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EVALUATION OF MAINTAINABILITY ENHANCEMENT
FOR TCP/TSP REVISION 6.0 UPDATE .20

Norman F. Schneidewind

February 1982

Final Report: 1 Jan 80 to 1 Jan 82

Approved for public release; distribution unlimited

Prepared for:
The Trident Command and Control Systems Maintenance Agency
Newport, Rhode Island

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A system of documentation which was designed to aid programmers of the Command and Control System Maintenance Agency (CCSMA) in maintaining the Trident Command and Control System software was evaluated. This system is called "Maintainability Enhancement for TCP/TSP Revision 6.0 Update .20" or simply 6.0/.20. It is essentially a hierarchical method of charting software procedures and the relationship between procedures. The difficulty of trying to overlay a structured documentation technique on programs which are inherently non-structured (written in low-level language and patched) is		

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discussed. Discrepancies which arose between the newly constructed charts and the original listings are highlighted. A conclusion of this study is that rather than improving clarity, applying structured documentation to non-structured programs may result in the opposite effect--incomplete, inconsistent, and ambiguous documentation--because a hierarchical format cannot adequately represent a non-hierarchical program.

SECNAVINST 3560.1 and MIL-STD 1679 (Navy) are considered by CCSMA to be relevant documents for maintenance purposes. Therefore, the documentation system was checked for conformance with applicable sections of 3560.1 and 1679. In addition, the documentation system was compared with applicable sections of FIPS PUB 38, published by the National Bureau of Standards. Although officially FIPS PUB 38 applies to ADP and not to embedded computer systems, it provides good guidelines for program documentation and maintenance. It was found that 6.0/.20 does not include coverage of many of the applicable sections of the three documents.

SUMMARY

Trident CCSMA requested the Naval Postgraduate School to evaluate the "Maintainability Enhancement for TCP/TSP Revision 6.0 Update .20," referred to as 6.0/.20. The approach for accomplishing this task was to compare 6.0/.20 for compliance or conformity with applicable sections of SECNAVINST 3560.1, FIPS PUB 38, AND MIL-STD 1679. In addition, a sample of 6.0/.20, Volume 2, was examined in some detail for its usefulness as a software maintenance tool in terms of consistency, completeness, understandability, and absence of errors. Many suggestions for improvement have been made.

Our conclusions are that 6.0/.20:

- Does enhance maintainability. However, we believe listings alone, even if they are structured, are inadequate for maintenance purposes.
- Does not include coverage of significant applicable items called for in 3560.1, FIPS PUB 38, and 1679.
- Appears to be incomplete and to contain a moderate amount of inconsistencies, ambiguities, and errors.
- Could provide an excellent software maintenance tool if its quality were improved in accordance with the suggestions made in this report.

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I. INTRODUCTION

A. Purpose

Trident CCSMA has requested the Naval Postgraduate School (NPS) to evaluate the "Maintainability Enhancement for TCP/TSP Revision 6.0 Update .20" documents, subsequently referred to as 6.0/.20, with respect to its usability for maintaining Trident Command and Control System software.

B. Approach

It is understood that one of the governing documents for the production and use of Trident software is "Department of the Navy Tactical Digital Systems Documentation Standards," SECNAVINST 3560.1, 8 August 1974. Therefore, it was deemed appropriate to use this standard as one means of evaluating the subject documents. It was felt that, as a minimum, documentation used on the Trident project should meet the applicable sections of this standard. However, recognizing that this standard was issued many years ago and that the field of software engineering has evolved in the interim, additional criteria which reflect more modern software design and maintenance techniques were used in the evaluation.

The part of 3560.1 which appears to be most applicable to maintenance is the Program Description Document, pages 2-137 to 2-152. As stated in this document, its purpose, in part, is the following: "As a detailed compendium of the subprogram structure, the Program Description document

will serve as the essential instrument for subsequent use by operational, maintenance, and contractor personnel diagnosing troubles, making adaption changes, designing and implementing modifications to the system, and introducing or adding new subprogram functions to the completed program" (underlining added by the author).

Another means of evaluation was with respect to the publication "Guidelines for Documentation of Computer Programs and Automated Data Systems," National Bureau of Standards, Federal Information Processing Standards Publication 38 (FIPS PUB 38), February 15, 1976. As stated in FIPS PUB 38, its purpose is the following: "These guidelines provide a basis for determining the content and extent of documentation for computer programs and automated data systems. Software development phases and related document types are identified, several examples of documentation options are given, and content guidelines for ten document types are provided." Although, officially, this guideline is not applicable to Trident software because it was written to apply to ADP systems under the provisions of Public Law 89-306 (Brooks Bill), which excluded embedded computer systems, it is of technical interest because it is one of the few Federal Government software guidelines which covers program maintenance.

As stated in FIPS PUB 38, "The purpose of the Program Maintenance Manual is to provide the maintenance programmer with the information necessary to understand the programs, their operating environment, and their maintenance procedures." The Program Maintenance Manual is described on pages 45-47 of FIPS PUB 38.

It was also considered important to examine 6.0/.20 with respect to the applicable sections of MIL-STD 1679 (Navy), 1 December 1978,

the Navy's Military Standard for Weapon System Software Development. The applicable section of 1679 is primarily 5.11 Configuration Management, pages 23-24.

C. Scope

In order to ensure good software maintainability, it is necessary to use sound programming methodology and procedures, as well as provide good documentation. It is difficult to evaluate the quality of documentation and not also consider the quality of the product that has been documented, because good documentation of non-structured programs which contain machine language code, although of some benefit, will not result in good software maintainability, nor will good documentation of highly patched programs allow software to be easily maintained. In other words, if programs are inherently difficult to change and understand and may not have been designed with maintainability in mind, documentation may only make a marginal contribution to the improvement of maintainability. Thus, this project poses a dilemma because we have been asked to review and evaluate documentation for programs which are non-structured, contain significant amounts of machine language code, and are highly patched. It is understandable that this is the case, since the programs were designed prior to the availability of a mature structured programming methodology and high level languages for tactical system software development. In addition, although machine language patching is generally considered to be undesirable, for certain administrative and contractual reasons it is a prevalent practice in Navy embedded computer software development. The argument can be made that, because of these practices, good documentation is

even more important in this environment than it would be in those situations where the use of structured programming and high level languages provide a degree of self-documentation. Accordingly, the scope of this paper will be limited to evaluating the adequacy of 6.0/.20 for maintaining the TCP/TSP software, ignoring what is perhaps the more fundamental maintenance issue of the adequacy of the underlying software.

A major assumption of this study which affects its scope is that the 6.0/.20 documentation is to be evaluated independently of the program listings. It is noted that listings are not included in the version of 6.0/.20 dated 29 September 1979, although these were included in a prior version (undated). Quoting from Volume 1 of the version dated 29 September 1979, "The primary goal is to improve this software's maintainability by making the programs and their patches understandable and visible in a single simplified form," (underlining added by the author). The implication which has been derived based on the above statement and the fact that the listings are not included in the latest version, is that 6.0/.20 is to be used for maintenance purposes primarily on a stand-alone basis with listings utilized as a secondary source of information. This interpretation is critical with respect to some of the results obtained in this study, because certain deficiencies in 6.0/.20, which are noted later in this report, regarding such items as data design, tables and indexes, are not addressed by 6.0/.20 but are covered in the listings. If it was the intent to use the listings with 6.0/.20 in a coordinated fashion, it would be helpful to provide a detailed cross-referencing between the two. A method for accomplishing this cross-referencing is suggested

in a later section. The scope of this report is limited to considering 6.0/.20 as an independent tool for maintenance which does not rely extensively on the use of program listings. However, since the flowcharts are based on the program logic, as expressed in the listings, it was necessary to make extensive reference to the listings in this report in order to understand and evaluate 6.0/.20. In fact, a result of this analysis was the conclusion that the two mediums should be used as an integrated documentation package and not in isolation.

II. EVALUATION OF 6.0/.20

A. With Respect to SECNAVINST 3560.1, Program Description Document, Pages 2-137 to 2-152.

The following 3560.1 pages and sections are covered by 6.0/.20:

<u>Page</u>	<u>Section</u>	<u>Title</u>
2-141	1.	Scope
2-141	2.	Applicable Documents
2-142	3.	<u>Requirements</u>
2-142	3.1	Subprogram Detailed Description
2-143	3.2	Subprogram Flow Diagrams
2-148	3.6	Conditions for Initiation
2-149	3.8	Interface Description

The 3560.1 pages and sections which apparently are not covered by 6.0/.20 are identified below. It is possible that these sections are not applicable to certain volumes of 6.0/.20. However, the named missing sections were not found in any of the 6.0/.20 volumes for which copies were provided to NPS, so it is assumed that it was not intended to include these sections in 6.0/.20. A brief description of the intended contents of the missing sections as specified by 3560.1 is given:

<u>Page</u>	<u>Section</u>	<u>Title</u>	<u>Contents</u>
2-144	3.3	Subprogram Data Design	General summary description of the subprogram data base.
2-144	3.3.1	Tables	Detailed description of each table used in the subprogram data base: a. Table name. b. Purpose and type. c. Size and indexing procedure. d. Structure and bit layout.

2-145	3.3.2	Variables	Detailed description of each variable used in the subprogram data base: a. Variable name. b. Purpose. c. Structure and bit layout.
2-145	3.3.3	Flags	Detailed description of each flag used in the subprogram data base: a. Flag name. b. Purpose and status. c. Structure and bit layout.
2-145	3.3.4	Indexes	Technical description of each index used in the subprogram data base: a. Index name. b. Purpose.
2-146	3.3.5	Common Data Base Reference	Complete list of all references to local and common data base items and the location of each reference.
2-146	3.4	Input/Output Formats	Brief description and graphic (sample) representation of each input and output message, card format, tape format, etc. processed by the subprogram.
2-148	3.7	Subprogram Limitations	Summary of any known or anticipated limitations of the subprogram.
2-149	4.	Quality Assurance Provisions	Reference to all applicable test plans and procedures that have been used for verification of the subprogram. (6.0/.20 should reference the Trident Test Specification Requirements and Test Procedures which are described in Refs. 1 and 2.)

NOTE: It was not possible to determine whether Section 3.5 Required System Library Subroutines was covered by 6.0/.20 because it was not known whether library subroutines were used.

B. With Respect to FIPS PUB 38, Program Maintenance Manual , Pages 45-47

The following Program Maintenance Manual sections are covered by 6.0/.20:

<u>Section</u>	<u>Title</u>
<u>1.</u>	<u>General Information</u>
1.1	Summary
1.2	Environment
1.3	References
<u>2.</u>	<u>Program Descriptions</u>
2.1	Program Identification
2.1.1	Problem and Solution Method
2.1.2	Input (description of)
2.1.3	Processing (logic, linkages, error handling)
2.1.4	Output (description of)
2.1.5	Interfaces
2.1.7	Run Description
<u>3.</u>	<u>Operating Environment</u>
3.2	Support Software
3.2.1	Operating System
3.2.2	Compiler, Assembler

The Program Maintenance Manual sections which apparently are not covered by 6.0/.20 are identified below. The caveats that were stated relative to 3560.1 also apply to this section.

<u>Section</u>	<u>Title</u>	<u>Contents</u>
2.1.2	Input	Layout, medium, codes, units of measurement, format, range of values or reference to a data element dictionary.
2.1.3	Processing	Variables, constants, restrictions, switches, flags.
2.1.4	Output	Layout, medium.
2.1.6	Tables	Identification, content, location, structure, purpose.
3.1	Hardware	Equipment required for operation of system and for each program.
3.3	Data Base	Description of data bases used or reference to a data element dictionary (codes, units of measurement, format, range of values).
<u>4.</u>	<u>Maintenance Procedures</u>	
4.1	Programming Conventions	Identification and descriptions.
4.2	Verification Procedures	Description of procedures to check the performance of programs, in general and following modification. Reference to test data and testing procedures. (6.0/.20 should reference the Trident Test Specification Requirements and Test Procedures which are described in Refs. 1 and 2).
4.3	Error Correction Procedures	Description of error conditions, sources and procedures for correction. (6.0/.20 should reference the Trident CCS Problem Reporting and Modification Systems which are described in Refs. 1 and 2.)
4.4	Special Maintenance Procedures	Description of special procedures which change with time or conditions (e.g., change of parameters, algorithms).
4.5	Listings and Flowcharts	Information about how to obtain copies of listings and flowcharts.

NOTE: It is possible that Section 3.3 Data Base is not applicable to any of the programs documented by 6.0/.20.

C. With Respect to MIL-STD 1679 (Navy), Configuration Management,
Pages 23-24

The following configuration management sections of 1679 are covered by 6.0/.20:

<u>Section</u>	<u>Title</u>
<u>5.11</u>	<u>Configuration Management</u>
5.11a	Positive identification of all program components
<u>5.11.1</u>	<u>Configuration Identification</u>
5.11.1.1	Baselines
<u>5.11.1.2</u>	<u>Documentation Identification</u>
5.11.1.2a	Component
	b. Purpose
	c. Baseline
	d. Serial, edition and change status

The sections which apparently are not covered by 6.0/.20 are identified below. The caveats that were stated relative to 3560.1 also apply to this section.

<u>Section</u>	<u>Title</u>
5.11b	Treatment of proposed changes to components under configuration control.
5.11c	Implementation of approved changes and dissemination of corrected documentation and program changes.
5.11d	Recording of status of all proposed changes.
5.11e	Verification of change control, identification and status account of documentation and program materials.

- | | | |
|----------|---------------------------------------|--|
| 5.11.2 | Configuration Control | Procedures for formal control of all documents, program materials and support library shall be established. |
| 5.11.2.1 | Software Changes | Proposed changes to software which is under configuration control shall be submitted to the appropriate software configuration control boards. |
| 5.11.2.2 | Documentation Changes | Procedures for controlling preparation and dissemination of changes to documentation shall be developed. |
| 5.11.2.3 | Software Configuration Control Boards | Each baseline plus approved changes from those baselines shall be under the formal control of a responsible board. |
| 5.11.3 | Configuration Status Accounting | Procedures to enable the generation of periodic status reports on all components under configuration management shall be established. |

With respect to the above sections, 6.0/.20 should reference the Trident CCS Problem Reporting and Modification Systems and the Configuration Management System which are described in Refs. 1 and 2.

III. OTHER COMMENTS

The following comments pertain to 6.0/.20 Volume 2, using it as an example.

A. Functional Description, on Pages 3-1 to 3-3

1. The discussion would be more meaningful if it were keyed to the hierarchical structure diagrams and to the flowcharts. For example, definitions and descriptions of pertinent interrupts should be provided, including important symbolic addresses which are utilized. This information and the interrupt numbers should be related to the diagrams.

2. Sub-headings for the various sections, such as "Interrupt Handling," would make the text more readable.

3. Some typos were observed which affect understandability. For example, the fifth line in the second paragraph on page 3-3.

4. Although this comment does not concern quality of documentation, it was noted on page 3-2 that the control memory test for all zeros and all ones should be preceded by setting the relevant portions of main memory to non-zero and non-one data, respectively, prior to the transfer of control memory to main memory.

B. Hierarchical Structure Diagrams

1. Hierarchical structure diagrams and flowchart symbols should be defined at the beginning of each volume. It is not clear that these diagrams strictly adhere to ANSI standards (see Reference 3).

2. A consistent hierarchical structure box numbering system should be utilized which would indicate at a glance two important pieces of information: the function (e.g., "Periodic Entry") to which the routine belongs, and the level of the routine within the function. This scheme is shown on the accompanying hierarchical structure diagrams, which were reproduced from Volume 2 (pages 4-4 to 4-8). The left digit is function number, the middle digit is level number and the right digit is routine number for a given level and function. Level numbers start at "1" and increase from top to bottom; routine numbers start at "1" and increase from left to right. These numbers should be referenced to the pertinent flowcharts, as shown on the accompanying diagrams (pages 4-9 to 4-12 of Volume 2). As a means of tying together hierarchical structure diagrams, flowcharts and listings, the identification numbers could be appended to the listings as shown on the reproduced CMS-2 Assembler listing (page 6 of listing), which is attached. Two columns are utilized: one is the "At" column corresponding to lines with labels; the other is the "To" column corresponding to lines with transfer of control. Perhaps these identifiers could be punched and printed in formatted columns as part of the "Comments" field. A further help would be to sort source statements by the "At" column and to indent based on the middle digit. This would provide a structured listing of an entire function in contiguous locations.

3. Although it is not a fault of the flowcharting process, it was observed that there is a similarity of labels (e.g., CTPRE and CTPER). This could lead to error in software maintenance.

C. Flowcharts

1. The entry to a flowchart page should be annotated with the flowchart page numbers which are associated with the source(s) of the transfer of control and the exit(s) from a flowchart page should indicate the page number(s) which are associated with the destination(s) of the transfer of control. This is shown on the attached pages 4-9 to 4-12 of Volume 2.

2. There is no loop back to CTPER1 on page 4-9 of the flowcharts, as indicated by the JBNZ instruction at line 223 on page 6 of the listing. Instead the box at the bottom of page 4-9 reads: "Repeat Data Pattern Test Using 'IWC' Control Word." Similarly there is no loop back to CTPER2 on page 4-10 nor loop back to CTPER3 on page 4-11, as shown by line 230 and 238, respectively, on the listing. This method of presentation seems to mask an important characteristic of the program logic.

3. There seem to be discrepancies between flowcharts and listings. For example, the second box from the bottom of page 4-11 figure 4.3 refers to IWC. Page 6, lines 243 and 244 refer to ICW. The box in the flowchart also refers to "Set Up Class IV," while line 243 on the listing refers to Class II.

D. Interpretation of Hierarchical Structure Diagrams

1. Using Volume 2 as an example, it appears that the hierarchical structure diagrams are not totally accurate in portraying program logic. For example, the following discrepancies were noted between hierarchical structure and the listings:

a. With respect to page 4-5, figure 4.2, CTPER is shown superior to all other routines on this chart, yet an analysis of the listing reveals that CTPER only happens to be the first label in this series of code and its only paths to other labels are to CTPER1 and CTPERROR. The latter reference brings to light another discrepancy. CTPER does have a conditional branch to CTPERROR in the listing (line 219), but according to figure 4.2, there is no path between these routines. With respect to figure 4.2, the listings indicate the following access paths among routines:

- CTPER accesses CTPER1 and CTPERROR.
- CTPER1 accesses CTPER2 and CTPERROR.
- CTPER2 accesses CTPER3 and CTPERROR.
- CTPER3 accesses CTRTN and CTPERROR.

Thus, a more accurate picture of this logic is shown in the diagram labeled "Revised Figure 4.2 CT Hierarchical Structure (2 of 5)." It should be noted that in this diagram the horizontal lines indicate paths between adjacent code segments that are in the same module and vertical lines indicate paths involving transfer of control. Also, the arrows, from left to right and from top to bottom, indicate the general direction of control flow. In large measure the "routines" which have been shown as hierarchical structures boxes in Volume 2 are simply labels in a segment of code. This has been pointed out in Volume 2 on page 4-3. The difficulty in constructing the hierarchical structure from program listings is that by definition, the diagrams are supposed to indicate hierarchy, i.e., superior-subordinate relationships, and programs designed using a top-down approach. Since the

programs were not written this way, the imposition of a hierarchical structure on a coding format that is inherently non-structured will lead to incompatibilities between diagrams and listings, unless great care is exercised in performing the translation.

b. Pages 4-7 and 4-8, figure 4.2, show CTKLAS2 as having access to CTKLASY. The listing indicates that this actually occurs via CTKLIPI (lines 314 and 342), which is not listed as a routine in figure 4.1, page 4-2 of volume 2. CTKLIPI also has a path to CTARITH via CTKL2XIT at line 349. Page 4-8 also shows no path between CTKAS2I and CTKLASY*. However, the listing shows this path to exist. This condition was verified by consulting the CMS-2 Assembler List Cross Reference Table. One of these references to CTKLASY occurs from the same routine.

- Pages 4-7 and 4-8 show no path between CTKLAS2 and CTKLAS2Z. However, line 335 on the listing shows that this label is contained within routine CTKLAS2.

- Page 4-8 shows no path between CTKLASY and CTKLAS2J. A check of the List Cross Reference Table revealed that this path does exist; this reference to CTKLAS2J occurs at line 430. However, this path is used only when a 4 stop condition does not exist.

- Taking the above difference into account, page 4-8 has been redrawn and is labeled as "Revised Figure 4.2 CT Hierarchical Structure (5 of 5)." Again, the procedure was to use horizontal arrows (going into side of box) to indicate adjacent code segment relationships (e.g., between CTKLAS2 and CTKLAS2Z and between CTKLAS2I and CTKLAS2J) and vertical arrows (going into top of box) to show transfer of control.

*At least it is not unambiguous as to whether there is a path between CTKLAS2 and CTKLASY or between CTKLAS2I and CTKLASY, or both.

- Note: The revised hierarchical structure diagrams would obviously have different numbers for some boxes than those used in Section B.2. The latter was based on the given hierarchical structure diagrams as shown in Volume 2.

c. It was not clear in what sense lines with arrows and those without arrows were used in the hierarchical structure diagrams of Volume 2. If the use of arrows was to show transfer of control and the absence of arrows to tie together routines of the same module, the method would be inconsistent because there are no arrows on the lines which connect CTKLAS2 to CTKLAS2(A-I) in figure 4.2 of Volume 2.

E. Inter-Module Message Tables

These tables, such as the one on page 4-34, figure 4.4, Volume 2, should indicate the page number of the flowchart of the referenced procedure (routine).

F. Configurations

The hardware and configuration to which 6.0/.20 applies should be defined in each volume.

G. Patch Listings

Patch listings in Volume 1 should have column headings.

H. Audit Comments

Although we do not agree with the comment on page A-1. Volume 2 that, ". . . the module is readily understandable even though it is non-modular," we do feel that this is a valuable part of maintenance documentation. Perhaps this section could be expanded.

MESSAGE ENTRY

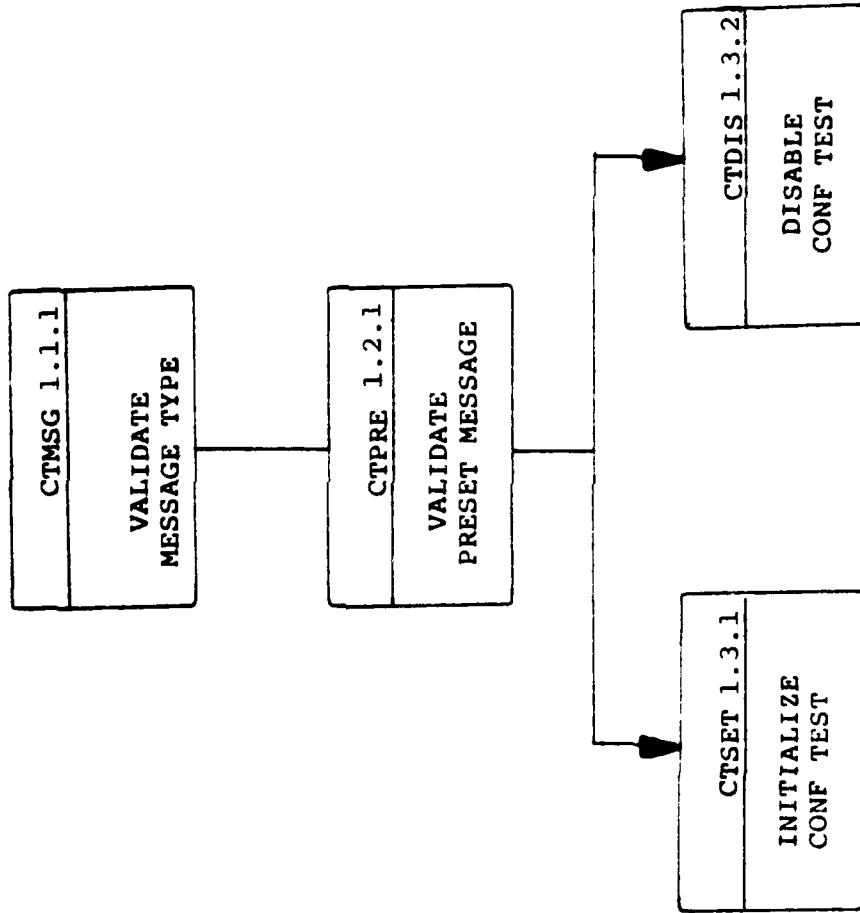


FIGURE 4.2 CT Hierarchical Structure (1 of 5)

PERIODIC ENTRY

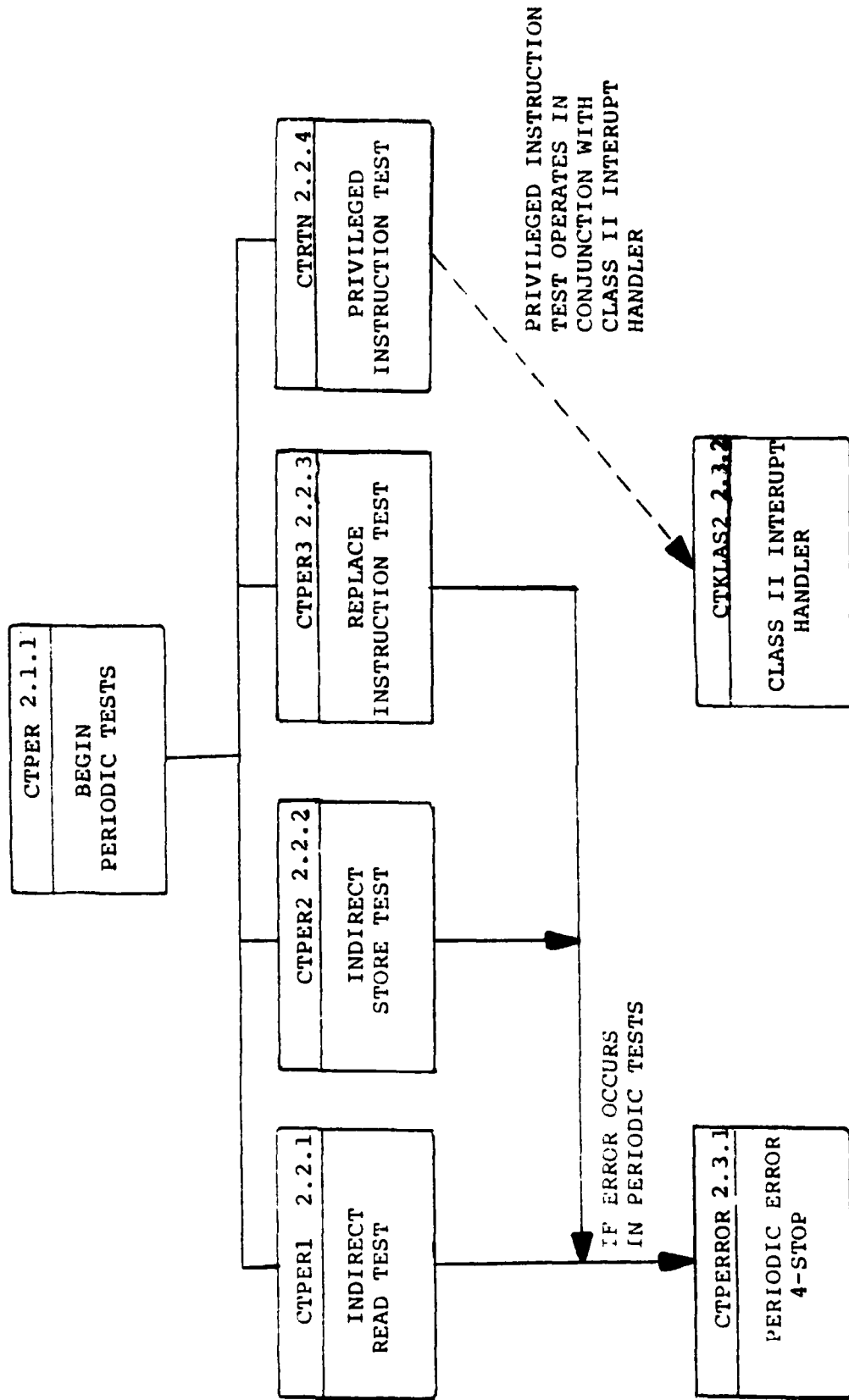


FIGURE 4.2 CT Hierarchical Structure (2 of 5)
Page 4-5

DEFERRED ENTRY

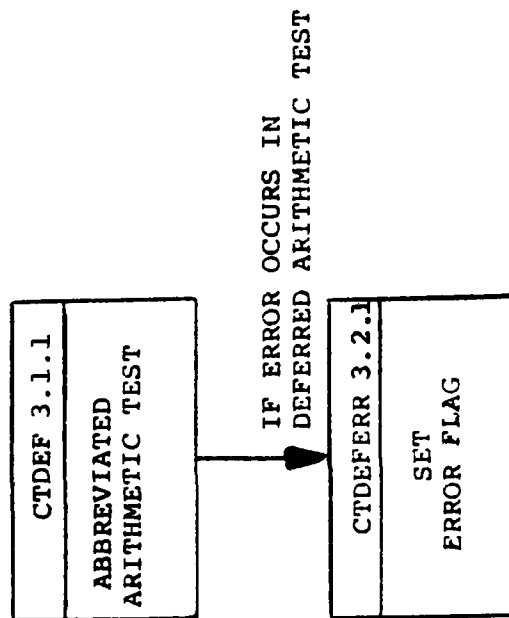


FIGURE 4.2 CT Hierarchical Structure (3 of 5)
Page 4-6

CLASS II INTERRUPT ENTRY

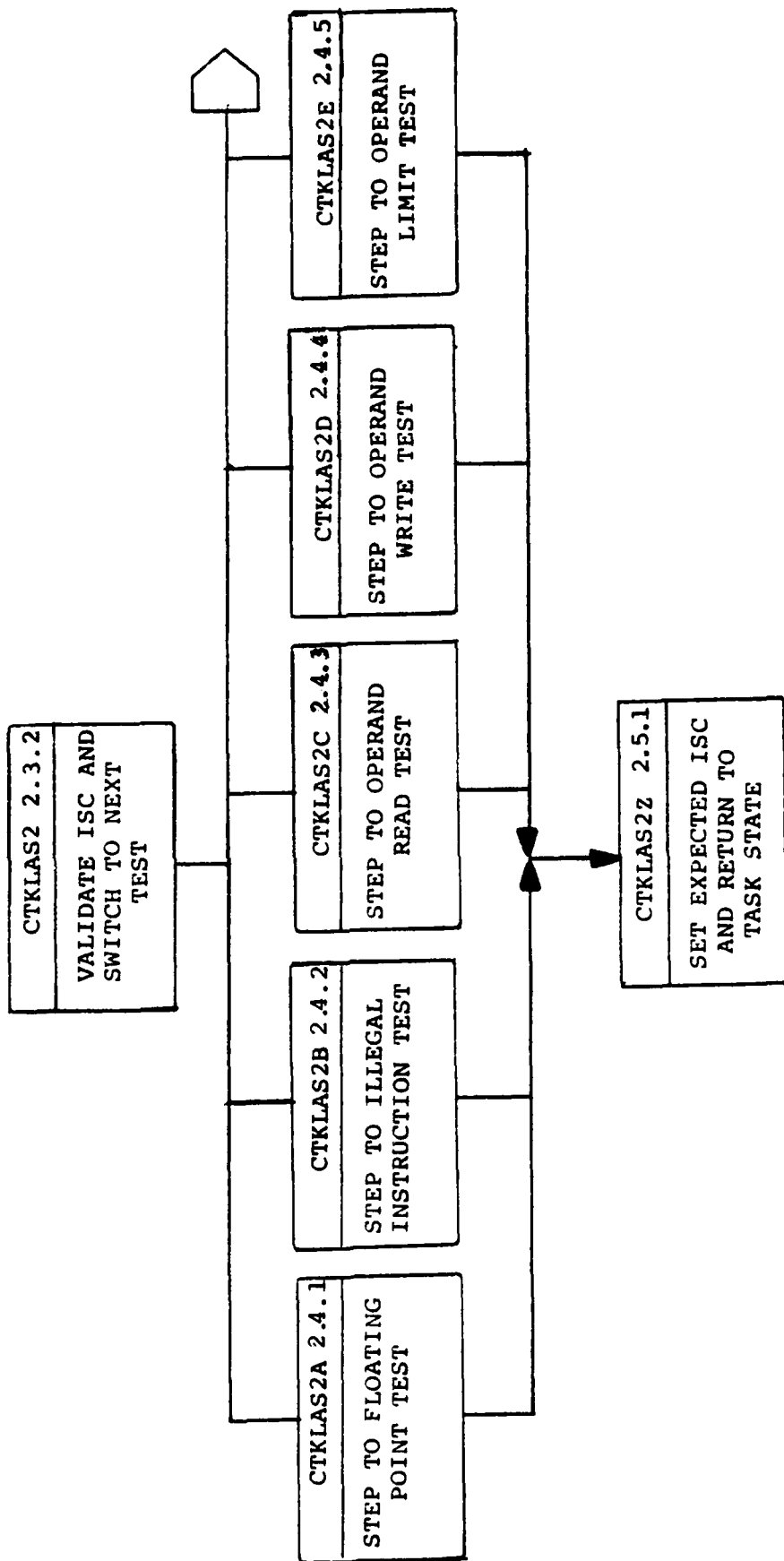


FIGURE 4.2 CT Hierarchical Structure (4 of 5)
Page 4-7

CLASS II INTERRUPT ENTRY

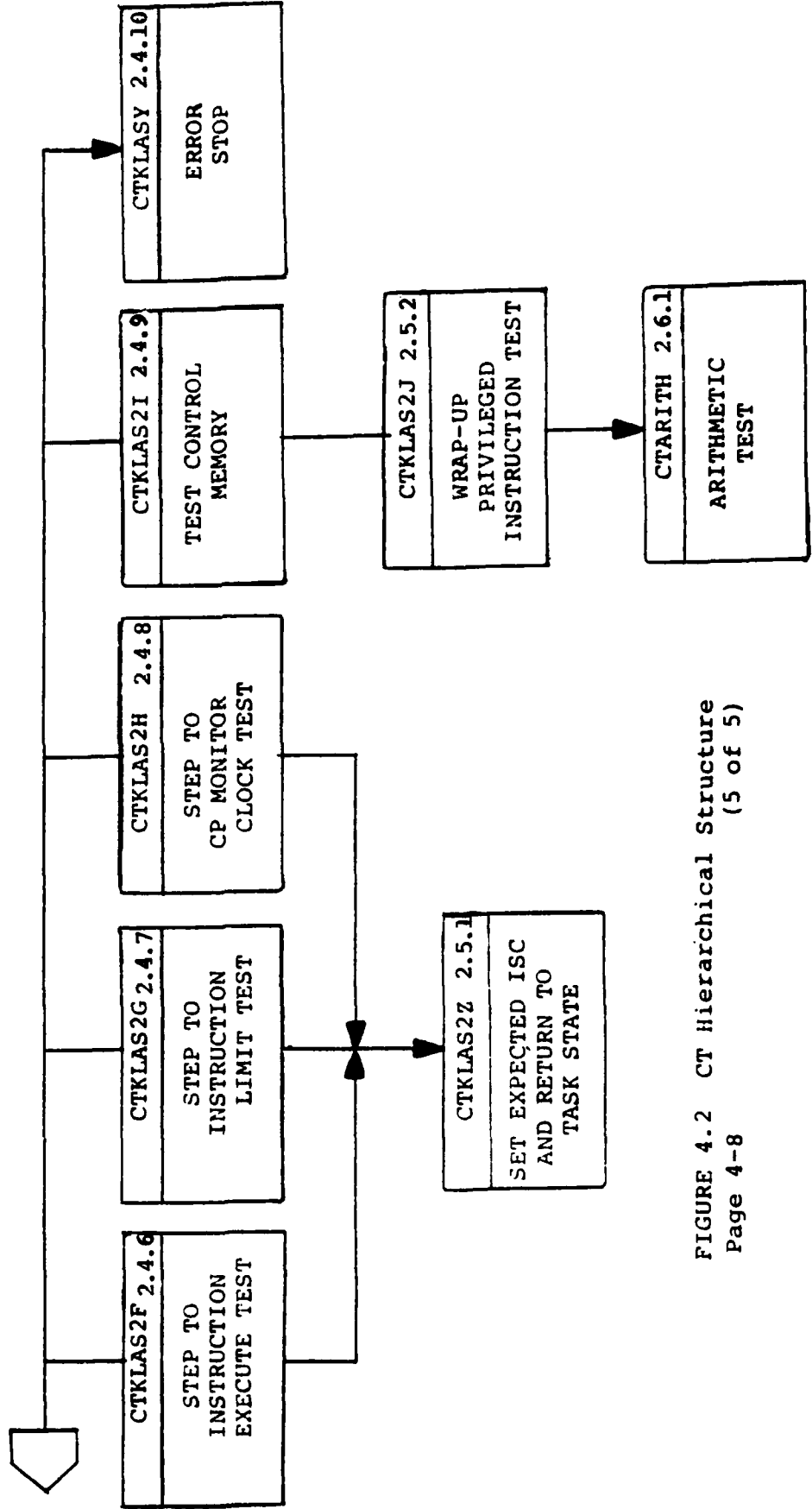


FIGURE 4.2 CT Hierarchical Structure
(5 of 5)
Page 4-8

From Periodic Entry

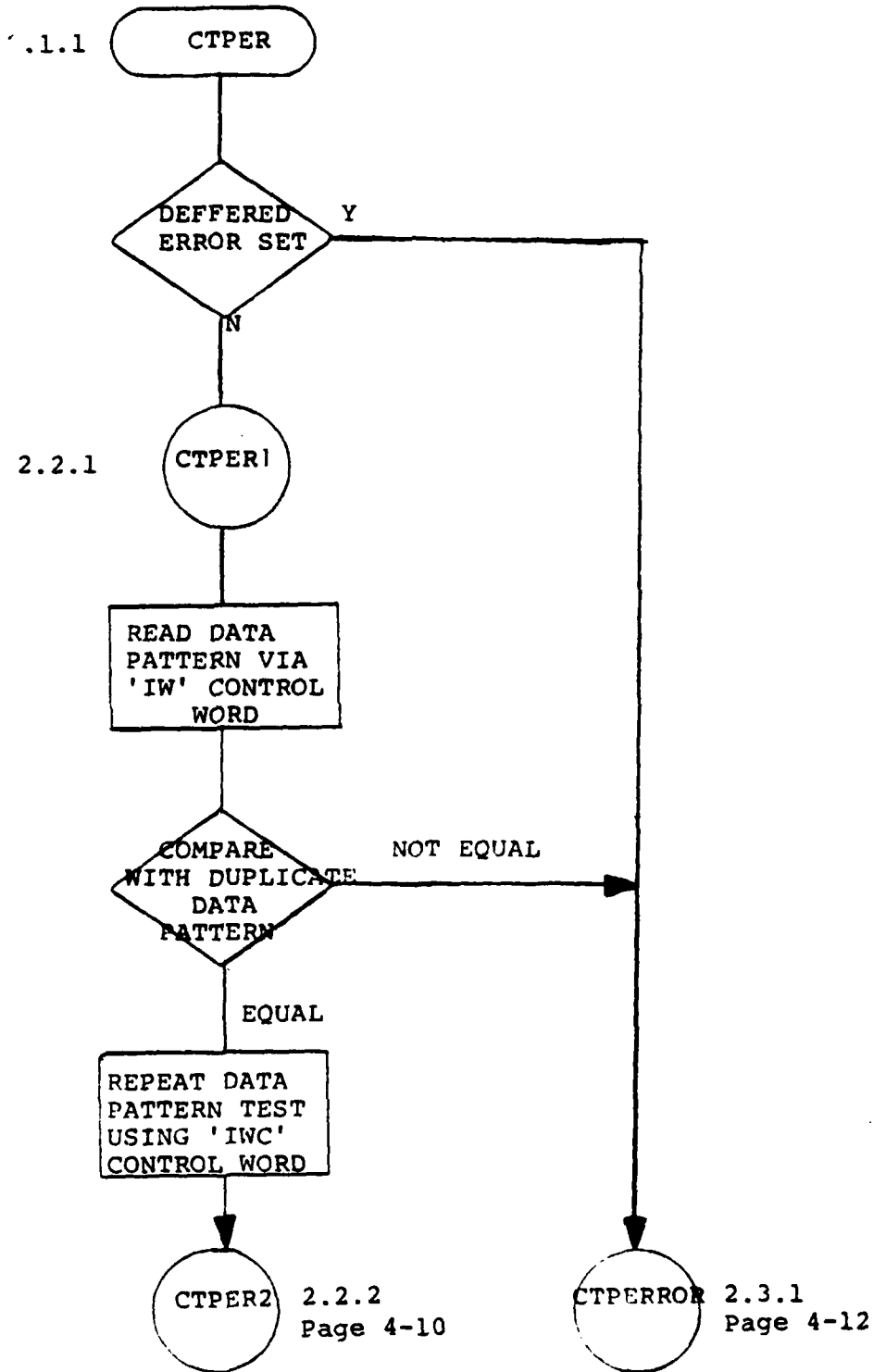


FIGURE 4.3 CT Flowcharts (1 of 25)
Page 4-9

From Page 4-9

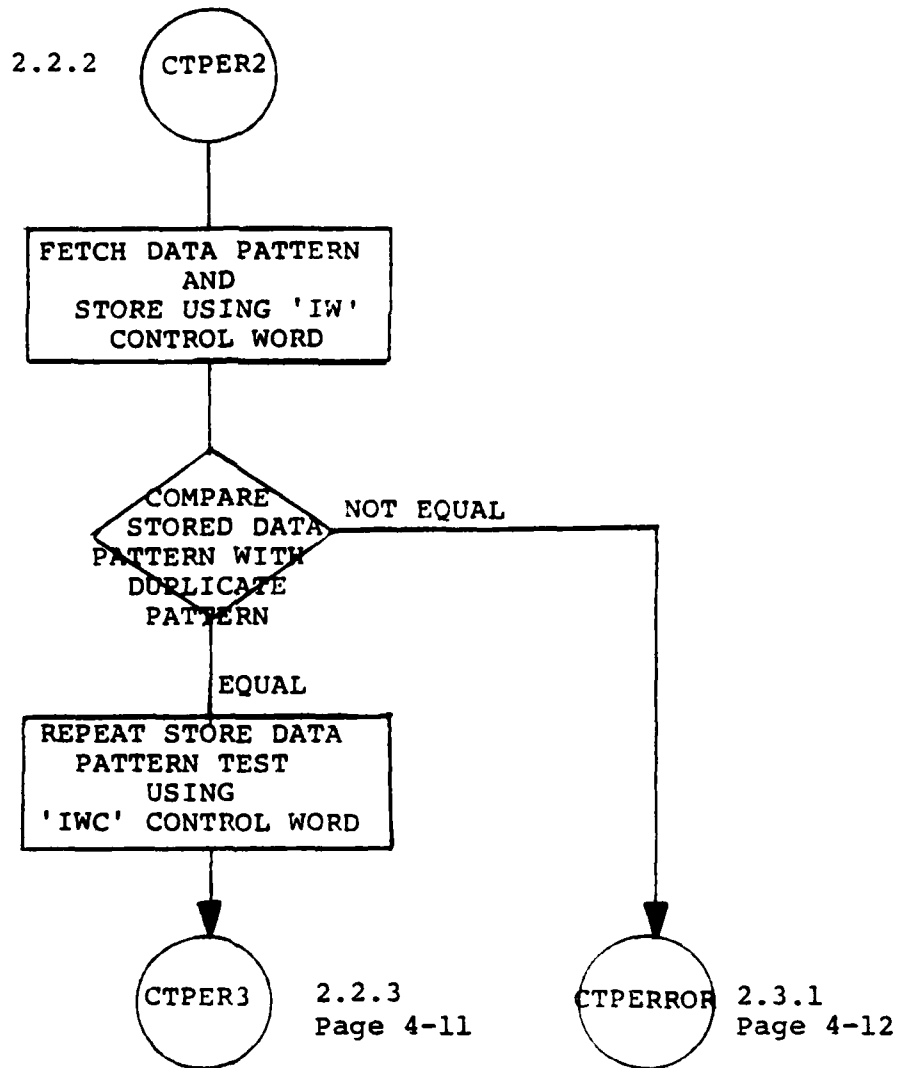


FIGURE 4.3 CT Flowcharts (2 of 25)
Page 4-10

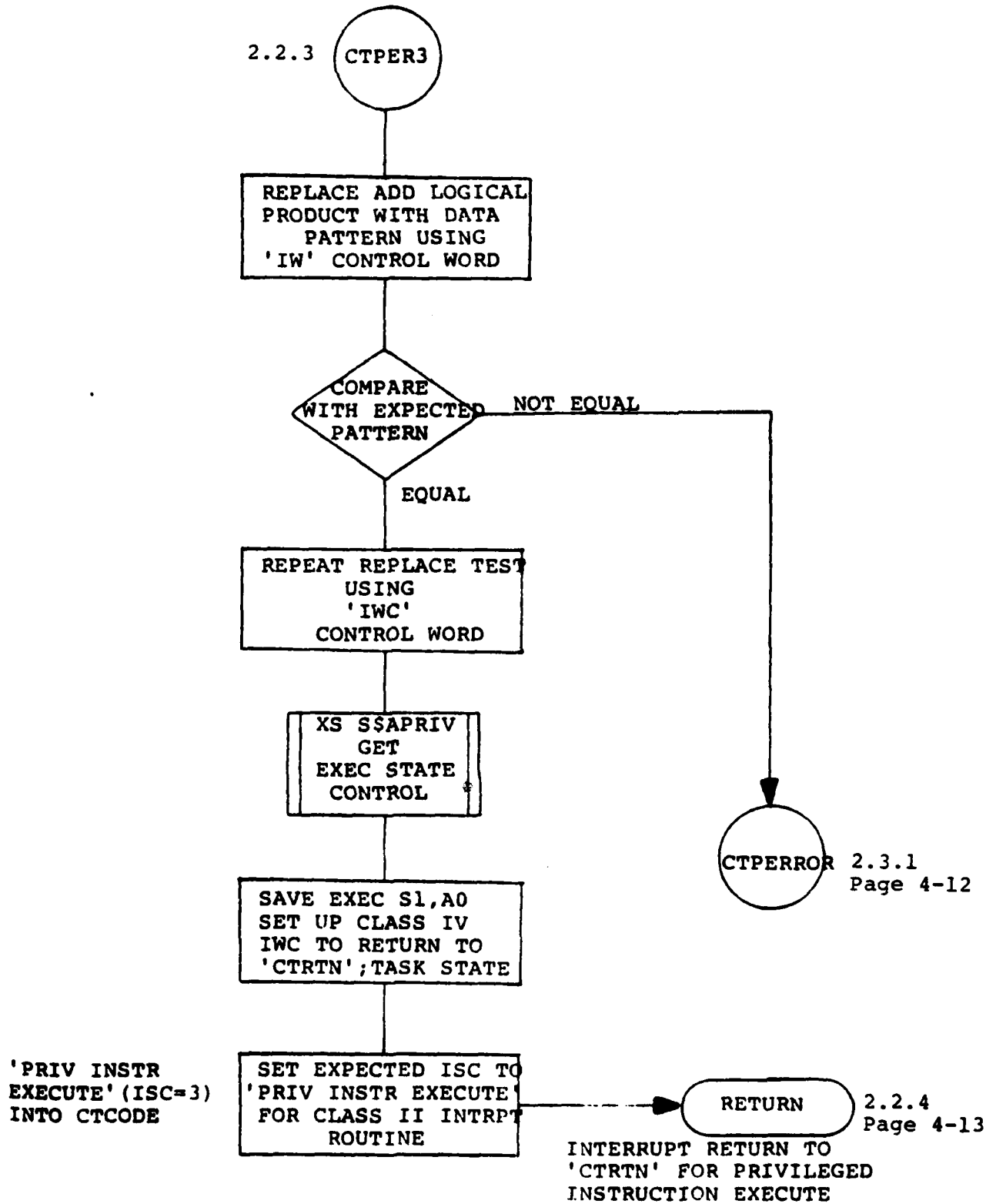


FIGURE 4.3 CT Flowcharts (3 of 25)
Page 4-11

From Pages 4-9,10,11

2.3.1 CTPERROR

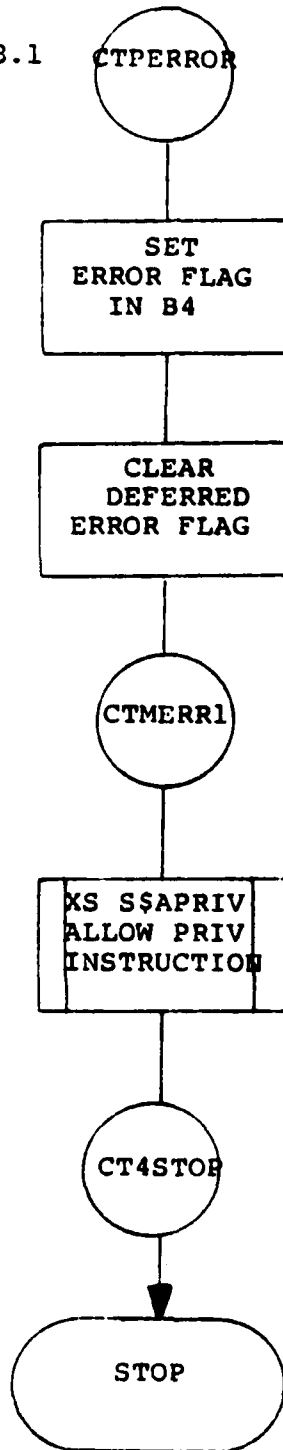


FIGURE 4.3 CT Flowcharts (4 of 25).
Page 4-12

CTA	ADDR	F	A	K	M	I	SY	LABEL	OP	CODE	OPERAND	COMMENTS	SEQUENCE
01191	000127	23	0	3	0	0	000521		SB		RD,CTCF,FLAG,3	• CLEAR ERROR FLAG	CIM100371
01192	000096	07	0	0	0	000104		KS	AS	SSEAIT	• EXIT	CIM10038	
01193	000091	07	0	0	0	000104		KS	AS	SDELPER	• DELETE PERIODIC	CIM10039	
01194	000092	07	0	0	0	000110		KS	AS	SDELDEF	• DELETE DEFERRED	CIM10041	
01195	000093	10	0	0	0	000194		LA	AD,CTERM,GE,AND,0,0,50		E150K2		
01196	000094	10	1	0	0	000004		LA	A1,4		E150K2		
01197	000095	07	0	0	0	000203		KS	S80NFS		E150K2		
01198	000096	07	0	0	0	000004		KS	SSEAIT		CIM10042		
01199	000097	20	0	0	0	000000		LB	F4,U	• MESSAGE ENTRY FLAG	CIM10047		
01200	000095	07	0	0	0	000425		CTHERM	S8APRIV	• ENABLE PRIVILEGED INST.	CIM10049		
01201	000051	53	3	0	0	000051		JSC	9,CT45TOP	• 4 STOP	CIM10092		
01202										• *****			
01203	000052	20	7	0	0	000001		CTPER	RD,CT45TOP	• *****			
01217	000053	42	07	0	0	000521		CTPER	RD,CT45TOP	• *****			
01218	000054	42	07	0	0	000521		CTPER	RD,CT45TOP	• *****			
01219	000055	10	0	3	7	000475		JNE	AD,CT1REFLAG	• CHECK DEFERRED ERROR			
01220	000054	14	0	3	7	000477		C	AD,CT1REFLAG	• GO TO ERROR MESSAGE			
01221	000055	53	0	0	0	000337		JNE	AD,CT1REFLAG	• CHECK HEAD CLASS			
01222	000060	52	7	1	0	000055		JNE	AD,CT1REFLAG	• IS IT CORRECT			
01223	000061	20	7	0	0	000001		CTPER	AD,CT1REFLAG	• IF NOT GO TO ERROR			
01224	000062	10	0	3	7	000473		LA	AD,CT1REFLAG	• TEST BOTH 1W AND 1AC			
01225	000063	24	0	3	7	000503		SA	AD,CT1REFLAG	• CHECK STORE CLASS			
01226	000064	10	0	3	7	000505		LA	AD,CT1REFLAG	• TRY IT			
01227	000065	14	0	3	7	000501		C	AD,CT1REFLAG	• FETCH WHOLE WORD			
01228	000066	53	0	0	0	000337		JNE	AD,CT1REFLAG	• CHECK IT			
01229	000067	52	7	1	0	000067		JNE	AD,CT1REFLAG	• IS IT CORRECT			
01230	000070	71	7	2	7	0		HAN	AD,CT1REFLAG	• 4ET BOTH			
01231	000071	20	7	0	0	000001		LA	AD,CT1REFLAG	• CLEAR MASK			
01232	000072	10	0	3	7	000473		LA	AD,CT1REFLAG	• TEST REPLACE CLASS			
01233	000073	03	7	1	0	000503		KALP	AD,CT1REFLAG	• TRY IT			
01234	000074	10	0	3	7	000505		LA	AD,CT1REFLAG	• CHECK IT			
01235	000075	14	0	3	7	000501		C	AD,CT1REFLAG	• IS IT CORRECT			
01236	000076	53	0	0	0	000337		JNE	AD,CT1REFLAG	• 4ET BOTH			
01237	000077	52	7	1	0	000067		JNE	AD,CT1REFLAG	• CLEAR MASK			
01238	000077	52	7	1	0	000067		JNE	AD,CT1REFLAG	• TEST REPLACE CLASS			
01239										• *****			
01240	000100	07	0	0	0	000425		CTPER	AD,CT1REFLAG	• *****			
01241	000101	54	70	0	0	000510		CTPER	AD,CT1REFLAG	• *****			
01242	000102	57	00	0	0	000514		CTPER	AD,CT1REFLAG	• *****			
01243	000103	57	44	0	0	000512		CTPER	AD,CT1REFLAG	• *****			
01244	000104	55	44	0	0	000516		CTPER	AD,CT1REFLAG	• *****			
01245	000105	57	21	0	0	000513		CTPER	AD,CT1REFLAG	• *****			
01246	000106	60	21	0	0			CTPER	AD,CT1REFLAG	• *****			
01247	000106	61	21	0	0			CTPER	AD,CT1REFLAG	• *****			
01248	000107	55	55	0	0	000511		CTPER	AD,CT1REFLAG	• *****			
01249	000110	55	57	0	0	000515		CTPER	AD,CT1REFLAG	• *****			
01250	000111	43	0	0	0	000524		CTPER	AD,CT1REFLAG	• *****			
01251	000112	10	0	0	0	000003		CTPER	AD,CT1REFLAG	• *****			
01252	000113	24	0	0	0	000525		CTPER	AD,CT1REFLAG	• *****			
01253	000114	07	0	5	0	000001		CTPER	AD,CT1REFLAG	• *****			
01254	000115	07	0	2	0	000000		CTPER	AD,CT1REFLAG	• *****			
01255	000116	07	0	3	0	000000		CTPER	AD,CT1REFLAG	• *****			

2.3.1
 2.2.1
 2.3.1
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 2.2.3
 2.3.1
 2.2.3
 2.2.4

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CMS-2 ASSEMBLER

CTA

ID	OP	AL	ADDR	E	A	K	R	I	SY	LABEL	OP	CODE	OPERAND	COMMENTS	SEQUENCE
00254			000117	07	0	4	0	0	000000		LD		0		CIMJ0172
00257			000120	07	0	5	0	0	000000		RM		0		CIMJ0173
00258			000121	53	4	2	0	0	000000		RJSC		4		CIMJ0174
00259			000122	53	4	3	0	0	000000		JSC		4		CIMJ0175
00260			000123	54	2	0	0	000000			LCT		020		CIMJ0176
00261			000124	54	6	0	0	000000			LCT		060		CIMJ0177
00262			000125	54	7	0	0	000000			LCT		070		CIMJ0178
00263			000126	55	0	0	0	000000			LCT		0		CIMJ0179
00264			000127	56	2	0	0	000000			SCT		020		CIMJ0180
00265			000130	56	5	0	0	000000			SCT		060		CIMJ0181
00266			000131	56	7	0	0	000000			SCT		070		CIMJ0182
00267			000132	60	2	0	0				HSCY		020		CIMJ0183
00268			000132	74	0	3	0	0			HNO				CIMJ0184
00269			000133	60	6	0	0				HSCY		060		CIMJ0185
00270			000133	74	0	3	0	0			HNO				CIMJ0186
00271			000134	60	7	0	0				HSCY		070		CIMJ0187
00272			000134	74	0	3	0	0			HNO				CIMJ0188
00273			000135	60	0	0	0	1			HSCY		0		CIMJ0189
00274			000135	74	0	3	0	0			HNO				CIMJ0190
00275			000136	61	2	0	0	0			HLCY		020		CIMJ0191
00276			000136	74	0	3	0	0			HNO				CIMJ0192
00277			000137	61	6	0	0	0			HLCY		060		CIMJ0193
00278			000137	74	0	3	0	0			HNO				CIMJ0194
00279			000140	61	7	0	0	0			HLCY		070		CIMJ0195
00280			000140	74	0	3	0	0			HNO				CIMJ0196
00281			000141	61	0	0	0	1			HLCY		0		CIMJ0197
00282			000141	74	0	3	0	0			HNO				CIMJ0198
00283			000142	77	0	0	0	0			HSTM		0		CIMJ0199
00284			000142	74	0	3	0	0			HNO				CIMJ0200
00285			000143	77	0	4	0	0			HPI				CIMJ0201
00286			000143	74	0	3	0	0			HNO				CIMJ0202
00287			000144	77	0	5	0	0			HAI				CIMJ0203
00288			000144	74	0	3	0	0			HNO				CIMJ0204
00289			000145	77	0	6	0	0			HALT				CIMJ0205
00290			000145	74	0	3	0	0			HNO				CIMJ0206
00291			000146	77	0	6	0	1			HAFI				CIMJ0207
00292			000146	74	0	3	0	0			HNO				CIMJ0208
00293			000147	07	1	0	0	000000			IPI				CIMJ0209
00294			000150	07	1	0	0	000000			AEL				CIMJ0210
00295			000151	05	0	0	0	000517			DL				CIMJ0211
00296			000152	06	0	0	0	000517			FA				CIMJ0212
00297			000153	00	0	0	0	000000							CIMJ0213
00298			000154	10	3	0	0	00154	CTOP1		L1				CIMJ0214
00299			000155	24	0	3	0	00155	CTOP2		SA				CIMJ0215
00300			000156	24	0	3	0	00156	CTOP3		SA				CIMJ0216
00301			000157	53	0	3	0	00163			J				CIMJ0217
00302			000160	20	0	0	0	000000	CTOP4		LB				CIMJ0218
00303			000161	53	0	3	0	00162			J				CIMJ0219
00304			000162	20	0	0	0	000000	CTOP5		LB				CIMJ0220
00305			000163	53	0	3	0	000163	CTOP6		J				CIMJ0221
00306			000166	54	7	0	0	000510							CIMJ0222
00307									CTKAS2	LCT					CIMJ0223

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00308			000165	40	46	0	1				HLCI		000000	• CHECK STATUS CODE	CI00195
00309			000166	40	0	0	0	000300			LD		000000	• INCREMENT TEST COUNT	CI00196
00310			000167	35	1	3	0	000524			RI		000000	• IS STATUS CODE CORRECT	CI00197
00311			000170	44	0	3	0	000525			C		000000		CI00198
00312															
00313															
00314			000171	53	1	0	0	000221			JNE		000000	• ALL PRIVILEGED INSTRUCTIONS	CI00200
00315											CTKLS21		000000	• INTR. POINT	CI00201
00316											C		000000	• INTR. POINT	CI00202
00317			000172	44	1	0	0	000034			JL		000000	• INTR. POINT	CI00203
00318			000173	53	1	0	0	000227			C		000000	• INTR. POINT	CI00204
00319			000174	44	1	0	0	000035			C		000000	• INTR. POINT	CI00205
00320			000175	53	1	0	0	000231			JE		000000	• INTR. POINT	CI00206
00321			000176	44	1	0	0	000036			C		000000	• INTR. POINT	CI00207
00322			000177	53	1	0	0	000233			JE		000000	• INTR. POINT	CI00208
00323			000201	44	1	0	0	000037			C		000000	• INTR. POINT	CI00209
00324			000201	53	1	0	0	000235			JE		000000	• INTR. POINT	CI00210
00325			000202	44	1	0	0	000040			C		000000	• INTR. POINT	CI00211
00326			000203	53	1	0	0	000237			JE		000000	• INTR. POINT	CI00212
00327			000204	44	1	0	0	000041			C		000000	• INTR. POINT	CI00213
00328			000205	53	1	0	0	000241			JE		000000	• INTR. POINT	CI00214
00329			000206	44	1	0	0	000042			C		000000	• INTR. POINT	CI00215
00330			000207	53	1	0	0	000243			JE		000000	• INTR. POINT	CI00216
00331			000210	44	1	0	0	000043			C		000000	• INTR. POINT	CI00217
00332			000211	53	1	0	0	000246			JE		000000	• INTR. POINT	CI00218
00333			000212	44	1	0	0	000044			C		000000	• INTR. POINT	CI00219
00334			000213	53	1	0	0	000252			JE		000000	• INTR. POINT	CI00220
00335			000214	24	0	3	0	000565			SA		000000	• INTR. POINT	CI00221
00336			000215	60	4	0	1				HLCI		000000	• INTR. POINT	CI00222
00337			000216	14	0	0	0	000001			AA		000000	• INTR. POINT	CI00223
00338			000217	61	4	0	1				AA		000000	• INTR. POINT	CI00224
00339			000220	07	0	5	0	000000			IN		000000	• INTR. POINT	CI00225
00340															
00341															
00342			000221	51	0	3	0	000335			JNZ		000000	• INTR. POINT	CI00226
00343											AD		000000	• INTR. POINT	CI00227
00344											CTKLS21		000000	• INTR. POINT	CI00228
00345			000222	07	0	0	0	000025			XS		000000	• INTR. POINT	CI00229
00346			000223	07	0	0	0	000016			X5		000000	• INTR. POINT	CI00230
00347			000224	61	11	0	0				HLCY		000000	• INTR. POINT	CI00231
00348			000225	02	0	2	1	000071			AM		000000	• INTR. POINT	CI00232
00349			000226	53	0	3	0	000032			J		000000	• INTR. POINT	CI00233
00350															
00351			000227	10	0	0	0	000001			LA		000000	• INTR. POINT	CI00234
00352			000230	53	1	0	0	000214			J		000000	• INTR. POINT	CI00235
00353			000231	10	0	0	0	000002			LA		000000	• INTR. POINT	CI00236
00354			000232	53	0	3	0	000214			J		000000	• INTR. POINT	CI00237
00355			000233	10	0	0	0	000006			LA		000000	• INTR. POINT	CI00238
00356			000234	53	0	3	0	000214			J		000000	• INTR. POINT	CI00239
00357			000235	10	0	0	0	000001			LA		000000	• INTR. POINT	CI00240
00358			000236	53	0	3	0	000214			J		000000	• INTR. POINT	CI00241
00359															

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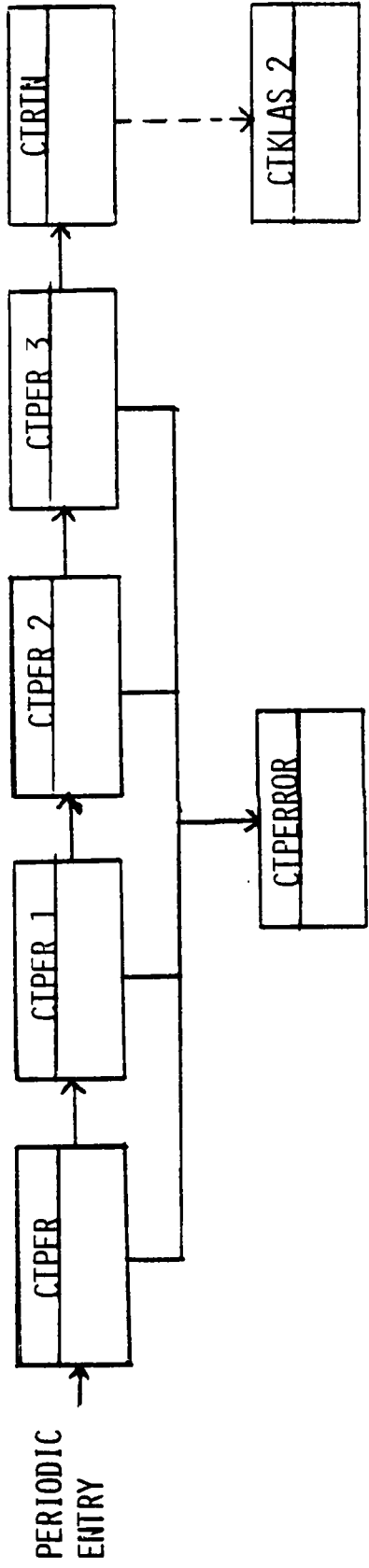
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00360		000237	10	0	0	0	0	000012	CTKLA52E	LA		AD,012	OPEN AND LIMIT	CTMI0231
00361		000240	53	0	3	0	0	000214		J		CTKLA52Z		CTMI0232
00362		000241	10	0	0	0	000015		CTKLA52F	LA		AD,015	INSTRUCTION: EXECUTE	CTMI0233
00363		000242	53	0	3	0	0	000214		J		CTKLA52Z		CTMI0234
00364		000243	55	47	0	0	000522		CTKLA52G	LCL		047ACTDUPM1	RESTORE S1 TO P-STORE	CTMI0235
00365		000244	10	0	0	0	000016			LA		AD,016	INSTRUCTION: LIMIT	CTMI0236
00366		000245	53	0	3	0	0	000214		J		CTKLA52Z		CTMI0237
00367		000246	55	47	0	0	000523		CTKLA52H	LCL		047ACTDUPM2	RESTORE S1 TO P-STORE	CTMI0238
00368		000247	10	0	0	0	000017			LA		AD,017	CP HUNTUM CLOCK	CTMI0239
00369		000250	55	10	0	0	000526			LCL		010,CTCLK	LOAD CP HUNTUM CLOCK	CTMI0240
00370		000251	53	0	3	0	0	000214		J		CTKLA52Z	SAVE EXEC REGISTERS	CTMI0241
00371		000252	20	7	0	0	000100		CTKLA52I	LB		07,0100		CTMI0241
00372		000253	20	1	0	0	000300			LB		01,0	CLEAR FLAG	CTMI0241
00373		000254	23	0	3	0	000521			SB		00,CTERFLA,K3		CTMI0242
00374		000255	07	7	6	0	000001			RP		7,1		CTMI0243
00375		000256	57	00	1	0	000531			SCI		AD,CTREGSTR,B1	LOAD WITH ZEROES ES21	CTMI0244
00376		000257	20	7	0	0	000100			LB		07,010		CTMI0245
00377		000260	07	7	6	0	000000			RP		AD,CTONPAT		CTMI0246
00378		000261	55	00	0	0	000527			LCL		07,0A7		CTMI0246
00379		000262	20	7	0	0	000067			LB		011,CTONPAT	STORE A6A7	CTMI0247
00380		000263	07	7	6	0	000000			RP		07,0100		CTMI0248
00381		000264	55	11	0	0	000527			LCL		01,0		CTMI0249
00382		000265	20	7	0	0	000100			LB		7,1	CHECK THEN	CTMI0250
00383		000266	20	1	0	0	000000			LB		AD,CTEMPSTR,01		CTMI0250
00384		000267	07	7	6	0	000001			RP		07,0100		CTMI0251
00385		000270	57	00	1	0	000631			SCI		01,0		CTMI0251
00386		000271	20	7	0	0	000100			LB		AD,CTEMPSTR,K3,B1		CTMI0252
00387		000272	23	0	3	0	000641			SB		07,CTLAST	GO IF ERROR	CTMI0253
00388		000273	20	1	0	0	000000			LB		07,0100	CHECK WITH ONES	CTMI0254
00389		000274	07	0	6	0	000001			RP		7		CTMI0255
00390		000275	10	0	3	1	000631			LA		AD,CTONES	TO TEMPORARY STORAGE	CTMI0256
00391		000276	52	7	1	0	000335			JBHZ		07,0100	CHECK THEN	CTMI0257
00392		000277	20	7	0	0	000100			LB		01,0		CTMI0258
00393		000300	07	7	6	0	000000			RP		AD,CTEMPSTR,B1		CTMI0259
00394		000301	55	00	0	0	000517			LCL		07,0100		CTMI0260
00395		000302	20	7	0	0	000100			LB		01,0		CTMI0261
00396		000303	20	1	0	0	000000			LB		7,1		CTMI0262
00397		000304	07	7	6	0	000001			RP		AD,CTEMPSTR,B1		CTMI0263
00398		000305	57	00	1	0	000631			SCI		07,0100		CTMI0264
00399		000306	20	7	0	0	000100			LB		01,0		CTMI0265
00400		000307	20	1	0	0	000000			LB		07,0100		CTMI0266
00401		000310	07	7	6	0	000001			RP		7,1		CTMI0267
00402		000311	14	0	3	1	000631			AA		AD,CTEMPSTR,K3,B1		CTMI0268
00403		000312	13	0	3	0	000535			AMA		AD,CTEMPSTR,K3		CTMI0269
00404		000313	51	0	3	0	000335			JMZ		AD,CTEMPSTR,K3		CTMI0269
00405		000314	20	1	0	0	000000			LB		01,0	RESTORE ORIGINAL CONF L'S	CTMI0266
00406		000315	20	7	0	0	000100			LB		07,0100		CTMI0267
00407		000316	07	7	6	0	000001			RP		7,1		CTMI0268
00408		000317	55	00	1	0	000531			LCL		AD,CTEMPSTR,B1		CTMI0269
00409												***PERIODIC *** PASSED		
00410												*****PERIODIC***** PASSED		
00411														

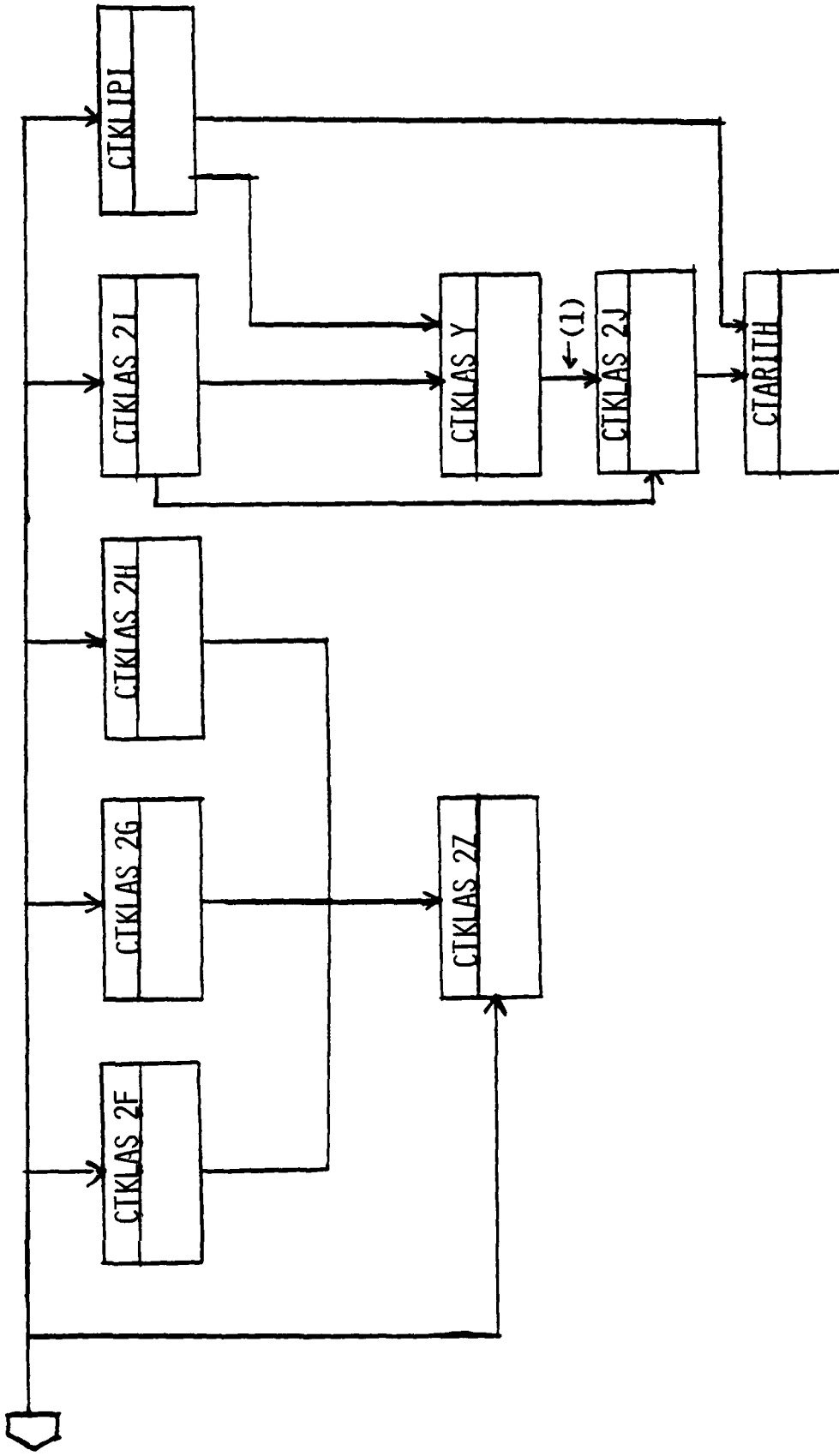
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ID	E	AL	ADDR	F	A	K	I	SY	LABEL	OP	CODE	OPERAND	COMMENTS	DI	JOBNUM
00412															
00413															
00414															
00415															
00416															
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REVISED FIGURE 4.2 CI HIERARCHICAL STRUCTURE (2 OF 5)
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(1) USED ONLY WHEN A 4 STOP CONDITION DOES NOT EXIST.

REVISED FIGURE 4.2 CT HIERARCHICAL STRUCTURE (5 OF 5)

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REFERENCES

1. Oxman, Steven W., "Fiscal Year 1979 CCSMA System-Level Software Maintenance Approach and Transition Plan," March 20, 1979, (Revision E), Software Systems Department, Trident, CCSMA, Newport, RI.
2. Oxman, Steven W., "The Testing of the Trident Command and Control System," Workshop on Software Testing and Test Documentation, December 1978, Digest.
3. Chapin, Ned, "Flowcharting with the ANSI Standard: A Tutorial," Computing Surveys, ACM, June 1970, Volume 2, No. 2.

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