

WRDC-TR-90-8007  
Volume V  
Part 25



**AD-A250 462**



INTEGRATED INFORMATION SUPPORT SYSTEM (IISS)  
Volume V - Common Data Model Subsystem  
Part 25 - Neutral Data Manipulation Language (NDML) Precompiler  
Generator Request Processor Driver Product Specification

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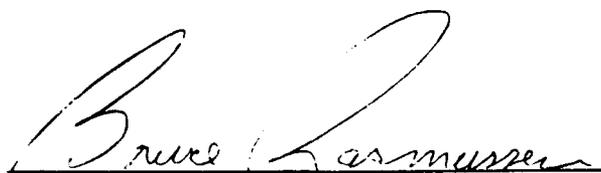
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FOREWORD

This technical report covers work performed under Air Force Contract F33600-87-C-0464, DAPro Project. This contract is sponsored by the Manufacturing Technology Directorate, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. It was administered under the technical direction of Mr. Bruce A. Rasmussen, Branch Chief, Integration Technology Division, Manufacturing Technology Directorate, through Mr. David L. Judson, Project Manager. The Prime Contractor was Integration Technology Services, Software Programs Division, of the Control Data Corporation, Dayton, Ohio, under the direction of Mr. W. A. Osborne. The DAPro Project Manager for Control Data Corporation was Mr. Jimmy P. Maxwell.

The DAPro project was created to continue the development, test, and demonstration of the Integrated Information Support System (IISS). The IISS technology work comprises enhancements to IISS software and the establishment and operation of IISS test bed hardware and communications for developers and users.

The following list names the Control Data Corporation subcontractors and their contributing activities:

<u>SUBCONTRACTOR</u>	<u>ROLE</u>
Control Data Corporation	Responsible for the overall Common Data Model design development and implementation, IISS integration and test, and technology transfer of IISS.
D. Appleton Company	Responsible for providing software information services for the Common Data Model and IDEF1X integration methodology.
ONTEK	Responsible for defining and testing a representative integrated system base in Artificial Intelligence techniques to establish fitness for use.
Simpact Corporation	Responsible for Communication development.
Structural Dynamics Research Corporation	Responsible for User Interfaces, Virtual Terminal Interface, and Network Transaction Manager design, development, implementation, and support.
Arizona State University	Responsible for test bed operations and support.

TABLE OF CONTENTS

		<u>Page</u>
SECTION 1.0	SCOPE .....	1-1
1.1	Identification .....	1-1
1.2	Functional Summary .....	1-1
SECTION 2.0	DOCUMENTS .....	2-1
2.1	Reference Documents .....	2-1
2.2	Terms and Abbreviations .....	2-1
SECTION 3.0	REQUIREMENTS .....	3-1
3.1	Structural Description .....	3-1
3.2	Functional Flow .....	3-1
3.3	Interfaces .....	3-1
3.3.1	Inputs/Outputs .....	3-1
3.4	Program Interrupts .....	3-2
3.5	Timing and Sequencing Description .....	3-2
3.6	Special Control Features .....	3-2
3.7	Storage Allocation .....	3-2
3.7.1	Database Definition .....	3-2
3.7.1.1	File Description .....	3-2
3.7.1.2	Table Description .....	3-2
3.7.1.3	Item Description .....	3-2
3.8	Object Code Creation .....	3-2
3.9	Adaptation Data .....	3-2
3.10	Detail Design Description .....	3-3
3.10.1	Where Include File Used List .....	3-3
3.10.2	Where External Routine Used List .....	3-4
3.10.3	Main Program Parts List .....	3-7
3.10.4	Module Documentation .....	3-10
3.10.5	Include File Description .....	3-17
3.10.6	Hierarchy Chart .....	3-19
3.11	Program Listings Comments .....	3-24
SECTION 4.0	QUALITY ASSURANCE PROVISIONS .....	4-1
4.1	Introduction and Definitions .....	4-1
4.2	Computer Programming and Test Evaluation .....	4-1

SECTION 1

SCOPE

1.1 Identification

This specification establishes the design of Function PRE14, "Generate Request Processor Driver", one of the major functions of the Configuration Item "Precompiler" to be built and formally accepted by the ICAM Program Office. This CI constitutes one of the subsystems of the Common Data Model Processor (CDMP).

1.2 Functional Summary

The purpose of this Computer Program Configuration Item (CPCI) is to generate a main program for each Request Processor needed to handle all of the NDML requests found in a user's logical unit of work grouping of user software modules.

The following functions will be performed by this CPCI:

1. Sort the table listing all generated Request Processors on database identifier.
2. For each database, generate a COBOL, FORTRAN, or C Request Processor driver module:
  - a) Use a macro to generate the Identification, Environment and Data Divisions of the program.
  - b) Use a macro to generate the case test and the call syntax in the Procedure Division of the program.
  - c) Use a macro for the error handling and termination of the program.

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## SECTION 2

### DOCUMENTS

#### 2.1 Reference Documents

1. ICAM Documentation Standards: IDS15012000A, 28 December 1981.
2. D. Appleton Co., CDM Administrators Manual; UM620141000, March 1984.
3. D. Appleton Co., CDM1-IDEF Model of the Common Data Model; CCS620141000, 15 May 1985.
4. D. Appleton Co., Computer Program Development Specification (DS) for ICAM Integrated Support System (IISS) Configuration Item: NDML Precompiler; DS620141200, October 1984.
5. D. Appleton Co., Embedded NDML Programmer's Reference Manual; PRM620141200, March 1985.
6. Softech, Inc., NTM Programmers Guide; UM620140001, July 1985.
7. Control Data Corp., Computer Program Development Specification (DS) for ICAM Integrated Support System (IISS) Configuration Item: NDDL Command Processor; DS620141100, June 1985.

#### 2.2 Terms and Abbreviations

Attribute Use Class: (AUC)

Conceptual Schema: (CS)

Common Data Model Processor: (CDMP)

Common Data Model: (CDM) Describes common data application process formats, form definitions, etc, of the IISS and includes conceptual schema, external, internal schemas, and schema transformation operators.

Data Field: (DF) An element of data in the external schema. It is by this name that an NDML programmer references data.

Database Management System: (DBMS)

Distributed Request Supervisor: (DRS) This IISS CDM subsystem configuration item controls the execution of distributed NDML queries and non distributed updates.

**Domain:** A logical definition of legal attribute class values.

**Domain Constraint:** Predicate that applies to a single domain.

**External Schema:** (ES)

**Forms:** Structured views which may be imposed on windows or other forms. A form is composed of fields where each field is a form, item, or window.

**Forms Processor:** (FP) A set of callable execution time routines available to an application program for form processing.

**Internal Schema:** (IS)

**Integrated Information Support System:** (IISS) A test computing environment used to investigate, demonstrate and test the concepts of information management and information integration in the context of Aerospace Manufacturing. The IISS addresses the problems of integration of data resident on heterogeneous databases supported by heterogeneous computers interconnected via a local Area Network.

**Mapping:** The correspondence of independent objects in two schemas: ES to CS or CS to IS.

**Network Transaction Manager:** (NTM) Performs the coordination, communication and housekeeping functions required to integrate the application processes and system services resident on the various hosts into a cohesive system.

**Neutral Data Manipulation Language:** (NDML) A language developed by the IISS project to provide uniform access to common data, regardless of database manager or distribution criteria. It provides distributed retrieved and single node updates.

**ORACLE:** Relational DBMS based on the SQL (Structured Query Language, a product of ORACLE Corp, Menlo Park, CA). The CDM is an ORACLE database.

**Parcel:** A sequential file containing section source code of the input application program.

**Request Processor:** (RP) A COBOL program that will satisfy a retrieval or update NDML subtransaction against a particular Database Management System.

**User Interface:** (UI) Controls the user's terminal and interfaces with the rest of the system.

**Virtual Terminal Interface:** (VTI) Performs the interfacing between different terminals and the UI. This is done by defining a specific set of terminal features and protocols which

must be supported by UI software which constitutes the Virtual Terminal Definition. Specific terminals are then mapped against the Virtual Terminal software by specific software modules written for each type of real terminal supported.

SECTION 3  
REQUIREMENTS

3.1 Structural Description

A graphic portrayal of this CPCI is included in Section 3.10. This chart shows the hierarchical relationship of each module making up this CPCI.

This CPCI uses a lower level module to write macros with the proper substitution parameters to the output file representing the generated Request Processor.

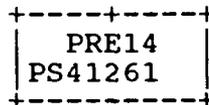
3.2 Functional Flow

This CPCI implements the logic defined in the Development Specification for this CPCI. Details of inputs/outputs and relationships between modules are to be found in Section 3.10.

The CPCI has been designated to operate in a batch or interactive mode. It must operate in the system environment established for IISS; that is, use of the Network Transaction Manager. It must use the ORACLE Database Management System installed on a DEC VAX computer.

3.3 Interface

The following diagram depicts the interface of PRE14 with other CPCI's in the system.



3.3.1 Inputs/Outputs

The following table depicts the inputs and outputs of this CPCI. A detail description for each item can be found in the DS for this CPCI.

Function: PRE14

<u>INPUT</u>	<u>OUTPUT</u>
None	

### 3.4 Program Interrupts

Not applicable to this CPCI.

### 3.5 Timing and Sequencing Description

This CPCI is a main module that calls several other modules for processing to generate a request processor driver program. It is assumed that all modules making up a logical unit of work are compiled as a single group.

### 3.6 Special Control Features

Not applicable to this CPCI.

### 3.7 Storage Allocation

#### 3.7.1 Database Definition

The database used by this CPCI is the Common Data Model (CDM) database. This model is defined by the CDM1, the IDEF-1 model of the CDM, Reference Number 31.

##### 3.7.1.1 File Description

No permanent files have been defined for this CPCI. It may use temporary scratch files for such things as generated program source code or temporary query results.

##### 3.7.1.2 Table Description

All tables used by this CPCI have been defined by the Development Specification for this CPCI.

##### 3.7.1.3 Item Description

Not applicable to this CPCI.

### 3.8 Object Code Creation

The object code for this CPCI will be created by the system integration test team by using defined IISS Software Configuration Management procedures. This CPCI will use the COBOL "C" language compilers.

### 3.9 Adaptation Data

This CPCI has been coded using ANSI COBOL. The intent was to provide a transportable system. Any system environment

supporting this language, a virtual memory management scheme, the COMM and NTM subsystems of IISS and the ORACLE Database Management System should be able to support this CPCI. Every possible attempt has been made to localize and identify any machine or environment dependent modules through the original design of the IISS and application of Configuration Management Procedures.

### 3.10 Detail Design Description

The following sections have been computer generated for this CPCI.

#### 3.10.1 Where Include File Used List

The following lists each include file in the documentation group and all the modules documented in this specification which include them. The purpose of each module is listed as well.

##### DOCGROUP PS41261 Where-include-file-used List

Include File -----	Module Name -----
CHKCDM	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
ERRCDM	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
EOD	CDCKNM CDP14 CDP14A CDRPSM
ERRPRO	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
ERRFS	CDP14
SBSTLST	CDP14 CDP14A
CGTABLE	CDP14

### 3.10.2 Where External Routine Used List

The following lists each external function or routine in the documentation group and all the documented modules which call it. The purpose of each module is listed as well.

#### DOCGROUP PS41261 Where-external-routine-used List

System Module -----	Module Name -----
SQLSCA	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLBS1	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLSCH	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLSCC	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLTFL	CDCKNM CDEL RPM CDRPSM
SQLOPN	CDCKNM CDEL RPM

DOCGROUP PS41261 Where-external-routine-used List

System Module -----	Module Name -----
SQLOSQ	CDRPSM CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLADR	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLAB1	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLEXE	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLAD1	CDCKNM CDP14 CDP14A
SQLFCH	CDCKNM

DOCGROUP PS41261 Where-external-routine-used List

System Module -----	Module Name -----
ERRPRO	CDP14 CDP14A
SQLWNR	CDCKNM CDEL RPM CDP14 CDP14A CDRPSM
SQLLO1	CDEL RPM CDRPSM
CDDBMSS	CDP14
CDLKLUW	CDP14
SQLTOC	CDP14
SQLCLS	CDP14 CDP14A
OPNFIL	CDP14 CDP14A
OUTFIL	CDP14
CLSFIL	CDP14
CDDBTP	CDP14

DOCGROUP PS41261 Where-external-routine-used List

System Module -----	Module Name -----
CDMACR	CDP14 CDP14A

3.10.3 Main Program Parts List

The following lists each Main Program in the documentation group and all the modules which are called either by that module itself or by any of the documented modules which it calls. It is possible for a non-main module to be listed more than once if it is called by multiple modules. The called modules, in this case known as program parts, are marked as to whether they are documented here. If so, the phrase "well-defined module" appears by the module name, if not it is an "external routine". The Purpose of the Main Program module is listed as well.

DOCGROUP PS41261 Main Program Parts List

Main Pgm Name -----	Module Name -----	Module Type -----
CDCKNM	SQLSCA	External routine
	SQLBS1	External routine
	SQLSCH	External routine
	SQLSCC	External routine
	SQLTFL	External routine
	SQLOPN	External routine
	SQLOSQ	External routine
	SQLADR	External routine
	SQLAB1	External routine
	SQLEXE	External routine
	SQLAD1	External routine
	SQLFCH	External routine
	ERRPRO	External routine
CDEL RPM	SQLSCA	External routine
	SQLBS1	External routine
	SQLSCH	External routine
	SQLSCC	External routine
	SQLTFL	External routine
	SQLOPN	External routine
	SQLOSQ	External routine
	SQLADR	External routine
	SQLAB1	External routine
	SQLEXE	External routine
	ERRPRO	External routine
	SQLWNR	External routine
CDP14	SQLSCA	External routine
	SQLBS1	External routine
	SQLSCH	External routine

DOCGROUP PS41261 Main Program Parts List

Main Pgm Name -----	Module Name -----	Module Type -----
	SQLSCC	External routine
	SQLOSQ	External routine
	SQLADR	External routine
	SQLAB1	External routine
	SQLEXE	External routine
	SQLAD1	External routine
	SQLFCH	External routine
	ERRPRO	External routine
	SQLLO1	External routine
	CDDBMSS	External routine
	CDLKLW	External routine
	CDCKNM	External routine
	SQLTOC	External routine
	SQLCLS	External routine
	OPNFIL	External routine
	OUTFIL	External routine
	CLSFIL	External routine
	CDDBTP	External routine
	CDMACR	External routine
	CDP14A	Well-defined module
	CDEL RPM	External routine
	CDRPSM	Well-defined module
CDP14A	SQLSCA	External routine
	SQLBS1	External routine
	SQLSCH	External routine
	SQLSCC	External routine
	SQLOSQ	External routine
	SQLADR	External routine
	SQLAB1	External routine
	SQLEXE	External routine

DOCGROUP PS41261 Main Program Parts List

Main Pgm Name -----	Module Name -----	Module Type -----
	SQLAD1	External routine
	SQLFCH	External routine
	ERRPRO	External routine
	SQLTOC	External routine
	SQLCLS	External routine
	CDMACR	External routine
CDRPSM	SQLSCA	External routine
	SQLBS1	External routine
	SQLSCH	External routine
	SQLSCC	External routine
	SQLTFL	External routine
	SQLOPN	External routine
	SQLOSQ	External routine
	SQLADR	External routine
	SQLAB1	External routine
	SQLEXE	External routine
	ERRPRO	External routine
	SQLWNR	External routine

3.10.4 Module Documentation

The following documentation describes information which is specific to each individual module in the documentation group being documented in this specification. It provides a compact way of getting information that would be otherwise buried within each module's source code.

The specific items in this module documentation have the following meanings:

**NAME:** Name of program Module.

**PURPOSE:** Purpose of Module as detailed in the source code.

**LANGUAGE:** Programming language source code is written in.  
The choices are:  
VAX-11 FORTRAN  
C (I/S-1 Workbench 'C')  
VAX-11 COBOL

**MODULE TYPE:** Whether a Program, Subroutine, or Function.

**SOURCE FILE:** Name of Source File from file specification.

**SOURCE FILE TYPE:** Source File Extension from file specification.

**HOST:** Whether this is a host-dependent routine (VAX or IBM) or blank if host-independent.

**SUBSYSTEM:** IISS sub-system this file resides in.

**SUBDIRECTORY:** Sub-directory of that subsystem in which this file resides.

**DOCUMENTATION GROUP:** Name of documentation group of which this source file is a member.

**DESCRIPTION:** A description of the module as obtained from the source code.

**ARGUMENTS:** The arguments with which this routine is called if it is a Subroutine or a Function.

**INCLUDE FILES:** A list of all the files that are included into this module as well as their purposes.

**ROUTINES CALLED:** Subroutines or Functions, either documented or external, called by this module, if any.

**CALLED DIRECTLY BY:** The documented routines which call this module, if any.

**USED IN MAIN PROGRAM(S):** The documented Main Programs which contain this module in their parts list according to the list in section 3.10.3.

The Module Documentation is arranged alphabetically according to Module Name.

DOCGROUP PS41261 Module Documentation

NAME: CDCKNM  
PURPOSE: GET A COUNT OF UNSUCCESSFULLY PRECOMPILED NDML  
MODULES  
LANGUAGE: VAX-11 COBOL  
SOURCE FILE: CDCKNM  
SOURCE FILE TYPE: PCO  
HOST:  
SUBSYSTEM: CDM  
SUBDIRECTORY: NDML

DESCRIPTION:

-----  
GIVEN A LOGICAL UNIT OF WORK NAME, DETERMINE HOW  
MANY NDML MODULES HAVE BEEN RECORDED IN THE CDM  
WHICH HAVE BEEN EITHER UNCSUCCESSFULLY PRECOMPILED  
OR NOT PRECOMPILED AT ALL YET. IF ANY ARE FOUND,  
THE CALLER WILL NOT BE ABLE TO GENERATE ANY  
REQUEST PROCESSOR DRIVERS.

ARGUMENTS:

-----  
LUW-NAME DSPLY[X(30)]  
BAD-COUNT DSPLY[S9(9)]  
RET-STATUS DSPLY[X(5)]

INCLUDE FILES:

-----  
CHKCDM  
ERRCDM  
EOD  
ERRPRO

ROUTINES CALLED:

-----  
SQLSCA  
SQLBS1  
SQLSCH  
SQLSCC  
SQLTFL  
SQLOPN  
SQLOSQ  
SQLADR  
SQLAB1  
SQLEXE  
SQLAD1  
SQLFCH  
ERRPRO



DOCGROUP PS41261 Module Documentation

NAME: CDP14  
PURPOSE: GENERATE REQUEST PROCESSOR DRIVERS FOR A LUW  
LANGUAGE: VAX-11 COBOL  
SOURCE FILE: CDP14  
SOURCE FILE TYPE: PCO  
HOST:  
SUBSYSTEM: CDM  
SUBDIRECTORY: NDML

DESCRIPTION:  
-----

UPDATED 1/31/89:  
WILL ALWAYS CREATE FILES RPMIN(F/C) TO CDMTEMPS  
(WILL BE STUBS IF THAT LANGUAGE NOT USED).  
UPDATED 12/12/89:  
RPMIN.C WILL GET CREATED AS A STUB IF LOCAL RP-MAIN  
HAS BECOME OBSOLETE.

ARGUMENTS:  
-----

LUW-NAME	DSPLY[X(30)]
CDM-USER-NAME	DSPLY[X(30)]
CODE-GENERATOR-TABLE	RECRD
MY-HOST	DSPLY[XXX]
RET-STATUS	DSPLY[X(5)]

INCLUDE FILES:  
-----

CHKCDM  
ERRCDM  
ERRFS  
SBSTLST  
EOD  
CGTABLE  
ERRPRO

ROUTINES CALLED:  
-----

SQLSCA  
SQLADR  
SQLLO1  
CDDBMSS  
CDLKLUW  
CDCKNM  
SQLBS1  
SQLSCH  
SQLSCC  
SQLTOC  
SQLOSQ  
SQLAB1  
SQLEXE  
SQLAD1  
SQLFCH  
SQLCLS

OPNFIL  
OUTFIL  
CLSFIL  
ERRPRO  
CDDBTP  
CDMACR  
CDP14A  
CDEL RPM  
CDRPSM

DOCGROUP PS41261 Module Documentation

NAME: CDP14A  
PURPOSE: GENERATE CASE CALL CODE INTO THE RP DRIVER  
LANGUAGE: VAX-11 COBOL  
SOURCE FILE: CDP14A  
SOURCE FILE TYPE: PCO  
HOST:  
SUBSYSTEM: CDM  
SUBDIRECTORY: NDML

DESCRIPTION:

-----  
SEARCH THE CDM FOR ALL RP-SUB'S FOR A  
SINGLE REQUEST PROCESSOR DRIVER (  
ONE DB ID AND ONE LUW). FOR EACH  
RP-SUB, GENERATE THE PROPER CODE INTO  
THE RPD WITH A CALL TO CDMACR.  
MODIFIED 10/30/87  
REMOVAL OF DYNAMIC CALL CAPABILITY ON THE IBM.

ARGUMENTS:

-----  
DB-ID                                   DSPLY[9(5)]  
LUW-NAME                               DSPLY[X(30)]  
FCB-O                                   DSPLY[S9(9)]  
LIBRARY-NAME                           DSPLY[X(30)]  
HOST-ID                                 RECRD  
LANG-NAME                               DSPLY[X(10)]  
LOCAL-REMOTE                           DSPLY[X]  
RET-STATUS                              DSPLY[X(5)]

INCLUDE FILES:

-----  
CHKCDM  
ERRCDM  
SBSTLST  
EOD  
ERRPRO

ROUTINES CALLED:

-----  
SQLSCA  
SQLBS1



### 3.10.5 Include File Descriptions

The following list contains a purpose and description of each include file in the documentation group as specified in the source code. The language it is written in is also given.

#### DOCGROUP PS41261 Include File Description

FILE NAME: CGTABLE  
PURPOSE: CODE GENERATING TABLE- TRACKS ALL GENERATED SOFTWARE  
LANGUAGE: VAX-11 COBOL

#### DESCRIPTION:

-----

HOLDS PERTINENT RESULTS  
ABOUT ALL CODE GENERATED OR MODIFIED BY THE  
PRECOMPILER

#### DOCGROUP PS41261 Include File Description

FILE NAME: CHKCDM  
PURPOSE: IISS CDMP CHECK STATUS CODES  
LANGUAGE: VAX-11 COBOL

#### DESCRIPTION:

-----

CONTAINS ALL STATUS CODES FOR THE \*  
CDMP MODULES \*

#### DOCGROUP PS41261 Include File Description

FILE NAME: EOD  
PURPOSE: SQL END OF DATA DEFINITION  
LANGUAGE: VAX-11 COBOL

#### DESCRIPTION:

-----

DOCGROUP PS41261 Include File Description

FILE NAME: ERRCDM  
PURPOSE: IISS ERROR STATUS CODES FOR CDMP MODULES  
LANGUAGE: VAX-11 COBOL

DESCRIPTION:  
-----

CONTAINS ALL ERROR CODES USED BY CDMP \*  
MODULES FOR ERROR HANDLING \*

DOCGROUP PS41261 Include File Description

FILE NAME: ERRFS  
PURPOSE: ERRFS.INC - FILE I/O PRIMITIVES (FILE SERVICES)  
LANGUAGE: VAX-11 COBOL

DESCRIPTION:  
-----

IISS ERROR CODES

THIS FILE DEFINES THE FS STATUS  
CODES IN COBOL FORMAT

DOCGROUP PS41261 Include File Description

FILE NAME: ERRPRO  
PURPOSE: PROCESS ERROR INCLUDE FILE  
LANGUAGE: VAX-11 COBOL

DESCRIPTION:  
-----

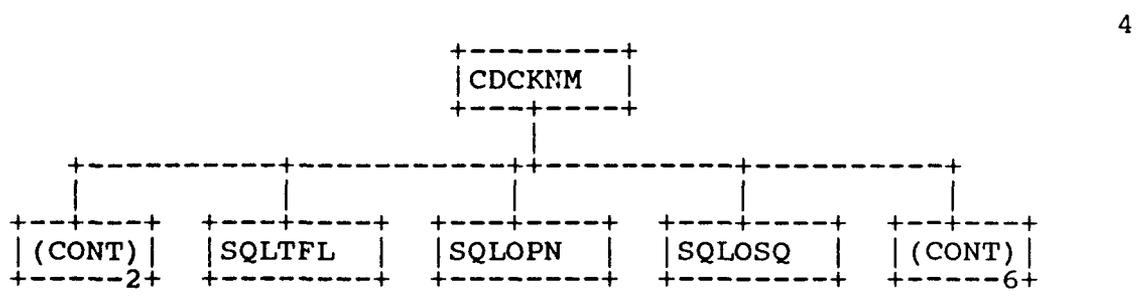
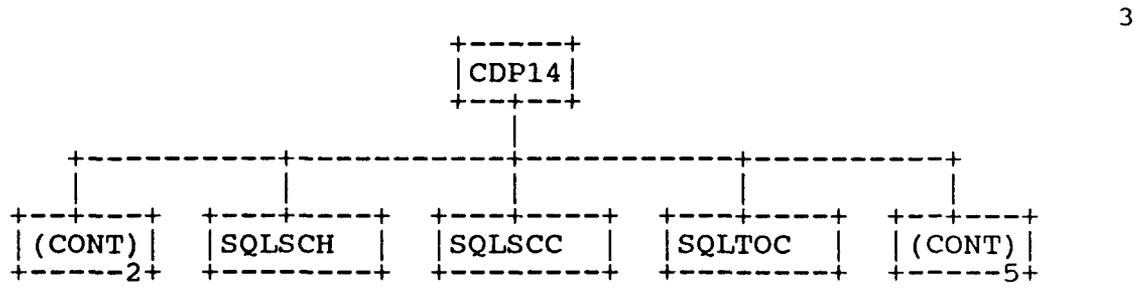
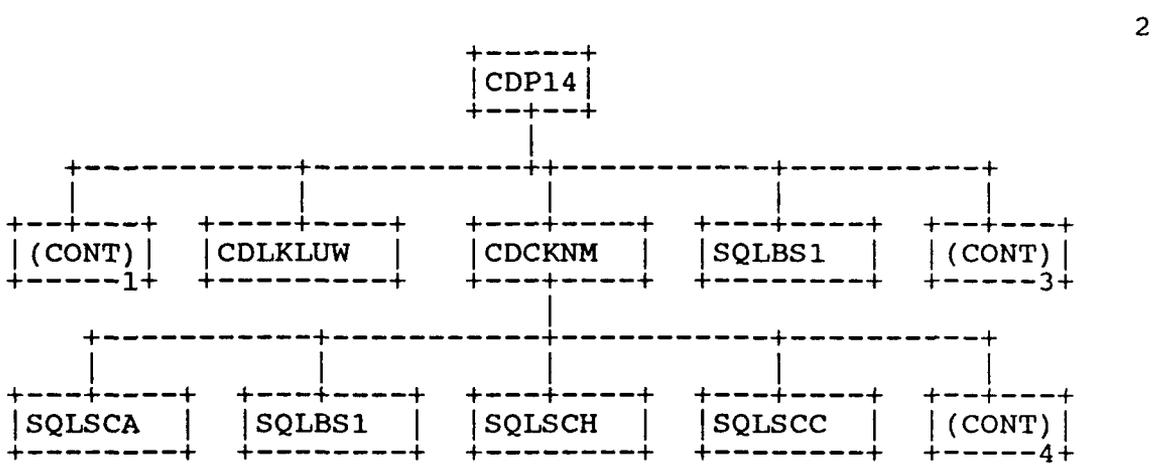
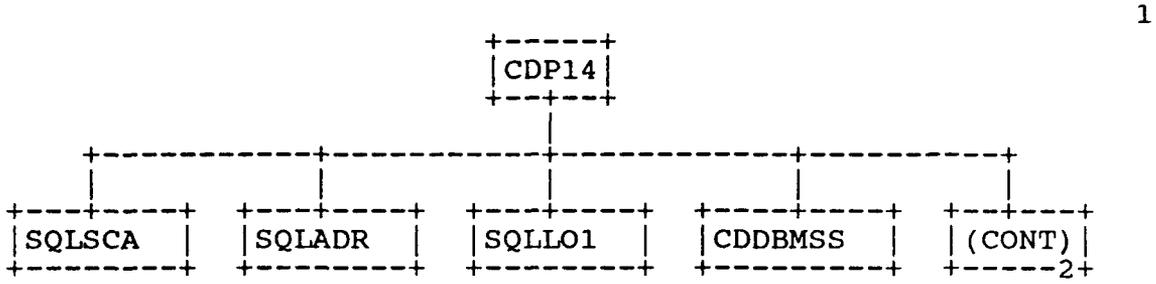
DOCGROUP PS41261 Include File Description

FILE NAME: SBSTLST  
PURPOSE: WS DEFINITION FOR THE SUBSTITUTION LIST TABLE  
LANGUAGE: VAX-11 COBOL

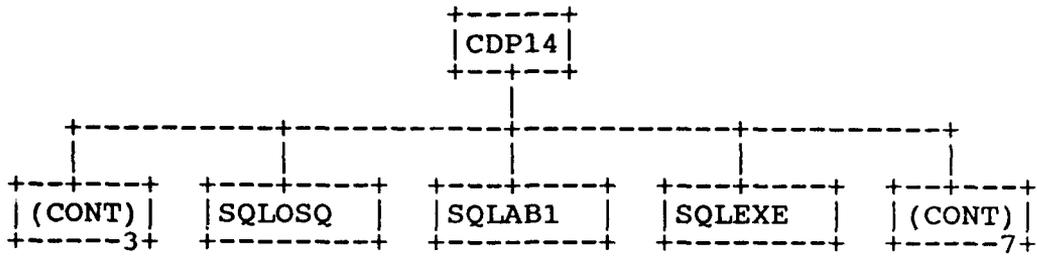
DESCRIPTION:  
-----

SUBSTITUTION-LIST REPRESENTS THE INPUT TABLE  
OF SUBSTITUTION PARAMETERS FOR THE CDMACR  
MACRO EXPANSION SUBROUTINE

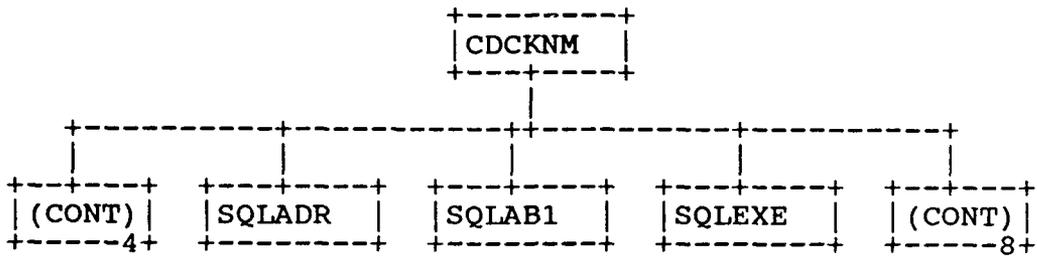
3.10.6 Hierarchy Chart



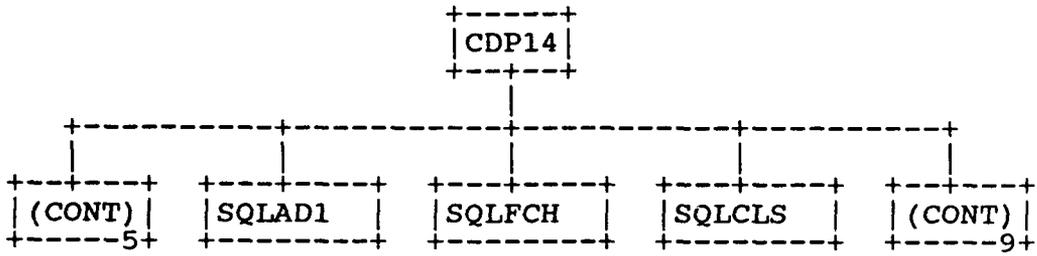
5



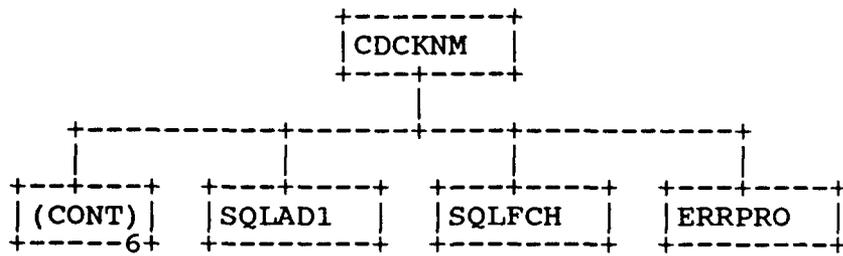
6



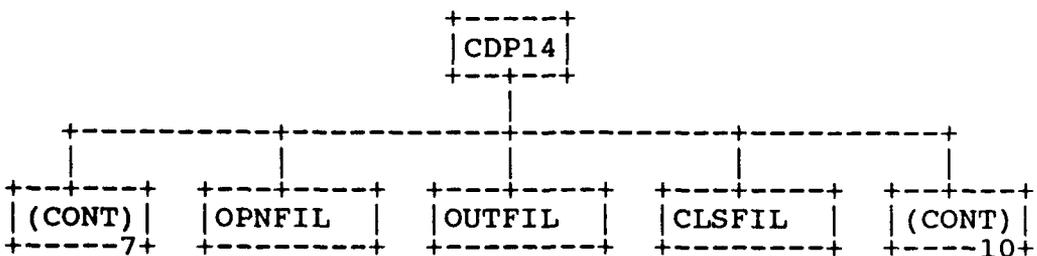
7



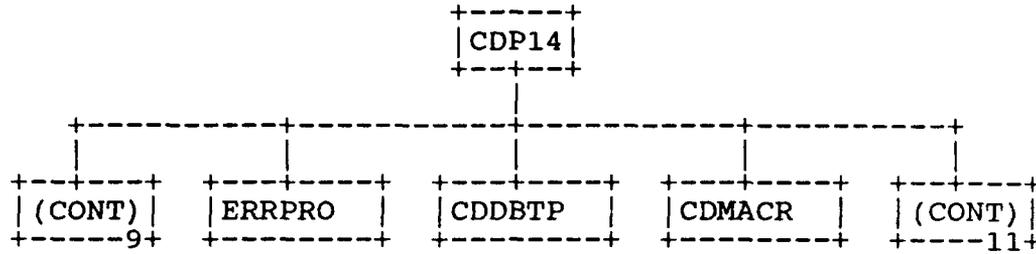
8



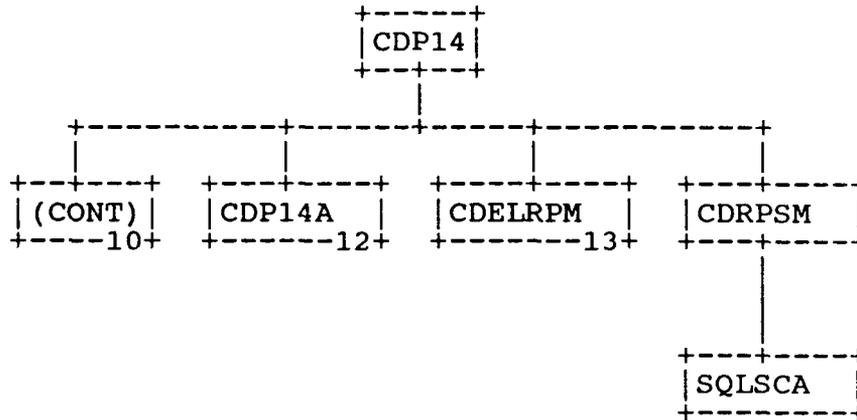
9



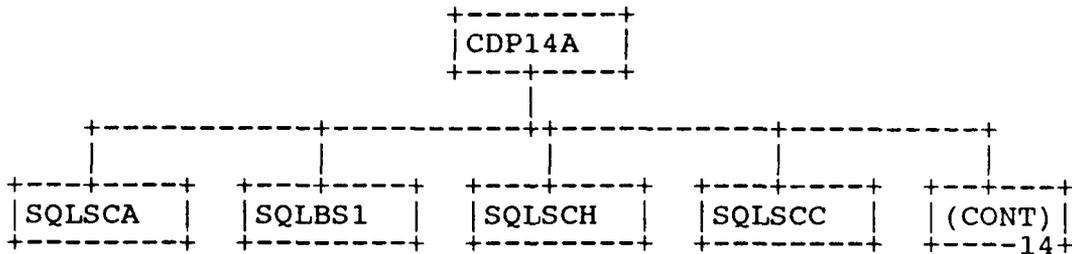
10



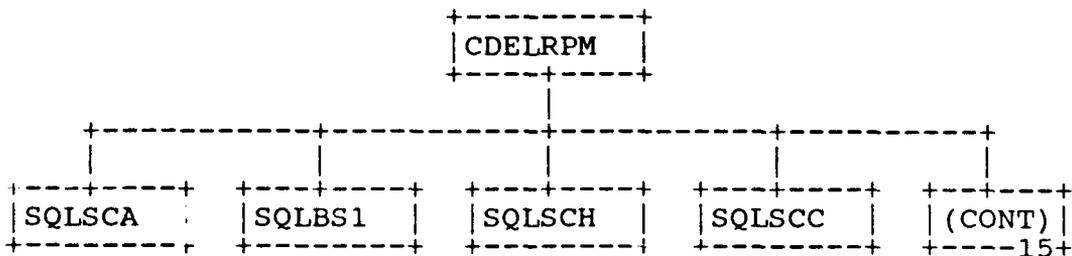
11



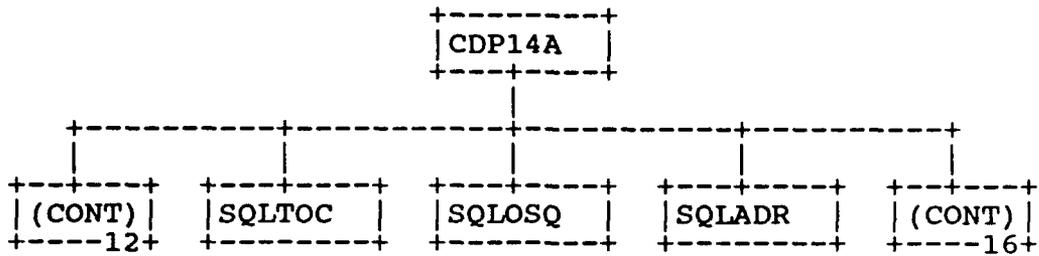
12



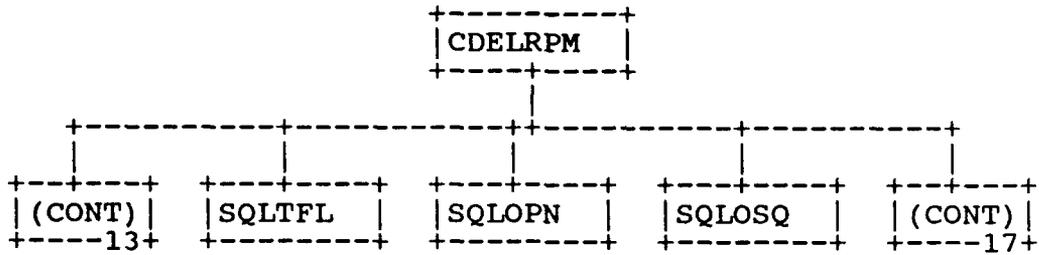
13



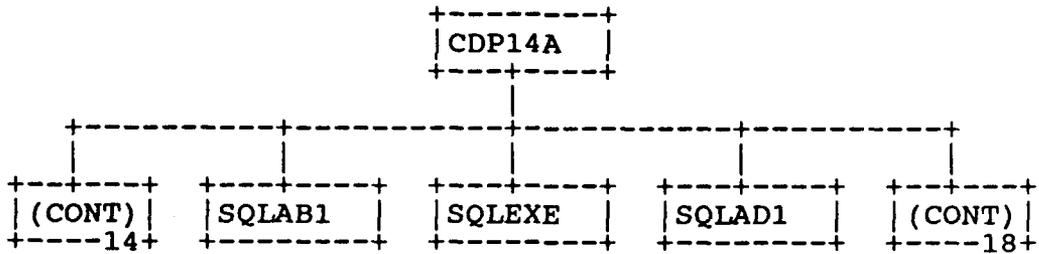
14



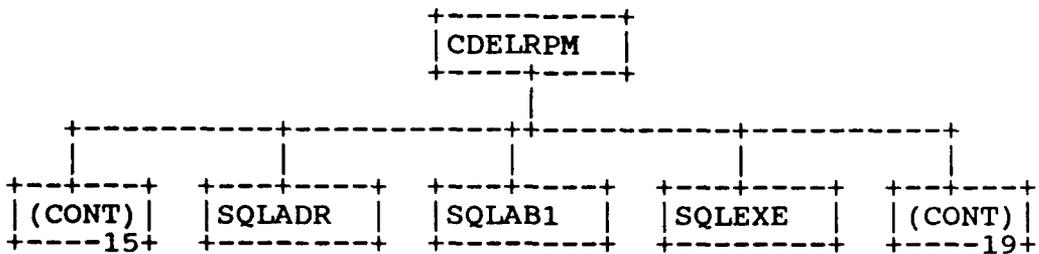
15



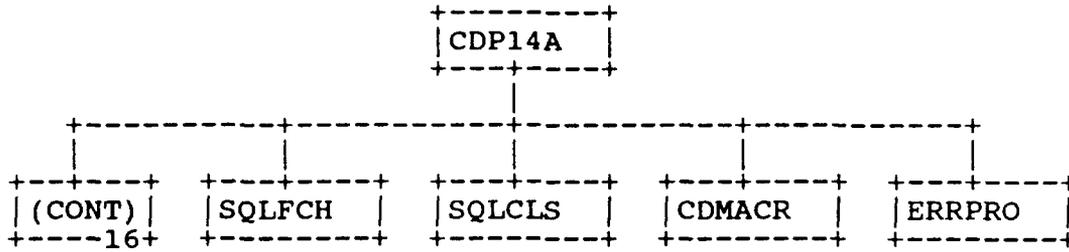
16



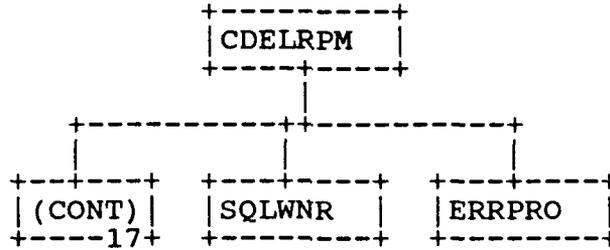
17



18



19



CDCKNM .....2  
 CDDBMSS  
 CDDBTP  
 CDEL RPM ...13  
 CDLKLUW  
 CDMACR  
 CDP14.....1  
 CDP14A ....12  
 CDRPSM ....11  
 CLSFIL  
 ERRPRO  
 OPNFIL  
 OUTFIL  
 SQLAB1  
 SQLAD1  
 SQLADR  
 SQLBS1  
 SQLCLS  
 SQLEXE  
 SQLFCH  
 SQLLO1  
 SQLOPN  
 SQLOSQ  
 SQLSCA  
 SQLSCC  
 SQLSCH  
 SQLTFL  
 SQLTOC  
 SQLWNR

3.11 Program Listings Comments

This information is contained in the Module Descriptions in section 3.10.

## SECTION 4

### QUALITY ASSURANCE PROVISIONS

#### 4.1 Introduction and Definitions

"Testing" is a systematic process that may be preplanned and explicitly stated. Test techniques and procedures may be defined in advance, and a sequence of test steps may be specified. "Debugging" is the process of isolation and correction of the cause of an error.

"Antibugging" is defined as the philosophy of writing programs in such a way as to make bugs less likely to occur and when they do occur, to make them more noticeable to the programmer and the user. In other words, as much error checking as is practical and possible in each routine should be performed.

#### 4.2 Computer Programming Test and Evaluation

The quality assurance provisions for test consists of the normal testing techniques that are accomplished during the construction process. They consist of design and code walk-throughs, unit testing, and integration testing. These tests are performed by the design team. Structured design, design walk-through and the incorporation of "antibugging" facilitate this testing by exposing and addressing problem areas before they become coded "bugs."