LOCATNG, ANALYZING, AND CORRECTING
LINK LIST TROUBLES
ALL GENERIC PROGRAMS
2-WIRE NO. 1 ELECTRONIC SWITCHING SYSTEM

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Tables

1. GENERAL

1.01 This section describes techniques for locating, analyzing and correcting link list troubles in the No. 1 Electronic Switching System (ESS). The information covered in this section is valid for all generic programs.

1.02 Whenever this section is reissued, the reasons for reissue will be listed in this paragraph.

LINK LIST DESCRIPTION

1.03 Link lists are also known as linked lists, linked lists of available space, free space, or holes. Link lists are lists of available (unused) program store (PS) memory words and are necessary so that these randomly scattered memory words can be used when they are needed. The link list tables contain the absolute addresses of the next available block of unused translation words (hole). The number of translation words in a hole is the ***size*** of the hole.

1.04 There are two link list tables in No. 1 ESS: a right-half word link list table and a left-half word link list table. The function of the right-half word link list table is to specify all right-half (23-bit) words that are unused in PS memory. The function of the left-half word link list table is to specify all left-half (14-bit) words which are unused in PS memory.

1.05 The right-half link list starts with a 33-word head table located at the master head table address plus octal 320 (decimal 208). The first word in the head table is always zero since there is no such thing as a hole of size zero. The next 32 words are the addresses of available right-half holes starting with holes of size one and proceeding in steps of one up to holes of size 32 or greater. If there are no available holes of a given size, the head table address is all zeros. Note that the holes of size 32 or greater are all linked in the same chain. The first word of the hole specifies the address of the next available hole of any size, provided they are 32 or greater. If there are no more holes of 32 or greater, then the first word contains all zeros. The second word of the hole (only for 32 and greater) contains the number of words in the hole.

1.06 The left-half link list starts with a 33-word head table. This head table is pointed to from a right-half program store word located at the master head table address plus octal 361 (decimal 241). The count of left-half words in a block is based on the number of available 14-bit words. When left-half words are used for translation purposes, two consecutive 14-bit words are required for each 23-bit translation word.

1.07 The first word in the head table is always zero since there is no such thing as a hole of size zero. The next 32 words are the addresses of available left-half holes starting with size one and proceeding in steps of one up to holes of size 32 or greater. Almost all words for addresses of odd size holes will contain zeros because very few odd size left-half word blocks are used. If there are no available holes of a given size, the address is all zeros. Note that the holes of size 32 or greater are all linked in the same chain.

1.08 The first two words of a hole specify the address of the next hole of the same size. The first word contains the 14 least significant bits of the address, and the second word contains the 9 most significant bits. If there are no more holes of the same size available, the first two words of the hole will contain zeros. For a more detailed description of linked list layouts in No. 1 ESS, refer Sections 231-048-001 and 231-048-010.

1.09 Recent changes against link lists are stored in the recent change area of memory and are administered via the recent change program. This means that additions and deletions to the lists are done by the recent change program. After cardwriting recent change entries, the list should show more or less available program store space (determined by recent change input message specifications). By maintaining a record of the list of available space and updating it before and after each cardwriting, a record will exist of how much memory space was used or returned at each cardwriting. This information may be used to determine how soon an office should prepare for the growth of another program store.

1.10 When space is seized from a link list, it is taken by the program from the ***top*** of the list. When space is added to a link list, it is placed by the program at the ***top*** of the list.

1.11 A symbolic layout of program store link lists in call store is shown in Figure 1. Shown in Figure 1 is the linkage of seven 3-word lists or blocks. In addition, two 31-word blocks are shown as well as a single 320-word block. The tags for the lists are shown originating in the primary recent change area of call store memory. Also shown in Figure 1 are two examples of bad linkages which are the cause of broken link lists.

REFERENCES

1.12 Table A lists references for personnel that may require more in-depth information concerning link lists.

2. LAYOUT OF LINKED LISTS IN TRANSLATIONS

PROGRAM STORE

2.01 When the initial translation data is compiled, a record of available PS space is created and is of maximum length. This record is kept in the PS in the form of linked lists of available blocks. Separate lists, as kept for right and left half of PS were discussed in Part 1.

A. Free Space or Holes

2.02 Free space consists of two or more sequential words in memory which are unused or unassigned. These blocks range in size from 1 to 31 words and word sizes that are 32 or greater. It is important to know the starting address of the master head table (MHT) for a particular office because link list head tables are located within this area of memory. This address varies and must be T-READ to be found.

2.03 There is one important fact to note when working with the link lists in an office. These are linked by address or tag.

B. Administration of Linked Lists

2.04 Proper administration and tracking of linked lists by address is vital to the integrity of translation memory. The VFY-SPACE and RC OVCK messages should be used periodically and immediately prior to a recent change update. Analysis of the responses will prove that the link lists are intact. The response to the VFY-SPACE message (TR13) provides a record of the translation memory space, available by address. This record is a good way for maintenance personnel to keep track of how much memory is being used at each card writing. Another use of the VFY-SPACE message immediately after the completion of card writing is important also. This check validates that the memory is still intact and that there were no interruptions or troubles during the transfer of data from call store (CS) to the memory card writer (MCW) via the peripheral unit address bus (PUAB).

2.05 The recent change programs (RCMS and RCSO) always use head table addresses in maintaining the linkage of any size auxiliary block list before card writing. New service orders seize blocks from the list. Out service orders return blocks to the list. Change service orders exchange blocks on the list. When the change programs return or seize a block, that exchange will always alter the contents of the head table address for those size blocks involved in the exchange.

2.06 All link lists are administered on a push down basis. This means that when blocks are returned to the link lists, the linkage is altered at the head table address. If there is a change to any of these lists, there will be a recent change entry in the primary recent change area of call store against that particular head table address.

2.07 The VFY-SPACE input message mentioned previously checks continuity and integrity of the link list and will be described in detail in succeeding parts of this section. The VFY-SPACE message can be used for checking continuity and integrity of the lists at the following times:

- Immediately PRIOR to card writing,
- Immediately AFTER card writing,
- Periodically between card writing, and
- Anytime for troubleshooting.

C. Forward Linkage

2.08 The layout of the forward linkage of the 2-word right-half link list as it might appear in a PS is given in Figure 2. As shown in the

figure, the contents of the head table address is another PS address (TAG). That PS address location contains another PS address and so on until all zeros are in the contents, indicating the end of the list for this size block.

CALL STORE

2.09 Since the No. 1 ESS program store memory is contained on magnetic cards and can be updated only through card writing, the CS area contains the recent changes in translation data. The CS area where they are stored temporarily, until a recent change (RC) update takes place, is known as the RC area. The RC area consists of the primary and auxiliary areas. The recent change area is shown in Figure 3.

A. Primary Recent Change Area

2.10 The primary RC area consists of pairs of words called RC registers (RCRs). The RCRs are in 2-word groups. The first word (TAG WORD) contains the status bits of the recent change entry in bits 22 and 21 and the TAG (PS address) in bits 20-0. The second word (PTW WORD) of the RCR contains a temporary auxiliary block indicator (TMPI) in bits 22-18 and a primary translation word (PTW). This will be discussed in depth later. The status bits are vital in the determination of the type of RC entry.

	22 21	20 18	17 0
TAG WORD	STATUS	PROGRAM STORE TAG (PTW ADDRESS)	
PTW WORD	TMPI≠0		PRIMARY TRANSLATION WORD (DATA)

2.11 The four states of the status (STA) bits correspond to the four possible state of an RC entry. They are as follows:

11—***TEMPORARY***—This type of change is not written onto the PS card during the card writing procedure. Temporary RCs are used for such functions as assigning a line to service observing, the plugged-up list, or call forwarding variable. All temporary RCs consist of one or more data word(s) and do not use the auxiliary RC area. A temporary RC entry is seen by the RC hunt program.

10—***PERMANENT***—This is the only type of RC entry that is written onto the PS cards during the card writing procedure. A permanent entry is seen by the RC hunt program.

01—***DELAYED***—This is the delayed service order RC entry. This type of entry has been inputted via a service order, and can become a permanent entry when activated by the use of a sevice order telephone.

00—***DELETED***—This RC previously existed as one of the other three types, but was created via a replacement RC order or as a result of an RC:UPDATE message after card writing. A deleted entry is not seen by the RC hunt program.

2.12 It is possible for more than one entry to exist for the same PS TAG. These entries are known as a TAG group. Within a TAG group, the recent change registers are arranged by status bits in the same order as the STA bits above are listed (11, 10, 01, 00). However, only ***one*** permanent RC can exist within an TAG group, except in the FROZEN state, when up to three permanent RCs could exist.

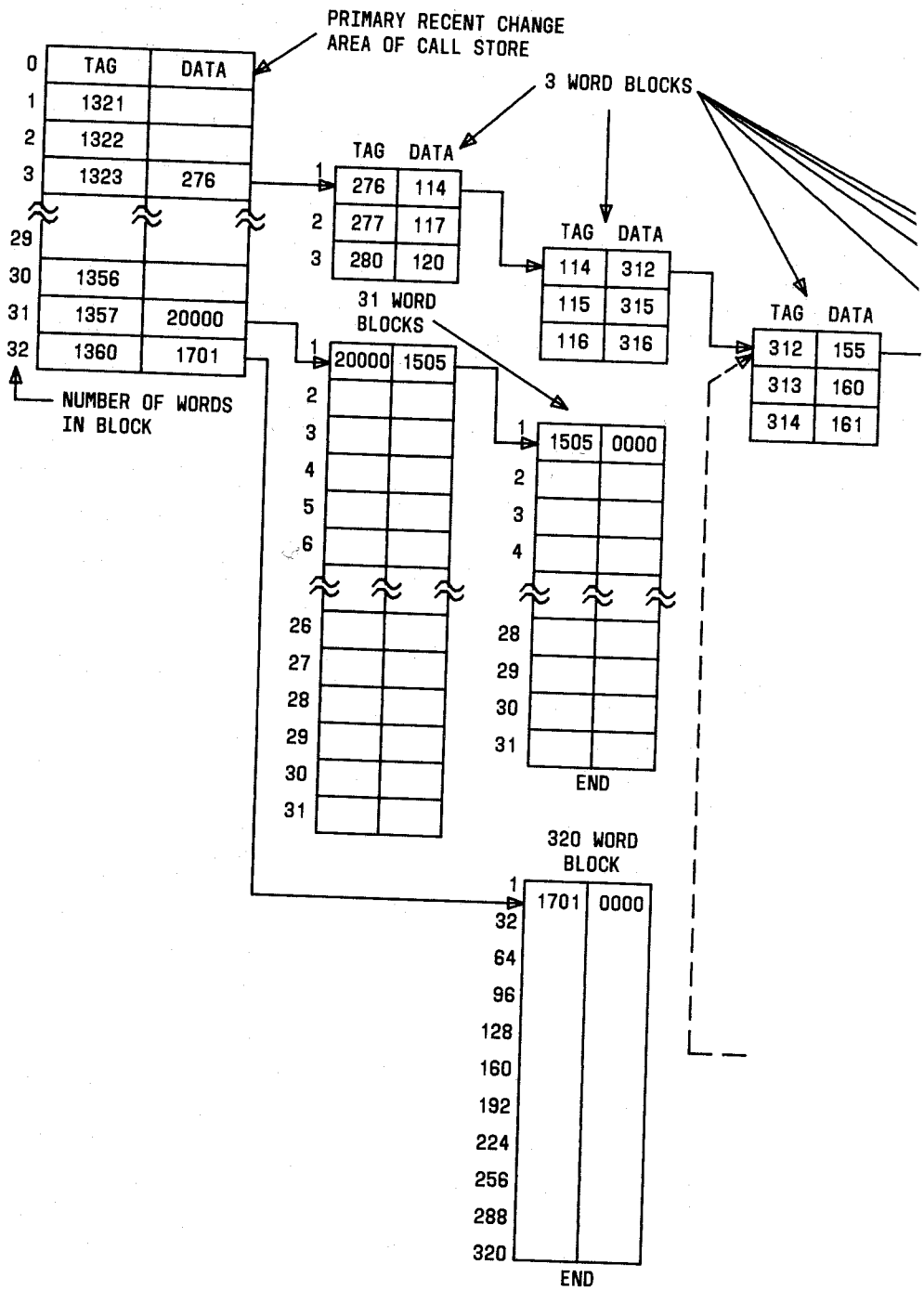
2.13 The second word of the RCR will contain either final data or an auxiliary block address. If a particular translation change requires the use of a PS auxiliary block, the second word of the RCR will point to an auxiliary recent change address where the new information will be stored.

B. Auxiliary Recent Change Area

2.14 The auxiliary RC area is used to store RC auxiliary blocks. These blocks are composed of auxiliary translation words and can contain permanent, temporary, or delayed RCs. When an RC to an auxiliary block in the program store is required, the entire auxiliary block is rewritten to include to new data and is stored in the auxiliary RC area. The appropriate primary RC is also generated to specify the call store address of the RC auxiliary block.

2.15 The auxiliary RC area auxiliary blocks may appear in several forms as follows:

- Auxiliary block length is 31 words or less,
- Auxiliary block length is greater than 31 words,
- 2-word pseudo auxiliary block (needed when nonzero PTW has bits 22-18 equal to zero),


PRIMARY RECENT CHANGE AREA OF CALL STORE
3 WORD BLOCKS
TAG DATA
0 1321
1 1322
2 1323 276
29
30 1356
31 1357 20000
32 1360 1701
NUMBER OF WORDS IN BLOCK
1 276 114
2 277 117
3 280 120
TAG DATA
114 312
115 315
116 316
TAG DATA
312 155
313 160
314 161
31 WORD BLOCKS
1 20000 1505
2
3
4
5
6
26
27
28
29
30
31
1 1505 0000
2
3
4
28
29
30
31
END
320 WORD BLOCK
1 1701 0000
32
64
96
128
160
192
224
256
288
320
END

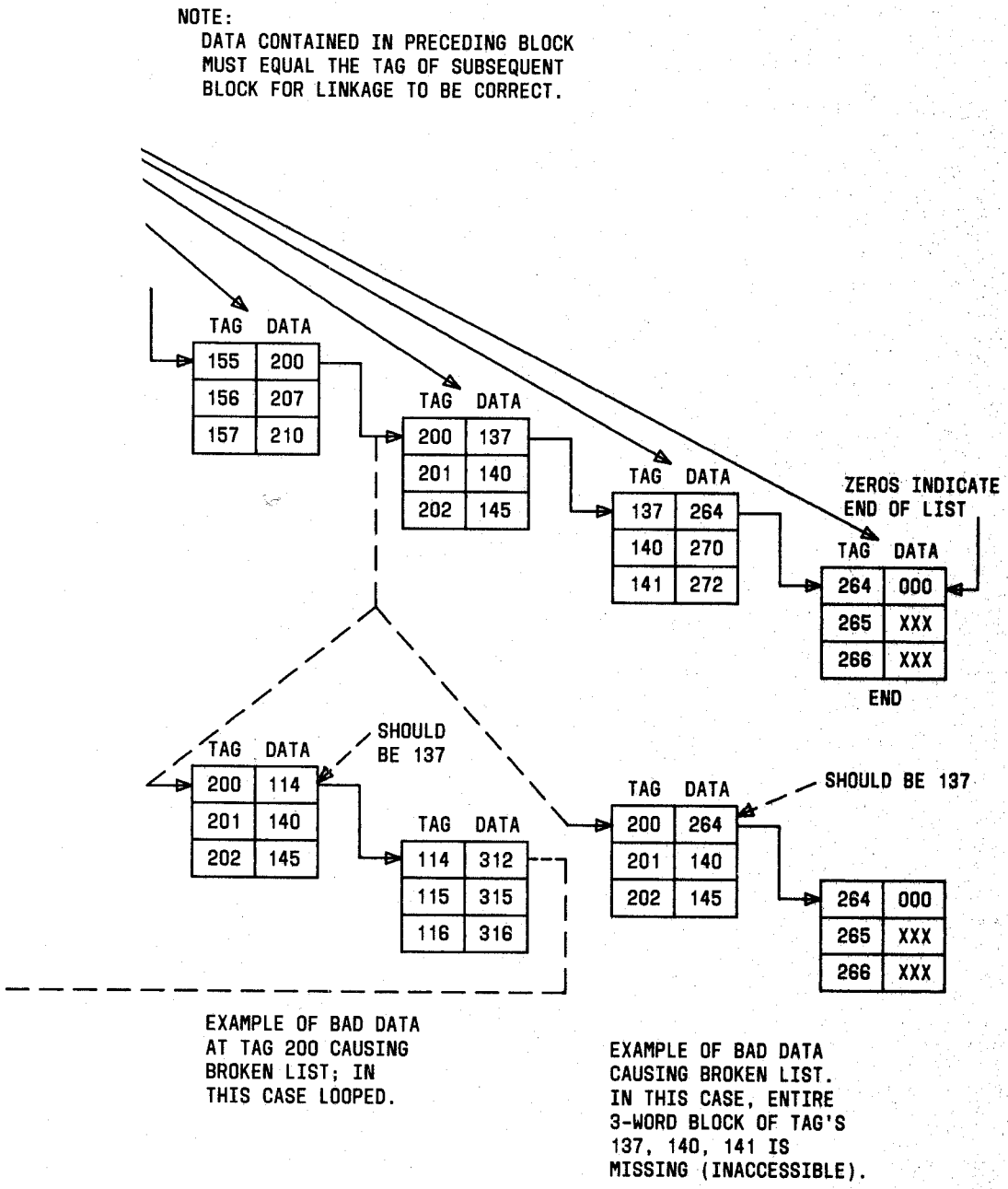


Fig. 1—Base Symbolic Layout of Link Lists With Error Examples in Call Store

TABLE A

LINK LIST INFORMATION REFERENCES

DOCUMENT	TITLE
PA-591003	Translations Output Configuration
PD-1A012	Audit Programs Description
PD-1A005	Maintenance Control Programs Description
PD-1A083	Recent Change Update and Control
PF-1A083	Programs Description and Flowcharts
PD-1A084	Service Order Programs Description
PD-1A085	Trunk Message Program Description
PD-1A112	Cardwriter Control Programs Description
PD-1A120	Translation Program Description
231-048-001	Basic Concepts of Translations (BSP).
231-048-010	MSN, CPDN, and Link List Translation Data Description (BSP)
231-048-305 or 231-118-325	RC Procedures for PSWD, GENT, PSBLK, and SUBTRAN (BSP)
231-048-XXX or 231-118-XXX	Recent change layer (BSPs); 048 layer is 1E6 and later generics 118 layer CTX6 through 1E5 generics
231-112-303	Analyzing Audit Output Message SA03 (BSP) (Through 1E4 Generic Program)
231-112-304	Analyzing Audit Output Messages (BSP)
IM-1A001	No. 1 ESS Input Message Manual
OM-1A001	No. 1 ESS Output Message Manual

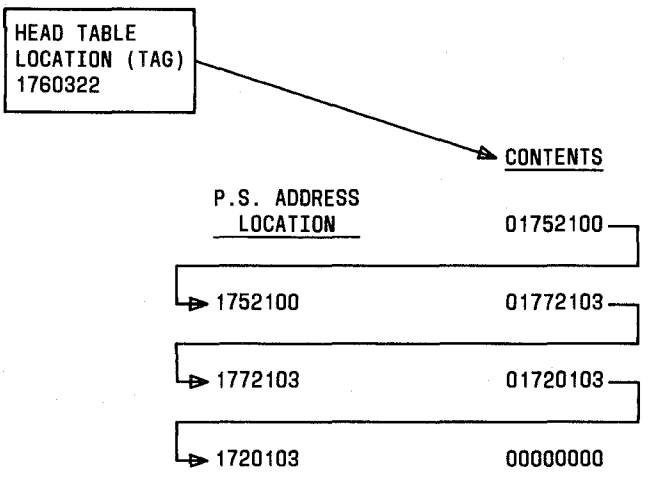


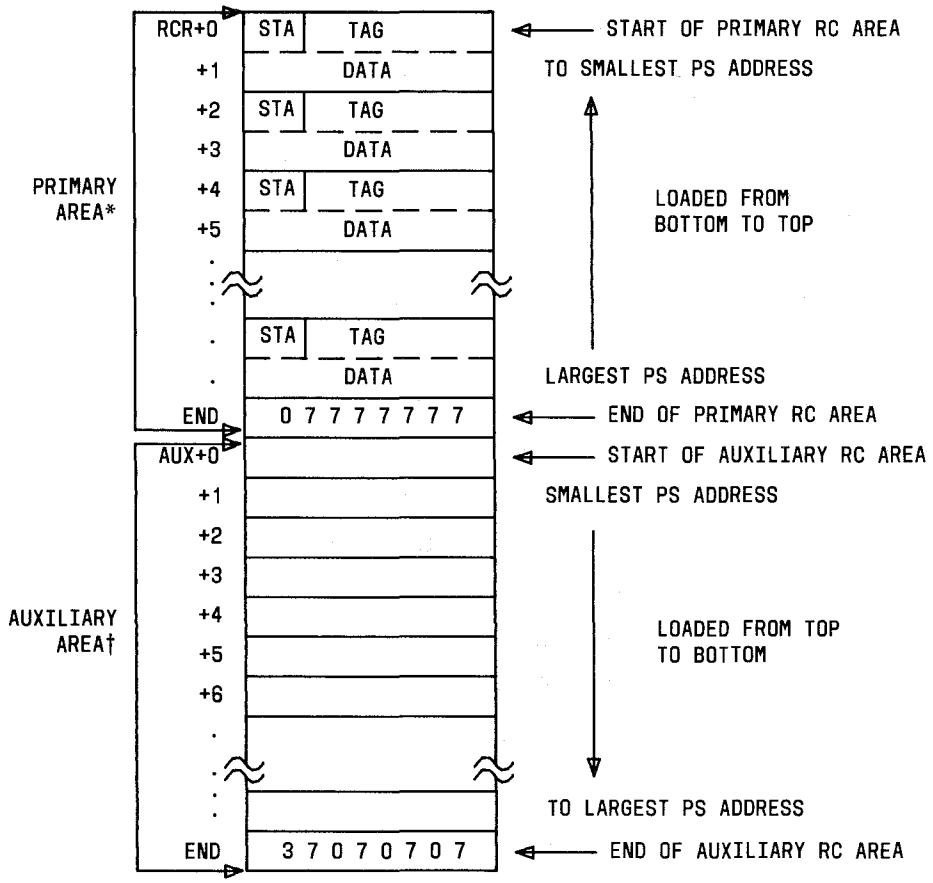
Fig. 2—Translations Available Space and Linkage in Program Store

- 5-word pseudo auxiliary block (needed to define and initialize a subtranslator) or a large block of memory,
- Delayed service order.

Word zero is the FIRST word of an RC auxiliary block.

Block Length is 31 Words or Less

2.16 When the block length is 31 words or less, the address of the RC auxiliary block (temporary auxiliary block indicator bits 22-18 equals 0) points to the first word in the RC auxiliary block. The first word in the RC auxiliary block



LEGEND:
RCR - RECENT CHANGE REGISTER
STA - STATUS BITS (BITS 22 AND 21)
* - THE PRIMARY RC AREA START AND END ADDRESSES ARE F4HHTC+2 AND F4HHTC+8 RESPECTIVELY.
† - THE AUXILIARY RC AREA START AND END ADDRESSES ARE F4HHTC+5 AND F4HHTC+9 RESPECTIVELY.

Fig. 3—Recent Change Area in Call Store Memory

contains WRDN (bits 22-18) which indicates the number of words in the program store version of the auxiliary block. The minus 1-word preceding the RC auxiliary block contains the permanent auxiliary address (PAA). This address is the STARTING address of a reserved block of PS memory where the auxiliary block will be written. The minus 1 word of the auxiliary block is not cardwritten. See Figure 4 for an example of this RC auxiliary block.

Block Length is 31 Words or Greater

2.17 When the auxiliary block length is 31 words or greater, the address of the auxiliary RC points to the first word in the auxiliary block. The first word in the auxiliary block contains zeros in bits 22-18 and the remainder of the word (bits 17-0) may or may not contain data. The true length (number of words in the auxiliary block) is located in the minus 1 word. The PAA is located

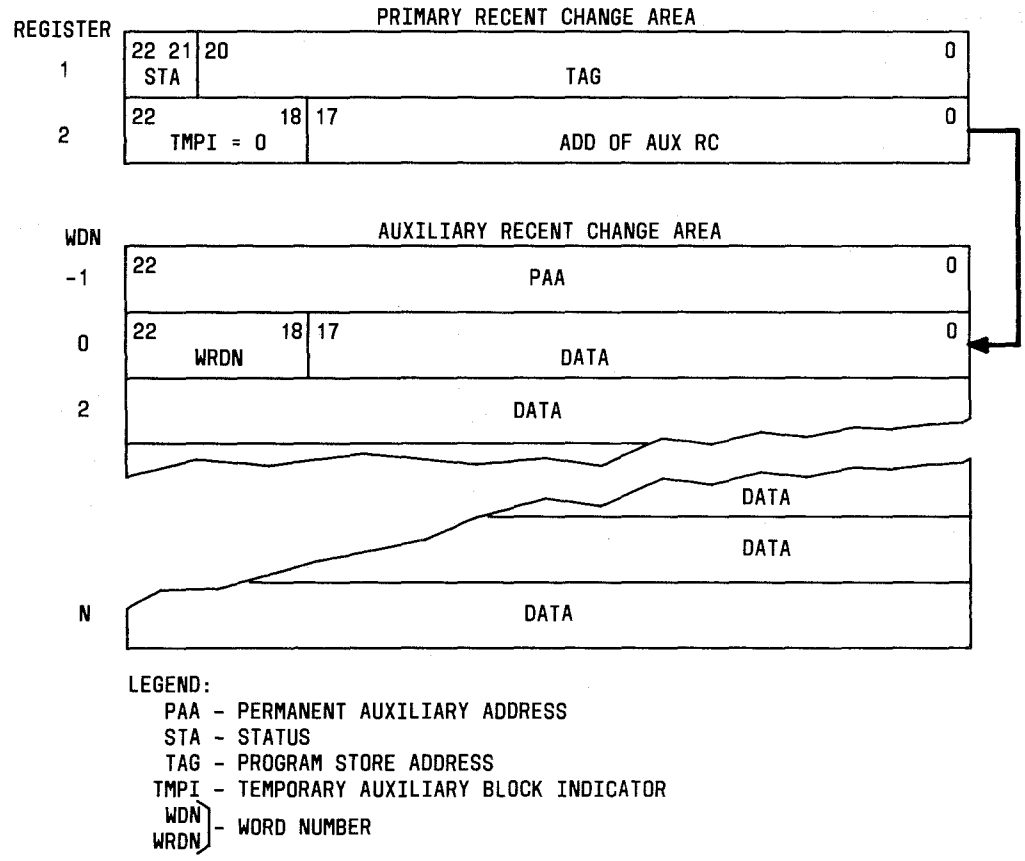


Fig. 4—Recent Change Type 2 Entry (Auxiliary Block < 32 words)

in the minus 2 word. The minus 2 word in the RC auxiliary block is not cardwritten, while the minus 1 word is cardwritten. See Figure 5 for an example of this RC auxiliary block.

2-Word Pseudo Auxiliary Block

2.18 Since nonzero data with five leading zeros (bits 22-18) cannot be stored in the PTW of a permanent RC without being interpreted as an address of an RC auxiliary block, a 2-word pseudo auxiliary block is required. The 2-word pseudo auxiliary block occupies 3 words of RC auxiliary memory and has the same format as an auxiliary block with a length greater than 31 words. An exception to this is that the minus 1 word contents, instead of being greater than 31, will be equal to 2. The first word contains zero in bits 22-18 and nonzero data in bits 17-0. The minus 2 word of the RC auxiliary block [TAG (1)], bits 20-0 is equal to the first word in the primary RC (TAG). See Figure 6 for an example of this RC auxiliary block.

5-Word Pseudo Auxiliary Block

2.19 The most common use is for initializing new subtranslators. The 5-word pseudo auxiliary

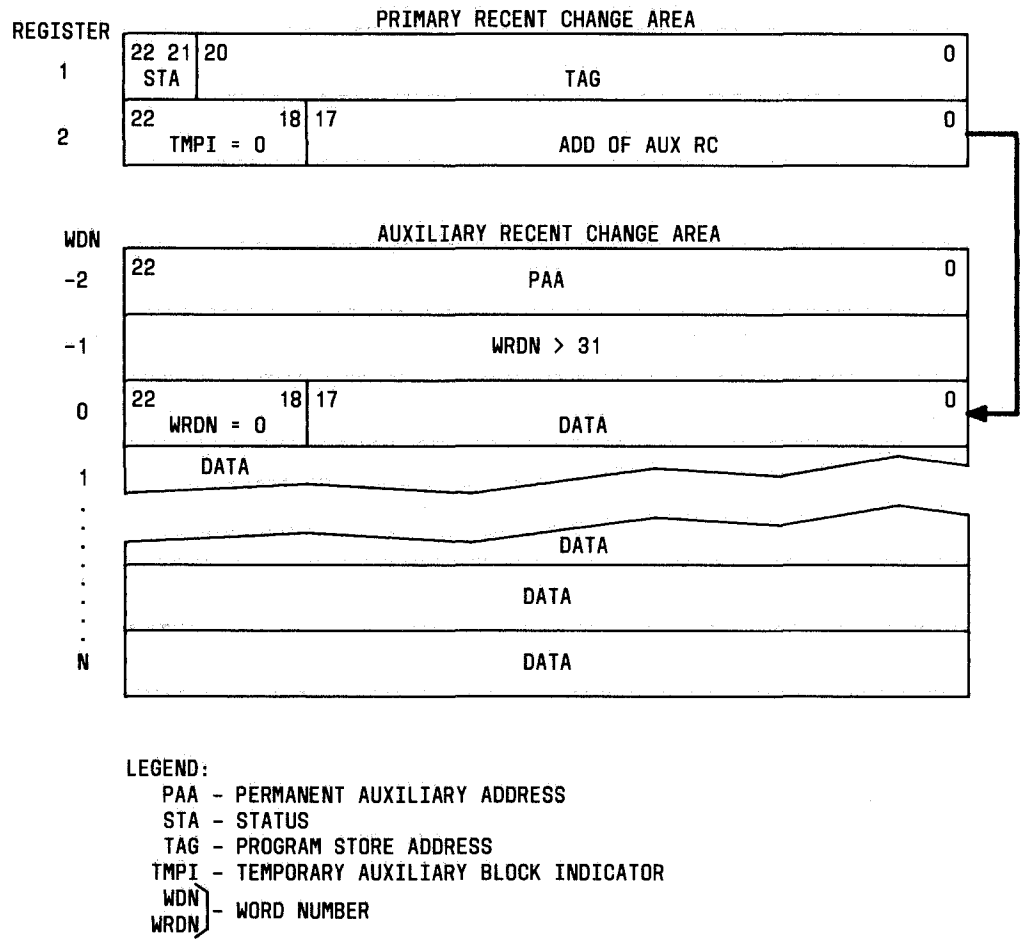


Fig. 5—Recent Change Type 3 Entry (Auxiliary Block >31 words)

block (occupying a 6-word block of call store) is used in translation growth to initialize each word of a large block of program store to the same given data. The address contained in the PTW word in the RC register points to the first word, word zero in the auxiliary block. The first word in the auxiliary block contains zeros. The minus 1 word contains the block length of 5. The minus 2 and second words of the RC auxiliary block contain a TAG equal to the TAG contained in the TAG word of the primary RC area. If bit 22 of the second word equals 0, left half 14-bit words in even and odd address of PS are to be initialized. If the bit equals 1, left half 23-bit words are to be initialized. The third and fourth words of the RC auxiliary block contain the length of the PS block to be initialized and the initialization data respectively. See Figure 7 for an example of this RC auxiliary block.

Delayed Service Order

2.20 The TAG is normally the address of the program store word that may be changed. Each delayed RC service order has a service order number where the TAG is normally contained (in

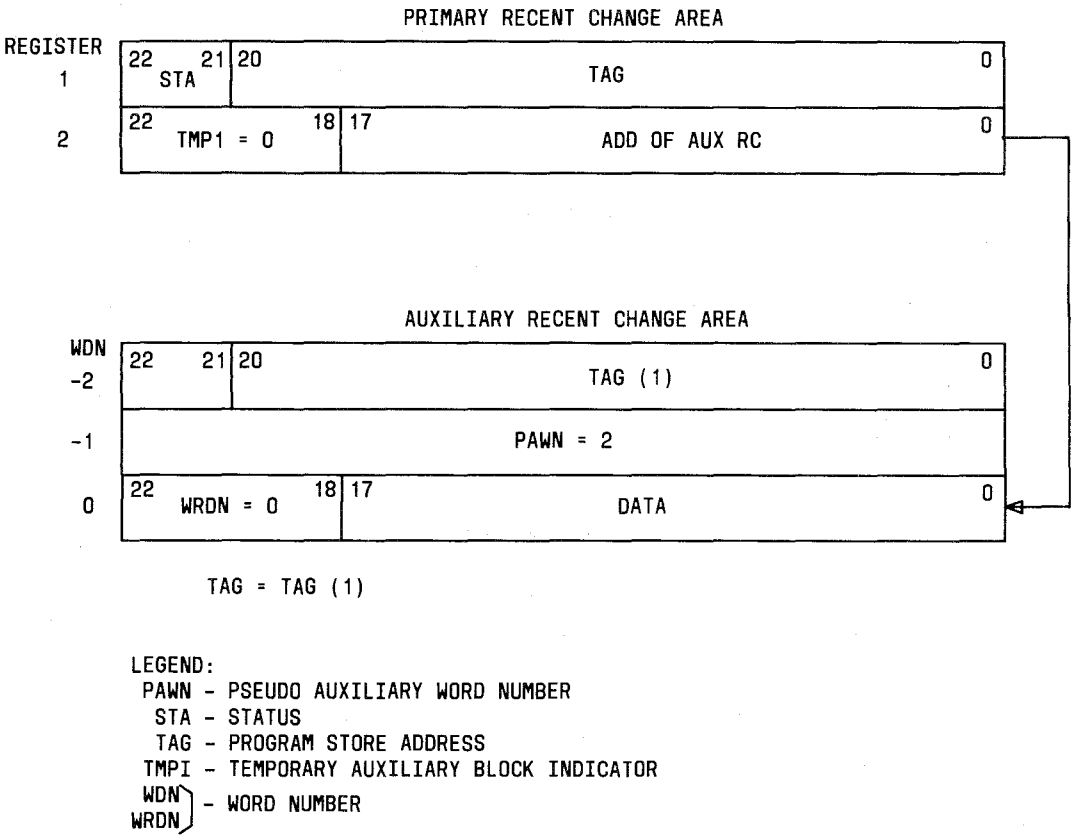


Fig. 6—Recent Change Type 4 Entry (Pseudo Auxiliary Block)

the primary RC register). A delayed RC service order is neither effective nor cardwritten until the message is activated. See Figure 8 for an example of this RC auxiliary block.

Auxiliary RC Consolidation

2.21 Consolidation of the auxiliary RC area takes place for one of the following three reasons:

- Once a day on a programmed scheduled basis,
- Because of a TTY request, or
- After card writing is completed (RC update).

2.22 Consolidation is necessary because of holes which develop during the normal course of service order activity. For example, a primary recent change may have been deleted and the auxiliary block associated with this change is no longer required. The consolidation routines consist of hunting the primary recent change for active auxiliary block entries, and repacking these blocks as tightly as possible, from the beginning of the auxiliary area.

3. BROKEN LINK LIST RECOGNITION

3.01 There are several ways to recognize broken link lists in translations. The type of problem and where the problem is located are factors that determine the type of output the system generates. The list could be looped within itself, broken at the head table location or anywhere in the list. Figure 1 shows examples to two possible problems. Keep in mind that Figure 1 is a symbolic

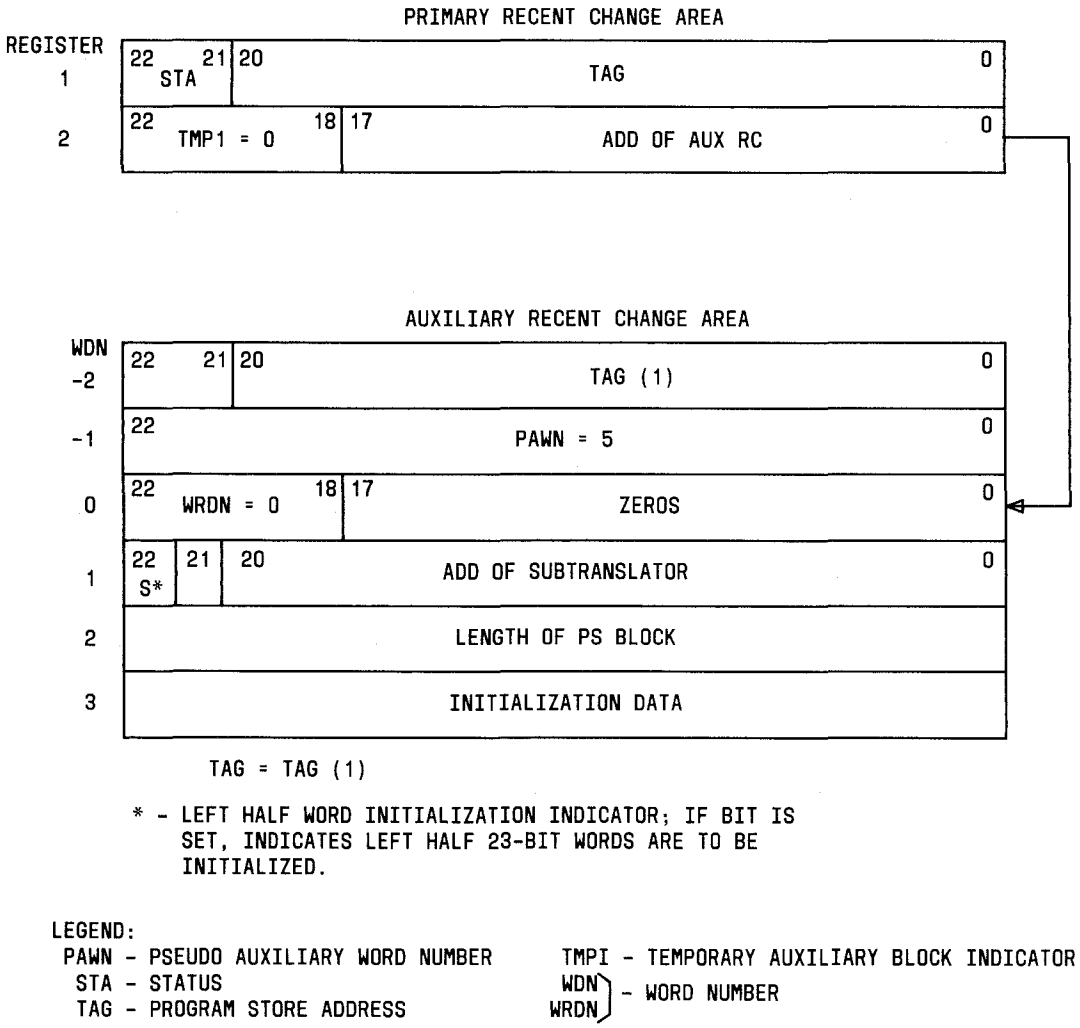


Fig. 7—Recent Change Type 5 Entry (New Subtranslator)

layout and that the actual layout will differ from what is shown there in.

LOOPED LINK LISTS

3.02 When a link list is looped within itself, a three line TR13 output message will result when the VFY-SPACE search is requested. The first line of the TR13 output is the LAST VALID LINKED ADDRESS. The second line can be the LOOPED ADDRESS or the BAD DATA. The third line is the OCTAL NUMBER OF LINKED BLOCKS preceding and including the block with suspected bad data. The address of the block with suspected bad data is found in line 1 of the TR13 message. An example of the TR13 message is as follows:

TR13 0 2

01721417◀ Last good address where bad data is suspected

02134105◀ Bad data

00000110◀ Number of addresses linked together.

The above printout is only an example.

SYSTEM AUDITS

3.03 Another indication that something is wrong in the Call Store Translation recent change area is the SA03 ERROR type audit. The SA03 ERROR 00 00 audit concerns pident RCUP and checks for invalid recent change data. The SA03 ERROR 04 04 audit also concerns pident RCUP and checks for invalid multiline hunt group data. The SA03 ERROR 04 07 audit concerns pident

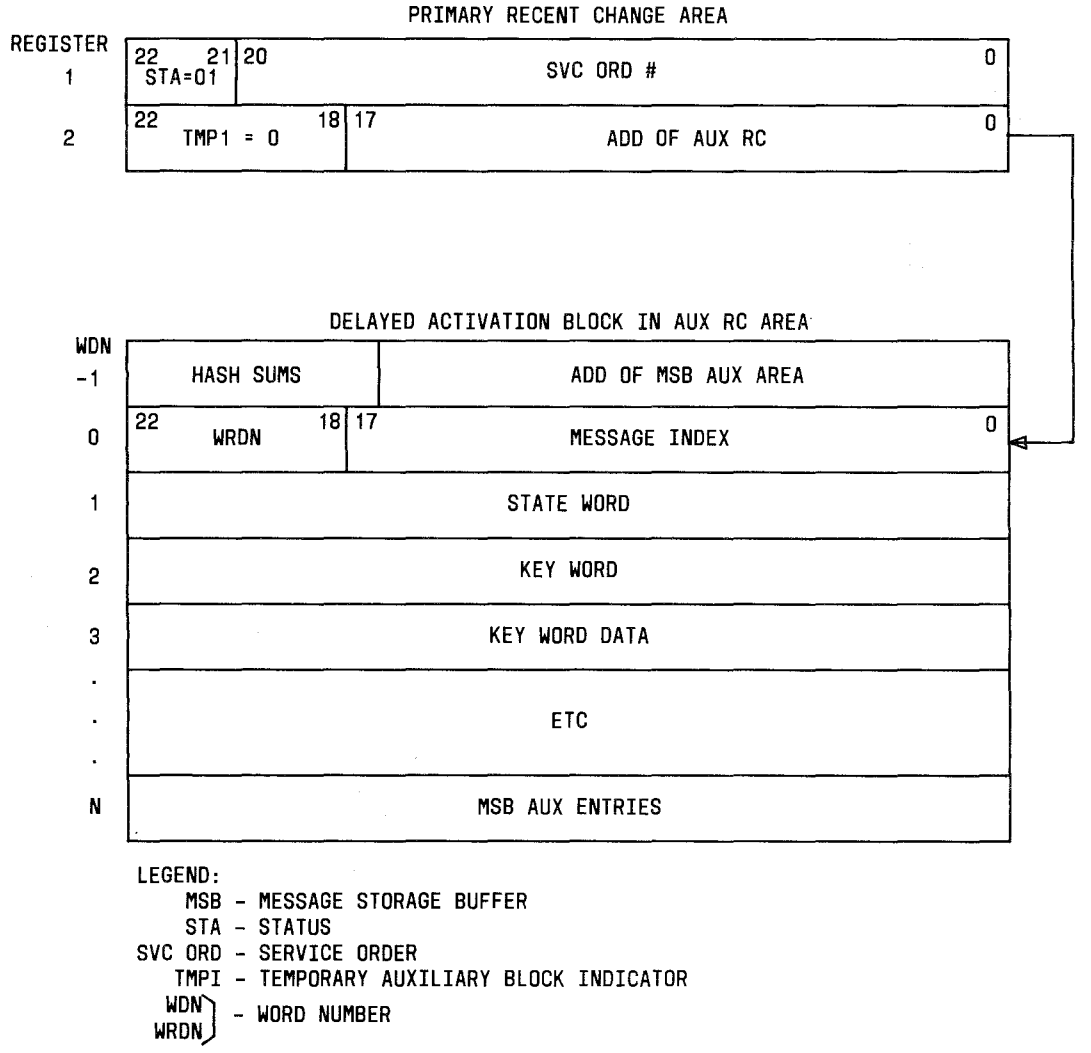


Fig. 8—Recent Change Type 6 Entry (Delayed Service Order)

SALT and checks for insufficient space for 2-way trunk activity words. These are all critical audits and could be caused by a broken link list.

3.04 In addition, there are several SA03 ERROR 04 type audits, though less critical than those mentioned above, that could be caused by link list problems resulting in multilated recent change memory. Refer to Section 231-112-303 for a more in depth analysis of the SA03 type system audit.

RC-CMODS

3.05 A quick check of all link lists can be made using the VFY-SPACE message. After a 10-line TR13 message is printed for each list, an RC-CMODS message can be inputted. This message requests that the system report those program store modules that have recent changes against them. The resulting RC05 message's information blocks can be checked to make sure that the recent change flags are set for translation modules only. Should a generic module show up on the RC-CMODS RC05 printout, the procedure given in Figure 9 can be used to remove the problem.

3.06 Normally, just an RC05 message will be printed out in response to the RC-CMODS input. There are two sets of information contained in the RC05 printout. The first set is the active copy of translations and is the program store H-half. The second set is for the standby copy and is the program store G-half. The RC-CMODS validates all tags in the primary and auxiliary RC area that have an active status. The RC-CMODS message looks at tags for reasonableness. Out-ot-range TAGs may result in D- or E-level interrupts. Therefore, an E-level interrupt could also follow

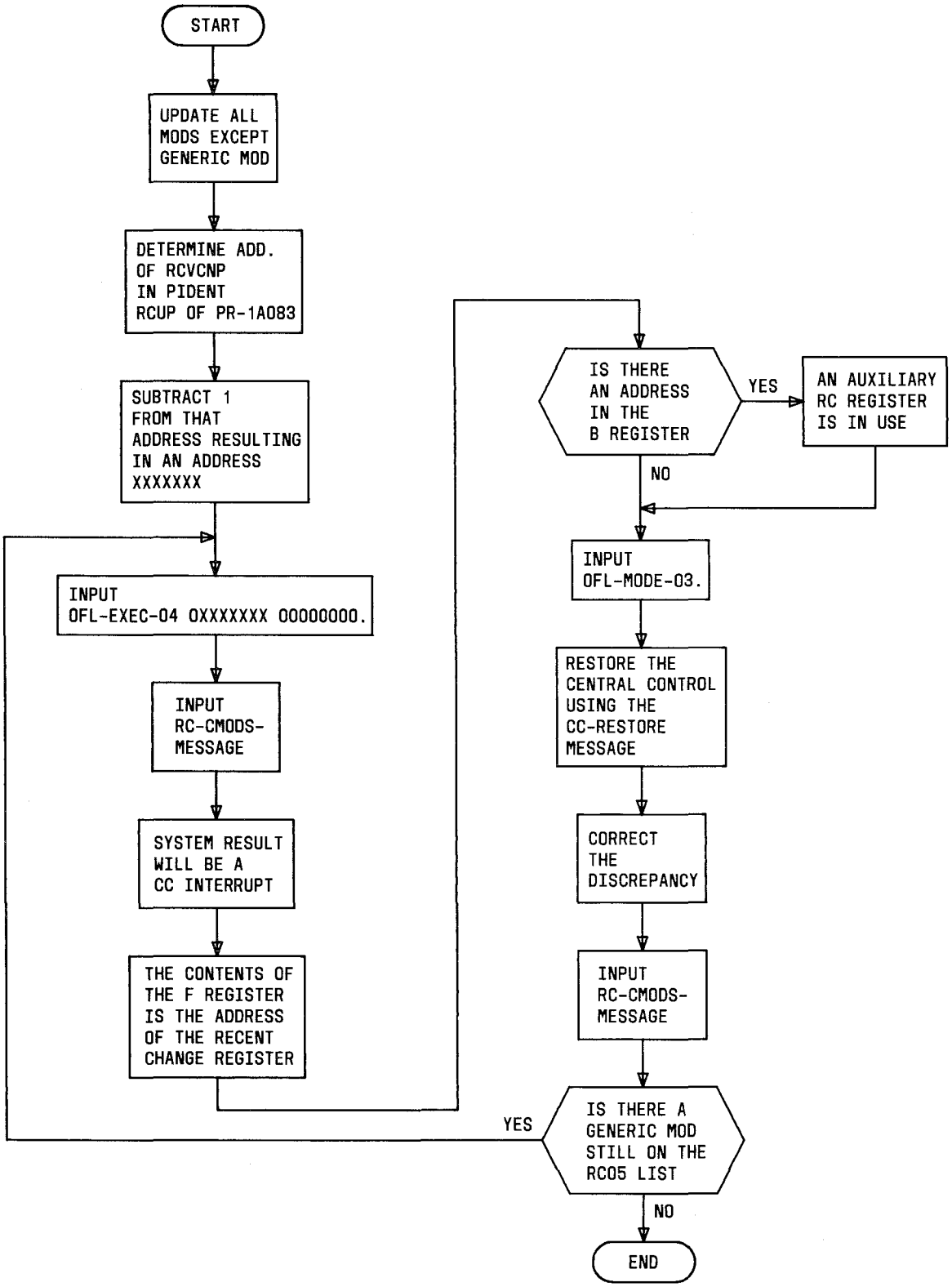


Fig. 9—Procedure for Removing Generic MODS From RC CMODS List

RC-CMODS if trouble on TAGS is present. Refer to Section 231-112-304.

4. BROKEN LINK LIST REPAIR

4.01 The most important point to be remembered when repairing broken link lists is that accuracy and not speed is what counts. Rushing through a repair procedure could lead to drastic results caused by inadvertent mistakes made in haste. Also, any vertification data taken (TR13's for example) at a previous cardwrite should be kept for future reference.

4.02 Keep in mind when shooting link list troubles, that there can be a recent change entry against a TAG on the link list which will supercede the address that is on hard copy (PS). Therefore, the VFY-PSWD message should always be used to pick up these recent change entries rather than the T-READ message.

GENERAL METHODS OF REPAIR

4.03 To correct the incorrect data, several methods may be used. Of primary importance is where the list is located that is in trouble. If it is in program store (written on cards) an interim fix using the RC:PSWD message creates a new recent change in call store with the correct information. The fix becomes permanent only through card writing. If the problem with the list is in call store (recent change area) there are different approaches that can be taken. The method depends upon the severity of the problem and office activity as well as other factors.

4.04 Either the RC:PSWD message or the T-WRITE message can be used to insert good data into the recent change primary area once the incorrect data is found. The T-WRITE message is more dangerous, in that, any service order recent change activity could displace the bad location in the RC area that was read via the T-READ message. Then, when the good data is written, other good recent change information may be inadvertently overwritten. This can cause severe translation problems and of course customer complaints. Service order activity should be stopped when using the T-WRITE message. The displacement of the bad location is caused by the recent change programs ordering (smallest to largest PS address from top of the primary area to the bottom) recent change entries in the primary RC area. Refer to Figure 3.

> ***Note:*** With the 1E6 generic program, the VS-DATA message is available to dump (read) large (up to 1024 decimal words) amounts of memory instead of using the T-READ message that dumps a maximum of 16 decimal words. In the 1E7 generic program, this message is the VF-DATA message.

4.05 Use of the RC:PSWD message overcomes the displacement difficulty because it creates a new recent change entry containing good data and then zeros the status bits of the old recent change entry containing the bad data. The new RC entry created by the RC:PSWD message is automtically ordered in the primary RC area by the recent change programs.

LOOPED LINK LISTS

4.06 As mentioned previously, if a link list is looped within itself, a three line TR13 message results when the VFY-SPACE search is requested. To locate the trouble, look at the first word in the TR13 message which is the address of the last properly linked block. Once the last properly linked address in the preceding block has been found by inspection, use the VFY-PSWD message to step through the troubled block until the source of the failure is located. Then, using the RC:PSWD message, zero the contents of the last properly linked block. Use the MOD 5 auxiliary program to relink the blocks. See Section 231-151-302.

CROSSED LINK LISTS

4.07 Crossed link lists are a different problem and can be caused by inadvertently returning a block of memory to the wrong sized list. When lists are crossed, the same program store addresses of one size blocks (eg, 3-word blocks) can appear on another sized blocks (eg, 4-word blocks) list. These addresses will be part of the TR13 message resulting from a VFY-SPACE message.

4.08 The problem should be cleared by the Switching Control Center (SCC). The SCC has available a specific command (ANAL:SORTADD) to filter all TR13 messages that have been generated at an ESS via VFY-SPACE input messages. The SORTADD command processes these TR13 messages and generates a report listing duplicate or adjacent

blocks of spare memory in the ESS. Then, the maintenance personnel should clear the link list problem at the ESS. Then, a second SORTADD command should be requested of the SCC to verify that the corrections made to the list(s), in fact, did correct the problem.

MANUAL REPAIR

4.09 Manual repair methods of link list problems consist of basically searching the primary or auxiliary recent change areas for discrepancies. If a TR13 message is printed out, the method used is to search the primary RC area for the RC register containing the last address in the TR13 output. If the TR13 output is three lines, a search is made for the address contained in line ***one.*** A definite linkage develops until the discovery of bad data. The bad data (status bits, TAGs, TMPIs, or auxiliary RC area addresses) can be corrected using a T-WRITE or an RC:PSWD message. A reverification of that list should show it as being restored.

4.10 If the data word looks like the first word of an auxiliary block with the exception of bits 18-22 being all zeros, the data word actually may be an indicator for either a temporary auxiliary block or a pseudo auxiliary block located in the auxiliary recent change area of call store. These items were described earlier in this section.

> ***Note:*** This paragraph deals with translations problems and not specifically link list problems. This is because link list entries are never entered in the auxiliary RC area.

4.11 If a translations problem is suspected as being in the auxiliary RC area, another method is used. This method involves T-READing the auxiliary RC area itself. It is important to T-READ only the ***active*** auxiliary area. To T-READ only the area which is active, first T-READ 14074 (F4HHTC+5) which is the start of the auxiliary RC area. The next is to perform an RC-UPDATE which consolidates the auxiliary area leaving ***no*** holes. Then a T-READ of 17210 (V4RCTR+1) will yield the next available auxiliary RC address location which will be used by the change programs. The contents of V4RCTR+1 is the end of the ***active*** auxiliary RC area. Generally, this area is not too large between card writing, but depends mainly on the types of service order activity. The data in this area is laid out in PF 1A083 for pident RCUP. Careful investigation yields the pattern layout to TAGs versus the auxiliary information. Use the RC:PSWD or T-WRITE message to correct the translations problems and verify that the auxiliary RC area is contiguous after the corrections have been made.

PROGRAM STORE OVERLAPS

4.12 Injudicious or erroneous use of the RC:PSWD or T-WRITE messages can result in overlaps of translation data program store. There is an auxiliary "MOD 5" program called translations check (XLCK) that finds PS overlaps. The erroneous recent changes, however, must be detected prior to any card writing activity.

> ***Note:*** The VFY-SPACE message will ***not*** detect program store overlaps or crossed link lists.

4.13 A search through the recent change area can find these errors, but it is time consuming and can block customer originated recent changes. To prevent this from happening, a method is used to allow periodic insertions of recent changes during the execution of the search for errors. This same method of allowing RC insertions can also be used to solve another problem. Recent change consolidation, which removes deleted auxiliary blocks and packs the remaining auxiliary blocks at the beginning of the RC auxiliary area, can also block customer-initiated recent changes.

4.14 During the card writing interval, the recent changes that are being transcribed onto the PS cards are left unaltered. After all the affected PS modules are written, the unduplicated permanent RC information in call store should match the ***updated*** program store. The RCs that match are deleted (status bits changed to zero). When all unduplicated permanent entries are deleted, the card writing period ends and the RC area is returned to the normal (unfrozen) state.

4.15 If there are any unduplicated permanent recent changes that mismatch, they must be detected and corrected. If the card writing mechanism is error free, the mismatches occur because the newly written RCs caused the PS overlaps. This happens when more than one RC changed the contents of the same PS address. These erroneous RCs can exist, as mentioned previously, because of a program bug or wrong

data inserted in the RC area with the T-WRITE or RC:PSWD messages.

4.16 The overlap check (OVCK) program is designed to detect erroneous RCs that would cause PS overlaps if card written. It does not find overlaps of new data with old pre-cardwrite data since no information on the latter is contained in recent changes. The program is requested via the input messae RC-OVCK. It should be called prior to freezing the recent change area when the RC area is in the normal state.

4.17 For any error, the TAGs of the RCs involved in the overlap as well as the future PS addresses and the length of the auxiliary block or subtranslator are printed in an RC23 output message. After finishing the check on the address range of the block in question, the program determines if this block overlaps any other block in the RC area. Since the TAGs are in ascending order, only RC registers for higher valued TAGs need be analyzed. The program store range of every auxiliary block and subtranslator not previously analyzed are computed and compared against the addresses of the blocks in question. If an overlap is found; the TAGs, future program store addresses, and lengths of the two blocks are printed in the RC23 output message. The explanation of the output message shows what block is being overlapped and whether a TAG or another block is overlapping.

MESSAGES USED IN LINK LIST REPAIR

4.18 Table B lists the input and output messages most often used in examining and repairing link lists. A brief description of the messages is given in the table as well as the corresponding input or output message if one is required to generate the message given in the table. It is important to understand the various messages and what they can do in aiding the repair procedure. For more detail refer to the No. 1 ESS input and output message manuals. Also, Switching Control Center (SCC) link list analyzation capabilities were discussed earlier.

LAST RESORTS IN LINK LIST REPAIR

4.19 There are two last resorts used to get an office out of link list troubles. Their use depends upon the mode that the office is in. They are:

- Zeroing translation words and,
- Translations repack.

4.20 When the office appears to be running normally between card writes and a link list problem is found, several procedures for locating and correcting the problem were given previously. If these procedures fail and the office gets into deeper link list trouble, it may be best to zero the affected PS words in the primary recent change area.

Caution: Zeroing translation words results in the loss of the remainder of the particular link list being corrected.

4.21 If the translation area in program store is almost full, a translation retrofit repack (TRR) is the best way to proceed. The principal function of the TRR system is to produce a memory card magnetizing (twistor) tape that contains the complete translation data recovered from an in-service office, functionally identical but in a repacked form. The main purpose of repacking translations is to consolidate the small "holes" left in program store memory by recent change activity into large "holes", thereby, making more space available for subsequent translations changes. Another use for TRR is to "move" translation, if required for any reason, from one range of memory blocks to another. A translation area analysis (TAA) is included as part of each TRR and provides listings of the structural defects in the translation area. If time is available, these defects may be corrected during TRR processing. The only disadvantage in obtaining a TRR is the cost.

4.22 If the office happens to be in the process of a card write and errors are found, it is desirable to "back out" of the card write. This is accomplished by inserting all previous (old) cards [that have had updated (new) cards] written for them back into the program stores and zeroing the RC area via the RC:PSWD message. The PSs should then look like they did before this card write started. Once the corrections are made and verified, the card write can be started again.

TABLE B

INPUT AND OUTPUT MESSAGES USED IN LINK LIST REPAIR

MESSAGE	INPUT (I) OR OUTPUT (O)	RESPONSE IF ANY OR INPUT	DEFINITION
RC-CMODS-.	I	RC05 or RC03	Requests report of those PS MODS that have RCs against them.
RC-FREEZE-.	I	PF	Sets an indicator showing that cardwriting is in progress and permits only RC information entered before this message to be card written.
RC-OVCK-.	I	PF and RC23	Performs overlap check which requests the system to find all RCs that exist in CS and, if card written, would cause invalid PS overlaps.
RC:PSBLK	I	PF	Used to seize from or return to the link list, a specific size block of memory.
RC:PSWD	I	PF	Used to write data at a PS address contained in the RC area.
RC:UPDATE	I	RC01, RC02, or RC04	Requests system to update the RC area of CS. Used after all PS MODS being updated are written, verified, and duplicated.
RC:XXTHAW	I	PF	Used only in offices with the RC protection during cardwriting feature (9GCWP). *This is an emergency action only.* It removes the duplication identifying RCs entered since the RC-FREEZE message. Cardwriting must start over, and RC information may be discarded to avoid inconsistencies in translations. This allows recovery from problems which *are not* discovered until after cardwriting began and which must be corrected before it can continue by cardwriting data.
T-READ-	I	TW02	Used to request that the system read a number of consecutive words (16 max.) from memory (either CS, PS, buffer registers or SP internal registers).
T-TRAN-	I	TW02	Requests that the system read a number (16 max.) of consecutive 23-bit translation items stored in the left-half of program store.
T-WRITE	I	OK	Used to change the contents of a memory location.
VFY-PSWD	I	TR34	Requests the system to verify a certain PS address.
VFY-SPACE	I	TR13	Used to obtain information pertaining to the link list; either the number of blocks of a specified length or, a list of available space of a specified length.
VS-DATA (1E6)	I	TR100	Requests the system to dump large (up to 1024 decimal words) amounts to memory.
VS-DATA (1E7)	I	TR100	

TABLE B (Contd)

INPUT AND OUTPUT MESSAGES USED IN LINK LIST REPAIR

MESSAGE	INPUT (I) OR OUTPUT (O)	RESPONSE IF ANY OR INPUT	DEFINITION
RC05	0	RC-CMODS-	Reports those PS MODS which have recent changes against them.
RC03	0	RC-CMODS-	Reports RC area consolidation not permitted because system is not in proper configuration.
RC23	0	RC-OVCK-	Each message contains information on two RCs that would cause an invalid PS overlap.
SA03 ERROR	0	—	An audit or a system program has found a trouble in the CS memory; could be caused by a hardware or software error.
TR13	0	VFY-SPACE	Prints translation information pertinent to the link lists. This is either the addresses and block lengths or the number of blocks of a specified length.
TR34	0	VFY-PSWD	Prints the contents of a PS address and all RC information pertaining to this address.
TR100	0	VS-DATA VF-DATA	Prints the information (memory locations and amount) requested in the VS-DATA or VF-DATA messages.
TW02	0	T-READ or T-TRAN	Prints octal contents of a memory block in response to an input message, a translation error, an out-of-range address, an EA phase, or a manually initiated off-line mode.

5. ABBREVIATIONS

TERM	ABBREVIATION
ASR	Address Storage Register
CS	Call Store
LSB	Least Significant Bits
MHT	Master Head Table
MSB	Most Significant Bits
PMT	Path Memory Table
PS	Program Store
PSBLK	Program Store Block
PSWD	Program Store Word
PTW	Primary Translation Word
PUAB	Peripheral Unit Address Bus
RC	Recent Change
RCR	Recent Change Register
REG	Register
VFY	Verify
WRDN	Word Number