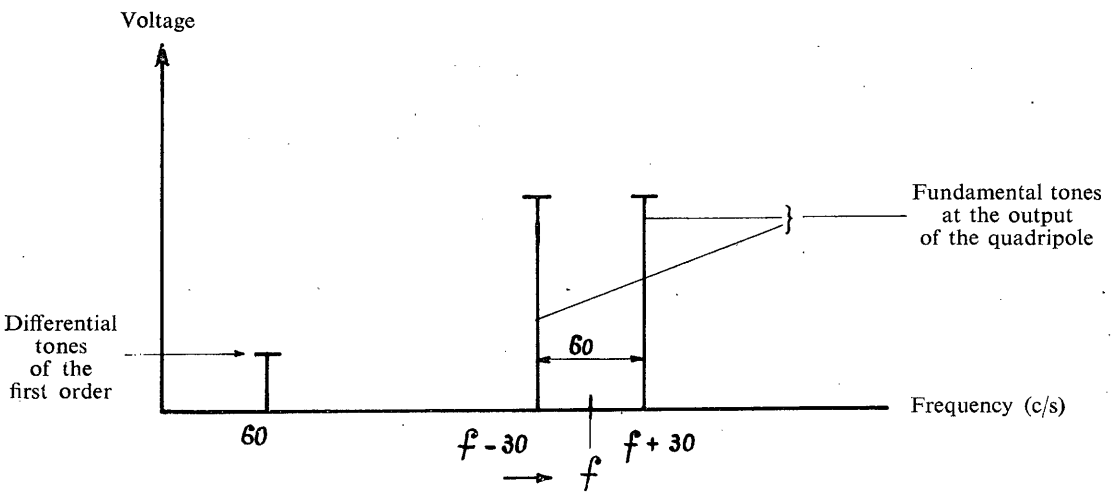


FIGURE 1. — *Measurement of coefficient of quadratic distortion*

frequency 60 c/s is then applied at the input of the filter, having an r.m.s. value equal to the sum of the r.m.s. values of the two fundamental frequencies $f+30$ c/s and $f-30$ c/s, at the output of the filter will be received a voltage of the value U_2. . The ratio U_1/U_2 expresses the coefficient of the quadratic distortion of the quadripole for the frequency f and for the input level p.

Measurement of the coefficient of cubic distortion. — In order to measure the coefficient of cubic distortion, for example of an electric quadripole, for a frequency f and for an input level p, at the input of the quadripole are applied simultaneously two sinusoidal waves of equal amplitude, and having frequencies $f+15$ c/s and $f-15$ c/s differing the one from the other by 30 c/s, so that the sum of the r.m.s. values of the two fundamental waves is equal to the r.m.s. value of a sinusoidal voltage or level p. The peak applied to the quadripole is thus the same as if it were a sinusoidal voltage of which the r.m.s. value corresponded to the level p. The quadripole should, during the measurement, be terminated under service conditions. The measuring apparatus connected to the terminals of the terminating impedance should have a relatively high input impedance. At the

output of the quadripole, will be received, amongst others, the two differential waves of the second order $2(f+15)-(f-15) = f\times 45$ c/s and $2(f-15)-(f+15) = f-45$ c/s and the two fundamental waves $f+15$ c/s and $f-15$ c/s. This mixture of frequencies is applied to a rectifier with a square law characteristic. After rectification, amongst others, two waves of frequencies 60 c/s are obtained which are the differential waves of the first order produced on the one hand by the waves $f+45$ c/s and $f+15$ c/s. These differential frequencies of 60 c/s obtained at the output of the rectifier are filtered through a band-pass filter with a very narrow pass-band extending from $60-\varepsilon$ to $60+\varepsilon$, ε being a small quantity, and at this point the total wave of frequency 60 c/s is measured (1st measurement, see top of Figure 2 below). Let U_1 represent the value of the voltage thus received. If then, instead of the two frequencies $f+15$ c/s and $f-15$ c/s, two waves of the frequencies $f+30$ c/s and $f-30$ c/s, having the same level are applied to the input of the quadripole, at the output of the filter a voltage of the value U'_2 will be obtained. The half of the ratio U'_1/U'_2 expresses the coefficient of the cubic distortion of the quadripole for the frequency f and for the input level p.

In the first measurement, the rectifier produces in particular, by intermodulation between each of the two fundamental frequencies of amplitude b (see at the top of Figure 2) and a differential of amplitude k, two frequencies of 60 c/s, the amplitudes of which are proportional to the product bk. As these two frequencies have very nearly the same phase, they form a resultant with a frequency of 60 c/s and an amplitude bk. In the second measurement, by intermodulation between the two fundamentals of amplitude b, are obtained (see bottom of Figure 2), a single frequency of 60 c/s, and an amplitude proportional to b^2. If the ratio of these two results of measurements is calculated, $\frac{2bk}{b^2} = 2\frac{k}{b}$ is obtained, this being independent of whether peak

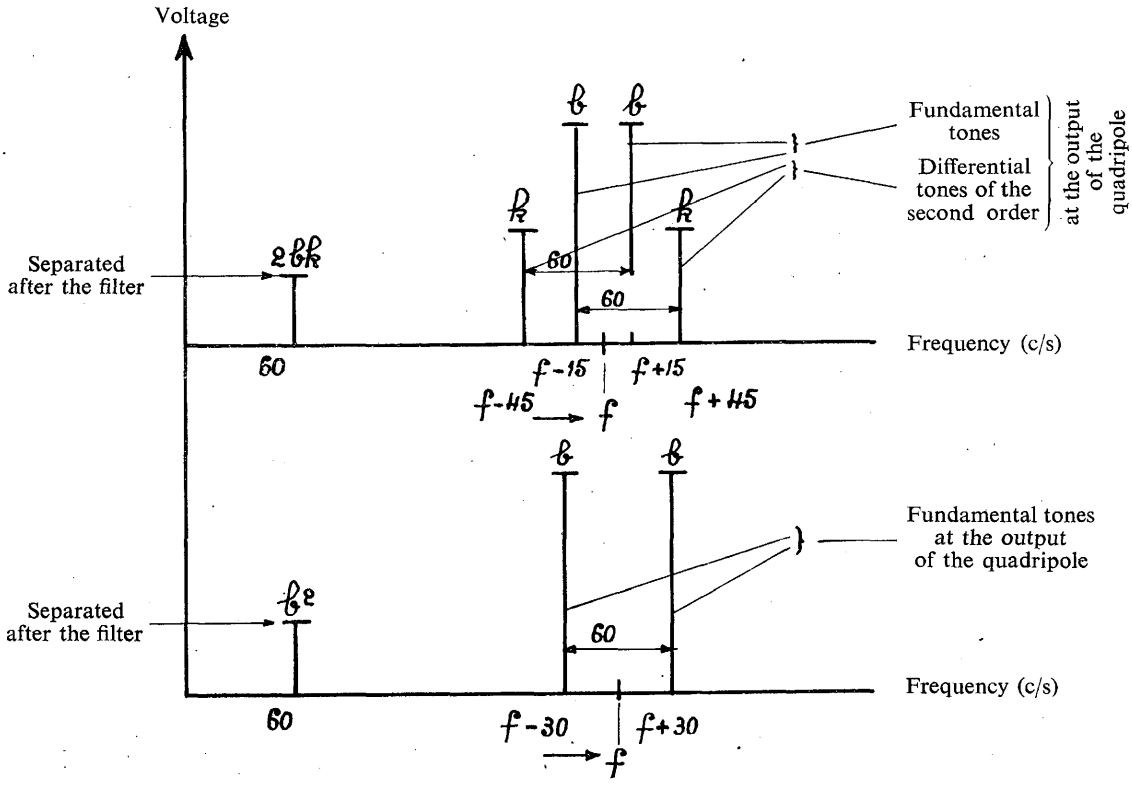


FIGURE 2. — *Measurement of coefficient of cubic distortion*

or r.m.s. values are measured. On the other hand, as the definition is based on the ratio of the sum of the r.m.s. values of the two differential frequencies of amplitude k, and the sum of the r.m.s. values of the two fundamental frequencies of amplitude b, which ratio is equal to k/b, the ratio of the values measured should be divided by 2, as given above.

ANNEX 2

(to Question 18 of Study Group 1)

Measurements of quadratic and cubic distortion made by the Netherlands Telephone Administration

Results of measurements (given only as an example).

The measurement was made on a programme circuit consisting of 5 sections each of 24·5 km (see figure 1). As is usually the case a sending amplifier was used.

The measuring apparatus available did not permit of the use of the measuring method recommended by the C.C.I.F.

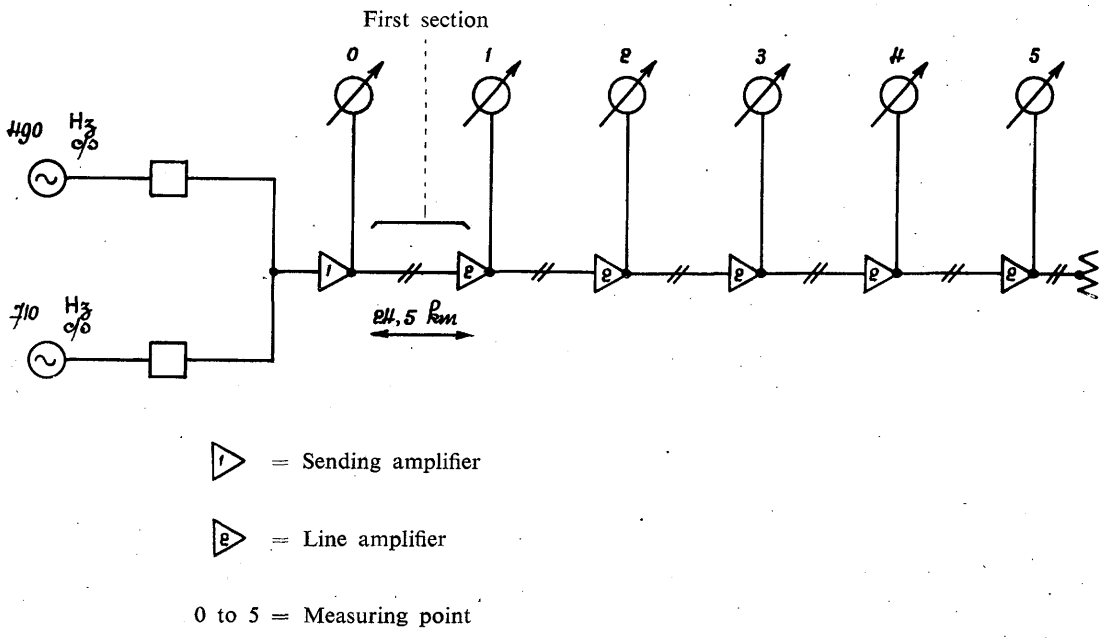
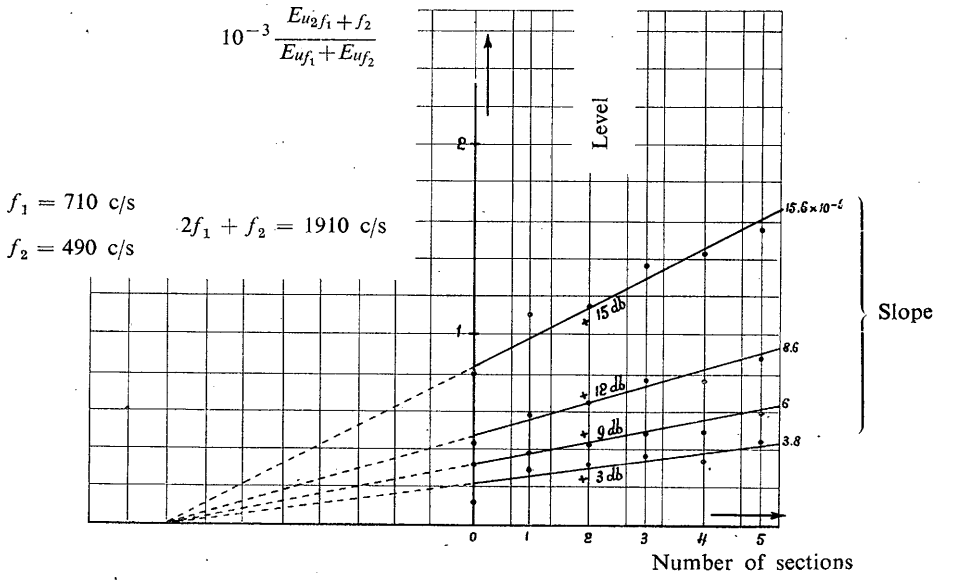


FIGURE 1. — *Circuit for programme transmissions*

Diagram I

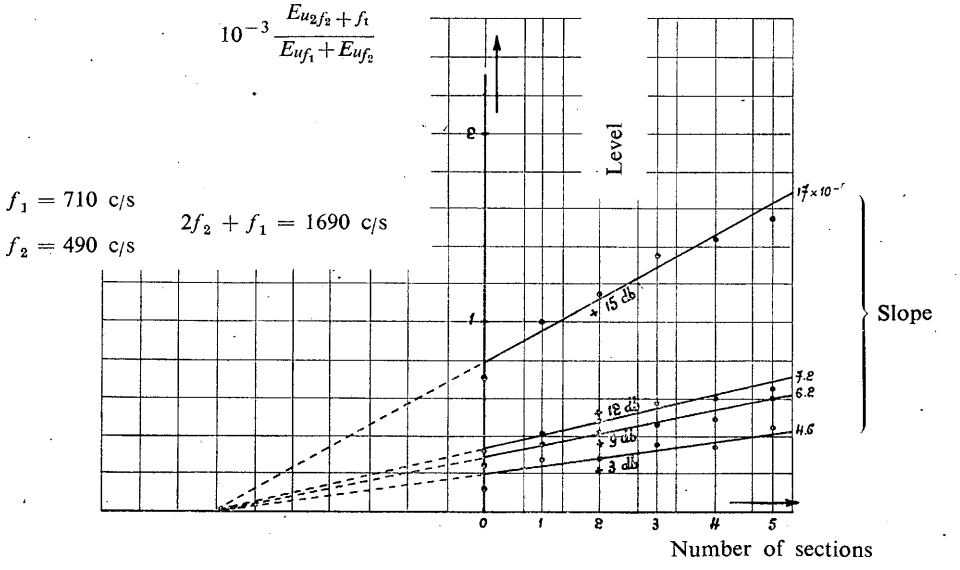


$E_{u2f_1+f_2}$ = Effective value of the frequency $(2f_1 + f_2)$

E_{uf_1} = Effective value of the frequency f_1

E_{uf_2} = Effective value of the frequency f_2

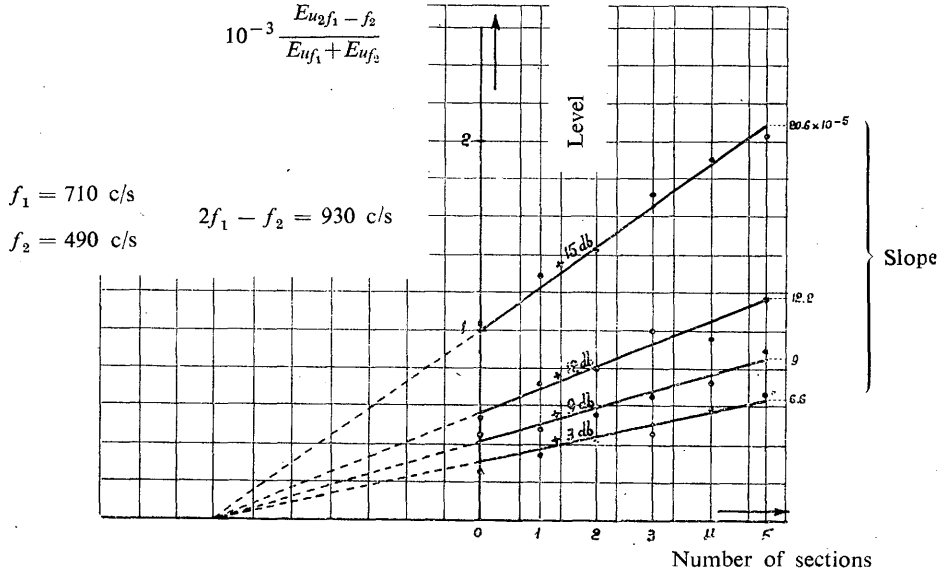
Diagram II



$E_{u2f_2+f_1}$ = Effective value of the frequency $(2f_2 + f_1)$

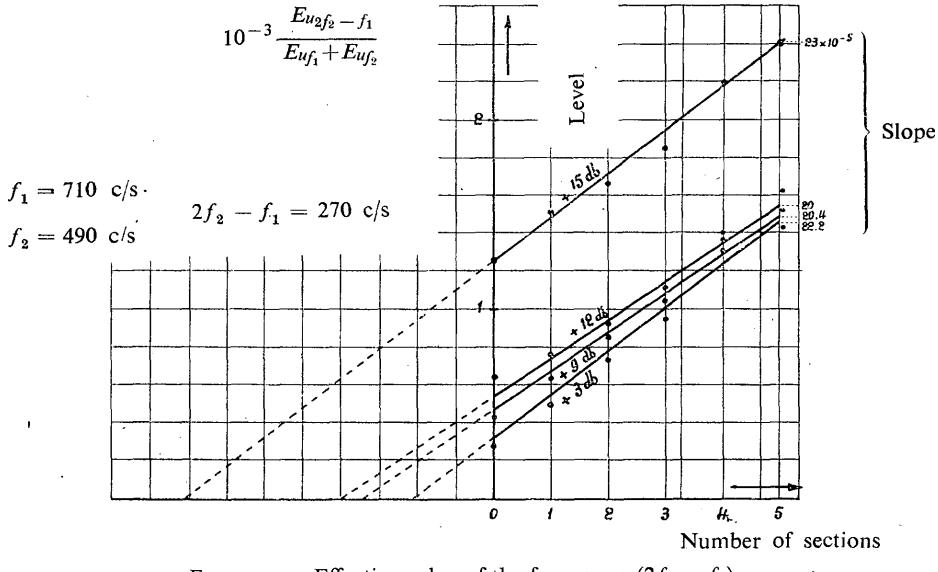
FIGURE 2

Diagram III



$E_{u2f_1-f_2}$ = Effective value of the frequency $(2f_1 - f_2)$

Diagram IV



$E_{u2f_2-f_1}$ = Effective value of the frequency $(2f_2 - f_1)$

FIGURE 3

The results are given for only one of these measurements. The differential tones of the first and second order were determined for two frequencies, i.e. 710 and 490 c/s.

The level of the two frequencies was the same.

The distortion was measured as a function of the number of sections, with the level (in db with respect to 0·775 volt) as parameter.

The results of the measurements of differential tones of the second order are shewn in diagrams I to IV of Figures 2 and 3.

It was found that the increase in the differential tones of the first order, when the number of sections was increased, was not measurable. The contribution of the line amplifiers was evidently too small compared with that of the sending amplifier.

In accordance with the definitions in Annex 1 of the text of this question, each of the diagrams shows the ratio of the effective value of one of the distortion products to the sum of the effective values of the fundamental frequencies.

Remarks. — *(a)* The straight lines shew that the voltages of the distortion products were additive.

(b) In the diagrams I to III the straight lines diverge from the same point. This indicates that, in these cases, the law of variation as a function of level is the same for the sending amplifier as for the line amplifiers.

(c) The variation of distortion as a function of level does not correspond to the ordinary limit of the relation between the input voltage and the output voltage in the form of a power series of three terms. It seems that the contribution of the higher power terms is still considerable.

ANNEX 3

(to Question 18 of Study Group 1)

Measurements of quadratic and cubic distortion made by the Federal German Republic Telephone Administration

Measuring equipment which has been developed by Siemens and Halske and based on the considerations mentioned in Annex 1 above has been tested by the Federal German Post and Telecommunications Administration. This measuring equipment uses the following frequencies :

(a) *Measurement of the coefficient of harmonic distortion.*

(1) Fundamental frequency . . . . . 60 c/s

The coefficient of cubic harmonic distortion K_3 is measured by using a band-pass filter with a mid-band frequency f_0, equal to 180 c/s.

(2) Fundamental frequency . . . . . 90 c/s

The coefficient of quadratic harmonic distortion K_2 is measured by using the same filter as that in (a) (1).

(3) Fundamental frequency . . . . . 533 c/s

The coefficient of cubic harmonic K_3 is measured by a band-pass filter with a mid-band frequency f_0, equal 1600 c/s.

(4) Fundamental frequency . . . . . 800 c/s

The coefficient of quadratic harmonic distortion K_2 is measured by means of the same filter as that in (a) (3).

(b) *Measurement of the coefficient of differential tone:*

(1) Fundamental frequencies . . . . . $f_1 = 5{\cdot}4$ kc/s and $f_2 = 7$ kc/s
The coefficient of quadratic disortion K_2 is measured with the 1600 c/s filter mentioned under (a) (3).

(2) Fundamental frequencies . . . . . $f_1 = 4{\cdot}3$ kc/s and $f_2 = 7$ kc/s
The coefficient of cubic distortion K_3 is measured; this corresponds to the differential tone $2f_1 - f_2$, which is in the pass band of the 1600 c/s filter.

The measuring frequencies shewn under (b) have been chosen to ensure that they are included in the limits within which the propagation time is practically constant and the measuring equipment thus is of universal application.

Remark. — The values obtained in Germany with the usual amplifying equipment for programme circuits, appear in the following articles :

(a) For old-type programme circuits : H. RIBBECK and F. STRECKER, Die elektrischen Übertragungseigenschaften des deutschen Rundfunkleitungsnetzes, *EFD*, 46 (1937), pages 108 to 117.

(b) For normal programme circuits : E. A. PAVEL, Übertragungseigenschaften niederfrequenzer Rf-Leitungen in den deutschen Trägerfrequenzfernkabeln, *FTZ*, 8 (1955), Vol. 8, pages 455 to 461.

Question 19.

(Sub-Group 1/1, in co-operation with Sub-Group 1/4)

(continuation of supplementary Question J, studied in 1955/56 by C.C.I.F. Study Group 3)

Where Administrations consider it useful to produce programme circuits transmitting a frequency band of at least 50-6400 c/s, using in a carrier system the frequency band corresponding to two telephone channels,

— what limits should be recommended for the general characteristics of such circuits ?

Note 1. — The C.C.I.F. has already recommended the use of the frequency band 88 to 96 kc/s in the basic group B for such circuits, with a virtual carrier frequency of 96 kc/s.

Note 2. — As regards the list of characteristics to be specified, those for normal programme circuits may serve as a guide. (C.C.I.F., *Green Book*, Vol. III, pages 183 to 191.)

Question 20.

(Sub-Group 1/1 in co-operation with Sub-Group 1/4, then with Study Group 3 and with the C.C.I.R.)

(a) Can the limits at present recommended by the C.C.I.F. for noise and intelligible crosstalk for programme circuits in cables, both for old type and normal type circuits

(C.C.I.F., *Green Book*, Vol. III 3rd part, sections 1 and 2), be met in the cases of 1,000 km circuits set up without special precautions on carrier systems ?

(b) If not, what special precautions should be recommended in the setting up of 1,000 km circuits, so that the limits mentioned in part *(a)* of this question would be met ?

Remark. — In studying parts *(a)* and *(b)* of this question, the case of normal circuits and that of old type circuits should be considered separately.

(c) What limits for noise and intelligible crosstalk can be met at the present time on a normal programme circuit of 2,500 km set up on carrier systems ?

(d) What value of psophometric power (measured with the new psophometer for programme circuits recommended by the C.C.I.F.) and what crosstalk ratio (corresponding to intelligible crosstalk) should be taken as design objectives for normal programme transmission circuits on the basis of the " hypothetical reference circuit for programme transmissions " (see annex below) ?

(e) What values of near-end crosstalk ratio can be reasonably obtained between the programme circuits set up on a carrier system on coaxial pairs and using respectively telephone channels of the same frequency and opposite directions of transmission ?

Remark 1. — It will be necessary to propose, in the reply to this question, certain assumptions on the question of the make-up of the hypothetical reference circuit for programme circuits.

Remark 2. — The value of the ratio between desirable components and crosstalk components, in the case of the transfer of a group or supergroup which have been recommended by the C.C.I.F. is a minimum normal value for telephone transmission. It will be necessary to verify if this value is sufficient when there are programme circuits on one of the groups adjacent to the transferred group. Appendix 2 contains a proposal from the United Kingdom.

ANNEX 1

(to Question 20 of Study Group 1)

Hypothetical reference circuit for programme transmissions

C.C.I.F. Study Group 3, during its meeting in March 1956 considered it desirable to have a hypothetical reference circuit for programme transmissions, similar to the hypothetical reference circuit of 2,500 km for television transmissions : this circuit would represent the chain made up of the international circuit or circuits and of the national extension or extensions.

This circuit will conform to figure 1, where, in the case of carrier transmissions, B.M.M′.

and C are the only points where audio frequencies appear. For example, in referring to figure 43 of Volume III of the *Green Book* points B and C could correspond to points B and H *.

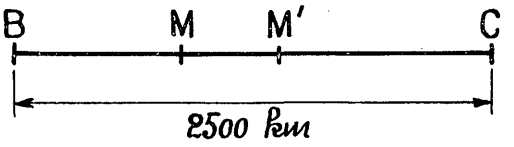


FIGURE 1

Study Group 3 proposed to the XVIIIth Plenary Assembly of the C.C.I.F. that all the values recommended for a circuit of 1000 km should be provisionally adopted, and that these should be applied without modification to the nominal maximum circuit defined above (figure 1), with the following reservations :

(1) For a circuit transmitting acoustic frequencies, all the existing limits apply, excepting those relating to intelligible crosstalk; the C.C.I.F. draws the attention of Administrations to the fact that, just as for a circuit of 1000 km, it is difficult to satisfy these limits when unscreened pairs are used.

(2) For a circuit set-up on a carrier system, all the existing limits apply, excepting those relating to intelligible crosstalk and noise, which form the subject of the above question.

ANNEX 2

(to Question 20 of Study Group 1)

Proposal from the United Kingdom relating to programme circuits from through groups and supergroups

The ratio 8 N or 70 db, recommended by the C.C.I.F. for intelligible or unintelligible crosstalk components is sufficient for telephony, but a value of 9·3 N or 80 db is necessary over the band for any group (of a through supergroup) on which an international programme circuit is to be set up. Normally, only groups 2·3 or 4 should be used for programme circuits.

Question 21.

(corresponding to C.C.I.R. Study Programme 75) (Sub-Group 1/4, then Study Group 1, in co-operation with the C.C.I.R.)

(continuation of Question 10 of C.C.I.F. Study Group 3, 1955/56) (documentary Question)

1. Study of the influence on the quality of television pictures of various factors such as :

— resolution
— contrast range
— law of contrast

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* *Note by the C.C.I.T.T. Secretariat.* — It appears that the notations of the *Green Book* should be revised (point H becoming C) so that the same notations may be adopted as in the case of television transmissions.

— geometry
— spectral response
— fidelity to colour (when it applies)

and also defects such as :

— noise (erratic, impulsive, periodic)
— shading
— streaking (traînage)
— overshoots
— excessive afterglow
— colour " crosstalk " } where it applies
— colour mis-registration } where it applies
— colour break up } where it applies

2. Study of methods by which the influence of such factors on picture quality might be objectively measured.

Question 22.

(to be studied by the Joint C.C.I.R.-C.C.I.T.T. Group for television transmission)

(continuation of question 11 of C.C.I.F. Study Group 3, 1955/1956)

A. What are the requirements for the transmission of monochrome television signals over long distances ?

Special attention should be given to methods of specifying and measuring :

(a) non-linearity distortions of the kinds important in monochrome television transmission,
(b) random noise,
(c) recurrent noise.

Note 1. — Appendix 1 below contains a provisional specification referring to television transmission over a distance of 1000 kilometres. The possibility of adopting the same specification for the 2500-kilometres hypothetical reference circuit should be included in the study of this question.

Note 2. — As regards random noise (point *(b)* above), an attempt will be made to standardize the weighting curve between defined limiting frequencies (e.g. between the line frequency and the nominal upper frequency of the video band), as well as the integration time of the measuring apparatus and the law of addition of components of various frequencies. It should then be possible to recommend a single value for the signal to noise ratio for all types of continuous random interference and for all television standards. As examples, Appendices 2 and 3 below show the weighting curves which have been suggested for various television standards.

Note 3. — As regards periodic noise (point *(c)* above), an attempt will be made to standardize the weighting curve of this noise, as well as the integration time of the

measuring apparatus and the law of addition of various components. It should thus be possible to recommend a single value for the signal-to-noise ratio for all types of periodic noise, considering :

1. the frequency of the line pilot for transmitting on long-distance coaxial pairs signals corresponding to various standards for television recommended by the C.C.I.R. and different periodic noise which may result;
2. the presence of all other periodic noise which may accompany the signals sent into the line;
3. the requirements of Broadcasting Organizations regarding the quality of pictures.

B. What are the requirements for the transmission of colour television signals over long distances ?

Note. — These requirements should be considered in relation to the systems of colour television which are now being studied.

APPENDIX 1

(to Question 22 of Study Group 1)

Draft recommendation to supersede pages 193 to 209 of Volume III of the C.C.I.F. Green Book

PART 4

INTERNATIONAL TELEVISION TRANSMISSIONS ON CABLES

1. GENERAL CHARACTERISTICS OF AN INTERNATIONAL TELEVISION CIRCUIT ON CABLES (PROVISIONAL RECOMMENDATION OF THE C.C.I.F., APPLICABLE TO ALL STANDARDS OF TELEVISION TRANSMISSION USED IN EUROPE)

1.1. *Definitions.*

1.1.1. *Definition of the constituent parts of an international television connection. Technical responsibilities during an international television transmission.*

In order to divide the responsibilities of a television transmission, there is need to distinguish (see figure 1) :

(a) The point considered as the origin of the television transmission (point A). This point is either the source of the programme (studio or outside-broadcast point) or a point such as a switching centre or the location of a standard's convertor.

(b) The outgoing local line, which connects point A to the first repeater station B.

(c) *The international television line* (long distance) BC consisting in principle of a chain of national or international television circuits, the national circuits being of the same constitution as international circuits.

(d) The incoming local line which connects the last repeater station (point C) to the point D, point of destination of the television transmission.

(e) The point D, point of destination of the television transmission. This point might be the incoming studio, a radio transmitter, a switching centre or perhaps the location of a standard's convertor.

The ensemble AD of the long-distance international television line BC and of the local lines (AB and CD) constitute the " *international television link* ".

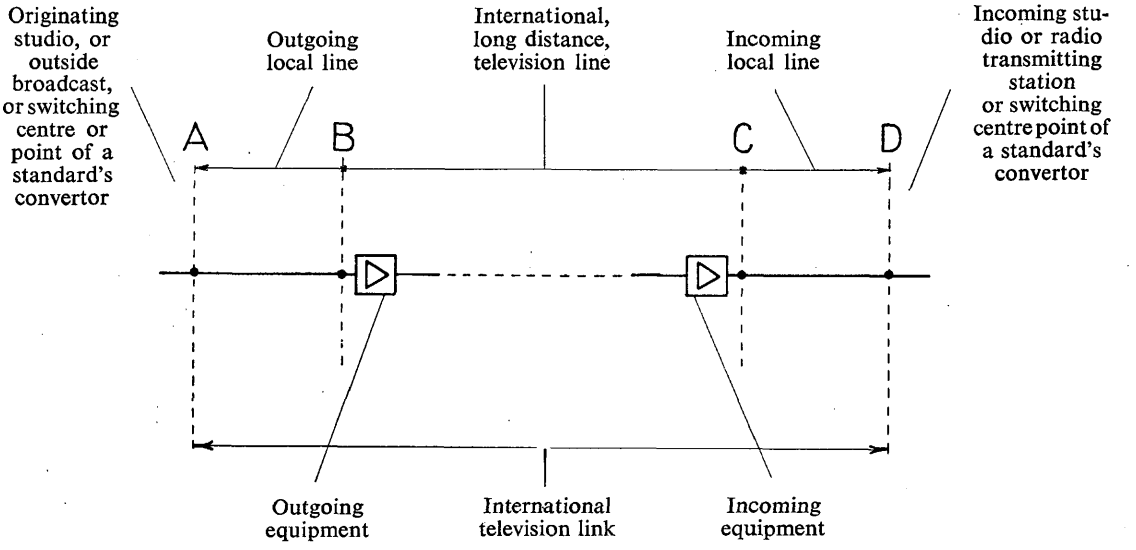


FIGURE 1. — *Diagram of an international television connection*

The points A and D are generally under the authority of the sending and receiving Broadcasting Organizations (except for the case in which these points correspond to a standard's convertor or a switching centre of a Telecommunication Administration).

The points B and C are under the authority of the Telecommunication Administrations of the countries concerned.

The long-distance international television line BC is, in almost all cases, under the sole responsibility of the Telecommunication Administrations.

The local lines may be under the responsibility either of the Telecommunication Administration or the Broadcasting Organization or the two together, according to local custom.

1.1.2. *Hypothetical reference circuit for television transmissions.*

The hypothetical reference circuits for television transmissions serve the purpose of coordinating, planning and installation of national and international circuits for television transmissions.

The hypothetical reference circuit for television transmissions on coaxial pairs conforms to the scheme shown in figure 2. (The C.C.I.R. has recommended the same hypothetical reference circuit for radio-relay systems.)

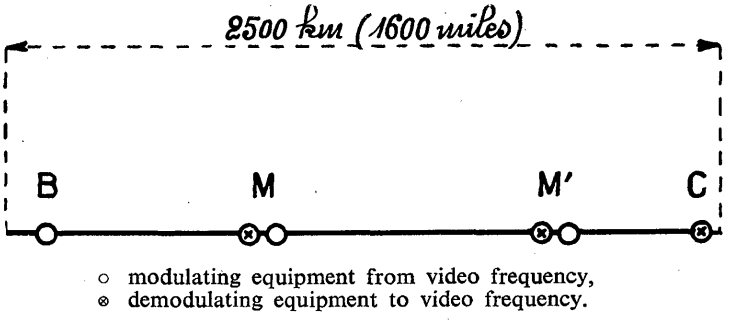


FIGURE 2. — *Hypothetical reference circuit for television transmissions on coaxial pairs.*

The total length of this circuit is 2500 km (1600 miles). It comprises four video junction points : the extremities BC of the long-distance line and two intermediate points (which are reduced to

video frequency MM). The three sections BM′, MM′ and M′ C are of equal length. It is assumed that these three sections can be connected together without the need for further adjustment.

The hypothetical reference circuit contains neither a standard's convertor nor a synchronizing-pulse regenerator.

1.2. *Specification of a long-distance international line for monochrome television transmissions.*

This specification relates at present to a long-distance international television line (see figure 1) of maximum length 1000 km, which may consist of two intermediate video-frequency junction points and three line-regulating sections.

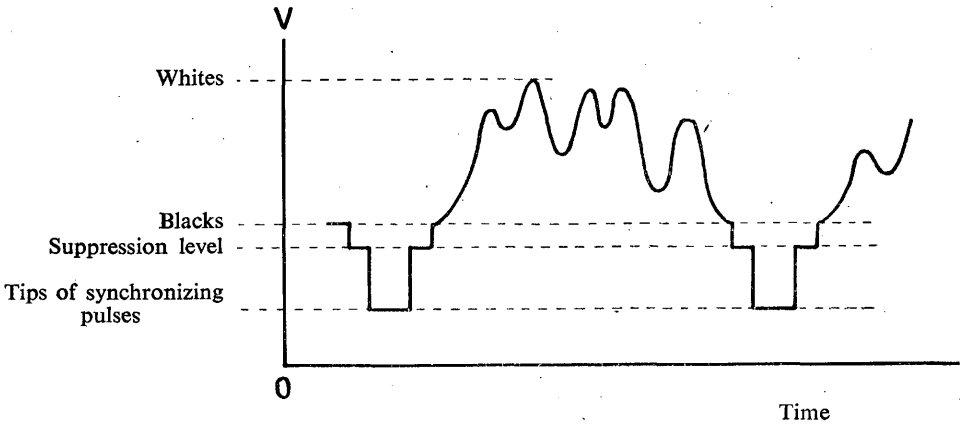
The C.C.I.R.-C.C.I.T.T. Joint Group will study whether this specification can be applied also to actual long-distance lines, having a total length of the order of 2500 km (1600 miles), with intermediate video-frequency points splitting it up into a number, yet to be decided, of line-regulating sections either on coaxial pairs or on radio links.

1.2.1. *Impedance.*

The input impedance (at point B) and the output impedance (at point C) of the terminal equipments of the long-distance line (see figure 2) as well as the impedances at the intermediate video-frequency junction points of the long-distance line have a nominal value of 75 ohms unbalanced. These impedances should have a return loss, relative to 75 ohms,* greater than 25 decibels.

1.2.2. *Polarity and d.c. component.*

At point B and C (see figure 2), and also at each intermediate video-frequency junction point between B and C, the polarity of the signal will be positive, i.e. such that the transition from black to white entails a rise, in the algebraic sense, of the potential of the terminal which is not at earth potential (see figure 3).



V = difference in potential between the terminal (not at earth potential) of the input (or output) impedance and earth (difference of potential positive in an upward direction).

FIGURE 3

The useful d.c. component (i.e. the component which is associated with the average luminance of the picture) may or may not be present in the video source and has not to be transmitted over the circuits nor delivered at the output.

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* The return loss, relative to 75 ohms, of an impedance Z is

$$20 \log_{10} \left| \frac{75 + Z}{75 - Z} \right| \text{ decibels.}$$

Any *non-useful d.c. component* accompanying the signal and unrelated to it (arising for example from the d.c. supply to valves) should be such as not to dissipate more than 0·5 watt in the load impedance of nominal value 75 ohms. (This specification is intended to indicate the electrical power that the nominal input resistance of 75 ohms should normally be capable of carrying with direct current).

When this resistance is disconnected, the voltage of the non-useful component should not exceed 60 volts d.c. (in order to limit the voltage to a value which should never be dangerous to the staff).

1.2.3 *Amplitude of the complete signal.*

At points B and C, regarded as terminals of the long-distance line, the suppression level being taken as the reference level, the nominal amplitude of the vision signal, possibly augmented by a pedestal, measured from the suppression level to the white level, is 0·7 volt, while the nominal amplitude of synchronizing pulse, measured from the suppression level to the tip of the synchronizing pulse, is 0·3 volt, so that the nominal peak-to-peak amplitude of the complete signal is 1·0 volt.

1.2.4. *Insertion Gain.*

The long-distance international line will, at the time of setting up, have an insertion gain of 0 db$\pm$1 db. It may not be possible to achieve this result without adjustment of the component sections of the international line.

Note 1. — The insertion gain is measured using the standardized test signal No. 2, whose characteristics are described in Annex 2 below.

This measurement is made as follows :

A waveform generator which produces test signal No. 2, and having an impedance of 75 ohms (pure resistance), is adjusted so that if connected directly to a 75-ohms resistance, it would produce line synchronizing pulses of 0·3 volt combined with a vision signal * of 0·7 volt. At the receiving end, the voltage between the suppression level and white level (bar amplitude) is measured, using an oscilloscope connected across a 75-ohms resistance. The ratio of this voltage to 0·7 volt is expressed in decibels or in nepers : this value in decibels or nepers is, by definition, the insertion gain of the television transmission circuit.

Note 2. — It is necessary to take precautions with the oscilloscope to read the suppression and white levels accurately, notably by using a graticule.

1.2.5. *Insertion gain stability.*

After setting-up, every endeavour should be made to keep variations in insertion gain of the long-distance international television line within the following limits :

(a) short-term variations (e.g. 1 second) . . . . . $\pm$ 0·3 db.

(b) medium-term variations (e.g. 1 hour) . . . . . $\pm$1 db.

1.2.6. *Non-linearity distortion.*

Provisionally, non-linearity distortion should be measured as stated in Annex 3 below, using test-signal No. 3.

(a) *Non-linearity distortion, at high frequency between black and white levels, as a function of the luminance content of the picture.*

The ratios $\frac{m_a}{M_a}$ and $\frac{m_b}{M_b}$ defined in Annex 3 should be not less than 0·8.

---

* Including the pedestal, if any.

(b) *Non-linearity distortion of the synchronizing pulses, as a function of the luminance content of the picture.*

For measuremen)s made as described in Annex 3, the following limits apply :

S_a 0·3 V+10% and −30%
S_b 0·3 V+10% and −30%, consequently

$$\frac{S_b}{S_a} \text{ 0·64 to 1·57.}$$

Note. — A high degree of linearity is very important for transmitting television signals. Methods sufficiently accurate and detailed to assess non-linearity distortion in a convenient way, and to determine methods of counteracting it, have yet to be established. The measurements described in Annex 3 should be considered as an approximate determination of non-linearity designed only for the purpose of periodic maintenance.

1.2.7. *Signal-to-noise ratio.*

The values given below should be maintained for at least 99% of the time, the total observation period being one hour *.

These values relate to the ratio, expressed in decibels :

$$\frac{\text{peak-to-peak amplitude of the vision signal (excluding synchronizing pulses)}}{\text{r.m.s. amplitude of noise ** in the band } 0\text{—}f_c}$$

for continuous random noise, f_c being the nominal upper video frequency of the system under consideration :

and of the ratio :

$$\frac{\text{peak-to-peak amplitude of the vision signal (excluding synchronizing pulses)}}{\text{peak-to-peak noise amplitude}}$$

for periodic noise and impulsive noise. Noise values for different systems are given below :

(a) continuous random noise, with uniform power frequency distribution;

(a') continuous random noise having power frequency distribution rising with frequency at the rate of 6 db per octave;

(b) periodic noise.

405-line system

(a) 48 db
(a') 40 db
} $f_c = 3$ Mc/s { If the weighting network described in Annex 4 is used, a value of 54 db can be taken as the signal/weighted-noise ratio, for all power/frequency noise distribution.

* The specification of total observation period and percentage time is for study by the C.C.I.R.

** It is recommended that continuous random noise be specified by its r.m.s. value rather than by its quasi peak-to-peak value defined in the draft report of C.C.I.R. Sub-Study Group XI-D (London 1953, Volume I, page 270). There are, in fact, certain difficulties in relating the quasi peak-to-peak amplitude with the r.m.s. value.

(b) 30 db for mains hum, including lower-order harmonics *
50 db from 1 kc/s to 1 Mc/s, and decreasing linearly from 1 to 3 Mc/s to 25 db at 3 Mc/s.

625-line system and Belgian 819-line system

(a) 46 db** } $f_c = 5$ Mc/s.
(a') 39 db** }

(b) 30 db for mains hum, including lower-order harmonics *
50 db from 1 kc/s to 1 Mc/s, and decreasing linearly from 1 to 5 Mc/s to 30 db at 5 Mc/s.

819-line system

(a) *** } $f_c = 10$ Mc/s
(a') 37 db }

(b) linear variation between points (30 db, 50 c/s) and (45 db, 100 c/s);
linear variation between points (45 db, 100 c/s) and (50 db, 1 kc/s);
constant value (50 db) from 1 kc/s to 1 Mc/s;
linear variation between points (50 db, 1 Mc/s) and (20 db, 7 Mc/s);
constant value (20 db) from 7 Mc/s to 10 Mc/s.

Note. — At present there is no internationally recommended method for measuring noise on television circuits.
The method is left for study by the C.C.I.T.T., which will in particular have to settle the following points :

— integration time of the measuring apparatus,

— weighting network to be used, as well as high and low pass filters associated with the measuring apparatus.

1.2.8. *Circuit response.*

A. *Waveform response.*

Waveform response is defined for recurrent signals having approximately the following durations :

— field-time waveform response,

— line-time waveform response,

— short-time waveform response.

---

* This indicates that the combined signal due to mains hum, including harmonics, should have a peak-to-peak amplitude of at least 30 db with respect to the vision signal and assumes that this form of interference can be appreciately reduced by suitable d.c. restoration circuits. This concerns the hum added to the signal, not the hum which has modulated the signal at the sending end, and so cannot be suppressed by restoration of the d.c. component.

** The corresponding figures proposed by the C.C.I.R. are 48 db and 41 db respectively.

*** For noise of type *(a)*, which occurs only on coaxial cables, no value has been laid down, as this method of transmission is not at present used for this 819-line system.

(a) *Field time waveform response.*

405-line, 625-line and 819-line systems.

On making the measurement with test signal No. 1 described in Annex 1, the curve obtained on the oscilloscope should lie within the limits of the mask of figure 4, provided that the oscilloscope is so adjusted that the middle of the edges of the white portion coincide with points M_1 and M_2 of the mask, and that the middle points of the " black " and " white " portions coincide respectively with the points B and W of the mask.

The thick lines of the mask correspond to $\pm 10\%$ about the amplitude of the white portion.

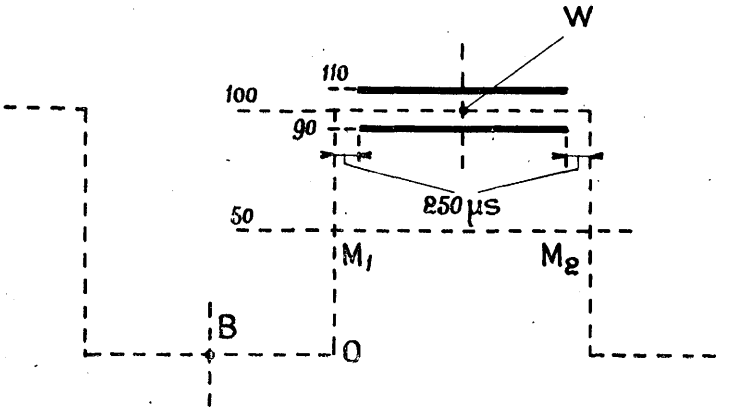


FIGURE 4. — *Mask for observation of field-time waveform response*

The mask on the oscilloscope screen comprises the two thick horizontal lines and the form points B, W′, M_1 and M_2 (figure 4).

(b) *Approximate line-time waveform response.*

405-line system.

This measurement is made using test signal No. 2, described in Annex 2, in which the rise-time or decay-time is $2T$ (0·33 µS). The curve obtained on the oscilloscope should lie within the limits of the mask of figure 5, provided that the oscilloscope is adjusted so that the middle of the edges of the half-line-bar coincide with points M_1 and M_2 on the mask, and that the middle points of the " black " and " white " portions coincide with B and W respectively.

The thick lines on the mask correspond to $\pm 5\%$ about the amplitude of the half-line bar.

The mask on the oscilloscope screen consists of the two thick horizontal lines and the four points B, W, M_1 and M_2 (figure 5).

625-line and Belgian 819-line systems.

The measurement is made using test signal No. 2, in which the rise-time or decay-time is T (0·1 µS) *. The curve should lie within the limits of the mask of figure 5, provided that the oscilloscope is adjusted so that the middle of the edges of the half-line-bar coincide with points M_1 and M_2 of the mask, and that the middle points of the " black " and " white " portions coincide respectively

* For tests on coaxial pairs, it may be necessary to use test signal No. 2 with rise and decay-times of 2 T (0·2µS).

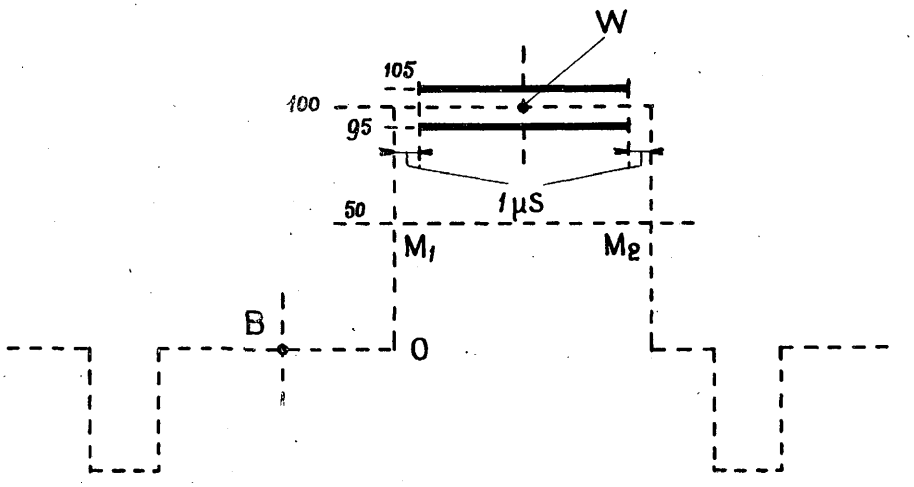


FIGURE 5. — *Mask for observation of line-time waveform response*

with points B and W of the mask. The thick lines of the mask correspond to values of ±5% about the amplitude of the half-line bar.

The mask on the oscilloscope screen consists of the two thick horizontal lines and the four points B, W, M′ and M_2 (figure 5).

819-line system.

The measurement is made with test signal No. 2, in which the rise or decay-time is T (0·05 µS). The curve should be within the limits of the mask of figure 5, provided that the oscilloscope has been adjusted so that the middle of the edges of the half-line-bar coincide with points M_1 and M_2 of the mask and that the middle points of the " black " and " white " portions coincide respectively with points B and W of the mask. The thick lines of the mask correspond to values of ±5% about the half-line-bar.

(c) *Short-time waveform response.*

405-line system.

Test signal No. 2 is used, with a sine-squared pulse of duration *T* (0·17 µS).

For the long-distance international television line, a specified rating factor of less than 5% should be regarded as desirable *.

In addition, to guard against possible overload, it is recommended that the gain of the long-distance line, measured with steady state for all video-frequencies, should not exceed the gain at line-frequency by more than 5 db.

625-line system on 7 Mc/s radio-channels, and the Belgian 819-line system (maximum video frequency 5 Mc/s).

Test signal No. 2 is used in which the rise-or decay-time is *T* (0·1 µS).

---

* See Annex 5 which describes a method of waveform measurement in which the result is given in terms of a specified rating factor.

The received unit-step is observed by means of a mask of the form shown in figure 6, the oscilloscope being adjusted so that M coincides with the middle of the rise and the black and white levels coincide with the segments B and W.

The oscillogram produced should lie within the limits of this mask.

If pseudo -oscillations are present in the regions B and W, the peaks of these oscillations should be set symmetrically with respect to B and W.

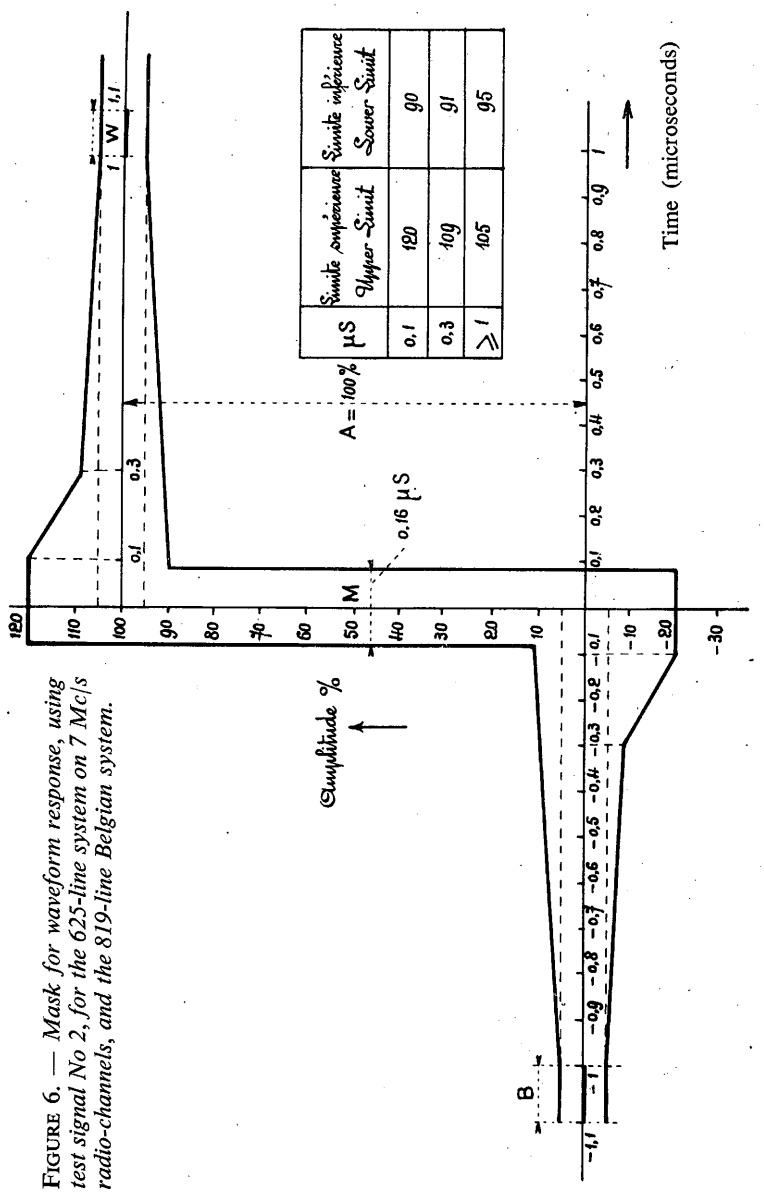


FIGURE 6. — *Mask for waveform response, using test signal No 2, for the 625-line system on 7 Mc/s radio-channels, and the 819-line Belgian system.*

625-line system in 8 Mc/s radio-channels (maximum video-frequency 6 Mc/s)

Test signal N° 2 is used.
The response curve should lie within the tolerances given in Figure 7.

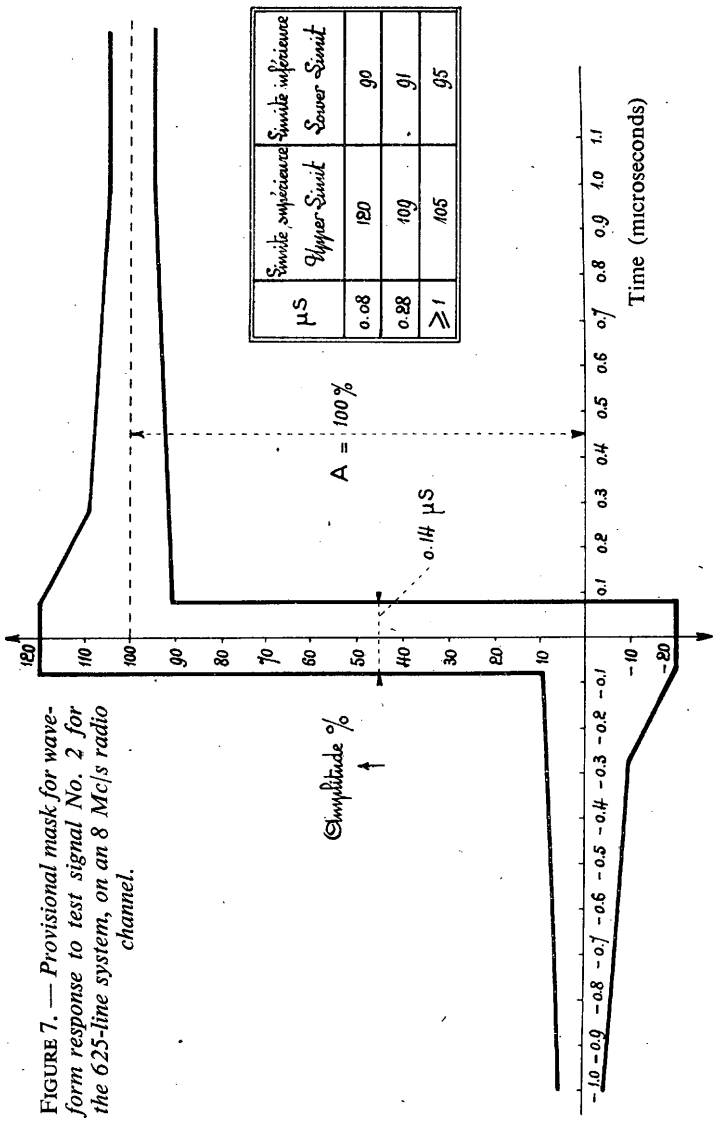


FIGURE 7. — *Provisional mask for waveform response to test signal No. 2 for the 625-line system, on an 8 Mc/s radio channel.*

819-line system.

Test signal No. 2 is used, with rise or decay-times of T (0·05 μS).

The received unit-step is observed using a mask as shown in figure 8, the oscilloscope being adjusted so that M coincides with the middle of the rise and the black and white levels coincide with segments B and W.

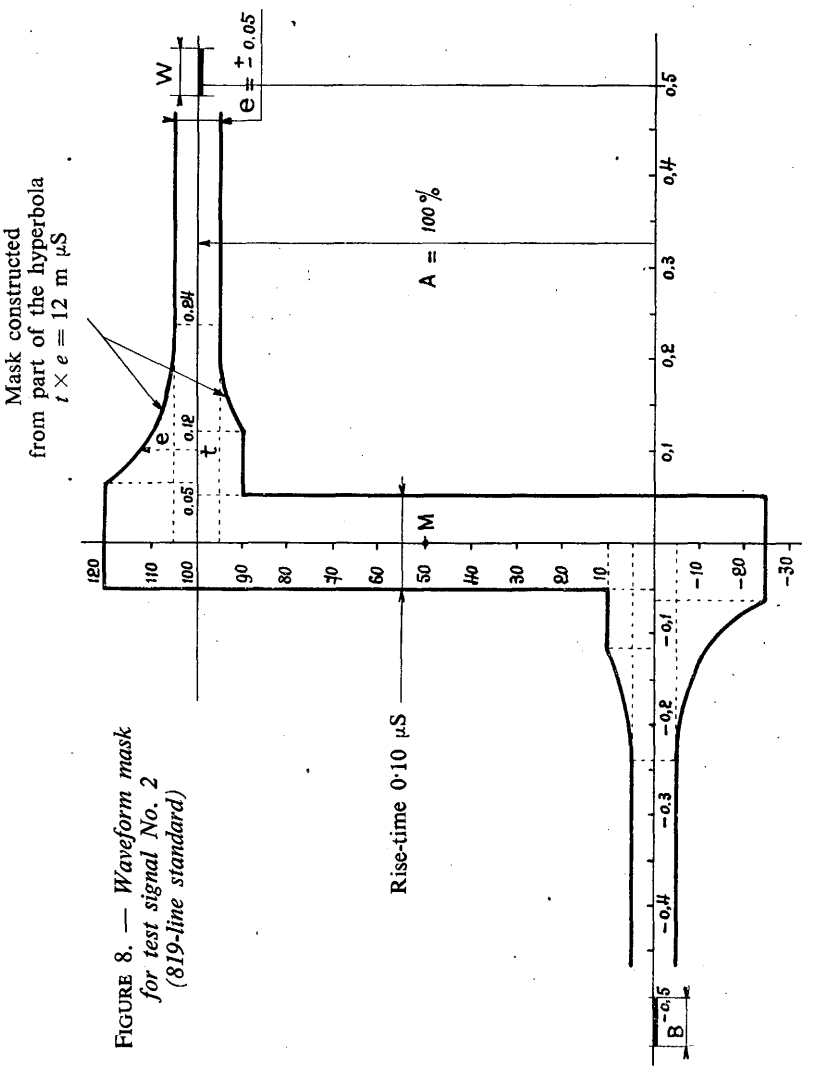


FIGURE 8. — *Waveform mask for test signal No. 2 (819-line standard)*

B. *Steady state.*

The specification itself does not include steady-state measurements.

Nevertheless, for maintenance of long-distance international television lines, it is useful to record some steady-state values and the graphs of figures 9 to 12 below may be used for this purpose, as well as serving as a design guide. No graph has been given for the 405-line system.

625-LINE SYSTEM AND BELGIAN 819-LINE SYSTEM

(1) for a 7 Mc/s radio-channel
(maximum video-frequency 5 Mc/s)

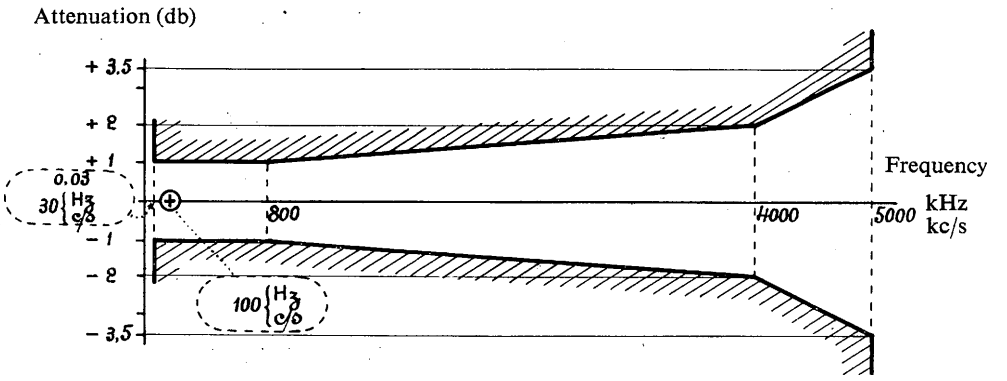
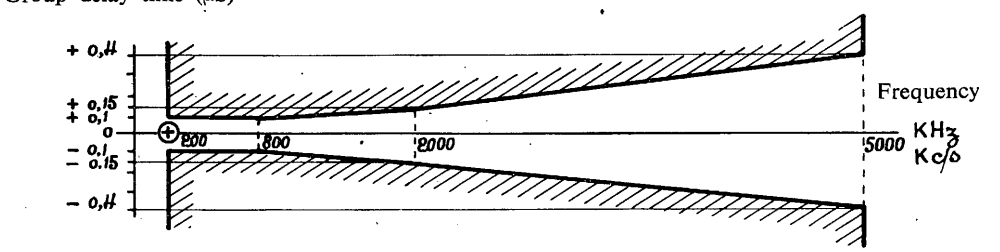


FIGURE 9. — *Attenuation frequency response relative to the value at 100 kc/s*

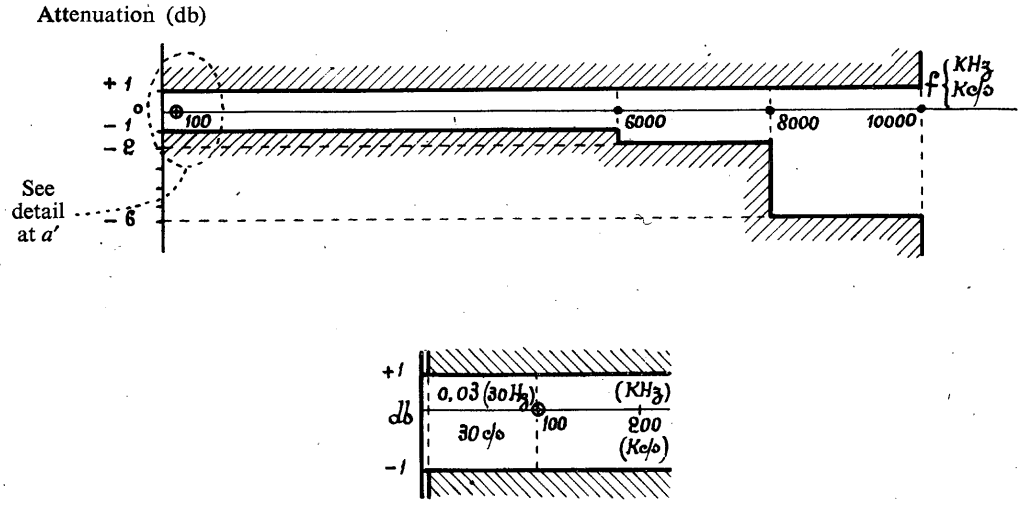


(2) For an 8 Mc/s radio-channel
(maximum video-frequency 6 Mc/s)

FIGURE 10. — *Group-delay/frequency response relative to the value at 200 kc/s*

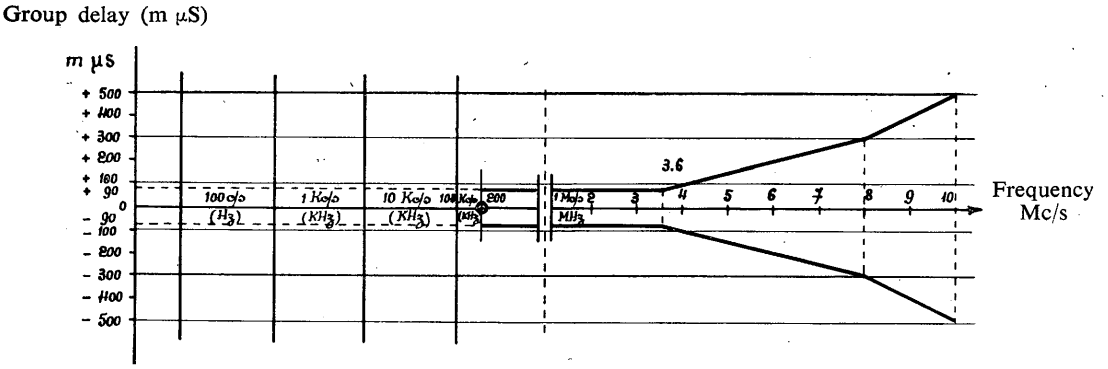
Identical to (1) but with values shown for 5000 kc/s now relating to 6000 kc/s

819-LINE SYSTEM



a') Detail of graph *a)*, form 30 c/s to 200 kc/s

FIGURE 11. — *Attenuation frequency, relative to value at 100 kc/s*



⊕ Conventional point of departure of the curve (1 m μs = 10^{-9} s.)

FIGURE 12. — *Group delay/frequency, relative to the value at 200 kc/s.*

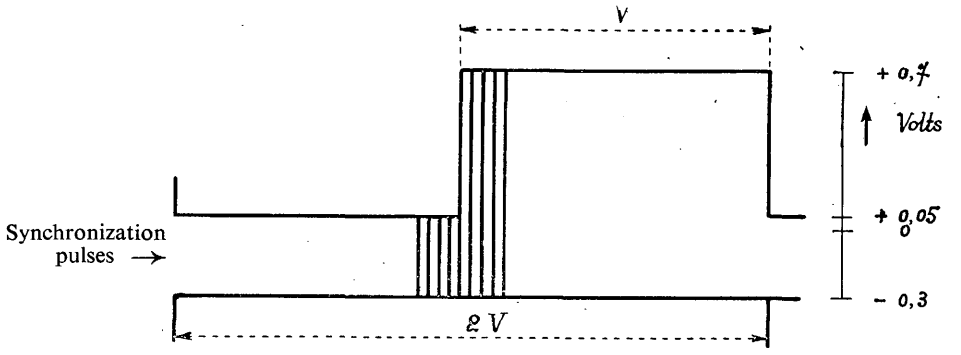
ANNEX 1

(to Appendix 1 to Question 22 of Study Group 1)

Test signal No. 1

Test signal No. 1 should be used for making field-time waveform tests on television circuits.

This signal, illustrated below, consists of a field-frequency square wave, superposed on the normal synchronizing and suppression pulses, either with or without pedestal.



Test signal No. 1

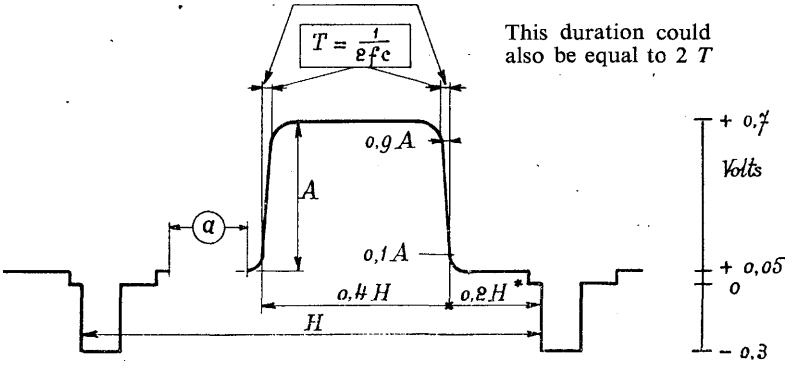
ANNEX 2

(to Appendix 1 to Question 22 of Study Group 1)

Test signal No. 2

Test signal No. 2 is used for making line-time and short-time waveform tests on television circuits.

This signal is also used for measuring insertion gain.



(a) Space available for additional waveforms, e.g.: sine-squared pulse, high frequency burst, etc...

Test Signal No. 2

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* The C.C.I.F. has requested that 0·1 H may be used, as an alternative to 0·2 H. It appears that a value of 0·1 H which exists already in certain generators in service, would be sufficient for all monochrome systems to the different standards, to show up pseudo-oscillations and overshoot which may occur in this part of the scanning line.

If desired, a supplementary signal, for instance a sine-squared pulse or a burst of high-frequency oscillations, can be added in the interval marked *(a)*. The pedestal difference between the black level and the suppression level is shown as equal to 5%, but it could be reduced to zero if it is desired to simplify the testing apparatus. The rise-time of the transition of the half-line-bar is determined by means of a shaping network of the type described by W. E. THOMSON (*Proceedings of the Institution of Electrical Engineers*, Vol. 99, Part III, page 373, 1952). This network was designed to give a rise-time $T = 1/2 f_c$.

ANNEX 3

(to Appendix 1 to Question 22 of Study Group 1)

Test signal No. 3 and measurements of non-linearity distortion

I. *Magnitudes measured.*

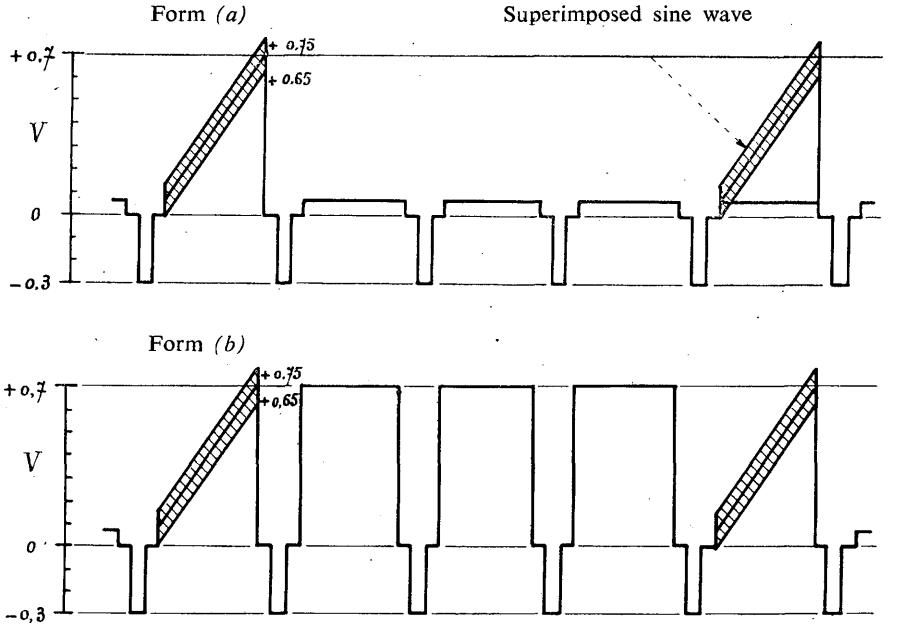
Pending the establishment of detailed methods for the determination of non-linearity distortion, measurements will be provisionally limited to the following magnitudes :—

I.1. Non-linearity distortion at high frequency as a function of the average picture-content (differential gain).

I.2. Compression of the synchronizing signals as a function of the average picture-content.

II. *Definition of the test signal.*

The signal may take consecutively the two following forms :



The difference between these two forms is that with form *(a)* the signal is at black level during the intervening lines, whereas with form *(b)* the signal is at white level during the intervening lines.

The frequency of the sine wave superposed on the sawtooth wave is 2·5 Mc/s for the 405-line system and 4 Mc/s for 625-line and 819-line systems.

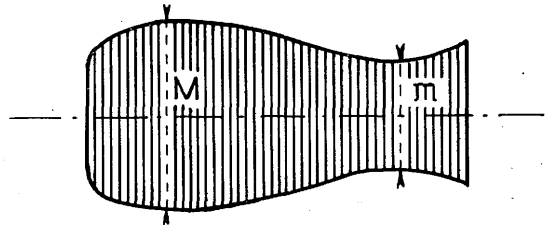
At the origin, for the peak-to-peak amplitude of this sine wave is 0·1 Volt for a signal of nominal amplitude.

III. *Utilization.*

III. (1) *Measurement of non-linearity distortion at high-frequency as a function of the average picture content.*

The signal in its *(a)* form is applied to the input of the circuit.

At the receiving end a high-pass filter separates the sine wave from the rest of the signal which is shown on the screen of an oscilloscope swept at line-frequency. The figure seen below has, for example, the following form : —



The distortion is thus given by the ratio m_a/M_a.

The same measurement is then made with the signal in its form *(b)*, and the ratio m_b/M_b is measured.

In this way, the non-linearity distortion at high frequency for two extreme values of picture content are measured.

III. (2) *Compression of synchronizing signals as a function of the average picture-content.*

At the receiving termination, the amplitude of the synchronizing signals is measured when the signal at the sending end has firstly the *(a)* form and then the *(b)* form. The measured amplitudes are denoted by S_a and S_b respectively. In each case this amplitude should be within the specified tolerances. The degree of compression of the synchronizing pulses is defined by the ratio S_b/S_a.

ANNEX 4

(to Appendix 1 to Question 22 of Study Group 1)

Noise weighting network for the 405-line monochrome system

1. *Introduction.*

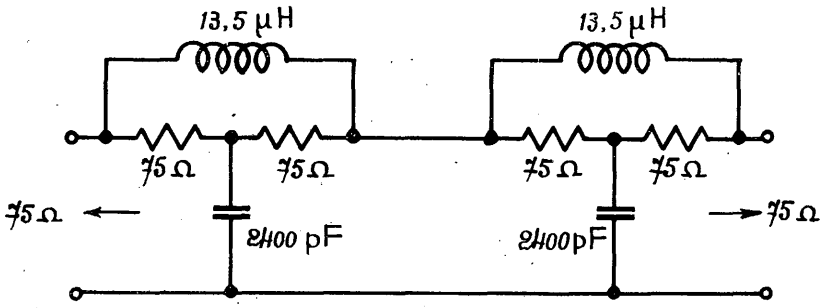
Brussels Document No. 51 of the C.C.I.R. gave details of a weighting curve which had been derived experimentally for noise in a 405-line monochrome television system. Clearly a network having a loss/frequency characteristic which is the inverse of this curve can be used as a weighting network for the measurement of noise in a television circuit and the ratio of signal to weighted noise at the threshold of visibility will then be the same for noise having any spectral distribution of energy. A simple network having the required characteristic is described in this paper and the conditions under which it may or may not be used are discussed.

2. *Network.*

A suitable constant-impedance 75-ohm network comprises two sections in tandem, each having a time constant of 0·18 μs, as shown in Figure 1. Its loss/frequency characteristic, together with the desired weighting curve, are shown in Figure 2.

The loss of the network to white noise in the band 0-3 Mc/s has been calculated and is 6·4 decibels; similarly for triangular (FM type) noise in the band 0-3 Mc/s, it is 14·1 db. The lowest permissible signal-to-noise ratios for transmission over the hypothetical reference circuit are 48

and 40 db respectively (Doc. 153 of the C.C.I.R., Warsaw) so that the corresponding ratios of signal to weighted noise are 54·4 and 54·1 db respectively. A single figure of 54 db is sufficiently accurate for all practical purposes.



Insertion loss $= 10 \log_{10} \{1 + 2 (\omega\tau)^2 + (\omega\tau)^4\}$

where $\tau = 2400 \times 10^{-12} \times 75 = 0{,}18$ µs

FIGURE 1. — *Constant impedance weighting network*

3. *Limitations on the use of the network.*

The network is suitable for use in the measurement of noise on circuits for the transmission of 405-line monochrome television signals when the noise is not substantially greater than the permissible value.

The network is not suitable for use with substantially higher levels of noise because :

(a) clamping equipment in a transmission circuit may convert high-frequency noise into low-frequency whole-line streaking effects of much greater subjective visibility;

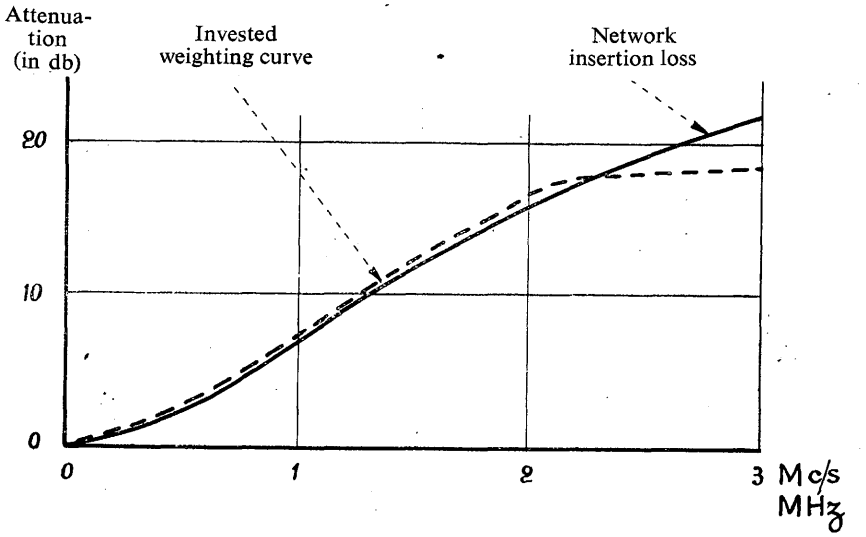


FIGURE 2. — *Loss characteristic of network*

(b) where non-linear processes are involved at the end of a transmission circuit, e.g. in tele-recording, noise energy from the top end of the spectrum may be converted into effects corresponding to noise at much lower frequencies with a much higher subjective visibility.

The network is not suitable for the measurement of noise on circuits for the transmission of colour television signals, in cases when the chrominance signal is accommodated within the luminance band, but would be suitable for measurements on a separate luminance channel.

The network is not suitable for assessing the performance of cameras or other picture generating devices in which the noise level varies with luminance owing to gamma correction.

4. *Conclusion.*

A network comprising two sections in tandem, each with a time constant of 0·18 μs is suitable for weighting noise in a 405-line monochrome television transmission circuit provided the noise level is not substantially greater than the permitted value.

ANNEX 5

(to Appendix 1 to Question 22 of Study Group 1)

The Waveform-Transmission Performance of Television Links and Equipment for 405-Line 3 Mc/s Monochrome Systems

1. *Scope.*

This Document describes two complementary methods of specifying transmission performance, between video input and output terminals, of television links and equipment intended for use in 405-line 3-Mc/s monochrome systems. Distortions due to non-linearity are dealt with elsewhere.

2. *General.*

The present limitations of available waveform-measuring equipment make it necessary to distinguish two complementary methods of testing performance. The first, or " routine-test ", method is rapid but less precise because it relies on direct oscilloscopic observations of the responses to prescribed test signals, and because the spectrum of one of these signals unavoidably extends beyond the 3 Mc/s limit of interest. The second, or " acceptance-test ", method is slow but more precise because a computational process applied to a series of waveform ordinates (measured by travelling microscope on a photographic record, or by other means) enables irrelevant information to be eliminated and certain measuring-equipment errors to be corrected.

The routine-test method may be used for *(a)* checking the performance of a batch of items when type-approval has been given after a full acceptance test on one item, *(b)* detecting gross distortion during the initial tests of a new item, and *(c)* checking the performance of temporary links and similar items when conditions do not permit of a full acceptance test.

The performance limits are given in terms of a rating factor, K, for which numerical values are assigned in the individual specifications for links and equipment. Rating factors may range from

several per cent for a complex system down to less than ½ % (K = 0·005) for a simple video amplifier. The basis of reference of the rating-factor method is distortion consisting only of a single long-term echo, the rating factor then being numerically equal to the relative amplitude of the echo.

3. *Test-Signal Waveforms.*

The following four test signals are required for the routine-test method; only three of these are required for the acceptance-test method. All have a 1-volt peak-to-peak amplitude and include normal 0·3-volt line-synchronizing pulses of 10-microsec duration and 10 kc/s repetition frequency.

3.1. *T-pulse Test Signal.* — The *T*-pulse is of approximately sine-squared shape with a half-amplitude duration of 0·17 microsec (a half-period of 3 Mc/s) and a repetition frequency of 10-kc/s. It is associated with synchronizing pulses and may, in addition, be combined with the " 40-bar " in

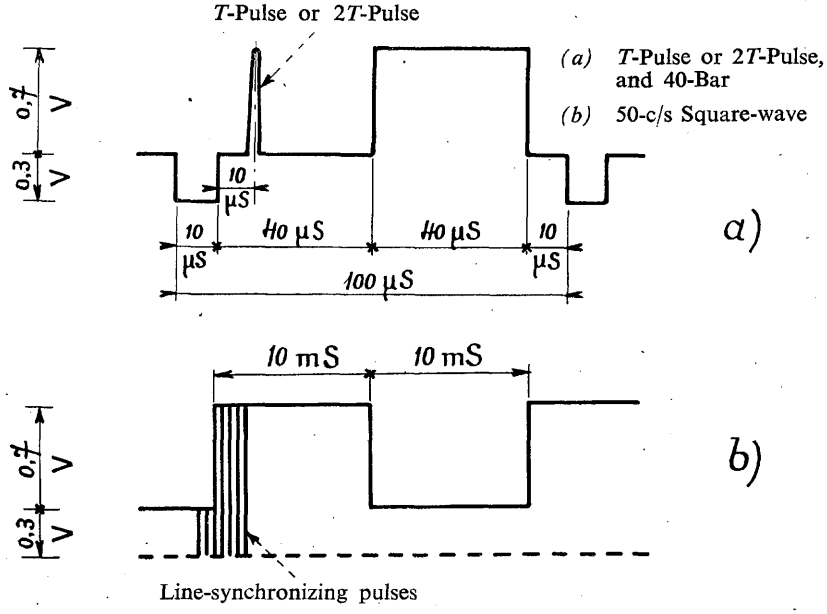


FIGURE 1. — *Test signal waveforms*

a composite pulse-and-bar test signal as shown in Figure 1. *(a)*. The precise shape and duration of the *T*-pulse are determined by the pulse-shaping network detailed in Figure 2, operated under the indicated conditions or their equivalent.

3.2. *2T-pulse Test Signal.* — The 2*T*-pulse is similar to the *T*-pulse in all respects except that the half-amplitude duration is 0·33 microsec (a whole period of 3 Mc/s). It is used only in the routine test method.

3.3. *40-bar Test Signal.* — This waveform consists of a " smoothed bar " of 40 microsec duration associated with synchronizing pulses as shown in Figure 1 *(a)*. Each of the bar transitions has approximately an integrated sine-squared shape with a 10-90 % rise time of 0·33 microsec. These transitions are determined by a pulse-shaping network identical with that detailed in Figure 2 for the 2 *T*-pulse, the driving waveform being specified to have transitions with 10-90 % rise times not exceeding 0·07 microsec.

3.4. *50-c/s Square-Wave Test Signal.* — This consists of a 50-c/s square wave associated with synchronizing pulses as shown in Figure 1 *(b)*.

4. *Routine-Test Method.*

To meet a specified rating factor, K, the responses to the various test signals should fall within the limits stated in the following sub-sections.

4.1. *40-bar Response.* — The limits are indicated by the oscilloscope mask shown in Figure 3 *(a)*. In effect, the oscilloscope controls are to be adjusted so that the mid-points of the bar transitions coincide with M_1 and M_2, and the mid-points of the 40-microsec " black " and " white " portions coincide with B et W respectively. The response should then fall within the $\pm$K limits indicated by the full lines, which extend to 1 microsec from each transition.

4.2. *2T-pulse Response.* — The limits are indicated by the oscilloscope mask shown in Figure 3 *(b)*. In effect, the oscilloscope controls are to be adjusted so that *(a)* the sweep velocity corresponds with the time scale indicated, *(b)* the " black " level of the response coincides with the horizontal axis, *(c)* the peak of the response falls on the unit-amplitude line, and *(d)* the half-amplitude points of the response are symmetrically disposed about the vertical axis.

4.3. *Bar/pulse Ratio.* — The ratio of the amplitude of the 40-bar response to the amplitude of the 2*T-pulse* response should fall within the limits $1 \pm 4K$. The amplitude of the bar is taken as the amplitude-difference between the points B and W already defined; the amplitude of the pulse is the difference between the " black " level and the peak of the response. These limits are also shown in Figure 3 *(a)*.

4.4. *T-pulse Response.* — In the routine-test method, only a few features of the *T*-pulse response need to be specified. The normal limits for those are given in the following table :

Because the *T*-pulse has a frequency spectrum with appreciable components above 3Mc/s, the responses of links or equipment depend to some extent upon their upper cut-off characteristics. For this reason, link or equipment specifications, permitting the use of the routine-test method, may in some cases call for limits different from those given above.

Features	Rating factors					
	1%	2%	3%	4%	5%	6%
Half-amplitude duration, maximum, μs . .	0·245	0·250	0·255	0·260	0·265	0·270
Ringing frequency, minimum, Mc/s. . . .	3	3	3	3	3	3
First lobe (negative), leading or trailing, maximum, %	10	12	14	16	18	20
Second lobe (positive), leading or trailling, maximum, %	6	8	9	10	11	12

4.5. *50-c/s Square-Wave Response.* — The limits are indicated by the oscilloscope mask shown in Figure 3 *(c)*. As for the 40-bar response, the oscilloscope controls are to be adjusted so that the waveform passes through the four marked points, the synchronizing pulses being ignored.

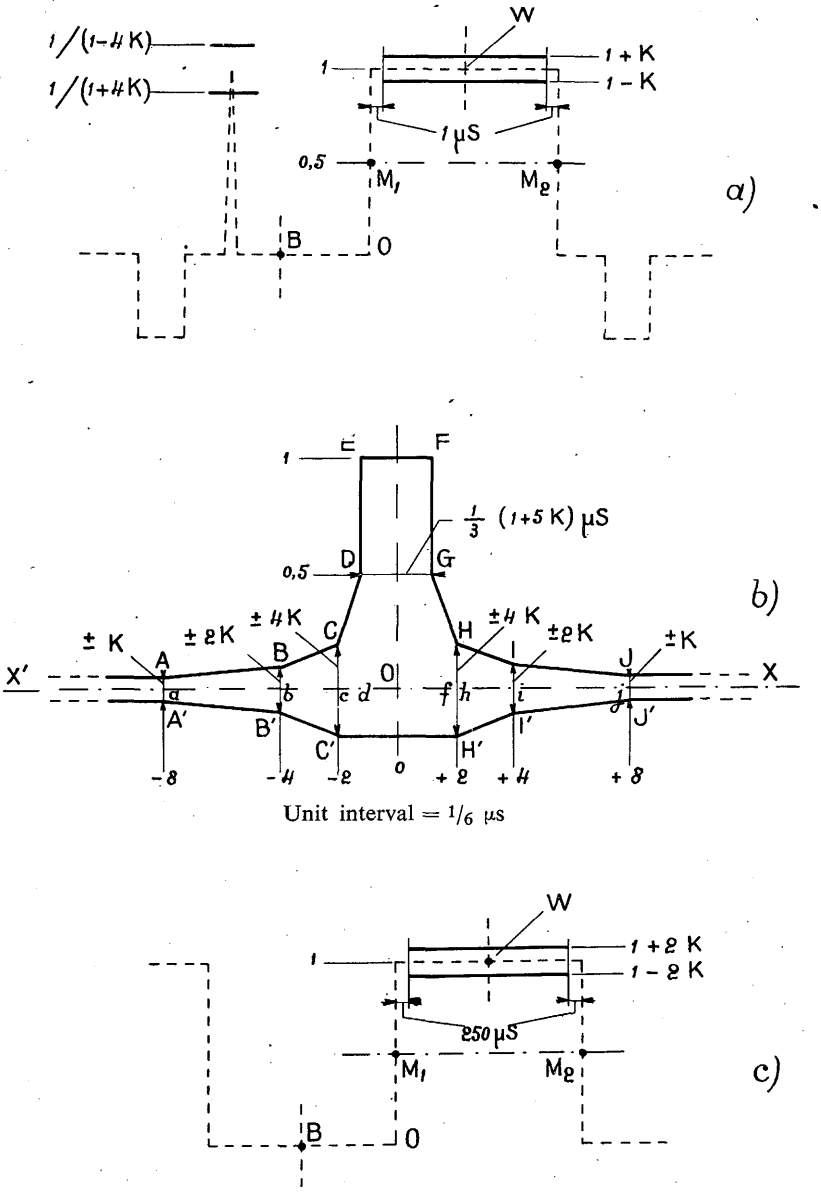


FIGURE 3. — *Waveform response limits*

(a) Response to 40-bar test signal
(b) Response to 2*T*-Pulse test signal
(c) Response to 50-c/s square wave test signal

5. *Acceptance-Test Method.*

5.1. *40-bar Response.* — The limits are identical with those given in paragraph 4.1 for the routine-test method.

5.2. *T-pulse Response.* — From the measured *T*-pulse response and the measured or assumed response of the measuring equipment itself, the " filtered impulse response " is derived and expressed in the form of a normalized time series. The " main " term of this series represents the ideal or non-distorting part of the transmission properties of the item under test, while the " echo " terms represent the distorting part. To meet a specified rating factor, K, the amplitudes of the echo terms should be such that each of the following four restrictions is met.

Let the time series representing the filtered impulse response be

$$B\,(rT) = \ldots\ldots\ B_{-r}\ \ldots\ldots\ B_{-1}\ B_0\ B_{+1}\ \ldots\ldots\ B_{+r}\ \ldots\ldots$$

and assume that this has already been normalized so that $B_0 = 1$.

Let the serial product of $B\,(rT)$ and the series [1/2 1 1/2] be

$$C\,(rT) = \ldots\ C_{-r}\ \ldots\ C_{-1}\ C_0\ C_{+1}\ \ldots\ C_{+r}\ \ldots$$

where $$C_r = 1/2\ B_{r-1} + B_r + 1/2\ B_{r+1}$$

Restriction (i) is then given by :

$$\frac{1}{8}\left|\frac{C_r}{C_o} - \frac{1}{2}\right| \leqslant K \quad \text{for} \quad r = \pm 1,$$

$$\frac{1}{8}\left|r\,\frac{C_r}{C_o}\right| \leqslant K \quad \text{for} \quad \begin{cases} -8 \leqslant r \leqslant -2 \\ +2 \leqslant r \leqslant +8 \end{cases}$$

$$\text{et}\left|\frac{C_r}{C_o}\right| \leqslant K \quad \text{for} \quad \begin{cases} r < -8 \\ +8 < r \end{cases}$$

Restriction (ii) is given by :

$$\frac{1}{4}\left|\frac{1}{C_o}\left(\sum_{-8}^{+8} B_r\right) - 1\right| \leqslant K$$

Restriction (iii) is given by :

$$\frac{1}{6}\left|\sum_{-8}^{+8} B_r - 1\right| \leqslant K$$

and Restriction (iv) is given by :

$$\frac{1}{20}\left(\sum_{-8}^{+8}\left|B_r\right| - 1\right) \leqslant K.$$

The series $C\,(rT)$ represents fairly closely the response to a $2T$-pulse. Restriction (i) is thus approximately equivalent to the limits indicated in Figure 3 *(b)* for the $2T$-response in the routine-test method. Restriction (ii) is similar to the limits placed on the bar/pulse ratio in the routine-test method. Restriction (iii) is equivalent to limits placed on the bar/pulse ratio of the response to a hypothetical pulse-and-bar test signal in which the pulse is an ideal filtered impulse. Restriction (iv) is an upper limit placed on the average amplitude, ignoring signs, of the 16 central echo terms.

5.3. *50-c/s Square-Wave Response.* — The limits are identical with those given in paragraph 4.5 for the routine-test method.

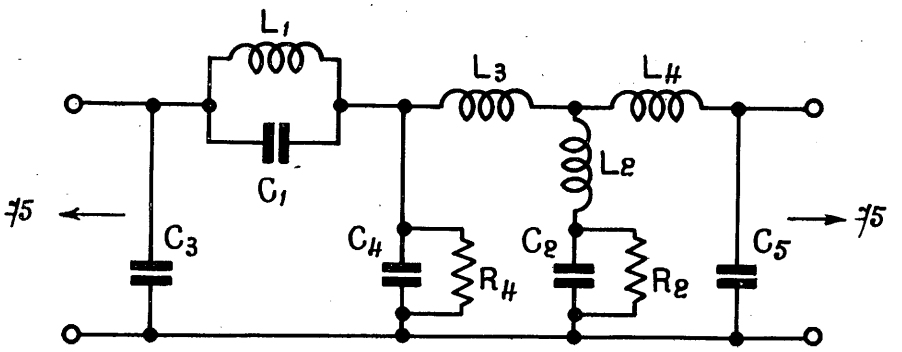


FIGURE 2. — *Sine-squared pulse shaping network*

Component	Value		Tolerance	Q (Note 3)
	H.A.D. = 1/6 μs	H.A.D. = 1/3 μs		
L1	1·580	3·159	±1%	⩾ 70
L2	0·308	0·617	(note 2)	⩾ 50
L3	3·091	6·182	±1%	⩾ 100
L4	3·035	6·069	±1%	⩾ 100
C1	79·22	158·4	2%	
C2	2168	4335	±0·5%	
C3	75·92	151·8	±2%	
C4	566·4	1133	±0·5%	
C5	166·4	332·9	±2%	
R2	1300	1300	±5%	
R4	5100	5100	±5%	

Notes. — 1. Inductances are given in μH, capacitances in pF, resistances in ohms.

2. Inductor L2 should be adjusted to make the insertion loss a maximum at 6·156 Mc/s for the 1/6 μsec network, and at 3·078 Mc/s for the 1/3 μsec network.

3. The values of Q should be measured at 4 Mc/s for the 1/6 μsec network, and at 2 Mc/s for the 1/3 μsec network.

4. The network should, if necessary, be connected between masking pads designed to present impedances of 75 ohms ±1% to the network under operating conditions.

5. An allowance for stray capacitance should be made in the value of any capacitor if the total capacitance would otherwise exceed the given limit.

6. The design is from " solution 3 " given by W. E. THOMSON " The synthesis of a network to have a sine-squared impulse response," *Proceedings of the Institution of Electrical Engineers*, Vol. 99, part III, pages 373, 1952.

7. The half-amplitude durations of the driving pulses should not exceed 0·035 μsec and 0·07 μsec for the 1/6 μsec and 1/3 μsec networks respectively.

APPENDIX 2

(to Question 22 of Study Group 1)

Weighting Curves for Television Transmission Systems

Note of the Cuban Telephone Company

Introduction. — It is well known that there are many forms of spurious signals (e.g. tones, pulsive noise, echoes, etc.). that can cause degradation of a television signal. Only " tandem noise " of a sufficiant bandwidth such that no pattern appears on the television screen will be dealt with in these proposals.

Experimental evidence has shewn that viewers describe different noise powers as just observable depending on the frequency spectrum of the noise. Broadly, high-frequency noise can be of very much higher power than low-frequency noise to cause the same degree of picture degradation.

It is thus reasonable to assume that a curve of loss against frequency could be drawn; such a network, having a response characteristic matching this curve, placed in front of a wideband power measuring set, would enable the noise power indication to be a measure of the television picture degradation, when the combination is connected to a suitable point in a television transmission system. This curve would then be a " videometric weighting network ".

Choice of a Videometric Weighting Network. — It is submitted that the phenomena leading to the observed lack of sensitivity to the higher frequency noise contributions in television pictures can be defined; and that " videometric noise weighting curves " can be synthesized for any television standard.

The aptness of these synthesized curves can then be checked against experimental evidence.

The phenomena concerned are the aperture effect of the eye, and the aperture effect of the cathode ray spot of the television receiver, which will be referred to as the subjective and objective weighting curves, respectively.

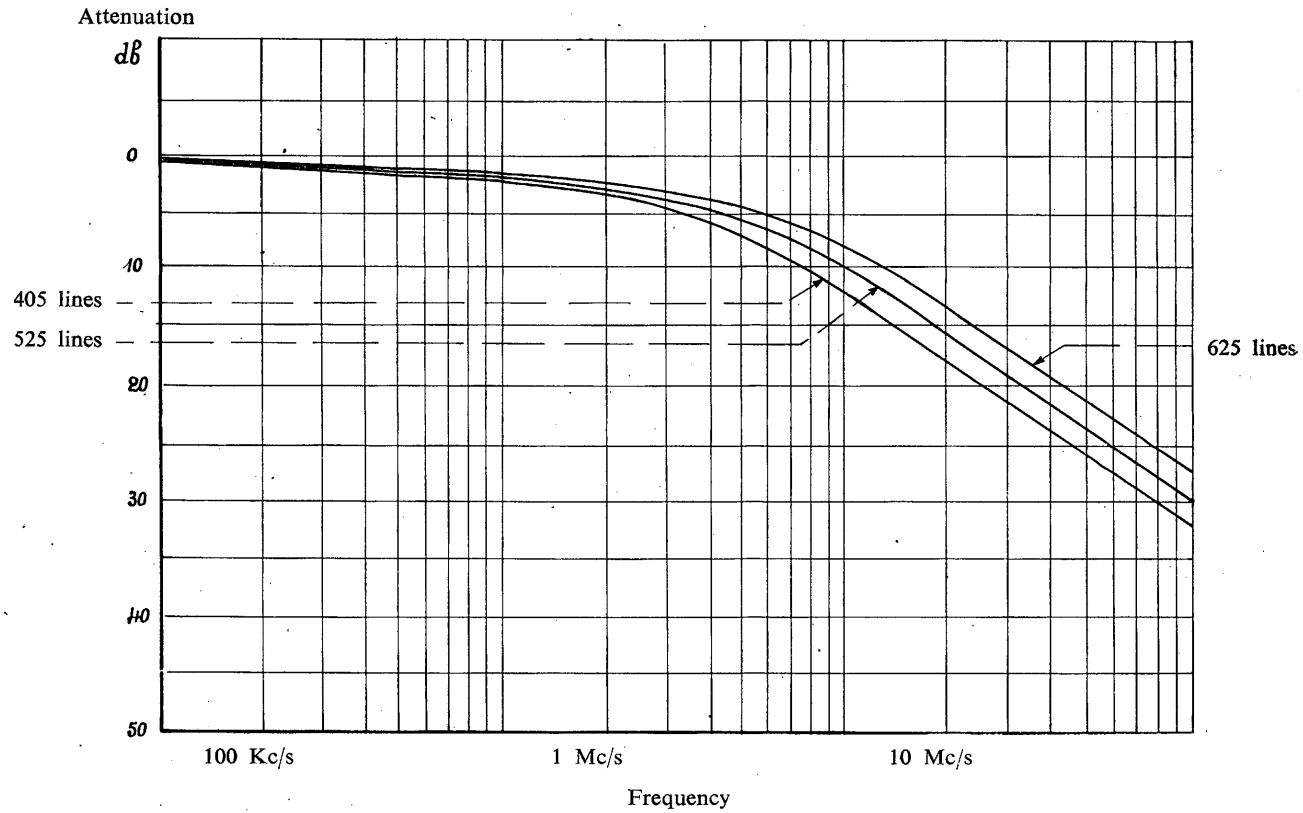
Objective Weighting Curve. — The effect of the television receiver cathode ray spot is a function of the raster employed, and hence is independent of the viewer it is thus an objective weighting. It is proposed that the spot size should be such that there is the full available range of intensities between two adjacent peak white lines, and that the intensity plotted across any diameter of the spot should describe a " cosine-squared " curve.

Curves showing the " objective weighting " for the British (405), American (525), and European (625) standards are shown in Figure 1. The shapes of the aperture effect for a spot of " cosine-squared " intensity are obtained from the reference [1 *(a)*].

Subjective Weighting Network. — The application of the aperture effect of the eye is fraught with difficulties; the most obvious being the choice of viewing distance (or angle subtended by the picture at the eye). The alternatives are probably that a line width should subtend a constant angle at the eye, and that this angle should be such that line structure is not visible, or that the angle subtended by the picture height should be such that the whole picture can be inspected without movement of the head—i.e. based on the minimum fatigue. To date, the latter alternative has found most favour, and will probably fit most " family circles " with the larger sizes of cathode ray tube now becoming popular, and also corresponds to the middle of the auditorium of cinemas.

Thus a " subjective weighting network " has been shown in Figure 2 for a viewing distance of a four times picture height.

The information for this curve has also been obtained from the reference [1 *(b)*].



(Cathode spot equivalent to grain size of picture using 3 times the bandwidth of the relevant system)

FIGURE 1. — *Objective videometric weighting curves. Aperture effect of receiver cathode ray spot*

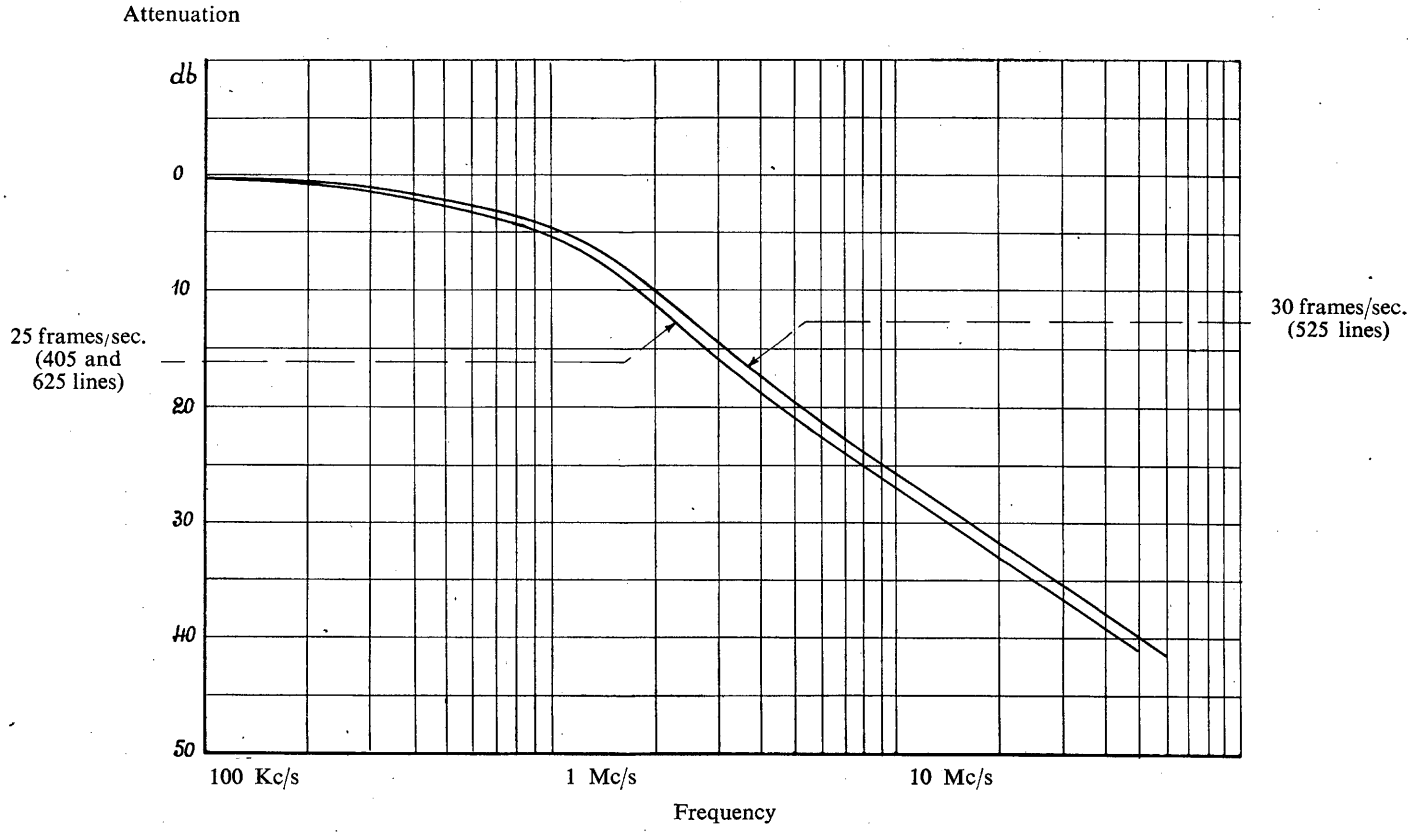


FIGURE 2. — *Television subjective weighting curve due to effect of eye at viewing distance 4 × picture height*

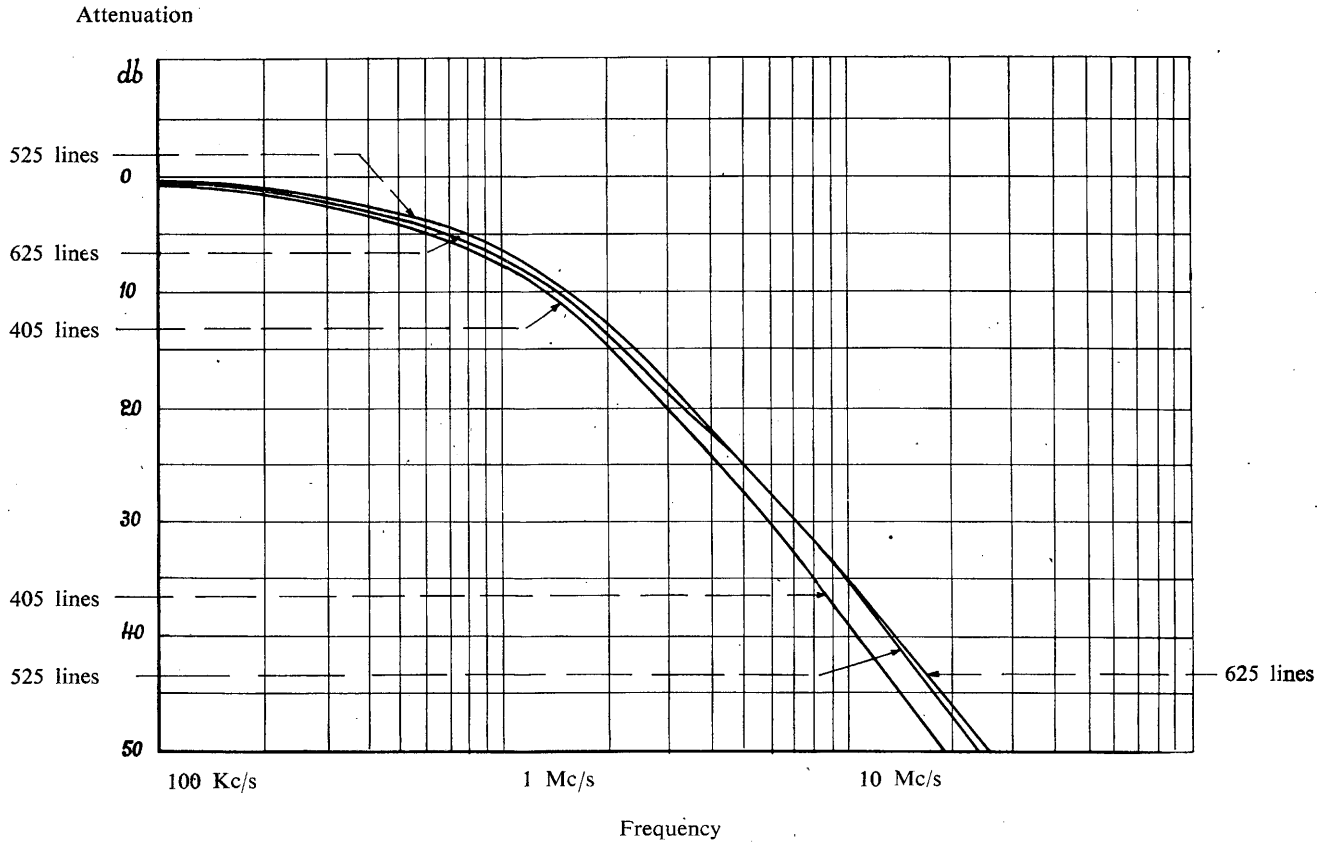


FIGURE 3. — *Proposed videometric weighting curves*

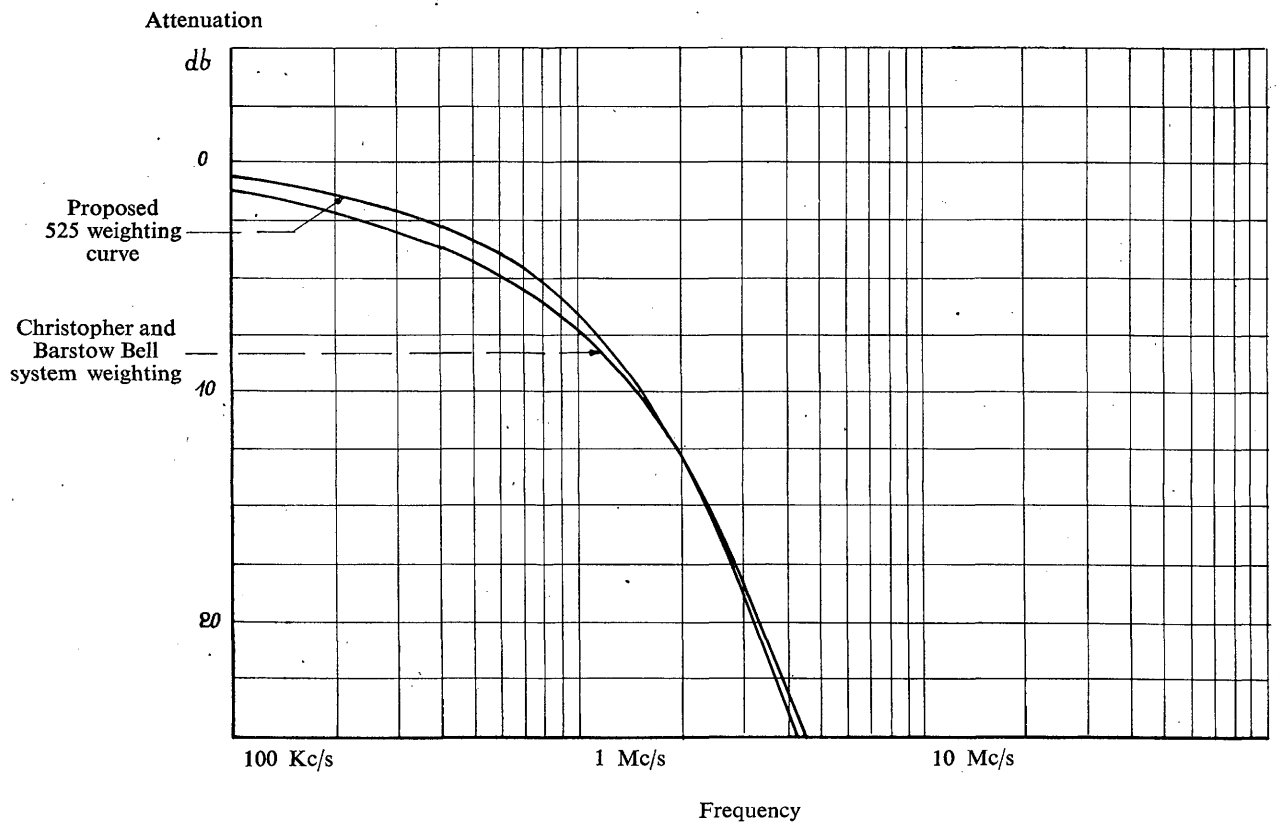


FIGURE 4. — *Comparison of weighting curves 525 lines*

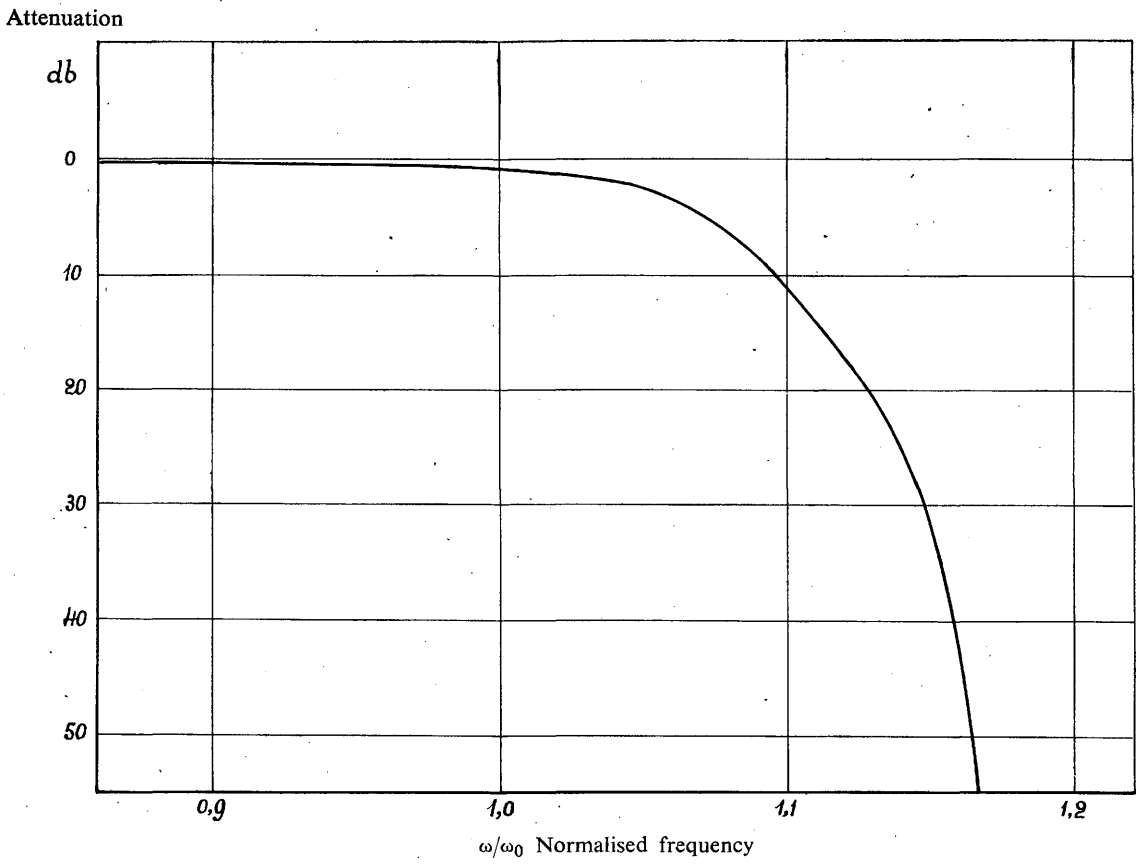


FIGURE 5. — *Proposed normalised cut-off characteristics*

It will be noted that the " subjective weighting curves " for the British (405) and Continental (625) are identical having the same number of frames/sec. This is suggested in the reference [1 *(c)*]. Some points to substantiate this are listed below :

(a) For a given amount of light from a total picture, the light per line will be inversely proportional to the number of lines.

(b) The area of illumination due to a " noise peak " will be independent of the raster.

(e) For higher frequency noise, within the bandwidth of the lower frequency system, the shapes illuminated by noise peaks are somewhat less easily visible when the number of lines is high than when it is low, as a high number of lines leads to a long thin dot, whereas the low number of lines leads to a more nearly square dot.

Although the evidence is not conclusive on a quantitative basis, on balance it seems reasonable to agree with the conclusions of the reference **[1.c]**.

Videometric Weighting Curve. — By combining the " subjective and objective weighting curves " a " videometric weighting curve " is obtained, Figure 3.

The effect of networks designed to have the loss characteristics defined by the weighting curves on the measurement of " flat " and " triangular noise " is given in Table 1.

A comparison of the " videometric weighting curve " proposed with that obtained experimentally by the Bell Laboratories (see Appendix 3) is shown in Figure 4.

Application of " Videometric Noise Weighting Curves ". — The application of the " videometric weighting curves " of Figure 3 would give an adequate indication of the picture degradation to be expected on a wide-band monitor tube at the end of a television transmission system. But the picture transmitted is intended for domestic receivers, which must, for reasons of bandwidth economy, have adequate cut-off at the end of the vision band to allow for the transmission of the sound carrier, and it is therefore justifiable to include a cut-off in the videometric noise measuring set that simulates the best filter that can be made to give adequate cut-off at the sound channel, and that this characteristic be defined as part of the videometric noise weighting curve, or as an addition thereto. Figure 5 shows the proposed cut-off characteristic on a normalised ω/ω_0 frequency basis, where ω_0 is the nominal cut-off according to the television standard.

Conclusion. — It is proposed that the measurement of noise at a terminal of a television transmission system should be made using a wide-band power measuring set in front of which is placed a network whose loss characteristic is defined by the " videometric weighting curve " (Figure 3) and a low pass filter defined by Figure 5. For completeness, it is suggested that a peak-to-peak picture signal to v.m.s. noise ratio of 54 db should be obtained for a 1000 km television transmission system (based on the interfering effect of low frequency noise).

REFERENCES

[1.(a)] " Television Electro-Optical Characteristics ", O. H. SCHADE, *R.C.A. Review*, Volume IX, p. 250.

[1.(b)] *Ibid.*, p. 32.

[1.(c)] *Ibid.*, p. 32 (§ 2).

TABLE 1

System	Type of noise	Objective weighting	Subjective weighting	Total weighting	Difference
405 lines 3 Mc/s 25 f.p.s.	Flat	3 db	6 db	9 db	5·5 db
	Triangular	4 db	10·5 db	14·5 db	
525 lines 4 Mc/s 30 f.p.s.	Flat	3 db	6·5 db	9·5 db	7·5 db
	Triangular	4 db	13 db	17 db	
625 lines 5 Mc/s 25 f.p.s.	Flat	3 db	8 db	11 db	8·5 db
	Triangular	4 db	15·5 db	19·5 db	

TABLE 2

Weighting curves

Frequency Mc/s	Subjective		Objective			Total		
	405 and 625	525	405	525	625	405	525	625
0·3	1·4	1·1	1·2	1·0	0·8	2·6	2·1	2·2
0·5	2·6	2·1	1·7	1·5	1·3	4·3	3·4	3·9
0·7	3·8	3·3	2·0	1·7	1·4	5·8	4·7	5·2
1·0	5·3	4·6	2·2	2·0	1·8	7·5	6·6	7·1
2·0	11·0	10·0	3·6	3·0	2·6	14·6	13·0	13·6
3·0	15·8	14·2	4·8	4·0	3·5	20·6	18·2	19·3
4·0	18·8	17·6	6·0	5·0	4·0	24·8	22·6	23·0
5·0	21·0	20·0	7·0	5·6	4·7	28·0	25·6	25·7
7·0	24·0	22·8	9·0	7·2	6·0	33·0	30·0	30·0
10·0	27·0	26·0	12·0	9·6	8·0	39·0	35·6	35·0
15·0	30·5	29·4	15·5	13·0	11·0	46·0	42·4	41·5
20·0	33·0	32·0	18·0	15·7	13·6	51·0	47·7	46·6

APPENDIX 3

to Question 22 of Study Group 1)

The Measurement of Random Monochrome Video Interference

[By J. M. BARSTOW, member A.I.E.E., and H. N. CHRISTOPHER. *Communication and Electronics* (American Institute of Electrical Engineers) no. 10, January 1954, pages 735-741].

One of the important factors in the design and maintenance of television transmission circuits is random interference, sometimes referred to as random noise. Much of this type of interference originates in the input stages of amplifiers but it may also originate in the line or in other parts of the transmission path. These noise components are greatly modified by circuit equalization which may vary from a few decibels (db) to possibly 27 or more db per octave. Thus the transmission

engineer is confronted with the problem of evaluating random interference having different energy levels, per cycle, over the television bandwidth. Before noise evaluations can be made, information must be obtained by subjective tests on the interfering effect of broad, narrow, and mixed bands of random noise distributed throughout the television band.

Out of the work associated with such tests comes a reasonable question, " Cannot random interference be measured in such a way that equal measurements will mean approximately equal interfering effect, regardless of the frequency composition of the noise ? "

This question may be divided into two parts :

1. What is the weighting or relative importance of random interference in different parts of the video spectrum ?

2. Does the human visual mechanism sum up the interference effects of random noise in various parts of the video spectrum in such a way that the over-all effect can be uniquely related to an over-all measurement, made with equipment that is not too complicated ?

Preliminary answers to these questions are given in the following sections of this paper. The answers are called preliminary because it is obvious that they depend to a large extent on the equipment used in making the judgment tests, and this equipment is undergoing constant change as the television art advances. At present, it is believed that a stage has been reached at which results of the type involved will be useful over a sufficiently long period to make publication worth while.

Others have considered this problem and have deduced approximate results by rationalizing a relatively small number of subjective measurements with related work involving photographic reproduction processes [1], [2]. The test results given here, however, are purely experimental and seem sufficient in scope and numbers to warrant conclusions.

Although they confirm, in part, the general characteristics of random noise weighting previously estimated, they are independent of any so far published.

Summary of Results. — The frequency weighting derived from the judgment tests is given in Figure 1. This weighting is for use with a simple power-summing measuring device.

The general principles derived from the tests may be summarized as follows :

1. Low-frequency noise is judged much more interfering than high-frequency noise of equal power.

2. A given amount of noise power is judged more objectionable if it is concentrated in a narrow band than if it is spread out over a wider band in the same frequency region.

3. Human vision in combination with the present television monitors does not precisely sum weighted noise powers in arriving at an overall assessment of the interfering effect of random noise bands. However, a reasonable compromise can be obtained with weighting applied to a power meter. In the region of 7 db above threshold, average errors of the order of 1 db with maximum errors of 2 db will obtain.

4. At frequencies above 4.5 Mc/s an unexpected effect was observed called sparkle effect. When the total noise power is contained in the region above 4 Mc/s, sharp points of light of very brief duration appear on the raster. It is believed that this effect is the result of the random occurrence of high peak potentials in the random noise which produce the sharp points of light on the raster before the extremely fine-grain noise effect becomes visible. The sparkle effect tends to flatten the weighting above 4 Mc/s.

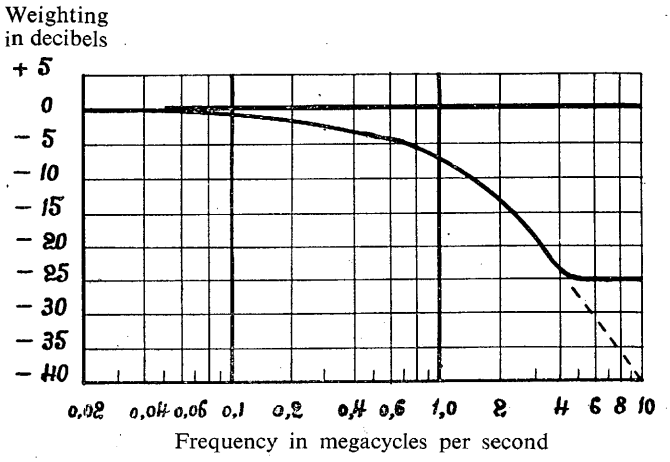


FIGURE 1. — *Random noise weighting for monochrome television*

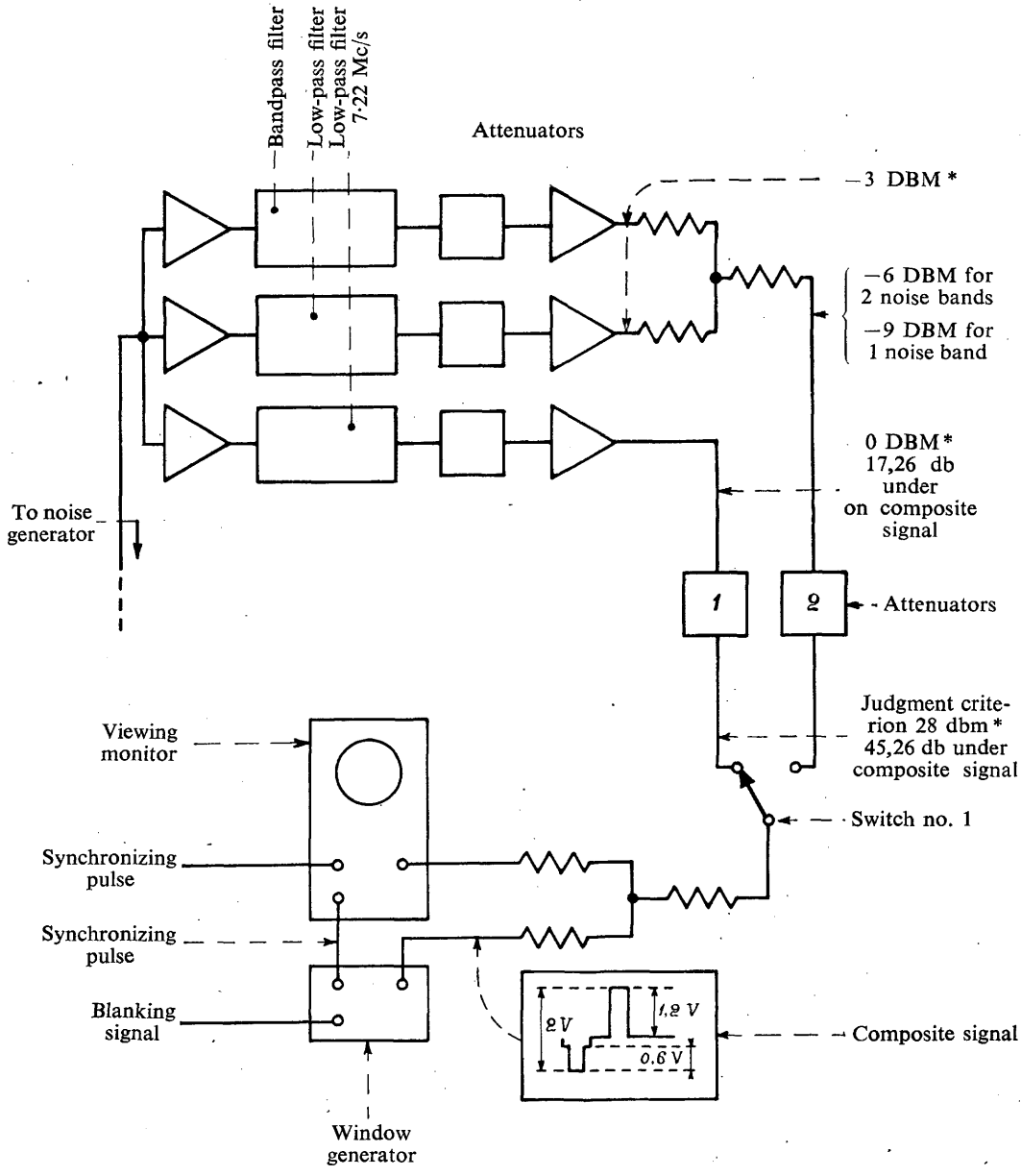
Subjective Test Conditions. — The objective in setting up the test condition was to simulate somewhat more severe viewing conditions than are usually encountered in the home. The test results were obtained by a jury of observers viewing the raster from a distance of four times the picture height. The raster was adjusted to 6 by 8 inches and was viewed in almost total darkness (ambient about 0·0025-foot lambert). The jurors were subjected one at a time to the test conditions, and for most tests three juries of 10 observers each were employed. The three juries had members in common, there being 14 different jurors used in all.

The test set-up is illustrated schematically in Figure 2. A test consisted of having the juror compare the judgment criterion (7·22 Mc/s low-pass band of flat noise at about 7 db above the threshold of visibility) with a test noise obtained by passing a wide band of flat noise through either a bandpass or a low-pass filter. The test level of about 7 db above the threshold of visibility (45·26 db below peak-to-peak composite signal) was chosen for the reference condition because it is in the region of a tolerable noise level, and therefore information on methods of measurement which apply to it would be most useful. (Zero db obtains when the ratio of rms noise volts to composite signal voltage, peak to peak = 1.) The observer was permitted to switch (switch 1, Figure 2) from one condition to the other at will, and was instructed to ask the test operator to raise or lower the level of the test noise as required to obtain interference equality in his judgment. The circuit arrangement of Figure 2 also permitted the mixing of two noise bands in different parts of the video spectrum for test.

In the early stages of noise tests, picture slides were used as subject material. It was soon observed, however, that the jurors were basing their judgments on the noise in middle grey areas of the picture and check tests were made on wholly grey areas to corroborate this observation. Subsequently the tests were made on wholly grey areas without the picture. This technique permitted the raster to be generated electronically without the use of a scanner, and thus provided essentially a noise-free raster, a feature greatly desired in noise studies.

It was found that about equal results were obtained over a range of grey areas varying in brightness from about 0·3-foot-to 0·6-foot lambert.

The types of random noise tested varied from very wide band noise (7·22-Mc/s reference condition) to narrow bands only 40 kc/s wide. Although no band used was narrow enough to



* DBM signifies r.m.s. noise power referred to 1 milliwatt.

FIGURE 2. — *Circuit used to determine the relative interfering effect of discrete bands of random noise*

produce definite line patterns on the raster, some bands were sufficiently narrow to produce fleeting appearances of herringbone patterns.

The tests on noises having two bands in different parts of the spectrum were made, to obtain additional evidence on the rule of combination of interfering effects as summed up by human vision. Noises typical of those encountered on standard transmission facilities were also included in the tests.

All viewing was on a laboratory monitor equipped with an 1816 P4 kinescope. The kinescope anode was operated at 11 kv and the associated video amplifier was substantially distortionless to above 15 Mc/s. The simulated picture signals were in accordance with the present United States standard of 525 lines, 60 fields per second, 30 frames per second, with alternate field interlace.

The electrical transmission circuits were uniform in their response up to about 8 Mc/s. This means that the monitor was superior to present-day broadcast television receivers in its response in the 0·4·3-Mc/s range, and very much more uniform in response in the range of 4.3-8 Mc/s. The monitor and associated circuits were made good in this high range to permit extension of the information on relative interfering effect toward 8 Mc/s. Hence, it is believed the weighting and measuring methods to be described apply to the present standard monochrome system up to 4·3 Mc/s, and give some indication of the weighting which should be applied to interference on wider circuits used for kinescope recording and wide-band theatre television employing 525-line 15,750-lines per second standards.

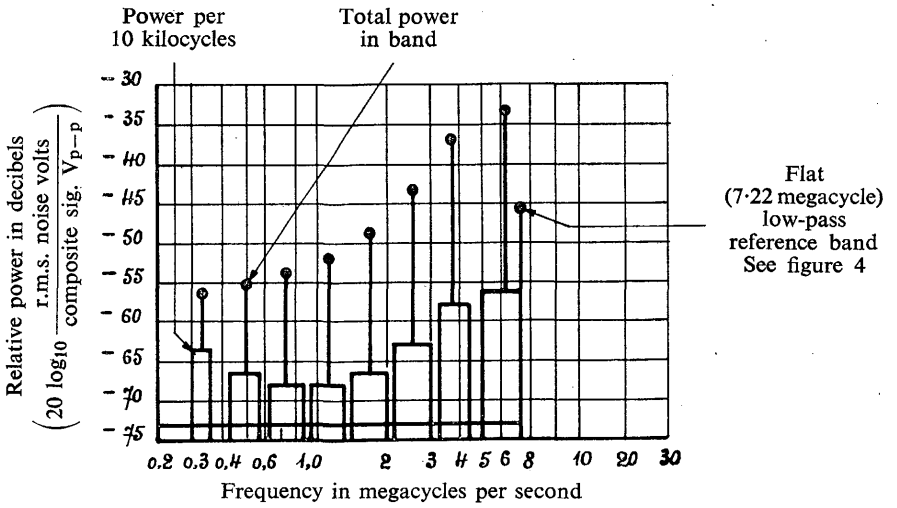


FIGURE 3. — *Powers in bands of noise judged to be equally interfering (30-observer data)*

Discussion of Results. — The results of the tests are shown in Figures 1, 3, 4, 5 and 6, and Tables I to III. Figure 3 shows the magnitudes of unweighted noise powers in the bands of noise which were judged to be equally interfering. The bandwidths indicated were selected to be narrow with respect to the full band but not narrow enough to cause bar pattern effects. The total power in each band is shown plotted near the center of each band. The point representing the total power in each band is the integral of the power per kilocycle over the area defined by the frequency boundaries of each band. For simplicity and ease of computation, the filter characteristics have been idealized. This figure shows that more power is required at high than at low frequencies

to produce a given interfering effect. The inverse of the shape revealed by the total power points is very nearly equal to the shape of the weighting given in Figure 1.

The unweighted power in the low-pass reference band is indicated in Figure 3 by a point plotted at 7·22 Mc/s, the upper stage edge of this band. This level is 45·26 db below the peak-to-peak composite signal. Because of the unsymmetrical nature of television video signals, it has become customary to refer to the signal in terms of the peak-to-peak magnitude (picture plus sync) while the noise is expressed in rms magnitudes.

TABLE 1

Unweighted Noise Powers Judged Equally Interfering *

30-Observer Bandpass Data of May 20, 1952, and July 18, 1950			
Passband, Megacycles (Mc)		Total power db	Power/10 Kc db
Mid	Full		
0·325	0·050	−56·8	−63·8
0·505	0·165	−55·4	−66·6
0·750	0·264	−53·9	−68·1
1·120	0·388	−52·3	−68·1
1·710	0·600	−48·8	−66·6
2·55	0·889	−43·5	−62·9
3·80	1·29	−36·9	−58·0
6·15	2·14	−33·4	−56·4

30-Observer Low-Pass Data of May 20, 1952 and July 18, 1950			9-Observer Low-Pass Data of July 18-27, 1952	
Upper Cut-off db	Total Power db	Power/10 Kc db	Total Power db	Power/10 Kc db
0·040	−59·8	−65·8		
0·080	−59·3	−68·4	−58·8	−67·8
0·133	−58·4	−69·6	−57·7	−68·9
0·211	−57·9	−71·1	−57·5	−70·7
0·320	−56·5	−71·5	−56·6	−71·7
0·473			−56·1	−72·3
0·501			−56·4	−73·4
0·585	−54·9	−72·6		
0·734			−54·7	−73·4
0·890	−53·4	−72·9		
1·215			−53·0	−73·8
1.360	−52·1	−73·4		
1·970			−50·9	−73·8
2·300	−49·8	−73·4		
3·075	−48·6	−73·4		
4·730	−46·6	−73·4	−47·1	−73·8
7·220	−45·0	−73·6	−45·3	−73·8
Judgement Criterion	−45·3	−73·8	−45·3	−73·8

* The indicated powers were judged to have the same interfering effect as the 7.22-Mc/s flat noise band used as a judgmen criterion

$$20 \log_{10} \frac{\text{R.m.s. noise volts}}{\text{Peak-to-peak composite signal volt}} = -45{\cdot}26 \text{ db}$$

TABLE 2

Description of Noises Tested

Noise Test		Weighted Power db	Deviation from Average db	Deviation Squared db
1.	Simulated TD, 12 db per octave maximum at 7·22 Mc/s	57·05	—0·95	0·900
2.	L3 noise, down 10 db at 0·5 Mc/s, 10 db at 1 Mc/s, 7 db at 2 Mc/s, 0 at 4·4 Mc/s	56·45	—1,55	2·400
3.	Flat noise, uniform energy per kc/s 0 to 7·22 Mc/s	56·43	—1·57	2·460
4.	Two noise bands, see Table III	57·47	—0·53	0·281
5.	Two noise bands, see Table III	57·86	—0·14	0·0196
6.	Two noise bands, see Table III	57·76	—0·24	0·0576
7.	Bandpass band centered at 0·325 Mc/s full band 0·050 Mc/s	60·00	+2·0	4·000
8.	Bandpass band centered at 0·505 Mc/s full band 0·165 Mc/s	60·06	+2·06	4·250
9.	Bandpass band centered at 0·750 Mc/s full band 0·264 Mc/s	60·02	+2·02	4·080
10.	Bandpass band centered at 1·120 Mc/s full band 0·388 Mc/s	60·52	+2,5	6·250
11.	Bandpass band centered at 1·710 Mc/s full band 0·600 Mc/s	60·24	+2·24	5·000
12.	Bandpass band centered at 2·550 Mc/s full band 0·889 Mc/s	60·10	+2·1	4·410
13.	Bandpass band centered at 3·800 Mc/s full band 1·290 Mc/s	59·28	+1·28	1·640
14.	Bandpass band centered at 6·150 Mc/s full band 2·140 Mc/s	58·30	+0·30	0·090
15.	Low-pass band 0 to 0·040 Mc/s	59·80	+1·80	3·250
16.	Low-pass band 0 to 0·080 Mc/s	59·50	+1·50	2·250
17.	Low-pass band 0 to 0·133 Mc/s	58·80	+0·80	0·640
18.	Low-pass band 0 to 0·211 Mc/s	58·60	+0·60	0·360
19.	Low-pass band 0 to 0·320 Mc/s	58·12	+0·12	0·0144
20.	Low-pass band 0 to 0·473 Mc/s	58·22	+0·22	0·441
21.	Low-pass band 0 to 0·501 Mc/s	58·61	+0·61	0·3720
22.	Low-pass band 0 to 0·585 Mc/s	58·35	+0·35	0·1220
23.	Low-pass band 0 to 0·734 Mc/s	57·65	—0·35	0·1220
24.	Low-pass band 0 to 0·890 Mc/s	56·90	—1·10	1·2100
25.	Low-pass band 0 to 1·215 Mc/s	57·12	—0·88	0·7750
26.	Low-pass band 0 to 1·360 Mc/s	56·50	—1·50	2·2500
27.	Low-pass band 0 to 1·970 Mc/s	56·72	—1·28	1·6400
28.	Low-pass band 0 to 2·300 Mc/s	56·15	—1·85	3·4200
29.	Low-pass band 0 to 3·075 Mc/s	56·05	—1·93	3·8100
30.	Low-pass band 0 to 4·730 Mc/s	56·15	—1·85	3·4300
31.	Low-pass band 0 to 7·220 Mc/s	56·17	—1·83	3·3500
		1801·00		62·8982
		58·00 average		2·03
				1·42 db standard deviation

TABLE 3

Results of 2-Band Noise Tests

Observations Made by 10 Observers						
Noise Test No.*	Filter	Passband, Mc/s		Unweighted Power in Each Band db	Weighted Power in Each Band db	Total Weighted Power Combined Bands db
		Mid	Full			
4	Low-pass .		0·133	—59·17	—59·77	
	Bandpass .	1·12	0·388	—53·06	—61·26	—57·47
5	Low-pass .		0·133	—60·06	—60·66	
	Bandpass .	3·80	1·29	—38·56	—61·04	—57·86
6	Low-pass .		0·211	—59·16	—60·16	
	Bandpass .	2·55	0·889	—44·76	—61·36	—57·76
3 Judgment criterion **	Low-pass .		7·22	—45·26	—56·43	—56·43

* Test numbers as listed in Table 2.

** The power in the combined bands was judged to equal the interfering effect of the 7.22 Mc/s low-pass band used as a reference or judgment criterion.

TABLE 4

Computation of Weighting from Bandpass Data of Figure 3

Mid-band frequency Mc/s (1)	Full Band-width Mc/s (2)	Total Relative Power for Equal Interfering Effect db (3)	Corrected Frequency Mc/s (4)
0·325	0·050	0	0·325
0·505	0·165	1·4	0·505
0·750	0·264	2·9	0·737
1·12	0·388	4·5	1·097
1·71	0·600	8·0	1·644
2·55	0·889	13·3	2·457
3·80	1·29	19·9	3·585
6·15	2·14	23·4	6·150

Figures 4 and 5 show the unweighted powers in low-pass noise bands which were judged to be equally interfering. These data were obtained approximately 1 year apart and, although two set-ups and slightly different noise bands were used, the data are in very good agreement. The total unweighted powers are plotted at the upper edge of the low-pass bands in these figures. Considering the rate of increase in the total noise power required to produce the reference interfering effect as the bandwidth is increased, these data show again that on a per-cycle basis, high-frequency

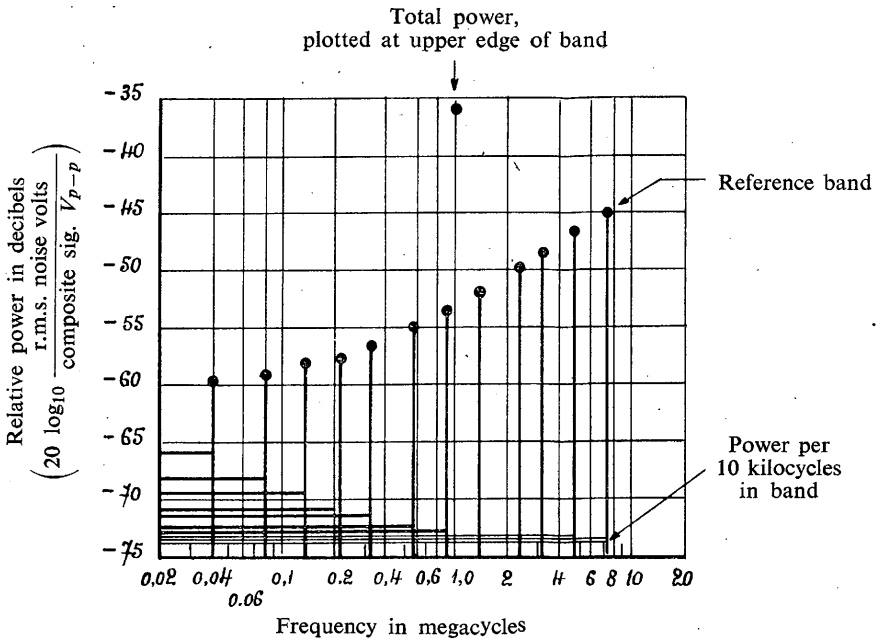


FIGURE 4. — *Powers in low-pass bands of noise judged to be equally interfering (30-observer data)*

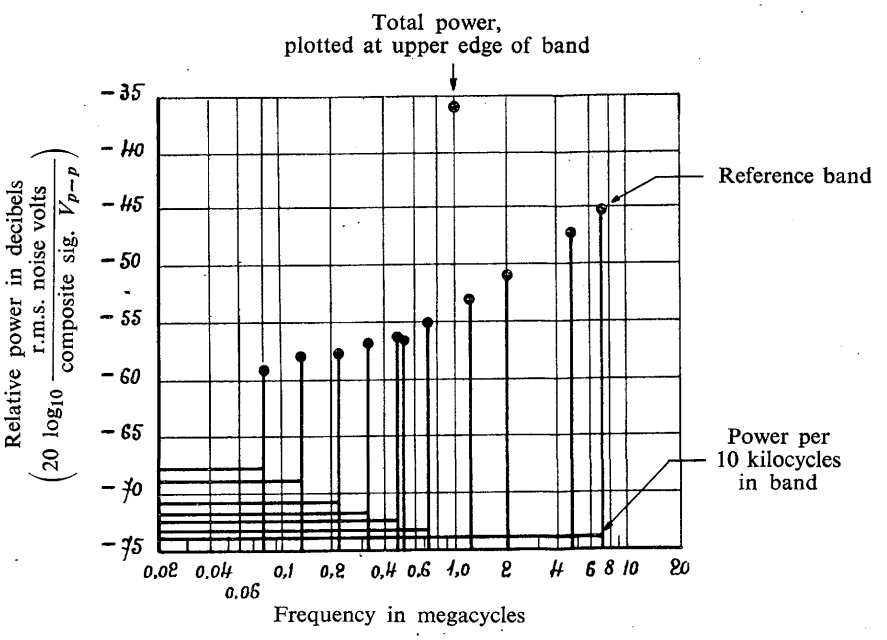


FIGURE 5. — *Powers in low-pass bands of noise judged to be equally interfering (9 observer data)*

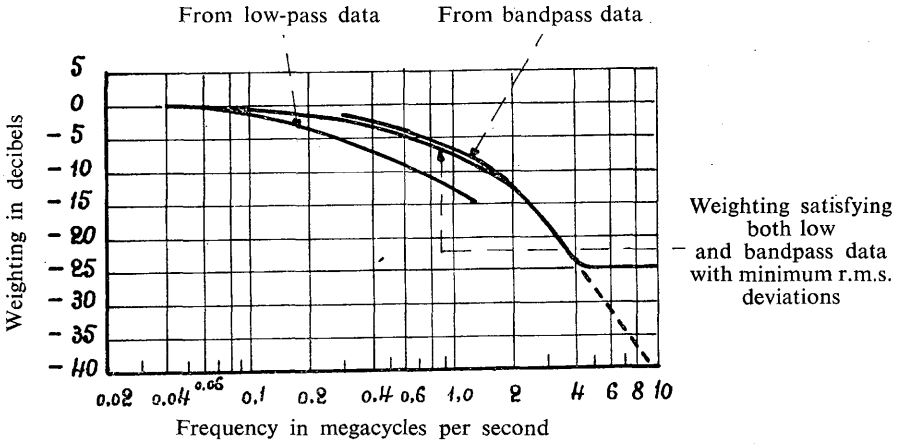


FIGURE 6. — *Weighting shapes derived from judgment tests*

noise power does not contribute as much to interfering effect as does low-frequency noise power In these figures the inverse shape formed by the total power points does not approximate to the best weighting shape. This may be better understood when it is pointed out that in an area where a positive slope of 3 db per octave is attained, the noise powers in that area would be contributing nothing to the interfering effect. This slope is very nearly attained in the 2-to-7-Mc/s region.

The horizontal lines showing the noise power per 10 kc/s in each band may be used to yield information on weighting also. A negative slope of 3 db in power level indicated by these lines per octave of total bandwidth would indicate a frequency region in which the weighting is constant. The lower two or three low-pass bands approach such a region.

It is interesting to observe the powers per 10 kc/s in the low-pass bands having upper edges above 1 Mc/s. These powers per 10 kc/s are nearly constant, indicating that, in the presence of the low-frequency noise power, the high frequencies are contributing little to the observed interfering effect. In some of the earlier work on the interfering effect of flat random noise, tests were made by starting with a 4 Mc/s band and gradually reducing its width towards 1 Mc/s, maintaining the power-per-kc/s constant. The observations showed that no appreciable change in interfering effect was produced. The present data of Figures 4 and 5 are in complete accord with these findings but they also show a marked increase in the interfering effect of noise in the region below 1 Mc/s. The early tests were not carried far enough to divulge this information.

Table 1 shows the magnitude of the unweighted noise powers plotted in Figures 3, 4 and 5.

Figure 6 shows three weighting curves, one derived from the bandpass data, another derived from the low-pass data and a third or compromise curve drawn in between the other two. An explanation of the derivation of the top and bottom curves is given in the annex.

The uppermost curve, derived from bandpass noises, extends down to only about 300 kc/s, since adequate data were not taken on bands below this frequency. The bottom curve, derived from low-pass data, is not shown beyond 1·3 Mc/s because in the presence of low-frequency

interference, the determination of the position of the high-frequency end of the curve is subject to large errors, and hence there is considerable uncertainty as to its proper level, based on the low-pass data alone.

The curves are so placed on the db scale that if the top curve is used for the bandpass noises and the bottom curve for the low-pass noises, computed weighted noise powers turn out to be approximately equal when the interferences were judged to be equal by the jury of observers.

It is obviously impracticable to employ one weighting and calibration for low-pass interference and another weighting and calibration for bandpass interference. Hence, a compromise is necessary if the summation of weighted power is used as an indication of interfering effect.

At this point it should be noted that the different positions of the two curves reveal that for the interference levels tested, human vision does not sum the weighted interference powers over the band in assessing over-all interfering effect. The relative positions of the curves indicate that a given amount of noise power is more interfering if it is concentrated in a narrow band (bandpass data) than if it is spread out over a wider band (low-pass data) in the same frequency region.

Consideration of the interfering effects of narrow-and wide-band noises, having the same power, in the same general frequency region, indicates that the average observer saw something that caused him to rate the narrow bands more interfering. It is a fact that narrow bands tend to produce fleeting patterns not very unlike herringbone effects. If the band could be made progressively narrower until only a single frequency was passed, bar patterns would result. In other words, the narrower the band, the less random the noise effect and hence the more objectionable it becomes. This is apparently one of the causes for the displacement of the two weighting curves, derived for low-pass and bandpass noises, shown in Figure 6.

Theorizing further on the observations, and noting that they were made at levels only a few db (about 7) above threshold, it appears reasonable that if the noise power in a narrow band at this level were redistributed over a much wider band, the resulting noise power per cycle might easily be so low as to be barely above threshold, or even slightly below threshold. Under these conditions a balance between the interfering effects would be obtained only by raising the power in the wide-band noise relative to that in the narrow-band noise. This reasoning offers a further explanation of the observed results.

The curve plotted between the two outside curves in Figure 6 is a compromise weighting which produces nearly constant computed weighted powers when different shapes of random interference are adjusted to be equally interfering by competent jurors. The philosophy involved in drawing this curve between the other two may be described as follows : at low frequencies, where the only evidence available is from noise obtained through low-pass filters, the compromise curve is near the low-pass curve. At high frequencies where the low-pass data gives very poor evidence of what the weighting should be, the compromise curve is drawn near the bandpass curve. This is done not only because the best evidence on what the weighting should be at high frequencies is obtained from the bandpass data, but also because in actual practice most random noise are tipped up to some extent, and therefore approach, in the limit, bandpass noise having high noise power per cycle near the upper edge of the band. It would appear that full weight should be given to high frequency noise when it occurs in this manner.

Figure 7 shows the computed interference magnitude for the series of random noises that were used in the course of these experiments. Each position along the abscissa presents a given noise, which is briefly described as regards frequency composition. A more complete description

of each noise is given in Table 2, together with numerical magnitudes of the data plotted in Figure 7. The computed magnitude using the compromise weighting is shown as the ordinate. Since all noises were judged to be equally interfering by jurors, the departure of the respective computed values from a constant average value represents the errors which might be expected from a meter designed to sum the weighted power according to the compromise weighting in Figure 6.

An examination of Figure 7 shows that narrow-band noises will in general be underweighted (the meter will read too low), and broad bands will be overweighted (the meter will read too high).

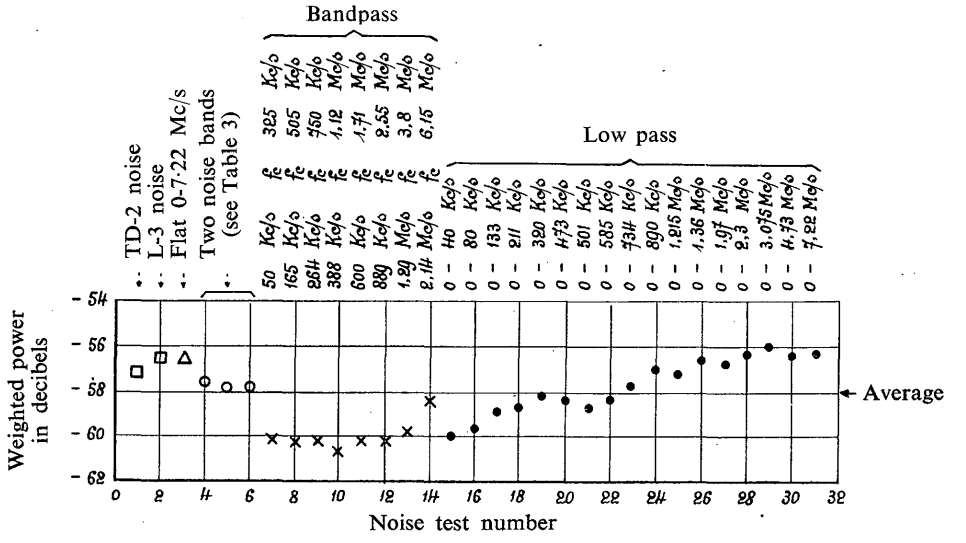


FIGURE 7. — *Weighted powers of noises judged to be equally interfering*

The rms deviation of the db magnitudes shown in Figure 2 from the average value is 1·42 db. This may be compared to the rms deviation from the mean of all observer judgements on the various noises. The latter figure is 1·45 db. From this it may be seen that the meter error (assuming the mean judgment of the jurors to be correct in every case) is of about the same order of magnitude as the observer deviation.

Sparkle effect. — Figure 1 shows two weightings for the area above 4 Mc/s. The lower weighting is an extrapolation of the weighting determined by the judgement tests for frequencies below 4 Mc/s, while the upper weighting more nearly represents the weighting determined by judgement tests on the noise band in the 4-8-Mc/s region.

The appearance of noise as observed on a picture tube varies enormously, depending upon the frequency composition. Very low-frequency noise creates a streaky, nebulous effect that is judged most annoying. As the frequency increases, the disturbance resembles photographic grain in which the individual grains have random motion and become finer and finer as the frequency increases. As the grain becomes finer, the input noise level must be increased to keep the fine grain visible. In the vicinity of 4·5 Mc/s an abrupt change occurs. The face of the picture tube now appears specked with minute points of light that endure for a fleeting instant and then

disappear. This sparking causes the observer evaluation to flatten out above 4·5 Mc/s. It occurs only when the total noise energy is contained in the area above 4·5 Mc/s. This effect appears related to the random occurrence of peak potentials in the random noise source and to the effect of these potentials on the kinescope. The output of the noise generator was examined periodically with an oscilloscope for evidence of clipping. These measurements indicated the output of the noise to have a peak factor of 14 db (peak noise volts to rms noise volts) and showed no evidence of clipping.

Overloading of the amplifiers external to the viewing monitor, Figure 2, tended to change the appearance of the sparkling. The minute bright areas became elongated and more nearly resembled short dashes of light. This change in character made it possible to differentiate between the true sparkle effect and overloading of the amplifiers. Three different 1816 P4 kinescopes showed the sparkle effect. This suggests that the effect is characteristic of the kinescope.

The interpretation of this result on design standards is of importance. If a situation arises in which the expected noise is all in the region above 4 Mc/s, the upper weighting curve should be employed, since the noise cannot be permitted to break through the threshold of the sparkle effect. If the expected noise is spread out over the low as well as the high frequencies, it would be permissible to use the lower curve, since the contribution of the high frequencies (when they are below the threshold of the sparkle effect) is negligibly low and is probably most accurately assessed by application of this weighting. As a practical matter, on general types of noises, it would probably not matter what curve is used, since the sparkle effect begins at levels over 25 db higher than the threshold of interference in the low frequency regions.

Two-Band Noise Tests. — Each 2 band noise was made up of a low-pass band (cut-off low on the frequency scale) and a high-frequency bandpass band. The levels of each were adjusted to be equally interfering. The observations were made in the same manner employed for the 1 band tests described earlier and shown schematically in Figure 2. Ten observers were employed. Table 3 gives the results of these tests and indicates the weighted power in the 2 band noises were from 1 to 1·4 db smaller then the weighted power in the judgement criterion. These results substantiate the general results presented here as regards the magnitudes of the deviations expected. More specifically, the added bands fall in the category of narrow bands and thus should be underweighted by the compromise weighting, as shown in Figures 6 and 7, and as is evident in the results.

Conclusion. — The results of the experiments described have indicated that random television interference can be measured with a power meter having frequency weighting with sufficient accuracy to be of value in the design and maintenance of television transmission circuits.

The relationship between the quantity measured and the subjective effect is not precisely unique but the order of magnitude of the errors is about the same for the weighted power meter as were the rms deviations of the observer data. Useful design and maintenance standards can be set up in terms of meter readings at given level points on transmission circuits.

ANNEX

(to Appendix 3 to Question 22 of Study Group 1)

Weighting from Bandpass and Low-Pass Data

Bandpass data. — The derivation of a frequency weighting from the bandpass data shown in Figure 3 is given in Table 4. The table, column 1, shows the mid-frequencies of the respective bands, and column 2 the full bandwidths. Column 3 gives the total power in each band in db,

TABLE 5

Computation of Weighting from Low-Pass Data of Figure 4

Bandwidth Mc/s (a)	Bandwidth Excess Over Adjacent Lower Band (b)	10-Log Excess Bandwidth 0·040 (c)	Relative Power per 10 kc/s Interfering Effect db (d)	Weighted Power in Adjacent Lower-Band (e)	Total Weighted Power for given interfering Effect (f)	Weighted Power in Bandwidth in Excess of Lower Adjacent Band db (g)	Total Level of Bandwidth in Excess of Lower Adjacent Band db (h)	Weighting for Bandwidth in Excess of Lower Adjacent Band db (i)	Mid-Frequency of Band in Excess of Lower Adjacent Band db (j)
0·040			0		1·000		0	0	0·020
0·080	0·040	0	—2·55	0·525	1·000	0·475	— 3·2	— 0·65	0·060
0·133	0·053	+ 1·2	—3·77	0·756	1·000	0·244	— 6·1	— 3·53	0·106
0·211	0·078	+ 2·9	—5·27	0·708	1·000	0·292	— 5·3	— 2·93	0·172
0·320	0·111	+ 4·4	—5·72	0·902	1·000	0·098	—10·1	— 8·78	0·266
0·585	0·265	+ 8·2	—6·74	0·791	1·000	0·209	— 6·8	— 8·26	0·452
0·890	0·305	+ 8·8	—7·11	0·918	1·000	0·082	—10·9	—12·59	0·737
1·360	0·470	+10·7	—7·53	0·908	1·000	0·092	—10·4	—13·57	1·125
2·300	0·940	+13·7	—7·56	0·993	1·000	0·007	—21·5	—27·64	1·836
3·075									
4·73									
7·22									

relative to the power in the first band when each noise was adjusted to have the reference interfering effect. In column 4 corrected frequency figures are given. These figures are very nearly the same as the figures in column 1 (mid-band frequencies) but slightly different because, if an appreciable slope in the weighting occurs over one of the given bands of noise, it is apparent that the center-of-interference of that band is not the arithmetic center of the band. Since it was desired to plot the weighting at the center-of-interference of each band, a small frequency correction was calculated whenever the db weighting across the band changed by 2 db or more. The figures in columns 3 and 4, when plotted, give the desired shape of the weighting. This is the shape given in the top curve of Figure 6.

As indicated in the text, the position of the curve on the db scale was determined by adjustment, to produce calculated magnitudes of noise from the bandpass data that were equal to the magnitudes of the low-pass noises calculated from the bottom curve.

Low-pass data. — The calculation of weighting from the low-pass data yields results which are considerably more inaccurate than those obtained from the bandpass data, especially in the frequency regions above 500 kc/s. This is because all the judgments from which weightings may be calculated were made in the presence of low-frequency noise which has been shown to be more interfering, per cycle, than high-frequency noise. Hence, small differences in the opinions of observers in the levels producing equal interfering effects result in very large differences in the estimated weightings for the frequency regions above the very lowest employed.

A very effective method of weighting derivation is the cut-and-try method. This, however usually involves several unsuccessful attempts and is correspondingly tedious because of the computations involved. Hence, a method of obtaining an initial curve from the data was worked out and a sample is carried out in Table 5 for the data given in Figure 4.

The principle involved in making the calculation was that each noise should be required, through the application of a calculated weighting, to produce a weighted power sum of unity, since each was judged to be equally interfering. A weighting of 0 db was assumed to apply all across the lowest band (40 kc/s wide). In the next wider band a 0-db weighting was assumed to hold over that portion common to the lowest band, and a lesser weighting calculated for the remainder of the bandwidth such that the total weighted sum of the power for the noise came out to be unity also.

For the third band the portion common to the second band was effectively treated with the two weightings previously derived and the remainder, in excess over the width of the second noisee was operated upon by a third weighting calculated to make the weighted sum of the powers unity. This method was carried on for bands up to 2·3 Mc/s wide. For wider bands the calculation, indicated that practically no contribution to interference was being made by the high frequencies and hence no evidence could be adduced as to where the weightings should be.

In Table 5, column *(a)* gives the bandwidths of the low-pass noises employed. Column *(b)* gives the excess bandwidth, for any particular low-pass band, over that of the adjacent lower band. Column *(c)* gives the frequency factor in db, of the excess bandwidths given in column *(b)*. Column *(d)* gives the relative powers per 10 kc/s in db for the bands when they were adjusted in level to produce equal interfering effects. These data are obtained from Figure 4, making the db figures relative to that for the narrowest band (40 kc/s). Column *(c)* gives the weighted power in that portion of any band common to the next lower adjacent band. These are power units and are obtained by reducing unity by the difference between the db Figure in column *(d)* and the corresponding Figure in the row immediately above. For example, the Figure 0·525 in column *(e)* corresponds to unity reduced by 2·55 db. Column *(f)* gives the power figure of unity to which the calculation in each row is directed. Column *(g)* gives the difference between

the figures in columns *(e)* and *(f)*. Column *(h)* is the db figure corresponding to the power figures in column *(g)*. Column *(i)* gives the desired weighting. This figure is obtained by combining the figures in columns *(c)*, *(d)* and *(h)* according to the equation $i = h - (d + c)$.

Column *(j)* gives the frequencies corresponding to the weightings. These frequencies are approximately the mid-frequencies of the portion of a given low-pass band not common to the next adjacent lower band.

The smoothed curve drawn through these points, averaged with a similarly derived smooth curve for the data shown in Figure 5 gives the shape of the bottom curve shown in Figure 6.

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[2] Otto H. SCHADE. Image Gradation, Graininess and Sharpness in Television and Motion Picture Systems, Part 2. *Journal, Society of Motion Picture and Television Engineers*, New York, N. Y., vol. 58, March 1952, pages 181-222.

Question 23.

(Sub-Group 1/1, then C.C.I.F. Study Group 1, in co-operation with the C.C.I.R., I.B.O. and E.B.U.)

(continuation of Question 12 of Study Group 3, studied in 1055/1056)

A. What values of random noise and periodic noise can be accepted in the equipment and the line for a vestigial sideband television system for transmission of signals in the 625-line system with a video-frequency band of 5 Mc/s or the Belgian 819-line system, subject to satisfying the overall conditions which will be laid down for the hypothetical reference circuit for television transmissions in reply to Question 22 ?

The admissible limits for random and periodic noise will be shown for :

(a) a modulating equipment,

(b) a demodulating equipment,

(c) on the H.F. line.

Note. — As regards random noise, the proposals previously made by the Federal German Administration and by the Cuban Telephone Company are reproduced in Appendices 1 and 2 below.

B. What characteristics should be recommended for the shaping filters for the vestigial sideband in the modulating and demodulating equipments for line transmission of television signals, either the 625-line system with a video-frequency bandwidth of 5 or 6 Mc/s, or the Belgian 819-line system ?

Note. — The C.C.I.F. has already recommended that modulating and demodulating equipments should contribute equally to this shaping. For information on this point, Annexes 3 and 4 below give details of proposals already made.

ANNEX 1

(to Question 23 of Study Group 1)

Proposals by the Administration of the Federal German Republic concerning admissible noise in television signal transmission

Provisionally, the allowable power for continuous random noise should be, in each case, divided equally between the terminal modulating and demodulating equipment and the sections of carrier line equipped with repeaters.

It would be premature to fix limits for recurring noise.

ANNEX 2

(to Question 23 of Study Group 1)

Performance Requirements of the Hypothetical Reference Circuit (for 405 and 625-line television)

(Note by the Cuban Telephone Company)

There are several types of imperfections, some of which add systematically and others which add at random.

Systematic addition (" In-phase addition ").

Non-linear distortion (which also causes amplitude compression of the image intensity).

Random Addition (" RMS " or " Power " Addition).

Variation of equivalent loss with time.
Noise, terminal and line.
Phase and amplitude characteristics, terminal and line.

The composition of the " International Television Connection AD " (Figure 1, of Appendix 1 to Question 22) may be analyzed in terms of the following " Units ".

		No. of « units » in overall connection	
a.	Local link A-B (one used)	1	
b.	Television to carrier translation (transmit terminals, 3 used)	3	Items c, d, e from the " International Television line " B-C.
c.	Long distance coaxial line (3 sections used)	3	
d.	Carrier to television translation equipment (Receive terminals) 3 used	3	
e.	Local link (C-D) (one used)	1	
	Total	11 Units	

The " International Television Connection " contains eleven units, while the " International Television Line " contains nine units.

It is proposed that each of these " units " should be allowed 1/22 of the total permissible imperfection (the division should take account of the type of addition which applies in each case). The remaining one half of the total permissible imperfection should be allocated to the long distance transmission circuits on a basis of their length relative to the total planning distance of 2,500 km (taking again into account the type of addition which applies for each type of imperfection).

An international connection such as that shown with 11 units and covering 2,500 km will, with the above allocation scheme, therefore be permitted to produce the full acceptable amount of imperfection.

In the international television line (B-C) when extended to 2,500 km the permissible imperfections should therefore be divided in the following relative proportions :—

3	Translations Television to Carrier	3 × 1 =	3
3	Carrier line transmission sections	3 × 1 =	3
	2,500 km	=	11
3	Translations carrier to television.	3 × 1 =	3
	Total		20

The division should in each case take account of the type of addition which applies.

ANNEX 3

(to Question 23 of Study Group 1)

Proposals by the Administration of the Federal German Republic concerning the form of the line-transmitted television signal

The following proposal has been made for 625-line television with a video band of 5 Mc/s : The lower sideband should be attenuated by the combination of the sending modulator and the receiving demodulator such that between 556 and 1556 kc/s there is a linear variation of amplitude as a function of frequency (see figure 1 curve *a*).

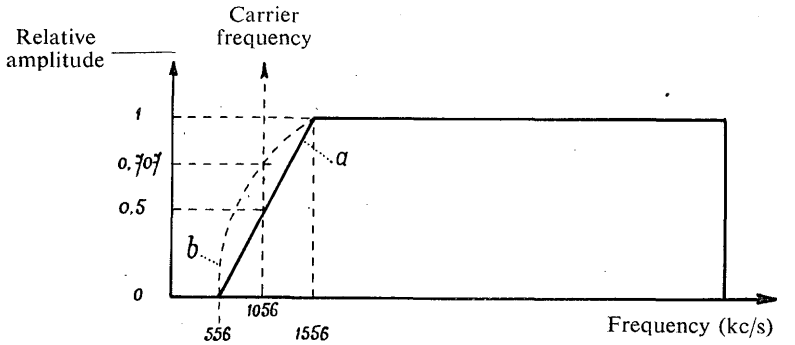


FIGURE 1. — *Partial suppression of the lower sideband*

Taking account of the preceding recommendation, the curve of variation of amplitude, as a function of frequency for a single filter has therefore the form of the curve *b* of figure 1. It rises proportionally to the square root of the difference between the frequency considered and 556 kc/s, from 0 for 556 kc/s to 0·707 for 1056 kc/s, and to 1·0 for 1556 kc/s. No proposal can yet be made for the allowable deviation from this nominal curve.

ANNEX 4

(to Question 23 of Study Group 1)

Proposals by the Cuban Telephone Company concerning the form of the line-transmitted television signal

1. The vestigial side-band region should cover a band from approximately 500 kc/s above the carrier frequency to about 500 kc/s below the carrier frequency. This represents a reasonable compromise between the difficulty of designing a narrow band filter and the difficulty of extending the frequency range of the repeaters in the low frequency direction.

The same filter is to be used at the transmitting and receiving terminal. The loss of each filter at the carrier frequency should therefore be 3 db relative to the filter loss at high frequencies where the transmission is single side-band. Thus, after passing through two filters, the side-band. associated with very low video frequencies will be attenuated by 6 db, i.e. to one half of the voltage of the single side-band by which high frequency information is transmitted. Thus in-phase addition of the two very low frequency side-bands produces video information of the same amplitude as the high frequency information.

With higher video frequencies the vestigial sideband filters will attenuate the two side-bands unequally. If the filters are phase equalized the two side-bands will in the process of demodulation, add in phase to give the video output. The requirement then to obtain a video output which is independent of frequency is that the sum of the two corresponding side-band amplitudes shall be constant for all video frequencies.

There are many possible filter characteristics which will fulfil this requirement. The mathematically simplest is that producing a linear voltage/frequency characteristic as shown in Figure of Annex 3 above.

It is, however, not possible to realize this characteristic with practical filters. The difficulty occurs at both extremes of the vestigial side-band region where the linear characteristic has a discontinuity. Practical filters would round off these regions and it is better to take such limitations into account in specifying the required characteristic.

A characteristic which produces the required side-band amplitudes and takes into account the limitations of practical filters is :—

For one send or one receive filter,

$$D(f) = 10 \log_{10} ERF(y) \text{ db}$$

where $D(f)$ is the filter loss at frequency f relative to the loss in the single side-band region.

$$y = \frac{f - f_0}{K}$$ where f_0 is the carrier frequency,

K is a constant defining the rate of cut-off of the unwanted side-band.

The function $ERF(y)$ is the error function of y defined as :

$$ERF(y) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{y} \exp\left(-\frac{y^2}{2}\right) dy$$

This function will be found tabulated in mathematical tables.

It is proposed that for the constant K a value in the region 200-230 kc/s should be agreed.

2. In specifying the accuracy with which such a characteristic should be met, the limits set should take into account the fact, that, for a given error in the video output, a much wider tolerance can be allowed at frequencies at which the filter attenuation is high.

This is satisfied by the following expression :—

$$E = \left| 10^{-\frac{D_a}{10}} - 10^{-\frac{D_f}{10}} \right|$$

E is a constant to be specified and which determines tolerances.
D_a is the actual filter discrimination (db).
D_f is the specified filter discrimination (db).

3. It is expected that if different manufacturers produce terminals which meet the above discrimination and equalization requirements, there should be no difficulty about interworking between terminals of different manufacture.

4. The side-band transmission from high video frequency signals should be limited by an attenuation/frequency curve which must be specified. In this case also it is recommended that the filter and compensation should be equally provided at the transmitting and receiving terminals.

Question 24.

(Sub-Group 1/1, then Study Group 1)

(continuation of Question 12 of C.C.I.F. Study Group 3, studied in 1955/1956)

A. In a 6 Mc/s coaxial-pair television system :

(a) What frequencies are to be recommended for pilots in addition to that of 308 kc/s, already recommended ?

Note. — The following frequencies have already been proposed for the 625-line television system, with a 5 Mc/s video-frequency band :—

6200 and 4092.45 kc/s
or 6142 and 4142 kc/s.

It is highly desirable to arrive at a single solution.

(b) What recommendations should be made to permit the best arrangement for interconnecting two line-systems of different types at an intermediate point such as a frontier repeater station ?

Note. — It would be preferable to make the connection between the two line-systems within a line-regulating section, or in other words, to allow the regulating pilots to cross the frontier, since this avoids undue limitation on the length of a regulating line section, and reduces the number of stop filters necessary. Nevertheless, for this to be possible it is necessary to specify the levels of the pilots with reference to point B (of figure 1) where the level of the vestigial sideband is defined. This is dealt with under *(c)*.

(c) In the case of a line crossing a frontier, is it possible to transmit the line pilots directly, avoiding the need for their suppression and re-injection at the frontier station ?

If so, what are the recommended values for the levels of these pilots at points corresponding to E and B of figure 1, these levels being related to the level at the output of the modulating equipment (point B in figure 1) ?

(d) What tolerance is to be recommended on the line pilot frequency ?

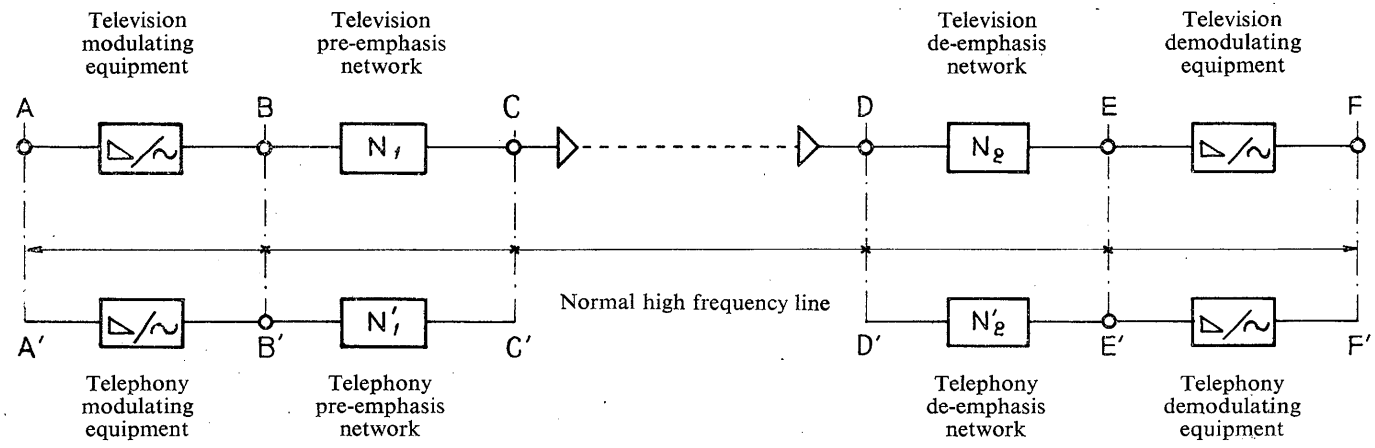


FIGURE 1. — *System of vestigial sideband television transmission on coaxial cable*

Remarks. — 1. Points A and F are video interconnection points.
Points B and E are television interconnection points at carrier frequency.
Points B′ and E′ are telephony interconnection points at carrier frequency.

2. The modulator characteristics should be defined between the points A and B. The demodulator characteristics should be defined between the points E and F.

3. Between BE and B′E′ the gain/frequency characteristic at the high frequency is uniform.

4. The networks N_1 N_2, etc..., should be chosen to facilitate the matching to the line and to present to the modulation and demodulation equipment standard conditions for level, etc.

5. If a number of high-frequency lines of different types are interconnected or if derivations are made at an intermediate point pre-emphasis and de-emphasis networks, etc..., will be necessary at junction points to enable the interconnection to be made at a point of defined level and independent of frequency.

6. For alternative telephony and television transmissions switching should be carried out at points C and D.

B. Is it desirable to use a 6 Mc/s system on coaxial pairs, established for television transmissions, as an alternative, for telephony transmission ?

If so,

(a) How many supergroups should be sent to line ?

(b) At what level should the line pilots be transmitted, bearing in mind that any telephony circuit obtained in this way should conform to the hypothetical reference circuit for telephony on coaxial pairs ?

Question 25.

(Sub-Group 1/1, in co-operation with Sub-Group 1/4, then with Study Group 1)

(continuation of Question 16 of C.C.I.F. Study Group 3, studied in 1955/56)

What characteristics are desirable for the repeaters of a television circuit on coaxial pairs, for the various television systems used in Europe ?

Note 1. — Particular consideration will be given to the limits to be imposed so that the signal-to-noise ratios mentioned in Appendix 1 to question 22 above might be met for the " nominal maximum circuit for television transmission on coaxial pairs ".

Note 2. — As examples, annexes 1 and 2 below indicate the characteristics specified by the Federal German Administration and the characteristics of typical repeaters employed by the United Kingdom Administration. It should be noted that all the repeaters described in these annexes might be used for alternative telephone and television transmission.

ANNEX 1

(to Question 25 of Study Group 1)

Characteristics proposed by the Administration of the Federal German Republic for television repeaters (625-line system)

The following text concerns repeaters for the 625-line system used by the Federal German Posts and Telecommunication Administration. The values given assume that the form and index of modulation given in Figure 1 is used. The nominal value of the peak voltage corresponding to the passage from " black " to " white " at the repeater output is 0·387 volt (corresponding to 1 mW in 75 ohms).

On this condition, the Federal German Administration of Posts and Telecommunication proposes the following values :

1. *Minimum value of harmonic margin.*

A sinusoidal wave of 1056 kc/s is applied at the input of the repeater at a level such that at the output of the repeater terminated by 75 ohms a power of 1 mW is measured. The second order harmonic margin should be at least 60 db and the third order margin at least 75 db.

2. *Maximum Usable Power.*

The absolute level of the maximum usable power of a repeater measured at a frequency of 1056 kc/s should not be less than 22 db.

This maximum usable power is defined as the output power for which an increase of 1 db corresponds to reduction of 20 db to the 3rd order harmonic margin.

3. *Maximum Gain.*

The complete equipment of an intermediate repeater station should provide a maximum gain of 57 db (6·6N) measured at 6·2 Mc/s.

4. *Basic Noise.*

The basic noise of an intermediate repeater should not be more than 6 db above the thermal noise.

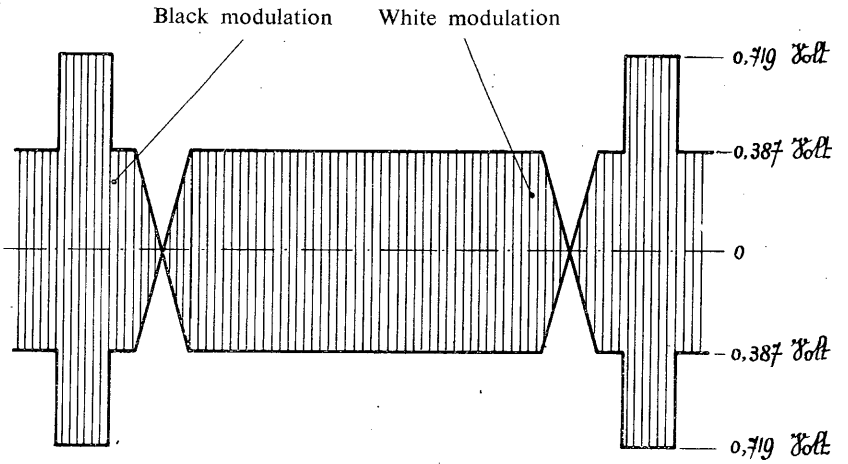


FIGURE 1. — *Graphical representation of modulation*

Remark: The voltages indicated are the nominal values in 75 ohms

ANNEX 2

(to Question 25 of Study Group 1)

Characteristics of repeaters used by the United Kingdom Telephone Administration on television circuits (405 line system)

Note. — For information, the main characteristics of repeaters used in the United Kingdom for the transmission of 405 line Television signals (3 Mc/s video bandwidth) over coaxial cables are :

SYSTEM I	SYSTEM II
Gain	
Matches the loss in 6 miles of 0·375 inch cable from 60 kc/s-4400 kc/s and is operated with a flat output characteristic over this range.	Matches the loss in 6½ miles of 0·375 inch cable from 60 kc/s-4100 kc/s and is operated with rising output characteristic over this range.

SYSTEM I	SYSTEM II
Regulation	
Intermediate repeaters are not regulated. Equalizers are switched in to correct for cable changes with temperature. Terminals have flat A.G.C. operated from 308 kc/s pilot.	Each repeater is regulated in gain according to a $\sqrt{F}$ law from a pilot at 4092 kc/s. The normal range of control is $\pm$ 4·5 db at the pilot frequency.
Overload Point	
+ 26 db relative to 1 mW, measured at 1 Mc/s. The overload point is taken as that when 1 db increase in input results in 0·8 db increase in output.	+ 25 db relative to 1 mW measured at 4·1 Mc/s.
Harmonics	
With an output signal of +10 db relative to 1 mW at 1 Mc/s,	
Signal/2nd Harmonic ratio not 75 db	Signal/2nd Harmonic not 53 db.
Signal/3rd Harmonic ratio not 95 db.	Signal/3rd Harmonic not 77 db.
Basic Noise	
Unweighted noise power output in a 4 kc/s band with the repeater input and output terminated in 75 ohm	
60-1000 kc/s — 98 db on 1 mW 1000-2000 kc/s — 93 db on 1 mW 2000-3000 kc/s — 89 db on 1 mW 3000-4000 kc/s — 80 db on 1 mW	60 kc/s — 102 db on 1 mW 4000 kc/s — 85 db on 1 mW
Return Loss	
The input and output impedances give a return loss of not less than 20 db over range 60-4400 kc/s.	The repeater gives the following return losses against 75 ohms.

Frequency	Input	Output
60 kc/s	30 db	13 db
500 kc/s	21 db	3·5 db
1000 kc/s	12 db	2·0 db
2500 kc/s	1·5 db	1·5 db
4000 kc/s	2·5 db	1·5 db

Question 26.

(Sub-Group 1/4, then Study Group 1, in co-operation with the C.C.I.R., I.B.O. and E.B.U.)
(continuation of Question 17 of C.C.I.F. Study Group 3, 1955/1956) (documentary question)

(a) Can the transient response of a transmission circuit to a given signal be deduced from the transient responses of the different parts of the circuit to the same signal without having to use spectral analysis ?

Note. — According to the initial results given by the study of this question, it is possible to deduce the transient response of a transmission circuit to a given signal from the transient response of different parts of the circuit to the same signal without having to use spectral analysis, provided that the signal has a limited bandwidth and if, as is generally the case in practice, the impedances at each junction point in the circuit are much the same. There are two practical methods of making the calculations (see the " note of the French and British Administrations on the methods of calculation in the transient state ", on pages 80-85 of the *Book of Appendices* to Volume III of the *Green Book*). The Annex 1 below indicates the relationships between these two methods. In particular it is necessary to study what will be the optimum value of the parameter τ defined in this note. It is also essential to agree on the method of defining the function $\tau\ (2\pi jf)$ introduced in this annex, in order that all users will employ the same values of the parameters t_k in their calculations.

(b) In the spirit of part *(a)* of this question, can a method be recommended for synthesizing a network having given transient characteristics, with the object, for example, of correcting the residual distortion of a transmission system, without having to make a detailed examination of the make-up of different sections of the system ?

N.B. — Annexes 2 and 3 give the replies received in 1955 and 1956 from the French Administration and the United Kingdom Administration to Question 17 of C.C.I.F. Study Group 3.

ANNEX 1

(to Question 26 of Study Group 1)

Reply by the French Administration to Question 17 studied in 1952/1954 by Study Group 3

Part (a). — The theoretical studies in the bibliography given on pages 84 and 85 of the *Book of Annexes* to Volume III of the C.C.I.F. *Green Book* have indicated that the problem is possible in the case where transmission circuits to be studied have a limited spectrum.

The French and British Administrations have proposed two methods described in the note on pages 80-85 of the *Book of Annexes* to Volume III of the *Green Book*. The two methods have the same starting point.

Let $(-f_u, +f_u)$ be the band of frequencies for which it is desired to know the transient response of a television circuit. In the two methods, a pulse I (t), of spectrum limited to the band $(-f_0, +f_0)$, wider than the useful band required $(f_0 > f_u)$, is applied to the circuit.

(In practice, the two Administrations propose a pulse of the cosine-squared (raised-cosine) form of half-amplitude width $\frac{1}{2f_u}$ and whose spectrum is limited to the band $(-2f_u, +2f_u)$ but this choice is by no means imperative).

Let $R\ (t)$ be the response of the circuit to this signal.

Both Administrations calculate, starting from $R\ (t)$, a series of coefficients characterizing the circuit.

The French Administration proposes to place $R\ (t)$ in the form :

$$R\ (t) = \Sigma\ \alpha_n\ I\ (t - n\tau) \qquad \tau = \frac{1}{2f_0}$$

(In the appendix a method is given for rapidly calculating α_n knowing $r_n = R\ (n\ \tau)$).

The British Administration for its part proposes to define the circuit by letting the series β_n represent the response of the circuit to a " filtered impulse " limited to the band $(-f_u, +f_u)$.

This signifies that if $J(t)$ is the filtered impulse and $S(t)$ the response of the circuit to this filtered impulse, $S(t)$ is in the form

$$S(t) = \Sigma \beta_n J\left(t - \frac{n}{2f_u}\right)$$

The method for calculating β_n is the following :

(a) the spectrum of $R(t)$ is limited to the band $(-f_u, +f_u)$ so that the series is given by $r'_n = R\left(n\frac{\tau'}{2}\right)$ with $\tau' = \frac{1}{2f_u}$

The values of r''_n are calculated from an expression of the form :

$$r''_n = \Sigma H_{m,n} r'_n$$

The new interval is $\tau' = \frac{1}{2f_u}$

The coefficients $H_{m,n}$ have a simple form because the time series of r''_n (interval $\frac{1}{2f_u}$) is related in a simple manner to the time series of r'_n (interval $\frac{1}{4f_u}$);

(b) To the spectrum of $R(t)$ is applied a correction factor which is the inverse of the pulse I (t) in the interval $(-f_u, +f_u)$ and zero beyond, an operation performed by convolution of r''_n with a known series.

The series β_n is thus the series of ordinates of the pulse response of the circuit at the instants $n\tau'$, when this circuit is followed by an ideal low-pass filter of cut-off frequency f_u.

In practice, the second method has the advantage over the first of yielding a shorter series in the case where the frequency f_u is greatly attenuated by the circuit. If this frequency is not greatly attenuated, the number of terms of the series increases and might then exceed those of the terms of the series α_n, This arises from the fact that the density of the energy spectrum is indeterminate in the filtered impulse $J(t)$ in the vicinity of f_u.

The second method on the other hand has the disadvantages of limiting information to the band f_u and requiring the presence of a low-pass filter of effective cut-off f_u in all experimental verification.

The essential difference between the two methods appears in the convolution of the circuits. In the French method the convolution for α_n is made relative to the different circuits, the series α_n is calculated relative to the overall circuit and then, if one seeks to minimise the number of coefficients characterizing the overall circuit, can be changed to β_n. In the British method β_n is calculated for the individual circuits and then β_n for the overall circuits is obtained by convolution.

The remark in the text of this Question concerns the annex published in the *Book of Annexes* to the *Green Book*, Volume III, pages 80-85. The conclusion (pages 83 and 84) remains valid with the following new explanation. The French Administration is prepared to translate the series of interval $\frac{1}{4f_u}$ according to its method into a series of interval $\frac{1}{2f_u}$ corresponding to that obtained by the British method. But it is useless for one Administration to take $\frac{1}{2f_u}$ as the interval and the other $\frac{1}{4f_u}$ in order to make the results transferable if it is not the same f_u in each case. An acceptable provisional proposition is to take for (f_u) one of the terms of the following series :

3 Mc/s (for example, the standard for 405 lines)
6 Mc/s (for example, the standard for 625 lines)
12 Mc/s (for example, the standard for 819 lines).

The users should also define the function $Y(2\pi jf)$, that is to say, specify :

(1) Between what points the function $Y(2\pi jf)$ is taken;

(2) To what signal the function $Y(2\pi jf)$ applies and at what reference level.

Regarding this the French Administration proposes the following :—

(1) $Y(2\pi jf)$ may be taken between the input of the long-distance line and the junction point between the two international circuits. If the junction is made by a radio link, the transmitter belonging to one Administration and the receiver to another, by agreement a junction point should be chosen on one side or the other of the radio link.

(2) As is well known, $Y(2\pi jf)$ the transmission factor in the band $(-f_u, +f_u)$ should be defined with respect to a given origin and level. It is recommended to take $Y(2\pi jf)$ such that the significant coefficients A_k (see the *Book of Annexes* to Volume III, page 81, formula 3) should be as few as possible (the term " significant " is taken as " not negligible " in the numerical calculation).

$Y(2\pi jf)$ will be placed in the form

$$Y(2\pi jf) = Ke^{-2\pi jft_0} \Sigma A_k e^{-2\pi jf\frac{k}{2f_u}}$$

t_o and K being chosen so that the number of significant terms A_k is as small as possible and the greatest of the terms A_k is equal to unity.

The choice of K and of t_o is mainly a question of convenience. It will be left to the discretion of Administrations.

As regards the quality and the order of magnitude of A_k (see the *Book Annexes* to Volume III page 83, 5th line) the question remains for study on the assumption that it will have three limitations :

(a) for the values of A_k with small index;

(b) for the values of A_k with high index and small value;

(c) for the values of A_k with high index and large value.

Part (b). — The method to be recommended for the synthesis of networks is based upon the theory of inversion of the time series given in an article by Thomson (*Proceedings of the Institution of Electrical Engineers*, Volume 99, Part IV, p. 397, December, 1952) and in "*L'étude No. 257 T du Service des Recherches et du contrôle techniques de l'administration francaise* ".

In this theory the inversion of a series X is defined as the operation which produces a series Y such that the convolution of X and Y gives a " unit " series, that is to say only possessing one non-zero term.

It may be shown that this operation is identical to the inversion of the spectrum of the function represented by the series and that it is possible if this spectrum is not zero anywhere in the interval $(-f, +f)$ where $f = \frac{1}{2\tau}$.

This being so, the operation is not directly applicable to the series α_n given by the method of the French Administration. The spectrum should first be limited to that of $-f_u, +f_u$. The result of this limitation obviously restores the series β_n given directly by the method of the British Administration.

The inversion of this series gives the filtered impulse response, limited to $(-f_u, +f_u)$, of the network which corrects the distortion of the circuit in this band.

In practice, it is easy to provide this correcting network by means of a delay line on which taps are arranged adjustable at intervals separated by $\tau = \frac{1}{2f_u}$.

It is then possible to effect the inversion (or the correction) by the adjustment of the apparatus without calculation.

For this purpose use is made of a pulse generator $I(t)$ followed by a low-pass filter of cut-off frequency f_u and an oscilloscope.

The object is to obtain the same pulse shape on the oscilloscope by direct transmission and by transmission through the circuit followed by the correcting network (see Figures 1 and 2).

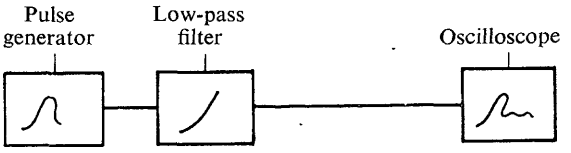


FIGURE 1

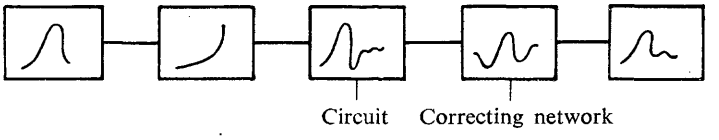


FIGURE 2

The presence of the low-pass filter of effective cut-off $f_u = \frac{1}{2\tau}$ is absolutely necessary but it is not important at what point in the circuit it is placed.

APPENDIX

(to Annex 1 to Question 26)

Calculation of the coefficients α_n

This calculation serves to solve the system of equations :

(1) $$r_n = \frac{1}{2}\alpha_{n-1} + \alpha_n + \frac{1}{2}\alpha_{n+1}$$

These equations have exact solutions when the following conditions are fulfilled :—

(2) $$\sum_n (-1)^n r_n = 0$$

(3) $$\sum_n (-1)^n n r_n = 0$$

These conditions indicate that the spectrum of the signal R_n, and also its derivative, is zero for the frequency $f_o = \frac{1}{2\tau}$.

They are in no way artificial and correspond to physical reality : the network studied should not specially favour the frequencies in the neighbourhood of $\frac{1}{2\tau}$ if it is desired to test it with the chosen pulse.

Therefore, the resolution of the system results in the following series of operations :—

(a) multiply the terms of the series r_n by $(-1)^n$

(b) form the series $b_n = \sum_0^n (-1)^p r_p$

(c) form the series $c_n = \sum_0^n b_p$

(d) multiply the terms of c_n by $(-1)^n$

Example.

Let the series

$$\overset{\tau}{\longleftrightarrow}$$

$$0 \quad 1 \quad 5 \quad 11 \quad 14 \quad 11 \quad 5 \quad 1 \quad 0$$

which represents the response of a network cutting off at $0{\cdot}75\, f_0$ to a cosine-squared pulse of half-amplitude $\frac{1}{f_0}$ and of spectrum from $(-f_0, +f_0)$ $\left(f_0 = \frac{1}{2\tau}\right)$

(a) multiply by $(-1)^n$

$$0 \quad \overline{1} \quad 5 \quad \overline{11} \quad 14 \quad \overline{11} \quad 5 \quad \overline{1} \quad 0$$

(b) form $b_n = \sum_0^n (-1)^p r_p$

$$0 \quad \overline{1} \quad 4 \quad \overline{7} \quad 7 \quad \overline{4} \quad 1 \quad 0$$

(c) form $c_n = \sum_0^n b_p$

$$0 \quad \overline{1} \quad 3 \quad \overline{4} \quad 3 \quad \overline{1} \quad 0$$

(d) multiply by $(-1)^n$

$$0 \quad 1 \quad 3 \quad 4 \quad 3 \quad 1 \quad 0$$

The check is immediate and gives the following table.

$$\underbrace{0\ 1} \quad \underbrace{3} \quad \underbrace{4} \quad \underbrace{3} \quad \underbrace{1} \quad \underbrace{0}$$

$$\underbrace{0\ 1}_{1} \quad \underbrace{4}_{5} \quad \underbrace{7}_{11} \quad \underbrace{7}_{14} \quad \underbrace{4}_{11} \quad \underbrace{1}_{5} \quad \underbrace{0}_{1}$$

ANNEX 2

(to Question 26 of Study Group 1)

Reply by the French Administration in 1955/1956, to Question 17 of C.C.I.F. Study Group 3

The wording of Question 17*a* seems a little overambitious, in view of present studies of the synthesis of delay-line networks. The most one can do is to urge that a full bibliography on the subject be compiled.

We can reply only to Question 17*b*, the scope of which should, we feel, be restricted. We ourselves shall consider only the following problem, which is no more than a part of Question 17*b*. It is set forth in terms which make use of the concepts and notations introduced in Annex 2 to Question 27 (to which kindly refer).

" Given the generating function $Q(z) = \Sigma\, a_n\, z^n$ characterizing a circuit in the $(-f_o, +f_o)$ band, how can the generating function $\Sigma\, b_n\, z^n$ of a network correcting the distortions of this circuit be calculated ? ".

The French Administration proposes, if $\Sigma\, a_n\, z^n$ is a polynomial, to put

$$Q(z) = \Sigma\, a_n\, z^n = Q_1(z)\ Q_2(z)$$

$Q_1\ (z)$ admitting only zeros with moduli greater than 1, and $Q_2\ (z)$ admitting only zeros with moduli less than 1;

Then to form the quotients

$$\frac{1}{Q_1\ (z)} \quad \text{and} \quad \frac{1}{Q_2\ (z)}$$

the first arranged in increasing powers of z and the second in decreasing powers.

The existence of zeros with moduli equal to 1 would mean that in $Q\ (z)$ certain frequencies between $-f_o$ and $+f_o$ would be absent. In this case distortion compensation would be essentially impossible.

A detailed article justifying the methods of calculation applied in Annex 2 for Questions 26 and 27 will be published in the near future. The note below further explains the standpoint given above.

Calculation of correcting networks.

A correcting network is calculated in the following way :

A signal is available which is defined by a series

$$a\ (z^2)$$

with intervals of $\frac{1}{2\,f_0}$. The spectrum of this signal is assumed to be included in its entirety in the interval $(-f_0, +f_0)$. It is desired to transform this signal into a signal defined by the series $b\ (z^2)$. For this purpose a network is available whose transmission factor is a polynomial $k\ (z^2)$ of which the coefficients may be varied. Putting $z^2 = Z$, the following equality will have to be fulfilled :

$$k\ (Z) = \frac{b\ (Z)}{a\ (Z)}\ Z^m$$

m being an exponent, making allowances for the fact that correction may require some delay.

$k\ (Z)$ may be calculated by dividing $b(Z)$ by $a(Z)$ and by retaining the first terms of the series obtained. There may be some difficulties as regards convergence of the quotient series, and to avoid them the French Administration proposes in its reply given above to split up $a(Z)$ into the product of two factors :

$$a\ (Z) = a_1\ (Z)\ a_2\ (Z)$$

a_1 admitting only roots with moduli > 1 and $a_2\ (Z)$ admitting only roots with moduli < 1. The French Administration then proposes that the expansions of

$$\frac{1}{a_1\ (Z)} \ , \ \frac{1}{a_2\ (Z)}$$

should be calculated, the first being arranged in rising powers of Z and the second in falling powers, proceeding after this to the product :

$$b\ (Z)\ \frac{1}{a_1\ (Z)}\ \frac{1}{a_2\ (Z)}$$

This procedure ensures convergence of the calculations.

The procedure is at fault only for roots of a (Z) having a modulus equal to 1. This case would hardly ever arise, for it would mean that one of the frequencies in the $(-f_0, +f_0)$ band was absent from the signal $a\ (Z)$. Equaliatzion is then essentially impossible, unless it be admitted that this frequency is likewise absent from $b\ (Z)$; the relation $\frac{b\ (Z)}{a\ (Z)}$ is then simplified by the factor corresponding to this frequency.

ANNEX 3

(to Question 26 of Study Group 1)

Reply by the U.K. Administration, in 1955/1956, to Question 17 of C.C.I.F. Study Group 3

(a) As far as the time-series approach is concerned, the method used in the United Kingdom has been fully described in items **[31]** and **[37]** of the bibliography on the subject (*Book of Annexes* to Volume III of the *Green Book*, page 85). For the 405-line television system, the nominal upper frequency of interest is 3 Mc/s, and the time-series interval is accordingly taken as 1/6 microsec.

(b) Referring to another kind of network synthesis, it may be of interest to mention that, for short-distance video circuits on coaxial or balanced-pair cables, the United Kingdom Administration is now designing precise waveform-correctors without recourse to steady-state measurements. In general, these correctors yield substantially better circuits, as judged on a waveform basis, than do conventional attenuation (and phase) equalizers. The basic principle is similar to that of the less precise waveform method which has been used for temporary outside-broadcast circuits for many years. A full description will be submitted in due course.

Question 27.

(Sub-Group 1/4, then Study Group 1, in co-operation with the C.C.I.R., I.B.O. and E.B.U.)

(continuation of Question 18 of C.C.I.F. Study Group 3, 1955/56)

When an international television circuit consists of several links belonging to countries having perhaps different standards of definition, the study of each of these sections in the transitory state should be made, for the respective needs of the countries to which they belong on the basis of one or more types of signal of the so-called " raised cosine type ".

(a) Is it possible to recommend the highest useful frequencies of these test waveforms and for the time-series intervals to be adopted in the analysis of the corresponding response curves, one or more groups of values such that the quality of the circuit for the type of transmission expected can be deduced sufficiently accurately for practical needs for the results of the study of each of the links ?

(b) In the affirmative, what method of synthesis should be recommended for combining these results in order to deduce the overall characteristics of the circuit for the transmissions envisaged ?

(c) In the negative, what supplementary tests should be made ?

Note. — Annex 1 gives a few preliminary considerations on this matter. Annexes 2 and 3 reproduce the replies sent during 1955 and 1956 by the French and United Kingdom Administrations to Question 18 of C.C.I.F. Study Groups 3.

ANNEX 1

(to Question 27 of Study Group 1)

Reply of the French Administration to Question 17 of C.C.I.F. Study Group 3, in September, 1954

From the individual responses of two linear networks to the same signal, it is possible to determine the response, to the same signal, of the tandem connection of the two networks.

When the signal considered has a limited frequency spectrum and does not contain any frequency exceeding f_0, the above operation may be performed by means of the ordinates obtained from analysis of the signal and the responses taken with a maximum spacing of $\frac{1}{2} f_0$.

With reference to the testing of television circuits by a test signal, and the combination of the test results of the different links of an international circuit, by the rules inspired by the methods outlined above, the French Administration recommends :—

1. One of the test signals should be a sine-squared (raised cosine) pulse having a half-amplitude duration equal to a half-cycle of f_u, the upper frequency of the band tested (e.g. 3 Mc/s for the British 405-line system). In the tests discussed in the Question above, the precise form of the signal is of secondary importance, because allowance may be made for the imperfections of the generator by an appropriate correction of the time series representing the transmission performance of a link. It should be noted that the imperfections of the signal used must be avoided as far as possible, in order not to unnecessarily complicate the calculations, and particularly in order to prevent the spectrum of the signal used speading beyond the spectrum of the theoretical sine-squared pulse, conditions which would spoil the selection proposed in 2 below.

2. The response of a link to the proposed test signal will be measured by selecting ordinates at intervals not greater than $\frac{1}{4} f_u$. When, in accordance with 3, the object of the calculation will be to define the response in the band $(-f_u, +f_u)$, the interval should be $\frac{1}{4} f_u$. When an Administration having a link defined by f_u has to put this link at the disposal of an Administration which uses only a band $f'_u < f_u$, the first Administration, always using a test signal corresponding to f_u, i.e. suitable for its own link, would be advised to take an interval which may be smaller than $\frac{1}{4} f_u$ and which at the same time is an integral sub-multiple of $\frac{1}{4} f'_u$, in a way which will facilitate the transformations described in 5.

In certain cases listed below in 5, however, the test signal corresponding to f_u may in practice give insufficient information in the band f'_u.

3. The calculation beginning with a series of interval $\frac{1}{4} f_u$, as mentioned in 2, will lead by means ot the now classical methods of calculation to a time series of interval $\frac{1}{2} f_u$, which will express the quality of a circuit by methods which are being studied.

4. The choice of the frequency f_u for the 625 and 819-line systems is left to the competent authorities; it is probable that for the 625-line system, the choice will be 5 Mc/s.

5. The method recommended for combining the relative results of the different links of an international television circuit passing through countries which will eventually have different standards, is still under study. It is to be hoped that each Administration will make known the value of the frequency f_u appropriate to its own circuits, so that the intervals mentioned in 2 may be known when an Administration tests one of these circuits. A single test, yielding several intervals should thus satisfy not only national but also international requirements.

For such international television circuits, practical considerations may make it necessary to proceed with these tests on the overall circuit and on the national links using only one test signal, which would be the signal adopted, in the sense specified in 1, to the band of frequencies corresponding to the definition to be transmitted.

For this reason the French Administration has proposed the new question, the text of which is given above.

ANNEX 2

(to Question 27 of Study Group 1)

Reply by the French Administration, in 1955/1956, to Question 18 of C.C.I.F. Study Group 3

(a) To test a circuit in the frequency band $(-f_0, +f_0)$ it is necessary to have a test signal with a limited spectrum which will cover the band $(-f_0, +f_0)$. To be more precise, the spectrum of the test signal :

(1) is never nil in the range $(-f_0, +f_0)$;

(2) is nil outside a certain interval $(-f_1, +f_1)$ with $f_1 > f_0$.

An analysis is made of the response curve with an interval of $\frac{1}{2F}$, where $F < \frac{f_0 + f_1}{2}$.

The raised cosine signal in Figure 1 opposite fulfils these conditions. Its half-amplitude width is $\frac{1}{2f_0}$. Its spectrum is to all intents and purposes contained in the band $(-3f_0, +3f_0)$

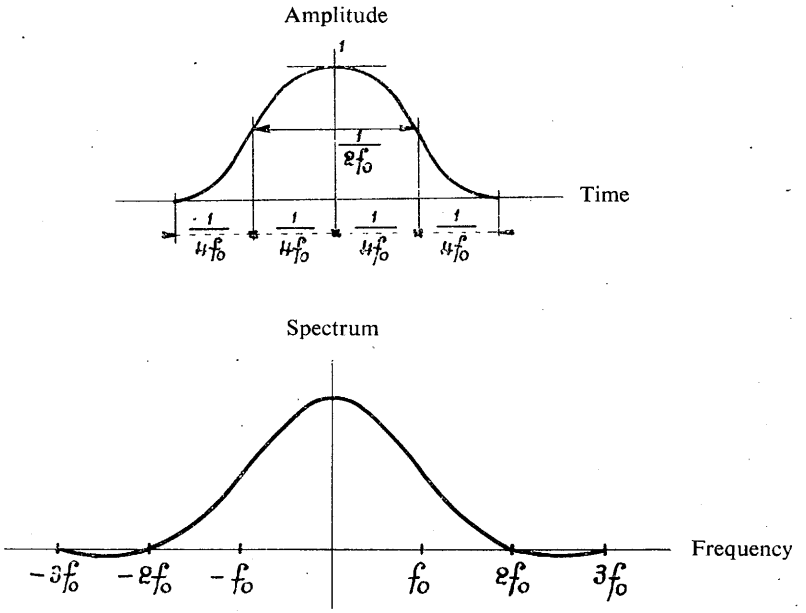


FIGURE 1

The signal received, which is compared with the test signal in order to test the circuit, must be analyzed by selecting ordinates at instants in arithmetical progression at a rate not greater than $\frac{1}{2f}$, f being the arithmetical mean of frequencies f_0 and f_1 or $2f_0$. We shall call the operation of selecting ordinates from a signal at regular intervals by the name of " sampling ".

Using the above definitions, the French Administration proposes to choose

(1) the band $(-f_1, +f_1)$, triple the band $(-f_0, +f_0)$,

(2) the sampling interval of the received signal equal to $\frac{1}{4f_0}$.

(3) the test signal (raised cosine) defined by the instantaneous values $\frac{1}{2}$, 1, $\frac{1}{2}$ at intervals of $\frac{1}{4 f_0}$ i.e., a signal which has a half-amplitude width of $\frac{1}{2 f_0}$.

In the study of a circuit containing links with different bandwidths, a test of the whole will be made by a test signal as defined above, taking for f_0 the cut-off frequency of the section with the lowest cut-off frequency.

The foregoing is the French proposal for the choice of a test signal for a circuit composed of one or several links. The following proposals concern the interpretation of the response to this test signal.

To make precise proposals, it seems necessary to introduce the notion of " generating unction " of a signal. This will be the function :

$$P(z) = \ldots + \frac{u_{-2}}{z^2} + \frac{u_{-1}}{z} + u_0 + u_1 z + u_2 z^2 + \ldots = \Sigma u_n z^n$$

The coefficients u_n are instantaneous signal values with intervals of $\frac{1}{4 f_0}$, the time origin being close to the instant when the signal reaches its maximum, the instantaneous values measured being given a suitable coefficient so that the maximum ordinate will be close to unity.

The generating function of the proposed test signal is

$$I(z) = \frac{1}{2z} + 1 + \frac{z}{2}$$

Similarly, we shall call $Q(z)$ the generating function of the filtered pulse response or the series

$$Q(z) = \ldots + \frac{V_{-2}}{z^2} + \frac{V_{-1}}{z} + V_0 + V_1 z + V_2 z^2 + \ldots$$

of which the coefficients are the instantaneous values, with intervals of $\frac{1}{4 f_0}$, of the signal received, if the signal transmitted is not the test signal $I(z)$ but the filtered Dirac pulse whose instantaneous values are given as a function of time by the expression

$$\frac{\sin 2\pi f_0 t}{2\pi f_0 t}$$

where t takes consecutive value at intervals of $\frac{1}{4 f_0}$.

It is proposed to define the circuit by the function $Q(z)$. It is then necessary to deduce $Q(z)$, obtained by applying a theoretical test signal (the filtered Dirac pulse), from the function $P(z)$, obtained by applying the standardised real signal $I(z)$ (raised cosine).

Now, theory shows that the series $Q(z)$ is deduced from the series $P(z)$ by multiplication of a series $R(z)$

$$R(z) = \ldots + \frac{w_{-2}}{z^2} + \frac{w_{-1}}{z} + w_0 + w_1 z + w_2 z^2 + \ldots$$

of which the coefficients (to the nearest factor) depend only on the shape of the test signal. If this test signal is $I(z)$, these coefficients have well determined numerical values. Calculation gives

$$R(z) = \frac{\frac{2}{\pi} \operatorname{arc\,tg} \frac{1}{3} + 1 + \frac{2}{\pi} \operatorname{arc\,tg} z}{\frac{1}{2z} + 1 + \frac{z}{2}}$$

The transmission characteristics of the circuit are then defined by the ν coefficients of the function $Q(z)$. As has already been pointed out by the United Kingdom Administration, these coefficients are not independent, so that either of the series

$$\ldots + \frac{V_{-4}}{z^4} + \frac{V_{-2}}{z^2} + V_0 + V_2 z^2 + V_4 z^4 + \ldots$$

$$\ldots + \frac{V_{-3}}{z^3} + \frac{V_{-1}}{z} + V_1 z + V_3 z^3 + \ldots$$

may serve entirely to characterize the circuit. The French Administration continues to advise its technicians to use the full series $Q(z)$, but nevertheless agrees to make do with a partial series having intervals of $\frac{1}{2f_0}$ to characterize circuits measured by another Administration.

One last remark. When the testing pulse is shorter than the pulse proposed (half-amplitude width : $\frac{1}{2f_0}$), another form of $R(z)$ must be used. The French Administration therefore asks that this search for $R(z)$ should be studied, that tables of the various forms of $R(z)$ that may arise in practice should be prepared, and that these tables should be published in the C.C.I.F. *Green Book*.

(b) This question relates to the composition of two successive links. If they both have the same bandwidth, and are defined respectively $Q_I(z)$ and $Q_{II}(z)$ in accordance with the preceding definitions, then the circuit thus made up will be defined by the function

$\frac{1}{2} Q_I(z)\ Q_{II}(z)$, if we keep the interval $\frac{1}{4f_0}$ or by the product $P_I(z)\ P_{II}(z)$ if we are satisfied with the interval $\frac{1}{2f_0}$, $P_I(z)$ and $P_{II}(z)$ being respectively the even parts of Q_I and Q_{II}.

More precisely, if p and i are the even and odd parts of Q, we shall have :

$$Q_I(z) = p_I(z) + i_I(z)$$
$$Q_{II}(z) = p_{II}(z) + i_{II}(z)$$

$Q(z) = p(z) + i(z)$ being the function defining the circuit thus made up, we obtain :

$$P(z) = p_I(z)\ p_{II}(z) = i_I(z)\ i_{II}(z)$$
$$i(z) = p_I(z)\ i_{II}(z) = p_{II}(z)\ i_I(z)$$

It will be seen that the formula

$$Q(z) = \frac{1}{2} Q_I(z)\ Q_{II}(z)$$

enables us to calculate slightly more precisely than the formula :

$$p(z) = p_I(z)\ p_{II}(z)$$

and can be used for useful verifications, for instance :

$$p_I\ p_{II} = i_I\ i_{II}$$
$$p_I\ i_{II} = p_{II}\ i_I$$

If the links have two different bandwidths, the French Administration asks for a study of the transformation of $Q_1(z_1)$, the generating function relative to $\frac{1}{4f_1}$, into $Q_0(z_0)$, the generating function relative to $\frac{1}{4f_0}$ $(f_0 < f_1)$. Whence we shall obtain :

$$Q_0(z_0) = Q_1(z_1) = Q_1[z_1(z_0)]$$

where $z_1(z_0)$ is a z_0 series which has to be normalized for a number of values of the ratio $\frac{f_0}{f_1}$.

ANNEX 3

(to Question 27 of Study Group 1)

Reply from the United Kingdom Administration, 1955/1956, to Question 18 of C.C.I.F. Study Group 3

Given the time series which represents the filtered impulse response of a television link up to a specified cut-off frequency (e.g. 10 Mc/s), it is possible by known interpolation and filtration processes to compute the time series which represents the filtered impulse response of the link up to any lower cut-off frequency (e.g. 3 or 5 Mc/s).

The question appears to be somewhat academic, however, because it is considered that the ability of a link to transmit television signals of any particular standard should be measured with the test signals appropriate to that standard, if accurate results are desired.

Question 28.

(Sub-Group 1/1, in co-operation with Sub-Group 1/4, then with Study Group 1)

(continuation of Questions 19, 19 bis, *and 19* ter *of C.C.I.F. Study Group 3, studied in 1955/56) (documentary question)*

Wat methods of waveform measurement best shown up the regularity of factory lengths of coaxial pairs intended for television transmissions, and also the regularity of a repeater section of coaxial cable for television transmission ?

Note. — There already exists a C.C.I.F. recommendation relating to measurements of impedance regularity of these coaxial pairs using pulse methods (see Annex 1). Other methods are described in Annexes 2 and 3 below.

ANNEX 1

(to Question 28 of Study Group 1)

Recommendation by the C.C.I.F. XVIIIth Plenary Assembly. Impedance Regularity in standardized coaxial pairs

(a) Impedance regularity in a factory length.

The measurements of impedance regularity are made by pulses applied to the coaxial pair, the echo being observed at the sending end.

Measurements may be made from one or both ends of a factory-length, and the pulse used should be of approximately sine-squared shape, with a half-amplitude duration of less than 0·1 microseconds. The results are expressed in echo-attenuation. Echo-attenuation relative

to a peak of the response curve is defined as the logarithmic ratio (in decibels or nepers) of the amplitude of the transmitted pulse to that of the peak being considered.

The echo-attenuation corresponding to the maximum peak on the echo curve on a factory-length must not be less than :

50 db or 5·8 *N* for all coaxial pairs,
54 db or 6·2 *N* for at least 95% of the coaxial pairs tested.

Furthermore, less than 20% of the cable lengths constituting a repeater section should contain one or more coaxial pairs having echo-attenuations between the values 50 and 54 db (5·8 to 6·2 *N*).

Moreover, it should be confirmed that one of the two following conditions is complied with :

1. The arithmetic mean of the three smallest echo-attenuations relating to a coaxial pair is at least equal to 55 db or 6·3 *N*;

2. The equivalent deviation does not exceed 0·6 ohms for lengths of less than 300 metres, and 0·8 ohms for lengths equal to or greater than 300 metres. Equivalent deviation is defined as the value of a single series resistive irregularity which, at the sending end, would produce the same reflected energy as the aggregate of irregularities of the coaxial pair being measured.

(b) Impedance regularity of a repeater section.

The impedance regularity of a repeater section may be checked either by steady-state measurements or by pulse measurements.

(*b* 1) *Steady-state measurements.* — At each end of a repeater section, the impedance over the transmission frequency-range is measured, the distant end being terminated by an impedance such that no appreciable reflection is produced.

A curve is drawn with frequency as abscissa and the resistive component of the impedance measured at the appropriate frequency as ordinate.

This curve will have undulations and a smooth curve is drawn through it. For all types of coaxial pairs used for telephony, the difference between the measured curve and the smooth curve should not exceed 3%.

For coaxial pairs used for television transmission the frequency band considered should extend at least from 0·5 to 6·2 Mc/s for 405 and 625-line systems on coaxial cables with 9·km repeater spacing, but Administrations may wish to make tests at higher frequencies in anticipation of the further utilization of coaxial cables. The limits to be recommended for the results of such tests are left for study by the C.C.I.T.T.

(*b*. 2) *Pulse tests.* — These tests should be made from each end of the repeater section with a pulse having a shape approximating to a sines-quared function. Its half-amplitude duration should be less than 0·2 microsecond.

Results of these tests will be expressed as echo-attenuation. Echo-attenuation, relative to a peak of the response curve, is defined as the logarithmic ratio (in decibels or in nepers) between the amplitude of the sent pulse and that of the peak under consideration.

The effect of the distortion undergone by the pulse during transmission over a cable can be corrected either by calculation, or by automatic or manual correction using networks.

The measured results should comply with the following limits, whether the coaxial pairs are used for telephony or for television.

1. After correction of the distortion introduced by the coaxial pair, the echo-attenuation corresponding to the greatest reflected pulse must not be less than 48 db (5·5 N).

2. Furthermore, one or other of the following clauses 2·1 or 2·2 should be adhered to :

2.1 The echo-attenuation corresponding to the greatest reflected pulse, without correction, must not be less than 54 db (6·2 *N*).

The echo-attenuation corresponding to the r.m.s. of the amplitudes of the three largest reflected pulses must not be less than 51 db (5·9 *N*) after correction.

2.2 The equivalent deviation without correction must not exceed 1 ohm.

Equivalent deviation is defined as the value of a single series resistive irregularity which, at the sending end, would produce the same reflected energy as the aggregate of irregularities of the coaxial pair being considered.

Where energy correction is applied, the equivalent deviation should be related to one kilometer of cable by dividing the measured value by $\sqrt{L}$, L being the length in kilometers of the half repeater-section under consideration. This deviation related to one kilometer must be less than 0·8 ohm.

Note. — The impedance of coaxial-pair cables produced by modern methods of manufacture is normally sufficiently uniform to ensure that values approaching the above limits are seldom encountered. However, if a certain number of repeater sections produced reflections approaching these limits, the transmission over a complete 2,500 km circuit would possibly be unsatisfactory.

ANNEX 2

(to Question 28 of Study Group 1)

Normalization of pulse tails on coaxial cables transmitting television,
by V. M. Stein

(Note submitted by the Administration of the U.S.S.R.)

1. *Assessment of the quality of factory lengths of coaxial cable.*

At present, the pulse method is chiefly used for measuring factory lengths of coaxial cable intended for television transmissions. The quality of the factory lengths is determined by the maximum lobes of the pulse characteristics. The method takes no account of the power and structure of the reflected signal.

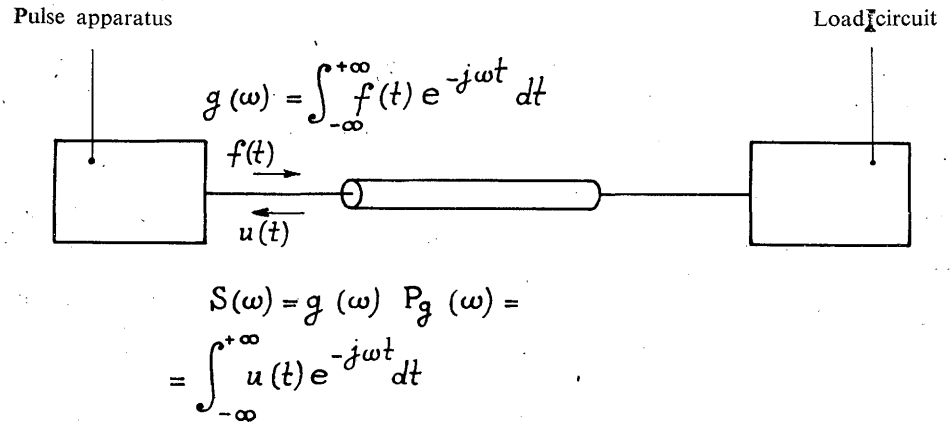


FIGURE 1

G. Fuchs [1] has proposed measuring a certain function $R(\tau)$ of the pulse characteristic

$$R(\tau) = \int_0^T U(t)\, U(t+\tau)\, \mathrm{d}t \qquad (1)$$

The value $R(0)$ determines the power of the reflected signal and the nature of the function $R(\tau)$ leads to interesting conclusions on the statistical properties of cable irregularities (*).

However, it would be reasonable to assess the quality of factory lengths, not by time characteristics but by spectrum characteristics.

The fact is that the characteristics of the channel units components (parameters of the cable, reflection coefficients at the ends of a repeater section, characteristics of terminal equipment) are much easier to express by spectrum than by time characteristics. Further, the operation of spectrum multiplication corresponds to a much more complicated operation (convolution) when time characteristics have to be combined. The author's experience has shown that the quality of factory lengths is determined by means of the weighted energy of a reflected signal.

It can be shown that the Fourier transform of the function $R(\tau)$

$$\left| S(\omega) \right|^2 = \int_{-\infty}^{+\infty} R(\tau) \cos \omega \tau \, \mathrm{d}\tau \qquad (2)$$

is the square of the modulus of the spectrum of a reflected signal.

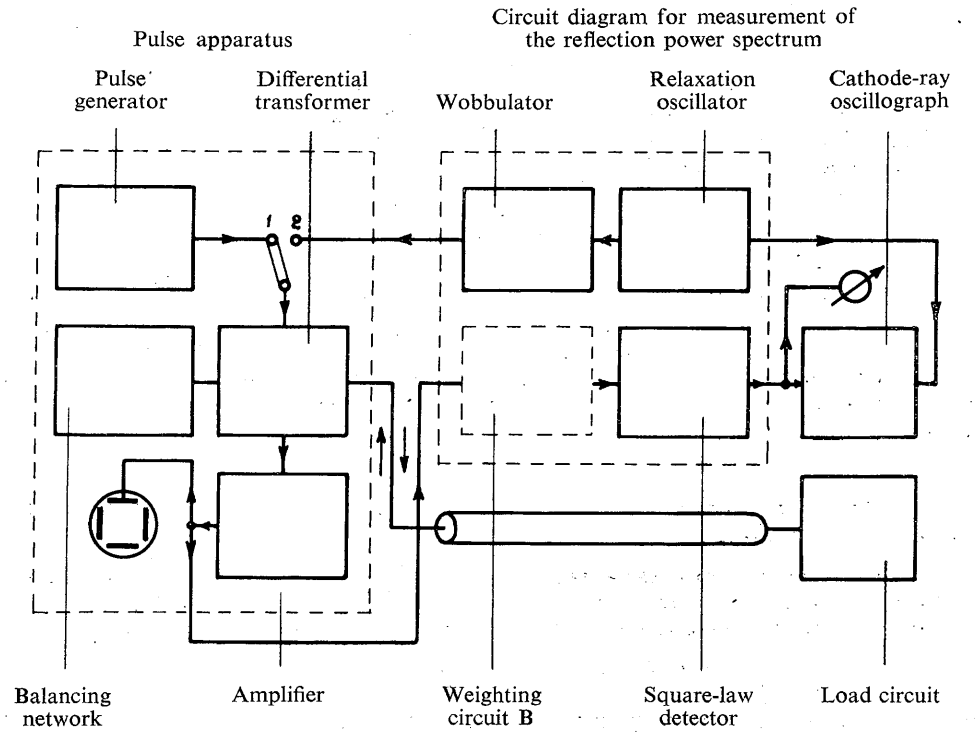


FIGURE 2

* Analysis of the mean function $R(\tau)$ reveals the hidden periods of occurrence of irregularities. Determination of these periods and comparison with the duration of the special technological operations makes it possible to detect which manufacturing processes give rise to the appearance of irregularities and to take action to remedy the defects.

The quotient

$$| P_g (\omega) |^2 = \frac{| S (\omega) |^2}{| g (\omega) |^2} \tag{3}$$

where $g (\omega)$ is the spectrum of a direct pulse $f(t)$ which determines the power spectrum of reflection of a factory length (see Figure 1).

The spectrum $P_g (\omega)$ can also be expressed by the deviation of the input impedance from the characteristic impedance

$$P_g (\omega) = \frac{Z_{BX} (\omega) - Z (\omega)}{Z_{BX} (\omega) + Z (\omega)} \tag{4}$$

Here $Z_{BX} (\omega)$ is the input impedance of the factory length for a matched output impedance and $Z (\omega)$ is the characteristic impedance at the origin of the factory length.

It has proved useful to complete the measurements of the pulse characteristics $U (t)$ by measurements of the reflection power spectra. For this purpose, a measuring set was built according to the diagram given in Figure 2.

Measurements of a factory length are made with the switch in position 1. The balancing network is adjusted and the characteristic impedance from one end of the cable is determined. The switch is then placed in position 2 and the pulse generator is replaced by a wobbulator. A square-law detector is inserted in the output of the receiving amplifier and it is followed by a cathode-ray oscillograph. The display shows the power spectrum $| P_g (\omega) |^2$.

A magneto-electric meter in the detector circuit determines the power of the reflected signal

$$\int_{\omega_1}^{\omega_2} | P_g (\omega) |^2 \, d\omega$$

Here ω_1 and ω_2 are the angular frequencies corresponding respectively to the upper and lower frequencies of the wobbulator. It is possible to insert a weighting network and to measure the weighted power of the reflected signal

$$\int_{\omega_1}^{\omega_2} | P_g (\omega) |^2 \, | B (\omega)|^2 \, d\omega \tag{5}$$

where $B (\omega)$ is the transmission factor of the weighting network.

In this way a single value can suffice for the assessment of the quality of a factory length.

When the mean reflection power spectrum $| P_g (\omega) |^2$ is known from measurement results, together with certain statistical properties of the characteristic impedances at the ends of the factory lengths, the statistical characteristics of the pulse tails on the television line can be determined.

II. *Determination of the components of the pulse tail frequency spectrum from measurements of factory lengths* **[2]**.

The pulse tail in the coaxial cable leads to small random variations in the transmission factor of the television channel. In this case, the transmission factor contains a factor $[1 + Q (\omega)]$, where $Q (\omega)$ is the frequency spectrum of the pulse tail. If $| Q (\omega | \ll 1$,

$$1 + Q (\omega) \approx \exp [R_e \, Q (\omega) + j \, I_m \, Q (\omega)] \tag{6}$$

that is, the real part of $Q (\omega)$ determines the deviations of the attenuation characteristic of the channel and the imaginary part of $Q (\omega)$ defines the deviations of the phase-shift characteristic. Further, with $| Q (\omega) | \ll 1$,

$$Q (\omega) \approx \sum_{i=1}^{i=m} q_i (\omega), \tag{7}$$

where $q_i (\omega)$ is the frequency spectrum of the pulse tails of the ith repeater section and m is the number of repeater sections.

It is reasonable to examine two components of the frequency spectrum of the pulse tails, $\overline{Q(\omega)}$ and $[Q(\omega) - \overline{Q(\omega)}]$.

It is obvious that
$$\overline{Q(\omega)} = \sum_{i=1}^{i=m} \overline{q_i(\omega)} \tag{8}$$

$$\overline{|Q(\omega) - \overline{Q(\omega)}|^2} = \sum_{i=1}^{i=m} \overline{|q_i(\omega) - \overline{q_i(\omega)}|^2} \tag{9}$$

and
$$\overline{|Q(\omega)|^2} = \overline{|Q(\omega) - \overline{Q(\omega)}|^2} + |\overline{Q(\omega)}|^2 \tag{10}$$

The mean frequency spectrum of the pulse tails $\overline{Q(\omega)}$ determines the mean deviation of the channel transmission factor due to pulse tails and the second-order absolute central moment $\overline{|Q(\omega) - \overline{Q(\omega)}|^2}$ determines the spread of the transmission factor around its mean value.

(a) The mean frequency spectrum of the pulse tails.

Some of the components of the mean frequency spectrum of pulse tails differ from zero.

The first component $\overline{Q_{cc}(\omega)}$, caused by pulse tails due to joints between the factory lengths, differs from zero for the following reasons :

1. The characteristic impedances at the ends of a factory length generally have random correlated values. The correlation rate is expressed by

$$r = \frac{\sigma_1^2 - \sigma_2^2}{\sigma_1^2} \tag{11}$$

where σ_1^2, is the spread of the characteristic impedances at the ends of the factory lengths and σ_2^2 is the spread of the difference between the characteristic impedances at the ends of a factory length which may be determined from pulse measurements of those impedances, from the ends of the factory lengths. With $r \neq 0$, the mean value of the product of the reflection coefficients of two neighbouring joints is not nil.

2. The characteristic impedance of the sleeve joining two successive factory lengths systematically differs from the average characteristic impedance of the cable. The effect of the jointing sleeve is equivalent to that of a small inductance L connected in series between the factory lengths (or a small capacity C in parallel). With $\overline{L} \neq 0$, there is a component which differs from zero in the mean frequency spectrum, due to pulse tails arising from the jointing sleeves.

The mean frequency spectrum of the pulse tails arising from joints in factory lengths due to two causes is determined by

$$Q_{cc}(\omega) = \frac{m(n-2)}{4 Z_0^2} r \sigma_1^2 e^{-2\gamma(\omega)l} - \frac{m \omega^2 (L)^2}{4 Z_0^2} \sum_{k=1}^{k=n-2} (n-k-1) e^{-2\gamma(\omega)kl} \tag{12}$$

Here n is the average number of factory lengths in the repeater section,

Z_0 is the mean characteristic impedance of the cable,

$\gamma(\omega) = \beta(\omega) + j\alpha(\omega)$ is the propagation constant at angular velocity ω and

l is the size of a factory length.

The effect of this component can be reduced by decreasing $r\sigma_l^2$ and $\overline{L}$. If l is a random variable, the pulse tail corresponding to the spectrum $Q_{cc}(\omega)$ can be attenuated by increasing the spread of l*.

The second component of the mean frequency spectrum $\overline{Q_{cy}(\omega)}$ due to pulse tails in the jointing sleeves and at the ends of the repeater section, is more important; it is given by

$$Q_{cy}(\omega) = \frac{j\,m\,\omega\,l}{2\,Z_0}\left[P'_y(\omega) + P''_y(\omega)\right]\sum_{k=1}^{k=n-2} e^{-2\gamma k l} \tag{13}$$

Here $P'_y(\omega)$ and $P''_y(\omega)$ are reflection coefficients at the ends of the repeater section due to mismatching between the repeater output impedance and the impedance of the cable.

The effect of this component (the most important) of the mean frequency spectrum can be practically reduced to zero whenever the sizes of the first and last factory lengths of the repeater section are random variables with regular distribution in the interval 0, l.

Lastly, there is still one component of the mean frequency spectrum of the pulse tails $\overline{Q_g(\omega)}$ due to correlation between the characteristic impedances in neighbouring points of a factory length. It may be said that

$$\overline{R_e\,Q_g(\omega)} \approx -\frac{m\,n\,\overline{|P_g(\omega)|^2}}{2\,e^{-2\beta(\omega)\,l}} \tag{14}$$

However, this component of the mean frequency spectrum is of subsidiary importance because of the slight delay of the echo and because slow variations in the frequency characteristics are offset when the channel is balanced.

(b) Second-order absolute central moment of the pulse tail spectrum.

The second-order absolute central moment of the pulse tail spectrum $|Q(\omega) - \overline{Q(\omega)}|^2$ is determined essentially by the pulse tails due to irregularities in the cable and at the ends of the repeater sections. It may be said that

$$\overline{|Q(\omega) - \overline{Q(\omega)}|^2} \approx \overline{|Q_{gy}(\omega) - \overline{Q_{gy}(\omega)}|^2} + \overline{|Q_{cy}(\omega) - \overline{Q_{cy}(\omega)}|^2} \tag{15}$$

where $Q_{gy}(\omega)$ is the pulse tail spectrum due to irregularities in the factory lengths and at the ends of the repeater sections and $Q_{cy}(\omega)$ is the frequency spectrum of the pulse tails due to joints in the factory length and at the ends of the repeater sections. Numerous other terms can be ignored. We have :

$$\overline{|Q_{gy}(\omega) - \overline{Q_{gy}(\omega)}|^2} \approx m\,\frac{|P'_y(\omega)|^2 + |P''_y(\omega)|^2}{1 - e^{-\gamma\beta(\omega)\,l}}\,\overline{|P_g(\omega)|^2} \tag{16}$$

---

* If the random variable l is normally distributed, the attenuation of the pulse tail is equivalent to the increase in attenuation of

$$\Delta\beta = \frac{\omega^2\,\overline{(l-\bar{l})^2}}{V^2\,\bar{l}}$$

where V is the speed of propagation.

The second term on the right-hand side of equation (15), when all the factory lengths are of the same size l, is equal to

$$\overline{|Q_{cy}(\omega) - \overline{Q_{cy}(\omega)}|^2} = \frac{m(|P'_y(\omega)|^2 + |P''_y(\omega)|^2)\, e^{-\gamma\beta(\omega)l}}{4Z_o^2(1 - e^{-\gamma\beta(\omega)l})} \times \times \left[2\sigma_1^2 + \omega^2\overline{(L-\overline{L})^2} - 2r\sigma_1^2 e^{-2\beta(\omega)l}\cos 2\alpha(\omega)l\right] \quad (17)$$

Reduction of $\overline{|Q(\omega) - Q(\omega)|^2}$ can be obtained by improving the quality of the factory lengths and joints and by decreasing the reflection coefficients at the ends of a repeater section $|P'_y(\omega)|$ and $|P''_y(\omega)|$. It is then reasonable to normalize the sum of the squares $[|P'_y(\omega)|^2 + |P''_y(\omega)|^2]$ and not the product $|P'_y(\omega)P''_y(\omega)|$, as the pulse tails due to the ends of a repeater section are so small as to be negligible.

III. *Simulation of pulse tails in coaxial cables* [3].

So far, the question of the permissible value of pulse tails has not been considered from the standpoint of television picture quality. Information on the effect of one or more echoes cannot be used, since pulse tails are a complicated random phenomenon which cannot be simulated by one or more echoes.

The present section examines the question of forming an artificial pulse tail equivalent in statistical characteristics to a real pulse tail.

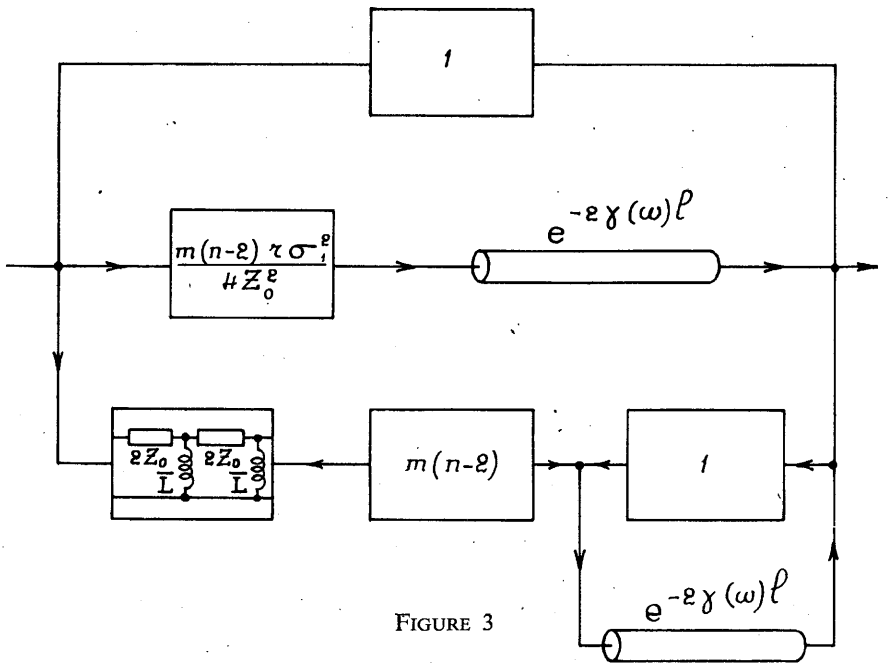


FIGURE 3

(a) Simulation of the pulse tail mean frequency spectrum.

Figure 3 shows the block schematic of the device, of which the transmission factor is equal to $1 + \overline{Q_{cy}(\omega)}$, where $\overline{Q_{cy}(\omega)}$ is the mean frequency spectrum of the pulse tails due to the ends of the repeater section and the joints in the factory lengths (formula 13). It is assumed that the transmission factors of circuits in parallel can be added and those of series circuits multiplied.

The multiplier

$$\sum_{k=1}^{k=n-2} e^{-2\gamma(\omega)kl} \approx \sum_{k=1}^{\infty} e^{-2\gamma(\omega)kl} = \frac{e^{-2\gamma(\omega)l}}{1-e^{-2\gamma(\omega)l}} \tag{18}$$

is simulated by means of an amplifier with a gain factor of 1, in the feedback circuit of which is inserted a cable section of length 2 l or an artificial line.

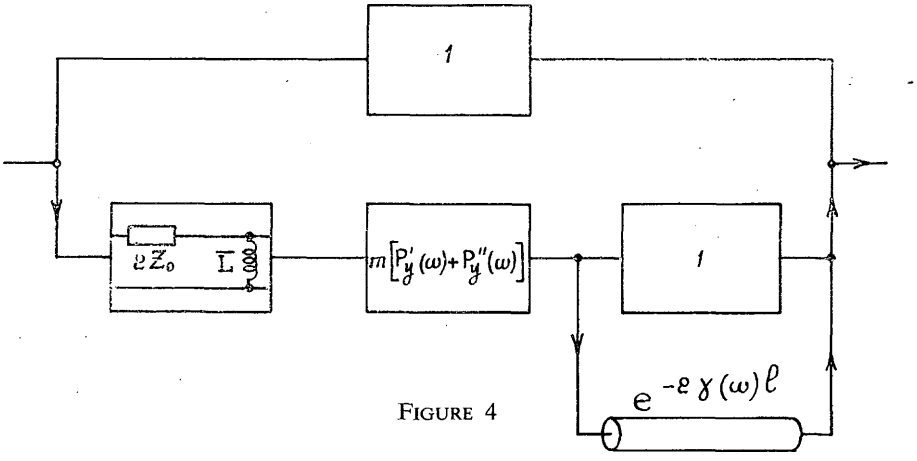


FIGURE 4

By means of the device shown in Figure 4 it is possible to simulate the second component of the mean frequency spectrum of the pulse tails due to joints in the factory lengths (formula 12). It is assumed that the arithmetical-geometrical progression can be replaced by the geometrical progression, i.e.,

$$\sum_{k=1}^{k=n-2} (n-k-1)\, e^{-2\gamma(\omega)kl} \approx \sum_{k=1}^{k=n-2} (n-2)\, e^{-2\gamma(\omega)kl} \approx \frac{(n-2)\, e^{-2\gamma(\omega)}}{1-e^{-2\gamma(\omega)l}} \tag{19}$$

(b) Simulation of the random frequency spectrum $Q(\omega) - \overline{Q(\omega)}$.

The problem can be set as follows. There is a linear quadripole with random propagation factors $K(\omega)$ (in our case, $K(\omega) = Q(\omega) - \overline{Q(\omega)}$). With the spectrum $g(\omega)$ at the input to the quadripole, there appears at the output a random transient phenomenon $U(t)$ with spectrum $g(\omega)\, K(\omega)$. One should obtain a characteristic of the phenomenon (or of the quadripole) which would fairly fully represent its statistical structure. It is evident that the mean power, spectrum $|g(\omega)|^2\, |\overline{K(\omega)}|^2$ cannot be used for this characteristic.

If it is known that the random phenomenon $U(t)$ follows the normal distribution in a space of multiple dimensions for any value of t, then $\overline{U(t)} = 0$ and the statistical properties of $U(t)$ are expressed by the correlation function

$$r(t, \tau) = \overline{U(t)\ U(t+\tau)}, \tag{20}$$

which is a function of two variables t and τ. It can be shown that, for any known action at the input to the quadripole, the function $r(t, \tau)$ may be determined if the correlation function of the real part of $K(\omega)$ is known, i.e. if the function of two variables

$$r_1(\omega, \Omega) = \overline{Re\ K(\omega)\ Re\ K(\omega+\Omega)} \tag{21}$$

is known.

In our case, it is easier to determine $r_1(\omega, \Omega)$ than $r(t, \tau)$. If it is assumed that the random spectrum $Q(\omega) - \overline{Q(\omega)} = K(\omega)$ is due to pulse tails caused by the ends of the repeater section and a large number of irregularities distributed at random along the repeater section, we have

$$r_1(\omega, \Omega) = 2\,\overline{|Q(\omega) - \overline{Q(\omega)}|^2}\left[\frac{\beta^2(\omega)}{4\beta^2(\omega) + \alpha^2(\Omega)} + \frac{\beta^2(\omega)}{4\beta^2(\omega) + \alpha^2(2\omega + \Omega)}\right] \quad (22)$$

It can be shown that the simulating device, with the same correlation function of the real part of the transmission factor, can be constructed by placing a large number of amplifiers with resonances at random frequencies in parallel. In this case, the amplifier characteristics should fulfill the specified conditions.

With such a device the author has studied the effect of artificial pulse tails on television picture quality **[4]**. It was found that the most harmful effect was produced by networks whose resonant frequencies were about 800 kc/s above the carrier frequency (if the upper side band is transmitted).

Tests using the simulating device show that the effect of the pulse tail with spectrum $Q(\omega) - \overline{Q(\omega)}$ is determined by the following value :

$$\int_{\omega_1}^{\omega_2} \overline{|Q(\omega) - \overline{Q(\omega)}|^2}\; A(\omega)\, d\omega, \quad (23)$$

where $A(\omega)$ is a certain weighting function, obtained during the tests.

If $A(\omega)$ is known, calculation will give the propagation factor of the quadripole with weighting $B(\omega)$ used for assesment of the quality of factory lengths (formula 15).

Thus, with the simulation method it is possible to specify conditions for pulse tails and for the quality of factory lengths of coaxial cable.

IV. *Determination of the second-order absolute central moment of the frequency spectrum of pulse tails from measurements of channel characteristics.*

It is possible to determine the second-order moment of the frequency spectrum of pulse tails $\overline{|Q(\omega) - \overline{Q(\omega)}|^2}$ from measurements of the characteristics of the television channel, in particular, on the basis of the group delay frequency characteristic. Assuming that $\overline{Q(\omega)} = 0$ and that the pulse tail is due to double reflections at the ends of the repeater section and to a large number of irregularities distributed at random along the repeater section, we have

$$\overline{|Q(\omega) - \overline{Q(\omega)}|^2} = 4\beta^2(\omega)\,\overline{\Delta^2 t_{2p}(\omega)} \quad (24)$$

where Δt_{2p} is the deviation of the group delay characteristic due to double reflections. It may be assumed that for a certain frequency range, the mean square of the overall deviation coincides with the mean square for the frequency and the moment $\overline{|Q(\omega) - \overline{Q(\omega)}|^2}$ can thus be found.

The error in the determination of the moment $\overline{|Q(\omega) - \overline{Q(\omega)}|^2}$ on the basis of the group delay characteristic is defined in principle by the fact that the deviation of the characteristic has causes other than pulse tails. However, in general, pulse tails are the cause of the most rapid fluctuations of the characteristic. Hence, for calculation precision, it would be desirable to use the characteristic of the second derivative of phase-shift with respect to the frequency in order comparatively to boost these rapid fluctuations. It would then be necessary to find methods of measuring such characteristics.

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[3] V. M. STEIN. Simulating pulse tails in coaxial cables. Collection of scientific works on wire telecommunications, No. 4, 1955, U.S.S.R. Academy of Science.

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ANNEX 3

(to Question 28 of Study Group 1)

Contribution from the Federal German Administration to the study of Question 28

The method of checking the impedance regularity of repeater sections of coaxial pairs standardized for telephony and television transmissions, enables impedance irregularities to be localized and their value measured with relatively cheap and compact apparatus. However, this method does not show up readily a factory-length having an impedance which differs from that of the majority of lengths in a repeater section. In such cases, the use for pulse tests of a unit-step signal with a use time equal to the half-amplitude duration of the pulse having sine-squared waveform might be useful. Variations in characteristic impedance of component lengths of a repeater section can be recognized as steps without ambiguity, while for sine-squared pulses, the transition points appear in the oscillogram only as points which in many cases can be distinguished from other local interference only with difficulty, for example, from the small additional capacitances with joints.

For this reason the Federal German Republic Administration intends to introduce this method of measurement as an alternative in repeater sections.

Question 29.

(Sub-Group 1/1, in co-operation with Sub-Group 1/4, then Study Group 1)

(Continuation of Question 20 of C.C.I.F. Study Group 2, 1955-56)

What are the conditions to be recommended for matching (at various frequencies) the impedance of the repeaters to that of the line (taking into account the internal impedance irregularities of the cable between adjacent repeaters) as regards the resultant echo at the end of an international television circuit on a coaxial cable of the type standardized by the C.C.I.F. for telephony ?

Note 1. — The overall limit for resultant echo, given on page 273 of Volume III of the C.C.I.F. *Green Book* applies to 4 Mc/s and 6 Mc/s systems : the possibility of applying the same limit to the 12 Mc/s system forms part B.*d* of Question 42 (see below).

Note 2. — As regards the division of this overall limit between the line and repeaters, the C.C.I.F. XVIIIth Plenary Assembly has made the recommendations given in Appendix 1 below.

Note 3. — Annex 2 below indicates a method of calculation which might be employed for the study of this question. Annexes 3 to 5 reproduce various propositions made in 1953.

ANNEX 1

(to Question 29 of Study Group 1)

Recommendation issued by the C.C.I.F. XVIIIth Plenary Assembly on the subject of the impedance of repeaters and coaxial cables used for television

(A) *Conditions regarding repeaters* (Provisional recommendation).

It is considered that for television signals to the 405 or 625 line standards, sent over the coaxial pair 2·6/9·5 mm standardized by the C.C.I.F. (*Green Book*, Volume III, Section 3.4.4 provisional document 129/C.C.I.F., page 88) with a bandwidth in the line of 0·5 to 4 Mc/s or of 0·5 to 6 Mc/s and with a 1056 Mc/s carrier, it is convenient to express reflection loss at the input and output of the intermediate repeater * for television transmission by reference to a pure 75 ohm resistance and not to the actual cable impedance.

It is provisionally recommended that the value of this reflection loss be at least 20 db at the carrier frequency. Above and below the carrier frequency the acceptable reflection loss limit may fall progressively to a minimum value of 15 db at 0·5 Mc/s and at 4 or 6 Mc/s as appropriate.

(B) *Conditions for cables.*

(a) Mean impedance of a repeater section. — The real part of the mean end-impedance of a standardized coaxial pair, measured ever a complete repeater section, should not depart by more than one ohm from the nominal value of 75 ohms at a frequency of 2·5 Mc/s.

There is no object in specifying values at other frequencies, since the characteristic impedance of the standardized coaxial pair follows a well-defined law as a function of frequency.

An approximate formula which is sufficiently accurate for transmission calculations at frequencies in excess of 1 Mc/s is as follows :

$$Z = 74.4 + \frac{0.95}{\sqrt{f}}(1 - j) \quad \text{ohms},$$

f being the frequency in Mc/s.

Verification that this condition is complied with may be made either by steady-state measurements or by pulse measurements. The " real part of the mean end-impedance at 2·5 Mc/s " is :

— for steady-state measurements, the ordinate corresponding to an abscissa of 2·5 Mc/s on the mean graph of the variation in the resistance component of the impedance plotted as a function of frequency,

— for pulse measurements, the resistive component of the impedance of the best-matched balance to the coaxial pair measured.

(b) Impedance regularity of a repeater section. — (See Annex 1, § *(b)*, to Question 28).

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* This naturally applies also to the output impedance of the repeater at the sending end and to the input impedance of the repeater at the receiving end.

ANNEX 2

(to Question 29 of Study Group 1)

Note by the French Administration

In Figure 1 is represented the schematic of a repeater section of coaxial cable between two adjacent repeaters.

R_1 and R_2 are the reflection coefficients between cables and repeaters.

$r_x, \ldots r_y$ are the reflection coefficients at the points of abscissae $x, \ldots . y$ of the cable; these reflections may be produced within a manufacturing length ($l = 230$ m) or at a junction point between two lengths.

It is known that, by double reflections, a parasitic wave, called the pulse tail, accompanies the useful signal. Thus, if two irregularities (x) and (y) are considered, their contribution to the pulse tail will be

$$- r_x \, r_y \, e^{-2\alpha(y-x)} \qquad (\text{with } y > x)$$

and this signal will arrive at the instant $0 = \dfrac{2\,(y-x)}{v}$ after the main signal.

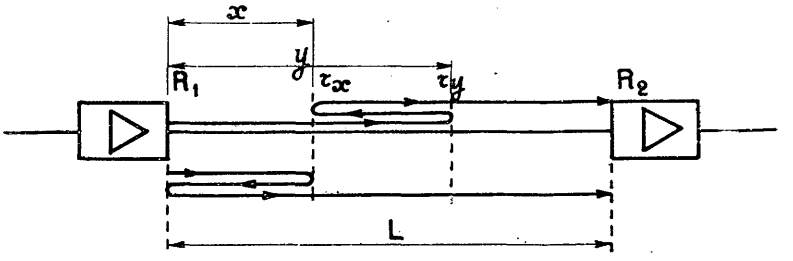


FIGURE 1

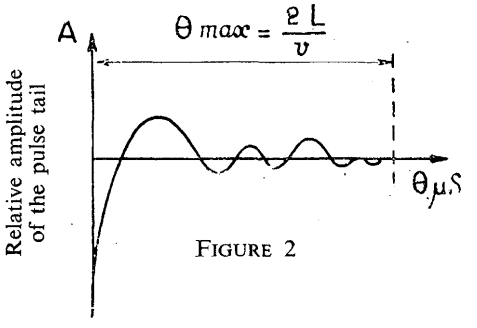


FIGURE 2

It is assumed that it is possible to determine an attenuation per unit length α and a group velocity v and that the amplitude of the main signal at the receiving end of a repeater section is unity.

In the pulse tail, three groups of terms of different origin may be recognised;

(1) double reflection between the equipments

$$q_1(\theta_{max}) = -R_1 \, R_2 \, e^{-2\alpha L} \qquad \left(\theta_{max} = \frac{2L}{v}\right)$$

(2) double reflection in the cable

$$q_2(\theta) = -\sum_{y-x=\frac{v\theta}{2}} r_x r_y e^{-2\alpha(y-x)} \quad \left(\text{summed over the values of } y-x=\frac{v\theta}{2}\right)$$

(3) interaction between the cable and the repeaters

$$q_3(\theta) = -R_1 r_x e^{-2\alpha x} - R_2 r_y e^{-2\alpha(L-y)} \quad \left(x \text{ and } y \text{ being such that } x = L-y = \frac{v\theta}{2}\right)$$

The C.C.I.F. has already proposed a provisional limit for the first term.

Let an attempt be made to evaluate the second term (contribution of the cable alone) and the third term (interaction) and to compare the two.

Experience has shown that on a manufacturing length (230 metres) the pulse tail q_2 is of the order of 2×10^{-6}.

For a repeater section of 9 km there are approximately 40 manufacturing lengths, and in the most unfavourable case one would have, without counting possible reflections at the joints :

$$q_2 = 80\times10^{-6}$$

In estimating the term q_3, the maximum value of the reflection coefficient observed on the cables should be substituted for r_x; it is of the order of 2×10^{-3}.

Consider finally the reflection at the output of a repeater. In order that the interaction term be not greater than that due to the cable alone

it is necessary that : $R_{\max} \times 2\times10^{-3} < 80\times10^{-6}$
whence : $R_{\max} < 4\%$.

If, on the contrary, it is supposed that the mismatch is complete $|R| = 1$, the interaction term becomes equal to 2×10^{-3}; it is thus 25 times greater than the term q_2 which characterises the intrinsic quality of the coaxial pair.

The effect is even more important if both the input and the output of the repeaters are mismatched.

Note. — The preceding calculation does not claim to be exhaustive, but only indicates a possible method of calculation.

The numerical results that are found are only indicative and are not put forward as a proposition even provisionally.

The two considerations which follow indicate nevertheless the direction of study which should be pursued :

(a) the hypothesis to render equal the distortion due to internal irregularities of the cable and that due to the interaction between the input (or the output) of the repeater and any irregularity of the cable should be reviewed.

(b) the hypothesis of reflection coefficient which is real and constant with respect to frequency should be abandoned to take into account the variation with frequency of this coefficient which is not necessarily real.

ANNEX 3

(to Question 29 of Study Group 1)

Reply, in 1953, of the Cuban Telephone Company to Question 20 of C.C.I.F. Study Group 1

1. It is recommended on page 213 of Volume III of the C.C.I.F. *Green Book* that the factor N (equal to twice the attenuation of a repeater section of line plus the return loss between the input and output impedances of the repeaters and the line) should be of the order of 70 db at frequencies in the region of the virtual carrier frequency used for the transmission over the line.

There is little probability that the lowest carrier frequency used will be less than about 800 kc/s and at this frequency the line attenuation is about 20 db so that to obtain a value of 70 db for the factor *N*, the sum of the return losses between the input and output impedances of a repeater and the line should be not lower than 30 db. It is possible to maintain a return loss of 30 db between, for example, the repeater input and the line, but it will probably be easier to maintain a return loss of 15 db at both the input and output.

2. The Cuban Telephone Company recalls that in the reply it made to Question No. 18 studied in 1951 (see " CCIF — 1950/1951 — 3rd SG — Document No. 18, " page 17), it was indicated that one would anticipate that an impedance irregularity in the line of $\pm$ 1 ohm relative to 75 ohms produces a parasitic signal, due to multiple echos, of about 50 db below the level of the vision signal, for a repeater section, for the case where the output impedance of the repeater was not matched to the impedance of the cable. If, nevertheless, a return loss of 15 db is maintained at the repeater output, the ratio between the signal and the parasitic signal will be 69 db, or, if one adds on a random law, 66 db if the repeater input has also a return loss of 15 db.

For a system consisting of 100 repeater sections, it might be expected that the level of the parasitic signal should be about 46 db below the vision signal and this value should be satisfactory.

It is therefore suggested that the input and output impedances of the repeater should be such that the return loss relative to the impedance of the line should be in the two cases greater than 15 db in the region of the virtual carrier frequency. A value slightly below this would probably be satisfactory for the higher frequencies transmitted on the line.

ANNEX 4

(to Question 29 of Study Group 1)

Reply, in 1953, by the American Telephone and Telegraph Company (United States) to Question 20 of the C.C.I.F. Study Group 3

Mismatch between line and repeater impedances is only one of the contributors to the overall echo level. The permissible magnitude of this mismatch depends on the degree of control of the other contributions (see Question 28) and on the particular design of the transmission system, for mismatch may be deliberately introduced to facilitate equalization.

In the American type L3 coaxial system it is considered desirable to match the impedance of the repeater to the impedance of the line as perfectly as can be done, within economic limitations. Special attention is paid to obtaining a good match at the frequency of the television carrier. At the present stage of development of the L3 system, the objective is for the reflection coefficient between line and repeater not to exceed about 5 to 7% over most of the frequency range used and about 10 to 14% at the upper end of the band.

ANNEX 5

(to Question 29 of Study Group 1)

Reply, made in 1953, by the French Telephone Administration to Question 20 of C.C.I.F. Study Group 3

To get an idea of the conditions to be recommended regarding the matching of the impedance of the repeaters to that of the line for an international television circuit on standard coaxial, cable 2·6/9·5 mm, the French Telephone Administration has taken as a basis the evaluation of the pulse tail at the end of a circuit 1000 km long, the coaxial pairs of which are of the technical quality obtained in present manufacture and are equipped with repeaters standardized by the French Administration.

An analysis of the various causes of streaking (" traînage ") enables the reflection coefficients to be classified in three categories, as follows :

1. *The reflection coefficients at the input and output of the repeater*, respectively R_E and R_S. These coefficients have been obtained by direct measurements with an apparatus of which the pulse duration is 0·2 microseconds. They are referred to a resistance of 75 ohms and are respectively equal to

$$R_S \approx 120 \times 10^{-3} \text{ (output)}$$
$$R_E \approx 70 \times 10^{-3} \text{ (input)}$$

2. *The internal irregularities of the pairs.* — These have been measured on a number of repeater sections by examining the echo curves. Their order of magnitude (peak maximum) is 1×10^{-3}.

3. *The irregularities at the junction of two manufacturing lengths (joints).* — The maximum value of such a reflection coefficient may be taken as 2×10^{-3}.

The evaluation of the pulse tail, taking the above values as a basis, gives for the tail of the signal an amplitude of 0·3 %. This value does not seem to give rise to noticeable distortion in the television transmission.

The C.C.I.F. has not fixed the admissible limit for the pulse tail. The C.C.I.F. has proposed a provisional limit for the term $R_1 R_2 e^{-2\alpha L}$ (α = the attenuation coefficient, L = the length of a repeater section). This limit is 300×10^{-6} in the region of the carrier frequency. The French equipments under the same conditions give 100×10^{-6} and are therefore well below this limit. The internal irregularities of the cables could be limited to conform to the criterion given in the reply of the French Administration to question 18 studied in 1951. The peak maxima of the reflection coefficients at the junction of the cable lengths should be limited to twice the value allowed for the internal irregularities of the cable.

This being so, there would seem no point in imposing a limitation of the pulse tail for circuits intended initially for telephony and of which the quality in the present state of technique would appear adequate for television transmission.

There is given in the appendices the detailed calculation of the pulse tail and the echo curves used to determine the reflection coefficients of the repeaters.

APPENDIX 1

(to Annex 5 to Question 29)

Evaluation of the pulse tail on a connection by coaxial cable 2.6 / 9.5 mm

1. *Statement of the problem.*

It is proposed to evaluate, by following the method described in Annex 2 above, the pulse tail of a pulse (0·20 microseconds at mid-height) over a connection of 1000 km on coaxial cable 2·6/9·5 millimetres. The figures used in this calculation correspond to the characteristics of current French coaxial cables and equipment.

2. *Summary of Annex 2.*

Figure 1 represents a repeater section of coaxial cable between two adjacent amplifiers.

R_1 and R_2 are the reflection coefficients between cables and equipments.

$r_x \ldots . r_y$ are the reflection coefficients at the points of abscissae $x \ldots . y$ of the cable, corresponding to the internal irregularities.

r_n is the reflection coefficient at the junction of the $(n + 1)$th and the nth factory length of cable.

If it is admitted that it is possible to define a linear attenuation α and a group velocity v and if one takes the amplitude of the main signal at the receiving end of a repeater section as unity, the contribution to the pulse tail of two irregularities x and y will be :

$$-r_x \, r_y \, e^{-2\alpha(y-x)}$$

and this signal will arrive at the instant $\theta = 2 \dfrac{y-x}{v}$ after the main pulse.

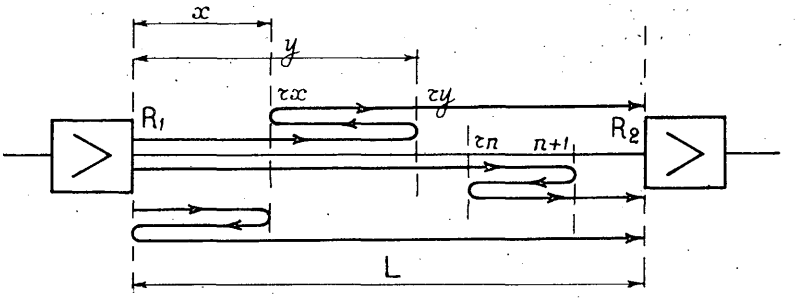


FIGURE 1

When θ varies from 0 to 0·2 microsecond, the pulse tail can be neglected in comparison with the attenuation due to the reflection losses [Σr_x].

We will examine below the pulse tail corresponding to $\theta \geqslant 0{\cdot}20$ *microseconds.*

The pulse tail disturbs the signals adjacent to the impulse considered; it plays the role of a noise.

3. *Order of magnitude of the reflection coefficients.*

3.1 *Equipment.*

From measurements made on a repeater for coaxial cables, standardized type 51740 of the French Administration (see the Appendix 2 attached) the order of magnitude of the coefficient R_1 and R_2 is :

$$R_1 \text{ (reflection at output)} \approx 120 \times 10^{-3}$$
$$R_2 \text{ (reflection at input)} \approx 70 \times 10^{-3}$$

3.2 *Internal irregularities.*

An examination of the curves of echo taken on a large number of repeater sections, according to the method given in the French reply to Question 18, studied in 1951, indicates that the magnitude of the maxima of the peak is 1×10^{-3}.

3.3 *Reflection between adjacent manufacturing lengths.*

The maxima of the reflection coefficients at the junction of two manufacturing lengths are greater. The order of magnitude of the maximum r_n will be taken as 2×10^{-3}.

4. *Evaluation of the pulse tail.*

The contributions of the different signals composing the pulse tail may be estimated in the following manner :

4.1 *Double reflection between the equipments.*

4.1.1 *Repeater section.*

$$q_1 (\theta \text{ max}) = -R_1 R_2 e^{-2\alpha L}$$

$$\theta \text{ max} = \frac{2L}{v} \approx \frac{2 \times 8}{0.28 \times 10^6} \approx 60 \ \mu s$$

The C.C.I.F. has proposed a provisional limit for this term : 300×10^{-6} in the region of the carrier frequency.

For present French equipment :

$$R_1 R_2 \approx 84 \times 10^{-4}$$

If, for example, the frequency of 1 Mc/s is considered, the total attenuation is

$$2 \alpha L = 2 \times 0.27 \times 8 = 4.3 \text{ N}$$

and

$$R_1 R_2 e^{-2\alpha L} \approx 100 \times 10^{-6}.$$

4.1.2 *Connection 1000 km long* (125 repeater sections).

The reflections between cable and equipment are of a systematic character; less than 20% of the sections have the same length within 60 m (distance occupied by the pulse in the cable), the total effect should reach a maximum :

$$q_1 = 125 \times 20 \times 10^{-6} \approx 0.25\%$$

4.2 *Double reflections between internal irregularities of the cable.*

4.2.1 *Repeater section.*

q_2 (θ) is of the order of 1×10^{-6} on manufacturing lengths, but the signal is random and the summation as a function of length is made on a root-mean square law.
This gives

$$1 \times \sqrt{20} \times 10^{-6} \approx 4.5 \times 10^{-6}$$

for a repeater section.

4.2.2

$$q_2 (\theta) \approx 4.5 \sqrt{125} \times 10^{-6} \approx 50 \times 10^{-6}$$

for a connection 1000 km long.

4.3 *Double reflections between joints.*

The corresponding pulse tail occurs at the times 3, 6, 9 .... microseconds. By adopting the value of $r_r = 2 \times 10^{-3}$, but admitting the law of summation of $\sqrt{n}$, this gives :

$$q_3 = 4 \times \sqrt{2500} \times 10^{-6} \approx 200 \times 10^{-6}$$

for a connection of 1000 km.

4.4 *Double reflections between a joint and an internal irregularity.*

To assess this effect the maximum values of r_n and r_x are taken but with any sign. For 1000 km, taking account that the reflection at a joint should be combined with two reflections situated, one before and the other after the junction but at equal distances from it

$$q_4 = 2 \times \sqrt{2} \sqrt{2500} \times 10^{-6} \approx 150 \times 10^{-6}$$

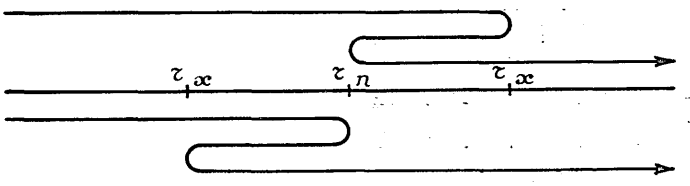


FIGURE 2

4.5 *Double reflections between equipment and internal irregularity.*

The most important term is obtained for a reflection from a maximum irregularity near the ends, for example a joint.

4.5.1 *Repeater section.*

In considering the reflection at the input one has

$$q_5 = 2 \times 70 \times 10^{-6} \approx 140 \times 10^{-6}$$

For the reflection at the output one has

$$q_5 = 2 \times 120 \times 10^{-6} \approx 240 \times 10^{-6}$$

In combining the two components of the pulse tail quadratically one has for a repeater section 280×10^{-6}.

4.5.2 *Connection of 1000 km.*

The above value is multiplied by 125 and gives

$$q_5 \approx 280 \sqrt{125} \times 10^{-6} \approx 3000 \times 10^{-6}$$

5. *Recapitulation.*

Now take q_1, q_2, q_3 q_4 and q_5 together.

q_1 is separated in time from the other components of the pulse tail and has a maximum value of 0·25%.

q_2, q_3, q_4, q_5 should be combined quadratically and q_5 being predominant gives the order of magnitude of the pulse tail thus :

$$\sqrt{q_2^2 + q_3^2 + q_4^2 + q_5^2} \approx 0.3\%$$

Even though the allowable limit of the pulse tail was not fixed by the C.C.I.F., it is reasonable that the value of 0·3% does not produce appreciable disturbance in the transmission of television pictures.

APPENDIX 2

(to Annex 5 to Question 29)

Determination in the transient state of the reflection coefficients of a coaxial cable repeater

The reflection coefficients of a standardized coaxial repeater have been determined in the transient state by pulse echometer of the *Société anonyme des Télécommunications* (S.A.T.), using a pulse of 0·2 microseconds.

These coefficients are referred to a resistance of 75 ohms.

In Figure 3 is shown the reflection by 70 ohms which was used for calibrating the apparatus.

Figure 4. — Reflection at the input (R_2).

Figure 5. — Reflection at the output (R_1).

Figure 6 and 7. — Reflection by the elements of the repeater which contribute to a large part of the mismatch.

REFLECTIONS MEASURED ON "S.A.T." PULSE ECHOMETER

Pulses of 0·20 μs duration at mid-height

Reflection from 70 ohms (calibration of the apparatus)

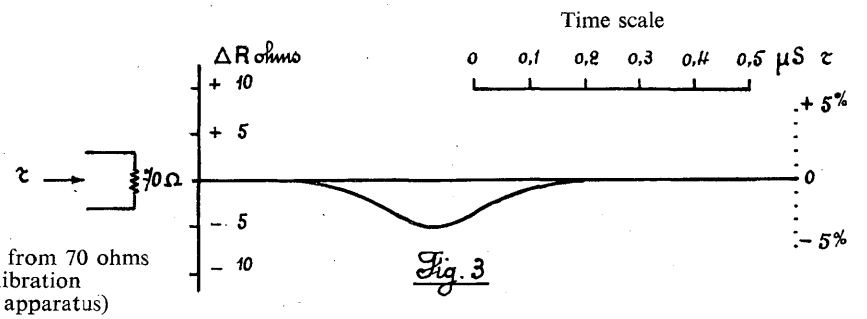


Fig. 3

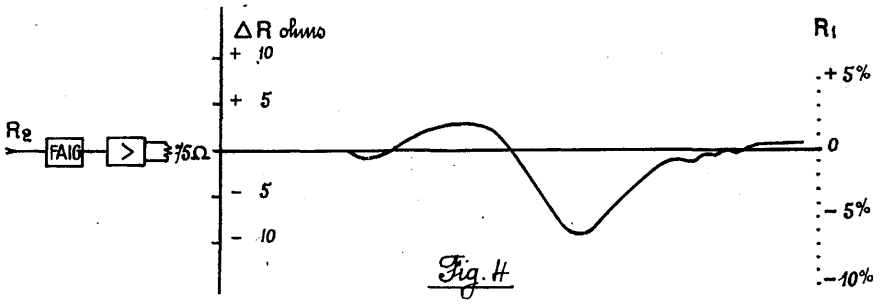


Fig. 4

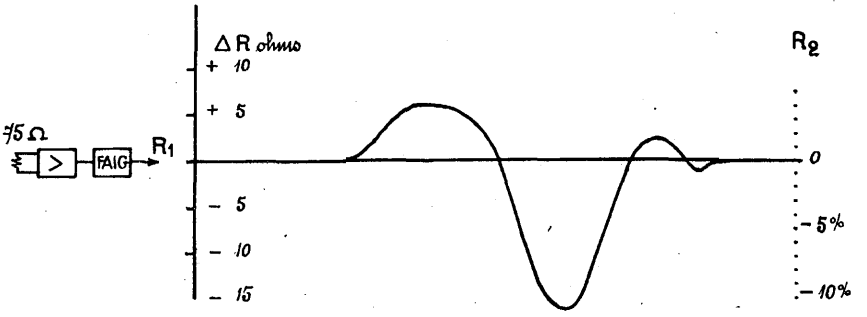


Fig. 5

REFLECTIONS MEASURED ON " S.A.T." PULSE ECHOMETER

Pulse of 0·20 μs duration at mid-height

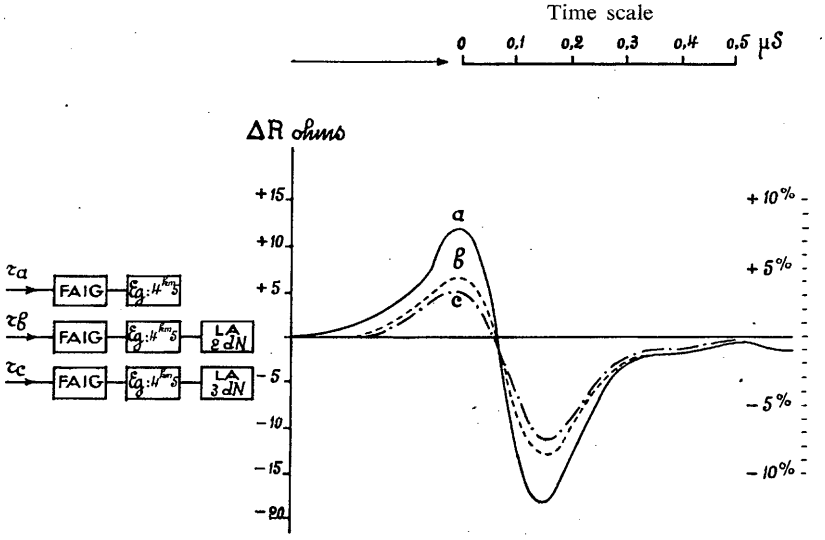


FIGURE 6

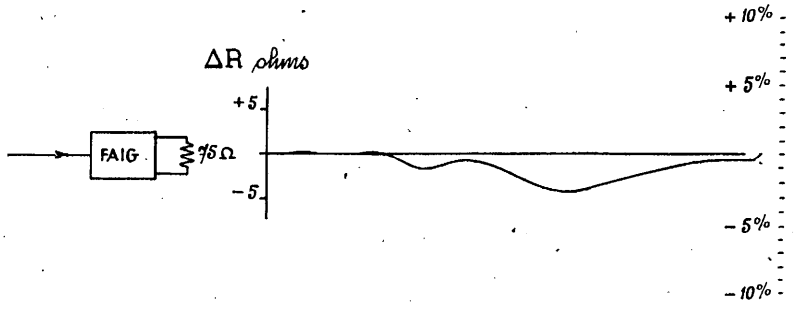


FIGURE 7

Question 30.

(Sub-Group 1/1, then Study Group 1, in co-operation with Study Group 4)

(Continuation of Question 29 of C.C.I.F. Study Group 3, 1955-56)

What frequency stability should be recommended for the generators of inter-supergroup frequencies, taking into consideration the following points ?

1. Permissible interference introduced into line pilot receivers by measuring frequencies.

2. Permissible interference introduced into the receivers for measuring frequencies by other measuring frequencies.

3. Attenuation at about 308 kc/s of the through supergroup filter equipment and/or additional suppression filters in the line.

4. Attenuation at about 556 kc/s of the through supergroup filter equipment.

5. Selectivity of line pilot receivers.

6. Selectivity of receivers for the measuring frequencies.

Note. — As regards point 1, it was recommended by the C.C.I.F. that convenient arrangements be made so that no appreciable interference appears at the line pilot receivers.

As regards point 2, this was examined by C.C.I.F. Study Group 9 who considered that the study of this point should be continued.

It is suggested to C.C.I.T.T. Study Group 4, replacing C.C.I.F. Study Group 9, to consider the possibility of admitting some interference when measuring simultaneously on two adjacent regulating sections, the attenuation of the filters being sufficient to avoid all interferences between two non-adjacent sections.

As regards points 3 and 4, it follows from the recommendations of the C.C.I.F. to its Question 32 that the through supergroup filter equipments should offer at frequencies of 308 kc/s and 556 kc/s an attenuation greater than 4·6 N (40 db) compared to that measured at 412 kc/s, but this recommendation does not give any specification at frequencies in the vicinity of 308 kc/s and 556 kc/s. The following provisional recommendation has been made on this subject.

"At through supergroup points, it is necessary to protect in a convenient manner the line regulating pilot, transmitted on the following regulating section, against interference from the additional measuring frequencies transmitted over the preceding section. For this purpose, it is provisionally recommended that the through supergroup equipments, possibly with the additional blocking filters, gives an attenuation at 308 kc/s $\pm$ 20 c/s which is 20 db above, and at 308 kc/s $\pm$ 50 c/s is 15 db above, the attenuation at 412 kc/s on condition that, according to existing recommendations, this attenuation is at least equal to 40 db at 308 kc/s.

At the final through supergroup point of the connection before reaching the frontier, it is provisionally recommended that each Administration make the necessary arrange-

ments to stop the additional measuring frequencies on the national sections, whatever the frequency stability.

The values to be specified for the corresponding attenuation, as a function of the frequency, remains for study by the C.C.I.T.T.

As regards points 5 and 6, there is no recommendation.

Point 2 must stay within C.C.I.T.T. SG 4; points 3, 4, 5 and 6 must be studied by C.C.I.T.T. SG 1.

Question 31.

(Sub-Group 1/1, then Study Group 1, in co-operation with Study Group 4)

(new question) (documentary question)

Administrations and Private Operating Companies are requested to furnish, by way of documentation, information on the following points :

What are the characteristics of the automatic regulators used for level-regulation on carrier systems, and in particular, what are :

(a) the principle of operation of these devices,

(b) their response times ?

Note. — This information will be supplied to C.C.I.T.T. SG 4.

Question 32.

(Study Group 1, in co-operation with Study Group 3 and with the C.C.I.R.; preliminary study by the joint C.C.I.T.T.-C.C.I.R. Noise Party)

*(continuation of Question 34*bis*, in 1955-56, of C.C.I.F. Study Group 3)*

Is there a need, for the calculation of noise at the end of a hypothetical reference circuit, to specify certain hypotheses for calculations ?

Note 1. — For study of this question, the case of the hypothetical reference circuit on radio links will be considered in co-operation with SG. 3 of the C.C.I.T.T. and with the C.C.I.R. The Appendix hereafter gives the recommendations issued by the C.C.I.R.

The following annexes are given as contributions from Holland (Annex 1), France (Annex 2), Fed. German Rep. (Annex 3), Cuban Telephone Company (Annex 4), Italy (Annex 5), Mexico Telephones (Annex 6), and Sweden (Annex 7).

APPENDIX

(to Question 32 of Study Group 1)

Recommendation by the C.C.I.R. VIIIth Plenary Assembly on hypothetical reference circuits for radio-relay systems

C.C.I.R. RECOMMENDATION 201

Hypothetical reference circuit for time-division multiplex radio-relay systems with 60 or less telephone channels

(C.C.I.R. Question 97)

The C.C.I.R., (Warsaw 1956)

considering

(a) that it is desired to define hypothetical reference circuits for radio-relay systems in order to offer guidance to the designers of equipment and systems for use in international telecommunication networks;

(b) that time-division radio-relay systems may form a part of an international circuit;

(c) that the C.C.I.F. has established a hypothetical reference circuit for the similar case of 60 and 120 telephone channels on symmetrical pairs (Volume III of the C.C.I.F. *Green Book*, Geneva 1954, page 68);

unanimously recommends

1. that a hypothetical reference circuit for time-division multiplex radio-relay systems with a capacity of 60 or less telephone channels per radio channel should be 2500 km long;

2. that this reference circuit should be constituted by 9 sections approximately 280 km long with voice-channel modulation and demodulation at each terminal of a section;

3. that in any hour the mean psophometric noise in a telephone channel at the ends of the overall circuit should not exceed 10·000 pW at a point of zero relative level;

4. that the allocation of this noise power to the single sections and the time distribution of the noise power should be further studied;

5. that the method of specification and permissible values of the psophometric noise for small percentage of time should be defined, but that a precise answer cannot be given at the present time.

C.C.I.R. RECOMMENDATION 202

Hypothetical reference circuit for F.D.M. radio-relay systems with capacity of 12 to 60 telephone channels

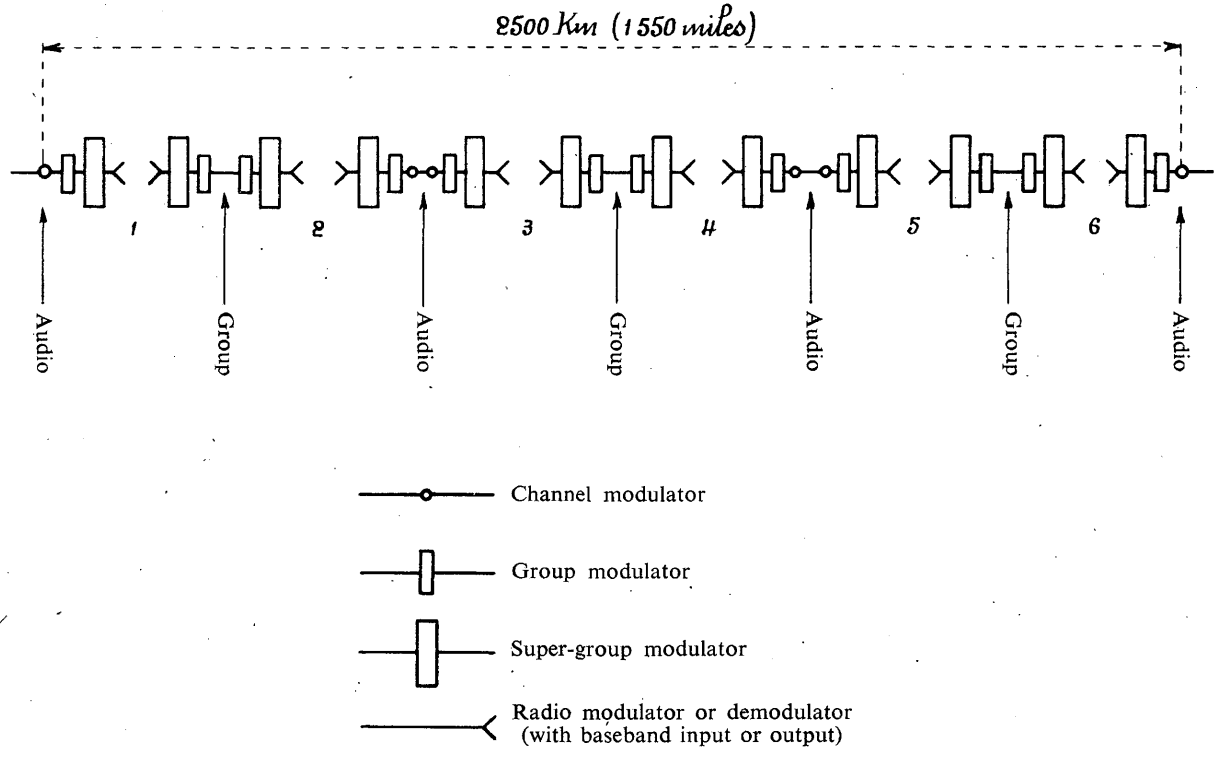
(C.C.I.R. Question 97)

The C.C.I.R., (Warsaw 1956)

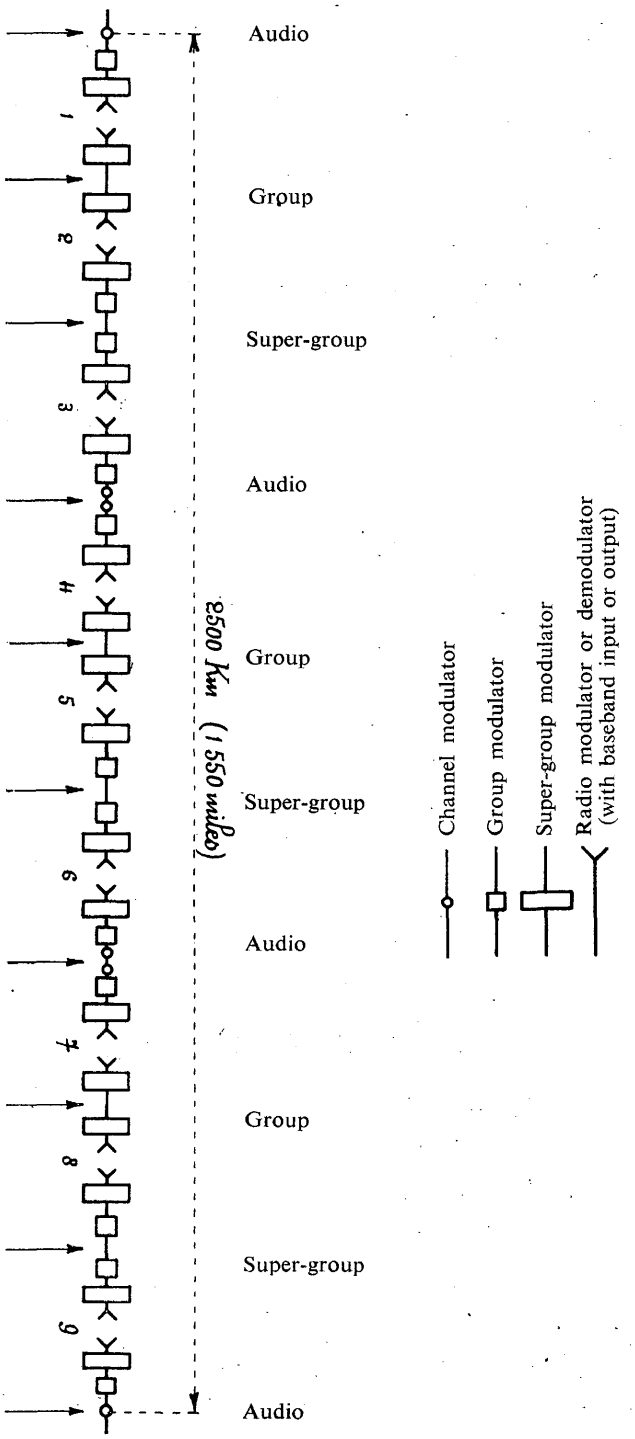
considering

(a) that it is desired to establish hypothetical reference circuits for radio-relay systems in order to afford guidance to the designers of equipment and systems for use in international telecommunication networks;

(b) that hypothetical reference circuits for radio-relay systems should be in agreement as far as possible with the circuits specified by the C.C.I.F., for cable systems;



Hypothetical reference circuit for wide-band frequency-division multiplex radio-relay systems with capacity of 12 to 60 telephone channels per radio frequency channel



Hypothetical reference circuit for F.D.M. radio-relay systems with capacity of more than 60 telephone channels per radio frequency channel

unanimously recommends

1. that a hypothetical reference circuit for frequency-division multiplex radio-relay systems with capacity of 12 to 60 telephone channels per radio channel should be 2,500 km long;

2. that the circuit should include for each direction of transmission :

— 3 sets of channel modulators,
— 6 sets of group modulators,
— 6 sets of supergroup modulators,

it being understood that a " set of modulators " comprises a modulator and a demodulator;

3. that this circuit should include respectively 6 sets of radio modulators and demodulators, for each direction of transmission, and that these should divide the circuit into 6 homogeneous sections of equal length.

Note. — In estimating noise, the position of a telephone channel in the baseband frequency range should be considered for each of the 6 homogeneous sections of the hypothetical reference circuit.

C.C.I.R. RECOMMENDATION 203

Hypothetical reference circuit for wide-band frequency-division multiplex radio-relay systems with capacity of more than 60 telephone channels

(C.C.I.R. Question 97)

(Warsaw, 1956)

The C.C.I.R.,

considering

(a) that it is desired to establish hypothetical reference circuits for radio-relay systems in order to afford guidance to the designers of equipment and systems for use in international telecommunication networks;

(b) that hypothetical reference circuits for radio-relay systems should be in agreement as far as possible with the circuits specified by C.C.I.F. for cable systems;

unanimously recommends

1. that a hypothetical reference circuit for frequency-division multiplex radio-relay systems with a capacity of more than 60 telephone channels per radio channel should be 2,500 km long;

2. that the circuit should include, for each direction of transmission :

— 3 sets of channel modulators,
— 6 sets of group modulators,
— 9 sets of supergroup modulators,

it being understood that a " set of modulators " comprises a modulator and a demodulator;

3. that this circuit should include 9 sets of radio-modulators and demodulators respectively, for each direction of transmission and that these should divide the circuit into 9 homogeneous sections of equal length.

Note. — In estimating noise, the position of a telephone channel in the base-band frequency range should be considered for each of the 9 homogeneous sections of the hypothetical reference circuit.

ANNEX 1

(to Question 32 of Study Group 1)

The computation of intermodulation noise due to non-linearity in radio relay systems

(Note submitted by the Dutch Administration)

The method hereinafter described was originally devised for the calculation of intermodulation noise in radio relay systems (Document 268, C.C.I.R. Study Group IX, Warsaw, 1956), but is generally applicable to systems the transmission characteristic of which can be written $y = ax + bx^2 + cx^3$.

This method can be also applied, with one frequency translation, to modulator systems. In this latter case, the factors *a*, *b*, and *c* do not only depend on the elements making up the frequency translating network. They vary, too, with the intensity and form of the modulating current.

The calculation of non-linear distortion in radio relay systems with frequency modulation

1. *Introduction.*

In the transmission of wide-band telephone signals, non-linear distortion gives rise to intermodulation noise. Each non-linear part of the transmission chain will contribute to the intermodulation noise, which contributions will add up according to a certain law.

The purpose of this document is to indicate a method of calculation of this intermodulation noise. How far the same method can be used in the case of a television signal is not quite clear. The approach to the problem for television lies mostly in the time domain whereas the theory treated in this document is a typical example of a frequency-domain analysis.

All calculations in this document are based on the quasi-stationary theory. This theory has its limitations, as is well known, but under most practical conditions the results of the quasi-stationary theory are quite satisfactory.

2. *Sources of intermodulation noise.*

In an FM radio-relay system the following important sources of intermodulation noise can be indicated :

1. modulators and discriminators;
2. the FM equipment of the relay stations and terminal stations, with the exception of the feeders;
3. reflections in the feeders;
4. multipath transmission.

2.1. Non-linear distortion in the modulator originates from the non-linear relation between the instantaneous value of the input voltage and the instantaneous value of the output frequency :

$$f = ae + be^2 + ce^3 + \ldots \qquad (1)$$

In a reverse sense a similar equation holds for the discriminator :

$$e = a'f + b'f^2 + c'f^3 + \ldots \qquad (2)$$

2.2. If the distortion in FM equipment is considered quasi-stationary, and, moreover, the limiters and discriminators are supposed to be ideal, we come to the conclusion that as a first approximation only the phase characteristic is of importance.

The input signal of the FM equipment being

$$e \exp [j (\omega_0 t + s)] \tag{3}$$

the instantaneous frequency of the signal is $\omega_0 + s'$. When the transfer function of the equipment is

$$A (\omega) \exp [j \varphi (\omega)] \tag{4}$$

then from a quasi-stationary point of view the output signal will be :

$$e A (\omega_0 t + s') \exp \left[j \left\{\omega_0 t + s + \varphi (\omega_0 + s')\right\}\right] \tag{5}$$

After having passed the ideal limiter and discriminator, the signal will be :

$$\frac{d}{dt} \left\{ \omega_0 t + s + \varphi (\omega_0 + s') \right\} = \omega_0 + s' + \frac{d}{dt} \varphi (\omega_0 + s') \tag{6}$$

The part ω_0 can be left out of consideration, and when, moreover, φ is developed in a Taylor series, we get for the output signal :

$$s' + \left(\frac{d\varphi}{d\omega}\right)_{\omega_0} \frac{ds'}{dt} + \frac{1}{2!} \left(\frac{d^2\varphi}{d\omega^2}\right)_{\omega_0} \frac{ds'^2}{dt} + \frac{1}{3!} \left(\frac{d^3\varphi}{d\omega^3}\right)_{\omega_0} \frac{ds'^3}{dt} + \ldots\ldots \tag{7}$$

The second term gives no non-linear distortion, so it can be ignored here. Then we get :

$$s' + \frac{b}{2} \frac{ds'^2}{dt} + \frac{c}{3} \frac{ds'^3}{dt} + \ldots \tag{8}$$

in which $b = \left(\frac{d^2\varphi}{d\omega^2}\right)_{\omega_0} = \left(\frac{d\tau}{d\omega}\right)_{\omega_0}$ and $c = \frac{1}{2} \left(\frac{d^3\varphi}{d\omega^2}\right)_{\omega_0} = \frac{1}{2} \left(\frac{d\tau}{d\omega}\right)_{\omega_0}$

The last equation can also be written as :

$$s' + b's'^2 + c's'_3 + \ldots \tag{9}$$

in which $b' = \mu b$ and $c' = \mu c$ when μ represents the frequency of the considered intermodulation product, which has been obtained by elaborating s'^2 and s'^3. Moreover, each intermodulation product obtained by means of (9) will have to be shifted 90° in phase (anti-clockwise) to represent an intermodulation product obtained from (8) **[1]**, **[4]**.

In (9) the coefficients b' and c' have a symbolic meaning only. In fact they should be considered as operators. In paragraph 3 the use of b' and c' will be clarified.

2.3 If, because of supposed small values of the reflection coefficients, only the first echo is taken into account, two signals will arrive at the output of the feeder.

The two said signals can be expressed as follows :

$\cos (\omega_0 t + s)$ and

$$r_1 r_2 e^{-2\alpha l} \cos \left\{ \omega_0 (t-2\tau) + s (t-2\tau) + \theta_1 + \theta_2 \right\} \tag{10}$$

in which the moduli are represented by r_1 and r_2, the arguments of the reflection coefficients by θ_1 and θ_2, the attenuation of the double length of the feeder by $e^{-2\alpha l}$, and the group delay by

$$\tau = \left(\frac{d\varphi}{d\omega}\right)_{\omega = \omega_0}$$

If we put $\omega_0 2\tau - \theta_1 - \theta_2 = \theta$, and $s\,(t - 2\tau) = s - 2\tau s'$ we can write for (10) (provided τ has a sufficiently small value) :

$$\cos(\omega_0 t + s)\,[1 + r_1 r_2 e^{-2\alpha l}\cos(\theta + 2\tau s')] + \sin(\omega_0 t + s)\, r_1 r_2 e^{-2\alpha l}\sin(\theta + 2\tau s') \qquad (11)$$

If we assume $r_1 r_2 \ll 1$, (11) can be written as :

$$\cos(\omega_0 t + s) + r_1 r_2 e^{-2\alpha l}\sin(\theta + 2\tau s')\sin(\omega_0 t + s) = A(t)\cos(\omega_0 t + s - \psi) \qquad (12)$$

in which $\psi \approx r_1 r_2 e^{-2\alpha l}\sin(\theta + 2\tau s')$.

After the ideal limiter and discriminator have been passed, we get :

$$\omega_0 + s' - r_1 r_2 e^{-2\alpha l}\frac{d}{dt}\left[\sin\theta\left\{1 - 2(\tau s')^2\right\}\right] + \cos\theta\left\{2\tau s' - \frac{4}{3}(\tau s')^3\right\} \qquad (13)$$

The angle θ is a "random" angle from feeder to feeder, so that we can pose $\cos\theta = \sin\theta = \frac{\sqrt{2}}{2}$. Therefore the distortion term is :

$$\sqrt{2}\, r_1 r_2 e^{-2\alpha l}\frac{d}{dt}\left[(\tau s')^2 + \frac{2}{3}(\tau s')^3\right] \qquad (14)$$

In a manner similar to that used in 2.2 we can write the entire output signal as :

$$s' + b'' s'^2 + c'' s'^3 \qquad (15)$$

in which $b'' = \mu\sqrt{2}\, r_1 r_2 \exp(-2\alpha l\tau^2)$ and

$$c'' = \mu\frac{2}{3}\sqrt{2}\, r_1 r_2 \exp(-2\alpha l\tau^3).$$

It is obvious that this derivation only holds for small values of τ **[1]**, **[3]**.

2.4 A similar formula to that derived in the previous paragraph holds good when it is a matter of one reflection e.g. against the surface of the earth. The value of the reflection coefficient and the difference in path-lengths of the two incoming signals will in general be quite different from those holding for feeders.

3. *Calculation of intermodulation noise spectra.*

In paragraph 2.1 it was stated that in general the following relation holds for a fourpole with non-linear distortion :

$$u = ae + be^2 + ce^3 + \ldots \qquad (16)$$

Usually the part of the output signal that is free of distortion ($= ae$) is taken as basis by posing : $e' = ae$. Consequently (16) will be :

$$u = e' + \frac{b}{a^2}e'^2 + \frac{c}{a^3}e'^3 + \ldots = e' + b_o e'^2 + c_o e'^3 + \ldots \qquad (17)$$

From the foregoing it will be clear that the coefficients b_0 and c_0 should in fact be considered as operators and not as constants, because b_0 and c_0 were in § 2·2 and 2·3 proportional to the frequency of the intermodulation-product. So in this case a random signal e' which is dependent

on time, must by means of a Fourier series or integral be developed into sinusoidal components. After that the products e'^2 and e'^3 must be determined, a more or less large number of intermodulation-products being obtained. The amplitude of each intermodulation-product depends on the value of b_0 (or c_0) and this value is determined by the frequency of the product.

A similar case, in which the values of b_0 and c_0 are dependent on the frequency of the intermodulation-product, appears with repeaters for frequency-division AM systems when the feedback is dependent on frequency. If in this case, moreover, the distortion sources are frequency dependent (iron distortion), the coefficients b_0 and c_0 are also dependent on the fundamental-tone frequencies. So in general we may say that the value of b_0 is dependent on three frequencies (two fundamental-tone frequencies and 1 interference-tone frequency), and that the value of c_0 is dependent on four frequencies (3 fundamental-tone frequencies and 1 interference-tone frequency).

In connection with the different manners in which the various intermodulation products may add up [5], it is desirable, when the intermodulation noise spectra are calculated, to distinguish between $x + y$ (> 0) and $x - y$ (> 0) products as regards the second-order distortion, and, between $x + y + z$ (> 0), $x + y - z$ (> 0) and $x - y - z$ (> 0) products as regards the third-order distortion.

The quantities u and e' can represent voltages, currents, deviations, etc.; so in general u and e' are quantities of which the square is proportional to the instantaneous power. For the sake of simplicity the said quantities will be assumed to represent voltages in what follows.

For the signal e' (which will contain all the frequencies in a certain frequency-band) we can write :

$$e' = \Sigma_n \, e'_n \cos(\omega_n t + \varphi_n) \qquad \omega_n \geqslant 0 \tag{18}$$

in which φ_n is a random phase angle.

If we introduce a quantity $W(f)$, which represents the energy dissipated per c/s in a resistance of 1 Ω and for which it consequently holds that :

$$W(f)\,\mathrm{d}f = \frac{e'^2}{2} \qquad \text{for } f > 0 \tag{19}$$

then for the energy per c/s dissipated by the second-order sum components in a resistance of 1 Ω, we find at the frequency f that :

$$W_{2,s}(f) = \int_{-\infty}^{+\infty} b_0^2 \, W_1(x) \, W_1(f-x) \, \mathrm{d}x \ \text{(volt)}^2 \ \text{sec} \tag{20}$$

In (20) there should be assumed $W_1(f) = 0$, if $f < 0$, and only $W_{2,s}(f)$ is of importance for positive values of f. In the same manner we find for the energy-spectrum of the second-order difference components

$$W_{2,v}(f) = 2 \int_{-\infty}^{+\infty} b_0^2 \, W_1(x) \, W_1(f+x) \, \mathrm{d}x \ \text{(volt)}^2 \ \text{sec} \tag{21}$$

under the same conditions as indicated for (20).

In (20), b_0 is in general a function of f, x and f-x, and in (21) of f, x, and $x + f$.

For the energy spectrum of the third-order components of the type $x + y + z > 0$, of the type $x + y - z > 0$, and of the type $x - y - z > 0$, (x, y and z positive frequencies) we find respectively :

$$W_{3,s}(f) = \frac{3}{2} \int_{-\infty}^{+\infty} W_1(x)\,\mathrm{d}x \int_{-\infty}^{+\infty} c_0^2 \, W_1(y) \, W_1(f-x-y) \, \mathrm{d}y \ \text{(volt)}^2 \ \text{sec} \tag{22}$$

$$W'_{3,v}(f) = \frac{9}{2} \int_{-\infty}^{+\infty} W_1(x)\,\mathrm{d}x \int_{-\infty}^{+\infty} c_0^2 \, W_1(y) \, W_1(f+x-y) \, \mathrm{d}y \ \text{(volt)}^2 \ \text{sec} \tag{23}$$

$$W''_{3,v}(f) = \frac{9}{2} \int_{-\infty}^{+\infty} W_1(x)\,\mathrm{d}x \int_{-\infty}^{+\infty} c_0^2 \, W_1(y) \, W_1(x-y-f) \, \mathrm{d}y \ \text{(volt)}^2 \ \text{sec} \tag{24}$$

When calculating the energy spectra (20) - (24) we have considered the fact that various interference-components at the same frequency are in phase, the result of which is voltage addit io n The various energy-spectra can be added up power-wise, as there is no correlation.

4. *Method of calculating the integrals (20) - (24).*

The integrals (20) - (24) have the character of the known convolution integrals of probabilite theory. If the coefficients b_0 and c_0 are supposed to be dependent only on the frequency of thy intermodulation-product or if they are supposed to be constant, which is mostly the case, they can be placed before the integrals. Then these convolution integrals can be simply solved by means of the so-called characteristic functions, even when the fundamental spectrum $W_1\ (f)$ is discontinuous.

By the characteristic function of the energy spectrum $W(f)$ we understand the Laplace transformation of that energy spectrum :

$$s\ (p) = \int_{-\infty}^{+\infty} W\ (f)\ e^{-pf}\ \mathrm{d}f \tag{25}$$

Hence conversely we get :

$$W\ (f) = \frac{1}{2\pi j} \int_{-j\infty}^{+j\infty} S\ (p)\ e^{pf}\ \mathrm{d}p \tag{26}$$

If $S_1\ (p)$, $S_{2,s}\ (p)$, $S_{2,v}\ (p)$, $S_{3,s}\ (p)$, $S'_{3,v}\ (p)$ and $S''_{3,v}\ (p)$ are the characteristic functions of respectively

$$W_1\ (f)\ ,\ \frac{W_{2,s}\ (f)}{b_0^2}\ ,\ \frac{W_{2,v}\ (f)}{2b_0^2}\ ,\ \frac{W_{3,s}\ (f)}{\frac{3}{2}\ c_0^2}\ ,\ \frac{W'_{3,v}\ (f)}{\frac{9}{2}\ c_0^2}\ ,\ \frac{W''_{3,v}\ (f)}{\frac{9}{2}\ c_0^2}\ ,$$ then we get

by means of (25) and (26) from (20) :

$$S_{2,s}\ (p) = S_1^2\ (p) \tag{27}$$

from (21) $$S_{2,v}\ (p) = S_1\ (p)\ S_1\ (-p) \tag{28}$$

from (22) $$S_{3,s}\ (p) = S_1^3\ (p) \tag{29}$$

from (23) $$S'_{3,v}\ (p) = S_1^2\ (p)\ S_1\ (-p) \tag{30}$$

from (24) $$S''_{3,v}\ (p) = S_1\ (p)\ S_1^2\ (-p) \tag{31}$$

The method of calculating the integrals (20) - (24) is the following.

With the aid of (25) the charateristic function of $W_1\ (f)$ is calculated. The relations (27) - (31) supply the characteristic functions of the various second-order and third-order spectra. Finally by means of the relation (26) and the remark made in the preceding paragraph, we can get the energy spectra themselves, a possible frequency dependency of b_0 and c_0 being taken into account. We get a simplification of the formulae found when $W_1\ (f)$ extends only to the frequency M, and is symmetrical with respect to $\frac{M}{2}$, while there may be a discontinuous band. Then it may be derived from (25) that :

$$S_1\ (p)\ e^{p\,M/2} = S_1\ (-p)\ e^{-p\,M/2} = S_{1,r}\ (p) = \int_{-M/2}^{+M/2} W_{1,r}\ (f)\ e^{-pf}\ \mathrm{d}f \tag{32}$$

if $W_{1,r}\ (f) = W_1\ (M/2+f) = W_1\ (M/2-f)$.

Because of the foregoing the following equation should hold : $W_{1,r}\ (f) = W_{1,r}\ (-f)$, so that, according to (32), $S_{1,r}\ (p) = S_{1,r}\ (-p)$ so that $S_{1,r}\ (p)$ is an even function of p.

Thus the equations (27) - (31) pass into :

$$\left.\begin{aligned} S_{2,s}(p) &= S^2_{1,r}(p)\, e^{-pM} \\ S_{2,v}(p) &= S^2_{1,r}(p) \\ S_{3,s}(p) &= S^2_{1,r}(p)\, e^{-p\,3M/2} \\ S_{3,v}(p) &= S^2_{1,r}(p)\, e^{-p\,M/2} \\ S''_{3,v}(p) &= S^2_{1,r}(p)\, e^{+p\,M/2} \end{aligned}\right\} \quad (33)$$

If we assume :

and

$$\left.\begin{aligned} W_{2,r}(f) &= \frac{1}{2\pi j}\int_{-j\infty}^{+j\infty} S^2_{1,r}(p) e^{pf}\, dp \\ W_{3,r}(f) &= \frac{1}{2\pi j}\int_{-j\infty}^{+j\infty} S^3_{1,r}(p) e^{pf}\, dp \end{aligned}\right\} \quad (34)$$

then by means of the well-known shifting theorem we can derive :

$$\left.\begin{aligned} \frac{W_{2,s}(f)}{b_0^2} &= W_{2,3}(f-M) \\ \frac{W_{2,v}(f)}{2b_0^2} &= W_{2,r}(f) \\ \frac{W_{3,s}(f)}{\frac{3}{2}c_0^2} &= W_{3,r}(f-3M/2) \\ \frac{W'_{3,v}(f)}{\frac{9}{2}c_0^2} &= W_{3,r}(f-M/2) \\ \frac{W''_{3,v}(f)}{\frac{9}{2}c_0^2} &= W_{3,r}(f+M/2) \end{aligned}\right\} \quad (35)$$

As $S_{1,r}(p)$ is an even function in p, the same holds for $S^2_{1,r}(p)$ and $S^3_{1,}(p)$; so that $W_{2,r}(f) = W_{2,r}(-f)$ and $W_{3,r}(f) = W_{3,r}(-f)$.

Therefore it is sufficient to calculate $W_{2,r}$ and $W_{3,r}$ either exclusively for positive frequencies or exclusively for negative frequencies. By means of (35) we can finally get the required second-order and third-order spectra. Hence when the said symmetry property holds we need calculate only 2 energy spectra, viz. $W_{2,r}(f)$ and $W_{3,r}(f)$, after which the others are found by means of shifting the frequency-axis. The energy-spectra can be calculated in the simplest manner by converting the integrals (34) and (26) into contour-integrals in the complex plane and by applying the residue theorem. Even if the energy spectrum $W_1(f)$ shows a complicated trend, the energy spectra of the second and third order can thus be very quickly found.

5. *Calculation of the noise power at a point of zero relative level, for the case of telephone channels adjacent in the frequency-band.*

This noise power will be calculated for the frequent case when $W_1(f)$ is independent of frequency in the frequency band used (outside this band $W_1(f) = 0$), and when b_0 and c_0 are exclusively dependent on the interference tone frequency. Then we can write :

$$\left.\begin{aligned}
W_{2,s}\ (f) &= b_0^2\, W_1^2\, F_{2,s}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W_{2,v}\ (f) &= 2b_0^2\, W_1^2\, F_{2,v}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W_{3,s}\ (f) &= \tfrac{3}{2}\, c_0^2\, W_1^3\, F_{3,s}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W'_{3,v}\ (f) &= \tfrac{9}{2}\, c_0^2\, W_1^3\, F'_{3,v}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W''_{3,v}\ (f) &= \tfrac{9}{2} c_0^2\, W_1^3\, F''_{3,v}\,(f) && \text{(volt)}^2\ \text{sec.}
\end{aligned}\right\} \qquad (36)$$

in which the F's represent the results of the convolution-integrals (calculated via the characteristic functions) in case $W_1 = 1$ in the frequency-band in use, and $= 0$ in the non-used frequency-band.

Now no more than 1/4 ($= \tau$) of the number of channels are active simultaneously, which requires a correction in the equations for the higher-order spectra. As 2 fundamental tones are required to get a second-order interference tone, a factor $(\tau)^2$ must be inserted in the equations for the second-order spectra. Similarly a factor $(\tau)^3$ must be inserted in the equations for the third-order spectra. Then we get :

$$\left.\begin{aligned}
W_{2,s}\ (f) &= b_0^2\, \tau^2\, W_1^2\, F_{2,s}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W_{2,v}\ (f) &= 2b_0^2\, \tau^2\, W_1^2\, F_{2,v}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W_{3,s}\ (f) &= \tfrac{3}{2}\, c_0^2\, \tau^3\, W_1^3\, F_{3,s}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W'_{3,v}\ (f) &= \tfrac{9}{2}\, c_0^2\, \tau^3\, W_1^3\, F'_{3,v}\,(f) && \text{(volt)}^2\ \text{sec.}\\
W''_{3,v}\ (f) &= \tfrac{9}{2}\, c_0^2\, \tau^3\, W_1^3\, F''_{3,v}\,(f) && \text{(volt)}^2\ \text{sec.}
\end{aligned}\right\} \qquad (37)$$

For the total fundamental power can be written :

$$P_1 = \frac{\tau N W_1 m}{R} \qquad \text{watts} \qquad (38)$$

N = number of channels,
m = channel bandwidth,
τ = 1/4,
R = resistance at the point considered.

In the same manner the noise power per channel can be determined :

$$\left.\begin{aligned}
P_{2k,s}\ (f) &= \frac{W_{2,s}\,(f)\, m}{R} && \text{watts}\\
P_{2k,v}\ (f) &= \frac{W_{2,v}\,(f)\, m}{R} && \text{watts}\\
P_{3k,s}\ (f) &= \frac{W_{3,s}\,(f)\, m}{R} && \text{watts}\\
P'_{3k,v}\ (f) &= \frac{W'_{3,v}\,(f)\, m}{R} && \text{watts}\\
P''_{3k,v}\ (f) &= \frac{W''_{3,v}\,(f)\, m}{R} && \text{watts}
\end{aligned}\right\} \qquad (39)$$

Thus we find :

$$\left.\begin{aligned} P_{2k,s}\ (f) &= \frac{b_0^2 F_{2,s}(f)\, P_1^2 R}{N^2 m} && \text{watts} \\ P_{2k,v}\ (f) &= \frac{2b_0^2 F_{2,v}(f)\, P_1^2 R}{N^2 m} && \text{watts} \\ P_{3k,s}\ (f) &= \frac{\frac{3}{2} c_0^2 F_{3,s}(f)\, P_1^3 R^2}{N^3 m^2} && \text{watts} \\ P'_{3k,v}\ (f) &= \frac{\frac{9}{2} c_0^2 F'_{3,v}(f)\, P_1^3 R^2}{N^3 m^2} && \text{watts} \\ P''_{3k,v}\ (f) &= \frac{\frac{9}{2} c_0^2 F''_{3,v}(f)\, P_1^3 R^2}{N^3 m^2} && \text{watts} \end{aligned}\right\} \quad (40)$$

At the point of zero relative level we get for the various noise powers :

$$\left.\begin{aligned} P^0_{2k,s}\ (f) &= \frac{b_0^2 F_{2,s}(f)\, P_1^0 P_1 R}{N^2 m} && \text{watts} \\ P^0_{2k,v}\ (f) &= \frac{2b_0^2 F_{2,v}(f)\, P_1^0 P_1 R}{N^2 m} && \text{watts} \\ P^0_{3k,s}\ (f) &= \frac{\frac{3}{2} c_0^2 F_{3,s}(f)\, P_1^0 P_1^2 R^2}{N^3 m^2} && \text{watts} \\ P^{0'}_{3k,v}\ (f) &= \frac{\frac{9}{2} c_0^2 F'_{3,v}(f)\, P_1^0 P_1^2 R^2}{N^3 m^2} && \text{watts} \\ P^{0''}_{3k,v}\ (f) &= \frac{\frac{9}{2} c_0^2 F''_{3,v}(f)\, P_1^0 P_1^2 R^2}{N^3 m^2} && \text{watts} \end{aligned}\right\} \quad (41)$$

If at the point considered the test-tone level is $+ a$ (dbm) then we get :

$$P_1 = P_1^0\, 10^{\,a/10} \quad (42)$$

If we use a sinusoidal test-tone, which at the point considered, represents a power of $+ a$ (dbm), the following equations hold for the relation between the power of the second and third harmonics (which harmonics should fall in the channel tested, in connection with the right value of b_0, when b_0 and c_0 are dependent on the interference-tone frequency) and the power of the fundamental wave :

$$\left.\begin{aligned} \frac{W_{2t}}{W_{1t}} &= \tfrac{1}{2} b_0^2 R \times 10^{\frac{a}{10}} \times 10^{-3} \\ \frac{W_{3t}}{W_{1t}} &= \frac{c_0^2}{4} R^2 \times 10^{\frac{2a}{10}} \times 10^{-6} \end{aligned}\right\} \quad (43)$$

Then (41) passes into :

$$\left.\begin{aligned}
P^0_{2k,s}(f) &= \frac{2\,(P^0_1)^2}{N^2 m}\,\frac{W_{2t}}{W_{1t}}\,10^3 \times F_{2,s}(f) \quad \text{watts}\\
P^0_{2k,v}(f) &= \frac{4\,(P^0_1)^2}{N^2 m}\,\frac{W_{2t}}{W_{1t}}\,10^3 \times F_{2,v}(f) \quad \text{watts}\\
P^0_{3k,s}(f) &= \frac{6\,(P^0_1)^3}{N^3 m^2}\,\frac{W_{3t}}{W_{1t}}\,10^6 \times F_{3,s}(f) \quad \text{watts}\\
P^0_{3k,v}(f) &= \frac{18\,(P^0_1)^3}{N^3 m^2}\,\frac{W_{3t}}{W_{1t}}\,10^6 \times F'_{3,v}(f) \quad \text{watts}\\
P^{0''}_{3k,v}(f) &= \frac{18\,(P^0_1)^3}{N^3 m^2}\,\frac{W_{3t}}{W_{1t}}\,10^6 \times F''_{3,v}(f) \quad \text{watts}
\end{aligned}\right\} \qquad (44)$$

Thus the intermodulation-noise power originating from the various kinds of distortion of the four-pole considered (with a test level of + a (dbm) per channel on the output side) is determined at a point of zero relative level. The total intermodulation-noise power at a point of zero relative level originating from all the four-poles (with distortion) in the transmission chain is found by summing the contributions of the separate fourpoles, certain rules of addition being taken into consideration.

The subject-matter of this section can be elaborated in a simple manner when $W_1(f)$ depends on frequency over the frequency-band in use.

If for P^0_1 the average fundamental power at the point of zero relative level is inserted, the average intermodulation noise power at this point is found.

This solves the problem of determining the noise power at a point of zero relative level.

It may be remarked that the preceding consideration is based specially on four-poles, the input and output quantities of the non-linear four-pole, as represented in (17), being voltages. The arguments hold, however, entirely when u and e' of (17) are deviations, because the square of a deviation is proportional to the power (obtained after discrimination), so that the formula (19) remains valid. Then the quantity R inserted in formula (38) should not be considered as a resistance, but as a constant of proportionality, which disappears in the ultimate equations (44).

6. The theory treated in the foregoing can be elaborated in a simple manner for the case where the non-linear series cannot be broken off after the third-order term. It is possible to derive corresponding formulae for the fourth and higher-order spectra, and to solve them by means of the characteristic function, attention being paid to the mutual correlation existing between the fourth—and higher-order spectra and between these spectra and the second and third-order spectrum, so that power addition is not allowed in all cases. In most cases it is permissible to break off the non-linear series after the third-order term, so that then the theory treated is applicable.

One of the cases in which it is not permissible to break off the series is the case of a long feeder, which case has been treated elaborately in **[2]**.

7. *Conclusions.*

In the foregoing, a theory has been developed by means of which the intermodulation-noise caused by non-linear distortion in FM radio-relay systems in the transmission of telephone calls, can be dealt with in a quasi-stationary manner.

The theory has been fully elaborated for the case in which the power series can be broken off after the third term. When higher-order terms play a role, there will be complications. When the signal to be transmitted is a television signal, the considerations are of less significance.

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ANNEX 2

(to Question 32 of Study Group 1)

Method employed by the French Administration for using the hypothetical reference circuits for carrier systems on symmetrical pair or coaxial pair cables

I. — *Hypothetical Reference Circuits on symmetrical Pairs*

A. *General.*

The recommendations of the C.C.I.F. relating to noise on the hypothetical reference circuit on symmetrical pairs are designed to serve as a guide for the constructions of systems. These imply specifications for each part of the system. The application of the recommendations consists then in verifying by calculation that the hypothetical reference circuit satisfies the requirements.

The problem raised, therefore, is the following :

Knowing the specifications proposed for the different parts of the system, how is the mean power of noise on the hypothetical reference circuit to be calculated ?

B. *Definition of the Hypothetical Reference Circuit.*

In order that this calculation shall be precisely laid down, the constitution of the hypothetical reference circuit must be stated exactly.

It is proposed, firstly, to assume that the hypothetical reference circuit is established on a cable consisting throughout of the same number of symmetrical pairs.

The hypothetical reference circuit shall be cut into six equal sections each of length $2500/6 = 420$ km; within any section, any one circuit is accompanied throughout the section by the same circuits. Each circuit transmits one conversation along its length and all circuits remain in the same relative position in the frequency band. This supposes that no demodulations exist within the section and justifies the name of " homogeneous section ". On the other hand, as between one section to the next, it is supposed that the hypothetical reference circuit may occupy a different position in the frequency band, the accompanying circuits will occupy different relative positions and will transmit different conversations. This supposes that one or more stages of modulation are interposed at the end of each section.

The aim of introducing these homogeneous sections defined in this way is to permit the assumption of power addition of noise of different types from one section to the next, and, on the other hand to permit voltage addition of 3rd order intermodulation noise components within each section.

C. *Calculation of the noise in a section.*

It is necessary to calculate the mean noise power in a homogeneous section. The definition of "mean power" requires certain basic assumptions to be agreed. It is already admitted that noise power must be calculated in terms of its mean value during the busy hour.

Three independent causes of noise exist in a circuit :

thermal agitation noise,
far-end crosstalk noise, and
non-linear crosstalk noise.

It can be supposed that these noises add on a power basis.

In the following, the suffix " r " refers to the " r^{th} " channel.

(a) Thermal noise $P_{t,r}$ is easily calculated by means of the formula :

$$\tfrac{1}{2} \log_e P_{t,r} = -16{,}25 + \tfrac{1}{2} \log_e F + \tfrac{1}{2} \log_e n + G_r - Y_r \qquad (1)$$

when

n = average number of line amplifiers in a section of 420 km.

F = noise factor of line amplifier.

G_r = insertion gain of line amplifier for channel of rank r.

Y_r = relative level of the r^{th} channel at the line amplifier output.

Account has been taken of the psophometric coefficient.

These quantities are fixed by the choice of working conditions.

(b) The *non-linear crosstalk* (intermodulation noise) is composed of two terms, one relative to 2nd and one relative to 3rd order products; products of higher order being neglected. It is assumed that 2nd order intermodulation products $P_{2,r}$ add on a power basis; and that the only 3rd order products $P_{3,r}$ which are not negligible are those of the type $A + B - C$ which add on a voltage basis. These are symplifying assumptions. Then :

$$\tfrac{1}{2} \log_e P_{2,r} = - H_{2,r}\ (\delta) + x_m + \tfrac{1}{2} \log_e 4 \left(1 - \frac{r}{2N}\right) - \psi_2 + \tfrac{1}{2} \log_e n \qquad (2)$$

$$\tfrac{1}{2} \log_e P_{3,r} = - H_{3,r}\ (\delta) + x_m + \tfrac{1}{2} \log_e \left[18 \left(\tfrac{1}{2} + \frac{r}{N} - \frac{r^2}{N^2}\right)\right] - \psi_3 + \log_e n \qquad (3)$$

where N

= number of channels on the system.

$H_{k,r}\ (\delta)$ = harmonic distortion margin of order k for a sine wave whose absolute power level at zero relative level point is $+ \delta$ where the k^{th} harmonic falls in the r^{th} channel. We have $H_{k,r}(\delta) = H_{k,r}\ (0) + (k - 1)\ \delta$, where $H_{kr}\ (0)$ is the harmonic distortion attenuation for a sine wave of power 1 mW, at a point of zero relative level.

x_m = mean power of a channel during the busy hour.

$$\delta = x_m + \tfrac{1}{2} \log_e N$$

ψ_k = psophometric weighting factor for the order k.

Then we may write by convention : $\psi_2 = \psi_3 = 0{\cdot}35$ nepers.

These formulae assume no pre-emphasis. When the working conditions of the system have been decided, N is known and $H_{k,r}$ is known for the different values of δ. But δ is not fixed until is given. A nominal value has been assumed by the 3rd study group (reply to question 3) x_m, precisely to permit such calculations. This value is

$$x_m = 1{\cdot}72 \text{ nepers } (-15 \text{ dbm0})$$

(c) Far-end crosstalk noise $P_{D,r}$. Crosstalk is assumed to add on a power basis. The formula is :

$$\tfrac{1}{2} \log_e P_{D,r} = x_m + \tfrac{1}{2} \log_e (s-1) + \tfrac{1}{2} \log_e n - D_m (r) \qquad (4)$$

where

x_m = has the same meaning as above.

S = number of pairs in the cable.

$D_m (r)$ = mean far-end crosstalk ratio for a repeater section (including reflected near-end crosstalk). This is the ratio which exists between a disturbed pair and a disturbing pair which induces a power equal to the mean power $e^{-2Dij(r)}$ induced by a pair i on a pair j and given by :

$$D_m (r) = -\tfrac{1}{2} \log_e \frac{2}{s(s-1)} \sum_{i=1}^{i=s-1} \sum_{j=1}^{j=s-i} e^{-2Dij(r)} \qquad (5)$$

When the system design is laid down, a value for the far-end crosstalk ratio $D_0 (r)$ is usually fixed and this ratio should always be exceeded. For simplicity one could take

$$D_m (r) = D_0 (r) + 1 \text{ neper.}$$

These different calculations give, on addition :

$$P_{t,r} + P_{2,r} + P_{3,r} + P_{D,r} = P_r \qquad (6)$$

P_r being the mean noise in the r_{th} channel.

This value has to be less then $\frac{7500}{6} = 1250$ pW.

It is seen that, with the aid of the hypotheses as given and the working conditions assumed, the calculation is made without ambiguity.

II. — *Hypothetical reference circuit on coaxial pairs*

All the conditions developed above may be applied to the coaxial reference circuit with the sole modification :

The " homogeneous sections " will be of lengths $\frac{2500}{9} = 280$ km.

The calculation of thermal agitation noise and of intermodulation noise will be affected with the same formulae (1), (2) and (3) above and the same hypotheses. Naturally, the far-end crosstalk will be negligible.

ANNEX 3

(to Question 32 of Study Group 1)

Remarks by the Federal German Administration and the Standard Elektrik AG Fernmeldewerk Mix & Genest (Stuttgart) on parts 4 , 5 and 6 of Question 34 bis of C.C.I.F. Study Group 3, 1955-1956.

I. — *Influence of group permutation*

The influence of a group permutation on noise at the end of the hypothetical reference circuit comprises two important effects :

1. It prevents voltage addition of the third-order differential intermodulation products of the form $(f_1 + f_2 - f_3)$.
2. It decreases the mean value of line noise, composed of thermal noise, intermodulation noise and crosstalk, as a function of frequency.

1. Voltage addition of third-order intermodulation products is prevented by the fact that, when the baseband frequencies are mixed by group permutation, the intermodulation products formed in the different homogeneous sections of the reference circuit are no longer situated at the same frequencies, so that the intermodulation noise of the different homogeneous sections can be added in terms of power. For s homogeneous sections, the gain obtained (in decibels) in relation to voltage addition is

$$g = 10 \log s$$

i.e., 7·8 db for six sections or 9·5 db for nine sections.

As a matter of fact, in this case it should be borne in mind that the part of the third-order intermodulation noise which arises from the intermodulation noise of one group only always appears at the same frequencies in the same group and should consequently be capable of voltage addition. The power of the intermodulation noise of this part is, however, in the case of s groups of the same size, lower by $1/s^3$ than the intermodulation noise produced by the groups as a whole and, taking account of voltage addition, is still lower by $1/s^2$ than the overall third-order intermodulation noise at the end of the hypothetical reference circuit, so that it can be ignored.

Besides group permutation, the following points also help to prevent voltage addition of third-order intermodulation products :

(a) branching (in or out) of groups at the branching points without the necessity for changing round the groups that are routed direct;

(b) small frequency variations or phase differences between the various groups that may result from modulations;

(c) serious phase distortion at modulations and on line.

Group permutation, which in practice is nearly always unsystematic (absolutely arbitrary), in combination with points *(a)*, *(b)* and *(c)* above, justifies the use of power addition of the third-order intermodulation noise of the different homogeneous sections. It does not seem necessary to determine a special re-arrangement hypothesis for this purpose.

2. In multi-channel systems, the attenuation of the cable is proportional to the square root of the frequency. For this reason, the noise produced by thermal agitation, which determines the sending level, depends on frequency according to the same law and, when circuits are re-arranged on account of group permutation, can be reduced at the end of the hypothetical reference circuit. (We are here assuming the optimum case, without pre-emphasis. With pre-emphasis, the gain is proportionally smaller). The gain is greatest with systematic, e.g. cyclic, permutation. This maximum gain has been calculated and is shown in Figure 1, for a maximum attenuation of 40 and 50 db in a repeater section, as a function of the number of groups permitted, which may at the most be equal to the number of homogeneous sections. The gain when $s = \infty$ corresponds to the mean noise value as a function of frequency over the channels as a whole.

With systematic permutation of s groups, the sending level can be reduced in accordance with the data shown in Figure 1. As a result of the reduced sending level, the conditions set for non-linear distortion attenuation in the line amplifiers for second-order distortion ($\Delta\, a_{K2}$) and third-order distortion ($\Delta\, a_{K3}$) are less strict, which is shown in Figure 3 as a function of the number of permuted groups.

With group permutation in accordance with the the present assumption, the thermal noise of the channel which has the highest frequency in a homogeneous section, is higher, according to the values in Figure 1, than the permissible mean value per kilometre (e.g., by about 6 db in the case of 6 permutations).

Since the assumed systematic group permutation cannot be exactly carried out for reasons of operating technique and since it must be expected that one channel beyond a homogeneous section will remain in the most unfavourable position (at the upper limit of the transmitted band), the C.C.I.F. Study Group 3, in its reply to Question 34 in 1955/1956, indicated that, for carrier systems on symmetrical pairs, the noise level on this most unfavoured channel of a homogeneous section should not be more than 3 db higher than the mean noise level. This condition limits the gain that can be obtained from group permutation—and consequently the permissible reduction of the sending level—to 3 db. The maximum departure from the conditions set for non-linear distortion attenuation for line amplifiers at the highest transmitted frequency is, on account of the permissible 3 db reduction of the sending level and the fact that the permissible intermodulation noise is 3 db higher for the highest channel, $\Delta\, a_{K2} = 6$ db and $\Delta\, a_{K3} = 9$ db.

Full use of the gain that can be obtained from systematic group permutation implies the use of permutation rules for the hypothetical reference circuit. Pre-emphasis is often used nowadays for multi-channel systems. This process requires no restrictive permutation rules and its effect is similar to that of group permutation. It would thus seem reasonable to make a comparison between the two methods.

With pre-emphasis, the sending levels (at the output of the line amplifiers) of the channels at the bottom of the frequency band are decreased with respect to the sending level of the highest channel, which is itself governed by thermal noise; it is thus the same, with or without pre-emphasis. Reduction of the sending level of channels which are lower in the frequency band involves a reduction of the loading of the system (equivalent power at the output of the amplifier), which is shown on Figure 2 as a function of the degree of pre-emphasis. Here we have adopted a frequency characteristic for the sending level in accordance with the formula acknowledged to be particularly favourable :

$$p_s = 10 \log (c_1 + c_2 f^4)$$

and, for the degree of pre-emphasis, we have taken the difference between the highest and lowest sending levels, i.e.

$$10 \log \frac{(c_1 + c_2 f_{\max}{}^4)}{c_1}.$$

For about 10 db pre-emphasis, which is usual in practice, the result is a reduction of 5·5 db in the loading of the system, which can be compared, for example, to a corresponding value of 5·5 db for group permutation on 6 sections (or 3 db taking account of the 3 db rule in a homogeneous section).

The gain over the conditions set for non-linear distortion attenuation $\Delta\, a_{K2}$ and $\Delta\, a_{K3}$ resulting from pre-emphasis (in relation to absence of pre-emphasis) is shown on Figure 4 as a function of the degree of pre-emphasis. It is a result partly of the above-mentioned decrease in the loading of the system and partly of a variation in the frequency curve of the power spectra of the non-linear distortion due to pre-emphasis. The curves plotted in unbroken lines for the upper limit of the band ($f = f_{\max}$) are valid in the first place for the design of the amplifiers and give a gain $\Delta\, a_{K2}$ of 13 db and $\Delta\, a_{K3}$ of 15 db in the case of 10 db pre-emphasis. These two figures should be compared, for example, with the gain $\Delta\, a_{K2}$ of 5·5 db or $\Delta\, a_{K3}$ of 11 db with group permutations on 6 sections (or $\Delta\, a_{K2} = 6$ db and $\Delta\, a_{K3} = 9$ db taking account of the 3 db rule in one section.)

The curves in broken lines for the lower limit of the band ($f = 0$) show that for second-order distortion, there is no gain when the degree of pre-emphasis is high and there is even a slight loss. However, this is not a disadvantage because the negative feedback of the amplifiers and consequently the non-linear distortion attenuation can always be made high enough in practice.

As will be seem from Figure 4, pre-emphasis also considerably reduces third-order non-linear distortion attenuation at the bottom of the band, which, in most cases, is determined by noise caused by the transformer cores and usually cannot be remedied by negative feedback.

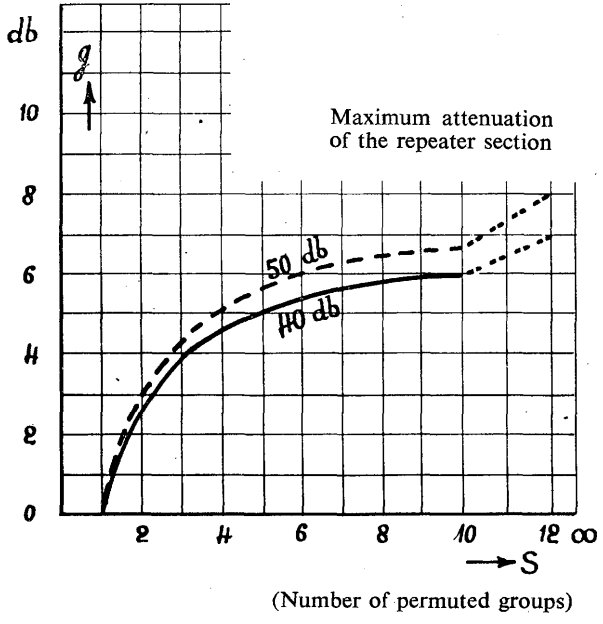


FIGURE 1. — *Group permutation*

Increase in signal-to-noise ratio
(decrease in sending level)
with systematic group permutation

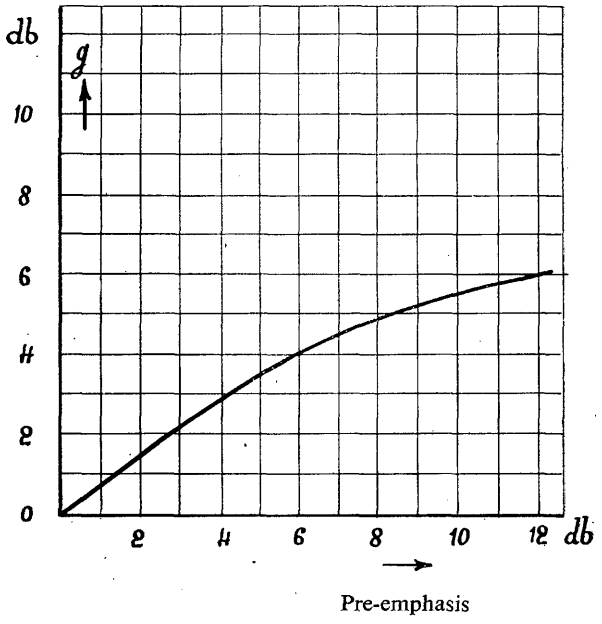


FIGURE 2. — *Pre-emphasis*

Decrease in loading of system as a function of
degree of pre-emphasis

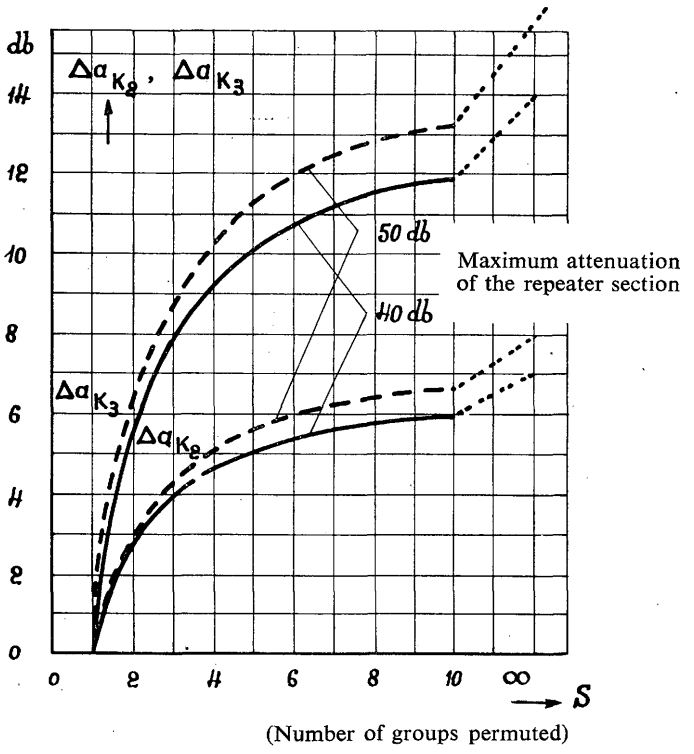


FIGURE 3. — *Group permutation*

Reduction of the conditions set for non-linear distortion attenuation for second-order distortion (Δa_{K2}) and for third-order distortion (Δa_{K3}) as a result of group permutation

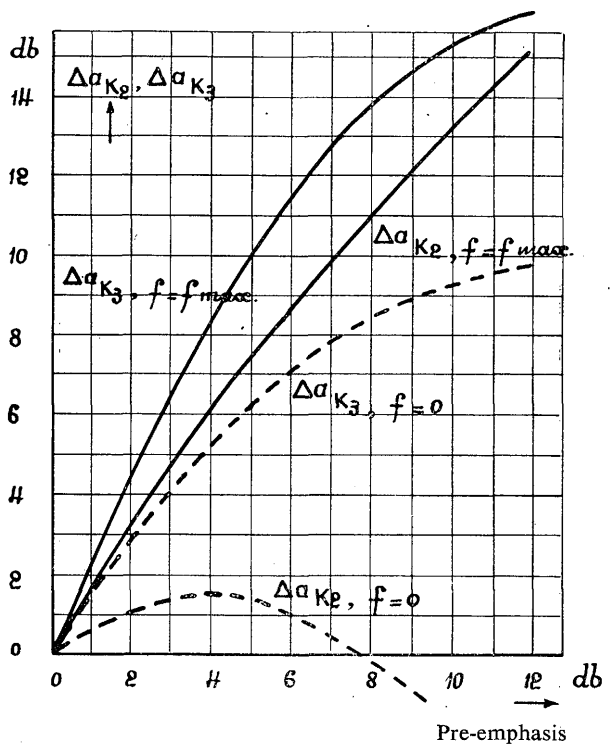


FIGURE 4. — *Pre-emphasis*

Reduction of the conditions set for non-linear distortion attenuation for second-order distortion (Δa_{K2}) and for third-order distortion (Δa_{K3}) at the highest transmitted frequency ($f = f_{max}$) and the lowest ($f = 0$) as a function of the degree of pre-emphasis

Comparison between group permutation and pre-emphasis from the standpoint of noise reduction leads to the conclusion that, at least for systems with a great many channels, pre-emphasis can be of advantage as it requires no hypothesis for the insertion or removal of groups or channels and it also provides greater gain, from the standpoint both of the loading of the system and the conditions to be set for the line amplifiers.

The conditions described here apply primarily to cable systems, but very similar conditions exist for FM radio relay systems in which the noise is proportional to the frequency. Use of pre-emphasis is current practice in such systems.

II. — *Determination of the "equivalent power" of the multi-channel signal as a function of the number of channels*

To calculate intermodulation noise, it is necessary to determine an "equivalent power" for the multi-channel signal. This equivalent power corresponds to a loading of the system by noise generators and has been determined by the method described in the appendix in such a way that the power of the intermodulation noise produced when the system is actually loaded by speech during the busy hour is the same as that produced when the system is loaded by a noise generator with the equivalent power.

For the following two reasons :

(a) variation of volume, and

(b) the existence of a non-Gaussian statistical distribution of instantaneous values when there are only a few channels,

this equivalent power, for less than about 200 channels, is slightly higher than the mean power of 32 μW per channel at a point of zero relative level. The values to be added to 32 μW per channel as a function of the number of channels to obtain the equivalent power are shown in Figure 5 and Table 1 which give the equivalent power as a function of the number of channels The Holbrook-Dixon curve which corresponds to the short duration volume of the multi-channel signal which is exceeded for 1% of the time, is plotted in broken lines for comparison.

TABLE 1

Values to be added to the mean power of a channel (32 μW) for determination of the equivalent power when there are few channels:

Distortion		Number of channels									
		1	2	6	12	24	36	48	60	120	240
Second-order distortion	db	10·2	8·7	6·2	4·5	2·9	2·1	1·6	1·3	0·6	0·3
Third-order distortion	db	16·9	14·7	10·7	7·6	4·9	3·7	3·1	2·6	1·6	0·9

When calculating cross-talk noise, for systems with fewer channels, account can be taken of the mean speech power of 32 μW in the disturbing channels, but care must be taken that in each case the normal conditions are maintained for the cross-talk ratio corresponding to intelligible

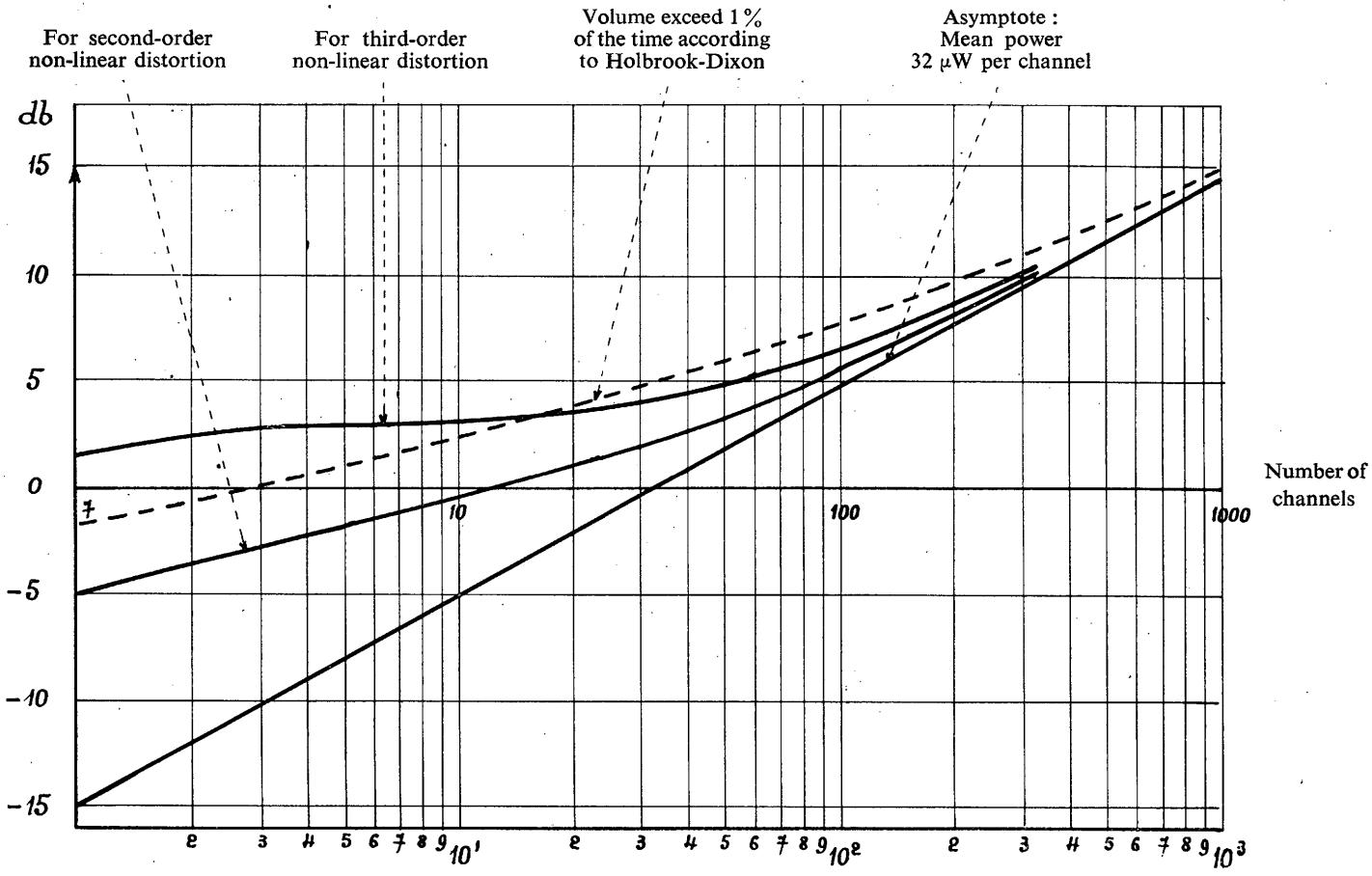


FIGURE 5. — *Equivalent power at a point of zero relative level as a function of the number of channels*

crosstalk which may, in short-distance systems, entail stricter conditions than those concerning crosstalk noise power.

However, when there are fewer channels than about 12, it is advisable to make a more accurate calculation taking account of the statistical distribution of the intermodulation products formed inside each channel. Account should also be taken of amplitude limiting in the channel amplifier.

To calculate unintelligible linear crosstalk noise, use can be made of a mean power of 32 uW per channel. When there are few disturbing telephone circuits, the condition concerning intelligible crosstalk must nevertheless be observed.

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APPENDIX

(to Annex 3 of Question 32)

Determination of the " equivalent power " of the multichannel signal, as a function of the number of channels

The following inquiry shows the values to be added to the mean power (32 μW) per channel to obtain the equivalent power.

(a) Variations in volume.

As is proved by Holbrook's and Dixon's measurements **[1]**, the probability distribution curves of the volume (short-term power) of the multichannel signal are " normal " on a scale graduated in nepers or decibels and have a spread which falls off as the number of channels increases. If we assume that V_0 be the median value and σ the standard deviation, the volume V_1, corresponding to the mean power $\overline{N}$ will be :

$$V_1 = V_0 + \sigma^2$$

whenever all values are expressed in nepers, or :

$$V_1 = V_0 + 0{\cdot}115\ \sigma^2$$

if expressed in decibels.

For calculation of the power of the second-order intermodulation noise, what we have to consider is not so much the mean power $\overline{N}$, but the mean square of the power, $\sqrt{\overline{N^2}}$, because the power of the intermodulation noise is proportional to the square of the basic power. The volume corresponding to this power is :

$$V_2 = V_0 + 2\sigma^2$$

whenever all values are expressed in nepers, or :

$$V_2 = V_0 + 2 \times 0{,}115\ \sigma^2$$

if expressed in decibels.

The mean cube of the power $\sqrt[3]{\overline{N^3}}$, with the relevant volume, has to be obtained in analogous fashion for third-order intermodulation noise. Thus :

$$V_3 = V_0 + 3\sigma^2 \qquad \text{(in nepers)}$$

$$V_3 = V_0 + 3 \times 0{\cdot}115\,\sigma^2 \qquad \text{(in decibels)}$$

Since V_1 corresponds to the value 32 μW per channel, the value Δ to be added for second-order distortion will be

$$\Delta_2 = V_2 - V_1 = \begin{cases} \sigma^2 & \text{(in nepers)} \\ 0{\cdot}115\,\sigma^2 & \text{(in decibels)} \end{cases}$$

and for third-order distortion

$$\Delta_3 = V_3 - V_1 = \begin{cases} 2\sigma^2 & \text{(in nepers)} \\ 2 \times 0{\cdot}115\,\sigma^2 & \text{(in decibels)} \end{cases}$$

The standard deviation σ was deduced from the Holbrook-Dixon curves as a function of the number of active channels (Figure 8) and is shown in Table 2 with the values to be added Δ_2 and Δ_3, calculated from this value of σ.

(b) Non-Gaussian statistical distribution of instantaneous values, when there are few channels.

Because of the non-Gaussian statistical distribution of the instantaneous values when there are few channels, there is a further increase in the intermodulation noise power, which has been calculated by Jacobsen **[2]**. The corresponding values δ to be added are taken from Figure 8 of this article. They show the deviation of the curves from their final asymptotic value (case of a great many channels) which corresponds to a Gaussian distribution. (The values taken as the increase in intermodulation noise power have been converted by calculation into a corresponding increase of the basic power by dividing the values obtained (in decibels) by 2 for second-order distortion and by 3 for third-order distortion). Since these curves originally applied to active channels with a constant volume, a slightly higher value of δ was used, corresponding to half the number of active channels, to take account of volume variations occurring at the same time. The values to be added determined in this way are also shown in Table 2 as a function

TABLE 2

Values to be added for determining the equivalent power as a function of the number of active channels

		Number of active channels n				
		1	2	4	16	64
Standard deviation on volume	σ db	5·8	4·4	3·4	1·95	1·15
Second-order distortion	Δ_2 db	3·85	2·24	1·33	0·44	0·15
	δ_2 db	3·40	3·40	2·30	0·78	0·125
	$\Delta_2 + \delta_2$ db	7·25	5·64	3·63	1·22	0·275
Third-order distortion	Δ_3 db	7·7	4·48	2·66	0·88	0·30
	δ_3 db	5·27	5·27	3·86	1·60	0·53
	$\Delta_3 + \delta_3$ db	12·97	9·75	6·52	2·48	0·83

of the number of active channels. Since the distribution of instantaneous values is, at a first approximation, independent of the distribution of the volume, the two supplements have been added to obtain the overall supplement, which is also shown in Table 2 as a function of the number of active channels.

(c) Consideration of the relation for n active channels in a system having N channels.

In the case of a mean time ratio for the "activity" of a channel $\tau = 1/4$, the probability that, in a system having N channels, precisely n channels will be active is given by

$$p\ (n) \quad = C_n^N \tau^n\ (1-\tau)^{N-n}$$

Assuming that N_0 is the mean power for one active channel (i.e.,

$$N_0 = 4 \times 32\ \mu W = 128\ \mu W)$$

and $q\ (n)$ is the power ratio corresponding to the values to be added (in which 10 log $q\ (n) = \Delta + \delta$), the total power of the intermodulation noise $N_K{}^2$ of second-order distortion is for a system having N channels, and neglecting a constant factor

$$N_{K2} \quad = \sum_1^N p\ (n)\ [n\ N_0\ q_2\ (n)]^2$$

and of third-order distortion

$$N_{K3} \quad = \sum_1^N p\ (n)\ [n\ N_0\ q_3\ (n)]^3$$

If, for a system with N channels, the increase in the basic power with respect to the value $N_0/4 = 32\ \mu W$ per channel is defined by the factor $Q\ (N)$ in such a way that the power of the intermodulation noise calculated with this corresponds to real conditions, i.e., if

$$N_{K2} \quad = \left[N \frac{N_0}{4}\ Q_2\ (N)\right]^2$$

$$N_K \quad = \left[N \frac{N_0}{4}\ Q_3\ (N)\right]^3$$

the following formulae are obtained for $Q\ (N)$

$$Q_2{}^2\ (N) = \sum_1^N p\ (n) \left[4\ \frac{n}{N} q_2\ (n)\right]^2$$

$$Q_3{}^3\ (N) = \sum_1^N p\ (n) \left[4\ \frac{n}{N} q_3\ (n)\right]^3$$

These values (expressed in decibels (i.e., 10 log $Q\ (N)$) have been calculated and are given in Table 1, in Annex 3 or in Figure 5, as a function of the number of channels.

Note. — In the calculation, the increase in the overall intermodulation noise power was computed in the basis of the statistical variations of speech and a possible variation of the intermodulation noise distribution curves with frequency was not considered. The influence of limiting speech currents in the channel amplifier has also been neglected.

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ANNEX 4

(to Question 32 of Study Group 1)

Comments from the Cuban Telephone Company on the definition of hypothetical reference circuits and calculation of noise on such circuits

I. — *Notes on the meaning and use of hypothetical reference circuits*

1. The hypothetical reference circuit is a convention made for the purpose of facilitating computations which lead to the design of components (such as amplifiers) which will be used in making up actual systems.

2. The hypothetical reference circuit should be a representation of what actual circuits are likely to be in practice. Sources of noise and distortion should be present in the reference circuit to an extent which represents faithfully what will generally not be exceeded in actual installations or will generally only be slightly exceeded.

3. The effect of deviations from the reference circuit ought therefore to " balance out ", i.e. if some parts of the circuits in practice have too much of a particular type of impairment, other parts ought by chance to have a sub-normal amount of this type of impairment. A correct reference circuit is one in which this condition is reasonably satisfied.

4. As an example of the effect of deviations, compare the non-linear distortion of third order in-phase type in a reference circuit which consists of six uniform sections giving in-phase addition inside the sections only and a slightly different reference circuit in which there are three sub-sections of length 2/9ths of the overall length + three of length 1/9th of the overall length. In this case the particular type of non-linear distortion will, if the same type of repeater is used in both cases, give 0·65 db less distortion in the case of the six uniform sections. This excess of permitted amplifier distortion may be considered negligible in view of the fact that the increase is only on a particular component of all the various noise effects but the example shows that increase of length is very important. One could make rules and the rule in this case should be to give a limit for the square root of the sum of the squares at all sub-section lengths because this is of controlling importance.

However, it is believed that in actual practice there will be a tendency in most countries to use more sub-sections in actual circuits than the six in the reference circuit for symmetrical pair carrier systems and that, therefore, this particular effect dealt with above will, in general, err on the safe side.

5. *Example.* — Particular aims of the coaxial hypothetical reference circuit.

A1. To allow for the presence in the overall circuit of nine pairs of supergroup terminal equipment.

A2. To allow for up to six pairs of group terminal equipment.

A3. To allow for up to three pairs of channel terminal equipment in the overall reference circuit.

In each case the aim is to allow for all the attenuation and delay distortion and noise produced by the terminal equipments mentioned.

B1. To indicate that the whole assembly of channels making up the coaxial system will not continue (on the average) for more than 1/9th of the total 2,500 km distance before being dispersed into supergroups.

B2. To indicate that a supergroup assembly of channels will be dispersed into groups three times with a length of the group link of 2/9ths of 2,500 km and three times with a length of 1/9th of 2,500 km.

B3. To indicate that the group assembly of channels will be dispersed into single speech circuits three times in the overall length of the reference circuit.

The effect of this is, for instance, to give a limit to the length over which certain types of distortion which add in-phase will continue to build up before a new assembly of the line spectrum is produced but it also indicates a requirement for the magnitude of similar effects occurring inside supergroups and groups.

In connexion with aims B, so far as the line amplifiers in a coaxial system are concerned, B.1 is probably the only effect of major importance, but for systems such as 60-channel systems B.2 may also be important. A particular type of third order distortion ($2f_1 - f_2$ type) will add in-phase and, what is more, the in-phase addition will continue inside a group for as long as that group lasts. This in-phase addition will apply to distortion in the repeaters and also in the terminal equipments and it is necessary to ensure that " extended in-phase addition " does not produce peak noise exceeding that to be specified (Question 24 refers). This is particularly so since these terms are very highly fluctuating (see Electrical Communication, July 1940, page 47, Figure 11).

6. *Effect of " Mixed " Circuits.* — In practice actual circuits will be made up of whatever facility is available for the section required. In this case one cannot rely on the properties of other systems being such that they will justify a particular system in question in having extraordinary properties. Thus it is almost implied for the individual reference circuits that they shall yield partial circuits which are suitable for being connected with other partial circuits and then to produce a satisfactory overall circuit.

Looked at in this way one cannot pre-suppose that other partial circuits will not have a performance of the best possible type, i.e. one according to which all channels just meet the exact noise power specification. It is, therefore, not permissible to assume that other partial circuits are better than they need be.

II. — *Calculation of noise on hypothetical reference circuits*

Although it would be advantageous to prescribe a precise method of calculating the noise to be expected on each type of reference circuit, it is not considered practicable to specify a simplified procedure which would be universally applicable to all system designs, since the adverse effects which such simplification might in some cases have on the overall performance are liable to be overlooked.

In what follows comments are given on the method of calculation proposed by the French Administration in the Annex 2 to the present question and attention is drawn to the various detailed factors which should strictly be taken into consideration in place of the rather simplified procedure suggested. It is not therefore considered that the French proposal should be adopted as a preferred or specified way of calculating the noise in symmetrical pair carrier systems.

Comments on Annex 2 (paragraph I.C.).

(a) Thermal noise. — It is assumed that the figure of $-16{\cdot}25$ N ($-141{\cdot}1$ dbm) in equation (1) relates to normal C.C.I.F. channels (300-3400 c/s).

(b) Noise due to non-linear distortion. — The present comment will be restricted to the second order non-linear distortion but similar statements could probably be made about the third order distortion which may or may not be limiting.

The formula shown is what may be called a " white noise " loading formula. It gives the noise which would be measured when all channels are loaded with " white noise " of a power equal to the long term mean speech loading of the channel in actual service.

This loading completely ignores the fact that the channels are only active for about 1/4 of the time, so that when they are active the loading will be 6 db higher. It similarly ignores the fact that the speech volumes on the channel are distributed with a log-normal deviation of about 6 db. It has previously been stated on the subject of noise loading that the error involved in designing the system to cope only with noise loading, as apart from true speech loading, will be very small only for very large numbers of channels. For 60 channels the error will certainly not be negligible. The following example is intended to illustrate this point.

Assume " white noise " loading of −15 dbm0 per channel. If the amplifiers are designed to accept this loading and produce then in 2,500 km a noise amounting to −53 dbm0p, it would in a 60-channel system (3 link) be found that noise peaks due to direct second harmonic of a channel falling into another channel would for about 1·5% of the time produce noise, due to this cause only, in excess of −46·5 dbm0p. This illustrates clearly the need for having a peak noise specification and also for taking into account the fact that the signal loading is speech and not " white noise ".

What has been said above for second order non-linear distortion holds also for third order non-linear distortion and here some further facts are operative, namely, that in-phase addition of some third order terms will be continued through a point where the system spectrum is dispersed into (say) five groups and will continue until the group spectrum is dispersed. These terms are almost certainly limiting for third order distortion in systems with smallish numbers of channels and in which groups could be extended over the whole 2,500 km distance. The reference circuit as now specified does not actually allow for this; it assumes that the groups will be broken down at least at two points in the overall circuit.

This may be a justifiable assumption for the time being, but in the long run it might become more common to send whole groups over very long distances; for the present it is certainly necessary to take account of the present hypothetical reference circuit which allows this " extended in-phase " addition to continue for up to about 800 km.

In view of the above it is not considered that Annex 2 above is a preferred or specified way of working out the noise in a 60-channel system. Until the C.C.I.T.T. agrees on the noise target (SG 1, Question 7), presumably the 1% C.C.I.F. noise recommendation will hold and performance requirements should take account of this and of the true speech loading. The fact that a mean power was agreed for the speech loading does not automatically justify the assumption that there is no fluctuation in the loading when it is due to speech and a fluctuation allowance must be made for all systems, although for the coaxial system it tends to be very small indeed. For a 60-channel system it will probably work out to be of the order of 4 db extra loading for short periods but the exact amount will depend on the noise target when it is chosen.

(c) Noise due to crosstalk. — While the simple relationship suggested for determining the r.m.s. crosstalk $D_{(m)r}$, from the specified worst value of crosstalk $D_{o(r)}$, may be useful for obtaining a preliminary estimate of noise due to crosstalk, it is considered that a precise determination of the r.m.s. crosstalk value should be made wherever possible.

ANNEX 5

(to Question 32 of Study Group 1)

Proposals by the Italian Telephone Administration on Calculation of Noise at the end of Hypothetical Reference Circuits

The Italian Administration considers that for this purpose other assumptions must be made and defined, apart from the data now being considered, for example :

(a) average power transmitted to line (with relevant peak factor) in the system, as a function of the number of circuits routed over that system;

(b) the law of addition of the various noise components.

Hypothetical reference circuit on FDM radio relay systems

Since Question 32, as far as radio relay systems are concerned, will be studied by C.C.I.T.T. Study Group 3, with the C.C.I.R., the Italian Administration offers the following comments and proposals :

The hypothetical reference circuit is intended as a guide for manufacturers. It is a circuit with conventional characteristics, based, whenever possible, on the statistical averages obtained in actual practice. When equipment satisfying recommendations valid for the hypothetical reference circuit is being used in actual operation, under conditions very different from those set for the reference circuit, suitable steps must be taken to ensure good transmission on the real telephone circuits, in accordance with criteria which have to be agreed upon (see Question 33).

So that the hypothetical reference circuit for multichannel FDM radio relay systems may be of use in the study of equipment we would suggest that its definition be supplemented as follows :

1. The reference circuit must be considered as made up of the sending and receiving equipment, the filters, decouplers, antennas and associated feeders, designed for normal use together.

2. Each section, 280 km long, must be divided into five sub-sections, each of them 56 km long. At the end of each of these latter is a simple relay station (without demodulation), while at the end of every 280 km section is a composite relay station (with demodulation).

The need for this division arises from the fact that the manufacturer must have full data to plan his equipment. 56 km is the average length of radio relay link sections already existing.

3. Propagation loss in each section must be assumed equal to the theoretical loss in free space, at the mid-frequency of the working high-frequency band, plus five decibels. The feeders must be of a kind actually used with the equipment, and must each be 15 m long. The filters, decouplers and antennas must be those actually used with the equipment.

Five decibels for the additional loss corresponds to a certain average, obtained statistically, which makes allowance for the possibility of deep fading on certain sections when each section

is some 50 km long. Similarly, fifteen m for each feeder is derived from statistics obtained with equipment actually built.

For the hypothetical reference circuit so made up, it is proposed that the power of the noise due to the modulation and demodulation equipment should not exceed 2,500 pW at a point of zero relative level, on the reception side. On the other hand, the power of the noise due to the high-frequency equipment must not exceed 7,500 pW at the same point, when standardized values are used for :

(a) frequency swing;

(b) pre-emphasis;

(c) power of the white noise representing the signal in the baseband.

(a) The RMS values of the frequency swing for a 800 c/s sine-wave signal, with 1mW at a point of zero relative level, that we propose are as follows :

Maximum number of channels	Frequency swing (Rms value) in kc/s
60	50-100-200
120	20-100-200
240	150
600	150

(b) The degrees of pre-emphasis which ought to be standardized will be considered later. Be that as it may, the total figure to be recommended for the frequency swing (RMS value) might usefully remain the same whether or no there be pre-emphasis. This latter should not exceed twelve decibels.

(c) A separate study ought to be made of the question of white noise level (uniform continuous spectrum signal in the baseband having a Gaussian probability density function) used to represent the multi-channel signal.

For radio relay systems, the Italian Administration uses the following powers levels, in dbm, at a point of zero relative level :

No. of channels	Power level
60	6·6
120	8·3
180	9·4
240	10·4
360	11·6
480	12·5
600	13·3

Standardization of frequency swings and of pre-emphasis seems necessary to ensure uniformity of operating conditions, especially in view of the possibility of radio relay systems belonging to different Administrations being interconnected at intermediate or high frequencies. In this case, on equipment in service, both the frequency swing and pre-emphasis will normally be adjusted to the figure which provides the best signal-to-noise ratio, as far as there can be any choice, bearing in mind other requirements, for example, the desirability of avoiding an excessive high-frequency spectrum width. Hence these figures can differ from the figures standardized for the hypothetical reference circuit according to circumstance (there may, for example, be topographical considerations), in the light of which the route and equipment are chosen. But if the equipment to be interconnected is standardized as to characteristics, then interconnection may be easier, provided that care is taken not to use such equipment in circumstances very different from the normal ones. Otherwise, there is a danger that the noise at the end of the circuit will be excessive.

From this point of view, it is, we think, necessary to agree on the power of the multiplex signal, so that there may be one factor common to all Administrations and all carrier systems.

ANNEX 6
(to Question 32 of Study Group 1)

Sociedad Teléfonos de México. Some Comments on Hypothetical Reference Circuits

We consider that the information is insufficient and requires to be supplemented.

It is very desirable, both for planning of international circuits and for the design of carrier systems, to be able to divide up the total noise requirement between the various parts of the circuit. The " circuit fictif de référence sur paires coaxiales ", for example, comprises in principle three voice frequency links in tandem, each including one through-supergroup and one through-group connection. Since a considerable increase can be foreseen in both international and national traffic, which will tend to be handled by the transmission of entire groups or supergroups, the question arises as to whether the existing reference circuit should not be supplemented by alternatives for the transmission of such groups over 2500 km. It is possible in principle to obtain these additional reference circuits by :

(a) replacing the existing voice frequency through-connections by through-group connections for the case of the unbroken group link,

(b) by replacing both the V.F. and group through-connections by through-supergroup connections in the case of the unbroken supergroup link.

The additional reference circuits would then comprise :

(a) for unbroken group link :
- 9 pairs of supergroup translating equipment;
- 6 pairs of group translating equipment;
- 1 pair of channel translating equipment;

(b) for unbroken supergroup link :
- 9 pairs of supergroup translating equipment;
- 1 pair of group translating equipment;
- 1 pair of channel translating equipment.

With these three alternative reference circuits, it is then possible in principle to divide up the total permitted noise amongst the various parts of the equipment. Due regard must be paid, both in the case of group and supergroup links, to the possibility of certain types of intermodulation products (e.g. $2f_1$-f_2) produced in group or supergroup translating stages respectively, adding on a voltage rather than a power basis within the unbroken group or supergroup.

ANNEX 7
(to Question 32 of Study Group 1)

Remarks by Swedish Administration on Hypothetical reference circuits

The Swedish Administration considers that more supergroup through connections may be required than those indicated for the present reference circuit. Moreover, it is not possible at present to determine what amount of noise is to be attributed to the different modulation stages, etc. Under these circumstances it may be questioned whether the present constitution of the reference circuit should not be re-considered, in view, *inter alia*, of the subsequent addition of master groups.

Question 33.

(Study Group 1, in co-operation with Study Group 3 and with the C.C.I.R.; preliminary study by joint Group C.C.I.T.T./C.C.I.R. of the problem of " noise ")

(New Question)

Is it possible to deduce, from the recommendations concerning noise on hypothetical reference circuits for telephony on cable and radio systems, conditions which should be satisfied as regards noise on an *actual* section of any length when it is being *set up* ?

If so, what specification *can* be recommended ?

Question 34.

(Sub-Group 1/1, then Study Group 1)

(continuation of part " b " of Question 36 of C.C.I.F. Study Group 3, 1955/1956)

What general electrical characteristics should be recommended for symmetrical pair cables and for carrier equipments designed to provide more than 60 circuits on symmetrical pairs ?

Note 1. — In the study of this question, the recommendation of the C.C.I.F. reproduced in appendix 1 which follows should be taken into account.

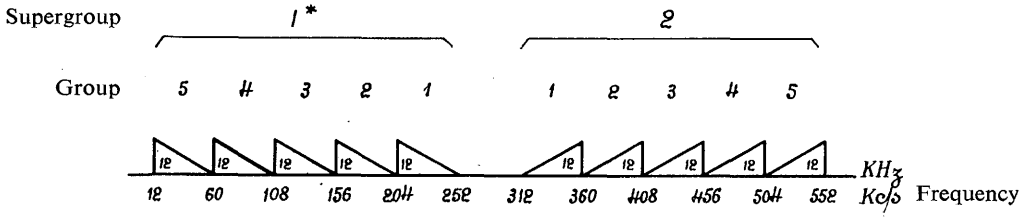
Note 2. — As a guide in the study of this question, appendix 2 which follows reproduces the proposals made by the Telephone Administration of the Federal German Republic for specifying the general characteristics of such systems. By way of example, appendix 3 describes an existing system satisfying the conditions given in appendix 2.

ANNEX 1

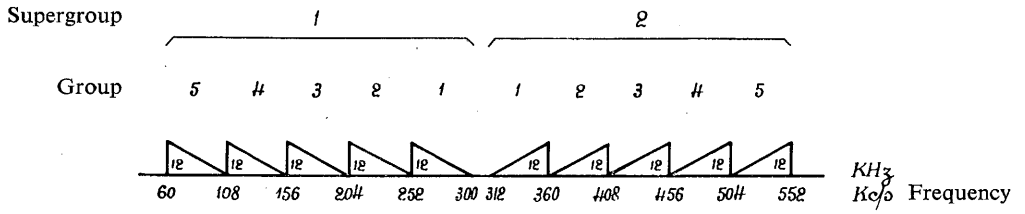
(to Question 34 of Study Group 1)

Recommendation made by the XVIIIth Plenary Assembly of the C.C.I.F. for the frequency allocation in 120-circuit carrier systems on symmetrical pair cables

Administrations or private operating companies wishing to use 120-circuit carrier systems on symmetrical-pair cables have the choice of the two schemes of line frequency allocation shown below.



Schema No. 1



Schema No. 2

Supergroups 1 and 2 are identical with those used on carrier systems on coaxial pairs. Supergroup 1 *) is identical with that which is normally recommended for 5 groups on symmetrical-pair cables.

Note. — By agreement between the interested Administrations or private operating companies, instead of supergroup 1 *, supergroup 1 *' corresponding to scheme No. 2, bis of figure 15 (*e*) of Volume III of the C.C.I.F. *Green Book* can be used for systems on symmetrical-pair cable giving 5 supergroups.

ANNEX 2

(to Question 34 of Study Group 1)

General characteristics proposed by the Telephone Administration of the Federal German Republic for a system giving 10 groups on a symmetrical-pair

If particularly low-loss insulating materials (Styroflex for example) are used instead of paper, symmetrical-pair cables for carrier systems can be made with attenuation at 552 kc/s not much greater than the attenuation of paper-insulated symmetrical-pair cables at 252 kc/s. Figure 1 following shows the attenuation (per kilometre) of paper-insulated symmetrical-pair cables,

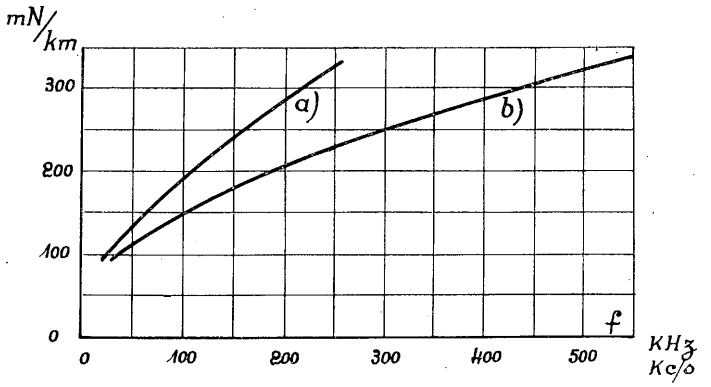


FIGURE 1

Attenuation of cable pairs used with carrier systems V 60 and V 120

Curve *(a)*: Star quad, copper conductor 1-2 mm, paper-insulated (V 60).
Nominal capacitance, 26 nF/km, Characteristic Impedance, 175 ohms.

Curve *(b)*: Star quad, copper conductor 1-3 mm, Styroflex-insulated (V 120).
Nominal capacitance; 22 nF/km, Characteristic Impedance, 190 ohms.

with a capacitance of 26·5 μF/km, curve (*a*) and of symmetrical-pair cables insulated with styroflex used in Germany (diameter of the copper conductors 1·3 mm. Nominal value of the capacity 22 μF/km curve (*b*)), with such pairs carrier telephone systems having 120 circuits can be used.

The electrical characteristics of carrier systems with 120 circuits must be fundamentally the same as those of systems with 60 circuits.

It appears desirable to retain at +0·2 N (+1·75 db) the relative channel level at the output of intermediate repeaters already recommended for 60-circuit systems. This will avoid difficulties of interconnection with 60-circuit systems and would not introduce additional maintenance difficulties. The consequent requirements for power handling capacity and harmonic margin of the line amplifiers would then be somewhat more severe than for 60-circuit systems as the number of channels is doubled.

The proposed 10-group (2 supergroup) carrier system for symmetrical pair cables may be defined more precisely by the following recommendations :—

General and System Operating Conditions

(Cf. Volume III of the C.C.I.F. *Green Book* under 3.3.1 to 3.3.5, pages 68 to 79)

1. *Hypothetical Reference Circuit.*

The composition of the hypothetical reference circuit for a 10-group (2 supergroup) carrier system should be the same as that of the hypothetical reference circuit for 16 supergroup coaxial cable system.

2. *Noise.*

Basic noise	1 pW/km
Intermodulation noise	1 pW/km
Crosstalk noise	1 pW/km

Note. — The figures are valid for the usual case in which the circuit in question changes its place several times in the frequency band at the intermediate modulations stages of the hypothetical reference circuit.

3. *Matching of repeater and cable impedances.*

As for systems having 5 groups, i.e., the permissible reflection coefficient may be

$$0{\cdot}15\sqrt{\frac{f_{\max}}{f}}$$

but not to exceed 0·25 $f_{\max}$ being the highest frequency transmitted.

4. *Line Regulating Pilots.*

The Telecommunications Administration of the Federal German Republic proposes the following pilot frequencies and levels, which conform to the present recommendations for 5 group systems (Volume III of the *Green Book*, page 72, paragraph A).

Lower pilot : −60 kc/s, absolute power level of −1·73 N (−15 db) at a point of zero relative level.

Upper pilot : −4 kc/s above the highest transmitted frequency, i.e., 556 kc/s, absolute power level of −1·73 N (−15 db) at a point of zero relative level.

5. *Relative Level at Repeater Outputs.*

As for 5-group systems, i.e., +0·2 N (+1·75 db).

6. *Intermediate Repeaters.*

(a) Maximum Gain : As for 5-group systems, i.e., 7 N (61 db nominally).

(b) Non-linear distortion :

Second Harmonic	9·5 N (82 db)
Third Harmonic	11·5 N (110 db)

Note. — These values apply when the repeater gain is set to 6·5 N (56·5 db) and for a fundamental power of 1 mW at a point of zero relative level, and assuming that average quality valves are used.

(c) Available power : The overload-point of a repeater should be not less than +3·3 N (+29 db).

(d) Crosstalk ratio between repeaters: As for 5-group systems i.e., 8·5 N (74 db).

(e) Basic Noise: Equal to the value proposed by the Telecommunications Administration of the Federal German Republic for 4 and 5 groups, i.e., at most 0·4 N (3·5 db) above thermal agitation noise in the case of a repeater having a uniform gain-frequency response.

LINES

A. *Cable Specification.*

(a) Type of cable.

The Telecommunications Administration of the Federal German Republic proposes to mention in the table on p. 79 of Volume III of the *Green Book*, a type of cable IV for the transmission of 120 channels in the band of frequencies 12 to 552 kc/s having the following (nominal values) characteristics :

Conductor diameter	1·3 mm
Effective capacitance	22 nF/km
Characteristic Impedance :	
at 60 kc/s	196 ohms
120 kc/s	193 ohms
240 kc/s	190 ohms
550 kc/s	188 ohms

(b) Regularity of Factory Lengths.

The same tolerances as for type III cable could be permitted for the regularity of factory lengths of type IV cable.

(c) Crosstalk.

The Telecommunications Administration of the Federal German Republic has decided to measure crosstalk directly in accordance with Volume III of the *Green Book*, under 3.3.6.Ac.1 pp. 80 and 81, and can propose only the following recommendation.

For a factory length of 230 metres, the crosstalk between any two circuits should satisfy the following conditions :

	at 240 kc/s
Far-end crosstalk attenuation	at least 7·8 N (68 db)
Near-end crosstalk attenuation	at least 6·6 N (56 db)

It appears unnecessary to fix a value for higher frequencies because, for factory lengths, sufficiently reliable statistical relationship exists between measured values at different frequencies and because measurements at, for example, 552 kc/s require disproportionate expense for factory equipment.

Note. — From the experience of the Telecommunications Administration of the Federal German Republic it may be stated that cables which satisfy the conditions mentioned can be obtained and also that the conditions mentioned above for a repeater section can be obtained if the usual methods of balancing are adopted.

(d) Insulation resistance.

As for cable type III.

(e) Dielectric strength.

As for cable type III.

B. *Specification for a Repeater Station.*

As for cable type III.

ANNEX 3

(to Question 34 of Study Group 1)

Description of a 120-circuit Carrier System on Symmetrical Pairs V 120

A. *System Design.*

The 120-circuit carrier system V 120 serves to transmit 2 supergroups on symmetrical pair cables. In this system, in addition to supergroup 1 * (12-252 kc/s) which is transmitted in the 60-circuit system V 60 and is obtained by supergroup modulation of the basic supergroup (312-552 kc/s), the basic supergroup is itself transmitted as supergroup 2 together with supergroup 1*.

B. *Electrical Characteristics of Carrier Equipments in System V 120.*

As it is assumed that it is intended to interconnect supergroup 1 * without frequency-changing in the carrier network already existing with 60-circuit (V 60) systems, the V 120 system has retained the same relative level of +0·2 N (+1·75 db) per channel at the output of terminal equipment and of intermediate repeaters, which has been fixed for 60-circuit systems. The overload-point of transmitting amplifiers and line repeaters on the V 120 system has been, because of the greater number of channels, increased above the 600 mW for 60-circuit systems, to 735 mW (+3·3 N or +29 db).

The harmonic margin for repeaters on the V 180 system is :—

For 2nd harmonic of a test frequency at 1 mW (at a point of zero relative level), $\geqslant$ 9·5 N (82 db).

For 3rd harmonic of a test frequency at 1 mW (at a point of zero relative level), $\geqslant$ 11·5 N (100 db).

The V 120 line repeaters serve to correct for the attenuation of a repeater section up to 7 N (61 db); repeater sections are usually of 6·5 N (56·5 db) attenuation but 20% of the sections may have an attenuation in excess of this, up to 7 N (61 db). With these values of attenuation for the repeater sections, the psophometric power of the basic noise in the telephone channels of the V 120 system remains less than or equal to 1 pW/km. So far as noise is concerned, all the channels of the V 120 system satisfy the recommendations of the C.C.I.F. for the hypothetical reference circuit of 2500 km. It is assumed here that the circuit in question is not transmitted throughout the length at the highest frequencies but its place in the frequency-band transmitted is several times changed at the intermediate stages of modulation specified in the hypothetical reference circuit.

C. *Cables for the V 120 Carrier System.*

Cables for the V 120 Carrier System contain star quads insulated with Styroflex. The attenuation of the cable-pairs of the V 120 system and the V 60 system (paper insulated) used up to the present is shown at Figure 1 of Appendix 1 above. Due to the use of Styroflex and a small increase in the diameter of the copper conductors from 1·2 mm to 1·3 mm, about the same attenuation is obtained at 552 kc/s on the cable pairs for the V 120 system as at 252 kc/s on the cable pairs for the V 60 system. The following cable types have been used up to the present for the V 120 system :

(1) 14-pair cables with a central quad and 6 quads in the outer layer on the Limburg-Koblenz-Trier route, which were also used with the V 60 system.

(2) 17-pair cables with a central group of coaxial pairs 2·6/9·5 mm conforming to the C.C.I.R. recommendations and on outer layer of 8 quads for the routes. München-Nürnberg-Frankfurt (Main), Düsseldorf-Bremen-Hamburg, Düsseldorf-Aachen. These 17-pair cables will be used for the proposed extention of the inter-urban German carrier network. The Nürnberg-Würzburg and Aachen-Düsseldorf-Dortmund sections have already been in service for some time.

The central pair in the 17-pair cable would be used for television transmission with repeater for the band 0·3-6 Mc/s. The picture signal (carrier frequency 1056 kc/s) is transmitted within the band 0·5 to 6 Mc/s. The television repeaters will also permit as an alternative to a television signal, 15 supergroups (supergroups Nos. 2 to 16) of a V 960 carrier system on coaxial pairs, in accordance with C.C.I.F. recommendations so far as circuit noise is concerned.

The length of the coaxial repeater sections is about 9·3 km but there is sufficient margin for 9·8 km sections. This is one-half the length of the 120 repeater sections. All the repeaters, including the V 120 repeaters in the outer layers are power-fed via the coaxial pairs (750 V, 50 c/s on each inner conductor of the two coaxial pairs). Three or four repeater stations may be power-fed and controlled on each side of a power-feeding station. In the event of a fault or of disconnection of an inner conductor of one of the coaxial pairs in a repeater section, power-feeding on one cable alone is sufficient to maintain the repeater supplies for both directions of transmission. Switching to local mains power is possible in all repeater stations.

As also in the V 60 carrier system, the phantom circuits in the V 120 system may be used for programme transmission (50 to 10,000 c/s) or for supervisory or speaker circuits. The following scheme may be used for an equipped cable :

Coaxial repeaters at each station :
mean spacing about 9 km.

V 120 repeaters at every second station :
mean spacing about 18 km.

Programme repeaters at every fourth station, mean spacing about 36 km.

Figure 2 gives, by the way of example, distribution curves of the values of far-end crosstalk attenuation after balancing measured on repeater section in completed working order.

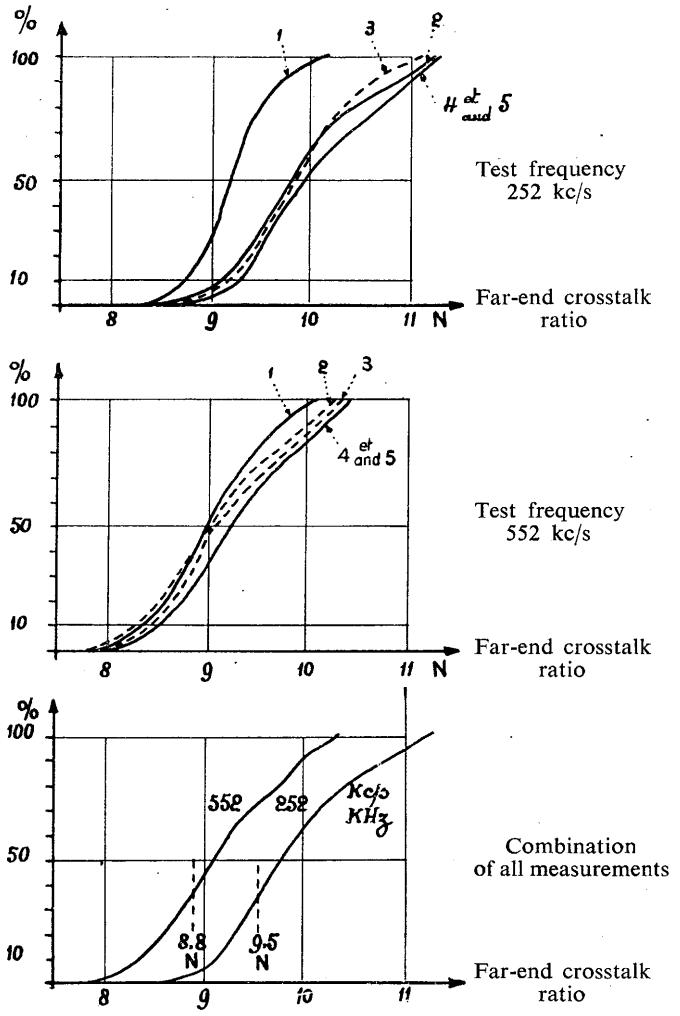


FIGURE 2. — *Distribution curves of Far-end crosstalk measurements on a " V 120 " repeater section Eggensee-Oberlaimbach*

1. Within-quad measurements (32 values)
2. Adjacent-quad measurements (128 values)
3. Between-quad measurements, one intermediate quad (128 values)
4. Between-quad measurements, two intermediate quads (128 values)
5. Between-quad measurements, three intermediate quads (64 values)

Question 35.

(Sub-Group 1/1, then Study Group 1)

(continuation of Question 37 of C.C.I.F. Study Group 3, 1955/1956)

What should be the characteristics of a second system giving 3 good quality telephone circuits (300-3400 c/s) on an open-wire pair, this second system being intended to

satisfy the needs of countries in which the 3 circuit system described in Section 3. 5.1 of the C.C.I.F. *Green Book* Vol. III (pages 104-106) is not suitable ?

Question 36.

(Sub-Group 1/1, then Study Group 1)

(New Question)

Considering the frequency band available for the 3 circuits system (Vol. III, page 106) operated on the same pair of open-wires as a 12 circuit system of Scheme I of the frequency spectrum, Figure 9, page 61, Vol. III of C.C.I.F., *Green Book*, it is considered that if the upper pilot is used (31, 110 kc/s) now recommended (page 105 of Volume III of the *Green Book*), the regulation of the 3 circuits system may be compromized by the presence of several filters in tandem on the line.

Should another upper pilot frequency be recommended, either as an alternative, or else to replace the frequency now recommended of 31, 110 kc/s and what should this now frequency be ?

Question 37.

(Sub-Group 1/3, them Study Group 1, in co-operation with Study Group 9) (question 37 of Study Group 9)

(New Question)

(a) Is it necessary to introduce, for international traffic, systems providing telegraph channels (up to six) in conjunction with 3 circuit carrier telephone systems on long open-wire lines in which a common repeater can be used for telegraphy and telephony ?

(b) If so, what characteristics should be specified concerning the number and the frequencies to be used for the telegraph channels, it being understood that the frequencies used should be adjacent to the bands of frequencies employed for the two directions of transmission of the three telephone circuits ?

Note. — The C.C.I.F. XVIIIth Plenary Assembly made some modifications in Volume III of the *Green Book* (page 104), especially in paragraph 3.5.1 :

> " This system can admit, as an integral part, a certain number of telegraph channels, without affecting the width of the frequency band transmitted by the carrier current circuits. However, in this case, the width of the band of frequencies transmitted by the voice frequency circuit is diminished."

This is important for some Administrations, especially in the Middle East. These Administrations desire to have a small number of telegraph channels (up to six) without having to use a *standard* voice frequency telegraph system on one of the telephone circuits, effecting thereby an economy, as all the telephone circuits are retained entirely for telephone traffic.

Question 38.

(Study Group 1, in co-operation with Study Group 5)

(continuation of parts (a), (b) *and* (c) *of Question 38 of C.C.I.F. Study Group 3, 1955/1956)*

(a) What is the maximum permissible value of the psophometric e.m.f. of the noise calculated at the end of the nominal maximum circuit on 12 circuit open-wire carrier systems (point of relative level −0.8 N or −7 db) ?

(b) What is the maximum permissible value of each of the main components of the total noise defined under *(a)*, for example, line noise, repeater noise, noise from terminal equipments, intermodulation and noise introduced by power lines ?

(c) What limits may be fixed for crosstalk at the end of the nominal maximum circuit on 12 circuit open-wire carrier systems, taking into account the improvement which may be obtained by inversion of the transmitted frequency bands, by staggering the carrier frequencies used for various systems on the same route, and by means of compandors ?

Note. — In the study of this question, particular note should be taken of the reply of the C.C.I.F. Study Group 3 to this question, in March 1956, reproduced in the following appendix.

ANNEX

(to Question 38 of Study Group 1)

Reply by C.C.I.F. Study Group 3 to parts (a) (b) and (c) of Question 38 studied in 1956.

(a) On the basis of the replies received, Study Group 3 concluded that the permissible psophometric e.m.f. of the noise measured at the end of the nominal maximum circuit should be 3 millivolts at a point of relative level −0·8 nepers (−7 db). This corresponds to a value of approximately 20,000 picowatts at a point of zero relative level. The nominal maximum circuit has been assumed to be a circuit of 1,600 miles, including three pairs of channel translating equipments and three pairs of group translating equipments.

The suggested value of three millivolts is the mean value of the noise during the busy hour for the period when the line is not adversely affected by very unfavourable climatic conditions (probably not less than 90% of the time).

Study Group 3 considers that the noise limit of 20,000 picowatts at a point of zero relative level should not prove too difficult to realise in practice. The calculated figures for crosstalk noise, both in the case of pole routes designed for up to sixteen parallel systems (based on figures

provided by the Cuban Telephone Co) and for smaller numbers of systems (based on figures provided by the Italian Administration) were within the limit of 10,000 picowatts proposed for this component in paragraph *(b)* below.

(b) and *(c)* The proposed maximum permissible value of each of the main components contributing to the total noise of 20,000 picowatts mentioned in *(a)* above is :

Line noise	17,500 picowatts
Terminal noise	2,500 picowatts

By way of example the following figures may serve as a guide to the composition of line noise :

Crosstalk	10,000 picowatts
Thermal (repeater) and intermodulation noise .	2,500 picowatts
Power line noise	Insignificant
Other line noise	5,000 picowatts
Total	17,500 picowatts

In determining the figure of line noise it was borne in mind that this noise determines the spacing of repeater stations and hence the whole cost of repeater stations including buildings.

A high proportion of the total noise has been allocated to crosstalk as the reduction of this component is known to be difficult and expensive.

The crosstalk induced in channels of 12 circuit carrier systems may be regarded as noise when :

(a) there is inversion,

(b) there is staggering, and

(c) there are a number of disturbing channels.

It may be calculated from the mean power of a channel (speech and signalling) according to the formula :

$$\text{Ndbm0p} = S - \bar{A}\mu + 10 \log_{10} (r-1) + 10 \log_{10} n - X\mu$$

where Ndbm0p = the psophometric weighted noise, the mean power being taken over the busy hour, in the disturbed channel due to crosstalk at the end of the reference circuit.

Ndbm0p is fixed at −50 dbm0p corresponding to the psophometric weighted noise power of 10,000 pW suggested for noise due to crosstalk at the point of zero level.

S = the long term (busy hour) mean power (speech and signalling) in a disturbing channel. −15 dbmo has been conventionally agreed upon by the C.C.I.F. for this.

$\bar{A}\mu$ = The mean value of line signal to crosstalk ratio (far-end including reflected near-end) for one repeater section. This mean value is determined on a power basis over a " modulation section " (one third of the assumed nominal maximum circuit) for these lines for which the position of channels according

to the recommended frequency schemes in *Green Book*, Volume III, e.g., page 62, remains constant. The mean value is obtained from the expression :

$$\overline{A}\mu = -10 \log_{10} \frac{1}{m} \Sigma_{k=1}^{k=m} 10^{-\frac{1}{10} A\mu k}$$

where m = the number of repeater sections over which the mean is taken, and,

$A\mu\ k$ = the line signal to crosstalk ratio between a particular combination (μ) of pairs in repeater section (k).

$r - 1$ = number of disturbing open-wire circuits,

n = number of repeater sections in the reference circuit,

$X\mu$ = psophometric weighting factor expressing advantage derived from staggering and/or inversion.

No firm figures can be given at this stage for the improvement in crosstalk due to the use of compandors. However, it can be estimated from the information given in the Appendix to Question 40 hereafter, that if the noise has a higher value than −30 dbm0, the improvement due to the compandor decreased linearly to zero at a level of noise of 0 dbm0. For example, in the case of noise of −15 dbm0, the improvement due to the compandor is about 10 db, resulting in an overall noise level of −25 dbm0.

Question 39.

(Study Group 1)

(continuation of Question 39 of C.C.I.F. Study Group 3, 1955/1956)

(a) What is the permissible maximum length for a system giving 12 carrier telephone circuits on a pair of open wires, in accordance with the Recommendations on pages 59 to 68 of the *Green Book* Volume III, on condition that these telephone circuits satisfy all the general recommendations of the C.C.I.F. relating to stability, noise, variation of equivalent as a function of frequency, crosstalk, etc... specified for international continental circuits on pp. 28-42 of the *Green Book*, Volume III ?

Note. — It is understood that in the reply to this part *(a)*, all useful information will be supplied concerning construction of the pole route, repeater spacing, climatic conditions, etc...

(b) What characteristics can be agreed to specify the definition of the hypothetical reference circuit of 2500 km on open-wire lines ?

Note. — The Annex below reproduces the reply made by Study Group 3 in March 1956. On the other hand, the permissible noise at the end of the hypothetical reference circuit is covered in Question No. 38.

(c) What transmission performance can be accepted in practice from the double point of view of technique and economy for very long open-wire circuits, for example between 2500 and 10.000 km ?

Note. — Regarding part *(c)* certain general information already exists in section 2.1 in Part I, Volume III, page 43. On the other hand it would be desirable to study in particular within the scope of part *(c)* the means of improving the stability of transmissions on very long open wire lines, and also to ascertain how the effects of excessive variations in climatic conditions could be remedied.

ANNEX

(to Question 39 of Study Group 1)

Reply by C.C.I.F. Study Group 3 to Question 39, studied in 1956.

Study Group 3 does not consider it has sufficient information available to reply to this question. In paragraph *(a)* of the Annex to Question 38, it is shown that for a 1600-mile nominal maximum circuit on open wire lines, having 3 pairs of channel modulating equipment, and 3 pairs of group modulating equipment, a psophometric e.m.f. of 3 millivolts at a point of relative level, −0·8 N (−7 db) can be accepted.

It is unlikely that this value can be improved to the extent of reaching the limit fixed for cable systems. It is also unlikely that the limits fixed by the C.C.I.F. for crosstalk (*Green Book*, Volume III, page 42), can be satisfied in the case of the nominal maximum circuit on open wire lines. It should be possible to satisfy the general clauses relating to frequency bands effectively transmitted, echoes, propagation time and non-linear distortion.

It is suggested this question should remain for study until greater experience has been obtained.

Question 40.

(Sub-Group 1/1, in co-operation with Sub-Group 1/2, then with Study Group 1)

(continuation of part (d) *of Question 38 of C.C.I.F. Study Group 3, 1955/1956)*

What essential characteristics (static and dynamic) should be recommended for companders intended for speech signals in the case of telephony ?

Note 1. — C.C.I.F. Study Group 3, during its meeting in March, 1956, proposed that the following characteristics should be defined for a syllabic compandor.

1. The normal level (niveau normal au point d'insertion) for which the attenuation of the compressor or the expander, as the case may be, is zero, must have the same value as the level at the point where the compressor or the expander is inserted (see annex 2.11).

2. The static characteristics as determined by the relation between the input and output of the compressor and expander when steady tones are applied; it is necessary to establish values for :

(a) expander rate $= \text{tg } \alpha = \dfrac{dn_S}{dn_E}$

(b) compressor rate $= \text{tg } \beta = \dfrac{dn_S}{dn_E}$

where n_E and n_S are the input and outpul levels, and

(c) the level range within which these relationships should be fulfilled (see appendix § 2.12).

3. Return losses with reference to the nominal impedance for input and output of compressor and expander (see appendix § 2.12).

4. Frequency response, with tolerances (see § 2.14 and remarks 1 and 2 in appendix).

5. Non-linear distorsion (see § 2.15 in appendix).

6. Unweighted noise for compressor and expander (see § 2.16 in appendix).

7. The operating and releasing time intervals between the 10% and 90% values of the output function, related to the steady state values, corresponding to an input step function (see § 2.17 in appendix).

Note 2. — The compandor should not reduce the stability of the circuit (see Appendix, § 2.2). It is very important, if compandors are applied to long open-wire circuits, that attention should be paid to the constancy of level of the point of insertion before the expander.

Note 3. — It seems desirable that the Administrations should give as soon as possible the results of their experience concerning the influence of syllabic compandors on speech intelligibility and on pulse distortion when dial pulse VF signals are transmitted, indicating how the results are obtained.

ANNEX

(to Question 40 of Study Group 1)

Proposals by the Telephone Administration of the Federal German Republic for the characteristics of syllabic compandors

The use of compandors on seriously disturbed circuits on carrier systems has already been studied in detail by various German firms. The Federal German Postal and Telecommunications Administration has long used over a wide field short distance carrier systems of type Z6NC with compandors. Experience has shown that the intelligibility of speech transmitted is not adversely affected by cascading 3 or 4 telephone circuits each equipped with compandors.

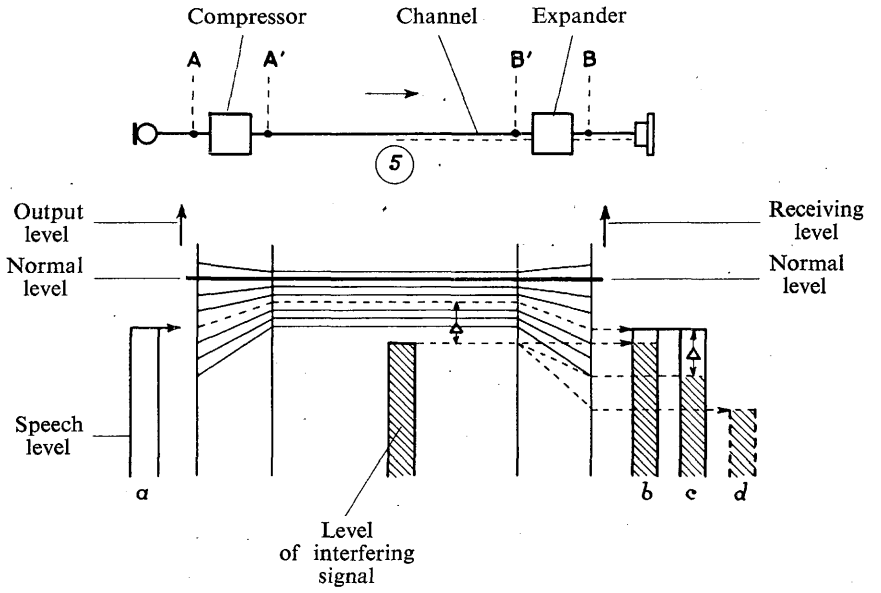
Assuming that compandors may be used in the same way on open-wire carrier systems, the essential characteristics of such compandors is given in the form of the following contribution by the manufacture of the Z6NC system. In this system, the compandors are incorporated in the channel translating equipments but there is no difficulty in making the same compandors as separate equipments which may be inserted as auxiliary items at the ends of a four-wire circuit.

Contribution by Standard Elektrizitäts-Aktiengesellschaft A.G. (Abteilung Mix & Genest Stuttgart) on essential characteristics (static and dynamic) of a syllabic compandor.

1. *Preliminary Note.*

Among the voice-operated equipment which has long been used over a wide field (echo-suppressors, singing suppressors [Vodas], volume regulators [Vogad], another type of equipment under the general heading of " compandor " (compressor and expander) is becoming more and more important **[1, 2, 3, 4]**.

The compandor has as its aim the reduction, in speech and music transmission systems, of the physiological effect of disturbing voltages which appear on a transmission channel. This result is achieved by preceding the transmission system proper by a *dynamic compressor* and following by a *dynamic expander*. A compandor always comprises two parts (figure 1). (By " normal level " in Figure 1 is understood the power level which exists at the point considered when the origin of the system (point of zero relative level) is energized with a power of 1 mW).



a = assumed speech level,
b = signal/noise ratio at the input to the receiver without compandor,
c = signal/noise ratio at the input to the receiver with compandor,
d = level of interfering signal at the input to the receiver during silent interval.

FIGURE 1

A compandor should be constructed in such a way that, on the one hand, the effect of the compressor on the transmitted signal is compensated by the effect of the expander, and, on the other hand, a disturbing voltage S should be made as small as possible on the receiving side. This effect is obtained by making the transmission equivalent of the compressor and expander to be a function of the level of the speech signals, and in such a way that the overall transmission equivalent is maintained constant between A and B, independently of the magnitude of the signal, but over the transmission channel A′—B′ the speech signals are transmitted compressed between narrow limits and at a higher mean level. The disturbing voltage S which appears on the transmission systems, on the other hand, passes through the expander only and appears, consequently, at the output of the expander much reduced relative to the speech signals (Figure 1).

As figure 1 clearly shows, the disturbing signal is reduced to the maximum extent during silent intervals. During the transmission of a speech signal, the disturbing signal will attain the value corresponding to the signal/noise ratio existing in the transmission channel (Δ of figure 1). The effect of this compandor characteristic on the clarity of speech is not exactly known, but it may be said, qualitatively, that it is principally the noise during silent intervals which is disturbing. During actual conversations, a much lower signal/noise ratio has a comparable disturbing effect, due to masking, as is already known from studies of noise caused by harmonic distortion.

Note. — It is proposed to make some fundamental studies on this subject in the C.C.I.F. laboratory. Two types of compandor may be distinguished :

A. *The Instantaneous Compandor* **[5, 6, 7]**, of which the characteristic is that instantaneous values of speech signals control the transmission of the compressor and the expander.

B. The Syllabic Compandor **[4, 8, 9, 10]** in which the mean value of the applied signal over a short time interval (several milliseconds for example) is used to control the transmission.

It is possible, with the aid of compandors, to improve greatly, at relatively small expense, the transmission quality of telephone circuits seriously disturbed in cables on open-wire lines or on radio links.

In the case of existing telephone circuits, use of the syllabic compandor only can be envisaged because it imposes no additional requirement on the characteristics of the transmission system (band-width, attenuation distortion, phase distortion, etc.).

Note. — *(a)* Instantaneous compandors can be constructed relatively simply (amplifier with a marked non-linear characteristic, e.g.,

$$U_2 = U_0 \times \ln \frac{U_1}{U_0}$$

and corresponding apparatus with an inversely non-linear characteristic as expander). This form is useful for pulse-modulation systems **[7]**.

This simple type is of less value on audio or carrier telephone circuits because it requires a considerable increase in the bandwidth of the transmission channel and will not tolerate even slight phase or attenuation distortions. The non-linear distortion products, which result from the non-linear characteristic of the compressor and include frequencies outside the speech band, should be transmitted as completely as possible up to the expander. If this requirement is not met, the effects of the compressor and the expander are not compensating and this results in a corresponding distortion of the speech signals at the output of the expander. Moreover, it is necessary also that phase distortion in the transmission channel should be very small if the compensation of the non-linearity of the compressor by the expander is to be effective. This applies also, but to a lesser extent, to attenuation distortion. Of course the possibilities are known

of transmitting the harmonic distortion frequencies produced in the compressor within the limits of the voice frequency band **[6]** but normal transmission channels do not satisfy other requirements e.g. sufficiently small phase distortion. The scope of the instantaneous compandor is thus limited in practice to pulse modulation systems.

(b) The Syllabic Compandor uses the principle of the automatically-regulated amplifier (static characteristic of the compressor level, for example :

$$U_2' = U_0' \ln \left| \frac{U_1'}{U_0'} \right|,$$

corresponding characteristics of the expander levels :

$$U_2'' = U_0'' \times \exp \left| \frac{U_1''}{U_0''} \right|).$$

The operating time is chosen in such a manner that the transmission equivalent varies without appreciable delay following the envelope of the speech signals. As may be easily understood, there is not produced in the compressor of the syllabic compandor system any frequency outside the speech frequency band applied to its input so that the bandwidth of the original signal is sufficient for transmission. The syllabic compandor does not, moreover, impose more severe conditions on the phase and attenuation distortion of the transmission channel than those which should be met on normal audio or carrier channels. To obtain a variation in the transmission equivalent, the mean value of signal existing for a short period of time is used. Its magnitude is essentially determined by the relatively high power existing in the lower third of the audio frequency band (about 1000 c/s). Phase and attenuation distortion are, furthermore, normally confined to the upper and lower limits of the frequency band.

In this form, the syllabic compandor may readily be inserted in existing telephone circuits (on voice-frequency, carrier and on radio link circuits) and, thus, may be used on international links.

In the following text are given some notes on the design of compandors and on their use on international telephone circuits.

By way of completion it is convenient to mention briefly the *piloted compandor*, a variant of the syllabic compandor. In this compandor, the transmission equivalent of the compressor only is controlled *directly* by the mean value of the speech signals. The transmission equivalent of the expander is controlled by the level of a pilot introduced *before* the compressor and controlled at the same time as the speech in the compressor by its regulating action. Apart from several advantages, the piloted compandor has the disadvantage that transmission of the pilot requires a special pilot channel of high quality, from the point of view of selectivity and of transmission time, within or outside the speech band. The two solutions, of restricting the speech-frequency band transmitted or extending the frequency band are hardly possible on international telephone circuits. Consequently, it is not necessary to give here a detailed description of the piloted compandor.

The observations given here refer exclusively to a compandor intended for transmission of speech. (Admittedly, it is also possible to apply the principle of the syllabic compandor to improve the signal/noise ratio in music transmission, but the high quality of reproduction required in this case demands much greater technical outlay.)

2. *Characteristics of a syllabic compandor.*

Before considering in more detail the various characteristics, it is convenient to indicate the limiting factors, so far as transmission is concerned, which are imposed in the operation of a 4-wire circuit equipped with two compandors. The object of inserting a compandor is to improve

speech quality without reducing reliability. In other words, the working conditions should be fixed equally from the point of view of *operation during transmission* as from the point of view of *stability*.

This division of functions is necessary if it is considered that the terminal stations A and B of an international circuit (figure 2) are located in different countries and comprise in general equipments, made by different manufacturers. The co-ordination of the equipment in the *two terminal stations* which are put in series in *one direction of speech* will determine the overall *transmission* quality (e.g. compressor of station A—expander of station B). This fact necessitates that corresponding characteristics should closely agree one with another.

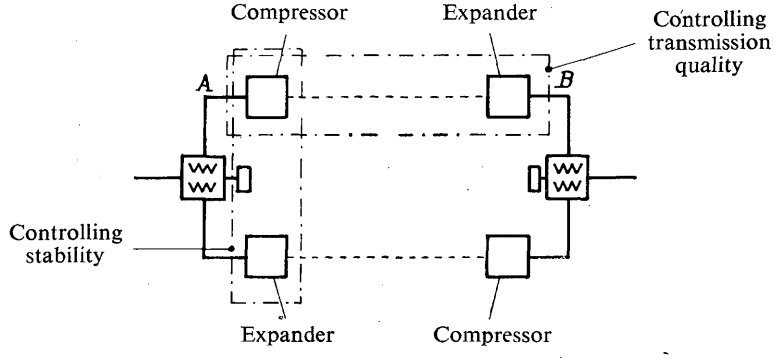


FIGURE 2

The *stability* of a 4-wire circuit depends, on the other hand, on the behaviour of the equipment in the two directions of transmission as a function of level, of frequency and of time. It is a sufficient condition of stability that the pair of a compressor and an expander at each individual terminal station should itself be very stable. If that is so, the complete 4-wire circuit will be equally stable. Such a division offers, in particular, an advantage when compandors are used in international traffic since characteristics fixed for compandors in national traffic require little modification. An important advantage of such sub-division of functions is that working conditions, which are locally different, may be taken as a basis for the setting-up of the static and dynamic characteristics.

2.1. *Operation during transmission.* — From the point of view of the quality of transmission or of intelligibility of speech, it is considered that the following characteristics are useful for designing individual units (compressors and expanders).

2.11. *Level.* — The relative level for which the insertion loss of the compressor or the expander is 0 N (0 db), and at the mean of which the equivalent of the overall circuit is measured with a test frequency of 800 c/s may be chosen equally freely for the compressor as for the expander.

Note. — The point (that is to say, the relative level) at which the compressor should be inserted in a 4-wire circuit may differ under the conditions at level existing in the network of a particular Administration. The only decisive factor is that a sufficiently high volume should be transmitted. The choice of relative level should, however, be such as will permit the insertion of a compandor in a 4-wire circuit without requiring auxiliary equipment (attenuator of amplifier), i.e., at the time of measuring the equivalent, the insertion loss of the compressor plus the expander should be 0 N (0 db). The power levels in multichannel systems will then undergo little modification, it is only in the case of systems having very many channels that the equivalent power will increase by 0·2 to 0·3 N (about 2 db).

2.12. *Characteristic curves.* — The characteristic curves (Figure 3) plotted with logarithmic abscissae and ordinates for the relation between the output level (n_S) and the input level (n_E) should have the shape depicted therein (see table below). The bend of the characteristic, with average service conditions, as regards both the compressor and the expander, must be 5·0 to 6·0 N (43 to 52 db) below the nominal level, in relation to the input to the compressor or the output of the expander.

Note 1. — A volume level of about 0·6 N (5·2 db) should not normally be exceeded on telephone circuits. The slope of the expander characteristic should be as great as possible considering the expander gain which can be achieved. (It is necessary to suppress noise during silent intervals.)

However, this means also that the variations in transmission equivalent are multiplied by this value of the slope and that, following strong compression (small range of signal levels) the efficiency and the linear crosstalk of multi-channel systems are unfavourably affected. A particularly favourable compromise corresponds to an expander slope of tg $\alpha = 2$, because the equipment cost can then be economically justified. With this assumption, the customary basis of design for multi-channel systems remains valid even when compandors are used on such systems.

The bend of the expander characteristic determines the minimum signal/noise ratio on a long-distance line for which the expander gain is adequate. Being given that at the extremity of an international link the signal/noise ratio (for a signal having a power of 1 milliwatt at a point of zero relative level) should be 5·8 N (50 db) in the worst case, the bend of the characteristic should as fas as possible be at a level which corresponds to this signal/noise ratio at the output of the expander. The compressor should, for stability reasons, have an analogous characteristic.

Note 2. — If, when an open-wire line is used, the expander is made to operate by a strong, disturbing radio transmitter, correct operation may be restored by preceding the expander by a suitable stop network.

Another possibility, if the disturbing radio transmission appears outside the speech band, consists in inserting selective networks in the operating circuit of the expander. This method is possible because low-energy components (above 1 kc/s) can be neglected in the functioning of the expander. When these measures are applied, it is however necessary to take note of other consequences which are described later.

2.13. *Impedance.* — The nominal value of the input and output impedances of the compressor of the expander is 600 ohms (pure resistance). A reflection coefficient of at most 20 % is permissible over the whole transmitted frequency band.

Note. — The condition to be fixed with regard to the balance about earth at the input to the compressor and the output of the expander differs for each case according to the arrangement at the point of insertion. A decision on this point may be left to the local Administration.

2.14. The variation of the transmission equivalent with frequency both for the compressor and the expander should not exceed 1/10th of the tolerance limits permitted by the C.C.I.F. (*Green Book*, Volume III, page 40, (figure 4)), measured in the usual way between 300 and 3400 c/s and at normal level. Further, each compressor or expander should satisfy this condition when the operating circuit is disconnected, the working point being kept at normal level for the duration of the test by means of a constant current.

Note 1. — When a syllabic compandor is used, it is not possible to determine the loss/frequency response of a telephone circuit by normal methods as the control circuits of the compressor and of the expander have themselves certain frequency characteristics. In operation, control is effected by means of the speech power concentrated in the low frequencies so that a variation with frequency

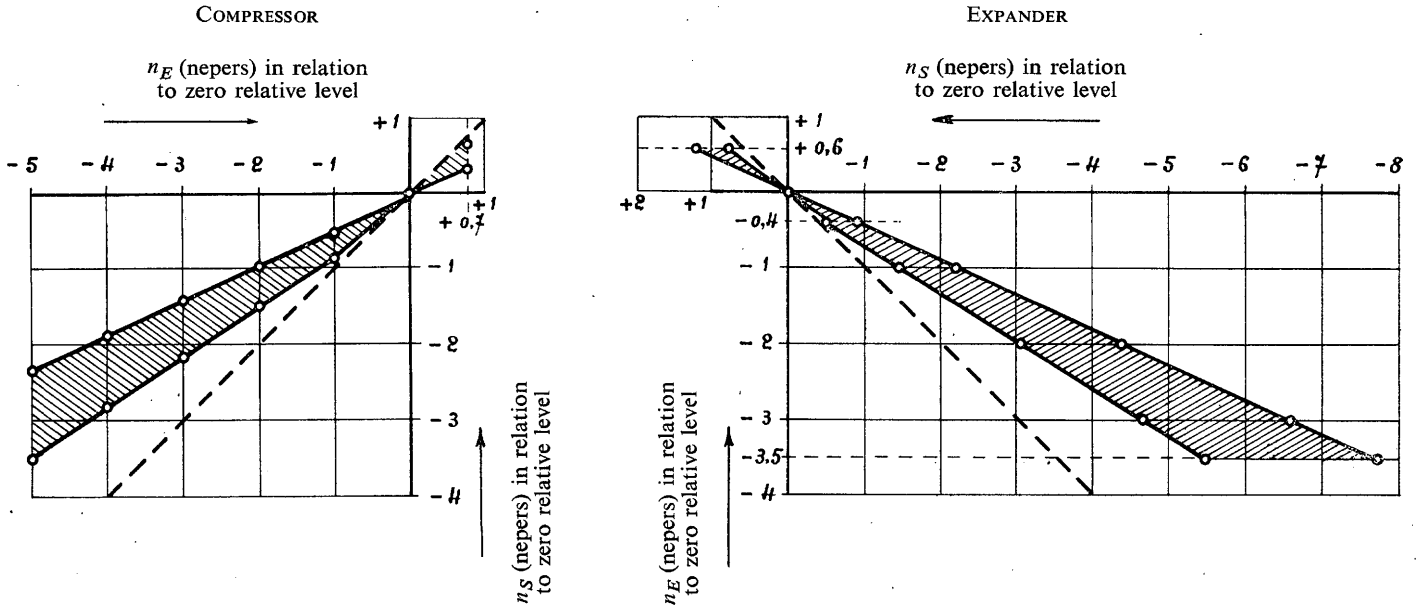


FIGURE 3. — *Characteristic curves*

Table for Figure 3

COMPRESSOR							
Input level n_E (nepers) * . .	+0·70	0	−1·0	−2·0	−3·0	−4·0	−5·0
Output level n_S (nepers) * . .	+0·35 . . . +0·60	0	−0·50 . . . −0·85	−0·95 . . . −1·50	−1·40 . . . −2·15	−1·85 . . . −2·80	−2.30 . . . −3·45
EXPANDER							
Input level n_E (nepers) * . .	+0·60	0	−0·4	−1·0	−2·0	−3·0	−3·50
Output level n_S (nepers) * . .	+0·75 . . . +1·2	0	−0·50 . . . −0·88	−1·46 . . . −2·20	−3·06 . . . −4·40	−4·66 . . . −6·60	−5·46 . . . −7·70

* In relation to zero relative level.

measured in the ordinary way is not noticeable at the receiver. In the second method of measuring described, which corresponds to practical conditions, this fact is taken into account. It is not however, necessary to abandon the usual simple testing method whenever a circuit is measured; it is sufficient if, putting the equipment into service, the second, more complicated, test is carried out.

On the other hand, it is otherwise when the transmission channel between the compressor and the expander has attenuation frequency distortion and the channel is tested by the usual methods as the expander multiples, by the slope of its characteristics, all the variations in equivalent which precede it. Results of such tests in no way correspond to the conditions existing during the transmission of speech. For this reason, it is recommended to take only one-half (for an expander having a characteristic with a slope of tg α = 2) of the measured variations.

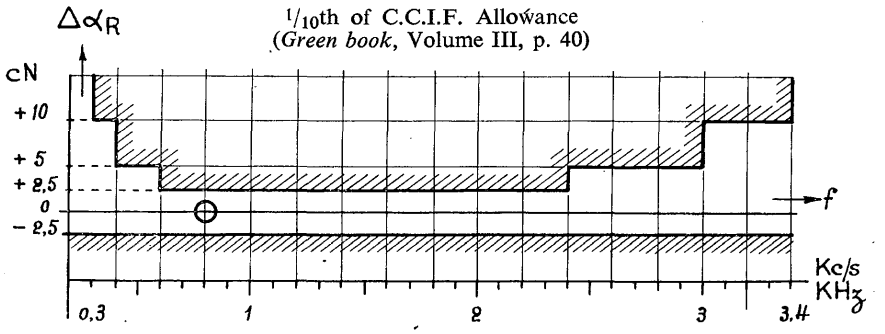


FIGURE 4. — *Permissible variation of transmission equivalent as a function of frequency referred to the nominal value at 800 c/s*

Note 2. — When an expander having a selective control circuit is used on a strongly disturbed open wire, the same characteristics should be given to the control circuit of the corresponding compressor if it is desired to measure the loss/frequency response by the usual method. It may be pointed out that this is not basically necessary since the quality of the telephone circuit is unaltered. If such additional equipment is not provided, then when using the normal testing methods, it is necessary to ensure that the frequency characteristic is measured only within the stop bands of these filters.

2.15. *Harmonic distortion coefficient.* — Definition : coefficient of total harmonic distortion within the transmitted frequency band, the measurement being made with a frequency of 800 c/s.

The coefficient of harmonic distortion measured at normal level in accordance with this definition should be, for the compressor or the expander, less than or equal to 4%. This value should be maintained for other frequencies within the transmitted band.

Note. — As a result of the complementary characteristics of compressor and expander, the non-linear distortion generated in the control elements will be opposite in phase. A small degree of compensation is thus produced. However assuming that the transmission channel has considerable phase distortion and a limited bandwidth, this compensation cannot in practice be counted upon. Furthermore other components of the compandor cannot be made entirely free from distortion so that the harmonic distortion coefficient may be greater for low levels. However, this increase has no important effect on intelligibility because the audibility of harmonic products decreases rapidly in proportion as the level is reduced.

2.16. *Parasitic voltages.* — The effective value of the sum of all the parasitic voltages measured at a point of zero relative level when the input and output is terminated with 600 ohms should be

$\leqslant$ 7 mV for the compressor and
$\leqslant$ 0·5 mV for the expander.

Note. — So as not to reduce unnecessarily the gain obtained from the expander or the signal/noise ratio obtained at the end of an international circuit, the contribution from the compandor itself should be reduced to the minimum.

2.17. *Control.* — The control time constants for increasing and decreasing signals in the compressor should be, in all working conditions, practically the same as those of the expander. Convenient standard values are

3 ms $\pm$ 2 ms for attack (to increasing signals)
15 ms $\pm$ 5 ms for recovery (from decreasing signals).

Note. — The expander should, for reasons of stability, have forward control because the gain increases proportionally with the control signal amplitude. Although it is desirable to apply the same control principles to the compressor and the expander so as to obtain exact compensation of the dynamic characteristics, the compressor may function satisfactorily with backward control. The latter is more useful as the compressor is generally inserted at a point of low relative level and to apply forward control adds the costs of preamplification.

When the control circuits of a syllabic compandor are tested, it should be checked at the same time that speech signals are not completely controlled, i.e., that the operating times on the one hand, and the distortions of syllables on the other hand, are not too great. Assuming that the attack and recovery times of the compressor and the expander are in each case in opposite senses, the overall dynamic characteristics will be compensated.

The build-up time should not be too large as otherwise control will begin too late and this will result in excessive levels of too long duration (risk of overload). On the other hand, if the compressor controls too fast, the low speech frequencies will be very distorted. The recovery time should not be chosen too long because otherwise a residual noise can be noticed. The ratio chosen between attack and recovery times ensures that the original volume of speech is unchanged.

Practical tests have shown that the control time constants may be varied considerably without affecting speech intelligibility.

The difference between the dynamic characteristics of the compressor and the expander should not, for reasons of stability, be too large (see 2.22).

When V.F. telegraphy pulses or V.F. selective signalling are transmitted via a compandor, signal distortions are produced due to transient phenomena and to worsening of harmonic distortion. On this account, a compandor will only slightly improve the quality of such circuits. It is preferable (and not difficult) to insert V.F. telegraphy or V.F. selective signalling equipments *between* the compressor and the expander.

2.2. *Stability.*

A criterion of reliable service is the stability of the complete 4-wire circuit. So that the stability should not be reduced by the insertion of compandors, compressors and expanders should satisfy the following common conditions :

2.21. *Characteristic Curves.* — The variation of the transmission equivalent of a compandor as a function of amplitude, measured with a test frequency of 800 c/s after the expander in average working conditions (compressor and expander set up in series and adjusted to the exact level) should not exceed the tolerance limits of figure 5. For all other frequencies in the transmitted band and for all other working conditions, the *upper* attenuation limit only should not be exceeded.

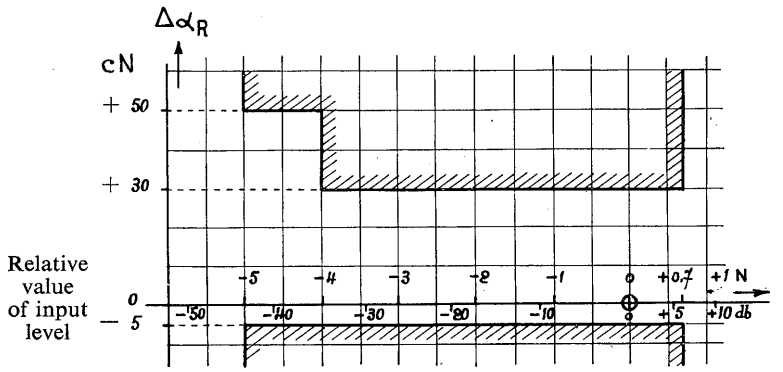


FIGURE 5. — *Permissible variation of transmission equivalent as a function of amplitude for one compandor*

Note 1. — In use, a 4-wire circuit is regularly checked by a test at normal level. However, assuming that for low levels the control networks may vary widely with temperature, and may drift greatly at high levels, there is a risk that the transmission equivalent may vary widely with time. So that basic noise or disturbance shall not cause false operation, the region of low levels should have increased stability.

If the characteristic curves of the compressor and the expander are fixed in such a way that the transmission equivalent increases slightly as the level decreases, the stability increases proportionally as the noise decreases on a long distance line. The small excess compression (residual compression) at low levels produces no noticeable reduction in the quality of transmission.

Note 2. — On open wire lines, disturbing transmitters may, as already mentioned, cause the expander to operate. If the measures described to reduce the disturbance are applied, it is necessary to ensure that the residual compression at low levels is maintained for all frequencies in the transmitted band.

2.22. *Stability of a 4-wire circuit as affected by false operation of the control circuits.* — In the same way as already mentioned in 2·17, the difference between the time constants of the compressor and the expander may introduce instability of the complete 4-wire circuit. Experience has shown that the tolerances shown in this paragraph give sufficient protection against such false operations.

3. *Syllabic compandors in practice*

The syllabic compandor should function in all possible working conditions (climate, supple voltages, etc.), in such a way that the dynamic and static characteristics mentioned in 2 will by maintained.

All maintenance and service instructions which are customary in repeater stations may be revised without restriction for this object.

When variations of transmission equivalent are being measured by the usual method, it is necessary to note that the measured values are not entirely indicative of the attenuation distortion throughout the spectrum of speech sounds (see 2.14).

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Question 41.

(Sub-Group 1/1, in co-operation with Sub-Group 1/4, then Study Group 1 in co-operation with the C.C.I.R., the I.B.O. and the E.B.U.)

(New Question)

What essential characteristics (static and dynamic) should be recommended for compandors controlled by audio-frequencies, in the case of programme circuits ?

Note. — It seems desirable that Administrations, in co-operation with the Broadcasting Organizations in their respective countries, should test the influence of compandors on the quality of music transmitted and communicate the results of these trials to the C.C.I.T.T. Secretariat, stating how the results were obtained.

Question 42.

(Sub-Group 1/1, in co-operation with Sub-Groups 1/2 (for part A), and 1/4 (for part B), then Study Group 1, in co-operation with Study Group 3; preliminary study by a specialized Working Party)

(continuation of Question 45 of C.C.I.F. Study Group 3, 1955/1956)

A. It is considered that the coaxial pair of the type standardised by the C.C.I.F. is capable of being used for systems having a frequency band wider than that of the 2.6 or 4 Mc/s systems. What are the characteristics to be recommended for such new systems having a transmitted frequency band of about 6 Mc/s (with repeaters spaced at about 9 km or 6 miles) or about 12 Mc/s (with repeaters spaced at about 4.5 km or 3 miles), and in particular :

(a) which five consecutive supergroups, selected from supergroups Nos. 3 to 16, already standardized by the C.C.I.F., should be assembled to form the basic mastergroup ?

(b) when, in such systems, the frequency band to be used for telephony by means of mastergroups, extends beyond 4028 kc/s :

1. Should the telephone channels of these mastergroups be transmitted to line erect or inverted ?
2. What should be the width of the gaps (i) between supergroup No. 16 and the first mastergroup transmitted to line, and (ii) between adjacent mastergroups ?

Note. — The XVIIIth Plenary Assembly has issued a provisional recommendation on parts *(a)* and *(b)* of this question and the opinion set forth in the Annex hereinafter.

(c) What nominal frequencies and levels and what tolerances on these values, should be recommended for :

1. main line regulating pilots ?
2. auxiliary line regulating pilots ?
3. additional measuring frequencies ?

Note. — In the study of part *(c)* of this question account should be taken of the possibility that such a system may be used for simultaneous transmission of telephony and television.

(d) 1. Should the use of a mastergroup pilot be recommended ?
2. What nominal values should be recommended for the level and frequency of this pilot and what tolerances should be allowed ?
3. Should this pilot be blocked at the end of a mastergroup link ?

Note. — C.C.I.F. Study Group 3, in March, 1956, proposed to reserve, provisionally, the frequency of 1800 c/s for international frequency comparisons and to choose a mastergroup pilot which would be placed in the free space between two supergroups : the formation of recommendations on the subject of the frequency and the level of this pilot is the subject of part *(d)* of Question 42.

(e) What should be the permissible limits for the ratio between the desirable components and the various unwanted components in the case of transfer of a mastergroup (the unwanted components being defined in the same way as in the case of transfer of a group or supergroup) ?

(f) What should be the frequency stability of the master oscillators used for these systems ?

(g) What values should be recommended for the sending and receiving relative power levels at mastergroup distribution frames ?

(h) What value (or values) of relative power level should be recommended at the output of intermediate repeaters ?

(i) 1. Is it necessary to define new nominal maximum circuits on coaxial cables to take account of the introduction of these new systems ?
2. If so, what would be the definitions of these new nominal maximum circuits ?

(j) What characteristics are to be specified for the repeaters of such a system and what values are to be recommended for these characteristics ?

(k) What recommendations are to be made concerning the regulation of such a system ?

Note. — In the study of parts *j* and *k* of this question account should be taken of the possibility that such a system may be used for simultaneous transmission of telephony and television.

B. What characteristics are to be recommended for a system having a bandwidth of about 12 Mc/s using a coaxial pair of the type standardized by the C.C.I.F. (with repeater spacings of about 4.5 km or 3 miles), and used for simultaneous transmission of telephony and television ?

In particular :

(a) What recommendations are to be made to avoid the production by telephony on the television transmissions of irregular and regular interference in excess of the permissible limits (see Question 22) ?

(b) What recommendations are to be made in order to avoid that the transmission of test signals over the television circuit, especially during the " setting-up period " or during the " preparatory period " of a television transmission, causes any disturbance to telephony (see Question 12 of Study Group 9) ?

(c) What is the frequency and the level to be recommended for the carrier frequency used for the transmission of television signals, it being assumed that, taking account of the frequency difference, the characteristics of the residual sideband signal will be similar to those considered for the 6 Mc/s coaxial pair system and of which a general description is given in the reply to Question 12 of C.C.I.F. Study Group 3 ?

Note. — In the case of the 4 Mc/s coaxial system there is a C.C.I.F. recommendation for the carrier frequency to be used for television transmissions; a similar draft recommendation was drawn up in 1956 for the case of a 6 Mc/s system. No similar recommendation exists for the 12 Mc/s system.

(d) Regarding the return current coefficients between the impedance of a coaxial pair and the input and output impedances of the repeaters used on this coaxial pair, could the limit of 8 nepers or 70 decibels be accepted for the sum, N, of the three terms defined on page 213 of Volume III of the *Green Book*, on the assumption that the television channel is transmitted by the upper part of the frequency band.

General Note. — It would be highly desirable to arrive at a definition for a single system which satisfies both conditions which will be determined by the reply to parts A and B of this question.

ANNEX

(to Question 42 of Study Group 1)

Opinion issued by the XVIIIth C.C.I.F. Plenary Assembly and approved by the C.C.I.T.T. 1st Plenary Assembly

Multi-circuit telephone systems on coaxial pairs or radio-relay systems.

The XVIIIth Plenary Assembly of the C.C.I.F. resolves that the Director of the C.C.I.T.T. be asked to request administrations to state within six months whether they regard as final the provisional recommendation shown hereafter. In the event of a negative reply, administrations would be asked to state what difficulties would be encountered in applying this recommendation. A study group will meet :

— in the event of agreement on the provisional recommendation referred to, in order to reply to the various points of Question 45, with its new text;

— should it be shown that application of this recommendation would raise difficulties, to study the best method of overcoming these difficulties.

It is desirable that this Study Group should comprise, as far as possible, the same members of C.C.I.T.T., S.G. 1, as those in the Working Party which met during the meeting of the C.C.I.F. S.G. 3 in November 1956 to prepare the reply to points *(a)* and *(b)*—(the provisional recommendation quoted)—and whose composition is given further on. The Italian Administration, too, will be represented in this working party.

The results of the first meeting of this Working Party would be communicated to C.C.I.T.T. S.G. 3 and to Study Group IX of the C.C.I.R.

This Working Party would then be completed by representatives from C.C.I.T.T. S.G. 3 and from S.G. IX of the C.C.I.R., which is charged with the specification of radio-relay systems. Thus it would be possible to co-ordinate studies concerning multi-circuit telephone systems (whether on coaxial pairs or radio-relay systems) which are capable of being used for simultaneous transmission of telephony and television.

Provisional Recommendation issued by the XVIIIth Plenary Assembly of the C.C.I.F. on twelve-megacycle coaxial-pair systems.

It is recommended that in systems transmitting a bandwidth of about 12 Mc/s on the C.C.I.F. standardized coaxial pair with a nominal repeater spacing of about 4·5 km or 3 miles, the allocation of frequencies transmitted to line (for telephony) should be in conformity with the following principles :

Frequencies below 4028 kc/s: As far as possible, the frequency allocation already recommended by the C.C.I.F. (*Green Book*, Volume III, pages 85 and 86) should be used.

Frequencies above 4028 kc/s: The telephone supergroups should be assembled in " master groups ", each mastergroup being made up of five supergroups separated by 8 kc/s gaps.

(a) The basic mastergroup should be made up of supergroups Nos. 4 to 8, already standardized by the C.C.I.F. and occupying the band 812 to 2044 kc/s *.

(b) 1. In the first three mastergroups, situated immediately above the existing spectrum (which extends to 4028 kc/s), the telephone channels should be transmitted inverted on the line, in order that, when telephony and television are being simultaneously transmitted, the interference between the telephone and the television channels may be kept to a minimum.

The next three mastergroups above the existing spectrum should be transmitted to line with the telephone channels erect, in order that all the mastergroup carrier frequencies may be multiples of 440 kc/s.

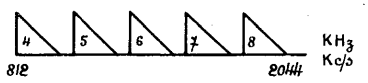
(b) 2. A gap of 304 kc/s should be arranged between supergroup No. 16 and the first mastergroup, and a gap of 312 kc/s between the two blocks of three mastergroups, to permit filtration at line frequency of each of these two blocks of three mastergroups, and of the frequency band up to 4028 kc/s, if so desired.

The above proposals entail a frequency spectrum as shown in Figure 1.

These recommendations have been made on the assumption that if the upper line-regulating pilot (yet to be standardized by the C.C.I.F.) is situated above the highest master group, the gap between this pilot and the highest mastergroup will not exceed some 200 kc/s.

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* The U.S.S.R. Administration is contemplating the use of a broad-band coaxial system using the same basic mastergroup, made up of supergroups 4 to 8. The mastergroups on the line would be spaced at 64 kc/s. This Administration has agreed to the provision of appropriate throughmastergroup filters at frontier stations.



Basic Mastergroup

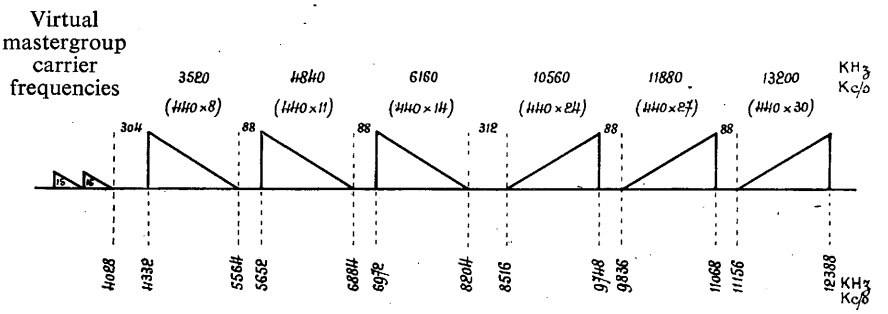


FIGURE 1. — *Line frequency spectrum*

Membership of the Working Party called upon, in 1956, to study the points outstanding in Question 45 of C.C.I.F. Study Group 3

Chairman: Mr. H. J. CLAEYS (Belgium)

Cuba (Cuban Telephone Company) .	Mr. M. VAN HASSELT.
Federal German Republic	Mr. F. RING. Expert : Mr. H. MARKO.
France	Mr. E. FERRIEU, Mr. M. TOUTAN. Experts : Messrs. M. BLONDET, A. FROMAGEOT, J. OSWALD.
Mexico (Teléfonos de Mexico) . . .	Mr. E. ERIKSEN.
Netherlands	Mr. W. F. RESER. Expert : Mr. H. N. HANSEN.
Sweden	Messrs. S. JANSON, V. STENDING.
Switzerland	Mr. G. FONTANELLAZ. Experts : Messrs. P. HARTMANN, T. STOLZ.
United Kingdom of Great Britain and Northern Ireland	Messrs. J. W. T. RHODES, B. W. WILLIAMS. Expert : Mr. B. B. JACOBSEN.
Union of Soviet Socialist Republics. .	Mrs. G. BESCHTCHEKOVA, Mr. G. BORODZIOUK.

National scientific or industrial organization:

Siemens and Halske, A. G.	Mr. W. VON WERTHER.

Question 43.

(Study Group 1, in co-operation with Study Group 8) (Question 43 of Study Group 8)

(New Question)

What general characteristics should be standardized to permit international transmission of accounting data ?

TABLE SUMMARIZING THE QUESTIONS ASSIGNED TO STUDY GROUP 1 AND TO ITS SUB-GROUPS

First Study Group

Chairman : Mr. G. H. BAST (Netherlands)
Vice-Chairman : Mr. R. H. FRANKLIN (United Kingdom)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
1	Characteristics of long distance intercontinental land circuits.		Preliminary consideration by S.S.G. 1/2
2	Noise on intercontinental circuits.	S.G. 3 S.G. 5 C.C.I.R.	N *
3	Frequency deviation and sudden phase changes.	S.G. 4	S.G. 4, then S.S.G. 1/3
4	Interconnection of three international circuits.	S.G. 11	S.S.G. 1/2
5	Reduction in transmission performance due to circuit noise.	S.G. 5, S.G. 11, S.G. 12	S.S.G. 1/2
6	Admissible variation, as a function of time, of the signal-to-noise ratio.	S.G. 3, S.G. 12	N *
7	Noise clause for all carrier systems.	S.G. 3, S.G. 9, C.C.I.R.	Joint C.C.I.T.T.-C.C.I.R. Noise Group
8	Circuit measurement between four-wire terminals.	S.G. 4	S.G. 4, then S.S.G. 1/2
9	New switching plan, from the transmission point of view.	S.G. 4, S.G. 12	S.S.G. 1/2
10	Reduction in the standardized equivalent for automatic circuits.	S.G. 11	S.S.G. 1/2
11	Half-tone transmission by radio and metallic channels jointly.	S.G. 8	S.S.G. 1/3
12	Use of phase correctors in phototelegraphy.	S.G. 8	S.S.G. 1/3
13	Limit for unweighted noise for a circuit carrying voice-frequency telegraphy.	S.S.G. 1/2	S.S.G. 1/3
14	Improvement of near-end crosstalk ratio.		S.S.G. 1/3

* *N* stands for a working party of Study Group 1, on the preliminary study of noise questions.

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
15	Use of frequency modulation for phototelegraphy.	S.G. 8	S.S.G. 1/3
16	Asymmetrical side-band modulation in photo-telegraphy.	S.G. 8	S.S.G. 1/3
17	Psophometer for programmes transmission.	S,G,s 5 and 12, C.C.I.R., I.B.O., E.B.U.	S.S.G. 1/4
18	Non-linear distortion on programme circuits.		S.S.G. 1/4
19	Characteristics of programme circuits transmitting frequencies from 50 to 6400 c/s, on carrier systems.	S.S.G. 1/4	S.S.G. 1/1
20	Noise and crosstalk on programme circuits.	S.S.G. 1/4, S.G. 3, C.C.I.R.	S.S.G. 1/1
21	The influence of various factors on the quality of television pictures.	C.C.I.R.	S.S.G. 1/4
22	Characteristics of a television transmission circuit.	(To be considered by the C.C.I.T.T.-C.C.I.R. joint Group on television transmission)	
23	Line transmission of television signals	C.C.I.R., I.B.O., E.B.U.	S.S.G. 1/1
24	Television transmission pilots; interconnection at frontiers.		S.S.G. 1/1
25	Television circuit repeaters.	S.S.G. 1/4	S.S.G. 1/1
26	Synthesis of networks in the transient state.	C.C.I.R., I.B.O., E.B.U.	S.S.G. 1/4
27	Transient-state composition of circuits applying different television standards.	C.C.I.R., E.B.U., I.B.O.	S.S.G. 1/4
28	Transient-state measurements of the regularity of a coaxial pair used for television.	S.S.G. 1/4	S.S.G. 1/1

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
29	Matching of repeater and line impedances in television.	S.S.G. 1/4	S.S.G. 1/1
30	Stability of additional measurement frequencies.	S.G. 4	S.S.G. 1/1
31	Automatic regulation of carrier-systems.	S.G. 4	S.S.G. 1/1
32	Detailed make-up of maximum nominal circuits for telephony.	S.G. 3, C.C.I.R.	Joint C.C.I.T.T.-C.C.I.R. noise group
33	Noise on a homogeneous physical carrier section.	S.G. 3, C.C.I.R.	
34	Systems with more than 60 channels on symmetrical pairs.		S.S.G. 1/1
35	Second three-channel open-wire system.		S.S.G. 1/1
36	Pilot on a three-channel open-wire system.		S.S.G. 1/1
37	Inter-band telegraphy on three channel open wire telephone systems.	S.G. 9	S.S.G. 1/3
38	Noise on the open-wire reference circuit.	S.G. 5	
39	Maximum length of a twelve-channel open-wire system.		
40	Telephone compandor characteristics.	S.S.G. 1/2	S.S.G. 1/1
41	Compandor characteristics for programme transmissions.	S.S.G. 1/4, C.C.I.R., I.B.O., E.B.U.	S.S.G. 1/1
42	Systems with more than 960 channels.	*Part A*: S.S.G. 1/2 S.G. 3 *Part B*: S.S.G. 1/4 S.G. 3	S.S.G. 1/1
43	The transmission of accounting data.	S.G. 8	

Sub-Group 1/1

Chairman : Mr. R. SUEUR (France)
Vice-Chairman : Mr. J. JACOT (Switzerland)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
—			
19	Characteristics of programme circuits transmitting frequencies from 50 to 6,400 c/s on carrier systems.	S.G. 1 S.S.G. 1/4	
20	Noise and crosstalk on programme circuits.	S.G. 1 and 3, S.S.G. 1/4 C.C.I.R.	
—			
23	Line transmission of television signals.	S.G. 1 C.C.I.R., I.B.O., E.B.U.	
24	Television transmission pilots ; interconnection at frontiers.	S.G. 1	
25	Television circuit repeaters.	S.G. 1, S.S.G. 1/4	
—			
28	Transient-state measurements of the regularity of a coaxial pair used for television.	S.G. 1, S.S.G. 1/4	
29	Matching of repeater and line impedances in television.	S.G. 1, S.S.G. 1/4	
30	Stability of additional measurement frequencies.	S.G.s 1, and 4	
31	Automatic regulation of carrier systems.	S.G.s 1, and 4	
—			
34	Systems with more than 60 channels on symmetrical pairs.		
35	Second three-channel open-wire system.	S.G. 1	
36	Pilot on a three-channel open-wire system.	S.G. 1	
—			

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
40	Telephone compandor characteristics.	S.G. 1, and S.S.G. 1/2	
41	Compandor characteristics for programme transmissions.	S.G. 1, S.S.G. 1/4, C.C.I.R., I.B.O., E.B.U.	
42	Systems with more than 960' channels.	S.G. 1. *Part A:* S.S.G. 1/2, S.G. 3. *Part B:* S.S.G. 1/4, S.G. 3	

Sub-Group 1/2

Chairman : Mr. R. H. FRANKLIN (United Kingdom)
Vice-Chairman : Mr. H. J. CLAEYS (Belgium)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
1	Characteristics of long intercontinental land circuits.	S.G. 1	
—			
4	Interconnection of three international circuits.	S.G.s 1, and 11	
5	Reduction in transmission performance due to circuit noise.	S.G.s 1, 5, 11 and 12	
—			
8	Circuit measurement between four-wire terminals.	S.G.s 1, and 4	S.G. 4
9	New switching plan from the transmission point of view.	S.G.s 1, 4 and 12	
10	Reduction in the standardized equivalent for automatic circuits.	S.G.s 1, and 11	

Sub-Group 1/3

Chairman : Mr. P. BASSOLE (France)
Vice-Chairman : Mr. FIJALKOWSKI (Poland)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
—			
3	Frequency deviation and sudden phase changes.	S.G.s 1, and 4	S.G. 4
—			
11	Half-tone transmission by radio and metallic channels jointly.	S.G.S 1, and 8	
12	Use of phase correctors in phototelegraphy.	S.G.s 1, and 8	
13	Limit for unweighted noise for a circuit carrying voice-frequency telegraphy.	S.G. 1, S.S.G. 1/2	
14	Improvement of near-end crosstalk ratio.	S.G. 1	
15	Use of frequency-modulation for phototelegraphy.	S.G.s 1, and 8	
16	Asymmetrical sideband modulation in phototelegraphy.	S.G.s 1, and 8	
—			
37	Inter-band telegraphy on three-channel open-wire telephone systems.	S.G.s 1, and 9	

Sub-Group 1/4

Chairman : Mr. J. MÜLLER (Federal German Republic)
Vice-Chairman : Mr. N. W. LEWIS (United Kingdom)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
—			
17	Psophometer for programme transmissions.	S.G.s 1, 5, and 12, and the C.C.I.R., I.B.O., and E.B.U.	

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
18	Non-linear distortion on programme circuits.	S.G. 1	
—			
21	The influence of various factors on the quality of television pictures.	S.G. 1, and the C.C.I.R.	
—			
26	Synthesis of networks in the transient state.	S.G. 1 C.C.I.R., I.B.O., E.B.U.	
27	Transient-state composition of circuits applying different television standards.	S.G. 1, C.C.I.R., I.B.O., E.B.U.	

QUESTIONS FOR WHICH THE COOPERATION OF STUDY GROUP 1 OR ITS SUB-GROUPS IS REQUESTED

Question No.	Question of S.G.	Brief description	Other S.G.s, or S.S.G.s, or international organizations concerned	S.S.G.s of S.G. 1 concerned	Comments
1	3	Interconnection of systems having different signalling methods.	S.G. 11 C.C.I.R.		
2	3	Interconnection of cable and radio relay systems at the super and master group levels.	C.C.I.R.		
3	3	Alternative or simultaneous telephone and television transmission over coaxial pairs or radio relay links.	C.C.I.R.		
4	3	Interconnection of television transmission systems on coaxial pairs and radio relay links.	C.C.I.R.		
5	3	Noise in radio relay with pulse-code modulation.	C.C.I.R.		
6	3	Variation in time of the signal-to-noise ratio.	S.G. 12		Question 6 of S.G. 1

Question No.	Question of S.G.	Brief description	Other S.G.s, or S.S.G.s, or international organizations concerned	S.S.S.s of S.G. 1 concerned	Comments
7	3	Noise clause common to all systems.	S.G.s 9 and 11, C.C.I.R.	Joint C.C.I.T.T./ C.C.I.R. Group	Question 7 of S.G. 1
8	3	Crosstalk with pulse position modulation.	S.G. 12, C.C.I.R.		
11	3	Radio relay systems using forward scatter propagation.	S.G. 4 C.C.I.R.		To be studied by the C.C.I.R.
3	4	Frequency deviations and sudden phase changes.		S.S.G. 1/3	Question 3 of S.G. 1
8	4	Circuit measurement between 4-wire terminals.		S.S.G. 1/2	Question 8 of S.G. 1
3	7	Denomination of different types of channel.	S.G. 9 C.C.I.R.		To be studied first S.G. 9
11	8	Transmission of half-tones by combined radio and metallic lines.	MP Group	S.S.G. 1/3	Question 11 of S.G. 1
12	8	Phase correctors for phototelegraphy.		S.S.G. 1/3	Question 12 of S.G. 1
13	8	Adaptation of phototelegraph apparatus for transmissions on carrier circuits.		S.S.G. 1/3	
15	8	Use of frequency modulation for phototelegraphy on wire circuits.		S.S.G. 1/3	Question 15 of S.G. 1
16	8	Asymmetrical side-band modulation for phototelegraphy.		S.S.G. 1/3	Question 16 of S.G. 1
43	8	Transmission of accounting data.			Question 43 of S.G. 1
6	9	Influence of disturbance on telegraph distortion.	S.G. 4		
16	9	Standardization of frequency-shift VF telegraphy.		S.S.G. 1/3	
37	9	Interband telegraphy on 3-channel open-wire carrier systems.		S.S.G. 1/3	Question 37 of S.G. 1
4	11	Interconnection of three international circuits.		S.S.G. 1/2	Question 4 of S.G. 1
10	11	Reduction of the standardized equivalent of automatic circuits.		S.S.G. 1/2	Question 10 of S.G. 1

Question No.	Question of S.G.	Brief description	Other S.G.s, or S.S.G.s, or international organizations concerned	S.S.S.s of S.G. 1 concerned	Comments
3	12	Measurement of the disturbance caused by impulsive noises.	S.G.s 10 and 11		
4	12	Effect on transmission performance of circuit noise limits.			Corresponds to Question 5*a* of S.G. 1
5	12	Effect of induced noise on transmission performance.	S.G. 5		Corresponds to Question 5*c* of S.G. 1
6	12	Effect of noise in radio relay systems on transmission performance.	S.G. 3, C.C.I.R.		Corresponds to Questions 6 and 7 of S.G.s 1 and 3
9	12	Limits applied in national local and long-distance networks.			
10	12	Limits for the efficiency of local systems.			

General Operating and Tariff Questions

entrusted to

Study Group 2

in 1957-1960

Question 1.

(Sub-Group 2/2, then Study Group 2)

(Continuation of Question 23 of the C.C.I.F. Study Group 7, studied in 1955-1956)

What system of international accounting might be recommended to replace that at present in use ?

[*See the Notes and Annex to this Question under the same question number in the List of Questions for Sub-Group 2/2*].

Question 2.

(Sub-Group 2/2, then Study Group 2)

(New Question)

Having regard to :

— the present difficulty in subjecting international accounts to adequate check (as envisaged in Article 51 of the Telephone Regulations) because of the extension of rapid operating methods and the non-availability of records at the incoming exchange;

— the likely development of international fully automatic service and the increasing difficulty in providing economically for satisfactory checks in these conditions ;

— and the continuing duty and responsibility of many Administrations to satisfy the requirements of public accountability in their international settlements;

Is it not appropriate to introduce a fresh basis of check of international accounts, whereby in respect of each international relation, each terminal Administration would,

at the request of the other, place at the latter's disposal, not more frequently than annually, facilities for examination of the basis of preparation of a selected account.

Question 3.

(Sub-Group 2/2, then Study Group 2)

(New Question)

Is it not desirable to recommend a more rapid procedure for the exchange of international accounts than that at present defined in the International Telephone Regulations ? (Such a procedure could be used, until the Regulations could be amended, on the basis of special agreements as defined in Article nº 51 of the Regulations). The principle on which the exchange of international accounts should be based might be as follows :

An account drawn up by an outgoing Administration is accepted by the transit and incoming Administrations without any formal act of acceptance being necessary, it being understood that the incoming and transit Administrations reserve the right to contest the account and, if agreed by the outgoing country, to have an adjustment made in the next account.

[*See the Annex to the text of this Question under the same question number in the List of Questions for Study Group 2/2*].

Question 4.

(Sub-Group 2/2, then Study Group 2)

(Continuation of Question 20 of C.C.I.F. Study Groups 6 and 7, studied in 1955-1956)

Is it desirable to make amendments or additions to C.C.I.F. Recommendation 4 to define the conditions of operation of inter-continental telephone services ?

In the affirmative, what changes and additions should be made to Recommendation 4 ?

[*See the Notes referring to points in Recommendation 4 which might be amended or amplified, under the same question number in the List of Questions for Sub-Group 2/2*].

Question 5.

(Sub-Group 2/4, then possibly Sub-Group 2/2, Study Group 2 and Study Group 11)

(New Question)

Considering that the conditions under which international automatic traffic flows are altogether different from those for the international manual or semi-automatic services;

and particularly that with the present charging methods, subscribers can repeat their calls many times without charge if the wanted subscriber is engaged or does not reply, so causing international circuits to be overloaded abnormally;

is there a need to consider making a charge for ineffective calls on the international automatic service, as some Administrations already do for their inland service, either restricting such charge to the case where the wanted line is reached (engaged or no reply), or extending it to cover the case where the international circuit is released before the call is completed ?

If so, what are the preferred charging methods as regards operation and tariff and what technical difficulties would arise from the application of these methods ?

Question 6.

(Sub-Group 2/4, then co-operation with Sub-Group 2/2, Study Group 2 and Study Group 11)

(New Question)

Is it possible, with the arrangements already in force for the national automatic service of each country, to reach standardization concerning the determination of the chargeable time in the international fully-automatic service, and if so, what arrangements should be adopted ?

In particular, it is convenient to consider whether the measurement of chargeable time should be controlled only from the calling subscriber's station, or whether the called subscriber's clearing signal can be used for the determination of the chargeable time by stopping the meter, after a certain delay following the reception of the called subscriber's clearing signal.

Question 7.

(Sub-Groups 2/4 and 2/2, then Study Group 2 and possibly Study Group 11)

(New Question)

When drawing up a routing plan for automatic traffic, it will be useful to know whether Administrations will be obliged to place a limit on the amount of the unit charge that can be recorded on subscriber's meters in condition of fully-automatic operation. " Unit charge " is here taken to mean the charge for a 3 minute call.

In the affirmative, what is the limit envisaged in each country as the ceiling of charge which will be recorded on meters ?

Further, what solutions have been found to the technical problem posed by the need to record on meters a large group of pulses or a succession of single pulses following one another at very short intervals ?

Question 8.

(Sub-Groups 2/1 and 2/3 in co-operation, then Study Group 2)

(New Question)

Review of the tariff, used in the European System, for phototelegrams, so as to bring the tariff into line with the actual costs of use of *modern* lines and equipment as well as the costs appertaining to specialist personnel staffing phototelegraph positions.

[*See the Notes and the Questionnaire for the study of costs of phototelegraph communications, under the same question number in the List of Questions of Sub-Group 2/3*].

Questions 9 to 31.

[*Concern only the Sub-Groups of Study Group 2*]

Question 32.

(Sub-Groups 2/1 and 2/2, then Study Group 2)

(Former Question 67 of the C.C.I.T.)

What procedure should be used for accounting when a telephone circuit used for an international VF telegraphy communication is provisionally replaced by a telephone circuit using a different route ?

(In this connection, see C.C.I.T. Recommendation G.13).

Question 33.

(Sub-Group 2/1, then Study Group 2)

(New Question)

How should international Telex accounts be established where there is a fully-automatic subscriber-to-subscriber service and in what terms should traffic be expressed for accounting purposes ?

Note. — (i) The most widely favoured system of charging for directly selected calls established by fully-automatic means appears to be the periodic pulse metering, with or without an initial pulse per call, the frequency pulses varying according to the tariff concerned.

(ii) Automatic metering equipment will also generally be used to measure in one form or another (e.g. in terms of chargeable time or circuit occupation time) the traffic destined for each terminal country.

(iii) It should therefore be possible to continue to establish the international accounts on the basis of the traffic exchanged, but agreement may have to be reached as to the methods to be employed to deduce chargeable time from circuit occupation time.

Question 34.

(Sub-Group 2/1, then Study Group 2)

Should ineffective and disputed Telex call charges necessitating refunds be dealt with so that any refunds are borne by the Administration or Private Operating Agency of origin ?

Question 35.

(Sub-Group 2/1, then Study Group 2)

(Former Question 73 of the C.C.I.T.)

Leased telegraph circuits.
Study of possible amendments to Recommendation H.5, concerning :

(a) conditions of use (single or multiple, duplex or simplex operation, simultaneous or successive telegraphy and telephony over leased telegraph circuits);

(b) rates;

(c) compensation when there is an interruption in the circuit;

(d) conditions for the rental of leases for groups of circuits.

Question 36.

(Documentary question)

(New Question)

What rules have been followed or what action has been taken by your Administration to obtain coordination of telephone and telegraph (including Telex) operation and tariffs in the *inland system* of your country ?

What principles or rules might, in your opinion, be adopted with a view to obtaining *good coordination of international telephone and telegraph operation and tariffs* ?

Note. — This question was raised by the Ist Plenary Assembly of the C.C.I.T.T. with a view to facilitating the job of Study Group 2, entrusted with the " co-ordination of operation and tariffs ", by providing it with documentation revealing :

— the opinion or position of each Administration with regard to such co-ordination;

— the experience each Administration may have gained in its own national service with regard to co-ordination.

TABLE SUMMARIZING THE QUESTIONS
assigned to Study Group 2

Chairman : Mr. LANGENBERGER (Switzerland)
Vice-Chairman : Mr. GARRIDO (Spain)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
1	Replacement of the present system of international accounts.	S.S.G. 2/2	S.S.G. 2/2
2	New method for checking international accounts.	S.S.G. 2/2	S.S.G. 2/2
3	Acceptance of international accounts.	S.S.G. 2/2	S.S.G. 2/2
4	Intercontinental services.	S.S.G. 2/2	S.S.G. 2/2
5	Charging for ineffective calls in international automatic service.	S.G. 11 S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
6	Determination of the chargeable period in international automatic service.	S.G. 11 S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
7	Limit on the international unit charge which can be recorded on the subscriber's meter.	S.S.G. 2/4 S.S.G. 2/2	S.S.G. 2/2
8	Tariffs for phototelegrams.	S.S.G. 2/1 S.S.G. 2/3	
—			
32	Accounting in the case of re-routing of a circuit carrying voice-frequency telegraphy.	S.S.G. 2/1 S.S.G. 2/2	S.S.G. 2/1
33	Establishment of accounts in the automatic Telex service.	S.S.G. 2/1	S.S.G. 2/1
34	Refunds in the Telex service.	S.S.G. 2/1	S.S.G. 2/1
35	Lease of telegraph circuits.	S.S.G. 2/1	S.S.G. 2/1
36	Co-ordination of telegraph and telephone operation and tariffs.		

Telegraph Operating and Tariff Questions
entrusted to
Sub-Study Group 2/1
in 1957-1960

Question 8/21 (Question 8 of Study Group 2)

(Sub-Groups 2/1 and 2/3, in collaboration, if required, with Study Group 8)

(New Question H of the Study Groups 6 and 7 of the C.C.I.F.)

Review of the tariff, used in the European System, for phototelegrams, so as to bring the tariff into line with the actual costs of use of *modern* lines and equipment as well as the costs appertaining to specialist personnel staffing phototelegraph positions.

Note 1. — A questionnaire will be drawn up as a preliminary step by the Committee for the Revision of International Tariffs which will subsequently study net costs on the basis of the replies received.

Note 2. — The current tariff for phototelegrams is based on the formula (from C.C.I.T. Recommendation G.4, Arnhem 1953, page 139) reproduced below :

	Surface area of phototelegram transmitted	Total phototelegraphic charge in frs.	Quota for each *Administration*	
			terminal	transit
1st step	up to 150 cm^2	$18+3y$	$9+3a$	$3b$
2nd step	over 150 cm^2 and up to 250 cm^2	$18+4y$	$9+4a$	$4b$
3rd step	over 250 cm^2 and up to 350 cm^2	$18+5y$	$9+5a$	$5b$
	increased by " y " for each increase of 100 cm^2			

In this table :

y signifies the charges in francs for a unit telephone call over the connection used for the phototelegraph transmission;

a the share of the charge *y*, belonging to each terminal Administration;

b the share of the charge *y*, belonging to each transit Administration.

Question 9/21 (Question 9/10 of Study Group 10)

(Sub-Group 2/1 and Study Group 10)

(New Question VII/3 of the C.C.I.T.)

Is there a need for further standardization of the sequences of signals and texts used in " service signals " in the international telex service, and if so, what should these standards be ?

Note by the Secretariat. — (a) the requirements of the " gentex " service should be borne in mind in this study; *(b)* the study should be begun by Sub-Group 2/1.

Question 10/21.

(This Question interests the C.C.I.R.)

(New Question IX/2 of the C.C.I.T.)

Study, in collaboration with the C.C.I.R., of the need for unifying the various codes used in the international telecommunication services and, if decided on, study of such unification.

(See Recommendation F.6 of the C.C.I.T.)

Question 11/21.

(New Question IX/5 of the C.C.I.T.)

Could any improvements be made in the method of assembling statistics for transmission times of international telegrams in pursuance of Recommendation F.1, and in the presentation of the statistics thus assembled ?

Question 12/21.

(Former Question 59 of the C.C.I.T.)

Study of the reception of telegrams on forms prepared in advance.

Note. — The administrations and recognized private operating agencies, making use in their services of the reception of telegrams on forms prepared in advance, are requested to provide the C.C.I.T.T. with any useful information on the matter, including the type of telegraph equipment employed.

Question 13/21.

(Former Question 60 of the C.C.I.T.)

Study of the use of tape or page printing apparatus in conjunction with the use of reperforators and automatic transmitters for the reception and retransmission of public international traffic (at transit centres, where it is at present the normal practice to retransmit traffic).

Question 14/21.

(New Question VIII/1 of the C.C.I.T., further to Question 57 of the C.C.I.T.)

Study of draft international operating regulations for the " Gentex " service. The establishment of a special service code for this service.

Note. — 1. Contributions to this study should be drawn up in accordance with the provisions appearing on page 19 of Document AP VIII/7 (See " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.").

2. Contributions to this study have been submitted by the Federal German Republic in Document SG VIII/30 and by Switzerland in Document SG VIII/27 (See " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.").

Question 15/21.

(New Question VIII/2 of the C.C.I.T., further to Question 57 of the C.C.I.T.)

Study of the composition of answer-back signals in the " Gentex " service. Should the limit of twenty signals be maintained ?

Note. — For the study, account should be taken of the contributions of the following Administrations :

France : Document SG VIII/23
Federal German Republic : Document SG VIII/24
The Netherlands : Document SG VIII/26
Austria : Document SG VIII/31

(These contributions are published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.")

Question 16/21.

(New Question VIII/3 of the C.C.I.T.)

Can a grade of service expressed as the proportion of calls failing to reach a teleprinter in either the called office or the nominated overflow centre, in the busy hour, be specified for traffic incoming to a national switching system from the " Gentex " service ?

Question 17/21 (Question 17/8 of Study Group 8)

(Sub-Group 2/1 and Study Group 8 ; the study should be begun by Sub-Group 2/1)

(New Question IV/5 of the C.C.I.T., replacing part 1 of former C.C.I.T. Question 46)

Is there a need to envisage the facsimile transmission of alphabetic telegrams in the international general public telegraph service ?

If so, what should be the characteristics of the facsimile system to be employed ?

Note. — *(a)* Having regard to the fact that such a facility neither exists nor is envisaged in the near future in the international service, it is too early to recommend standards.

(b) Administrations which may have experience of such a facility within their national telegraph service, should be invited to contribute information to the C.C.I.T.T., as a basis for further study.

Question 18/21 (Question 18/8 of Study Group 8)

(Sub-Group 2/1 and Study Group 8; the study should be begun by Sub-Group 2/1)

(New Question replacing former Question 46, part 2, of the C.C.I.T.)

(a) Is there any need to introduce a new service into the international service to cater for the transmission by facsimile between subscribers of messages, business papers and similar documents?

(b) If so, what standards should be specified for such an international service?

Note. — So that the standardization of the facsimile equipment can proceed without undue delay, it is desirable for Administrations to supply to the C.C.I.T.T. details of equipment now in use or proposed to be used in their national service.

Study, so far, of the question of the facsimile transmission of business documents, indicates that, in the event of such a service being established internationally, the following standards would be technically suitable for the transmission of documents of different national standard sizes in the range approximately *18 to 21·6 cms wide* and *27 to 33 cms long.*

Index of co-operation : 264
Drum diameter : in the range 66 to 74 mm.

To meet the case of the possible use of drum type receivers, the transmitter drum factor, i.e.

$$\frac{\text{usable drum length}}{\text{drum diameter}}$$

should not exceed 4·7.

Similarly, the drum factor for receivers using drums should not be less than 4·7.

Drum rotation speed. — The joint C.C.I.T./C.C.I.R. Study Group No. V has proposed that, in the absence of any evidence that the conditions for the radio transmission of business documents differ materially from those for phototelegraphy, drum speeds of 90 r.p.m. and 45 r.p.m., in association with an index of 264, should be applied to the direct recording radio facsimile transmission of business documents, as in the case for phototelegraphy (see C.C.I.T. Recommendation D.4).

As regards transmission over metallic circuits, whereas higher speeds than those recommended for phototelegraphy are in certain circumstances possible, e.g. on domestic systems operating within urban areas, further experience of the various possibilities would be necessary before a final opinion could be formed as to what speeds might be recommendable.

Question 19/21.

(Documentary Question further to former C.C.I.T. Question 68)

Duplex operation in the international Telex service: examination of the reports from administrations which have experience of duplex operation. (See Recommendation H.3 of the C.C.I.T.)

Question 20/21.

(Former Questions 69 and 70 of the C.C.I.T.)

Examination of the possibility of allowing international telex calls for conferences or broadcasts.

Question 21/21.

(Former Question 76 of the C.C.I.T.)

If it is considered desirable that observations should be taken on international telex traffic, to verify the standard of service given to the subscribers, how should these be taken, what standard should be laid down and what arrangements should be made for other countries concerned to be advised ?

Question 22/21 (Question 22/8 of Study Group 8)

(Sub-Group 2/1 and Study Group 8)

(New Question III/6 of the C.C.I.T.)

1. Are there needs in the telegraph service which cannot be met by the use of International Telegraph Alphabet No. 2 ? If so, what are they ?

2. If the answer to § 1 is affirmative, which of these needs require to be satisfied in the international service, and in what manner shall they be provided ?

Notes. — In the study of this question the attention of Administrations is drawn to the following contributions :

Italy — Document SG III/37
Poland — Document SG III/24
Sweden — Document SG III/36
U.S.S.R. — Document SG III/34

which are published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.".

3. If after consideration of this question it is suggested that a new International Telegraph Alphabet, having more than 5 units, should be standardized, then Administrations are invited to consider whether this alphabet should replace the International Telegraph Alphabet No. 2, or whether it should be employed as a supplementary Alphabet. In the latter case, should the constitution of the alphabet permit interworking with International Telegraph Alphabet No. 2?

Question 23/21.

(New Question X/6 of the C.C.I.T.)

Possible revision of the Telegraph Regulations.

The Telegraph Regulations, which can be modified only by Administrative Conferences, contain detailed provisions regarding operating and tariff.

The Administrative Conferences only meet at long intervals and the constant progress in the technical field may necessitate changes of operating practice and tariff at much shorter intervals.

It is therefore proposed :

(a) that the C.C.I.T.T. should consider what provisions of the Telegraph Regulations could be modified or withdrawn so that the matters now governed by these provisions could be dealt with by the C.C.I.T.T.;

(b) that the C.C.I.T.T. should study the subjects which it judges to be susceptible to such treatment and propose a procedure for dealing with them.

If the appropriate study group should arrive at conclusions in sufficient time before the next Telegraph and Telephone Conference, these conclusions would be submitted to Administrations for study, with a view to facilitating discussion at that Conference.

Note. — This Question should be dealt with by the Study Group of the C.C.I.T.T., responsible for operating and tariff questions in the telegraph service. This Study Group will study the procedure to be followed to carry out the work and to obtain the cooperation of the other Groups concerned.

In view, however, of the urgency and complexity of the problem, the VIIIth Plenary Assembly of the C.C.I.T. recommends the First Plenary Assembly of the C.C.I.T.T. to set up a small Working Party, drawn from the Study Group in question, to prepare preliminary proposals for the consideration of that Study Group, whose work, it believes, might in this way be expedited.

The Director of the C.C.I.T.T. should at once inform all the Members and Associate Members of the Union, so that any Administrations that may so wish will be able to send in their views for communication to the Working Group in time to be taken into account by the Group.

Question 24/21.

(Further to Question 72 of the C.C.I.T.)

Study of possible amendments to the Telex Regulations :

(a) with regard to the actual regulations,

(b) with regard to rates, taking into account the provisions of Recommendation No. H.14 of the C.C.I.T.

Question 25/21.

(New Question X/1 of the C.C.I.T., further to Question 63 of the C.C.I.T.)

Study of the proposals submitted at the Paris Conference, 1949, by the delegations of *Denmark* and *Portugal* (See Resolution No. 10 annexed to the Telegraph Regulations, 1949) and of the proposal by the *Spanish* delegation, reproduced in the Arnhem Documents, page 235. See Recommendations G.6 and G.7 of the C.C.I.T.

ANNEX 1

(to Question 25/21 of Sub-Group 2/1)

Resolution No. 10 of the Paris Conference

New Tariff Systems

The International Telegraph and Telephone Conference, Paris, 1949,

Considering :

1. that Proposal 567 of Portugal, concerning amendments to be made to Articles 25, 26 and 27 of the Telegraph Regulations (Cairo Revision), with a view to establishing a new tariff system by zones;

2. that Proposal 952 of Denmark, for the establishment of a tariff system in the extra-European system on new bases;

contain suggestions of outstanding interest;

Resolves :

that the above-mentioned Proposals be referred to the C.C.I.T. for study, for possible submission to the International Telegraph and Telephone Conference.

ANNEX 2

(to Question 25/21 of Sub-Group 2/1)

Proposal by Spanish Delegation

If, as seems to be universally recommended, the charge for a telegram is to correspond to the cost price of routing it, the present system of charges falls far short of this condition.

Two telegrams, the first charged for 5 words and the second for 50 words, handed in in the same country of origin for the same country of destination, will give rise to the following operations :

The first :	*The second :*
In the Administration of origin	
— Acceptance, charging and registration. — Handling (" tri ", " boulisterie "). — Accounting.	Exactly the same, in number and cost.

In the Administration of destination

— Handling (" tri ", " boulisterie "). — Registration and accountancy. — Delivery.	Exactly the same, in number and in cost.

Between the two Administrations

— Transmission of 5+7 = 12 words (Use of circuits, apparatus and staff)	Transmission of 50 + 7 = 57 words (i. e. 4.75 times more).

It can therefore be said that, in general, the cost of the second telegram will not be three times that of the first; the charge collected, however, will be ten times higher. The disproportion is obviously considerable.

If, in these circumstances, in the relation under consideration, the total income balances out the total costs, the result will be that senders of long telegrams (the best telegraph customers) will have paid for the deficit created by the senders of short telegrams. This seems neither fair nor proper. Especially since, with the development of the telex service, it is to be expected that the number of long telegrams will steadily decrease.

In view of the above, would it not be advisable for the C.C.I.T., with a view to a possible proposal to the next Telegraph and Telephone Conference, to study a system of telegraph charges more closely corresponding to the production and development of costs, or at least provisionally a relationship between them ?

This could be effected by means of a " charge per word " and a " charge (or surcharge) per telegram ", without in any way changing the present system of word counting, nor causing any complication as regards charging at the handing-in counter or the establishment of international accounts between administrations.

The charge per word, which we might here call the " transmission charge ", could be very much smaller than it is at present.

The charge per telegram could be composed of a fixed terminal charge (the sum of those established by each of the terminal administrations) based on the cost of the terminal operations other than transmission, plus a given number (e. g. five) of units of the " transmission charge " to compensate for the preamble. This total would be a fixed quantity for each relation and channel, i. e. to each " charge per word " would correspond a " charge per telegram ". Of the charge (or surcharge) per telegram, the first item would belong exclusively to the terminal administrations, and the second would be distributed between those routing the telegram, as for the collection of charges per word.

The collection of a certain number of units for the preamble seems quite natural. Of the information elements that a message may contain, obviously considerable importance is attached to those which express its origin in time and space, i. e. the place, the date and the time. It therefore seems right that they should be charged for.

For the rapid introduction of such a system in the European service, even though the cost prices were to be more strictly calculated, it would be very easy, by means of very simple calculations, to fix the charges (per word and per telegram) for each relation, in such a way that the totals for each of the Administrations concerned would in principle be the same as now.

For further details see the *Telecommunication Journal* No. 2 (February 1953).

Question 26/21.

(New Question X/2 of the C.C.I.T.)

General study of Tariffs in the European System.
(See C.C.I.T. Recommendation G.16)

Question 27/21.

(New Question X/3 of the C.C.I.T., further to Question 63 of the C.C.I.T.)

Revision and simplification of the rules on word counting.

At its meeting in 1955, the Study Group X of the C.C.I.T. had recognized that the revision and simplification of the existing rules on word-counting (Chapter VI of the Telegraph Regulations) concerned all Administrations and recognized Private Operating Agencies and had instructed the Director of the C.C.I.T. to ask them to send him their comments and proposals on the subject.

The Director of the C.C.I.T. had conveyed this request to all Administrations and recognized Private Operating Agencies and in Document CCIT SG X/64 of May 1956 had classified the replies by numbered reference to the Telegraph Regulations.

These proposals had been submitted by the Administrations of the following countries : Australia, Belgium, China, Japan, Federal German Republic, Rhodesia and Nyasaland, United Kingdom, Sweden, Switzerland, U.S.S.R. and the companies Cable and Wireless Ltd., and Italcable.

As the Telegraph Conference was to take place at the end of 1958 and since, on the one hand, few replies had been received to the circular and, on the other, among the great number of Administrations and Private Operating Agencies who had not replied there would be some that wished to put forward proposals, it was thought that the question should be passed to the C.C.I.T.T., so that it could again invite Administrations and Private Operating Agencies to submit as soon as possible any proposals they might wish to make on the rules for word-counting. Only after it had received these supplementary contributions, would the responsible Study Group of the C.C.I.T.T. be able to examine the replies and then instruct the Director of the C.C.I.T.T. to send the Study Group's comments and proposals to Administrations and Private Operating Agencies, so that they could take them into account for the Telegraph and Telephone Conference.

Question 28/21 (Question 28 of Sub-Group 2/2)

(Sub-Groups 2/1 and 2/2)

(New Question IX/4 of the C.C.I.T.)

To speed up the establishment and clearing of phototelegraph communications on telephone circuits, can it be envisaged that the phototelegraph positions should call each other direct on a circuit provided for telegraph transmission ?

If so, what should be the general provisions to be recommended for this kind of operation and, in particular, what should be the frequency used for the phototelegraph service to operate a call signal in the phototelegraph positions ?

ANNEX 1

(to Question 28/21 of Sub-Group 2/1)

Establishment of phototelegraph communications

First Comments by the Federal German Republic

Bonn, 10 January 1956.

(a) Experience shows that phototelegraph transmissions are nearly always concentrated in a short space of time, on the occasion of special events. Hence, the loss of time resulting from delay in making channels available for phototelegraph transmissions and in returning them to the telephone service after the end of the transmissions, makes itself felt in a very disagreeable fashion. For this reason, the Federal German Administration has decided that in the national service all communications relative to phototelegraph calls shall be given fast service treatment. The repeater stations concerned reach agreement, by use of the network of speaker lines, as to the telephone circuits to be used for putting a phototelegraph connection through, and on the moment when putting through of the phototelegraph call shall start. At the same time they warn the phototelegraph stations, in order that these may bring their phototelegraph equipment into circuit in due time and may be ready to start work as soon as the phototelegraph call is put through. At the agreed moment, all the repeater stations concerned enter the circuits in question and switch then to phototelegraph transmission as soon as the established telephone call has ended. The trunk operators do not intervene at all in putting phototelegraph calls through, but, in the trunk office, the telephone circuits interrupted in favour of the phototelegraph transmissions are marked by the normal busy signal. This procedure has proved highly successful. Thanks to it, the loss of time, between the moment the telephone circuit is made available and the moment the phototelegraph transmission starts, has been reduced to less than one minute, on the average.

The experience we have acquired shows that the procedure whereby phototelegraph calls are requested at the trunk office and are put through in the order of existing telephone bookings is less likely to allow of a sudden rush of phototelegraph traffic being passed without loss of time, all the more so in that, in many cases, the moment when a telephone circuit is made available for the phototelegraph call does not coincide with that when the phototelegraph sets are ready for working. It has often happened that a telephone circuit made available for a phototelegraph transmission has had to remain unused for some time, because, at that particular time, one of the phototelegraph stations concerned was busy with other phototelegraph calls.

Over a lengthy period, we had the phototelegraph service monitored on a number of international telephone circuits, on which phototelegraph calls are put through in accordance with the procedure described above. We noticed that the loss of time before the phototelegraph call is put through was 11·4 minutes on the average. In relation to the duration of the phototelegraph transmissions properly so called, this figure represents by itself a loss of some 40%.

To accelerate the routing of phototelegraph traffic and to reduce the time lost in making transmission channels available, it is necessary, we think :

1. to introduce greater flexibility into the method used for putting through phototelegraph calls in international traffic;
2. to ensure use of a uniform method for putting through and cutting off phototelegraph calls by adding special rules to the Telegraph Regulations.

The putting through of phototelegraph calls could, we feel, be much accelerated if the repeater stations at the extremities of the international telephone circuits earmarked for phototelegraph transmissions could communicate between themselves direct in an interval between two phototelegraph calls. To this end, we suggest that a special method be used, using a calling

frequency other than that employed by the telephone service, and setting off, on the corresponding side, a calling signal in the repeater station. The repeater stations at the extremity of the international circuit can then immediately communicate, without the operators having to intervene, during an interval between the telephone calls, and can agree as to the circuits to be used, as well as on the moment they shall start to put the phototelegraph call through. It is especially important to decide on such a moment in cases when the international telephone circuit does not end in the same place as that in which the phototelegraph office is. In this case, to avoid loss of time, it is exceedingly important to make the international circuit and the national one available at the same time. In view of the ever greater efforts being made to give fast-service treatment to international telephone calls, we would not at all object if phototelegraph transmissions were no longer ranked, in order of booking, among telephone calls of the same class (Telegraph Regulations, Article 67, § 4), as set forth in the rules proposed. We should be in favour of time losses being reduced to a great extent, so that telephone calls can be passed much more quickly, thanks to a better use of telephone circuits. At the same time, the above procedure makes it possible to adapt the time at which circuits are made available for phototelegraph transmissions to the requirements of the phototelegraph service, much more effectively than hitherto.

We consider that in normal periods of traffic the telephone service will not suffer if phototelegraph calls are put through by this method. To avoid difficulties in case of large-scale breakdowns, or when telephone calls have to have special priority (SVH calls, lightning calls, urgent government calls, etc.), the use of telephone circuits for phototelegraph transmissions should be temporarily stopped and the phototelegraph traffic should be diverted.

The proposed calling method can be used, too, to send an end-of-message signal over the phototelegraph circuit after the phototelegraph transmission is over. In the case of phototelegraph circuits made up of several sections, this fact is of considerable importance in inviting the intermediate repeater stations to disconnect as soon as possible after the end of the phototelegraph transmission.

The above calling method is no less important when, on the occasion of breakdowns, the extreme repeater station or the intermediate stations have to be asked to break into the photos telegraph circuit.

We are ready to introduce this calling method for the German national phototelegraph circuit too, so that, in every case, the calling and end-of-message signals may be transmitted to the extremity of the phototelegraph circuit.

(b) Hereinafter appears a set of draft instructions, showing how we conceive the practical use of this method, and setting forth the recommendations we think are necessary as a complement to the Telegraph Regulations, in connection with the putting through of phototelegraph calls.

APPENDIX

(to Annex 1 to Question 28/21)

Instructions for the putting through of phototelegraph calls on international telephone circuits

I. *Preliminary technical conditions*

1. In the extreme repeater stations of the international telephone circuits used for phototelegraph transmissions, the telephone circuits must pass through special switching equipment, enabling the telephone circuit to be disconnected from the trunk position and to be connected in a four-wire arrangement to the phototelegraph station, or two telephone circuits to be united in a four-wire transit circuit.

2. In the phototelegraph equipment mentioned above, the telephone circuits used for phototelegraph transmissions shall be equipped with special signalling devices, enabling the extreme repeater stations on the telephone circuit to call each other in order to reach agreement, when the established telephone call is finished, on a phototelegraph transmission which is to take place, or to transmit the end-of-message signal after the phototelegraph transmission is over.

3. All phototelegraph stations (public and private) shall be connected by four-wire arrangement by special local lines to the phototelegraph switching equipment at the nearest repeater station.

4. A direct telephone circuit between the phototelegraph station and the phototelegraph switching equipment (besides the trunk circuit of the phototelegraph apparatus indicated under I.3) is recommended. The phototelegraph station can, by this channel, at any time request phototelegraph calls or announce the end of them. Inversely, it can be quickly warned that a phototelegraph transmission is going to take place. In case of breakdowns, this telephone circuit is important, too, for the purpose of immediately asking the repeater station to intervene and of making a reserve circuit available, if necessary.

II. *Booking a phototelegraph call and announcement of its end*

1. A phototelegraph call can be booked at the phototelegraph centre of the competent repeater station, either by a transmitting station or by a receiving one.

2. The phototelegraph call can be booked with a view to it being put through as soon as possible or at any later moment (delayed phototelegraph call).

3. If the booking comes from a private phototelegraph station, the repeater station decides which of the parties concerned shall pay the charges.

4. If there are several local lines between the phototelegraph station and the repeater station (under I.3 above), the two shall reach agreement when the call is booked as to the trunk circuit on which the call is to be put through.

5. As soon as it is ready to operate, the phototelegraph transmitting station shall emit the phase signal (or another substitute signal).

6. The transmitting station *and* the receiving station shall announce the end of the phototelegraph transmission to the phototelegraph centre to which they are connected.

III. *Announcement of a phototelegraph call*

1. The repeater station which has received the booking of a phototelegraph call puts through the phototelegraph call on the telephone circuit earmarked for that purpose, as soon as the established telephone call is finished. In addition, after the end of this telephone call, it shall disconnect the circuit of the trunk position and shall call the corresponding repeater station on that circuit.

2. The phototelegraph transmission, which is to take place, must be announced to the extreme repeater station on the circuit. Should the person making the call want it to be put through at any particular moment (see II.2 above), this moment must likewise be announced.

3. The corresponding repeater station immediately determines if and when the called phototelegraph station will be ready to operate. Thereafter the two of them reach agreement as to the moment at which the phototelegraph call shall begin.

4. If the international circuit does not end in the same place as that in which the phototelegraph office is situated, the repeater station for the called phototelegraph station shall be asked to warn the latter and to help, at the right moment, in making the national circuit available.

N. B. — Until the signalling devices mentioned in I.2 are available, the communication between the two extreme repeater stations on the international telephone circuit is made by the trunk operators, unless direct service circuits can be used.

IV. *Preparations for the phototelegraph call*

1. The repeater stations concerned in putting through the phototelegraph call make the preparations for the necessary communications in order that the phototelegraph transmission be not thereafter delayed by supplementary switching operations.

2. The repeater stations concerned must be asked in time, before the moment decided on for the transmission (see III.3 above) to put their apparatus into the " ready-to-go " position.

3. The repeater station responsible for the phototelegraph transmitting station must consider whether this latter transmits the phase signal on the trunk circuit agreed on (see III.2 above).

V. *Putting the phototelegraph call through*

1. At the moment agreed upon for transmission (see III.3 above), all the repeater stations concerned in putting through the call ensure that the telephone circuits in question are free and note when the established telephone calls end.

2. They thereupon switch the telephone circuits to the phototelegraph service, and disconnect the trunk positions.

3. If normal and reserve circuits are available, both shall be examined at the same time. The circuit first freed must be used for the phototelegraph call.

4. Reception of the phase signal (see II.5 above) indicates to the repeater stations concerned that the phototelegraph call has been put through as far as them.

5. Reception of the phase signal indicates to the receiving station that the phototelegraph call has been put through.

6. All the stations concerned in putting through the phototelegraph call remain in contact until the phototelegraph stations are communicating.

VI. *Announcement of the end of phototelegraph calls, and return of circuits to the telephone service*

1. After the phototelegraph transmission is finished (see I.4 above), the terminal repeater stations emit the call current on the phototelegraph circuit (see I.2 above). This sets off an end-of-message signal in the corresponding station, and perhaps in the transit station too.

N. B. — Until the signalling devices mentioned in I.2 are available, the transit station must be particularly invited to enter the circuit by the extreme repeater station of the national circuit.

2. The transit station confirms to *both* terminal repeater stations that it has received the end-of-message signal. At the same time it receives, over the national circuit, an announcement of the chargeable times valid for the beginning and end of the phototelegraph transmission.

3. The extreme repeater stations on the international telephone circuit compare these chargeable times.

4. They thereupon reach agreement to decide whether the circuit is to be cut or switched to another phototelegraph station.

5. The repeater stations concerned shall switch back to the telephone service, as soon as possible, the circuits they no longer need for the phototelegraph transmission.

VII. *Special provisions*

When, in case of large-scale breakdown or of telephone calls with special priority (SVH calls, lightning calls, urgent government calls, etc.), the telephone traffic on certain trunk circuits cannot be interrupted, use of such circuits for phototelegraph transmissions shall temporarily be prohibited.

ANNEX 2

(to Question 28/21 of Sub-Group 2/1)

Opinion of the Federal German Republic regarding the report of the 6th and 7th Study Groups of the C.C.I.F. on the revision of C.C.I.F. Recommendation No. 51

The Administration of Posts and Telecommunications of the Federal German Republic is of the opinion that account should be taken of the steady increase in phototelegraph traffic and of the growing number of illustrated press releases nowadays, adopting the principle that the phototelegraph service should itself establish the communications it requires. The volume of phototelegraph traffic is not yet of a size to justify a special network for this service, but we should nevertheless ensure that circuits envisaged for phototelegraphy transmission will be available to it, without any restrictions when the need arises. Since phototelegraph traffic is always concentrated in short time periods, during special events, and since it calls for the rapid transmission of phototelegrams, delays in the preparation of phototelegraph communications are particularly disagreeable; such delays are inevitable when the service is coupled with the telephone service (as phototelegraph bookings are ranked among bookings of telephone calls).

Contrary to the opinions expressed so far, the idea should be expressed that telephone circuits should not be used for phototelegraphy but, on the contrary, phototelegraphy circuits should be made available to the telephone service when they are not needed for phototelegraph transmissions. Priority should be granted to the telephone service, using phototelegraph circuits only in cases of serious breakdown or bookings for priority calls (distress, lightning, urgent government calls, etc.).

The method proposed by the German Administration would allow phototelegraph positions at any time to disconnect a trunk circuit reserved for phototelegraph transmissions from the trunk position (if the circuit is engaged, after the end of the call in progress) and to use it for establishing a phototelegraph communication. During the time when the circuit was unconnected, the usual engaged signal would appear at the trunk office. According to the method proposed, phototelegraph positions would be able to call each other, agree, and give an end-signal on phototelegraph circuits, as soon as the phototelegraph transmission is over. The great advantage of such a method is that phototelegraph communications would always be ready when the phototelegraph positions concerned were actually ready for work; also, that time losses would hardly occur when a transmitting station communicates successively with different receiving stations or when several transmitting stations have to be connected successively to one receiving station.

A method, maintaining that circuit bookings for phototelegraph transmissions must be ranked among existing telephone call bookings, cannot offer such possibilities. Finally, the telephone service is itself affected by inevitable delays in the routing of phototelegraph traffic, whereas better use of trunk circuits would enable telephone calls too to be routed more quickly.

Moreover, the Federal German Administration of Posts and Telecommunications considers that such a method is incompatible with the convention relative to the time at which phototelegraph transmissions should take place.

For the above reasons, the Federal German Administration of Posts and Telecommunications recommends the adoption of a no-delay service for the establishment of phototelegraph communications, to be entrusted exclusively to phototelegraph positions. The German Administration would, in passing, emphasize that the method it proposes has already been applied in the inland service, where it has proved its worth.

Question 29/21.

(Sub-Groups 1 and 2 of Study Group 2)

(Former Question 87 of the C.C.I.T.)

(a) Is it desirable to supplement the general provisions of Articles 67 and 69 of the Telegraph Regulations by recommendations relative to the establishment of phototelegraph communications, and could such recommendations usefully be assembled into a special set of regulations for the establishment of phototelegraph communications ?

(b) What rules, if any, should then be recommended, in addition, for the establishment of phototelegraph calls ?

Comment. — 1. In phototelegraph transmissions over telephone circuits, the total time during which the transmission channel is made available often greatly exceeds the duration of the transmission between phototelegraph transmitter and receiver.

2. After connection has been made between the transmitting and receiving stations, there is often a very long preparation period before the phototelegraph transmission properly so called.

3. Phototelegraph transmissions are often disturbed by the fact that office staff enter the circuit during phototelegraph transmission, without being authorized to do so.

4. The telephone circuits used for phototelegraph transmissions are not always immediately made available again to the telephone service after the end of the phototelegraph transmission.

Note. — In this connection, see the provisional draft recommendation issued by the working party of Sub-Groups 2/1 and 2/2 at its meeting in Frankfurt, February 1957 (Contribution Sub-Group 2/1, No. 1).

Question 30/21.

(Former Question 65 of the C.C.I.T.)

Is there any need to recommend that, in the event of interruption of normal telegraph circuits provided by wire or by radio and on occasion when such circuits are closed at night or on holidays, telegraph offices should route telegraph traffic by telex service circuits and start-stop apparatus located in those offices, pending the setting-up of a European automatic telegraph network ?

If so, what would be the transit charges ?

(See, in this connection, C.C.I.T. Recommendation G.12).

Question 32/21 (Question 32 of Study Group 2 and Sub-Group 2/2)

(Sub-Groups 2/1, and 2/2 and Study Group 2; Proposals to be prepared in the first place by Sub Group 2/1)

(Former Question 67 of the C.C.I.T.)

What procedure should be used for accounting, when a telephone circuit used for an international VF telegraphy communication is provisionnally replaced by a telephone circuit using a different route ?

(In this connection, see C.C.I.T. Recommendation G.13).

Question 33/21 (Question 33 of Study Group 2)

(Sub-Group 2/1 and Study Group 2; Proposals to be prepared in the first place by Sub-Group 2/1)

(New Question XI/5 of the C.C.I.T.)

How should international Telex Accounts be established, where there is a fully automatic subscriber-to-subscriber service and in what terms should traffic be expressed for accounting purposes ?

Note. — (i) The most widely favoured system of charging for directly selected calls, established by fully automatic means, appears to be the periodic pulse metering, with or without an initial pulse per call, the frequency of pulses varying according to the tariff concerned.

(ii) Automatic metering equipment will also generally be used to measure in one form or another (e.g. in terms of chargeable time or circuit occupation time) the traffic destined for each terminal country.

(iii) It should therefore be possible to continue to establish the international accounts on the basis of the traffic exchanged, but agreement may have to be reached as to the methods to be employed to deduce chargeable time from circuit occupation time.

Question 34/21 (Question 34 of Study Group 2)

(Sub-Group 2/1 and Study Group 2; Proposals to be prepared in the first place by Sub-Group 2/1)

(New Question XI/6 of the C.C.I.T.)

Should ineffective and disputed Telex call charges, necessitating refundments, be dealt with so that any refunds are borne by the administration or private operating agency of origin ?

Question 35/21 (Question 35 of Study Group 2)

(Sub-Group 2/1 and Study Group 2; Proposals to be prepared in the first place by Sub-Group 2/1)

(Former Question 73 of the C.C.I.T.)

Leased telegraph circuits.

Study of possible amendments to Recommendation H.5, concerning:

(a) conditions of use (single or multiple, duplex or simplex operation, simultaneous or successive telegraphy and telephony over leased telegraph circuits);

(b) rates;

(c) compensation when there is an interruption in the circuit;

(d) conditions for the rental of leases for groups of circuits.

TABLE SUMMARIZING

the Questions assigned to Sub-Group 2/1

Chairman: Mr. T. PERRY (Netherlands)
Vice-Chairman: Mr. VARGUES (France)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments:
8/21	Rates for phototelegrams.	S.S.G. 2/3 S.G. 8	
9/21	Standardization of service texts in telegraph switching.	S.G. 10	
10/21	Unification of service codes.	C.C.I.R.	
11/21	Improvement of statistics of transmission speeds.		
12/21	Reception on forms prepared in advance.		
13/21	Transit with reperforators.		
14/21	Operational regulations for the Gentex services.		
15/21	Composition of answer-back signals in the Gentex service.		
16/21	Grade of service in the Gentex service.		
17/21	Facsimile transmission of alphabetic telegrams.	S.G. 8	
18/21	Facsimile service between subscribers.	S.G. 8	
19/21	Duplex operation in the Telex service.		

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments :
20/21	Conference of broadcast Telex communications.		
21/21	Observations on the quality of traffic in the Telex service.	S.G. 8	
22/21	New telegraph alphabet.		
23/21	Possible revision of the Telegraph Regulations.		
24/21	Amendments to the Telex Regulations		
25/21	Composition of telegraph tariffs.		
26/21	General study of tariffs in the European system.		
27/21	Revision of rules for word counting.		
28/21	Speeding-up the putting-through of photo-telegraph communications.	S.S.G. 2/2	
29/21	Operational rules for phototelegraphy.	S.S.G. 2/2	Study of this will probably be finished after the ad hoc Frankfurt meeting in February 1957.
30/21	Use of Telex service for general traffic.	S.S.G. 2/2	
32/21	Accounting in the case of re-routing of a circuit carrying voice-frequency telegraphy.	S.S.G. 2/2	
33/21	Establishment of accounts in the automatic Telex service.	S.G. 2	Proposals to be drawn up by S.S.G. 2/1 first.
34/21	Refunds in the Telex service.	S.G. 2	
35/21	Leased telegraph circuits.	S.G. 2	
	Questions for which the collaboration of Sub-Group 2/1 is required		
21/8	Checking reception through return circuit.	S.G. 8	
11/9	Use of the ideas of efficiency factor and quality index.	S.G. 9	
4/10	Barring in telegraph switching.	S.G. 10	
5/10	Methods to obtain the attention of an operator in the course of a defective connection.	S.G. 10	
8/10	Numbering plan.	S.G. 10	

Telephone Operating and Tariff Questions

entrusted to

Sub-Study Group 2/2

in 1957-1960

Question 1.

(Sub-Group 2/2, then Study Group 2)

(Continuation of Question 23 of the C.C.I.F. Study Group 7, studied in 1955-1956)

What system of international accounting might be recommended to replace that at present in use ?

Note 1. — It is desirable that the study of this question should take account of alternative routing with semi-automatic and automatic operation, where several normal routes exist via different countries.

Note 2. — The Annex shows the *technical* advantages and disadvantages of the various available methods of establishing international accounts (extract from the information prepared by the C.C.I.F. Study Group 8 and approved by the C.C.I.F. Study Group 7 in 1956).

ANNEX

(to Question 1 of Sub-Group 2/4)

Technical advantages and disadvantages of the various methods of international accounting

A. *Terminal Services.*

1. In terminal services, the available methods for the division of international revenues can be classified, in order of complexity, as follows :

Method 1. — Each Administration retains the charges it collects;

Method 2. — Each Administration leases, at appropriate rentals, the circuits carrying its outgoing traffic;

Method 3. — Meters are used to measure circuit occupation time;

Method 4. — A meter is used with each circuit to measure the " chargeable time " of calls passing over the circuit;

Method 5. — All the information about each call is collected and the charges made to subscribers on the basis of this information enable the payments due to each Administration to be calculated with complete exactness.

2. Method 1 assumes that direct circuits between two countries do not traverse a third country and that the volume of traffic on the one hand, and the lengths of national sections of each circuit on the other hand, are comparable. This is usually the case only in frontier relations.

3. Method 2 has more general application and can be applied without difficulty when a circuit passes through one, or more, transit countries.

4. Neither of these methods requires technical devices to be used.

5. Method 3 measures the circuit occupation time. The method is relatively simple, and consequently economical, since all that is required is a check of the " free " or " busy " condition of the circuit, conditions which are characterized by a static potential for example..., etc. One meter only will serve to record the information for a complete group of circuits.

This method assumes that a correction factor will subsequently be applied to derive from the occupation times so measured a reasonable estimate of the value of the charges collected from subscribers. This correction factor would be determined from statistical analyses made over a suitable period of time and taking account of ineffective calls, operating times, times of transmission of tones, etc...

6. Method 4 enables receipts to be better estimated, since it measures " chargeable duration ", that is to say conforming with the definition of " duration of the call " given on page 12 of Volume VI of the *Green Book* of the C.C.I.F.

. . . . . .

" The interval of time between the moment when connection is established and conversation can commence between the calling and called stations and the moment when the calling station gives the clearing signal. " *

. . . . . .

However, method 4 requires much more complicated equipment than is required for method 3, since it is necessary to measure, for each call, the time between signals of limited duration, the answering signal (backward signal) and the clear forward signal (forward signal) and moreover to detect short signals without risk of error.

The relation between conversation time, "chargeable time" and charges actually made should nevertheless not be taken as being readily determinable or as absolutely exact. This relation depends on the manner of charging subscribers. The present standard method of charging (unit of 3 minutes, followed by units of 1 minute) is in this respect the least favourable since the time charged for and the chargeable duration are not in strict proportion.

7. Method 5 is that actually used in international working with manual service or semi-automatic service. It can be used with fully-automatic service only if " automatic-ticketing " machines are available. (These machines supply information either on tickets or in some other form for immediate use with mechanical accounting systems).

These machines give certain advantages against which must be set the costs associated with " calling subscriber identification." Such machines can, in effect, be regarded as being intended primarily to provide information for charging subscribers and as a secondary purpose only to serve as a means for the sharing of international call charges. This might be a solution if it were desired to restrict access to a fully-automatic international network to certain subscribers only.

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* Clearly, it is desirable to clear-down a call if, for one reason or another, the calling subscriber has not cleared and a suitable interval has elapsed after receipt of the called subscriber's clearing signal. This clearing of the call after a given delay is, of course, positively indicated by the transmission of a clear forward signal.

8. It is noted that methods 3 and 4 will not allow, without serious complication of the equipment, of discrimination between charging zones in cases where there are several such zones in the country of destination.

This is a fresh argument for each country to constitute one single charging zone.

B. *International transit operation.*

With international transit operation the difficulties of determining the division, origin and destination of calls are such that it is preferable to adopt broad methods of estimating traffic quantities and receipts.

Question 2.

(Sub-Group 2/2, then Study Group 2)

(New Question)

Having regard to :

— the present difficulty in subjecting international accounts to adequate check (as envisaged in Article 51 of the Telephone Regulations) because of the extension of rapid operating methods and the non-availability of records at the incoming exchange;

— the likely development of international fully automatic service and the increasing difficulty in providing economically for satisfactory checks in these conditions;

— and the continuing duty and responsibility of many Administrations to satisfy the requirements of public accountability in their international settlements;

Is it not appropriate to introduce a fresh basis of check of international accounts, whereby in respect of each international relation, each terminal Administration would at the request of the other place at the latter's disposal, not more frequently than annually, facilities for examination of the basis of preparation of a selected account ?

Question 3.

(Sub-Group 2/2, then Study Group 2)

(New Question)

Is it not desirable to recommend a more rapid procedure for the exchange of international accounts than that at present defined in the Telephone Regulations ? (Such a procedure could be used, until the Regulations could be amended, on the basis of special agreements as defined in Article 51 of the Regulations). The principle on which the exchange of international accounts should be based might be as follows :

An account drawn up by an outgoing Administration is accepted by the transit and incoming Administrations without any formal act of acceptance being necessary : it being understood that the incoming and transit Administrations reserve the right to contest the account, and if agreed by the outgoing country, to have an adjustment made in the next account.

Remark. — See Annex hereafter.

ANNEX

(to Question 3 of Sub-Group 2/2)

The arrangements set out in Article 51 of the Telephone Regulations, for the establishment of international accounts, are based on checks by the country receiving the traffic. These checks are becoming more and more difficult to apply because of the extension of rapid operating methods and the non-availability of records at the incoming exchange.

These difficulties were foreseen in Recommendation 51, which recommends checks of traffic by sampling : but the samples bear no direct relation to the figures shown in the monthly accounts and are not very practical for the examination of inward traffic, and are thus, finally, of doubtful value for the effective check of monthly accounts.

In these conditions it seems preferable to give up at once checks which are becoming more and more fictitious.

On the other hand, the present procedure for the establishment of monthly accounts and for their approval by the Administrations of the incoming country only serves to retard settlements, especially when some of the figures are contested : moreover, such contestations are nearly always ineffective, since the Telephone Regulations recognize the validity of the outgoing side's data in the case of a disparity which cannot be cleared up.

One method which seems to be recommendable in the present situation and which, further, is already blessed in practice (accounts for inter-continental services having long been established on this basis) is to dispense with preliminary acceptance by the receiving country, the accounts established by the originating country being accepted as the definite basis for the monthly settlements. That would not prejudice :

— either the correction of discussed and recognized errors, the amounts of which would be carried forward to the next account,

— or the exercise of checks, by any country which desires to do so, on its inward traffic in order to be able to claim, when appropriate, and as at present, an *a posteriori* correction of figures which do not conform.

The following draft Recommendation is accordingly proposed :

" THE INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE,

Considering,

That the preliminary acceptance of monthly accounts by the Administration of the incoming country is becoming less and less effective, because new methods of operation do not permit of checks of incoming traffic,

Considering, on the other hand,

That the delay imposed by this acceptance merely results in delayed settlements,

Issues the Recommendation,

That, while always respecting the right of an incoming Administration to make a considered claim for a correction *a posteriori*, the accounts established by the Administration of the out-outgoing country shall be taken as definitive by the Administrations of the transit and the incoming countries. Amendments, accepted by mutual agreement between the Administrations of the outgoing and incoming countries, would be brought to account in a subsequent monthly account. "

Question 4.

(Sub-Group 2/2, then Study Group 2)

(Continuation of Question 20 of the C.C.I.F. Study Groups 6 and 7, studied in 1955-1956)

Is it desirable to amend or add to C.C.I.F. Recommendation 4 to define the conditions of operation of inter-continental telephone services ?

In the affirmative, what changes and additions should be made to Recommendation 4 ?

Note 1. — The points in connection with which it might be useful to modify or expand Recommendation 4 are as follows :

Part A. — Among the facilities offered to users, should, for example, collect calls and conference calls be admitted ?

Part C. — In what types of intercontinental connection would it be worthwhile to introduce rapid operating methods ?

What arrangements should be recommended for rapid operation in such cases ?

Part D. — The section dealing with " Charging for calls in the European System..." should apply to the territories actually included in the Interconnection Plan, i.e. :

Europe,
The Mediterranean Basin,
The Middle East,
South Asia.

Is it not desirable to establish a routing plan for these territories such that the primary routes would have maximum use, in order to limit the number of secondary routes ? (This Routing Plan might be called " Inter-Regional Transit Centres ").

Is it not equally desirable to amend the last three paragraphs of Part D (page 22), to indicate, for example, that the country operating the radio-terminal from which an international landline extension is made, should not claim a transit quota in respect of the land-line extension, its terminal quota for the radio-telephone circuit being considered sufficient ?

Part F. — Is it not expedient to make it clear that the 8 minutes surcharge, for a broadcast transmission involving one or more countries in the territory of the Interconnection Plan, applies only to *land-line extensions* of inter-continental radio-telephone circuits ?

Is it not also expedient to make it clear that the minimum chargeable duration of use of an intercontinental radio-telephone circuit for a broadcast transmission should be at least 10 minutes, in order to take account of the costs of preliminary tests and of telegrams and other service discussions which take place in preparing the broadcast transmission ?

Note 2. — To meet the particular needs of certain users interested only in either the reception or transmission of messages, photographs or broadcast programmes, is it to be recommended that Administrations or private operating agencies should arrange, in parallel with the existence of radiotelephone (or telephone) circuits, for *lease* of transmitters or receivers (possibly connected by telephone circuits to the domicile of those interested) in order to effect either reception only or simply transmission ?

If so, what general regulations (conditions of admission and charging) should be observed in the interest of the general telephone service ?

Question 5.

(Sub-Group 2/4; thereafter cooperation, possibly, with Sub-Group 2/2 and Study Groups 2 and 11)

(New Question)

SUMMARIZED WORDING : Should ineffective automatic international calls be charged for ?

Full wording: To be found in the list of Study Group 2 questions or in the list of Sub-Group 2/4 questions, under the same question number.

Question 6.

(Sub-Group 2/4, and thereafter cooperation with Sub-Group 2/2, Study Groups 2 and 11)

(New Question)

Is it possible, with the arrangements already in force for the national automatic service of each country, to reach standardization concerning the determination of the chargeable time in the international fully-automatic service, and if so, what arrangements should be adopted ?

Special consideration should be given to whether the measurement of chargeable time should be controlled only from the calling subscriber's station, or whether the called subscriber's clearing signal can be used for the determination of the chargeable time by stopping the meter, after a certain delay following the reception of the called subscriber's clearing signal.

Question 7.

(Sub-Groups 2/4 and 2/2 together, then Study Group 2 and, possibly, Study Group 11)

(New Question)

When drawing up a routing plan for automatic traffic, will Administrations be obliged to place a limit on the amount of the unit charge that can be recorded on subscribers' meters in condition of fully automatic operation ? " Unit charge " is here taken to mean the charge for a 3-minute call.

In the affirmative, what is the limit envisaged in each country as the ceiling of charge which will be recorded on meters ?

Further, what solutions have been found to the technical problem posed by the need to record on meters a large group of pulses or a succession of single pulses following one another at very short intervals ?

Questions 8 and 9.

[*Question 8 of Study Group 2 and Questions 8 and 9 of Sub-Group 2/4 are peculiar to Study Group 2 and Sub-Group 2/4*]

Question 10.

(Sub-Groups 2/2 and 2/4)

(New Question)

If the establishment, in the future, of automatic transit switching centres in Europe is found to be worthwhile on operational and economic grounds, what changes might be recommended in the assessment of quotas in the individual relations affected by the establishment of any such centre and equipment :

— better to reflect the redistribution of net costs, as between lines on the one hand, and terminal equipment on the other ;

— and to take account of economies which may result ?

Question 11.

(Sub-Groups 2/2 and 2/4)

(New Question)

Referring to the note appended to C.C.I.F. Recommendation 41 *bis* (telephone operation and rates), what administrative measures can be recommended for general application in order to reduce the anomalies between charging by units of one minute on the one hand, and by periodic pulses on the other, in order to retain a fair balance between the average out-payments by the subscribers of both the countries concerned and to enable the Administrations to be correctly remunerated ?

Question 12.

[*Question 12 of Sub-Group 2/4 is peculiar to that Sub-Group*]

Question 13.

(Sub-Group 2/4, then Sub-Group 2/2, and Study Group 11)

(New Question)

Considering firstly, that calls to certain special services—absent subscribers, ceased subscribers, changed numbers, etc.—are not treated uniformly as regards charging by Administrations,

Considering also that it is desirable that calls of this type passed by subscribers of a given country over the international automatic service to various destination countries should be treated in a uniform manner,

Could the method of handling such calls be standardized and, if so, what methods should be recommended ?

Question 14.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

(a) In planning the development of the automatic international service, is standardization of the information given to the calling subscriber in certain special classes of completed call, e.g. spare code, spare level, line out of order, congestion, etc., possible ?

(b) If so, what standards should be recommended ?

(c) If not, how should difficulties be overcome if a standard method cannot be recommended ?

Question 15.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

SUMMARIZED WORDING : Use of letters with figures on the dial, for fully-automatic international telephony.

Full wording: Appears in the list of Sub-Group 2/4 questions, under the same question number.

Question 16.

(Sub-Group 2/4, then Sub-Group 2/2)

(New Question)

Considering that in the international automatic service, subscribers do not always consult the telephone directory of their own country, and sometimes give information which is either not clear or incomplete, obtained from notepaper heading giving the subscriber's number which is to be dialled following the international code for the country of destination,

Considering that as a result of this, ambiguity and error may arise, resulting in incorrectly-routed calls which may possibly give rise to complaints by subscribers, and in any case cause unnecessary loading of circuits,

Is it desirable and possible to lay down general rules, valid for all Administrations who intend to take part in the introduction of a fully-automatic international service, regarding the method of indicating clearly and without ambiguity the complete number to be dialled by the caller after dialling the international code of the destination country ?

In particular, is it desirable and possible to recommend that the number dialled after the international code should always be the complete national number of the called subscriber (such as would be shown on the letter-heading of a subscriber) ?

Question 17.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

SUMMARIZED WORDING : A relation operated (in transit) sometimes with automatic, sometimes with manual switching.

Full wording: With an annex, appears under the same question number in the list of Sub-Group 2/4 questions.

Question 18.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

Considering :

— that under semi-automatic and fully automatic operating conditions a planned International European Switching Network will offer increasing scope for the use of transit operation,

— and bearing in mind the special conditions attached to the use of telephone circuits for :

  — voice-frequency telegraph systems and reserves,
  — photo-telegraph services,
  — broadcast services,
  — leased circuits (other than permanent full time leases),

What arrangements should be made, particularly at international transit centres, to ensure that telephone circuits can rapidly be made available for these services when required ?

Question 19.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

SUMMARIZED WORDING : Priority for automatic calls in transit through an automatic transit centre.

Full wording: See, under the same question number, the list of Sub-Group 2/4 questions.

Question 20.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Can the bases of calculation—particularly the values of probabilities of lost calls—used in the determination of the number of circuits required for semi-automatic operation be regarded as equally valid for fully automatic operation ?

If not, what basis should be adopted for such calculations ?

How should a group of circuits be treated which carries both semi-automatic and fully-automatic traffic ?

Question 21.

[*Question 21 of Sub-Group 2/4 is peculiar to this Sub-Group*]

Question 22.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

SUMMARIZED WORDING : Confidence intervals for traffic measurements.

Full wording: With an annex, appears in the list of Sub-Group 2/4 questions, under the same question number.

Question 23.

(Sub-Group 2/2, then Sub-Group 2/4)

(New Question)

For international semi-automatic or automatic service is it desirable to change the definitions of normal routes, auxiliary routes, and emergency routes ?

In automatic or semi-automatic service :

— the 1st, 2nd and *n*th choice normal routes should be defined, and these should be the routes agreed in the "Automatic Routing Plan, "

— the notion of auxiliary routes should not be referred to,

— emergency routes should be defined as in manual operation practice, namely as routes to be used in the event of total breakdown or serious interruption to the normal routes.

Note 1. — This is a very urgent question and should be replied to :

— either by the IInd Plenary Assembly of the C.C.I.T.T., if this takes place prior to the International Administrative Telegraph and Telephone Conference;

— or otherwise by the Committee for the Revision of the Telephone Regulations which should meet one year before the International Administrative Telegraph and Telephone Conference.

Note 2. — The following Appendix shows the conclusions reached by the Sub-Committee on Rapid Operating Methods in 1956, on completion of the study of Supplementary Question B.

ANNEX

(to Question 23 of Sub-Group 2/2)

Answer by the C.C.I.F. Sub-Committee on Rapid Operating Methods to its supplementary Question B in 1956

1. In the process of examining supplementary question B and the contributions made by Administrations towards the study of this question, the Sub-Committee on Rapid Operating Methods expressed the view that the concept of an " auxiliary route " was badly defined in the case of international semi-automatic operation.

The ideas of normal, auxiliary and emergency routes are related to the application of the Telephone Regulations and are bound up with international charging and accounting questions. Normal and auxiliary routings should, in principle, make use of routes in the same countries. Calls carried on emergency routes are subject to a division of charges between Administrations in accordance with the methods specified in operating Recommendation 11 (page 33 of Volume VI of the *Green Book*).

The definitions of normal, auxiliary and emergency routes are given in Article 2 of the Telephone Regulations and are repeated in operating Recommendation 1 (on page 17 of Volume VI of the *Green Book*). The definition of an auxiliary route is as follows :

> " A route (other than the normal route) to be used whenever it is in the interests of rapidity of the service. "

Semi-automatic operation is compatible only with immediate availability of circuits, and in this form of operation, reference to an improvement in the speed of service would be meaningless. This is one reason why the last Plenary Assembly introduced into the definition of a normal route on page 17 of Volume VI of the *Green Book* the following new paragraph :

> " In semi-automatic operation, economic reasons could lead to the use of several normal routes (the switching equipment having to be arranged to take account of the different normal routes). There could be, for example, a first choice normal route, a second choice normal route, a last choice normal route; the term " overflow route " is suitable for every normal route other than the first choice one. "

2. To sum up, in manual operation, the disposal of occasional traffic peaks could not be properly handled except by recourse to the use of auxiliary routes.

Operating by means of semi-automatic service is, in practice, placed much more favourably, for, on the one hand, the groups of circuits which are employed consist, in general, of a relatively

greater number of circuits (by comparison with the number of circuits which were employed in the manual service and particularly in advance preparation manual service).

On the other hand these groups of circuits are calculated on much more liberal bases, i.e. :

— a loss probability in the busy hour between 3% and 5%

instead of

— a percentage of calls not completed at the first attempt of between 7% and 30% (C.C.I.F. tables A and B).

In semi-automatic service, therefore, occasional traffic peaks are better absorbed than in manual service. They will be so much better absorbed that a systematic recourse to overflow routes will be feasible.

3. Use of overflow routes implies in principle passing through one or several transit centres. From the technical point of view the use of overflow routes presents no difficulties. However for tranmisssion reasons, the 3rd Study Group considered in 1952 that it would be wise to avoid having recourse to two transit centres.

Against this, the use of overflow routes assumes the solution of several problems of tariffs and division of charges, and the Sub-Committee on Rapid Operating Methods ventures to draw the attention of the 7th Study Group to the fact that the present wide-spread extension of semi-automatic operation renders the solution to these problems an urgent matter.

For example it would indeed be ill-advised systematically to instal on all semi-automatic international positions facilities to indicate the routing actually followed by a call, if in the near future bulk methods for the division of charges are to be adopted which will in the case of semi-automatic operation permit a departure from a system of international accounting based on the details relating to each call. The adoption of these bulk methods would appear to become necessary for fully automatic international service and it seems likely that they will be equally as good for semi-automatic operation.

4. It has been seen that the use of overflow routes should facilitate the handling of traffic in the event of exceptional peaks. Nevertheless, prolonged congestion might arise.

In this case, in semi-automatic operation, when operators have direct access to circuits, arrangements could be made as a temporary expedient to withdraw rapid service on the route affected and to operate on an advance preparation basis. In a fully automatic service, or when in the semi-automatic service operators gain access to circuits through switching equipment, no entirely satisfactory solution to the problem is available. One method consists of permitting the connection of a limited number of calls dependent on the number of circuits available. This method avoids constant competition amongst operators to seize the circuits which are available.

In any event, the arrangements to be made may be considered as solely a national matter.

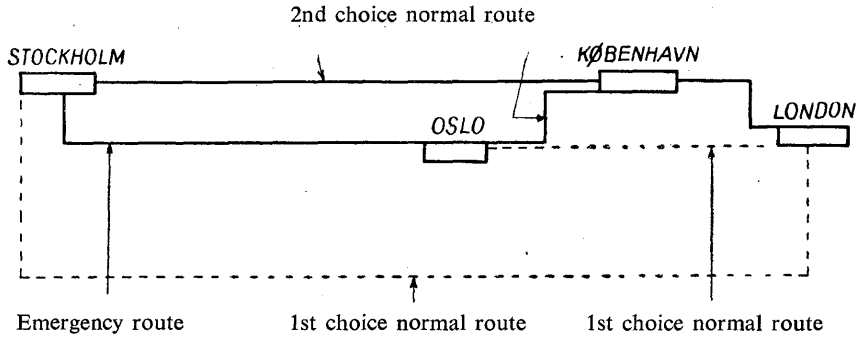
5. In contrast to the case of the concept of an auxiliary route, the idea of an emergency route remains perfectly clear in semi-automatic operation. It is not a case of dealing with exceptional traffic peaks but of coping with the difficulties arising from large-scale interruptions of transmission systems.

It is well recognized that to minimize the effects of these extensive interruptions, the best method is to divide the circuits into two or more groups following different itineraries so that a breakdown on any one of the groups affects only part of the circuits on any particular traffic route.

6. Other methods can similarly be envisaged for bringing emergency routes into use.

While still maintaining, in general, the semi-automatic system of operation, it can be envisaged that an outgoing exchange could be given some means of diverting traffic into an emergency route through a transit centre in another country. The emergency route should of course normally be barred in the registers but be capable of being opened by a simple switching operation. Transit centres should be provided with sufficient equipment to allow through routing on emergency routes without excessive congestion of the diverted traffic.

The following arrangement for the Stockholm-London traffic is given by way of an example of a probable case of diversion. The fact emerges that in certain cases it will be necessary to make provision for two transit centres.



It might be feared that this system might involve a disruption of the traffic on the routes employed—in the example given, between Oslo, London and København. It should however be noted that the use of an emergency route might be needed at any hour of the day or night, but the need might not necessarily arise at the same time as traffic peaks in the busy hour. In the example quoted, the use of the Oslo-London route during the night would not give rise to any difficulties.

In manual service, assuming that calls are connected in the same way, the use of an emergency route is subject to supervision by the exchange whose normal operation might be restricted by those calls routed by emergency route. In semi-automatic service it would be necessary to duly inform the other exchanges concerned at the same time that the emergency route was opened at the outgoing exchange by a switching operation.

Question 24.

(Sub-Group 2/2)

(New Question)

(a) In relations in which the service is conducted entirely on a fully automatic basis is it necessary to preserve the following categories of calls :

Urgent calls,
Lightning calls,
Subscriber's calls,
Fixed time calls,
Collect calls,
Avis d'appel calls,
Préavis calls ?

(b) In the affirmative, is it necessary to recommend the retention of :

— outgoing and incoming operators,
— or an outgoing operator ?

(c) How should such calls be charged for in a service conducted entirely on a fully automatic basis and what should be the arrangements for the settlement of international accounts in respect of them ?

Question 25.

(Sub-Group 2/2)

(New Question)

With the object of reducing language difficulties for operators in the semi-automatic service is there not good cause to leave the identification of the called subscriber to the calling subscriber ? The outgoing operator would then connect the two subscribers together as soon as she heard the ringing tone and would start to time the call as soon as she heard the conversation start.

Remark. — This question stems from the fact that, with local or interurban fully-automatic service, subscribers are used to identifying the called subscriber without any contribution from an operator in setting up the call. In general, a subscriber only books a foreign call if he and his correspondent understand a common language, usually the mother tongue of one or other of them. With semi-automatic service it will thus be easier for the calling subscriber to identify the called subscriber than for an operator to do so, particularly when it is necessary to use languages little known to operators.

Question 26.

(Sub-Group 2/2)

(New Question)

Is it desirable to recommend that Administrations and private operating Agencies which have introduced a rapid service should give ordinary calls more speedy treatment than that given to calls of special classes (as set out in the Annex below) ?

ANNEX

(to Question 26 of Sub-Group 2/2)

With rapid operating methods it is necessary to forego the advantages obtained with the advance preparation method, of securing the maximum output from the staff, lines and equipment used. In fact, for a given volume of traffic and in order to be able to reduce waiting times to values acceptable in that type of service it is necessary to provide additional staff and a greater number of lines and operators' positions. The maximum efficiency is obtained from these arrangements if operators in the " rapid " service have only to connect ordinary calls *. Special classes of calls, such as those with préavis, with avis d'appel, etc., which by their very nature must be set up on an advance preparation basis should be handled on " advance preparation " positions or, if they are handled at rapid operating service positions, should rank below ordinary calls. It is worth recalling that the one-minute surcharge does not cover the additional work involved in setting up special classes of calls. Moreover, since the calling subscriber knows that with special class calls he is recalled after the operator has contacted the called subscriber, he will not worry about a small increase in waiting time. On the contrary, subscribers knowing that their *ordinary*

* See, for example, the end of the article by A. LANGENBERGER, on reducing delay in the international telephone service (*Telecommunication Journal*, No. 10, October, 1956).

calls are connected in the shortest possible time will appreciate the improvement in service. It is the experience of the Swiss Administration that, in giving priority in this way to ordinary calls, the improvement in service encourages subscribers to make more use of the telephone.

Question 27.

(Sub-Group 2/2)

(New Question)

The present rules relating to préavis calls provide that the calling subscriber *must* give his telephone number and *may* give his name if he wishes to do so.

This freedom given to the calling subscriber, whereby he is only obliged to give his telephone number, may cause difficulty, particularly to the called subscriber who may not be aware of the identity of the person who wishes to talk to him.

Is it desirable to make it obligatory, when a préavis call is booked, for the name of the caller to be given in addition to the telephone number ?

Remark. — The name of the caller must be given in connection with avis d'appel calls.

Question 28.

(Sub-Group 2/1, then Sub-Group 2/2)

(New Question)

To speed up the establishment and clearing of phototelegraph communications on telephone circuits, can it be envisaged that the phototelegraph positions should call each other direct on a circuit provided for phototelegraph transmission ?

If so, what should be the general provisions to be recommended for this kind of operation and, in particular, what should be the frequency used for the phototelegraph service to operate a call signal in the phototelegraph positions ?

Remark. — See the Annex to this Question, under the same question number, in the list of Sub-Group 2/4 questions.

Question 29.

(Sub-Group 2/2)

(New Question)

(a) Having regard to international fully automatic operation, is it not desirable to define frontier relations on the basis of the structure of the frontier networks and no longer solely on a basis of distance (see C.C.I.F. *Green Book*, Volume VI, Page 91) ?

(b) In the affirmative, how should Part "A. Frontier Relations ", of the directives for the calculation of international telephone charges in C.C.I.F. Recommendation 41, be reworded ?

Note 1. — With a fully-automatic long distance service it is recommended that the charge should be determined by the first figure of the national number. In frontier traffic, a single figure will not suffice to determine the local networks.

Note 2. — In frontier automatic services it may be expedient to distinguish between the following zones :

i) 1st frontier zone for traffic between *districts of nodal centres* (or equivalent zones) which have a common boundary or whose centres are not more distant from each other than x km.

ii) 2nd frontier zone for traffic between *districts of principal centres* (or equivalent zones) of groups of networks which have a common boundary or whose centres are not more distant from each other than y km.

Question 30.

(Sub-Group 2/2, and outcome of the inquiries referred to Study Group 7)

(New Question)

(a) Is it necessary from the telephone point of view, to define the following terms :
public telephone network,
private telephone network,
leased circuit service ?

(b) If so, should not the following draft definitions be considered ?

1. *Public telephone network :* a network set up for the operation of the public telephone service, which is owned by an operating Telephone Administration (or recognized private operating Agency) and which can be used to give a general telephone service.

2. *Private telephone network :* a network, set up to meet the needs of a Special telephone service, by an Organization other than a telecommunication operating Administration (or recognized private operating Agency) : usually the network is owned by that Organization.

3. *Leased circuit service :* a service in which circuits in the public telephone network are put at the disposal of a user (or of a group of users) for his (or their) exclusive use.

Question 31.

(Sub-Group 2/2, and then Study Group 7)

(New Question)

Is it not desirable to revise C.C.I.F. Recommendation 61, relating to the General Telephone Statistics published by the I.T.U. General Secretariat, in order to reduce the work falling to the lot of Administrations and private operating Agencies (reduction in the number of items and, as necessary, of the periodicity) ?

TABLE SUMMARIZING

the questions assigned to Sub-Group 2/2

Chairman: Mr. TERRAS (France)
Vice-Chairman: Mr. Van Dijk (Netherlands)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments: Preliminary consideration by
1	Replacement of the present system of international accounts	S.G. 2	S.S.G. 2/2
2	New method of checking international accounts	S.G. 2	S.S.G. 2/2
3	Acceptance of international accounts	S.G. 2	S.S.G. 2/2
4	Intercontinental services	S.G. 2	S.S.G. 2/2
5	Charging for ineffective calls in international automatic services	S.G. 2 S.G. 11 S.S.G. 2/4	S.S.G. 2/4
6	Determination of the chargeable period in international automatic service	S.G. 2 S.G. 11 S.S.G. 2/4	S.S.G. 2/4
7	Limit on the international unit charge which can be recorded on the subscriber's meter	S.G. 2 S.S.G. 2/4	
—			
—			
10	Assessment of quotas in the case of automatic transit	S.S.G. 2/4	
11	Elimination of charging dissymetries in international automatic service	S.S.G. 2/4	
—			
13	Standard indications for "abnormal conditions" in international automatic service	S.G. 11 S.S.G. 2/4	S.S.G. 2/4
14	Standardization for "abnormal conditions" in international automatic service	S.G. 11 S.S.G. 2/4	S.S.G. 2/4
15	Association of letters and digits on the dial for international automatic service	S.G. 11 S.S.G. 2/4	S.S.G. 2/4
16	Method for indicating the number to dial, in international automatic service	S.S. G. 2/4	S.S.G. 2/4
17	Routes operated in transit, partly with automatic switching, partly with manual switching	S.G. 11 S.S.G. 2/4	S.S.G. 2/4

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
18	Setting-up of circuits for special purposes in international automatic service	S.G. 11 S.S.G. 2/4	S.S.G. 2/4
19	Seizing priority for automatic calls in transit in an international transit centre	S.G. 11 S.S.G. 2/4	S.S.G. 2/4
20	Basis for computation of number of circuits in automatic international service	S.G. 11 S.S. G. 2/4	S.S.G. 2/4
—			
22	Confidence intervals for traffic measurements	S.G. 11 S.S.G. 2/4	S.S.G. 2/4
23	Definition of normal, auxiliary and emergency routes in the international automatic service	S.S.G. 2/4	S.S.G. 2/2
24	Categories of calls to be admitted in an international automatic relation		
25	Identification of the called subscriber in semi-auto service, by the calling subscriber himself		
26	Priority given, in rapid service, for ordinary calls over other categories of calls		
27	Compulsory indication of the calling subscriber's name for a préavis call		
28	Speeding up the putting through of phototelegraph calls	S.S.G. 2/1	
29	Definition of frontier relations and frontier tariffs		
30	Definition of public and private networks and services		
31	General telephone statistics		
32	Accounting in case of re-routing of a circuit carrying voice-frequency telegraphy	S.S.G. 2/1 S.G. 2	S.S.G. 2/1

Costing
entrusted to
Sub-Study Group 2/3
in 1957-1960

Question 8.

(Sub-Groups 2/1 and 2/3 together, then Study Group 2)

(New Question)

Review of the rates applicable to phototelegrams in the European System, with a view to bringing these rates into line with the actual costs of use of *modern* lines and equipment and with the cost of using specialist personnel to staff phototelegraph positions.

Note 1. — A study of net costs will first be carried out by Sub-Group 2/3 on the basis of the questionnaire annexed below.

Note 2. — The current tariff for phototelegrams is based on the formula (from C.C.I.T. Recommendation G.4, Arnhem 1953, page 139) reproduced below :

	Surface area of phototelegram transmitted	Total phototelegraphic charge in frs.	Quota for each *Administration* terminal	transit
1st step	up to 150 cm^2	$18+3y$	$9+3a$	$3b$
2nd step	over 150 cm^2 and up to 250 cm^2	$18+4y$	$9+4a$	$4b$
3rd step	over 250 cm^2 and up to 350 cm^2	$18+5y$	$9+5a$	$5b$
	increased by "y" for each increase of 100 cm^2			

In this table :

y signifies the charges in francs for a unit telephone call over the connection used for the phototelegraph transmission;

a the share of the charge y, belonging to each terminal Administration;

b the share of the charge y, belonging to each transit Administration.

ANNEX
(to Question 8 of Sub-Group 2/3)

A questionnaire on the net costs of phototelegraph communications

1. *How the questionnaire has been drawn up.*

1.1. This questionnaire is intended to enable net costs to be assessed :

(a) for phototelegraph calls,

(b) for phototelegrams,

in the European System.

1.2. The net cost of phototelegraph calls is mainly determined by the use made of the international telephone circuit. This use can be divided into :

(i) occupation of the circuit for the setting-up of the phototelegraph call and then, at the end of this call, for the operations involved in handing back the international circuit to the telephone service;

(ii) occupation of the telephone circuit during the phototelegraph transmission.

It may nevertheless be desirable, too, to take into account the cost of the international phototelegraph positions and of the specialist staff required to operate them.

1.3. The net cost of a phototelegram is determined by :

(i) the net cost of the phototelegraph call by which the phototelegram is sent;

(ii) the cost of accepting the phototelegram and delivering it to the addressee;

(iii) the costs of sending or receiving the phototelegram.

1.4. Hence this questionnaire is divided into three sections :

Section A: Net cost of a phototelegraph call.

Section B: Cost of acceptance and delivery.

Section C: Cost of sending and receiving.

Each of these three sections is preceded by notes intended to show how the elements to be considered in assessment of costs should be determined.

Some of the information asked for is of a statistical nature, and these data are not always essential for the determination of net costs. They have been requested so that all useful information may be available for the competent C.C.I.T.T. Sub-Groups which will have to define a method for charging for phototelegraph calls and phototelegrams.

2. *General.*

2.1. *Calculation of costs of installations, equipment and accommodation.* — Costs of installations and equipment should be expressed in terms of annual charges. These annual charges should be determined on the basis of :

— capital invested (interest and depreciation);

— maintenance costs (especially consumable material and electric power).

The calculation should be shown in every case, indicating the working life of the equipment and, if necessary, its residual value.

Capital costs should not include the cost of accommodation (land, buildings, etc.). In general, phototelegraph installations and switching equipment are housed in buildings common to other services (telegraph services, repeater stations, etc.), and it seems better to calculate the cost of accommodation in the form of an annual rent to be added to the annual charges on installation and equipment.

2.2. *Calculation of staff costs.* — Staff costs should include salaries and allowances of all kinds paid to staff, and any contributions by the Administration for pension funds, social insurance, free medical attention, leave, etc.

Account should be taken not only of staff employed on operational duties, but also of supervisory staff, maintenance control, and staff employed on auxiliary duties (clerical, claims, statistics, accounting, etc.), and of reliefs.

2.3. *Definitions.* — For the purpose of this questionnaire the following terms are assumed to be as defined below :

Phototelegraph station: a phototelegraph apparatus with its auxiliary equipment.

Phototelegraph centre: all the staff and material housed in the same premises for the operation of one or more phototelegraph stations.

Phototelegraph position: a manual position in a trunk telephone exchange or repeater station, equipped to enable a phototelegraph centre (or station) to be connected to a four-wire trunk circuit.

Telegraph office: a telegraph centre at which phototelegrams may be handed in, or from which they are delivered to users of the service.

SECTION A

3. *Cost of a phototelegraph call.* (In the European System only and in respect of outgoing calls only).

3.1. The cost of an international phototelegraph call is mainly determined by the use made of the international circuit.

The average durations of the different phases of a phototelegraph call should be obtained for an adequate number of actual calls, as follows :

(a) the setting-up of the phototelegraph call;

(b), *(c)* and *(d)* the call itself,
sub-divided into :
- *(b)* the adjustment period;
- *(c)* the transmission of picture signals;
- *(d)* the supplementary period.

(e) disconnection of the call and handing back the circuit to the telephone service.

(Determination of the average durations *(b)*, *(c)* and *(d)* is of interest for costs only in the case of phototelegraph calls concerning a public station. A breakdown of the total $b+c+d$ is asked for only in case of private post-to-post calls).

Measurement of duration will apply only to *outgoing* traffic.

3.2. The average durations obtained will be recorded in the following table. This table has, too, a heading *(f)* which will be filled in only when, in exchange of service information, an international circuit is used (service circuit or general network circuit) other than that used for the phototelegraph transmission.

The number of phototelegraph calls observed with an eye to determine average durations will be entered under *(g)*.

To make allowance for phototelegraph calls not charged for because the picture has been faulty and transmission has been repeated, or attributable to tests, the average percentage of these calls in relation to the total number of calls will be entered under *(h)* for every column.

3.3. Only transmissions at 60 r.p.m. and with an index of cooperation of 352 are to be taken into account for the purposes of this table when transmissions are from a public station.

		Public station to public station Col. 1	Public station to private station Col. 2	Private station to public station Col. 3	Private station to private station Col. 4
(a) Average occupation, in minutes, of the international telephone circuit for the establishment of the phototelegraph call.		.....	.....	.....	.....
Average duration, in minutes, of the phototelegraph call in respect of :	*(b)* Adjustment period (between the time when the phototelegraph stations are connected and the start of the picture transmission).	.....	.....	.....	.....
	(c) The phototelegraph transmission proper (transmission of picture signals).	.....	.....	.....	.....
	(d) Supplementary period between the end of the picture transmission and the notice of termination given by the phototelegraph stations (e.g. for examination, if need be, of the picture received, but excluding the case of a repetition of transmission if the picture is defective).	.....	.....	.....	.....
(e) Average occupation, in minutes, of the international circuit between the notice of termination and the time when the circuit is handed back to the telephone service.		.....	.....	.....	.....
(f) Average duration, in minutes, of a speaker circuit occupation and/or service calls for the exchange between the phototelegraph positions of : — preliminary information for the setting-up of the circuit, — information for handing back the circuit to the telephone service.		.....	.....	.....	.....
(g) Number of observed phototelegraph calls on which the average figures given here are based.		.....	.....	.....	.....
(h) Percentage of calls not charged for because the picture transmitted is faulty or because of tests, in relation to the total number of calls in the column.		.....	.....	.....	.....

3.4. Besides the cost for occupation of telephone circuits, it may be necessary to make allowance, too, for costs involved by the existence of an international phototelegraph position and by recourse being had to specialized personnel to operate it. However, when calculating such extra costs, it should be remembered that the costs of using an international telephone circuit (see C.C.I.F. Recommendation 41 : 0.80 gold francs per international terminal exchange) already include a quota for the cost of employing operators and of using positions.

	Yes, I do	No, I do not
Do you, then, feel that these extra expenses should be taken into account.	.....	.....

If you do, kindly indicate what these extra expenses are, and show in detail how they are calculated. This calculation should be made as shown hereafter and for the international phototelegraph position chosen by your Administration as the most important (indicate the name of the centre so selected).

	National currency	Gold francs
Extra expenses for the international phototelegraph position and for the specialized staff to run it	.....	.....

Calculation of additional costs in connection with an international phototelegraph position and the existence of specialized staff to run it

(Name of the centre chosen : .....)

		National currency	Gold francs
A.1.	Value of the capital invested in the international phototelegraph position (1) (2)	.....	.....
A.2.	Average rate of interest	.....	
A.3.	Estimated life of the international phototelegraph position	.....	
A.4.	Where applicable, the residual value, as a percentage, of the equipment in the position	.....	
	A.5. Annual charges on *capital invested* in the position (1), (2)	.....	.....
	A.6. Annual cost of *upkeep* (3)	.....	.....
	A.7. Annual charge for *accommodation* of the position (4) . .	.....	.....
	A.8. Annual cost of *operating* staff (full or part-time) (5) . . .	.....	.....
A.9.	Total of annual charges thus calculated	.....	.....
A.10.	Addition for overheads (percentage : ...%)	.....	.....
A.11.	Total annual charges	.....	.....

Notes (1) Value as new (replacement cost).

(2) Allowance being made for common equipment (power supply, cables, measuring and control apparatus, etc.).

(3) Allowance being made in these maintenance costs for electric power costs, material for maintenance of apparatus, and cost of technicians.

(4) The cost of accommodation includes the annual rent for the area used by the phototelegraph centre, maintenance, heating, lighting, cleaning and caretaker.

(5) It not infrequently happens that staff used for the phototelegraph service is used for other services too. When this is the case, the way in which such staff apportions its times among the different services should be assessed.

A.12. Number of chargeable phototelegraph calls set up by this position . . . .

Comprising :

Inland phototelegraph calls . . . .

European phototelegraph calls. . . . .

Extra-European phototelegraph calls . . . .

A.13. Give figures for the following ratios of costs for phototelegraph calls :

(i) $\frac{\text{inland service}}{\text{European service}}$ = ...

(ii) $\frac{\text{extra-European service}}{\text{European service}}$ = ...

A.14. Is it your view that the costs obtained should be multiplied by a factor to make allowance for the fact that the data apply to the most important phototelegraph position ? If so, what factor do you suggest ? . . . .

SECTION B

4. *Cost of acceptance and delivery.*

4.1. *General.* — To simplify calculations, the cost of acceptance (or of delivery) of phototelegrams should be computed only for the town in which the public phototelegraph centre is situated, since the greatest volume of traffic is in general exchanged with the town itself.

(Costs relative to acceptance or delivery should be indicated per phototelegram regardless of the surface area of the picture or the category of the phototelegram).

4.2. *Acceptance costs* (including overheads). — Phototelegrams may be handed in :

— at the counter, in a telegraph office;

— by private messenger at the phototelegraph office itself.

	National currency	Gold francs
(a) Handing-in over the counter in a telegraph office :		
(1) costs of accepting and registering the phototelegram, assessment of charge scale, collection of charge	.....	.....
(2) cost of transporting the phototelegram from the office where it is handed in to the phototelegraph centre (either by runner or by pneumatic tube)	.....	.....
Total	.....	.....
(b) Handing-in by private messenger : cost of acceptance and registration, assessment of charge scale, collection of charges	.....	.....

	National currency	Gold francs
(c) Percentage of phototelegrams handed in		
— at the counter		
— by private messenger		
Total : 100		
Average cost (result of weighting *(a)* and *(b)* according to distribution *(c)*)	A_1 = ...	A_1 = ...

4.3. *Cost of delivery* (including overheads). — Phototelegrams may be delivered :

— by messenger;
— collection by the addressee.

(a) Delivery by messenger :		
(1) cost of wrapping (envelope, protective cardboard, addressing, etc.)	.....	.....
(2) cost of transport to the telegraph office responsible for sending the runner	.....	.....
(3) cost of sending the runner	.....	.....
Total	.....	.....
(b) Collection by addressee :		
(1) cost of advising the addressee by telephone (this can be represented by a local telephone call unit)	.....	.....
(2) cost of handing to the runner (registration, receipt)	.....	.....
Total	.....	.....
(c) Percentage of phototelegrams delivered :		
— by messenger		
— by collection		
Total : 100		
Average cost (result of weighting *(a)* and *(b)* according to distribution *(c)*)	A_2 = ...	A_2 = ...

SECTION C

5. *Cost of sending or receiving.*

The elements to be taken into account for this calculation are those relating to the phototelegraph centre chosen by the Administration as being the most important for its phototelegraph traffic (give the name of this centre : .....).

	National currency	Gold francs
C. 1. Value of capital invested in the phototelegraph centre (1), (2) (including darkroom equipment)	.....	.....
C. 2. Average rate of interest	.....	
C. 3. Average life of a phototelegraph apparatus	.....	
C. 4. Ratio (as a percentage) between the residual and the initial value of a phototelegraph apparatus	.....	

		National currency	Gold francs
C.5.	Annual charges on the *capital invested* (1), (2)	.....	.....
C.6.	Annual *maintenance* costs of the phototelegraph centre (3)	.....	.....
C.7.	Annual cost of *premises* (4)	.....	.....
C.8.	Annual *staff* costs (5) (full-time or part-time staff operating the phototelegraph stations in the phototelegraph centre)	.....	.....
C.9.	Annual cost of connecting circuits between the phototelegraph centre and its phototelegraph position	.....	.....
C.10.	Total annual charges calculated as above	.....	.....
C.11.	Addition for overheads (multiplying factor : ..... %)	.....	.....
C.12.	Total annual charges	.....	.....
C.13.	Number of chargeable phototelegrams (6) transmitted by the phototelegraph centre (7)	.....	
	These outgoing phototelegrams were distributed as follows :		
	Inland	.....	
	European	.....	
	Extra-European	.....	
C.14.	Number of chargeable telegrams (6) received by the phototelegraph centre (7) annually	.....	
	These incoming phototelegrams were distributed as follows :		
	Inland	.....	
	European	.....	
	Extra-European	.....	
C.15.	What, in your view, is the ratio between :		
	$\frac{\text{Cost of transmitting } a \text{ phototelegram by this centre}}{\text{Cost of receiving } one} = \ldots$	.....	
C.16.	Annual cost of consumable material in the phototelegraph centre (sensitized paper, developer, fixer) (costs peculiar to reception)	.....	
C.17.	Give figures for the following ratios :		
	$\frac{\text{Cost of an inland phototelegram}}{\text{Cost of a phototelegram in the European System}} = \ldots$	.....	
	$\frac{\text{Cost of an Extra-European phototelegram}}{\text{Cost of an European System phototelegram}} = \ldots$	.....	
C.18.	Do you consider that the net costs obtained from the above data should be increased by a multiplying factor in view of the fact that such costs are based on data for the most important centre for your phototelegraph traffic ? If so, what factor do you suggest ? . . .	.....	

Notes (1) Value as new (replacement cost).

(2) Allowance being made for common equipment (power supply, cables, measuring and control apparatus, etc.).

(3) Allowance being made in these maintenance costs for electric power, material for maintenance of apparatus, and cost of technicians.

(4) Cost of accommodation includes the annual rent for the area used by the phototelegraph centre, maintenance, heating, lighting, cleaning and caretaking.

(5) It not infrequently occurs that the staff operating the international phototelegraph position are used by other services too. If this is so, indicate how their time is distributed between the various services.

(6) Hence excluding test phototelegrams and repetitions.

(7) Each chargeable phototelegram counts as one unit, regardless of its size. If several phototelegrams are transmitted in one single communication, each counts as one unit.

TABLE SUMMARIZING

the questions assigned to Sub-Group 2/3

Chairman : Mr. BORNEMANN (Federal German Republic)
Vice-Chairman : Mr. HEIMBÜRGER (Sweden)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
8	Rates for phototelegrams	S.S.G. 2/1 S.G. 2	To be considered by S.S.G. 2/3 first of all.

Automatic Telephone Operating Questions

entrusted to

Sub-Study Group 2/4

in 1957-1960

(beginning at Question 5)

Question 5.

(Sub-Group 2/4, then possibly Sub-Group 2/2, Study Group 2 and Study Group 11)

(New Question)

Considering that the conditions under which international automatic traffic flows are altogether different from those for the international manual or semi-automatic services;

and particularly that with the present charging methods, subscribers can repeat their calls many times without charge if the wanted subscriber is engaged or does not reply, so causing international circuits to be overloaded abnormally;

is there a need to consider making a charge for ineffective calls on the international automatic service, as some Administrations already do for their inland service, either restricting such charge to the case where the wanted line is reached (engaged or no reply), or extending it to cover the case where the international circuit is released before the call is completed ?

If so, what are the preferred charging methods as regards operation and tariff and what technical difficulties would arise from the application of these methods ?

Question 6.

(Sub-Group 2/4, then Sub-Group 2/2, Study Group 2 and Study Group 11)

(New Question)

Is it possible, with the arrangements already in force for the national automatic service of each country, to reach standardization concerning the determination of the chargeable time in the international fully-automatic service, and if so what arrangements should be adopted ?

Special consideration should be given to whether the measurement of chargeable time should be controlled only from the calling subscriber's station, or whether the called subscriber's clearing signal can be used for the determination of the chargeable time by stopping the meter, after a certain delay following the reception of the called subscriber's clearing signal.

Question 7.

(Sub-Groups 2/4 and 2/2, then Study Group 2 and perhaps Study Group 11)

(New Question)

When drawing up a routing plan for automatic traffic it will be useful to know whether Administrations will be obliged to place a limit on the amount of the unit charge that can be recorded on subscriber's meters in condition of fully automatic operation. " Unit charge " is here taken to mean the charge for a 3-minute call.

In the affirmative, what is the limit envisaged in each country as the ceiling of charge which will be recorded on meters ?

Further, what solutions have been found to the technical problem posed by the need to record on meters a large group of pulses or a succession of single pulses following one another at very short intervals ?

Question 8.

(Sub-Group 2/4, then Study Group 11)

(New Question)

Considering

— that under international semi-automatic operating conditions the answer signal has a supervisory function to indicate that either the incoming operator or the called subscriber has replied to the call;

— that with fully automatic operation the answer signal is used to initiate the registration of the call charge;

Should it be recommended that in a fully-automatic international service a subscriber-dialled call should never be routed to or intercepted by an operator in the incoming country's Administration who returns an answer signal when she replies to the call ? Alternatively, what other recommendation might be made ?

Question 9.

(Sub-Group 2/4, then Study Group 11)

(New Question)

Considering

— that in the international fully-automatic service certain release operations, which are under the control of an operator in a semi-automatic service, are effected automatically,

— that to avoid unnecessary occupation of international lines, it is desirable that there should be forced release on the outgoing side after a certain time if the called subscriber does not reply; and also for the called-subscriber—held conditions,

Is it possible, with the arrangements adopted for the national automatic service of each country, to provide such arrangements for the release of the international connection in the international fully-automatic service ?

Question 10.

(Sub-Groups 2/2 and 2/4)

(New Question)

If the establishment, in the future, of automatic transit switching centres in Europe is found to be worthwhile on operational and economic grounds, what changes might be recommended in the assessment of quotas in the individual relations affected by the establishment of any such centre and equipment :

— better to reflect the redistribution of net costs, as between lines on the one hand, and terminal equipment on the other ;

— and to take account of economies which may result ?

Question 11.

(Sub-Groups 2/2 and 2/4 together)

(New Question)

Referring to the note appended to C.C.I.F. Operating and Tariffs Recommendation 41*bis*, what administrative measures can be recommended for general application in order to reduce the dissymmetry between charging by units of one minute on the one hand, and by periodic pulses on the other, in order to retain a fair balance between the average out-payments by the subscribers of both the countries concerned and to enable the Administrations to be correctly remunerated ?

Question 12.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

(a) Is it desirable to standardize certain characteristics of ringing tone and busy tone in European countries to facilitate the recognition of these tones by subscribers in the international fully automatic service ?

(b) If so, what limits should be recommended for the periodicity, frequency and level of these tones ?

Note. — The characteristics of the existing tones are indicated on pages 25 to 27 of Volume V of the C.C.I.F. *Green Book*.

Question 13.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

Considering firstly, that calls to certain special services—absent subscribers, ceased subscribers, changed numbers, etc.—are not treated uniformly as regards charging by Administrations,

Considering also that it is desirable that calls of this type passed by subscribers of a given country over the international automatic service to various destination countries should be treated in a uniform manner,

Could the method of treatment for the above calls be standardized, and if so what methods should be recommended ?

Question 14.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

(a) In planning the development of the automatic international service, could the information given to the calling subscriber in certain special classes of completed call, e.g. spare code, spare level, line out of order, congestion, etc., be standardized ?

(b) If so, what standards should be recommended ?

(c) If not, how should the difficulties anticipated be overcome if a standard method cannot be recommended ?

Question 15.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Considering

— that the general recommendations regarding national numbering plans contained in Part 2, Chapter 3, § 4 of Volume V of the C.C.I.F. *Green Book* state that if an Administration which uses the Latin alphabet wishes to make use of letters in its national numbering plan it will be desirable to use dials (or keys) which conform to the association of letters and numbers which is more generally used in Europe, since the adoption of a standardized association of letters and numbers will facilitate the work of operators in the international semi-automatic service;

— that there is at present a lack of uniformity in respect of the association of letters and numbers in the national numbering plans of different European countries where letters are used;

— that an Administration not making use of letters in its national numbering plan would not normally provide subscribers with lettered dials, but might nevertheless find it desirable to provide them for a fully-automatic international service;

— that to facilitate subscriber dialling in a fully-automatic international service it is desirable to have complete uniformity in the association of letters and numbers throughout Europe if subscribers are required to dial letters ;

Should the present recommendations mentioned above be revised to take into account the conditions which may arise with a fully-automatic international service, and if so, what should the general recommendation be ?

Question 16.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)
(New Question)

Considering that in the international automatic service, subscribers do not always consult the telephone directory of their own country, and sometimes give information which is either not clear or incomplete, obtained from notepaper heading giving the subscriber's number which is to be dialled following the international code for the country of destination,

Considering that as a result of this, ambiguity and error may arise, resulting in incorrectly-routed calls which may possibly give rise to complaints by subscribers, and in any case cause unnecessary loading of circuits,

Is it desirable and possible to lay down general rules, valid for all Administrations who intend to take part in the introduction of a fully-automatic international service, regarding the method of indicating clearly and without ambiguity the complete number to be dialled by the caller after dialling the international code of the destination country ?

In particular, is it desirable and possible to recommend that the number dialled after the international code should always be the complete national number of the called subscriber (such as would be shown on the letter-heading of a subscriber) ?

Question 17.

(Sub-Group 2/4, then Sub-Group 2/2)
(New Question)

Considering that under semi-automatic and fully-automatic operating conditions certain calls may be switched automatically via international transit centres whilst other calls may be manually switched at those centres;

what arrangements should be made at international terminal and transit centres to enable operators at these exchanges to complete calls which are :

(a) proper to be manually controlled,

(b) routed to operators for assistance purposes, for example when there is prolonged congestion or serious interruption of the service ?

Remark. — See Annex hereafter.

ANNEX

(to Question 17 of Sub-Group 2/4)

Traffic routed through an international transit centre to particular destinations may be switched at this centre either automatically or manually, according to the agreed method of operation or the requirements of the service at any particular time. For instance, traffic for a country normally switched automatically at the transit centre may be manually switched, when there is congestion, to facilitate disposal of this traffic in competition with traffic for the same destination originating at the transit centre itself or in other countries.

When access to the international circuits is obtained by automatic selection, which would be the case at an automatic transit centre, special arrangements would need to be made to give operators access to these circuits, especially if these operators are to be given preference for circuit selection over automatically switched traffic.

A similar situation could arise at an outgoing international terminal exchange under international subscriber dialling conditions, when congestion arises on any outgoing international route. Persistent congestion conditions may cause subscribers to seek the assistance of operators at the outgoing international terminal exchange for the completion of calls. In this case, these operators would need to be placed in a better position for the selection of any available circuits than the subscribers themselves.

The question also arises of what arrangements should be made at both international terminal and transit exchanges to be sure of having enough operators and operating positions to handle the additional manually switched traffic due to congestion.

Question 18.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

Considering that under semi-automatic and fully-automatic operating conditions a planned International European Switching Network will offer increasing scope for the use of transit operation,

And bearing in mind the special conditions attached to the use of telephone circuits for :

— telegraph systems and reserves,

— photo-telegraph services,

— broadcast services,

— leased circuits (other than permanent full time leases),

What arrangements should be made, particularly at international transit centres, to ensure that telephone circuits can rapidly be made available for these services when required ?

Question 19.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

(a) Should a system be used on the international automatic or semi-automatic network in which, under certain conditions and for a strictly limited number of calls in each direction, there is the possibility of a predetermined waiting time while other calls are lost ? What should these conditions be ?

Note. — On this point, reference should be made to Document " C.C.I.F. — 1955/1956 — S.G. 8 — Document No. 20 — Study on the question of the calculation of the number of circuits in the semi-automatic service, by M. E. A. Zayontchkovski, U.S.S.R. Telecommunication Administration. "*

(b) Considering that, for the establishment of transit calls, the waiting delays and the risks of lost calls in the use of the circuits are greater than in the case of the establishment of terminal calls, would it be useful in international transit centres to use a switching system such that a transit call always has priority over terminal calls in the seizure of a free line ?

Note. — The arrangements to be recommended for assuring the priority of transit traffic might be the blocking of circuits for terminal traffic if there is at least one transit call to be established, or the introduction of a short delay in the seizure of a free channel for terminal traffic or any other method.

(c) Assuming that a better grade of service is necessary for transit calls compared with that given for international terminal traffic, what arrangements should be recommended, in the case where the terminal and transit traffic is carried by a common group of circuits, to guarantee the appropriate grade of service for each of these two classes of traffic ? What method for calculating the number of circuits could be recommended in this case ?

Question 20.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Can the bases of calculation—particularly the values of probabilities of lost calls—used in the determination of the number of circuits required for semi-automatic operation be regarded as equally valid for fully-automatic operation ?

If not, what basis should be adopted for such calculations ?

How should a group of circuits be treated which carries both semi-automatic and fully-automatic traffic ?

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* Copies available on request from the Secretariat of the C.C.I.T.T.

Question 21.

(Sub-Group 2/4, then Study Group 11)

(New Question)

Modifications and additions to be carried to Recommendation No. 63*ter* of the C.C.I.F.

Note 1. — Annex 1 below describes a method recommended by the Netherlands Administration for determining with the maximum speed using pre-established diagrams, an arrangement which represents if not the best economic solution, at least a solution with very little inaccuracy.

Note 2. — The calculations mentioned in the example of an application to a practical case of the calculations in Recommendation No. 63*ter* (the example given at the end of this Recommendation) refer to annual charges for alternative routes which are considered as values given *a priori*, and not as values depending upon the number of minutes actually charged for, obtained for the different groups envisaged. Determination of the number of minutes effectively charged, obtained for the circuits of different groups, can lead to certain variations in the determination of the best economic arrangement.

ANNEX

(to Question 21 of Sub-Group 2/4)

Description of a method recommended by the Netherlands Administration for the rapid determination of the optimum number of circuits between three telephone exchanges with overflow facilities

(Document 462/MRE-41 of the C.C.I.F.)

1. *Introduction.*

Figure 1 is a diagram of a network linking exchanges A, B and T. Exchange T can act as overflow exchange for traffic between exchanges A and B.

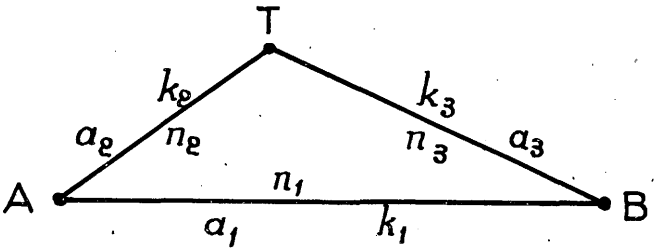


FIGURE 1

In the above figure, a_1 is the sum of the volumes of traffic from A to B and from B to A; a_2 (a_3) is the sum of the volumes of traffic from A (B) to T (T) and from T (T) to A (B). For each of the three routes, n_1, n_2 and n_3 give the number of circuits and k_1, k_2 and k_3 represent the costs per circuit. It is assumed that these " cost " factors include the costs of the terminal equipment of each circuit. Since traffic a_1 can be carried wholly or in part by T, depending on the number of circuits n_1 in the direct route, it is necessary to determine n_1 and thence n_2 and n_3 so that the total costs of the network will be at a minimum for a given loss probability.

The optimum solution is obtained by the Wilkinson method, already published **[1]**, for the calculation of circuit groups. This method of approximation, based on theoretical considerations, gives a very good description of the real state of affairs, as Wilkinson and others have verified experimentally.

In principle, determination of the optimum network can be effected as follows. Let n_1 have a given value. If the group n_1 is fully available, Erlang's formula can be used to calculate the overflow traffic b passing through T for any value of a_1. In the same way, the variance v of this traffic can be determined.

The traffic in group AT thus has a volume a_2+b and a variance a_2+v, so that the values of n_2 and n_3 can be determined from Wilkinson's theory for the given loss probability not to be exceeded. Hence, for a given traffic, n_2 and n_3 are functions of n_1 and it follows that the total cost K of the network is also a function of n_1.

By varying n_1 the minimum of K can be determined with respect to n_1. However, such a method of computation takes too much time in practice. To avoid lengthy calculation, it would be better to prepare nomograms. But this proved impossible on account of the numerous parameters involved.

Computation has shown that the curve of the cost K as a function of the number of circuits n_1 shows a practically horizontal trend near the minimum. This fact has made it possible to indicate a simple method for the determination of an approximate optimum solution. This method of approximation is such that the cost as given by the solution differs from the optimum solution by less than 3%. Since such an approximation to the optimum solution is generally quite suitable for practical purposes, this simple method can be used.

The appendix hereto gives a description of the exact calculation of the optimum solution and the expansion of the method of approximation. We would point out that in these calculations a distinction should be made in principle between two different *requirements* as regards the accepted loss probability.

Requirement a)

For the total traffic on the route AT (a_2+a_1 overflow) the accepted loss probability is given; similarly for route TB.

Requirement b)

The loss probabilities for traffics a_1, a_2 and a_3 from the origin to the destination are given.

The exact calculation for each of these requirements, referred to hereinafter as *a)* and *b)*, is described in the appendix. In general, the results of the exact calculations for *a)* and *b)* are very similar.

2. *Method of determining the optimum number of channels n_1 in the direct circuit.*

Starting from a given volume of traffic a_1, a_2 and a_3 and given cost factors k_1, k_2 and k_3, the parameters t and c are first calculated, t and c being defined by the following formulae:

$$t = \frac{k_2a_2+k_3a_3}{(k_2+k_3)a_1} \quad \text{and} \quad c = \frac{k_2+k_3}{k_1}$$

The calculation of n_1, the number of circuit in the direct route, is made by means of two graphs. On one of them (Fig. 2*a*), the variable c is shown on the abscissae and the variable t on the ordinates. A number of curves divide the t-c graph into separate parts designated by the symbols:

$$> \text{I} \quad > \text{II} \quad > \text{III} \text{ and } > \text{IV}.$$

In the second graph (Fig. 3*a*), the variable c is again shown on the abscissae and the variable a_1 is shown on the ordinates. This graph is also divided into areas designated by the symbols

$$< \text{II} \quad < \text{III} \quad < \text{IV} \text{ and } < \text{V}.$$

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[1] R. I. WILKINSON: Theories for Toll Traffic Engineering in the U.S.A., *Bell System Technical Journal*, March 1956, No. 2.

Since the condition for the required solution is that the cost should not differ from the minimum by more than 3%, it has proved possible to divide the interval of variation of n_1 into five parts, i.e. :

I	$n_1 = 0$
II	$n_1 = a_1$
III	$n_1 = a_1 + 1/3\ (\bar{n}_1 - a_1)$
IV	$n_1 = a_1 + 2/3\ (\bar{n}_1 - a_1)$
V	$n_1 = \bar{n}_1$

In these expressions, $\bar{n}_1$ corresponds to the number of circuit in the direct route which are necessary according to Erlang's formula if all the traffic a_1 is carried direct by AB with the accepted loss probability.

For given traffic volumes and cost factors, a point situated in one of the areas will consequently be found in the two graphs. For instance,

for $c = 1{\cdot}5$ and $t = 1{\cdot}25$ on the $t-c$ graph a point in the area $>$ I will be found
and for $c = 1{\cdot}5$ and $a_1 = 5$ on the a_1-c graph a point in the area $<$ IV.

This means that when n_1 is calculated from formulae III or II and the values of n_2 and n_3 are obtained from n_1 by the Wilkinson method, all the solutions obtained satisfy the requirement that the corresponding cost should not differ from the optimum solution cost by more than 3%.

Some difficulty may be experienced in the choice of the formula for the calculation of n_1. Thus, for instance, for the case $c = 1{\cdot}5$, $a_1 = 2{\cdot}2$ erlangs and $t = 0{\cdot}5$. In the $t-c$ graph, the point $c = 1{\cdot}5$, $t = 0{\cdot}5$ is in the area $>$ II while in graph a_1-c the point is in the area $<$ III. This result shows that the division of the interval of n_1 into 5 parts is not fine enough for this case. For n_1, it will then be necessary to choose the value which is roughly the average of the results obtained from formulae II and III.

It should be noted that it is, of course, possible to divide the interval of the values of n_1 into fewer or more than five parts, according to the degree of accuracy required in the solution. For an accuracy of 3%, with a probability of occupation of 1% and the given intervals of a_1, t and c, the division into five parts has proved adequate.

Graphs 2*a* and 3*a* are plotted for a loss probability of 1% and for requirement *a)*. Graphs 2*b* and 3*b* show similar curves for 1% loss probability but for requirement *b)*.

Example: $a_1 = 5$ erlangs, $a_2 = 5$ erlangs, $a_3 = 10$ erlangs
$k_1 = 100$, $k_2 = k_3$, $k_2/k_1 = 0{\cdot}75$, $w = 0{\cdot}01$, therefore $t = 1{\cdot}5$ and $c = 1{\cdot}5$

(a) *Requirement a)*

Graph 2*a* shows that the point (1·5; 1·5) is in area $>$ I.
Graph 3*a* shows that the point (1·5; 5) is in area $<$ IV.

The formula to be used is therefore $n_1 = a_1$ or $n_1 = a_1 + 1/3\ (\bar{n}_1 - a_1)$:

From the first formula we obtain $n_1 = 5$ and from the second formula $n_1 = 7$, since $\bar{n}_1$ must be equal to 11 from Erlang's formula.

Hence, we can choose 5, 6 or 7 as the value of n_1. The corresponding values of n_2 and n_3 are given in the table below. For the calculation, see appendix 1 *(a)* :

n_1	5	6	7
n_2	14	13	12
n_3	20	19	19
K	3050	3000	3025

This table also shows the cost K for each of the three cases. The optimum cost seems to be 3000. It is clear that the other solutions given satisfy the 3% requirement.

(b) *Requirement b)*

Graph 2*b* shows that the point (1·5; 1·5) is in area $>$ I.
Graph 3*b* shows that the point (1·5; 5) is in area $<$ IV.

As in the previous case, the calculation of n_1 is from formula $n_1 = a_1$ or from formula $n_1 = a_1 + 1/3\ (\bar{n}_1 - a_1)$.

Hence, for n_1 we can again choose the value 5, 6 or 7. The corresponding values of n_2, n_3 and K are given in the table below.

For the calculation see Appendix 1 *(b)*. In the case under consideration, the solutions for requirements *a)* and *b)* are identical. The difference between the two requirements generally assumes importance only when $n_1 < a_1$. Such a value of n_1 is favourable when the point corresponding to the data is situated in the area $<$ II of graph $a_1 - c$.

Figures 3*a* and 3*b* show that this can occur only when $c \leqslant 1$.

n_1	5	6	7
n_2	14	13	12
n_3	20	19	19
K	3050	3000	3025

APPENDIX

1*(a)*. *Determination of n_2 and n_3 as a function of n_1 if the loss probability is taken in the sense of requirement a).*

The Wilkinson method uses two quantities in the probability distribution of the traffic offered, namely the mean volume and the variance. For " pure chance " (random) traffic, the variance is equal to the volume; for overflow traffic, the variance is higher than the volume. The volume of the overflow traffic b of a_1 is $b = a_1 E_{n_1}(a_1)$, its variance v is

$$v = b\left(1 - b + \frac{a_1}{n_1 + 1 + b - a_1}\right).$$

There are graphs for reading v and b as functions of a_1 and n_1 (see **[1]** Figs. 12.1, 12.2, 13.1 and 13.2). The total traffic on group n_2 has a volume $A_2 = a_2 + b$ and a variance $V_2 = a_2 + v$. For the traffic (A_2, V_2) a hypothetical random traffic A_f and a hypothetical group n_f are then determined so that the group overflow traffic has a volume A_2 and a variance V_2 when the traffic A_f is offered to the group n_f. If the traffic A_f is offered to the group $N_f = n_f + n_2$, the loss in this group is

$$A_v = A_f \,.\, E_{N_f}(A_f).$$

The real loss is equal to this value.

It follows that the loss probability w_0 displayed by the mixed traffic (A_2, V_2) on the group n_2 is equal to $w_0 = \frac{A_f}{A_2} E_{N_f}(A_f)$. Hence n_2 must be determined in such a way that w_0 is equal to the accepted loss probability w_s. Graphs have been published giving a direct reading of the number of circuits required n_2 as a function of A_2 and V_2 for loss probabilities of 0·01, 0·03, 0·05 and 0·10 respectively (see **[1]**, Figs. 46 to 49).

Example. — $a_1 = 5$ erlangs; $a_2 = 5$ erlangs; $a_3 = 10$ erlangs; $w_s = 0{\cdot}01$, $k_2 = k_3$. n_2 and n_3 have to be determined, the number of direct circuits $n_1 = 6$ being given. It will be seen from Fig. 12.1 **[1]** that the 5 erlangs overflow traffic offered to a full availability group of 6 circuits, is equal to 0.96 erlangs. From Fig. 13.1 (1) the variance of this traffic is obtained as 1·68. The traffic on group AT has thus a volume of $5 + 0{\cdot}96 = 5{\cdot}96$ erlangs and a variance of $5 + 1.68 = 6.68$.

Similarly, the traffic on group TB has a volume of 10·96 erlangs and a variance of 11.68. Fig. 46 **[1]** shows that for a loss probability $w_s = 0{\cdot}01$, group AT must comprise $n_2 = 13$ circuits and group TB $n_3 = 19$ circuits.

1*(b)*. *Calculation of n_2 and n_3 as a function of n_1 if the loss probability is taken in the sense of requirement b).*

Groups n_2 and n_3 should be of such a size that the following conditions are met.

1. The loss probability displayed by the traffic a_2 (a_3) on group n_2 (n_3) should be at the most equal to the accepted loss probability W_{ob}.

2. The loss on a_1 should at the most be equal to $a_1 W_{ob}$. Let b be the overflow of a_1; the sums of the loss probabilities encountered by traffic b on groups n_2 and n_3 successively should thus not exceed

$$\frac{a_1}{b} W_{ob}.$$

thus $$w^1 = \frac{a_1}{b} W_{ob}.$$

It is obvious that for high values of n_1 (i.e. little overflow) the first requirement is the more stringent, while for lower values of n_1 the second requirement is more stringent. However, for low values of n_1, the overflow b is not small in respect of a_1. The value w^1 for the loss probability of occupation of b is thus of the same order as the accepted value W_{ob}, which is generally low. In these circumstances, the loss probability on groups n_2 and n_3 in series is practically equal to the sum of the loss probabilities of the individual groups. In principle, there are different ways of distributing the loss probability w on the two groups; in this case also, there exists an optimum distribution. But calculation would become very complicated if it took account of this. That is why we accept a loss probability of $w^1/2$ for each of the groups n_2 and n_3. Calculation has shown that such a distribution constitutes a good approximation even for highly unbalanced traffic loads.

The loss probabilities for traffics a_2 and b passed over group n_2 can thus be calculated. Wilkinson's method mentioned in § 1 *(b)* makes it possible to find the overall loss probability w_o of the mixed traffic a_2+b for a given value of n_2. The loss probabilities w_2 and w_b, displayed individually by traffics a_2 and b, are not equal to w_o; in fact, $w_2 < w_o$ and $w_b > w_o$. The overall loss is equal to the sum of the individual losses : we thus have the relation

$$a_2 w_2 + b w_b = (a_2+b)\ w_o \quad \text{or} \quad w_b = \frac{(a_2+b)\ w_o - a_2 w_2}{b}.$$

If we succeed in determining w_2, it is possible to calculate w_b. Wilkinson has given an approximate method for calculating w_2, starting from the fact that the call congestion (= loss probability) of the random traffic a_2 is equal to the time congestion of group n_2 loaded with a_2+b (see **[1]**, § 7.5). w_2 can then be determined from a formula provided by Brockmeyer. The numerical expansion of this formula takes considerable time and it is simpler to calculate only a few points for n_1 small and a number of points for n_1 great. The other points are obtained by graphical interpolation. The method used is the following :

For $n_1 = 0$ the traffic offered to group n_2 is random. Erlang's formula will thus give n_2.

For $n_1 = 1$ the relative variance v/b of the overflow traffic hardly exceeds unity whereas in general the overflow traffic b is not small in respect of a_2. In these circumstances, $w_b \approx w_o$. n_2 is determined from Fig. 25 or Fig. 26 **[1]** so that we have

$$w_o \leqslant \frac{w^1}{2}.$$

For high values of n_1, n_2 is determined so that the loss probability w_2 of a_2 is equal to the accepted value w_{ob}. Graphs have been published showing n_2 as a function of $A_2 = a_2 + b$ and $V_2 = a_2 + v$ for loss probabilities of 0·01, 0·03, 0·05 and 0·10 (see **[1]**, Figs. 42 to 45). Fig. 25 or 26 of **[1]** is then used to check whether w_b is below the acceptable value $w^1/2$.

Example. — $a_1 = 5$ erlangs; $a_2 = 5$ erlangs; $a_3 = 10$ erlangs; $w_{ob} = 0{\cdot}01$; $k_2 = k_3$. n_2 and n_3 are to be determined as a function of n_1.

If the load a_1 is fully passed by direct circuits, group AB should comprise $n_1 = 11$ circuits according to Erlang's formula. In Table I, n_1 is made to vary from 0 to 11; for each value of n_1 the following are shown :

— volume and variance of the overflow traffic,
— volume and variance of the traffic present on groups n_2 and n_3 and
— accepted loss probability w^1 for the overflow on path ATB.

For each case the number of circuits required, n_2 or n_3, is given. At the side of these columns for n_2 and n_3 will be found indications of how the values were obtained.

TABLE I

$a_1 = 5 \quad a_2 = 5 \quad a_3 = 10 \quad w_{ob} = 0{\cdot}01$ (requirement b)

n_1	Overflow traffic a_1		Loss probability acceptable w^1 for b via ATB	Group n_2 traffic		Group n_3 traffic		n_2	Remarks	n_3	Remarks
	volume b	variance v		volume a_2+b	variance a_2+v	volume a_3+b	variance a_3+v				
0	5	5	0·01	10	10	15	15	18·6	Erl. form.	25·0	Erl. form.
1	4·17	4·6	0·012	9·17	9·6	14·2	14·6	17·5	**[1]** Fig. 25	23·9	**[1]** Fig. 25
2	3·38	4·2	0·015	8·38	9·2	13·4	14·2	16·45	graphic	22·8	graphic
3	2·65	3·6	0·019	7·65	8·6	12·6	13·6	15·4	inter-	21·7	inter-
4	1·99	3·0	0·025	6·99	8·0	12·0	13·0	14·3	polation	20·6	polation
5	1·42	2·3	0·035	6·42	7·3	11·4	12·3	13·2		19·6	
6	0·96	1·7	0·052	5·96	6·7	11·0	11·7	12·5		18·8	
7	0·603	1·1	0·083	5·60	6·1	10·6	11·1	11·9		18·4	
8	0·35	0·6	0·143	5·35	5·6	10·3	10·6	11·5	**[1]** Fig. 42	18·0	**[1]** Fig. 42
9	0·187	0·3	0·267	5·19	5·3	10·2	10·3	11·2		17·8	
10	0·092	0·2	0·544	5·09	5·2	10·1	10·2	11·1		17·6	
11	—	—	1	5	5	10	10	10·8		17·5	

2. *Determination of the cost function.*

n_2 and n_3 being determined as functions of n_1 and the cost factors k_1, k_2 and k_3 being given, it is possible to calculate the cost K as a function of n_1. Since the shape of the cost function is not affected by the absolute values of the cost factors, but only by their relations, we put $k_1 = 100$. As we have already said, the cost ratio c is defined as

$$c = \frac{k_2+k_3}{k_1}$$

For the sake of simplicity, we have assumed $k_2 = k_3$ in the calculations.

Figure 4 shows the cost functions corresponding to various values of c for a load $(a_1, a_2, a_3) = (5, 5, 10)$ and $w_{ob} = 0{\cdot}01$. The line in dots and dashes represents the geometric locus of the minima; the line in dashes represents the geometric locus of points for which the cost is 1·03 times the minimum. For a given cost ratio, a value must be taken for n_1 situated between the two lines.

The two extreme values of n_1 will be called the upper and lower limits of n_1.

We have plotted graphs similar to those in Fig. 4 for various other loads. They show that the upper limit curve is essentially determined by the value of a_1 and is only very slightly influenced by the parameter t. The lower limit curve, however, is only very slightly affected by a_1 but it is strongly influenced by variations in t. Because of the shapes of the upper and lower limit curves and the fact that the cost function is horizontal near the minimum, it has proved possible to indicate a simple, satisfactory approximate calculation.

The horizontal trend of the minimum led us to seek a number of simple relations for n_1 and a_1. The formula to be used for computing the upper limit is determined by the values of a_1 and c. The formula used to calculate the lower limit is determined by the values of c and t.

The formulae found admit a maximum deviation of 3% :

I	$n_1 = 0$
II	$n_1 = a_1$
III	$n_1 = a_1 + 1/3\ (\bar{n} - a_1)$
IV	$n_1 = a_1 + 2/3\ (\bar{n} - a_1)$
V	$n_1 = \bar{n}_1$

in which $\bar{n}_1$ is the value obtained from Erlang's formula $w_s = E_{\bar{n}_1}(a_1)$ or $w_{ob} = E_{\bar{n}_1}(a_1)$.

Fig. 5 shows the upper and lower limits as a function of c for a special case. The above-mentioned formulae are shown therein in the form of a step curve.

Approximate representation by means of a step curve makes it possible, with the help of figures such as Fig. 5, i.e. figures corresponding to defined values of a_1, to show in an $a_1 - c$ graph the points where, for a constant value of a_1 and a variable value of c, formula III, for instance, should be abandoned in favour of formula II.

Similarly, we plotted graph $t - c$ for the lower limit.

Comparison of figures 5 and 2*a* shows that the points where the lower limit coincides, in Fig. 5, with the approximate step curve, are not to be found on the respective boundary lines of Fig. 2*a*, but to their right. This is because the lower limit depends not only on t, but also, to some extent, on a_1. Hence, when making a figure similar to Fig. 5 for a traffic load with the same value of t but a different value of a_1, the points on the t-c graph (Fig. 2*a*) corresponding to the points I ... IV on the lower limit, will not coincide with the points corresponding to the points situated on the lower limit in Fig. 5 but will be slightly to the left or right of them. Now, if the boundary lines to be plotted are to meet the 3% requirement in respect of the cost in both cases, the system of points on the left of Fig. 2*a* is essential for tracing the boundary lines, which results from the structure of Fig. 5.

A similar difficulty arises when plotting the boundary lines in Fig. 3*a*, which are determined by the upper limit of n_1. Here, the right-hand system of points is essential.

In Fig. 2*a* and 3*a*, the boundary lines have been drawn in such a way that for the intervals of a_1 and t shown on the graph, they meet the 3% requirement for the approximation of the cost.

The procedure we have just described implies renunciation of part of the margin originally acceptable for n_1, i.e., the margin between the upper and lower limits found for various traffic loads. Graphs similar to those in Fig. 2*a* and 3*a* could be plotted for a wider interval of a_1 and t only at the expense of the margin for n_1.

The calculations made have shown that in the narrowing of the margin for n_1 traffic loads with low a_1 play the most important part. The results seem to show that it might be useful to replace the graphs in Fig. 2*a* and 3*a* by two other systems of graphs, one of them with an interval of variations of

$$a_1 = 0 \ldots 5 \text{ erlangs} \qquad t = 0.5 \ldots 3$$

and the other with an interval of variations of

$$a_1 = 5 \ldots 15 \text{ erlangs} \qquad t = 0.5 \ldots 3$$

As mentioned above, we made the calculations on the assumption that $k_2 = k_3$.

When $k_2 \neq k_3$, a similar method of calculation can be used.

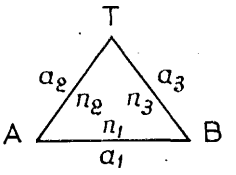
I. $n = o$

II. $n_1 = a_1$

III. $n_1 = a_1 + \frac{1}{3}(\bar{n}_1 - a_1)$

IV. $n_1 = a_1 + \frac{2}{3}(\bar{n}_1 - a_1)$

V. $n_1 = \bar{n}_1$



$\bar{n}_1$ { *résulte de* / *results from* } $E_{\bar{n}_1}(a_1) \leqq W_s$

$$t = \frac{k_2 a_2 + k_3 a_3}{(k_2 + k_3) a_1}$$

$$c = \frac{k_2 + k_3}{k_1}$$

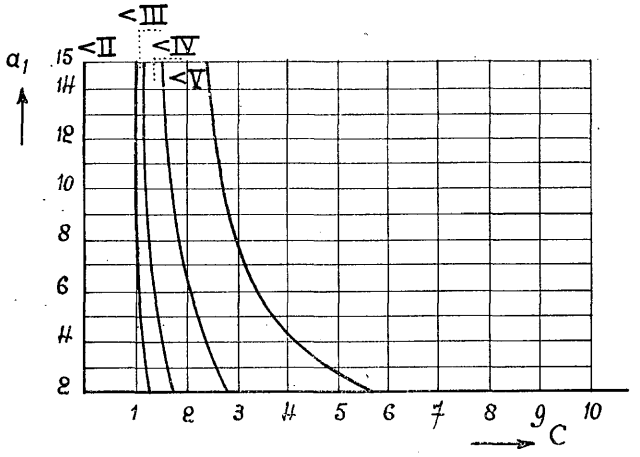


FIGURE 3*a*

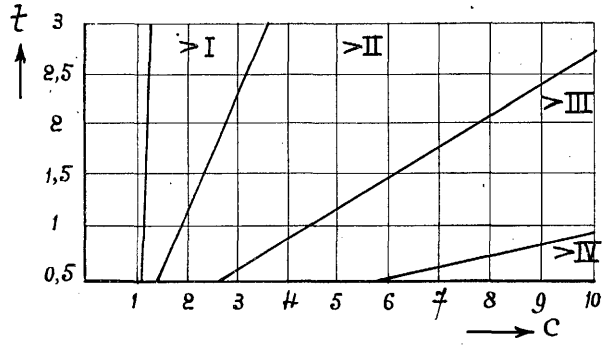


FIGURE 2*a*. — *Determination of the optimum value of* n_1, *if per section a loss probability* $W_s = 0{\cdot}01$ *is accepted (requirement a).*

I . $n_1 = 0$

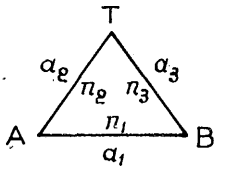
II . $n_1 = a_1$

III . $n_1 = a_1 + \frac{1}{3}(\bar{n}_1 - a_1)$

IV . $n_1 = a_1 + \frac{2}{3}(\bar{n}_1 - a_1)$

V . $n_1 = \bar{n}_1$

$\bar{n}_1$ { résulte de / results from } $E_{\bar{n}_1}(a_1) \leqslant W_{ob}$



$$t = \frac{k_2 a_2 + k_3 a_3}{(k_2 + k_3) a_1}$$

$$C = \frac{k_2 + k_3}{k_1}$$

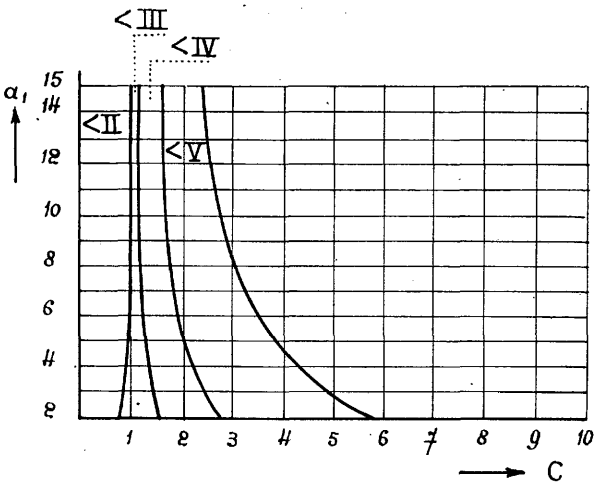


FIGURE 3*b*

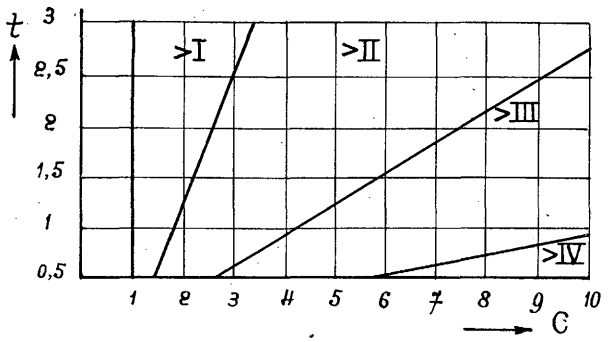


FIGURE 2*b*. — *Determination of the optimum value of* n_1, *if a loss probability* $W_{ob} = 0{\cdot}01$ *from the origin to the destination is accepted (requirement b).*

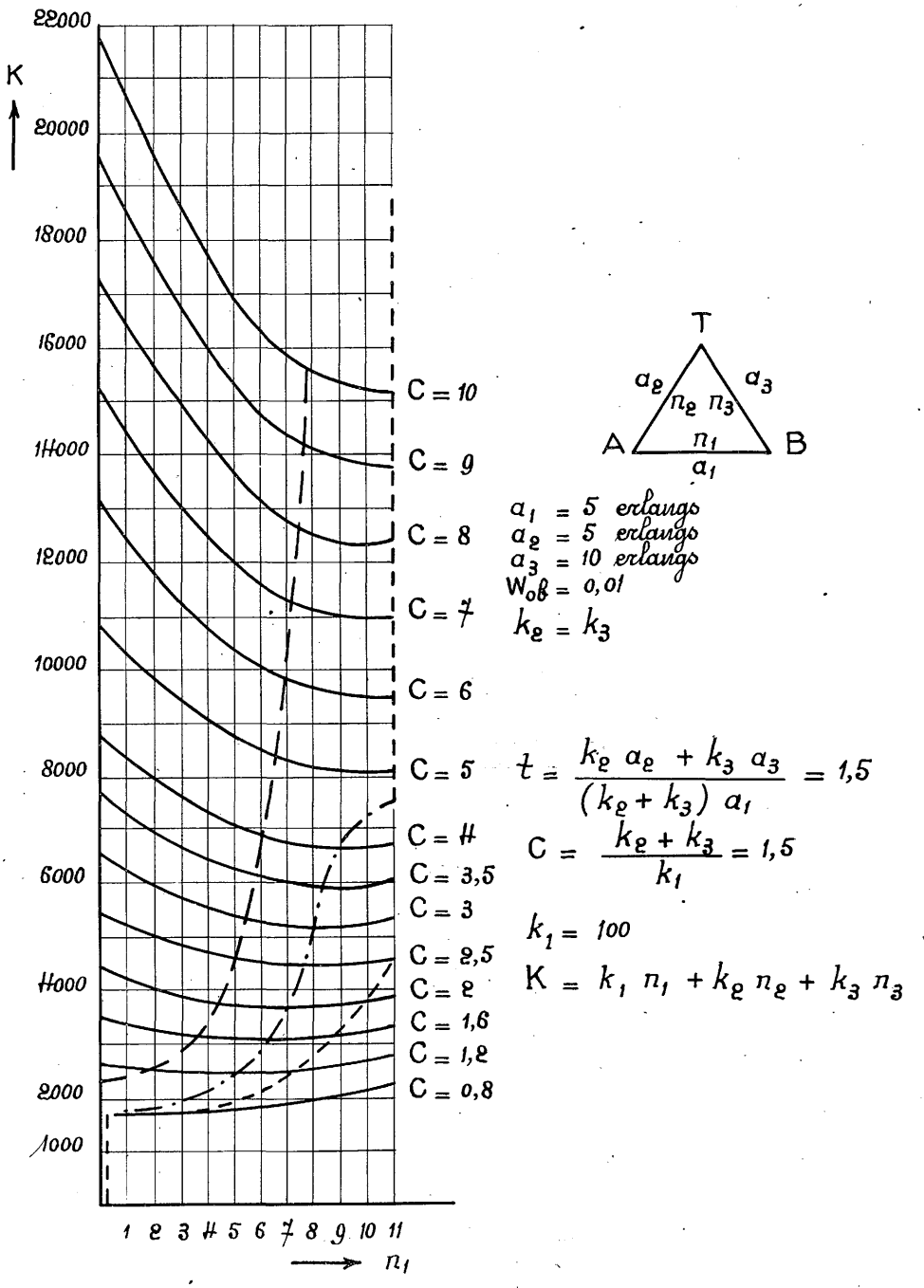


FIGURE 4. — *Cost function K for various values of* c_1 *when the loss probability from the origin to the destination can be* $W_{ob} = 0{\cdot}01$ *(requirement b).*

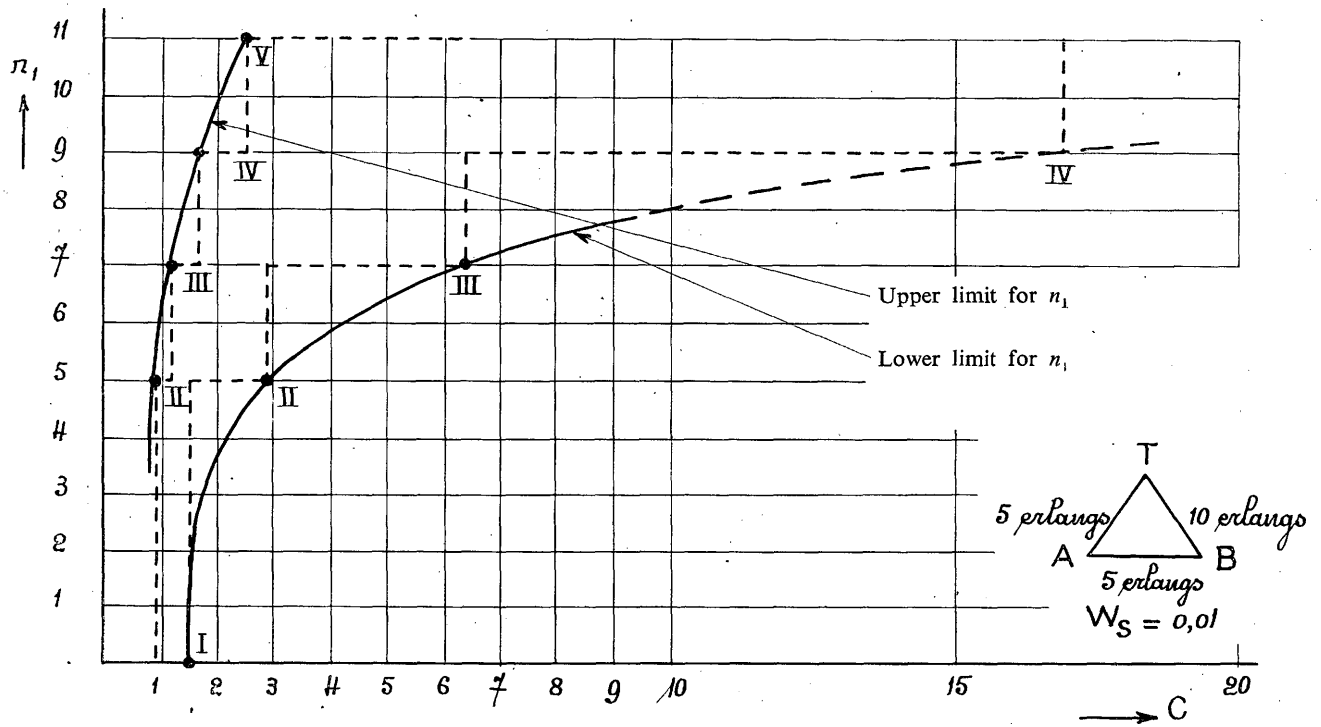


FIGURE 5. — *Replacement of the upper and lower limits of n_1 by a step curve.*
(The limits are calculated for requirement *a*).

Question 22.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Considering

— that the definition of the traffic during the busy hour is given on pages 15 and 16 of Volume VI of the *Green Book*;

— that it is desirable that traffic measurements made by various Administrations shall be truly comparable in spite of the random nature of all telephone traffic;

— that to obtain a real basis for such a comparison a certain standard of accuracy is required and, for this purpose, the theory of random sampling methods gives a well known basis for comparison namely " confidence intervals " and " confidence coefficients " (See note below);

1. Will it be an advantage to obtain an agreement upon the accuracy of certain measurements carried out on a statistical basis (for instance to measure the amount of telephone traffic by groups of international circuits) and,

2. if so, for which cases of measurements should an agreement be obtained and what values of " confidence intervals " and " confidence coefficients " should be proposed for these cases ?

3. What degree of accuracy would be required of the measuring equipment ?

Note. — A typical example illustrating the use of these two terms is given in the appendix. If agreement is reached on particular values of " confidence intervals " and " confidence coefficients " for a certain class of statistical measurement, then the extent of the measurements necessary is obtained from the curves. The " confidence intervals " and " confidence coefficients " will ensure that measurements made in different centres will become truly comparable.

ANNEX 1

(to Question 22 of Sub-Group 2/4)

Example illustrating the use of the terms " confidence interval " and " confidence coefficient "

The degree of confidence which can be obtained with estimates of traffic population parameters by the sampling method is closely linked with the size of the sample and with the standard error of the parameter in question.

Since the average value of the sample will, in general, differ from the true value of the population, the estimate of the latter is expressed as a range within which it is confident the true value lies. This degree of confidence can however only be expressed in terms of probability and the answer must therefore be in terms of a *range* together with an *associated probability.*

This *range* is known statistically as the " confidence interval " and is defined as follows :

" If it is possible to define two statistics t_1 and t_2 (function of the sample values only) such that θ being the parameter under estimate

$$P\ (t_1 \leqslant \theta \leqslant t_2) = a$$

where a is some fixed probability,

the *interval* between t_1 and t_2 is called a " confidence interval. " The assertion that θ lies in this interval will be true, on the average, in a proportion " a " of the cases where the assertion is made. "

The *associated probability* is known as the " confidence coefficient " and is defined as the " measure of probability a " associated with a " confidence interval " expressing the probability of the truth of a statement that the interval will include the parameter value.

The following figure 1 is a rough sketch of an example of the use of the above terms in the case of measurements of traffic quantities.

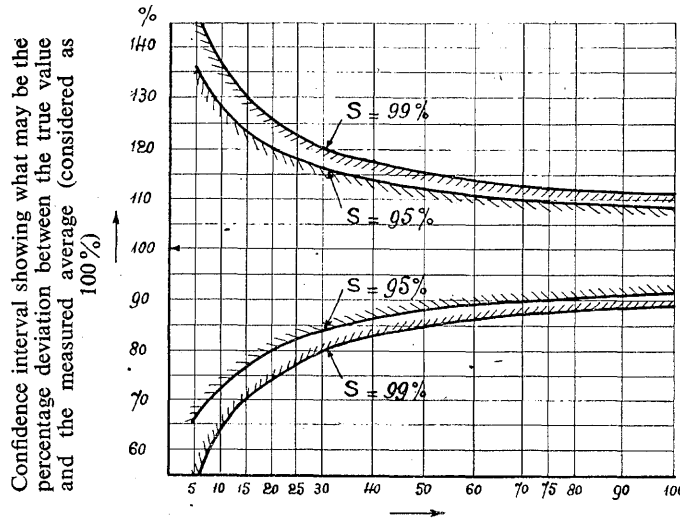


FIGURE 1

Figure 1 above is valid when the average holding-time of the circuit per call remains constant (e.g., about 6 minutes for the figure under consideration).

The ordinates show the confidence intervals in which the true traffic volume should be found as a function of the size of the samples measured.

It is assumed that the measure of traffic volume is the measure of traffic during a specific period of time—day, hour or, for instance, the busy hour. The size of the sample taken, i.e., the *amount* of traffic observed, is expressed in erlangs × hours, that is, in hours of occupation for the circuits of the group.

The confidence intervals are defined for confidence coefficients S of 95% and 99%. The value of S, 95% for instance, means that the true traffic volume can deviate from the mean value obtained during the measurements but, in 95% of cases, will be situated between the limits defined by the two curves marked 95%; in other words, there are only 5 chances in 100 that the true value will be outside these limits.

The practical applications are as follows :

1. Assuming that there is agreement on a confidence coefficient $S = 99\%$ and confidence intervals $\pm 20\%$, the traffic measurements should correspond to 5 hours of circuit occupation. This number of hours should be the same for all the traffic measurements, whether on large or small groups and the number of measurements to be made is determined by this rule.

2. If it is desired to define the confidence interval by a possible deviation of $\pm 10\%$ from the true value (instead of $\pm 20\%$), it will be seen from the graph that the measurements should be made corresponding to 120 hours of occupation.

3. If there is agreement, on the other hand, to use a confidence coefficient S of 95% while maintaining the same confidence intervals as before, the measurements can be made corresponding to a smaller number of hours :

corresponding to 20 hours of occupation, for an interval of $\pm 20\%$
corresponding to 70 hours of occupation, for an interval of $\pm 10\%$.

Question 23.

(Sub-Group 2/2, then Sub-Group 2/4)

(New Question)

For international semi-automatic or automatic service is it desirable to change the definitions of normal routes, auxiliary routes, and emergency routes ?

In automatic or semi-automatic service :

— the 1st, 2nd and *n*th choice normal routes should be defined, and these should be the routes agreed in the " Automatic Routing Plan ",

— the notion of auxiliary routes should not be referred to,

— emergency routes should be defined as in manual operation practice, namely as routes to be used in the event of total breakdown or serious interruption to the normal routes.

Note 1. — This is a very urgent question and should be replied to :

— either by the IInd Plenary Assembly of the C.C.I.T.T., if this takes place prior to the Administrative International Telegraph and Telephone Conference;

— or otherwise by the Committee for the Revision of Telephone Regulations which should meet one year before the Administrative International Telegraph and Telephone Conference.

Note 2. — The following Annex shows the conclusions reached by the Sub-Committee for Rapid Methods of Operation in 1956, on completion of the study of Supplementary Question B.

ANNEX

(For this Annex see list of Questions for Sub-Group 2/2).

TABLE SUMMARIZING

the questions assigned to Sub-Group 2/4

Chairman : Mr. LAMBIOTTE (Belgium)
Vice-Chairman : Mr. CHOVET (France)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
5	Charging for ineffective calls in international automatic services.	S.G. 2 S.G. 11 S.S.G 2/2	S.S.G. 2/4
6	Determination of the chargeable period in international automatic service.	S.G. 2 S.G. 11 S.S.G. 2/2	S.S.G. 2/4
7	Limit on the international unit charge which can be recorded on a subscriber's meter.	S.G. 2 S.S.G 2/2	
8	No sending of the answer signal when an international automatic call arrives on an operator.	S.G. 11	S.S.G. 2/4
9	Release, not under the control of the calling subscriber, of an international automatic connection.	S.G. 11	S.S.G. 2/4
10	Assessment of quotas in the case of automatic transit.	S.S.G. 2/2	
11	Elimination of charging dissymetries in international automatic service.	S.S.G. 2/2	
12	Standardization of national busy and ringing tones.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
13	Standardization for " abnormal conditions " in international automatic service.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
14	Standard indications for " abnormal conditions " in international automatic service.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
15	Association of letters and digits on the dial for international automatic service.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
16	Method for indicating the number to dial, in international automatic service.	S.S.G. 2/2	S.S.G. 2/4
17	Routes operated in transit, partly with automatic switching, partly with manual switching.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
18	Setting up of circuits for special purposes in international automatic service.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
19	Seizing priority for transit calls in an international transit centre.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
20	Basis for computation of the number of circuits in automatic international service.	S.G. 11	S.S.G. 2/4
21	Changes in Recommendation No. 63*ter*.	S.G. 11	S.S.G. 2/4
22	Confidence intervals for traffic measurements.	S.G. 11 S.S.G. 2/2	S.S.G. 2/4
23	Definition of normal, auxiliary and emergency routes in the international automatic service.	S.S.G. 2/2	S.S.G. 2/4

Questions concerning Radio Relay Links

entrusted to

Study Group 3

in 1957-1960

Question 1.

(Study Group 3 in co-operation with Study Groups 1 and 11 and with the C.C.I.R.)

(New Question)

When four-wire interconnection of telephone circuits is made at audio-frequency between circuits on systems using different signalling methods (e.g. a frequency division multiplex radio-link or even a system in cable on the one hand, and on the other a radio time-division multiplex system) what particular recommendations should be made for repeating the signalling from one system to the other at the interconnection point ?

Note. — According to Recommendation No. 186 of the C.C.I.R., time division multiplex radio relay systems forming part of an international circuit should conform, as far as possible, to the relevant recommendations of the C.C.I.F. as regards the method of signalling on the international circuits : in these systems, signalling methods are often used which differ from the signalling methods used on frequency-division systems.

Question 2.

(Study Group 3 in co-operation with Study Group 1 and the C.C.I.R.)

(Continuation of Questions 2 and 5 studied in 1955-1956 by C.C.I.F. Study Group 5)

Considering that the XVIIIth Plenary Assembly of the C.C.I.F. has taken into consideration for 12 Mc/s coaxial cable systems the definition (for the band above 4,028 kc/s) of master-groups of 300 telephone circuits, and that the question will arise of interconnection of such systems with other systems of smaller capacity, by radio or by cable :

(a) Should provision be made to permit interconnection through one or more 300-circuit mastergroups, or through 60-circuit supergroups ?

(b) If interconnection through one or more 300-circuit master-groups is to be envisaged, what frequency allocations should he used below 4028 kc/s ?

(c) In this case is it not necessary to envisage (1) a radio system with a capacity of one mastergroup (300 telephone circuits) which takes the place of the system of 240 telephone circuits now recommended by the C.C.I.R. and (2) systems with capacities equal to two or more mastergroups ?

(d) What should then be the relative levels of the speech channels at the point of interconnection ?

(e) What should be the frequencies and levels of the pilots which the C.C.I.T.T. would consider necessary to transmit on the radio links of capacity equal to one or more 300-circuit mastergroups ?

Question 3.

(Study Group 3 in co-operation with Study Group 1 and the C.C.I.R.)

(Continuation of Question 13 studied in 1955-1956 by C.C.I.F. Study Group 5)

(a) What are, in the case of international transmissions, the conditions to be fixed for the inter-connection between coaxial cable systems transmitting alternatively telephony or television, and a radio relay system having the same alternative transmission facilities ?

(b) What are the frequency allocations to be recommended for the systems envisaged under *(a)* ? The case of coaxial cables and the case of the radio relay systems should be examined at the same time.

(c) What are, (in the case of international transmissions) the conditions to be fixed for the inter-connection between a coaxial cable system transmitting simultaneously telephony and television and a radio relay system also transmitting simultaneously the two signals ?

(d) What are the frequency allocations to be recommended for the systems envisaged under *(c)* ? The case of coaxial cables and of radio relay systems should be examined at the same time.

Note. — Study of this Question is associated with that of Question 42 of Study Group 1.

Question 4.

(Study Group 3 in co-operation with Study Group 1 and the C.C.I.R.)

(Continuation of Question 14 studied in 1955-1956 by C.C.I.F. Study Group 5)

What are, in the case of international transmissions, the conditions to be fixed for the inter-connection between a coaxial cable system carrying a television transmission and a radio relay system carrying the same transmission :

(a) in the case of inter-connection at video frequencies ?

(b) in the case where the modulated signal transmitted on the coaxial pair is applied to the radio relay system, if this is possible ?

Question 5.

(Study Group 3 in co-operation with Study Group 1 and the C.C.I.R.)

(Continuation of Question 12 studied in 1955-1956 by C.C.I.F. Study Group 5)

Pulse Code Multiplex telephone systems used on radio-relay links permit a very large signal-to-noise ratio to be obtained for all noise introduced between the coding and decoding of signals. At the same time, the coding principle introduces a noise called " quantisation noise " which exists only with the signal to be transmitted.

Under these conditions, can present C.C.I.F. recommendations for noise on international telephone circuits be applied to this type of modulation :

1. As regards the method of measuring noise or signal-to-noise ratio ?
2. As regards the specification of maximum permissible noise or minimum permissible signal-to-noise ratio ? (If not, the minimum signal-to-noise ratio should be indicated).

Note 1. — Various Administrations which have had experience of multi-channel pulse-code-modulated telephony are asked to make (if possible) tests for example using arrangements and conditions described in the following Annex.

Note 2. — The attention of C.C.I.T.T. Study Group 9 should be drawn to the desirability of drawing up documentation on the subject of the effect produced by quantisation noise on telegraph transmission, and particularly multi-channel V.F. telegraphy on telephone circuits.

Note by the C.C.I.R. — As far as is known, there is no proposal to use Pulse Code Modulation on international connections : the C.C.I.R. does not, therefore, propose to comment on this question at present.

ANNEX

(to Question 5 of Study Group 3)

Proposals from the French Telephone Administration on laboratory tests to determine the disturbing effect of quantisation noise on telephone speech

Quantisation noise in code modulation presents as well as the characteristics of only being present in the presence of signals, the two following peculiarities :

(a) The frequency band occupied by this quantisation noise is large and depends directly on the number of coding levels used. It is, however, only necessary to consider that portion of the noise which appears in the speech band after demodulation. It has been noted incidentally that in this frequency band the energy spectrum of the noise is almost constant (white noise).

(b) In order to take advantage of possibilities offered by code modulation, the quantisation steps are not generally constant but depend upon the amplitude of the signal to be coded.

It can be admitted, at least as an approximation, that the value of the quantisation step is proportional to that of the sample to be coded; or alternatively, the relative value of the quantisation step may be considered as constant.

Taking account of the foregoing considerations, the French Telephone Administration considers that the arrangement described below should be used to determine the maximum permissible level for noise of this type (at a zero level point) without necessarily having in mind any particular system.

The test arrangement is shown schematically in Figure 1.

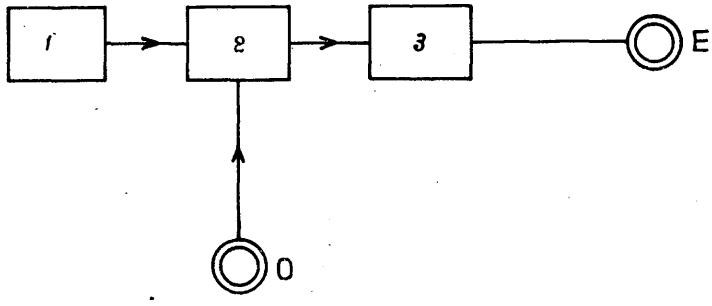


FIGURE 1

It consists essentially of :

— A noise generator (1) delivering white noise over a spectrum of 4 kc/s.

— A modulator (2) of push-pull Class B type, for example.

— A band-pass filter (3) 300-3400 c/s.

The speech of the reference signal is applied to the modulator (2), at O; the noise from the noise generator is also applied to the modulator (2) thus modulating the signal coming from O. From the nature of the modulator in use, the noise received at E is negligible when the signal is not applied to O at the modulator. At the output E therefore there is white noise covering the band 300-3400 c/s which only exists in the presence of the signal and the level which is a function of the signal as required by Note *(b)*. In order to evaluate the admissible signal-to-noise ratio it is only necessary to make subjective tests between O and E for various noise levels.

Figure 2 gives as an example the schematic of a possible modulator.

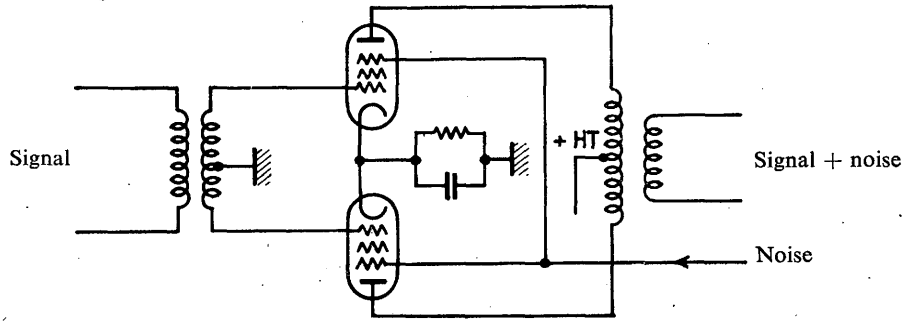


FIGURE 2

In order to determine the relationship between signal-to-noise ratio in such a device, the following procedure should be followed :—

A. Apply to O a sinusoidal 800 c/s signal at a level of 0 nepers (at a point of zero level) and measure at E the level of received signal.

B. Apply to O a sinusoidal signal (for example at 4 kc/s) at a level of 0 db (zero level point). At E this signal is received and its harmonics removed by a filter (3). The signal is then modulated by noise and the detected noise measured at E.

On the assumption that the conversion gain of the modulator is constant over the band 0-4 kc/s it can be assumed that the definition of *signal-to-noise ratio* will be *the relation between the effective value of the signal measured as in A and the value of the noise measured as in B.* Replacing therefore the single frequency signal by speech, it is possible to take account of the effect produced by noise for given values of the signal-to-noise ratio which has just been defined.

Question 6.

(Study Group 1 in co-operation with Study Groups 3 and 12; preliminary study by the Study Group 1 Working Party on " Noise ") (Question 6 of Study Group 1)

(Continuation of Question 6 studied in 1955-1956 by C.C.I.F. Study Group 5)

What is the variation (as a function of time) of the ratio between the signal and noise that might be allowed in an international telephone communication ?

Study of this question should be continued, as non-urgent, assuming :

(1) Study Group 1 will continue to study the subject of permissible noise on carrier systems during brief periods, within the framework of its Question 7;

(2) Study Groups 1 and 3 will be able to supply useful information on the tests suggested in the text of Question 6 of Study Group 12.

Question 7.

(Study Groups 1, 3 and 9 in co-operation with the C.C.I.R.; preliminary study by a joint C.C.I.T.T./C.C.I.R. Working Party) (Question 7 of Study Group 1)

Continuation of Question 7 studied in 1955-1956 by C.C.I.F. Study Group 5)

Will it be possible to have a clause concerning the total noise which is common to all systems of wideband carrier transmissions (coaxial cable systems, systems of symmetrical pair cable and systems on radio relay links) ?

Note 1. — In its reply to this Question in Geneva, 1956, the C.C.I.F. Study Group 3 agreed to fix a common noise clause for carrier systems on symmetrical pairs, coaxial pairs and radio relay links. This is in the form of a mean noise clause calculated for hypothetical reference circuits.

Administrations are asked to consider whether it is also desirable to specify as an objective for the design of carrier systems :

(a) a law for distribution of total noise with time;

(b) how this total noise distribution should be divided to obtain the distribution law for the shorter sections of the hypothetical reference circuit.

Note 2. — Study Group 12 should provide results of opinion tests which may be useful for the study of this question. (See also Question 5 of Study Group 1).

Note 3. — Annexes 1, 2 and 3 reproduce respectively the observations of the Administrations of Italy, the United Kingdom and France on the subject of Question 24 studied in 1956 by C.C.I.F. Study Group 3. Annex 4 contains the report of the first meeting (February, 1957) of a working party which established a programme of tests to be carried out for the study of this question. The Appendix below contains the recommendations issued by the VIIIth Plenary Assembly (Warsaw, 1956) on admissible noise in hypothetical reference circuits for radio relay systems.

ANNEXES 1, 2, 3 and 4

(to Question 7 of Study Group 3)

These annexes appear below Question 7 of Study Group 1.

APPENDIX

(to Question 7 of Study Group 3)

Recommendations issued by the VIIIth Plenary Assembly of the C.C.I.R. (Warsaw, 1956) concerning hypothetical reference circuits for telephony over radio relay links and the allowable noise at the end of these circuits

Note by the C.C.I.T.T. Secretariat. — The VIIIth Plenary Assembly of the C.C.I.R., in the recommendations reproduced in the Appendix to Question 32 of Study Group 1, has defined hypothetical reference circuits for telephony over radio relay links,

— with time division multiplex and having at least 60 telephone channels (Recommendation No. 201),

— with frequency division multiplex and having a capacity of 12 to 60 telephone channels (Recommendation No. 202),

— with frequency division multiplex and having a capacity greater than 60 telephone channels (Recommendation No. 203).

Concerning the allowable noise at the end of these hypothetical reference circuits, Recommendation No. 201 (see below) contains some details regarding the hypothetical reference circuit defined in this recommendation. Recommendation No. 200 (see below) indicates the values already recommended and the values that are still to be fixed for the case of hypothetical reference circuits on radio relay links with frequency division multiplexing defined in Recommendations Nos. 202 and 203. The C.C.I.R. Study Programme No. 105 sets out the studies which the C.C.I.R. intends to make which are of a similar nature to those covered by Question 7 of C.C.I.T.T. Study Groups 1 and 3.

C.C.I.R. Recommendation No. 201

HYPOTHETICAL REFERENCE CIRCUIT FOR TIME-DIVISION MULTIPLEX RADIO-RELAY SYSTEMS WITH 60 OR LESS TELEPHONE CHANNELS

(C.C.I.R. Question No. 97)

(Warsaw, 1956)

The C.C.I.R.,

Considering :

(a) That it is desired to define hypothetical reference circuits for radio-relay systems in order to offer guidance to the designers of equipment and systems for use in international telecommunication networks;

(b) That time-division radio-relay systems may form a part of an international circuit;

(c) That the C.C.I.F. has established a hypothetical reference circuit for the similar case of 60 and 120 telephone channels on symmetrical pairs (Volume III of the *Green Book* of the C.C.I.F., Geneva 1954, page 68);

Unanimously recommends :

1. That a hypothetical reference circuit for time-division multiplex radio-relay systems with a capacity of 60 or less telephone channels per radio channel should be 2500 km long;

2. That this reference circuit should be constituted by 9 sections approximately 280 km long with voice-channel modulation and demodulation at each terminal of a section;

3. That in any hour the mean psophometric noise in a telephone channel at the ends of the overall circuit should not exceed 10 000 pW at a point of zero relative level;

4. That the allocation of this noise power to the single sections and the time distribution of the noise power should be further studied;

5. That the method of specification and permissible values of the psophometric noise for small percentages of time should be defined, but that a precise answer cannot be given at the present time.

C.C.I.R. Recommendation No. 200

ALLOWABLE NOISE POWER IN THE HYPOTHETICAL REFERENCE CIRCUIT FOR RADIO-RELAY SYSTEMS WITH FREQUENCY-DIVISION MULTIPLEXING

(C.C.I.R. Question No. 97)

(Warsaw, 1956)

The C.C.I.R.,

Considering :

(a) That the hypothetical reference circuit is intended as a guide to designers and constructors of actual systems;

(b) That the total noise power in a radio-relay system is dependent on the one hand upon a number of factors concerned with equipment design, and on the other hand upon the path attenuation and the variation of path attenuation with time, which is in turn dependent on factors such a spacing of stations and the nature of the intervening terrain;

(c) That it is desirable to fix nominal values for propagation conditions in the hypothetical reference circuit, but at present there is insufficient information to enable this to be done precisely (see C.C.I.R. Question 136);

(d) That typical values of the factors concerned with equipment design and path attenuation are given in Annex I;

(e) That the total noise may be calculated by methods such as those given in Annex II, which gives also the numerical results of typical calculations;

(f) That the total noise power in the hypothetical reference circuit should not be so great as to cause serious hindrance to conversation in a substantial proportion of telephone calls or to the transmission of telegraph signals;

(g) That, in the opinion of the C.C.I.R., based on evidence so far available from the C.C.I.F. and other sources, a distribution of noise power with time in a month, such as that given in Annex III, is considered provisionally to be unlikely to cause serious hindrance to telephone conversations;

(h) That it is convenient to specify the total noise power in the hypothetical reference circuit in a manner suitable for sub-division of the noise power into each of the 6 or 9 equal homogeneous sections;

(i) That the noise power in actual radio-relay systems may differ from that in the hypothetical reference circuit due for example to the use of equipment designed for association with a given station spacing in the hypothetical reference circuit but used in an actual system with much greater spacings;

(j) That it is advisable that in view of the application of the data of the hypothetical reference circuit to physical circuits, the method of specification and permissible values of psophometric noise for short percentages of time should be stated;

Unanimously recommends :

1. That the total psophometric noise power at a point of zero relative level in any telephone channel in the 2500 km hypothetical reference circuit for frequency division multiplex radio-relay systems with 12 to 60 channels and in the 2500 km hypothetical reference circuit for radio-relay systems with more than 60 channels, should not exceed the provisional values : *, **

(a) 5000 pW mean value in the busy hours, in the absence of fading,

(b) 7500 pW mean value in any hour;

2. That the method of specification and permissible values of the psophometric noise for short percentages of the time should be defined, but that a precise answer cannot be given at the present time. Proposals under consideration are given in Annex II and in Annex III.

Annex I

(to C.C.I.R. Recommendation No. 200)

FACTORS AFFECTING NOISE IN A LONG RADIO-RELAY SYSTEM FOR MULTI-CHANNEL TELEPHONY

1. *Introduction.*

The value of the total noise power is affected by two groups of factors :

(a) features of the equipment design such as the transmitter power output, the aerial gains, the use of diversity reception, and the amplitude and phase characteristics, etc.;

(b) the path attenuation, and the variation of path attenuation with time, which are dependent upon factors such as the radio frequency, the distance between stations, and the nature of the terrain.

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* Noise in the frequency-division multiplex equipment is excluded. The C.C.I.F. allows 2500 pW for this noise.

** It is emphasised that these values are provisional and may be revised later to take account of additional information on path attenuation (C.C.I.R. Question No. 136) and of the later opinions of the C.C.I.T.T.

These factors will vary from system to system. In order to give guidance on methods of computing the total noise, some examples are given below. These are examples only, and different examples could be chosen which are equally representative of good practice.

2. *Examples of Features of Equipment Design.*

(a) Transmitter Output Power. — The transmitter output power might be between about 0.2 watt and about 20 watts or more, with a tendency for the higher powers to be available at the lower frequencies. Typical values of output power at 4000 Mc/s might be 1 to 3 watts.

(b) Transmitting and Receiving Aerial Gains. — It is often the practice to use aerials with a gain of 4000 Mc/s between 30 and 40 db.

(c) Frequency Deviation and Maximum Modulating Frequency. — In accordance with C.C.I.R. Recommendation No. 191, the frequency deviation without pre-emphasis in (for example) a 600-channel system would be 200 kc/s for the test tone at zero relative level in each telephone channel. The use of pre-emphasis may be allowed for, if desired, by assuming an improvement of several decibels (e.g. 4 db) in the signal-to-noise ratio in the « top » telephone channel—i.e., the telephone channel at the maximum modulating frequency which would be 2.54 Mc/s for a 600 channel system.

3. *Examples of Features Affecting the Path Attenuation.*

(a) Radio Frequency. — Radio frequency bands centred on approximately 2000 Mc/s, 4000 Mc/s and 6500 Mc/s are available for wide-band radio-relay systems and in the present examples a frequency of about 4000 Mc/s will be assumed; the path attenuation, aerial gains, and fading characteristics would of course be different for another frequency band.

(b) Number and Length of Repeater Sections. — A radio-relay system is made up of repeater sections which might vary in length between a few kilometres and perhaps 100 kilometres or more, depending on the terrain, the meteorological conditions and other factors which affect fading, and on the design of the equipment. In the present example it will be assumed that a 2500 km radio-relay system is composed of 9 equal homogeneous sections, each with 5 repeater sections of average length 55.6 km.

(c) Path Attenuation of a single Repeater Section. — The attenuation between isotropic aerials in free space at 4000 Mc/s for a distance of 55.6 km is approximately 139 db.

The path attenuation of a single repeater section varies with time due to fading, and the thermal noise power in a telephone channel varies in an approximately similar manner. The distribution of noise power with time depends on a number of geographical and other factors and so varies from one radio link to another. It has been found as a result of experience that the distribution often approximates to either a Rayleigh or a log-normal distribution* and it is possible as a result of experience to suggest the likely form of distribution for particular cases. More specific information can be obtained by making tests over the particular path in question but this requires a long period of testing.

For an overland path without a strong ground reflection, the path attenuation does not vary by more than a few decibels from the free space value during much of the time (e.g., perhaps 90% of the time). For these periods typical curves showing approximately the distribution of thermal noise power in a telephone channel in one repeater section are shown in Figure 1, curve A (log-normal, standard deviation 1 db) and curve B (log-normal, standard deviation 3 db).

* See Volume I of the Documents of the VIIIth C.C.I.R. Plenary Assembly (Warsaw, 1956), page 176.

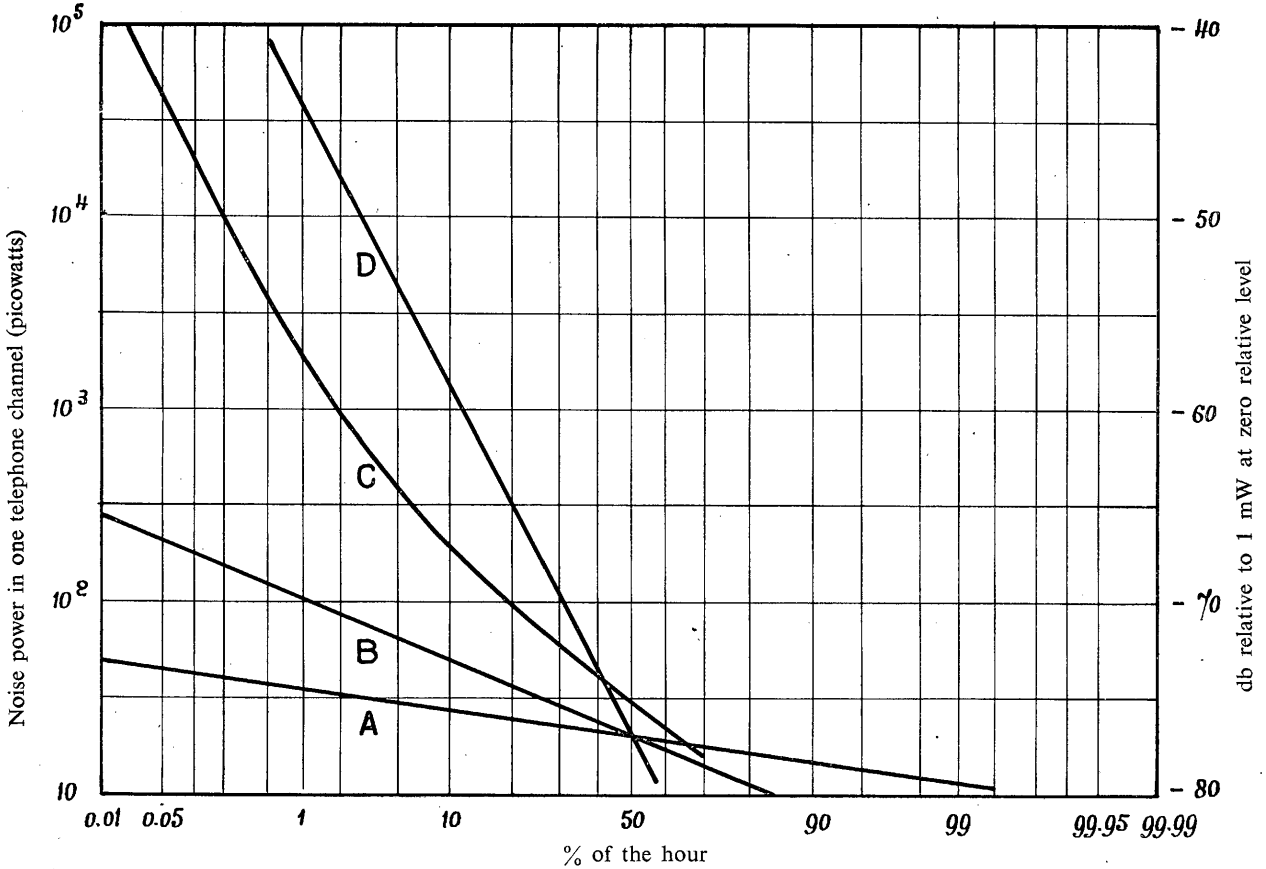


FIGURE 1. — *Examples of distributions of noise with time in one hour*

(Psophometric noise in one repeater section of a radio-relay system)

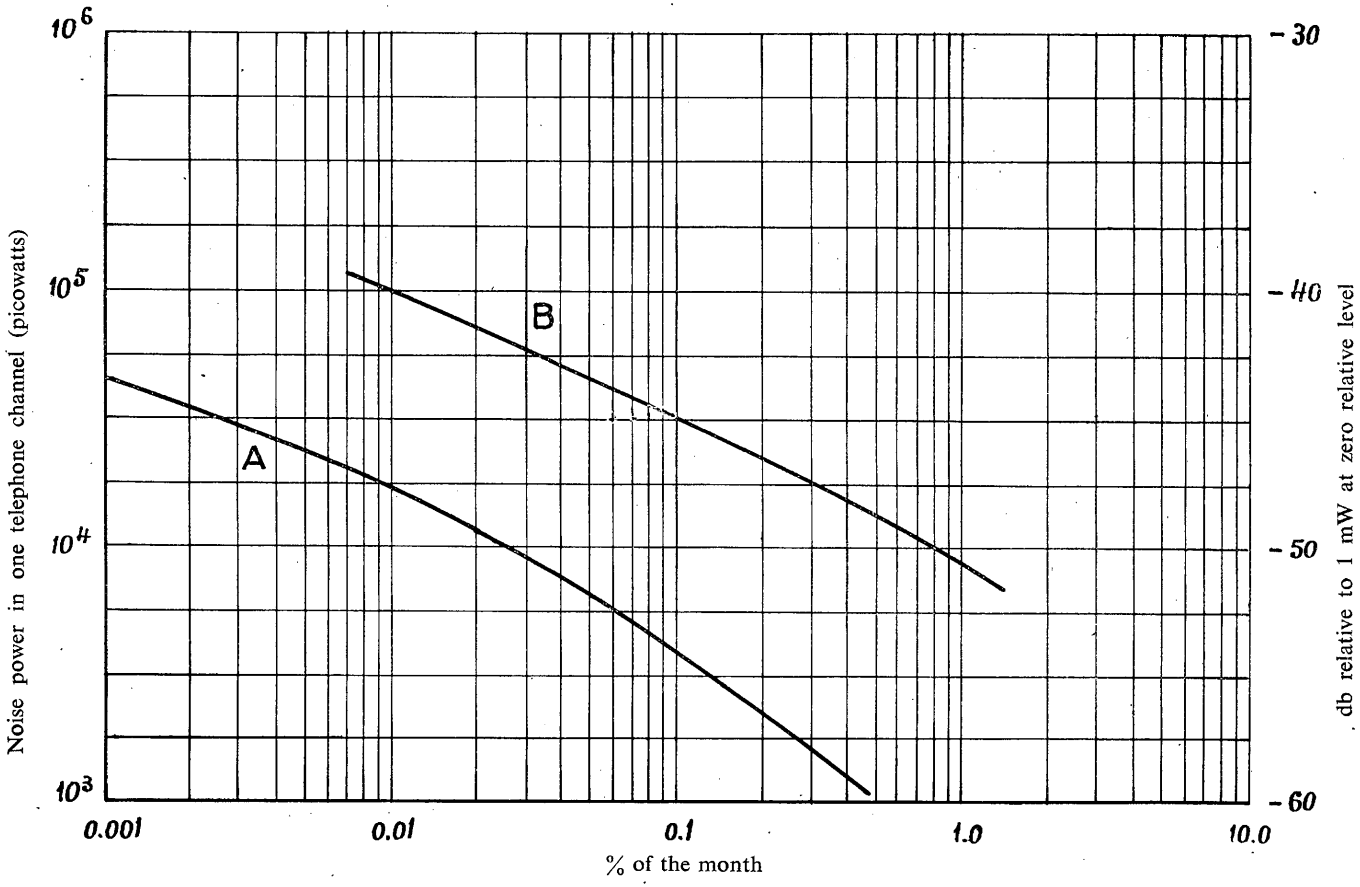


FIGURE 2. — *Examples of distribution of psophometric noise with time in one month*

Curve A — one repeater section
Curve B — 45 repeater sections

At other periods (e.g., in the remaining 10% of the time), severe multi-path propagation may occur, and a Rayleigh distribution (Figure 1, curve C) or a log-normal distribution with a large value of standard deviation, e.g., up to 14 db (curve D) might apply.

In day-time (and of course during the busy hours) the fading is often slight and curves A and B may be typical, but occasionally more severe fading approaching that of curves C and D may take place.

At night-time and early morning, severe fading for which curves C and D may be appropriate, is more common than in day-time. The traffic is, however, considerably smaller at night, and the intermodulation noise power is therefore smaller, thus allowing a greater thermal noise power.

In considering high values of noise existing for only short periods of time, a curve of distribution with time over a month is useful. A typical curve obtained from measurements on several overland paths in which conditions are not too severe is given as curve A of Figure 2; this is a log-normal curve with a standard deviation of 8 db.

For oversea paths, and for very long overland paths, the distributions of noise with time may be worse than those given here as examples. Moreover, for oversea paths severe fading may occur in every hour of every day and not just in certain hours at night. In such cases, however, the use of diversity reception may result in curves of distribution of noise power with time representing conditions which are not too severe. Diversity reception in the form of frequency diversity may be used if a protection channel is provided.

Annex II

(to C.C.I.R. Recommendation No. 200)

AN EXAMPLE OF THE COMPUTATION OF TOTAL NOISE POWER IN A LONG CIRCUIT

The methods of computation given here are for example only. The values assumed are based on Annex I, and are typical of normal overland routes with First Fresnel Zone clearance operating at frequencies of several thousand Mc/s.

1. *Mean Thermal Noise Power of One Repeater Section for a Period with Severe Fading.*

If a Rayleigh distribution applies (see Annex I.3.*c*), and under practical conditions the thermal noise power varies inversely with the received signal power,

$$W\ (N) = e^{-\frac{N_0}{N}} \tag{1}$$

$W\ (N)$ is the probability of N not being reached in a repeater section,
where N is the fluctuating noise power
and N_0 the noise power without fading.

The mean value of the noise power $\overline{N}$ can be obtained by an integration which has to be broken off at a high value N'. It could be assumed for example that a standby or diversity device is provided for protection when the noise power exceeds N'; the choice of the value N' is not very critical. The result is, according to Jahnke-Emde :

$$\frac{\overline{N}}{N_0} = 0{\cdot}23 \times 10 \log_{10} \frac{N'}{N_0} - 0{\cdot}577 \tag{2}$$

As an example, if

$$10 \log_{10} \frac{N'}{N_0} = 45 \text{ db}$$

then

$$\bar{N} = 10\ N_0 \tag{3}$$

The mean value of the noise power of one section during a period with Rayleigh distribution fading exceeds by approximately 10 db the value without fading.

If, alternatively, a log-normal distribution with standard deviation σ decibels applies, it can be shown that

$$\text{mean value (in db)} = \text{median value (in db)} + 0{\cdot}115\ \sigma^2.$$

2. *Mean Value of the Thermal Noise Power at the End of the Hypothetical Reference Circuit*

It may be assumed that the hypothetical reference circuit consists of z repeater sections of equal lengths. Only on k sections may Rayleigh distribution occur at the same time. The mean value of the noise power coming from these k sections is then

$$\bar{N}_k = 10\ N_0 \times k \tag{4}$$

The average noise power for the remaining $z-k$ sections does not differ much from the value without fading and according to experimental data

$$\bar{N}_{z-k} = 1{\cdot}44\ N_0\ (z-k) \tag{5}$$

The mean noise power $\bar{N}_z$ at the end of the hypothetical reference circuit is given by the sum of eq. (4) and eq. (5). Divided by the value without fading this gives

$$\frac{\bar{N}_z}{z \times N_0} = 10\ \frac{k}{z} + 1{\cdot}44\ \frac{z-k}{z} \tag{6}$$

For $z = 50$ repeater sections each 50 km long (total length 2500 km), we arrive at the following if propagation conditions in k sections correspond to Rayleigh distribution

TABLE I

k	$\frac{k}{z}$ (in %)	$\frac{\bar{N}_z}{z \times N_0}$	$10 \log_{10} \frac{\bar{N}_z}{z \times N_0}$ (in db)
5	10	2·3	3·6
10	20	3·15	5
20	40	4·9	6·9
50	100	10	10

Assuming, in that example, that during a very unfavourable hour 10 out of a total of 50 sections will simultaneously suffer from strong fading, the mean noise power in an hour without fading must be 5 db smaller than the required mean value with fading. Taking typical figures for the noise power in the hypothetical reference circuit :

Thermal noise power without fading		1250 pW
Mean value of the thermal noise power	3750 pW	
Intermodulation noise	3750 pW	3750 pW
Mean value of total noise power in any hour	7500 pW	
Total noise power without fading		5000 pW

3. *Noise Power in a very small Percentage of the Time.*

The high values of noise power in a very small percentage of the time are largely due to the increase of thermal noise at times of severe fading. The value of noise power may be estimated from previous experience. Taking as an example curve A of Fig 2 (see Annex I, § 3) (based on measurements over a month on single repeater sections in which the conditions are not too severe) then curve B of Fig. 2 can be deduced as appropriate (with a small error of the order $\pm$ 1 db) for a 2500 km circuit with 45 repeater sections. Thus in this example, the noise power in the 2500 km circuit would be approximately 100,000 pW for 0.01 % of a month. This example, however, relates to a radio link in which the fading is not very severe, due perhaps to the particular meteorological conditions or to close spacing of the repeater stations. An example will now be given of computation of noise power for short periods of time in a radio link with more severe fading.

The probability that a noise power value N which is very high with respect to N_0 is exceeded on a single section, according to equation (1) (Annex II) is to a good approximation :

$$1 - W(N) = \frac{N_0}{N} \tag{7}$$

for the time a Rayleigh distribution prevails.

Let us denote by p the probability that this distribution prevails. The probability that the noise power is exceeded for long periods is thus found to be

$$p \frac{N_0}{N}$$

For z sections there is, with sufficient accuracy

$$1 - W_z(N) = z\, p \frac{N_0}{N} \tag{8}$$

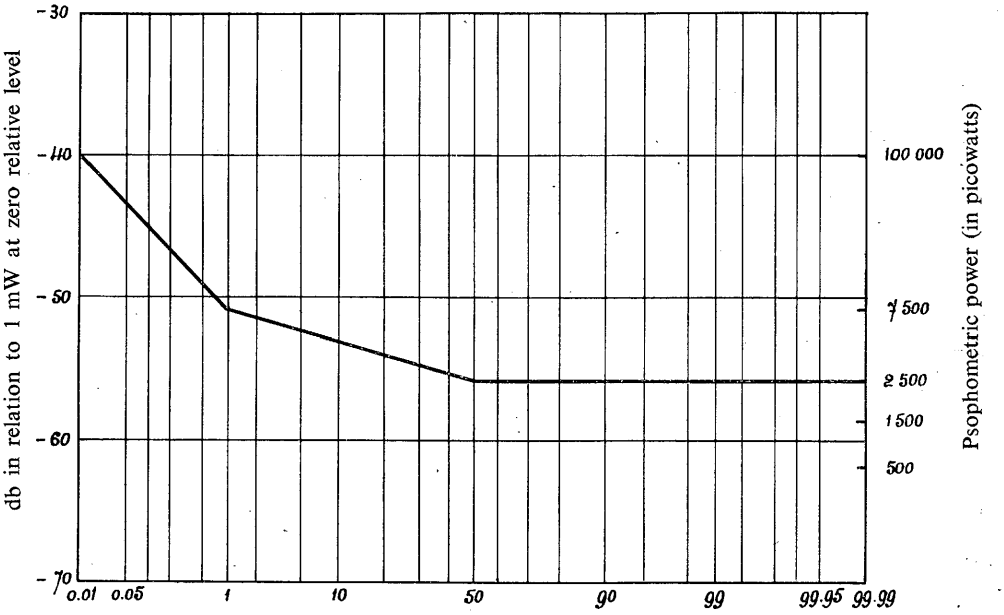
In this second example a value $p = 0.08$ was found from propagation measurements for a year in a particular radio link. It might be assumed that for an unfavourable month a value three times as great, $p = 0.24$, is appropriate. Furthermore, for $z \times N_0$ a value of 1250 pW is assumed. Then a noise power of 300,000 pW is exceeded in the 2500 km circuit in an unfavourable month, with a probability of 0.1 %.

The second example shows that it is possible for the noise power in short periods of time to reach high values. For this reason, radio links are often designed with small repeater spacings or with protection channels which automatically take over service when the noise power exceeds a predetermined value. By these methods, smaller values of noise power, such as a maximum value of 300,000 pW for 0.01 % of a month, may be achieved. It may be noted that a protection channel is usually necessary also because of equipment failure which, in the absence of a protection channel, is likely to result in a probability of interruption at least as great as (and perhaps much greater than) that due to fading in a single channel.

Annex III
(to C.C.I.R. Recommendation No. 200)

ALLOWABLE WEIGHTED NOISE POWER AT ZERO LEVEL,
(EXCLUDING NOISE DUE TO F.D.M. TERMINAL EQUIPMENTS)

(Suggested for 2500 km hypothetical reference circuit.)



Annex IV
(to C.C.I.R. Recommendation No. 200)

AN EXAMPLE OF A METHOD FOR CALCULATING
THE PRINCIPAL PARAMETERS OF RADIO EQUIPMENT
ON THE BASIS OF THE MEAN NOISE POWER IN A TELEPHONE CHANNEL
AT THE END OF A HYPOTHETICAL REFERENCE CIRCUIT

The principal parameters of radio equipment can be calculated if the allowable mean noise power P_{Na} during any hour (including busy hour) at the end of a hypothetical reference circuit is specified.

The allowable mean noise power P_{Na1} produced on a homogeneous section of the hypothetical reference circuit is

$$P_{Na1} = \frac{P_{Na}}{\nu} \tag{1}$$

ν — is the number of homogeneous sections in the hypothetical reference circuit.

It is well known, that the mean noise power at the end of a modulation section is

$$P_{Na1} = P_{Nt} + P_{N2} + P_{N3} \tag{2}$$

where P_{Nt} is the average thermal noise power,
P_{N2} is the average intermodulation noise power due to non-linearity of the second order,
P_{N3} is the average intermodulation noise power due to non-linearity of the third order.

It is assumed that the intermodulation noise due to non-linearity of the orders higher than 3 is negligible.

It can be shown that equation (2) is expressed by :

$$P_{Na1} = P_{Nt} + P_{N2} + P_{N3} = A\frac{1}{x} + Bx + Cx^2 \tag{3}$$

at the point of zero relative level,
where the value of x, A, B and C in the case of hypothetical reference circuit are the following :

$$x = \left(\frac{\Delta f_0}{\Delta f_1}\right)^2 \tag{4}$$

Δf_0 is the RMS frequency deviation per channel (for 1 mW 800 c/s tone at a point of zero relative level);

Δf_1 is the unit value of a frequency deviation (for example : $\Delta f_1 = 1$ Mc/s);

$$A = A_0\gamma = \frac{4n\,\Delta F_c\, K_p^2}{P_e}\left(\frac{F_c}{\Delta f_1}\right)^2 \frac{16\pi^2 R_0^2\, b_f^2}{\lambda^2\, G_A^2}\, m\gamma \quad \text{(in pW)} \tag{5}$$

where :

n	is the noise factor of receiver;
P_e	the transmitter power expressed in pW;
$\Delta F_c = 3100$ c/s	the bandwidth of a telephone channel;
$K_p = 0.75$	the psophometric factor according to the psophometrical curve recommended by the C.C.I.F. in 1946;
F_c	is the mean frequency of a telephone channel at the baseband;
R_o	is the length of one repeater section;
m	is the number of repeater sections in one modulation section of the hypothetical reference circuit;
λ	is the wave-length;
G_A	is the aerial gain with reference to an isotropic antenna;
b_f	is the attenuation of the feeder;
γ	is the average ratio (during one hour) of the received signal power in the absence of fading to the received signal power in typical fading conditions (the fading margin required for each repeater section).

$$B = \frac{\Delta F_c\, K_p^2\, 10^9}{\Delta F}\, e^{4b_N}\, y_2(\sigma_c)\left[4e^{-2b_{21}} + (2\pi F_c)^2\,\Delta f_1^2 \times \frac{1}{2}\,\alpha_1^2\right] \quad \text{(pW)} \tag{6}$$

$$C = \frac{\Delta F_c\, K_p^2\, 10^9}{\Delta F}\, e^{6b_N}\, y_3(\sigma_c)\left[24e^{-2b_{31}} + (2\pi F_c)^2\,\Delta f_1^4 - \frac{2}{3}\,\alpha_2^2\right] \quad \text{(pW)} \tag{7}$$

where :

$\Delta F = F_2 - F_1$; F_2 and F_1	are the frequency limits of the baseband;
$e^{2bN} = S_N$ (mW)	is the mean power of the multiplex signal with N channels during the busy hour in mW;
$b_N = (-1.72 + \frac{1}{2}\log_e N)$	Nep. according to the Document No. 339 of the C.C.I.F.
$y_2(\sigma_c)$ and $y_3(\sigma_c)$ *	are coefficients depending on the mid-frequency F_c, or on the value $\sigma_c = \frac{F_c - F_1}{F_2 - F_1}$ of the channel considered ;

* BROCKBANK and WASS, Non-linear distortion in transmission systems, *Proc. I.E.E.*, Vol. 94, part 3, March 1945.

b_{21} and b_{31} are the attenuations of non-linearities of second and third orders of the quadripole consisting of a modulator, demodulator and telephone amplifiers, measured with a unit value of frequency deviation Δf_1;

α_1 and α_2 are the non-linearity coefficients of the group-delay characteristic of the whole modulation section of the hypothetical reference circuit (the coefficients of linear and parabolic terms).

When long feeders are used it may be necessary to add to the value of B, defined above (6), the following value

$$B_f = \frac{\Delta F_c \, K_p^2 \, 10^9}{\Delta F} \, e^{4b_N} \, (2\pi F_c)^2 \, (2\pi \Delta f_1)^4 \, \frac{4m \, r_1^2 \, r_2^2 \, \tau_f^4}{b_f^2} \quad \text{(pW)} \tag{8}$$

if the feeders are identical,
where

r_1 and r_2 are the reflection coefficients at the ends of a feeder;

τ_f is the group delay of a feeder.

The equation (8) is correct if $4\pi \, \Delta f_o \, \tau_f \, e^{b_N} \leqslant 0.5$.

The quantities A_0, B and C are the principal parameters of radio equipment. If the values of γ and x are known, the optimum values of A_0, B and C can be determined by the following way.

Values of A, B and C are the optimum values, when the noise power at the end of a modulation section is equal to a minimum value and is equal also to the allowable value P_{Na1}. As it can be seen from (3) these conditions correspond to :

$$\frac{\mathrm{d}}{\mathrm{d}x} P_{Na1} = 0,$$

or

$$0 = -A \frac{1}{x^2} + B + 2 \, Cx \tag{9}$$

From (3) and (9) can be obtained :

$$Bx = 2 \, P_{Na1} - 3A \frac{1}{x} \quad \text{or} \quad P_{N2} = 2 \, P_{Na1} - 3 \, P_{Nt} \tag{10}$$

$$Cx^2 = 2A \frac{1}{x} - P_{Na1} \quad \text{or} \quad P_{N3} = 2 \, P_{Nt} - P_{Na1} \tag{11}$$

It is completely clear, that in any case

$$P_{N2} > 0 \quad \text{and} \quad P_{N3} > 0$$

therefore from equations (10) and (11) it follows

$$\frac{1}{2} P_{Na1} < P_{Nt} < \frac{2}{3} P_{Na1} \tag{12}$$

Let us write :

$$P_{Nt} = A \frac{1}{x} = A_0 \gamma \frac{1}{x} = \xi \, P_{Na1} \tag{13}$$

where the values of ξ in accordance with (12) are in the limits :

$$\frac{1}{2} < \xi < \frac{2}{3} \tag{14}$$

Then, from (10) and (11) we can obtain :

$$P_{N2} = Bx = 3\,P_{Na1}\left(\frac{2}{3} - \xi\right) \tag{15}$$

$$P_{N3} = Cx^2 = 2\,P_{Na1}\left(\xi - \frac{1}{2}\right) \tag{16}$$

To illustrate these relations the graph in figure 1, showing

$$\frac{P_{Nt}}{P_{Na1}}, \quad \frac{P_{N2}}{P_{Na1}} \quad \text{et} \quad \frac{P_{N3}}{P_{Na1}} \quad \text{as functions of } \xi \text{ may be used.}$$

Lastly, we can find the principal parameters of radio equipment from equations (13), (15) and (16).

$$A_0 = P_{Na1}\frac{\xi x}{\gamma} \quad (17) \qquad B = P_{Na1}\frac{(2-3\,\xi)}{x} \quad (18) \qquad C = P_{Na1}\frac{(2\,\xi-1)}{x^2} \quad (19)$$

The value of ξ defining a relationship between three components of the total noise power must be chosen by a designer of equipment within certain limits according to the inequality (14).

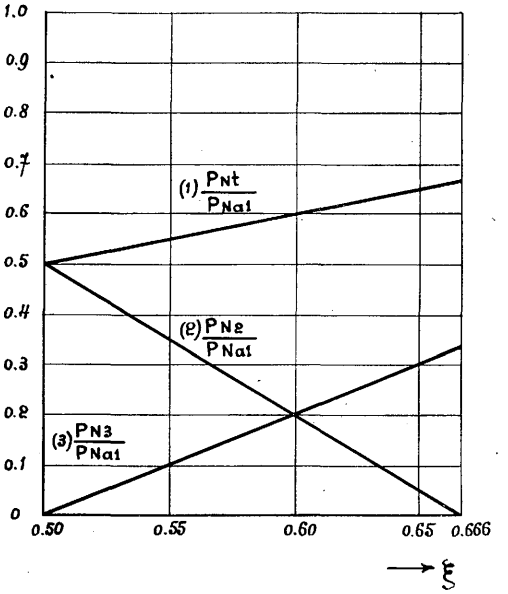


FIGURE 1

C.C.I.R. Study Programme No. 105

WIDEBAND RADIO RELAY SYSTEMS
NOISE TOLERABLE DURING VERY SHORT PERIODS OF TIME

(C.C.I.R. Question No. 97)

(Warsaw, 1956)

The C.C.I.R.,

Considering :

(a) That for radio relay links, it is necessary to clarify how high noise levels occurring for short periods of time should be taken into consideration;

(b) That consideration must be given not only to the percentage of time during which high noise levels occur but also to the duration of each burst of noise;

(c) That account should be taken of the fact that in radio-relay systems high noise often occurs at night when the traffic is particularly light;

(d) That examples of the distribution of noise with time in radio-relay systems are given in the annexes to C.C.I.R. Recommendation 200 and that these annexes also contain examples of the values of noise power likely to be experienced for short periods of time;

Unanimously decides that the following studies should be carried out :

1. In what way should the maximum value of noise be specified when considering transmission on radio-relay systems ?

2. What should be the time constant of the noise measuring apparatus ?

3. Should a limit be set to the number of high noise bursts, of a duration exceeding a given value, occurring in a given time ?

4. In considering this problem should account be taken of the fact that the traffic loading is greater during the day than during the night ?

5. In what way can the maximum tolerable noise power for a part of a radio link be deduced from the maximum value of noise power tolerable for the complete radio link ?

Question 8.

(Study Group 3 in co-operation with Study Groups 1 and 12 and the C.C.I.R.)

(Continuation of Question 8 studied in 1955-1956 by C.C.I.F. Study Group 5)

In a multi-channel telephony system using pulse-position modulation, crosstalk tested on a disturbed channel may be different depending upon whether the disturbed channel is or is not carrying speech currents.

In such a system, how may the requirements of crosstalk between telephone channels be defined ?

Note. — Study Group 3 considers that when the studies of the C.C.I.R. on this subject are completed, the results should be communicated to Study Group 3 so that Study Group 4 can be advised in good time to study the arrangements to be taken for maintenance of radio links using pulse-position modulation.

Question 9.

(Study Groups 4 and 3 in co-operation) (Question 9 of Study Group 4)

(Continuation of Question 9 of C.C.I.F. Study Group 5 and of Questions 13 and 14 of Study Group 9 studied in 1955-1956)

Preparation of draft " Instructions for periodic maintenance, localization and clearance of faults on radio relay links forming part of the general telephone network ".

Note 1. — It is desirable that the instructions for periodical maintenance, localisation and clearance of faults, applicable to land lines and to radio relay links should be as homogeneous as possible.

It is also important that designers of radio links for use in the telephone network take account of the requirements for the general maintenance of telephone circuits.

Note 2. — The recommendations contained in the following annex were made in 1956 with the aim of defining essential points for the maintenance of radio relay links.

ANNEX

(to Question 9 of Study Group 3)

Essential points for the maintenance of radio relay links stressed by XVIIIth Plenary Assembly of the C.C.I.F. (1956)

Point 1 Control and sub-control stations.

Firstly it appears useful to recall the definitions for control and sub-control stations given on page 237 of Volume III of the C.C.I.F. *Green Book:*

" A control station is designated :

— for each international circuit,

— for each group or supergroup link : " group control station " or " supergroup control station ",

— for each line used for a carrier system : " control station for the line " (in particular a coaxial line, a symmetrical pair line or a radio link)."

There is therefore a need carefully to avoid any confusion between these different ideas. The terms " control station " and " subcontrol station " should not be used alone, except where no ambiguity can result and they must always be followed by mention of the responsibility of the station :

— circuit,

— link (group or supergroup),

— carrier system (on a coaxial cable or radio link).

For an independent radio link, i.e., where there is modulation and demodulation with restoration to audio frequencies at the terminals, at least one station of the radio link (or an exchange associatied with a radio link station) should be staffed. This station (or exchange) will be considered:

as the *control station* for *the radio link*, and

as *sub-control station* for the *telephone circuits* which are in part routed on the radio link.

In the case of a radio link directly connected to a section of line in a cable, the *control station for the radio link* should be the last station of the carrier system on the land line. In such a case the cable line and radio link together could be considered as a single transmission path with a " high frequency sub-control station " (cf. page 535 of Volume I of the *Green Book*) but the use of this expression is not recommended.

It will be seen later in point 2 of this reply that the ideas of the regulating section must also be carefully defined and that the junction point between the cable line and the radio link does not in principle constitute a sub-control station for the line regulating section.

The C.C.I.F. therefore expressed the wish that the C.C.I.R. suppress Recommendation No. 128 (London, 1953) or at least modify the wording, because the text could only result in confusion. It is of course the C.C.I.R. responsibility to define the responsibilities of the terminal stations of the radio links from the point of view of the operation of the radio link itself, but it is desirable to avoid the use of the term " sub-control station " without some qualification. The points taken into consideration in Recommendation No. 128 should also be reviewed.

Point 2. — Line regulating sections. Transmission of line regulating pilots by a radio link.

Normally a line regulating section consists of a particular type of transmission system and not an assembly of several transmission systems in tandem. The definition of a line regulating section is given on page 269 of Volume III of the *Green Book*. A line regulating section on a symmetrical pair carrier system has for example been defined : it is in a symmetrical pair carrier system the line section over which the line regulating pilot or pilots are transmitted from end to end without regulation, particular to these pilots, at intermediate points. The line regulation section for a coaxial line is defined in the same way.

If, therefore, a radio link is inserted between two cable lines (in general coaxial), the radio link between its two terminal stations can be considered as a " line regulating section over the radio link." The arrangements required for the regulation of the radio link are the responsibility of the C.C.I.R. Recommendation No. 198 given on page 4 of the document " C.C.I.F.—1955 1956—9th S.G.—Document No. 30 " describes the choice of a regulating pilot frequency for wide band radio links.

To avoid disturbances with the transmission on adjacent metallic lines, any frequency used within the radio link for checking its operation must be staffed at the ends of the link under conditions similar to those given on pages 52 and 54 of Volume III of the *Green Book*.

However, it may be desired to transmit over the radio links the line regulating pilots of the cable section between which the radio link is inserted, especially if these cable sections are relatively short. These pilots transmitted over the radio link are used only for regulating the cable sections and not, of course, for regulating the radio link.

To facilitate the organization of the general maintenance of mixed lines, comprising cable sections and frequency division radio links, it is therefore a great advantage if the radio links are arranged so that the line regulating pilots for metallic lines recommended by the C.C.I.F. can be transmitted from end to end. This is stated by the C.C.I.R. in Report No. 73 reproduced on pages 2 and 3 of document " C.C.I.F.—1955/1956—9th S.G.—Document No. 30."

In its Report No. 73, the C.C.I.R. draws the attention of the C.C.I.F. to the interest in defining line regulating pilots for carrier systems of 4 supergroups (240 channels) and 10 supergroups (600 channels) in addition to the line regulating pilots recommended on page 87 of Volume III of the *Green Book*. The C.C.I.R. has suggested as frequencies for the upper line-regulating pilots the values 1116 kc/s for 240 channel links and 2604 kc/s for 600 channel links.

Regarding transmission over radio links of the pilots appropriate to cable systems, the C.C.I.F. has already stated the possibility of using a pilot of 2604 kc/s for 600-circuit systems on coaxial

cable systems, and S.G. s 3 and 5 of the C.C.I.F. have no objection to the use of a pilot at 1116 kc/s on short-length systems where the frequency-band 60 to 1052 kc/s is used, when these systems form part of the the same line-regulating section as a radio link with 240 telephone circuits.

Point 3. — Transmission of group and supergroup reference pilots over a radio link.

If a group (or supergroup) provided on a metallic line carrier system passes through a terminal station of a radio link without reduction to channels (or groups), it must include its group (or supergroup) reference pilot.

To ensure adequate flexibility for the interconnection of radio links with metallic lines in the international network, it is therefore recommended that for each radio link which may be used in the international network, provision should be made to transmit and faithfully restore the group and supergroup reference pilot recommended by the C.C.I.F. The frequencies and levels of these pilots are given in the following table :

Pilot	Frequency in kc/s	Absolute power level at a point of zero relative level
Group	84·080	−20 db or −2·3 N
	84·140	−25 db or −2·9 N
Supergroup	411·860	−25 db or −2·9 N
	411·920	−20 db or −2·3 N

The C.C.I.R. has mentioned this point in the first paragraph of Report No. 73. This point should be covered in the essential clauses of a specification for the provision of a radio link.

Point 4. — Speaker circuits and alarm channels.

(a) *Speaker circuits.* — The general telephone network includes radio links as well as metallic lines.

For the maintenance of this general network, it is essential that at least the terminal stations of a radio link be connected by a speaker circuit.

The provision of speaker circuits should be on the basis of the greatest possible security. It is therefore preferable that the speaker circuit between the radio link terminal stations should be entirely independent of the radio link itself. It may of course be provided on cable pairs or on an independent radio link according to the facilities available in the telephone network.

For the operation of the radio link itself, as was stated by the C.C.I.R. in its Report No. 72 (Warsaw 1956), it is necessary that the attended and unattended stations of a wide-band radio link :

— be connected to the general telephone network,

— be connected together by speaker circuits.

These latter speaker circuits should also be provided by highly secure means and should, therefore preferably be routed independently of the radio link itself. If this cannot be done, it is the C.C.I.R. responsibility to ensure this security.

(b) *Alarm channels.* — Concerning alarm channels, the C.C.I.F. considers that this question is specific to the technique of the radio link and should be dealt with by the C.C.I.R.

The C.C.I.F. however draws the attention of the C.C.I.R. to the fact that from the point of view of general maintenance, consideration may be given to the possibility of extending alarms from unattended stations :

— either to attended stations of the radio link, or
— to a neighbouring repeater station with qualified maintenance staff.

Question 10.

(For study by the C.C.I.R. in co-operation with Study Groups 3 and 4)

(Following Question 10 studied in 1955-1956 by C.C.I.F. Study Group 5)

What is the duration of interruptions to transmission to be expected on radio links when switching from normal to stand-by equipment (see Recommendation No. 196 of the C.C.I.R.) ?

Note. — It is necessary to distinguish the duration of breaks in transmission for the three following cases :

(a) failure of normal equipment,
(b) fading in radio propagation indicated by the presence of excessive noise at a switching point of the radio link,
(c) changeover of the normal and standby equipment for maintenance of the radio link.

Question 11.

(For study by the C.C.I.R. in co-operation with Study Groups 1, 3 and 4)

(New Question)

It seems that new radio relay systems are about to be developed ; these use the propagation phenomenon known as " forward scatter " and they can provide carrier telephone circuits. It would consequently be desirable, with a view to the inter-connection of these systems between themselves and with systems recommended by the C.C.I.T.T., to proceed at once to study the following question in co-operation with the C.C.I.R. (Study Group IX) and Study Groups 1, 3 and 4 of the C.C.I.T.T.

(1) Can a hypothetical reference circuit be specified relating to circuits which use propagation by tropospheric or ionospheric forward scatter ?

If so, what should be the composition of this circuit and the mean psophometric power at the end of a 2500 km line ?

(2) What should be, in actual service, the statistical distribution as a function of time of the signal-to-noise ratio of telephone circuits set up on these links ?

(3) In actual service, what should be the statistical distribution, as a function of time, of transmission breaks on such links :

(a) resulting from equipment failures ?
(b) from power supply failures ?
(c) from propagation failures ?

(4) How many carrier telephone circuits and how many telegraph systems could be provided by these systems, and what should be the division of the frequency spectrum at the input and output terminals ?

(5) What modulation system should be recommended on radio links of this type and how should the telephone circuits be assembled at the input and output terminals ?

(6) For what purpose should these systems be used ?

TABLE SUMMARIZING

the questions assigned to Study Group 3

Chairman : Mr. GORI (Italy)
Vice-Chairman : Mr. BORODITCH (Union of Soviet Socialist Republics)

No.	Brief description	Other Study Groups, Sub-Study Groups, or international organizations cooperating in the study	Comments :
1	Interconnection of systems using different signalling methods	S.G. 1, S.G. 11, C.C.I.R.	
2	Interconnection of cable systems and radio relay links at the level of the mastergroup or supergroup	S.G. 1, C.C.I.R.	
3	Transmission, alternate or simultaneous, of telephony and television on coaxial pairs or radio relay links	S.G. 1, C.C.I.R.	
4	Interconnection of television transmission systems on coaxial cables and radio relay links	S.G. 1, C.C.I.R.	
5	Noise in pulse-code modulated radio relay links	S.G. 1., C.C.I.R.	
6	Variation, as a function of time, of the signal-to-noise ratio	S.G. 1 S.G. 12	
7	Noise clause for all systems	S.G. 1, S.G. 9, S.G. 11, C.C.I.R.	To be considered by a joint C.C.I.T.T./ C.C.I.R. Working Party
8	Crosstalk in the case of pulse position modulation	S.G. 1, S.G. 12, C.C.I.R.	
9	Maintenance of radio relay links	S.G. 4, C.C.I.R.	
10	Interruptions in transmission on radio relay links	S.G. 4, C.C.I.R.	Matters to be investigated by the C.C.I.R.
11	Radio relay links using forward scatter	S.G. 1, S.G. 4, C.C.I.R.	

Questions for which the cooperation of Study Group 3 is requested

Question No.	of S.G.	Brief summary	Other Study Groups, Sub-Study Groups, or international organizations interested	Comments :
2	1	Noises on intercontinental circuits	S.G. 5, C.C.I.R.	
6	1	Admissible variation, as a function of time, of the signal-to-noise ratio	S.G. 12	Question 6 of S.G. 3
7	1	Noise clause for all carrier current systems *	S.G. 9, C.C.I.R.	Question 7 of S.G. 3
20	1	Noise and crosstalk on circuits for broadcast transmissions	S.S.G. 1/4, C.C.I.R.	
32	1	Detailed constitution of hypothetical reference circuits for telephony *	C.C.I.R.	
33	1	Noise on an actual homogeneous carrier current section *	C.C.I.R.	
42	1	Systems with more than 960 channels	S.S.Gs. 1/1, 1/2, 1/4	related to Question 3 of S.G. 3.
9	4	Maintenance of radio relay systems		Question 9 of S.G. 5
10	4	Switching sections of radio relay systems		

* These questions will first be studied by a joint C.C.I.T.T./C.C.I.R. Working Party.

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Maintenance Questions
entrusted to
Study Group 4
in 1957-1960

Question 1.

(Former Questions 1 and 2 of C.C.I.F. Study Group 9 studied in 1955-1956)

Transmission stability on European international circuits. Long-term variations in the circuit-equivalent as a function of time. Causes of these variations.

Note. — See Annexes 1 and 2 below.

ANNEX 1
(to Question 1 of Study Group 4)

Conclusions reached by the C.C.I.F. after the 5th series of tests on the variation of equivalent of international circuits

(October 1955 to January 1956)

I. — MEASUREMENTS AND RECORDINGS

1. In accordance with decisions taken at the previous meeting of the Working Group in Geneva in June 1955 (see pages 33 to 40 of document " C.C.I.F.—1955/1956—9th Study Group—Document No. 9 ") tests were carried out on a number of international circuits from 3rd October 1955 to 7th January 1956, with a view to studying the variation of equivalent of the circuits.

2. The circuits, with the exception of the circuit København-Stockholm, were all routed on a telephone channel of a direct group, and included no return to audio frequencies by demodulation at an intermediate point in the routing.

3. The circuits were as follows :

Germany (Federal Republic)—France:
channel 9 of the Frankfurt/M-Paris 901 group
length of circuit : 720 km.

Germany (Federal Republic)—Netherlands:
channel 6 of the Frankfurt/M-Rotterdam 901 group
length of circuit : 560 km.

Germany (Federal Republic)—Switzerland:
channel 11 of the Frankfurt/M-Zürich 902 group
lengh of circuit : 450 km.

Belgium—France:
channel 10 of the Bruxelles-Paris 905 group
length of circuit : 420 km.

Belgium—United Kingdom:
channel 4 of the Bruxelles-London 901 group
length of circuit : 360 km.

Denmark—Netherlands:
channel 2 of the København-Rotterdam 901 group
length of circuit : 965 km.

Denmark—Sweden:
København-Stockholm circuit
length of circuit 835 km.
channel 12 of the København-Malmö 905 group
+ a channel of a symmetrical pair system Malmö-Göteborg
+ a channel of a coaxial system Göteborg-Stockholm.

France—Italy:
channel 8 of the Milano-Paris 901 group
length of circuit 1000 km.

France—United Kingdom:
channel 5 of the London-Paris 917 group
length of circuit : 467 km.

France—Switzerland:
channel 6 of the Paris-Zürich 901 group
length of circuit : 685 km.

Netherlands—United Kingdom:
channel 8 of the London-Rotterdam 903 group
length of circuit : 474 km.

4. The tests were carried out in two consecutive periods of seven weeks.
During the first period (from 3rd October to 19th November 1955) the circuits and the groups on which they were routed were subjected to normal periodic maintenance.
During the second period (from 20th November 1955 to 7th January 1956) no periodic maintenance was carried out on the circuits or on the groups on which they were routed. Maintenance measurements on the line sections and on the supergroups were however carried out as usual.

5. The conditions under which the tests were carried out were described on pages 33 to 40 of document " C.C.I.F.—1955/1956—9th Study Group—Document No. 9 " and are recalled briefly below.

(a) A level recorder was used at each end of the circuit for each of the two directions of transmission. Recording was carried out continuously, using a frequency of 800 c/s sent at an absolute power level of −0·7 N (−6 db) at a point of zero relative level.

(b) In addition, as a check, daily measurements at the same time each day were made at 800 c/s with a level measuring set. These measurements were made with the maximum precision, using the same measuring sets throughout the tests, the sets being calibrated before each measurement.

(c) In addition to the measurements and recordings made on the circuit itself, recorders were used continuously on the group or line pilots associated with the routing of the circuit.

II. — LONG TERM VARIATIONS OF EQUIVALENT. STABILITY OF THE NETWORK. CONCLUSIONS.

Standard deviation of the variations observed.

The standard deviation of the variations of level on the circuits was calculated :

(a) from hourly (at least) readings taken from the recorder charts.
(b) from the daily measurements made using level measuring sets.

The results obtained for the two periods of tests under consideration, together with those obtained during the tests made from January to March 1955, are given in Table 1 which follows.

In this table :

— the circuits are designated by the conventional initial letters representing the countries between which the circuits were established,
— the length of the circuit is shown,
— the different series of tests are shown by means of :
  — (a) for series January to March 1955,
  — (b) for the period *with* maintenance (3rd October-19th November 1955),
  — (c) for the period *without* maintenance (20th November 1955-7th January 1956).
— the standard deviations calculated from readings taken from the recorder charts are shown under R (recordings), and those calculated from the measurements by level measuring sets are shown under M (measurements),
— the last column gives the mean value for the two directions of transmission of the standard deviation R of the circuit obtained from the readings taken from the recorder charts (this value being considered as most representative of the stability of the circuit).

TABLE 1

Table summarizing the values of standard deviation

Series of tests : (a) 4th January-March 1955.
(b) 5th October 1955-January 1956, 1st period.
(c) 5th October 1955-January 1956, 2nd period.

Circuit between A and B		Length	Series of tests	Standard deviation (nepers)				Mean of R
				A to B		B to A		
		km		R	M	R	M	
S	DK	35	a	0·04	0·04	0·08	0·08	0·06
		835 *	b	0·12	0·11	0·19	0·19	0·15
		835 *	c	0·15	0·19	0·20	0·16	0·18
B	GB	233	a	0·05	0·09	0·07	0·08	0·06
		360	b	0·15	0·12	0·17	0·24	0·16
		360	c	0·09	0·09	0·09	0·14	0·09
B	NL	234	a	0·09	—	0·09	0·09	0·09
		234	b	—	—	—	—	—
		234	c	—	—	—	—	—

R — from values taken from the recorder charts.
M — from measurements made with level measuring sets.
* This circuit has been excluded from the calculation of the mean value of R.

Circuit between A and B		Length	Series of tests	Standard deviation (nepers)				Mean of R
				A to B		B to A		
		km		R	M	R	M	
NL	GB	306	a	0·05	0·06	0·07	—	0·06
		474	b	0·08	0·09	0·13	0·09	0·10
		474	c	0·07	0·07	0·06	0·10	0.07
D	CH	450	a	0·09	0·05	0·08	0·05	0·08
		450	b	0·07 [1]	0·06 [1]	0·06	0·05	0·06
		450	c	0·04 [1]	0·04 [1]	0·07	0·06	0·05
B	F	420	a	0·10	0·09	0·11	0·10	0·10
		420	b	0·11	0·10	0·11	0·21	0·11
		420	c	0·08	0·09	0·08	0·16	0·08
F	GB	467	a	0·09	0·10	0·13	0·14	0·11
		467	b	0·11	0·10	0·09	0·09	0·10
		467	c	0·11	0·10	0·11	0·10	0·11
D	NL	560	a	0·12	—	0·06	0·04	0·09
		560	b	0·07	0·09	0·08	0·07	0·08
		560	c	0·06	0·06	0·06	0·06	0·06
F	CH	685	a	0·07 [1]	0·08 [1]	0·11	0·12	0·09
		685	b	0·07 [1]	0·06 [1]	0·08	0·07	0·07
		685	c	0·06 [1]	0·06 [1]	0·09	0·09	0·07
D	F	800	a	0·11	0·10	0·16	0·07	0·13
		720	b	0·07 [2]	0·07 [2]	0·07 [3]	0·06 [3]	0·06
		720	c	0·06 [2]	0·07 [2]	0·06 [3]	0·05 [3]	0·06
NL	DK	965	a	0·05	—	0·11	—	0·08
		965	b	0·14	0·11	0·14	0·11	0·14
		965	c	0·11	0·16	0·06	0·08	0·09
F	I	1000	a	0·12	0·12	0·13	0·12	0·12
		1000	b	0·11	—	0·11	0·10	0·11
		1000	c	0·11	—	0·12	0·13	0·12
Mean		513	a	—	—	—	—	0·09
		610	b	—	—	—	—	0·10
		610	c	—	—	—	—	0·08

R — from values taken from the recorder charts.
M — from measurements made with level measuring sets.

[1] With automatic regulation on the group reference pilot for the direction under consideration.

[2] With automatic supergroup regulation for the direction under consideration.

[3] With, for the direction under consideration, overall automatic group regulation, and automatic supergroup regulation on the section in France.

3.4 There is now an improvement in the stability of the network, the results of the 5th series confirming those of the 4th.

3.5 When the two periods, with and without maintenance, are compared, it is seen that according to the circuit the standard deviation either remains much the same or becomes slightly diminished. The duration of the tests is however too short for this difference to be considered as significant and to decide that in the future periodic maintenance measurements should be made at longer intervals. It is however interesting to note that stopping the maintenance on the groups for a period of seven weeks had no adverse effect.

It will be necessary to make further tests on this subject before being able to draw definite conclusions.

4. *Variation of standard deviation as a function of the length of the circuits.*

4.1 Over the range of lengths of the circuits tested, i.e. 350-1000 km and for circuits in direct groups, the results of the present series of tests may be represented by the following straight line.

5th series $\sigma = 0{\cdot}052+0{\cdot}000058\ l$ σ in nepers and l in km.

which represents over this range the best fitting line for the results, on the basis of the minimum sum of the squares of the differences between the results obtained and the straight line.

For the results of the series of tests from January to March 1955, the best fitting line is

4th series $\sigma = 0{\cdot}063+0{\cdot}00005\ l$

and for the combined results for series 4 and 5

$$\sigma = 0{\cdot}059+0{\cdot}000051\ l$$

Consequently for these results the relation may be taken as

$$\sigma = 0{\cdot}06+0{\cdot}00005\ l$$

4.2 The Federal German Administration examined the variation of standard deviation as a function of length, on the national sections of the circuits it had under test, and reached the conclusion that on these circuits (carrier systems on symmetrical-pair cables) the standard deviation of the variations followed a parabolic law, proportional to the square root of the length of the carrier system. This law was obtained over a range of lengths from 0 to 300 km.

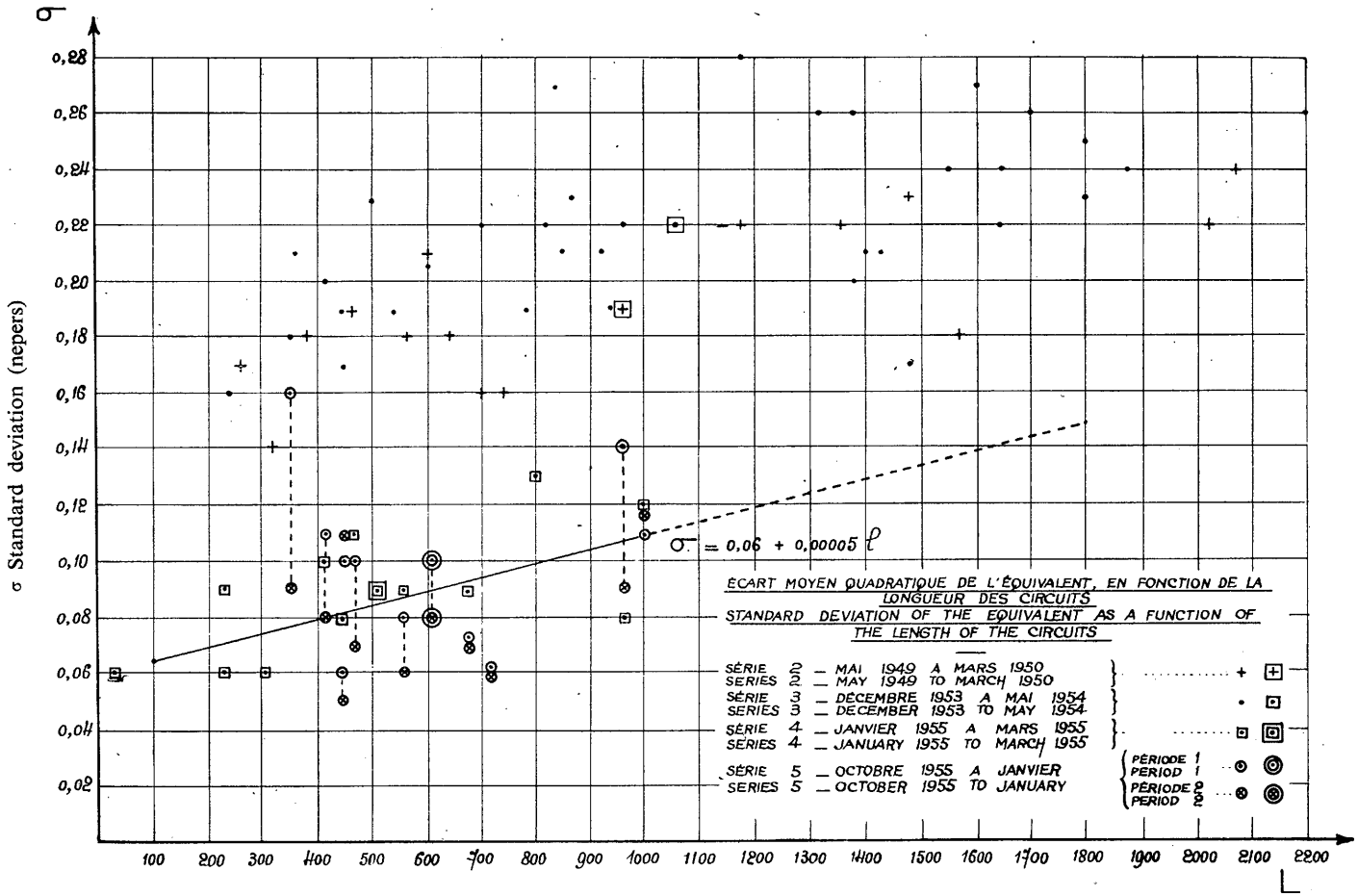
4.3 It seems reasonable to include a constant term in the law of variation of the standard deviation as a function of the length of circuit to take account of the influence of the carrier system terminal equipment.

4.4 It does not appear possible to extrapolate the above-mentioned laws of variation beyond the range for which they are defined and it is premature to draw conclusions to define, for example, the standard deviation to be expected for the hypothetical reference circuit of 2500 km length.

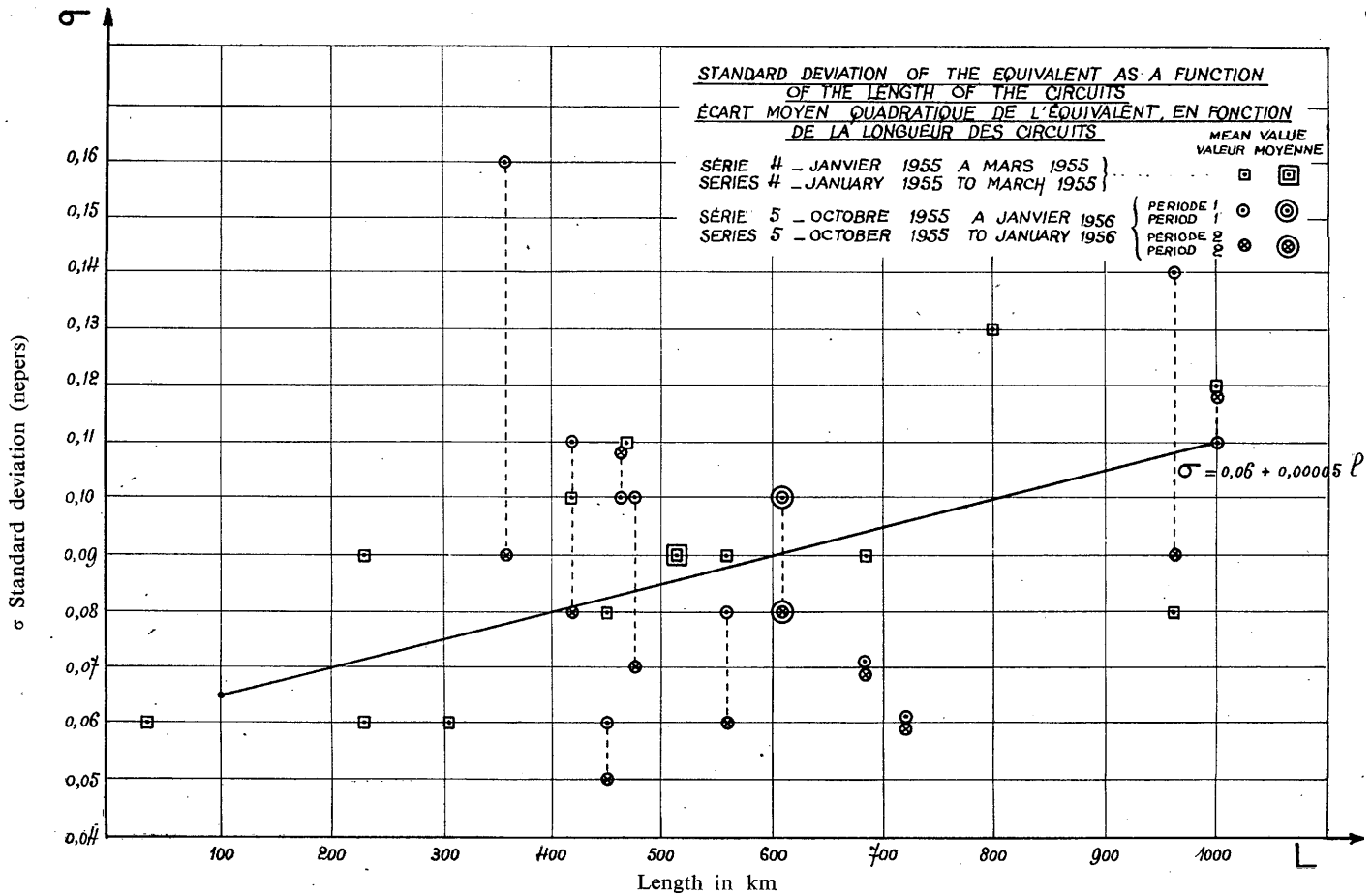
5. *Influence of automatic regulation.*

The influence of automatic regulation systems may be seen in Table 1, where the circuits provided with such regulation are marked with reference to notes at the bottom of the table. For these circuits, the standard deviations are clearly smaller than for the other circuits.

This influence has already been noted during the series of tests of January-March 1955, in the case of the Paris-Zurich circuit (see page 3 of the document " C.C.I.F.—1955/1956—9th Study Group—Document No. 24 "). The results of the present series of tests confirm this influence for the Paris-Zurich direction. The results for the opposite direction Zurich-Paris are however equally good, which may be attributed to the existence of line regulation on the longest sections of the route.



Variation of equivalent of international circuits



Variation of equivalent of international circuits

Comments on the values obtained

The conclusions drawn from an examination of the long-term variations of the circuits and the corresponding standard deviations are as follows :

1. *The results can now be considered as significant.*

Contrary to the previous series of tests of January-March 1955 :

1.1 There is a good agreement between the standard deviations calculated from values taken from the recorder charts and those calculated from the daily measurements by level measuring sets.

1.2 There is also in general a good agreement between the values of standard deviation for the two directions of transmission of the same circuit.

1.3 It may therefore be considered that the method of making the tests is now well established and gives representative results.

1.4 The accuracy of the measurements can be considered as adequate, thanks in particular to the use of recorders. It must be said that this has been obtained only by taking extreme precautions.

2. *Distribution of the level variations.*

The long-term variations of level follow a *normal* distribution law so long as they are due only to influences having a statistical character, such as for example temperature variations, ageing of valves, variations in power supplies, etc. On the other hand, each appreciable variation caused by an equipment fault or by a readjustment, especially in the case of a maladjustment following an incorrect measurement, resulted in a more or less appreciable deviation of this distribution law relative to the normal distribution, producing in particular distribution curves with several peaks. The variations in level, due to the effect of these adjustments, could only be interpreted correctly from a statistical viewpoint by carrying out level recordings for a long time (at least for a year), which was not done for the present series of tests.

3. *Improvement in the stability of the network.*

3.1 The number of values taken from the recorder charts outside the limits ± 5 db ($\pm 0{\cdot}58$ N), relative to the nominal value recorded, is very small. The percentage of time during which these limits of ± 5 db were exceeded is about 0·1 %.

3.2 The graphs 1 and 2 enable a comparison to be made of the results for the two periods—with and without maintenance—of the present series of tests, with the results obtained during the series of tests from January to March 1955. On these graphs, the values corresponding to the two periods of the present series are joined together by a dotted line.

3.3 The following table summarizes the mean values of the standard deviations for all the previous series of tests.

Series	Period of the tests	σ Standard deviation	Percentage of measurements outside the limits $\pm$ 0·5 N	Mean length of circuit km	Number of circuits tested
1	May 1949-July 1949	0·21	—	—	—
2	Sept. 1949-March 1950	0·19	7·17	960	30
3	Dec. 1953-May 1954	0·22	5·53	1064	64
4	Jan. 1955-March 1955	0·09	range of 0·1	509	12
5	Oct. 1955-Jan. 1956				
	1st period	0·10	range of 0·1	596	11
	2nd period	0·09	range of 0·1	596	11

The same influence was noted this time on the Frankfurt/M-Paris circuit for which the level variations were appreciably reduced following the insertion of a group regulating amplifier. The value of the standard deviation of the level of the group reference pilot is 60% less at the output of the group regulating amplifier than the corresponding value at the input.

6. *Transmission of the group reference pilot.*

The transmission of a group reference pilot, provided for in the Maintenance Recommendations (page 47 and page 67 of the document " C.C.I.F.—1955/1956—9th Study Group—Document No. 9 ") should be systematically applied. This pilot enables measurements to be made without the need for cooperation from the distant end of the circuit in another country and therefore enables measurements to be made as often as desired. This pilot also enables automatic regulation to be provided for the carrier system, when this is necessary.

III. — SHORT TERM VARIATIONS (SUDDEN VARIATIONS)

The analysis of the sudden variations has been made in accordance with the directives on pages 33 to 40 of the document " C.C.I.F.—1955/1956—9th Study Group—Document No. 9 ". This relates to sudden variations with amplitudes of about 1·5 db or more.

The results of this analysis are given in tables 2 and 3.

Table 2 relates to the 1st period of the tests, i.e. with circuit maintenance.

Table 3 relates to the 2nd period of the tests, i.e. without circuit maintenance.

Comments on the results of the analysis of sudden variations.

1. The use of recorder on the pilots on the various group and supergroup sections, at the ends of regulating sections, and at frontier stations, has enabled the causes of certain variations to be found and has appreciably reduced the proportion of incidents in the " cause unknown " category by comparison with the preceding series of tests in January-March 1955.

The percentage of sudden variations classed in the " cause unknown " category is however very variable for the circuits tested.

2. It may be considered that the method of making the tests for sudden variations is now well developed and satisfactory.

3. When the results for the 1st and 2nd periods are compared, it will be seen that the number of faults is much the same, except of course for variations due to periodic maintenance on the groups which do not appear for the period without maintenance. The percentage of sudden variations of unknown cause is also sensibly the same for the two periods.

4. The number of impulsive type changes included in the statistics of sudden variations depends to some extent on the characteristics of the recorder used. Depending on its sensitivity, a very short duration interruption may show on the recorder as an impulse of greater or less than 1·5 db amplitude.

As confirmation of this, the number of very short duration interruptions shown on fairly sensitive recorders used at Zurich was only about half the number of interruptions obtained on equipment for counting the interruptions installed by the Swiss Administration in addition to the normal recorders specified in the directives for the present series of tests (equipment showing an interruption each time the received level was less than 1 neper below the nominal value).

This explains why for certain circuits there was an appreciable difference between the number of impulse-type sudden variations for the two directions of transmission of the circuit, the sensitivity of the recorders used at the two ends of the circuit not being the same.

Causes of sudden variations			Number of sudden variations											
			Impulsive character				Step character							
			$A > 1{\cdot}5$ db, $t < 2'$				$0{\cdot}5$ db $< A < 1{\cdot}5$ db				$1{\cdot}5$ db $< A$			
			Individual		Series		Individual		Series		Individual		Series	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
I	Faults	Power plant	136	12·2	49	11·0	5	0·7	10	4·1	58	16·7	8	6·2
		Equipment	59	5·3	39	8·7	14	1·9	7	2·8	51	14·7	16	12·4
		Cables	7	0·6	3	0·7	3	0·4	2	0·8	12	3·5	4	3·1
II	Periodic maintenance	Power plant	93	8·3	4	0·9	8	1·1	1	0·4	1	—	—	—
		Equipment	49	4·4	26	5·8	18	2·5	5	2·0	16	4·6	2	1·5
		Groups	23	2·0	14	3·1	39	5·2	25	10·2	13	3·8	7	5·4
III	Adjustments other than those included under I and II		33	2·9	21	4·7	233	32·5	69	27·9	39	11·3	15	11·7
IV	Internal work (working parties)		222	19·8	134	30·1	41	5·7	23	9·4	59	17·1	30	23·2
V	Cause unknown		498	44·5	153	35·0	362	50·0	105	42·4	98	28·3	47	36·5
VI	Total		1120	100·0	443	100·0	723	100·0	247	100·0	347	100·0	129	100·0

TABLE 2

Analysis of the sudden variations
Period 1 (with maintenance)

Causes of sudden variations			Number of sudden variations											
			Impulsive character				Step character							
			$A > 1{\cdot}5$ db, $t < 2'$				$0{\cdot}5$ db $< A < 1{\cdot}5$ db				$1{\cdot}5$ db $< A$			
			Individual		Series		Individual		Series		Individual		Series	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
I	Faults	Power plant	158	15·2	52	12·5	4	0·7	4	1·7	39	13·8	3	2·6
		Equipment	83	7·9	40	9·6	4	0·7	12	5·4	43	15·2	15	13·3
		Cables	13	1·2	11	2·7	1	0·2	2	1·0	9	3·2	4	3·6
II	Periodic maintenance	Power plant	71	6·8	7	1·7	1	0·2	6	2·6	4	1·4	1	1·0
		Equipment	59	5·7	42	10·1	12	2·0	14	6·2	8	2·9	4	3·6
		Groups	—	—	—	—	—	0·2	—	—	—	1·0	—	—
III	Adjustments other than those included under I and II		34	3·3	17	4·1	237	39·6	51	22·6	21	7·4	5	4·5
IV	Internal work (working parties)		178	17·1	99	23·8	44	7·3	27	11·8	57	20·0	29	25·9
V	Cause unknown		445	42·8	148	35·5	295	49·1	110	48·7	100	35·1	51	45·5
VI	Total		1041	100·0	416	100·0	598	100·0	226	100·0	281	100·0	112	100·0

TABLE 3

Analysis of the sudden variations
Period 2 (without maintenance)

5. Amongst the sudden variations shown in the statistics, will be found a certain number of step-type variations of amplitude 0·5 to 1·5 db which should not be considered as due to faults, but which are a result of the design of the equipment. In the case of automatic regulation systems of the type used by the French Administration, adjustment steps of the order of 1 decineper are used. These step-type sudden variations are classed in category III "Adjustments other than I and II" in the corresponding column.

6. Power supplies contributed appreciably in producing sudden variations; many incidents are caused by drops in voltage on public supply networks. The number of sudden variations caused by power supplies has increased relative to those in the previous series of tests from January to March 1955. This arises from the fact that for the present series a larger number of incidents has been localised and attributed to power supplies.

7. The importance should also be noted of sudden variations caused by working parties which are responsible for about 25% of the impulsive type of sudden variations.

8. There appears to be some correlation between the standard deviations obtained from recorder charts and the number of step-type sudden variations of appreciable amplitude. To determine the correlation more precisely, it would be necessary to consider only those step-type variations of appreciable amplitude which are not followed later, e.g. after 6 hours, by a variation in the opposite direction. As a rough estimate, the standard deviation is about 0·06 N when there are no sudden variations and twice as large when there are about twenty of these sudden variations.

ANNEX 2

(to Question 1 of Study Group 4)

Results of the measurements made in the United States in 1954-1956 on variations of circuit-equivalent

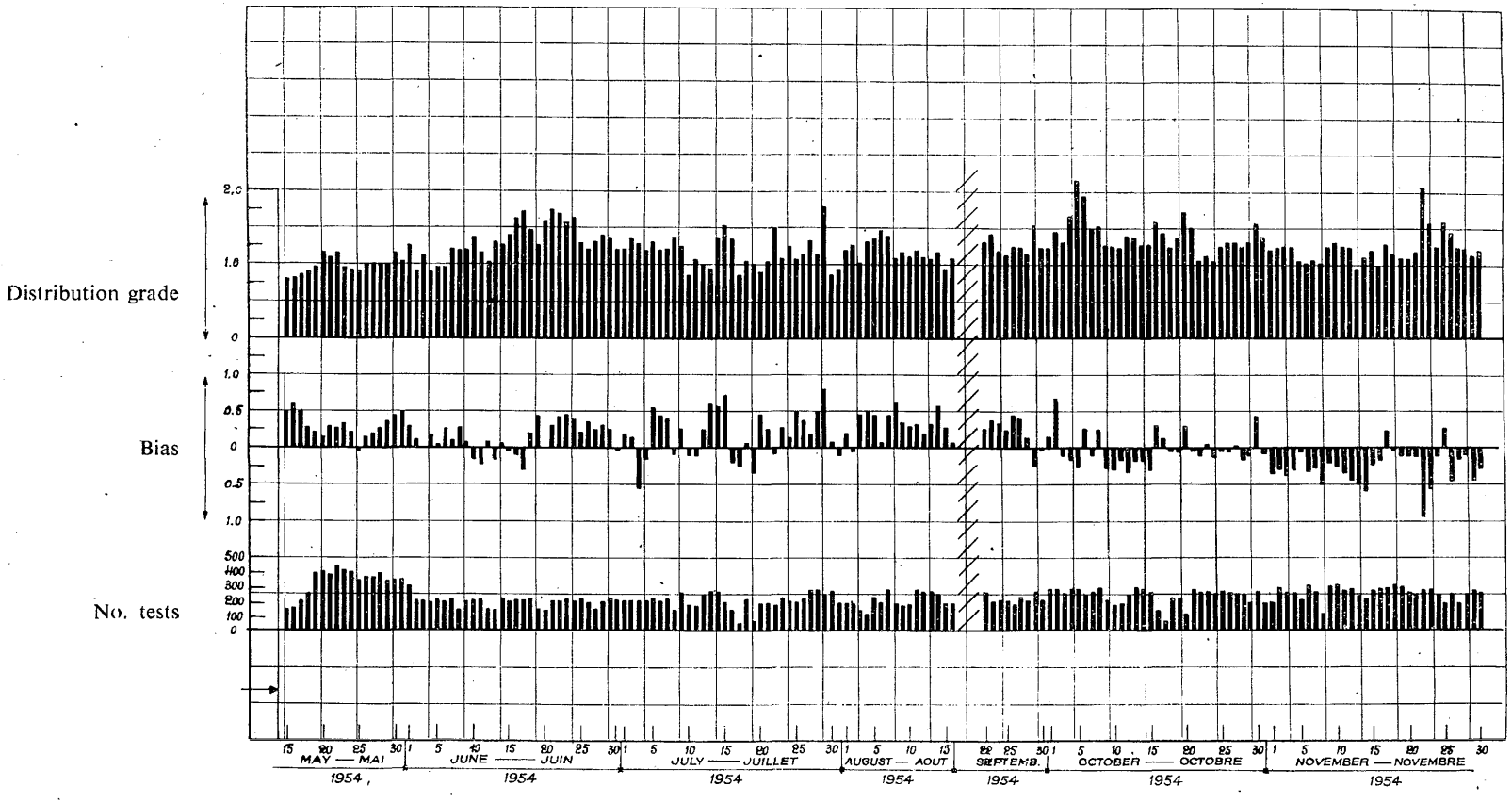
A series of investigations into the subject of variations in circuit-equivalent was completed in 1955 in the U.S.A. This series of investigations was made on a 700-mile group of about 42 trunk circuits consisting of telephone circuits in K-carrier system (12-circuit on symmetrical pairs), L-carrier systems (coaxial-pair systems) and radiolink systems, as well as from combinations of these. Automatic test and recording apparatus was used which enabled measurements to be made readily on the whole of the circuits in the network several times daily. The automatic equipment tested the circuits for the engaged condition, and took them for test only if they were disengaged. Initially the group of circuits was taken for test six times a day. During the latter part of the test period this frequency was reduced to four times daily, yielding a total of about 22,000 measurements for each direction of transmission.

Each circuit was measured the indicated number of times a day to obtain a true picture of the daily and long-term behaviour of the circuits. Special adjustments, based on the overall measurements on the circuits, were made only when a specific fault was found. The results of these trials are plotted on the associated chart, in which :

(a) *distribution grade* is the standard deviation of all measurements in a particular day from the average of that day's measurements;

(b) *bias* is the departure of the daily average loss from the specified loss;

(c) "ATTC" is the "Automatic Transmission Test and Control circuit" used for making the measurements.



Stability tests on Washington-Atlanta

Daily summary of tests with A.T.T.C.

Question 2.

(Former Question No. 3 of Study Group 9 of C.C.I.F. studied in 1955-1956)

(a) Statistical study of the duration and frequency of occurrence of short breaks in transmission on an international telephone circuit.

(b) Investigation into the most likely causes of these short breaks.

(c) Precautions to be recommended for reducing the scale of these short breaks to a minimum.

Note 1. — Study of this Question should enable the telegraph services :

— to determine the scale and the frequency of short breaks in transmission;

— to make investigation, as requested by the VIIIth Plenary Assembly of the C.C.I.T., into the causes of these short breaks interfering with the reception of signals over a VF telegraph channel, by making a detailed analysis of the distribution of these short breaks.

Note 2. — To enable points *(b)* and *(c)* to be studied, it would be desirable to make tests in which short breaks are classified in steps of 5 milliseconds up to a value of at least 50 ms, and at larger steps thereafter. Attention is drawn to the method used by the Swiss Administration (see Annex 1) for determining the duration of these short breaks, a method which might well be adopted for the tests to be undertaken.

Note 3. — The results obtained up to 1954 from the study of this question were published in Volume I of the C.C.I.F. *Green Book*, on pages 518 to 522. Annexes 1 and 2 below give an extract of the results and conclusions mentioned in the replies of the Netherlands and Swiss Administrations to this Question in 1956.

ANNEX 1

(to Question 2 of Study Group 4)

Summary of the reply given in 1956 by the Swiss Telephone Administration

On the occasion of the 4th and 5th series of tests of the level stability, the Swiss Administration proceeded to record interruptions in transmission on the two circuits under observation.

1. *Recording Device.*

The recording device, which was as simple as possible, is indicated in Figure 1.

The 800 c/s signal, amplified and rectified, maintains the operation of a telegraph relay having a short transit time. The normal operating current of the telegraph relay is adjusted so that any fall in level greater than 1 N below the nominal value causes the release of the relay.

A stabilized d.c. source is applied to a recording milliamperemeter via the marking contact of the telegraph relay. This d.c. is adjusted so as to obtain an almost full deflection of the milliamperemeter needle.

When an interruption to the transmission circuit occurs, the relay releases and the needle restores to zero. On termination of the interruption the relay re-operates and the needle again takes up its deflected position. When a short interruption occurs, the needle may not have sufficient

time to return to zero : the length of the deflection traced by the needle bears a relationship to the duration of the interruption.

By producing circuit interruptions with different pre-determined durations, it is possible to establish a calibration curve as shown in Figure 2.

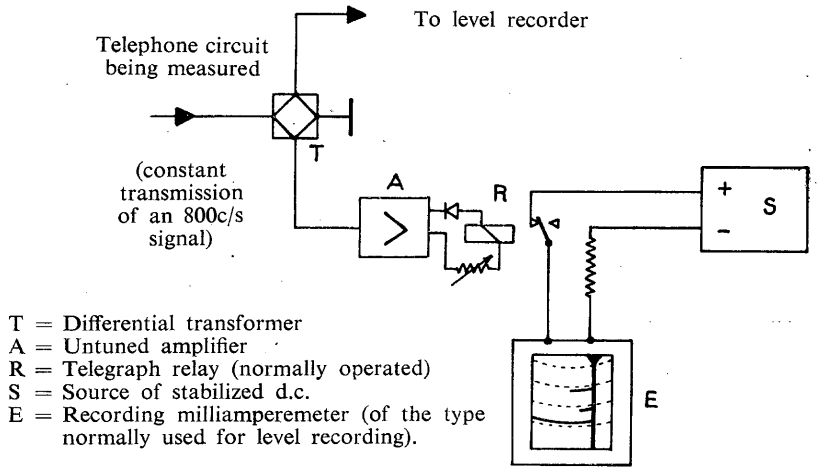


FIGURE 1. — *Device for recording interruptions in transmission*

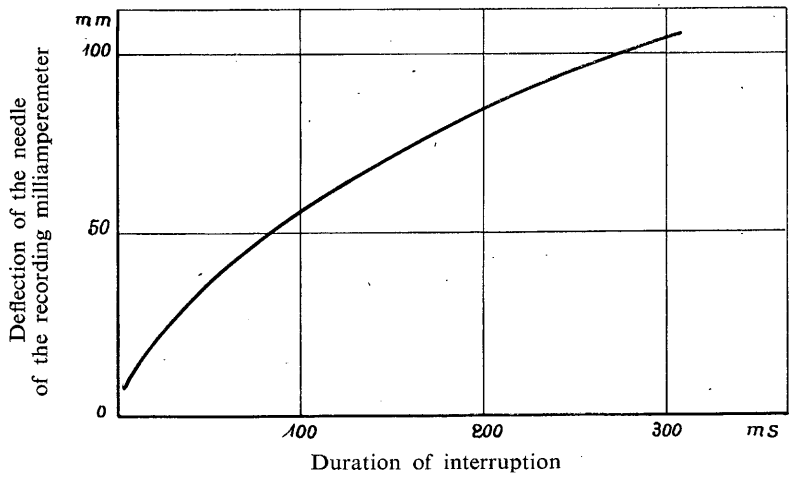


FIGURE 2. — *Calibration curve for the recording device*

2. *Consideration of the recording system.*

The interruptions are recorded on a chart calibrated in hours. It is therefore possible to establish the connection between the interruptions recorded and the work, operations, disturbances, etc., going on in the repeater stations.

The duration of an interruption is registered with its actual value, bearing in mind the degree of accuracy of the system. It is thus possible to group the interruptions in any desired classes according to duration.

If several short-duration interruptions succeed one another very rapidly, they cannot be distinguished from a single interruption of longer duration.

Interruptions whose duration is less than 3 ms are not recorded : those of duration between 3 and 4 ms are not recorded accurately.

3. *Interruptions classified as indicated in Question 3 of C.C.I.F. Study Group 9 in 1955-1956.*

Table 1 below gives the interruptions per day and per 100 km of telephone circuit for the two circuits Frankfurt-Zürich and Paris-Zürich for the series of tests 4 and 5.

TABLE 1

Number of interruptions per day per 100 km

Ms	Frankfurt-Zürich circuit		Paris-Zürich circuit	
	4th period	3rd period	4th period	3rd period
< 5	0	0·03	0	0
5 to 10	0·07	0·07	0·07	0·07
20 to 100	0·20	0·18	0·06	0·06
100 to 300	0·04	0·05	0·04	0·01
> 300	0·07	0·14	0·15	0·07
Total	0·38	0·47	0·32	0·21

The average of the interruptions per circuit per 100 km per day is *0·35*.

The figure of 2 or 3 interruptions per day per 100 km given in Note 6 of Question 3 studied in 1955/1956 thus seems to be too high and not in accordance with practice.

4. *Interruptions classified in groups of 5 ms.*

The classifying of interruptions into the groups recommended in Question 3 does not give a precise impression of any law of distribution. It has accordingly seemed useful to make a new distribution in steps of 5 ms.

It was immediately apparent that for the two circuits, the number of interruptions in certain groups greatly exceeded the values found in other groups. It was also noticed that the interruptions in these particular groups occurred at well-defined times.

Thanks to these data it was possible to localize faults and effect a partial remedy.

5. *Comparison between the interruptions recorded on the circuit and the interruptions recorded on the group reference pilot.*

In a note to the question studied in 1954/1956 it is shown that the results presented in 1953/1954 show the presence of a considerable difference (a ratio of 1:10) between the interruptions counted upon a telephone circuit and the number of interruptions observed upon the reference pilots. In this note, it is not clearly stated whether the line pilot or the group reference pilot is meant.

It seemed useful to the Swiss Administration to look into this question, and to this end every interruption observed on the two circuits during the two trial periods was compared with the recording of the group reference pilot.

Results show that at least 87% of the interruptions of the Frankfurt-Zürich circuit and 84% of those on the Paris-Zürich circuit are produced on the group link, and as a consequence are shown on the record of the group reference pilot.

The proportion of 10% stated in the above-mentioned note is thus far from corresponding with reality, and should be revised.

6. *Comparison between the interruption charts and variations in the circuit equivalent.*

Examination of the chart of level variations alone does not enable a variation lasting several seconds, yet of relatively low amplitude, to be distinguished from a total interruption in transmission lasting several milliseconds. Comparison with the chart of interruptions enables this uncertainty to be practically eliminated.

ANNEX 2

(to Question 2 of Study Group 4)

Improvement of the stability of trunk and international circuits as regards abrupt interruptions

(Extract from the reply to this Question given in 1956 by the Netherlands Administration)

Observations by the Netherlands Administration in 1954/1956.

1. During the period from March 1954 to June 1956, the Netherlands Administration proceeded to count up the number of short interruptions on the alarm circuits of voice-frequency telegraph systems. These systems had previously been subjected to a systematic examination by means of vibration tests. During the months of May and June 1954, routine testing procedure was suspended and operations in the repeater stations concerned in the trials were reduced to the bare minimum. Figure 1 shows the average number of " day " and " night " periods per month and per circuit in which one or more short interruptions on the alarm channel of a voice-frequency telegraph system were recorded (the *go* and *return* station). This figure confirms the considerable reduction in the number of short interruptions which results from the suppression of routine testing.

2. During the trials, it was found that it was sufficient to count only the short interruptions in one direction of transmission, and also that it was sufficient to resort to a single alarm channel per system for telegraph circuits having a given routing. By thus reducing the work of the staff, it was possible to reduce the percentage of unknown causes from 70% to 20%.

3. Figure 2 shows the correlation between the number of short interruptions and the number of the staff in the repeater station, a correlation which is more clear than that already indicated with the volume of traffic.

4. Forewarned by the results under 1 and 3, the Netherlands Administration decided to defer :

— dangerous maintenance measurements until the hours of relatively light traffic (18.00 to 20.00 hours), and

— the dangerous operations (for example, work on carrier current cables, power plant, common carrier-frequency generating equipment), as far as possible to the night hours.

Figure 3 shows the average number of " day " and " night " periods per month and per circuit where one or more short interruptions have been recorded on one direction of transmission of the alarm channel of a voice-frequency telegraph system. The figure demonstrates clearly that the number of short interruptions has diminished considerably during the " day " period, but also that this total number has also diminished for the total of the " day " and " night " periods. This is due to special courses given to the staff, during which they were instructed in special precautions to take, not only for maintenance measurements but also for the general work in stations or on cables.

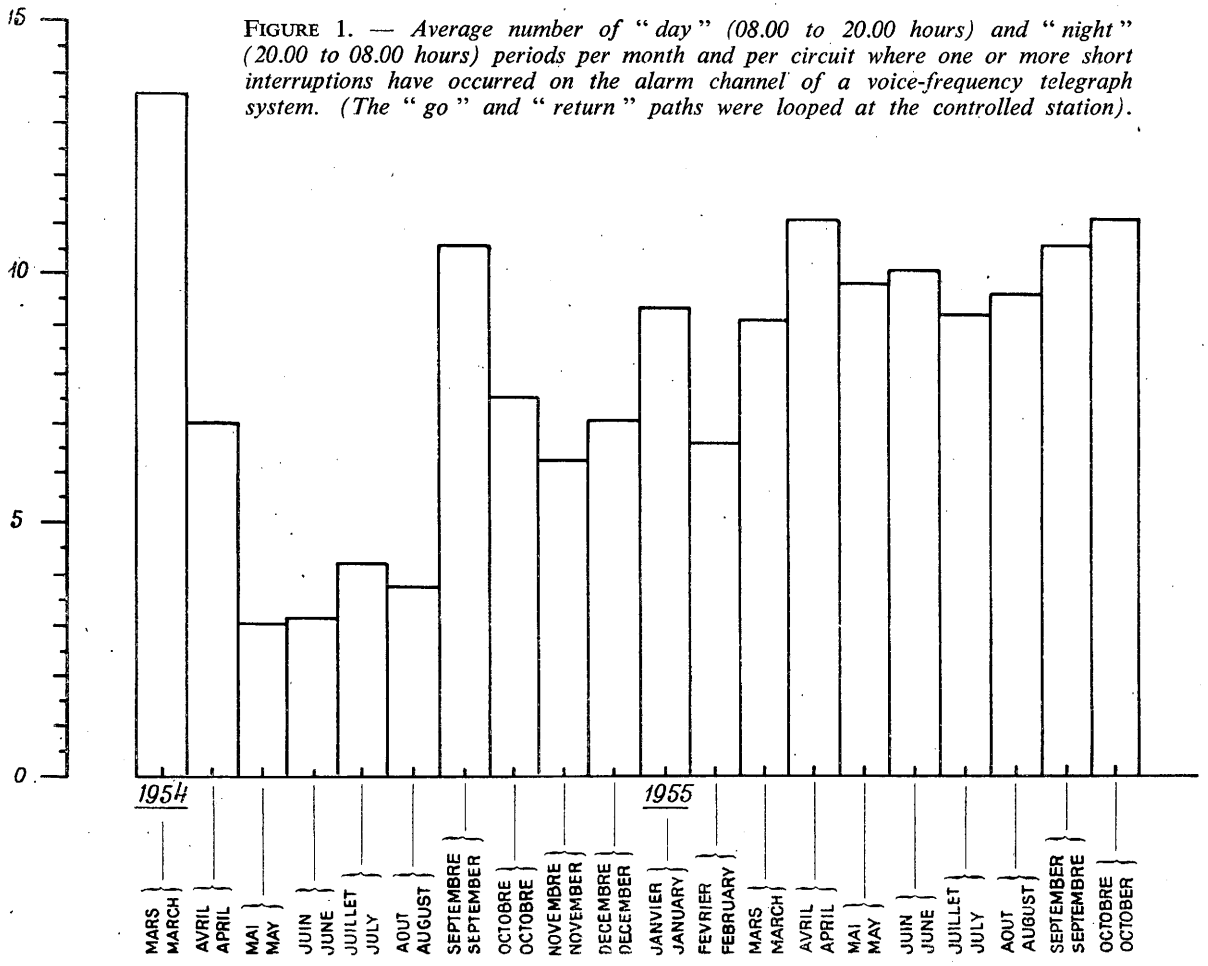
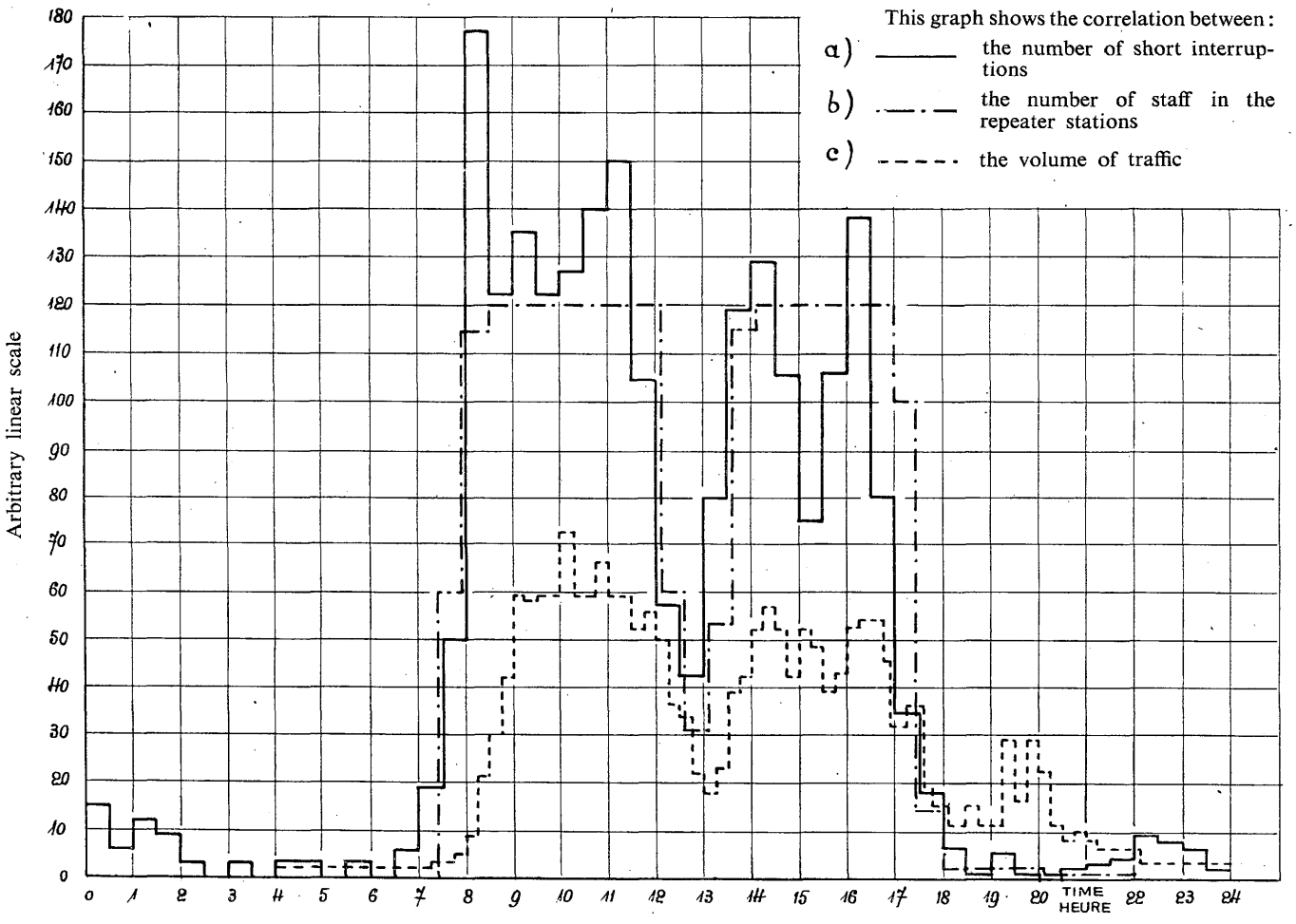


FIGURE 1. — *Average number of "day" (08.00 to 20.00 hours) and "night" (20.00 to 08.00 hours) periods per month and per circuit where one or more short interruptions have occurred on the alarm channel of a voice-frequency telegraph system. (The "go" and "return" paths were looped at the controlled station).*

FIGURE 2


This graph shows the correlation between :
a) the number of short interruptions
b) the number of staff in the repeater stations
c) the volume of traffic
Arbitrary linear scale
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 TIME HEURE 22 23 24

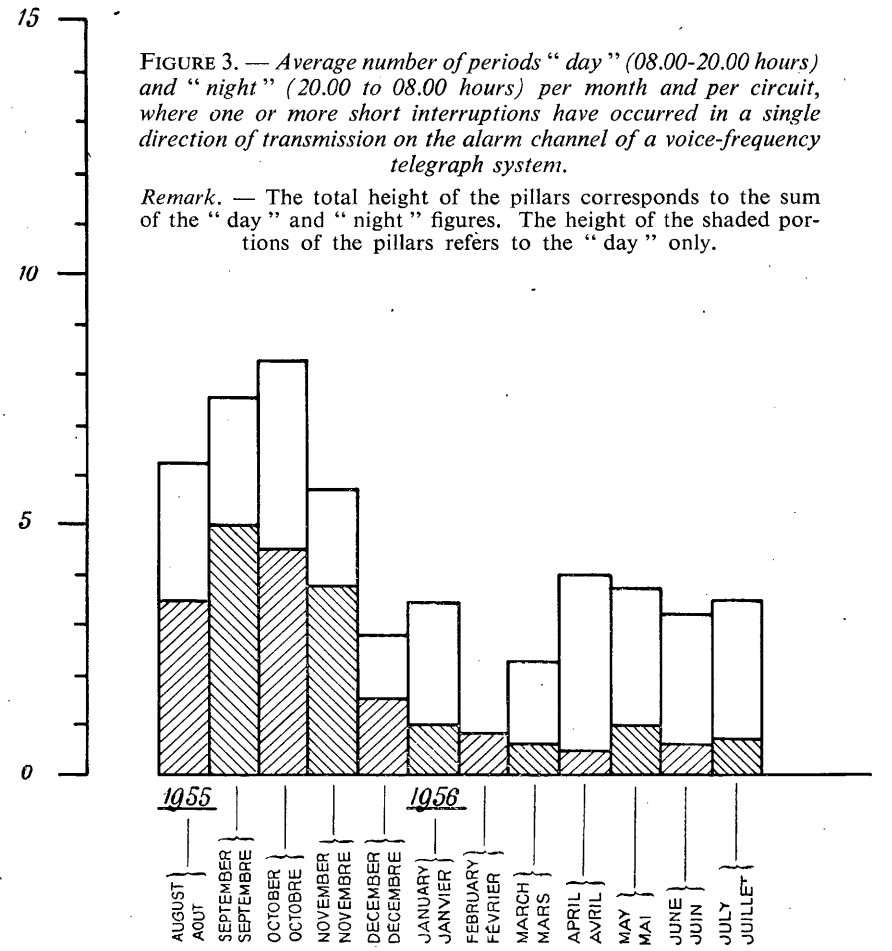


FIGURE 3. — *Average number of periods " day " (08.00-20.00 hours) and " night " (20.00 to 08.00 hours) per month and per circuit, where one or more short interruptions have occurred in a single direction of transmission on the alarm channel of a voice-frequency telegraph system.*

Remark. — The total height of the pillars corresponds to the sum of the " day " and " night " figures. The height of the shaded portions of the pillars refers to the " day " only.

5. The Netherlands Administration has made an analysis of the causes of short interruptions during the month of January 1956. These results are summarized in the Table below.

Abrupt interruptions due to:	%
Station equipment	7
Cables	2
Incorrect operation	14
Failures in public mains supply	5
Maintenance, construction and re-arrangements in H.F. circuits	52
Unknown causes	20

The Table shows that, even in spite of the precautions described above, the fact that the staff should carry out maintenance and construction with the utmost care is of the greatest importance.

Question 3.

(Study Group 4 in cooperation with Sub-Group 1/3)

(New Question)

What are the actual service values of

(a) frequency deviations,
(b) sudden phase-changes,

observed on carrier telephone circuits used for voice-frequency telegraphy ?

Note 1. — This Question is in response to a request made by the telegraph services for the purpose of forming recommendations for the use of frequency-modulated systems of voice-frequency telegraphy. This request is the subject of the following Note by the C.C.I.T. issued during its VIIIth Plenary Assembly, Geneva, December 1956 (Annex 1).

Note 2. — Annex 2 below contains results of frequency deviation measurements carried out by the Swiss Administration in 1956.

ANNEX 1

(to Question 3 of Study Group 4)

Note by the C.C.I.T.

The C.C.I.T.,

Considering

That there is need to introduce, particularly for very long international telegraph circuits operating under adverse conditions, frequency-shift modulated voice-frequency telegraph systems ;

That the standardization of the characteristics of such systems has been recommended and that studies of this subject are in progress;

That the frequency deviation and channel spacing of such systems will be largely determined by the frequency stability of the telephone circuits over which they work;

That the lengths of circuit over which such systems will operate make it highly desirable to obtain as many channels as possible from each telephone circuit and, for this reason, the recommended frequency deviation of the frequency-shift channels may be as little as ± 30 c/s;

That the present limits for frequency error in carrier telephone channels have been set by considering the requirements of amplitude-modulated telegraphy and phototelegraphy;

Requests

1. That administrations should undertake measures to determine what frequency errors do exist in the carrier telephone channels at present used for voice-frequency telegraphy;

2. That administrations should undertake measurements to determine in typical cases what transient frequency errors occur in carrier telephone channels used for voice-frequency telegraphy in consequence of a change-over of carrier supplies, loose connections, discontinuity of resonance

frequency in piezo-electric crystals, irregular working of thermal controls, sudden variation of power supplies etc., and that these measurements should not be limited only to variations in master oscillators, but should include also the effects introduced in the actual carrier supplies.

Remark. — Attention is drawn to the fact that a difference of phase existing between carrier supplies at the moment of change-over from one to another may produce an adverse effect on any voice-frequency telegraph system. It would be useful to determine the maximum phase difference which might exist at the instant of change-over, if precautions were to be taken to make a voluntary change-over at the optimum moment.

ANNEX 2

(to Question 3 of Study Group 4)

Frequency deviations on telephone circuits

(Measurements carried out by the Swiss Administration)

Below are given some results of measurements of frequency deviations on carrier telephone systems, carried out on the network of the Swiss Administration.

In order to determine these deviations we compared, every day except Sundays, the frequency of 10 master oscillators for coaxial pair telephone systems with

(a) the carrier frequency (200 kc/s) of the Droitwich transmitter (making allowances for monthly corrections),

(b) the standard frequency of the Neuchâtel Observatory.

Leaving aside short-term variations, a steady rise in the frequency was noted, due to the ageing of the crystal.

There was an average increase of $8{\cdot}9\times10^{-5}$ c/s per day for an oscillator frequency of 100 000 c/s or $8{\cdot}9\times10^{-10}$ per day and per c/s. The least stable of the oscillators under observation gave a value of 26×10^{-10} c/s, while the most stable gave 4×10^{-10} c/s. Only one of the oscillators showed a slight steady frequency decrease of $2{\cdot}4\times10^{-10}$ c/s per day and per c/s.

By taking the basic stability of $\pm1\times10^{-7}$ recommended by the C.C.I.F. on page 85 of Volume III of the C.C.I.F. *Green Book* (and leaving aside once again the short-term variations), it is possible to determine the maximum optimum period during which oscillators do not need to be readjusted. It is sufficient to divide the maximum admissible variation by the daily variation. In our specific case we obtain

$$\frac{2\times10^{-7}}{8{\cdot}9\times10^{-10}}=225 \text{ days}$$

for average oscillators. For extreme cases we obtain 77 and 830 days respectively.

But to these steady variations due to ageing of the crystal we must add irregular variations caused by changes of temperature, variations of the supply voltage, inaccurate measurements, etc. The curves for frequency variations as a function of time then become jagged and the theoretical period between two consecutive adjustments is reduced.

The average of this reduced period for the ten oscillators is 141 days, while for the extreme cases we obtained about 60 and 360 days.

We may therefore conclude that if adjustments are carried out at shorter intervals than those determined above, the stability of $\pm1\times10^{-7}$ recommended by the C.C.I.F. can be satisfied.

Measurements carried out over a much shorter period on master oscillators for symmetrical-pair carrier systems produced similar results.

No information on abrupt phase changes can be given for the time being.

Question 4.

(New Question)

Is it possible to define certain rules relating to the general arrangement for the protection of power supplies to repeater station equipment in order to avoid disturbances, and especially interruptions in transmission, in the event of a short-circuit on the neighbouring racks ?

Note. — This question does not aim at standardizing fuses : such a study is proper to Study Committee No. 23 of the International Electrotechnical Commission (I.E.C.), and for 1956 it is the subject of drafts in course of approval by the corresponding national Committees of the I.E.C.

The present question should permit study of the most favourable arrangements (choice of protective devices, their grading and their general arrangement for the power supplies at repeater stations). The following Annex describes the result of observations which have been made by the Netherlands Administration and is intended to outline the scope of this question.

ANNEX

(to Question 4 of Study Group 4)

Studies made in the Laboratory of the Netherlands Administration on the subject of short interruptions caused by the operation of protective devices on neighbouring equipment

Measurements made in the laboratory of the Netherlands Administration have shown that short breaks in transmission are produced because of insufficient care in the design of protective devices in power supplies. These measurements were made with a double-beam oscilloscope together with a camera. It was thus possible to observe and record two occurrences simultaneously : current variations and the drop in potential in the behaviour of a repeater short-circuit. The diagram below gives an example taken from the record obtained.

In the event of a short-circuit upon a panel of a rack, the anode potential on neighbouring racks falls sufficiently to interrupt the operation of repeaters and oscillators. When the fuse has broken the short-circuit current, the anode voltage is re-established on the other racks, after some transients. As a result, short breaks in transmission of the order of a millisecond occur.

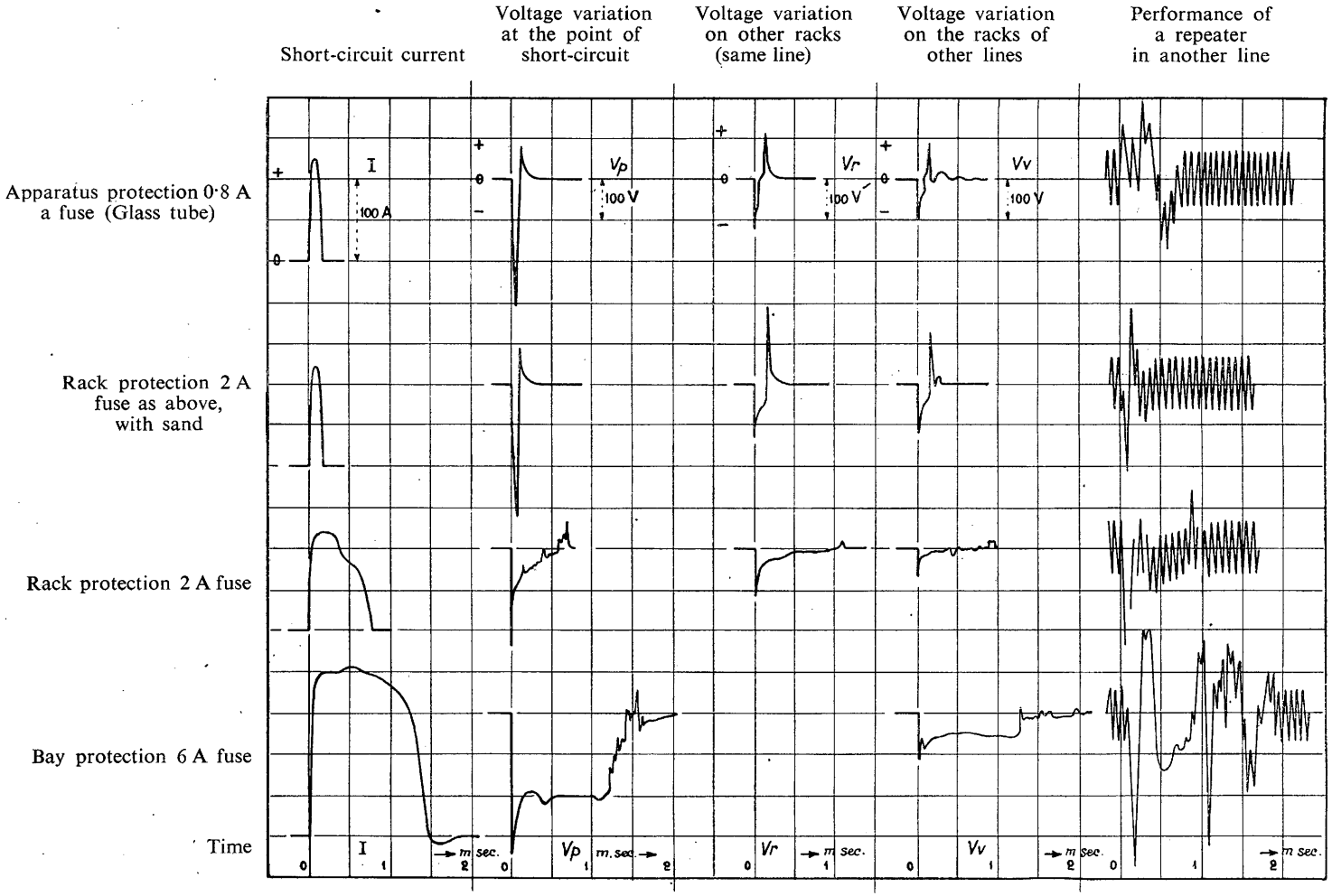
A report of the work done on this subject in the laboratory of the Netherlands Administration is described in Report 99 TL, *Examinination of selectivity in the protection of power supplies in repeaters stations*, by F. W. Hold.

A bibliographic study, *Selective blowing of fuses on the occurrence of high currents*, by W. Wijnstok has also been made and described in " Report No. 28 Bidoc." These reports can be obtained on request to the Directorate of the Netherlands Administration, " Long-distance Lines Maintenance Division."

Question 5.

(New Question)

Is there a need to modify the requirement appearing in the Maintenance Instructions (see pages 16 and 55 of the Instructions, or pages 242 and 281 of Volume III of the C.C.I.F. *Green Book*) which state that in case of maladjustment of a circuit, a group or a supergroup, the nominal adjustment value should be restored ?


Short-circuit current
Voltage variation at the point of short-circuit
Voltage variation on other racks (same line)
Voltage variation on the racks of other lines
Performance of a repeater in another line
Apparatus protection 0·8 A a fuse (Glass tube)
Rack protection 2 A fuse as above, with sand
Rack protection 2 A fuse
Bay protection 6 A fuse
Time
I
100 A
Vp
100 V
Vr
100 V
Vv
100 V
m sec.

This rule is clearly justified when the cause of the maladjustment is known. When, on the other hand, the cause is unknown, there is a risk—particularly on systems with only a manual regulation which is carried out at relatively long intervals of time—of introducing a spread in variations and in the end of increasing rather than decreasing the standard deviation.

Note. — The recommendation mentioned above was established in 1950, with the object of increasing the transmission stability and there is no doubt that it resulted in some improvement in this respect. Nevertheless, the results obtained during the series of observations of variations in circuit-equivalent carried out in 1955/1956 introduce certain doubts as to the advisability of this systematic readjustment to the nominal value after each periodic maintenance measurement.

Question 6.

(New Question)

Is it possible to issue working instructions for the establishment of automatic regulation of groups and supergroups, taking into account the length and the complexity of these groups ?

Note. — Information has been requested from Administrations and Private Operating Agencies about the characteristics of their automatic regulators, and the methods applied to coordinate the operating of these regulators when several are placed in tandem. This information forms the subject of Question 31 of the 1st Study Group.

Question 7.

(Former Question 9 of C.C.I.F. Study Group 9 studied in 1955-1956)

(a) As a method of measuring intermodulation effects on a carrier system, should a method be recommended in which the system to be measured is loaded with " white noise " ?

(b) In what cases and in what precise conditions should this method of testing be used ?

(c) Is there need for a given method to fix limits for the results of such intermodulation measurements ?

Note 1. — Distinction should be made between the cases of carrier current systems on metallic lines and systems on radio links where the conditions for using this method may be different.

Note 2. — Annex 1 reproduces a memorandum by the Australian Telephone Administration which describes in detail such a testing method and at the same time proposes permissible limits for intermodulation noise.

Annex 2 is a memorandum by the Dutch Administration on this testing method.

ANNEX 1

(to Question 7 of Study Group 4)

Note by the Australian Telephone Administration on intermodulation testing of multi-channel carrier system and of radio links by the use of random noise

Introduction — General nature of the test

The general nature of the measurement of the intermodulation caused by the application of noise can be explained with the aid of a block schematic diagram, Figure 1 attached. The essential elements are :

— a generator of continuous spectrum random noise;
— band stop and band pass filters;
— measuring instruments;
— the system to be tested.

These elements are connected as shown in the schematic diagram of Figure 1 which also shows the frequency spectrum of the noise energy used as a test signal, at various points in the circuit.

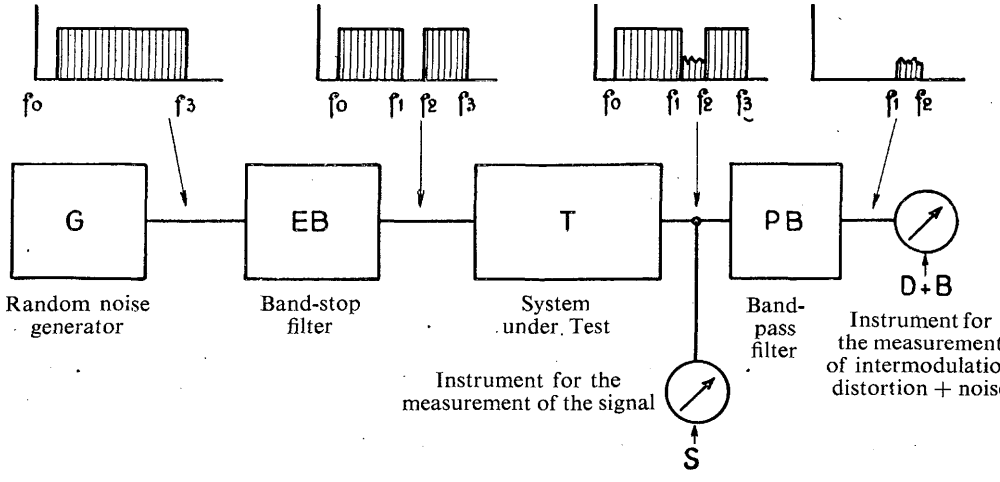


FIGURE 1. — *Block schematic of the arrangement of equipment used for the measurement of intermodulation by the application of noise*

The signal output from the random noise generator would normally have a spectrum with constant energy in all frequency components between frequencies f_0 and f_3 as shown. The limits f_0 and f_3 are adjusted to be approximately the same as those of the speech signals or speech-modulated carrier waves normally applied to the system. The frequency spectrum may be altered by means of equalizers to give other distributions if desired.

The band-stop filter shown in Figure 1 greatly attenuates all frequency components between the frequencies f_1 and f_2. The band f_2-f_1 is made 4000 c/s or thereabouts, so as to simuleta approximately one quiet speech channel.

Non-linear distortion and undesired noise sources (such as cable resistance noise, valve noise, etc.) within the communication system give rise to an increase in the noise signal in the band f_1-f_2, as shown in the spectrum diagram.

The combined amplitude of these distortion components is then measured by means of the band-pass filter and measuring instrument shown in Figure 1. A second measuring instrument is used to measure the total energy of the random noise signal transmitted out of the communication system under test. The amount of non-linear distortion in the band f_1 to f_2 is a function of the amplitude of the output signal of the transmission system; this may be adjusted to certain definite values representing certain conditions of speech traffic loading, or it may be varied over a range of values, if it is desired to find the loading which gives maximum signal-to-noise ratio.

Advantages of the measurement of intermodulation, by the application of noise when applied to multi-channel carrier telephone systems

The particular advantage of this method of measurement is that it simulates actual speech loading conditions. The band-stop, band-pass filter arrangement is equivalent to the equipment arrangement in a carrier system, and in fact it is desirable in many cases to make use of existing channel translating equipment to carry out this test. In such a case, individual noise generators would be applied except one, and the resulting distortion products measured (with a C.C.I.F. psophometer) in the quiet channel at the far end.

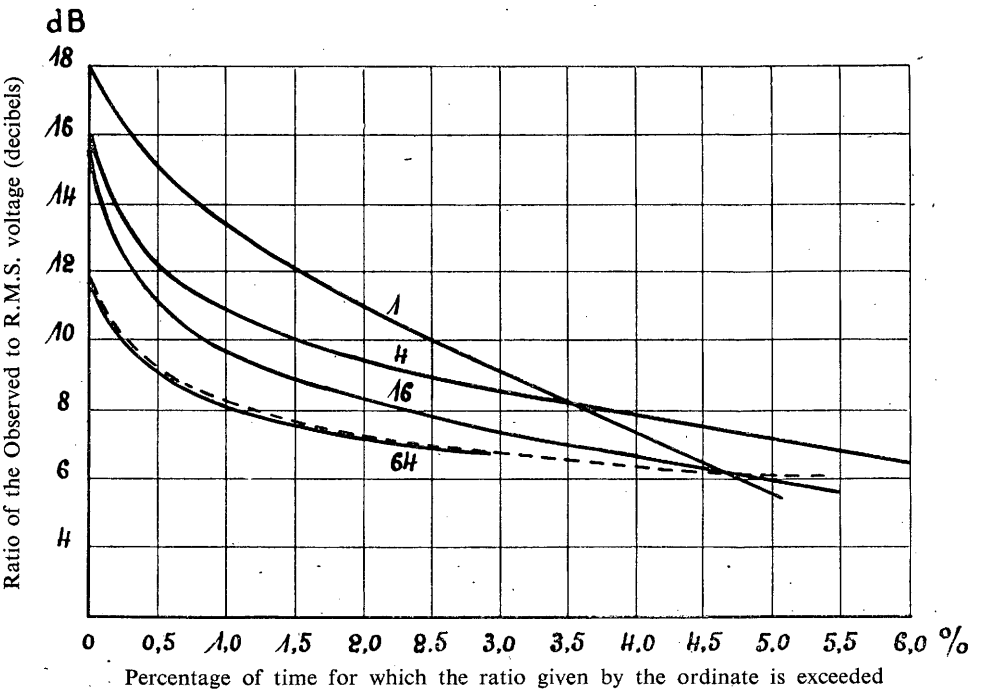


FIGURE 2. — *Statistical distribution of the voice currents produced by a group of talkers*

The complex signal, resulting from the combination of the speech signal in a frequency-division multi-channel telephone transmission system, has a random character which can be simulated by continuous spectrum noise from a random noise generator.

Figure 2 shows the statistical distribution, as a function of time, of random noise peaks and compares them with the statistical distribution as a function of time, of peaks in a multi-channel telephone system (this figure is reproduced from an illustration in an article by E. Peterson in Bell Laboratories Record, November, 1939).

The power level during the busy hour, due to the speech currents in a multi-channel telephone system, is given in Figure 3 for various numbers of channels. Figure 3 is based upon Figure 6 in a paper by Holbrook and Dixon in the *Bell System Technical Journal*, October, 1939. Holbrook and Dixon's data are based upon a mean talker volume at a point of zero relative level of −16·0 db relative to " reference volume " (equivalent to " *puissance vocale normale* " used with the S.F.E.R.T. in the C.C.I.F. Laboratory). For estimating the load of a carrier system " reference

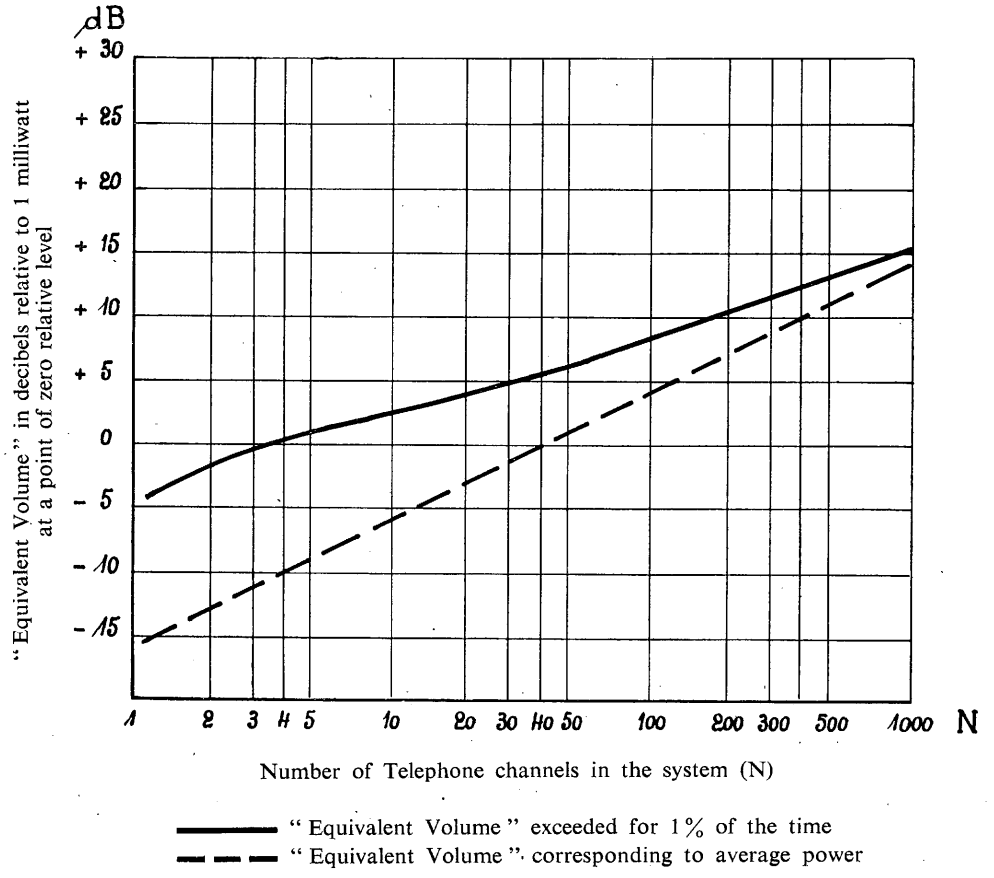


FIGURE 3. — " *Equivalent volume* " *for carrier systems of N channels*

volume " is taken as representing an average power in continuous speech of 1·66 mW (+2·2 db). The standard deviation of talker levels is 5·8 db *. A mean channel activity, during the busy hour, of 25% is assumed.

In carrying out intermodulation tests by the random-noise method, the power level of the noise signal at a point of zero level is adjusted to a value given by the curves of Figure 3, the " 1 per cent " or " average power " curve being used according to the information desired.

As mentioned above, when individual channels in a carrier system are loaded with separate noise generators, the distortion products are measured by means of a psophometer in the idle channel. When testing a high frequency repeatered line or similar system, the bandwidth of the bandpass filter used should preferably be equal to the equivalent noise bandwidth of the C.C.I.F. psophometer (1780 c/s).

Application of the test to particular groups of channels in carrier systems on coaxial pairs

(a) 12-channel basic groups. — In testing a complete carrier system comprising one 12-channel group, it is most convenient to connect independent random noise generators to 11 of the 12 channels, the power level being adjusted to an absolute level of −8 db per channel at a point of zero relative level, if the equivalent volume exceeded during 1% of the time is to be simulated. If " average power " conditions are to be simulated, the corresponding absolute level of the noise signal would be −16 db, on each channel at a point of zero relative level. The noise level at a point of zero level in the unoccupied channel at the end of a system 2500 km long should not exceed −50 db (psophometric power of 10·000 pW) when measured with the standard C.C.I.F. psophometer.

(b) 60-channel supergroups. — In the case of 60 channel supergroups, it seems appropriate to carry out tests independently of the channel translating equipment, using a single wide-band noise generator and sets of band-stop and band-pass filters. The bandwidth of the noise generator should be adjusted to 312 kc/s - 552 kc/s, the bandwidth of the standard supergroup. The power level would be set to an absolute level of +6·5 db at a point of zero relative level, to simulate the equivalent volume exceeded 1% of the time and to a level of +1·5 db to simulate the equivalent volume corresponding to average power.

The bandpass filter at the receiving end should preferably have an effective bandwidth for noise corresponding to that of the standard C.C.I.F. psophometer. In cases where the bandpass filter has some other bandwidth, its value should be measured and an appropriate correction made.

The maximum permissible level of unwanted noise and distortion depends upon the proportion to be allocated to the terminal channel translating and group modulating equipment, but generally this is so small (see *Yellow Book*, Volume I *bis*, pages 321-327, reply by the British Administration to Question 25, studied in 1950/1951) that for practical purposes a limit of an absolute level of −50 db (10,000 pW) at a point of zero relative level in a circuit of length 2500 km can be applied.

(c) Groups of 600 channels or more. — The procedure in this case is exactly similar to that described above for a 60-channel supergroup. The bandwidth of the noise generator is adjusted to the appropriate value and the power level to be used is determined from Figure 3. The limit

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* There are several indications that the voice power levels given in the article by Holbrook and Dixon have changed: the mean volume of speech produced by a subscriber in the Bell System is about 4 db less than the value given and has a little less spread.

to be applied to the unwanted distortion and noise depends upon the limits assigned to the terminal channelling and the group and supergroup modulation equipment, as discussed under *(b)* above. This latter limit is generally small, so that it is again practical to apply, for the noise measured at the end of a circuit of 2500 km, the value corresponding to an absolute level of −50 db (psophometric of 10,000 picowatts) at a point of zero relative level.

Comments on the technical requirements of the equipment used for the measurement of intermodulation by the application of noise

(a) *Random noise generators.*

The primary requirement is that of uniform spectrum energy per cycle (equal power in each frequency band of 1 c/s) throughout the transmission band, with purely random phase relationship between the frequency components. Normally the noise generator itself operates at a low power level, and amplification is necessary. The overload level of the amplifier should be sufficient to enable a signal with a peak-to-r.m.s. ratio of at least 12 db to be amplified without peak clipping.

For noise generators supplying a voice-frequency spectrum only, it has been found convenient to use gas-tube noise generators, because of their high output level. For wideband noise generators, a temperature limited diode, developing " shot " noise, is more satisfactory because of its relative stability and uniformity of frequency spectrum.

(b) *Filters.*

A primary requirement is that the filters themselves shall not produce non-linear distortion. Air-cored inductors are therefore desirable, but iron dust cores of permeability 2 or 3 have been used, in certain cases, with entire success.

The frequency spectra shown in Figure 1 have been drawn on the assumption that filters with rectangular attenuation/frequency characteristics are used. In practice it is convenient to use a band-pass filter with a response curve having a rounded top and sloping sides. The bandwidth of the band-stop filter must be not less than that of the band-pass filter. The band-pass and band-stop filter connected in cascade should have an attenuation of the order of 70-80 decibels or better at all frequencies.

ANNEX 2

(to Question 7 of Study Group 4)

Note by the Dutch Telephone Administration

With reference to the note by the Australian Administration (Annex to Question 34), the Netherlands Administration draws attention to the following method of measurement by which the use of a noise generator and of different band-pass and band-stop filters can be avoided.

In the method in question, one or more amplifiers with linear characteristics, and taken from the same system (e.g. the amplifier from the other direction of transmission) are used as a noise generator; while the necessary filtration is obtained by means of the band-pass filters used for the various channels of the system. The method of operation may be clarified with the aid of a simplified schema which illustrates the measurement on a radio link (see Figure 1).

The thermal noise, amplified in the amplifiers with linear characteristics, is separated into different frequency bands by the receive side of the auxiliary multiplex apparatus (channel equipment). The low-frequency 4-wire outputs thus provide 12 sources of incoherent noise, having a noise energy which may be equalized as necessary in the different channel amplifiers.

The system to be measured may be loaded by the noise provided by these " incoherent noise " sources.

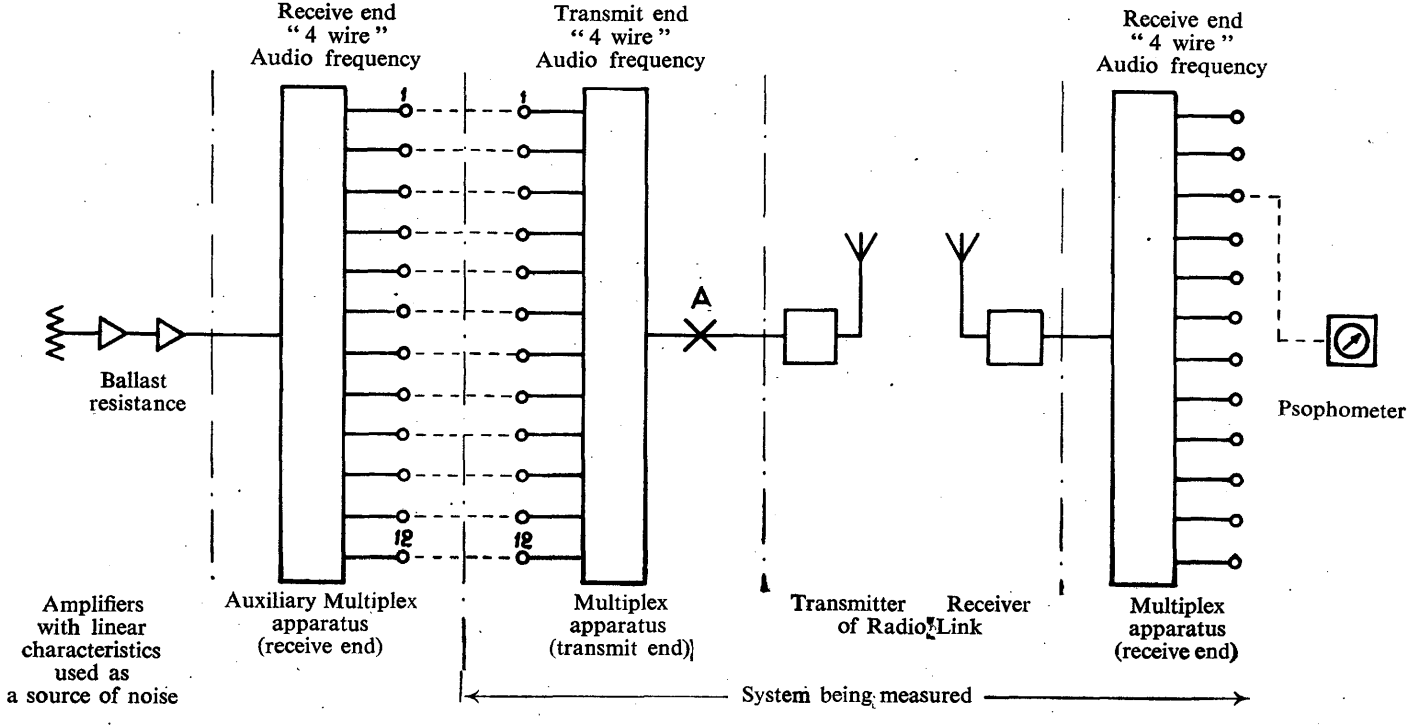

Receive end
" 4 wire "
Audio frequency
Transmit end
" 4 wire "
Audio frequency
Receive end
" 4 wire "
Audio frequency
1
12
A
Ballast
resistance
Psophometer
Amplifiers
with linear
characteristics
used as
a source of noise
Auxiliary Multiplex
apparatus
(receive end)
Multiplex
apparatus
(transmit end)
Transmitter
of Radio Link
Receiver
Multiplex
apparatus
(receive end)
System being measured

FIGURE 1

The noise resulting from this loading is measured by means of a psophometer on the receive end of a channel, provided that the transmit end is not connected to a source of noise. As there is complete freedom in the choice of the channel on which to measure (channel 3 in the example of Figure 1), as well as the channels to which noise is applied, the component in each individual channel may readily be observed for any combination of loading of the channels.

Note 1. — In favourable circumstances, the receive end of the multiplex apparatus to be tested, which is already available in the station given as an example, may be used in place of the auxiliary multiplex apparatus. For this to be possible, it is necessary for the near-end reflected crosstalk (echoes) between the receive and transmit ends to be sufficiently good, because this near-end crosstalk also introduces noise in the channel to be measured. It goes without saying that this latter noise should be negligible compared with the noise it is desired to measure.

Note 2. — It can be seen that when a 24 channel link is measured, 12 sources of " incoherent noise " are sufficient if each of them is connected to two 4-wire transmit ends of the system to be measured.

The mean apparent power can be checked by measuring at point A with a voltmeter having a square law addition. If the increase of apparent power is proportional to the increase in the number of channels loaded with noise, it follows that the correlation between the loading of the different channels is sufficiently small.

Question 8.

(Study Group 4 in cooperation with Sub-Group 1/2)

(New Question)

The present Recommendations for the equivalent of an international circuit given in Volume III of the C.C.I.F. *Green Book* apply to its terminal conditions, i.e. to the circuit between two-wire points.

However, where circuits are used in automatic working, and the circuits terminate on automatic switches or relay sets and do not have a four-wire terminating set, would it not be better :

— to specify the overall loss of a circuit as a four-wire loss between the points where the circuit is switched, and

— to test the circuit between these points ?

Question 9.

(Study Group 4 in cooperation with Sub-Group 3)

(Former Questions 13 and 14 of C.C.I.F. Study Group 9 studied in 1955-1956)

Establishment of a draft " Instruction for periodic maintenance, localization and clearance of faults on radio-links integrated with the general telephone network."

Note 1. — It is desirable that the Instructions for periodic maintenance, localization and clearance of faults, applicable to land lines and to radio links should be as uniform as possible.

It is also important that designers of radio-links intended for integration with the landline telephone network should take into consideration the requirements for the general maintenance of telephone circuits.

Note 2. — The recommendations in the Annex below were defined in 1956 in order to settle the essential points for the maintenance of radio links.

ANNEX

(to Question 9 of Study Group 4)

Essential points for the maintenance of radio relay links stressed by the XVIIIth Plenary Assembly of the C.C.I.F.

Point 1. — Control and sub-control stations.

Firstly it appears useful to recall the definitions for control and sub-control stations given on page 237 of Volume III of the C.C.I.F. *Green Book:*

"A control station is designated :

— for each international circuit,

— for each group or supergroup link : " group control station " or " supergroup control station ",

— for each line used for a carrier system : " control station for the line " (in particular a coaxial line, a symmetrical pair line or a radio link)."

There is therefore a need carefully to avoid any confusion between these different ideas. The terms " control station " and " subcontrol station " should not be used alone, except where no ambiguity can result and they must always be followed by mention of the responsibility of the station :

— circuit,

— link (group or supergroup),

— carrier system (on a coaxial cable or radio link).

For an independent radio link, i.e., where there is modulation and demodulation with restoration to audio frequencies at the terminals, at least one station of the radio link (or an exchange associated with a radio link station) should be staffed. This station (or exchange) will be considered :

as the *control station* for *the radio link*, and

as *sub-control station* for the *telephone circuits* which are in part routed on the radio link.

In the case of a radio link directly connected to a section of line in a cable, the *control station for the radio link* should be the last station of the carrier system on the land line. In such a case the cable line and radio link together could be considered as a single transmission path with a " high frequency sub-control station " (cf. page 535 of Volume I of the *Green Book*) but the use of this expression is not recommended.

It will be seen later in point 2 of this reply that the ideas of the regulating section must also be carefully defined and that the junction point between the cable line and the radio link does not in principle constitute a sub-control station for the line regulating section.

The C.C.I.F. therefore expressed the wish that the C.C.I.R. suppress Recommendation No. 128 (London, 1953) or at least modify the wording, because the text could only result in confusion. It is of course the C.C.I.R. responsibility to define the responsibilities of the terminal stations of the radio links from the point of view of the operation of the radio link itself, but it is desirable to avoid the use of the term " sub-control station " without some qualification. The points taken into consideration in Recommendation No. 128 should also be reviewed.

Point 2. — Line regulating sections. Transmission of line regulating pilots by a radio link.

Normally a line regulating section consists of a particular type of transmission system and not an assembly of several transmission systems in tandem. The definition of a line regulating section is given on page 269 of Volume III of the *Green Book*. A line regulating section on a symmetrical pair carrier system has for example been defined : it is in a symmetrical pair carrier system the line section over which the line regulating pilot or pilots are transmitted from end to end without regulation, particular to these pilots, at intermediate points. The line regulation section for a coaxial line is defined in the same way.

If, therefore, a radio link is inserted between two cable lines (in general coaxial), the radio link between its two terminal stations can be considered as a " line regulating section over the radio link. " The arrangements required for the regulation of the radio link are the responsibility of the C.C.I.R. Recommendation No. 198 given on page 4 of the document " C.C.I.F.—1955-1956—9th S.G.—Document No. 30 " describes the choice of a regulating pilot frequency for wide band radio links.

To avoid disturbances with the transmission on adjacent metallic lines, any frequency used within the radio link for checking its operation must be staffed at the ends of the link under conditions similar to those given on pages 52 and 54 of Volume III of the *Green Book*.

However, it may be desired to transmit over the radio links the line regulating pilots of the cable section between which the radio link is inserted, especially if these cable sections are relatively short. These pilots transmitted over the radio link are used only for regulating the cable sections and not, of course, for regulating the radio link.

To facilitate the organization of the general maintenance of mixed lines, comprising cable sections and frequency division radio links, it is therefore a great advantage if the radio links are arranged so that the line regulating pilots for metallic lines recommended by the C.C.I.F. can be transmitted from end to end. This is stated by the C.C.I.R. in Report No. 73 reproduced on pages 2 and 3 of document " C.C.I.F.—1955/1956—9th S.G.—Document No. 30. "

In its Report No. 73, the C.C.I.R. draws the attention of the C.C.I.F. to the interest in defining line regulating pilots for carrier systems of 4 supergroups (240 channels) and 10 supergroups (600 channels) in addition to the line regulating pilots recommended on page 87 of Volume III of the *Green Book*. The C.C.I.R. has suggested as frequencies for the upper line-regulating pilots the values 1116 kc/s for 240 channel links and 2604 kc/s for 600 channel links.

Regarding transmission over radio links of the pilots appropriate to cable systems, the C.C.I.F. has already stated the possibility of using a pilot of 2604 kc/s for 600-circuit systems on coaxial cable systems, and S.G's 3 and 5 of the C.C.I.F. have no objection to the use of a pilot at 1116 kc/s on short-length systems where the frequency-band 60 to 1052 kc/s is used, when these systems form part of the same line-regulating section as a radio link with 240 telephone circuits.

Point 3. — Transmission of group and supergroup reference pilots over a radio link.

If a group (or supergroup) provided on a metallic line carrier system passes through a terminal station of a radio link without reduction to channels (or groups), it must include its group (or supergroup) reference pilot.

To ensure adequate flexibility for the interconnection of radio links with metallic lines in the international network, it is therefore recommended that for each radio link which may be used in the international network, provision should be made to transmit and faithfully restore the group and supergroup reference pilot recommended by the C.C.I.F. The frequencies and levels of these pilots are given in the following table :

Pilot	Frequency in kc/s	Absolute power level at a point of zero relative level
Group	84·080	−20 db or −2·3 N
	84·140	−25 db or −2·9 N
Supergroup	411·860	−25 db or −2·9 N
	411·920	−20 db or −2·3 N

The C.C.I.R. has mentioned this point in the first paragraph of Report No. 73. This point should be covered in the essential clauses of a specification for the provision of a radio link.

Point 4. — Speaker circuits and alarm channels.

(a) *Speaker circuits.* — The general telephone network includes radio links as well as metallic lines.

For the maintenance of this general network, it is essential that at least the terminal stations of a radio link are connected by a speaker circuit.

The provision of speaker circuits should be on the basis of the greatest possible security. It is therefore preferable that the speaker circuit between the radio link terminal stations should be entirely independent of the radio link itself. It may of course be provided on cable pairs or on an independent radio link according to the facilities available in the telephone network.

For the operation of the radio link itself, as was stated by the C.C.I.R. in its Report No. 72 (Warsaw 1956), it is necessary that the attended and unattended stations of a wide-band radio link :

— be connected to the general telephone network,

— be connected together by speaker circuits.

These latter speaker circuits should also be provided by highly secure means and should therefore preferably be routed independently of the radio link itself. If this cannot be done, it is the C.C.I.R. responsibility to ensure this security.

(b) *Alarm channels.* — Concerning alarm channels, the C.C.I.F. considers that this question is specific to the technique of the radio link and should be dealt with by the C.C.I.R.

The C.C.I.F. however draws the attention of the C.C.I.R. to the fact that from the point of view of general maintenance, consideration may be given to the possibility of extending alarms from unattended stations :

— either to attended stations of the radio link, or

— to a neighbouring repeater station with qualified maintenance staff.

Question 10.

(New Question)

What recommendations should be transmitted to the C.C.I.R. regarding the selection of stations which are to be terminals of " switching sections " on the radio-relay links having service and stand-by channels, that is to say regarding the division of a radio-relay link into switching sections ?

Question 11.

(Study Group 4 in cooperation with Study Group 11)

(New Question)

To facilitate periodic maintenance measurements, can an automatic equipment be used to find out whether the margins of the equivalent of a (semi)-automatic telephone circuit are exceeded ?

In the affirmative :

(a) what recommendations should be established for such an automatic equipment (i.e., essential clauses of a model specification) ?

(b) would it be possible to reduce the frequency of the periodic maintenance measurements at 800 c/s, or even to cease them and to retain only the multi-frequency periodic maintenance measurements at several frequencies, and if so with what periodicity ?

Question 12.

(Continuation of former Question 12 of C.C.I.F. Study Group 9 studied in 1955-1956)

What recommendations should be incorporated in an " Instruction for the establishment and maintenance of an international circuit for television transmissions ? »

Note. — A provisional text was approved in 1956 and is published in Volume III *bis* of the *Green Book*, but this text needs revising.

TABLE SUMMARIZING

the questions assigned to Study Group 4

Chairman : Mr. VALLOTON (Switzerland)
Vice-Chairman : Mr. BILLEN (United Kingdom)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
1	Stability in the European network.		
2	Short breaks in transmission.	S.S.G. 1/3	S.G. 4
3	Frequency deviations and sudden phase variations.		
4	Short breaks in transmission due to short circuits in neighbouring racks.		
5	Readjustment to the nominal value.		
6	Automatic regulation of groups and super-groups.		
7	Measurement of inter-modulation effects.		
8	Measurement of a circuit between four-wire terminals.	S.S.G. 1/2	S.G. 4
9	Maintenance of radio relay links.	S.G. 3	
10	Switching sections of radio relay links.	S.G. 3	S.G. 4
11	Automatic measuring apparatus for maintenance of international circuits.	S.G. 11	
12	Maintenance of television circuits.		

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Questions concerning Protection against Dangers and Interference of Electromagnetic Origin

entrusted to

Study Group 5

in 1957-1960

Question 1.

(Following Question 1, studied in 1955-1956 by C.C.I.F. Study Group 1)

(a) Study of the equivalent disturbing voltage and of the equivalent disturbing current of power and traction installation operating with a.c. and d.c. current.

(b) The study, as a function of load, of the equivalent disturbing current relative to the residual current in the case of 3 phase electric networks with their neutral connected to earth.

(c) Limit of the normal values of the telephone form factor of the voltage—as a function of the load—to be observed in the construction of different sorts of machines and apparatus.

Note 1. — *(a)* The actual state of this question is explained in the following Annex.

(b) To carry out measurements on electrical machines or on industrial lines, it is not necessary to use an apparatus having the highest sensitivity such as some psophometers for commercial telephone circuits have. Some simpler apparatus without an amplifier could perhaps be employed on condition that they meet the specification established by the C.C.I.F. for psophometers (*Green Book*, Volume IV, pages 121 to 129, and the *Directives*, Rome edition 1937, revised in Oslo in 1938 and brought up to date in Geneva in 1952, Chapter XV, Section A, § 74), as regards :

1. The characteristic curve of the filter network of the psophometer (*Green Book*, Volume IV, pages 121 to 125, and the *Directives* §, 74 *(a)*;
2. The dynamic characteristics (Volume IV, page 127, § 5, and the *Directives*, § 74 *(f)*;
3. The quadratic law of addition of the harmonics (Volume IV, page 126, § 3, and the *Directives*, § 74 *(d)*,

and that they have a sufficiently high impedance and must be unaffected by the action of extraneous magnetic and electric fields.

(c) In the study of the equivalent disturbing voltage, when one wishes to make measurements on machines on the test bench, it would be of interest to make these measurements with the two types of coupling corresponding to the factors $k_f = 1$ and $k_f = f/800$ (see the *Directives*, Chapter XV, Section B).

It would be well to see if a relation exists between one or the other of the values obtained with the two types of coupling, and to compare the results with those obtained on the network when the machine is put into service.

(d) In the future, the measurements will have to be normally made with a psophometer having a filter network following the curve defined by the XIVth Plenary Assembly of the C.C.I.F. Each time measurements are made, they should if possible be effected with this apparatus and also with the psophometer used previously.

Note 2. — When studying this question the following documents should be considered :

CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.), pages 1 and 2
CCIF — 1955/1956 — SG 1 — Document 21 (U.S.S.R.).

Note 3. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 2 of the 1st Section of the C.M.I.

ANNEX

(to Question 1 of Study Group 5)

Measurements of the *equivalent disturbing voltage* and of the *equivalent disturbing current* have been made in some countries by means of psophometers fulfilling the specification established at Budapest in 1934. But the results obtained to-date have not been sufficiently numerous for mean values representative of these two magnitudes to be deduced. On the other hand, the adoption of the new specification of the characteristic curve of the filter network might entail some modification of these values, although different studies might enable verification to be obtained as to the values determined with the old psophometer being generally of the same order of magnitude as those determined with the new.

That is why it seems useful to mention certain results obtained so that an idea can be formed of the values which must be expected in the case of various types of power and traction installations.

The results shown below must be considered not as confirmed values, but only as indications of measurements made, often in very different conditions, which explains certain discrepancies.

The various results of measurements have been obtained, either by connecting between the psophometer and the power installation studied, an additional apparatus having the effect of multiplying by the corresponding frequency, the relative amplitude of each harmonic, or without such additional apparatus. In the first case, the indication of the result of the measurement is followed by the sign $\times f$; in the second case, by the sign $\times 1$ (multiplied by unity).

Table of values of the telephone form factor measured on various electric power installations

I. *Rectifiers without grids*

1.	Six-phase rectifiers	1·5 to 4·5% ($\times 1$)
2.	Twelve-phase rectifiers	1 to 1·5% ($\times 1$) 0·9 to 2·2% ($\times 1$)

II. *Rectifiers with grids*

1. Six phase rectifiers

Percentage of control : 1·0 { up to 3·3% (×1) / up to 3 % (×f) }

Percentage of control : 0·8 { up to 12 % (×1) / up to 11 % (×f) }

Results of systematic tests effected on apparatus in service

(a) A rectifier of 75 kW (750 V, 100 A)

Percentage of control	Telephone Form Factor of the Voltage	
	at full load	at 1/3 of full load
1·0	2·7% (×1)	2·8% (×1)
0·9	3·7% (×1)	7·3% (×1)
0·8	4·8% (×1)	9·1% (×1)

(b) A rectifier of 220 kW (440 V, 500 A)

Percentage of control	Telephone Form Factor of the Voltage	
	at 3/4 of full load	at 1/4 of full load
1·0	3·1% (×1)	2·6% (×1)
0·9	6·9% (×1)	9·5% (×1)
0·8	9·3% (×1)	12·1% (×1)

2. Twelve-phase frequency rectifiers

Percentage of control : 1·0 { up to 2 % (×1) / up to 2·4% (×1) }

Percentage of control : 0·9 up to 5·5% (×1)

III. *Single-phase lines* (Contact lines of a.c. railways at 16·66 c/s)

1. Measurements in a sub-station :
   0·1 to 0·25% (×f)
2. Measurements on a contact line :
   0·14 to 1·4% (×1)
   0·66 to 1·5% (×f)

IV. *Three-phase network* (measurements taken between 2 phases)

1. Cable network
   (a) 5 kV — load : six-phase rectifier
   0·5 to 3·8% (×f)

(b) 6 kV —
0·4 to 0·7% (×1)
0·1 to 0·3% (×f)

(c) 10 kV — load : twelve-phase rectifier
1·0 to 1·65% (×1)
1·1 to 2·1% (×f)

2. Overhead network

110 kV — without rectifier load
0·4 to 0·55% (×1)
0·12 to 0·22% (×f)

110 kV — with rectifier load
up to 3·5 (×f)

In general it is not possible to determine the values of the telephone form factor of the characteristic voltage of power installations. For a given line, particularly, this factor varies along the line.

In this respect, having regard to the elements making up a complex network, it will be interesting to examine in the course of the studies to be undertaken, if it is possible at least in certain cases, to deduce information about the disturbing voltage for the whole of the network.

On the other hand, this factor depends notably on the type of load of the power line; very different values can be observed on power installations of similar construction, according to whether they supply lighting, machines, railway installations or rectifier installations.

Table of values of weighting ratio of the current measured on some three-phase networks having their neutrals connected to earth

I. *Networks without appreciable rectifier loads or traction installations*

Voltage	RMS value	Weighting Ratio
	Of the current circulating in the phase conductors	
110 kV	from 20 A to 50 A from 50 A to 150 A	from 1 % to 1.3% from 0·4 % to 0·8%
220 kV	from 100 A to 180 A from 200 A to 280 A	from 0·5 % to 0·8% from 0·45% to 0·5%

Voltage	RMS value	Weighting Ratio
	Of the residual current	
110 kV	from 0·1 A to 1 A	from 5% to 12%
220 kV	from 2 A to 3 A	from 3% to 10%

II. *Network with appreciable traction load*

Voltage	RMS value	Weighting Ratio
	Of the residual current	
110 kV	from 2 A to 3 A	from 10% to 25%

Question 2.

(Following Question 2, studied in 1955-1956 by C.C.I.F. Study Group 1)

(a) Comparison of the results of simultaneous measurements of the psophometric e.m.f. on a telephone circuit and of the equivalent disturbing voltage or equivalent disturbing current of the influencing or inducing power line.

(b) Do relations exist between the telephone form factor of the voltage K_v of the electric line, the weighting ratio K_I of the current in that line and the weighting ratio k_t of the voltage measured between the two wires of a telephone circuit, or the weighting ratio k_l of the voltage measured between the wires and earth ?

Note 1. — Up to the present the *Directives* have allowed that a sufficient estimate of the psophometric e.m.f. likely to be found in the case of exposure of a telephone circuit to a power line, may be obtained by measuring the value of the equivalent disturbing voltage or the equivalent disturbing current of that line by relating the latter values to a voltage or current at 800 c/s.

In fact, voltages or currents exercise a magnetic or electric induction consisting always of many harmonics, for which the coupling coefficients between the lines are different. The introduction, in the definition of the equivalent disturbing voltage and the equivalent disturbing current, of coefficients k_f and h_f allow for this circumstance only in a rather imperfect manner.

In view of the search for a better way of calculating the estimated psophometric e.m.f., it will be interesting to make simultaneous measurements of the psophometric e.m.f. between the telephone conductors and earth (and in addition, of the psophometric e.m.f. in the telephone circuit loop) and of equivalent disturbing currents and voltages in numbers of different situations (regions where the conductivity of the soil is different, different separations, exposures of large or short length, predominance of certain harmonics, etc...), to determine the differences between the measured values of psophometric e.m.f. and the values calculated by means of the formulae in the Directives and to try to determine if it is possible to establish a correlation between these differences and the different circumstances of the measurements.

When possible, it is desirable to add to the report on these investigations a harmonic analysis of the currents in the phase conductors and also of the residual currents.

Note 2. — When studying this question, the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R. Administration), pages 3 and 4
CCIF — 1955/1956 — SG 1 — Document 23 (U.S.S.R. Administration).

Note 3. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 1 of the 1st Section of the C.M.I.

Question 3.

(New Question) (documentary question)

Under what circumstances should special protection against accidental contact be provided at crossings between electric and telecommunication lines ?

When such protection must be given, what is the best method to be recommended ?

When protection is by means of an insulated covering on the electric or telecommunication wire, what characteristics should be recommended for the insulating covering, whether of plastic or other material ?

What arrangements are necessary to ensure that the protection furnished does not deteriorate with time and climatic conditions below a safe limit ?

Question 4.

(Following Question 4, studied in 1955-1956 by C.C.I.F. Study Group 1)

To what risks are underground and overhead metallic sheathed telephone cables exposed, when a high potential gradient is produced in the earth (due for example, to a short circuit to earth of an electric line) and what are the protective measures against these risks ?

Note 1. — It is necessary to examine in particular the following cases :

(a) cables serving sub-stations or power stations where the neutral of the transformers is connected directly to earth;

(b) cables serving sub-stations or power stations where the neutral is earthed through a Petersen coil;

(c) cables placed in close proximity to buried conductors, interconnecting pylons of an electric line forming part of a system whose neutral is directly earthed;

(d) where, because of an accident affecting an electric cable, a neighbouring telecommunications cable comes into contact with it or an electric arc appears between the two.

In cases *(a)* and *(b)*, it is necessary to determine what is the value of the potential difference between the station earth at the power station and that of a distant earth plate, which is considered to be dangerous, and it is necessary to devise a method which will allow it to be calculated.

Note 2. — When studying this question, the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 6 (France)
CCIF — 1955/1956 — SG 1 — Document 13 (Federal German Republic)
CCIF — 1955/1956 — SG 1 — Document 14 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 16 (Telephone Assoc. of Canada)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy)
CCIF — 1955/1956 — SG 1 — Document 22 (Sweden).

Note 3. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 5 of the 1st Section of the C.M.I.

Question 5.

(New Question) (documentary question)

Study of the arrangements permitting, in special cases, the reduction of noise at the extremities of telephone lines exposed to magnetic or electric induction.

Note. — Among these arrangements can be considered :

— the improvement of transpositions on open wire overhead lines,

— the improvement of the balance, with respect to earth, of a cable already in position,

— recourse to devices giving a better signal to noise ratio,

— the substitution of twisted pairs for the open wire overhead circuits, etc.

Question 6.

(Following Question 6, studied in 1955-1956 by C.C.I.F. Study Group 1)

(a) Is there need to specify the general indications given in the *Directives* for approachments between lines and telecommunication cables which include power feeding circuits for the supply of repeaters or circuits which are permanently connected to apparatus at high voltages (for instance insulation watchers) ?

What specific rules should be applied ?

(b) What arrangements should be made to avoid interference with the working of repeater power feeding circuits, by magnetic induction from a neighbouring power line or galvanic coupling with a neighbouring electric line ?

Note. — When studying this question the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 1 (Chile Telephone Co.)
CCIF — 1955/1956 — SG 1 — Document 6 (France)
CCIF — 1955/1956 — SG 1 — Document 13 (Federal German Republic)
CCIF — 1955/1956 — SG 1 — Document 14 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy).

Question 7.

(Following Question 7, studied in 1955/1956 by C.C.I.F. Study Group 1)

How can the rules of the *Directives* relative to cases of approachments between electric lines and telecommunication cables be completed when the telecommunication cables include circuits which are not terminated on transformers whose line windings are isolated from the cable sheath and earth and the duration of the fault and the resistance to breakdown of the dielectric are taken into account ?

Note. — When studying this question the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 1 (Chile Telephone Co.)
CCIF — 1955/1956 — SG 1 — Document 6 (France)
CCIF — 1955/1956 — SG 1 — Document 12 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy).

Question 8.

(Following Question 8, studied in 1955/1956 by C.C.I.F. Study Group 1)

Interference caused in telephone circuits by rapid variations of traction current in a neighbouring direct current traction line.

Note 1. — When studying this question the following Documents should be taken into consideration :

CCIF — 1952/1954 — SG 1 — Document 25 (U.I.C.)
CCIF — 1955/1956 — SG 1 — Document 5 (U.I.C.)
CCIF — 1955/1956 — SG 1 — Document 9 (United Kingdom), pages 1 and 2 *
CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.), page 7
CCIF — 1955/1956 — SG 1 — Document 24 (U.S.S.R.).

Note 2. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 4 of the 1st Section of the C.M.I.

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* With the following modification : at the end of the last phrase of the second sub-paragraph on page 2 instead of " London-Sheffield " read " London-Shenfield ".

Question 9.

(Continuation of Question 9, studied in 1955-1956 by C.C.I.F. Study Group 1)

Conditions of coexistence of very high voltage D.C. power lines and neighbouring telephone lines.

Note 1. — The following points should be studied :

1. The character of the transients on the high tension line which arise in normal operating circumstances at the instant when the voltage is applied and in abnormal conditions such as breakage of a conductor, accidental earth faults, etc.
2. The effect of these transients on neighbouring telecommunication lines.
3. The noise which may arise in the telecommunication lines as a result of the current fluctuations.
4. Increase in harmonics in the a.c. power lines feeding the substation which converts the direct current into alternating current or in the lines fed by that substation.

In the case of d.c. submarine power cables, attention is drawn to the fact that the principal effect to be investigated appears to be that arising from aerial lines between the submarine cable and the current supplying substation.

It would be useful to determine what method could be recommended for the calculation of noise and of danger which telecommunication circuits may experience from neighbouring d.c. power lines of very high voltage.

Moreover, it would be desirable to investigate the best methods of reducing the fluctuations of the direct current in these power lines.

Note 2. — When studying this question, consideration should be given to the following documents :

CCIF — 1955/1956 — SG 1 — Document 14 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.).

Note 3. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in collaboration with Study Group 9 of the 1st Section of the C.M.I.

Question 10.

(Following Question 10, studied in 1955-1956 by C.C.I.F. Study Group 1) (documentary question)

(a) Study of devices that may be inserted in telephone lines exposed to severe induction, so as to reduce the voltage between wires and earth.

(b) In the case of open-wire telecommunication lines which it is desired to be equipped with a set of discharge tubes, associated or not associated with short-circuiting earthing relays, how can the number of tubes be determined that may be employed without impairing the transmission ?

A distinction should be made between the case of V.F. circuits and carrier-frequency circuits, with or without repeaters.

(c) What are the recommendations that could be made to obtain a reduction in the resistance of the earthing system for the discharge tubes in open-wire telecommunication lines in regions where the resistivity of the soil is very high (rock, sand) or in regions where frost conditions permanently prevail?

Note 1. — In cases where such devices are permanently installed, attention must be paid to the steps required for periodic control to maintain the circuits in good condition.

Note 2. — The study of this question is related to that of Question 21.

Note 3. — When studying this question the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 8 (Canada)
CCIF — 1955/1956 — SG 1 — Document 9 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 11 (Federal German Republic)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy)
CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.).

Note 4. — The study of the question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 10 of the 1st Section of the C.M.I.

Question 11.

(New Question)

Is it necessary to modify or complete the definition of high security lines, taking specially into account the average frequency of incident which can affect them?

Note. — For this study it would be necessary to examine the statistics compiled by power supply authorities on the number of incidents per year per 100 km of line affecting lines in the high security category, as at present defined.

It would also be interesting to know the number of accidents to personnel, of breakdowns, of damage to material and of interruptions to supply ..... reported on the telecommunication lines which have resulted from faults affecting this type of electric line.

It would also be desirable to report and describe some typical cases of accidents or incidents which it would be possible to correlate with faults on electric lines.

Question 12.

(Following Question 12, studied in 1955-1956 by C.C.I.F. Study Group 1)

Statistical study of the values of the coefficients of sensitivity relative to magnetic and electric induction (such as those defined in Recommendation 8 *) for short sections of telephone circuits.

* Recommendation 8, approved by the C.C.I.F. XVIIIth Plenary Assembly (see, provisionally " CCIF — 1955/1956 — SG 1 — Document 25 ", pages 8 and 46-54).

Note 1. — For the execution of measurements of sensitivity coefficients and with the object of interpreting the results of these measurements, it is necessary to take into consideration the detailed recommendations given in the Annex to Recommendation 8.

Note 2. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 7 of the 1st Section of the C.M.I.

Question 13.

(Study Group 5 in co-operation with Study Groups 11 and 12)

(Following Question 13, studied in 1955-1956 by C.C.I.F. Study Group 1)

What limits should be assigned to the degrees of unbalance :

(a) of subscribers' installations,

(b) of telephone exchange installations, when these latter are in the condition of conversation ?

Note 1. — To obtain a reply to this question it is necessary firstly to assemble information based on measurements made in accordance with the method described in Recommendation 8 *.

Note 2. — It would then be interesting to associate these results, in particular those having abnormal values, with an explanation of their causes.

Note 3. — The study of this question will be undertaken by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 7 of the 1st Section of the C.M.I.

Question 14.

(Following Question 14, studied in 1955-1956 by C.C.I.F. Study Group 1)

(documentary question)

(a) Should the protection principles at present in use be modified ?

(b) What would be the best method to define and measure the characteristics of the protection apparatus ?

(See Volume II of the C.C.I.F. *Green Book*, Recommendation 3 entitled " Principles of Protection " and Recommendation 4 " Principal Characteristics of Protection Equipment ".)

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* Recommendation 8, approved by the C.C.I.F. XVIIIth Plenary Assembly (see, provisionally " CCIF — 1955/1956 — SG 1 — Document 25 ", pages 8 and 46-54).

Note 1. — In the course of the study of this question, attention should be directed to the following points :

(a) Is it desirable to examine whether it is possible to simplify the protection schemes by eliminating certain elements from them and to determine particularly in what condition it is appropriate to use :

— a protection system comprising three elements (fuse, lightning arrestor and fuse);

— a protection system with two elements (fuse and arrestor);

— a protection system with a single element (arrestor).

It would equally be useful to examine the operating conditions of the various elements of a protection system, when they are used on a circuit, in which the entry into the exchange is done by means of a cable, and to take into consideration different lengths of cable.

(b) It is desirable to associate the study of lightning arrestors (dischargers), used in normal conditions with that of the fuses used in the protection system employed. The use of lightning arrestors capable of discharging currents, which are larger than for certain existing models, reaching for example several tens of amperes during one or a few seconds, should also be envisaged.

(c) It would be very desirable to have available lightning arrestors having great regularity and stability of operation.

(d) It would be useful to observe the relation between operation (glow discharge or arc discharge) and heating of the lightning arrestor under service conditions (with or without fuse).

Note 2. — In order to complete the information in § *(e) Characteristics of Robustness*, of the Annex to Recommendation 4 of the C.C.I.F. (*Green Book*, Volume II, page 12) it would be necessary to study the operation of various types of lightning arrestors subjected to shock waves from an impulse generator.

Note 3. — When studying this question, the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 11 (Federal German Republic)
CCIF — 1955/1956 — SG 1 — Document 15 (American Telephone & Telegraph Co.)
CCIF — 1955/1956 — SG 1 — Document 16 (Telephone Association of Canada)
CCIF — 1955/1956 — SG 1 — Document 18 (U.S.S.R.)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy)
CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.).

Question 15.

(Following Question 15, studied in 1955-1956 by C.C.I.F. Study Group 1)

(documentary question)

(a) Study of the characteristics of devices for protection against acoustic shock, based on the use of rectifying elements, variable resistance elements and lightning arrestors in association with voltage transformers.

(b) Establishing of a note relating to the definition of the general characteristics of protection devices based on the use of rectifier elements.

Note. — Certain Administrations and private telephone undertakings have, in the past, already supplied information relating to this question. It would be useful if they would kindly make known what are the devices at present in use giving, in this connection, indications as to their nature, operating characteristics, method of use, position of installation, space occupied, etc....

For the study of the second part of this question, the detailed specifications already communicated to the C.C.I.F., in the documents listed below, will be taken into account :

CCIF — 1950/1951 — SG 1 — Document 14
CCIF — 1952/1954 — SG 1 — Document 21 } (Federal German Republic)
CCIF — 1952/1954 — SG 1 — Document 31
CCIF — 1955/1956 — SG 1 — Document 1 (Chile Telephone Company).

Question 16.

(Following Question 16, studied in 1955-1956 by C.C.I.F. Study Group 1)

Conditions of coexistence of carrier current systems on telephone lines and carrier current systems on power lines in the case of proximity of these lines.

What method of calculation can be recommended for the predetermination of the action of the power line carrier current circuits on the telecommunication carrier current circuits ?

Is there reason to introduce into this calculation a conception similar to that of the coefficient of sensitivity ?

Note 1. — While awaiting the results of tests in hand, it is recommended to use, when possible, different frequencies for the carrier current systems in the two types of lines, when parallelisms are foreseen between them, and to obtain, in future, for the stability of the carrier frequencies, conditions which are as good as possible and comparable on the two types of line.

For the study of this question, Document " CCIF — 1952/1954 — SG 1 — Document 42 " should be particularly noted.

Note 2. — When studying this question consideration should be given to the following documents :

CCIF — 1952/1954 — SG 1 — Document 42 (U.S.S.R.)
CCIF — 1955/1956 — SG 1 — Document 6 (France)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy).

Note 3. — The study of this question will be carried out by Study Group 5 of the C.C.I.T.T. in co--operation with Study Group 5 of the 1st Section of the C.M.I.

Question 17.

(Following Question 17, studied in 1955-1956 by C.C.I.F. Study Group 1)

(documentary question)

Has telephonic operating trouble been experienced in the case of carrier current lines situated near electric lines, because of electric or magnetic induction due to the latter ?

Note 1. — The present position is explained in the Annex below.

Note 2. — When studying this question the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 19 (Italy)
CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.).

Note 3. — The study of this question will be continued by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 11 of the 1st Section of the C.M.I.

ANNEX

(to Question 17 of Study Group 5)

1. As regards transmission and distribution lines, it will be necessary to examine, in particular, what is the interfering action exerted by these lines on the carrier current channels of the telecommunication lines, which could arise from the corona effect or from sparking developed in items of equipment with incipient faults. It would be useful to define the limiting spacing which can be adopted between these two types of line, in order to avoid trouble, account being taken of the method of construction of the high tension line which will determine the corona effect.

2. As regards traction lines, the operating trouble which they cause to telephone lines equipped with carrier current systems has been determined by the Telephone Administration of the U.S.S.R., where traction by direct current is utilised. Preliminary measurements on this subject (described in Document 6 of C.C.I.F. Study Group 1, 1946, pages 22-29) have led to the following conclusions :

(a) The contact wires of D.C. electric railways are undoubtedly the source of interference which has been observed in the high frequency bands on open-wire telephone circuits.

(b) In the frequency band between 4 kc/s and 10 kc/s the interfering voltages in the contact wires are produced by mercury vapour rectifiers and by sparking at the contact wire.

(c) In frequency bands above 10 kc/s the interfering voltages are due principally to sparking at the contact wire.

The study of this question should therefore be continued. It seems that for this study it would be useful to adopt the following method : to study, by means of band-pass filters, the magnitude of the components of voltage in the different frequency bands, between the contact wire and earth and between the conductors of the telephone circuit simultaneously. To determine, with greater accuracy, the interfering voltage arising from mercury vapor rectifiers on the one hand and the interfering voltages from sparking at the contact wires on the other hand, it appears useful to make, on the one hand, tests in which the mercury vapor rectifier will be loaded by a rheostat, and on the other hand by tests under normal operating conditions. Measurements on telephone circuits and on the traction lines should be made simultaneously.

Question 18.

(New Question) (documentary question)

The precautions necessary to avoid interference to d.c. signalling or to a.c. signalling at industrial frequencies over short or medium length telephone lines (overhead open wire aerial or underground cable and composite lines) from neighbouring a.c. or d.c. electric lines.

Question 19.

(Study Group 5 in co-operation with Study Group 11)

(Following Question 19, studied in 1955-1956 by C.C.I.F. Study Group 1)

Protection of signalling on long-distance automatic or semi-automatic telephone circuits against harmful effects of electric lines.

Note 1. — The basis of study for this question will result from the conclusion of the work of C.C.I.T.T. Study Group 11 on the subject of the limitation of circuit noises which is necessary to ensure the operation of signal receivers.

Note 2. — When studying this question, the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 15 (American Telephone & Telegraph Co.)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy).

Question 20.

(Study Group 5 in co-operation with Study Group 6)

(Following Question 20, studied in 1955-1956 by C.C.I.F. Study Group 1)

Is there need to take special steps to eliminate the risks of danger and interference in cabled telephone circuits when the sheaths of these cables are connected to electric cables, gas or water mains, pipelines or electrified railway tracks, to effect a communal electrical corrosion protection scheme ?

Note 1. — When studying this question, the following documents should be considered :

CCIF — 1955/1956 — SG 1 — Document 14 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy).

Note 2. — The study of this question will be made by Study Group 5 of the C.C.I.T.T. in co-operation with Study Group 6 of the C.C.I.T.T. and with the Study Groups 12 of the 1st Section and 26 of the 2nd Section of the C.M.I.

Question 21.

(Following Question 21, studied in 1955-1956 by C.C.I.F. Study Group 1)

A. When a general scheme of protection, which includes special devices inserted in the line (for example, discharge tubes with or without relays), is applied to telecommunication circuits (open-wire or cable) which are subject to the risk of high induced voltages, to what value should the induced voltage between any point of the line and earth be limited :

(a) in the case of ordinary electric lines,

(b) in the case of high security lines ?

Is it desirable to apply the same limit to both types of electric line ?

B. Is it necessary to replace the present limit (430 or 650 volts) of longitudinal e.m.f., magnetically induced throughout the length of an overhead open wire telecommunications line, by a new limit based on the e.m.f. induced per kilometre of line ?

Note 1. — Part B of this question has been suggested by C.I.G.R.E. and U.N.I.P.E.D.E. with the following comments :

Progress in the construction of gas discharge lightning arrestors indicates that it is now possible to so arrange them that they present the following characteristics :

1. The lightning arrestor can carry, without modification of its other characteristics, an intense specified current of N amperes for 5 seconds, the arrestor withstanding this operation many times.
2. When the lightning arrestor is destroyed, it provokes a short circuit.

In these conditions it is logical to fix a limit to the current which must flow in the lightning arrestor. This implies that it is necessary to fix the electromotive force induced per kilometre in the present type of overhead open wire line.

The procedure could be limited to high security lines where the duration of faults is strictly limited.

Note 2. — The study of this question is related to that of Question 10.

Note 3. — Attention of telecommunication Administrations is drawn to :

1. the general conditions of Volume II of the *Green Book*, page 60, § *(a)* " Discharge Tubes ",
2. the opportunity to take into account, in the study of this problem, interference to operation which could result from the presence of an excessive number of discharge tubes on a long distance voice frequency or carrier current telephone circuit.

Note 4. — When studying this question the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 9 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 10 (Australia)
CCIF — 1955/1956 — SG 1 — Document 20 (U.S.S.R.).

Question 22.

(Following Question 22, studied in 1955-1956 by C.C.I.F. Study Group 1)

(documentary question)

A. What modifications are required to the formulae given in the *Directives* for the calculation of induced E.M.F. in a telephone cable from currents in a neighbouring electric line, to take account of the resistance between the cable sheath and earth ?

The following cases should be considered :

(a) The resistance between telephone cable sheath and earth is uniformly distributed.

(b) The cable sheath is insulated, with connections to earth having finite resistance placed at intervals along the cable route.

(c) Two or more telephone cables with insulated sheaths are laid side by side and share a common earthing system.

(d) The sheath is completely isolated from earth throughout its length by a thick covering either continuous or sectionalized by insulating joints.

It will be useful to consider in particular the case where the cable sheath is desired to have a low screening factor and has high conductivity but has to be insulated, as for example, if it is of aluminium, and it is necessary to arrange connection to earth electrodes with comparatively low resistance.

B. When it is proposed to employ a telephone cable with a metallic sheath protected by a thermoplastic covering and metal armouring, what arrangements are recommended to ensure :

(a) good preservation of the whole,

(b) a good screening factor ?

Note. — When studying this question, the following documents should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 6 (France)
CCIF — 1955/1956 — SG 1 — Document 14 (United Kingdom)
CCIF — 1955/1956 — SG 1 — Document 19 (Italy).

Question 23.

(Following Question 23, studied in 1955-1956 by C.C.I.F. Study Group 1)

Is it desirable to modify or to complete the rules relating to the protection of telecommunication cables against the harmful effect of electric lines in the following cases :

(a) The use of a non-metallic sheath or of a sheath including only a thin metallic layer ?

(b) Use of insulants other than paper ?

Note 1. — It would be of particular interest to determine the statistical values of the coefficients of sensitivity to electric or magnetic induction for each type of new cable.

Note 2. — When studying this question the following document should be taken into consideration :

CCIF — 1955/1956 — SG 1 — Document 15 (American Telephone & Telegraph Co.).

Question 24.

(Following Question 24, studied in 1955-1956 by C.C.I.F. Study Group 1)

Revision of the *Directives concerning the protection of telecommunication lines against the harmful effects of electric lines.*

Note. — When preparing the revision of Annex 2 to Recommendation 7 (see hereinafter) account will be taken of and attention drawn to the following points :

1. The value of the resistance to earth of the fault when calculating the short-circuit current.
2. Reduction of the compensating effect of tape or wire armoured cables by saturation of the iron during the first few cycles of the short-circuit current.
3. Method to be adopted for the determination of the distribution of discharge tubes inserted in lines (see also Questions 10 and 21).

ANNEX 2

(to Recommendation 7, of the XVIIIth Plenary Assembly of the C.C.I.F.)

Principal modifications to be made to the text of Part 3 of the Directives (Geneva Edition 1952) relative to the rules for application of the Directives

CHAPTER VI

The definitions appearing at present in Chapter VI of the Directives (edition published at Geneva in 1952) will be carried over to Chapter 0, at the beginning of the new Directives. The following text will remain in Chapter VI.

Part 3. — RULES FOR APPLICATION OF THE DIRECTIVES

CHAPTER VI

General

§ 20. — *General.*

The object of this part is to lay down rules which should be followed to ensure that the precautions of Part 3 are observed.

This study is conducted successively :

— in the case of balanced alternating current electric lines with regard both to danger (Chapter VII) and to interference (Chapter VIII);
— in the case of alternating current traction lines with rail return (Chapter IX);
— in the case of direct current traction lines with rail return (Chapter X).

Chapters IX and X deal with both points of view, that of danger and that of interference.

§ 21. — *General conventions for the calculations.*

1. When it is a question of assessing the various risks of danger, the whole of the approachments are included in the calculations, unless indicated to the contrary.

2. In the study of interference on a telecommunication line, it is necessary to distinguish between the effects of magnetic and electric induction on the telecommunication line assumed to be perfectly balanced (with respect to earth), and when it is unbalanced (see chapter XVI).

With regard to interference resulting from direct action, when the two-wire telecommunication line includes transpositions, it is necessary to take into account the fact that the effects of induction exercised on the various sections of the line can compensate themselves : on a section of parallelism, these effects increase with length if the relative positions of the conductors of this line and of the electric line remain unaltered. From the point where the positions of the two-wires of the telecommunication line are interchanged—all other conditions remaining the same—these effects vary in the opposite manner up to the next point of transposition, and so on.

For a given line, a *non-compensated* length is the maximum length (determined by the scheme of transpositions used) for which the effects vary constantly in one direction as a function of length. In the case of a bed of wires having several bifilar lines, the longest *non-compensated* length relative to each of these lines is still called the non-compensated length.

If the total length of telecommunication line exposed is less than the non-compensated length, calculations are effected by considering the total of the approachments.

If the total length of a telecommunication line exposed is greater than the non-compensated length, the calculations are effected by considering the most unfavourable section of approachment and including in this section a continuous length equivalent to the non-compensated length. If, for this section, there is not, in the exposed zone, a continuous length equal to the non-compensated length, the length of the approachment in the exposed zone is introduced into the calculation.

With respect to the interference arising from unbalance with respect to earth, the calculation should be made by introducing the total length of the approachments.

3. In the case of telegraph lines, it is necessary to study separately the situation of each section of telegraph transmission with regard to exposure to danger or interference.

4. From the calculation point of view, the noise components can be split into two parts, those arising from electric induction and those from magnetic induction. In addition, it is assumed that the total longitudinal electromotrice force due to the effects of magnetic induction is the quadratic sum of the psophometric electromotive forces caused by direct action and unbalance with respect to earth. The same condition is assumed in respect of the psophometric electromotive forces due to electric induction. Finally, it is taken that the total electromotive force is the quadratic sum of the psophometric eletromotive forces corresponding to magnetic and electric induction.

Depending upon circumstances, it is possible to conclude that certain of these components are negligible in comparison with others.

CHAPTERS VII, VIII, IX AND X

1. The rules concerning calculations relative to danger for all types of symmetrical electric line, will be collected into a single chapter, and all those concerning calculations due to interference into another chapter.

2. The developments of § 22, 25, 28, 34, 37 and 40 already appearing in the 1st or 2nd parts or in the first chapters of Part 3 (corresponding to the present Chapter VI) will not be reproduced. Other information will be given as and when it will be useful.

3. Generally, it will be the aim to establish some very simple formulae to enable rough assessments to be made where exact calculations are not necessary.

4. *Dangers due to the effects of magnetic induction* (Chapters VIII and IX of the Geneva edition),

— sub-paragraphs 226 to 229 will not be reproduced,

— in the sub-paragraphs corresponding to 230 and 231, it will be shown that the resistance of the fault should be taken into account, when assessing danger for the case of phase to earth faults;

— the text of sub-paragraph 232 will remain unaltered, but a reference to the chapter corresponding to the present Chapter XIV (which will consequently have to be completed) will indicate that it is in this chapter that there are the indications necessary to determine the conditions of application of the principle in sub-paragraph 232;

— sub-paragraphs 234 to 237 inclusive, will not be reproduced. The sub-paragraph corresponding to 233 will indicate therefore only those sub-paragraphs of Part 2 where the limits of longitudinal electromotive force for different cases, are to be found;

— it will be stated to which cases the formulae in sub-paragraph 238 relate. The formula relative to oblique approachments and crossings given in the Note added to Recommendation No. 9 of Volume II of the *Green Book*, will also be indicated. Finally, it will be shown that it is necessary to take into account the fact that the screening factor can have different values at different sections of the line. The text of sub-paragraph 240 will be reproduced except for the words " the crossings are not taken into account ", which will be deleted;

— of the sub-paragraph 29 *(g)—Kilometric mutual inductance*, only the first phase of 240 will be inserted in Part 3. The remainder of this sub-paragraph will be carried over to the chapter corresponding to the present Chapter XII, which moreover must conform completely with Recommendation 9 of Volume II of the *Green Book*.

Block No. 1 will be reproduced, as far as possible on a graduated basis, to permit clearer recognition of the lines corresponding to the coordinates of round value. The values of σ will be expressed in MKSA units.

Block No. 2 will not be reproduced.

Blocks Nos. 3 and 4 will be reproduced as they are.

The numerical tables giving the value of M as a function of the distance d of the induced line to the parallel inducing line, will be added after the Carson-Pollaczek formula.

Finally this information will be completed by two nomograms which enable M to be obtained as a function of d and σ for $f = 50$ c/s and $f = 800$ c/s, these magnitudes being expressed in MKSA units.

The present Chapters IX and X relative to danger are still valid. They can however be edited to ensure uniformity in presentation, taking into account the information previously given on the subject of Chapter VIII.

5. *Dangers relative to electric induction* (Chapters VII and IX of the Geneva edition)

— the present paragraph 23 will be replaced by Recommendation 10 of Volume II of the *Green Book*.

However, the formula could be modified if it appears necessary to substitute a more exact formula which will better conform to modern line construction.

On the other hand, information should be added on the subject of the determination of the value of the voltages to which telephone wires are raised, by electric induction when the influencing electric line is :

(a) in conditions of normal operation,

(b) having a fault between one phase and earth.

For the determination of this voltage, particulars of the telephone line installation which could permanently reduce this voltage, should be taken into account. Attention will be drawn to the dangerous consequences or to the interference to the working which could result from an excessive value of these electrically induced voltages, principally that which appears under normal working conditions of the electric line, due principally to the too frequente operation of lightning arrestors in the telephone circuit.

6. *Interference due to electric induction* (Chapters VII, IX and X of the Geneva edition),

— the formulae of this edition will be replaced by more exact formulae more suitable to modern electric line construction. When producing these formulae, Document 411/C.C.I.F., which relates to a complete recasting of Chapter XI and is devoted to the establishment of formulae relative to calculation of the effects of electric induction, will be considered.

7. *Interference due to magnetic induction* (Chapters VIII, IX and X of the Geneva edition),

— it is necessary to examine which formulae should be used for the various functions in the expression for psophometric electromotive force due to magnetic induction, which up to now, have not been taken into consideration. The present Chapter XII should be completed.

Note. — In the absence of measured values of equivalent disturbing current, it has been agreed that the following values will be adopted :

Lines of a network with neutral connected directly to earth or through a limiting impedance

Without important rectifier load	0·2 A
With important rectifier load.	1 A

Lines of a network with isolated neutral or neutral connected to earth through an arc suppression coil

It is assumed that the *equivalent disturbing current*, under normal operating conditions, is a three-phase current and that, for each phase, its numerical value, expressed in amperes, is equal to 1/200 of the numerical value of the supply voltage of the line, expressed in kilovolts.

8. *Calculation of interference in general,*

— with the aid of the general theory applying to the case of long approachments, it is necessary to complete Chapters XI and XII, relative to the calculation of interference in cases of short approachments, where the effects of attenuation and phase shift of the harmonics along the power line and the telephone circuit are negligible.

Question 25.

(New question) (documentary question)

In the event of the use by power authorities of audio-frequency power injected into the power network for the operation of remote control systems, what special conditions should apply to this practice ?

Note. — Difficulties have been found, particularly in the use of excessive powers and of frequencies particularly disturbing to the telephone service.

Question 26.

(New question)

Study of induction in carrier current overhead open wire line, due to radio stations :

(a) In what conditions (distance between radio station and telephone lines, transposition scheme, coefficient of sensitivity of the circuit, etc.) can noises appear in a carrier current channel ?

(b) How can the value of the noise caused by a radio station in a telephone circuit be calculated ?

(c) What measures can be recommended for the reduction of these noises ?

Question 27.

(New question) (documentary question)

Precautions to be taken when lines pass in immediate proximity to powerful radio stations to avoid :

— the dangers due to excessive induced electromotive forces,

— interference arising for example, due to the rectifying effect of carbon microphones.

Question 28.

(New question) (documentary question)

1. Collection of information on the methods of measurement and apparatus used to determine the apparent conductivity of the earth when required for calculation of mutual inductance of an electric line and a telecommunications line.

2. Revision of the table, on page 42 of the *Directives* (Geneva edition 1952) for the approximate determination of the conductivity of the earth from a knowledge of the nature and the constitution of the soil, climatic characteristics, etc. It would be desirable to take into account the results of measurements made up to the present time to determine if it is possible to introduce, into this table, additional subdivisions of the nature of the soil, narrowing the earth conductivity ranges.

3. Methods of determining the apparent conductivity of the earth from measurements of mutual induction between two lines with earth return or from measurements of the induction between one line and a test coil.

Question 29.

(New question) (documentary question)

Co-existance of overhead open wire or aerial cable telecommunication lines on the same supports as electric lines.

Note. — For the study of this question Administrations and Private Telephone Companies are asked to communicate to the Secretariat of the C.C.I.T.T. information on the arrangements that are adopted for the construction of telecommunication lines on the same supports as electric lines.

Attention is called especially to the following points :

1. Conditions which enter into the choice and method of construction. (Is it adopted, whatever the nature and importance of the telecommunication lines, or is it limited to secondary circuits and subscribers' lines? Up to what electric line voltages is it adopted ?)

2. Special characteristics of the material used : nature of the supports, the conductors...; spacing between the conductors or telecommunication cables and the electric conductors according to the voltage of the electric line;...

3. Precautions against danger, protection equipment of the line (fuses, lightning arrestors, other arrangements...), safety precautions for workmen on the telecommunication lines;...

4. Arrangements for protection against noise (special rules for transpositions, anti-noise arrangements...)

5. Tests made and results obtained either from the safety of personnel aspect (accidents) and installations or from the point of view of the use of the lines (quality of connexions).

TABLE SUMMARIZING

the questions assigned to Study Group 5

Chairman Mr. L. J. COLLET (France)
Vice-Chairman : Mr. MIKHAILOV (U.S.S.R.)

No.	Brief description	Other Study Groups, Sub-Study Groups or international organizations cooperating in the study*	Comments
1	Equivalent disturbing voltage telephone form factor.	C.M.I., 1st Section, S.G. 2	
2	Relation between equivalent disturbing voltage or current and induced psophometric e.m.f.	C.M.I., 1st Section, S.G. 1	
3	Special protection in case of crossing with a power line.		
4	Danger to a cable due to a high potential gradient.	C.M.I., 1st Section, S.G. 12	
5	Devices for reduction of noise.		
6	Telecommunication lines with power feeding conductors.		
7	Telecommunication circuits in cables not insulated from earth.		
8	Trouble due to D.C. power lines.	C.M.I., 1st Section, S.G. 4	
9	D.C. power lines at very high voltage.	C.M.I., 1st Section, S.G. 9	
10	Devices reducing the voltage of wires with respect to earth.	C.M.I., 1st Section, S.G. 10	
11	High-security power lines.		
12	Coefficient of sensitivity.	C.M.I., 1st Section, S.G. 7	
13	Unbalance of telephone installations.	S.G. 11, S.G. 12, C.M.I., 1st Section, S.G. 7	

* The following international bodies will also be consulted in connection with such questions of C.C.I.T.T. Study Group 5 as might interest them : The International Conference on Main High-Tension Networks (C.I.G.R.E.); the International Union of Producers and Distributors of Electric Power (U.N.I.P.E.D.E.); the International Railway Union (U.I.C.); the International Public Transport Union (I.P.T.U.).

No.	Brief description	Other Study Groups, Sub-Study Groups or international organizations cooperating in the study *	Comments :
14	Principles of protection; characteristics of protection apparatus.		
15	Devices for protection against acoustic shock.		
16	Coexistence of carrier systems on telephone lines and on power lines.	C.M.I., 1st Section, S.G. 5	
17	Carrier currents on telephone lines situated near power lines.	C.M.I., 1st Section, S.G. 11	
18	Protection of telephone signalling over short or medium distances.		
19	Protection of long-distance telephone signalling.	S.G. 11	
20	Danger and trouble due to the electrical protection of cables against corrosion.	S.G. 6, C.M.I., 1st Section, S.G. 12 and 2nd Section, S.G. 26	
21	Tolerable induced voltage in telecommunication circuits protected by special devices.		
22	Protection of a cable with an insulated sheath.		
23	Protection of a non-metallic sheathed cable or the use of an insulance other than paper.		
24	Revision of the Directives.		
25	Audio-frequency signals on power networks.		
26	Influence of radio stations on open-wire carrier circuits.		
27	Lines close to radio stations.		
28	Determination of the apparent conductivity of the soil.		
29	Coexistence of telecommunication lines and power lines on the same supports.		

* See the note on the preceding page.

Questions requiring the cooperation of Study Group 5

Question No.	Question Study Group	Brief description	Other Study Groups, Sub-Study Groups or international organizations cooperating in the study	Comments :
1	1	Noise on intercontinental circuits.	S.G. 3, C.C.I.R.	
5	1	Reduction in performance rating due to circuit noise.	S.G. 11, S.G. 12	
17	1	Psophometer for programme transmissions.	S.G. 12, C.C.I.R., I.B.O., E.B.U.	
38	1	Noise on the hypothetical reference circuit over overhead wires.		
5	12	Effect of induced noise on performance rating.	S.G. 1	

Questions concerning the Protection of Cable Sheaths

entrusted to

Study Group 6

in 1957-1960

Question 1.

[*Question number not allocated*]

Question 2.

(Documentary Question) (Continuation of Question 2 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

(a) A study of the conditions producing or accelerating intercrystalline disintegration of telephone cable-sheaths made from lead alloys (vibration, temperature changes, etc.). Remedial measures (laying methods, self-supporting cables, cables in steel pipes, etc.).

(b) Reduction of these disintegrating effects by the use of sheaths made of suitable alloys.

Note 1. — The special arrangements made in various countries during cable-laying to reduce intercrystalline disintegration are mentioned in Volume II *bis* of the C.C.I.F. *Green Book*, under the title " Methods of reducing intercrystalline disintegration of cable-sheaths ".

Information on the lead alloys used for cable-sheaths and their resistance to intercrystalline disintegration is given in Chapter IV of the " Recommendations concerning the protection of cables against corrosion " (Paris, 1949, § 134, page 21); account should also be taken of Recommendation 15 for the Protection of cables against corrosion (Volume II *bis* of the C.C.I.F. *Green Book*, Geneva 1956).

Note 2. — For the carrying out of laboratory tests on the resistance to mechanical disintegration offered by various alloys, particular consideration could be given to the method described in Annex 1 below.

Note 3. — While examining cases of intercrystalline disintegration, it would be of interest to ascertain, if possible, over a period of time, details of the vibration (amplitude and frequency) to which the cable is subjected.

ANNEX 1

(to Question 2 of Study Group 6)

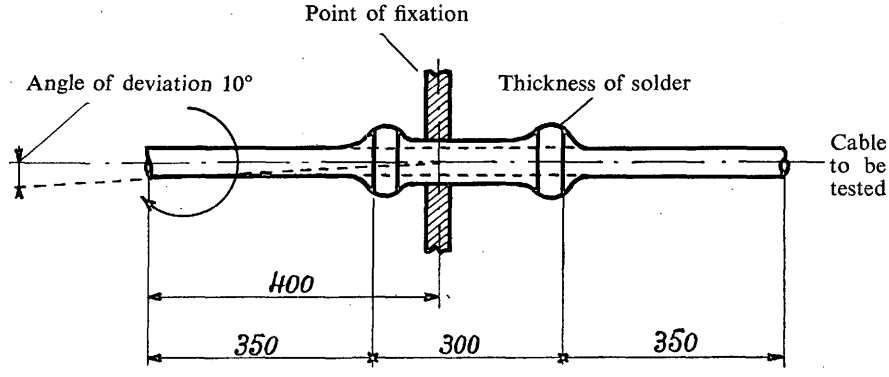
Laboratory study of breaking conditions of cables by intercrystalline disintegration resulting from repeated bending (note transmitted by the Swiss Telephone Administration)

It has been noticed that the lead sheaths of cables placed under the platforms of bridges are often affected by intercrystalline disintegration (breaks due to fatigue). It was first thought that these breaks were due to the transversal vibrations imparted to the bridges by the movements of vehicles. But further observations have shown that the breaks noticed were always caused by the longitudinal movements of the platforms of the bridges.

A method was then sought that would permit the comparison in the Laboratory of the different cables used and to submit them to strains similar to those to which they would be submitted on the bridges. One of the ends of the cable to be tested is solidly fixed : a machine impresses circular vibrations on the other extremity. The cable is thus bent in all directions following an angle and a frequency variable at will.

The sheaths of cables submitted to these tests show a state of disintegration identical with that of the sheaths of cables placed in the ground.

In order to be able to examine at the same time the behaviour of joints, lead sleeves are soldered on the ends of the cable to be tested. The sketch below shows the form of the cable as prepared for testing.



As an indication the results of four tests are given in the table below :

Test	Outside diameter mm	Thickness of the sheath mm	Number of vibrations before breaking			Remarks
			minimum	maximum	average value	
Pure lead	15·1	2·0	314 983	450 500	377 703	sleeve soldered without special precautions
Pure lead	17·8	1·8	108 476	243 200	158 129	
Lead with 0·7% antimony .	17·3	1·7	1 166 167	1 727 673	1 276 720	
Lead with 0·7% antimony .	19·0	1·7	941 520	1 430 740	1 186 130	

In all the tests, the breaks were in the sheaths and not in the sleeves.

The thicknesses of the sheaths play an appreciable part in the resistance to repeated bending.

For equal sheath thickness, the cables having the greatest diameter are most liable to breakage.

The sheaths consisting of an alloy of lead with 0·7% antimony show a resistance to breakage by intercrystalline disintegration 4 to 6 times as great as pure lead sheaths.

Question 3.

(Continuation of Question 3 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Modifications and additions that may possibly be made to the text of " Recommendations concerning the protection of underground cables against corrosion " (Paris, 1949).

Note 1. — It would be useful to collect information on the modifications to be expected to take account of the ever-increasing use of electrical protection schemes, and

Note 2. — See the replies to Questions 2, 14, 20, 21 and 22.

Question 4.

(Documentary Question) (Continuation of Question 4 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Protection of cables against lightning (composition of cables with special protection, methods of laying, etc...).

Note 1. — The documentation received up to 1956 is summarized in Volume II *bis* of the C.C.I.F. *Green Book* (Protective measures against lightning).

Note 2. — The Annex below summarizes the conclusions reached by the C.C.I.F. 2nd Study Group in October 1956.

Note 3. — The study of this question will be pursued in cooperation with Study Committee No. 28 of the 2nd section of the C.M.I.

ANNEX

(to Question 4 of Study Group 6)

Important points raised in 1956 by the C.C.I.F. 2nd Study Group

1. In 1954, it was judged opportune to mention that :

" 1. The tests undertaken in different countries to increase the protection of metallic sheath cables by covering them with a thick sheath of high dielectric strength insulating material (notably of rubber) have sometimes given satisfactory results; however, it is not certain that this protection is sufficient in all cases.

In particular, it has been reported that certain specified insulating layers intended for protection only against corrosion, have been found damaged over long lengths by a lightning discharge and owing to this have lost part of the efficacy against corrosion ".

The efficacy against lighting discharges of a protective covering designed essentially to protect against corrosion now appears doubtful after the findings, amongst others, of the Italian Administration. It appears preferable therefore not to mention this procedure in the *Green Book* and it is desirable to omit § *(b)* on this subject which appears at the top of page 100 of Volume II of the *Green Book*.

2. In 1954, the 2nd Study Group of the C.C.I.F. mentioned :

" It appears that the immediate proximity of metal rails ensures an efficient protection against lightning. "

The experience of the French Administration with a cable in French West Africa (A.O.F.) has lead to the conclusion that parallelism with a metal rail will protect the cable, if it is not more than two or three metres from the rail, but this protection is insufficient if the region is particularly unfavourable.

3. In 1954, the 2nd Study Group asked for complementary information on the subject of the use of screening wires buried parallel to the cable.

The experience of the French Administration with the previously mentioned cable, of the Swedish and U.S.S.R. Administrations shows that the use of screening wires considerably reduces the danger due to lightning.

Types of screening wire networks used, are :

Cable in A.O.F.	3 parallel bare copper wires of 3 mm diameter, spaced at 20 cm from each other and connected together every 20 m by a transverse wire of the same diameter, this trellis being placed at 30 cm above the cable.
Sweden	1 or 4 copper wires of 3 mm, 4 aluminium wires of 9·5 mm.

It is also important, in the construction of a screening wire network, that the characteristic impedance of the network for a wave set up by lightning is clearly less than that of the cable sheath. To estimate the probable efficiency of such a screening network, a calculation can be made by arbitrarily fixing the characteristics of the shock wave, taking for example a wave of the same type as the standard shock wave used for tests of high voltage installations.

In the case of bare wires, it could be possible, by measurements of the loop resistance, using a wire of the cable as the return conductor, to verify the continuity of a screening wire over a length of some kilometres. Another solution reported in 1954, for checking the continuity of the screening wires, utilizes stranded wires having at the centre of the strand an insulated conductor.

4. The presence of overhead lines parallel to the cable and at a distance of about ten metres from it can ensure an efficient protection.

In the particular case of the A.O.F. cable, it has been possible to conclude that :

" The presence of two parallel overhead lines, less than fifteen metres away, affords a definite measure of protection, but the presence of a single line is not always sufficient. "

Identical conclusions have been reached from experiments of the U.S.S.R. Administration. To protect their cables against lightning the presence of an overhead bare wire telecommunication line, parallel to already existing cable, is taken into account and in certain cases an overhead line is specially constructed solely for protection against lightning. In the case of a working overhead telecommunication line the connexion to earth of the wires of the line is effected by discharge gaps (2 to 3 cm) spaced at approximately every 200 m. In the case of a specially constructed overhead line, a line having 2 wires connected directly to earth at approximately 200 m intervals, is used.

To estimate the probable efficiency of such a protection system, it is possible to determine by calculation the potential attained by different points of the line, supposing it to be struck by lightning receiving for example a wave of the same form as the shock type wave used for high voltage testing of installations.

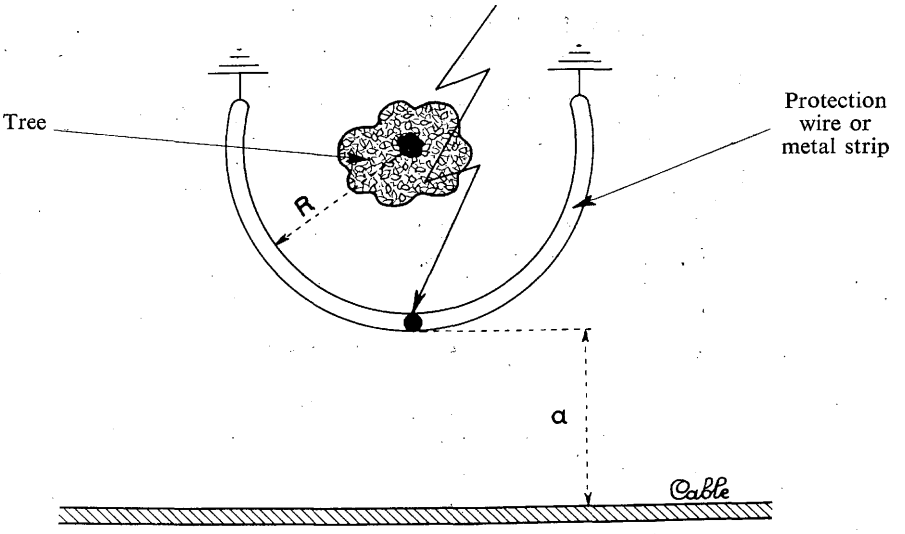
5. The 2nd Study Group of the C.C.I.F. asked in 1954 for information on the subject of the effect exercised by trees in the vicinity of cables and the protective measures adopted.

In the particular case of the cable in A.O.F., it can be stated that the passage through a forest does not materially change the degree of exposure to danger; the presence of numerous trees

struck by lightning confirms the danger but does not permit limitation of the zones to be protected. On the other hand no case has been found where the lightning has been conducted to the cable by the roots of trees.

The Italian Administration has found a considerable number of faults close to plane trees. However, it is not possible to give precise information on the influence of different species of trees.

The U.S.S.R. Administration indicates that in the case of isolated trees or groups of trees near the cable, in danger zones due to lightning, protection is effected by placing in the earth, between the cables and the trees, a wire or a strip connected to earth at each end, as shown in the diagram which follows.



6. The remark at the end of the text relating to protection measures against lightning, in Volume II of the *Green Book* should be amended to refer, not to a monograph of the Bell Telephone System, but to Chapter IX of the book entitled *Earth Conduction Effects in Transmission Systems*, by E. D. SUNDE (Van Nostrand, New York).

The experience obtained in the case of the A.O.F. cable previously mentioned has enabled the statement to be made that it is possible to calculate with good approximation the number of faults which may be expected per 100 km of cable per annum, by using the formulae (or diagrams deduced from these formulae) which are shown in the above mentioned works.

Question 5.

(Documentary Question) (Continuation of Question 5 of C.C.I.F. Study Group 2, studied in 1954-1956)

(a) Supervision of the continuity of sheaths of cables or the maintenance of their insulation.

(b) Maintenance of pressurised cables.

(c) Methods using tracer gases (radio-active or other gases) for the localisation of faults.

Note. — 1. The documentation received up to 1956 is summarized in Volume II of the *Green Book* (Use of compressed gas in cables — Use of tracer gases — Apparatus for permanent insulation checking).

2. It would be desirable to study whether it is possible to establish recommendations which could be a guide to Administrations and Private Operating Agencies for the maintenance of pressurised cables.

The main points that should be examined are the following :

— what pressure should be maintained in the cable ?

— what spacing should be allowed between the supply units of compressed gas ?

— at what distance apart should the manometers be placed ?

— at what pressure and with what precision should the manometers operate ?

— what gases, radioactive or not, can be recommended to facilitate the localisation of faults ?

The Annex below summarizes information sent to the C.C.I.F. with regard to maintenance of cables under gas pressure.

ANNEX

(to Question 5 of Study Group 6)

Indications on the subject of the maintenance of cables under gas pressure

	Federal German Republic			France	Great Britain	Sweden
Pressure normally maintained in the cable (pressure in gf/cm² with respect to the atmospheric pressure of reference : 1033 gf/cm²)	approx. 1000			650	700	5 to 600
Space between supply groups in compressed gas (in km) (gas sections) .	approx. 9			27 to 36	5 to 20*	automatic filling : an impulse is emitted by the refilling bottle each time the pressure falls : 3·7 kgf/cm²
Distance between pressure gauges (in m)	460 to 1150			1830	900 to 5000**	
Operating pressure of the pressure gauges (pressure of gf/cm²).		metallic pressure gauge	mercury tube			
	disconnection	600	750	500±25	420±15	
	connection	±2 or	±10	560±25		
Localization of faults by means of				freon	arcton	radioactive gas

* For the coaxial pair cables, the length of the supply section in gas corresponds to the length of the repeater section, 6 miles (10 km) at present. For the new cables, this length will be 3 miles (5 km). For long distance voice frequency cables, the length of the supply section varies according to the cables, but it is limited to a maximum of 12 miles (20 km).

** For coaxial pair cables in service, where the repeater section is 6 miles long, the pressure gauges on the conductor are placed at 1000 yards (900 metres) intervals. For the new coaxial pair cables, no switch will be inserted in the cable and the pressure gauges will probably be installed at each repeater station, that is to say every 3 miles (5000 metres).

Question 6.

(Documentary Question) (Continuation of Question 6 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

(a) Determination of the value of flow coefficients, as defined in Annex 1, § 222, page 30 of the " Recommendations for the protection of underground cables against the action of stray currents arising from electric traction installations (Florence 1951) ", in relation to different methods of laying and construction of electrified railways. Extension of the concept of coefficient of flow to a duct-line insufficiently insulated and liable to exchange currents with the surrounding earth. Variation of the flow coefficient for an electrified railway as a function of atmosphere conditions.

(b) The study of the dispersion of current in the vicinity of special situations along an electrified railway line : level-crossings, bridges or other permanent structures and in the neighbourhood of points where the railway line is connected to earthed metallic structures.

(c) The study of the variation in the difference of potential existing between the rail of an electrified railway line and points in the earth, more or less distant, in a direction perpendicular to the railway line.

Note. — The study of this question will be pursued in cooperation with Study Committee 22 of the 2nd section of the C.M.I.

Question 7.

(Continuation of Question 7 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Amendments and additions to be made, if necessary, to the text of the " Recommendations for the protection of underground cables against the action of stray currents arising from electric railway installations " (Florence, 1951).

Note 1. — Is there particular need to amend or to complete the directions concerning the general conditions of carrying out electrical protection, which at present figures in § 142 (pages 20 and 21) and 171 (page 23) and in the Annex IV (pages 60 to 62) ?

It could be useful, in effect, to state how, when preparing a plan of electrical protection of certain underground pipes (whether it is a new scheme or a modification of an already existing scheme of electrical protection) one must ensure that there is no need to include the other pipes and ducts existing in the same locality.

What values should be taken as criteria on this subject and what limits should be recommended for these values ?

One can, in particular, study the positive variation of the potential of the unconnected structure, produced by the electrical protection of the other structures, or the absolute value of a negative potential with respect to the neighbouring earth, of this unconnected structure.

In Annex 1, there is a note describing the procedure in use in Great Britain.

When it is not desirable, for special reasons, to include a cable or underground duct in an electrical protection scheme, it is useful to specify special precautions that should be taken in the preparation of this scheme.

Is there need to fix a minimum distance between the sacrificial anode and the telecommunication cables protected by this system?

Note 2. — See the reply to Question 6.

Note 3. — Annex 2 below contains additions to the Recommendations, as proposed by the Swedish Administration.

ANNEX 1

(to Question 7 of Study Group 6)

Precautions taken in Great Britain to determine whether a cathodic protection must be extended to neighbouring structures

Methods of assessing the adverse effects of a cathodic protection installation on neighbouring pipes or cables which are not protected electrically have been considered in Great Britain by a Joint Committee on which are represented organizations operating various types of plant (water, gas and oil pipes, railways, telephone and power cables).

The criterium chosen was the change of the potential difference between the unprotected structure and the soil due to the cathodic protection installation. Two methods of measurement were considered :

1. The potential between metal and soil may be measured at a number of points before the cathodic protection installation is put into service, the tests being repeated after a period of operation of the cathodic protection system.

This method has the advantage that long term changes of polarization may be taken into account, but it gives inconsistent results if, as is frequently the case, there are changes of potential which originate from some source other than the cathodic protection installation. Moreover, two visits to each test position are necessary and it is sometimes difficult to foresee where the tests should be made.

2. The cathodic protection may be switched on and off alternately at regular intervals, preferably by means of a time switch, the potential change occurring at each switching operation being noted.

Results by this method are less affected by changes of potential which do not originate from the cathodic protection system under test. Only one visit to site is necessary and the number of test positions can be extended as desired until an adequate indication of conditions has been obtained. On the other hand, this method does not take into account long-term polarization effects.

Provisionally method 2 has been adopted by the British Joint Committee. Generally, the assessment is based on the greatest changes in the positive direction, although it is considered that it may be desirable to avoid excessively negative potentials on served pipes or cables.

Experience on a considerable number of installations has shown that the test method is easy to apply and that the results are consistent. Possible methods of reducing the time required and in particular the question of suitable test limits are under consideration.

ANNEX 2

(to Question 7 of Study Group 6)

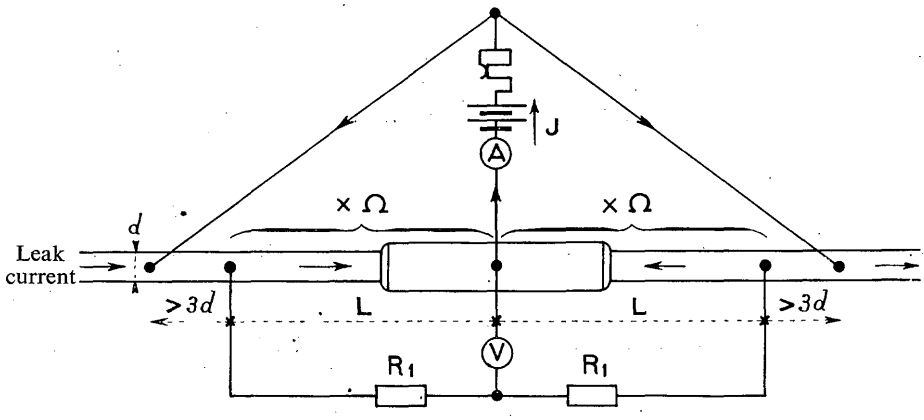
Additions to the text of the Recommendations, proposed by the Swedish Administration

1. On *page 36*, under A 2.2.3., Recording apparatus, the following passage might perhaps be inserted :

" The Swedish Administration uses moving coil recorders (Siemens SD 12 KT) for electrolytic measurements; these recorders include an amplifier for the oscillating circuit and a rotary switch for 7 measurement bands between 3 mV and 30 V. Consumption is 2 μA in the bands 0±3 mV (R_a=20 ohms), 0±12 mV (R_a=200 ohms), 0±60 mV (R_a=1000 ohms) and 0±300 mV (R_a=2500 ohms); in bands 0±1·2 V, 0±6 V and 0±30 V, consumption is 40 μA and the internal resistance of the instrument is 16 660 ohms/V. The figures in brackets indicate the maximum admissible external resistance for the measuring circuit and object. The measurements show an accuracy of 2·5%. "

2. On *pages 42-44*, under 2.4.1, Measurement of the strength of a current in a metallic cable sheath, the following might perhaps be inserted :

" When the strength of a current in a cable is being measured, it is often necessary, when measuring the voltage, to use all the cable length that is accessible in a cable chamber. If there is a splice in this section, calculation of the resistance of the cable sheath necessarily becomes very uncertain. Nevertheless, the method described below gives, apart from leak currents, a reliable figure for the sheath's resistance :



In principle, the assembly sketched above enables an adjustable current, I, to pass to the cable from the two sides of the central point of the splice. If a stray current which is passing, say, from left to right (see Figure 1) exists in the cable, the measuring and leak currents will be added together on the left of this point, while they will be subtracted on the right of it. The drop in voltage, U, measured by the voltmeter, will then be equal to the average drop in voltage on section L which has a sheath resistance of x. For the section L we therefore have

$$x = \frac{2U}{I}$$

The ammeter and the millivoltmeter must be connected to the central point of the splice. The additional resistances R_1, which are identical and much smaller than the resistance of the voltmeter, should be inserted in the voltage branches. A car battery of 6 volts is generally used as the source of current. "

Question 8.

(Continuation of Question 8 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Conditions for the co-existence of very high-tension direct-current power lines and telecommunication cables.

Note 1. — According to the tests carried out up to the present time, the principal risks that can be expected, in the case of the use of a permanent or temporary earth-return, are the corrosion of metallic duct-lines and of buried cables, and the disturbance to signalling systems (signalling using an earth-return for part of the current; railway signalling using track circuits).

In the event where, for reasons of economy, consideration is to be given to the distribution of power at a very high D.C. voltage, it would be desirable to collect information on the following points :

(a) What separation would it be desirable to allow between the telecommunication cables and the earthing points of the high voltage D.C. power distribution lines with earth-return, as a function of the soil conductivity and the value of the current flowing in the earth connection ?

(b) What separation would it be desirable to allow between the telecommunication cables and the high voltage D.C. power distribution lines for that section of the latter line situated between the earthing points of the terminal poles ?

(c) What measurements can be contemplated for the protection of telecommunication cables against stray currents due to very high voltage D.C. power distribution lines (e.g. the use of electric drainage), if it is not possible to satisfy points *(a)* and *(b)* above ?

Note 2. — See the C.C.I.F. documents submitted for this Question in 1954-1956, i.e., "CCIF — 1954-1956 — 2nd SG :

— Document No. 8 (Swedish Administration),

— Document No. 15 (Administration of the U.S.S.R.) "

Note 3. — The study of this question will be pursued in cooperation with Study Committee No. 29 of the 2nd section of the C.M.I.

Question 9.

[*Question number not allocated*]

Question 10.

(Documentary Question) (Continuation of Question 10 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

(a) Information concerning cases of the corrosion of underground cables sheaths noticed, even though these sheaths were acting as cathodes.

(b) Nature of electrolytic corrosion noticed in the case of alternating and direct stray currents in superposition. Possibility of corrosion by a direct current resulting from the effect of rectification of alternating currents during their passage from the cable into the nearby soil.

Note 1. — 1. See the C.C.I.F. documents submitted for this Question in 1954-1956, i.e., " CCIF — 1954/1956 — 2nd SG :

— Document No. 9 (Australian Administration),

— Document No. 13 (Italian Administration) "

2. Consideration will also be given to the indications concerning the corrosion diagram for lead and contained in the document " CCIF — 1952/1954 — 2nd SG — Document No. 18 " to which should be added the similar publication made, in English, in the *Journal of the Electrochemical Society* (98 (1951) 57).

This diagram is only valid in the cases where the surroundings contain carbon dioxide (CO^2).

It would be useful to complete the study by the establishment of diagrams of the corrosion of lead in other surroundings (e.g. in the presence of acetic acid, phenol, etc.).

3. Regarding the part *(a)* of the question, the document " CCIF — 1952/1954 — 2nd SG — Document No. 9 " points out a case of corrosion that could be included under this heading. As is also shown by the above-mentioned corrosion diagram, this case of corrosion can probably be explained by the alcalinity of the surroundings (high pH value) and by an insufficient electro-negative potential.

It would be proper to examine from this point of view if, and in what conditions, the passage of an electric current can render cement (or asbestos-cement) aggressive with respect to lead or lead alloys, in particular, in the case of cables laid in conduits of cement or asbestos-cement and forming part of an electrical protection system.

4. Regarding part *(b)* of this question, the document " CCIF — 1952/1954 — 2nd SG — Document No. 7 " cites instances where it is thought that alternating currents have played a part in corrosion phenomena.

5. With the object of better defining the causes of corrosion, it would be desirable to collect more extensive information on the character of the attack, as expounded at the present time in the " Recommendations for the protection of underground cables against corrosion " (Paris, 1949), § 2.2.3.3.1., sub-division 38, page 10.

Note 2. — The study of this question will be pursued in cooperation with Study Committees Nos. 21, 25 and 26 of the 2nd Section of the C.M.I.

Question 11.

[*Question number not allocated*]

Question 12.

(Continuation of Question 12 of the C.C.I.F. Study Group, studied in 1954-1956)

Should special measures be taken when telecommunication cables, power cables, gas and water mains, electrified railway tracks, pipelines, etc., are to be connected between themselves with the object of achieving electrical protection, more particularly in the case where other considerations render the separation of certain of these installations desirable ?

What should these measures be ?

Note 1. — 1. In the case of protection in common to power cables, telecommunication cables, gas or water mains, pipe lines, etc., by electrical protection, the following points should be kept in view :

(a) Are there, either permanently or during a short-circuit on a power cable included in the electrical protection plan, any possible disadvantages, such as : danger of gas explosion, fire risks, deterioration of cable sheaths, danger resulting from the rise in potential of these sheaths, etc. ?

(b) What special measures are to be taken and, if required, the arrangements to be expected for protection against these phenomena ?

2. The reply to this question leads to the completion of § 5.4, pages 24 and 25 and § *(a)* 4.4 of Annex IV, page 62 of the " Recommendations for the protection of underground cables against the action of stray currents arising from electric traction systems " (Florence 1951).

Note 2. — The Annex below gives the conclusions reached by the C.C.I.F. 2nd Study Group in 1956, taking into account the points of view expressed during its October meeting and the contributions received.

Origin	Reference
American Telephone & Telegraph Co. :	CCIF — 1955/1956 — Document No. 4.
Australia :	CCIF — 1955/1956 — Document No. 9.
Italy :	CCIF — 1955/1956 — Document No. 13.
United Kingdom :	CCIF — 1955/1956 — Document No. 14.
U.S.S.R. :	CCIF — 1955/1956 — Document No. 15. and Document No. 17.

Note 3. — The study of this Question will be pursued by C.C.I.T.T. Study Group 6 in cooperation with C.C.I.T.T. Study Group 5 and with the Study Groups No. 12 of the 1st section and No. 26 of the 2nd section of the C.M.I.

ANNEX

(to Question 12 of Study Group 6)

Conclusions reached by the C.C.I.F. 2nd Study Group in October, 1956

When, to obtain common electrical protection, telecommunication cables are directly connected to the sheath of a power cable, it is necessary to take into account the risks to personnel

working on the telecommunication cables in the event of short-circuit to earth of one phase of the power cable. These risks are especially to be feared when the power network is a high voltage network with neutral connected directly to earth.

In the vicinity of the point of connection of the power cables and the telecommunication cables, it is necessary then to determine what will be the rise of potential of the telecommunication cable sheath with respect to the potential of this same cable at a distant point, when a short-circuit occurs on the power cable, and then to ascertain if this rise of potential can be permitted.

For information, it can be stated that the British Administration considers that this rise of potential should not exceed 430 volts (see document — " CCIF — 1955/1956 — 2nd SG — Document No. 14 ").

It appears desirable, on the other hand, to recommend to workmen likely to work on the telecommunication cables where the sheath is connected to that of a power cable, to shunt, beforehand, by a conductor wire of sufficient section, the two sides of the part of a telephone cable that one proposes to cut.

It is useful therefore for the future to modify line 181 of § 5.4 mentioned above so as to read :

" ..... It is useful furthermore to take all precautions so that in the case of an accident affecting the high voltage or low voltage cables the currents likely to circulate in the telecommunication sheaths are limited to such a value that it is not likely to result, for telecommunication networks, in *any risk whatsoever for the personnel working on the cables* *, nor in any damage to the materials or any interference to working ".

Question 13.

(Documentary Question) (Continuation of Question 13 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Protective measures to be taken against explosive and poisonous gases which may be encountered in cable chambers of underground telecommunication cables.

Note. — The documentation received on this question up to 1956 is summarized in Volume II *bis* of the C.C.I.F. *Green Book* " Protective measures against explosive and poisonous gases which may be encountered in cable chambers of underground telecommunication cables ".

Considering the importance of this problem which involves risk to the lives of workmen, it is to be desired that Administrations and Private Operating Agencies communicate to the C.C.I.T.T. Secretariat the provisions that they apply in this connection in their own country, the apparatus that they use and the additions which they consider may usefully be made to this above mentioned text.

Attention is drawn in particular to the following points :

1. Jointing and soldering of the cables. In the documentation received, it is recommended that the use of unprotected flames be avoided for the performance of these operations in manholes where the presence of gas has been noted. In certain countries, this practice is easily followed; on the contrary, other countries find some difficulty in applying it. It would be desirable to specify what conditions should be fulfilled to remove these difficulties. It is possible, in particular, that the sizes of the manholes as well as the arrangement of the cables in them should be studied.

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* Underlined text = amendment.

2. Drying of the joints. Other than drying by silica-gel, certain other procedures under test seem to give good results ;

— drying by means of plaster of Paris. Examination should be made to find out whether corrosion is to be feared ;

— electric drying. The British Telephone Administration uses hot air electric drying apparatus. The apparatus operates on 24 volts with a power of 500 watts; it can be supplied by means of the generator and battery used for the lighting of the manhole.

3. Static ventilation. Besides the static ventilation of the manholes, certain countries install ventilation systems at high and low points in the actual ducts.

4. Penetration of the gases into neighbouring buildings via the telecommunication ducts. Incidents of this type have occurred in certain countries. A study should be made of the arrangements to be adopted to avoid such incidents (sealing of the individual branch ducts or of the ducts themselves).

5. Rules for the protection of workmen against explosive and poisonous gases. Rules of this type exist in certain countries; in particular, an example will be found in the documents " CCIF — 1952/1954 — 2nd SG — Document No. 19 " (British Administration, American Telephone and Telegraph Company, Australian and Italian Administrations) and " CCIF — 1954/1956 — 2nd SG — Document No. 6 " (Canada).

Examination should be made to see whether it is possible to establish rules on this point which could serve as a guide to Administrations and Private Operating Agencies for the completion of their own rules.

Question 14.

(Continuation of Question 14 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Study of the corrosion of the lead sheaths of telecommunication cables in the presence of products for the impregnation of the covering or armourings of these cables :

Note 1. — 1. It would be of interest, in view of the controversies raised on this subject and the anomalies sometimes found, to define the respective roles played by :

— the phenol contained in the covering of cables, and

— the products resulting from the deterioration of the jute under various actions (in particular, bacteria).

Recommendation 14 in Volume II *bis* of the C.C.I.F. *Green Book* takes into account the conclusions reached in 1956 by the C.C.I.F. 2nd Study Group.

2. In view of the complexity of the problem, consideration should be given as to whether there is reason to extend the scope of the study to the examination of the various physico-chemical phenomena which may occur in this problem.

3. It should be examined whether it would not be useful to set up a detailed programme of laboratory or field tests, which could form a guide to Administrations and Private Operating Agencies desiring to go forward with tests on this question.

Note 2. — The study of this question will be pursued in cooperation with Study Group No. 23 of the 2nd section of the C.M.I.

Question 15.

(Documentary Question) (Continuation of Question 15 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

What measures can be recommended for the protection of telecommunication trunk cables (and possibly other neighbouring ducts) against electrolytic corrosion due to currents caused by remotely fed intermediate repeaters, when this remote feeding is made by means of D.C. transmitted over the conductors of the cable and with an earth return ?

Note 1. — For the study of this question, the following points in particular could be examined :

(a) Theoretical and practical studies concerning the remote feeding currents thus transmitted, on the value and the sign of the potential and on the value of the leakage current along the cable sheath, as a function of the construction of the sheath and the armouring of the cable, the soil conductivity and the distance between the cable and the earthing points at the two ends of the amplification section.

(b) Definition of the most effective practical provisions that can be recommended to ensure the protection of the cable (installation of an earth point at a positive potential at a suitable distance; electrical drainage at the end of an amplification section where the earthing point is at a negative potential; use of cathodic protection or protection by reactive anodes, etc.).

Note 2. — See the C.C.I.F. documents submitted for this Question in 1954-1956, i.e., documents " CCIF — 1954/1956 — 2nd SG :

— Document No. 4 (American Telephone and Telegraph Company),

— Document No. 15 (Administration of the U.S.S.R.) ".

Note 3. — The study of this Question will be continued in cooperation with Study Group No. 24 of the 2nd section of the C.M.I.

Question 16.

(Documentary Question) (Continuation of Question 16 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Protection of submarine coaxial pair cables and their overland extensions against corrosion.

Note 1. — For the study of this question, in particular, examination will be made of the following points :

(a) Methods which can be considered for terminations and interconnections :

— of the outer conductor of the coaxial pair,

— of the armouring of the cable,

— of the various earth connections.

(b) Precautions to be taken in the event of the use of submarine repeaters fed from shore repeater stations.

Note 2. — See the C.C.I.F. documents submitted for this Question in 1954-1956, i.e., documents " CCIF — 1954/1956 — 2nd SG :

— Document No. 4 (American Telephone and Telegraph Company),

— Document No. 7 (French Administration) ".

Question 17.

[*Question number not allocated*]

Question 18.

(Documentary Question) (Continuation of Question 18 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

Preventive measures that can be taken in the construction and the laying of telecommunication cables to protect them from damage caused by insects, rodents, etc.

Note 1. — In the study of this question the following points should be examined :

— origin of the faults (insects or animals which cause them),

— nature of the faults,

— particular conditions, such as the attack by insects coming from the drums on which the cables are wound, etc.

Note 2. — See the C.C.I.F. documents submitted for this Question in 1954-1956, i.e., documents " CCIF — 1954/1956 — 2nd SG :

— Document No. 5 (Greek Administration),
— Document No. 7 (French Administration),
— Document No. 9 (Australian Administration),
— Document No. 13 (Italian Administration) ".

Question 19.

(Documentary Question) (Continuation of Question 19 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)

1. What methods for the impregnation of wood poles for telecommunication lines are successfully used in each country (methods of impregnation before erection and subsequent re-impregnation of poles already erected) ?

2. What tests can be made to establish that a pole is no longer in a satisfactory condition and how are these tests made in practice ?

Note. — See the C.C.I.F. documents submitted for this Question in 1954-1956, .e., documents " CCIF — 1954/1956 — 2nd SG :

— Document No. 5 (Greek Administration),
— Document No. 7 (French Administration),
— Document No. 10 (Federal German Administration),
— Document No. 11 (Austrian Administration) ".

Question 20.

(Documentary Question) (Continuation of Question 1, part (a), *of the C.C.I.F. 2nd Study Group, studied in 1954-1956)*

Substitution for lead of certain metals (e.g. steel or aluminium)—finally associated with thermoplastic materials for the construction of cable sheaths.

The following information is required :

1. Nature of metal used, conditions of forming the sheath.
2. Method used for making the joints.
3. Conditions of use of the cables (overhead cable, cable in duct, cable buried in the earth).

Remark. — Fairly long lengths of cable of the following types are now laid in various countries :

— Alpeth cables, the sheath of which consists of a sheath of thin aluminium covered by a layer of polythene.

— Stalpeth cables, the sheath of which is composed of an interior sheath of thin aluminium (to conduct the electricity), covered with a steel sheath welded along the seam (to ensure water tightness), covered finally with an external sheath of polythene.

— Cables, the conductors of which are covered with a polythene sheath and the core surrounded by a sheath of plastic material, then by a nonwatertight metallic screen.

— Cables the sheath of which is formed of metal or alloy other than lead and covered with a plastic material sheath (including rubber).

Question 21.

(Documentary Question) (Continuation of Question 1, part (d), *of the C.C.I.F. 2nd Study Group, studied in 1954-1956)*

The use of cables the sheath of which is made entirely of plastic material. A distinction will be made between the cases where the conductors of the cable are insulated with paper and those where the conductors are insulated with plastic substances (sheath not proofed against humidity).

The following information is required :

1. Nature, physical and mechanical properties of the plastic materials used, their working conditions; nature of substances attacking these materials and likely to be found in the soil or in the conduits, notably after drawing through other cables (vaseline, soap, etc.).

   Annex 1, which follows, gives the results of a bibliographic study of the behaviour of polythene in the presence of certain materials.

2. Method used for making joints.

3. Type of use of cable (overhead cable, cable placed in conduit, cable buried in the earth). Preservation of the insulation inside the cable where the sheath is not entirely proof against humidity and arrangements for the localization of faults.

Remark. — The total replacement of a lead sheath by a plastic sheath gives rise to the following difficulties :

a) the electromagnetic or electrostatic screening with regard to the internal and external fields is cut out and the corresponding protection must, if it is necessary, be sought by other means;

b) it is no longer possible to use the metal cable sheath for signalling;

c) the size of the cables is increased.

ANNEX

(to Question 21 of Study Group 6)

Behaviour of polyethylene in the presence of certain substances (Bibliographical study)

A bibliographical study has been made with the object of discovering what substances are likely to have a harmful effect on polyethylene used for cable sheaths. It results from this that the following substances are mainly concerned :

1. *Wetting agents and certain detergents.* — Exposed to the influence of such agents polythene splits and forms cracks. The magnitude of the effect depends essentially on the composition of the agent.

2. *Plasticisers, chiefly those of the ester type.* — Same effect as that mentioned above. A plasticiser being able to penetrate by contact from a plasticised plastic into the polythene, such a contact must be avoided. In the sheaths composed of a combination of polyvinyl chloride and polythene, metal foils may be placed between the layers of plastic. The effects are very different for different types of plasticisers.

3. *Hydrocarbons, aliphatic and aromatic.* — At ordinary temperatures, there is practically no effect; but above 60° C, the solubility rises with temperature.

4. *Oils.* — Mineral oils are slowly absorbed at ordinary temperatures, but the absorption is more rapid at higher temperatures. Under prolonged influence, there will be splits and cracks as in 1.

Vegetable and animal oils produce the same effect, but to a lesser degree.

5. *Polar organic matters such as alcohols, aldehydes, acids, esters and ketones.* — These substances cause polythene of low molecular weight to be breakable, particularly when it is subjected to mechanical strain (internal or external tensions).

6. *Silicones.* — (See under 4).

7. *Sulphur and sulphurous accelerators.* — During prolonged influence, sulphur can to a certain degree be absorbed by polythene, causing deterioration of the electrical properties of the latter. A similar effect, but to a more marked degree, can be caused by sulphurous accelerators used in the vulcanisation of rubber. In the case of mixed sheaths, it is necessary in consequence to take the same precautions as those mentioned under 2.

8. *Soaps.* — Soft soaps produce the same effects as the substances mentioned under 1.

In a general way, it should be pointed out that the attacks caused by the above substances are more marked on polythenes of low molecular weight or those which are submitted to mechanical strain than on polythenes of high molecular weight which are not submitted to mechanical strain.

In the appreciation of the above data, it should be remarked that these substances are rarely to be found in the soil, while lead is likely to be attacked by substances such as humic acids, non-calcareous water, mortar, etc., substances which are often found in the soil and which have no action on polythene.

Question 22.

(Documentary Question) (following Question 11 and parts (b) *and* (c) *of Question 1 of the C.C.I.F. 2nd Study Group, studied in 1954-1956)*

The use of plastic materials as protection against corrosion of :

— the metal sheath of telecommunication cables,
and/or
— the armouring of these cables.

The following information is required :

1. Nature, physical and mechanical, of the thermoplastic materials used, conditions of use; nature of matter attacking these substances and likely to be found in the earth or in the conduits, especially after pulling through other cables (vaseline, soap etc.) (see Annex to Question B).

2. Method of jointing.

3. Condition of use of cable (overhead, cable in duct, cable buried in the earth).

Remark 1. — The requirements of a thermoplastic covering to be used for protecting the lead against corrosion are as follows :

a) the material should be effective in preventing the passage of molecular water vapour, moisture and ions;

b) the material must be of homogeneous constitution ; it should be of sufficient mechanical strength and toughness to withstand the normal conditions of installation and use. It should be as free as possible from internal stresses. Properties should not materially change with time;

c) the flexibility of the material should permit normal bending;

d) if the cable has to be exposed, the weather resistance of the covering should be sufficiently high; the covering should not deteriorate under the action of sunlight;

e) other points may require consideration under specific conditions :

— inflammability,

— attack by rodents,

— resistance to fungus, etc...

Remark 2. — One cannot indicate in the present state of the technique in 1956 a single method permitting rapid verification of the qualities of the thermoplastic protective sheath.

Certain arrangements can be made, however, to verify that the thermoplastic sheath has not been damaged during its construction or during the laying of the cable :

— measurements of the insulation resistance of the thermoplastic sheath,

— tests by means of the following apparatus (electric brush).

The apparatus comprises an interrupter and an induction coil and delivers at its terminals a high voltage of known value. One terminal is connected to the bunch of conductors, the other to a probe which is brought into contact with the surface of the insulation.

Remark 3. — See the documents received by the C.C.I.F. in 1954-1956 for the study of this question and in particular the documents :

" CCIF — 1954/1956 — 2nd S.G. — Document No. 12 " of the Austrian Administration on the subject of the lessening of the " screening effect " exercised by the cable armouring in the case of electric influence, when the armouring is eaten away by corrosion.

" CCIF — 1954/1956 — 2nd S.G. — Document No. 14 " of the British Administration on the subject of difficulties met when jointing.

Remark 4. — The study of this question will be pursued in co-operation with Study Group No. 25 of the C.M.I.

Question 23.

(Documentary Question) (New Question)

(a) What are the thermoplastic materials that can be recommended for the insulation of telephone conductors :

(i) conductors for local or trunk cables;

(ii) insulated conductors without sheaths for subscribers' distribution;

(iii) conductors for internal telephone installations.

(b) What conditions should be imposed on the thermoplastic materials used to insulate the conductors ?

(c) What tests can be made to verify that the conditions are fulfilled ?

(d) Conditions of the use or placing of these conductors.

Remark 1. — The aim is to collect information relative to the specifications used by the Administrations for these conductors and of the standards imposed on the thermoplastic materials mentioned in these specifications.

Remark 2. — One will distinguish, if necessary, the case of copper conductors and that of conductors of another metal (steel, aluminium).

TABLE SUMMARIZING
the questions assigned to Study Group 6

Chairman : Mr. HALSTRØM (Denmark)
Vice-Chairman : Mr. GAGLIARDI (Italy)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study *	Comments
—			
2	Crystalline disintegration.		Documentary
2	Modifications to the " Paris Recommendations (1949)."		
4	Protection against lightning.	C.M.I., 2nd Section, S.G. 28	Documentary
5	Continuity of cable sheaths.	C.M.I., 2nd Section, S.G. 22	Documentary

* The following international bodies will also be consulted in connection with such Study Group 6 Questions as may interest them : International Conference of Large Electrical Networks (C.I.G.R.E.), the International Union of Producers and Distributors of Electrical Power (U.N.I.P.E.D.E.), the International Railway Union (I.R.U.), the International Gas Union (I.G.U.) and the International Public Transport Union.

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
6	Study of " flow coefficients. "	C.M.I., 2nd Section, S.G. 22	Documentary
7	Modification to the " Florence Recommendations, 1951. "		
8	Very-high-voltage direct-current power distribution lines.	C.M.I., 2nd Section, S.G. 29	
—			
10	Unusual cases of corrosion.	C.M.I., 2nd Section, S.G.s 21, 25 and 26	Documentary
—			
12	Cathode protection common to several networks.	C.M.I., 1st Section, S.G. 12, and 2nd Section, S.G. 26	
13	Protection against explosive and poisonous gases.		Documentary
14	" Phenolic " corrosion.	C.M.I., 2nd Section, S.G. 23	
15	Corrosion due to currents for the remote feeding of repeaters.	C.M.I., 2nd Section, S.G. 24	
16	Corrosion of submarine coaxial cables		Documentary
—			
18	Damage caused by insects and rodents.		Documentary
19	Wooden poles.		Documentary
20	Metals replacing lead in cable sheaths.	C.M.I., 2nd Section, S.G. 25	Documentary
21	Cables with sheaths made entirely of plastics.	C.M.I., 2nd Section, S.G. 25	Documentary
22	Plastic materials for the protection of lead sheaths.	C.M.I., 2nd Section, S.G. 25	Documentary
23	Insulation of conductors by plastic materials.		Documentary

Questions concerning Vocabulary and Symbols

entrusted to

Study Group 7

in 1957-1960

Question 1/7.

(This question concerns the C.C.I.R. and the International Electrotechnical Commission)

(It is the result of the amalgamation of question VI/1 set by the VIIIth Plenary Assembly of the C.C.I.T. and question 1 of the C.C.I.F. 11th Study Group set by the XVIIIth Plenary Assembly of the C.C.I.F.)

What amendments or addition ought to be made to the definitions contained in the " List of Definitions of Essential Telecommunication Terms ", Part I (General Terms, Telegraphy, Telephony).

COMMENTS

(Extracts from Documents AP I/27 and AP I/28, approved by the First Plenary Assembly of the C.C.I.T.T.)

Continuation of preparatory work for producing the List of Definitions of Essential Telecommunication Terms

A draft edition of the List of Definitions of Telegraph Terms has been approved by the VIIIth Plenary Assembly of the C.C.I.T.

The Draft List of Definitions of Telephone Terms was approved by the XVIth Plenary Assembly of the C.C.I.F. in 1951.

It should therefore now be possible for the Joint Study Group of the C.C.I.s to meet in order to prepare a single document, to combine these two documents.

It is of interest to note that the International Electrotechnical Commission, having had under revision for some years the International Electrotechnical Vocabulary and intending to include a certain number of definitions on the subject of Telecommunication, has made considerable progress in this work without however having yet commenced to produce the section dealing with Telegraphy and Telephony. However, this Commission is now ready to examine a proposal from one of its Members which includes a very great number of definitions for terms included in the Draft List produced by the C.C.I.F. and the C.C.I.T. The Commission would be quite willing to take these Draft Lists into consideration in the course of its study provided they are communicated to the Committee in good time.

Since the International Electrotechnical Vocabulary is a document which most countries regard as authentic, it would be highly confusing if many of the Telecommunication definitions in this Vocabulary differed in substance from those in the List to be published by the Union.

In order to avoid as far as possible the difficulty referred to above, it would be advantageous to hold an early Meeting of the Joint Study Group of the C.C.I.s of the Union with the following task :

1. To ensure that in the Draft Lists of Definitions established by the C.C.I.F. and the C.C.I.T. there be no disagreement between certain terms which are defined in both Draft Lists.
2. To take note of proposals already received by the International Electrotechnical Commission, in order to be able to indicate those proposals on which the C.C.I.'s have no reservations and also to indicate the definitions already appearing in the Draft Lists of the Union which seem preferable to certain definitions proposed.

This programme should be completed by 30 June 1957, by which time I.E.C. expects to take its decision on establishing the section in question of its vocabulary.

Note by the Secretariat. — To this end, the First Plenary Assembly of the C.C.I.T.T. decided at its 7th meeting to convene a working party of Study Group 7 in March 1957.

This working party met in Geneva, at the end of March, 1957, and drew up the " List of definitions of essential telecommunication terms—Part I : General Terms-Telephony-Telegraphy".

This document was published in August 1957 and made available to Administrations.

The aim of question 1/7 is to prepare additions (and amendments) to this List.

Question 2/7.

(Former Question 52 of the C.C.I.T.)

Contribution to the preparation of the " International Telecommunication Vocabulary ".

Note by the Secretariat. — The Vocabulary in question is the 8 languages Vocabulary published at the request of the 1938 Cairo Conference.

A preliminary Draft of Telecommunication Vocabulary was published in 1940, with a supplement in 1941, by the Bureau of the International Telecommunication Union (White Book).

The revision of this preliminary Draft was requested by the XVth Plenary Assembly of the C.C.I.F. and approved by the 7th Session of the Administrative Council (Resolution 248).

Study Group VI of the C.C.I.T. issued in July 1955, a document entitled " Contribution by the C.C.I.T. to the establishment of the International Telecommunication Vocabulary " *(Yellow Book)*.

Question 3/7.

(In collaboration with Study Groups 1 and 9 and with the C.C.I.R.; Study Group 9 is to issue its proposals first)

(New C.C.I.T. Question I/5)

To establish an appropriate terminology specifying the different types of " channel " mentioned in the documents of the C.C.I.T. and C.C.I.R.

Note. — This question arises from the fact that, for example, it is becoming more common for a channel obtained by frequency-division multiplex to be itself divided by time-division multiplex and these time divisions are also called channels, which may lead to confusion in practice.

Question 4/7.

(Concerns the International Electrotechnical Commission)

(Question 2 of the 11th Study Group of the C.C.I.F.)

What new relay definitions should be given in the Draft List of Definitions of Essential Telephone Terms ?

Note. — In studying this question, the following documents should be considered :

C.C.I.F. — 1952/1954 — Vocabulary — Document No. 3 (or CCIT SG VI/11 — SG VII/3) * Contribution by the Netherlands Telephone Administration on the study of relay definitions.

C.C.I.F. — 1955-1956 — SG 11 — Document No. 3. Reply (dated 17 August 1956) from the Federal German Telecommunication Administration to Question 1 of CCIF — SG No. 11.

The following definitions have already been adopted by the XVIIIth Plenary Assembly of the C.C.I.F. :

1. *Relay (Electrical).* — A device, operated electrically and causing by its operation abrupt changes in an electrical circuit (e.g. breaking the circuit, changing the circuit connections or causing variations in the circuit characteristics).
2. *Electro thermal relay.* — A relay whose action depends upon the heating effect of a current.
3. *Static relay.* — A relay without moving parts.
4. *Electromagnetic differential relay.* — A relay having two or more windings so connected that when two or more windings are appropriately energized together, their magnetic effects neutralize each other.
5. *Polarized relay.* — Relay of which the final condition at a sufficiently high value of the actuating quantity is dependent upon the direction of this quantity.
6. *Shunt-field relay.* — Electromagnetic relay in which the magnetic flux can be routed outside the armature, for which reason the armature is insufficiently attracted.
7. *Winding (Relay).* — A number of turns of wire constituting a single circuit.
8. *Coil (Relay).* — An assembly of one or more windings.
9. *Make-Contact Unit.* — A combination of two electrical contact elements which make connection when the relay is operated.
10. *Break-Contact Unit.* — A combination of two electrical contact elements which break connection when the relay is operated.

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* Document published in the Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.

11. *Changeover Contact Unit.* — A combination of three electrical contact elements in which, when the relay is operated, a connection is broken between two contact elements and subsequently another connection is made between one of these two and a third contact element.

12. *Armature clearance.* — Movement which the armature can make from its rest position, until the pressure of the contact springs is exercized on it.

13. *Contact follow.* — Movement of two contact elements from the moment at which they just make contact with each other till the moment at which the armature has reached the final position.

14. *Change-over time.* — In case of a change-over contact, time interval between the breaking of the first contact and the making of the second contact.

Question 5/7.

(Concerns the C.C.I.R. and the International Electrotechnical Commission)

(Further to Question No. 3 (Part I) of the 10th Study Group of the C.C.I.F.)

Preparation of an introduction to the list of graphical symbols for telecommunication, laying down the guiding principles to be followed in using these symbols.

Note 1. — In this connection, see C.C.I.T. (Recommendation I.4, Annex, Section A).

Note 2. — In studying this question, consideration will be given to the following Annex to document No. 6 of the 10th Study Group of the C.C.I.F.

ANNEX

Introduction to the list of graphical symbols for light-current installations

A. *General.*

In the choice of symbols for the proposed telecommunication installations, the C.C.I.F. (and the C.C.I.T.) are governed by the following guiding principles :

The symbol should be as simple as possible, to simplify the drawing process and to save time.

It should be clear and exclude any confusion with other symbols.

The mechanical construction of the apparatus or of its part represented is of secondary importance. Thus the same symbol is used for all types of relay which fulfil the same function, even though their construction may differ.

Symbols for telephony, telegraphy and radio should be the same and all unnecessary repetition should be avoided.

Symbols for telecommunication fall into four sections :—

Section 1 — Symbols common to telecommunication.
Section 2 — Symbols for telephony.
Section 3 — Symbols for telegraphy.
Section 4 — Symbols for radio communication.

Within each section, the order of classification is :—

Symbols mainly for circuit diagrams.
Symbols mainly for block diagrams.
Symbols mainly for plans and operating maps.

Motor-generators and other items of heavy-current equipment used in telecommunication installations should be represented by the corresponding symbols adopted by the I.E.C.

Use of general and special symbols.

1. A general symbol relates to an assembly of items of a common character.

When this assembly can be split up into large groups, an individual symbol is allotted to each one, either by completing the general symbol by a particular symbol (sketch, letter or group of letters) or, when possible, by associating several symbols, either of a general nature or basic symbols defining the various characters of the category considered.

Certain of the symbols thus prepared may themselves be treated as general symbols, from which special symbols may be derived by a similar process.

2. Report to special symbols is not obligatory when the particular detail is made sufficiently clear in some way (e.g. title, legend, reference to a specification), or even when this is quite clear from the diagram.

3. In general, only essential details necessary for following the diagram should be shown.

4. If variants are given under the same name, the user may use his discretion.

5. It is not always necessary to show connecting lines to symbols as indicated in the text, but long standing custom should be respected.

6. In general, symbols may also be drawn in any direction, even when of symmetrical shape.

7. Lines of different thickness and different scales may be used. Less important detail may be drawn to a smaller scale.

Question 6/7.

(In collaboration with Study Group 11) (Concerns the C.C.I.R. and the International Electrotechnical Commission) (Study in the first place by Study Group 11)

(Further to Question No. 3 (Parts 2 and 3) of the 10th Study Group of the C.C.I.F.)

1. Preparation of a classification of all types of diagrams according to their use.

2. Preparation of rules to which each category of diagram must conform so that the information they give may be as clear as possible.

Note. — The following appendices should be considered in studying this question.

ANNEX 1

Numbering the positions taken up by moving devices in diagrams

Basically, diagrams should show apparatus in the unoperated position (i.e. with no current flowing) unless the contrary is indicated, particularly as regards relays or similar devices controlling one another. In such cases these devices should be shown in mutually compatible positions.

Keys, relays and other switching devices may be shown by either :—

1. Grouping the contact units immediately adjacent to the controlling device (key, winding, etc.).

2. Separating the contact units from the device and setting them out parallel and in line.

3. Spreading the contacts over the diagram using reference letters corresponding to the controlling device.

Case of a diagram for a telegraph communication. (C.C.I.T. Recommendation I.4).

1. In a diagram representing a complete telegraph connection, all the positions which the moving parts in this connection should simultaneously occupy, so that the electromagnet of the receiver shall be in a given position (A or Z), should be designated in the same way as this position.

2. In the case of a point-to-point circuit, the moving parts should all be shown in position Z.

3. In the case of a diagram of a switched connection, the moving parts should all be shown in the position corresponding to the free condition of the circuits.

Thus, for example, in the standardized international Telex system the position in question is A.

4. Position A is that which corresponds to the start signal of a standardized start-stop apparatus controlling the connection; position Z is that which then corresponds to the stop signal.

5. In a diagram representing a constituent part of a particular telegraph connection, the same conventions are applied.

ANNEX 2

Netherlands' Rules for the Preparation of Telecommunication Diagrams

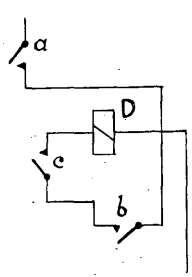
Circuit.

Speech and feeding wires are shown horizontally, if most of the constituent parts of an equipment are in pairs (or in multiple). The direction in which the connection is set up, or in which energy is transmitted, is from left to right (unless some indication to the contrary is given in the fundamental diagram).

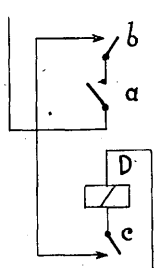
These circuits are generally shown in the upper part of the diagram. Other circuits are shown vertically below these circuits. A circuit between a battery and earth is shown in such a way that it progresses vertically downwards from the earth to the battery respectively.

Exceptionally, circuits which are shown only partly in the diagram, and which extend to another diagram, can be drawn horizontally, if this assists in making the diagram easy to understand.

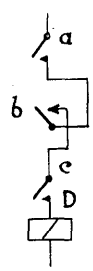
All the components of a circuit are shown in the order in which they are connected. Connections between these elements should be shown on the same straight line.



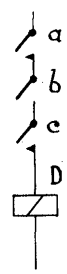
Incorrect



Incorrect



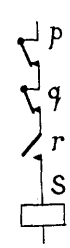
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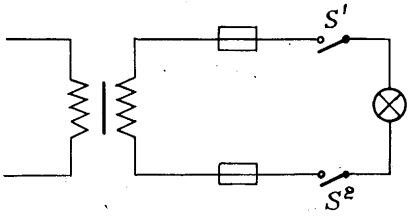
Incorrect



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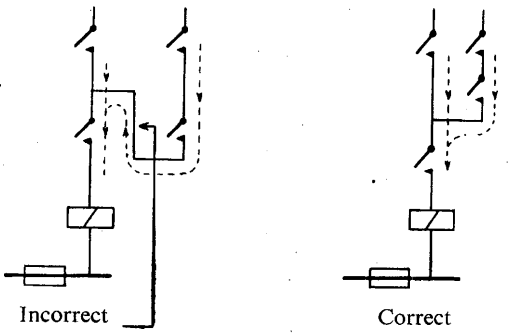
If a circuit includes a voltage generator (a source of current), the circuit is shown in the form of a rectangle. The generator (or equivalent components) is shown on the left hand vertical side of this rectangle : the receiving part of the circuit is shown on the right hand vertical side of the rectangle.

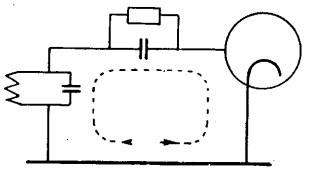
Interconnecting components can be shown on the horizontal lines.



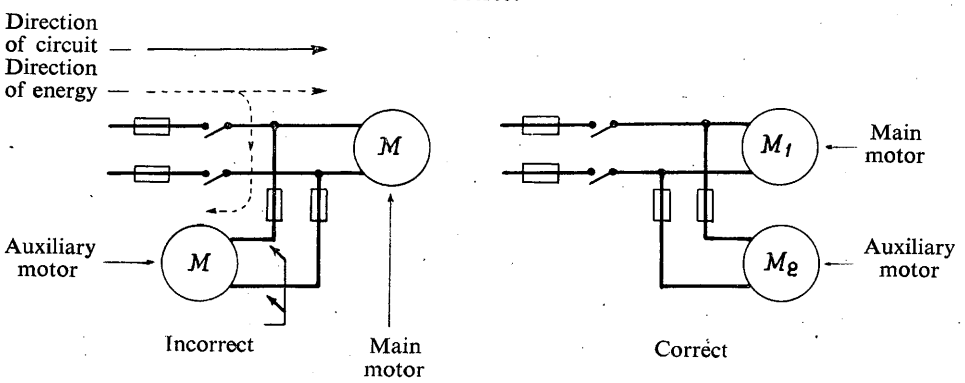
Branching circuits.

These should be shown by a line connecting at right angles with the line showing the main circuit : it is not permitted that in the drawing of the branch circuit, there should be any lines which would be operated in the opposite direction to those of the circuit under consideration.





Correct



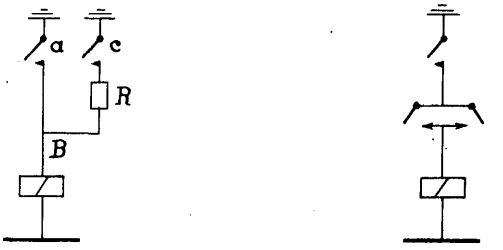
When two circuits have a common part, the circuit which operates first is shown to the left of the other circuit.

If a relay should — on the one hand, establish a circuit (1),
— on the other hand, be used to maintain another circuit (2),

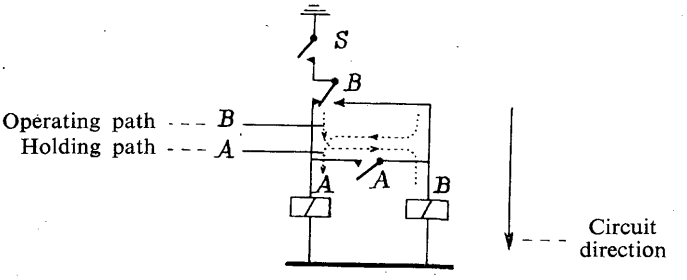
then circuit (1) should always be shown on the left of circuit (2).

The more important circuit is shown by a single straight line, while the less important circuit is shown, branching, by means of a broken line leading away from this straight line.

When the two circuits have the same importance, they are both shown in the same way leading away from the straight line corresponding to the common part.



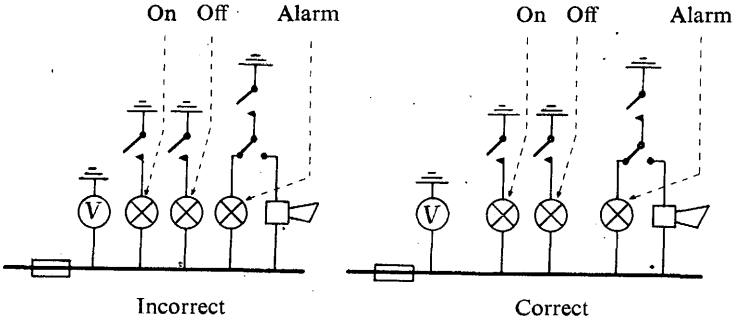
It is possible that current can flow in either of two directions in a part of a circuit. In such a case, this part of the circuit should be drawn at right angles to the rest of the circuit.



Grouping.

All the circuits which have a particular function in common are grouped together. These groups of circuits are shown from left to right on the diagram in the order in which they begin to operate.

In the same way, the circuits of a particular group are shown from left to right in order of operation.



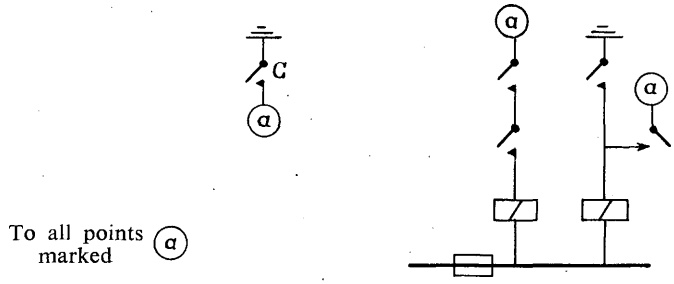
Common Wires.

In an equipment, there are a number of components which are not connected together and which are connected to the same point, common wire, etc.

This common point is, for example, the anode voltage in the case of radio equipments, or the " common earth " in the case of telephonic and telegraphic equipment.

This " common earth " is a wire which is connected to earth during nearly all the time that the apparatus is in use. When the connection between this wire and earth is broken, the holding circuits of several relays are interrupted, which permits the equipment to return to its normal condition.

In such a case, it is desirable to use symbols enclosed within a circle, these symbols being explained by a key. For example :

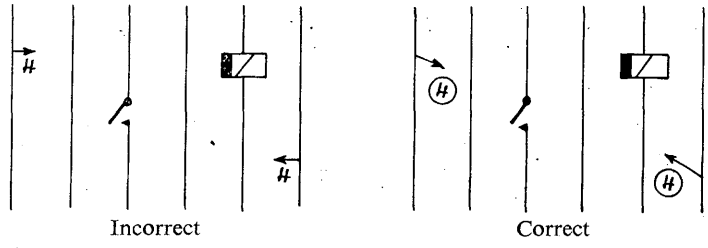


Connection between points widely separated on a diagram. References.

A connection between two circuits which are shown on the diagram some distance apart could result in a number of crossings of other circuits.

The difficulty is overcome by using arrows, accurately directed and sufficiently long to indicate precisely the direction.

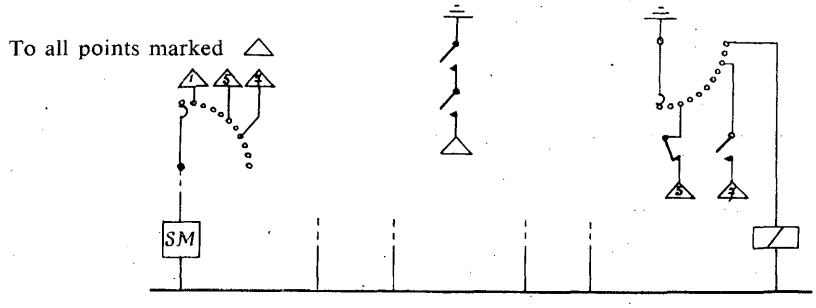
These references should be clearly marked, the recommended method being the use of a heavy circle with the reference number inside it.



Similar References.

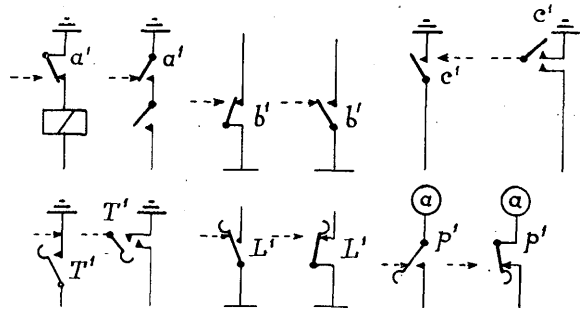
There are cases where many circuits lead from one part of a diagram to other parts which appear some distance away on the diagram.

By using the references shown below (or similar references), the need for many long lines connecting together all the points marked can be avoided.

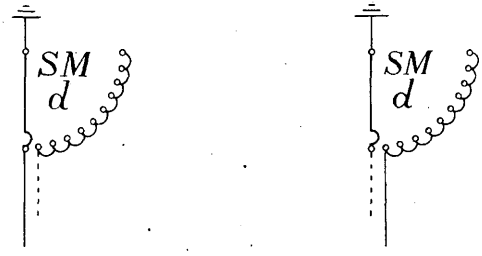


Separation of Contacts.

To the same end, the switching contacts of a relay or of a key, of which the contact spring (or one of the contact springs, in the case of double make or double break contacts) is directly connected to earth, can be shown separately.



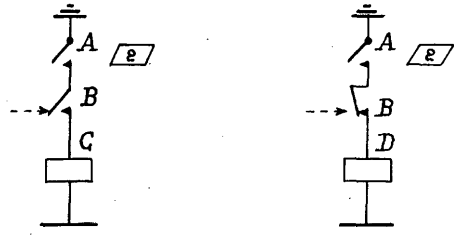
Similarly, the wiper of a rotary switch can be shown separately when the wiper is connected directly to earth, to the " common earth ", or to battery :



In all such cases, the existence of the rest of the connection is shown, without drawing it by two small dashes.

Showing components more than once.

As far as possible, a particular component should only be shown once. Nevertheless, cases may arise where the repetition of a component several times can be justified. In such cases, a number in a small square should be shown close to the component. This number will indicate how many times the component appears in the diagram.



Intersection.

By following all the rules in the foregoing, it should be possible to avoid all but a very few intersections. It is very important to avoid them as far as possible, provided that the diagram is not thereby made too difficult to follow.

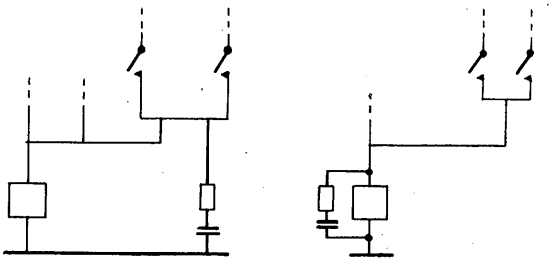
Relative importance of component parts.

If there are in a diagram certain parts or circuits so important that they should be specially indicated, they can be drawn larger or in heavier lines.

On the other hand, it is recommended that parts or circuits of secondary importance (for example, spark quenches), should be shown smaller or in lighter lines.

Clear indication of function.

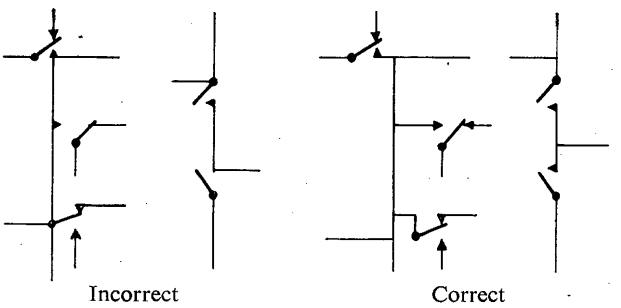
The contacts of short-circuit or spark quench devices should be closely related to the apparatus to which they apply.



Position of Contacts.

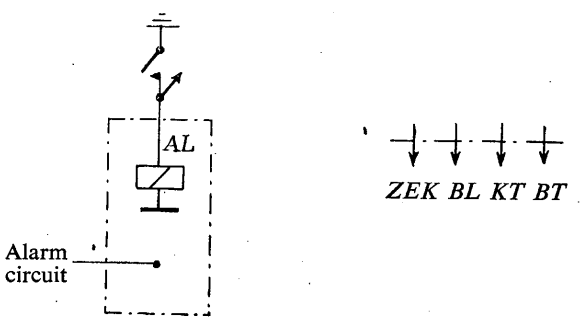
Contacts of selection, etc., should be shown in the normal position, and the contacts of relays in the position they occupy when the relay is not operated.

Two or more lines should never be shown connected to the same connecting point of an apparatus item. This applies equally to a continuous line.



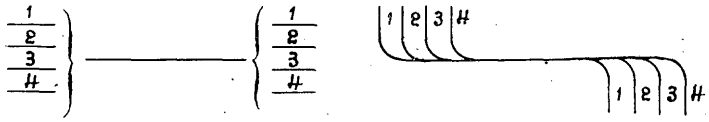
Extension of a circuit in another equipment.

It sometimes happens that a circuit is extended in another item of equipment. In this case, that part of the circuit which is in the other equipment should be drawn in a separate enclosed section of the diagram. If desired, all the common wires, and wires outgoing, can be shown separately on the diagram at any convenient point.



Parallel Lines.

It is permissible to group together a large number of parallel lines occurring in the same diagram.



If it is desired to show all the lines separately, it is preferable to arrange them in groups of not more than three.



Incorrect Correct

Naming the components.

It is necessary that all the components should be clearly identified. Different components should not carry the same description.

When it is possible to choose the identification for each component, it is preferable to use a correct sequence of letters or figures.

(For example, the relays of an impulse corrector should not be drawn in the order X, Z, Y, but in the order X, Y, Z.)

The component parts of the same apparatus item should carry the same primary identification. For example, the contacts of a contractor C should be shown as C^1, C^2, etc. The figures indicate the numbers of these contacts. It can happen that the contacts of the same relay can appear in several identical circuits, of which only one is drawn. In this case, it is necessary to indicate for which circuits the contacts have been used, or in a general way to indicate the number of the contact by "*x*".

For example, if the name of the relay is Bl, the number of the contact would be indicated by Bl^x.

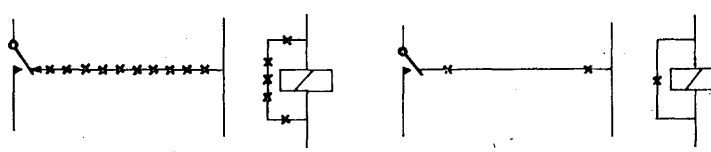
Important Data.

When it is useful to do so, data as to the characteristics should be shown close to the components.

This applies particularly to the ratio of a transformer, to the make and break intervals of an interrupter, etc.

Alternative circuit arrangements.

It is desirable to avoid, as far as possible, showing alternative circuit arrangements. If it is necessary to show them, it is recommended that the connection should not be indicated by means of crosses, or other symbols, throughout their length. A single symbol, or, in the case of long lines, one at the start and one at the end, will suffice.



Incorrect Correct

Summary of information about relays, keys, etc.

It is necessary to show, in summary form, the component parts of each relay, key, jack, etc., since the components of such units will in general be shown in different parts of the diagram.

For relays, a table is recommended.

Contacts or springs to which wires are not connected should be shown in brackets in the summary.



A letter may be used instead of a small figure. Thus, in the example shown above, we should have :

(R) C

Indication of Position.

In general, it is recommended that diagrams should be divided into squares, to enable appropriate references to be made.

Squares of 3 cm × 3 cm are generally used.

The part of the diagram on which the components of relays and keys are to be found can then be shown in the summary table.

Application of the Rules.

These rules should only be departed from if their application would make it difficult to follow the diagram, simplicity in this respect being the primary objective.

APPENDIX 3

Guiding principles to be observed in using the symbols and in preparing diagrams

(Extract from the Introduction to Brochure BS 550 concerning the list of graphical symbols used in the United Kingdom)

General.

. . . . . .

3.* Diagrams should be drawn so that the main sequence of cause to effect goes from left to right, and/or from top to bottom. The input (e.g. aerial of receiver) should always be on the left, and the output (e.g. aerial of transmitter) on the right. When this is impracticable, the direction of operation should be shown by an arrow. Balanced circuits are permitted exceptions from these recommendations. Components associated with each operational stage should be grouped together.

3*a*.* Subsidiary circuits (e.g. local oscillator, automatic gain control) should be drawn outside the main signal circuit, and may be shown in the lower part of the diagram.

4.* Frequently-occurring groupings of symbols, i.e. circuit elements, should be drawn in standard recognized forms. Examples are shown at the next page.

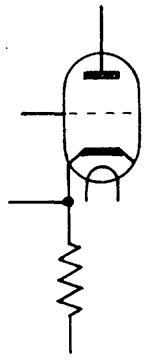
5.* Wires need not always be drawn as vertical and horizontal lines; it is sometimes preferable to draw a connection between two points as an oblique line. (See examples at the next page.)

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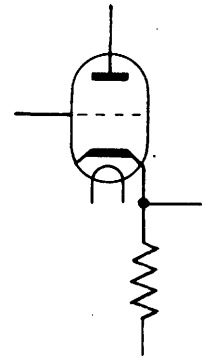
* The paragraphs marked with an * were in principle agreed by the 10th Study Group in 1956, the others are left open for discussion.

Examples for grouping of symbols

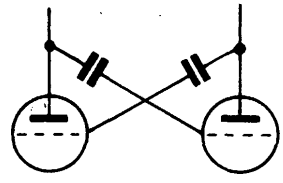
A cathode-input resistor should be connected to the left-hand end of the cathode, thus :



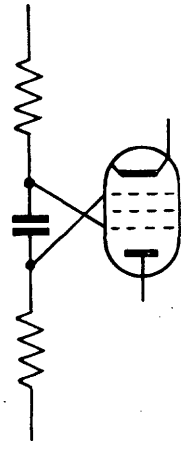
A cathode-follower output resistor should be connected to the right-hand end of the cathode, thus :



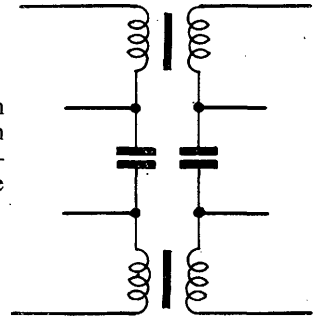
In a multivibrator the coupling capacitors should be shown thus :



The so-called " Transitron " circuit should be drawn thus :



A transmission Bridge as used in telephone engineering should be drawn thus :

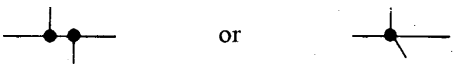


. . . . . .

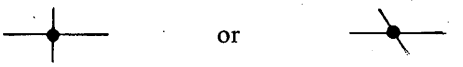
7.* A line should not change direction at a point where it crosses another line, nor should it cross over a junction between other lines.

. . . . . .

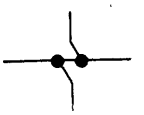
10.* In order to avoid confusion with conductors which cross without connection, conductors which are in contact may be staggered thus :



and not thus :



Connections (e.g. from cathodes of push-pull valves (see paragraph 21*a*) may be shown thus) :



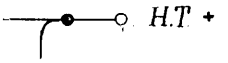
14.* The listed symbols and their various obvious combinations should meet nearly all the requirements of current telecommunication practice. In course of normal progress, however, new items will arise, which cannot be represented by the listed symbols. In such cases, the item may be represented by a simple geometrical shape (e.g. by a circle or a rectangle) with a brief verbal identification. Alternatively a new symbol can be devised. Any such new symbol may later find its way into common usage (as newly coined words do in technical language). It is therefore important that it should be devised with care. It should be as simple as possible, consistent with the main requirements already mentioned in the foreword, viz., it should be sufficiently pictorial to be self-explanatory and it must be unambiguous. That is, it should be so devised as to be suitable for inclusion in a subsequent revision of this Standard.

. . . . . .

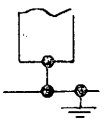
" Detached Contact " system

18.* *Earth and Chassis Connections.* — It may be advantageous to repeat the symbol 11 (or 11.1) to indicate connections of some components to earth (or chassis) in order to avoid unnecessary lines or cross-overs.

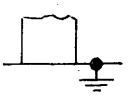
18*a*. Clarity in circuit diagrams is sometimes enhanced by substituting a tangent quadrant for a tee at some junctions (e.g. at the junctions of leads with an H.T. busbar), in order to emphasize a particular path, thus :



18*b*.* The chassis or earth connection line should not be used to represent part of a box or case, but the method of earthing such a box or case should be shown thus :



and not thus :

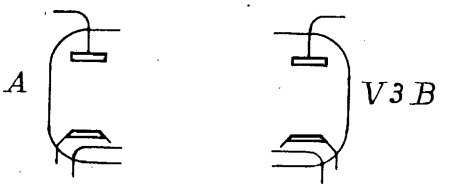


19. *Multi-points Plugs and Sockets.* — Short leads connecting plugs and sockets may be drawn near each plug or socket, each group being bracketed together with a suitable reference.

If there are more than four connections to a plug or socket or (in any case) if the sequence of connections is not the same at both ends, the connections should be separately coded.

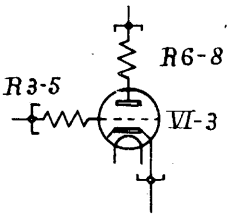
Valves and Valve Circuits

20.* Where the two "halves" of a "double" valve are associated with different parts of the circuit not adjacent in the diagram, the envelope and cathode may be drawn in two halves, with A and B suffixes to the valve designation. The following example shows a double diode with separate cathodes.



21.* Two or more valves connected substantially in parallel may be represented by one symbol, with a note of the number, provided that all the respective electrodes (with the possible exception of the heaters) are paralleled. The components (such as 'stopper' resistors) closely associated with each valve of a number in parallel can be shown in the same way. The valves and components will each have individual coded references which will be shown grouped beside the *single* components on the circuit diagram.

The use of the symbol—common connection to grouped apparatus—is recommended as shown above.

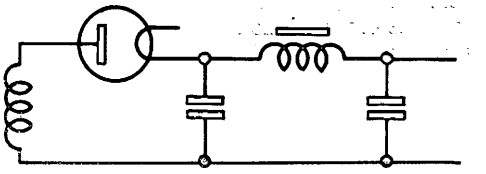


21*a*.* When drawing push-pull amplifiers, the two valves or groups of valves may be shown as mirror images. A twin amplifier should not usually be drawn thus.

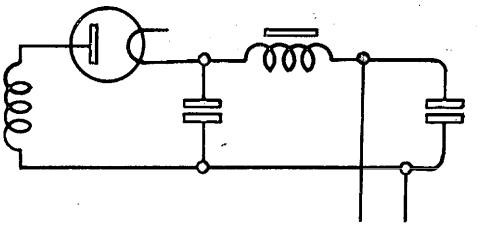
21*b*.* Key diagrams showing the physical arrangement of connections to valves may be drawn on circuit diagrams, where convenient.

21*c*.* Where two or more electrodes are connected together, they should still be drawn separately but shown connected.

22.* H.T. supply circuits which include a rectifier should preferably be drawn with the rectifying device in a horizontal path, and the reservoir capacitor in a vertical path, thus :



No output connection should be drawn from the part of the load between the rectifier and the reservoir (or smoothing) capacitor, thus :

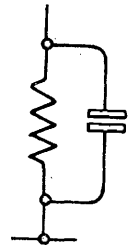


26. The principal voltage supply lines should be placed in order of their potential, positive lines above and negative lines below.

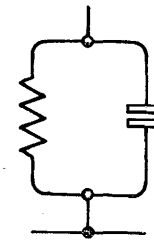
27.* Where a number of wires are shown as parallel lines, they should be grouped according to their functions, with wider spacing between the groups.

. . . . . .

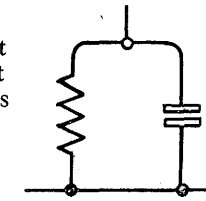
32.* Components in parallel should preferably be drawn thus :



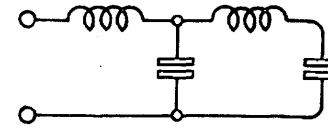
or



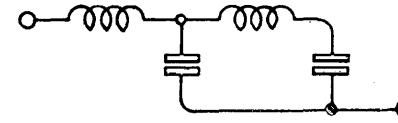
but not thus



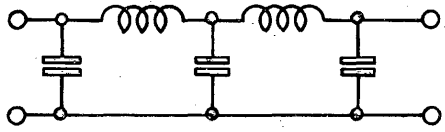
33.* Two-terminal networks should be drawn with the terminals at the same end, thus :



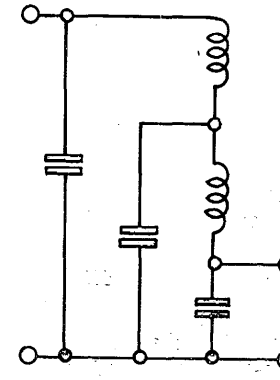
but not thus :



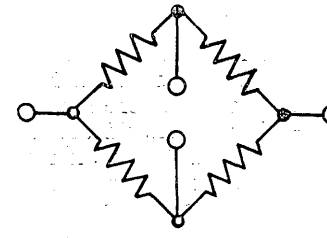
34.* Networks such as filters, smoothing circuits, attenuators, also phaseshift networks, should be drawn thus :



but not thus :

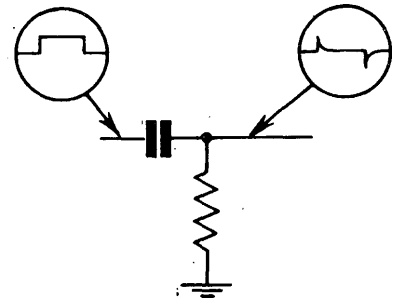


An exception is the bridge circuit which is preferably drawn in the diamond shape, thus :



Indication of wave form

35.* The operation of a circuit can often be clarified by the inclusion of representations of the voltage or current wave-form present at successive points in the circuit. These may be indicated by drawing the wave-form in a circle placed near the relevant point, this point being identified by a line starting from the circle and terminating in an arrow just short of the point. It is recommended that no attempt should be made to draw an *exact* representation of the waveform. The wave-form will usually be one of *voltage*. If some current wave-forms are shown. they can be distinguished by inserting the letters I or V in the circles to indicate the respective current or voltage.



Component location

37. It is frequently necessary to locate, in a circuit diagram in which each component is marked with its appropriate code reference, some particular component which is referred to in the associated text or elsewhere by the coded reference only. One method of facilitating such location is illustrated below.

	1	2	3	6	7		
R			4		8		R
			5				
C	1		2	4		5	C
			3			6	

This indication extends along the length of the diagram. A separate row is allocated to each class of component and is marked at each end with the code letter of the class, the numbers being distributed along the rows vertically above and below the corresponding component in the diagram. One row marked MISC at each end is allocated to the remaining components. In this row the full code reference is used thus :

MISC	LPI	XI	X2	TLI	X3	MISC

37*a*. In a diagram which is very complicated, or contains a large number of components, a map-grid system of location (e.g. with letter-number references) may be necessary. The grid lines need not be drawn across the diagram.

37*b*. In testing or finding faults it is often necessary to associate one end of a component in a circuit diagram with the corresponding end in the layout diagram.

In the *servicing* diagram, one end of each component (preferably the end more clearly visible in the actual equipment) should therefore be distinguished by some common indication such as a *wedge-shaped* mark. The same mark must appear against the corresponding end of each component in the circuit diagram. An excess of such marks may be avoided by drawing more of the connecting wires, especially in those servicing diagrams which also serve as wiring diagrams.

Diagrams

(a) By Circuit Diagram is meant a diagram which depicts in simple form, by means of symbols, the essential components and the interconnection required to provide the information necessary to show the operation of the circuit.

A circuit diagram will usually be so drawn as to show the operation of the circuits as clearly as possible, and therefore will not necessarily depict the various items, and their connections, in their actual spatial relationship.

(b) By Block Schematic Diagram is meant a diagram in which a group of components forming a unit—in the sense that they are all associated with a single stage or process—in a system comprising a number of different stages or processes, is usually depicted as a rectangle with a legend. The interconnections of such groups in the system are usually shown by single lines. This is sometimes called a " skeleton drawing " and was so called in the previous edition of this Standard.

The abbreviation Block Schematic is deprecated except as a colloquialism.

(c) By Plan is meant a drawing showing the geographical, technical, or administrative arrangement of installations or stations of a telecommunication system.

Diagrams, additional to those mentioned in paragraphs *(a)*, *(b)* and *(c)*, are defined as follows :

Installation diagram. — A diagram which depicts the separate units of all or part of an installation, together with all their interconnecting cables and wires and the necessary junction boxes.

Simplified diagrams. — A circuit diagram which depicts only those components and interconnections necessary to illustrate a particular disposition or to facilitate explanation of the circuit.

Functional diagram. — A diagram which illustrates the function of a piece of equipment. Note. This is often partly electrical and partly mechanical and therefore, does not conveniently fall under any of the other headings.

Wiring diagram. — A diagram which should enable the wiring to be traced out, but does not itself show the physical arrangement of that wiring.

Wiring layout. — A diagram which indicates the physical layout of the wiring Note. This is sometimes called a bench wiring diagram, a term which is objectionable as it can be confused with the wiring diagram of a bench.

Component layout. — A diagram or illustration which shows the whereabouts of various components.

Servicing diagram. — A diagram drawn specially to assist in the servicing of equipment. It generally includes many details such as location of components, adjusting and testing points (mainly for voltage tests), method of dismantling and mechanical adjustment. Such diagrams are usually supplemented by detailed textual instructions.

Routed schematic diagram. — A circuit diagram which also acts as a wiring diagram and shows uniquely the point-to-point connections of all wires.

Question 7/7.

(Concerns the International Electrotechnical Commission)

(Further to C.C.I.T. Question 49 and Question 1 of the 19th Study Group of the C.C.I.F.)

What amendments or additions should be made to the List of Graphical Symbols for Telecommunications already proposed by the C.C.I.F. and the C.C.I.T. ?

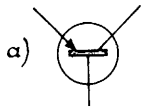
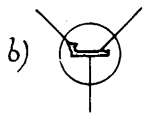
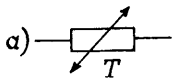
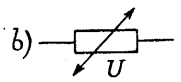
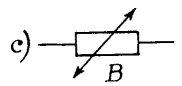
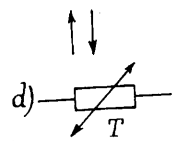
Note. — The part of this list comprising Section 1 (Symbols common to telecommunications) and Section 2 (Symbols peculiar to telephony) is annexed to C.C.I.F.Recommendation 5 (Volume I *bis* of the *Green Book*).

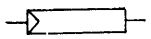
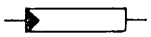
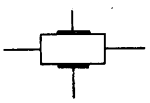
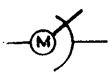
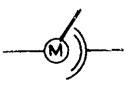
The part of this list comprising Section 3 (Symbols for telegraphy) is annexed to C.C.I.T. Recommendation I.4 (Graphical symbols) (Documents of the VIIIth Plenary Assembly, Geneva 1956).

Note. — In studying this question, Administrations may base themselves on the proposals in Annexes 1 and 2 below.

ANNEX 1

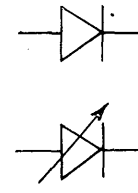
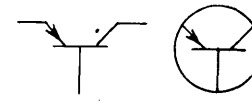
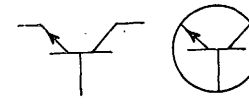
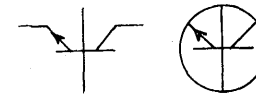
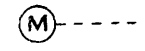
Proposals from the Federal German Administration for new graphical symbols for semi-conductors and motor-uniselectors

a)  b) 	*Contact Transistor or Junction-Transistor.* *Transistor*, p-n-p type  Emitter  Collector  Base *Transistor*, n-p-n type. The arrow shows the direction of emitter current.
	*Semi-conductor diode.*
a)  b)  c) 	*Variable resistor.* *(a)* T = temperature—dependent (conductor—hot conductor—cold). *(b)* U = voltage dependent (Varistor). *(c)* B = dependent upon magnetic field. The direction of resistance variation as a function of T, U or B may be drawn by a double arrow : Example : *(d)*.  same direction  opposite direction
d) 	*(d)* Conductor in hot state, shown by the double arrow in opposite directions (R falls when T rises).

Semi-conductors	
	*Photo-electric resistor.* Homegeneous, independent of current direction.
	*Photo-electric diode.* Barrier layer (dependent on current direction). *Without* auxiliary voltage as photo-electric *element* (current source). *With* auxiliary voltage (usually cut-off voltage) as photo-electric cell
	*Photo-electric Transistor.*
	*HALL Generator.*
	*Crystal counter.* As for GEIGER counter, but with semi-conducting crystal.
	*Photo-electric effect.*
Motor selectors	
	*Motor selector.* General, single motion.
	*Motor selector.* Two-motion.

ANNEX 2

Proposals of Expert of Commission No. 3 of the I.E.C.

No.	Name	Symbol
	Electronic Valve elements	
26	Element with asymmetrical conductivity (general symbol). *Note.* — If the current can be varied this may be indicated by means of an arrow. Example :	
26*a*	Dry plate rectifier.	
27*a*	Point contact or junction triode transistor with n-type base (2 variants).	
27*b*	Point contact or junction triode transistor with p-type base (2 variants).	
27*c*	Junction tetrode transistor with transverse biased p-type base.	
	Note. — For symbols 27*a*, 27*b*, 27*c*, the different electrodes are shown as represented by the drawing in next column. The arrow is always on the emitter and shows the direction of the current in the forward direction.	emitter collector  base
	Controlling elements	
203	Motor drive.	

Question 8/7.

(Concerns the C.C.I.R. and the International Electrotechnical Commission)

(New C.C.I.T. Question VI/3)

Is it desirable to have graphical symbols to represent the properties inductance, capacitance and resistance, in addition to those representing objects possessing these properties (inductor, capacitor, resistor) ?

How, for example, should the following be represented :

(a) a grid and a plate in a valve, if it is considered useful to indicate that the capacitance between them is not negligible;

(b) a piece of connecting wire, if it is considered useful to indicate that its inductance is not negligible in the conditions in which it is used;

(c) a coil, if it is considered useful to indicate that its capacitance is large enough, without the use of a capacitor, for it to be used as a tuning circuit ?

Is it desirable to recommend that these properties should be indicated by means of the symbols representing the objects possessing them, or by means of symbols derived from them ?

Question 9/7.

(Concerns the C.C.I.R. and the International Electrotechnical Commission)

(New C.C.I.T. Question VI/4)

How can the graphical representation of the contacts be improved ?

Note. — The following points should be considered :

1. Is it desirable to have different symbols for relay contacts, contacts of switches, dials, keys and buttons, selectors (in the idle position or in other positions), fuse alarms, etc. ?

If so, what should these symbols be ?

2. Is it necessary to have a special symbol in the list to denote a contact breaking a circuit simultaneously at two points ?

3. What conventions are followed at present when representing the moving part of a contact ? (For example, in some countries this moving part is represented in such a way that it should move round its axis in an anticlockwise direction when the contact is to be made. Another convention is to represent the armature always to the left or below the connecting line so that the letters or figures identifying the symbol are as close to the connecting lines as possible). Is it desirable to recommend these or other conventions ?

4. Is it desirable to use the filled-in triangle to represent the fixed part of the contact ?
5. Should the moving part of the contact be thicker than the connecting lines ?
6. Is it desirable to insert other contact devices in the List of Graphical Symbols, in addition to break contacts and make contacts ? If so, what devices should be represented ?

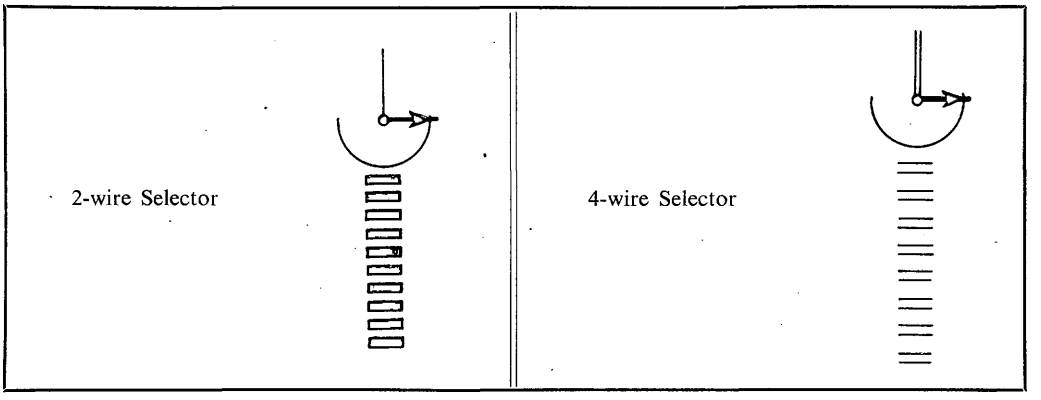
Question 10/7.

(In collaboration with Study Group 11)

(New Question 4 of the 10th Study Group of the C.C.I.F.)

How should a selector in a four-wire switching circuit be represented, to distinguish it from a two-wire switching circuit ?

Note. — In studying this question, the following proposal by the United Kingdom Administration (Document " C.C.I.F. — 1955/1956 — SG 10 — No. 5 ") should be considered.



Question 11/7.

(In collaboration with the C.C.I.R.)

(Further to Question 5 of the 10th Study Group of the C.C.I.F.)

Symbols for waveguide technique

Note. — In studying this question, the suggestions made by the British Administration, given in pages 546 to 558 of Volume I of the *Green Book*, should be particularly considered.

The following documents also relate to this question :

— " CCIF 1955/1956 — SG 10 — No. 4 — Reply from Mexico Telefones to question No. 5 of SG 10 ".
— " Working document DT/94 — Proposals from the Netherlands Administration on Question No. 5 ".

Question 12/7.

(Concerns the Technical Committee No. 43 of the I.S.O.)

(Former Question 2 of the 10th Study Group of the C.C.I.F.)

Letter symbols of principal constants of acoustics, in particular those concerning telephony.

Note 1. — It seems that a preliminary study of this question should be made by Technical Committee No. 43 of the I.S.O.

Note 2. — For the study of this question particular examination could be made of the proposals contained in the following documents :

— " CCIF — 1947/1948 — Symbols — Document No. 1 " : Remarks by the Telephone Administrations of Denmark, Norway, Czechoslovakia, Sweden and Switzerland concerning questions studied by the Letter and Graphical Symbols Committee.

— " CCIF — 1947/1948 — Symbols — Document No. 4 " : Replies by the Telephone Administration of the Netherlands to questions studied by the Letter and Graphical Symbols Committee.

— " CCIF — 1947/1948 — Symbols — Document No. 7 " : Replies by the Telephone Administration of Sweden and the *Sociedad Teléfonos de México* to Questions Nos. 1 and 2 studied by the Letter and Graphical Symbols Committee.

Question 30/7 (30 of Sub-Group 2/2)

(Study Group 7 and Sub-Group 2/2: Study to be made in the first place by Sub-Group 2/2)

(New Question set by the C.C.I.F.)

(a) For telephony, is it necessary to define the following terms :

— public telephone network,

— private telephone network,

— leased circuits service ?

(b) If so, could the following definitions be taken into consideration :

1. Public telephone network : Network set up to perform the telephone service for the public. It belongs to a telecommunication operating body (administration or private operating agency), and may be used to provide general telephone service.

2. Private telephone network : A network set up to provide a special telephone service by an organization other than a telecommunication operating administration or a private operating agency; generally, the network is the property of that organization.

3. Leased Circuits Service : A service whereby a circuit (or circuits) of the public telephone network is made available to a user (or group of users) for his (or their) exclusive use.

Note. — The VIIIth Plenary Assembly of the C.C.I.T. (Geneva, 1956) issued a recommendation No. I2 (Document of the VIIIth Plenary Assembly of the C.C.I.T. — *Mauve Book*) proposing to the Telegraph and Telephone Conference similar definitions for the telegraph service. These definitions can also be found at the beginning of the " List of Definitions of Essential Telecommunication Terms ".

TABLE SUMMARIZING

the questions assigned to Study Group 7

Chairman : Mr. GELLA (Spain)
Vice-Chairman : Mr. BIGI (Italy)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments :
1/7	Changes or additions to the Glossary of Definitions.	C.C.I.R., I.E.C.	
2/7	International Telecommunication Vocabulary.	C.C.I.R. I.E.C.	
3/7	Denomination of the various types of channels.	S.G.s 1, and 9, C.C.I.R.	Investigation first by Study Group 9
4/7	Relays : definitions.	I.E.C.	
5/7	Introduction to the List of Graphical Symbols.	I.E.C., C.C.I.R.	
6/7	Classification and standardization of circuit diagrams.	S.G. 11, I.E.C., C.C.I.R.	Investigation first by Study Group 11.
7/7	Changes or additions to the List of Graphical Symbols.	I.E.C.	
8/7	Graphical symbols for inductance, capacitance and resistance.	I.E.C., C.C.I.R.	
9/7	Contacts—how to represent graphically.	I.E.C., C.C.I.R.	
10/7	Representation of a four-wire selector.	S.G. 11	
11/7	Wave guide symbols.	C.C.I.R.	
12/7	Letter symbols for acoustics.	I.S.O. (Technical Committee 43)	
30/7	Extension to telephony of the definitions of public network, private network, lease of circuits.	S.S.G. 2/2	First to be considered by S.S.G. 2/2

Questions concerning Telegraph Apparatus

entrusted to

Study Group 8

in 1957-1960

Question 1/8.

(Former C.C.I.T. Question 34, amended)

What measurement methods can be recommended to ensure that start-stop telegraph apparatus satisfies the conditions laid down in Recommendation C.4 ?

Remarks. — To continue the study of the question it is advisable to consider the following aspects :

1. The measurements should be classified into :
   (a) those for the acceptance of machines from the factories, or from workshops after repair;
   (b) local measurements on machines in service, the measurements being made at the terminals of the machine.

2. In making these measurements it is desirable to define in each of the foregoing cases :
   — Sections of the teleprinter to which the measuring equipments are connected.
   — Nature and characteristics of such equipments.
   — Possible alterations which may have to be made to the teleprinter to make such measurements possible.
   — Value and tolerances of the various parameters concerned.
   — Physical and operating conditions of the teleprinter.

3. A point of special interest in relation to the measurements which it would be desirable to make is the determination of a practical method :
   (a) to establish a relationship between the error rate in translation by the receiving apparatus and the measured margin;
   (b) to establish a relationship between the measured transmitter distortion and the probability that this measured value of distortion will be exceeded.

Notes. — See, at the end of Question 3/8, the notes common to Questions 1/8, 2/8 and 3/8.

Question 2/8.

(In collaboration with Study Group 9)

(Former C.C.I.T. Question 37 amended)

In attempting to measure the margin of a local end (with its terminations) from a distant point, through the intermediary of a transmission channel, what relation is there between the result of this measurement, the true margin of the local end and the degree of inherent distortion in the transmission channel?

Should such measurements be recommended?

COMMENTS

The aim of the measurements shall be to establish a relationship between the result of measurements of telemargin (see *(a)* below) and the probability that the receiving apparatus will show an error rate lower than a given value. This value will have to be fixed later, in the light of the Recommendations B.51 and F.7 of the C.C.I.T., the results of measurements carried out by Administrations within the framework of Questions 34, 37 and 38 and the limits already indicated in Recommendation B.25 of the C.C.I.T.

The measurements of telemargin will be made with measuring sets conforming to the suggestions contained in the Note 3.

The measurements should consist of:

(a) a margin measurement M (telemargin) towards the receiving apparatus from the end of the transmission channel remote from the receiving apparatus (1 in Diagram 1);

(b) a margin measurement μ towards the local end (with its terminations) made from the last point at which the signals are repeated (2 in Diagram 1);

(c) a measurement of the inherent distortion δ of the transmission channel between points 1 and 2.

In the case of the margin measurements M and μ it would be useful to prepare the curve showing the frequency of occurrence of errors for each degree of applied distortion. In the case of measurements of inherent distortion δ, it would be useful to prepare the curve showing the frequency with which the measured degree of distortion is exceeded.

Notes: See, at the end of Question 3/8, the notes common to Questions 1/8, 2/8 and 3/8.

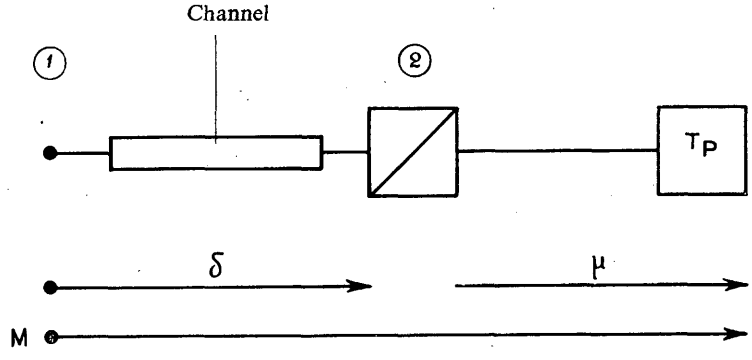


Diagram 1

Question 3/8.

(In collaboration with Study Group 9)

(Former C.C.I.T. Question 38 amended)

In measuring the degree of distortion at the output of a transmission channel associated with a local end (with its terminations), what relation is there between the result of the measurement, the degree of distortion at the junction of the local end and the channel, and the degree of inherent distortion of the channel?

COMMENTS

It is required to establish a relationship between the results of a measurement of teledistortion (see *(a)* below) and the probability that this result will be exceeded.

The measurements should consist of:

(a) a measurement of transmitter distortion *D* (teledistortion) of the signals transmitted by the apparatus and received at the extremity of the transmission channel (1 in Diagram 2);

(b) a measurement of the distortion *d* of the signals transmitted by the transmitter measured at the first point at which the signals are repeated after transmission (2 in Diagram 2);

(c) a measurement of the inherent distortion δ of the channel between points 2 and 1.

For these measurements *D*, *d* and δ, it would be useful to prepare a curve showing the frequency with which each degree of measured distortion is exceeded.

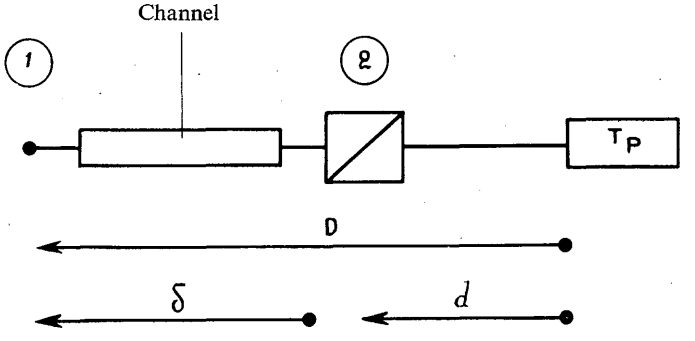


Diagram 2

NOTES COMMON TO QUESTIONS 1/8, 2/8 AND 3/8

NOTE 1. — The portion of the communication section metallically connected to the apparatus (from the last point at which the signals are repeated) constitutes the local end and its terminations mentioned in Questions 2/8 and 3/8.

NOTE 2. — The transmission channel is the channel included between the measuring set and the last point at which the signals are repeated.

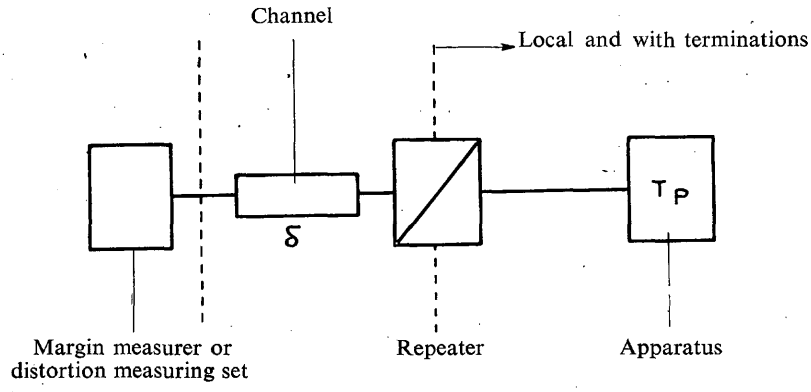


Diagram 3

The inherent distortion of this channel in the direction under consideration will be represented as δ (Diagram 3).

Measurements will be made by Administrations according to their own method of working (single-current or double-current).

NOTE 3. — *Suggestion on the subject of certain characteristics of measuring apparatus in view of the study of Questions 1/8, 2/8 and 3/8.*

Since, on the one hand, it is necessary to make statistical measurements for the study of the margin and the transmitter distortion of standardized start-stop apparatus;

and, on the other hand, a comparison between the results supplied by the different Administrations can only be made if the measurement conditions employed to obtain the results are uniform, the characteristics specified below are recommended for the measuring apparatus.

I. *Margin measuring apparatus.*

(a) the mean speed accuracy should be $\pm 0{\cdot}1\,\%$. The apparatus can, if necessary, be calibrated before each measurement or series of measurements;

(b) the nominal transmission cycle should be 7 and/or 7·5 units;

(c) the international text will be used (see Recommendation B.33);

(d) it is desirable that comparative measurements should be taken employing the following methods to obtain distortion:

1. by lengthening all the " start " signals (" late " distortion) or shortening all the " start " signals (" early " distortion), the code elements retaining their nominal theoretical length, and the intervals between successive start signals being constant and equal to the duration of the nominal transmitting cycle;

2. as above, but in alternate cycles;

3. in accordance with the proposal of the Federal German Republic (see Documents CCIT-SG III/26 and III/33, published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.");

4. by any other method.

Remark. — To carry out the comparative measurements mentioned in paragraph *(d)*, the teleprinters and any part of the circuit or circuit equipment which cannot be dissociated shall be left in nominal working conditions.

II. *Start-stop distortion measuring sets.*

(a) the mean speed accuracy should be $\pm$ 0·1 %. The apparatus can, if necessary, be calibrated before each measurement or series of measurements;

(b) the accuracy of reading should be $\pm$ 1·0 %.

Question 4/8.

In collaboration with Study Group 10)

(New Question III/1 of the C.C.I.T.)

The need has arisen, or is envisaged, for the use of five-unit signals for supervisory purposes and for the control of start-stop apparatus on an established connection. (See Recommendation F.10 of the C.C.I.T.).

The special signals needed include :

— start of message, start of text and end of message signals, for example for tape-relay and similar systems,

— waiting and error indicating signals for synchronous systems,

— signals for the control of apparatus (e.g. connecting and disconnecting a reperforator),

— a signal to indicate a fault in the course of a communication.

1. *(a)* What special signals of the types referred to above are used by the Administrations ?

(b) How are they provided ?

2. What new special signals are there for which an essential need is foreseen and, if so :

(a) Could they be obtained by using the secondaries of combinations 6, 7 and 8 and combination 32 of International Telegraph Alphabet no. 2 either singly or in groups ?

(b) If not, how is it proposed to obtain them ?

Are there, for example, sequences of other combinations of International Telegraph Alphabet No. 2 which could be used, either alone or in conjunction with the combinations mentioned in 2 *(a)* and which are liable to occur with negligible frequency in normal text.

Note 1. — In order to facilitate the study of the question, Administrations are invited to advise the Study Group dealing with technical aspects of telegraph apparatus of :

(a) the actual uses of the secondaries of combinations 6, 7 and 8 and of combination 32 of International Telegraph Alphabet No. 2,

(b) the signals or sequences of signals mentioned in 2 *(b)* which they consider could be used.

Note 2. — It is desirable that in studying this question the following factors be borne in mind :

Signals destined to initiate some auxiliary function, such as the operation of the control, connection or disconnection of control equipment in tape relay or equivalent systems or in reperforator switching systems, should be of a type which would never legitimately occur within the body of the message.

While it is desirable that they should also have a pattern which may be recognized by means of simple equipment, if their spurious occurrence is likely to have serious results, they should not—unless they require to be repeated more than once or are used in combination with other signals—be of a type which is prone to spurious generation by transitory faults.

Note 3. — See comments of Study Groups III and VII of the C.C.I.T. on Question 7/10 (" message separation " signal) of Study Group 10.

Question 5/8.

(New Question III/2 of the C.C.I.T.)

1. What are the devices already used or envisaged by Administrations to facilitate correct page layout on a receiving teleprinter ? (Any information on this subject should be forwarded to the Study Group entrusted with the technical study of telegraph apparatus).

2. What special signals, if any, will be necessary ? (Type and composition).

Note. — It is desirable to reduce to a minimum the number of additional signals which may be required. It may be possible to use some of the signals mentioned in Question 4/8 for switching control and for ensuring a correct page layout. (For example, the start-of-message, start-of-text, end-of-message and message-separation signals, etc.).

Question 6/8.

(Interests the C.C.I.R.)

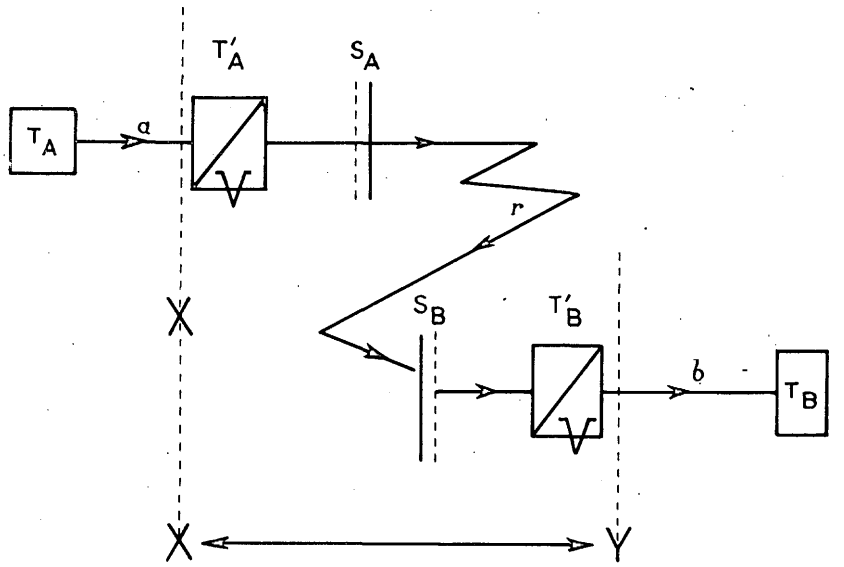
(Former Question 42 of the C.C.I.T.)

A. Study of cooperation between synchronous and start-stop systems.

B. Study of the influence of this cooperation on the minimum duration of the start-stop regenerative-repeater cycle.

COMMENTS

1. For a better understanding of the question, the general arrangement of a communication system invclving transmission over a synchronous channel, is shown below :



Synchronous system

In this arrangement : T_A and T_B are start-stop teleprinters.

T'_A and T'_B are repeaters with or without storage.

a and *b* represent the networks connecting teleprinters T_A and T_B to the repeaters T'_A and T'_B. These networks may comprise any number of channels in tandem, relays or regenerative repeaters.

S_A and S_B are the distributors of the synchronous system, the complexity of which it is not necessary to state.

r denotes a synchronous radiotelegraph channel.

It is agreed that for the study of this question, the synchronous system includes all the equipment shown between lines X and Y on the diagram.

The input and output of the synchronous system are thus directly connected to the start-stop networks.

2. By reason of the essentially different characteristics of line and radio transmission systems, particularly concerning the differences of signal level and interference,

It is recommended that Administrations discuss separately the conditions of inter-working between start-stop and synchronous systems operating

— on the one hand by line,

— on the other hand by radiotelegraph channel.

Question 7/8.

(Interests the C.C.I.R.)

(Former C.C.I.T. Question 43, amended)

What procedure and equipment should be used to permit interconnection of circuits worked by means of synchronous systems using special codes (see Recommendation C.24 of the C.C.I.T.) with circuits on which the International Telegraph Alphabet No. 2 is used ?

COMMENTS

1. The radiotelegraph channel is defined as being in conformity with Figure 1 given below. (This definition does not in any way affect the distribution of the study between the C.C.I.R. and the C.C.I.T.).

In this diagram the radiotelegraph channel includes all the equipment contained between lines X and Y, that is to say the radio transmitter E and radio receiver R proper, as well as the repeaters T'_A and T'_B.

T_A and T_B are start-stop teleprinters linked to the radio channel by parts *a* and *b* of the network. These may include any number of channel sections, relays, repeaters or regenerative repeaters, etc.

In the study of this question it might be useful for the radio channel, as defined above, to be linked to a repeater (Figure 2) comprising a receiving element R′ and a transmitting element E′.

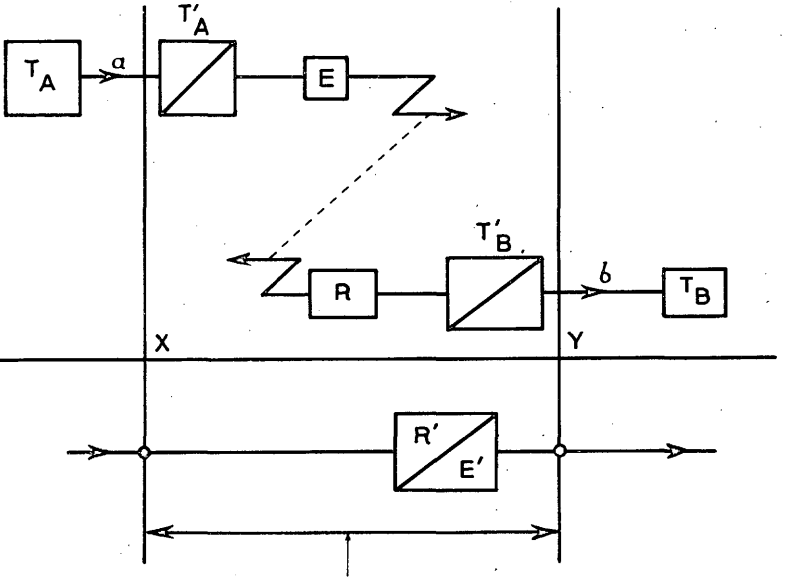


FIGURE 1

FIGURE 2

2. The study of the operating conditions to be imposed on the radio channel could be usefully carried out in accordance with the following :

(a) Conditions to be imposed on the receiving element R′ of the repeater equivalent to the radio channel (Figure 2).

(b) Conditions to be imposed on the transmitting element E′ (Figure 2).

(c) Conditions for the transmission of signals other than those of International Telegraph Alphabet No. 2, e.g., switching signals, control signals, etc.

(d) In the case of systems using storage, the delay in the re-transmission of the signals.

(e) What arrangements are to be recommended for the interconnection of two or more channels in tandem as may be required in international Telex working ?

(f) As there is some objection in certain circumstances to the use of perforated tape as a means of signal storage at the input to a synchronous telegraph system, what alternative arrangements can be recommended ?

Note. — Question 129 (point 4) of the C.C.I.R., is to be studied in collaboration with the C.C.I.R. within the more general framework defined above.

Question 8/8.

(In collaboration with Study Group 9)

(Former Question 27, Part 1, of the C.C.I.T.)

What requirements must be fulfilled by regenerative repeaters ?

(See note and study programme concerning Questions 22/9 and 25/9 of Study Group 9).

Question 9/8.

(New Question III/4 of the C.C.I.T.)

In order to permit :

(a) certain switching functions,

(b) certain measurements of the transmission characteristics of start-stop apparatus,

1. Is there any need to standardize :

(a) the total transmission time of the start-stop signals of International Telegraph Alphabet No. 2 of the answer-back unit, so that they follow each other at intervals of time equal to 7·5 units, that is to say with stop signal durations of 1·5 units ?

(b) the delay occurring between the instant of reception of the start element of the who-are-you signal first and the commencement of the start element of the first signal of the answer-back ?

In the affirmative,

2. What should the standards be ?

Note. — The conditions which lead to point 4 of Recommendation B.19 can now be considered as exceptional.

Question 10/8.

(New Question VI/5 of the C.C.I.T.)

1. Is it desirable to standardize any characteristics of start-stop automatic transmitters other than those already specified in Recommendation C.4 ?

2. Is there particularly a need to standardize the period of delay between receipt of the paper feed release and the moment when the corresponding combination can be transmitted ?

In the affirmative, what should this delay be ?

Note. — In this connection, the attention of Administrations is drawn to Point 3 of Recommendation C.4 of the C.C.I.T., recommending that the nominal duration of the transmitting cycle should be at least 7·4 units (preferably 7·5), the stop element lasting for at least 1·4 units (preferably 1·5), and also to the note following this Recommendation which recommends Administrations to withdraw apparatus which does not correspond to these standards from international service as soon as possible.

Question 11/8.

(Study Group 8, Sub-Group 1/3 and Joint C.C.I.T.T./C.C.I.R. Study Group for phototelegraphy)

(Former C.C.I.T. Question 44, revised)

Study of the transmission of half-tone pictures over combined radio and metallic circuits, when direct frequency modulation of the radio frequency carrier is used.

Question 12/8.

(Study Group 8 and Sub-Group 1/3)

(New C.C.I.T. Question IV/2)

Study of the possibility of increasing the speed of transmission for facsimile (including phototelegraph) systems in the international service by the use of equipment for correcting delay distortion on the carrier telephone circuits utilised.

(See the information concerning delay distortion quoted in the Annexes to Recommendation D.3 of the C.C.I.T. and the further information contained in Document SG IV/45 published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.".)

Question 13/8.

(Study Group 8 and Sub-Group 1/3)

(Former C.C.I.T. Question 45)

Can the recommendations contained in Recommendation D.1 of the C.C.I.T. be amplified or made more precise insofar as they relate to the indices of cooperation, speeds of drum rotation, and carrier current frequency to be used when operating over carrier telephone circuits having a frequency band width of 300 to 3·400 c/s ?

Note. — The VIIIth Plenary Assembly of the C.C.I.T. has studied the information received from the C.C.I.F. on delay distorsion on carrier telephone circuits and agreed that this would be annexed to Recommendation D.3 of the C.C.I.T.

However, it was concluded that, in the absence of appropriate practical experience, this information was not in itself sufficient to enable the prescriptions of Recommendation D.1 of the C.C.I.T. in respect of the index of co-operation, drum speed and picture carrier frequency to be used on carrier telephone circuits, to be made more precise.

It was therefore agreed that the Question be left for further study, to enable the results of practical trials to be communicated by Administrations.

Question 14/8.

(New Question IV/4 of the C.C.I.T.)

Is it desirable to establish standardized test charts for use in the international service for checking the quality of facsimile transmissions :

(a) with half tones,

(b) without half tones ?

and, if so, what should be the characteristics of such charts ?

Question 15/8.

(Study Group 8 and Sub-Group 1/3)

(Former C.C.I.T. Question 47).

Is there a need to envisage the use of frequency-modulation for facsimile apparatus working over international metallic telephone circuits ?

If so, what characteristics are to be recommended ?

COMMENTS

Study Group IV of the C.C.I.T. has studied the proposals issued by the XVIIth Plenary Assembly of the C.C.I.F. on the use of frequency modulation for phototelegraphy on metallic circuits and agreed to their incorporation in Recommendation D.3 of the C.C.I.T.

A statement concerning possible interference with V.F. signalling receivers has also been included in that Recommendation. The Study Group noted, nevertheless, that this would become

of importance only if at any time the C.C.I.T.T. proposed the adoption of automatic switching in the establishment of phototelegraph calls, but considered that a competent Study Group of the C.C.I.T.T. would be better able to pronounce on this point.

The information on experience with F.M. supplied by various Administrations was also studied, but it has been agreed that it was not yet possible to issue positive recommendations as to the circumstances in which F.M. should be used on metallic circuits. Frequency modulation has, however, been included as an alternative to amplitude modulation in Recommendation D.1 of the C.C.I.T.

The Question is therefore left open for further study with a view to acquiring practical experience.

Question 16/8.

(Study Group 8 and Sub-Group 1/3)

(New C.C.I.T. Question IV/1)

Is there a need to envisage the use of asymmetric sideband operation for permitting higher operating speeds on facsimile (including phototelegraph) apparatus working over international metallic telephone circuits ? If so, what characteristics are to be recommended ?

(See in this connection C.C.I.T. Document SG IV/44, published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.").

Question 17/8.

(Study Group 8 and Sub-Group 2/1 ; study to be started by Sub-Group 2/1)

(New Question IV/5 of the C.C.I.T., replacing former Question 46, Part 1, of the C.C.I.T.)

Is there a need to envisage the facsimile transmission of alphabetic telegrams in the international general public telegraph service ? If so, what should be the characteristics of the facsimile system to be employed ?

Note. — (a) Having regard to the fact that such a facility neither exists nor is envisaged in the near future in the international service, it is too early to recommend standards.

(b) Administrations which may have experience of such a facility within their national telegraph service, should be invited to contribute information to the C.C.I.T.T., as a basis for further study.

Question 18/8.

(Study Group 8 and Sub-Group 2/1 ; study to be started by Sub-Group 2/1)

(New C.C.I.T. Question, replacing former Question 46, Part 2, of the C.C.I.T.)

(a) Is there any need to introduce a new service into the international service to cater for the transmission by facsimile between subscribers of messages, business papers and similar documents ?

(b) If so, what standards should be specified for such an international service ?

Note. — In order that the standardization of the facsimile equipment can proceed without undue delay, it is desirable for Administrations to supply to the C.C.I.T.T. details of equipment now in use or proposed to be used in their national service.

Study, so far, of the question of the facsimile transmission of business documents, indicates that, in the event of such a service being established internationally, the following standards would be technically suitable for the transmission of documents of different national standard sizes in the range approximately *18 cms to 21·6 cms wide* and *27 to 33 cms long.*

Index of co-operation : 264.
Drum diameter : in the range 66 to 74 mm.

To meet the case of the possible use of drum type receivers, the transmitter drum factor, i.e.

$$\frac{\text{usable drum length}}{\text{drum diameter}}$$

should not exceed 4·7.

Similarly, the drum factor for receivers using drums should not be less than 4·7.

Drum rotation speed. — The joint C.C.I.T./C.C.I.R. Study Group V has proposed that, in the absence of any evidence that the conditions for the radio transmission of business documents differ materially from those for phototelegraphy, drum speeds of 90 r.p.m. and 45 r.p.m., in association with an index of 264, should be applied to the direct recording radio facsimile transmission of business documents, as in the case for phototelegraphy (see C.C.I.T. Recommendation D.4).

As regards transmission over metallic circuits, whereas higher speeds than those recommended for phototelegraphy are in certain circumstances possible, e.g. on domestic systems operating within urban areas, further experience of the various possibilities would be necessary before a final opinion could be formed as to what speeds might be recommendable.

Question 19/8.

(In collaboration with the Joint C.C.I.T.T./C.C.I.R. Study Group for phototelegraphy and with the W.M.O.)

(New C.C.I.T. Question IV/6, replacing former Question 46, Part 3, of the C.C.I.T.)

Study of the recommendable characteristics for apparatus for the facsimile transmission of meteorological charts. (This study is undertaken at the request of the World Meteorological Organization. It should be carried on in co-operation with this Organization and the results communicated to it).

Question 20/8.

(New Question IV/3 of the C.C.I.T.)

What methods and what apparatus characteristics could be recommended for the recording of facsimile (including phototelegraph) signals with a view to subsequent transmission or retransmission ?

Question 21/8.

(In collaboration with Sub-Group 2/1, to which the results will have to be communicated before decision)

(New Question III/7 of the C.C.I.T.)

Would it not be desirable in certain cases to make use of the return circuit of telegraph connections with a view to ensuring an immediate check at the transmitting end that the text transmitted has been correctly received ?

For this purpose the following system might be considered :

(a) the connections in question would be established over 2-way simplex circuits;

(b) teleprinters should be made available designed with a view to the immediate retransmission, over the return circuit, of the signals corresponding to the characters printed by the apparatus when operating as a receiver;

(c) the possible use of devices associated with the teleprinters to stop and start retransmission; these devices would be controlled by means of the appropriate signals;

(d) the possible use of an automatic device in the sending apparatus to check that the texts coincide.

ANNEX

(to Question 21/8 of Study Group 8)

Background of the Question, proposed by Belgium

In many cases it is important for the operator sending a message by telegraphy (whether in the case of Telex, leased circuits, the public station-to-station service or the switched service) to be almost absolutely sure that the text received by his correspondent coincides with the text transmitted. This applies for example to financial transactions, price offers, orders, and the transmission of numerical data to accounting machines.

The same also applies in the case of circuits which are especially subject to disturbance, such as those including a radio path; this is particularly true when the latter is not provided with a repeater system, when it is important for the correspondents to be assured that reception is correct.

A similar requirement arises in the international public switched service, in which the problem of notification of receipt has not been solved entirely.

In none of the above-mentioned cases does correct reception of the answer-back afford sufficient guarantee.

A highly attractive solution to ensure efficient and immediate checking of good reception would be to make use of the return circuit, which is very badly utilised at present and which exists in the switching centres as well as in voice-frequency channels. Duplex is in fact practically non-existent in Telex and relatively uncommon in station-to-station connections (except in radio connections of the public service). In other words the return circuit is really used only for receiving the answer-back.

The check in question could easily be made for apparatus connected by 4 wires (duplex) if teleprinters could be constructed in such a way that they could immediately retransmit signals corresponding to the characters they are receiving and printing. In this way the text returned would be printed by the sending equipment.

Another solution would be to design a device in the sending apparatus which would automatically check that the signals emitted and received are similar.

Supplementary arrangements should be made to ensure that the answer-back is released. One solution would be to operate the change to the " retransmission of check " position by remote control, using one of the signals mentioned in Question 4/8.

Question 22/8 (22/21 of Sub-Group 2/1)

(Study Group 8 and Sub-Group 2/1)

(New Question III/6 of the C.C.I.T.)

1. Are there needs in the telegraph service which cannot be met by the use of International Telegraph Alphabet No. 2 ? If so, what are they ?

2. If the answer to § 1 is affirmative, which of these needs require to be satisfied in the international service, and in what manner shall they be provided ?

Notes. — 1. In the study of this Question the attention of Administrations is drawn to the following contributions :

Italy,	Document SG III/37
Poland,	Document SG III/24
Sweden,	Document SG III/36
U.S.S.R.,	Document SG III/34

which are published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.F.".

2. If after consideration of this Question it is suggested that a new International Telegraph Alphabet, having more than 5 units, should be standardized, then Administrations are invited to consider whether this alphabet should replace the International Telegraph Alphabet No. 2, or whether it should be employed as a supplementary Alphabet. In the latter case, should the constitution of the alphabet permit interworking with International Telegraph Alphabet No. 2 ?

Question 43/8 (43 of Study Group 1)

(Study Groups 1 and 8)

(New Question 48 of the C.C.I.F.)

What general characteristics should be standardized to permit international transmission of metering data ?

COMMENTS

The scope of this Question is defined in the contribution sent by Sweden to the C.C.I.T. (C.C.I.T. Document SG III/36) which reads as follows :

Transmission over telecommunication circuits of data intended for computing and data-processing machines

During the last few years the question concerning the transmission over telecommunication circuits of data intended for computing and data-processing machines has aroused an increasing degree of interest. Among the questions to be answered in this connection the following may be mentioned :

1. What type of system should be chosen for the transmission of such data ?
2. Should telephone or telegraph circuits be used ?
3. Should transmission of such information be allowed on the general telephone or Telex communication networks, or should the use of special rented circuits be prescribed ?
4. What checking devices could be used to ensure a correct and perfect transmission of the material ?

Even though the question regarding the transmission of information of this nature is primarily of national interest only, the Swedish Administration is of opinion that this question should nevertheless be taken up for study. One of the reasons for this opinion is the desirability of standardizing data-processing machines as well as the special teletechnical equipment required. After the question has been studied by the C.C.I.T. in its different aspects, a Recommendation could be issued to all Administrations.

Under these circumstances, the Swedish Administration proposes that the C.C.I.T.T. should include in its programme the study of the following question : Transmission over telecommunication circuits of data intended for computing and data-processing machines.

TABLE SUMMARIZING

the questions assigned to Study Group 8

Chairman : Mr. PELLÉ (France)
Vice-Chairman : Mr. AMARANDOV (U.S.S.R.)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
1/8	Measurements on start-stop apparatus.		
2/8	Telemargin.	S.G. 9	
3/8	Teledistortion.	S.G. 9	
4/8	Five-unit supervisory and control signals.	S.G. 10	
5/8	Page layout.		
6/8	Cooperation between synchronous and start-stop systems.	C.C.I.R.	
7/8	Interconnection of circuits using special codes with circuits using a standardized code.	C.C.I.R.	

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
8/8	Regenerative repeaters.	S.G. 9 (see question 25/9)	
9/8	Standardization of answer-back units.		
10/8	Standardization of automatic transmitters.		
11/8	Transmission of half-tone pictures over combined radio and metallic circuits.	S.S.G. 1/3, S.G. MP	
12/8	Use of phase correctors for phototelegraphy.	S.S.G. 1/3	
13/8	Adaptation of phototelegraph apparatus for transmission over carrier circuits.	S.S.G. 1/3	
14/8	Standardized test charts for facsimile telegraphy.		
15/8	Use of frequency modulation for phototelegraphy (over metallic circuits).	S.S.G. 1/3	
16/8	Use of asymmetric sideband operation for phototelegraphy.	S.S.G. 1/3	
17/8	Facsimile transmission of alphabetic telegrams.	S.S.G. 2/1	Study to be begun by S.S.G. 2/1
18/8	Facsimile service between subscribers.	S.S.G. 2/1	Study to be begun by S.S.G. 2/1
19/8	Transmission of meteorological charts.	W.M.O. S.G. MP	
20/8	Recording of facsimile signals.		
21/8	Checking reception through return circuit.	S.S.G. 2/1	
22/8	New telegraph alphabet.	S.S.G. 2/1	
43/8	Transmission of metering data.	S.G. 1	
	Questions for which the collaboration of Study Group 8 is required		
8/21	Rates for phototelegrams.	S.S.G. 2/1 S.S.G. 2/3 S.G. 2	Possibly
21/21	Observations on the quality of traffic in the Telex service.	S.S.G. 2/1	
5/9	Observation of distortion.	S.G. 9	
8/9	Theoretical study of addition of distortion.	S.G. 9	
22/9	Transmission standards.	S.G. 9	

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Questions concerning Telegraph Channels

entrusted to

Study Group 9

in 1957-1960

Question 1/9.

(New Question I/1 of the C.C.I.T.)

Since the degree of individual distortion of a significant instant depends on the choice of the corresponding ideal instant, is it necessary to recommend a particular method of choosing the ideal instant ?

If the answer is affirmative, what rules will permit the ideal instant to be determined ?

What use can be made of the definition of degree of individual distortion, so defined, to simplify the definitions pertaining to degree of distortion of a modulation or restitution?

Note. — For the study of this question reference could be made to C.C.I.T. Document SG I/21 of 6 November 1956, published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.".

Question 2/9.

(New Question I/2 of the C.C.I.T.)

What are the constituent elements of a channel to which the notion of inherent distortion can be applied ?

How can the inherent distortion of these elements be determined ?

Question 3/9.

(Former Question 6 of the C.C.I.T.)

What method could be recommended for the determination of the law of distribution of the various values of degree of distortion pertaining to a prolonged modulation (or restitution) in the case :

(a) of an isochronous modulation (or restitution) ?

(b) of a start-stop modulation (or restitution) ?

(c) when the distortion considered is individual distortion ?

Question 4/9.

(New Question I/6 of the C.C.I.T.)

Is it possible to measure separately the degree of the different types of distortion which affect a telegraph modulation or restitution ? If so, what methods are recommended ?

Question 5/9.

(In collaboration with Study Group 8)

(Former Question 14 of the C.C.I.T.)

(a) What are the best conditions of observation (namely the nature of the modulation and the time and the duration of the test) which can be recommended for the measurement of signal distortion on an international telegraph circuit, in order to be sure the measurement obtained gives a good indication of what the performance of the circuit will be during periods of normal traffic ?

(b) By how much is it necessary to increase the distortion measured according to the conditions defined above in order that the result thus obtained should be equal to the value of the maximum distortion which can appear during the periods of use of the circuit in normal traffic ?

(c) What is the probability that the distortion actually produced by the circuit exceeds the value measured according to the conditions already defined in *(a)* ?

Note for the study of Question 5/9

It is to be understood that this question refers to methods of measurement to be used for the normal maintenance tests. These tests are applied to single links and are used to determine, on the one hand, whether adjustment is necessary to secure the best setting of controls and, if readjustment is made, to observe whether the subsequent performance is good. On the other hand, one can obtain from these tests data for the statistical control of performance.

In order to reply to the question, it is necessary to make a very great number of measurements in diverse conditions. The experimental results furnished by the Administrations in reply to other questions (e.g. Question 9/9 - former C.C.I.T. Question 12) could also give useful information.

At present it is neither possible nor desirable to define a programme of studies and measurements. On the contrary, it will be better to leave Administrations complete liberty in the choice of conditions and methods when they make measurements in order to reply to this question.

It only seems necessary to draw the attention of Administrations to the following points :

The method of measurement, time of day, and duration of test are to be chosen with a view to securing adequate performance of a link not only by itself, but also as one of several links in a complete circuit, and in addition to secure data for computing the conventional degree of distortion of such a complete circuit, making due allowance for the normal loss of performance between routine adjustments.

It may be necessary to suggest a compensating factor to be applied to the observations made at periods of light traffic, and it may be necessary to add to the normal routine, for example, by

making mesurements before readjustment (when this is not already done) to secure statistical data.

In view of the fact that Recommendation B.35 permits the measurement either of isochronous distortion or arythmic distortion using the standard text, but does not specify either the time or the duration of the test, and in view of the fact that the results taken at the busy hour will differ from those taken at other times, and that the longer observations of distortion are continued the greater in general is the degree of distortion indicated, it is necessary that the results of measurements should be accompanied by precise information regarding these points and other conditions of test.

These measurements should make it possible to define :

I) the relationship between results obtained with rhythmic (isochronous) and start-stop distortion meters; II) the circumstances in which the results are related by a simple correction factor and III) the circumstances in which it is desirable to use one type of apparatus rather than the other.

It is of interest to know not only what are the best conditions of measurement but also what reliance can be placed on the degrees of distortion observed.

Administrations are therefore invited to submit data regarding the uniformity obtained in measurements made by different methods and by different observers, and, if possible, to compare these observations with measurements made by apparatus not subject to visual errors, such as the Telegraph Distortion Analysers used by different countries.

Question 6/9.

(In collaboration with Study Groups 1 and 4 for Questions 6 and 7 of this Study Group)

(Former Question 16, Part 2, of the C.C.I.T.)

What are the causes of disturbances to signals received on a channel of communication, and how do they individually contribute to the resulting distortion ?

(See Recommendation B.41 of the C.C.I.T., Questions 2 and 3 of Study Group 4, Questions 6 and 7 of Study Group 1).

Question 7/9.

(New Question I/7 of the C.C.I.T.)

1. A qualitative study of the causes of fortuitous distortion and of their distribution in time.

2. The study of the possibility of realizing a generator reproducing as faithfully as possible the causes of fortuitous distortion; determination of the characteristics of such a generator.

3. Study of a means of measuring fortuitous distortion alone on a channel.

4. Systematic study of the effect of fortuitous distorsion on the total distorsion of tandem connected channels.

Question 8/9.

(In collaboration with Study Group 8)

(New Question I/4 of the C.C.I.T.)

By what method, founded on theoretical considerations, can the degree of distortion of tandem-connected channels be predicted with an accuracy sufficient for practical purposes when that for each of the channels is known ?

Note. — For the study of this question reference could be made to the Annex, hereafter, which is extracted from C.C.I.T. Document SG I/16 of 7 August 1956.

ANNEX

(to Question 8/9 of Study Group 9)

1. A change in significant condition, taken in conjunction with the (significant) instant at which it takes place, is called a " mutation " or " sematic element ").

Hence a sematème is made up of a succession of mutations.

Each of these mutations is represented by a number, called its index number, which characterises it completely and without ambiguity. This number is calculated bearing in mind all the elements in the sematème, but these grow in importance the closer they are to this mutation.

2. With one channel (which may or may not be made up of several channels joined end-to-end) and in given transmission conditions, the degree of individual distortion of a mutation belonging to a perfect outgoing sematème presents the following peculiarities :

(a) If the distortion is characteristic, it depends on the index number of the mutation, and on that alone. In theory there is a single-value correspondence between the index number and the individual distortion.

(b) Should the distortion be fortuitous, it is independent of the index number.

(c) Should the transmission channel suffer characteristic and fortuitous distortion simultaneously, the individual distortion of the mutation will be equal to the sum of the two degrees of individual distortions.

3. In taking the same time origin to define the individual distortion, *we are assuming, as a first approximation*, that the individual distortion produced by a link is merely added to that produced by the preceding links.

4. We assume that for each link the probability of a given degree of purely fortuitous individual distortion being reached is known.

5. *With an isochronous sematème.*

(a) Let us, provisionally, assume that the fortuitous distortion is nil. We then look (by means of its index number) for the mutation which, at the output of the complete channel, is restituted with the smallest restitution delay, that is to say, the mutation which presents the *smallest* characteristic individual distortion *c*.

We discover this latter by calculation, by graphical method or experimentally. In principle, if the sematème has no peculiarities, such a mutation will be unique. In reality, there are other sematèmes with distortions very much the same as its own. We determine the frequency p_o with which these mutations occur.

(b) At the output of the first link, one of these mutations is restituted with a delay equal to the algebraical sum of the delay due to the characteristic distortion and of a fortuitous digression.

There is a certain probability that this fortuitous digression will be equal to a given negative figure (it will be noticed that in such circumstances the mutation is restituted earlier then it would have been had there been no fortuitous distortion).

In other words, then, there is a probability p_1 of the mutation being restituted with an individual distortion *less* by a given quantity f_1 than its characteristic individual distortion.

Now if *the second link* produced no fortuitous distortion, it would restitute the mutation with a certain individual distortion due to the first link and to its own characteristic distortion. But because of the fortuitous distortion, there is a probability p_2 of it being restituted with an individual distortion *less* by a given quantity f_2 than this above-mentioned individual distortion.

And so on up to the final link.

Thus, one step leading to another, the restitution occurs *in advance* of the time schedule it would have if there were no fortuitous distortion. Hence the mutation finally suffers an individual distortion *less* than the smallest which would be due to the characteristic distortion alone.

(c) Provided that :

$$p_1 \frac{df_1}{dp_1} = p_2 \frac{df_2}{dp_2} = \ldots,$$

the probability of a mutation being eventually restituted with an individual distortion equal to :

$$d = C + f_1 + f_2 + \ldots$$

is :

$$p = p_0\ p_1\ p_2\ \ldots$$

(d) We effect the same calculations while endeavouring to come across cases in which, from one step to another, restitution occurs *with a lag* in relation to the time schedule it would have if there were no fortuitous distortion. Hence this will lead to an individual distortion *greater* than the largest that would be due to the characteristic distortion alone.

These calculations indicate (with a notation the significance of which is evident) that the probability of a mutation eventually being restituted with an individual distortion equal to :

$$D = C + F_1 + F_2 \ldots$$

will be :

$$P = P_0\ P_1\ P_2\ \ldots$$

provided that :

$$P_1 \frac{dF_1}{dP_1} = P_2 \frac{dF_2}{dP_2} = \ldots$$

(e) Then the distortion of the restituted isochronous sematème at the end of the chain will be :

$$\Delta = D - d$$

From these results, the probability that the degree of distortion Δ will be exceeded may be deduced.

6. *With a start-stop sematème.*

With a start-stop sematème, *all the mutations*, including the " start " ones, are generally restituted with different restitution delays. Hence all suffer an individual distortion.

Hence, too, the problem is not fundamentally different from the problem of the isochronous sematème.

The same procedure, suitably adapted, is applied in the following fashion :

(a) We determine the probability of, *in the same signal*, the start mutation suffering an individual degree of distortion less by a certain amount than the smallest individual degree of characteristic distortion, and of any one of the mutations suffering an individual degree of distortion greater by a certain amount than the greatest individual degree of characteristic distortion.

(b) We then determine the probability of the start mutation suffering a very high degree of distortion and of any mutation in the same signal suffering a very low degree of distortion.

(c) The degree of distortion of the start-stop sematème, and the probability of it occurring, will be given by the less favourable of the two results obtained.

The probability of it being exceeded may be deduced from this result.

All this presupposes that we know, for each link :

1. The degree of characteristic individual distortion of a mutation as a function of its index number;
2. The law governing the probability that fortuitous digressions will appear.

The inherent distortion of a transmission channel includes both characteristic and fortuitous distortion. We shall experimentally separate out this latter by transmitting a sematème of reversals and by measuring the distortion of its restitution. In this case the characteristic distortion appears

to be nil, and only the fortuitous distortion remains (provided, of course, that any bias distortion has been annulled in advance).

We eliminate the causes of systematic errors due to resonance effects by making measurements with different reversals :

$$\frac{1}{1}, \quad \frac{2}{2}, \quad \frac{3}{3} \quad \ldots$$

If, now, we refer back to what has been said above, to Question 12 *bis* of the VIIIth Plenary Assembly at Arnhem, and to the work plan laid down in Geneva in 1955, we may make the following statement :

1. Measurement of the inherent distortion of a transmission channel with reversals $\left(\frac{1}{1} \text{ or } \frac{2}{2}\right)$ provides information about its fortuitous distortion, and about *that alone*. The law governing the composition of distortion for tandem connected channels depends on the probability curve for each link.

2. Measurement of the inherent distortion of a transmission channel with $\frac{1}{6}$ or $\frac{6}{1}$ signals gives, in practice, no results, for the two kinds of distortion are mixed. There is, in addition, little likelihood that just those two index numbers given by the sematemе will be precisely those corresponding to the extreme degrees of characteristic individual distortion.

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Question 9/9.

(Former Questions 12 and 12 bis *of the C.C.I.T.)*

Study of the influence of different sections (links) on the quality of transmission of a complete telegraph connection ? (See Recommendation B.23 of the C.C.I.T.).

For rhythmic service distortion, and in the case in which the distortion on symmetrical signals has been previously reduced to a minimum by a suitable adjustment, can the results obtained be expressed by a law of addition of distortion lying between arithmetical and quadratic additions of the component values ?

NOTE

The investigations carried out by Administrations in connection with Question 12 *bis*, Part B, have established that a law of addition lying between arithmetical and quadratic additions of the component values of distortion is applicable in all but exceptional cases, but a more precise basis for calculation is desirable.

In general the isochronous standardized test distortions (reference B.51 of the Draft List of Definitions, page 49) of a telegraph circuit consisting of a number of links in tandem, lies between the arithmetic sum and the square root of the sum of the squares of the degrees of distortion of the individual links,

$$\sum_{i=1}^{n} \delta_i > \delta > \sqrt{\sum_{i=1}^{n} \delta_i^2}$$

n being the number of links in tandem.

The few exceptions to this rule which have been observed related to extremely long circuits (for example, 4 links, each of approximately 3500 km., looped at voice-frequency at the distant end to give the equivalent of 4 links (each 7000 km. go and return) and a total length of approximately 28000 km. on cable and open wire carrier telephone channels).

It was therefore considered to be of interest to the C.C.I.T. further to study whether the same law of addition of degree of distortion is equally applicable to extremely long links and to links of average length.

Furthermore, tests carried out by the Netherlands Administration seem to indicate that the following general formulae are in conformity with the practical results so far obtained in tests on telegraph channels in the Netherlands Telex Service.

For such purpose as planning networks, the probable degree of distortion of a telegraph circuit consisting of n channels or links in tandem in the Telex service (where a great number of channels will be interconnected at random) is given by :

$$\delta_{\text{inherent}} = \sum_{1}^{n} \delta_c + \sqrt{\sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2} \qquad (n \gg 1)$$

Similarly, for the combination of a transmitter and a telegraph circuit consisting of n channels or links in tandem in the Telex service, the probable degree of distortion is given by :

$$\delta_{\text{texte}} = \sum_{1}^{n} \delta_c + \sqrt{\delta_t^2 + \delta_v^2 + \sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2} \qquad (n \gg 1)$$

where

δ_{inherent} = the probable degree of inherent standardized test start-stop distortion,

δ_{text} = the probable degree of gross start-stop distortion in service,

δ_c = the degree of characteristic start-stop distortion of a single channel or link,

δ_t = the degree of synchronous start-stop distortion of the transmitter,

δ_v = the degree of gross start-stop distortion due to the speed error of the transmitter, which is equal to six times the actual speed error,

δ_{bias} = the degree of asymmetrical (bias) distortion of one channel measured using 1 : 1 or 2 : 2 signals (either 1 : 1 or 2 : 2 signals should be used according to which is normally employed for adjusting the channels),

$\delta_{\text{irreg.}}$ = the degree of fortuitous distortion of one channel measured using 1 : 1 or 2 : 2 signals.

Moreover, it is believed that if the values of distortion inserted in the foregoing formulae are only exceeded with a probability of 1 in 100000, then the results given would be the degrees of conventional distortion.

The degree of characteristic distortion δ_c of a channel is fairly constant for each type of voice-frequency channel and can be determined in laboratory tests.

Empirical values for δ_c can be obtained with reasonable accuracy by measuring the total distortion with Q9S signals after bias has been adjusted to minimum, and subtracting from it the irregular distortion measured using 1 : 1 or 2 : 2 signals. Except in the case of old VF telegraph systems incapable of transmitting accurately a long train of 1 : 6 signals, one may use instead of the degree of distortion of Q9S signals, the degree of distortion of 1 : 6 or of 6 : 1 signals, if either of these is larger than the degree of distortion of the Q9S signals.

Other Administrations are requested to use the results of tests obtained on their own telegraph channels to check whether the Netherlands formula is of general application. Administrations in a position to do so should apply these formulae both to amplitude-modulated and to frequency-modulated voice-frequency telegraphy channels.

Question 10/9.

(New Question 1/3 of the C.C.I.T.)

Study of the influence of constituent elements of a single channel upon the inherent distortion of that channel.

Is it necessary to introduce notions analogous to those employed in telephony for the study of insertion and matching?

Note. — It is a question of knowing whether it is possible to predict the effect on the inherent distortion on a channel; of the removal or replacement on an element, e.g. a receiver, an equalizer, etc.

Question 11/9.

(In collaboration with Sub-Group 2/1, to which the proposals of Study Group 9 will have to be communicated before decision)

(Former Question 5 of the C.C.I.T.)

How can the ideas of " efficiency factor of a telegraph communication ", " quality index of telegraph operation " and " quality index of a modulation or restitution " be applied to assess the quality of a radio-telegraph communication?

What method could be used to attain this result?

Question 12/9.

(New Question II/12 of the C.C.I.T.)

Are any countries still using direct-current telegraphy for their international communications?

If the answer be negative, could not Recommendations B.3, B.4, B.5, B.6, B.7, B.8, B.9, B.10 and B.28 be deleted?

If the answer is affirmative, ought not the above Recommendation to be brought up-to-date and in what manner?

Question 13/9.

(In collaboration with Study Group 4; this study will be left pending until the study of Question 2 of Study Group 4 has been concluded)

(Former Question 15 of the C.C.I.T.)

What maximum transitory distortion can be tolerated on signals when the transmission equivalent of circuits carrying voice-frequency telegraph channels suddenly varies?

The further study of this question should be pursued in the following manner :

1. What are the duration, amplitude and frequency of occurrence of the level variations ?

2. Are the resulting distortions tolerable when their frequency of occurrence is taken into consideration ?

Question 14/9.

(Former Question 22 of the C.C.I.T.)

1. Should voice frequency telegraph systems be used in international traffic which give low value transitory distortion for sudden variations of the equivalent of carrier circuits ?

2. If so, what are the conditions which such systems should fulfil ?

Note. — In the study of this question, it is of interest to note that a frequency modulated telegraph system, using the same (pass) bandwidth as an amplitude modulated system, gives a very satisfactory result.

1. When the signal level varies extremely widely, the distortion of a frequency modulated system remains small by comparison with an amplitude modulated system (without automatic control by a pilot channel), although the sensitivity to frequency variations (due, for example, to transmission through a single side band carrier telephone system) is greater.

2. A frequency modulated system needs no control for signal level, and there is no need to fear additional distortion either for slow or rapid variations of received signal level. It is difficult to ensure this virtue in an amplitude modulated system without transmitting a pilot signal for level control.

3. Theory suggests, and practice confirms, that a frequency modulated system is more secure against interference than an amplitude modulated system, although this advantage is somewhat reduced if the signal levels are so chosen that, during busy hours, the average (voice frequency) power is the same for both systems.

4. The control and maintenance of frequency modulated telegraph channels are facilitated by the existence of a permanent signal upon the line.

5. A frequency modulated system is directly applicable to radio (telephone) transmission.

6. When used for switched telegraph networks, frequency modulated systems give rise to far fewer false calls than amplitude modulated systems, for the reasons indicated in § 3 and 4.

In any case, the study of voice frequency telegraph systems, insensitive to large variations of level, should be fully examined to avoid :

(a) distortion due to slow and rapid variations of signal level.

(b) false calls in switching systems.

Note. — If the control current in the static relay (or its equivalent) used for control of the alternating signal fails, or if the telephone line is severed, it is just as important for a frequency modulated system as for an amplitude modulated system, that the output from the receiver should be the significant condition corresponding to start.

In the event of an almost complete break in transmission on the telephone line, a normal voice frequency telegraph system would seem to be at no disadvantage compared with a voice frequency system insensitive to great variations of level, if the latter is arranged so that in response to signal failure, the output from the receiver is the significant condition corresponding to start.

Question 15/9.

(New C.C.I.T. Question II/1, replacing C.C.I.T. Questions 16 bis, *20 et 21)*

Study of cooperation between different amplitude-modulated voice-frequency telegraph systems.

Note. — This question should be studied from the following points of view :

1. the duration and amplitude of noises liable to operate the voice-frequency detectors;
2. the form and frequency spectrum of the signals transmitted;
3. insensitivity to slow but large variations of level;
4. reducing the risk of false calling signals;
5. insensitivity to the effects of non-linearity in the telephone channel.

Question 16/9.

(In collaboration with Sub-Group 1/3)

(New C.C.I.T. Question II/2, further to C.C.I.T. Question 23)

Study of the standardization of frequency-shift modulated voice-frequency telegraph systems (see Recommendations B.48).

Note 1. — This question should be studied from the following aspects :

1. The frequency spectrum of the signals transmitted.
2. The tolerances for variation in level of the signal transmitted.
3. The methods which should be employed (if necessary) to reduce the sensitivity of the system to frequency shifts whether by a pilot channel or by an adequate device in each channel.
4. The minimum level below which the receiving equipment might give an alarm, and the level (which might be the same) below which the receiving equipment should transmit the start polarity in the case of complete or partial failure of the telephone circuit.

5. The tolerable degrees of distortion in the channels :

(a) In the case of normal transmission level and without frequency error in the telephone circuit,

(b) in the case of slow variations of +1 neper (+8.7 db) above and −2 nepers (−17·4 db) below the normal level of the received signals,

(c) in the case of abrupt variations in the level of the received signals by steps of 1 neper (8·7 db) in the range from +1 neper (+8·7 db) to −2 nepers (−17·4 db),

(d) due to the presence of a sinusoidal interference whose level is 2·3 nepers (20 db) below the level of the signal and whose frequency is equal either to the mean frequency, or to either of the frequencies corresponding to the stop and start polarities,

(e) if the frequencies are displaced by 3 c/s and by 5 c/s by transmission through the telephone circuit.

6. Insensitivity to the effects of non-linear distortion in the telephone circuits.

7. The limits of near-end cross-talk permissible between the two directions of transmission of a 4-wire telephone circuit used for frequency-shift modulated voice-frequency telegraphy.

8. Any other standardization which may be necessary for satisfactory co-operation between frequency-shift modulated voice-frequency telegraph equipments of different designs.

Note 2. — The determination of the spectrum of the signals transmitted (with limits) is a very difficult question. The detailed study of this question should be continued. In the course of discussion the following suggestions were put forward by way of example.

In systems in which at the significant instants of modulation, the frequency of the oscillator changes suddenly (but without phase discontinuity) it will suffice, in order to define the frequency spectrum of the signals transmitted, to give the attenuation and phase characteristics of the sending filters in their pass bands and their attenuation characteristics in their attenuating ranges, because the spectrum of a wave whose frequency changes suddenly (with phase discontinuity) is well known.

For systems in which the transition from the start frequency to the stop frequency or vice-versa takes an appreciable time, the spectrum of the signals transmitted should be defined, both in amplitude or in phase, either theoretically or empirically, in the band of frequencies $F_o \pm 60$ c/s (where F_o is the mean frequency) and should be defined only in amplitude in the remainder of the frequency band.

In the band of frequencies $F_o \pm 60$ c/s one need consider only the discontinuous spectrum corresponding to 4:4 signals at 50 bauds; for the other frequencies the spectrum should be defined by the envelope of the maxima of the components of each frequency for signals whose modulation rate may vary from 0 to 50 bauds.

Note 3. — A possible disadvantage of frequency-shift modulated telegraph systems is their greater sensitivity to frequency differences between the two ends of a system resulting from frequency errors in the bearer telephone channel, where the latter undergoes one or more stages of frequency translation. The effect of a difference of

1 c/s between the frequencies at the two ends of a frequency-shift modulated telegraph system using a frequency deviation of ±30 c/s is to introduce approximately 2% distortion, unless an adequate device is introduced in each channel, or a correcting pilot channel is used.

When the solution by a pilot frequency is used, this frequency is transmitted with the normal channels in the system and is thus subject to the same frequency error in transmission. At the receiving end, the pilot frequency can be used either to compensate, automatically, the frequency error, or its effects. The United Kingdom Administration has employed the latter method with great success in a system operating over the Transatlantic Telephone cable (London-Montreal). The method employed is that at the receiving terminal a voltage, proportional to the frequency error, is derived from the 300 c/s pilot channel and applied continuously to each telegraph channel to control an automatic bias correcting circuit which compensates for any frequency difference up to 10 c/s. Practical results show that with this arrangement a frequency error of 1 c/s causes an increase in bias distortion of only 0·2% and that the maximum increase in distortion resulting from a frequency error of 10 c/s is 2%.

From a maintenance viewpoint, the use of a pilot channel can offer the following advantages :

(a) recording frequency errors in the bearer telephone channel, and

(b) making records of level variations and interruptions in the bearer telephone channel as a means of assessing the interruption rates in the telegraph channels.

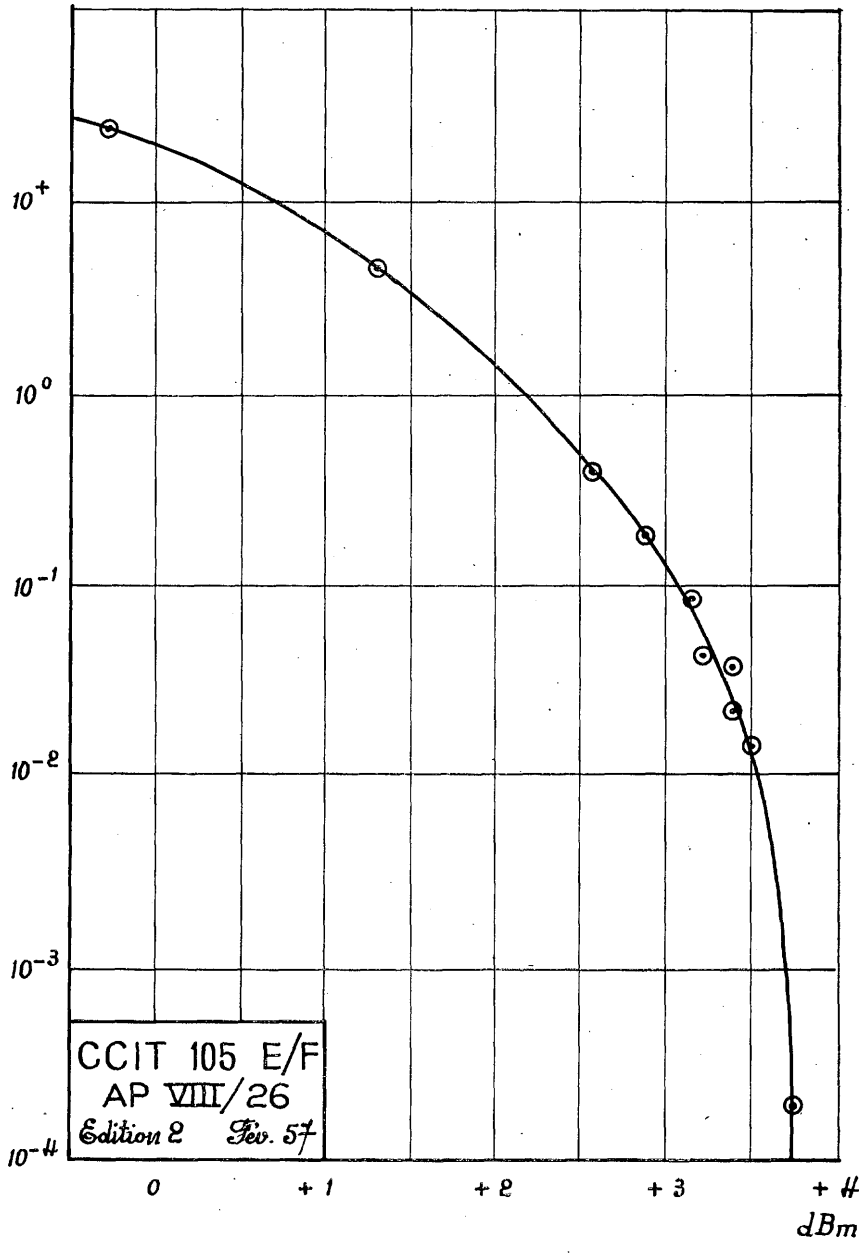
Note 4. — The limits recommended for the degree of distortion must be satisfactory when all the channels in the system are operating simultaneously at a modulation rate of 50 bauds, except in cases *(c)* and *(d)* of § 5, Note 1, for which the channel measured shall be the only working channel.

Note 5. — Study Group II of the C.C.I.T. has taken note of the transmission levels recommended by Study Group 3 of the C.C.I.F. for frequency-shift modulated voice-frequency telegraph systems.

It considers that the reduction in levels asked for, compared with those permitted in amplitude modulation, does not seem to be entirely justified for the following reasons :

1. The use of equipments already in service seems to show that it would not be unreasonable to maintain the same levels as in amplitude modulation.

2. Tests made by U.S.S.R., the Netherlands and the Federal German Republic seem to prove that the level of 5 milliwatts (+7 dbm) is never reached in practice. For example, in the Netherlands, for a group of 24 amplitude-modulated channels, transmitting the voice-frequencies simultaneously, a level of +3·7 dbm at a point of zero relative level is reached only once every 3 hours. The curve given in the attached drawing (C.C.I.T. No. 105) shows the number of times per second when the peak voltage exceeds the threshold indicated in the abscissae.


10^{+}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
+ 1
+ 2
+ 3
+ 4
dBm
CCIT 105 E/F
AP VIII/26
Edition 2 Fev. 57

Question 17/9.

(New Question II/6 of the C.C.I.T.)

1. Is it necessary to introduce for international traffic frequency-shift modulated voice-frequency telegraph systems having a spacing between the mean frequencies exceeding 120 c/s ?

2. If so, what characteristics of these systems should be standardized ?

Note 1. — If it is desired to transmit signals whose modulation rate may reach 70 or 80 bauds, it will be necessary to increase the band of frequencies allocated to each channel beyond 120 c/s.

Note 2. — Would it be worthwhile, from the point of view of economy and maintenance, to use such systems for short links, even for the transmission of telegraph signals at the normal modulation rate of 50 bauds ?

Question 18/9.

(New Question II/10 of the C.C.I.T.)

Drafting of separate Recommendations for *(a)* amplitude-modulated voice-frequency telegraph systems, *(b)* frequency-modulated voice-frequency telegraph systems ?

Note. — It seems particularly desirable to envisage different maintenance instructions for the two types of modulation needs.

Question 19/9.

(New Question II/11 of the C.C.I.T.)

Is it necessary to clarify Recommendation B.13 and, in the affirmative, what modifications should be proposed ?

Question 20/9.

(Interests the C.C.I.R.)

(Former Question 24 of the C.C.I.T.)

What are the conditions which should be imposed on V.F. telegraph plant employing double current technique used on modulated radio transmission channels ?
(Question to be studied jointly with the C.C.I.R.)

Note. — In the study of this question it will be interesting to compare transmission systems in which marking and spacing are obtained by the two-tone method

and by the method of frequency shift of a single tone (point 1 of C.C.I.R. Study Programme 9, Question 43).

It is also proposed that representatives of Study Group II should attend C.C.I.R. meetings dealing with this question and that the relevant C.C.I.R. document be circulated to all members of Study Group II.

Question 21/9.

(New Question II/15 of the C.C.I.T.)

What limits of distortion measured by start-stop telegraph distortion measuring apparatus, are appropriate to standardized telegraph channels ?

Note 1. — Recommendation B.52 of the C.C.I.T. permits the measurement of start-stop telegraph distorsion for the normal maintenance tests of telegraph channels, as an alternative to the measurement of standardized isochrome telegraph distorsion.

Note 2. — It has been established both by theory and in practice that start-stop and isochrome distorsion tests yield different results when applied to the same telegraph circuit.

Question 22/9.

(In collaboration with Study Group 8)

(Former Question 25 of the C.C.I.T.)

What are the telegraph transmission standards which should be adopted for teleprinter switching network :

(a) between a user's station and an international line-head office ?

(b) between international line-head offices ?

(See Recommendations B.25 and B.36).

Note 1. — Administrations are requested to collaborate in carrying out a series of tests representative of present conditions on the international switching networks (Telex and general service) between subscribers who are located unfavourably, from a transmission viewpoint, in their national network and subscribers similarly located in other countries. Each test should include a measurement of the degree of start-stop distortion of the complete connection, including the teleprinter, for each direction of transmission. The results should be communicated to the competent Study Group.

Note 2. — Administrations and Private Operating Agencies are requested to furnish the following information to the Secretariat of the C.C.I.T.T. to enable a comprehensive

map to be prepared and issued which will assist in the future planning of the international switched network :

(a) The location of their present international line-head office(s) e.g. international Telex Zone centres.

(b) Number and composition of the trunk circuits from their international line-head office(s) to similar offices located in other countries. The degree of start-stop distortion to be expected under normal conditions on each trunk circuit should be quoted, together with the measured values on which this expectation is based.

(c) Number of voice-frequency links between their international line-head offices and subscribers who are located unfavourably in their national network from the point of view of transmission. The degree of start-stop distortion to be expected on the corresponding national connections including the repeater, measured at the international line-head office, should be quoted, together with the results of the relevant measurements on which this expectation is based.

See also the study programme following Question 24/9.

Question 23/9.

(Former Question 10 of the C.C.I.T.)

Is there a need to introduce the idea of " factor of safety of a telegraph connection ". as the difference between the margin of the receiving apparatus and the degree of distortion of the restitution measured at the input to this apparatus ?

Question 24/9.

(Former Question 26 of the C.C.I.T.)

What methods of measurement can be recommended for international teleprinter circuit with a view to checking that a reasonable factor of safety exists between :

the degree of distortion of the received signals at the junction points of the various sections which make up the circuits, and

the permissible limits quoted in Provisional Recommendation B.25.

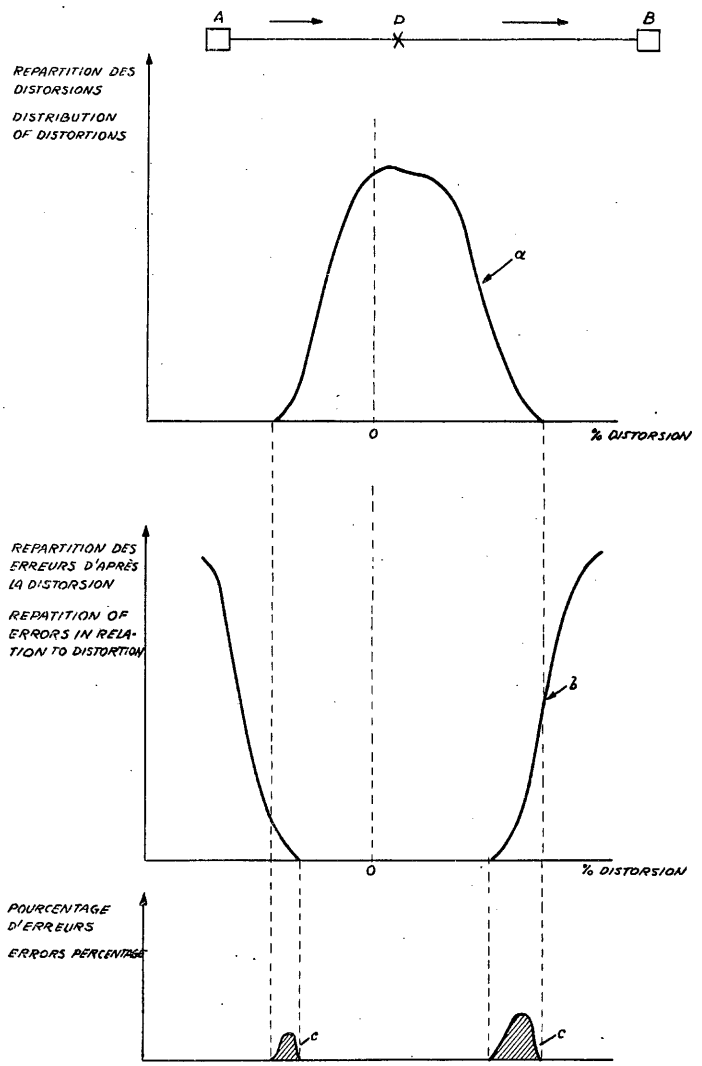
Contributions to the study of Question 24/9 (Safety Factor)

FEDERAL GERMAN REPUBLIC

As has been proved by the French Administration in the case of a start-stop transmitter (Document SG II/37-SG III/22) *, the distribution of individual distortion of the various significant instants in a prolonged emission can be diagrammatically represented (C.C.I.T. Drawing No. 83). If we observe at a point P in a circuit the signals emitted by a subscriber's station A, we shall obtain, for example, a repartition curve *a* (we have indicated the absolute values and neglected the sign).

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* This contribution is published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.".



FACTEUR DE SECURITÉ

FACTOR OF SAFETY

C.C.I.T. N° 83 E/F

SG II / 52

EDITION I 24-II-56

As the French Administration has shown, too, the significant instants can be counted which give rise to faulty reception when signals are transmitted from this same point P, towards the subscriber B, by means of a transmitter the distortion of which can be adjusted to a required value. We thus obtain curve *b*.

If curve *a* does not reach the point at which curve *b* begins, no error can occur in the circuit. Otherwise we can determine the probability of error for the various values of distortion at P by multiplying the probability that this distortion will appear in the signals received from station A (curve *a*) by the probability that an error will arise when signals are transmitted with this distortion towards station B (curve *b*). We shall thus get curve *c*.

The probability of errors for the circuit in question is given by the integral of curve *c*.

Should the probability thus calculated be less than the figure adopted for satisfactory operation (for example : 1 : 100000), the curve *b* will be shifted in the direction of decreasing distortion until the figure adopted is reached. The shift thus obtained could then indicate the factor of security of the communication.

Provided further experiment indicates a simple way of drawing curves *a* and *b* with a fair degree of accuracy, the procedure described above could be used to determine the factor of safety.

SIEMENS HALSKE (FEDERAL GERMAN REPUBLIC)

The original intention was to define a level of distortion for intermediate stations, but as we are not able to solve the problem of distortion addition and consider that it is difficult to define maximum distortion, we wish to make a new proposal for measuring the factor of safety (see Sketch No. 82 attached).

In intermediate station X we measured :

(a) the distribution of distortion in transmissions from a single distant teleprinter;

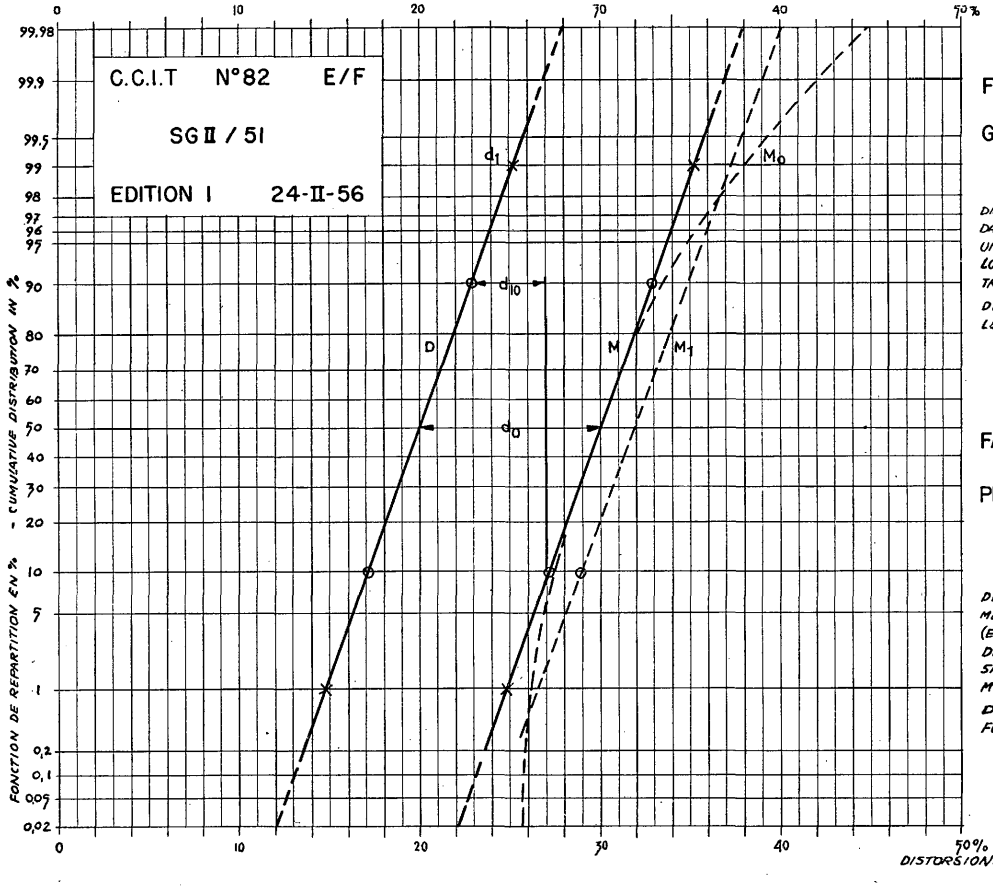
(b) the distribution of distortion in a large number of distant teleprinters.

We shall limit ourselves to a discussion of case *(b)*, since the solution of case *(a)* is analogous. In the graph showing our results we have used the cumulative distribution function, as bell-shaped curves create unnecessary problems. The result of our measurement is shown by line D; it has been recognized that we have a gaussian distribution, except at the extremities, where the law of large numbers no longer applies. In addition, the graph method enables us to discuss curves differing from the ideal distribution. It is sufficient to measure two points on the line, the percentage of apparatus giving a distortion of less 15%, for example, for the first point, and for the second the percentage giving a distortion, for example, of more than 25%. These points may be chosen in such a way that the ordinate of the first is between 1 and 10%, and that of the second between 90 and 99%.

In the same way we can measure the amount of distortion of which distant receivers are capable (telemargin). The result is shown by curve M; this curve must not be parallel to the first curve. The distance between these two curves indicates transmission safety. We must choose either the median distance d_0, or the distance between values 90% (or 99%) of the first curve D, and 10% (or 1%) of curve M. M_1 and M_a give us further examples.

From these two curves we can calculate mathematically the number of false characters or the number of faulty communications (see Table 1). If we measure incoming distortion, for example 22%, any receiver not supporting a distortion of 22% is unsatisfactory. For example, in the table derived from the graph, we see that 17% of the apparatus measured (d) are situated between 20 and 21%; 0.01% of the receivers do not support this distortion (M). The number of faulty communications is the product of these two figures, i.e., 0.17×1 on 10000 communications. The aggregate of unsatisfactory communications to be expected is the total of the whole column, i.e., 18 out of 10000; this value is the result for dispersion in our case. With 12% mean safety (M_1), unsatisfactory communications would only be 2 in 10000.

It seems that this method enables us to estimate accurately the safety of a service, and, even more important, by basing ourselves on distortion measurements, the quality of the complete or service communication, expressed in terms of the number of errors.



FACTEUR DE SECURITÉ

GRAPHIQUE DE PROBABILITÉ

DISTRIBUTION DE LA DISTORSION MESURÉE D DANS UN POSTE INTERMÉDIAIRE (SOIT POUR UN GRAND NOMBRE DE TRANSMETTEURS LOINTAINS, SOIT POUR LES ÉMISSIONS D'UN TRANSMETTEUR INDIVIDUEL)
DISTRIBUTION DE LA TÉLÉMARGE M POUR LES RÉCEPTEURS LOINTAINS

FACTOR OF SAFETY

PROBABILITY DIAGRAM

DISTRIBUTION OF DISTORTION D, MEASURED IN AN INTERMEDIATE STATION (EITHER FOR A LARGE NUMBER OF DISTANT TRANSMITTERS OR FOR THE SIGNALS FROM AN INDIVIDUAL TRANSMITTER
DISTRIBUTION OF THE TELEMARGIN M FOR DISTANT RECEIVERS.

TABLE SHOWING TOTAL ERRORS ACCORDING TO DISTRIBUTION OF DISTORTION

Teledistortion % of distortions	% of total D	% of faulty translations (from M)	Probability of errors D×M	D×M1	D×M2
			×10⁻⁴	×10⁻⁴	
20-21	17	0·01	0·17	0·034	
21-22	13	0·02	0·26	0·065	
22-23	10	0·1	1	0·1	
23-24	6	0·4	2·4	0·12	
24-25	2·6	1·4	3·64	0·36	
25-26	1	4	4	0·4	0·6
26-27	0·3	10	3	0·42	1·5
27-28	0·08	19	1·52	0·32	1·6
28-29	0·02	33	0·60	0·2	0·7
29-30	0·01	50	0·5	0·9	0·5
		Total	$\approx 18\times10^{-4}$	$\approx 2\times10^{-4}$	$\approx 5\times10^{-4}$

Question 25/9.

(Former C.C.I.T. Question 27, Part 2)

Where and in what circumstances is it desirable to insert regenerative repeaters in international Telex circuits?

Note. — This question should be studied in relation to the question of the transmission of the 7 or 7½ unit code signals and of dialling impulses and clearing signals. (See Recommendations B.20, B.21, B.26, C.4, E.1, E.2 and E.5).

Study programme concerning Questions 22/9 and 25/9

The study of Questions 22/9 and 25/9 should follow the following study programme:

Examine the information which Administrations should provide in answer to the request concerning the plans for the establishment of the switched network with the object of:

(a) establishing Recommendations for the improvement of the network from the transmission point of view and revising Recommendations B.24 and B.25;

(b) determining where and in what circumstances it would be desirable to insert regenerative repeaters in international Telex circuits and whether they should be inserted permanently or selectively (with a view to further revision of Recommendation B.26).

Note. — In view of the measuments already made by certain Administrations, it appears that the correct standards of transmission are not always observed;

These standards must be fixed not by consideration of the number of links in tandem but in terms of the degree of conventional gross start-stop distortion;

Start-stop regenerative repeaters are probably already necessary in certain Telex connections although they are not, however, generally available;

It may be necessary in the future to transmit codes employing more than five units, for which the existence of five unit regenerative repeaters would introduce difficulties.

Question 26/9.

(New Question II/8 of the C.C.I.T.)

Is there a need to simplify, or to carry out less frequently, the maintenance measurements made on international voice-frequency telegraph channels in accordance with Recommendations B.34 and B.35 ?

Note 1. — For voice-frequency telegraphy systems of high stability it appears to be no longer necessary to make monthly maintenance measurements.

Note 2. — In order to avoid unnecessary interruptions to the service and, bearing in mind that the bearer telephone channel can be checked by the telegraph equipment, it appears possible to abandon maintenance measurements, on the bearer channel by telephone personnel.

Note 3. — In view of the growth in the number of voice-frequency telegraph systems it will be more and more difficult to carry out § 2 of Recommendation B.34.

Question 27/9.

(New Question II/9 of the C.C.I.T.)

Considering :

1. the stability of modern voice-frequency telegraph systems;
2. the practice at present established in international telegraph service;
3. the relatively small number of international circuits consisting of more than one voice-frequency telegraph section,

Is it possible and desirable to delete Recommendation B.44 of the C.C.I.T. ?

Question 28/9.

(In collaboration with Study Group 4)

(Former Question 17 of the C.C.I.T.)

1. What monitoring of signalling devices should be used for voice-frequency telegraph systems, the channels of which are used for international switching circuits ?

2. What frequency should be recommended for use on the special channel on which this monitoring and signalling be carried out ?

3. What special arrangements should be made for locating causes of false signals due to transitory changes in transmission level or transitory increases in noise level on voice-frequency telegraph lines ?

4. What standards of performances should be agreed with the telephone services, with respect to these questions ?

(See Recommendations B.42 and B.43).

Note. — A special test, extending over several months, has been made by the United Kingdom Administration in which simultaneous records of interruptions were taken on each of the channels of an amplitude-modulated multichannel voice-frequency telegraph system. In addition, a record was taken of the number of occasions when all channels were simultaneously interrupted.

Separate tests were made with all the channels operated in the " tone-off " and " tone-on " conditions. In both cases the results have indicated that large individual differences frequently occur in the numbers of false signals and interruptions recorded in the channels during identical periods. Furthermore, there is a lack of consistency in the relative interruption rates of the different channels. Another point of interest was that in the special tests of one system the number of interruptions which occurred simultaneously in all the channels was extremely low (1 or 2 per month). Further investigation of the matter is in progress, with a view to establishing the reasons for the individual differences between channels, some of which may have arisen in the terminal apparatus.

Other Administrations are invited to make similar tests with a view to confirming whether or not a pilot channel is likely to give a useful indication of the performance of all channels in a VF telegraph system.

Question 29/9.

(In collaboration with Study Group 4)

(Former C.C.I.T. Question 31, amended)

1. What measures should be taken to ensure that breakdowns affecting switched telegraph communications are repaired as quickly as possible ?

2. What instructions should be given in the case of the Telex service for international Telex positions ?

3. What provision should be made for a technical organization which would quickly take the necessary steps on switched telegraph communications, and what simple technical methods can be recommended for the location of breakdowns ?

Note by the specialized Secretariat. — The attached diagram gives the definitions of the various parts of a telegraph circuit, as prepared by Study Group II for its own purposes.

NOTE

In the further study of this question attention should be given to the following study programme :

(a) Compilation of a code indicating the abbreviations to be used for service messages.

In this connection, the following phrases have so far been suggested for inclusion in the code;

(i) Those listed in Recommendation H.1 Art. 26.

(ii) The following additional phrases :

Here is ...
Bad transmission reported from ... Please give reference number, test and report result.
Reference number is ...
Here is result of test on ...
Machine faulty.
Line faulty.
Position equipment faulty.
Fault now cleared.
No fault found.
Please co-operate on routine test of ...
Please send undistorted test message on ...
In am sending undistorted test message on ...
Please measure distortion on ... and report result.
I am unable to co-operate. I will recall you in ... minutes.
The distortion on ... is ... %.
I am unable to read your signals.
Meet me on circuit No. ...
Please check subscriber No. ...
Speed deviation of ... % ... etc.

(b) Whether automatic test routining of channels (without readjustment, except in the case of faults) should be carried out regularly and, if so :

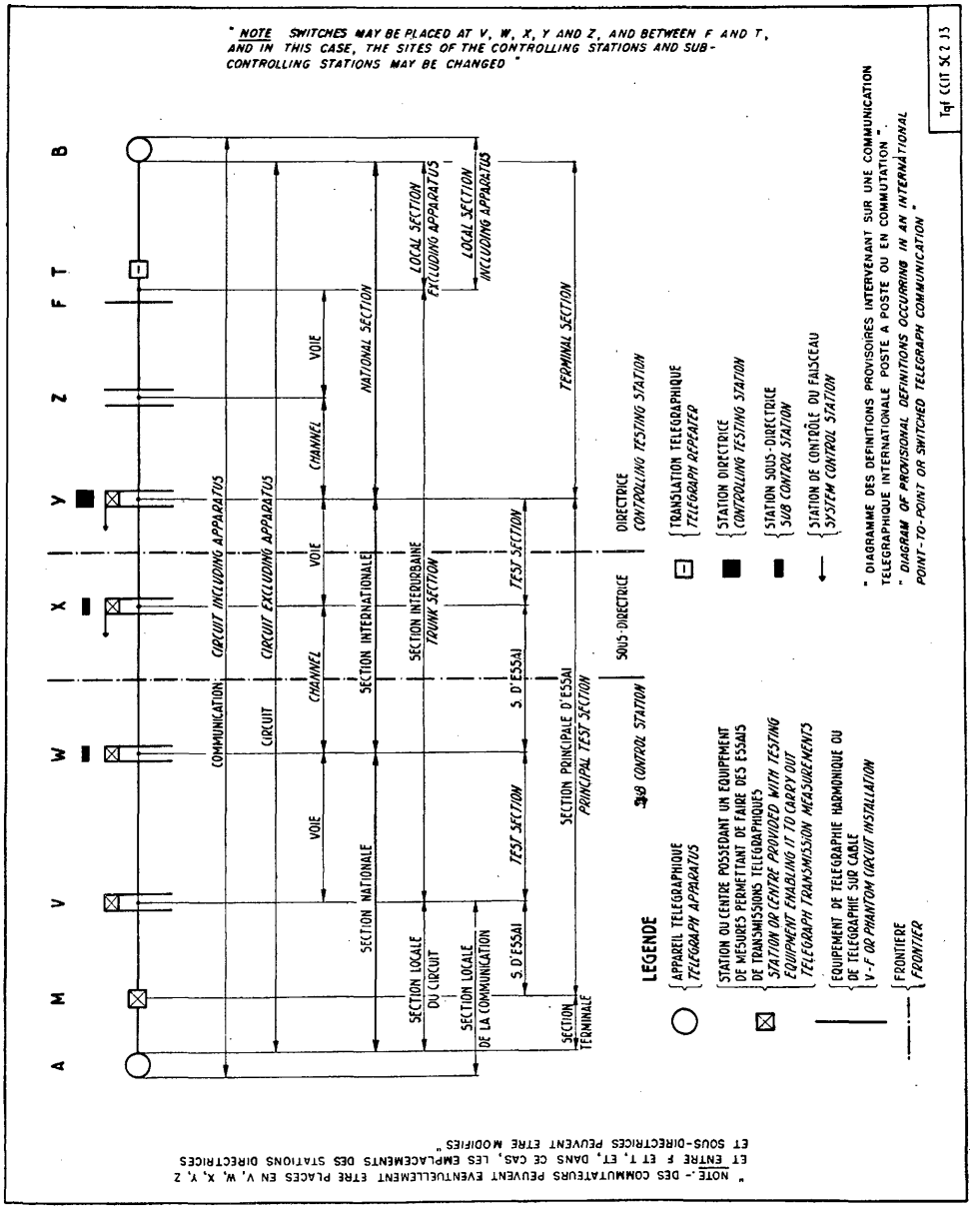
1. What methods should be adopted.
2. Whether any extension of the interval between scheduled maintenance routines could be permitted ?

Note. — In this connection the suggestions which have been made by various Administrations include the following facilities, to which access would be obtained by switching :

1. An undistorted test message, which would enable the distortion of the incoming channel to be measured.
2. A loop circuit, which would enable the loop distortion of an international circuit to be measured and, in conjunction with (1), an estimate to be made of the distortion of the outgoing channel.
3. Automatic distortion measuring equipment.
4. A loop circuit which would enable the loop distortion on 1:1 or 2:2 signals of an international circuit to be measured automatically and which is designed so that upon receipt of a predetermined signal (e.g. a signal of at least 300 m.s. of stop polarity) the polarities at the distant end are reversed (i.e. outgoing signals of stop polarity are retransmitted on the return channel as signals of start polarity and vice versa).

It is further pointed out that limits should be set for these measurements which will allow for the normal deterioration of the apparatus between maintenance routines, while ensuring that a sufficient margin is maintained against failure in service.

(c) Whether there is a need to hold connections to enable certain faults to be located and cleared and if so, in what circumstances the use of this facility is envisaged ?


" NOTE SWITCHES MAY BE PLACED AT V, W, X, Y AND Z, AND BETWEEN F AND T, AND IN THIS CASE, THE SITES OF THE CONTROLLING STATIONS AND SUB-CONTROLLING STATIONS MAY BE CHANGED "
A M V W X Y Z F T B
COMMUNICATION
CIRCUIT INCLUDING APPARATUS
CIRCUIT
CIRCUIT EXCLUDING APPARATUS
VOIE
CHANNEL
VOIE
VOIE
CHANNEL
VOIE
NATIONAL SECTION
LOCAL SECTION EXCLUDING APPARATUS
LOCAL SECTION INCLUDING APPARATUS
SECTION NATIONALE
SECTION INTERNATIONALE
SECTION INTERURBAINE
TRUNK SECTION
SECTION LOCALE DU CIRCUIT
SECTION LOCALE DE LA COMMUNICATION
S. D'ESSAI
TEST SECTION
S. D'ESSAI
TEST SECTION
SECTION TERMINALE
SECTION PRINCIPALE D'ESSAI
PRINCIPAL TEST SECTION
SOUS-DIRECTRICE
SUB CONTROL STATION
DIRECTRICE
CONTROLLING TESTING STATION
TERMINAL SECTION
LEGENDE
APPAREIL TELEGRAPHIQUE
TELEGRAPH APPARATUS
STATION OU CENTRE POSSEDANT UN EQUIPEMENT DE MESURES PERMETTANT DE FAIRE DES ESSAIS DE TRANSMISSIONS TELEGRAPHIQUES
STATION OR CENTRE PROVIDED WITH TESTING EQUIPMENT ENABLING IT TO CARRY OUT TELEGRAPH TRANSMISSION MEASUREMENTS
EQUIPEMENT DE TELEGRAPHIE HARMONIQUE OU DE TELEGRAPHIE SUR CABLE
V-F OR PHANTOM CIRCUIT INSTALLATION
FRONTIERE
FRONTIER
TRANSLATION TELEGRAPHIQUE
TELEGRAPH APPARATUS
STATION DIRECTRICE
CONTROLLING TESTING STATION
STATION SOUS-DIRECTRICE
SUB CONTROL STATION
STATION DE CONTRÔLE DU FAISCEAU
SYSTEM CONTROL STATION
" DIAGRAMME DES DEFINITIONS PROVISOIRES INTERVENANT SUR UNE COMMUNICATION TELEGRAPHIQUE INTERNATIONALE POSTE A POSTE OU EN COMMUTATION ".
" DIAGRAM OF PROVISIONAL DEFINITIONS OCCURRING IN AN INTERNATIONAL POINT-TO-POINT OR SWITCHED TELEGRAPH COMMUNICATION "
Tgf CCIT SC 2 33
" NOTE - DES COMMUTATEURS PEUVENT EVENTUELLEMENT ETRE PLACES EN V, W, X, Y, Z ET ENTRE F ET T, ET, DANS CE CAS, LES EMPLACEMENTS DES STATIONS DIRECTRICES ET SOUS-DIRECTRICES PEUVENT ETRE MODIFIES "

Question 30/9.

(New C.C.I.T. Question II/5, replacing Questions 29 and 30 of the C.C.I.T.

What arrangements should be made to replace defective VF telegraph circuits and what amendment should therefore be made to Recommendation B.39 ?

Remarks. — 1. It is necessary to reduce the duration of interruptions to service on multi-channel voice-frequency telegraph systems to a minimum, especially as an increasing number of telegraph channels in such systems are employed for telegraph switching services;

2. the development of semi-automatic and automatic telephone switching services is increasing, thereby reducing the possibility of manual selection of suitable telephone trunk circuits for use, when required, as reserve circuits for VF telegraphy;

3. furthermore, when a telephone circuit, which has been nominated for use as a reserve circuit is taken from telephone service to replace a defective VF telegraph circuit, it is essential that the change-over should be made without breaking down an established connection;

4. it is possible to envisage semi-automatic or automatic methods of selection and change-over to reserve telephone circuits for VF telegraphy;

5. C.C.I.T. Study Group 2 has taken note of the technical arrangements envisaged by Study Group 8 with a view to ensuring that interruption of voice-frequency telegraphy be kept to a minimum. These are given in the Annex hereafter.

ANNEX

(to Question 30/9 of Study Group 6)

From the technical and operating points of view, it is better to allocate manual circuits, rather than automatic ones, as emergency circuits for voice-frequency telegraphy, as long as, in the same relation, there are manually-operated circuits and automatic or semi-automatic ones.

Quite obviously, everything must be done to ensure that interruption voice-frequency telegraphy be kept to a minimum. To this end, the control station on the circuit concerned must have the emergency circuit available as soon as the current telephone call comes to an end. What arrangements are required can be left to nations to decide. It might be well to provide the following on the panels at which the (manual) switching of normal voice-frequency telegraph circuits and emergency circuits is effected :

— direct signalling showing occupied circuits;

— means for blocking :

  — normal blocking of the kind envisaged for semi-automatic circuits (see page 36 of the *Green Book*, Volume V);

  — " Preliminary Blocking " of the circuit, so that the circuit can be blocked against any fresh call, as soon as the current one is finished.

Seizure of the emergency circuit for voice-frequency telegraphy must take place at both ends of the circuit.

It might be well if means were available whereby the official effecting the seizure at the control

end of the telegraph circuit might automatically effect the seizure at the other end, without any action by maintenance staff in the foreign country being called for.

Note. — C.C.I.F. Study Group 6 had sent, in 1956, the following answer to C.C.I.T. Question 30 (extract from Document SG II/56) :

It considers that as far as possible, there should be no interruption of established telephone calls.

Action of two different kinds is called for :

(a) Major traffic relations, with numerous telephone circuits and circuits for voice-frequency telegraphy.

In such circumstances, circuits should be exclusively allocated to the telegraph services, to act as emergency circuits. There will be no difficulty in assigning the requisite circuits. The telegraph services must be in a position to defray the cost of taking out of action those circuits which are used exclusively as emergency circuits.

This having been done, no interruption of established telephone calls can be tolerated.

(b) Relations in which traffic is but slight.

In such cases, by prior agreement between the heads of the international terminal exchanges concerned, an exception might be allowed in the general rule to enable an operator to break into an established call to warn the correspondents that the circuit is needed and that the call has to be transferred to another circuit.

Question 37/9 (37 of Study Group 1)

(Study Group 9 and Sub-Group 1/3)

(New Question II/7 of the C.C.I.T.)

1. Is it necessary to introduce, for international traffic, systems providing telegraph channels (up to six) in conjunction with 3-circuit carrier telephone systems on long open-wire lines in which a common repeater can be used for telegraphy and telephony ?

2. If so, what characteristics should be specified concerning the number and the frequencies to be used for the telegraph channels, it being understood that the frequencies used should be adjacent to the bands of frequencies employed for the two directions of the telephone circuits.

Note. — C.C.I.F. Study Group 3 in its reply to Question 37 of the C.C.I.F. Study Group 3 has proposed some modifications to the text of § 3.5.1. Volume III of the *Green Book* (page 104).

" This system can admit, as an integral part, a certain number of telegraph channels, without affecting the width of the frequency band transmitted by the carrier current circuits. However, in this case, the width of the band of frequencies transmitted by the voice-frequency circuit is diminished ".

This is important for some Administrations especially in the Middle East. These Administrations desire to have a small number of telegraph channels (up to six) without having to use a *standard* voice-frequency telegraph system on one of the telephone circuits, thereby effecting an economy, as all the telephone circuits are retained entirely for telephone traffic.

TABLE SUMMARIZING

the questions assigned to Study Group 9

Chairman : Mr. VAN LOMMEL (Netherlands)
Vice-Chairman : Mr. ROQUET (France)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
1/9	Study of degree of individual distortion.		
2/9	Application of the notion of inherent distortion.		
3/9	Law of distribution of degrees of distortion.		
4/9	Separation of types of distortion.		
5/9	Observation of distortion.	S.G. 8	
6/9	Causes of disturbances.	S.G. 1 S.G. 4	
7/9	Study of fortuitous distortion.		
8/9	Theoretical study of addition of distortion.	S.G. 8	
9/9	Addition of distortion.		
10/9	Study of insertions and adaptations.		
11/9	Use of the ideas of " efficiency factor " and " quality index ".	S.S.G. 2/1	
12/9	Revision or cancellation of recommendations on direct-current telegraphy.		
13/9	Sudden variations of level.	S.G. 4	The study of this question will be left in abeyance until S.G. 4 reaches its conclusions on Question 2.
14/9	V.F. Systems protected against sudden variations of level.		
15/9	Cooperation between amplitude modulation systems.		
16/9	Standardization of frequency-shift modulation.	S.S.G. 1/3	
17/9	Wide-band frequency-shift modulated systems.		
18/9	Separation of recommendations for amplitude-modulated and frequency-shift modulated telegraph systems.		

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
19/9	Revision of Recommendation B.13.		
20/9	V.F. over radio channels.	C.C.I.R.	
21/9	Limits of start-stop distortion.		
22/9	Transmission standards.	S.G. 8	
23/9	Safety margin.		
24/9	Measurement of safety factor.		
25/9	Regenerative repeaters.		
26/9	Frequency of maintenance measurements for voice-frequency telegraphy.		
27/9	Deletion of Recommendation B.34.		
28/9	Monitoring of V.F. channels.	S.G. 4	
29/9	Signalling and repairing of breakdowns.	S.G. 4	
30/9	Change-over of defective voice-frequency telegraph circuits.		
37/9	Inter-band telegraphy on 3-channel open wire carrier telephone circuits.	S.S.G. 1/3	
	Questions for which the collaboration of Study Group 9 is required		
3/7	Denomination of the various types of channel.	S.G. 7 S.G. 1 C.C.I.R.	Proposals to be drawn up by S.G. 9 first
2/8	Telemargin.	S.G. 8	
3/8	Teledistortion.	S.G. 8	
8/8	Regenerative repeaters.	S.G. 8	See Question 25/9
6/10	Selective insertion of regenerative repeaters.	S.G. 10	

Telegraph Switching Questions
entrusted to
Study Group 10
in 1957-1960

Question 1/10.

(Former C.C.I.T. Question 53 revised)

Is further standardization of the signalling conditions for the Telex service desirable, in particular as concerns the best method of cooperation between keyboard selection and dial selection systems, and, if so, what should these standards be ? (See Recommendation No. E.1).

Question 2/10.

(New Question VIII/4 of the C.C.I.T.)

Is it desirable to standardize the signalling conditions for the Gentex service ? If so, what should these standards be ?

Note. — In considering this question, the provisions contained in Recommendation E.1, relating to the signalling conditions for use in the International Telex service, shall be taken into account.

Question 3/10.

(In collaboration with the C.C.I.R.)

(Former Question 82 revised)

Further study of the standardization of switching signals to be used in the international Telex service on communications involving radio circuits operated by means of synchronous 7-unit systems affording error correction by means of automatic repetition.

COMMENTS

by Study Group VII which have been considered and accepted by the C.C.I.R.

1. In the case of radio circuits which can transit 5-unit start-stop signals with a satisfactory degree of accuracy, there are no special conditions which need to be imposed in respect of the transmission of supplementary signals required for the establishment of switched communications (e.g. in the international Telex service).

This applies more particularly to radio circuits operated at frequencies higher than 30 Mc/s.

2. Radio circuits operated by means of synchronous error-correcting systems, which use a 7-unit error detecting code and provide error correction by means of automatic repetition, are already in use, and satisfactory co-operation between 5-unit start-stop systems has been established by means of these radio circuits.

Such error correcting systems provide in addition to the 32 combinations of International Alphabet No. 2 and a combination used for error correction, two further combinations known as α and β. (See Recommendation C.24 of the C.C.I.T.).

If these latter combinations are used to transmit continuous signals corresponding to the start polarity and stop polarity respectively, then the supplementary signals required to establish switched communications (e.g. in the international Telex service) can be transmitted. Since the signals concerned are transmitted over the radio path as 7-unit synchronous signals in a similar manner to the normal teleprinter signals, no special conditions in respect of the radio transmission itself are necessary. It is however necessary that so long as continuous start polarity is applied at the input, continuous start polarity shall appear at the output, whether or not errors occur in the α signals transmitted over the radio path. Similarly during the application of continuous stop polarity at the input, continuous stop polarity must appear at the output despite the occurence of errors in the transmitted β signals.

It is not necessary, however, that a pre-determined number of α or β signals be used to characterize the switching signals required for example in the Telex service.

There are certain operating differences between these error correcting systems and normal start-stop systems, notably in respect of the variable delay with which a change of condition at the input may re-appear at the output. These differences entail certain special arrangements, but do not affect the radio transmission as such.

3. The study of this question should be related to that of Recommendation E.6 of the C.C.I.T. and of Question 7/8.

Question 4/10.

(In collaboration with Sub-Group 2/1)

(New Question VII/1 of the C.C.I.T.)

Barring of certain classes of international connections in automatically switched telegraph networks.

What technical means can be adopted to bar international calls between specified categories of teleprinter stations, and irregular connections between international teleprinter trunk circuits ?

COMMENTS

It has become clear that with the introduction of fully automatic switching into the international service it would be necessary to make certain technical arrangements in order to bar certain classes of international connection.

The principal means envisaged consist of :

1. The transmission over the international circuit either before or after the selection signals, of a supplementary signal identifying the class of the calling station in the country of origin or the class of traffic concerned;

2. Discrimination on a specified digit or digits of the called number. It has been noted that this second method of discrimination could be facilitated by the adoption of numbering schemes having easily identifiable characteristics.

The question as to whether barring should be effected in the country of departure or of arrival remains to be resolved.

For these reasons Study Group VII considered that this question should be studied in general terms.

Note. — See also Annex 9 to Document CCIT-AP VIII/15 published in the " Supplements to Documents of the VIIIth Plenary Assembly of the C.C.I.T.".

Question 5/10.

(In collaboration with Sub-Group 2/1)

(New Question VII/4 of the C.C.I.T.)

Methods enabling a Telex subscriber to obtain the attention of an operator in the course of a defective connection including a radio circuit without breaking the connection.

Question 6/10.

(In collaboration with Study Group 9)

(New Question II/4 of the C.C.I.T.)

Study of methods for selective insertion of start-stop regenerative repeaters in international Telex connections and general switching network with a view to recommending standards.

Note. — Although the C.C.I.T. did not complete its study of Question 25* concerning telegraph transmission standards for teleprinter switching networks, and Question 27, part 2 **, concerning the need for, and siting of, start-stop regenerative repeaters in international Telex circuits, it seems that start-stop regenerative repeaters, if necessary, should preferably be inserted, as required, by selective switching, rather than being permanently associated with the Telex trunk circuits :

(a) the need, from a technical and economic viewpoint, to restrict the number of start-stop regenerative repeaters employed in the international Telex network to the minimum, consistent with satisfactory transmission standards, and

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* Now Question 22/9.

** Now Question 25/9.

(b) the possible need to cater for the transmission of 6-unit signals (or more), in addition to 5-unit signals and signals employed in switching systems.

Question 7/10.

(New Question IX/1 of the C.C.I.T., further to Question 60, Part 2, of the C.C.I.T.)

Message separation signal.

In transit centres where it is the practice to retransmit traffic automatically or semi-automatically using reperforators and auto-transmitters, it is necessary to insert a " message separation " signal at the end of a telegram or group of telegrams to a particular destination. What should be the composition of this " message separation " signal having for its object the stopping of the auto-transmitter in order to permit the switching of traffic to a different destination without rupture of the tape ?

COMMENTS

The C.C.I.T. has made the following comment on the factors affecting the choice of a " message-separation " signal.

1. Is it required that the signal shall produce a printed indication on a receiving teleprinter ? If so, it must include at least one of those combinations admitted as giving a printed indication in the International Alphabet No. 2. If printing is only required on printing reperforators (e.g. those used at transit centres), then the signals for " carriage return " and " line-feed " might also be regarded for this purpose as printing characters (see Recommendation C.10).

2. Is the complete signal to be inserted by the originating teleprinter operator ? If so, it could only be composed of used combinations in International Alphabet No. 2. Specifically this would exclude Combination No. 32.

3. If the signal (or part of the signal) is to be inserted otherwise than by an actual operation of the teleprinter keyboard, then it could possibly include Combination No. 32. It would need to be decided at what point in the system the signal (or the appropriate part thereof) was to be inserted.

4. Is the signal to be used in conjunction with messages originating at offices connected to an automatic teleprinter exchange but destined to be passed to a transit centre employing a semi-automatic or automatic reperforator switching ? If co-operation between the two systems is in fact envisaged, there might be some advantage in including in the signal a sequence of several Combinations 32, because these are generated by the clearing signal used in switched networks and would, in any event, appear on a reperforator receiving the signals.

5. It would seem to be prudent to choose as " message separation " signal a combination or series of combinations selected from the International Alphabet No. 2, which would not be likely to appear erroneously either as the result of a fault or by reason of a misoperation by the sending operator, and which would never, or extremely rarely, occur in the body of the message.

In this connection Combination No. 32, because of its simple pattern, can be easily produced automatically and can be easily detected at the point where it is required to be effective.

On the other hand, it can readily be produced by a transient fault on a telegraph channel. The seriousness of the effect of the occurrence of a spurious « message separation " signal would depend upon the exact operations initiated in a given system upon its reception. The longer the series of combination composing the " message separation " signal, the less likely it is to occur erroneously and cause a false switching operation.

6. If it were necessary, the various combinations composing the " message separation " signal need not all be effective in every country, and administrations could if necessary be free to choose which combination in the signal would be effective in their own country.

7. The C.C.I.T. was not able to make a comprehensive study of all the technical factors likely to affect the choice of a " message separation " signal, but consideration of the foregoing comments might enable administrations, wishing to make use of a " message separation " signal in the international public telegraph service, to submit positive proposals tending to lead to an acceptable basis for standardization.

8. The following information was also given :

(i) The U.S.S.R. already uses Combination No. 32 of International Alphabet No. 2, repeated twice, as a " message separation " signal.

(ii) A system designed for use in Argentina and which combines both automatic switching and reperforator switching uses Combination No. 4 preceded by Figure Shift (who are you ?).

(iii) The Federal German Republic and the United Kingdom propose to use four repetitions of Combination No. 26 preceded by Figure Shift (four + signs are printed on the receiving teleprinter) in connection with leased networks.

The C.C.I.T. was unable to consider in detail the relative merits of the foregoing signals but it seemed rather likely that the use of the " who are you ? " signal, at any rate in the European system, would entail operation complications, and this use justified further study taking account of the provisions of Recommendation C.11.

Question 8/10.

(In collaboration with Sub-Group 2/1)

(New Question VII/2 of the C.C.I.T.)

International numbering plan for automatically switched teleprinter networks.

Is it necessary to have a standard international numbering plan for prefixes denoting the called country for international telegraph switching systems ? If so, what numbering plan should be recommended for :

(a) the Telex service ?

(b) the European Switching Network for the general telegraph service ?

Note. — In this study it would be advisable to examine the corresponding plan of the C.C.I.F. for the international telephone service (see C.C.I.F. *Green Book*, Volume V, XVIIth Plenary Assembly, Geneva, October 1954).

Question 9/10 (9/21 of Sub-Group 2/1).

(Study Group 10 and Sub-Group 2/1)

(New Question VII/3 of the C.C.I.T.)

Is there a need for further standardization of the sequences of signals and texts used in " service signals " in the international Telex service, and if so, what should these standards be ?

Note by the Secretariat. — *(a)* The requirements of the Gentex service should be borne in mind during this study;

(b) The study should be begun by Sub-Group 2/1.

TABLE SUMMARIZING

the Questions assigned to Study Group 10

Chairman : Mr. JOLLEY (United Kingdom)
Vice-Chairman : Mr. FAUGERAS (France)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments
1/10	Standardization of signalling for Telex service.		
2/10	Standardization of signalling for Gentex service.		
3/10	Standardization of Telex signals on radio-telegraph circuits.	C.C.I.R.	
4/10	Barring in telegraph switching.	S.S.G. 2/1	
5/10	Methods to obtain the attention of an operator in the course of a defective connection.	S.S.G. 2/1	
6/10	Selective insertion of regenerative repeaters.	S.G. 9	
7/10	Message separation signal.		
8/10	Numbering plan.	S.S.G. 2/1	
9/10	Standardization of service texts in telegraph switching.	S.S.G. 2/1	
Questions for which the collaboration of Study Group 10 is required			
4/8	Five-unit supervisory and control signals.	S.G. 8	

Telephone Switching and Signalling Questions

entrusted to

Study Group 11

in 1957-1960

Question 1.

(Former Question 4 of C.C.I.F. Study Group 8, studied in 1952/1954)

Considering that

— a clause relating to the maximum psophometric electromotive force which the guard circuit of a signal receiver should take into account, is specified on pages 67 and 77 of Volume V of the C.C.I.F. *Green Book*;

— but that line noise may comprise not only a continuous noise of uniform energy spectrum of the type assumed in that clause, but also induced noises, at a low frequency and high level, and noises of a transient nature;

— in particular, that a clause of this type could not provide protection against infrequent peaks of noise of short duration, but of large amplitude, such as those which can result from surges arising from switching operations, or from microphonic effects due to the movement of adjacent switches on the switching apparatus racks;

What information exists on the nature, duration, distribution in time, and amplitude, of noises of the transient nature referred to above ?

Should the occasion arise, what changes would it be advisable to introduce into the specification for the signalling systems, particularly for the signal receivers, to take account of the points enumerated above ?

Note 1. — The information which was furnished in response to this question in 1954, in particular the information provided by the Federal German Administration (information reproduced in the following Appendix) appears to indicate that there is no actual reason to modify the signal receiver specifications in the Specification for signalling systems.

Note 2. — However, most of the information available on the subject of noise measurements has been obtained with noise measuring apparatus having an integration time of 200 milliseconds, whereas the fundamental subject of this question relates to

transient noise of a much shorter duration. It is thus desirable to know the influence of transient noise, by measuring such noise with apparatus having an integration time much shorter than 200 milliseconds. In this connection, see the study of Question 3 (new) of Study Group 12 : " Measurement of the disturbing effect of impulsive noise. "

Note 3. — Lastly, *(a)* all the tests carried out so far were made on circuits operated in the manual service and it is possible that tests carried out at transit centres on transit calls will produce results somewhat different from those obtained up to now.

(b) A number of suggestions have been made in order that the signal receiver will function in a satisfactory manner in the presence of a level of noise much higher than that actually specified, particularly at the lower frequencies.

APPENDIX

(to Question 1 of Study Group 11)

Study made by the Federal German Administration of the nature, the duration, the time distribution and the amplitude distribution of noise of a transient character

Since it is known that the perfect conversion of a signalling current in a voice-frequency signal receiver can be jeopardized by strong disturbing voltage peaks of short duration on a transmission channel, the Federal German Telecommunication Administration has carried out an investigation into the *nature* of line noise and its *influence* on the performance of voice-frequency signal receivers. To this end, a number of different circuits with voice-frequency selection were chosen, of which some were particularly unfavourable, and their disturbing noise was registered on a sound recorder and analysed. The noise voltage of *the most unfavourable* trunk circuit, measured by means of a psophometer was, under these conditions, 1 millivolt at the relative level point 0.8 neper; therefore lower than the value of 3 millivolts indicated in the *Yellow Book*. The results of these tests are given below.

1. *Nature of the disturbance.* — Besides a noise of more or less uniform spectrum, the leaks of a 4 kc/s carrier, represented as a permanent frequency existing on the circuit, and high voltage pulses of short duration, have been observed. The transient effects of high voltage surges such as those which occur, for example, in the operation of relays, have not been ascertained (surges having for their origin the opening and closing of continuous current circuits on the line wires).

2. *Duration of disturbances.* — The duration of the part of the disturbing voltage peak which exceeds the mean level of noise, is very short and is generally not greater than 1 millisecond. However, it often happens that several disturbing voltage peaks follow each other in quick succession. It can therefore result in disturbances of a much longer duration (several milliseconds) : up to 10 voltage peaks in 10 milliseconds have been observed. Such an accumulation of voltage peaks could possibly jeopardize the conversion of signal currents in the voice-frequency signal receivers.

3. *Time distribution of disturbing voltage peaks.* — The repetition frequency of disturbing voltage peaks varies largely according to the trunk circuit and they may occur irregularly and only in an isolated manner : they can emerge from background noise with some character of periodicity every 200 to 300 milliseconds, but they can also be present for minutes at intervals of the order of 10 to 40 milliseconds. In addition, the character of the disturbance varies according to the hour of the day or the intensity of traffic and occupation of adjacent channels.

TABLE

Division in time of disturbing voltage peaks for different circuits at the relative level point —0·8 N

The tests were carried out with a peak volume indicator (integration time : about 10 milliseconds, swing-back : about 1 sec.)

Duration of observation →		1st min.			2nd min.			3rd min.			4th min.			5th min.			6th min.			7th min.			Total number of peaks observed during 5 minutes	Values measured with psophometer	
Circuit and voltage of peak at the relative level point —0.8 N mV		0 to 20 sec.	20 to 40 sec.	40 to 60 sec.	60 to 80 sec.	80 to 100 sec.	100 to 120 sec.	120 to 140 sec.	140 to 160 sec.	160 to 180 sec.	180 to 200 sec.	200 to 220 sec.	220 to 240 sec.	240 to 260 sec.	260 to 280 sec.	280 to 300 sec.	300 to 320 sec.	320 to 340 sec.	340 to 360 sec.	360 to 380 sec.	380 to 400 sec.	400 to 420 sec.		Psophometric voltage mV	Parasitic voltage mV
Circuit 1	>17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
Frankfurt/M-Paris	>10	—	—	2	2	3	1	3	—	4	15	3	2	2	6	2	—	4	2	—	—	7	45	0·7 ...1	0·8 ...
	> 6·5	2	3	13	5	10	5	8	2	10	22	8	4	9	10	10	—	6	8	1	2	16	121		... 1·4
	> 4	23	21	32	20	25	24	26	22	22	30	21	20	19	30	22	27	28	22	25	31	27	357		
	> 2·5	Background noise																							
Circuit 2	>17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						—		
Frankfurt/M-München	>10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						—		
	> 6·5	—	—	—	—	1	—	—	2	—	—	1	—	—	5	—	—						9	0·17...	0·33...
	> 4	—	1	8	27	26	—	3	10	5	3	1	1	3	10	6	5						104	...0·25	... 0·4
	> 2·5	2	5	15	29	26	8	10	14	10	8	4	5	7	11	19	16						173		
Circuit 3	>17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—							—		
Frankfurt/M-Köln	>10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—							—		
	> 6·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—							—		
	> 4	—	—	17	10	—	—	—	—	1	1	1	3	1	3	—							37	0·33...	1·5
	> 2·5	1	2	22	11	7	4	5	4	5	6	6	7	7	5	2							94	...0·4	
Circuit 1 (comparison made with a twin-wire oscillograph)	>17																					1			
	>10																					16			
	> 6·5																					71			
	> 4																					257			
	> 2·5																					883			

4. *Amplitude distribution of disturbing voltage peaks.* — The disturbing voltages of the circuits tested, which were recorded on a sound track, were measured by means of a peak meter having an integration time of 10 seconds (for 90% of the actual voltage) and a swing back to zero of about 1 second. The preceding table shows the time distribution of the amplitude of the disturbance.

Since, as mentioned under 2 and 3, the duration of the different voltage peaks is only of the order of 1 millisecond and that several peaks occur during 1 second, the total number of peaks will be much greater than those determined in that manner. The values which figure in the table should, in consequence, be considered only as *reference values for a duration of several seconds.* A much more precise measurement of the noise peaks, carried out on the most unfavourable circuit for 20 seconds by means of a twin-wire oscillograph, gives much higher figures which are also indicated in the table.

Question 2.

(New Question)

What arrangements should be made in the construction of telephone *exchanges* to reduce to a minimum the noise introduced on a transmission channel of an international circuit due to switching operations or any other reason ? For the study of this question it will be recalled that the noise introduced on international circuits can come from disturbances which occur at any point of a telephone exchange, whatever type of exchange this may be (local exchange, transit centre or international terminal exchange) through which an international call is switched.

Note. — The arrangements to be made should tend to complete the arrangements already recommended and which concern only the increase in the reliability of contacts (See Supplements to Vol. V of the *Green Book* of the C.C.I.F., in Vol. 1 *bis* of the *Green Book*).

APPENDIX

(to Question 2 of Study Group 11)

Known causes of noise

1. Mechanical construction of contacts and of switches which can cause contact vibration and produce microphonic noise.

2. Effect of capacity in sliding contact switches and in the associated cabling during the search of the bank contacts.

3. Noise on the speech path coming from power supply sources :
   - — presence of ripples in the power supply or
   - — impedance of the busbars which causes important variations of potential due to load fluctuations and to inductive discharges.

4. Crosstalk in the telephone exchange cabling and in particular in switch multiples. Noise can be introduced in the conversation path by capacitive or inductive coupling which may come from other conversation channels or from variable signalling currents transmitted over other conversation channels or from separate signalling channels.

Question 3.

(New Question)

What are, from the point of view of the reliability of contacts situated in the conversation path, the results obtained by the wetting method which uses high-frequency alternating currents (of the order of 20 kc/s) ?

Note. — Attention is drawn to the fact that the frequency of the wetting current used should be chosen so that it will not cause disturbances on transmission systems or with signalling in different countries.

Question 4.

(Sub-Group 1/2, then Study Group 1 and Study Group 11)

(New Question)

Considering

— that international automatic and semi-automatic calls are at present limited to routings which consist of not more than two international circuits switched in tandem ;

— that such a restriction is a serious limitation for the complete development of the switching plan for the European network ;

— that studies are in progress to ascertain whether a reduction in variations of circuit equivalent as a function of time will make it possible for this equivalent to be held within sufficiently narrow limits and so to make possible the use of three international circuits in tandem ;

Has the state of the European network, as regards variations in circuit equivalent, improved sufficiently for permitting routings comprising three international circuits in tandem, using signalling equipment conforming to the specifications contained in Volume V of the *Green Book ?*

Note 1. — The quality of telephone transmission during a call on the chain of international circuits is the subject of Question 9 of Study Group 1.

Note 2. — The Annex to Question 1 of Study Group 4 gives the variations in equivalent of international circuits observed in 1955-56 during the 5th series of C.C.I.F. tests.

Question 5.

(Sub-Group 2/4, then possibly Sub-Group 2/2, Study Group 2 and Study Group 11)

(New Question)

Considering that the conditions under which international automatic traffic flows are altogether different from those for the international manual or semi-automatic services;

and particularly that with the present charging methods, subscribers can repeat their calls many times without charge if the wanted subscriber is engaged or does not reply, so causing international circuits to be overloaded abnormally;

Is there a need to consider making a charge for ineffective calls on the international automatic service, as some Administrations already do for their inland service, either restricting such charge to the case where the wanted line is reached (engaged or no reply), or extending it to cover the case where the international circuit is released before the call is completed ?

If so, what are the preferred charging methods as regards operation and tariff and what technical difficulties would arise from the application of these methods ?

Question 6.

(Sub-Group 2/4, then Sub-Group 2/2, Study Group 2 and Study Group 11)

(New Question)

Is it possible, with the arrangements already in force for the national automatic service of each country, to reach standardization concerning the determination of the chargeable time in the international fully-automatic service, and if so, what arrangements should be adopted ?

Special consideration should be given to whether the measurement of chargeable time should be controlled only from the calling subscriber's station, or whether the called subscriber's clearing signal can be used for the determination of the chargeable time by stopping the meter, after a certain delay following the reception of the called subscriber's clearing signal.

Question 7.

(Question number unused, to avoid confusion with Question 7 of Sub-Group 2/4)

Question 8.

(Sub-Group 2/4, then Study Group 11)

(New Question)

Considering

— that under international semi-automatic operating conditions the answer signal has a supervisory function to indicate that either the incoming operator or the called subscriber has replied to the call;

— that with fully automatic operation the answer signal is used to initiate the registration of the call charge;

Should it be recommended that in a fully-automatic international service a subscriber-dialled call should never be routed to or intercepted by an operator in the incoming country's Administration who returns an answer signal when she replies to the call ? Alternatively, what other recommendation might be made ?

Question 9.

(Sub-Group 2/4, then Study Group 11)

(New Question)

Considering

— that in the international fully-automatic service certain release operations, which are under the control of an operator in a semi-automatic service, are effected automatically ;

— that to avoid unnecessary occupation of international lines, it is desirable that there should be forced release on the outgoing side after a certain time if the called subscriber does not reply; and also for the called-subscriber—held conditions ;

Is it possible, with the arrangements adopted for the national automatic service of each country, to provide such arrangements for the release of the international connection in the international fully-automatic service ?

Question 10.

(Sub-Group 1/2, then Study-Group 1 in cooperation with Study-Group 11)

(New Question)

The results of the 5th series of observations, made from October 1955 to January 1956, prove that the standard deviation of the equivalent is sufficiently low.

Considering that the stability of telephone circuits is now improved, is it possible to reduce the fixed value of 7 db which was laid down (page 51 of Vol. V of the *Green Book*) for the transmission equivalent of international semi-automatic or automatic circuits, and, if so, by how much ?

Question 11.

(Study Group 4 in cooperation with Study Group 11)

(New Question)

To facilitate making periodic maintenance measurements, can an automatic equipment be used to find out whether the margins of the equivalent of a (semi)-automatic telephone circuit are exceeded ?

In the affirmative,

(a) what recommendations should be established for such an automatic equipment (i.e., essential clauses of a model specification) ?

(b) would it be possible to reduce the frequency of the periodic maintenance measurements at 800 c/s, or possibly to cease them and to retain only the multi-frequency periodic maintenance measurements at several frequencies, and if so, with what periodicity ?

Question 12.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

(a) Is it desirable to standardize certain characteristics of ringing tone and busy tone in European countries to facilitate the recognition of these tones by subscribers in the international fully-automatic service ?

(b) If so, what limits should be recommended for the periodicity, frequency and level of these tones ?

Note. — The characteristics of the existing tones are indicated on pages 25 to 27 of Volume V of the C.C.I.F. *Green Book.*

Question 13.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

Considering firstly, that calls to certain special services—absent subscribers, ceased subscribers, changed numbers, etc.—are not treated uniformly as regards charging by Administrations ;

Considering also that it is desirable that calls of this type passed by subscribers of a given country over the international automatic service to various destination countries should be treated in a uniform manner ;

Could the method of treatment for the above calls be standardized, and, if so, what methods should be recommended ?

Question 14.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

(a) In planning the development of the automatic international service, could the information given to the calling subscriber in certain special classes of completed call, e.g. spare code, spare level, line out of order, congestion, etc., be standardized ?

(b) If so, what standards should be recommended ?

(c) If not, how should the difficulties anticipated be overcome, if a standard method cannot be recommended ?

Question 15.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Considering

— that the general recommendations regarding national numbering plans, contained in Part 2, Chapter 3, § 4 of Volume V of the C.C.I.F. *Green Book*, state that if an Administration which uses the Latin alphabet wishes to make use of letters in its national numbering plan, it will be desirable to use dials (or keys) which conform to the association of letters and numbers which is more generally used in Europe, since the adoption of a standardized association of letters and numbers will facilitate the work of operators in the international semi-automatic service;

— that there is at present a lack of uniformity in respect of the association of letters and numbers in the national numbering plans of different European countries where letters are used;

— that an Administration not making use of letters in its national numbering plan would not normally provide subscribers with lettered dials, but might nevertheless find it desirable to provide them for a fully-automatic international service;

— that to facilitate subscriber dialling in a fully-automatic international service it is desirable to have complete uniformity in the association of letters and numbers throughout Europe, if subscribers are required to dial letters;

Should the present recommendations mentioned above be revised to take into account the conditions which may arise with a fully-automatic international service, and, if so, what should the general recommendation be ?

Question 16.

(Question number unused, to avoid confusion with Question 16 of Sub-Group 2/4)

Question 17.

(Sub-Group 2/4, then Sub-Group 2/2)

(New Question)

Considering that under semi-automatic and fully-automatic operating conditions certain calls may be switched automatically via international transit centres whilst other calls may be manually switched at those centres;

What arrangements should be made at international terminal and transit centres to enable operators at these exchanges to complete calls which are :

(a) proper to be manually controlled,

(b) routed to operators for assistance purposes, for example when there is prolonged congestion or serious interruption of the service ?

Remark. — See Annex to Question 17 in the List of Questions for Sub-Group 2/4.

Question 18.

(Sub-Group 2/4, then Sub-Group 2/2 and Study Group 11)

(New Question)

Considering that under semi-automatic and fully-automatic operating conditions a planned International European Switching Network will offer increasing scope for the use of transit operation,

And bearing in mind the special conditions attached to the use of telephone circuits for :

— telegraph systems and reserves,

— photo-telegraph services,

— broadcast services,

— leased circuits (other than permanent full-time leases),

What arrangements should be made, particularly at international transit centres, to ensure that telephone circuits can rapidly be made available for these services when required ?

Question 19.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

(a) Should a system be used on the international automatic or semi-automatic network in which, under certain conditions and for a strictly limited number of calls in each direction, there is the possibility of a predetermined waiting time while other calls are lost ? What should these conditions be ?

Note. — On this point, reference should be made to Document " C.C.I.F. — 1955/1956 — S.G. 8 — Document No. 20 — The calculation of the number of circuits in the semi-automatic service, by M. E. A. Zayontchkovski, U.S.S.R. Telecommunication Administration." *

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* Copies available on request from the Secretariat of the C.C.I.T.T.

(b) Considering that, for the establishment of transit calls, the waiting delays and the risks of lost calls in the use of the circuits are greater than in the case of the establishment of terminal calls, would it be useful in international transit centres to use a switching system such that a transit call always has priority over terminal calls in the seizure of a free line ?

Note. — The arrangements to be recommended for assuring the priority of transit traffic might be the blocking of circuits for terminal traffic if there is at least one transit call to be established, or the introduction of a short delay in the seizure of a free channel for terminal traffic or any other method.

(c) Assuming that a better grade of service is necessary for transit calls compared with that given for international terminal traffic, what arrangements should be recommended, in the case where the terminal and transit traffic is carried by a common group of circuits, to guarantee the appropriate grade of service for each of these two classes of traffic ? What method for calculating the number of circuits could be recommended in this case ?

Question 20.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Can the bases of calculation—particularly the values of probabilities of lost calls—used in the determination of the number of circuits required for semi-automatic operation, be regarded as equally valid for fully-automatic operation ?

If not, what basis should be adopted for such calculations ?

How should a group of circuits be treated which carries both semi-automatic and fully-automatic traffic ?

Question 21.

(Sub-Group 2/4, then Study Group 11)

(New Question)

Modifications and additions to be carried into Recommendation 63 *ter* of the C.C.I.F.

Note 1. — The Annex to Question 21 in the List of Questions for Sub-Group 2/4, describes a method recommended by the Netherlands Administration for determining (with the maximum speed by use of pre-established diagrams) an arrangement which represents if not the best economic solution, at least a solution with very little inaccuracy.

Note 2. — The calculations mentioned in the example of an application to a pratical case of the calculations in Recommendation 63 *ter* (the example given at the end of

this Recommendation) refer to annual charges for alternative routes which are considered as values given *a priori*, and not as values depending upon the number of minutes actually charged for, obtained for the different groups envisaged. Determination of the number of minutes effectively charged, obtained for the circuits of different groups, can lead to certain variations in the determination of the best economic arrangement.

Question 22.

(Sub-Group 2/4, then Study Group 11 and Sub-Group 2/2)

(New Question)

Considering

— that the definition of the traffic during the busy hour is given on pages 15 and 16 of Volume VI of the *Green Book*;

— that it is desirable that traffic measurements made by various Administrations shall be truly comparable in spite of the random nature of all telephone traffic;

— that to obtain a real basis for such a comparison a certain standard of accuracy is required and, for this purpose, the theory of random sampling methods gives a well known basis for comparison namely " confidence intervals " and " confidence coefficients " (See note below);

1. Will it be an advantage to obtain an agreement upon the accuracy of certain measurements carried out on a statistical basis (for instance to measure the amount of telephone traffic by groups of international circuits) and,

2. if so, for which cases of measurements should an agreement be obtained and what values of " confidence intervals " and " confidence coefficients " should be proposed for these cases ?

3. What degree of accuracy would be required of the measuring equipment ?

Note. — A typical example illustrating the use of these two terms (confidence interval and confidence coefficient) is given in the Annex to Question 22 in the List of Questions for Sub-Group 2/4. If agreement is reached on particular values of " confidence intervals " and " confidence coefficients " for a certain class of statistical measurement, then the extent of the measurements necessary is obtained from the curves. The " confidence intervals " and " confidence coefficients " will ensure that measurements made in different centres will become truly comparable.

TABLE SUMMARIZING

the Questions assigned to Study Group 11

Chairman : Mr. BARRON (United Kingdom)
Vice-Chairman : Mr. VASSILIEFF (U.S.S.R.)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
1	Noises causing operation of the signal receiver.		
2	Reduction to a minimum of noise in exchanges.		
3	Contact wetting with high frequency.		
4	Interconnection of three international circuits.	S.S.G. 1/2	S.S.G. 1/2
5	Charging for ineffective automatic international calls.	S.G. 2 S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
6	Determination of the chargeable period in automatic international service.	S.G. 2 S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
—			
8	No sending of the answer signal when an international automatic call arrives on an operator.	S.S.G. 2/4	S.S.G. 2/4
9	Release, not under the control of the calling subscriber, of an international automatic connection.	S.S.G. 2/4	S.S.G. 2/4
10	Reduction in the standard equivalent for automatic circuits.	S.S.G. 1/2	S.S.G. 1/2
11	Automatic measurement device for maintenance purposes.	S.G. 4	
12	Standardization of national busy and ringing tones.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
13	Standardization for special routings in international automatic service.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
14	Standard indications for special routings in international automatic service.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
15	Association of letters and digits on the dial for international automatic service.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
—			
17	Routes operated in transit partly with automatic switching, partly with manual switching.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
18	Setting up of circuits for special purposes in international automatic service.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
19	Seizing priority for transit calls in an international transit centre.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4
20	Basis for computation of the number of circuits in international automatic service.	S.S.G. 2/4	S.S.G. 2/4
21	Changes in Recommendation 63 *ter*.	S.S.G. 2/4	S.S.G. 2/4
22	Confidence intervals for traffic measurements.	S.S.G. 2/2 S.S.G. 2/4	S.S.G. 2/4

Questions concerning Telephone Transmission Quality and Local Networks

entrusted to

Study Group 12

in 1957-1960

Question 1.

(New Question)

What should be the reference equivalents which should never be exceeded for the national sending and receiving systems in an international call between two operators, it being understood that the C.C.I.F. recommendation concerning the reference equivalents for the link between the operators, whether the subscriber lines are connected or disconnected, is complied with ?

Question 2.

(continuation of Question 2 studied in 1955-1956 by the C.C.I.F. Study Group 4) (Background question)

(a) What conditions are used by your Administration for the measurement of the reference equivalent of the sidetone of subscriber's telephone sets for speech ?

(b) Can a measuring technique be recommended for the determination of the reference equivalent of sidetone for speech and for room noise when using the ARAEN as a reference system ?

(c) What is the minimum limit that your Administration admits for the reference equivalent of sidetone, for speech and for room noise, measured by your method ?

Question 3.

(Study Group 12 in cooperation with Study Groups 1, 10 and 11)

(continuation of Questions 3 and 4 studied in 1955-56 by the C.C.I.F. Study Group 4)

What methods and what apparatus should be recommended for the objective measurement of a quantity representative of the subjective disturbing effect (on the

quality of telephone transmission) of a rapid series of clicks of small amplitude : e.g. disturbances produced by the Telex service on a telephone call or disturbances due to the existence of faulty switching apparatus ?

Question 4.

(Study Group 12 in cooperation with Study Group 1)

(New question)

In the light of tests based on the opinions of typical telephone users what is the effect on transmission performance of the provisional noise limits adopted by the XVIIIth Plenary Assembly of the C.C.I.F. as proposed by the C.C.I.F. Study Group 3 ?

Note. — Annex 1 shows the provisional limits. Annex 2 gives the results obtained by the C.C.I.F. in determining reductions in transmission performance due to circuit noise. The tests based on the opinions of typical telephone users mentioned in Annex 2 were carried out in accordance with the method described in Annex 3; the working party of the C.C.I.F. Study Group 4, which examined these results, proposed that for future tests this method should be modified as described in Annex 4.

ANNEX 1

(to Question 4 of Study Group 12)

Amendments to Volume III of the " Green Book " approved by the XVIIIth Plenary Assembly of the C.C.I.F., following proposals by the C.C.I.F. Study Group 3 on the subject of circuit noise

1. — *Modified text of the paragraph " Noise on the hypothetical reference circuit on coaxial pairs "*

(page 94 of the *Green Book*, volume III)

" For planning carrier systems on coaxial pairs the following hypothesis is used :

" The mean psophometric power at a point of zero relative level at the end of the hypothetical reference circuit on coaxial pairs, during any hour, is 10 000 picowatts.

" It may be assumed that, for each channel of each link on which the hypothetical reference circuit is established, the mean signal power in any hour is equal to the nominal mean power of the signal during the busy hour adopted by the C.C.I.F. for design purposes. This value, at a point of zero relative level has been fixed at $=15$ dbm or $=1{\cdot}73$ neper (i.e., a power of 31·6 microwatts) ".

2. — *New text to insert under the title " Noise on the hypothetical reference circuit on symmetrical pairs "*

(page 70 of the *Green Book*, volume III)

" For planning carrier systems on symmetrical pairs, the following hypothesis may be used :

" The mean psophometric power at a point of zero relative level at the end of the hypothetical reference circuit on coaxial pairs, during any hour, is 10 000 picowatts.

" It may be assumed that, for each channel of each link on which the hypothetical reference circuit is established, the mean signal power in any hour is equal to the nominal mean power of the signal during the busy hour adopted by the C.C.I.F. for design purposes. This value, at a point of zero relative level, has been fixed at −15 dbm or −1·73 neper (i.e. a power of 31·6 microwatts)".

3. — *New text for the section " Circuit noise — including intermodulation cross-talk "* *

(page 42 of the *Green Book*, volume III)

" It is desirable that the total circuit noise (including intermodulation cross-talk) *measured* at the end of a circuit with the C.C.I.F. psophometer shall not on an average exceed a value corresponding to an E.M.F. of 2 millivolts at a point of relative level −0·8 neper or − 7 decibels."

and add in a *footnote* the following comment :

" The mean value of psophometric power of 10 000 picowatts at a point of zero relative level, which serves as a design basis for planning carrier systems, will correspond to an E.M.F. of about 2.2 millivolts at a point of relative level −0·8 neper or −7 decibels ."

ANNEX 2

(to Question 4 of Study Group 12)

Summary of results already obtained for the determination of reductions in transmission performance due to circuit noise

(Taken from the Report by the Working Party entrusted with Questions 5 and 6 of the C.C.I.F. Study Group 4, in November 1956)

1. *Articulation test results.*

Articulation tests have been made in the C.C.I.F. Laboratory using the AEN technique as described in Volume IV of the C.C.I.F. *Green Book*. The results of these experiments appear in the following documents :

CCIF — 1952/1954 — SG 4 — Documents Nos. 25 and 25 *bis*
CCIF — 1955/1956 — SG 4 — Documents Nos. 2 and 28

These experiments give, for the Swiss commercial telephone system ** a curve of transmission impairment due to circuit noise as a function of the psophometer reading expressed in db relative to 1 milliwatt of circuit noise. This curve (figure 1) is of the form :

$$I = 12 \log_{10} \left(1 + 10 \frac{N + 68}{12}\right)$$

where I is the impairment due to circuit noise and
N is the noise level at the distant local receiving exchange.

* All this part of Volume III of the *Green Book* applies to continental circuits for which it seems implied that their length will not exceed 2500 km.

** The Swedish and Dutch sets give only slightly different results; the results for the Swiss set have been shown because this set most typifies modern practice.

TABLE 1

Noise level (dbm)	Psophometric e.m.f. (mV)	Impairment (db)
−88	0·06	0
−83	0·11	0·3
−78	0·19	0·7
−73	0·34	1·7
−68	0·61	3·6
−63	1·10	6·8
−58	1·95	10·7

This relationship has been found to apply for the following types of circuit noise :

— white noise,
— white noise limited in frequency bandwidth to 300-3400 Hz,
— noise on a radio relay link,
— noise on a 60-channel carrier system on balanced pair cable,
— noise on a 12-channel carrier system on balanced pair cable,
— noise on a 5-channel carrier system on rural cable,
— noise due to the reaction of rectifiers on the six-phase lines that feed them (the principal components of this noise had frequencies of 250, 350, 550, 650, 1050, 1350, 1950, 2050, 2150, 2350, 2550, 2950 and 3050 c/s).

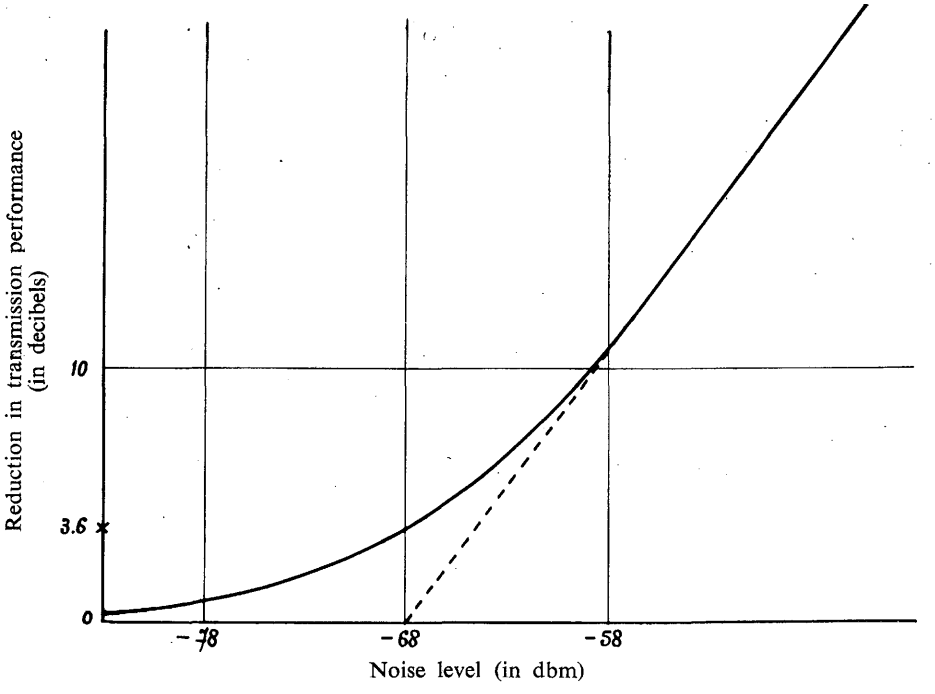


FIGURE 1

The noise by induction from the D.C. side of a six-phase rectifier (frequency components 300, 600, 900 c/s etc.) gave less impairment for the same psophometric voltage. The relationship was as follows :

$$I = 12 \log_{10} \left(1 + 10 \frac{N + 60}{12}\right)$$

where I is the impairment due to circuit noise
and N is the noise level at the distant local receiving exchange (see Table 2).

TABLE 2

Noise level (dbm)	Psophometric e.m.f. (mV)	Impairment (db)
−80	0·16	0
−75	0·28	0·3
−70	0·49	0·7
−65	0·87	1·7
−60	1·55	3·6
−55	2·80	6·8

The measurements of noise level were made at the receiving terminal exchange using the C.C.I.F. psophometer for commercial telephone circuits as defined in Volume IV of the *Green Book* of the C.C.I.F. The results were expressed as db relative to 1 mW. For this measurement the feeding bridge, the subscribers' line and the subscribers' set were replaced by a pure resistance of 600 ohms.

Under these articulation test conditions the speech volume at the point at which the noise was measured was—51 db relative to 1 volt, measured with the volumeter of the ARAEN and in the absence of circuit noise; applying the correction of—3 db (difference between readings on the ARAEN volumeter and the Vu—meter obtained with continuously spoken speech) (see " CCIF — 1955/1956 — SG 4 — Document No. 11 — Reply of the British Administration to Question 1 ") : this speech volume corresponds to −54 Vu.

As an alternative to presenting the results of the AEN measurements as a curve of impairment as a function of circuit noise level, the same results may be shown in the form of a curve giving the noise level at which 80% sound articulation is obtained as a function of the speech volume, at the point at which the noise level is measured (see figure 2).

The curve was obtained by noting the speech volume at the receiving terminal exchange when the junction attenuator was set to give 80% sound articulation for each value of circuit noise (also measured at the same point). The curve therefore shows the maximum level of circuit noise which will enable 80% of sounds to be correctly received in an articulation test carried out by the C.C.I.F. Laboratory team.

The curve was inferred from the results obtained by the Swiss local telephone system and a mean value was taken of the results for the various types of circuit noise which gave the same impairment as white noise. Maximum values of noise level, at least 3 db greater than those shown, should be used to take into account various factors such as room noise which may degrade transmission.

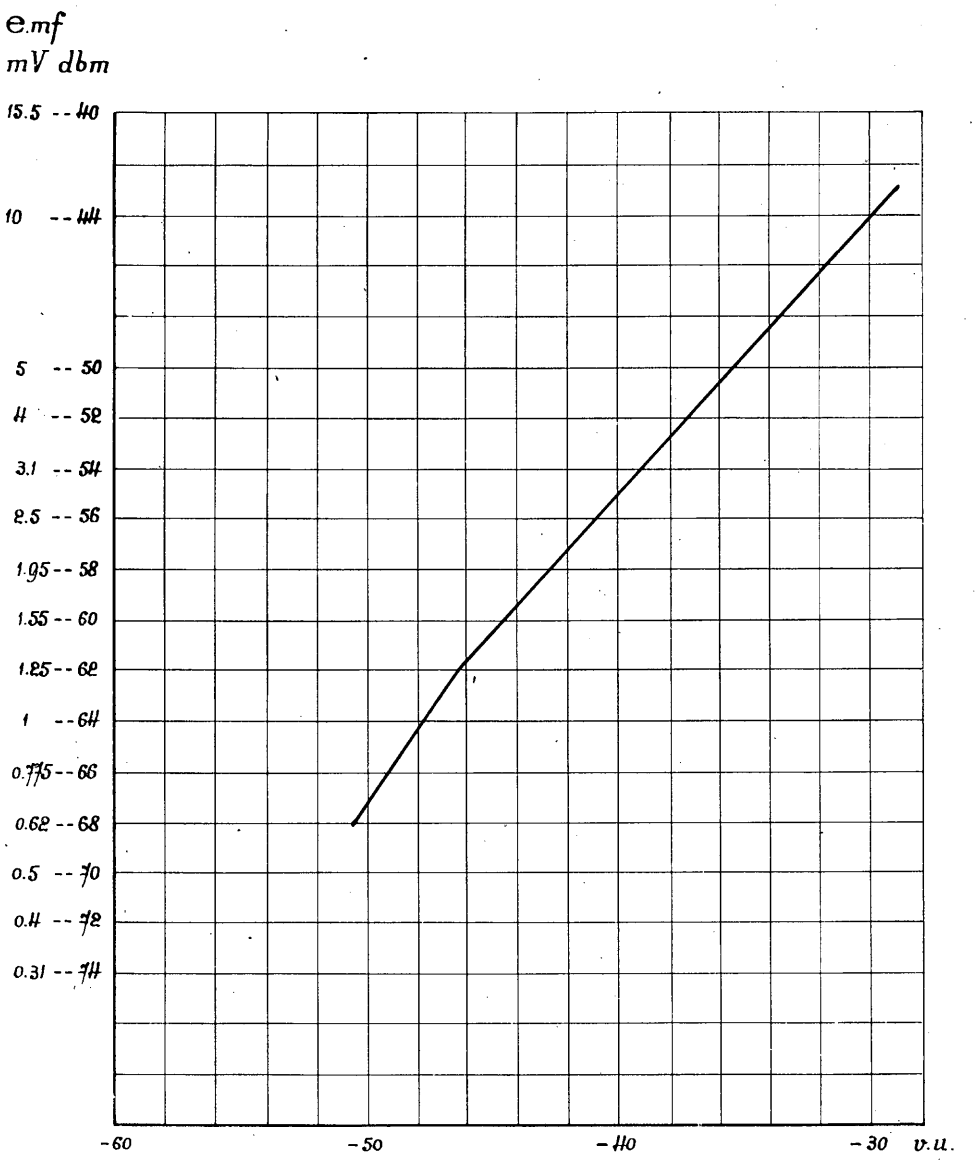


FIGURE 2. — *Relation between the noise level corresponding to 80% sound articulation and speech volume at the point at which the noise level is measured*

Note. — Results obtained from the 11th series of tests in the C.C.I.F. laboratory, using the Swiss local telephone system.

2. *Opinion test results.*

Tests based on the opinion of typical telephone users have been carried out by the following Administrations and Private Operating Agencies : the Federal German Telephone Administration, the United Kingdom Telephone Administration, the F.A.T.M.E. Company of Italy, Teléfonos de Mexico and Siemens & Halske Company of the Federal German Republic.

The results of these tests are reported in the following documents :

CCIF — 1955/1956 — CE 4 — Document Nos. 29, 30, 31 and 37.

The tests were carried out in accordance with the Annex 3 of this draft reply which also shows the agreed method of analyzing the results.

The results expressed as mean opinion scores have been assembled in the following table :

TABLE 3

Results expressed as Mean Opinion Scores of opinions given
(50 db Room noise present at each station)

J db	N dbm	Mean Opinion Score				
		Federal German Administration	United Kingdom Administration	FATME (Italy)	Mexico	Siemens & Halske (Fed. German)
10	$-\infty$	3·6	3·6		3·6	3·5
	−65	3·3	3·4			3·1
	−62			*Note:*	3·6	
	−58	3·4	3·5	The results		3·2
	−56			for Italy are	3·5	
	−51	3·1	3·2	given in		3·4
	−50			table 3 *bis*	3·5	
	−44	2·7	3·0		3·1	3·3
	−38				2·6	
	−37	1·9	2·5			3·0
30	$-\infty$	1·7	2·4		2·3	0·9
	−75	1·9	2·7			1·3
	−68	1	2·8	*Note:*	2·0	1·4
	−62			The results	1·9	
	−61	1·4	2·4	for Italy are		1·2
	−56			given in	1·8	
	−54	0·7	2·0	table 3 *bis*		1·0
	−50				1·3	
	−47	0·1	1·6			0·5
	−44				0·5	
Reference equivalent :						
Sending		8 db W	7 db W	4 db W	9 db W	8 db W
Receiving		3 db B	1 db B	0 db	1 db W	0 db

In Table 3, J represents the total loss between the distant local exchanges and N, the noise level measured with the C.C.I.F. psophometer for commercial telephone circuits at the distant local exchange and expressed in db relative to 1 mW.

For this measurement, the feeding bridge, subscriber's line and subscriber's set were replaced by a pure resistance of 600 ohms.

TABLE 3 *bis*

Results expressed as Mean Opinion Score of opinions given (F.A.T.M.E. Italy)
50 db Room noise present at each station

J db	N dbm	Mean Opinion Score	
		First replication	Second replication
0	$-\infty$	3·5	3·5
	−40	3·0	3·0
	−30	2·6	2·8
	−20	2·2	2·2
	−10	0·9	0·7
14	$-\infty$	3·0	3·1
	−54	3·0	3
	−44	2·7	2·7
	−34	2·1	2·2
	−24	1·7	0·7
28	$-\infty$	2·5	2·7
	−68	2·7	2·7
	−58	2·3	2·5
	−48	1·8	2
	−38	0·65	0·7
42	$-\infty$	1·65	1·8
	−82	1·7	1·65
	−72	1·45	1·8
	−62	1·4	1·5
	−52	0·4	0·7

Reference equivalent of local telephone circuit : Send : 4·0 db worse
Receive : 0 db.

The results for intermediate values of J may be interpolated if a supplementary test is carried out using several values of J and no circuit noise. The results of such a supplementary test are given in Table 4.

TABLE 4

Results (expressed as Mean Opinion Scores of opinions given) of a supplementary test with no circuit noise

J db	Federal German Administration	United Kingdom Administration	FATME (Italy)	Mexico	Siemens & Halske (Fed. German Republic)
0		3·8	This supplementary test is not required in the case of Italy as the experiments were differently arranged.		
10		3·7			
20		3·1			
30		3·0			
40		1·8			

Using this information, families of curves may be plotted showing mean opinion scores as functions of junction loss, J, and circuit noise level, N. The curves in figures 3*a*, 3*b*, 3*c*, 3*d* and 3*e*, give the results in this form. The values of reference equivalent corresponding to the values of junction loss are also shown.

FIGURE 3. — *Curves showing Mean Opinion scores as functions of junction loss (or Reference Equivalent) and Circuit Noise Level*

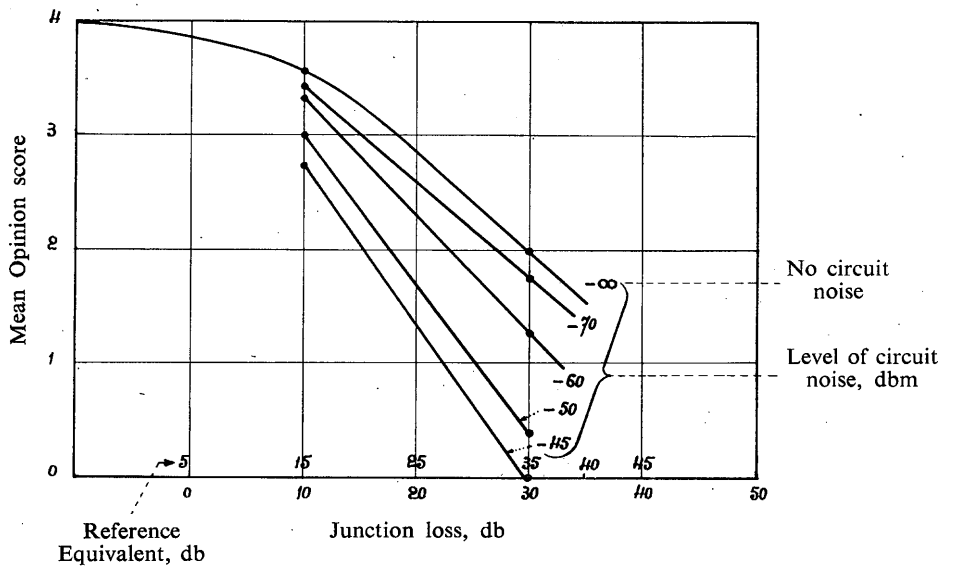


FIGURE 3*a*. — *German Administration*

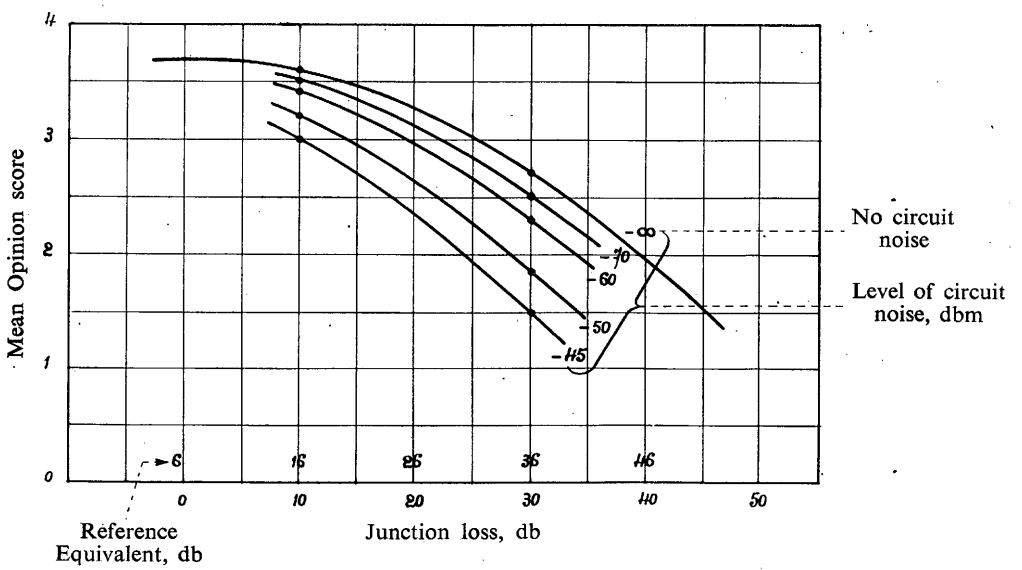


FIGURE 3*b*. — *United Kingdom Administration*

FIGURE 3 (cont.). — *Curves showing mean opinion scores as functions of junction loss (or reference equivalent) and Circuit Noise Level*

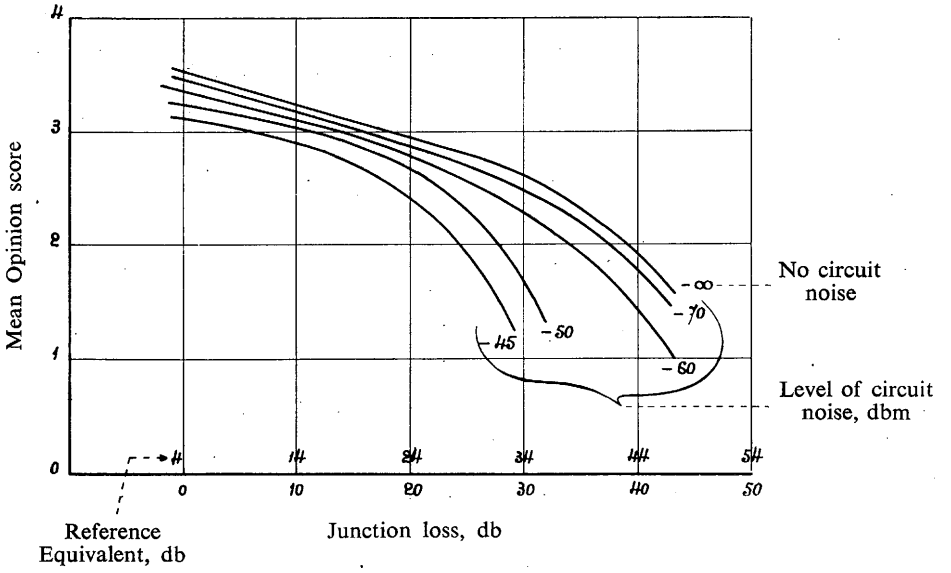


FIGURE 3c (1). — *Italy (F.A.T.M.E.), 1st replication*

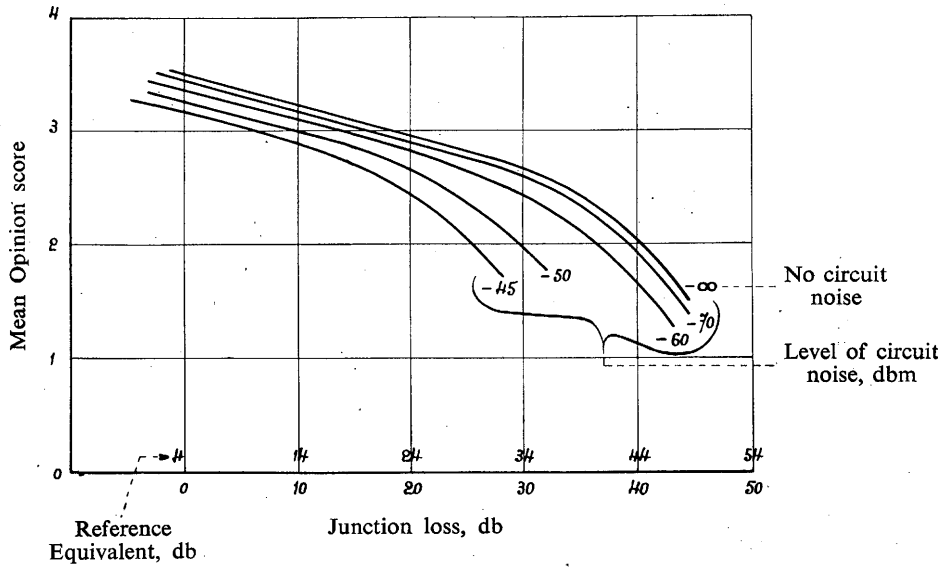


FIGURE 3c (2). — *Italy (F.A.T.M.E.), 2nd replication*

FIGURE 3 (cont.). — *Curves showing mean opinion scores as functions of junction loss (or reference equivalent) and Circuit Noise Level*

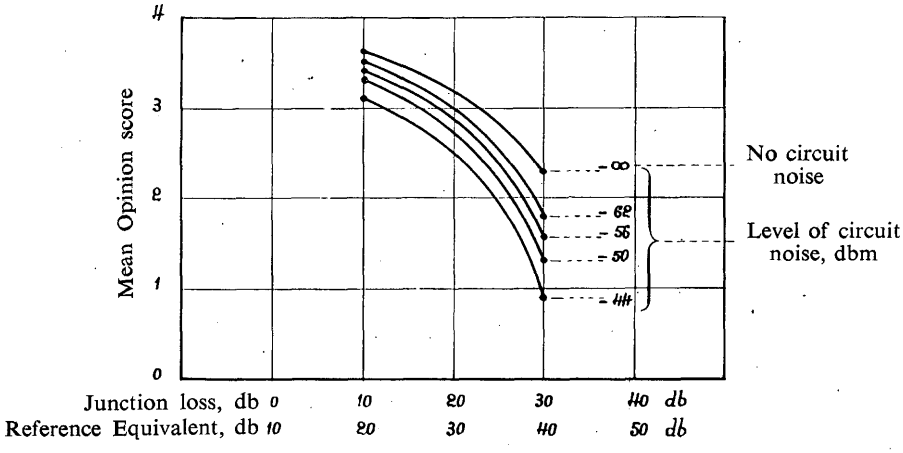


FIGURE 3*d*. — *Teléfonos de Mexico*

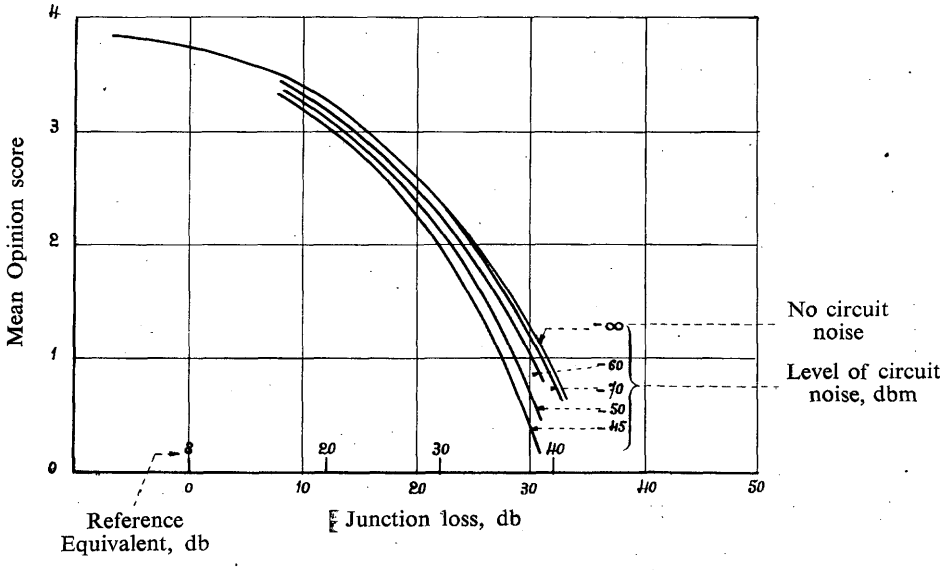


FIGURE 3*e*. — *Siemens Halske Company*

From figures 3*a*, 3*b*, 3*c*, 3*d* and 3*e* it is possible to determine values of noise transmission impairment for several values of circuit noise.

Table 5 shows these impairments for 2 values of overall reference equivalent of a call (30 db and 40 db).

TABLE 5

Noise Transmission Impairments for several values of Circuit Noise Level at two values of Overall Reference Equivalent of a call

N dbm	Overall Reference Equivalent db	Federal German Administration	United Kingdom Administration	FATME (Italy)		Mexico	Siemens & Halske (Fed.German Republic)
				1st replication	2nd replication		
−70	40	2·5	3·5	2·0	1·0		1·0
−62						3·0	
−60		7·5	5·5	5·5	4·5		1·5
−56						4·5	
−50		14·0	11·5	10·5	10·5	6·0	3·0
−45		16·0	15	14·0	14·5		4·5
−44						8·0	
−70	30	2·5	3·0	3·5	2·5		0·5
−62						3·5	
−60		6·0	6·0	6·0	5·5		1·0
−56						5·5	
−50		10·5	11·5	8·0	9·5	7·5	2·0
−45		12·5	15·5	12·0	13·5		3·0

Note. — Interpretation of the curves 3*a*, *b*, *c*, *d* and *e* requires the conversion of the mean opinion scores into percentages of users who express the opinions E or G, or the opinions E or G or F. The method described in Annex 3 leads to the following relationships shown in Tables 6 and 7.

The curves shown in figures 3*a*, *b*, *c*, *d* and *e*, in which mean opinion score is plotted, can be converted to curves in which the percentage of users who express the opinions E or G, or the opinions E or G or F by means of tables 6 and 7 and the results obtained by the British Administration and the F.A.T.M.E. (Italy), converted in this manner, are given as an example (see Figures 4 and 4 *bis*).

TABLE 6

Percentages of Opinion E or G as a function of Mean Opinion Score

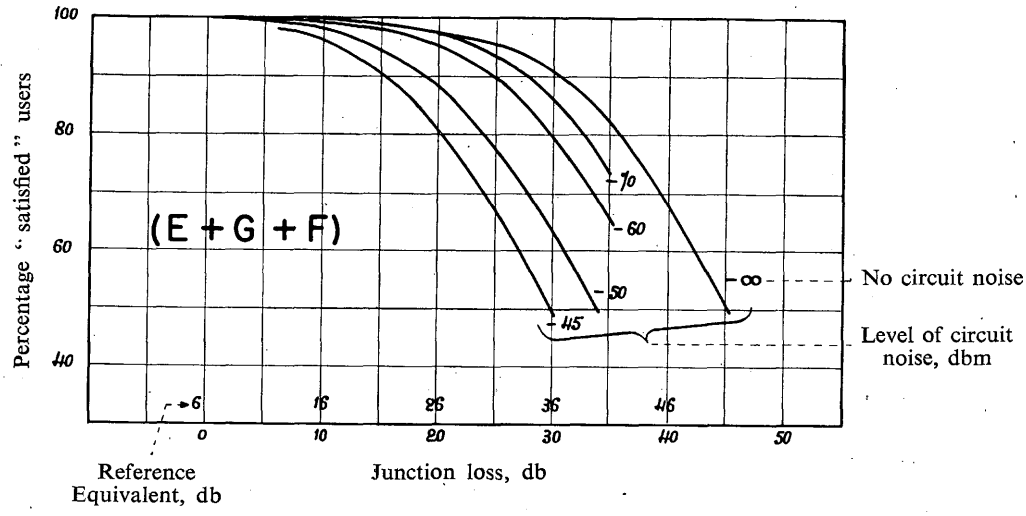
Mean Opinion Score	Federal German Republic	U. K.	FATME (Italy)		Teléfonos de Mexico	Siemens & Halske
			1st Rep.	2nd Rep.		
1·0	5	6·6			3·0	6
1·1		7·8			3·8	
1·2		9·2			4·7	
1·3		10·7			5·9	
1·4		12·5			7·2	
1·5	13	14·2	12	14·5	8·9	13
1·6		16·3			10·8	
1·7		18·7			12·7	
1·8		22·1			16·1	
1·9		24·8			18·7	
2·0	27	28·8	29	33	22·7	27
2·1		31·9			26·1	
2·2		35·9			30·9	
2·3		40·5			35·9	
2·4		45·2			41·7	
2·5	50	50·0	54	61	47·2	50
2·6		54·8			52·8	
2·7		59·5			58·3	
2·8		64·1			64·1	
2·9		69·1			70·2	
3·0	76	74·2	82	83	76·1	75
3·1		78·8			81·3	
3·2		83·6			85·7	
3·3		86·9			90·0	
3·4		90·8			93·2	
3·5	95	93·4			95·9	94
3·6		96·0			97·8	
3·7		97·6			99·0	
3·8		98·87			99·6	
3·9		99·61			99·9	
4·0		100·00			100·00	

TABLE 7

Percentages of Opinion E or G or F as a function of Mean Opinion Score

Mean Opinion Score	Federal German Republic	U. K.	FATME (Italy)		Teléfonos de Mexico	Siemens & Halske
			1st Rep.	2nd Rep.		
1·0	29	33·0			29·8	31
1·1		35·9			33·4	
1·2		39·4			37·8	
1·3		42·9			41·7	
1·4		46·4			45·6	
1·5	50	50·0	36	44	50·0	50
1·6		53·6			54·4	
1·7		57·1			58·3	
1·8		61·8			64·1	
1·9		64·8			67·7	
2·0	74	69·1	67	71	72·6	71
2·1		72·2			76·1	
2·2		76·1			80·2	
2·3		79·7			83·9	
2·4		82·9			87·3	
2·5	91	85·8	89	90	90·0	88
2·6		88·1			92·2	
2·7		90·3			94·1	
2·8		92·2			95·5	
2·9		94·2			97·0	
3·0		95·7	98·5	98·5	98·0	97
3·1		96·9			98·8	
3·2		97·9			99·2	
3·3		98·57			99·6	
3·4		99·18			99·8	
3·5		99·48			99·9	
3·6		99·75			99·96	
3·7		99·89			99·98	
3·8		99·96			—	
3·9		99·99			—	
4·0		100·00			100·00	

FIGURE 4. — *Percentages of "satisfied" users as a function of junction loss and circuit noise level*
(U. K. Administration)



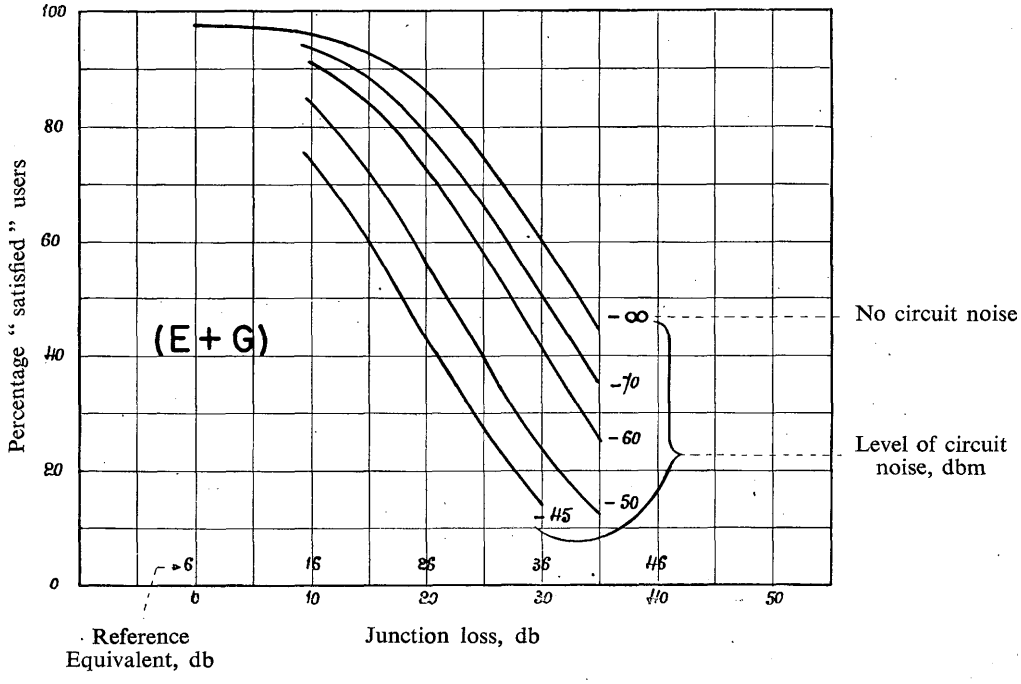
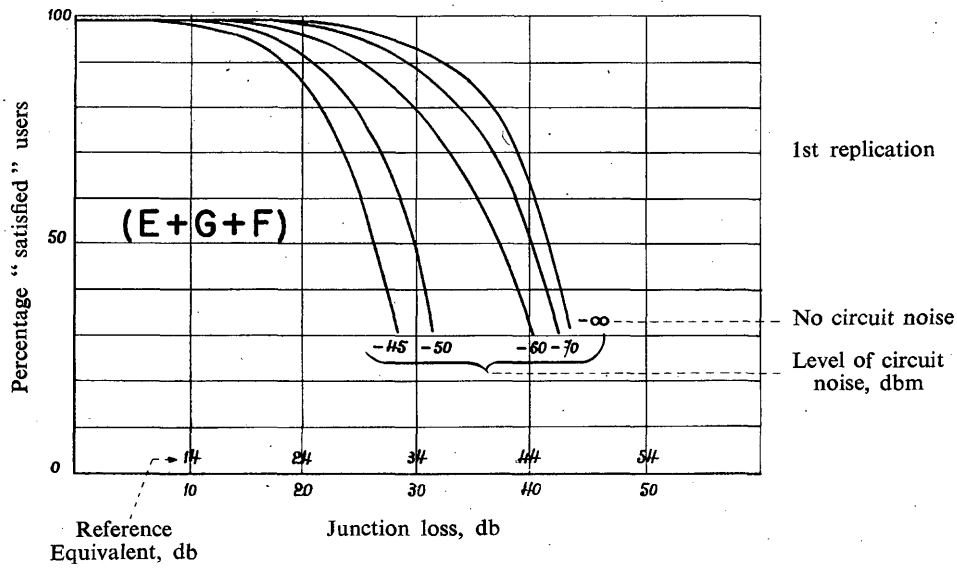


FIGURE 4 *bis.* — *Percentage of "satisfied" users as a function of junction loss and circuit noise level*

(F.A.T.M.E. — Italy)



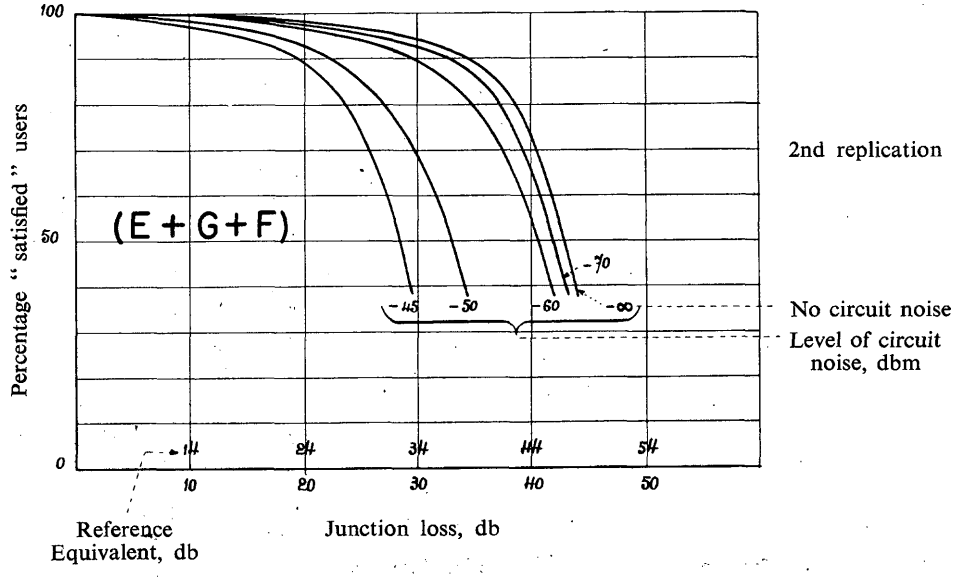
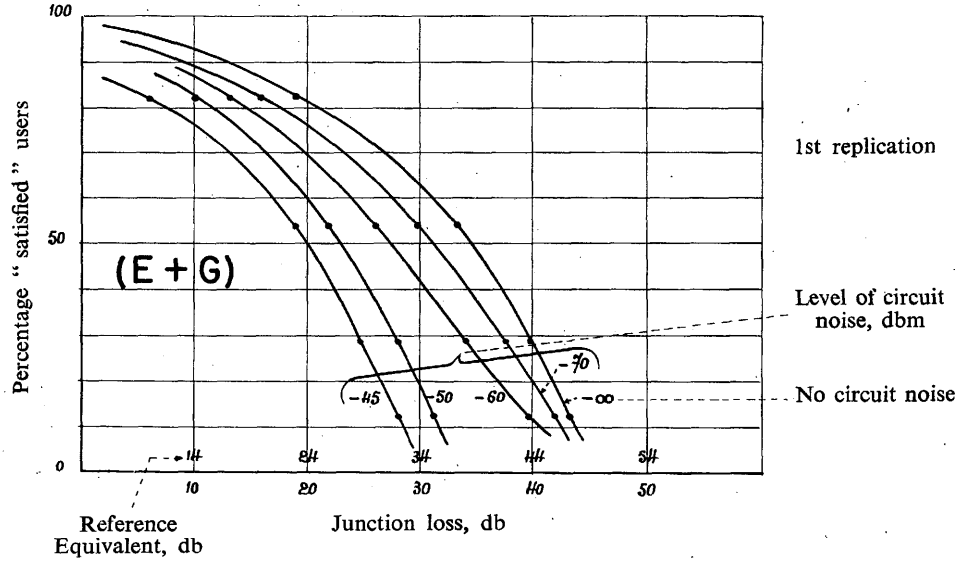
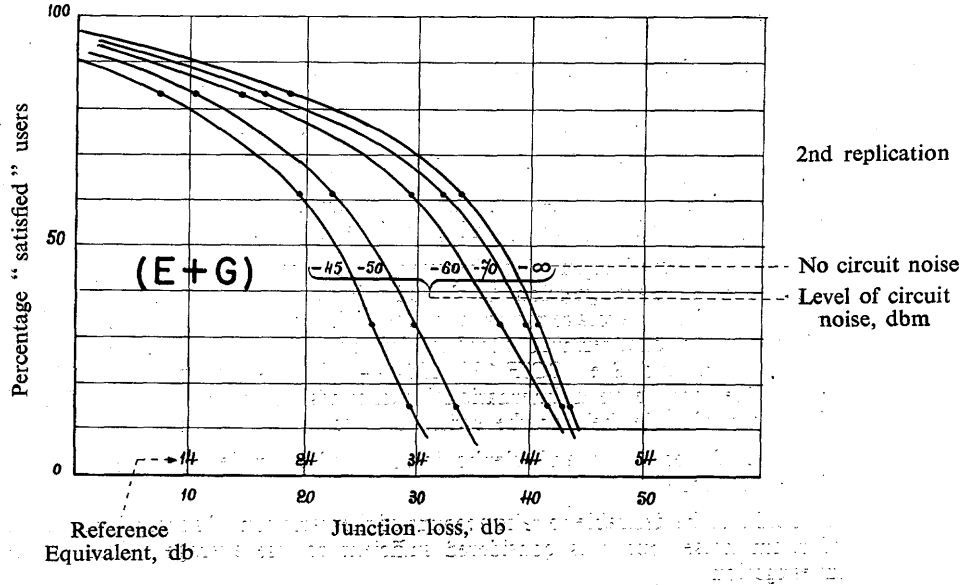


FIGURE 4 *bis* (cont.). — *Percentage of "satisfied" users as a function of junction loss and circuit noise*

(F.A.T.M.E. — Italy)





3. *Discussion of the results of articulation and opinion tests.*

Examination of tables 1 and 5 show that although there is no complete agreement between the impairment values given by the various opinion test experiments, the opinion test results all show considerably lower impairments than those given by the articulation test results for the same levels of circuit noise.

The Working Group is of the opinion that the most realistic results are provided by the opinion tests. The articulation data suffer from the following important artificialities :

(a) a highly trained crew of operators is used who do not react to circuit degradations in the same way as real telephone users;

(b) the talking distance and vocal level, and also the position of the hand-set, are arbitrarily fixed and the influence of the circuit on these quantities is not taken into account;

(c) the speech material used is of a very formal character, namely meaningless Esperanto mono-syllables.

Opinion tests, on the other hand, are made under conditions which allow the subjects taking part therein the greatest possible freedom in their manner of using the telephone and being thus free from the above-mentioned artificialities, approximate much more closely to actual service conditions.

In view of this, the Working Group considers that a final reply to Questions 5 and 6 of the C.C.I.F. Study Group 4 can best be given by means of results of tests based on the opinions of telephone users. The method of making such opinion tests, which is described in Annex 3, is the nearest approach to this objective which is available at the present time. The Working Group is of the opinion that certain minor improvements should be made to this method and these are indicated in Annex 4.

ANNEX 3

(to Question 4 of Study Group 12)

Experiments to determine the effect of circuit noise on the opinions of telephone users

It is required to assemble information which will enable the proportion of " unsatisfactory " calls to be estimated, taking account of the following :

(a) Variation of noise level. The results of the measurements to be taken in reply to Question 7 of C.C.I.T.T. Study Group 1, will provide appropriate statistical distributions.

(b) Variation of overall circuit loss between exchanges. The replies made in 1952/1954 to the supplementary question A of Study Group 4 have given appropriate statistical distributions for the average rating in service of the connection between the local exchange and the international terminal exchange for the national networks of a certain number of Administrations (See "CCIF 1952/1954 — SG 4 — Documents 40, 41, 42, 43, and 46 "). The loss between international exchanges might be taken as 7 decibels with allowances of 1 decibel for the switching loss at each international exchange.

(c) Variation of speech level and telephonic ability of a sample of ordinary, untrained users of the telephone.

(d) It would also be desirable to take account of the variation of subscriber's lines and levels of room noise, but it is considered sufficient to use average values in the present investigation.

The following experiment will provide the necessary information for a sufficiently wide range of variation of *(a)*, *(b)* and *(c)*.

The following telephone circuit should be set up.

At each end — modern type subscriber's telephone sets,
— average subscriber's lines and feeding bridges,
— hoth spectrum room noise at a level of 50 decibels.

The two extreme local telephone sets should be connected together through two 600 ohm attenuators with means for injecting circuit noise at the point where these are joined together. Thus by setting the attenuators to equal values, the same level of circuit noise will be heard at each end of the circuit.

Two settings will be used for J, for the overall junction loss including the two attenuators together with the circuit used for injecting the circuit noise, namely 10 decibels and 30 decibels.

For each setting of J, six levels of white noise, restricted in frequency bandwith to 300-3400 c/s (expressed as decibels relative to 1 mW psophometric power measured at either end of the junction will be used, i.e. at the terminal exchange).

The following values are only for guidance and the exact values must be subject to a preliminary trial. The noise level is denoted by N and the following values of N should be used.

J = 10 N = $-\infty$ (no noise), -65, -58, -51, -44 and -37
J = 30 N = $-\infty$ (no noise), -75, -68, -61, -54 and -47

For each combination of J and N, conversations should take place between twelve pairs of subjects. The subjects should be chosen from ordinary persons, not trained and not directly concerned with speech studies; they should also have no personal interest in the results of the experiments.

Each conversation should consist of the following: the subject at one end should describe a number of designs of random shape such that each can be recognized by the other subject out of a number of similar designs. The subjects then exchange rôles and converse again. The total duration of conversation will be about 4-6 minutes. At the end of this procedure each of the subjects will express their opinions of the circuit on a copy of the following form.

Independent opinions

Please express your opinion, when notified by the operator, by ticking the appropriate letter. Do not discuss your opinion with your companion.

E	Excellent circuit; complete relaxation possible while conversing.	E	
G	Good circuit; attention necessary but no appreciable effort required.	G	
F	Fair circuit; moderate but not excessive effort required.	F	
P	Poor circuit; conversation possible but much difficulty experienced on unfamiliar words.	P	
B	Bad circuit; usable only with extreme difficulty.	B	

Suitable sheets of designs with full details of their use will be supplied by the British Post Office to the C.C.I.F. Secretariat who will supply copies to Administrations who indicate their willingness to take part in this investigation. The observations should be made with proper attention to statistical design and analysis. A suitable design is a 12 × 12 latin square as follows.

Subject Pair	First Session			Second Session			Third Session			Fourth Session		
	Design Set 1	Design Set 2	Design Set 3	Design Set 4	Design Set 5	Design Set 6	Design Set 7	Design Set 8	Design Set 9	Design Set 10	Design Set 11	Design Set 12
A	a	b	c	d	e	f	g	h	i	j	k	l
B	b	c	d	e	f	g	h	i	j	k	l	a
C	c	d	e									
D	d	e	f									
E	e	f	g									
F	f	g	h									
G	g	h	i									
H	h	i	j									
I	i	j	k									
J	j	k	l									
K	k	l	a									
L	l	a	b									

The rows and columns of the above Latin share should be randomised for each new replication and the twelve conditions (12 combinations of junction loss and circuit noise) allocated at random to the letters a to 1.

At least two replications should be made using 24 different subjects in each.

Certain supplementary measurements can conveniently be made. These should include volume (expressed in vu) of each subject while describing his designs but may include also, if desired, a count of repetitions requested.

Analysis of the Results

The numbers of opinions expressed in each category should be scored as follows :

0 for B 1 for P 2 for F 3 for G 4 for E

The mean values of these scores shall be calculated for each test condition and are assembled as shown in Table 3 of Annex 2 above.

The Mean Opinion Scores may be plotted as functions of noise level N, for the two values of J.

A curve of the form

$$y = a + b \exp\left(\frac{x}{c}\right)$$

may be fitted to each set of points by the techniques used at one time in the C.C.I.F. Laboratory for fitting articulation curves (analysis of results of the 8th and 9th series of tests by the C.C.I.F. Laboratory : see Volume IV of the C.C.I.F. *Yellow Book*, pp. 84 et seq.), except that a constant weighting coefficient should be used instead of one depending upon y.

For interpolation between the two values of J the following procedure may be used. Curves of Mean Opinion Score, y, as a function of J with N as parameter, are more simply related to each other than curves of y as a function of N with J as parameter. Two points on each of a family of such curves can be determined from the curves fitted to the results and shown in Figures 3*a*, *b*, *c*, *d*, *e* (Annex 2). The next step is to interpolate between these points by means of curves of suitable form.

A supplementary experiment may be conducted in which the junction loss J is varied (5 settings) and no circuit noise is present. The results of this experiment (expressed as Mean Opinion Scores) are shown in Table 4 (Annex 2). A curve of $y = \alpha + \beta (x - y)^2$ may be fitted to the results. Curves of the same form and with the same curvature can be drawn through each pair of points corresponding to a given value of N.

This family of curves shown in Figure 3*a*, *b*, *c*, *d*, *e* of the reply enables the Mean Opinion Score to be read off for any combination of values of J and N within the ranges covered by the experiment.

The final results are required in the form of percentages of users who would express various classes of opinions for any combination of J and N.

It may reasonably be anticipated that the percentage of users who express say E+G+F opinions will be related to junction loss by a " probit " curve. A user may, perhaps, be taken as " satisfied " if he expresses one of these three opinions because this corresponds to the use of no more than a moderate effort. A more critical standard of " satisfaction " would be given by taking E+G.

The next step is to relate these percentages, which take account of the variability of users, (including their speech levels and telephonic abilities), to the Mean Opinion Score, from which the effects of variability about an average user have been practically eliminated by averaging, i.e. Mean Opinion Score would be little changed by selecting a small team of average users whereas values of percentage " satisfied " users would be considerably altered.

The percentages of users who expressed the opinions E+G and E+G+F can be plotted against Mean Opinion Score.

The " probit " (equivalent number or fraction of standard deviations) of the percentage of " satisfied " users when plotted against $\sqrt{4 - y}$ (y being the Mean Opinion Score) will be a straight line.

The best fitting straight lines may be drawn passing through the points :

$p = 50\%$, $y = 1{\cdot}5$ for E+G+F and
$p = 50\%$, $y = 2{\cdot}5$ for E+G.

Values taken from these lines may be restored to their original units and tables may be prepared for E+G and E+G+F as shown in table 6 (Annex 2).

Information given in this table enables the curves of Figures 3*a*, *b*, *c*, *d*, *e* to be converted from Mean Opinion Scores to percentage "satisfied" in Figure 4 (Annex 2). In one family "satisfaction" corresponds to users expressing opinions E+G+F and in the other to the higher standard of E+G.

ANNEX 4

(to Question 4 of Study Group 12)

Recommended improvements to the method of conducting opinion tests and analyzing their results

The following features of the opinions method are considered essential :

(a) the opinions must be based on vigorous both-way conversation of 1-3 minutes duration. A conversation may be initiated by random shaped puzzles (These are described in Research Report no. 12 970 of the British Administration and the C.C.I.F. Secretariat will supply sheets of these designs to Administrations and Private Operating Agencies who desire to contribute to the study of this question), crossword puzzles or any other method, provided that vigorous conversation results;

(b) the subjects should be chosen from ordinary persons, not trained and not directly concerned with speech studies; they should also have no personal interest in the results of the experiment;

(c) each person should express his opinion once only within an experiment on any given circuit condition. If it is desired to use the same subjects again on the same condition, the results should be kept separate and analzyed as a separate replication.

The form of opinion scale which should be used was discussed and it was decided that a 5 point scale should be retained, but that for future work only the simple headings Excellent (E), Good (G), Fair (F), Poor (P) and Bad (B), should be used without any accompanying descriptions.

Owing to the large effect of loss on the opinions any future tests should be made using 3 or, if possible, 4 values of junction loss, J. A typical experiment might use four values of J and five values of circuit noise N (including $N = -8$) making twenty circuit conditions in all.

The method of analysis and of presentation given in Annex 3 should be retained, but consideration should be given to the applicability of the following binomial formula for relating the proportions of opinions to the mean opinion score :

$$P\ (x) = \frac{n!}{x!\ (n-x)!} \cdot p^n\ (1-p)^{n-x}$$

where :

$P(x)$ = the proportion of opinions expressed for the xth category, i.e. $x = 0$ for Bad, $x = 1$ for Poor ....., $x = n$ for Excellent;

n = one less than the number of categories, i.e. in this case $n = 4$;

$p = \dfrac{\text{mean opinion score.}}{n}$

Table 8 gives values of this expression for a 5 point scale.

TABLE 8

Binomial distribution of opinions on 5-opinion rating scale

Opinion	Excellent	Good	Fair	Poor	Bad
Score	4	3	2	1	0

Mean score	Proportion of opinions				
	Excellent	Good	Fair	Poor	Bad
3·9	0·9037	0·0927	0·0036	0·0001	0·0000
3·8	0·8145+	0·1715−	0·0135+	0·0005	0·0000
3·7	0·7321	0·2374	0·0289	0·0016	0·0000
3·6	0·6561	0·2916	0·0486	0·0036	0·0001
3·5	0·5862	0·3350−	0·0718	0·0068	0·0002
3·4	0·5220	0·3685−	0·0975+	0·0115−	0·0005−
3·3	0·4633	0·3931	0·1251	0·0177	0·0009
3·2	0·4096	0·4096	0·1536	0·0256	0·0016
3·1	0·3608	0·4189	0·1824	0·0353	0·0026
3·0	0·3164	0·4219	0·2109	0·0469	0·0039
2·9	0·2763	0·4192	0·2385+	0·0603	0·0057
2·8	0·2401	0·4116	0·2646	0·0756	0·0081
2·7	0·2076	0·3998	0·2888	0·0927	0·0112
2·6	0·1785+	0·3845	0·3105+	0·1115	0·0150+
2·5	0·1526	0·3662	0·3296	0·1318	0·0198
2·4	0·1296	0·3456	0·3456	0·1536	0·0256
2·3	0·1093	0·3232	0·3583	0·1766	0·0326
2·2	0·0915+	0·2995−	0·3675+	0·2005−	0·0410
2·1	0·0760	0·2749	0·3731	0·2251	0·0509
2·0	0·0625	0·2500	0·3750	0·2500	0·0625
1·9	0·0509	0·2251	0·3731	0·2749	0·0760
1·8	0·0410	0·2005	0·3675+	0·2995−	0·0915+
1·7	0·0326	0·1766	0·3583	0·3232	0·1093
1·6	0·0256	0·1536	0·3456	0·3456	0·1296
1·5	0·0198	0·1318	0·3296	0·3662	0·1526
1·4	0·0150+	0·1115−	0·3105+	0·3845−	0·1785+
1·3	0·0112	0·0927	0·2888	0·3998	0·2076
1·2	0·0081	0·0756	0·2646	0·4116	0·2401
1·1	0·0057	0·0603	0·2385+	0·4192	0·2763
1·0	0·0039	0·0469	0·2109	0·4219	0·3164
0·9	0·0026	0·0353	0·1824	0·4189	0·3608
0·8	0·0016	0·0256	0·1536	0·4096	0·4096
0·7	0·0009	0·0177	0·1251	0·3931	0·4633
0·6	0·0005−	0·0115−	0·0975+	0·3685−	0·5220
0.5	0·0002	0·0068	0·0718	0·3350−	0·5862
0·4	0·0001	0·0036	0·0486	0·2916	0·6561
0·3	0·0000	0·0016	0·0289	0·2374	0·7321
0·2	0·0000	0·0005−	0·0135+	0·1715−	0·8145+
0·1	0·0000	0·0001	0·0036	0·0927	0·9037

In addition to the above proposals consideration should be given to the use of a direct conversational comparison method as a means of providing direct comparisons between telephone systems, noise levels, or any other conditions to be tested.

Question 5.

(Study Group 12 in cooperation with Study Groups 1 and 5)

(New question)

The XVIIIth Plenary Assembly of the C.C.I.F. fixed the permissible limit of 1 millivolt psophometric e.m.f. corresponding to noise due to magnetic induction and/or to the effect of the electric field of the power lines acting on the one or more parts of the chain connecting the subscriber's set to his international exchange; this value being determined at the " line " terminals of the subscriber's set (considered at the receiving end) on the assumption that the items of telecommunication equipment inserted in this chain are all perfectly balanced with respect to earth (see the Annex below).

Administrations are asked to make tests based on the analysis of the opinions of typical telephone users to determine whether the limit of 1 millivolt is acceptable in the case of induced noise of specified wave-form:

— a waveform corresponding to the noise from the D.C. side of a six-phase rectifier,

— a waveform corresponding to the noise due to the reaction of the rectifiers on the three-phase lines feeding them.

Note 1. — The experimental circuit used for these tests should simulate as closely as possible an actual commercial communication but should be as perfectly balanced with respect to earth as possible.

Note 2. — Opinion tests are described above in Annexes 3 and 4 to Question 4.

ANNEX

(to Question 5 of Study Group 12)

Passages in the Directives referring to inducted noises in telephone circuits

The XVIIIth Plenary Assembly of the C.C.I.F. approved a new text for the first two parts of the *Directives concerning the protection of telecommunication lines against the adverse effects of power lines.* The passages of this new text relative to the limit of induced psophometric e.m.f. in audio-frequency telephone circuits (open-wire or cable) are reproduced below. These passages replace in particular paragraphs 93 and 100 of the *Directives* (Geneva revision, 1952).

§15. *Comments on calculation of interference.*

. . . . . .

225. Resulting from these considerations, the values of calculated psophometric electromotive force are not so exact as the values of electrically induced currents or induced electromotive forces calculated in connection with the assessment of the risk of danger. They only represent an order of values, and even then, are not very precise. However, carefully interpreted, the results of the calculation do indicate, for example, if a proposed situation entails any risk of inadmissible interference, or, in other cases, if a particular special simple arrangement would be sufficient to eliminate the noises, or even if it would be better to consider a major modification to the project.

§16. *General Principle.*

226. The psophometric e.m.f. corresponding to the noise due to magnetic and/or electric induction from a group of electric lines, arising in one or more parts of a chain of lines connecting a subscriber's station to its international exchange should not exceed 1 millivolt, this value being measured at the " line " terminals of the subscriber's set (when receiving) and for the case when the telecommunications installations in the chain are perfectly symmetrical with respect to earth *.

227. With regard to the resulting noise, it is generally possible, in practice, to determine, for each national network, the switching centres which correspond, for long distance national communications, with the international exchange in international communications.

228. It is then sufficient to determine the psophometric electromotive forces arising from the whole of the electric lines in one or more sections of the chain of lines which connect such a centre to the subscriber's station.

§17. *Overhead open-wire telephone lines.*

229. In certain cases where it would be too difficult or onerous to provide adequate spacing between an electric line and an overhead open-wire telephone line, keeping within the limi- of 1 mV for the psophometric e.m.f., conforming to sub-paragraph 226 (limit which must be respected if it is desired to include an audio circuit in the make up of a long distance communication), can necessitate, in exceptional circumstances, the introduction of certain special arrangements, consisting, for example, of adding certain devices to the overhead open-wire line or having recourse to another type of construction or method of operation.

230. In order to assess the risks of interference of a permanent or lasting character which would arise from a projected approachment of an electric line and a telephone line, it is necessary to determine by calculation the values of the psophometric e.m.f. likely to appear in the most unfavourable circumstances.

231. From the point of view of calculations, it is possible to separate the components of the resulting noise into those due to electric induction and those due to magnetic induction. When it has been possible to foresee that certain of these components are negligible when compared with others and that, consequently, it is unnecessary to calculate them, this is indicated in the following sub-paragraphs. Where it has been recommended that the noise components be calculated, the resulting e.m.f. is obtained by quadratic addition of the e.m.f. components.

Note by C.C.I.T.T. Secretariat.

§ 18 (" Cable telephone lines ") of the new text mentions no exceptions to the general principle stated in § 16 which can hence be applied completely to this type of line.

Question 6.

(Study Group 12 in cooperation with C.C.I.T.T. Study Groups 1 and 3 and the C.C.I.R.)

(Continuation of Question 6, studied in 1955-56 by the C.C.I.F. Study Group 4)

What is the effect on transmission performance, as shown by the results of opinion tests (involving typical telephone users), of the various hypothetical distributions of noise level in radio relay systems submitted by the C.C.I.T.T. Study Groups 1 and 3 ?

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* Even if the limit fixed for the psophometric e.m.f. determined in this case is respected, the noise which is heard in the subscriber's receiver can be inadmissible if the installations forming the chain of circuits considered are not sufficiently symmetrical with respect to earth.

Information on the effects of dissymmetry on lines and equipment is given in chapter...

Note 1. — The distributions should take the form of curves indicating the proportion of intervals, each of one minute duration, for which the mean noise power, measured with the psophometer specified by the C.C.I.F. for commercial telephone circuits, does not exceed each of a number of values. These curves should be determined by the method described in full in Annex 4 to Question 7 of C.C.I.T.T. Study Group 1 and summarized in Annex 1 below.

Note 2. — Annex 1 below indicates how such opinion tests might be carried out. By way of example, Annex 2 describes the method used by the U. K. Administration for such tests.

ANNEX 1

(to Question 6 of Study Group 12)

Indications on how to carry out opinion tests (involving typical telephone users) concerning variable noise

I. — *Taken from the Report by the Working Party of the C.C.I.F. Study Groups 3 and 4 (Geneva, November 1956)*

The Working Group considers that the experience gained so far in the use of the method based on the opinions of telephone users (see Annexes 2, 3 and 4 to Question 4 of C.C.I.T.T. Study Group 12) has shown that results using such a method might enable a definite reply to be given to Question 5*a* of C.C.I.F. S.G. 4 *. The results are not yet complete.

These same results might enable limiting values of circuit noise to be specified and so lead to a definite reply to Question 5*b* of C.C.I.F. Study Group 4 **. In this connection the articulation tests carried out in the C.C.I.F. Laboratory have been useful in showing that certain types of noise may be classified together and give the same impairment as white noise (see Annex 2 to Question 4 of C.C.I.T.T. Study Group 12) but that six phase rectifier noise (frequency components 300, 600, 900, etc., c/s) of psophometric level, N dbm, gives the same impairment as white noise of psophometric level, $N = -8$ dbm. This conclusion is believed to apply also when the impairment is assessed by opinions method instead of by articulation.

Completion of the opinions results and presentation of them in the form of percentages of users expressing the opinion (E+G+F) (see, by way of example, Figures 4 and 4 *bis* of Annex 2 to Question 4 of C.C.I.T.T. Study Group 12) might enable the effect of noise which varies from one call to another, as in the case of a radio relay link, to be studied on a statistical basis. Such a study will enable any given statistical distributions of noise level (for example, of noise in a radio relay link) to be considered in terms of the proportion of unsatisfied users. This study (Annex 2) by the British Administration indicated that for the particular distribution taken, the percentage of unsatisfied users was only very slightly greater than would have been the case if

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* This question ran as follows : " What method or apparatus should be used to determine the impairment due to noise reproduced by telephone receivers ? " In reply to this question Study Group 4 proposed to the XVIIIth Plenary Assembly of the C.C.I.F. to recommend that the reduction of transmission quality due to circuit noise be determined by tests based upon the opinions of typical telephone users.

** This question ran as follows : " What is the limiting value of noises reproduced by telephone receivers which can be regarded as admissible ? " It was replaced by Questions 4 and 5 of C.C.I.T.T. Study Group 12.

the noise had the same " mean power ". It should be noted, of course, that the data used in that study were based on the results of earlier tests by the British Administration and were slightly modified to correspond with a population of users somewhat less dispersed than those used in the experiments referred to in Annex 2 to Question 4, of C.C.I.T.T. Study Group 12.

II. — *Taken from the Report by the Working Party of C.C.I.T.T. Study Group 1 (Geneva, February 1957)* *

The Working Party's recommendations can be summed up in the three proposals which follow :

1. Permanent noise observations should be effected on a telephone channel of a radio relay system. A minute-by-minute analysis would give a noise distribution curve. A detailed study of the outcome of these observations will be made at a meeting fixed for February, 1958, to be attended by representatives of the Administrations taking part in the tests.

2. Administrations and Private Operating Agencies might consider it useful for a choice to be made of representative magnetic-tape recordings of high noise encountered on radio relay systems, so that tests could be made to determine the effect of such noise on :

(a) telephone calls (by sounding the views of typical telephone users);

(b) telephone signalling and telegraph transmission.

The choice of these recordings and responsibility for studying the effect of such noise on the type of transmission under consideration would be left entirely to the initiative of the Administrations and Private Operating Agencies wishing to undertake tests of this kind.

3. Metering should be undertaken to show how many times in a month a certain high noise level is exceeded. Such metering would be designed to define the conditions in which radio relay systems are used for telegraphy, and for automatic telephony, if desired. The outcome of such metering, like the outcome of the observations described in paragraph 1 above, will be sent to the C.C.I.T.T. Secretariat.

Determination of the curve of noise distribution on a telephone channel in a radio relay system.

A. *Aim. Type of measurements made.* — The curve to be obtained is of the type shown in figure 1, giving the distribution of the noise on a telephone channel in a radio relay system. The most interesting part of the curve is the left-hand side corresponding to probabilities of occurrence of great noise, probabilities lower than 1 % for instance.

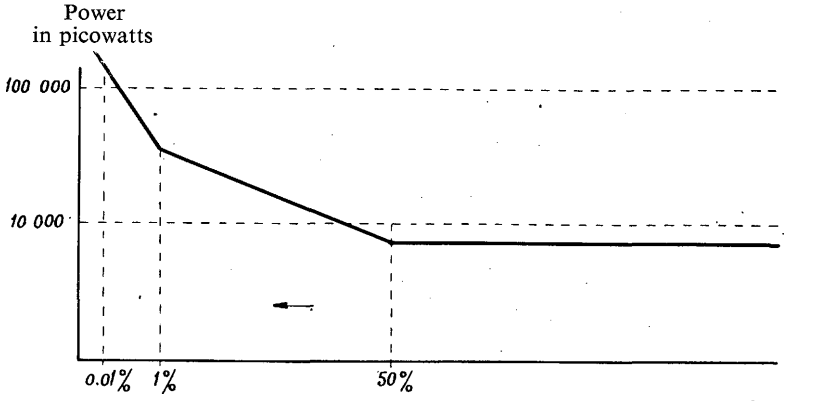


FIGURE 1

* This report, contained in Document " C.C.I.T.T. — SG 12-2 ", is reproduced in full as Annex 4 to Question 7. of C.C.I.T.T. Study Group 1.

This curve will be determined by making measurements on a telephone channel in a radio relay system *every minute* for a period of several months, considered in principle as equal to one year.

The measurement will give a value representing, if not the mean noise power during the minute under consideration, at least a figure very close to that power.

B. *Choice of magnetic-tape recordings representative of the noise met with on radio relay systems.*

For the study of Question 6 (C.C.I.T.T. Study Group 12), Administrations should start tests on the reduction of transmission performance due to noise on radio relay systems. These tests should be made by assembling the opinions of typical subscribers. The specimens of noise on radio relay systems should be chosen by these Administrations among magnetic-tape recordings made at the time when noise is at its peak. It will not be very hard to obtain some recordings of this kind, for the periods of intense fading on radio circuits are (generally speaking) well known.

The recordings so made should include, at the beginning and at the end, the recording of a 800 c/s frequency at a given power, in such a manner that the noise conditions of the recording may be characterized, and so that, later, the chosen noise may be attached to a probability of occurrence on the noise distribution curve, when this curve has been defined.

The choice of these recordings is left entirely to the initiative of the Administrations and Private Operating Agencies wishing to undertake tests of the type described in Question 6 of Study Group 12.

These recordings may also be used for studies of the effect of noise on telegraph transmission performance (increase in telegraph distortion), or on signal receivers used for long-distance automatic telephone signalling.

ANNEX 2

(to Question 6 of Study Group 12)

A statistical study of the effect of circuit noise with a specified time-distribution

(Research Report No. 14 069 of the British Administration)

1. *Introduction.*

The C.C.I.R. has at present under consideration the specification of limits for the noise to be permitted on international telephone circuits set up over microwave radio links. As the radio propagation conditions vary with time, it is natural to propose that the permissible noise should be defined by a statistical distribution with respect to time. This Report describes an investigation to estimate the effect on the quality of service, from the transmission point of view, of noise with a particular distribution that has been suggested in the United Kingdom, and as far as practicable to compare the service given by circuits having this noise distribution with the service given by coaxial circuits in accordance with existing practice.

The ultimate judge of the telephone service is the subscriber, and if it were practicable to ascertain the opinions of the subscribers at the conclusion of a large number of calls, a real assessment of the quality of the service would be obtained. Specifically, the subscribers might be asked to classify the calls as ' excellent ', ' good ', ' fair ', ' poor ', or ' bad ', these terms being defined as indicated in the Appendix.

It is the purpose of the present study to estimate what the result of such an enquiry would be. To obtain a single figure indicating the quality of service, the proportion of ' unsatisfactory ' calls is calculated; ' unsatisfactory ' has been taken to include both ' poor ' and ' bad ', since either of these two categories represents failure to provide as good a service as the subscriber might reasonably expect.

An investigation of this kind could, if desired, be carried out for a very wide class of calls, for example, the class comprising all international calls. This would be open to the objection that it is both natural and economic to set different standards for calls over different distances;

it therefore appears preferable to deal with more restricted classes of calls. The term ' class ' is here used with a geographical significance; for example, a class might comprise international calls over distances of the order of 2,500 km. The calculations must also be made for specified ' conditions ' of circuit noise and many other variables. The classes and conditions examined in the present study are detailed in Section 2.

Only an outline of the method adopted in the investigation need be given here. Assuming statistical distributions or fixed values for the various conditions, the total population of calls of a given class can be divided into groups, each associated with a certain combination of conditions described by sufficiently small ranges of the variables. The proportion of calls within each group that would be considered unsatisfactory is then found from data accumulated in an extensive series of laboratory tests. In these tests, circuits corresponding to various conditions were set up in the laboratory; for each, a number of people representative of telephone subscribers were invited to use the circuit and afterwards to express an opinion in the form reproduced in the Appendix. Although the number of conditions assessed in this way was naturally small compared with those of interest in the actual telephone system, it is considered that a sufficient number was taken to justify the necessary interpolation. Finally, the total proportion of unsatisfactory calls for the class is obtained by summation over the groups concerned.

In the conditions so far assessed in the laboratory, circuit noise has taken the form of steady white noise, and the long-time mean value of the weighted power has been taken as the measure of its magnitude. The general method outlined above can be extended to other kinds of noise, if the latter can be described in terms that enable them to be reproduced, or if representative samples can be made available.

2. *Classes of calls and conditions.*

Calculations have been made for two classes of calls, each under four conditions of circuit noise. The classes of calls considered are :

Class 1. — International calls between subscribers in two zones, each zone centre being 500 km from the international exchange, and the international exchanges being 2,500 km apart.

Class 2. — As above, but international exchanges 500 km apart.

The conditions of circuit noise and loss are summarized in Figure 1. For each noise condition it is assumed that the system design is uniform throughout the international circuit and the two national circuits that connect a zone centre to an international exchange. In the four conditions the noise on these circuits is briefly :

Condition (a) : none.

Conditions (b) : Steady white noise :

(b1) : 10,000 pW for the 2,500 km circuit,
2,000 pW for each 500 km circuit,

(b2) : 5,000 pW for the 2,500 km circuit,
1,000 pW for each 500 km circuit.

Condition (c) : White noise varying fairly slowly with time and having the statistical distribution suggested for radio circuits.

The noise powers stated represent long-time mean weighted power at zero level, i.e. referred to the origin of each circuit, at which the noise may be imagined to be injected.

These conditions are further discussed in Section 3.

The following conditions for variables other than circuit noise are assumed in all the eight cases treated; some are constant and others are defined by statistical distributions :

Subscriber characteristics. — As the basic data employed were obtained in free-conversation tests in which a number of ordinary people took part, account is taken automatically of the variation between subscribers of personal characteristics such as general telephonic ability and speaking level.

Room noise. — The following distribution :

⩽ 40 db *	30%
45 db	40%
50 db	24%
55 db	5%
60 db	1%

This corresponds to a mean level of 45 db and a standard deviation of 5 db. Rather low levels have been taken, bearing in mind that international calls are being considered and subscribers may be expected to secure fairly quiet conditions for such expensive calls. The lower levels have been grouped together because the effects of levels lower than 40 db are negligible.

Telephone instruments. — At each end, subscriber's sets including Transmitter, Inset, No. 13; Receiver, Inset, No. 2P; and Coil, Induction, No. 27. These are reasonably representative of modern sets in current use.

Subscriber's lines. — 6½ lb cable; a distribution at each end represented by the following proportions :

Zero resistance	24%
270 ohms (1 mile)	58%
540 ohms (2 miles)	18%

Circuits between terminal exchanges and zone transit centres. — Circuits assumed noiseless. Losses, including any intermediate switching points, distributed as follows :

0 db	10%
2 db	14%
4 db	20%
6 db	22%
8 db	18%
10 db	10%
12 db	6%

These have been taken from the results of a study on the national routings of a sample of international calls. This distribution has a mean value of 5·5 db and a standard deviation of 3·5 db. A switching loss of 1 db for the zone centre is included. For the departure of the loss of amplified circuits from nominal value, mean values have been taken.

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* Room noise levels are expressed in terms of the reading on a Sound Level Meter calibrated to a datum at 1,000 c/s of 0.0002 dyne/cm2 (approximately equal to the threshold of audibility).

Circuits between zone centres and international exchanges. — Loss 1·5 db, based on a nominal zero loss with an allowance of 1·5 db for the mean departure from the nominal loss. A switching loss of 1 db for each international exchange.

International circuit. — Loss 7 db, irrespective of length.

3. *Circuit noise.*

3.1. *Coaxial circuit noise.*

The C.C.I.F. specification * relating to noise on coaxial circuits is as follows :

" The psophometric power on the " hypothetical coaxial reference circuit " should not correspond to a probability of exceeding, for more than 1% of the time, 10,000 picowatts at the zero-level point, it being understood that the measurements would be made during a period (usually the busy hour) when it is to be expected that the level of noise would be the highest ".

"... as a guide... the psophometric power corresponding to the noise produced by all the modulating equipments... should not exceed one quarter of the limit fixed above, i.e. 2,500 picowatts at the zero-level point. This leaves available... at least 7,500 picowatts for the " high-frequency line ", i.e. for the 2,500 kilometres of coaxial pair and all the associated intermediate repeaters ".

In the present investigation, this specification is of very limited assistance, for the following reasons :

(a) The use of the term " psophometric power " in the specification appears to imply that, in considering the variation of the noise with time, the objective measure to be taken is the instantaneous indication of a psophometer. The latter has, however, a short integration time (about 200 milliseconds) and may well give a fluctuating indication on noise that sounds quite steady; even on white noise over the band 300-3400 c/s, the indication of a psophometer fluctuates over a range that would be visually estimated as about one decibel. Thus it can hardly be expected that the subjective quality of the circuit, which is of prime interest in this work, will vary in the same manner as the psophometer indication **.

(b) The specification envisages some period of observation, over which the variation of the noise power is to be examined; the period of observation is to be chosen as one for which, in some broad and undefined sense, the level of noise would be highest ; the duration of the period of observation is not specified. A limit is then fixed at one point only of the cumulative time-distribution of the noise power over the period of observation. The complete time-distribution of the noise power is not specified, and in fact will vary from one coaxial system to another, since it depends on features of the system design that the C.C.I.F. does not attempt to standardize.

It is therefore desired to avoid any implication that the performance of coaxial systems can be calculated with precision. It is, however, thought that the dispersion of the noise power *** on a coaxial circuit is likely to be small, and that Condition (*b*1), corresponding to 10,000 pW of steady white noise at zero level on a 2,500 km circuit, may be taken as a rough guide to the performance of coaxial circuits in practice.

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* The term " specification " is used for brevity, but these provisions, taken from Tome 3 bis (Florence, 1951), have in fact only the status of an agreed provisional basis for the establishment of international systems. (After this Report had been drafted, C.C.I.F. Study Group 3, meeting at Geneva in March 1956, recommended that the specification be altered, to delete reference to 1% of the time and to place a limit of 10,000 pW on the mean noise power over the busy hourt.

** It is suggested that an objective measure more closely related to subjective quality might be obtained if the weighted power were integrated over a few seconds.

*** i.e. the weighted power integrated over a few seconds.

3.2. *Radio circuit noise.*

Figure 2, Curve A, shows the distribution that has been suggested for the variation with time during any month of the allowable noise power at zero level on the 2,500 km hypothetical radio reference circuit; Curve B shows an assumed distribution for a 500 km circuit. These distributions do not include noise due to frequency-division-multiplex terminal equipments, which has been taken as 2,500 pW for a 2,500 km circuit and 500 pW for a 500 km circuit.

Figure 3 shows these distributions in histogram form, and Figure 4 the resultant distributions, at the listening-end zone centre, for the two classes of calls considered.

Some assumptions have been necessary for the following reasons :

(a) The quantity to whose distribution with time the proposal refers is not completely defined; it is certainly weighted power, but neither the instantaneous weighted power nor the 200-millisecond mean weighted power (psophometric power) appears appropriate as a measure of circuit quality varying over a month. A suitable integration time for the weighted power will no doubt be specified later *.

(b) There is not as yet very comprehensive information on the nature and manner of variation of the noise to be expected on microwave radio links.

To enable the investigation to proceed, it has been assumed that the radio circuit noise comprises (or is equivalent to) white noise that is steady during any call, but has a long-term mean power that varies from one call to another in accordance with the proposed distribution.

4. *Results.*

The proportions of unsatisfactory calls calculated for the eight cases are shown in the Table. It will be seen that in the complete absence of circuit noise the proportion is about 1 %, and that with noise having the suggested distribution, the proportion rises to about 1·5 %. Comparison

Table of results

Case	Length of international circuit	Noise per 2,500 km	Percentage of unsatisfactory calls
1 (*a*)	2500 km	None	0·9
1 (*b*1)	2500 km	10 000 pW	1·9
1 (*b*2)	2500 km	5000 pW	1·6
1 (*c*)	2500 km	suggested distribution	1·6
2 (*a*)	500 km	None	0·9
2 (*b*1)	500 km	10 000 pW	1·6
2 (*b*2)	500 km	5000 pW	1·3
2 (*c*)	500 km	suggested distribution	1·4

* In relation to the effect of noise on ordinary telephonic communication, no case is seen for an integration time less than 5 seconds; it is suggested that this value be adopted for the time being. When the results of measurements, showing the variation over a month of the 5 second mean weighted power, are available, it will be possible to consider whether a longer integration time (such as 100 seconds)

of Condition (*b*2) and (*c*), which are identical for 50% of the month, shows that high noise for small percentages of the month has little effect.

Taking Condition (*b*1) as a rough guide to the performance of coaxial circuits in accordance with current practice, it may be concluded that radio circuits with the suggested noise distribution would give a performance of the same order.

Conclusions.

The suggested distribution for the variation of noise with time on microwave radio telephony circuits is not inconsistent with existing practice on coaxial systems, as judged by the proportion of unsatisfactory calls over long and medium distance international circuits. The effect of the high noise that is expected to occur on radio circuits for short periods is relatively small, and any considerable expenditure that might be incurred in an attempt to reduce this noise might be better devoted to improve other features of the telephone network.

These conclusions are subject to the reservation that in this investigation it has been necessary to make certain assumptions about the nature of the noise on radio circuits; it is not implied that these assumptions are necessarily valid.

APPENDIX

(to Annex 2 to Question 6)

Reproduction of opinion form used in free conversation tests

Independent opinions

Please express your opinion, when notified by the operator, by ticking the appropriate letter. Do not discuss your opinion with your companion.

E	Excellent circuit; complete relaxation possible while conversing.	E	
G	Good circuit; attention necessary but no appreciable effort required.	G	
F	Fair circuit; moderate but not excessive effort required.	F	
P	Poor circuit; conversation possible but much difficulty experienced on unfamiliar words.	P	
B	Bad circuit; usable only with extreme difficulty.	B	

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would give a satisfactory indication of the variation of circuit transmission quality from one call to another. In relation to signalling, or to facilities other than ordinary telephony, a different point of view may of course be appropriate. (At its meeting in Geneva, March 1956, Study Group 4 of the C.C.I.F. recommended that noise measurements be made on long-distance circuits set up over cable and radio systems, to obtain statistics of the variation of the noise from one call to another, i.e. from one period of (say) 3 minutes to another.)

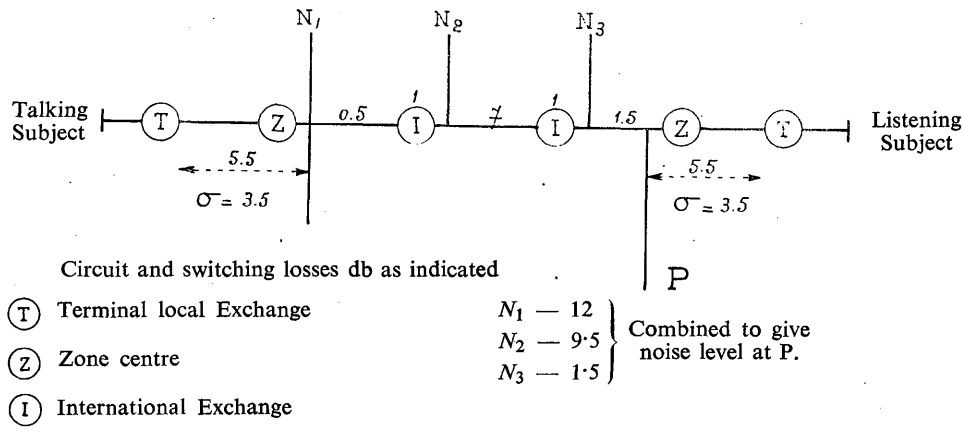
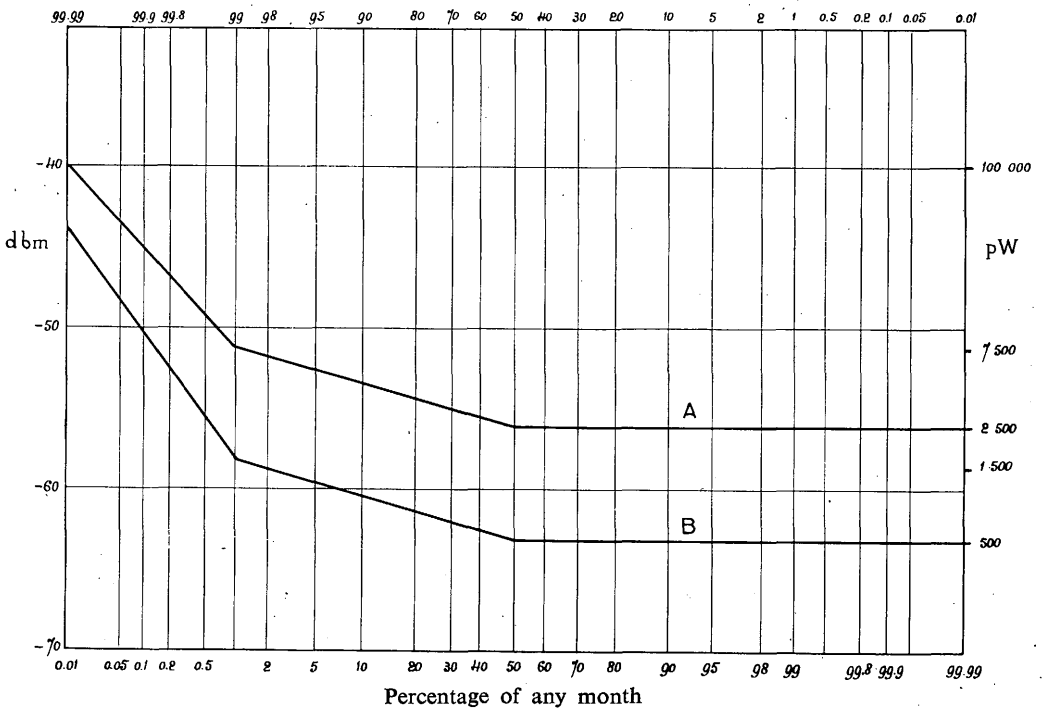


FIGURE 1. — *Statistical study of effect of circuit noise*
Summary of circuit noise and loss conditions

Case	N_1 dbm	N_2 dbm	N_3 dbm	Noise level at P, dbm
1 (a) or 2 (a)	Nil	Nil	Nil	Nil
1 (b1)	−57	−50	−57	−55
1 (b2)	−60	−53	−60	−58
1 (a)	Figure 3			Figure 4
2 (b1)	−57	−57	−57	−58
2 (b2)	−60	−60	−60	−61
2 (c)	Figure 3			Figure 4



Allowable weighted noise power at zero level, excluding noise due to F.D.M. terminal equipments

A. — Suggested for 2500 km hypothetical reference circuit

B. — Assumed for 500 km circuit

FIGURE 2. — *Distributions for noise on radio circuits, proposed by the United Kingdom Administration*

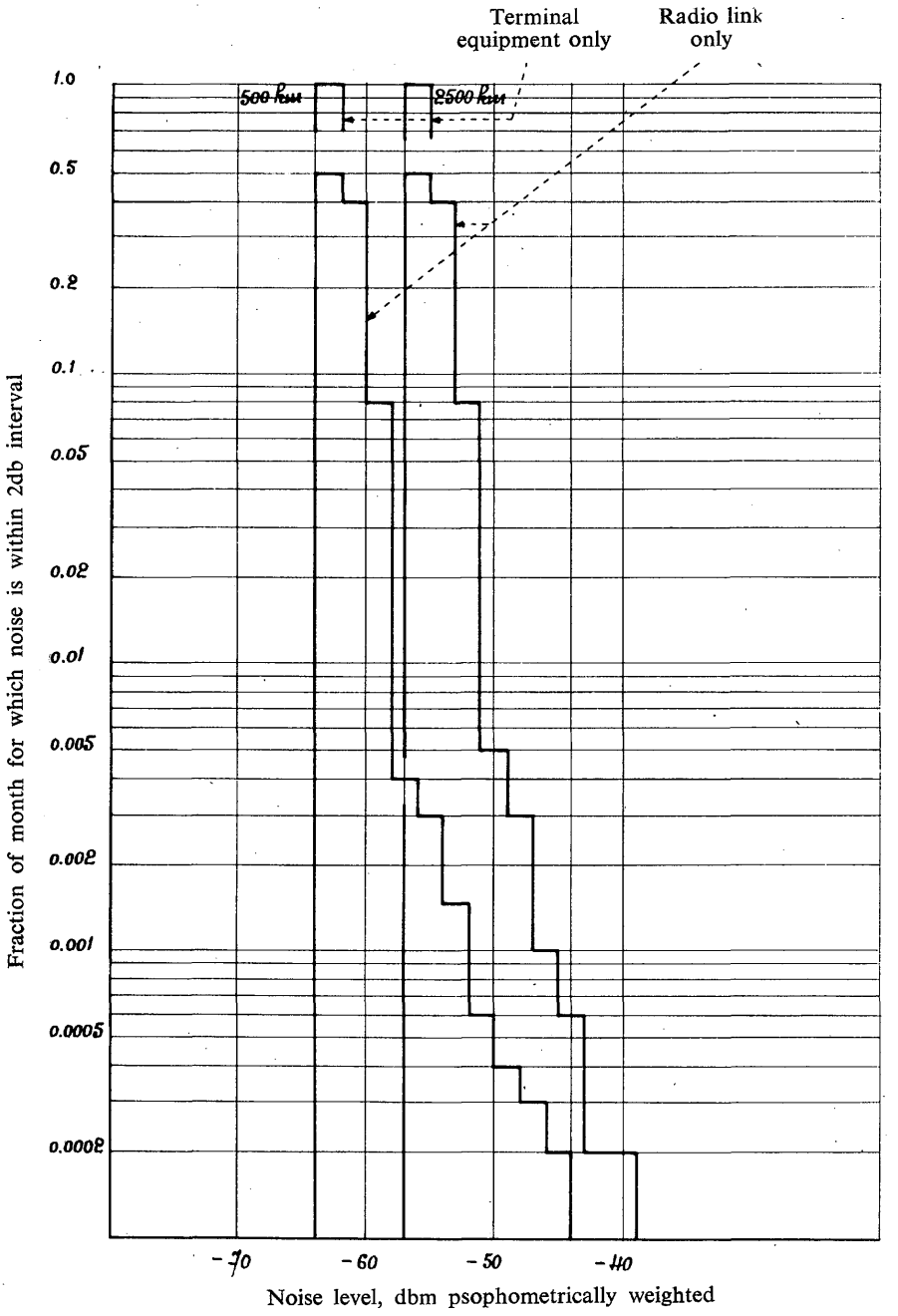


FIGURE 3. — *Histogram of noise level on radio link at zero level point*

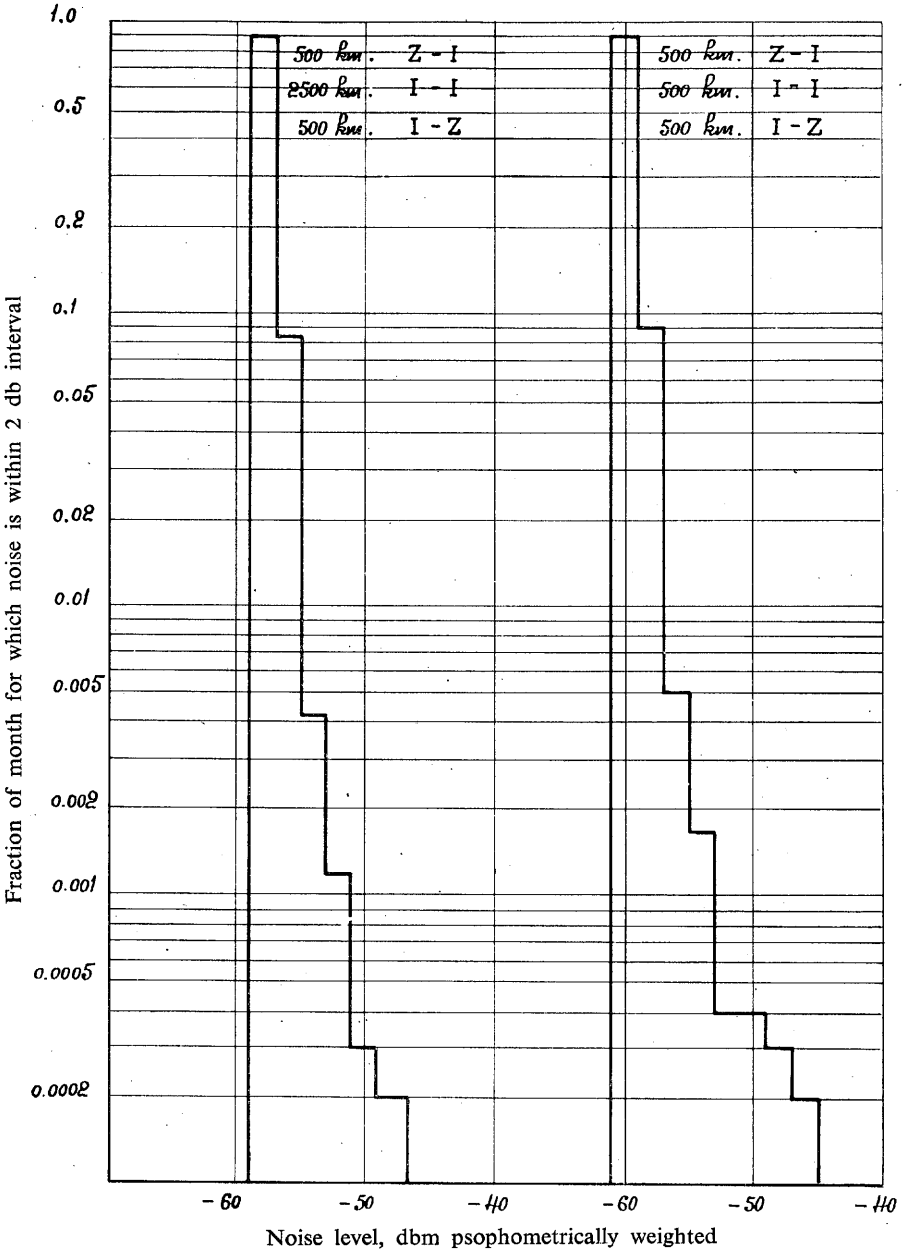


FIGURE 4. — *Histogram of resultant noise level due to three tandem radio links (referred to input side of zone transit centre at listening end)*

Question 7.

(continuation of Question 7, studied in 1955-56 by the C.C.I.F. Study Group 4)

(a) What criterion should be adopted to determine equality of performance of dfferent transmission systems ?

(b) What simple and practical method, based on objective measurements and which could give results in agreement with the adopted criterion of equality, should be specified for the determination of the transmission performance of local telephone systems ?

Note 1. — It is desirable that this method of objective measurement gives results which are in good agreement with the opinions expressed by telephone users.

Note 2. — By way of information, the Annexes Nos. 1, 2, 3 and 4 below describe methods for the evaluation of transmission quality from the results of objective measurements. Consideration should also be given to Annexes Nos. 21 and 22 of the Book of Annexes to Volume IV of the C.C.I.F. *Green Book* which describe apparatus for the objective measurement of reference equivalents used by the telephone Administrations of the Federal German Republic and of Switzerland.

ANNEX 1

(to Question 7 of Study Group 12)

Contribution by the American Telephone and Telegraph Company to the study of Question 7 of the C.C.I.F. Study Group 4, 1955-1956

Introduction

The new method of evaluating performance ratings of circuits and components in terms of objective measurements that is being developed in the Bell System is described in the article reproduced below. The A.T.T.C. is now in the process of changing its basic engineering data over to this method.

The adoption of this method in the Bell System has been facilitated by the facts that in most cases the frequency characteristic of overall transmission (including telephone sets) is now free from resonant peaks and is essentially flat over a reasonably wide band, and that the sets are practically all anti-side tone, so that loudness alone is a reasonably good measure of transmission performance. Those cases where this is not so can be taken care of by suitable corrections for frequency or other distortion, noise, etc....

Among the features making the method attractive to us are :

1. The " loudness " concept on which the method is based is easily understood and, when combined with its other simple features, gives both technical and non-technical people a good overall picture of transmission and of factors affecting it. It is, furthermore, a concept that can be retained in mind without constant association and without the need of periodic refresher courses.

2. The numbers used have the same general significance as numbers used in purely electrical measurements, a positive number indicating a loss in acoustic pressure between the talker's lips and the listener's ear on an over-all telephone connection, while a negative number indicates a gain. This eliminates the need for a " reference " system based on the concept of quantities starting from some arbitrary " zero ".

3. After the development of proper testing instrumentalities, the same data can be used for maintenance as for engineering, which has not been possible with the " effective " method

of rating—for example, the method will serve for the measurement of plant in place, survey of transmission conditions, and various other purposes.

4. As the ratio of acoustic pressures constitutes the rating of a connection, testing methods are relatively simple and inexpensive. No master reference system is required for establishment of a common datum, and the interchange of information between Companies is facilitated.

We do not anticipate that the matter of corrections for frequency distortion, noise, and other factors will present any very great problem. Considering the principal components of an overall connection :

1. *Telephone sets and loops.* — The variability of this component in the past led to our adoption of transmission ratings based on repetititon rates, as a means of bringing out clearly what the true transmission situation was, and for focusing attention on the important steps that needed to be taken for improvement. This work has led to certain general requirements for frequency-response, sidetone, and non-linear distortion which if met would in our opinion leave loudness the most significant quality affecting transmission. Most of the sets now in Bell System Plant meet such requirements, all new sets being added meet them, and the few old sets that fail to meet them are not sufficiently numerous to be of much concern. This latter group are, of course, ear-marked, and will in time be modified or replaced in connection with normal in and out station movement.

2. *Intertoll and connecting trunks.* — The work that has been going on in the individual countries and in the C.C.I.F. Laboratory has developed a good general understanding of the factors affecting transmission over trunks, and of the penalty properly assignable to failure to meet certain objectives. The more important of these factors are :

(a) Noise. — With the extensive development and application of carrier systems, noise has become more a system design consideration than an individual circuit phenomenon. Our systems, especially in the introductory phases, can and sometimes do go into operation without meeting the 29 dba * noise objective, for which there is no assignable N.T.I. Ensuing field experience and investigation then points out the approach to bring the system within the design objectives. The degree to which this is done, especially as the objectives are approached, will be influenced by the costs of further improvements. With the noise situation thus followed closely on a system basis and with the generally favourable noise conditions brought about in this way we no longer find it essential to take into account individual circuit N.T.I. in circuit layout work. We have in fact discontinued the practice of entering N.T.I.'s on circuit layout cards.

(b) Frequency-distortion. — This likewise is predominantly a system design consideration and in general no new system is developed that has sufficient D.T.I. to warrant attention in circuit layout work. We still have some systems with sizeable DTIs and these will receive attention to the extent economically worth while. But the only use now made of D.T.I.'s on circuit layout cards is to indicate test frequencies for checking the transmitted band.

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* The American psophometer is calibrated in " adjusted decibels " (dba), zero corresponding to a calibrating wave at 1000 c/s at an absolute power level of —85 db.

A revised telephone transmission rating plan

by P. W. BLYE, O. H. COOLIDGE and H. R. HUNTLEY

(published in the *Bell System Technical Journal*, Vol. 34, May 1955, pp. 453-472)

Although the telephone appears to be a relatively simple device, it is in fact one of the more complex elements of the telephone business, primarily because its operation depends on transforming sound waves into electrical waves and vice-versa. This fact makes its performance difficult to evaluate and measure. It is not surprising, therefore, that the problem of evaluation and measurement, that is, of " rating ", has been the subject of much thought and work over many years and that even today widely different methods are used in different parts of the world.

The Bell System has done its full share of work in this connection and as the art and state of knowledge have changed, several different rating methods have been used. In the past twenty-five years or so the methods have come almost full circle from " loudness " through " effective transmission " to " loudness " again; but with a significant difference. The earlier ratings (loudness originally, effective later) were always in terms of so many db poorer or better than a standard rating. While this standard was specifically defined, only a few people were sufficiently familiar with it to appreciate thoroughly whether something which was rated, say, 6 db better than the standard was good, bad or indifferent.

The new rating system avoids this problem by not having any fixed standard at all. It is based primarily on the ratio of the loudness of the sounds into the listener's ear to the loudness of the sounds out of the talker's mouth but with suitable modifications to take care of factors other than loudness which affect ease of conversation.

This system also has the advantage that " gain " and " loss " have acceptable connotations; that is, an over-all gain means that the weighted sound pressures out of the receiver are greater than the weighted sound pressures at the talker's lips and a loss means the reverse. Thus this system should not be rendered out of date by any foreseeable developments in subsets or other transmission instrumentalities.

While the quantities used in the new rating method strictly speaking are not decibels, it is expected that the adoption of this method will have no effect on the usage of the term " decibel " either inside or outside of the Bell System.

This article discusses the over-all problem, gives a brief historical review and describes in some detail the new rating system now being adopted.

Introduction.

In the years prior to about 1930, performance ratings were assigned to telephone transmission circuits in terms of loss of speech volume or loudness. The adverse effects on transmission quality of such parameters as sidetone, distortion and noise were recognized, but until the 1930's no way was known of incorporating them, together with loudness loss, into a single figure of merit for rating transmission performance.

Antisidetone station sets were first used in quantity in the Bell System in 1932, followed in 1937 by the 302-type combined sets. While these instrumentalities did not yield appreciably greater loudness than their predecessors, they exhibited marked improvements in such characteristics as sidetone, frequency response and nonlinear distortion, which have a marked effect on the ability of a listener to *understand* as well as to *hear* transmitted speech. Thus it became necessary to devise a rating system which would give adequate recognition to the contributions of these improvements to over-all transmission performance. There resulted the " effective loss " method of transmission rating **[1] [2]**.

The effective loss rating system assigned a figure of merit to a customer-to-customer transmission circuit, based fundamentally on the rate at which listeners requested repetititon of what the talkers had said. This basis evaluated transmission circuits from the standpoint of transmitted intelligibility, as well as loudness. In practice, the circuit to be rated was compared with a "working reference system" **[2]**, which consisted of representative subscriber loops and station sets, and a variable, distortionless trunk. In principle at least, the trunk of the reference system was adjusted until the repetition rate was the same on both circuits. The attenuation of the trunk in decibels was then a measure of the effective loss of the circuit under test.

An effective loss of zero on the working reference system was a theoretical point, arbitrarily assigned, so that the system tied in numerically with its predecessor. If a listener could not hear *and understand* a given talker as well over the circuit being rated as over the reference system at its zero point, the circuit under test was said to have a *positive* effective loss. If the reverse was true, the circuit was said to have a *negative* effective loss. Effective loss was expressed in db and, from a practical point of view, may be considered an *equivalent* loss in loudness.

While the effective loss system has served an important purpose in giving due weight to important transmission characteristics other than loudness efficiency, it has a number of practical disadvantages. For example, the effective losses of circuits containing electro-acoustic transducers, such as telephone transmitters and receivers, cannot be measured by objective methods. Hence they must be determined statistically by time consuming subjective methods such as repetition tests. Relatively few people have had the experience, personally, of listening to speech over the reference system; hence there is little tie-in between effective transmission and practical experience.

Also, the telephone transmitters and receivers used in the reference system were of obsolete types, their frequency characteristics were far from flat and the circuits in which they were used introduced both sidetone and nonlinear distortion. Hence, modern station sets invariably exhibit performance superior to those used in the reference system and thus yield negative effective losses. The combination of positive and negative losses, together with the inability of the practical user to correlate the net result with any physical bench mark with which he was familiar, often prevented complete understanding and acceptance of the rating system, except by transmission specialists. Although transmission engineers have become expert in designing exchange area plant based upon effective loss techniques, the fact that effective losses cannot be measured directly prevents close correlation between design and maintenance. This is an important drawback because wherever practicable it is very desirable to be able to measure performance of all parts of the plant in the same terms that are used in laying it out.

The telephone art has now advanced to a point where a much simpler rating system appears practicable. It is the purpose of this paper to describe the more significant features of a modified system which, it is believed, will eliminate most of the practical disadvantages of the effective loss plan.

Proposed rating plan.

As pointed out above, the effective loss method of rating transmission circuits was adopted in order to give proper recognition to factors such as sidetone, frequency response and nonlinear distortion, which, in combination with loudness, determine the over-all performance of a telephone circuit. Today, between 80 and 90% of Bell System telephones provide reasonably effective antisidetone features and it seems evident that on the average little additional effective gain can

be accomplished by further reducing sidetone. Also, in the case of the modern 302- and 500-type station sets, which constitute a constantly increasing portion of the station plant, impairments due to frequency response and nonlinear distortion are so small that they leave little need for improvement in future designs. It seems evident, therefore, that loudness has again become the main variable factor in plant design and is likely to be the most important consideration in future telephone set design. In view of this situation it seems desirable to return to a rating system based primarily upon loudness considerations.

While one of the chief reasons for returning to a loudness basis is the need for a rating system in which the parameters can be measured by objective methods, it is recognized that, strictly speaking, loudness itself is a subjective factor which can be measured only by the composite judgment of a number of human observers. As used here, however, loudness is determined by objective measurements which do not always duplicate true loudness determinations precisely, but which are sufficiently good approximations for practical purposes.

Although it is contemplated that *loudness* loss will be used in the great majority of day-to-day engineering problems, other factors contributing to effective loss will not be disregarded. In special cases, where these may assume importance, allowances may be made for them in the form of " penalties " to be added to *loudness* loss. The resulting rating, including all penalties, will be referred to as *subjective* loss to distinguish it from *loudness* loss and the present *effective loss*. It is contemplated that the use of subjective losses will be necessary only for some special service applications, for the design of apparatus and systems, and for cases in which noise is important. It is recognized that occasionally there may be special types of speech transmission systems in which factors other than loudness are controlling. In such cases it may be more practicable to provide ratings by means of over-all subjective tests rather than by measurements of loudness corrected by the penalties referred to above.

To provide maximum usefulness in the engineering of the telephone transmission plant, a rating system must include means not only for appraising an over-all telephone connection but also for assigning figures of merit for the various components making up the connection. Thus it is highly desirable that it make possible the rating of transmitting circuits, connecting lines, and receiving circuits as separate entities.

Definitions covering the rating of component portions of a telephone system must, of course, be consistent with the definition for over-all system rating. It becomes necessary, therefore, to specify under what conditions the sum of the component ratings is equal to the over-all rating; other conditions require reflection corrections in order that the rating system be consistent.

The rating definitions involve both acoustic pressures and electric voltages. They are based on the use of speech, or an equivalent complex voice frequency test tone and artificial mouth, as a source of acoustic energy, and on meter indications of voltage or sound pressure suitably weighted to simulate the loudness perception of human hearing.

Over-all loudness rating.

A loudness transmission rating of zero is assigned to an over-all telephone connection in which the output acoustic speech pressure delivered by the telephone receiver to the ear of the listener is equal to the input acoustic speech pressure at the lips of the talker. The measurement of talking pressure is made under free field conditions, that is, with the telephone transmitter removed from in front of the talker's lips or other sound source. During the measurement of

output pressure, the transmitter of the talking telephone set is placed in the modal position with respect to the sound source *.

As shown in Figure 1, if S_L is the output pressure at the listening end in microbars (dynes per square centimeter) or millibars (thousands of dynes per square centimeter), and S_T is the corresponding input pressure at the talking end of an over-all telephone connection, the transmission loss, or rating, of the connection, R_0, is

$$R_0 = -20 \log_{10} \frac{S_L}{S_T} \quad **$$

Thus losses are defined by positive numbers and gains by negative numbers.

It will be noted that speech pressures, rather than speech powers, have been chosen as references; this has been done for two reasons. In the first place, speech power is very difficult, whereas speech pressure is relatively easy, to measure. Secondly, the ear appears to be a pressure sensitive rather than a power absorbing device, in the same sense that the input circuit of a vacuum tube is considered to be voltage actuated rather than power absorbing. When a telephone receiver is held close to the ear, the acoustic impedance presented to it is largely reactive. The real part of the acoustic impedance is largely due to the leakage path to the outside air between the receiver cap and the ear. Consequently the acoustic power is dissipated, for the most part, in this leakage path. Hence, whereas power rating would provide a satisfactory measure of the merit of a receiver as a loudspeaker, it seems more reasonable to use pressure in rating its effectiveness as a transducer when held close to the ear.

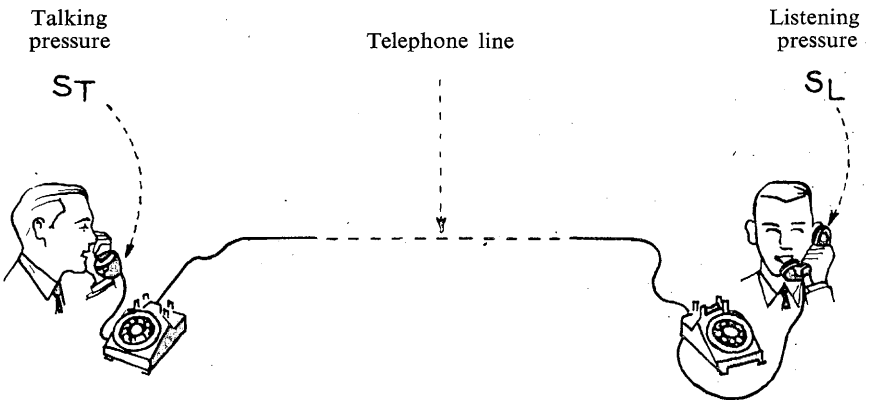


FIGURE 1. — *Loudness rating of an over-all telephone connection* $= -20 \log_{10} S_L/S_T$
Rating is zero when $S_L = S_T$.

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* The modal position is the same distance from, and angular position with respect to, the sound source as the transmitter would assume when used correctly by a talker whose facial measurements are the mode of a very large distribution representative of telephone subscribers [3].

** Since the ratios in this equation and those which follow involve either pressures across dissimilar acoustic impedances or an acoustic pressure and an electric voltage, the resulting ratings should not be expressed in decibels. However, the equations yield db-like quantities which may be measured on meters equipped with scales calibrated in decibels which will give numerically accurate results. The use of logarithmic units is highly desirable since this makes possible the direct addition of component ratings to give the over-all rating of a particular connection.

Loudness rating of transmitting components.

When figures of merit are to be assigned to the components of a telephone connection apart from the over-all rating described in the previous section, it is convenient first to divide the connection into two basic categories, one of which includes the transmitting transducer and the other the receiving transducer. In this section we consider components which include the transmitting transducer, while those which include the receiving transducer are treated in the following section.

For engineering purposes the transmitting component of greatest interest is probably the transmitting telephone set itself. A transmitting telephone set has a transmission rating of zero when the voltage (in volts) it delivers across a 900-ohm resistive load is equal to the pressure (in millibars) at the talker's lips. As in all ratings involving transmitters, the measurement of talking pressure is made in a free field, with the transmitter removed from in front of the sound source, while the output measurement is made with the transmitter in the modal position with respect to the sound source. Thus the rating, R_T, of any transmitting set is :

$$R_T = -20 \log_{10} \frac{V_T}{S_T}^*$$

where V_T is the voltage across the load and S_T is the talking pressure in millibars. It may be noted that the same numerical ratings will be obtained if the voltage is expressed in millivolts and the pressure in microbars.

Since the transmitting efficiencies of commercial telephone sets vary with the direct current in the transmitter, it is necessary to specify an appropriate value of line current or voltage representative of typical operation, when expressing the transmission rating of a transmitting telephone set. For present commercial sets, with carbon-type transmitters, the value of line current specified is 100 milliamperes, which is appropriate because it represents nearly the maximum dc obtainable on short loops. Any departure from 100 milliamperes in a commercial telephone connection using present sets causes a current supply loss (or gain), which is added algebraically to the transmission rating of the transmitting telephone set to obtain the transmitting conversion loss. The sign of the transmitting current supply loss will usually be positive for current less than 100 ma, and negative (a gain) for currents greater than 100 ma.

Transmitting loop losses can be defined and measured in the same way as the rating of a transmitting telephone set if the 900-ohm resistive load is located at the output (central office end) of the loop instead of at the output of the transmitting telephone set. In this case the rating of the loop is equal to the sum of the rating of the transmitting telephone set, the transmitting current supply loss, and the insertion loss of the subscriber line between the impedance of the telephone set and the 900-ohm termination. The last is called the subscriber line loss.

Loudness rating of receiving components.

As in the case of rating transmitting components, the item of greatest engineering interest in the category containing receiving transducers is the receiving telephone set itself. To be consistent with the foregoing definitions for transmitting components and for over-all connections, its rating is defined as follows. A receiving telephone set has a loudness transmission rating of zero when

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* See foot note on page 639.

the output acoustic speech pressure (in millibars) delivered by the receiver to the ear of a listener, is one half the open circuit voltage (in volts) of a 900-ohm resistive source which energizes the set as a load. The transmission rating, R_L, of any telephone set when receiving, then is

$$R_L = -20 \log_{10} \frac{S_L}{V_W/2} \quad *$$

where S_L is the listening pressure in millibars and V_W is the open circuit voltage of the 900-ohm source. As before, pressure in microbars and voltage in millivolts will give the same numerical ratings.

The same appropriate value of line current or voltage that is specified for transmitting ratings is also specified when expressing the transmission rating of a receiving telephone set. For present sets, as stated, the value is 100 milliamperes line current. Departures from this value cause a receiving current supply loss in telephone sets with current controlled equalizers. For currents less than 100 milliamperes the sign of this loss is usually negative because of the increased circuit efficiency on longer loops. The sum of the rating of the receiving telephone set and the receiving current supply loss is the receiving conversion loss. In present telephone sets without equalizers the receiving current supply loss is zero, so the receiving conversion loss is the same as the receiving rating of the set.

The foregoing equation also expresses the transmission rating of a receiving loop provided the 900 ohm source is applied to the input (central office end) of the loop instead of to the receiving telephone set. The rating of the loop, so obtained, is equal to the sum of the rating of the receiving telephone set, the receiving current supply loss, and a loss called the receiving subscriber line loss which is equal to the insertion loss of the subscriber line between 900 ohms and the impedance of the telephone set. If like facilities and instrumentalities are used for both transmitting and receiving loops, the transmitting and receiving subscriber line losses will be the same, although the loop losses will not be the same because of the different set ratings.

Additive property of component ratings **.

It was pointed out earlier that consistency of the definitions of the component ratings may be demonstrated by showing under what conditions the sum of the component ratings is equal to the over-all rating. The simplest telephone circuit that can be visualized for this purpose is illustrated in Figure 2.

Here two commercial type telephone sets, each supplied with 100 milliamperes dc, are connected to each other by way of an imaginary amplifier inserted for the purpose of providing a pure resistive impedance of the right magnitude. This amplifier has input and output impedances each equal to 900 ohms pure resistance, and an image gain of zero decibels. It will be noticed that the transmitting telephone set has a 900-ohm resistive load impedance, so the ratio of the voltage V_T, across the input of the amplifier, to the talking pressure, S_T, is a measure of the trans-

* See foot note on page 639.

** While it is recognized that the additive property of component ratings can be only approximate if a wide variety of frequency spectra is taken into account, nevertheless this is of little practical concern in the case of spectra usually encountered in the modern telephone plant. In this paper it is convenient for the sake of simplicity to disregard the approximation.

mitting rating of the telephone set by definition. Also, the output of the amplifier is a 900 ohm resistive voltage source for the receiving telephone set. If the open circuit output voltage of the amplifier is V_W, then the ratio of the listening pressure, S_L, to $V_W/2$ (shown by the dashed arrows in Figure 2) by definition measures the receiving rating of the

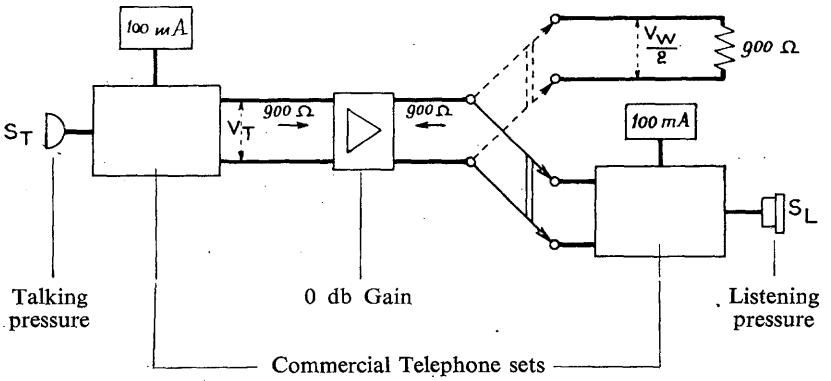


FIGURE 2. — *Additive property of transmission ratings*

Transmitting rating : $R_T = -20 \log_{10} V_T/S_T$
Receiving rating : $R_L = -20 \log_{10} (S_L/V_W/2)$
Since $V_W/2 = V_T$, over-all rating, $R_0 = -20 \log_{10} S_L/S_T = R_T + R_L$.

telephone set. Furthermore it can be shown by network theory that the open circuit output voltage of an amplifier of zero db image gain is twice the voltage across its input, provided its output and input impedances are equal. In other words, in this circuit,

$$V_W/2 = V_T.$$

Since this is so, the over-all rating of this telephone connection, measured by the ratio of listening to talking pressure, is equal to the sum of the transmitting and receiving ratings of the respective telephone sets *.

It is apparent from this discussion that if the two telephone sets are connected to each other back to back, without including the hypothetical amplifier of Figure 2, the sum of their component ratings must be augmented by a reflection loss in order to equal the over-all rating. This comes about because the choice of definitions for transmitting and receiving ratings was dictated by the practical consideration that the more difficult transmission conditions occur when lines or apparatus are interposed between the sets. Thus it is advantageous to have the basic ratings more appropriate to these actual conditions.

By the definitions given here, the sum of two loop losses will also equal the over-all rating if the loops are connected to each other through the hypothetical amplifier. The majority of all actual telephone connections involves two loops connected to each other by some form or combination of trunks, instead of by the amplifier. The inclusion of trunks in the connection augments the two loop losses by the attenuation, reflection and interaction losses associated with the trunks. While there is considerable variation in the impedances of facilities making up loops and trunks, the resulting reflection and interaction losses can be minimized, and in many cases may be neglected altogether, by the choice of a compromise impedance for the rating definitions, which is reasonably

* A further note on the effect of frequency characteristics of components on the additive property of component ratings is included in Appendix A.

representative of the entire distribution of loop and trunk impedances. These considerations dictated the particular choice of 900 ohms resistance as the terminating and source impedances in the definitions of transmitting and receiving component ratings.

One other aspect of the selection of definitions of transmitting and receiving ratings will now be discussed. We mentioned earlier that it seemed more logical to base the rating system on ratios of pressure and voltage than on power ratios because the human ear appears to be a pressure sensitive device. As a result of this decision it becomes apparent on reflection that the *numerical* apportionment of an over-all loss between transmitting and receiving components is an arbitrary choice. The range of numbers involved can be controlled by the units in which the voltages and pressures are expressed, or by inclusion of an arbitrary numerical factor by which the voltage-pressure ratios are multiplied, without affecting the additive property of the component ratings. It is desirable to obtain an appropriate range of numbers by means of the simplest possible definitions of the transmitting and receiving ratings, if possible avoiding the use of arbitrary multiplying factors. This objective has been attained without multiplying factors by specifying that the voltages be expressed in volts and the pressures in millibars, or, which comes to the same thing, millivolts and microbars.

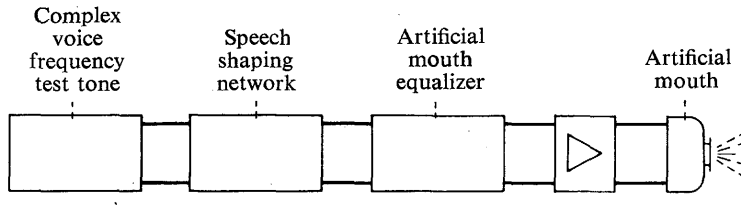
The range of numbers is appropriate because of the choice of units in the definitions. The transmitting ratings of present commercial sets, transmitting conversion losses and loop losses will all have negative signs, while the corresponding receiving ratings will all be positive. This is consistent with the fact that carbon transmitters produce gain and electromagnetic receivers loss as transducers between acoustic and electric energy. Even if more efficient receivers of this type are developed in the future, the definition of receiving ratings is such that the numerical values can never become negative without the aid of a gain producing device such as an amplifier.

Line losses.

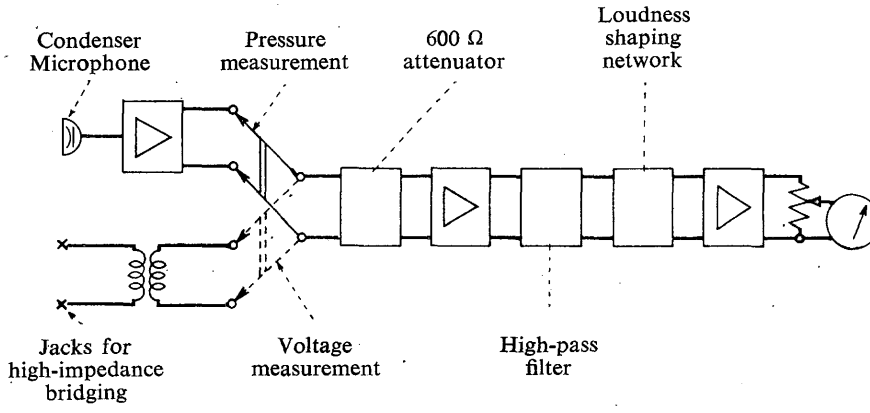
The line is here considered to be that portion of an over-all telephone connection between the line terminals of a transmitting telephone set and those of a receiving telephone set. In the simple circuit of Figure 2 the " line " consists solely of the hypothetical amplifier, and the line loss, considered as a separate entity, is zero. In this case the over-all rating, as already stated, is equal to the sum of the transmitting and receiving ratings of the telephone sets. More generally, if the dc supplies for present sets are other than 100 milliamperes, the over-all rating is equal to the sum of the transmitting and receiving *conversion* losses, since conversion loss was defined as the sum of set rating and current supply loss.

If, now, the hypothetical amplifier is replaced by an actual line, consisting perhaps of two subscriber lines, battery supplies and a trunk, we are interested in the amount of loss which must be added to the conversion losses in order to equal the new over-all loss. This added amount defines the line loss, considered as an entity by itself. It is composed of reflection losses (involving the differences between reflection losses of the sets against the impedance of the line and the sets against 900 ohms), attenuation losses and interaction losses. As a practical matter, however, line loss is defined as the difference between the over-all rating of the telephone connection and the sum of the transmitting and receiving conversion losses.

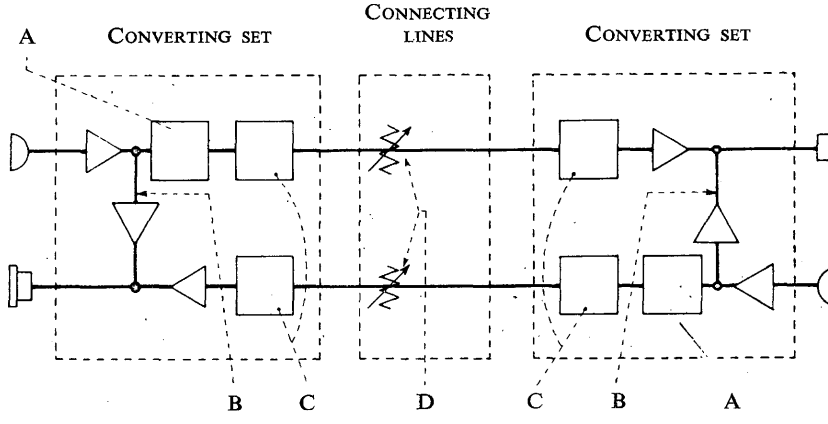
The breakdown of line losses into components suitable for engineering uses is beyond the scope of this paper. Little departure from established practice in this matter is made necessary by the new transmission rating system. The general principles which have been discussed may be helpful in taking care of such departures as appear. As a final example, loop losses have been defined here as the sum of conversion losses and subscriber line losses. If loop losses are to be used for engineering purposes, it is then possible to define " connecting circuit loss ", caused



(a) Sound source



(b) Indicating meter for pressure or voltage



A Shaping network
B Sidetone path
C 900 Ω variable attenuators
D 900 Ω shaping network

(c) Basic telephone connection

FIGURE 3. — *Electro-acoustic transmission measuring system*

by a trunk or combination of trunks, as the difference between the over-all rating of the telephone connection and the sum of the two loop losses. Thus the line loss is equal to the sum of two subscriber line losses and the connecting circuit loss.

Electro-acoustic measuring system.

It was stated earlier that one of the advantages in going to a loudness basis in the new rating plan is that it permits objective transmission measurement, whereas the subjective factors included in the effective loss system of rating make this impossible. It was pointed out that loudness itself is a subjective matter, but that objective measurements can be made which usefully approximate, although they do not duplicate, loudness determinations. While other systems are being investigated, the assembly of apparatus which has been used so far in the laboratory for this purpose is described in this section. It is called the electro-acoustic transmission measuring system. A functional diagram of its parts is shown in Figure 3.

It is convenient for descriptive purpose to divide the electro-acoustic measuring system into three parts :

1. The sound source, which takes the place of a human talker at the talking end of a telephone connection, as shown in Figure 3*(a)*.

2. The indicating meter for acoustic pressure or electrical voltage. This is a substitute for a human listener at the receiving end of a telephone connection, and is shown in Figure 3*(b)*.

3. The basic telephone connection, an intermediate link between sound source and indicating meter, which is provided with stable transducers as a substitute for commercial telephone connections for purposes which will be described further on. This appears in Figure 3*(c)*.

The sound source consists essentially of an electric generator of complex voice frequency waves and an artificial mouth **[4]**. The electrical output of the tone generator is shaped by a network to have the frequency spectrum of human speech. An equalizer is included in the circuit to correct the sound field from the artificial mouth so that it will be flat for a flat electrical input. An amplifier with variable gain permits adjusment of the acoustic level at the output of the artificial mouth to values comparable to the levels of human speech. One form of complex tone generator which has been used is a warbler oscillator in which the frequency of oscillation is varied linearly with time from 300 cps to 3,300 cps and back to 300 cps, six times per second. The sharp changes in amplitude caused by modulation products, and the frequency range, result in an acoustic output from the artificial mouth which has some of the characteristics of human speech, insofar as activation of commercial carbon type transmitters is concerned. In addition to the warbler oscillator, other types of tone source are being investigated.

The indicating meter shown in (*b*) of Figure 3 is adaptable either to measurements of the acoustic pressure of real or simulated speech at the two ends of a telephone connection, or to speech voltage measurements at an intermediate point. For pressure measurements a condenser microphone is used as a transducer. Voltage measurements are made by means of a high impedance bridging connection. A high-pass filter is employed to reduce components of noise, particularly 60-cycle hum and its immediate harmonics, which are below the frequency range normally passed by telephone circuits. The meter circuit also includes a loudness shaping network which weights indications so that the difference between two measurements represents, approximately at least, the loudness difference perceived by the human ear **[5]**.

The basic telephone connection, parts of which may be used with portions of a commercial telephone connection to make up an over-all connection, is shown in Figure 3*(c)*. This is a two-way four-wire connection which makes use of electromagnetic, rather than carbon type, transmitters in order to avoid the instabilities of the latter type. However, shaping networks are employed in the transmitting portions of the two converting sets to provide the frequency characteristics of modern carbon type transmitters. The characteristics are roughly a compromise between

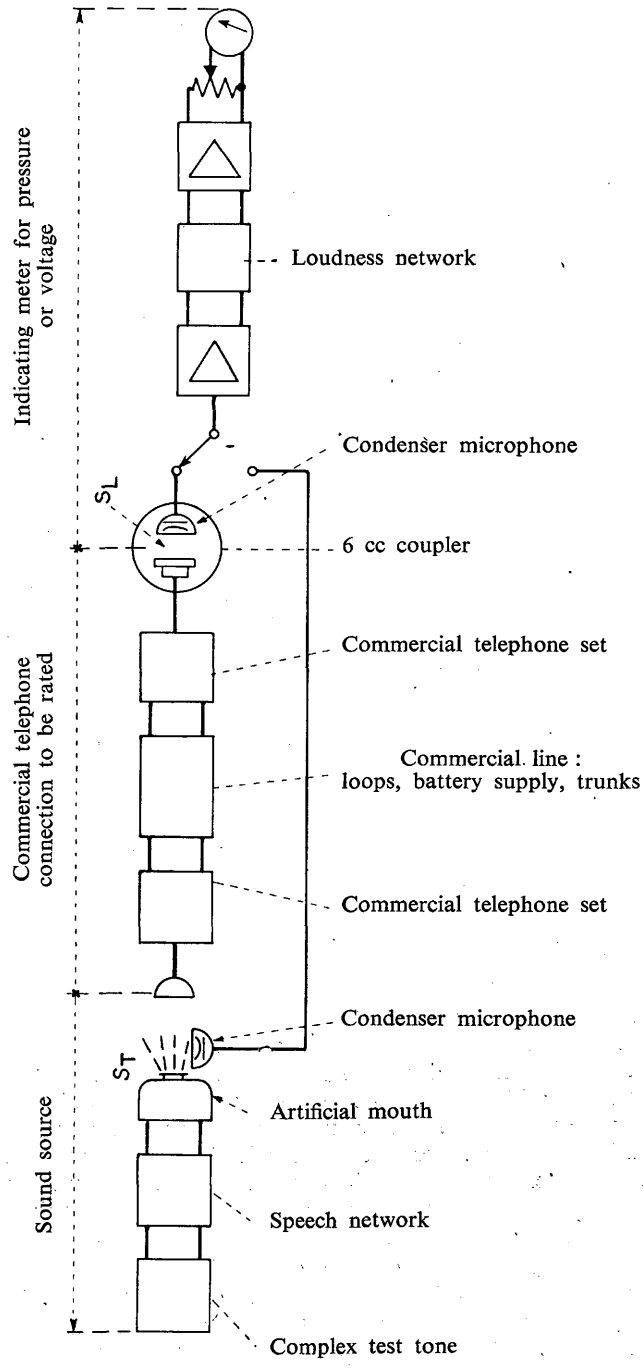


FIGURE 4. — *Measurement of over-all rating of a telephone connection*

those of the F1 and T1 transmitters. The line impedances of both transmitting and receiving portions of the converting sets are 900 ohms pure resistance, matching the 900-ohm distortionless connecting lines without reflection. The gain of amplifiers in the transmitting and receiving portions of the sets may be adjusted so that the sets have convenient transmitting and receiving ratings in terms of the new rating system. An additional amplifier in each converting set provides an adjustable sidetone path so that the connection will not sound dead to human talkers and listeners.

Methods of use.

Examples of various methods of use of the electro-acoustic measuring system are given in Figures 4, 5, 6 and 7. Since these are laboratory measurements, line facilities such as loops and trunks are simulated by equivalent networks. Thus both ends of telephone connections, which might be far apart in the actual case, are readily available for measurements in the laboratory.

The first example, Figure 4, illustrates the use of the sound source and indicating meter to measure the over-all rating of a complete telephone connection. During measurement of the talking pressure, S_T, the telephone handset is removed and the condenser microphone placed at a carefully gauged position with respect to the guard ring of the artificial mouth. When this measurement has been made the handset is replaced, with the transmitter positioned by template. Different templates are necessary for F-type and G-type handsets so that each will be in the modal position with respect to the source of sound. The condenser microphone is then removed from its artificial mouth position and placed in the 6-cc coupler at the listening end of the connection. The telephone receiver is also clamped to the coupler which furnishes an acoustic termination similar in impedance to that provided by the human ear when the receiver is held tightly against it **[6]**. Prior to the measurement of listening pressure, as in all measurements involving carbon transmitters, the carbon must be conditioned. This is a process of physical agitation in a prescribed manner, and a momentary acoustical overload, which eliminates packing of the carbon which might otherwise occur when the handset is held rigidly in a fixture. It places the carbon in a configuration similar to that experienced under normal talking conditions. After conditioning the measurement of listening pressure is made.

The use of the sound source and indicating meter for rating a transmitting telephone set is shown in Figure 5. Here the output measurement is one of voltage rather than pressure. For this the indicating meter is bridged to the circuit by means of a high impedance connection.

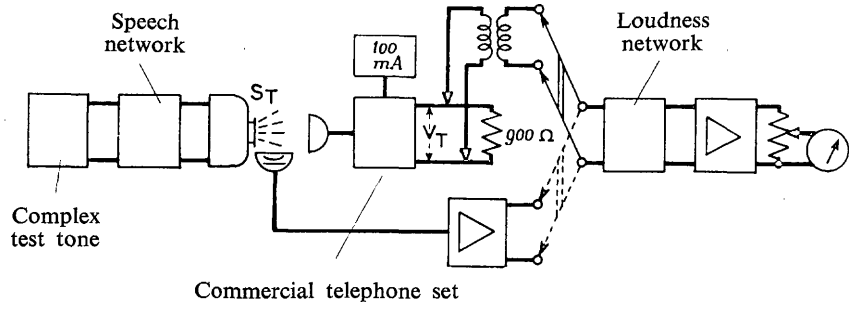


FIGURE 5. — *Measurement of transmitting rating of a telephone set*

Receiving rating of a telephone set is illustrated in Figure 6 which shows measurements of the source voltage and listening pressure. The frequency characteristic of the source voltage includes not only speech weighting but also the response characteristic of carbon transmitters.

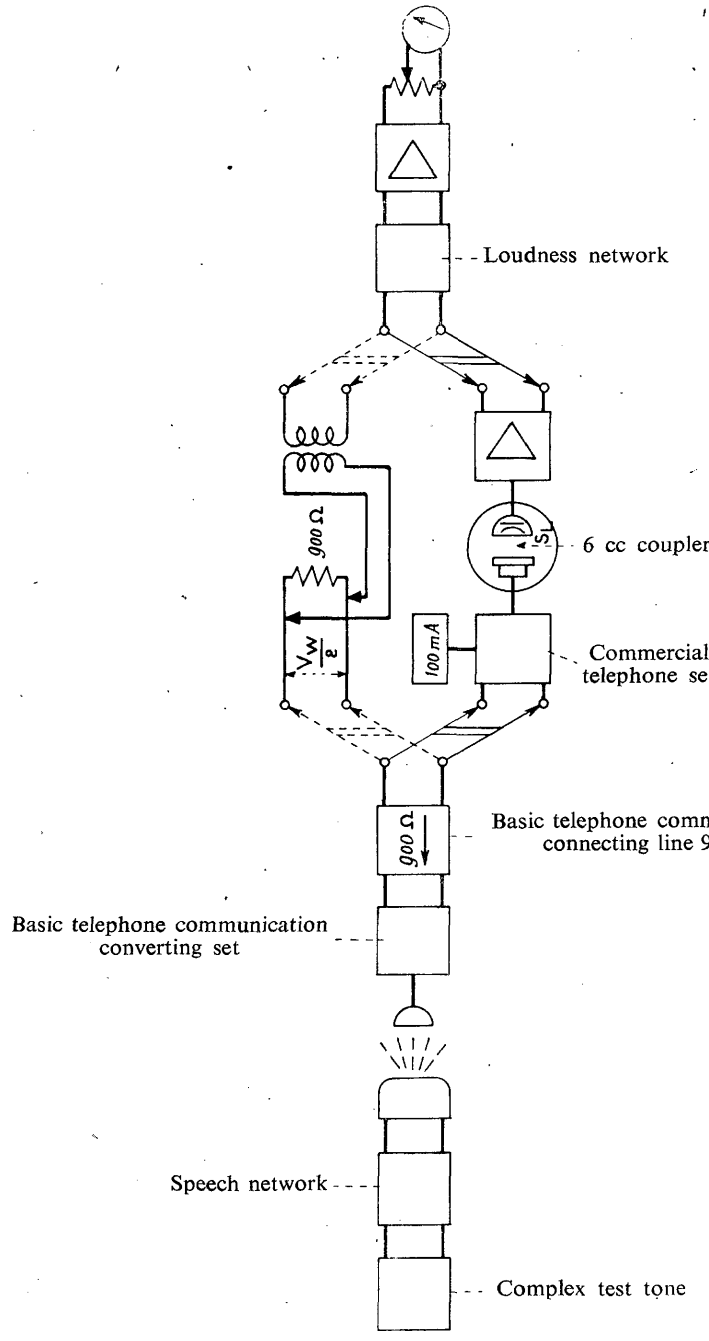


FIGURE 6. — *Measurement of receiving rating of a telephone set*

This is necessary in order that the component ratings may add up to the over-all rating, as indicated in Appendix A. A convenient way of supplying the desired frequency characteristic is to use the artificial mouth and the transmitting converting set of the basic telephone connection. The output from the 900 ohm connecting line is a voltage of proper frequency characteristic from a 900-ohm source, as required for the receiving rating of commercial telephone sets. The measurements of source voltage and listening pressure are made in the same manner as in the previous examples. No conditioning is necessary prior to these measurements because the transmitter of the converting set is electromagnetic instead of carbon type.

Another use of the basic telephone connection is to obtain basic data for subjective rating by means of comparison tests. Subjective ratings require human talkers and listeners. An example of this use is shown by Figure 7 in which a transmitting telephone set is rated subjectively in order to check data obtained by objective measurement. In this test the talker speaks alternately into the transmitter of the set to be rated and into that of the converting set of the basic telephone connection. The listener listens at the receiver of the basic telephone connection to speech from

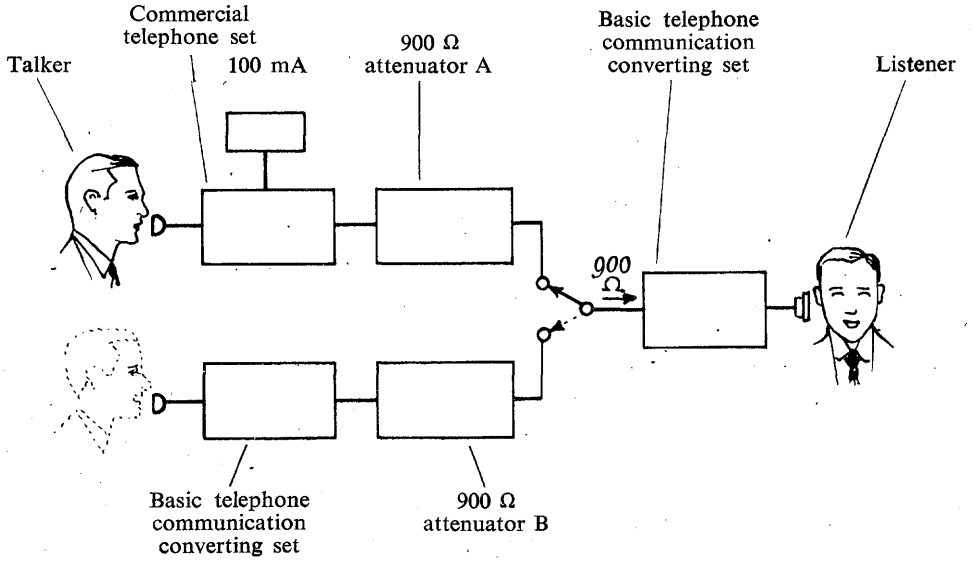


FIGURE 7. — *Use of basic telephone connection in subjective rating of a transmitting telephone set on a comparison basis*

both sources. He adjusts the attenuator (B) in the basic telephone connection until he judges the two to be equal. The difference between the settings of the two attenuators is then a measure of the rating of the commercial telephone set relative to that of the converting set in the basic telephone connection. The basis of equality in the observer's judgment must be specified; loudness may be specified, or some other subjective factor such as general satisfaction. Subjective tests of this kind require a number of different listeners, and often a number of different talkers, to yield results that are useful. Other arrangements of the basic telephone connection can be used for similar comparison tests of other commercial telephone components.

Apparatus for field testing.

As already stated, the transmission measuring system described in the previous sections was assembled to obtain laboratory data which will be of use to transmission engineers in the field. The data so obtained are in terms of the transmission rating system discussed in this paper. It requires no great stretch of imagination to visualize the development of apparatus functionally similar to that which has been described, but much smaller, lighter in weight and far less complex, which might be used by field personnel. Elements of such a measuring system would be located in central offices. Other elements might be carried to subscribers' locations in the normal complement of tools used by installation or maintenance forces. This field transmission measuring apparatus would be used to make field transmission surveys. It might also be used for maintenance purposes : values of electro-acoustic transmission loss measured in the field under circumstances of suspected trouble could be compared with transmission design data. The possibilities of such uses are wide in scope. These possibilities were in mind when the loudness rating plan was devised.

Summary.

Some of the disadvantages of the effective loss system for rating transmission were mentioned in the introduction. It is confidently expected that the revised rating plan presented here is free from these disadvantages and has merits of its own. The basis for this confidence lies in the following advantages of the plan, which are briefly summarized.

References are dispensed with in the loudness rating plan. Instead of references, ratings are in terms of absolute physical quantities which can be readily understood, and the ratings, therefore, can be visualized. This should lead to a far wider understanding of transmission rating, and of the meaning of rating numbers.

Ratings for the transmitting and receiving components of telephone connections have additive property and, for modern station instrumentalities, result in a range of rating numbers which is appropriate.

Loudness ratings may be measured objectively, instead of being determined by time consuming subjective methods.

The rating plan permits development of light weight field transmission measuring apparatus for field survey and maintenance purposes.

In special cases, where loudness rating is inadequate, subjective ratings may be applied by the addition of transmission penalties to loudness ratings.

At the present time engineers at Bell Telephone Laboratories are engaged in an extensive program of measurements so that the new rating plan may be implemented as soon as possible.

APPENDIX

(to Annex 1 to Question 7)

The effect of frequency characteristics on the additive property of component ratings

It is recognized that, strictly speaking, there is no known way to define component losses in such a way that all of them are independent of the remainder of the circuit with which they are used, and at the same time that their individual ratings add up to the over-all rating under all conditions. Consider as an extreme example an over-all connection in which the transmitting component produces frequencies only in the band from zero to 1,500 cps, and the receiving component is responsive to frequencies in the band from 1,500 to 3,000 cps. If the transmitting circuit alone were measured in a wide band measuring circuit it would be assigned a rating of, say, X.

Likewise if the receiving circuit by itself were measured by a wide band measuring circuit it might be assigned a rating of Y. The two added together would provide an over-all rating of X + Y; yet obviously the actual over-all loss would be infinite. If, however, the response-frequency characteristic of the transmitting circuit were included in the source voltage for the receiving circuit measurements, the receiving rating would no longer be Y, but would be an infinite loss.

In this case the receiving rating would not be independent of the rest of the circuit, but the sum of the transmitting and receiving ratings would be equal to the over-all rating.

An alternative would be to apply the response-frequency characteristic of the *receiving* circuit to the measuring circuit when measuring the output of the *transmitting* circuit. In this case it would be the transmitting circuit which shows an infinite loss, while the receiving rating would be finite; the transmitting rating would not be independent of the circuit, but the two would add up to the over-all rating.

In the example cited, which is of course an absurd extreme, one is left with the dilemma : which of the two circuits, transmitting or receiving, should be the one to be rated as an infinite loss ? There is no ready answer to this question. Fortunately, in more practical cases, the choice becomes an academic one because, first, the telephone plant is designed so that its components work together rather than in opposition to each other, and secondly the response of receiving circuits is in general relatively flat with frequency. The first of these reasons means that there would be little difference in the component ratings if either alternative were adopted. The second reason permits a method of measurement under the second alternative which still allows the component ratings to add up to the over-all rating.

In the rating plan described in this paper the first of the two alternatives mentioned above was chosen : namely, that transmitting ratings are determined by measurements independent of the remainder of the circuit, while receiving ratings are determined by measurements in which the source voltage includes the frequency-response characteristic of modern carbon transmitters. Three reasons dictate this choice :

1. It permits simple definitions of component transmitting and receiving ratings.
2. The input and output measurements for the component ratings are conveniently made.
3. Greater generality is provided because the additive property of component ratings does not depend on flatness of the receiver characteristic.

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ANNEX 2

(to Question 7 of Study Group 12)

Tonality method studied by the Soviet Administration for determining articulation

A. — *Method with a listening operator.*

At present we are studying the possibility of applying a method which is known in Russia as the " tonality method " for assessing the transmission performance of telephone systems by determining the articulation for logatoms or sounds, dispensing with actual articulation measurements.

The essential aspect of this method is that the whole frequency range from 100 to 10,000 kc/s is divided into 20 bands of equal articulation and in each band the articulation of the formants is $A_k = 0{\cdot}05$.

The bands of equal articulation and their mid-frequencies for Russian speech are indicated in Table 1.

TABLE 1

Bands of equal articulation for Russian speech

Band number	Frequency Range c/s	Average Frequency c/s	Band number	Frequency Range c/s	Average Frequency c/s
1	100-500	300	11	1950-2100	2025
2	500-700	600	12	2100-2300	2200
3	700-820	750	13	2300-2550	2425
4	820-980	900	14	2550-2850	2700
5	980-1130	1050	15	2850-3150	3000
6	1130-1300	1200	16	3150-3550	3350
7	1300-1450	1375	17	3550-3950	3750
8	1450-1600	1525	18	3950-4400	4125
9	1600-1750	1675	19	4400-5400	4900
10	1750-1950	1850	20	5400-10000	7700

The microphone of the transmitting portion of the telephone system undergoing the test is excited by pure tones having frequencies equal to the average frequencies of the bands of the same articulation.

The excitation is produced by an artificial mouth. The acoustic pressure at each frequency si fixed at a value equal to the peak of voice pressure in a frequency band which has the same

TABLE 2

Frequency c/s	Acoustic pressure (microbars)	Frequency c/s	Acoustic pressure (microbars)
300	50·0	2000	7·2
600	27·2	2200	6·8
750	18·8	2400	6·4
900	14·8	2700	6·0
1050	14·0	3000	5·6
1200	10·8	3400	5·4
1400	9·6	3760	5·6
1550	8·8	4100	5·6
1700	7·2	5000	5·2
1850	7·2		

width as the critical band for the ear having an average frequency equal to the excitement frequency (i.e. the average frequency of the band of equal articulation).

These pressures are given in Table 2.

The microphone of the sending apparatus is placed at a distance of 2 cm. from the radiating orifice of the artificial mouth.

The acoustic pressures shown in Table 2 are produced at the spot which would be occupied by the microphone in an actual articulation test.

The operator, while listening to the pure tone in the receiver of the telephone system being tested, changes the fixed pressure in accordance with Table 2 to a value corresponding to the audibility threshold of that sound in the conditions set for the test.

The difference between these acoustic pressures, expressed in db, represents the sensation level of the formants in the band of equal articulation which has an average frequency equal to that of the pure tone.

To determine the articulation of formants in each band of equal articulation, the sensation levels of the formants at the receiving end are multiplied by the coefficient of perception P_k. The relation between the coefficient of perception P_k and the sensation level of the formants for Russian speech is shown in Figure 1 (we have changed this relationship after it was published in a Document " CCIF — 1952/1954 — SG. 4 — Document 54 ", Figure 4).

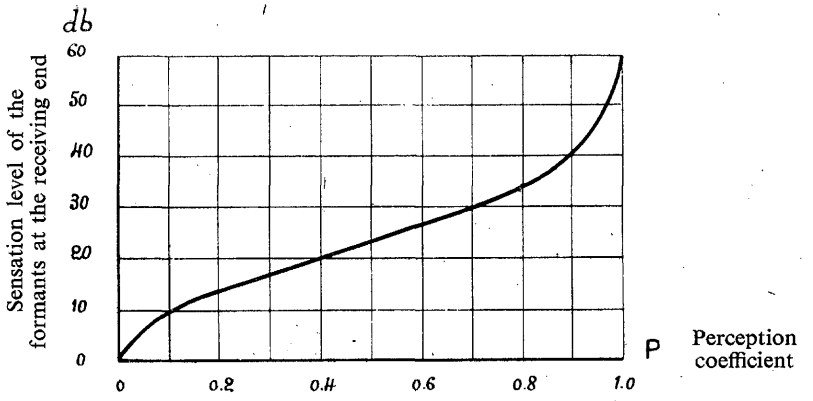


FIGURE 1. — *Relation between the perception coefficient and the sensation level of the formants, for Russian speech*

The resultant articulation of the formants for the whole speech spectrum is given by the formula :

$$A = \sum_{k=1}^{k=20} P_k \, A_k = 0{\cdot}05 \sum_{k=1}^{k=20} P_k$$

The passage of articulation resulting from the formants A to the articulation for logatomes S is effected in accordance with the formula $S = f(A)$, represented in Figure 2 (reproducing Figure 5 in the above-mentioned document).

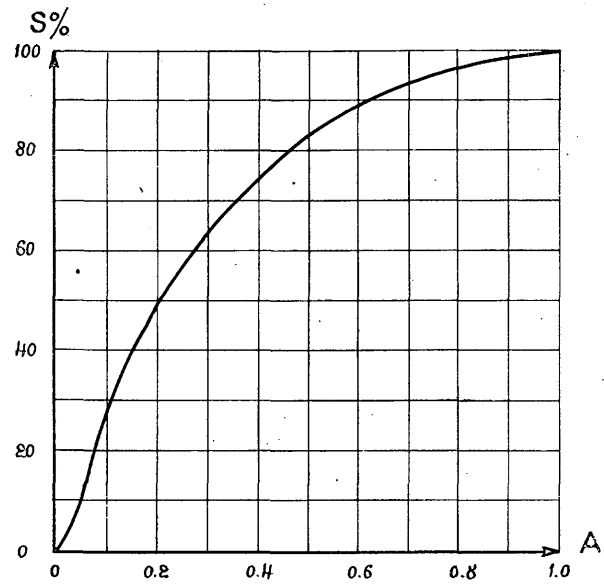


FIGURE 2. — *Relation between the articulation of the formants (A) and that for the logatoms (S), in Russian speech*

From the articulation for logatoms, we can determine the articulation for the sounds, words and phrases in accordance with the relations represented by Figures 3, 4, and 5 (reproducing Figures 6, 7, and 8 of the above-mentioned document).

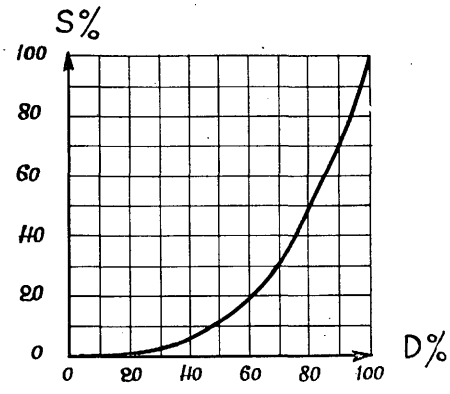


FIGURE 3. — *The dependency of syllabic articulation (S) on sound articulation (D)*

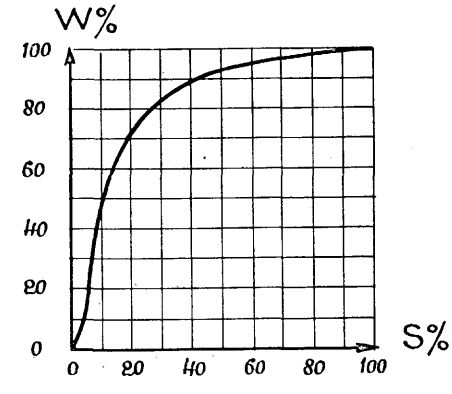


FIGURE 4. — *The dependency of word articulation (W) on the syllabic articulation (S)*

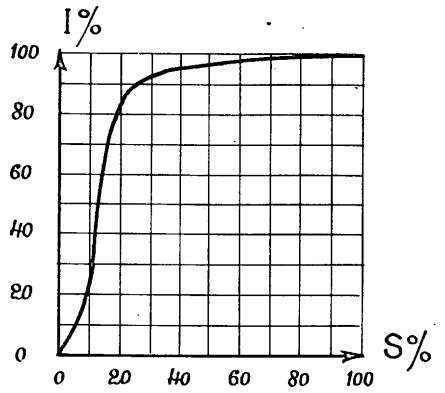


FIGURE 5. — *The dependency of articulation for sentences (J) on the syllabic articulation (S)*

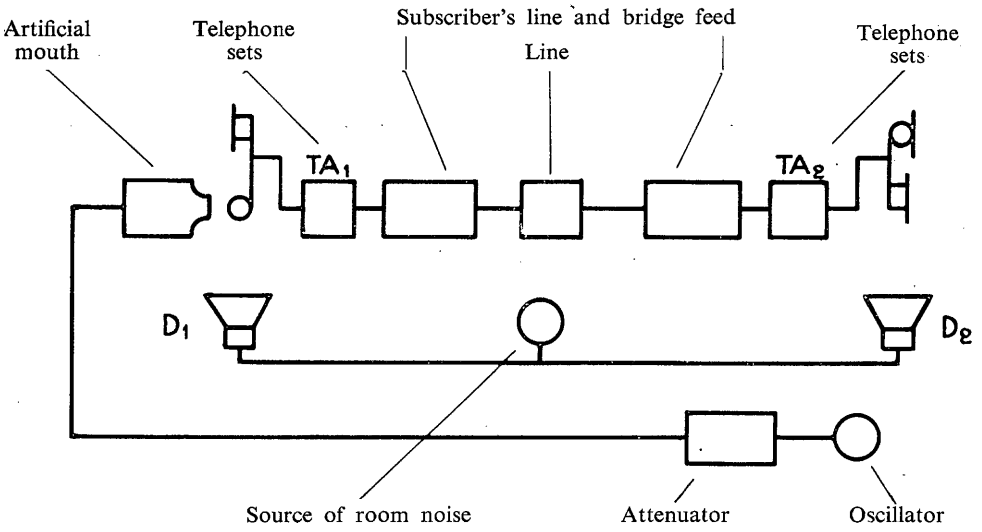


FIGURE 6

In practice, the measurements are made as follows :

Figure 6 diagrammatically represents the measurement equipment.

With the aid of the oscillator giving rise to audio frequencies, we successively apply electrical oscillations with frequencies equal to the mean frequencies of the bands of equal articulation, at the input terminals of the artificial mouth (BA).

By means of the attenuator, adjustable in 0·1 db steps, the voltages applied to the input terminals of the artificial mouth are adjusted in such a fashion that the acoustic pressures from the artificial mouth at a point two cm. from the centre of the orifice correspond to the figures shown in Figure 2.

Such an adjustment is made in the absence of the microphone of the transmitting apparatus of the telephone system under trial.

Measurement of the acoustic pressure is done by an acoustic probe which produces practically no distortion of the acoustic field.

The handset of the transmitting apparatus is installed in such a manner that the centre of the input orifice of the microphone is at the point at which the tube of the acoustic probe was placed. The position of the microphone must correspond to its position in normal operating conditions. Before the measurements, the microphone is subjected to a standardized treatment, acoustic and mechanical.

At the sending and receiving ends a noise is generated with a spectrum and intensity varying according to the conditions of the test. For this the noise generator and loudspeakers D1 and D2 are used. The operator, who listens while holding his handset in the normal listening position, adjusts the attenuation in such a way that he obtains a threshold of audibility for the pure tone to which he is listening.

The difference between the attenuation introduced to obtain the acoustic pressure in accordance with Table 2 and the attenuation introduced to obtain the threshold of audibility is the unknown value of the level of audibility of the formants in the band of equal clarity having a mean frequency equal to that of the pure sound.

This is what the experimental part of the " tonality method " consists of.

The subsequent calculations needed to determine clarity for the logatoms have been explained above. We have tried the tonality method by comparing it to an ordinary method of measuring articulation. On the occasion of these tests we have by various means checked the definition of the threshold of audibility, namely :

1. Method with a single operator, in which the listening operator himself adjusts the attenuator.

2. Method with two operators, in which the listening operator does not adjust the attenuator, but simply tells the second operator to reduce or to increase attenuation until the sound disappears.

3. Method described by the C.C.I.F., in which the threshold of audibility is determined as the mean value of the indications received when the sound disappears and reappears.

The comparative articulation tests were made with the aid of an ordinary method, by transmitting tables of combinations of sounds accepted in our practice for Russian speech.

We have reached the following conclusions :

1. The tonality method, with all the methods given above for defining the threshold of audibility, gives results which coincide with the method of articulation measurement, to within 5%.

2. The standard deviation relative to the mean value of articulation obtained with an equal number of trials is the same for the tonality method as for the articulation measurement method.

By one single test we mean, with the tonality method, obtaining logatom articulation in accordance with the measurements made once by an operator on each of the twenty frequencies and with the method of measurement of articulation, obtaining logatoms articulation in accordance with the data received during the transmission and reception of a table of fifty logatoms by two people (one speaking and the other listening).

3. The time required to determine articulation by use of the tonality method is about the same as with the other system (for the same number of trials).

The advantages of the tonality method are as follows :

1. Articulation tests properly so called, with voice transmission in the form of tables of logatomes, are not needed.

2. No special team of operators in required, trained for articulation measurements.

The training of operators to determine the threshold of audibility takes less time than to train a team of operators for articulation measurements.

When there is a change in the nature of the distortion in the telephone system, the operators' team has to be trained anew for articulation tests, whereas this has no effect at all with the tonality method.

3. The tonality method makes it possible, by simple means, to determine the size, from the point of view of articulation, of the separate frequency bands transmitted by the system under test.

We are pursuing our studies of the tonality method with the object of replacing the human ear by an artificial one (see paragraph B below).

It should be noticed that, when the tonality method is used, the operator, of any nationality, in using the relations corresponding to no matter what language, can determine the performance rating of a telephone system on the basis of the clarity for that language.

It may well be considered that the tonality method, in which tables of logatoms do not have to be transmitted, may help to solve the questions raised by the peculiarities of the various languages used when clarity is determined.

B. — *Possibility of an objective measurement of articulation on a transmission system by the tonality method, using an artificial ear.*

The possibility of an objective measurement, set forth hereinafter, supplements the tonality method described in A above. The measurement procedure is based on the fact that in the presence of a noise at the point of reception, of which the sensation spectrum has a level $Z > 10$ db, we can assume that the masking effect for a pure sound is :

$$M = Z = B_b + K - \beta_0$$

where B_b = is the level of the noise spectrum at a frequency equal to that of the masked sound;
K = is the logarithmic width of the critical band for the ear at this frequency; and
β_0 = is the threshold of audibility of the pure sound at a given frequency, during silence.

Then the threshold of audibility of this same sound, in the presence of noise, will be :

$$\beta_m = \beta_0 + M = B_b + K$$

Thus to measure β_m at the given frequency f, $B_b + K$ has to be measured, i.e., the noise level integrated into a band of width equal to the critical band for the ear, the mean frequency of which is equal to the given frequency f.

The measurement is diagrammatically shown in Figure 7, where :

GS = Oscillator
MA = Adjustable attenuator
IN_1 = Level indicator
BA = Artificial mouth
OA = Artificial ear
FBE = Narrow-band filters with twenty passbands having the width of the critical band for the ear at the mean frequencies of the bands of equal articulation (see table 1 and Figure 8).
IN_2 = Level indicator
M = Microphone of the subscriber's set in the sending telephone system
$STLE_1$ = Sending local telephone system
L_c = Junction line
$STLE_2$ = Sending local telephone system
T = Receiver of the subscriber's set in the sending telephone system
GB = Room noise generator
HP = Loudspeaker.

By creating, with the room noise generator and loudspeaker, the noise of the spectrum desired at the receiving end, we determine with IN_2, for the given passband of the filters FBE, the value $B_b + K = \beta_m$. Then we excite the microphone M by a pure tone equal to the mean frequency of this band of the filter, i.e., at the mean frequency of the band of equal articulation in the presence of the acoustic pressure developed at the site of the microphone, as shown in Table 2. This is done by the aid of an oscillator and of the level indicator (IN_1), by adjusting to a suitable figure the adjustable attenuator (MA).

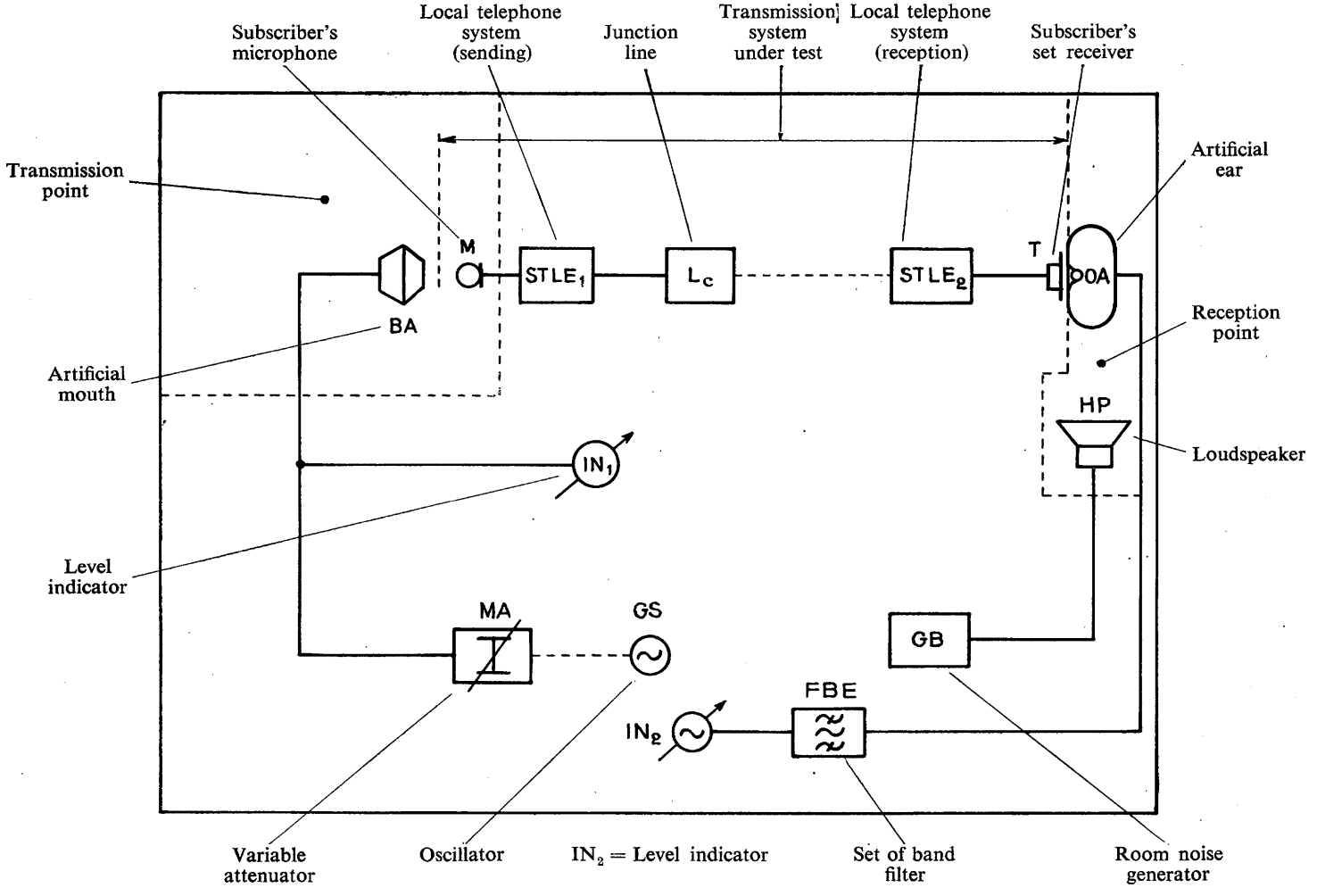

Subscriber's microphone
Local telephone system (sending)
Junction line
Transmission system under test
Local telephone system (reception)
Subscriber's set receiver
Transmission point
Artificial ear
M
STLE1
Lc
STLE2
T
OA
BA
Reception point
Artificial mouth
HP
Loudspeaker
IN1
Level indicator
MA
GS
GB
FBE
IN2
Variable attenuator
Oscillator
IN2 = Level indicator
Set of band filter
Room noise generator

FIGURE 7

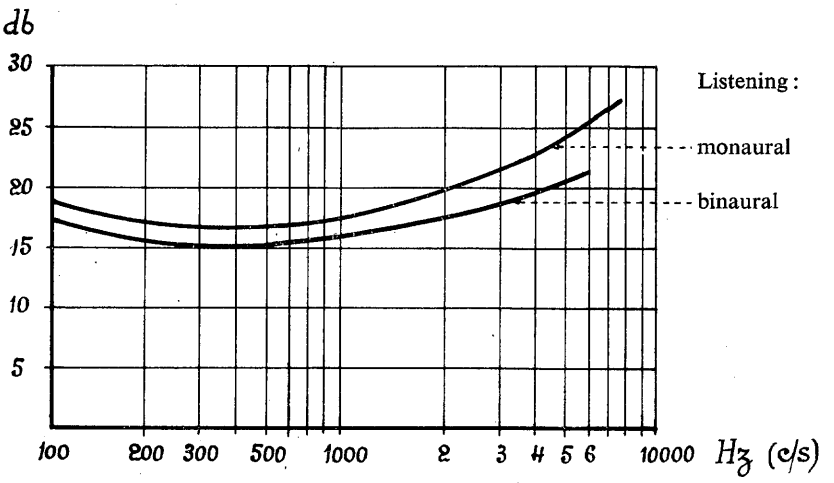


FIGURE 8. — *Width (on a logarithmic scale) of the critical band for the ear, as a function of frequency*

Then, with the aid of the attenuator MA, we bring the figures shown by the level indicator IN_2 to a figure which has been determined, for this frequency, during the measurement $\beta_m = B_b + K$. The attenuation to be introduced or taken out to this end in the attenuator gives the level of sensation of the pure tone given above the threshold of audibility, in the presence of the noise, when this sound is transmitted over the transmission system under test. In accordance with the level of sensation, we determine, as already mentioned in § A above, a value of articulation for the formants A, the syllables S or the sounds D.

In Table 3 the results are shown obtained with a particular system in the presence of the noise at the point of reception, equal to 65 db (integrated value), when the level of sensation of the pure tones is determined by a subjective method by the technique set forth in paragraph A above (Column 2), together with the results of the measurement of these same values by an objective measurement (Column 3).

TABLE 3

Frequencies : kc/s	Subjective Measurements db	Objective Measurements db	Difference db
1	2	3	
300	16	12	+4
600	20	23	−3
750	23	26	−3
900	16	13	+3
1050	16	13	+3
1200	18	17	+1
1400	24	27	−3
1550	21	19	+2
1700	15	16	−1
1850	14	13	+1
2000	9	7	+2
2200	9	7	+2
2400	—	—	—
2700	—	—	—
3000	—	—	—

Column 4 gives the difference in db between the subjective and objective measurements of the level of sensation of the formants.

The articulation for the formants A and logatomes S, calculated on the basis of these measurements, gives :

for subjective measurements : A = 18·3%; S = 47%
for the objective ones : A = 20·4%; S = 50%.

For measurements of articulation, such agreement can be considered very satisfactory. There is one practical difficulty in the measurement procedure described, namely, the adjustment, on the artificial ear, of the cap of telephone receiver under test in such a way that, by means of necessary pressure, the artificial ear is acoustically insulated in the same way as the human ear when the telephone receiver is applied to it.

Studies made with different types of handset show that this difficulty can be avoided and that the difference between the values of the level of sensation measured on the artificial ear and those subjectively measured on the human one do not exceed ± 3 db.

ANNEX 3

(to Question 7 of Study Group 12)

Contribution by the Italian Administration to the study of objective methods of measuring reference equivalent and articulation reference equivalent

Summary.

The aim of this paper is to devise objective methods of determining reference equivalent and articulation reference equivalent (AEN) of a telephone system, assuming certain hypotheses to calculate the characteristics of the human voice and ear.

The methods so devised result from considerations analogous to those explained by Braun for reference equivalent, and by French and Steinberg for articulation reference equivalent.

The agreement between the results reached provides an assurance of the validity of the theoretical study and of the legitimacy of applying these methods to systems, even if very different from those tested.

The performance rating of a telephone system can be characterized by the judgement of the users, but the use of that judgement cannot be applied to tests made in laboratories, or tests on part of a system only.

To eliminate these drawbacks, a team of operators can be employed to assess the quality of the system under test, in relation to the quality of a system chosen as reference system.

The performance of the reference system is made to vary by the aid of an attenuator, and the " performance rating " of the system under test is defined as the reading of the attenuator when, in the judgment of the team, the two systems present the same transmission quality.

Naturally, this comparison can be made between two corresponding parts of the system under test and reference system.

According to the criterion chosen for assessing equality in performance rating, several methods of assessment are possible.

In the C.C.I.F., the two methods now being considered are : firstly, that based on the intensity of the sounds received, i.e., the method of reference equivalent, and secondly, that based on the clarity of sounds, i.e., the method of articulation reference equivalent (AEN).

The first of these methods takes into account merely the intensity of the sounds arriving at the listening operator's ear, while the second is based on the intelligibility of these sounds, takes their intensity into account, but also the effect of disturbances, i.e., noise and distortion.

The numerical values obtained also depend on the operating team. They are, however, subjective.

It is very valuable to obtain the same results from objective measurements and several methods have been devised, using only the results of physical measurements on the system under test, to determine the performance rating without subjective tests.

The point of departure of the objective methods is experimental. and their validity depends on how far their results coincide with those obtained from subjective measurements. This is valid for systems equal or similar to those which have been tested, but not for very different systems.

The aim of this study is to find a theoretical justification of the objective methods for determination of reference equivalent and of the AEN, calculating the characteristics of the voice and of the human ear.

Reference Equivalent.

We intend, first of all, to find some relationship between the physical intensity of the sound and its effect on the human ear, basing ourselves on the fact that the intensity of the sensation transmitted by a nerve cell is constant, no matter what the intensity of the stimulus may be, and that, therefore, the relation between the sensation and the stimulus depends on the number of nerve cells excited.

When a sinusoidal sound reaches the threshold of audibility, it causes a sensation that we can consider as being due to the excitation of a nerve cell. By increasing the intensity by a certain amount, it may be thought that a second nerve cell is being excited, when we begin to feel a variation in sensation, and so on as the intensity increases.

This consideration indicates a method for determining a relationship between the acoustic intensity and the number of cells excited on the basis of the figure Δn for the smallest change in level perceptible as a function of the level above the threshold of audibility n.

We can in fact consider Δn as the variation in level necessary to excite a new nerve cell, and its reciprocal $1/\Delta n$ as the number of nerve cells excited when the level increases by one unit.

If we calculate the integral :

$$I = \int \frac{1}{\Delta n} \, dn$$

from the threshold of audibility up to n, we can consider the value :

$$T = I + 1$$

as the total number of nerve cells stimulated for the level n.

Strictly speaking the number T has a meaning only when it is a whole number, and the curve of the variation T as a function n is therefore discontinuous. We shall use, for simplicity's sake, a continuous curve, which coincides with the strict curve, especially for sufficiently high values of n.

For the numerical evaluations, we have taken as a basis the results of tests on the smallest perceptible change in level, published in the book by Fletcher **[14]**.

The tests were made by superposing two sinusoidal sounds with the frequency differing by three c/s and of sufficient intensity to make the beats perceptible.

If the maximum values of the pressures relative to the two sounds be called p_1 and p_2, the variation of level is given by :

$$\Delta n = 20 \log_{10} \frac{p_1 + p_2}{p_1 - p_2} \text{ db}$$

In Table 1, we have shown the values of $1/\Delta n$ as a function of the level above the threshold corresponding to the pressure $p_1 - p_2$ (whereas in Fletcher's table the level corresponds to the pressure p_1) for the frequencies 200, 1000, 4000 and 8000 c/s, and we have traced in figure 1 the corresponding curves with extrapolation up to $n = 0$.

These curves are much the same shape, and if we multiply the corresponding values by a coefficient k_f (1·35 for 200 c/s, 0·75 for 4000 c/s and 1·1 for 8000 c/s) we shall have three curves similar to that for the frequency 1000 c/s. From these four curves we have calculated the mean curve (values in the last line of Table 1) traced on the same figure 1.

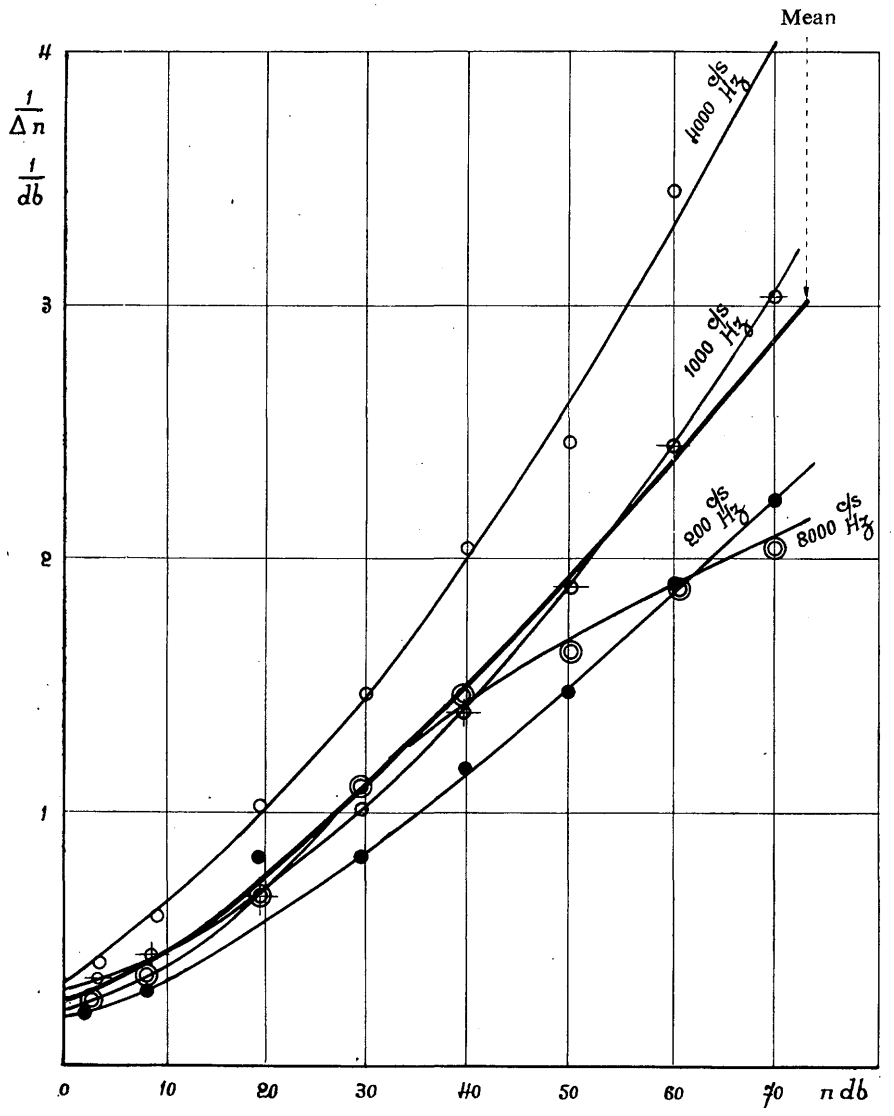


FIGURE 1. — *Curves representing the number of nerve cells stimulated when the level of a sinusoidal sound increases by 1 db*

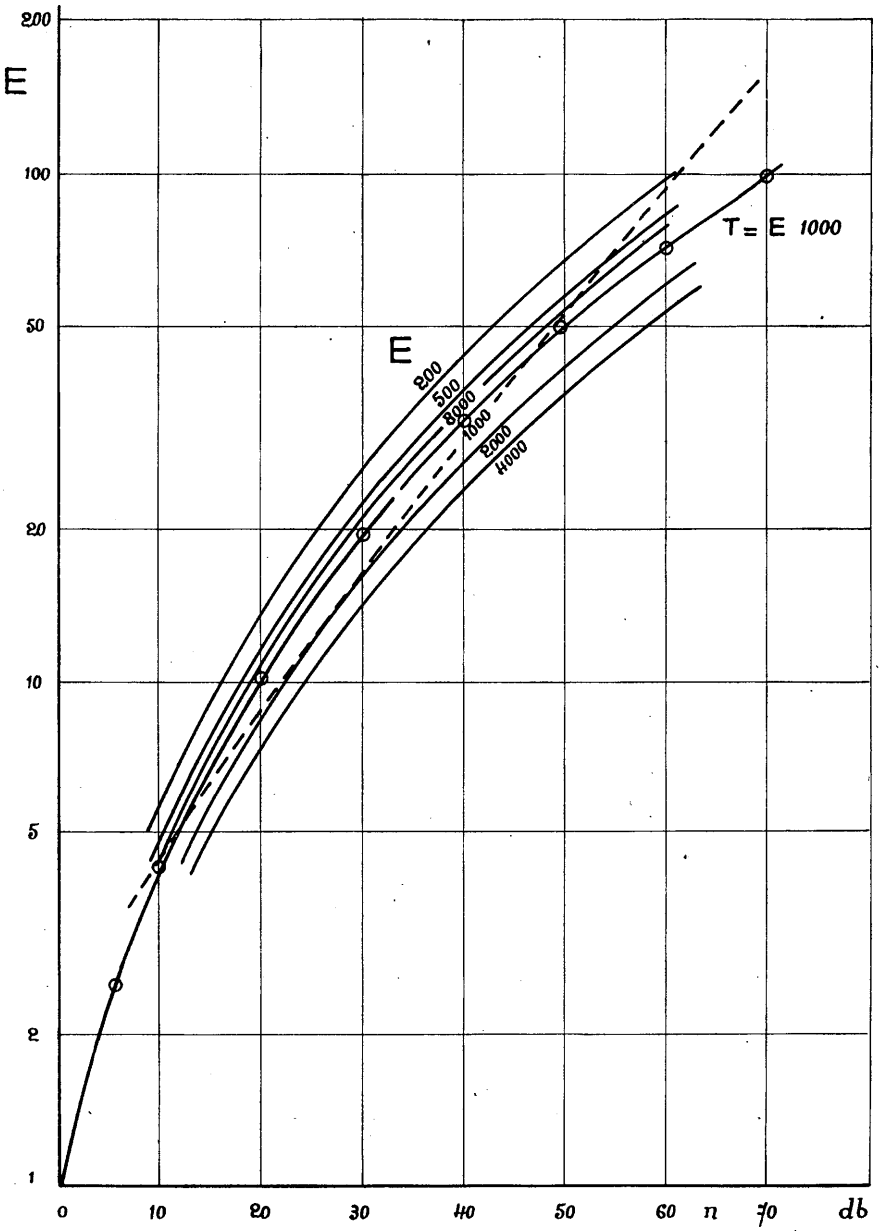


FIGURE 2. — *The effect of a sinusoidal sound wave*

TABLE 1

f= 200	n		2·34	8·12	19·36	29·36	39·56	49·66	60	70
	$1/\Delta n$		0·213	0·294	0·833	08·33	1·16	1·47	1·89	2·22
f=1000	n		3·38	8·77	19·2	29·5	39·62	50	60	70
	$1/\Delta n$		0·333	0·435	0·667	1	1·39	1·89	2·44	3·03
f=4000	n		3·67	9·12	19·52	29·66	40	50	60	70
	$1/\Delta n$		0·4	0·588	1·03	1·47	2·04	2·44	3·45	4
f=8000	n		2·78	8·48	19·2	29·54	40	50	60	70
	$1/\Delta n$		0·25	0·357	0·667	1·11	1·47	1·64	1·89	2·04
mean	n	0	5	10	20	30	40	50	60	70
	$1/\Delta n$	0·26	0·34	0·45	0·75	1·11	1·51	1·93	2·38	2·84

From this mean curve, we have calculated the integral, giving it the value 1 to correspond to the threshold, and this gives the number T of the nerve cells stimulated by a sine wave of frequency 1000 c/s as a function of the level.

The value of T is shown in figure 2.

If now we trace the curve representing the square of T we shall see that by changing scale, it coincides with the sound curve expressed in sones, as a function of the equivalent level above the threshold in phons (this equivalent level coincides with the level above the threshold for the frequency 1000 c/s), on page 193 of Fletcher's book.

In figure 3, the curve is that of Fletcher and the points represent the values of T^2 (scale 1 : 1000).

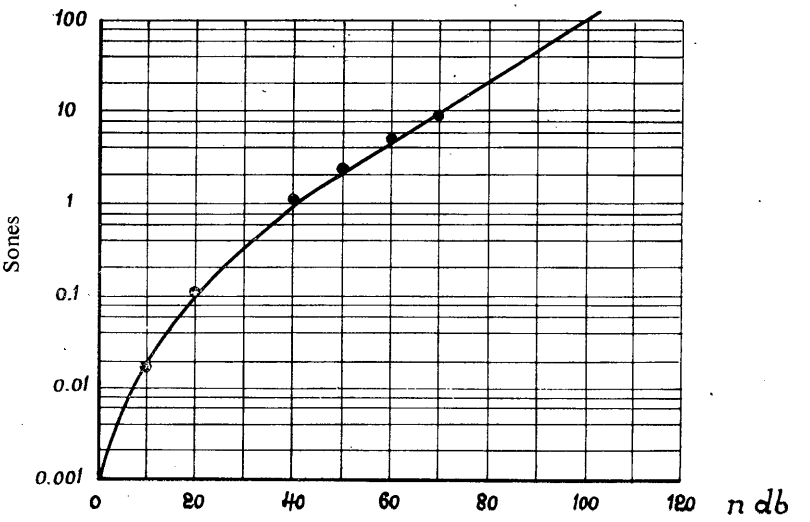


FIGURE 3. — *Sound variations as a function of the equivalent level in relation to the threshold*

This coincidence signifies that the auditory sensation is proportional to the square of the number of nerve cells stimulated, the effect of which, therefore, can be considered as a pulse of equal value for each cell, whence it follows that the square of the sum of these pulses, i.e., of the total current is proportional to the power.

For sine sounds of frequency other than 1000 c/s, the number of nerve cells stimulated is

$$T_f = T/k_f$$

and is greater than T for 1000 c/s and smaller for the frequencies 200 and 8000 c/s.

We know that for the same value of the level above the threshold, the sound sensation for the frequency considered behaves the opposite to T_f. Hence we must suppose that the effect of stimulating a nerve cell is different according to the frequency, and especially that it is greater for the frequencies corresponding to a higher value of k_f and inversely.

Among the numerous assumptions possible about the law according to which the effect on a nerve cell depends on frequency we can choose the simplest, which coincides well with the results of experience, namely :

$$E = k_f{}^2 \times T_f = k_f\, T$$

With this hypothesis, the effect of a sound of frequency other than 1000 kc/s can be derived from the value of T (figure 2), multiplied by the coefficient k_f represented by the curve in figure 4.

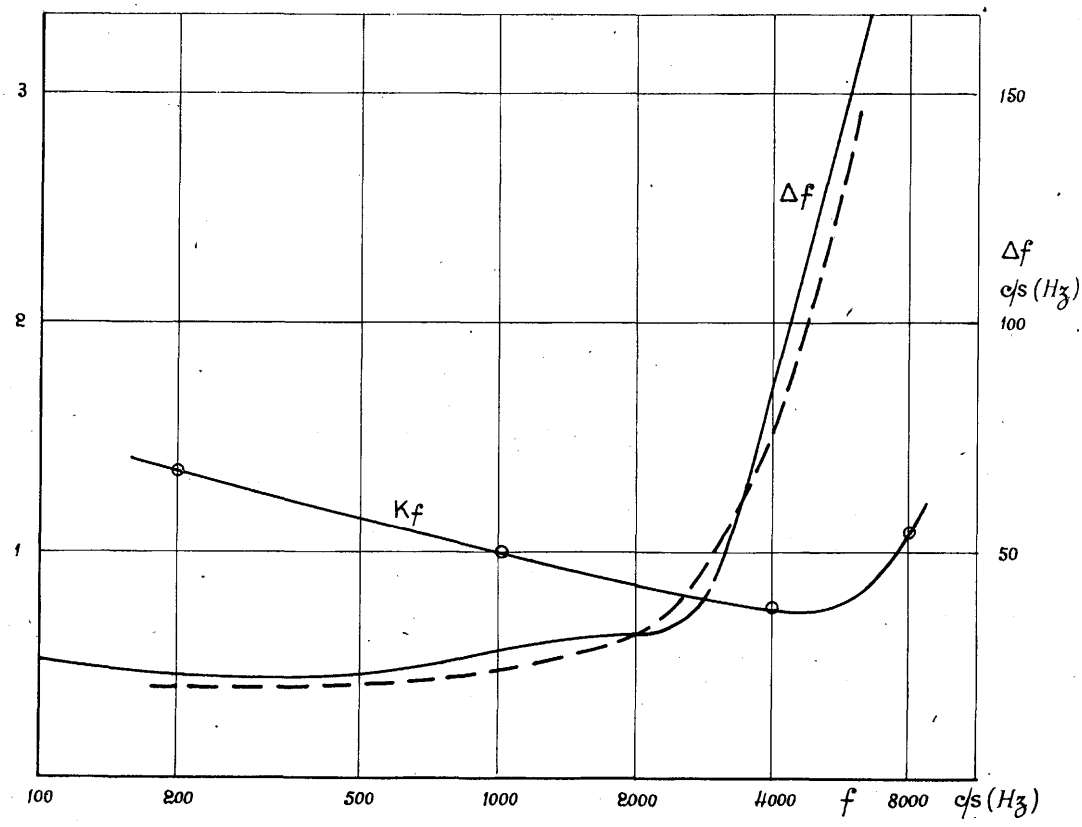


FIGURE 4. — *Variation curves as a function of frequency*

k_f = of the effect of the stimulated cell,
Δ_f = of the smallest perceptible change of frequency in relation to the threshold.

In figure 2 we have entered the curves showing the variation of E for the frequencies 200, 500, 2000, 4000 and 8000 c/s besides the curve showing the variation T (giving the value of E for the frequency 1000 c/s).

These curves naturally hold good in the limits between which the function T can be considered as continuous.

From these curves we have deduced isophonic curves for 20, 40 and 60 phons in figure 5, in which the points represent the values extracted from figure 134 on page 188 of Fletcher's book. It will be readily seen that there is reasonable concordance between the curves and points.

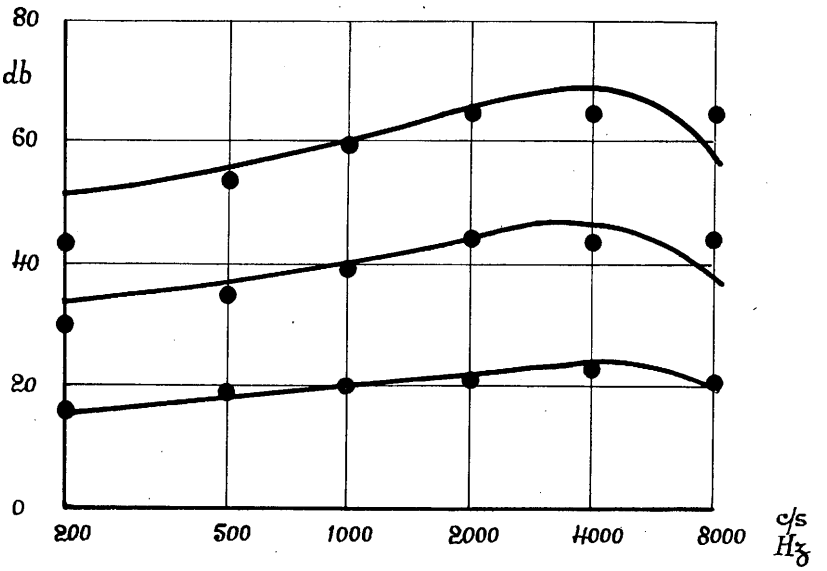


FIGURE 5. — *Isophonic curves*

We have considered the case of a pure tone, but of course the real problem in telephony is a complex sound which may be considered as a continuous series of pure tones characterized by the spectral curve of the intensity, i.e., by a curve which gives the level (relative for example to 1 picowatt per square metre and per c/s) as a function of frequency.

As criterion for this division into bands, we have taken tests based on the smallest perceptible change of frequency. If, for example, the frequency of a pure tone passes from f to $f + \Delta f$, this change will be perceived only if Δf reaches a certain value. This value depends either on the frequency or on the level, and by extrapolation we have determined the values of Δf corresponding to the level 0, i.e., to the threshold of audibility.

French and Steinberg have applied a similar criterion **[8]** by shifting the threshold as a function of the width of the critical bands. This width differs from the value of Δf by a factor which remains almost constant with the frequency.

In figure 4 the values of Δf extracted from table 25 on page 148 of Fletcher's book are shown by a line, and the critical bands divided by 7 are shown by dotted lines.

We could then divide the abscissa line of the spectral curve into numerous bands of width Δf, varying with the frequency according to the curve in figure 4. We can assume that a nerve ending corresponds to each of these bands, composed of a series of cells, and a number of cells stimulated for each band could be calculated in the same way as with a pure tone. The sum of the effects of each band gives the total effects.

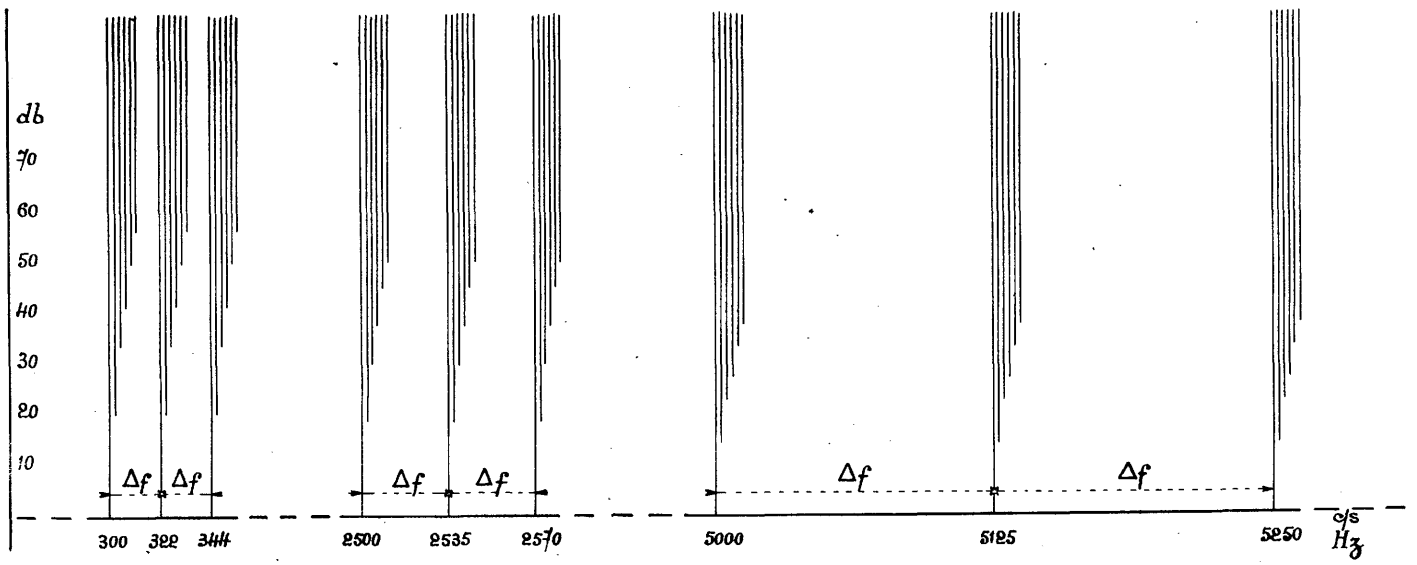


FIGURE 6. — *Nerve terminals and component cells for different frequencies*

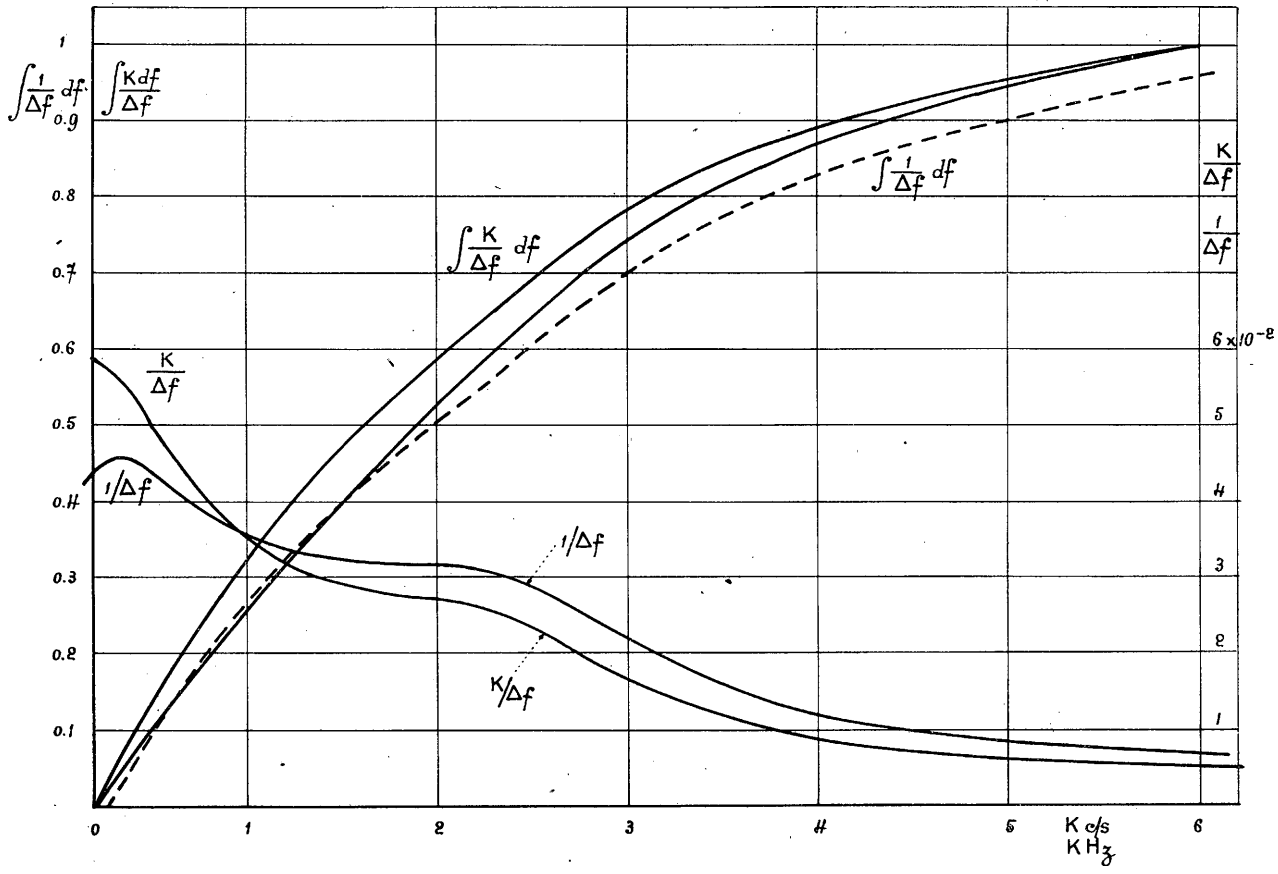


FIGURE 7. — *Curves to determine the scale of the abscissa of the abacus for the calculation of the reference equivalent* $\left(\int \frac{k}{\Delta f} \mathrm{d}f\right)$ *and of AEN* $\left(\int \frac{1}{\Delta f} \mathrm{d}f\right)$

In figure 6, we have shown these nerve terminals distributed along the axis of the frequencies at distances Δf, in the form of organ pipes, this meaning that the cells in each terminal are successively excited as the level is increased.

The total effect of a complex sound reaching a listener's ear, when we know its level as a function of the frequency, can be readily determined by graphical methods by using a special abacus.

If we set the frequency scale of this abacus in such a fashion that each unit length corresponds to the same number of nerve terminals, i.e., by joining up the frequencies where Δf is larger, and separating them where Δf is smaller, and if we plot as the ordinate the effect for each band, the total effect will be proportional to the circuit comprised between this curve and the axis of the abscissa.

To determine the scale of the abscissa, it suffices to integrate the values of $1/\Delta f$.

We find the curve $1/\Delta f$ and its integral in figure 7, in which we have limited the field of variation of frequencies, theoretically infinite, to the values 200 and 6000 kc/s, giving the value 0 to the integral curve for frequency 200 c/s and 1 for the frequency 6000 c/s.

The values of the effects for each band will be calculated from the level relative to 1 picowatt per square metre :

$$b = B + 10 \log \Delta f \quad \text{db}$$

in which B is the given level of the spectrum relative to 1 picowatt per square per c/s.

For further simplification and to use the curve $T = E_{1000}$ in figure 2 to obtain the effects at all frequencies instead of applying the coefficient k_f to the ordinates, we can apply it to the abscissa without changing the surface concerned, i.e., we can calculate the frequency scale by integrating the curve $k/\Delta f$.

The curves representative of $k/\Delta f$ and its integral are also shown in figure 7.

We can, for example, calculate the total effect with a listener using one ear only listening to an average voice 1 metre distant, i.e. at the extremity of an orthotelephonic system (for example, ARAEN without line filter).

TABLE 2

f (1)	B_0 (2)	10 log ΔF (3)	$b_0 = B_0 + 10 \log \Delta f$ (4)	t (5)	$n_0 = b_0 - t$ (6)	n_a (7)
200	35	13·6	48·6	23	25·6	25·6
300	36·5	13·4	49·9	18·5	31·4	31·4
400	36·8	13·4	50·2	14·6	35·6	35·6
500	36·5	13·6	50·1	13	37·1	37·1
600	35·5	13·8	49·3	11	38·3	38·3
800	32·2	14·2	46·4	10	36·4	36·7
1000	29	14·5	43·5	8	35·5	36·4
1200	26·5	14·7	41·2	6·5	34·7	36·3
1500	23·2	14·9	38·1	6·1	32	35
2000	19·3	15	34·3	2·1	32·2	36·8
2500	16·0	15·4	31·4	0	31·4	37·6
3000	13·5	16·6	30·1	—0·1	30·2	37·7
4000	9·5	19·4	28·9	0	28·9	36·1
5000	6·5	20·9	27·4	4·2	23·2	26·3
6000	4	21·9	25·9	11·2	14·7	14·7

Legend.

column 1 : frequency in c/s,

2 : speech level, in db, relative to 1 picowatt per square metre and per c/s at a distance of 1 metre from the mouth of the speaker **[8]**,

3 : 10 log Δf,

4 : speech level in the Δf band, in db, relative to 1 picowatt per square metre at a distance of 1 metre from the speaker,

5 : audibility threshold, in db, relative to 1 picowatt per square metre (5% curve of figure 96, page 135 in the book by Fletcher),

6 : speech level in the Δf band, in db, above the threshold at a distance of 1 metre from the mouth of the speaker,

7 : speech level in the Δf band, in db, above the threshold at the end of an orthotelephone system (listening at a distance of 1 metre from the mouth, account taken of the obstruction caused by the presence of the listener's head [22]).

Figure 8 shows the diagrams relative either to listening at the end of an orthotelephone system (with the values given in column 7 of Table 2), or to listening on systems having an attenuation of 10 db or a gain of 10, 20 and 30 db in relation to the orthotelephone system. The scale of abscissae has been calculated on the basis of the integral curve of $k/\Delta f$ and the ordinates have been calibrated direct in levels above the threshold, making use of the curve $T = E_{1000}$ of figure 2.

For each of these cases the area under the corresponding curve can be calculated and if this area is divided by the distance between the frequency limits, the average height of the curves is obtained which corresponds to the following levels : 25·7, 35·4, 45·5, 55·3, 65·3 db.

The difference between these levels is more or less equal to the corresponding differences in gain.

Once the reference equivalent of an orthotelephone system is known, i.e. 32·3 db (measured with the ARAEN without filter), the corresponding level of the average height of the curve relative to SFERT may be determined by interpolation, the result being 67·6 db.

The difference between 67·6 and the level of the average height of the curve relative to each system, then gives the reference equivalent of the system.

If the system is one that has not been deduced from an orthotelephone system by a gain or attenuation, the corresponding n values will have to be calculated using, for example, the values of n_o (column 6 of Table 2) and the response curve of the system.

For a complete system the response curve is obtained by adjusting an artificial mouth fed by a sinusoidal oscillator having a frequency varying between 200 and 6000 c/s so as to produce a constant talking pressure at a distance of 1 metre, and by placing it before a guard ring of the combined set of the system to be tested, the receiver of which is situated on an artificial ear.

The difference between the relative levels of the pressure obtained on the artificial ear and the pressure produced by the artificial mouth at a distance of 1 metre gives, as a function of the frequency, the response curve of the system.

From this diagram we can pass to that of the Braun method **[5]**, assuming that the variation in level for the various frequencies will be so small as not to take into account the non-linearity of the effect in relation to the level.

If we trace the integral lines of the diagrams in figure 8, relating them to a maximum value of 100, we obtain very similar curves; the average of these curves can be used for the scale of abscissae of the new diagram, the ordinates of which should show the values of the response curve instead of the level; with an orthotelephone system or a system deduced by introduction of a gain or attenuation, this response curve will be a straight line parallel to the axis of the abscissa.

This average curve is shown in figure 9 and the dotted line shows the curve obtained by Braun.

For the ordinates, the scale of the diagram in figure 8 can be used, making the origin correspond to a level of 67·6 db and changing the direction. Figure 2 shows the curve obtained by Braun as a dotted line.

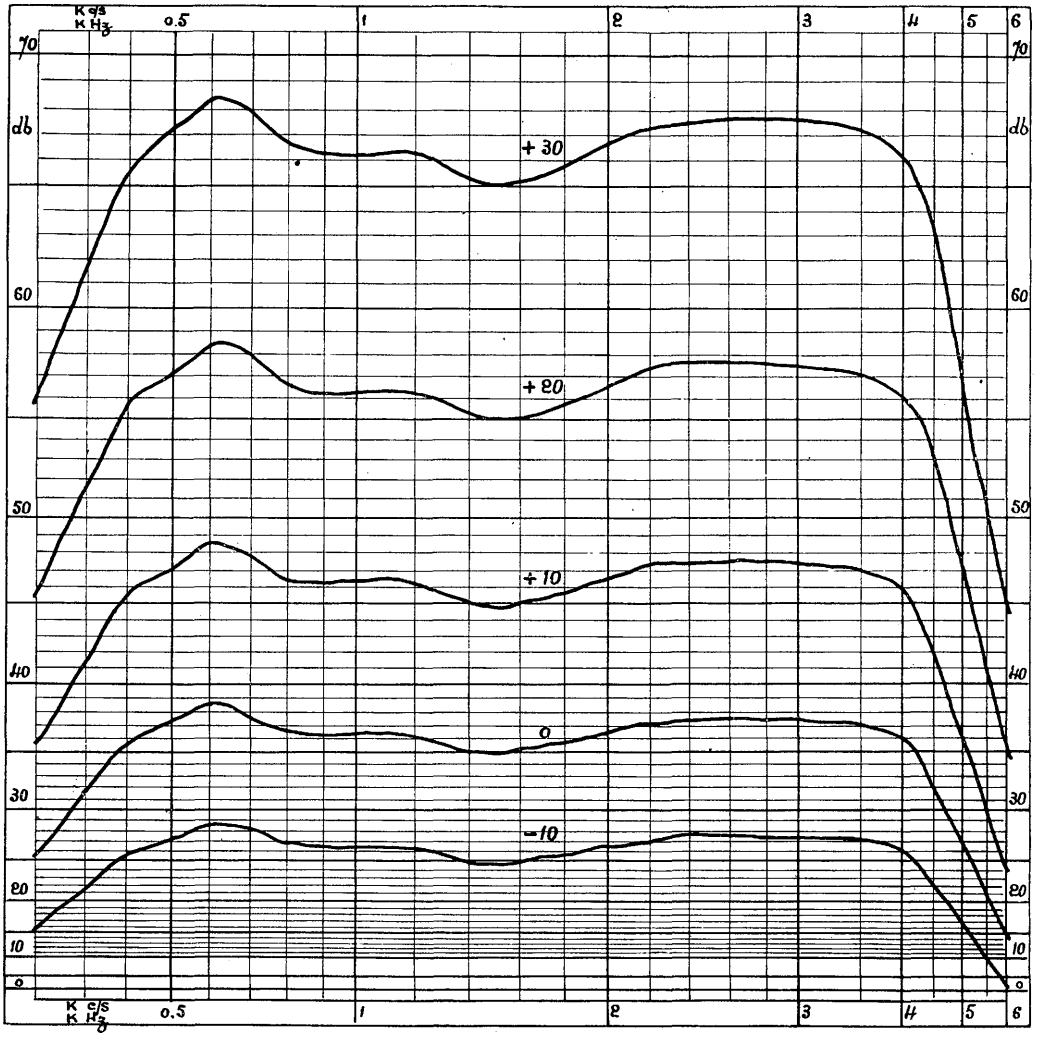


FIGURE 8. — *Diagrams for determining the reference equipment with the data given in table 2*

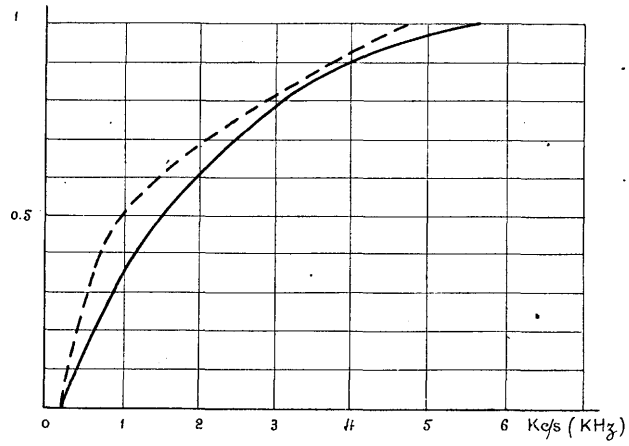


FIGURE 9. — *Curves for the scale of abscissa in Braun's diagram*

Figures 2 and 9 show that there is a sufficient degree of coincidence between the theoretical curves and Braun's experimental curves.

Articulation reference equivalent (AEN).

To determine the AEN, we consider the " articulation rating " introduced by Collard **[1, 2, 3, 4]** which has been used by several authors, as it possesses an additive property, thus making it possible to calculate separately the contribution by each frequency band to this " articulation rating " and to obtain the overall rating by adding up the ratings obtained for each band.

According to Fletcher and Galt **[10]**, the articulation s for sounds may be considered as the probability of a sound being understood exactly. The error probability will therefore be given by

$$e = 1 - s$$

If we assume that a sound is transmitted by n frequency bands and that each band has an error probability of e_1, e_2, e_3 ..... e_n, the total error probability will be :

$$e = e_1 \times e_2 \times e_3 \times \ldots \times e_n$$

whence $$1 - s = (1 - s_1)\ (1 - s_2)\ \ldots\ldots\ (1 - s_n)$$

and hence $$\log\ (1 - s) = \sum_{k=1}^{n} \log (1 - s_k)$$

The expression $\log\ (1 - s_k)$ can be considered, to the nearest constant, as the contribution by band k to the total value

$$\log\ (1 - s)$$

and the preceding relation expresses that this value is capable of being summed.

This expression has received the name of " articulation rating " and its value will be represented by

$$A. = - K \log\ (1 - s)$$

The minus sign enables the expression to be given a positive value : K is an arbitrary constant.

If we assume that A is equal to the unit for $s = 0{\cdot}985$, which is considered to be the largest value which can be obtained in practice, we arrive at :

$$A = -0{,}55 \log_{10} (1 - s)$$

and

$$s = 1 - 10^{-A/0{,}55}$$

Instead of the values of s, it is sufficient to consider those of A and comparison will be made between the system undergoing the test and the ARAEN, for A = 0·385, which corresponds to $s = 0{\cdot}80$.

We can then consider a small frequency band, the frequencies of which have the same sound strength and we shall assume to begin with that there is no superimposed interference.

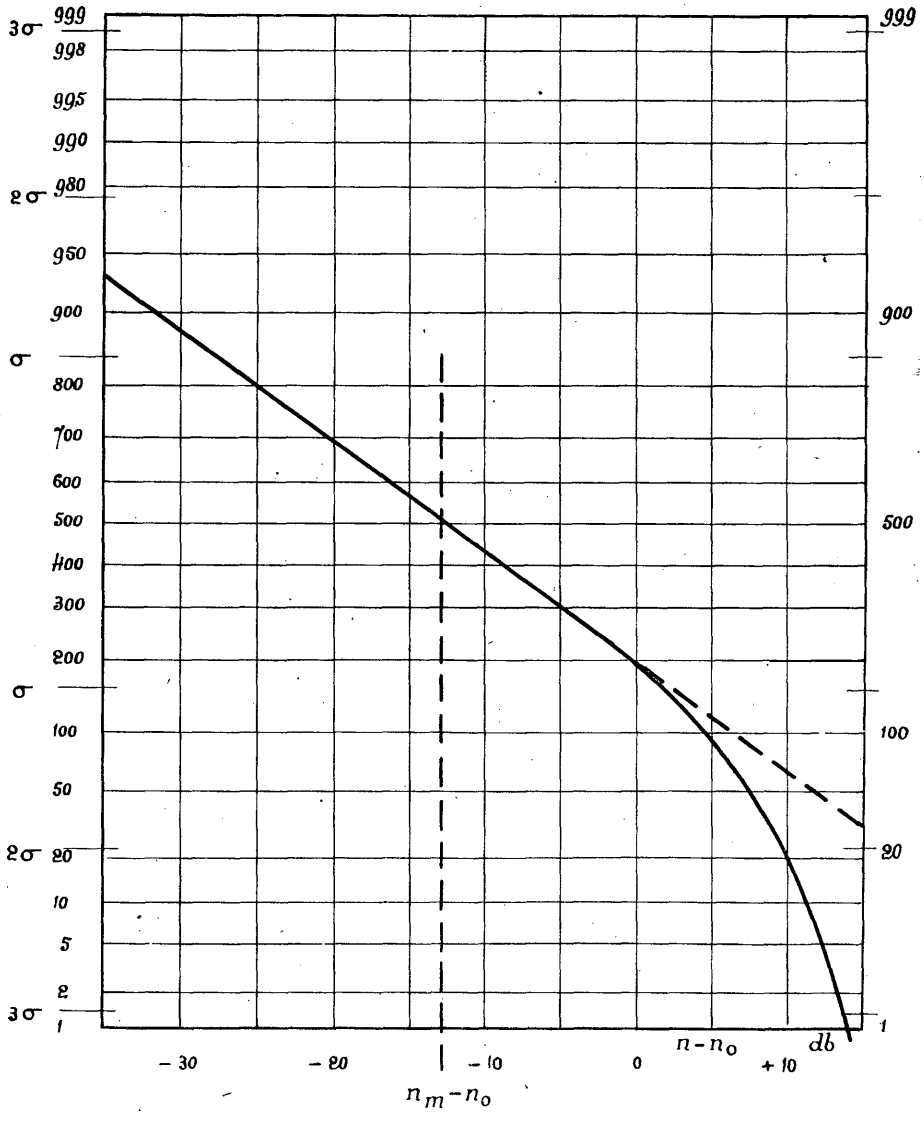


FIGURE 10. — *Distribution of the instantaneous intensity of human speech*

The level of each frequency of human speech is relative to the average intensity over a long period of time.

But if we consider the average intensity for a series of very short time intervals (which are nevertheless always longer than the shortest frequency period) the corresponding level (which we shall call instantaneous level) varies during the call according to Gauss's law, with the exception of the higher levels.

Using data published by Holbrook and Dixon **[6]**, Fletcher (pages 80, 81 of his book) and by French and Steinberg **[8]**, the curve shown in figure 10 can be traced (on paper having a total probability scale); the ordinates show the percentage of time during which the instantaneous level is higher than that shown in the abscissa. The level n_o corresponds to the average intensity determined by integration.

This curve may be considered as valid either for all the frequencies covered by the human voice or for a single frequency band.

The " articulation rating " characterizes the possibility of understanding the sounds; it is linked up with the possibility of distinguishing the various sound intensities and hence it is reasonable to assume (as can be seen for example in French and Steinberg **[8]**) that the " articulation rating " contributed by each frequency band is proportional to the fraction of time during which the instantaneous intensity is higher than the threshold value, it being possible to find out this fraction from the curve in figure 10 if the level corresponding to the average intensity and the threshold for the frequency band under consideration are known.

It is interesting to note that this distribution of the levels of human voice stretches over an interval of roughly 50 db, while the difference between the pain threshold and the audibility threshold is more than about a hundred db for all the frequencies with which telephony is concerned; this means that as soon as the average intensity level reaches a certain point, articulation remains more or less constant, even for the highest intensity values, which in telephony never in practice reach the pain threshold.

Turning from a small frequency band to the whole sound spectrum, the same procedure is followed as in the case of the reference equivalent. In other words, the value of n (level above the threshold for a band) will be

$$n = B_s + 10 \log_{10} \Delta f - t = b_s - t$$

where B_s is the sound level in relation to 1 pW per square metre and per c/s, t the threshold in relation to 1 pW per square metre, and b_s the band level in relation to 1 pW per square metre, and the frequency scale will be obtained from the integral curve of $1/\Delta f$ of figure 7. (The dotted line shows the scale obtained by French and Steinberg **[8]**.)

If there is any noise or in general any disturbances superimposed on the useful sounds, the audibility threshold will be raised. This raising of the threshold for each frequency in the case of a continuous spectrum noise (if its intensity variation curve as a function of the frequency is not too steep) is :

$$b_r = B_r + 10 \log_{10} \Delta f$$

where B_r is the noise level (in relation to 1 picowatt per square metre and per c/s, and Δf is the width of the band already defined.

It might be expected that the value of n can be corrected simply by the value b_r, but that would lead to the absurd case that, should noise be nil, i.e. in the case of $b_r = -\infty$, we should obtain

$$n - b_r = \infty$$

This means that, even in the absence of external noise, there is in fact a certain amount of interference which can be considered as physiological noise due partly to processes which take place in the human body even when it is in a resting position and partly to Brown's movement **[21]**.

The level of this physiological noise n_r (in relation to the threshold) can be deduced from the Δn curves extrapolated up to $n = -\infty$, taking into account that the threshold value is the increase value which we must give to physiological noise for the increase to be perceptible.

This value $\Delta n_{-\infty}$ is linked to the physiological noise pressure p_r and to noise pressure p_0 by the relation :

$$\Delta\ n_{-\infty} = 20\ \log_{10}\ \frac{p_r + p_0}{p_r}$$

The n_r values are shown as a curve in figure 11.

In the absence of external noise we then have this physiological noise whose value r, in relation to 1 picowatt per square metre, is given by

$$r = t + n_r.$$

If there is any external noise, the level of which is b_r for each band (in relation to 1 picowatt per square metre), the total noise will be :

$$b_r\ (+)\ r$$

where the symbol (+) indicates the sum of powers and hence the reduction to be made to n is :

$$Z = b_r\ (+)\ r - r$$

The value $x = n - Z$ must then be introduced on to the axis of the abscissae on figure 10.

If external noise is much greater than physiological noise, we obtain

$$x = b_s - b_r + n_r$$

In the method worked out by French and Steinberg (8), the contribution W_i by the first frequency band to the " articulation rating " depends upon the parameter

$$x = n - [b_r\ (+)\ t - t]$$

which corresponds to the expression

$$x = n - Z$$

if we consider the threshold level instead of the physiological noise level.

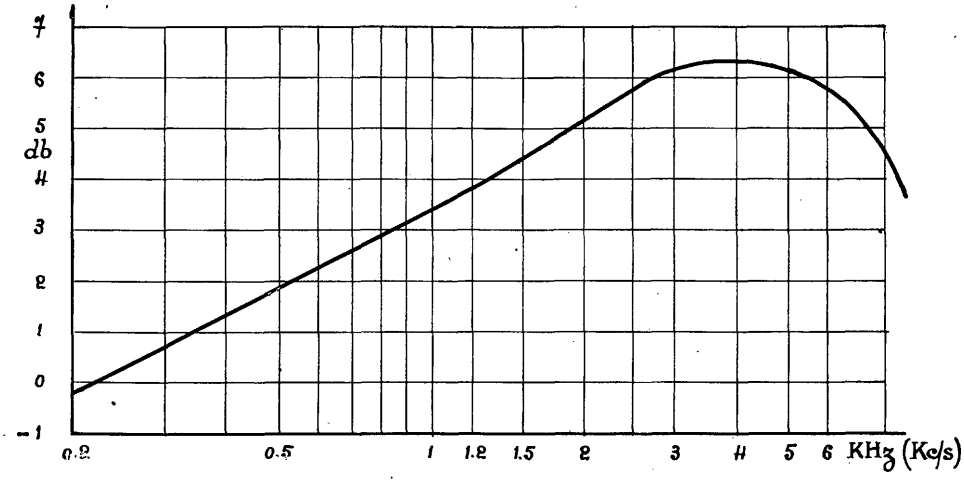


FIGURE 11. — *Physiological noise level variation (in relation to the threshold) as a function of the frequency*

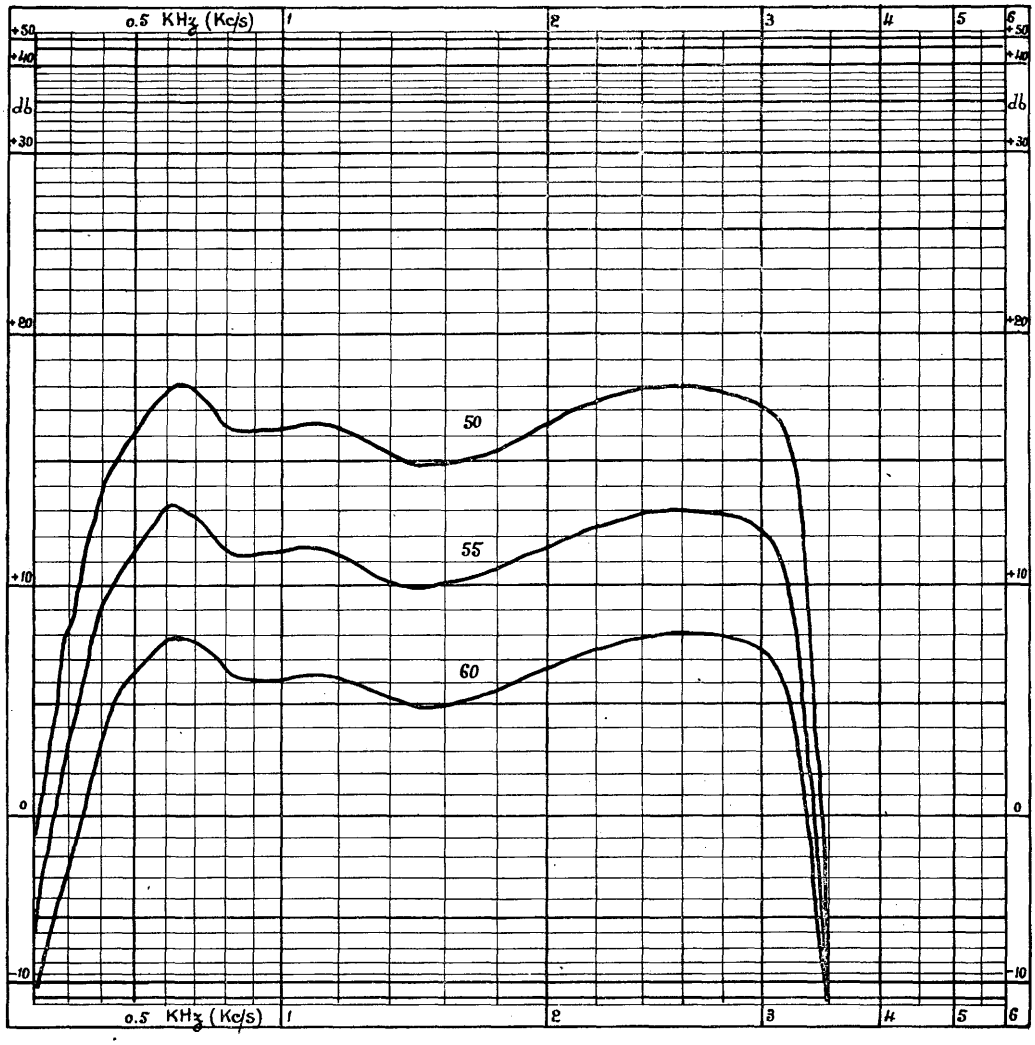


FIGURE 12. — *Diagrams for determining the ARAEN articulation rating, in the absence of noise, with the data given in table* 3

The relation between the values of w and x depends, according to French and Steinberg, on the distribution law of the instantaneous speech levels, and the curve used by French and Steinberg is not very different from that which we have used as far as the values normally applied in commercial telephony are concerned.

Let us now calculate the " articulation rating " for the ARAEN corresponding to an ortho-telephone system, with and without the introduction of electric noise at the receiving system's input, but with the filter on the line.

TABLE 3

f (1)	n_a (2)	B_r (3)	$b = B_s + 10^r = \log \Delta f$ (4)	n_r (5)	$r = t + n_f$ (6)	$Z = b_r (+) r - r$ (7)	$x = n - Z_a$ (8)
200	19·5	12·9	26·5	—0·2	22·8	5·3	14·2
300	28·9	10·1	23·5	+0·7	19·2	5·7	23·2
400	34·3	8·2	21·6	1·4	16	6·7	27·6
500	36·3	6·7	20·3	1·9	14·9	6·5	29·8
600	38	5·4	19·2	2·2	13·2	7	31
800	36·4	3·4	17·6	2·8	12·8	6	30·4
1000	36·4	2·8	17·3	3·3	11·3	7	29·4
1200	36·3	2·6	17·3	3·8	10·3	7·8	28·5
1500	35	2·1	17	4·4	10·5	7·4	27·6
2000	36·8	1·7	16·7	5·2	7·3	9·9	26·9
2500	38	1·6	17	5·7	5·7	11·6	26·4
3000	37·2	1·2	17·8	6·1	6	12·1	25·1
4000	—14	—2·3	17·1	6·4	6·4	11	—25

column 1 : frequency in c/s,

2 : speech level in a band, in db, in relation to the threshold at the end of the ARAEN with 30 db line attenuation (column 7 of table 2 with the correction due to filter attenuation),

3 : noise level, in db, in relation to 1 picowatt per square metre and per c/s at the ARAEN output with a noise (Hoth type) having a psophometric e.m.f. of 2 mV at the input of the receiving system,

4 : level, in the band under consideration, of the column 3 noise, in db, in relation to 1 picowatt per square metre,

5 : level above the physiological noise threshold in db,

6 : level, in the band under consideration, of the physiological noise, in db, in relation to 1 picowatt per square metre,

7 : correcting term for the noise effect,

8 : speech level in the band under consideration, in db, in relation to the threshold at the end of the ARAEN with 30 db line attenuation, account being taken of the specified electric noise.

In figures 12 and 13 the scale of abscissae is deduced from the integral curve of $1/\Delta f$, and that of the ordinates from the curve in figure 10 calibrated direct in values of x.

In figure 12 the diagrams corresponding to the ARAEN, with filter and in the absence of noise, have been traced with line attenuation values of 50, 55 and 60 db respectively, deduced from the n_a values.

In figure 13 the diagrams corresponding to the ARAEN with filter and with a specified electric noise have been traced with line attenuation values of 40, 45 and 50 db respectively, deduced from the x values.

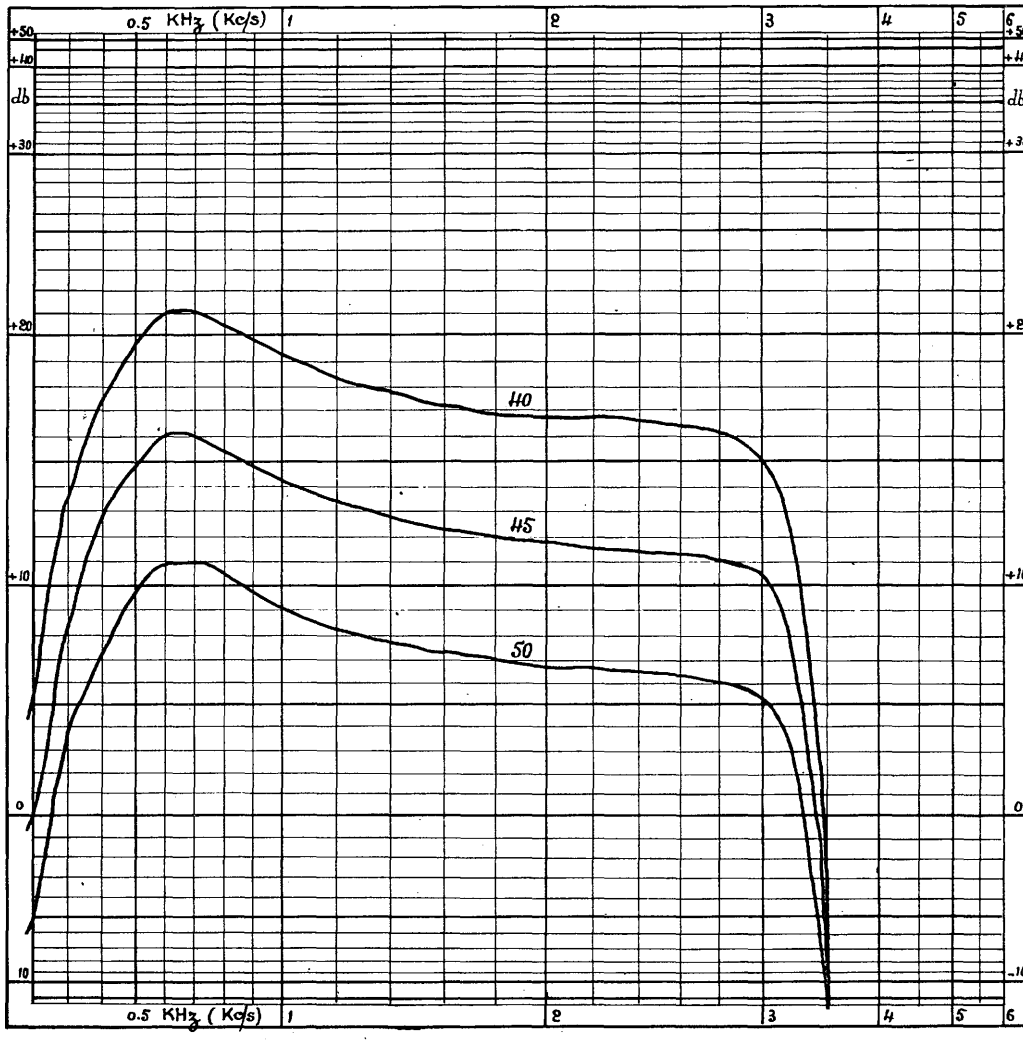


FIGURE 13. — *Diagrams for determining the articulation rating of the ARAEN with a specified electric noise, using the data given in table 3*

The articulation rating in each of these cases is given by the relationship between the area below each curve and the total area of the graph. By interpolation (figure 14) it is possible to find the line attenuation corresponding to an articulation rating of 0·385 ($s = 0{\cdot}8$) which is 54 db for the ARAEN without noise and 45 db for the ARAEN with an electric background noise.

The corresponding value can be found in the same way for any system and the difference between 45 db and this value gives the articulation reference equivalent.

The considerations upon which this study is based, and the results obtained, lead to the following two conclusions :

1. From the acoustic point of view, we think that the correlations indicated between several types of measurements could be used to deduce the results of specially difficult experiments, such as the loudness curve and isophonic curves, from the results of easier experiments, such as the measurement of the smallest change in the perceptible level.

2. From the telephony point of view, we think it would be desirable to carry out further experiments with the aim of establishing as accurately as possible graphs which would enable the reference equivalent and the AEN to be determined from the response curve and the noise spectrum curve.

These results could be obtained either by means of direct measurements, using the methods of Collard, Braun, French and Steinberg, Fletcher and Galt, etc., or by calculating the characteristics of the human voice and ear, as has been attempted in this study.

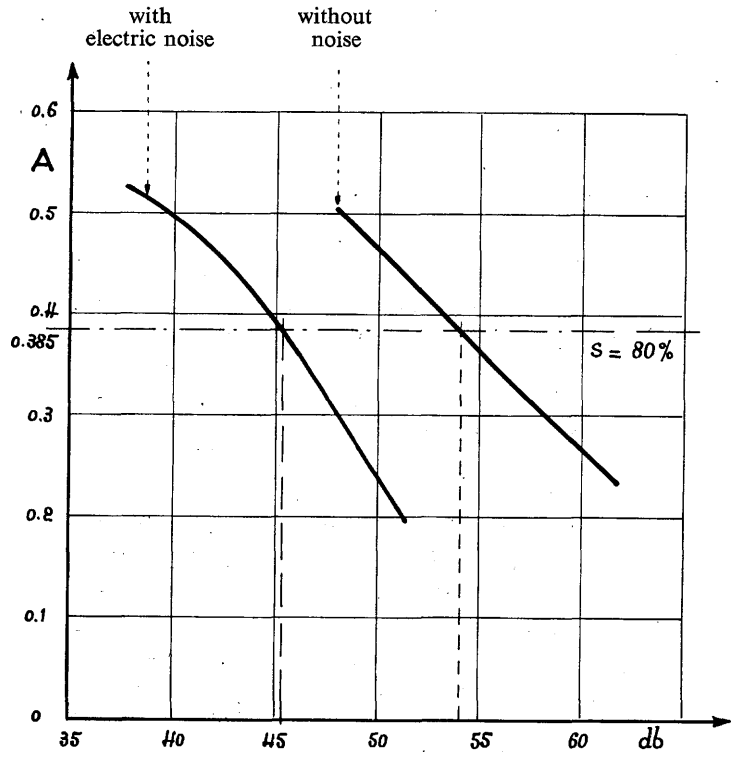


FIGURE 14. — *Assessment of the ARAEN line attenuation corresponding to an articulation of 80%*

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[23] D.L. RICHARDS and R.B. ARCHBOLD, A development of the Collard principle of articulation calculation. *Proceedings of the Institution of Electrical Engineers*, part. B, vol. 103, September 1956, p. 679 (See Annex 4 below).

ANNEX 4
(to Question 7 of Study Group 12)

A development of the Collard principle of articulation calculation *

List of principal symbols

f = Frequency, c/s.
s = Sound articulation as a proportion, $0 \leqslant s \leqslant 1$.
s_{Li} = Sound articulation obtained with a channel having a low-pass filter with cut-off at f_i.
s_{Hi} = Sound articulation obtained with a channel having a high-pass filter with cut-off at f_i.
s_{Hj} = Sound articulation obtained with a channel having a high-pass filter with a cut-off at f_i in addition to a low-pass filter with cut-off f_j. $(f_j < f_i)$.
S = Speech power, watts.
N = Noise power, watts.
x = Speech/noise ratio expressed in db; also used for the setting of an attenuator during an articulation measurement.
$x_{0,8}$ = Setting of an attenuator corresponding to $s = 0{\cdot}8$.
B = Maximum possible value of band articulation with a low-pass filter in circuit, $0 \leqslant B \leqslant 1$.
B' = Derivative of B with respect to f, or band-articulation weighting coefficient.
P = Proportion of maximum possible contribution to band articulation of a narrow frequency band, $0 \leqslant \mathrm{P} \leqslant 1$.
$l(\mathrm{P})$ = 'Logit' of P, defined as arc tanh $(2\mathrm{P} - 1)$.
$\bar{\mathrm{P}}$ = Band articulation, or weighted mean of P.
$w(f)$ = Function relating B' to f; $B' = w(f)$.
$\phi(\bar{\mathrm{P}})$ = Function relating s to $\bar{\mathrm{P}}$; $s = \phi(\bar{\mathrm{P}})$.
$\psi(S/N)$ = Function relating P to S/N; $\mathrm{P} = \psi(S/N)$.
a_1, a_2, b_1, b_2 = Parameters of ϕ and ψ.

1. *Introduction.*

The proportion of words or syllables correctly received over a telephone channel has been used for many years as a measure of the effectiveness of that channel for transmitting speech. The earliest reference in the bibliography at the end of this Annex is by Campbell **[1]** in 1910, but records of such articulation measurements by the British Post Office date back at least to 1905.

It is clearly desirable to be able not only to measure the performance of any given speech link but to relate this to its physical characteristics. This was first attempted by Collard in 1929 **[2, 3, 4]**. Further work based on Collard's theoretical approach has been published by Pocock **[7]**, French and Steinberg **[11]**, and Beranek **[12]**. An alternative basis has more recently been suggested by Fletcher and Galt **[15]**. Much use has been made in the Post Office of calculations based on the Collard theory, including an extensive study **[5]**, during 1934-36, in co-operation with the C.C.I.F. Laboratory (then the S.F.E.R.T. Laboratory), of the possible application of the theory

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* By D.L. RICHARDS and R.B. ARCHBOLD, in *Proceedings of the Institution of Electrical Engineers*, volume 103, part B, No. 11, September 1956.

to international telephone assessment problems. An elegant theorem by Ackroyd **[14]** also based on this theory, was used to predict the best frequency characteristics for hearing aids and telephone transmitters.

Improvements since 1946 in the technique of conducting articulation measurements **[19]** and of analyzing the results, coupled with the use of a high-quality reference telephone channel **[16]** now enable the Collard theory to be set in a new mathematical framework.

Two purposes for developing an articulation calculation technique must be clearly distinguished. One purpose is the very practical one of dispensing with actual measurements, to save time and expense. Another would be to express the performance of a telephone channel in terms which are independent of the actual articulation-testing crew, i.e. in terms of an ideal articulation score. The method described here has only the first purpose in view. The technique attempts to reproduce by calculation the results which would be obtained by one particular crew trained in a given manner and following a closely specified procedure. The information given here should enable a more rational approach to be made to many telephone design problems which are at present studied by means of series of articulation measurements.

The sequence adopted is as follows :

(a) To elaborate the theoretical framework of the method.

(b) To discuss measurements made by means of a high-quality telephone channel from which the parameters of the basic data are deduced.

(c) To consider very briefly the application to commercial telephone channels.

2. *Theory.*

The Collard theory is based on the following statements :

(a) The syllable or sound articulation as measured is uniquely related to a quantity termed ' band articulation '.

(b) The band articulation is the weighted mean over the speech frequency range of a quantity P which is a function of speech-to-threshold (or speech-to-noise) ratio. The weighting function is fundamental and is a function only of frequency.

Statement *(b)* may be written

$$\bar{\mathrm{P}} = \int B' \mathrm{P} \mathrm{d}f$$

where $\bar{\mathrm{P}}$ is the band articulation, B′ is the frequency weighting function and the derivative with respect to frequency of a quantity B which will be referred to later, and P is a function of S/N. S is the speech power at the ear and N is the noise power at the ear. The ratio S/N is also a function of frequency, depending on the telephone channel. It will be necessary to consider $B = \int_0^{fi} B' \,\mathrm{d}f$ as a function of f_i, i.e. the cumulated value of B'. The quantities $\bar{\mathrm{P}}$ and P are analogous to probabilities and, like B, range from 0 to 1.

Sound articulation (which is used here in preference to logatom articulation) is related to band articulation by a single-valued function $s = \phi(\bar{\mathrm{P}})$.

Writing B' and P as $w(f)$ and $\psi(S/N)$ the complete hypothesis is expressed by

$$s = \phi\left[\int_0^{\infty} w(f)\psi(S/N)\mathrm{d}f\right] \qquad (1)$$

The problem then becomes one of determining ϕ, w and ψ so that the best agreement is secured between measurement and calculation. As might be expected, considerable flexibility is possible

in the forms of these functions. It is therefore attractive to seek simple mathematical forms for them which can be specified by not more than, say, two parameters each. To estimate these parameters will, of course, be a simpler process than estimating a curve of unrestricted form.

Success has been achieved over several years in using the logistic curve for fitting to sound-articulation/sensitivity measurements; a technique for analyzing the results of articulation measurements based on a logistic transformation and applying the polynomial coefficient method (Emmens) **[13]** has been developed in the Post Office and has been adopted by the C.C.I.F. Laboratory **[17, 22]**. Moreover, P as a function of $10 \log_{10} (S/N)$ is also a sigmoid of approximately symmetrical form, and so the logistic function seemed a reasonable choice for this case as well. A possible theoretical justification for the logistic function in this context is given elsewhere **[25]**. Accepting the two logistic functions for s and P defines the form of relation between s and $\overline{\mathrm{P}}$.

The most convenient form of the logistic function is

$$f(x) = \tfrac{1}{2} + \tfrac{1}{2} \tanh (a + bx)$$

where a and b are parameters and $x = 10 \log_{10} (S/N)$, namely the speech/noise ratio of the telephone channel in decibels or the sensation level at the ear of the listener. (Sensation level is the level of a sound above the threshold of audibility masked by any noise reaching the ear.)

If S/N is independent of f, eqn. (1) may be written

$$s = \phi\left[\int_0^\infty w(f)\mathrm{d}f\psi 3(S/N)\right] \tag{2}$$

But, by definition, $\int_0^\infty w(f)\mathrm{d}f = 1$. Therefore, under these conditions, $s = \phi[\psi(S/N)]$.

We may substitute $\mathrm{P} = f_1(x)$ for $\psi(S/N)$ so that decibels may be used rather than ratios of speech-power to noise-power. Then

$$\mathrm{P} = f_1(x) = \tfrac{1}{2} + \tfrac{1}{2} \tanh (a_1 + b_1 x) \tag{3}$$

and

$$s = f_2(x) = \tfrac{1}{2} + \tfrac{1}{2} \tanh (a_2 + b_2 x) \tag{4}$$

from which

$$s = \phi\left[\tfrac{1}{2} + \tfrac{1}{2} \tanh (a_1 + b_1 x)\right]$$

$$= \tfrac{1}{2} + \tfrac{1}{2} \tanh (a_2 + b_2 x)$$

Writing

$$Y_1 = a_1 + b_1 x \tag{5}$$

and

$$Y_2 = a_2 + b_2 x \tag{6}$$

and using the inverse functions $Y_1 = \text{arc tanh } (2\mathrm{P} - 1)$ and $Y_2 = \text{arc tanh } (2s - 1)$

we have

$$Y_1 = a_1 + (b_1/b_2)(Y_2 - a_2)$$

and

$$\text{arc tanh } (2\mathrm{P} - 1) = a_1 + (b_1/b_2)[\text{arc tanh } (2s - 1) - a_2] \tag{7}$$

This will simplify, if desired, by substituting

$$\tfrac{1}{2}\, ln\, [P/(1 - P)] = \text{arc tanh } (2P - 1)$$

to give $$P/(1 - P) = [\exp\ (2a_1 - 2a_2b_1/b_2)][s/(1 - s)]^{b_1/b_2} \tag{8}$$

Because arc tanh (2P − 1) has been tabulated as a function of P (see, for example, Finney **[20]**) the most convenient form is

$$\text{arc tanh } (2P - 1) - a_1 = (b_1/b_2)[\text{arg tanh } (2s - 1) - a_2] \tag{9}$$

arc tanh (2P − 1) is termed the 'logit' of P* and will be denoted by $l(P)$.

Therefore $$l(P) - a_1 = (b_1/b_2)[l(s) - a_2]$$

or $$l(s) - a_2 = (b_2/b_1)[l(P) - a_1] \tag{10}$$

which gives the required form of the function $s = \phi(P)$. The same function applies for $s = \phi(P)$ in the general case when P is not constant.

The function $P = f_1(x)$ may be written either in the form of eqn. (3) or in the form

$$P = 1/\{1 + \exp.\, [-\ 2(a_1 + b_1x)]\} \tag{11}$$

whence, substituting $x = 10 \log_{10} (S/N)$

$$P = 1/\{1 + [\exp\ (-\ 2a_1)](S/N)^{-b_1 0{,}1151}\} \tag{12}$$

If a_1 and b_1 assume the critical values 0 and 0·1151 respectively, we have $P/(1 - P) = S/N$. In fact, as will be seen later, these critical values are not found, although the departure is not very great.

Of the three functions ϕ, w and ψ which appear in eqn. (1), ϕ is defined by eqn. (10) and ψ by eqn. (12). Functions ϕ and ψ are defined, therefore, by the four parameters a_1, a_2, b_1 and b_2. Estimation of these and determination of the function w will be described below.

3. *Estimation of parameters.*

The parameters a_1, a_2, b_1 and b_2 are estimated from the results of a series of articulation measurements using a high-quality telephone channel in which, not only is the precise frequency bandwidth known, but also the value of S/N can be set to a number of controlled values. To a considerable extent the estimation of the parameters of all three functions ϕ, ψ and w proceeds simultaneously.

The high-quality telephone channel used has been described elsewhere; **[16]** the sensitivities of the sending and receiving ends are given in tabular form in Table 13 (in the Appendix below). The sending and receiving ends are connected together by a variable attenuator of 600 ohms characteristic impedance with which may be associated a filter or other transmission element. A speech voltmeter is bridged across the output terminals of the sending end so that the speech level may be controlled.

The material used consists of lists of logatoms (consonant-vowel-consonant combinations) each based on the strongly stressed syllables of English conversational speech **[23]**.

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* The logit of P is more frequently defined as 5 + arc tanh (2P — 1) so as to avoid negative numbers in most practical cases. Omission of the additional 5 is more convenient in the present discussion.

3.1. *Determination of the Parameters of ψ.*

The first set of measurements is conducted with the aid of a set of filters with the ratio S/N large enough to ensure that all frequency components transmitted within the pass range contribute their maximum to the band articulation. Outside the pass range the attenuation must be so great that no contribution is made. In other words, P = 1 in the pass range and P = 0 outside. The filters actually used here attenuated at least 60 db to within 9% of the cut-off frequency.

Measurements were made using complementary low-pass and high-pass filters with cut-off at $f_1, f_2, f_3 \ldots f_n$ (n should be not less than 5 and the frequencies should range from approximately 500 to 4000 c/s). By ensuring that the sensitivity of each channel is set to yield the maximum value of sound articulation, the condition P = 1 in the pass range is ensured. Except at very low frequencies of low-pass filter and very high frequencies of high-pass filter, the maximum value of articulation occurs within the range ± 10 db about the sensitivity corresponding to a one-metre air path, namely 30 db attenuation between sending and receiving ends of the high-quality channel employed. It was therefore sufficient to measure at the three attenuations of 20, 30 and 40 db and to take the mean values of sound articulation. The results of these measurements are as follows, and will be referred to as a set of complementary sound articulation values and denoted by s_{Li} and s_{Hi} for the frequency f_i.

TABLE 1

Complementary Sound-Articulation Values

Frequency	Measured sound articulation	
	Low-pass filter	High-pass filter
c/s	%	%
600	65·5	98·7
850	75·7	98·3
1 200	84·5	95·8
1 700	90·4	91·9
2 400	96·3	81·0
3 400	97·9	72·5

For the channel used in measuring s_{Li}

$$\psi(S/N) = 1 \qquad 0 \leqslant f \leqslant f_i$$
$$\phi(S/N) = 0 \qquad f_i < f$$

and when s_{Hi} was measured

$$\psi(S/N) = 0 \qquad 0 \leqslant f \leqslant f_i$$
$$\psi(S/N) = 1 \qquad f_i < f$$

Therefore

$$s_{Li} = \phi\left(\int_0^{fi} B' \mathrm{d}f\right)$$

and

$$s_{Hi} = \phi\left(\int_{fi}^{\infty} B' \mathrm{d}f\right)$$

Let $$B_i = \int_0^{fi} B' \mathrm{d}f$$

then $$1 - B_i = \int_{fi}^{\infty} B' \mathrm{d}f$$

because $$\int_0^{\infty} B' \mathrm{d}f = 1$$

Therefore $$s_{Li} = \phi(B_i) \tag{13}$$

and $$s_{Hi} = \phi(1 - B_i) \tag{14}$$

The logistic is an odd function of $\overline{\mathrm{P}} - \frac{1}{2}$ and therefore

$$l(1 - \overline{\mathrm{P}}) = - l(\overline{\mathrm{P}})$$

And, for these filtered channels, $\overline{\mathrm{P}} = B$.

From eqns. (10), (13) and (14)

$$l(s_{Li}) - a_2 = (b_2/b_1)[l(B_i) - a_1] \tag{15}$$

and $$l(s_{Hi}) - a_2 = (b_2/b_1)[- l(B_i) - a_1] \tag{16}$$

Adding eqns. (15) and (16),

$$l(s_{Li}) + l\,(s_{Hi}) - 2a_2 = - 2(b_2/b_1)a_1$$

Therefore $$l(s_{Li}) + l(s_{Hi}) = 2a_2 - 2a_1(b_2/b_1)$$

When $B_i = 0{,}5$ on a $l(s_{Li}) = l(s_{Hi})$.

let the corresponding value of s be $s_{0{\cdot}5}$.

Therefore $$l(s_{0,5}) = a_2 - a_1(b_2/b_1) \tag{17}$$

If $l(s_{Hi})$ is plotted against $l(s_{Li})$ the result should be a straight line of slope -1 passing through 0, $(2a_2 - 2a_1b_2/b_1)$. Where this line intersects the line $l(s_{Li}) = l(s_{Hi})$, B_i is 0·5, whence we have the value of $l(s_{0{\cdot}5})$ and therefore of $s_{0{\cdot}5}$.

The test of the foregoing is whether a straight line of slope -1 is in fact obtained. The data of French and Steinberg **[11]**, Fletcher and Galt **[15]** and of two previous unpublished Post Office determinations carried out in 1953 using different types of logatoms from those now employed, have been plotted in this way and show reasonable agreement with this hypothesis. The data given in Table 1 have been plotted in Figure 1. The agreement is typical of that obtained using any of the other data, but, as might be expected from the use of different logatoms and measuring techniques, the value of $(2a_2 - 2a_1b_2/b_1)$ varies as follows:

From data in Table 1 (Figure 1)	2·36 (91·4%)
French and Steinberg	1·90 (87·0%)
Fletcher and Galt	1·92 (87·2%)
Post Office (1935):	
With Esperanto logatoms	2·00 (88·1%)
With earlier type of English logatoms	1·76 (85·3%)

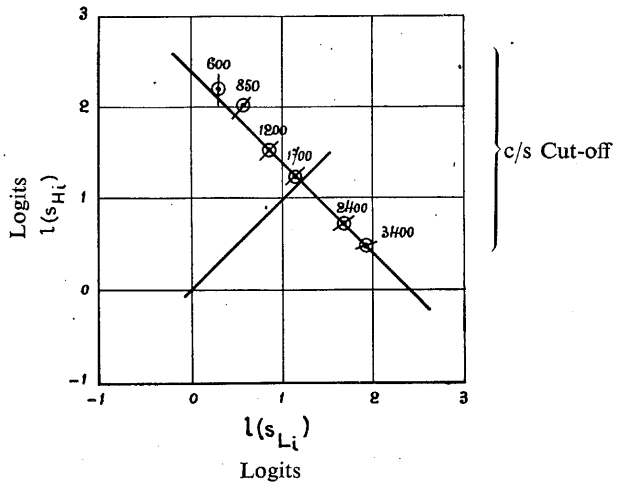


FIGURE 1. — *Relation between complementary sound-articulation values expressed as logits*

The figures in brackets are the corresponding values of $s_{0\cdot5}$; these have been obtained from eqn. (17).

If one more value of s can be determined for a known value of $\bar{P}$, the function ϕ can be defined. It is convenient to determine $s_{0\cdot25}$, which may be done in either of two ways.

The preferred method is that described in the original paper by Collard and is as follows. The value of $s_{0\cdot5}$ having been determined, the corresponding cut-off frequency of a low-pass filter can be estimated from the measurements; let this be $f_{0\cdot5}$. Using such a low-pass filter, a further set of measurements must be made using also a set of high-pass filters whose cut-off, frequency is less than $f_{0\cdot5}$. The articulation value at which s_{Hj} in this new set of measurements equals s_{Li} of the previous set yields $s_{0\cdot25}$. The method is equally applicable using a high-pass filter with cut-off at $f_{0\cdot5}$ together with a set of low-pass filters. The disadvantage of this method is that a special high-grade filter must be made after the first set of measurements have yielded $f_{0\cdot5}$. Suitable filters are very expensive and usually take a long time to produce.

The method used here is that described by French and Steinberg. A channel of unrestricted bandwidth is attenuated in sensitivity until s falls to $s_{0\cdot5}$. The low-pass and high-pass filters used previously are then inserted and a new set of articulation measurements made; let these results be denoted by s'_{Li} and s'_{Hi}. It is then argued that, when $s'_{Li} = s'_{Hi}$, P = 0·25. This method has the disadvantage that, under the attenuated channel conditions, P is not constant within the pass range of the filters. This does not invalidate the determination of $s_{0\cdot25}$, but the frequency at which $s'_{Li} = s'_{Hi}$ is not necessarily the same as $f_{0\cdot5}$. This feature could be overcome by degrading the channel with noise of such spectrum that P was constant within the pass range of the filters instead of attenuating the channel.

These results yield $s_{0\cdot25} = 65\%$. Therefore, because $s_{0\cdot5}$ has already been estimated at 91·4%, $l(s_{0\cdot5}) = 1\cdot18$ corresponds to $l(\mathrm{P}) = l(0\cdot5) = 0$, and $l(s_{0\cdot25}) = 0\cdot31$ corresponds to, $l(\mathrm{P}) = l(0\cdot25) = -0\cdot55$.

From eqn. (10)

$$1{,}18 - a_2 = (b_2/b_1)(-a_1)$$

$$0{,}31 - a_2 = (b_2/b_1)(-0{,}55 - a_1)$$

from which

$$b_2/b_1 = 1{,}58 \qquad (18)$$

and $$(a_2 - a_1b_2/b_1) = 1{,}18 \quad (19)$$

Therefore $$l(s) = 1{,}18 + 1{,}58l(\bar{P}) \quad (20)$$

which is the required function ϕ.

This has been plotted in Figure 2 on percentage scales.

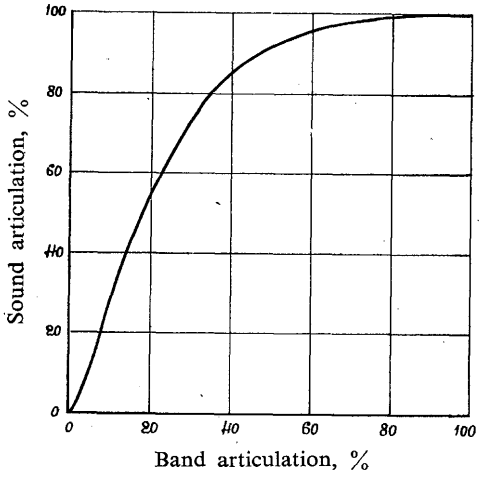


FIGURE 2. — *Sound articulation as a function of band articulation (Function ϕ)*

3.2. *Determination of the Parameters of ψ.*

The foregoing yields $(a_2 - a_1b_2/b_1)$ and b_2/b_1, but the required parameters of P as a function of x are a_1 and b_1 [eqn. (3)].

The experimental data now required are s as a function of x under conditions where P is constant, i.e. with $P = \bar{P}$. The values of s can then be transformed to values of $\bar{P}$ by eqn. (20) or Figure 2. This condition can most conveniently be met by degrading the channel with random noise which has the same power-density spectrum as that of the speech, and choosing the listening level so that the threshold of audibility is completely masked by the noise at all speech frequencies; this ensures that x is independent of frequency and that P is therefore constant, a_2 and b_2 can then be estimated from the data by fitting eqn. (4) by the method of maximum likelihood **[20]**.

The spectrum of speech given by Ackroyd **[14]**, has been found to be in good agreement with later Post Office determinations and so the mean of those results for male and female speakers has been taken. (The Post Office articulation crew is composed equally of males and females.) An equalizer has been constructed having this frequency characteristic, and white noise has been shaped by transmitting it through this equalizer.

At this stage it is necessary to consider the definition of units in which x is to be measured. An arbitrary choice must be made of the method of measuring the levels of the speech and the noise. An obvious choice for measuring noise of random character is to measure its mean power or the r.m.s. value of the noise voltage. It is possible also to use mean power for speech, and indeed this was done by French and Steinberg and by Fletcher and Galt. Pocock has followed Collard in using peak values. The problem of measuring speech levels is discussed by Shearme

and Richards **[28]**, and it is sufficient to state that speech levels have here been measured with a speech voltmeter. When logatoms are spoken by members of a trained articulation crew the speech voltage exceeds the r.m.s. value by 1·4 db. The corresponding relation for continuously spoken speech (read from a book) is 6·9 db. The r.m.s. value is difficult to measure during conversation owing to the fragmentary nature of the speech; speech voltage, however, is equally applicable to all types of speech, although its relation to other measurements may differ.

It is pointed out by French and Steinberg that the distribution (on a decibel scale relative to a given percentile) of speech levels within narrow frequency bands is practically independent of frequency; it follows that a constant difference exists between any two percentiles. It is therefore permissible to choose the speech spectrum level in such a way that when integrated the speech voltage is given, and to regard the result as applying to the same percentile for narrow frequency bands as the speech voltage does for whole-band speech. The speech pressure at 13¼ in from the lips for reference vocal level is 1 dyne/cm², and so (assuming the shape of spectrum already referred to) the power-density spectrum expressed relative to the power corresponding to 0·002 dyne/cm² in a 1 c/s bandwidth at this point is as given in Table 2.

TABLE 2

Miscellaneous Basic Data

Band number	Mid-frequency	Speech spectrum		Spectrum of typical room noise		Threshold of audibility
		1 dyne/cm²	11 dynes/cm²	50 db level	60 db level	
	c/s	db	db	db	db	db
1	98	40	61	33	41	19
2	236	46	67	27	35	3
3	372	47	68	24	32	— 2
4	510	46	67	22	30	— 6
5	646	42	63	20	28	—10
6	784	39	60	18	26	—12
7	926	36	57	18	26	—14
8	1 083	34	55	16	24	—14
9	1 272	32	53	15	23	—13
10	1 493	30	51	14	22	—12
11	1 752	28	49	13	21	—11
12	2 055	27	48	12	20	—11
13	2 411	26	47	10	18	—13
14	2 830	24	45	9	17	—10
15	3 319	22	43	8	16	— 8
16	3 894	19	40	6	14	— 7
17	4 570	16	37	4	12	— 9
18	5 363	15	36	2	10	— 9
19	6 293	14	35	—1	7	— 5
20	7 385	13	34	—4	4	— 3

The above are referred to a datum o 0·0002 dyne/cm² in a 1 c/s bandwidth.
Room noise level is specified in terms of the reading of a sound-level meter. Different frequency weightings are used for levels below and above 55 db.

The values of a_2 and b_2 obtained on this basis are 1·99 and 0·135 respectively. Hence a_1 and b_1 can be calculated from eqns. (18) and (19) ($a_1 = 0{\cdot}513$, $b_1 = 0{\cdot}0855$). Substituting a_1 and b_1 in eqn. (12) yields the function ψ. In practice it is more convenient to use eqn. (11), and Figure 3 shows the resulting graph of P as a function of x.

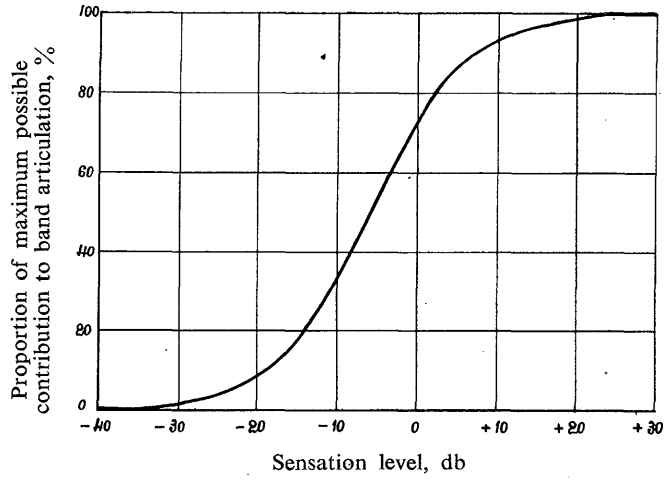


FIGURE 3. — *Proportion of maximum possible contribution to band articulation as a function of sensation level. (Function ψ)*

3.3. *Determination of the Parameters of w.*

The sound-articulation values given in Table 1 for low-pass filters can be converted to values of band articulation $\overline{P}$ by means of the function ϕ already determined (Figure 2). Similarly, the corresponding values for high-pass filters can be converted to values of $1 - \overline{P}$ and so give the complementary values of band articulation. Both sets of results have been plotted in Figure 4. It remains now to choose a simple form of curve to fit these points.

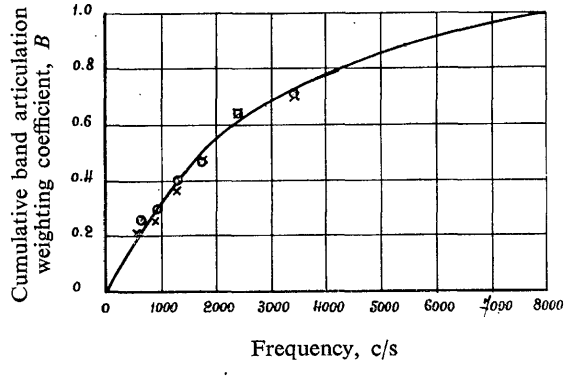


FIGURE 4. — *B, the cumulative value of function w, band articulation weighting coefficient, as a function of frequency*

× High-pass filter.
o Low-pass filter.

There is considerable evidence (see, e.g., that assembled by Gabor **[10]**) that the ear treats tones up to about 1000 c/s on a basis of equal weight per unit of frequency. Above this frequency the evidence points towards a logarithmic frequency basis, i.e. equal weight per unit of log$f$. This would imply, when applied to the present problem, a linear relation between B and f up to a critical frequency f_c, and a linear relation between B and log$f$ above this frequency. It is possible to choose f_c so that B' is continuous, and this has been done to give the curve shown in Figure 4; it has also been assumed that $B' = 0$ outside the frequency range 30-8000 c/s.

The parameters are as follows :

$$\text{for} \quad 30 \leqslant f \leqslant 857, \qquad B = 0{,}000\,365(f - 30);$$
$$\text{for} \quad 857 \leqslant f \leqslant 8000, \qquad B = 0{,}313 \ln f - 1{,}809;$$
$$\text{or} \qquad B = 0{,}720 \log_{10} f - 1{,}809.$$

The limits of 20 bands which correspond to equal increments of B have been calculated, and these, together with their mid-frequencies, are given in Table 3.

TABLE 3

Limits of Mid-frequencies of 20 equally important Frequency Bands

Band number	Mid-frequency	Lower limit	Upper limit	Width	10 $\log^{10}$ (width)
	c/s	c/s	c/s	c/s	
1	98	30	167	137	21·4
2	236	167	304	137	21·4
3	372	304	441	137	21·4
4	510	441	578	137	21·4
5	646	578	715	137	21·4
6	784	715	852	137	21·4
7	926	852	1 000	148	21·7
8	1 083	1 000	1 174	174	22·4
9	1 272	1 174	1 378	204	23·1
10	1 493	1 378	1 617	239	23·8
11	1 752	1 617	1 897	280	24·5
12	2 055	1 897	2 226	329	25·2
13	2 411	2 226	2 612	386	25·9
14	2 830	2 612	3 064	452	26·6
15	3 319	3 064	3 595	531	27·3
16	3 894	3 595	4 219	624	28·0
17	4 570	4 219	4 951	732	28·7
18	5 363	4 951	5 809	858	29·3
19	6 293	5 809	6 817	1 008	30·0
20	7 385	6 817	8 000	1.183	30·7

4. *Application of the data.*

The basic data assembled above are sufficient to enable the sound-articulation percentage to be calculated, given :

(a) The spectrum and level of speech sounds at the ear.

(b) The spectrum and level of noise at the ear.

(c) That the noise is audible over the whole speech spectrum, i.e. that it is wholly above the threshold of audibility from 30 to 8000 c/s.

The speech sounds which reach the ear depend upon the spectrum of acoustical speech power and the air-to-air attenuation of the speech link. The spectrum of speech pressure at the level at which articulation measurements are conducted is given in Table 2. The sensitivities of the sending and receiving ends of the high-quality telephone channel referred to here are given in Table 13 (in the Appendix), and the air-to-air sensitivity may be obtained by adding these together and allowing for the loss in the attenuator connecting them.

The noise which reaches the ear may result from circuit noise or room noise. If it comes from circuit noise, it is necessary to know the power-density spectrum at some point in the electrical circuit and the sensitivity of the circuit from this point to the ear. If room noise is present it will enter the ear by two paths, namely through sidetone and by leakage past the receiver earcap. Room noise reaching the ear by sidetone can be calculated from a knowledge of the power-density spectrum of the room noise and the air-to-air attenuation of the sidetone path. Similarly, the amount of noise entering the ear by leakage past the receiver earcap requires a knowledge of the acoustical attenuation of this path.

Several methods have been proposed for determining the attenuation of the earcap leakage path, but the most appropriate seems to be that based on pure-tone threshold measurements in the presence of ambient noise. The threshold of audibility is first determined in silence. A room noise of known level and spectrum derived from a white-noise generator is then set up at the position to be occupied by the receiver when applied to the ear but in the absence of the head and the receiver. The minimum audible level of pure tones is then redetermined and the shift in pure-tone threshold due to the presence of the noise is calculated. The shift in continuous-spectrum threshold will be the same, so that the continuous-spectrum threshold masked by the room noise which has leaked into the cavity between earcap and ear can be calculated. The level of noise which must have been present to cause this amount of masking can be calculated sufficiently by taking the ' power difference ', i.e. converting the levels from decidels to power ratios, subtracting the unmasked threshold power from the masked threshold power and reconverting to decibels. Table 13 shows the results obtained in this way for a high-quality moving-coil receiver with soft sponge-rubber ear-pad.

When the noise is inaudible over any part of the speech spectrum, account must be taken of the actual threshold of audibility; this can be done by assuming the threshold of audibility for continuous-spectrum sounds to be replaced by a continuous-spectrum noise of the same power-density spectrum. This hypothetical noise can then be combined by power addition with any actual noise present.

The pure-tone threshold of audibility of the Post Office articulation crew has been measured using the receiving end of a high-quality telephone channel. The level of tone which was just audible was determined for a number of frequencies from 300 to 6000 c/s. The corresponding pressures measured in a real ear were determined from the known sensitivities of the receiving end. The results agree reasonably well with those of Dadson and King **[21, 27]**, up to about 2500 c/s but are somewhat higher above this frequency. This effect may perhaps be accounted for by the higher average age of the crew. (The Dadson and King results are based on subjects aged 18-25 years.)

For calculations of articulation the threshold for continuous-spectrum sounds is required, expressed relative to 1 c/s bandwidth, i.e. in dynes per square centimetre per cycle per second or, as here, in decibels relative to the datum of 0·0002 dyne/cm^2 per cycle per second. This is obtained from the pure-tone results by taking into account Fletcher's 'critical bandwidths'. A critical bandwidth is the width in cycles per second of a band of continuous-spectrum sound at the threshold of audibility (let this level relative to datum power per cycle per second be denoted by y_1), such that y_1 integrated over this bandwidth is equal to the threshold level of a pure tone at the centre of the band in frequency. Let this pure-tone threshold level be y_2. The pure-tone threshold curve, plotted in decibels relative to datum power, is therefore located above the continuous-spectrum threshold curve, plotted in decibels relative to datum power per cycle per second, by an amount equal to

$$y_2 - y_1 = K = 10 \log_{10} \text{(critical bandwidth)}$$

K is tabulated by French and Steinberg (Table VII), and by Fletcher and Galt (Table XXX). The continuous-spectrum thresholds corresponding to the Post Office results for the frequency range 300-6000 c/s are given in Table 2, in which the results for frequencies below 300 c/s have been derived from those of Dadson and King. Above 6000 c/s the Post Office results have been extrapolated at a slope derived from other published data for older subjects.

5. *Examples.*

5.1. *High-quality Microphones and Receivers.*

The first examples given below are of telephone channels based on a high-quality telephone channel and have been chosen to give a reasonably severe test of the agreement between measured results and the corresponding calculated values.

Calculation of the articulation score for a given telephone circuit consists in evaluating the expression in eqn. (1) given the functions ϕ (Figure 2), ψ (Figure 3) and B (Figure 4), together with the speech/noise ratio at the ear as a function of frequency. The last item is calculated from the speech spectrum (Table 2), the air-to-air sensitivity of the circuit as a function of frequency and the threshold of audibility masked by any noise present. It is convenient to perform the calculations in twenty 'equally important' frequency bands, because, once the mid-frequencies

TABLE 4

Listening condition	Attenuator setting	Sound articulation	
		Measured	Calculated
	db	%	%
In silence	60	97·5	98
	65	94	95
	70	87	88
	75	75	74
	80	50	50
In 60 db room noise, with sidetone facility	25	98	99
	30	96	98
	35	87	91
	40	62	75
	45	31	47

of these have been chosen, B is disposed of. A convenient computational procedure is given in the Appendix, which also contains the necessary data in a convenient form.

The first two examples (Table 4) each give the measured and calculated sound-articulation percentages for five settings of the attenuator connected between the sending and receiving ends of a high-quality telephone channel.

The measured articulation percentages are reliable to within about $\pm 1\%$.

The room noise, which had a spectrum typical of noise likely to be encountered in telephone subscribers' premises **[8]** (see Table 2), was measured with a sound-level meter **[9]** calibrated to a datum sound pressure at 1000 c/s of 0·0002 dyne/cm^2.

It is frequently convenient to express the performance of a telephone channel in terms of the setting of the attenuator connecting the sending and receiving ends which yields a sound articulation of 80%; such a setting is given the symbol $x_{0\cdot8}$. The results for a number of telephone channels, including the two referred to above, are given in Table 5 in this form. These channels are all based on the same high-quality telephone channel and differ only in respect of the listening conditions and of the presence or absence of a band-pass filter or other transmission element inserted between the attenuator and the receiving end.

The measured values of $x_{0\cdot8}$ may be relied upon to within ± 2 db (95% confidence interval), except for channels 1 and 7 which have been used more frequently and may be relied upon to within $\pm$ 1 db.

The band-pass filter was designed to simulate the characteristic of a channel of a carrier system having a channel spacing of 4 kc/s.

Network A is an equalizing network designed to simulate the approximate frequency-response characteristic of a Post Office ' Transmitter, Inset, No. 13 '. Network B is an equalizing network designed to simulate the overall air-to-air sensitivity characteristic of a typical telephone connection.

The sidetone facility used with the high-quality channel is arranged so that a noise voltage (Hoth spectrum) picked up by an auxiliary microphone circuit appears across the receiver terminals. This voltage produces a sound pressure at the ear equal to that which would exist under free field conditions, in the absence of the receiver, due to the room noise present. The arrangement reduces the effect of variations of leakage path between the receiver ear-pad and the ear, which, if present, would limit the precision of experiments.

TABLE 5

Channel number	Listening condition	Transmission element	Value of $x_{0,8}$	
			Measured	Calculated
			db	db
1	In silence	None	73·6	73·5
2	In silence	300-3400 c/s band-pass filter (b.p.f.) and network A	50·7	48·5
3	In silence	B.P.F. and network B	32·7	32·5
4	In 60 db room noise	B.P.F.	59·9	62·5
5	In 60 db room noise	B.P.F. and network A	37·4	40·0
6	In 60 db room noise	B.P.F. and network B	19·7	22·5
7	In 60 db room noise with side-tone facility	None	37·3	39·0
8	In 60 db room noise with side-tone facility	B.P.F.	33·6	36·0

The agreement shown in the above examples between the measured and the calculated values is considered sufficiently close, bearing in mind the limited precision of the measured values, to validate the calculation technique for the range of conditions likely to be encountered in making articulation measurements on practical commercial telephone channels.

5.2. *Commercial Telephone Sets.*

The articulation calculation technique can clearly be applied in the same manner to practical telephone channels, provided that the appropriate sensitivities are known. Unfortunately, it is by no means easy to decide which are the appropriate means of measurement for commercial transmitters and receivers. No completely satisfactory solution has so far been obtained, but the procedure indicated below, which has been arrived at largely by a cut-and-try process, is a reasonably good compromise.

5.2.1. *Transmitters.* — The carbon-microphone type of telephone transmitter, at present universally used in public telephone systems on account of its high sensitivity, introduces several serious difficulties of measurement.

Being a handset microphone, spoken into at a close but relatively undefined distance, it is subject to a rather uncertain level of speech pressure. Amplitude distortion is also a serious matter, so that the sensitivity itself is dependent upon the sound pressure. These difficulties are circumvented in articulation measurements by a trained crew by adopting a fixed distance between lips and mouthpiece opening and by controlling the vocal level.

Articulation measurements are conducted at reference vocal level, i.e. with the speech pressure controlled to a level of 1 dyne/cm^2 at a distance of 13¼ in (33·7 cm) in front of the lips. The distance between lips and mouthpiece opening for the present British Post Office Telephone No. 164 Handset when the standardized talking position is adopted is 2·5 cm. Taking the conclusion of Dunn and Farnsworth **[6]**, that the equivalent point source is situated 0·6 cm behind the lips, the distance between this point and the centre of the mouthpiece opening is therefore 3·1 cm, and between the equivalent point source and the point at which the speech pressure is 1 dyne/cm^2 is 34·3 cm. By invoking the inverse-square law for sound power, the freefield sound pressure at the point occupied by the mouthpiece opening is 11 dynes/cm^2. This pressure is, like that in terms of which reference vocal level is specified, defined in terms of the reading of a speech voltmeter associated with a calibrated microphone; the instantaneous sound pressure, of course, ranges much higher, perhaps to more than 100 dynes/cm^2.

Because the carbon microphone is non-linear and gives rise to amplitude distortion, it does not follow that a sensitivity/frequency characteristic measured with pure tones should use the same pressure as the speech pressure at which it will be used, Various methods have been suggested and tried **[7, 18]**, but the best results, when the pure-tone sound pressure has been restricted to one value independent of frequency, have been obtained at a pressure of 50 dynes/cm^2.

The agreement between measured and calculated articulation results is conveniently illustrated by quoting the amount of loss which must be introduced to reduce the sound articulation to 80%;

(a) for a high-quality but limited bandwidth (300-3400 c/s) telephone channel with a relatively distant-speaking linear microphone (so that the sensitivity is in little doubt), and

(b) for the same channel but with the sending end replaced by a local telephone circuit containing a carbon-microphone handset.

The difference between these two amounts of loss (termed the sending rating) will be largely independent of the articulation crew, on the one hand, and the precise accuracy of the parameters of the articulation data on the other. Table 6 shows the measured and calculated sending ratings

of two types of Post Office subscribers' sets, both using the Transmitter, Inset. No. 13; set A uses Coil, Induction, No. 18·35A and set B, Coil, Induction, No. 27. Each set is associated with a subscriber's line of 450 ohms in 10 lb cable (2·56 miles) connected to a 50-volt non-ballast feeding bridge having 200 + 200-ohm relays. Listening is in the presence of 60 db room noise, and the sidetone facility is associated with the high-quality receiving end. The measured ratings have 95% confidence intervals of ± 1 db, and the calculated ratings are expressed to the nearest 0·5 db.

TABLE 6

Subscriber's set	Measured rating	Calculated rating
	db	db
A	−13·6	−15·0
B	−14·6	−14·5

The sensitivity discussed in the foregoing is that which applies to the speech input; it is necessary also to consider the sensitivity of the transmitter to room-noise excitation. A room-noise level of 60 db corresponds to a weighted sound pressure of 0·2 dyne/cm^2. Under pure-tone conditions the sensitivity would be extremely low at such a sound pressure. In practice it is found that the sensitivity applicable corresponds to that measured at a sound pressure of 3 dynes/cm^2. There is also evidence that the same sensitivity is maintained even at lower levels of room noise; the high sensitivities may well be due to the slight agitation of the handset while held in the hand for listening.

For the present, therefore, it seems best to measure the sensitivity of a carbon-microphone telephone handset at a free-field sound pressure of 50 dynes/cm^2 for speech and at 3 dynes/cm^2 for room-noise excitation. This conclusion is based on experience with the Transmitter, Inset, No. 13 used in the Telephone No. 164 Handset and certainly requires caution before being applied to any handset which is substantially different in characteristics.

5.2.2. *Receivers.* — The sensitivities of telephone receivers are commonly measured by means of an artificial ear having a cavity of volume 3 cm^2 (see B.S. 2042 : 1953) **[26]**. Such sensitivities, when used in articulation calculations, yield results which are considerably higher (about 6 db) than those obtained by measurement. Subjectively measured sensitivities are also lower than those from artificial-ear measurements by about 6 db, independently of frequency. This discrepancy is believed to be due to the fact that artificial ears are designed to simulate a particularly careful application of the receiver earpiece to the ear which does not apply under articulation measurement conditions for commercial handset telephones having hard ear-caps. The difficulty does not arise with the receivers of the high-quality telephone channel, because they have soft ear-pads and a much larger volume of air is enclosed. The artificial ear used for these receivers takes due account of this larger volume.

Use of a sensitivity/frequency characteristic 6 db lower than that obtained with the 3 cm^3 artificial ear has been found to yield reasonable agreement between measured and calculated articulation scores. This rule applies equally well to the Post Office Receiver, Inset, No. 1L, which has a very peaked sensitivity characteristic, and to the Receiver, Inset, No. 2P, which is very smooth in characteristic.

Examples are given below after discussion of the other factors affecting reception.

5.2.3. *Ear-cap Leakage and Sidetone Attenuation.* — With a telephone handset in the presence of room noise, reception is impaired by leakage of this noise past the receiver ear-cap into the listening ear and by transmission of the room noise through the sidetone path (transmitter, electrical circuit and receiver). Noise entering the non-listening ear may be neglected.

The subjective method described in Section 4 yields, for receivers with hard ear-caps, attenuations which are somewhat too high for good agreement between articulation measurements and calculations; accordingly the lower values recorded in Table 13 (see the Appendix) have been found to be more appropriate. This disagreement is probably due to the excessive care used in placing the receiver to the ear during threshold measurements.

A similar subjective method may be employed to determine the attenuation of the sidetone path, and the results obtained are in good agreement with the attenuation calculated from the 3-dynes/cm^2 transmitter sensitivity characteristic, electrical measurements on the induction coil and the artificial-ear sensitivity of the receiver reduced by 6 db, as discussed in Section 5.2.2.

5.2.4. *Receiving Performance.* — The choice described very briefly above of methods for measuring the sensitivity of the transmitter to room-noise excitation, the receiver sensitivity and the ear-cap leakage-path attenuation has been based on a rather complicated study directed to securing good agreement between measured and calculated articulation scores over a wide range of listening conditions.

TABLE 7

Subscriber's set	Measured rating	Calculated rating
	db	db
A	+13·5	+13·0
B	+21·1	+21·5

The agreement is illustrated in Table 7 for one condition which involves all the factors discussed. Receiving ratings are given, obtained in a manner analogous to the sending rating described in Section 5.2.1. Both sets use Transmitter, Inset, No. 13; set A uses Coil, Induction, No. 18·35A (rather poor sidetone suppression) and Receiver, Inset, No. 1L (peaked sensitivity characteristic), and set B uses Coil, Induction, No. 27 (good sidetone suppression on the subscriber's line associated) and Receiver, Inset, No. 2P (smooth characteristic). Each set is associated with a subscriber's line of 450 ohms in 10 lb cable (2·56 miles) connected to a 50-volt non-ballast feeding bridge having 200 + 200-ohm relays. Listening is in the presence of 60 db room noise.

The measured ratings have 95% confidence intervals of ± 1 db, and the calculated ratings are expressed to the nearest 0·5 db.

5.2.5. *Overall Performance of a Commercial Telephone Channel.* — The overall effect of the various choices of measuring methods applicable for commercial telephone sets is illustrated in Table 8 by a comparison of the sound articulation scores obtained by measurement and calculation for two complete commercial telephone channels. The results are given for a number of settings of the attenuator "line" connecting two similar commercial local telephone circuits. A band-pass filter (300-3400 c/s) was included in the junction, and listening was in the presence of 60 db room noise of typical spectrum. In both examples the subscriber's line consisted of 450 ohms of 10 lb cable and the feeding bridge was of the 50-volt non-ballast type. The measured

scores have been taken from two selected experiments which yielded the most typical results. The confidence intervals of the measured scores are about ± 4% at 80% but become smaller towards 100% and larger at the lower percentages involved.

Sets A and B were of the same types as described in Sections 5.2.1 and 5.2.4.

TABLE 8

Subscriber's set (each end)	Junction attenuator setting	Sound articulation	
		Measured	Calculated
	db	%	%
A	20	91·3	94
	25	87·8	92
	30	83·3	87
	35	76·5	79
	40	68·1	65
B	30	91·5	94
	35	90·4	91
	40	80·1	86
	45	68·5	76
	50	54·7	59

The attenuator settings which correspond to 80% sound articulation ($x_{0·8}$) have also been determined for these circuits and the results are given in Table 9. The measured values have 95% confidence intervals of about ± 1 db and the calculated values are expressed to the nearest 0·5 db.

TABLE 9

Subscriber's set (each end)	Value of $x_{0·8}$	
	Measured	Calculated
	db	db
A	31·9	34·5
B	40·2	43·5

It is interesting to note that the relative results (set B minus set A) are in better agreement than the actual $x_{0·8}$ values, namely measured 8·3 and calculated 9·0 db. Experience has shown that comparisons of telephone channels which differ only slightly may be relied upon to a much greater extent than measures of absolute performance or comparisons between widely differing channels.

6. *Further study.*

Clearly, a great deal of further study of the subject is required, especially of the appropriate measurement of transducer sensitivities. It cannot be claimed that calculated results can always be relied upon without some supporting measurements, but the present stage of the calculation technique permits a very broad field to be explored with the aid of only a few actual measurements.

It is not possible at present to say whether the discrepancies that do exist are due to shortcomings of the theory or to ignorance of the precise physical conditions which obtain during the articulation measurements. It is, however, considered that the theory is sufficiently soundly based to justify further study of the physical conditions.

It must be admitted that articulation as a measure of telephone transmission performance has its limitations, particularly in the degree to which the conditions of measurement approximate to the actual conditions under which the public telephone network is used. In practice, various allowances must be made for the influences which the circuit itself has on the behaviour of the user. For example, articulation measurements are made at constant vocal level and with a fixed speaking position, whereas it is known that loud sidetone or high loss in the circuit affects markedly the speech output produced by the user **[24]**. Such artificialities can largely be removed by making telephone assessments under more appropriate and therefore less formal conditions and using untrained subjects. The general problem of assessment has been discussed elsewhere **[25]** but it is worth noting here that the theoretical framework described above may well be applicable also for assessment methods other than articulation. It is already clear that the relative importance of certain factors is different under normal conditions of use from that found during articulation measurements with a trained crew.

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APPENDIX

(to Annex 4 of Question 7)

A convenient method of performing the calculations is illustrated here by the following problem.

It is desired to estimate the effect upon transmission of the presence of a line noise consisting of band-pass-filtered white noise of level −60 dbm measured with the C.C.I.F. psophometer. The effect is to be expressed as an ' impairment ', i.e. as the amount of loss which must be removed from the circuit when the noise is present in order to restore a given level of performance which was obtained with the noise absent. The level of performance under consideration will be defined as 80% sound articulation. The problem is therefore :

(a) to calculate the amount of loss x_1 which must be inserted to reduce the sound articulation to 80% in the absence of the noise,

(b) to calculate the amount of loss x_2 required to reduce the sound articulation to 80% in the presence of the noise, and

(c) to calculate the impairment, which is $x_1 - x_2$.

The telephone circuit considered consists of two modern-type subscribers' sets each with typical subscribers' lines of 1 mile of 6½ lb cable (270 ohms). Listening is in the presence of 50 db room noise. Table 13 gives the sensitivity and attenuation data which will be used. Table 2 gives a summary of various basic data which will also be required.

The computations are conveniently set out in a series of Tables for which blanks having the necessary headings can be prepared if a large number of articulation calculations are to be

made. For convenience in describing the computing steps, the Tables, which are assembled at the end of this Section, will be referred to as follows :

Chart A (Table 13) Sensitivity and attenuation data.
Chart B (Table 14) Calculation of masked hearing threshold.
Chart C (Table 15) Calculation of speech-masked threshold ratio.
Chart D (Table 16) Calculation of sound articulation.

The computations will be described column by column, and it is implied that all the figures of a column are treated similarly using corresponding figures in the other columns referred to. For brevity, column 3 of chart B will be referred to as B3; similarly C4 will denote column 4 of chart C, and so on.

Chart A (Table 13).

The sending and receiving sensitivities, expressed in units of volts and dynes per square centimetre, together with ear-cap leakage and sidetone-path attenuations for the local telephone circuit concerned, are assembled on chart A. Columns 7-10 only are used in this example.

Chart B (Table 14).

Chart B yields the threshold of audibility masked by the noise present. The effect of room noise is treated first and line noise allowed for afterwards. The steps are as follows.

Enter room noise (see Table 2) in B3.
Enter sidetone-path attenuation in B4 from A10.
B5 = B3 — B4.
Enter ear-cap leakage attenuation in B6 from A9.
B7 = B3 — B6.
B8 is obtained by ' power summation ' of B5 and B7. This is achieved with the aid of Table 10 which relates the amount in decibels which must be added to the higher of the two levels as a function of the difference between the two levels. Care must be exercised in taking correct account of algebraic signs.

TABLE 10

Power Summation of Two Quantities expressed in Decibels

Difference between the two levels	Amount to be added to higher level
db	db
0	3
1	3
2	2
3	2
4	1
5	1
6	1
7	1
8	1
9 or greater	0

Enter threshold of audibility (Table 2) in B9.

B10, which is the masked threshold when room noise only is present, is obtained by ' power summation ' of B8 and B9.

Columns (11) to (14) permit the effect of line noise also to be allowed for.

Enter line noise in B11. The line noise should be expressed relative to a datum of 0·0002 volts (−74 db relative to 1 volt) in a 1 c/s bandwidth; this saves later conversion of sound pressures in dynes per square centimetre to the basis of 0·0002 dyne/cm^2 in a 1 c/s bandwidth, which is used for the other threshold data.

Enter receive-end sensitivity in B12 from A8.

B13 = B11 + B12.

B14, which is the masked threshold when line noise as well as room noise is present, is obtained by ' power summation ' of B10 and B13.

Chart C (Table 15).

Chart C enables the speech level at the ear to be calculated, and hence, using the results of chart B, the speech-masked threshold ratio.

Enter sending sensitivity in C3 from A7.

Enter loss of the band-pass filter in C4.

Enter receiving sensitivity in C5 from A8.

C6 = C3 − C4 + C5.

Enter speech at appropriate level (11 dynes/cm^2 in this case, from Table 2) in C7.

C8 = C6 + C7.

C9, which is the speech/masked-threshold ratio when room noise only is present, is given by C8 − B10 (for 0 db setting of the attenuator).

C10 is the corresponding speech/masked-threshold ratio when line noise is also present and is given by C8 − B14.

Chart D (Table 16).

C9 and C10 must be adjusted to allow for the setting of the attenuator connected, in addition to the band-pass filter, in the junction connecting sending and receiving ends. It is desired here to determine x_1 and x_2, namely the settings to correspond to 80% sound articulation, respectively without and with the line noise present. A number of settings must be chosen, the articulation percentage calculated for each and the values of x_1 and x_2 obtained by interpolation.

The calculations are shown on chart D for two settings of the attenuator under each noise condition. It is often necessary to calculate for three or four settings before satisfactory interpolation is possible (to the nearest 0·5 db).

The procedure is as follows for the no-line-noise condition. In D3 enter C9 minus the attenuator setting (in this case 50 db).

In D4 enter 100P from Table 11.

TABLE 11

100P as a Function of Speech/Masked-Threshold Ratio

(a) Positive values of speech-threshold.

	0	1	2	3	4	5	6	7	8	9
0	73	77	80	82	85	87	89	90	92	93
10	94	95	96	96	97	97	98	98	98	99
20	99	99	99	99	99	100	100	100	100	100

(b) Negative values of speech-threshold.

	0	−1	−2	−3	−4	−5	−6	−7	−8	−9
0	73	70	66	62	58	54	50	46	42	38
−10	34	30	27	23	20	18	15	13	11	10
−20	8	7	6	5	4	4	3	3	2	2
−30	2	1	1	1	1	1	1	0	0	0

The entry in D4 for band 15 is shown in brackets because the cut-off frequency of the band-pass filter falls in the band so that only 80% of band 15 is effective. The second figure in D4 for band 15 is therefore 80% of the value in brackets.

D4 is summed to give Σ 100P.

The mean value is given by $\overline{100P} = \frac{1}{20}\Sigma$ 100P.

The percentage sound articulation (100*s*) is given in Table 12 for $\overline{100P}$.

TABLE 12

Percentage Sound Articulation as a Function of Percentage Band Articulation

Band articulation $\overline{100P}$, %										
Tens	Units									
	0	1	2	3	4	5	6	7	8	9
0	0	1	3	4	6	9	12	15	20	23
10	26	29	32	35	38	41	44	47	49	52
20	54	57	59	61	63	65	67	69	71	72
30	74	75	76	78	79	80	81	82	83	84
40	85	85	86	87	87	88	89	90	90	91
50	91	92	92	93	93	94	94	94	95	95
60	96	96	96	96	97	97	97	97	98	98
70	98	98	98	98	98	99	99	99	99	99
80	99	99	99	99	99	99	99	100	100	100
90	100	100	100	100	100	100	100	100	100	100

The same procedure is then followed in D5 and D6 for another choice of attenuator setting (55db). The 55 db setting yields a sound articulation percentage very close to 80%; similar calculations (not shown) for 56 db setting yield 78%, whence by interpolation $x_1 = 55{\cdot}5$ db to the nearest 0·5 db.

D7 to D10 illustrate the procedure when line noise is also present.

In D7 enter C10 minus the line attenuator setting (45 db).

In D8 enter 100P from Table 11.

D8 is then treated as described for D4.

Columns D9 and D10 show similar computations for a setting of 50 db. Further calculations (not shown) for settings of 47 and 48 db yield sound articulations of 82% and 79%, whence by interpolations $x_2 = 47{\cdot}5$ db.

The impairment due to this level (−60 dbm) of line noise at the input of the receiving local telephone circuit is therefore calculated as $x_1 - x_2 = 55{\cdot}5 - 47{\cdot}5 = 8$ db. Measurement gave 9·3 db with a 95% confidence interval of $\pm$ 2 db.

TABLE 13 — CALCULATION CHART A

Sensitivity and attenuation data

Band number	Mid-frequency	High-quality telephone channel				Typical commercial local telephone circuit			
		Send sensitivity rel. 1 volt per dyne/cm²	Receive sensitivity rel. 1 dyne/cm² per volt	Ear-cap leakage path attenuation	Sidetone path attenuation	Send sensitivity rel. 1 volt per dyne/cm²	Receive sensitivity rel. 1 dyne/cm² per volt	Ear-cap leakage path attenuation	Sidetone path attenuation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	c/s	db	db	db	db	db	db	db	db
1	98	−1	20	6	2	−43	14	0	38
2	236	1	21	13	− 2	−41	27	4	29
3	372	0	20	17	0	−40	32	8	24
4	510	0	20	20	0	−39	33	10	23
5	646	0	20	23	0	−38	34	13	22
6	784	0	21	27	− 1	−35	34	15	22
7	926	0	22	31	− 2	−32	34	18	20
8	1 083	0	22	30	− 2	−29	34	21	16
9	1 272	0	22	28	− 2	−25	34	23	6
10	1 493	0	24	26	− 2	−26	36	24	−3
11	1 752	0	24	26	− 4	−25	36	24	3
12	2 055	0	26	27	− 4	−25	31	23	15
13	2 411	−1	26	30	− 4	−28	28	21	19
14	2 830	0	27	28	− 6	−32	32	19	12
15	3 319	0	28	22	− 8	−38	27	18	23
16	3 894	1	28	Data unreliable above band 15	− 8	Sensitivities fall steeply above band 15		Data unreliable above band 15	Attenuation rises steeply above band 15
17	4 570	1	26		− 6				
18	5 363	1	25		− 6				
19	6 293	2	28		−10				
20	7 385	0	31		−10				

Note 1. — Send sensitivity measured with free-field sound pressure at centre of mouthpiece opening of 50 dynes/cm² and p.d. measured across 600-ohms termination.

Note 2. — Sound pressure from receiver measured with 3 cm² artificial ear, but results decreased 6 dB uniformly with frequency. 600-ohms source used and sensitivity expressed in terms of p.d. measured with the local telephone circuit replaced by a 600-ohms termination.

Note 3. — Sidetone path attenuation calculated from transmitter measurements at 3 dynes/cm² free-field sound pressure at centre of mouthpiece opening and receiver sound pressure measurements as Note 2.

TABLE 14 — CALCULATION CHART B

Calculation of threshold of audibility masked by noise

Band number	Mid-frequency	Effect of room noise only								Additional effect of line noise			
		Room noise, 50 db level	Sidetone path attenuation	Sidetone noise at ear	Ear-cap leakage attenuation	Noise at ear by leak	Total noise at ear	Hearing threshold	Threshold masked by room noise	Line noise, −60 dbm level	Receive-end sensitivity	Line noise at ear	Threshold masked by line noise and room noise
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	c/s	db	db	db	db	db	db	db	db	db	db	db	db
1	98	33	38	— 5	0	33	33	19	33	−33	14	−19	33
2	236	27	29	— 2	4	23	23	3	23	−26	27	1	23
3	372	24	24	0	8	16	16	— 2	16	−23	32	9	17
4	510	22	23	— 1	10	12	12	— 6	12	−22	33	11	15
5	646	20	22	— 2	13	7	7	−10	7	−21	34	13	14
6	784	18	22	— 4	15	3	4	−12	4	−21	34	13	13
7	926	18	20	— 2	18	0	2	−14	2	−21	34	13	13
8	1 083	16	16	0	21	— 5	1	−14	1	−21	34	13	13
9	1 272	15	6	9	23	— 8	9	−13	9	−21	34	13	14
10	1 493	14	−3	17	24	−10	17	−12	17	−21	36	15	19
11	1 752	13	3	10	24	−11	10	−11	10	−21	36	15	16
12	2 055	12	15	— 3	23	−11	— 2	−11	— 2	−21	31	10	10
13	2 411	10	19	— 9	21	−11	— 7	−13	— 6	−21	28	7	7
14	2 830	9	12	— 3	19	−10	— 2	−10	— 1	−21	32	11	11
15	3 319	8	23	−15	18	−10	— 9	— 8	— 5	−21*	27	6*	6*
16	3 894	6						— 7					
17	4 570	4						— 9					
18	5 363	2						— 9					
19	6 293	— 1						— 5					
20	7 385	— 4						— 3					

* Cut-off frequency of band-pass filter includes 80% of band 15.

TABLE 15 — CALCULATION CHART C

Calculation of ratio of speech level to masked threshold

Band number	Mid-frequency	Send-end sensitivity	Junction loss	Receive-end sensitivity	Attenuation setting 0 dB			Speech to masked threshold ratio	
					Overall sensitivity	Speech, 11 dynes/cm²	Speech at ear	Room noise only present	Line noise and room noise present
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	c/s	db	db	db	db	db	db	db	db
1	98	−43	12	14	−41	61	20	−13	−13
2	236	−41	5	27	−19	67	48	25	25
3	372	−40	2	32	−10	68	58	42	41
4	510	−39	1	33	− 7	67	60	48	45
5	646	−38	0	34	− 4	63	59	52	45
6	784	−35	0	34	− 1	60	59	55	46
7	926	−32	0	34	2	57	59	57	46
8	1 083	−29	0	34	5	55	60	59	47
9	1 272	−25	0	34	9	53	62	53	48
10	1 493	−26	0	36	10	51	61	44	42
11	1 752	−25	0	36	11	49	60	50	44
12	2 055	−25	0	31	6	48	54	56	44
13	2 411	−28	0	28	0	47	47	53	40
14	2 830	−32	0	32	0	45	45	46	34
15	3 319	−38	0*	27	−11*	43	32*	37*	26*
16	3 894					40			
17	4 570					37			
18	5 363					36			
19	6 293					35			
20	7 385					34			

* Cut-off frequency of band-pass filter includes 80% of band 15.

TABLE 16 — CALCULATION CHART D

Calculation of sound articulation

Band number	Mid-frequency	Room noise only present				Line noise and room noise present			
		Setting 50 db		Setting 55 db		Setting 45 db		Setting 50 db	
		Speech to threshold ratio	100 P	Speech to threshold ratio	100 P	Speech to threshold ratio	100 P	Speech to threshold ratio	100 P
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	c/s	db		db		db		db	
1	98	−63	0	−68	0	−58	0	−63	0
2	236	−25	4	−30	2	−20	8	−25	4
3	312	− 8	42	−13	23	− 4	58	− 9	38
4	510	− 2	66	− 7	46	0	73	− 5	54
5	646	2	80	− 3	62	0	73	− 5	54
6	784	5	87	0	73	1	77	− 4	58
7	926	7	90	2	80	1	77	− 4	58
8	1 083	9	93	4	85	2	80	− 3	62
9	1 272	3	82	− 2	66	3	82	− 2	66
10	1 493	− 6	50	−11	30	− 3	62	− 8	42
11	1 752	0	73	− 5	54	− 1	70	− 6	50
12	2 055	6	89	1	77	− 1	70	− 6	50
13	2 411	3	82	− 2	66	− 5	54	−10	34
14	2 830	− 4	58	− 9	38	−11	30	−16	15
15	3 319	−13*	(23) 18	−18*	(11) 9	−19*	(10) 8	−24*	(4) 3
16	3 894								
17	4 570								
18	5 363								
19	6 293								
20	7 385								
		Σ 100P	914		711		822		588
		100$\bar{P}$, %	45,7		35,6		41,1		29,4
		100*s*, %	89		81		85		73

* Cut-off frequency of band-pass filter includes 80% of band 15. Values of 100P given in brackets would apply if whole of band 15 were effective; values to be used here are 80% of the values in brackets.

Question 8.

*(Continuation of Question 10*bis, *studied in 1955-56 by the C.C.I.F. Study Group 4)*

The shape of the sensitivity/frequency characteristic of a sending system having a carbon microphone depends greatly on the method of measurement.

Similarly the shape of the sensitivity/frequency characteristic of a receiving system depends upon the artificial ear used and also upon the method of measurement employed.

What methods of measurement should be recommended for tracing these curves and what accuracy should be recommended for these measurements ?

Note 1. — The XVIIIth C.C.I.F. Plenary Assembly requested the C.C.I.T.T. Laboratory to carry out objective measurements on the sending telephone systems (including the modern type telephone systems tested in the 11th Series of experiments at the C.C.I.F. Laboratory and also the French and Norwegian telephone sets tested in the 8th and 9th Series of experiments) making use of various available artificial mouths and following the instructions set out in the annex to this reply. For this purpose, it asked each of the Administrations and private operating agencies to send to the C.C.I.T.T. Laboratory, accompanied by the necessary documentation, an artificial mouth of a type similar to that used in their own laboratories.

Note 2. — The various methods described in the Book of Annexes to Volume IV of the *Green Book* (Annexes 21 and 22, on pages 172 and 177) should also be applied to telephone systems other than those to which they have already been applied. The documentation thus accumulated is to be sent to the C.C.I.T.T. Secretariat.

ANNEX

(to Question 8 of Study Group 12)

Programme of measurements to be carried out by the C.C.I.T.T. Laboratory with various artificial mouths

The testing programme is in two parts.

Part 1: Determination of the electro-acoustic characteristics of the artificial mouths.

These measurements will be carried out with the help of the Swiss Telephone Administration in the Research and Testing Laboratory at Berne.

For each type of artificial mouth the following meaurements are to be made :

(a) determination of the frequency characteristic.
— using a " point by point " method,
— using a recording apparatus.
These measurements will be made at a mean pressure of 10 dynes/cm^2 measured at a distance of 5 cms from the lips of the artificial mouth.

(b) Determination of the horizontal polar diagram at a distance of 5 cm from the lips of the artificial mouth.

(c) Determination of the variation of the acoustic field along the axis of the artificial mouth, the pressure being measured at points situated at distances of 2, 5, 10, 20, 33·5 and 60 cms from the centre of the lips of the artificial mouth.

(d) Measurement of the absolute efficiency of the artificial mouth.

(e) Measurement of the non-linear distortion for sound pressures, measured at a point 5 cms from the lips, equal to 3 and 30 dynes/cm² (± 10 db relative to 10 dynes/cm², point *(a)*. However, if certain Administrations consider that this range is too great for their artificial mouth, they should specify the range over which the measurement is to be made.

The 4th C.C.I.F. Study Group considered that it would be desirable for the C.C.I.T.T. Laboratory to participate in the various measurements outlined above, if only for the fact that in the future, measurements of this kind will be carried out in the C.C.I.T.T. Laboratory.

Part 2: Determination of the efficiency/frequency characteristics of the local telephone sending systems.

These measurements will be carried out in the C.C.I.T.T. Laboratory and will be as follows :

(a) Determination of the efficiency/frequency characteristic of the local sending system (subscriber's set, subscriber's artificial line and the feeding bridge; the latter to be terminated with a pure resistance of 600 ohms) under the following conditions :

— with the guard ring specified for reference equivalent determinations, and the hand set in the position it would occupy during a reference equivalent determination,

— the mean pressure developed by the artificial mouth is to be 10 dynes/cm² measured at a distance of 5 cms from the lips of the artificial mouth (see point *a*) of the first part),

— two noise generators will be used :

1) the noise generator of the Federal German Administration which produces a warble tone sweeping backwards and forwards in one second over a frequency range of 200 to 4000 c/s (see Annexes 8 and 21 of the *Book of Annexes* to Volume IV of the *Green Book*),

2) the noise generator of the Swiss Administration which is partly described in Annex No. 10 of the *Book of Annexes* to Volume IV of the *Green Book*,

— indicating instruments will be the hypsoscope which forms part of the apparatus used by the German Federal Republic for the objective determination of reference equivalents and also the Brüel and Kjaer recorder; both these instruments are at present available in the C.C.I.T.T. Laboratory.

Similar measurements will be made on the sending systems of the SFERT and the ARAEN.

(b) The C.C.I.T.T. Laboratory, using the graphical method described in Annex 22 of the *Book of Annexes* to Volume IV of the *Green Book*, will determine the reference equivalent of these sending systems from the response curves thus obtained.

The objective reference equivalent will also be determined using the apparatus for objective determination of reference equivalents described in Annex 21 of the *Book of Annexes* to Volume IV of the *Green Book*.

Question 9.

(Study Group 12 in cooperation with Study Group 1)

(Continuation of Question 9 studied in 1955-1956 by the C.C.I.F. Study Group 4) (background Question)

What are the limits applied by your Administration, to the junction and trunk networks of your country in order to ensure satisfactory quality for national calls, it being understood that the recommendation of the C.C.I.F. relating to reference equivalent and the rule relating to transmission performance rating are satisfied for international calls ?

Note. — Relevant documentation already assembled by the C.C.I.F. is contained provisionally in document " C.C.I.F. — 1955/1956 — S.G. 4 — Document 27 " (pp. 29-53) and in " C.C.I.F. — 1955/1956 — S.G. 3 — Document 49 " (pp. 229-253); it will later be included in C.C.I.F. books.

Question 10.

(Study Group 11 in cooperation with Study Group 1)

(Continuation of Question 10 studied in 1955-1956 by the C.C.I.F. Study Group 4) (Background question)

Considering that modern developments have realized considerable improvements in the efficiency of telephone sets and that even further increases in efficiency can readily be achieved, it is desirable to examine the consequences of such increases in efficiency and the manner in which they may best be turned to advantage.

If transmitting and receiving efficiency of subscribers' apparatus are increased above levels at present prevailing, what will be the consequences in regard to :

(a) the subscribers' behaviour ?

(b) the performance of transmission systems ?

Note 1. — It is desirable to establish the speech levels and statistical distribution law of these levels, in vu, which are at present found acceptable for sending; these levels are measured at local exchanges and/or at the terminals of international lines.

Note 2. — It is desirable to study the effect upon volume in service and its distribution when subscribers are provided with telephone sets which are more efficient than those to which they have been accustomed.

Note 3. — Some of the transmission features which are liable to be affected by the introduction of more efficient telephone instruments are :

(a) non-linear distortion and cross modulation in multichannel transmission systems;

(b) cross-talk in cables and lines;

(c) audibility of echo;

(d) signal imitation;

(e) side tone and singing through coupling between transmitter and receiver;

(f) room noise impairment.

Note 4. — For the sake of uniformity in replies to this question, it is recommended that data relating to speech levels should be expressed in vu, the levels being measured at local exchanges and/or at the terminals of international lines.

Question 11.

(Continuation of Question 11 studied in 1955-1956 by C.C.I.F. Study Group 4) (background Question)

Collection of information concerning the application of statistical methods to the control and direction of subjective tests.

Note 1. — The method of statistical analysis which was used by the C.C.I.F. Laboratory during the 8th and 9th series of experiments is described in pages 84-86 of Volume IV of the C.C.I.F. *Yellow Book* (Paris, 1949).

Note 2. — The method of statistical analysis which was used in the 10th series of experiments of the C.C.I.F. Laboratory is described on pp. 89-113 of the *Green Book*, Volume IV (Geneva 1954).

Question 12.

(Continuation of Question 12 studied in 1954-1956 by C.C.I.F. Study Group 4) (background Question)

What general characteristics and corresponding tolerances should be fixed for artificial voices, mouths and ears ?

Note 1. — Until the International Standardization Organization or the International Electrotechnical Commission standardizes an artificial ear for general use, the XVIIth Plenary Assembly of the C.C.I.F. (Geneva 1954) recommends the provisional adoption of a " reference artificial ear " which will be used by the Telephone Administration and Private Companies which participate in the work of the C.C.I.F. as well as the C.C.I.F. Laboratory. The dimensions of the coupler which forms this " reference artificial ear " are given on pp. 118-119 of the C.C.I.F. *Green Book*, Volume IV. Annex 6 of the *Book of Annexes* to Volume IV of the *Green Book* gives, by way of information, extracts from a description of the American method for calibrating telephone receivers on a coupler.

Note 2. — Annexes 7 to 10 of the *Book of Annexes* to Volume IV of the *Green Book* describe, for the sake of information, the artificial mouths and ears used by the Administrations of France, Federal Germany and Great Britain. A description of the artificial mouth and ear used by the Soviet Administration will also be included in the C.C.I.F. books *. The Annex below contains a contribution to the study of a probe microphone by the Italian Administration.

Note 3. — When this documentation upon the existing apparatus has been completed, it would be desirable, if possible, to study the essential clauses of a specification for the provision of an artificial voice, mouth and ear.

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* See provisionally " CCIF — 1952/1954 — SG 4 — Document 55 " and " CCIF — 1955/1956 — SG 4 — Document 36 ".

Note 4. — When the essential electro-acoustic characteristics of an artificial voice, mouth and ear have been standardized, rules should be formulated for the objective determination of " sensivity-frequency " characteristics (response curves) of subscriber's telephone apparatus by means of this artificial voice, mouth and ear.

ANNEX

(to Question 12 of Study Group 12)

Study of a probe microphone

(Note submitted by the Italian Administration)

Note. — The study of artificial voice, mouth and ear characteristics calls, in general, for sound field measurements taken with the aid of probe microphones. The following study is accordingly submitted as a contribution to Question 12.

1. A microphone to be used for measuring sound pressure must obviously satisfy the essential condition of not altering the pressure to be measured.

If the microphone measures the pressure in a small closed cavity (a pressure-chamber), it is usually sufficient for the incoming sound impedance to be large, compared with the cavity impedance. This condition is analogous to that required of voltmeters.

If, on the other hand, it is desired to measure the free sound field pressure, or the pressure in a large chamber, the high impedance condition is easily satisfied; however, there appears then a condition regarding the dimensions of the microphone, which must be smaller than the smallest measuring frequency wavelength.

Since the smallest sound frequency wavelength is about 2 cm (corresponding to the frequency 17 000 c/s), it can be said that a microphone smaller than ½ cm can be used correctly for all sound frequencies. There are nevertheless some cases in which the microphone dimensions are subject to even narrower conditions. This occurs when the sound field is explored in a cavity which is not small enough to have a constant pressure in all its volume or where a microphone cannot be introduced, for instance, when pressure in the human ear is being measured, and particularly in the hearing channels.

A similar case arises when the sound field between the sound source and a nearby obstacle is studied, for example between the human mouth or an artificial mouth and the microphone of a subscriber's set.

It is obvious that in such cases a veritable " probe microphone " with dimensions of about 1 mm must be used, which can be obtained by removing the microphone from the point where the pressure is to be measured and by connecting it to that point by a very slender tube.

2. The probe microphone used in the U.S.A. for measuring pressure in the ear (see the bibliography **[4]**), is connected to a condenser microphone of the well-known " Western Electric 644 AA " type. It consists of a flexible tube whose internal diameter is 0·64 mm and whose length is 11·5 cm. This tube is connected to the microphone by a very thin layer of air, having a thickness of 0·12 mm. The response curve of this probe decreases regularly by 6 to 7 db per octave with oscillations of $\pm$ 3 db which are obviously due to stationary waves.

Another probe studied by the British Administration is connected to an electrodynamic microphone (standard 4021); the tube is rigid, its internal diameter is 0·77 mm and its length 12·7 cm. The coupling cavity between the microphone membrane and the tube is very difficult to obtain since the surface of the membrane is spherical. The construction and placing of the closing wall is very critical, its dimensions are : height of the external ring zone-0·35 mm, radius of curvature of the spherical layer-1·57 cm, height of the same layer-0·13 mm.

The heights are determined empirically by numerous tests.

The height of the air layer must be readjusted when the microphone is changed, even if the new microphone is of the same type. If the height of the spherical air layer is given a value of 0·10 mm (or 0·15 mm), instead of the 0·13 mm indicated above, considerable irregularities occur in the response curve.

With a view to simplifying long adjustment tests, it is advisable to introduce in the lower end of the probe tube a strand of wool having a sound resistance which will naturally diminish the sensitivity of the probe microphone.

3. An attempt has been made in the tests of which the results are given below, of reducing the drawbacks to the above-mentioned solutions by studying a probe for which the characteristics to be obtained can be theoretically planned.

The tube of the probe microphone can be treated as an electric line with a characteristic impedance of Z_0 approximately equal (to a satisfactory degree) to $\rho c/S$ where ρc is the sound impedance of the air and S the section of the tube. This approximation, which presupposes that attenuation in the tube is negligible, is still acceptable even for very slender tubes for the lowest frequencies coming into play in telephony.

In order to avoid producing attenuation distortion, it would therefore be necessary for the tube to be closed on a real sound impedance equal to the afore-mentioned impedance.

Unfortunately, it does not seem possible to satisfy this condition physically, at least for the very slender tubes under consideration (for tubes having a diameter greater than 1 cm (see **[5, 6, 7]**.)

In fact the coupling cavity of the microphone probe, whose volume can never be nil, corresponds to an imperfect condenser having an appreciable loss angle increasing for decreasing heights of the air layer owing to the dissipations of the power due to viscosity and thermal conduction in the air.

The tube thus terminates on the impedance of the coupling cavity in parallel with the impedance of the microphone membrane; the impedance of the membrane is very large, in other words negligible, for an electrostatic microphone, but not for an electrodynamic microphone.

The empirical determination of the optimum height of the coupling cavity (described under paragraph 2) gives the impedance on which the probe must terminate a value of roughly $\rho c/S$.

Since the impedance of a cavity of very low height, one side of which is opened by the terminal orifice of the probe and the opposite side of which is constituted by the microphone membrane, is not known with sufficient precision and since the membrane impedance is known even less, the height of the coupling cavity cannot be calculated in advance. This calculation should moreover be very exact because the sound impedance of the cavity gains very rapidly with its height.

The strand of wool placed in the tube (mentioned under paragraph 2) is meant to set up a sound resistance R, in series with the impedance Z_c of the cavity, large in relation to Z_c so that $R + Z_c$ is roughly equal to ρcS.

The drawback of this solution is that the resistance R has to be evaluated by trial and error; hence it is not very constant as a function of time and it is difficult to reproduce.

An attempt was then made to obtain the resistance R with a very fine tube connecting the end of the probe to the cavity bounded by the microphone membrane.

The resistance obtained by this method can be calculated with the help of well-known formulae; if it is desired that the small tube should have the character of a pure resistance for most sound frequencies, its diameter must not exceed 0·2 mm; R can then be calculated as a function of the diameter and length of the little tube.

If it is admitted that all the sound pressure is concentrated in the resistance R of the little tube and that Z_c is very small in relation to R, it suffices to calculate the dimensions of the little tube in such a way that R is equal to ρcS.

For a probe having an internal diameter of 1 mm connected to a small tube with a diameter of 0·2 mm, the length of the little tube is 2 mm. It is obvious that the above is an extreme case which should not be approached too closely, since the sound pressure on the membrane corresponds to a difference in potential applied to the terminals of the impedance Z_c and since, if Z_s is very small in relation to R, the resulting sensitivity of the probe microphone would also be very small.

Moreover, part of the resistance is concentrated in the cavity and membrane and the small tube must give only the difference between these resistances and ρcS.

4. The procedure to be followed in practice for constructing the probe is as follows : the cavity bounded by the microphone membrane must not be made too low—it should be, for instance, 0·15 or 0·20 mm, which avoids any possibility of damaging the membrane; a small coupling tube is built which gives the resistance ρcS in its entirety and then its length is decreased until a better response curve is obtained. This adjustment is simple because R is proportional to the length of the small tube, contrary to the impedance of the cavity which varies very rapidly as a function of its height, as has already been mentioned under paragraph 2.

The probe microphone made by the laboratories of the Italian Administration is represented by figure 1.

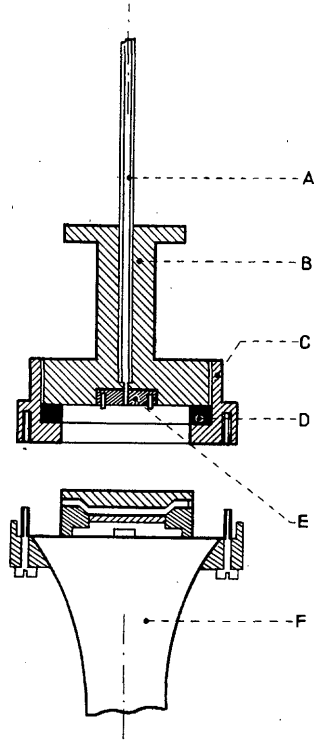


FIGURE 1

To check on the accuracy of the method, measurements were taken as a function of the principal parameters, namely :

diameter and length of the probe, height of the coupling cavity,
diameter and length of the small tube giving the resistance R. The condenser microphone utilised is of the ALTEC 21B type.

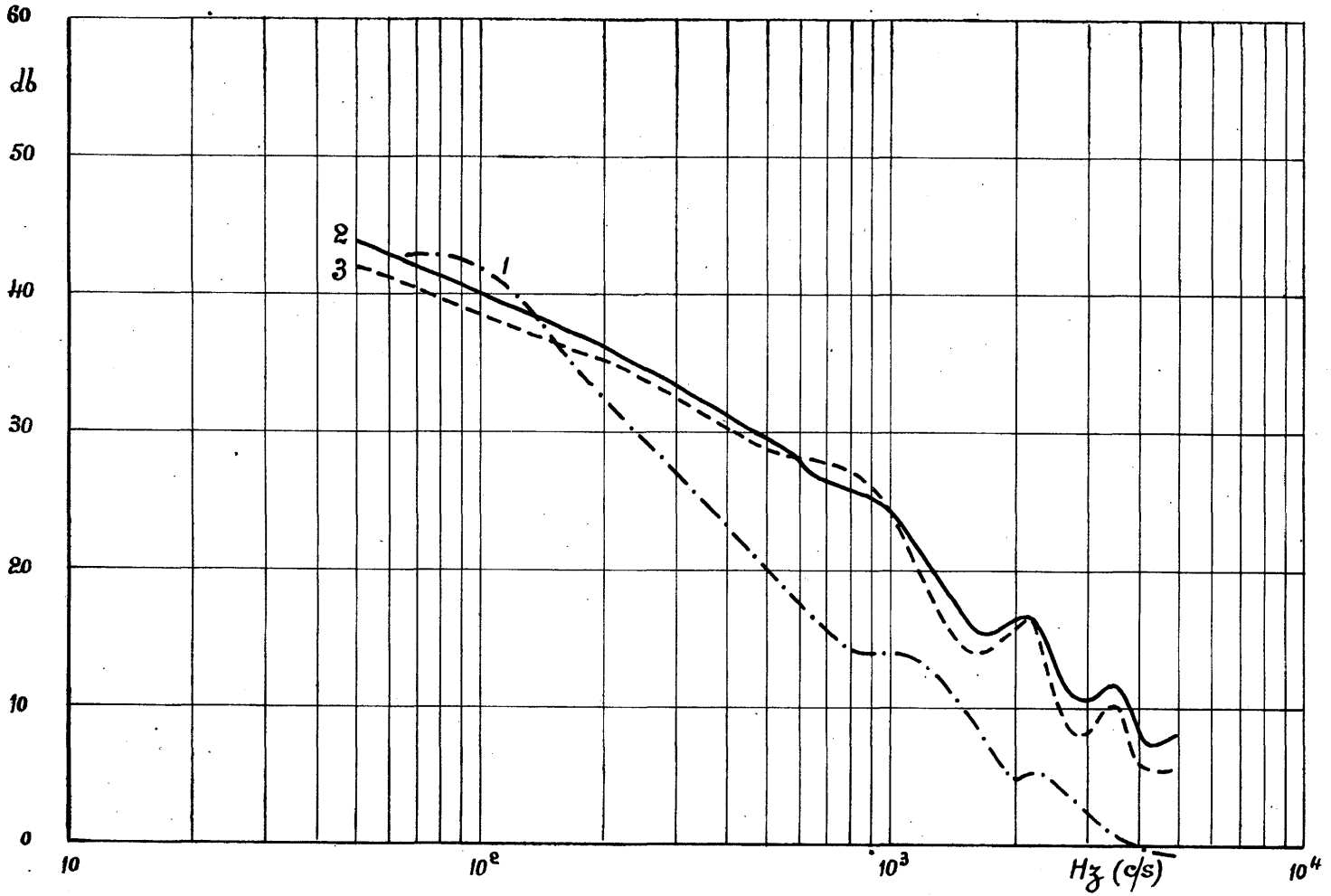
The results obtained are summed up in the curves reproduced here, from which it can be seen that :

— a reduction of the diameter of the probe to less than 1 mm increases the slope of the response curve, i.e. attenuation at high frequencies (see figure 2);

— reduction of the cavity height to less than 0·15 mm increases the attenuation for all frequencies; this reduction has no appreciable effect for the narrowest probe (see figures 3, 4, 5);

— a reduction of the diameter of the small tube which gives the resistance R, for the same length, reduces the frequency of the maxima and minima of the response curve by a half; in fact, we pass from fluctuations of $\frac{1}{2}\lambda$ to fluctuations of $\frac{1}{4}\lambda$ (see figures 6 and 7).

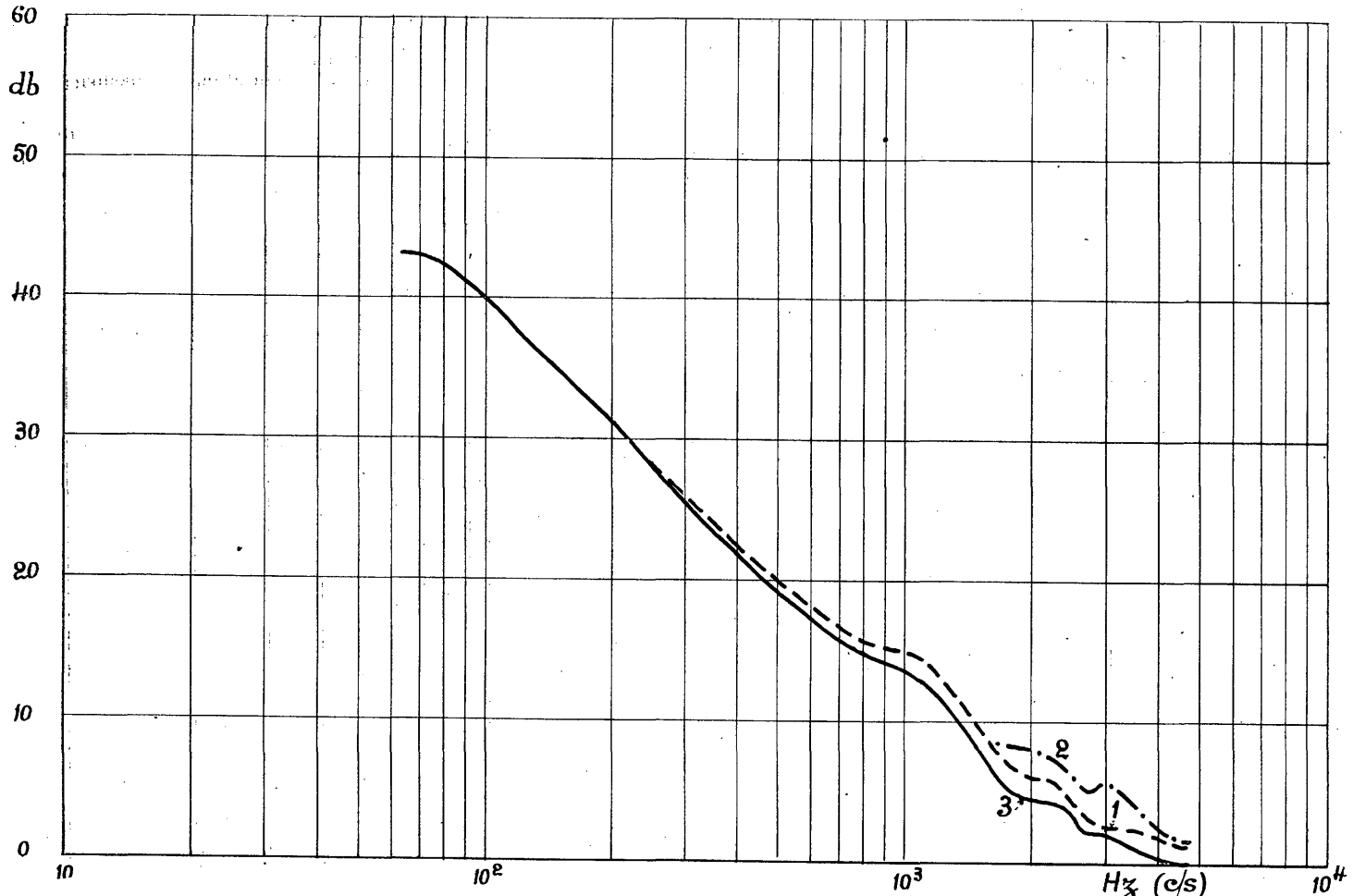
A similar effect has been noted by varying the length of the small tube for the same diameter of 0·25 mm (see figure 8).



Diameter of the probe : 0·6 mm curve 1
1·1 mm curve 2
1·6 mm curve 3

FIGURE 2

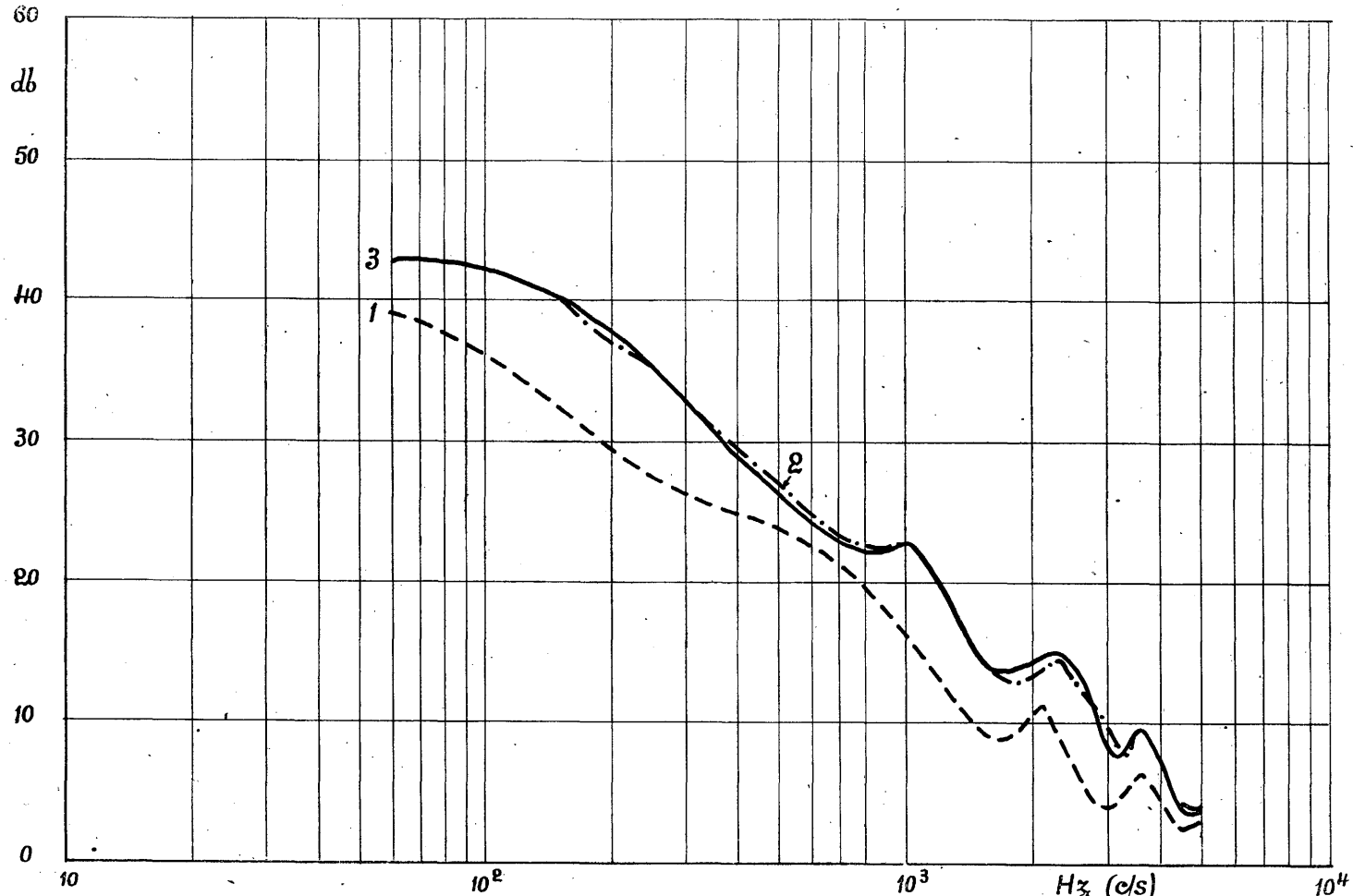
Cavity height : 0·2 mm
Sound resistance : diameter 0·25 mm
length 1·0 mm



Diameter of the probe : 0.6 mm
Cavity height : 0.10 mm curve 1
0.15 mm curve 2
0.20 mm curve 3

FIGURE 3

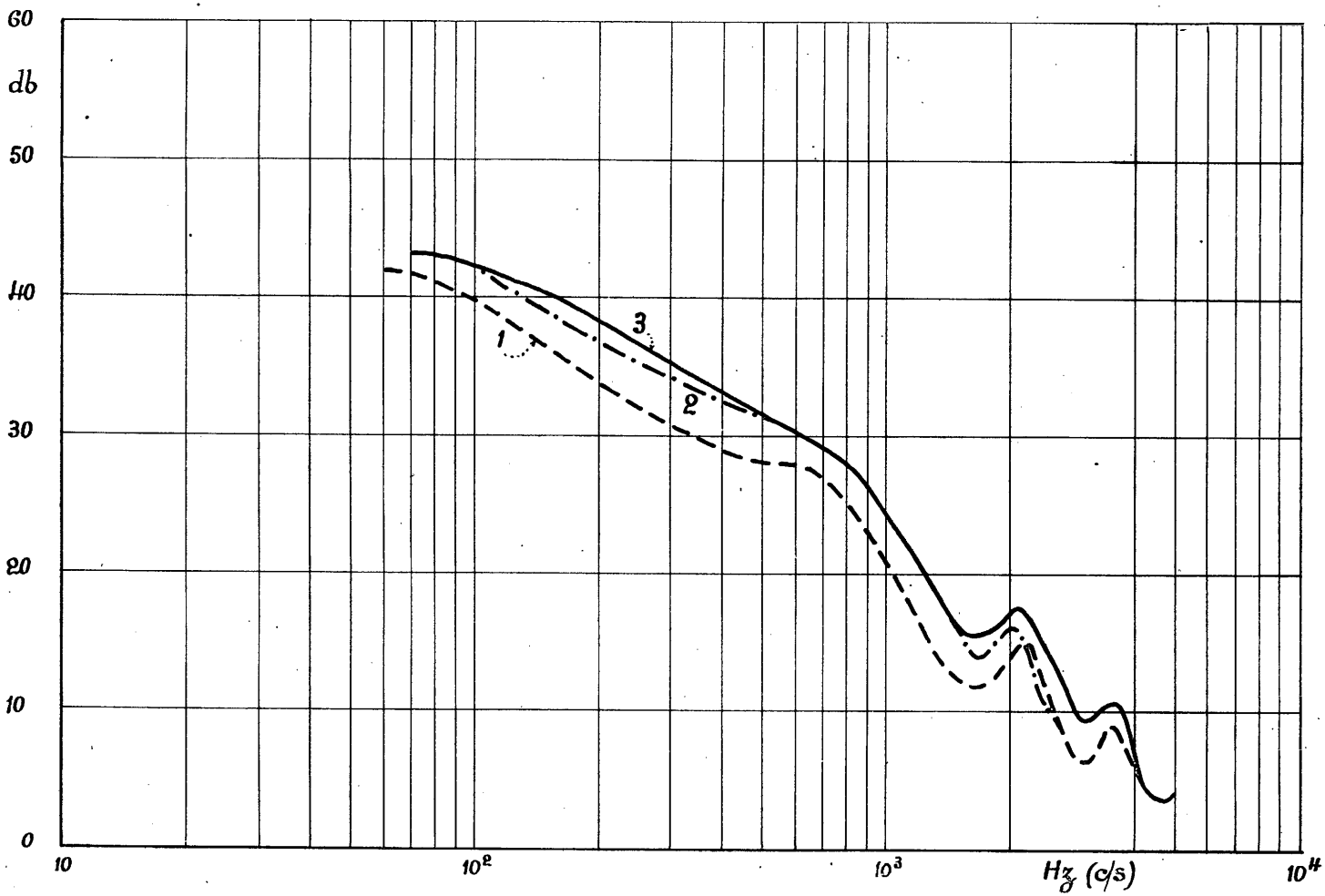
Resistance : diameter 0·25 mm
length 1·0 mm



Diameter of the probe : 1·1 mm

Cavity and resistance as in figure 3

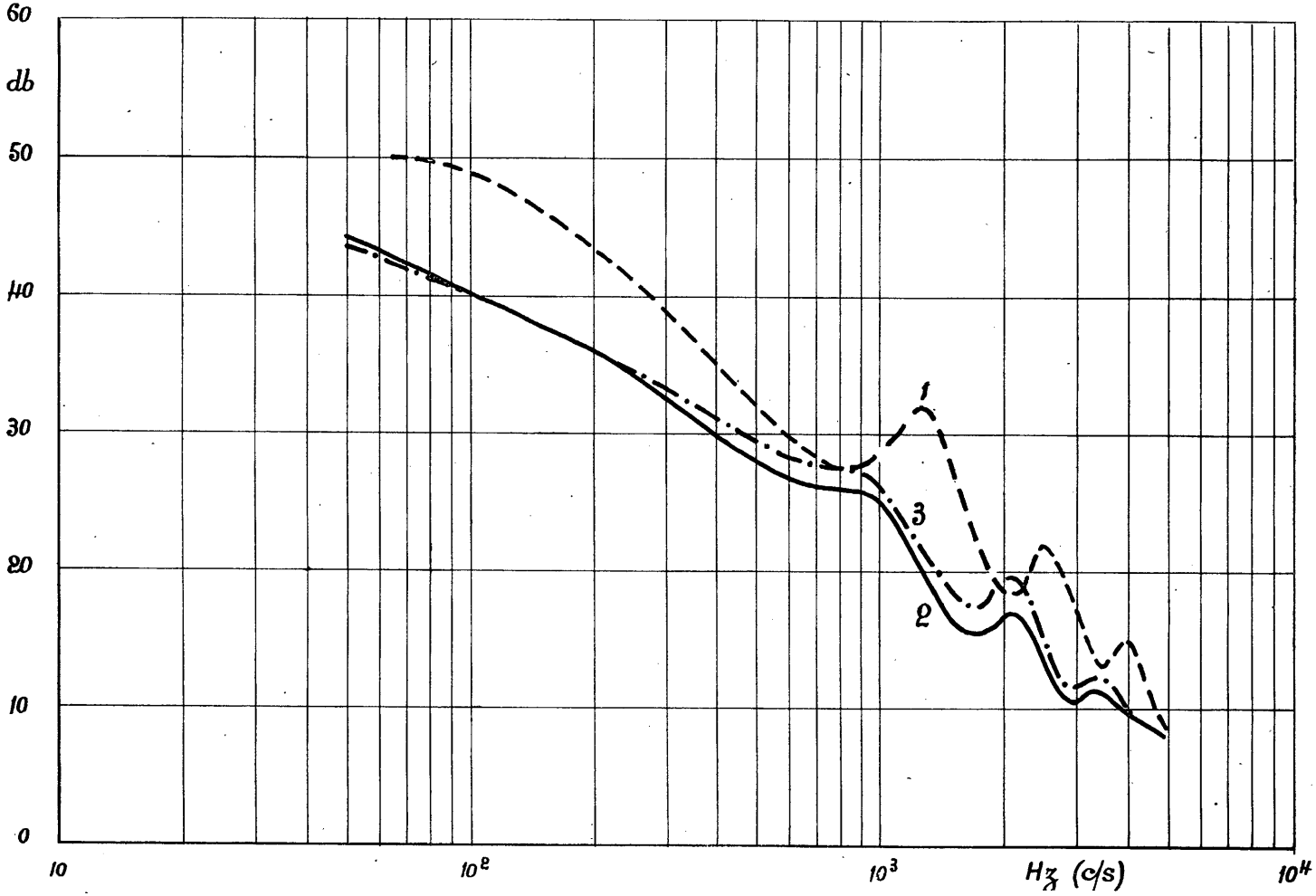
FIGURE 4



Diameter of the probe : 1·6 mm

Cavity and resistance as in figure 3

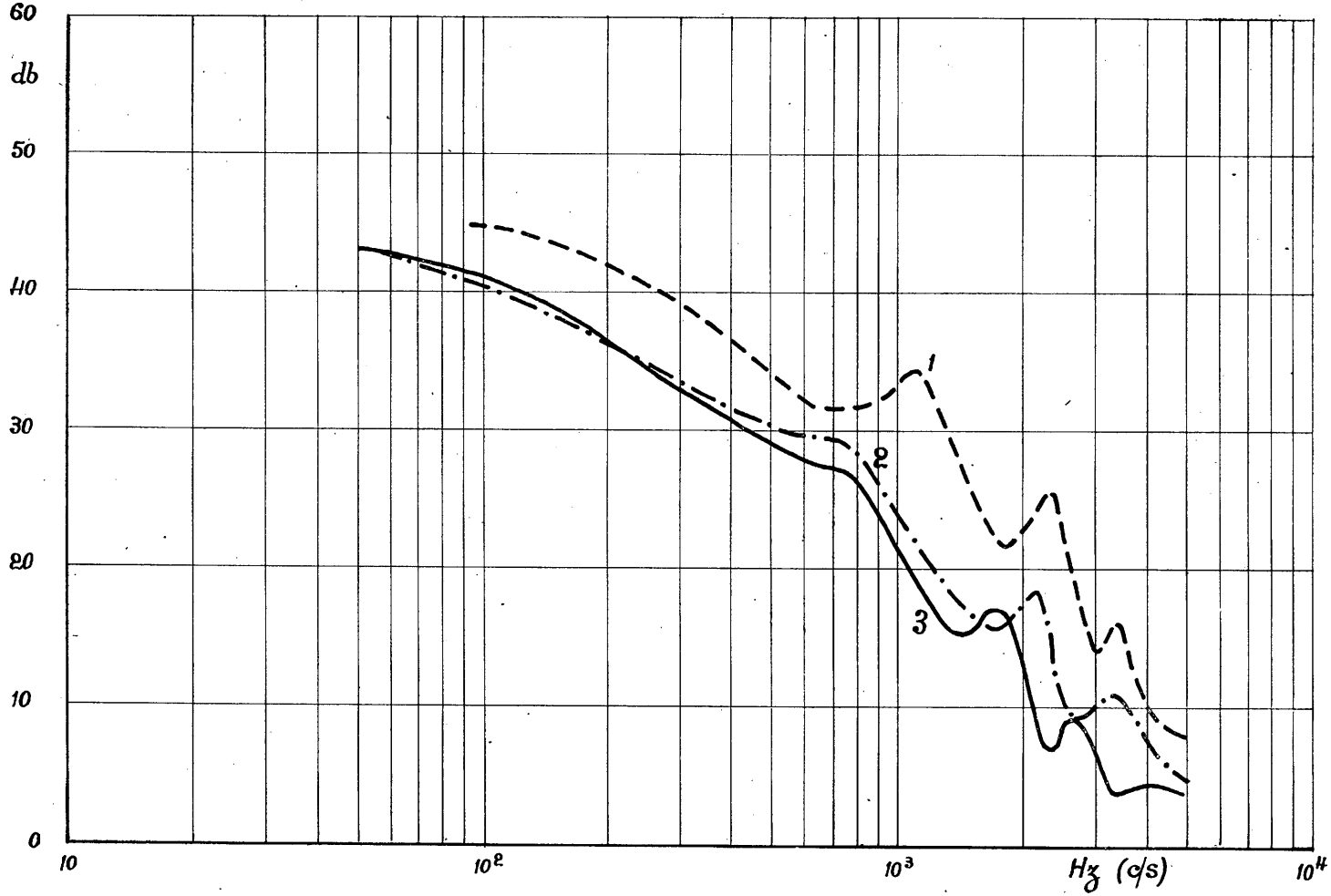
FIGURE 5



Probe diameter : 1·1 mm
Cavity height : 0·2 mm

FIGURE 6

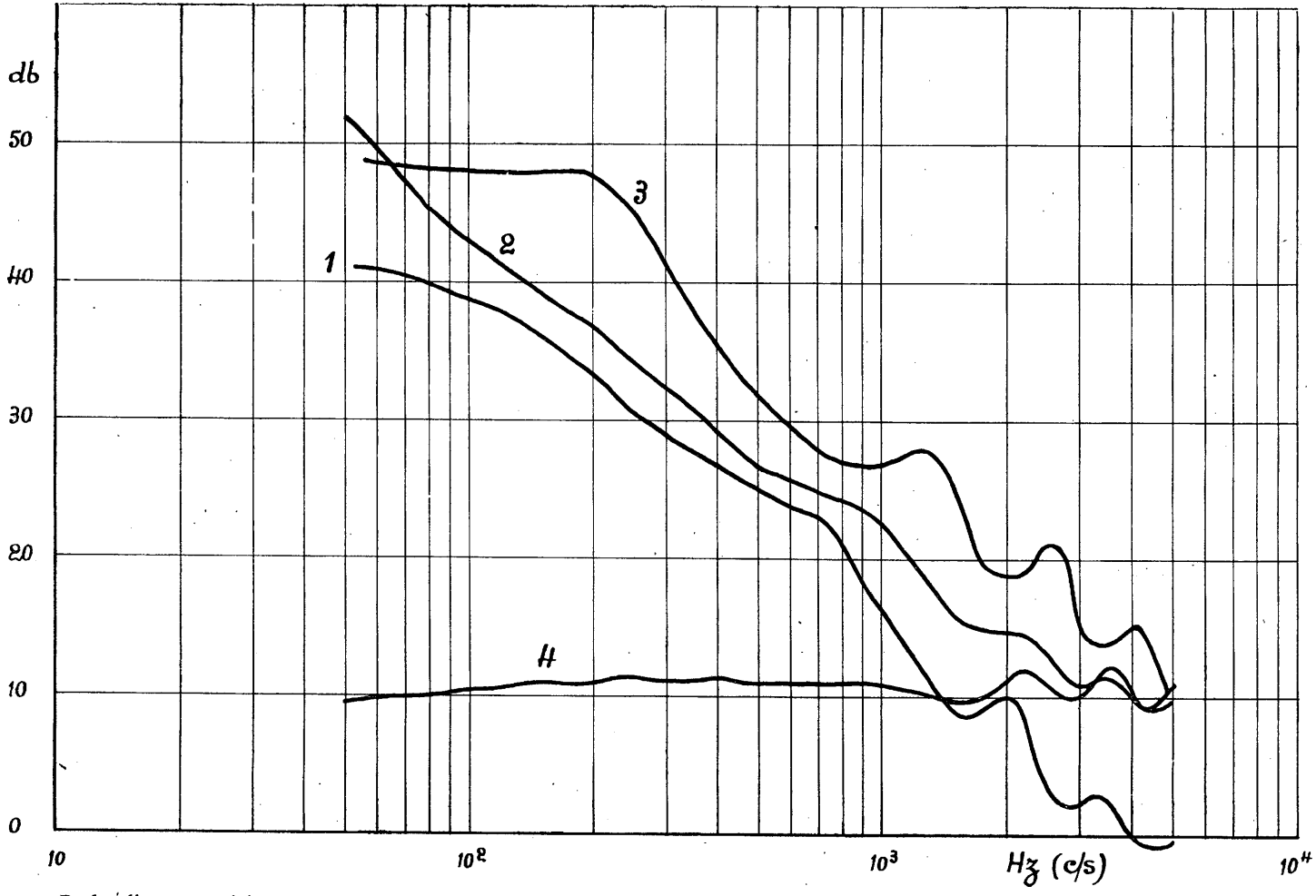
Resistance : length 1·0 mm
diameter 0·50 mm curve 1
0·25 mm curve 2
0·20 mm curve 3



Probe diameter : 1·6 mm

Cavity and resistance as in figure 6

FIGURE 7



Probe diameter : 1·1 mm
Cavity height : 0·2 mm

FIGURE 8

Resistance : diameter 0·25 mm
length 0·1 mm curve 1
0·4 mm curve 2
3·7 mm curve 3

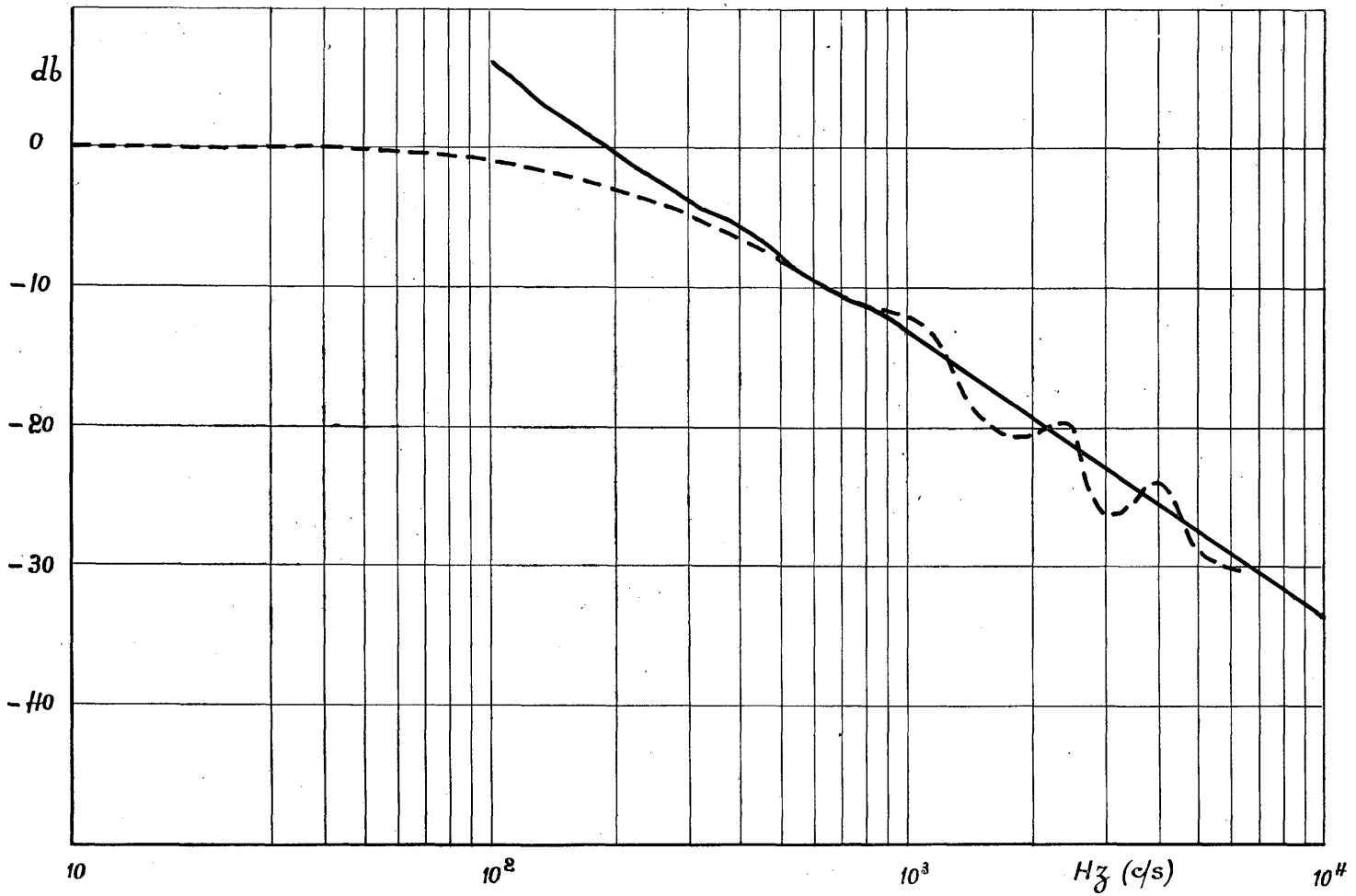


FIGURE 10

It can be seen, too, that the best curve is obtained with the probe having a diameter of 1·1 mm with an air layer of 0·2 mm (which is added to the air layer existing between the membrane and the protective screen of the microphone) and with a small tube having a diameter of 0·25 mm and a length of 0·4 mm.

The mean slope, which is fairly regular, of the response curve, has been corrected by a network inserted between the output of the microphone pre-amplifier and the input of the following amplifier.

The adjusted response curve is represented by curve 4 in figure 8.

Figure 9 shows the layout of the equalizer network :

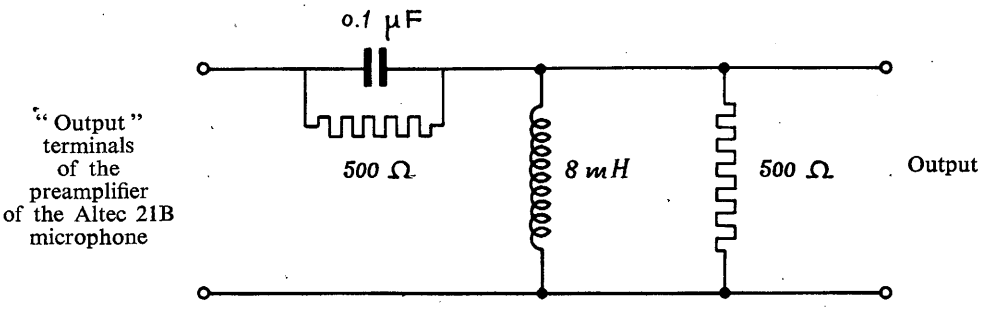


FIGURE 9

The absolute efficiency of the probe microphone described above, measured at the output of the 400 c/s equalizer (curve 4 of figure 8), is 6 microvolt/microbar.

The mean slope of the response curve can be easily calculated assuming that :

— the tube is closed on an impedance $R_o + 1/j\omega C$, where $R_0 = \rho cS$, and where C is the pressure elasticity of the air layer, and that,

— attenuation of the probe is negligible.

We then obtain :

$$P_c/P_e = \frac{1}{j\omega C} \times \frac{1}{R_0 + \frac{1}{j\omega C}}$$

where P_c is the sound pressure in the cavity, and
P_e the external sound pressure which it is desired to measure.

Figure 10 shows the calculated curve in comparison with the experimental curve, and it can be seen that they fit in well.

The method described for the construction of probe microphones offers great advantages, both as regards stability in time and the possibility of adaptation to microphones of the same type.

BIBLIOGRAPHY

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[2] R. B. ARCHBOLD, *Post Office Electrical Engineers' Journal*, 45 (1953), p. 145.

[3] W. WEST, *Acustica*.

[4] L. L. BERANEK, *Acoustic Measurements* (1950), pp. 187 and 731.

[5] H. J. GRIESE, *Archiv der Elektrischen Übertragung*, 4 (1950), p. 259.

[6] V. N. FEDEROVIC and S. SOLTYKOV, *Journal of technical physics*, 9, No. 8 (1939).

[7] K. W. GOFF and D. M. A. MERCER, *Journal of the Acoustical Society*, 27 (1955), p. 1133.

Question 13.

(Continuation of Question 13 studied in 1955-1956 by the C.C.I.F. Study Group 4) (background Question).

1. On the effects which the non-linear distortion of a subscriber's telephone apparatus has on the quality of telephone transmission.

2. On methods of measuring the non-linear distortion of subscriber's telephone apparatus, and :

3. On the effects of carbon microphone noise in subscriber's telephone apparatus on the quality of telephone transmission.

Note. — The documentation collected up to the present time is contained in Annex 20 of the *Book of Annexes* to Volume IV of the C.C.I.F. *Green Book.*

Question 14.

(Continuation of Question 14 studied in 1955-1956 by the C.C.I.F. Study Group 4)

Arrangement of accommodation for the C.C.I.T.T. Laboratory in the new building of the International Telecommunication Union at Geneva.

Note 1. — The C.C.I.F. Study Group 4 recommended, in November 1956, that the preliminary study of this accommodation should take into account the comments given on pages 67 to 75 of Document " CCIF-1955/1956 — SG 4 — Document No. 39 ". Following instructions issued by the Ist Plenary Assembly of the C.C.I.T.T., these comments have been submitted to C.C.I.T.T. Study Group 12 which has approved them by letter (see C.C.I.T.T. documents " SG 12 — contribution 1 " and " SG 12 — contribution 3 ").

Note 2. — The C.C.I.T.T. laboratory is carrying out tests to determine the relative equivalents (in relation to the ARAEN) on 7 types of commercial telephone systems, in accordance with the programme drawn up by the C.C.I.F. Study Group 4. The primary objective of these tests is to determine whether there exist testing conditions, with which relative equivalents with respect to the ARAEN would give results differing from reference equivalents (relative to SFERT) by a constant number of decibels, characterizing the reference equivalents of ARAEN transmitting and receiving systems respectively. In the light of these tests, C.C.I.T.T. Study Group 12 will examine whether there is any need to maintain the SFERT when the C.C.I.T.T. Laboratory is transferred to the new I.T.U. building.

Once the above tests which are necessary for the attainment of the first objective are completed, it will be possible to consider a new technique for making loudness balances, using the ARAEN as a reference system, and using the talking distance,

the speaking level and the position of the handset usual for AEN measurements; conditions which more closely resemble those of normal service conditions. The received speech level corresponding to normal service conditions could also be used.

Question 15.

(Continuation of Question 15 studied in 1955-1956 by the C.C.I.F. Study Group 4) (background Question)

Administrations and Private Operating Companies are asked to send to the Secretariat of the C.C.I.T.T. a bibliography of all publications (in their own language) which they consider as presenting a general interest in the study of the subjects concerning C.C.I.T.T. Study Group 12.

Question 16.

(New Question)

What form of construction should be adopted for the anechoic chamber and the screened room of the C.C.I.T.T. Laboratory in the new building of the I.T.U. ?

Note. — Draft proposals, drawn up by Professor Furrer, Technical Adviser of the C.C.I.T.T. Laboratory, will be submitted to the members of C.C.I.T.T. Study Group 12. The Secretariat of the C.C.I.T.T. will make itself responsible for collecting the comments of the Members on these draft proposals.

Question 17.

(Continuation of supplementary Question B studied in 1955-1956 by the C.C.I.F. Study Group 4)

What conditions should be satisfied (from the point of view of telephone transmission) by subscribers' telephone stations which may be used for international calls and which include loudspeakers or broadcasting type microphones with amplifiers ?

Question 18.

(New Question) (background Question)

Have Administrations any comments to make on the results of tests made by the C.C.I.T.T. Laboratory and published in the Technical Reports of the C.C.I.T.T. Laboratory during the period 1957/1960 other than those referring to questions being studied by Study Group 12 ?

TABLE SUMMARIZING THE QUESTIONS

assigned to Study Group 12

Chairman : Mr. G. SWEDENBORG (Sweden)
Vice-Chairman : Mr. F. KROUTL (Czechoslovakia)

No.	Brief description	Other Study Groups, Sub-Groups, or international organizations cooperating in the study	Comments : Preliminary consideration by
1	Reference equivalents of national systems in a communication between operators.		
2	Measurement and limits of reference equivalent for side-tone.		
3	Measurement of the disturbing effect of clicks.	S.G.s 1, 10 and 11	
4	Effect of limits on circuit noise on transmission performance.	S.G. 1	
5	Effect of induced noise on transmission performance	S.G.s 1 and 5	
6	Effect on transmission performance of noise in radio relay links.	S.G.s 1 and 3 C.C.I.R.	
7	Determination of transmission performance by objective measurements.		
8	Measurement of sensitivity of a carbon microphone.		
9	Limits applied in national trunk and local networks.	S.G. 1	
10	Limits for the efficiency of local systems.	S.G. 1	
11	Statistical methods of checking subjective tests.		
12	Artificial voices, mouths and ears.		
13	Non-linear distortion of telephone apparatus.		
14	Premises for the C.C.I.T.T. Laboratory.		
15	Bibliography.		
16	The Laboratory—sound—proof room and Faraday cage.		
17	Loudspeaker telephones.		
18	Laboratory tests unconnected with S.G. 12 questions.		

Questions for which the cooperation of S.G. 12 has been requested

Question No.	Question of S.G.	Brief summary	Other Study Groups, Sub-Groups, or international organizations interested	Comments
5	1	Reduction in transmission performance due to circuit noise.	S.G. 5, S.G. 11	Subject dealt with by S.G. 12 in the study of S.G. 12 Q. 4.
6	1 and 3	Admissible variation, as a function of time, of the signal-to-noise ratio.		Corresponds to S.G. 12 Q. 6.
9	1	New interconnection plan from the transmission point of view.	S.G. 4	
17	1	Psophometer for broadcast transmissions.	S.G. 5 C.C.I.R., I.B.O., E.B.U.	
8	3	Cross-talk in the case of position pulse modulation.	S.G. 1, C.C.I.R.	
13	5	Dissymmetry of telephone installations.	S.G. 1, C.M.I., Section 1, Study Committee No. 7.	

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LIST OF STUDY GROUPS AND SUB STUDY GROUPS

SET UP BY THE FIRST PLENARY ASSEMBLY OF THE C.C.I.T.T

Designation adopted		Title of Study Group or Sub-Study Group	Chairman	Vice-Chairman	Previous Designation *
Study Group	Sub-Study Group				
1		Coordination of studies of line transmission and general transmission problems.	Mr. BAST (Netherlands)	Mr. FRANKLIN (United Kingdom)	C
	1/1	Specification of trunk lines.	Mr. SUEUR (France)	Mr. JACOT (Switzerland)	C1
	1/2	Use of international lines for telephony.	Mr. FRANKLIN (United Kingdom)	Mr. CLAEYS (Belgium)	C2
	1/3	Use of international lines for telegraphy.	Mr. BASSOLE (France)	Mr. FIJALKOVSKI (Poland)	C3
	1/4	Use of international lines for broadcasting and television.	Mr. MÜLLER (Federal German Republic)	Mr. LEWIS (United Kingdom)	C4
2		General coordination for operation and tariffs (including coordination of regulations for leased circuits and regulations for private networks).	Mr. LANGENBERGER (Switzerland)	Mr. GARRIDO (Spain)	F
	2/1	Telegraph operation and tariffs (Telex service included).	Mr. PERRY (Netherlands)	Mr. VARGUES (France)	F4
	2/2	Telephone operation and tariffs.	Mr. TERRAS (France)	Mr. VAN DIJK (Netherlands)	F2
	2/3	Costing.	Mr. BORNEMANN (Federal German Republic)	Mr. HEIMBÜRGER (Sweden)	F3
	2/4	Telephone semi-automatic or automatic operation.	Mr. LAMBIOTTE (Belgium)	Mr. CHOVET (France)	F1

* These previous designations were used in discussions in the Plenary Assembly in 1956; henceforth they must no longer be used.

Designation adopted		Title of Study Group or Sub-Study Group	Chairman	Vice-Chairman	Previous Designation *
Study Group	Sub-Study Group				
3		Introduction of radio relay links into the general line telecommunication network. Linking-up of radio circuits to the general network.	Mr. GORI (Italy)	Mr. BORODITCH (U.S.S.R.)	E
4		Maintenance of the general telecommunication network.	Mr. VALLOTON (Switzerland)	Mr. BILLEN (United Kingdom)	D
5		Protection against dangers and disturbances of electromagnetic origin.	Mr. COLLET (France)	Mr. MIKHAILOV (U.S.S.R.)	A
	5/1	Revision of Directives.			
6		Protection and specifications of cable sheaths and poles.	Mr. HALSTRØM (Denmark)	Mr. GAGLIARDI (Italy)	B
	6/1	Revision of Recommendations.			
7		Definitions, Vocabulary, Symbols.	Mr. GELLA (Spain)	Mr. BIGI (Italy)	G
8		Telegraph apparatus and local connecting lines. Facsimile and phototelegraphy.	Mr. PELLÉ (France)	Mr. AMARANTOV (U.S.S.R.)	K
MP		Joint Study Group C.C.I.R.-C.C.I.T.T. for phototelegraphy.	Mr. PELLÉ (France)	to be nominated by the C.C.I.R.	
9		Quality of telegraph transmission, specification of channel equipments and directives for maintenance of telegraph channels.	Mr. VAN LOMMEL (Netherlands)	Mr. ROQUET (France)	L
10		Telegraph and Telex switching.	Mr. JOLLEY (United Kingdom)	Mr. FAUGERAS (France)	N
11		Telephone signalling and switching.	Mr. BARRON (United Kingdom)	Mr. VASSILIEFF (U.S.S.R.)	I
12		Telephone transmission quality and local telephone networks.	Mr. SWEDENBORG (Sweden)	Mr. KROUTL (Czechoslovakia)	H
PLAN		General Plan for the development of the international network.	Mr. ANTINORI (Italy)	Mr. MIRZA (Pakistan)	Z

* These previous designations were used in discussions in the Plenary Assembly in 1956; henceforth they must no longer be used.

PARTICIPATION AUX COMMISSIONS ET SOUS-COMMISSIONS
MEMBERSHIP OF STUDY GROUPS AND SUB-STUDY GROUPS

1re Commission d'études — Study Group 1

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Ceylan — Ceylon	.....
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Danemark — Denmark	H. LAURSEN, H.E. MADSEN
(The Great Northern Telegraph Co. Ltd.)	B.A.K. GEHLSHØJ
Espagne — Spain	D.J.M. ARTO MADRAZO
(Compañía Telefónica Nacional de España)	J. M. REBOLLO
Etats-Unis d'Amérique — United States	F. COLT DE WOLF
(American Telephone and Telegraph Cy)	A.M. DOWLING, W.E. BLOECKER
Ethiopie — Ethiopia	G. TEDROS
France	SUEUR, BELUS, JOB, TOUTAN, LE GOURRIEREC, BASSOLE, FERRIEU, ICOLE, DUBOIS
Hongrie — Hungary	J. BREBOVSZKY
Inde — India	S.K. KANJILAL
Irlande — Ireland	W. DAIN
Italie — Italy	FARIELLO, BONACCI
Japon — Japan	A. HATSUSE
(Teléfonos de México)	E. ERIKSEN, C.G. MÅNSSON, J. PYDDOKE, O. BAGER
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(N.V. Philips' Telecommunicatie Industrie)	F. DE FREMERY, N. RODENBURG, H.N. HANSEN, F. ELENBAAS
Pologne — Poland	J. WOJCIKIEWICZ, F. BLOCKI, J. FABIJANSKI
Portugal	J. BARROS
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(Deutsch-Atlantische Telegraphengesellschaft)	W. GLITSCH
(Felten & Guilleaume Fernmeldeanlagen G.M.B.H.)	OEHLEN, HANNEWALD
(Felten & Guilleaume Carlswerk A.G.)	H. FREYTAG, G. REUSCHENBACH
(Siemens & Halske A.G.)	F. BATH, E. HOLZLER, W. VON WERTHER, H. FÜLLING.
(Telefunken G.M.B.H.)	G. WUCKEL, K.H. WERNER
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Roumanie — Roumania	.....

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Suède — Sweden	S. NORDSTRØM
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Tchécoslovaquie — Czechoslovakia	.....
Tunisie — Tunisia	.....
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(Cuban Telephone Company)	T.R. GUBBINS, VAN HASSELT, T. JONES
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Inde — India	S.K. KANJILAL
Irlande — Ireland	W. DAIN
Italie — Italy	D. GAGLIARDI
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Portugal	J. BARROS
Allemagne (R. F.) — F. German Republic	F. RING
(Siemens & Halske A.G.)	F. BATH, W. VON WERTHER
(Telefunken G.M.B.H.)	K.H. WERNER, E. KOCH, W. WOLFF
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Tunisie — Tunisia	.....
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Ethiopie — Ethiopia	Betrou ADMASSIÉ
France	JOB, TOUTAN, DUBOIS, LE GOURRIEREC
Inde — India	S.K. KANJILAL
Irlande — Ireland	W. DAIN
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Japon — Japan	A. HATSUSE
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Portugal	J. BARROS
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(The Great Northern Telegraph Co. Ltd.)	B.A.K. GEHLSHØJ
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Tunisie — Tunisia	.....
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Espagne — Spain	J.M. ARTO MADRAZO, I. MIRO
(Compañía Telefónica Nacional de España)	C. MORENO TOLEDANO
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(American Telephone and Telegraph Company)	A.M. DOWLING, W.E. BLOECKER
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France	JOB, TOUTAN, DUBOIS, ICOLE
Inde — India	S.K. KANJILAL
Irlande — Ireland	W. DAIN
Italie — Italy	F. NICOTERA
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Tchécoslovaquie — Czechoslovakia	.....
Tunisie — Tunisia	.....
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2me Commission d'études — Study Group 2

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Bulgarie — Bulgaria	.....
Canada	.....
Ceylan — Ceylon	.....
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Espagne — Spain	J. GARRIDO *(vice-rapporteur principal — vice-chairman)*
(Compañía Telefónica Nacional de España)	E. DEL RIEGO
Etats-Unis d'Amérique — United States	F. COLT DE WOLF, H. WOODWARD
(American Telephone and Telegraph Company)	A.M. DOWLING, W.E. BLOECKER
(American Cable and Radio Corporation)	A.A. HENNINGS
(The Commercial Cable Company)	T.S. GREENISH
Ethiopie — Ethiopia	G. TEDROS
France	TERRAS, VARGUES, CHASSIGNOL, DREVET, FAUGERAS, FRANZ, CHOVET, DUGUET, MIGEON, FERRIEU
(Compagnie Française de Câbles sous-marins)	R. CHEVALIER, G. VERGRIETE
Hongrie — Hungary	G. REVESZ
Inde — India	S.K. KANJILAL, G.D. GOKARN
Irlande — Ireland	S.O. DROMA
Italie — Italy	M. FARIELLO, L. FEI, E. SACCO
(Italcable)	A. SPASIANO
Japon — Japan	T. KASHIWAGI
Liban — Lebanon	.....
(Teléfonos de México)	O. BAGER
Norvège — Norway	L. LARSEN, A. STRAND
Pays-Bas — Netherlands	T. PERRY, R.P. VAN DIJK
Pologne — Poland	H. ZDZIECH, J. KARAS, S. SZYDLOWSKI
Portugal	J. CRUZ FILIPE
(Companhia Portuguesa Radio Marconi)	E. MENDES BARBOSA
Allemagne (R. F.) — F. German Republic	H. BORNEMANN, R. FERNAU, O. HUBER, W. SCHAAF
(Deutsch-Atlantische Telegraphengesellschaft)	W. GLITSCH
(Felten & Guilleaume)	SCHRAMM
Yougoslavie — Yugoslavia	R. LILER, B. LUKIĆ, I. SVETEL, T. TESLIĆ, K. HORVAT, V. MIHAJLOVIĆ, M. MILIĆ, L. KOSTIĆ, N. SEVERDJAKOV, S. KOJOVIĆ.
Roumanie — Roumania	.....
Royaume-Uni — United Kingdom	J.W. GRADY, D.G.C. LAWRENCE, S.H.P. CROFT, V.F.B. MEDLAND, L.T. ANDREW
Suède — Sweden	H. HEIMBÜRGER, G. SVEDHEM
Suisse — Switzerland	A. WETTSTEIN, A. LANGENBERGER *(rapporteur principal — chairman)*, H. WYSS
Tchécoslovaquie — Czechoslovakia	.....
Tunisie — Tunisia	.....
U.R.S.S. — U.S.S.R.	.....
O.M.M. — W.M.O.	V. SUNDARAN, W.B. LECLERCQ

Sous-Commission d'études 2/1 — Sub-Study Group 2/1

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Belgique — Belgium	VANDENHOVE, SOVET
Canada	.....
Ceylan — Ceylon	.....
(Chile Telephone Company)	L.P. LOWRY
Chine — China	Y.T. CHANG, LEE WAN
Danemark — Denmark	C.B. NIELSEN
(The Great Northern Telegraph Co.)	A.W. MORTENSEN, K.W. SIMONSEN
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Tunisie — Tunisia	.....
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Chine — China	Y.T. CHANG
(Cuban Telephone Cy)	VAN HASSELT, J. KRUITHOF
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Espagne — Spain	.....
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Ethiopie — Ethiopia	Betrou KIDANEMARIAM
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Ceylan — Ceylon	.....
Chine — China	Y.T. CHANG
Espagne — Spain	FOZ, J. MARTINEZ-BURGOS
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Inde — India	S.K. KANJILAL, G.D. GOKARN
Irlande — Ireland	S.O. DROMA
Italie — Italy	A. BIGGI, B. VIESI
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Pays-Bas — Netherlands	R.P. VAN DIJK
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Tchécoslovaquie — Czechoslovakia	.....
Tunisie — Tunisia	.....

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Irlande — Ireland	S.O. DROMA
Italie — Italy	FARIELLO, G. VERLICCHI
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Roumanie — Roumania	.....
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Ceylan — Ceylon	.....
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(Telefunken G.M.B.H.)	W. WOLF
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8me Commission d'études — Study Group 8

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Plan pour le développement du réseau international
Plan for the development of the international network

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CHARTS OF ORGANIZATION OF THE C.C.I.T.T.

General Chart

Partial plan No. 1 (Transmission)

Partial plan No. 2 (Operation, Tariffs, Switching)

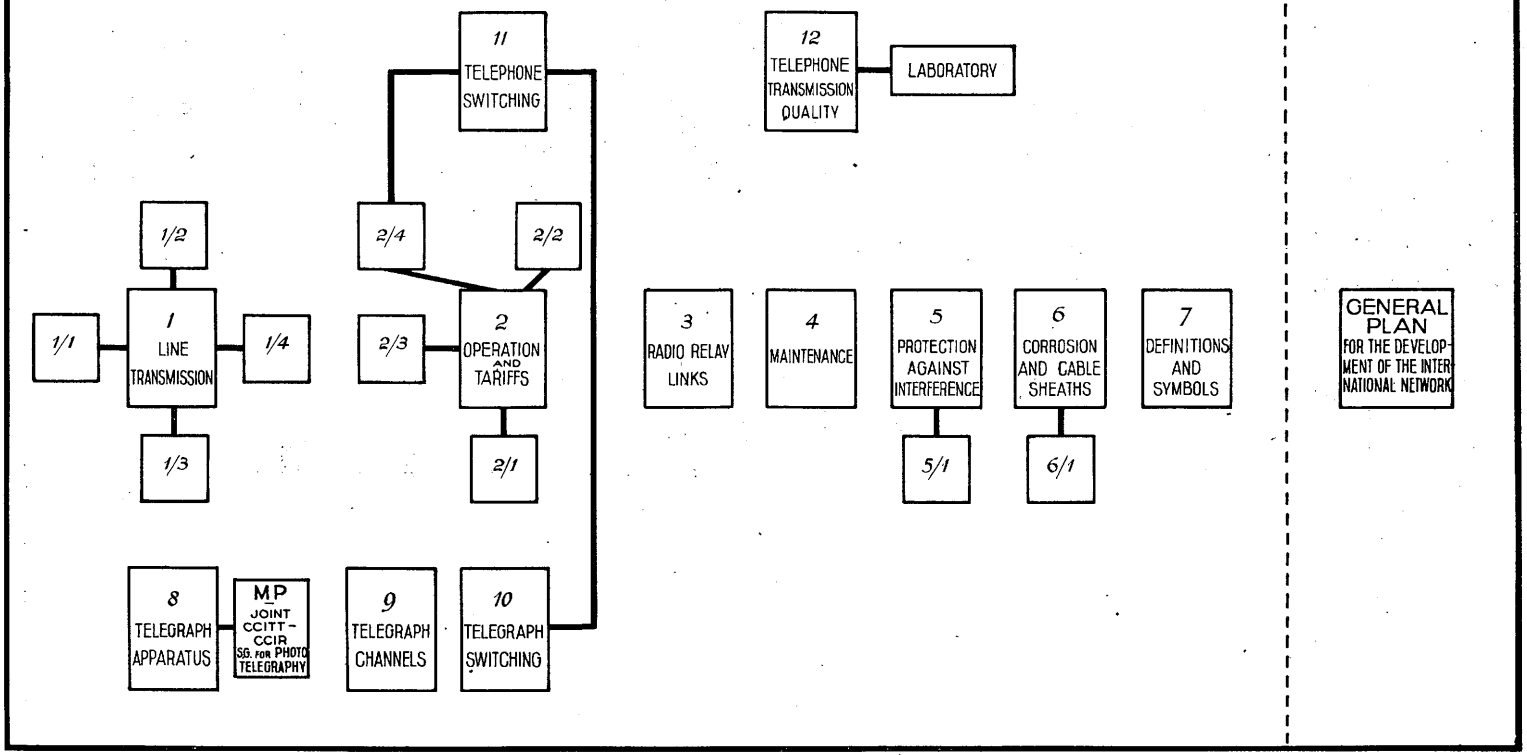
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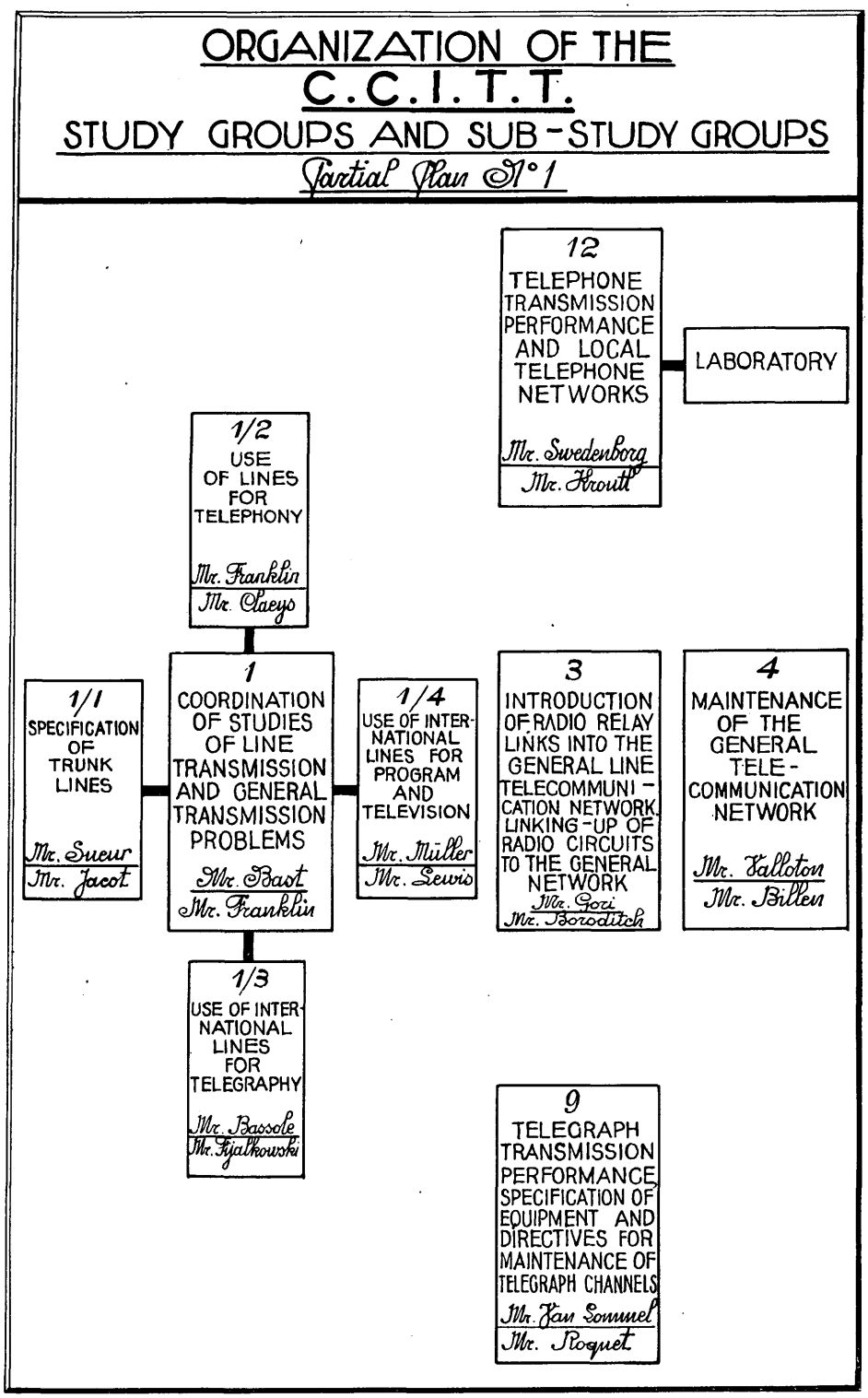
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ORGANIZATION OF THE "C.C.I.T.T."

(INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE)

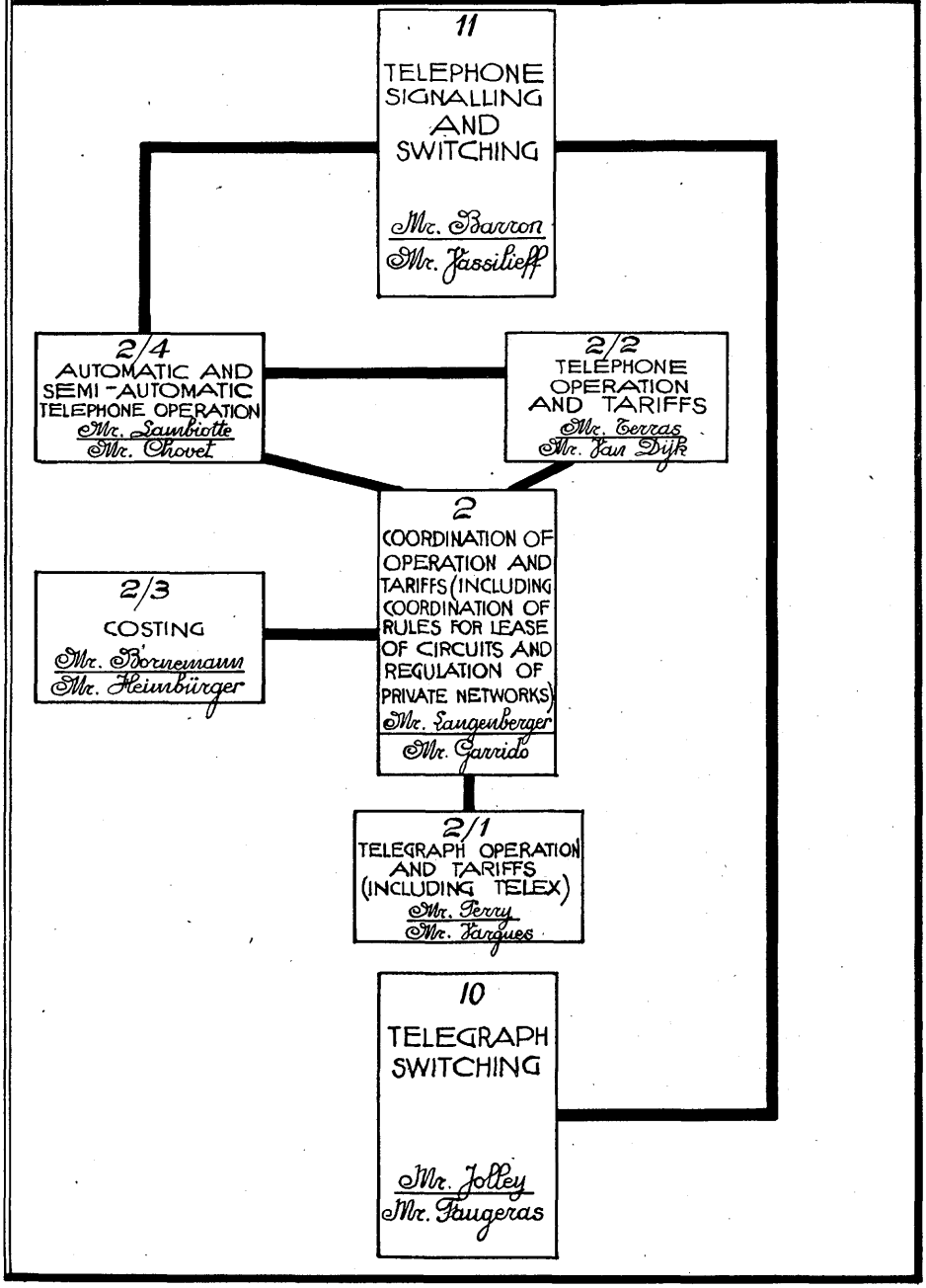


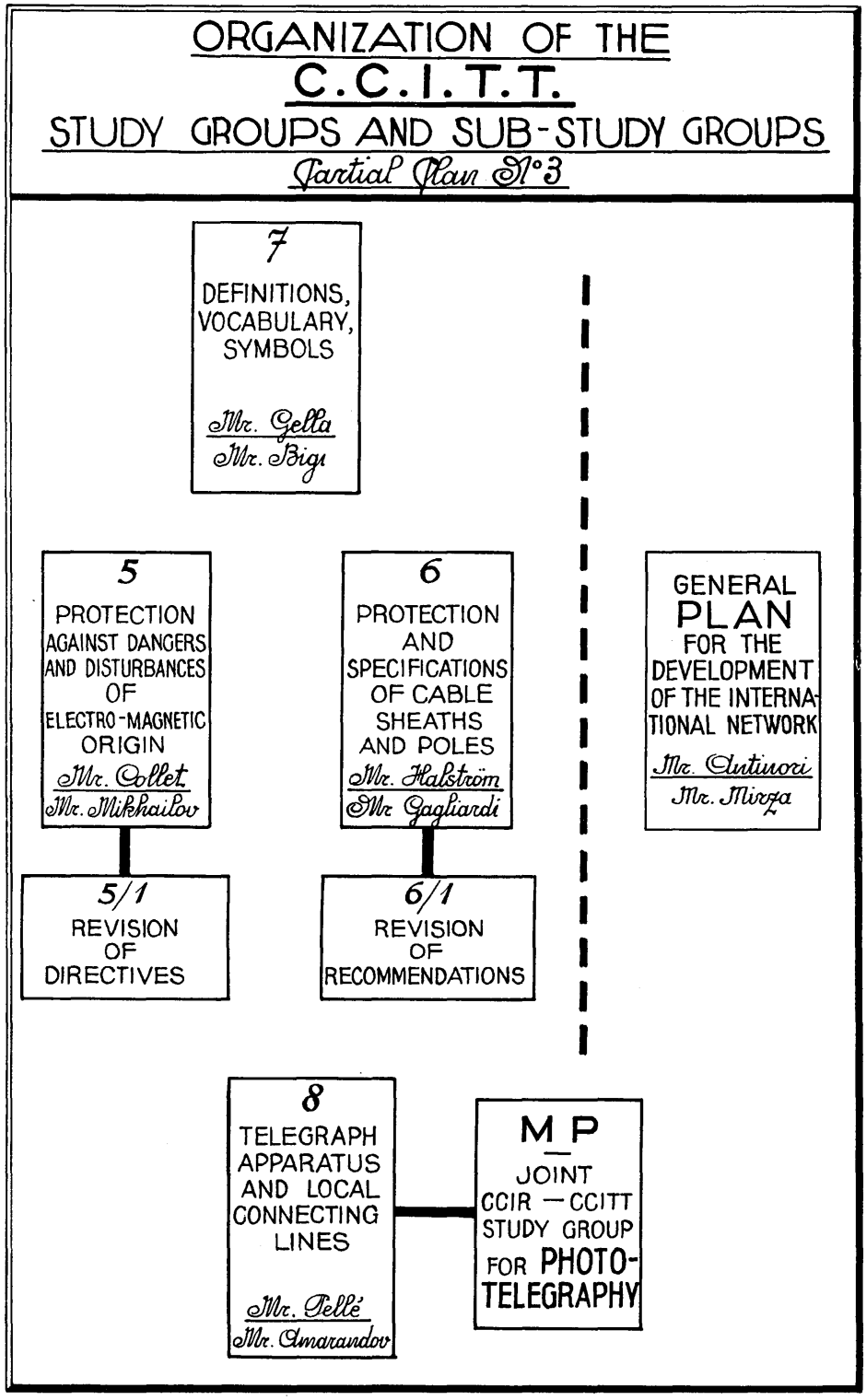

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