60483500

CONTROL DATA CORPORATION

DMS-170

CYBER DATABASE CONTROL SYSTEM VERSION 2 FORTRAN APPLICATION PROGRAMMING USER'S GUIDE

CDC® OPERATING SYSTEMS:
NOS 2
NOS/BE 1

REVISION RECORD

Revision	Description
A (03/06/81)	Original release at PSR level 528.
B (10/08/82)	Updated to reflect FORTRAN Data Base Facility (FDBF) 1.3, CYBER Database Control System (CDCS) 2.3, and use under NOS 2 (but not NOS 1); released at PSR level 564. The guide has been retitled. Major changes include adding documentation of data base transactions, and creating the data base for sample programs with FORTRAN.

REVISION LETTERS I, O, Q, AND X ARE NOT USED

Address comments concerning this manual to:

CONTROL DATA CORPORATION
Publications and Graphics Division
215 MOFFETT PARK DRIVE
SUNNYVALE, CALIFORNIA 94086

or use Comment Sheet in the back of this manual

LIST OF EFFECTIVE PAGES

New features, as well as changes, deletions, and additions to information in this manual are indicated by bars in the margins or by a dot near the page number if the entire page is affected. A bar by the page number indicates pagination rather than content has changed.

Page	Revision
Front Cover	-
Inside Front Cover	B
Title Page	-
ii	B
iii/iv	B
v	B
vi	B
vii	B
viii	B
ix	A
1-1 thru 1-3	A
1-4 thru 1-7	B
2-1 thru 2-3	A
2-4 thru 2-6	B
3-1 thru 3-4	B
3-5 thru 3-14	A
3-15 thru 3-19	B
4-1 thru 4-6	B
5-1	B
5-2	A
5-3	B
5-4	A
5-5	A
5-6	B
5-7 thru 5-22	A
5-23 thru 5-28	B
6-1 thru 6-3	B
A-1 thru A-4	A
B-1 thru B-3	B
C-1	B
C-2 thru C-10	A
C-11 thru C-15	B
Index-1 thru -3	B
Comment Sheet	B
Mailer	-
Back Cover	-

PREFACE

The DMS-170 data management system clearly defines two roles: the role of a data administrator who develops, controls, and maintains the physical data base; and the role of an application programmer who accesses and manipulates the data within that data base. Although the two roles differ considerably, each role requires a knowledge of the tasks being performed by the other. The data administrator, for example, cannot develop a data base without first understanding what type of applications will be required. The application programmer, on the other hand, cannot successfully access data without first understanding how the data is described and what specific controls have been established.

This guide describes the role of the FORTRAN 5 application programmer who is accessing data within a DMS-170 controlled data base environment. The presence of a data administrator is assumed, and the functions associated with that position are described as they directly affect the application programmer.

You should note that appendix C, entitled The Sample Application, is particularly important. This appendix sets up a working environment complete with stored data for use with sample programs. This environment can be duplicated to provide a better understanding of DMS-170 and the tools that are used to create a total data management system.

As described in this publication, DMS-170 operates under control of the following operating systems:

- NOS 1 for the CONTROL DATA CYBER 170 Series; CYBER 70 Models 71, 72, 73, and 74; and 6000 Series Computer Systems.
- NOS/BE 1 for the CDC CYBER 170 Series; CYBER 70 Models 71, 72, 73, and 74; and 6000 Series Computer Systems.

The NOS Manual Abstracts and the NOS/BE Manual Abstracts are instant-sized manuals containing brief descriptions of the contents and intended audience of all NOS and NOS product set manuals, and NOS/BE and NOS/BE product set manuals, respectively. The abstracts manuals can be useful in determining which manuals are of greatest interest to you. The Software Publications Release History serves as a guide in determining which revision level of software documentation corresponds to the Programming Systems Report (PSR) level of installed site software.

As a FORTRAN 5 application programmer, you can find additional pertinent information in the listed Control Data Corporation publications. These publications are listed alphabetically in groupings that indicate relative importance to you as readers of this guide.

The following manuals are of primary interest:

Publication	Publication Number
FORTRAN Data Base Facility Version 1 Reference Manual	60482200
FORTRAN Version 5 Reference Manual	60481300

The following manuals are of secondary interest:

Publication	Publication Number
CYBER Database Control System Version 2 Reference Manual	60481800
NOS Version 1 Manual Abstracts	84000420
NOS Version 1 Reference Manual, Volume 1 of 2	60435400
NOS/BE Version 1 Manual Abstracts	84000470
NOS/BE Version 1 Reference Manual	60493800
Software Publications Release History	60481000

CDC manuals can be ordered from Control Data Corporation, Literature and Distribution Services, 308 North Dale Street, St. Paul, Minnesota 55103.

This manual describes a subset of the features and parameters documented in the FORTRAN Data Base Facility Version 1 Reference Manual. Control Data cannot be responsible for the proper functioning of any features or parameters not documented in the FORTRAN Data Base Facility Version 1 Reference Manual.

CONTENTS

TABLES

NOTATIONS

The specifications for FORTRAN DML statements and for particular control statements are described in reference formats. The notations used in the reference formats are described as follows:

UPPERCASE	Uppercase words are reserved words and must appear exactly as shown. You can use reserved words only as specified in the reference formats.
Lowercase	Lowercase words are generic terms that represent user-supplied words or symbols.
[ ]	Brackets enclose optional portions of a reference format. You can optionally omit or include all of the format within the brackets.
...	Ellipses immediately follow a pair of brackets to indicate that you can optionally repeat the enclosed material.

Punctuation symbols shown within the formats are required unless enclosed in brackets and specifically noted as optional. One or more spaces separate the elements in a reference format. Numbers shown are decimal unless otherwise specified.

FORTRAN PROGRAMMING WITHIN DMS-170 1

DMS-170 is a Control Data software package for data management. The system was designed on the premise that a data base should be centrally controlled and the data within that data base should be completely independent of application programs. In line with this philosophy, the role of data administrator emerged. This individual was to lead the design, programming, implementation, maintenance, and recovery efforts associated with the DMS-170 data management system.

The data administrator is responsible for the structural organization and layout of an entire data base. This individual assigns names to and describes the characteristics of all data items within the data base. This total description is called a schema. The schema is generated by the data administrator and stored as a permanent file.

As a FORTRAN programmer, you probably would never need or even want to access an entire data base. You would, however, need to access selected portions of a data base organized in a number of ways to meet the requirements of your various application programs. The grouping of data base items into separate data base portions is the responsibility of the data administrator. The descriptions of these grouped items are called sub-schemas. Sub-schemas are generated by the data administrator and stored in a permanent file library.

Internal control is handled by the CYBER Database Control System (CDCS). CDCS interprets all data base requests from application programs, ensures the validity of such requests, and passes them along to the input/output processor. The controls exercised by CDCS guarantee that one user cannot alter the contents of the data base and adversely affect another user's program.

The controls designated by the data administrator, incorporated into the schema and sub-schema, and carried out by CDCS relieve application programmers of many tedious tasks such as data description, data conversion, and validity checking.

SYSTEM COMPONENTS

The components of DMS-170 that are discussed in this guide include the language that describes the data (Data Description Language); the language that provides data base access to a FORTRAN application program (FORTRAN Data Manipulation Language); the module that controls data base activity (CYBER Database Control System); and the processor that handles all input and output operations (CYBER Record Manager). The components of DMS-170 that are not discussed in this guide include a special, nonprocedural language (Query Update) that provides data base access to programming and nonprogramming users and the COBOL Language extensions that provide data base access to COBOL application programs.

DATA DESCRIPTION LANGUAGE

The Data Description Language (DDL) is a compiler language that the data administrator uses to describe data. DDL can generate four types of descriptions: the schema definition that describes an entire data base; the FORTRAN sub-schema definition that describes selected portions of a schema-defined data base for use by a FORTRAN application program; the COBOL sub-schema definition that describes selected portions of a schema-defined data base for use by a COBOL application program; and the QUERY UPDATE sub-schema definition that either describes selected portions of a schema-defined data base or describes an independently controlled data base for use by the interactive query software product Query Update. The data descriptions for the schema and each sub-schema are declared in DDL source statements for input to the DDL compiler.

A block diagram illustrating schema/sub-schema generation is shown in figure 1-1.

The Schema

The schema is a detailed description of all the data in a data base. The schema description is generated from DDL statements that name the schema, organize the schema into files (called areas in the schema), describe each record type together with the characteristics of the data in the record, and describe relationships (called relations) and dependency conditions (called constraints) among areas. The schema also includes an access control capability that provides privacy at the area level.

The data administrator writes the DDL source statements and uses them as input to the DDL compiler for compilation into an object schema or schema directory. After storing the directory as a permanent file, the data administrator provides you with pertinent information so you can tailor your FORTRAN program to meet processing requirements. If, for example, you need to access an area that has been defined as having controlled access in the schema, it is the responsibility of the data administrator to supply you with the appropriate privacy key.

The Sub-Schema

The sub-schema is a detailed description of selected portions of the data in a data base. The FORTRAN sub-schema description is generated from DDL statements that identify the schema and sub-schema, specify files (called realms in the sub-schema) and the content and structure of records, indicate changes in data format required by the application program, identify relations to be used, and specify record qualification for relation processing.

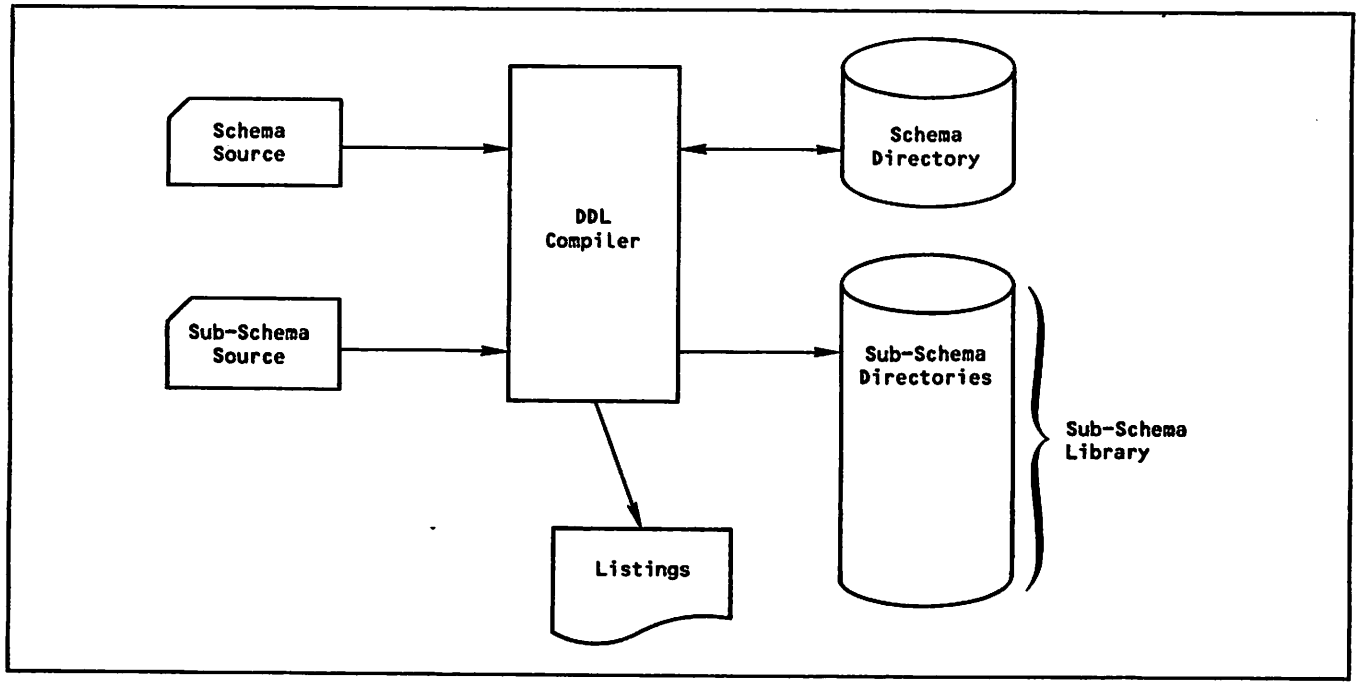


Figure 1-1. Schema and Sub-Schema Generation

The data administrator writes the DDL source statements and uses them as input to the DDL compiler for compilation into an object sub-schema or sub-schema directory. After storing the directory in the sub-schema library, the data administrator provides you with a listing of the sub-schema so you can obtain the names and descriptions of the data to be referenced in your FORTRAN program. The data administrator also provides you with the name of the sub-schema library, which you must attach with an operating system ATTACH control statement for DML preprocessing of the Data Manipulation Language statements in your FORTRAN program just before compilation.

FORTRAN DATA MANIPULATION LANGUAGE

The FORTRAN Data Manipulation Language (DML) is the language that provides a FORTRAN application program with access to the DMS-170 controlled data base. The language consists of a series of statements that provide for opening and closing of data base files; reading, writing, updating, and deleting records from those files; and relation processing. The DML statements you include in your FORTRAN source program code are translated by the DML preprocessor into statements acceptable to the FORTRAN compiler.

CYBER DATABASE CONTROL SYSTEM

The central controlling component of DMS-170 is CYBER Database Control System (CDCS), which monitors and interprets all data base requests from application programs. CDCS preprocesses each application program request, performs any necessary data conversion, handles structural differences between the schema and the sub-schema by an operation called mapping, and prepares the request for input/output processing.

Master Directory

The master directory is a file that contains information relating to all data bases, schemas, and sub-schemas known to CDCS. The directory is generated by one of the data base utilities provided through CDCS. The data administrator creates the master directory and stores it as a permanent file. Your application program cannot reference a sub-schema unless information about that sub-schema exists in the master directory. It is the responsibility of the data administrator to ensure the sub-schema is valid. The master directory file is attached through the job stream of CDCS and is automatically available for your job.

CDCS Batch Test Facility

The CDCS Batch Test Facility is an absolute program that you can use during program development and testing. The facility enables you to run CDCS as a normal batch job, which means you can attach a new version of the master directory file each time you run a job.

The program, which resides on the system library, is called into execution by the CDCSBTF control statement. When using this facility, you are responsible for attaching the master directory file and any necessary log files each time you run a job.

Data Base Procedures

Data base procedures are special-purpose subprograms that CDCS calls when specific situations occur during CDCS processing. The data administrator writes the data base procedures and stores them in a permanent file library. The name of the procedure, the point at which it is to be called, and the conditions governing its execution are specified in the schema definition. Loading of data base procedures is handled automatically for you.

CYBER RECORD MANAGER

CYBER Record Manager (CRM) is the processor that performs all input/output operations for FORTRAN as well as the other CYBER host languages operating within DMS-170. The Advanced Access Methods (AAM) file manager handles all operations concerning the physical storage and access of data by application programs. All data base files supported by CDCS are conventional CRM files.

All necessary information regarding the characteristics of a data base file is supplied to CRM at schema compilation time. The data administrator specifies appropriate parameters on FILE control statements that are included in the DDL source deck when the schema is created. In DMS-170, all communication with CRM is handled automatically for you.

A block diagram illustrating the CRM interface with CDCS and the data base is shown in figure 1-2.

File Organization

File organization information is stored in the schema directory. The three file organizations allowed for data base files that are to be accessed through CDCS are: indexed sequential, direct access, and actual key.

Records in indexed sequential files are stored in ascending order by key. An application program can access the records either randomly by key or sequentially.

Records in direct access files are stored randomly in fixed-length blocks. The number of the block to receive a record is determined by a calculation performed by the system on the record. An application program can access the records either randomly by key or sequentially.

Records in actual key files have key values assigned by the system. The key value is a number that identifies the block and the position within the block in which the record is stored. An application program can access the records either randomly by actual key or sequentially.

The primary key is specified in the schema. A listing of the sub-schema provides you with this information.

Multiple-Index Processing

Multiple-index processing is performed when alternate keys are defined for a file. An index is created for each alternate key in a data file when the file is created. The indexes are updated automatically whenever the data file is updated. An application program can retrieve the records by the primary key or by an alternate key.

Each alternate key is specified in the schema. A listing of the sub-schema provides you with this information.

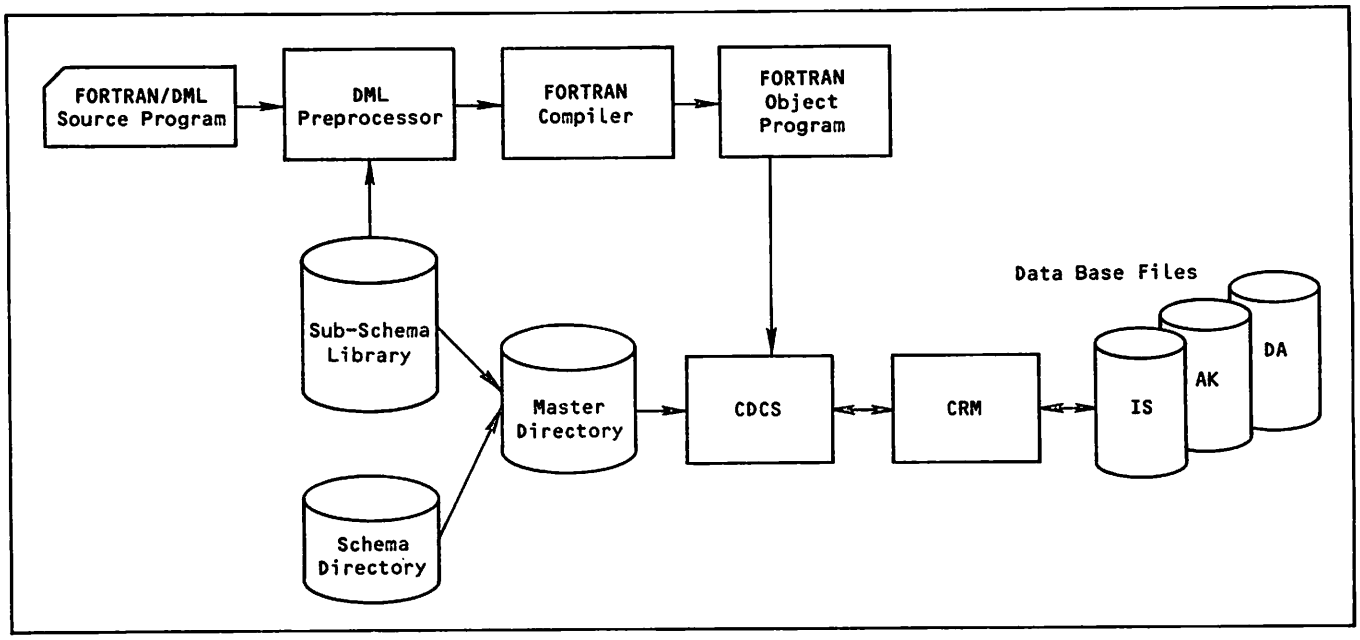


Figure 1-2. CYBER Record Manager Interface

SPECIAL FEATURES

Eight special features with which you need to be familiar are: concurrency, immediate return, file privacy, relations, constraints, data base versions, recovery, and data base transactions. When these mechanisms are present in the CDCS operating environment, some action on the part of your application program might be required.

CONCURRENCY

The concurrency feature allows two or more application programs to access the same data base file at the same time for retrieval or update purposes. During concurrent update operations, CDCS provides a locking mechanism by which files and records can be locked and unlocked at appropriate times.

CDCS always locks the current record whenever the file is opened for input/output. Your application program, however, can issue explicit lock and unlock requests for CDCS to lock the entire file. By issuing a lock request, your program prevents other jobs from updating the file that it is using until it issues an unlock request. The file being locked and unlocked must be a file identified in the sub-schema.

A deadlock situation can occur when a program attempts to access files or records that have been locked by CDCS for other programs. When this situation occurs, CDCS arbitrarily releases the locked resources held by one of the contending programs. To ensure proper recovery handling in this type of situation, you should include appropriate code in your FORTRAN program.

IMMEDIATE RETURN

The immediate return feature of CDCS provides FORTRAN application programs with the ability to receive an immediate response from CDCS when either CDCS cannot get the resources it needs, or a fatal error occurs. When this feature is used, CDCS returns control to the application program.

The immediate return feature cannot be enabled before CDCS is invoked. See the CDCS 2 Application Programming reference manual for more information.

FILE PRIVACY

The file privacy feature provides file access control. When file privacy has been specified in the schema, your program must supply privacy keys to gain access to the file.

The data administrator provides you with this information so you can ensure your FORTRAN program meets the privacy requirements when CDCS checks for appropriate privacy keys.

RELATIONS

The relational data base feature allows files to be linked together into a logical relationship called a relation. An application program can access the data from related files with a single read request. Relations are specified in the schema. Any relation that is available to an application program is specified in the sub-schema.

Your application program can access a relation by specifying a single read request with the name of the relation that is to be read. CDCS processes the request and returns a record occurrence from each file in the relation to your program's working storage area for the file.

The data administrator can place limitations on relations by including restrictions in the sub-schema. Restrictions are in the form of qualification criteria that must be satisfied before a record occurrence is made available to your program.

A listing of the sub-schema provides you with the name of the relation and indicates what specific restrictions apply.

CONSTRAINTS

The constraint feature allows controls to be imposed on update operations involving logically associated files. Constraints protect the integrity of the data base by allowing update operations to be performed only when specific conditions are satisfied. Constraints are specified in the schema and are enforced by CDCS.

The data administrator provides you with information concerning constraints. You can avoid constraint violations by becoming familiar with the rules that apply when modifying files on which constraints have been imposed.

DATA BASE VERSIONS

The data base version feature of CDCS allows an application program to use the same schema and subschema to access more than one group of permanent files corresponding to the areas in the schema; each of these groups is defined as a data base version. Data base versions are defined by the data administrator in the master directory. By specifying use of different versions, an application program can perform operations on different groups of files, each group forming a data base version. For detailed information about this feature, see the CDCS 2 Application Programming reference manual.

RECOVERY

The recovery feature provides for reconstruction of a damaged or inconsistent data base and provides for the removing of updates made with erroneous logic. The data base can be recovered when physical storage or system failure occurs and all or part of the data base is lost or otherwise unreadable. The data base can be restored to a previous checkpoint or beginning of job when an application program failure or logic error occurs.

Recovery operations are made possible through a logging facility, which is the recording of user interactions with a data base file. Logging requirements are defined by the data administrator for a schema and serviced by CDCS. CDCS records the logging information on an independent file that ultimately serves as input for data base recover and restore operations. Log files, if specified, are attached through the job stream of CDCS and are automatically available to record the interactions of your program with the data base.

DATA BASE TRANSACTION

The data base transaction feature of CDCS provides the FORTRAN application program with the ability to group a series of data base updates into a logical unit, called a data base transaction.

The application program specifies the beginning of the transaction, performs the update operations, and specifies the end of the transaction, which can be either a commit or a drop. When the application program specifies a commit operation, all updates made within the transaction become permanent. When the application program specifies a drop operation, all updates within the transaction are reversed; therefore, the data base remains in the state it was in before the beginning of the transaction.

If the application program fails to commit a transaction because of system or program failure, automatic recovery is performed; that is, the transaction is dropped and the data base is restored to its state before the beginning of the transaction.

Transaction processing also provides an application program with the ability to determine the point at which to restart processing after a system failure. The application program can use this feature to determine the last transaction that was committed before the system failure occurred. The program can then determine the point at which processing should be restarted.

SUMMARY OF DMS-170 COMPONENTS AND FEATURES

A summary of DMS-170 components and features appears in table 1-1. This table provides a quick reference for appropriate information.

TABLE 1-1. SUMMARY OF DMS-170 COMPONENTS AND FEATURES

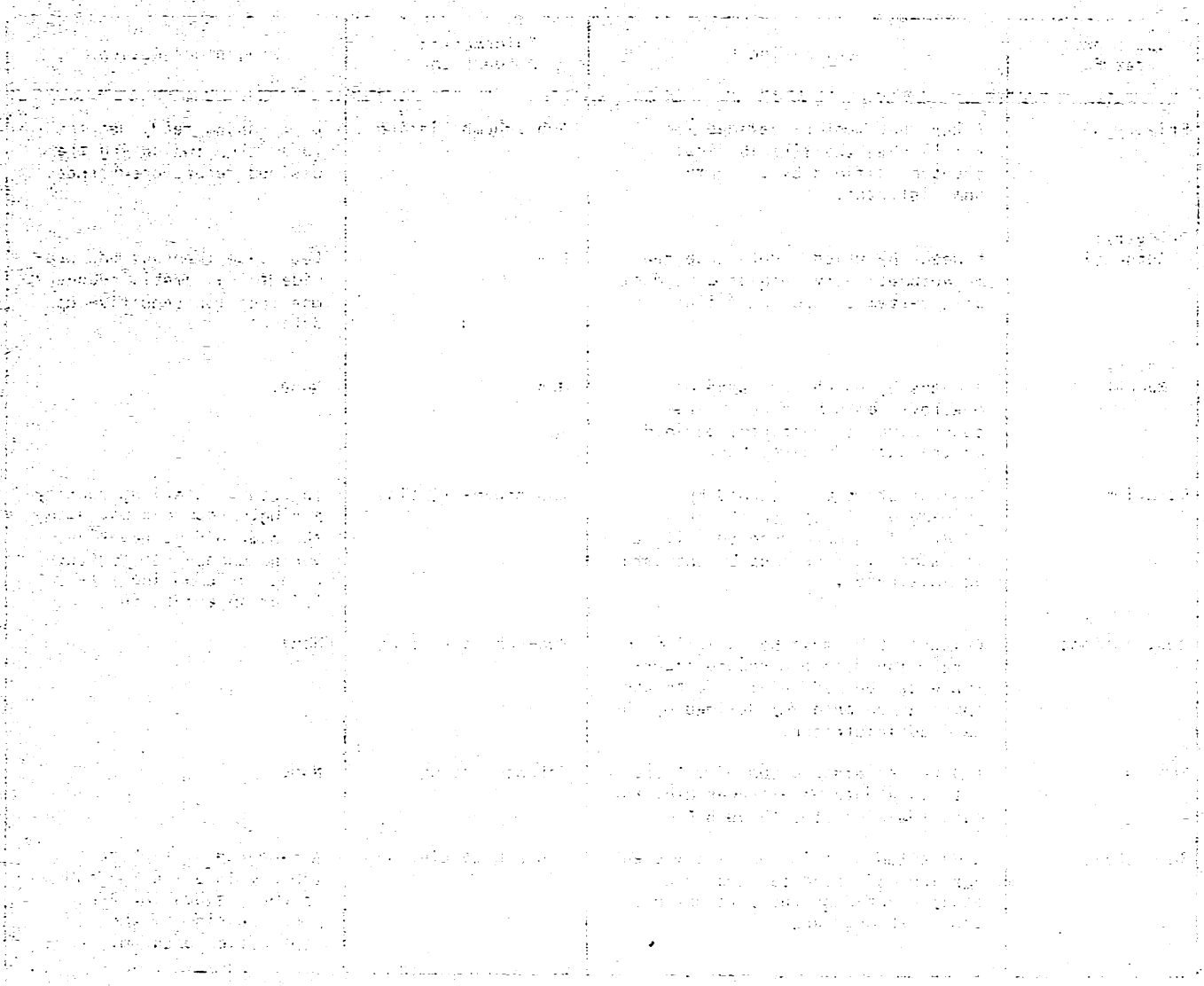
Component/ Feature	Definition	Information Appears In	Programmer Action
Alternate key	A key other than the primary key by which a file can be accessed; defined by the data administrator.	Sub-schema listing	On a random read, set the key to a value indicating the desired record occurrence.
CDCS Batch Test Facility	A non-concurrent version of CDCS for use during program development.	N/A	Attach the master directory when executing the application program.
Concurrency	Simultaneous access to the same data by two or more application programs.	N/A	Include appropriate code in the application program to handle a deadlock situation; deadlock can occur when two programs are contending for access to a locked file or record.
Constraints	Controls imposed on records in associated files or on items in a single file to protect the integrity of the data base during update operations; defined by the data administrator.	Schema	Obtain information from the data administrator. Follow the rules for modifying files on which constraints have been imposed.
CYBER Database Control System (CDCS)	The central controlling module of DMS-170.	N/A	None.
CYBER Record Manager (CRM)	The input/output processor for DMS-170 operations.	N/A	None.
Data base procedures	Special-purpose routines that perform predefined operations; written by the data administrator.	Schema	None.

TABLE 1-1. SUMMARY OF DMS-170 COMPONENTS AND FEATURES (Contd)

Component/ Feature	Definition	Information Appears In	Programmer Action
Data base transaction	A series of update operations identified by a user-assigned transaction identifier. A transaction is bracketed by a begin transaction operation and either a commit or drop operation.	N/A	Include appropriate code in the application program to bracket the series of update operations and to assign transaction identifiers. Transaction log files must have been defined by the data administrator in the master directory.
Data base status block	An array defined within an application program to which CDCS returns information concerning the status of operations on data base files and relations.	N/A	Include appropriate code in the application program.
Data base version	A set of permanent files that is associated with the areas described by the schema; defined by the data administrator.	Master directory	To use a data base version other than MASTER (which is otherwise assumed), specify the version name in the application program.
Data Description Language (DDL)	The language that is used to structure a schema and sub-schema; used by the data administrator.	N/A	None.
File organization	The predetermined arrangement of stored data; indexed sequential, direct access, or actual key; defined by the data administrator.	Schema	None.
File privacy	A situation in which an application program can only gain access to a file by supplying a privacy key; defined by the data administrator.	Schema	Obtain information from the data administrator. Include a PRIVACY statement in the application program.
FORTRAN Data Manipulation Language (DML)	The language that provides a FORTRAN application program with access to the DMS-170 controlled data base.	N/A	Include appropriate DML statements in the FORTRAN source program code.
Immediate return	A feature of CDCS that provides FORTRAN application programs with the ability to receive immediate response from CDCS when either CDCS cannot get the resources it needs, or a fatal error occurs.	N/A	Include appropriate code in the application program.
Log files	Disk files on which user interactions with data base files are recorded for recovery purposes.	Master directory	None. Facility.
Master directory	A file containing information relating to all data bases, schemas, and sub-schemas known to CDCS; created by the data administrator.	N/A	Attach the master directory only when executing the program through the CDCS Batch Test Facility.
Multiple-index processor	A processor that allows CRM files to be accessed by alternate keys.	N/A	None.

TABLE 1-1. SUMMARY OF DMS-170 COMPONENTS AND FEATURES (Contd)

Component/ Feature	Definition	Information Appears In	Programmer Action
Primary key	A key that must be defined for a file when the file is first created; defined by the data administrator.	Sub-schema listing	On a random read, set the key to a value indicating the desired record occurrence.
Recovery: Automatic	A means by which a data base can be automatically recovered in case of a system or program failure.	N/A	Data base transactions provide for automatic recovery; use them for sensitive updates.
Recovery: Manual	A means by which a damaged or destroyed data base can be reconstructed or restored; defined by the data administrator.	N/A	None.
Relations	Logical structures formed by the joining of files; permit retrieval of data from more than one file at the same time; defined by the data administrator.	Sub-schema listing	To read a relation, specify a single read request with the name of the relation. During update, follow the rules for updating files joined in a relation.
Restrictions	Criteria that must be satisfied in a relation before a record occurrence can be made available to the application program; defined by the data administrator.	Sub-schema listing	None.
Schema	A detailed description of all the data in a data base; created by the data administrator through DDL.	Schema listing	None.
Sub-schema	A detailed description of selected portions of the data in a data base; created by the data administrator through DDL.	Sub-schema listing	Attach the sub-schema library in which the sub-schema resides for DML preprocessing of the application program.



ACCESSING THE DATA BASE 2

Every DMS-170 data base file that is to be accessed through FORTRAN must be described in a directory called a FORTRAN sub-schema. The data administrator, working with application programmers, is responsible for creating the sub-schemas. Every FORTRAN program that accesses a DMS-170 data base file must use the FORTRAN Data Manipulation Language (DML). The application programmer is responsible for coding appropriate DML statements and including them in the FORTRAN source program.

This section details the two principal data base access tools: the sub-schema that describes the data, and the language that provides access to that data.

INTERPRETING THE FORTRAN SUB-SCHEMA

The data administrator tailors sub-schemas to meet specific applications. Assume, for example, you have an application that requires access to only two fields in a data base file: student IDs and tuition charges. The data administrator might provide you with a sub-schema that resembles sub-schema SAMPLE1 shown in figure 2-1.

With the exception of the sub-schema library name and any required privacy keys, the listing provides you with complete information. The handwritten notation in this example indicates the sub-schema library name is DDLLIB. If you were planning to compile an application program using sub-schema SAMPLE1, you would need to attach DDLLIB. Since no privacy key is required, the schema obviously imposes no access control on realm ACCOUNT.

Notice the three aliases assigned. Since symbolic names in FORTRAN cannot exceed seven characters and cannot include a hyphen, the data administrator changes the names for your application.

Assume, for example, you have an application that requires access to two data base files. Assume, also, that you need a relationship between the two files so that you can search one file and retrieve corresponding records from the other. The data administrator might provide you with a sub-schema that resembles sub-schema SAMPLE2 in figure 2-2.

The handwritten notation in this example indicates the sub-schema library name is DDLLIB. If you were planning to compile an application program using sub-schema SAMPLE2, you would need to attach DDLLIB. The schema apparently imposes access control on realm FILE2. The privacy key XX99 must be included in a DML PRIVACY statement to gain access to that realm.

FORTRAN DATA MANIPULATION LANGUAGE

The FORTRAN Data Manipulation Language (DML) is the means through which your FORTRAN program accesses the data base. You must code the DML statements along with FORTRAN statements in the FORTRAN source program. The DML statements identify the sub-schema, establish an interface with CDCS, and provide access to realms defined by the sub-schema. DML statements can appear both in the main program and in subprograms.

The DML statements are translated into statements acceptable to the FORTRAN compiler. The DML preprocessor performs the translation and writes the translated statements to a file along with the FORTRAN statements in the source program. This new file is then the input file to the FORTRAN compiler.

DML LANGUAGE COMPONENTS

The DML language components include DML statement keywords, recognized symbols and punctuation, and user-supplied names of variables and constants. These components are grouped together into statements for input to the DML preprocessor, which translates each statement appropriately into a FORTRAN specification or CALL statement.

The first word of a statement is always a DML keyword that identifies the task to be performed. Most keywords are followed by user-supplied elements and sometimes are followed by additional keywords.

A list of available DML statements is shown in table 2-1 for reference purposes. The statements are listed in alphabetic order by the leading word (keyword), which identifies the purpose of the complete statement. The comments column provides specific rules for the statement and includes applicable default options.

SYNTAX REQUIREMENTS

The syntax requirements and coding conventions for DML statements are exactly the same as for FORTRAN statements. The following restrictions apply:

- A DML statement cannot be the object of a logical IF.
- A DML statement must not reference files that are referenced elsewhere in the program by a conventional FORTRAN input/output statement or by a FORTRAN PROGRAM statement.

Any executable DML statement can have a statement label. The DML preprocessor copies the label into the translated FORTRAN statement.

STATEMENT POSITIONING

Some DML statements require special positioning within the FORTRAN source program. These requirements are illustrated in figure 2-3.

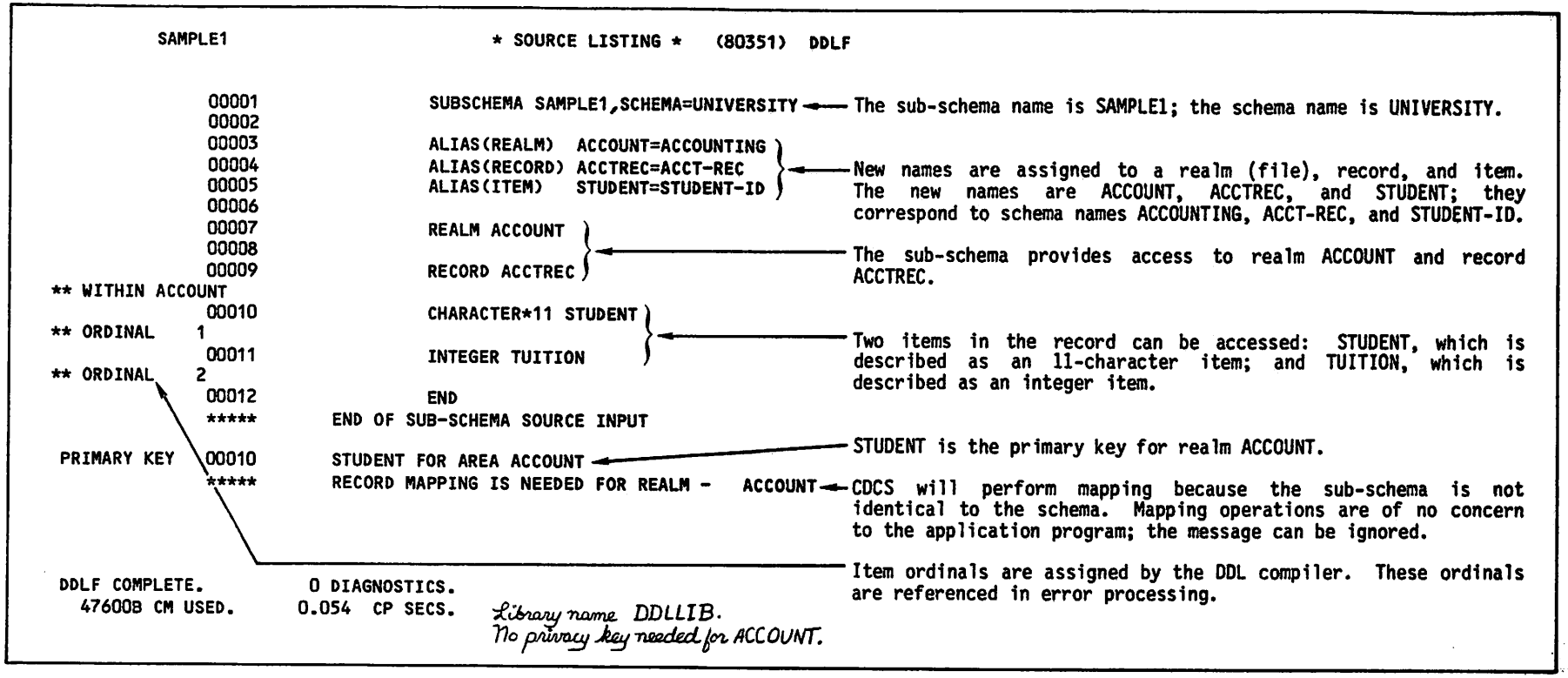


Figure 2-1. A Basic FORTRAN Sub-Schema

```
          SAMPLE2                    * SOURCE LISTING *   (80351)  DDLF

                00001          SUBSCHEMA SAMPLE2,SCHEMA=UNIVERSITY
                00002
                00003          ALIAS(REALM)  FILE1=STUDENT
                00004          ALIAS(RECORD) FIL1REC=STUDENT-REC
                00005          ALIAS(ITEM)   FILE1ID=STUDENT-ID.STUDENT-REC
                00006
                00007          ALIAS(REALM)  FILE2=CURRICULUM
                00008          ALIAS(RECORD) FIL2REC=CURR-REC
                00009          ALIAS(ITEM)   FILE2ID=STUDENT-ID.CURR-REC
                00010
                00011          REALM FILE1
                00012          REALM FILE2
                00013
                00014          RECORD FIL1REC
** WITHIN FILE1
                00015          CHARACTER*11 FILE1ID
** ORDINAL    1
                00016          CHARACTER*20 MAJOR
                00017
** ORDINAL    2
                00018          RECORD FIL2REC
** WITHIN FILE2
                00019          CHARACTER*14 IDENT
** ORDINAL    1
                00020          CHARACTER*11 FILE2ID
** ORDINAL    2
                00021          REAL GRADE
                00022
** ORDINAL    3
                00023          RELATION REL1
 PRIMARY KEY    00015      FILE1ID FOR AREA FILE1
 ALTERNATE KEY  00016      MAJOR FOR AREA FILE1
 PRIMARY KEY    00019      IDENT FOR AREA FILE2
 ALTERNATE KEY  00020      FILE2ID FOR AREA FILE2
 ALTERNATE KEY  00021      GRADE FOR AREA FILE2
                *****      RECORD MAPPING IS NEEDED FOR REALM -   FILE1
                *****      RECORD MAPPING IS NEEDED FOR REALM -   FILE2
                00024              RESTRICT FIL2REC(GRADE .EQ. 4.0)
                00025              END
                *****      END OF SUB-SCHEMA SOURCE INPUT

                *****                RELATION   STATISTICS                *****
 RELATION 001               REL1 JOINS            AREA - FILE1
                                                  AREA - FILE2

Library name DDLLIB.
Privacy key 'XX99' needed for FILE2.

 DDLF COMPLETE.          0 DIAGNOSTICS.
   505008 CM USED.       0.102  CP SECS.
```

The subschema name is SAMPLE2; the schema name is UNIVERSITY.

New names are assigned to two realms, records, and items. The new names are FILE1, FIL1REC, and FILE1ID, respectively, for the first realm; FILE2, FIL2REC, and FILE2ID, respectively, for the second realm.

The sub-schema provides access to two realms: FILE1 and FILE2.

The sub-schema provides access to record FIL1REC within FILE1.

Two items in record FIL1REC can be accessed: FILE1ID and MAJOR. FILE1ID is described as an 11-character item; MAJOR is described as a 20-character item.

The sub-schema provides access to record FIL2REC within FILE2.

Three items in record FIL2REC can be accessed: IDENT, which is described as a 14-character item; FILE2ID, which is described as an 11-character item; and GRADE, which is described as a real item.

A relation called REL1 is available. FILE1 and FILE2 are joined.

Primary and alternate keys are listed.

A restriction is placed on record FIL2REC. Only records with a grade point average of 4.0 are to be returned.

Figure 2-2. A Relational FORTRAN Sub-Schema

TABLE 2-1. DML STATEMENTS

Statement	Description	Comments
ASSIGNID	Obtains a restart identifier assigned by CDCS.	The program must execute the ASSIGNID statement before processing data base transactions in order to determine the status of a data base transaction in a restart operation after a system failure occurs. The FINDTRAN statement is used in the restart operation.
BEGINTRAN	Begins processing of a data base transaction.	Updates are considered temporary until the data base transaction is committed.
CLOSE	Ends processing of a realm.	Realms can be opened and closed any number of times by a program.
CLOSE relation	Ends processing of the realms joined in a relation.	Relations can be opened and closed any number of times by a program.
COMMITTRAN	Completes processing of a data base transaction.	This statement causes all updates within the data base transaction to be considered permanent.
DELETE	Removes a record from a realm.	The record being deleted is the record most recently read from the realm. The value of the primary key cannot change after the last read.
DROPTRAN	Cancels processing of a data base transaction.	All realms are restored to the states that existed just before the data base transaction began.
FINDTRAN	Obtains information for a program restart operation after system failure.	The program must have obtained a restart identifier by executing the ASSIGNID statement in order to use the FINDTRAN statement.
INVOKE	Establishes the interface between the executing program and CDCS.	The statement must be executed before any other DML statements except SUBSCHEMA.
LOCK	Establishes an exclusive or protected lock on realms. Exclusive prohibits read and update operations on the realm. Protected prohibits only update operations (allows read operations).	The realm must be a realm described in the sub-schema.
NEWVERSION	Changes the data base version being used by an application program.	All sub-schema realms must be closed before executing the NEWVERSION statement. See the CDCS 2 Application Programming reference manual for details.
OPEN	Initiates processing of a realm.	If the processing mode is not specified, the realm is opened for input/output.
OPEN relation	Initiates processing of the realms joined in a relation.	If the processing mode is not specified, the relation is opened for input/output. A processing mode of open for output only is not valid.
PRIVACY	Establishes the right of a program to access a realm.	If the processing mode is not specified, the realm can be accessed for input/output. The mode must be the same as the mode indicated in the OPEN statement.

TABLE 2-1. DML STATEMENTS (Contd)

Statement	Description	Comments
READ	Transfers data from a realm record to the variables defined in the sub-schema record description.	If a key is not specified, the read is sequential. If a key is specified, the value of the referenced key must be set by the program before the read is executed.
READ relation	Transfers data from the relation records to the corresponding variables defined in the sub-schema record descriptions.	If a key is not specified, the read is sequential. If a key is specified, the key must be in the root realm; the value of the referenced key must be set by the program before the read is executed.
REWRITE	Replaces the last record read with a new record, using the current values of the variables defined in the sub-schema record description.	The value of the primary key must not have changed since the last read.
START	Logically positions a realm for a subsequent sequential read operation.	The processing mode must be either input or input/output. If a key is specified, it must be a primary or alternate key defined for the realm. If a key is not specified, positioning is by primary key.
START relation	Logically positions the root realm (the first realm named in the sub-schema) of a relation for a subsequent relation read operation.	The processing mode must be either input or input/output. If a key is specified, it must be a primary or alternate key that is defined in the root realm. If a key is not specified, positioning is by primary key of the root realm.
SUBSCHEMA	Identifies the sub-schema to be used by the program.	A FORTRAN program can reference only one sub-schema.
TERMINATE	Terminates the interface between the FORTRAN program and CDCS.	When a TERMINATE statement is issued, an INVOKE statement must be executed before any other DML statements are issued.
UNLOCK	Releases a lock on a specified realm and releases all record locks.	The realm must be a realm described in the sub-schema.
WRITE	Writes a record, using the current values of the variables defined in the sub-schema record description.	Schema record data items that are not defined in the sub-schema are given null values by CDCS.

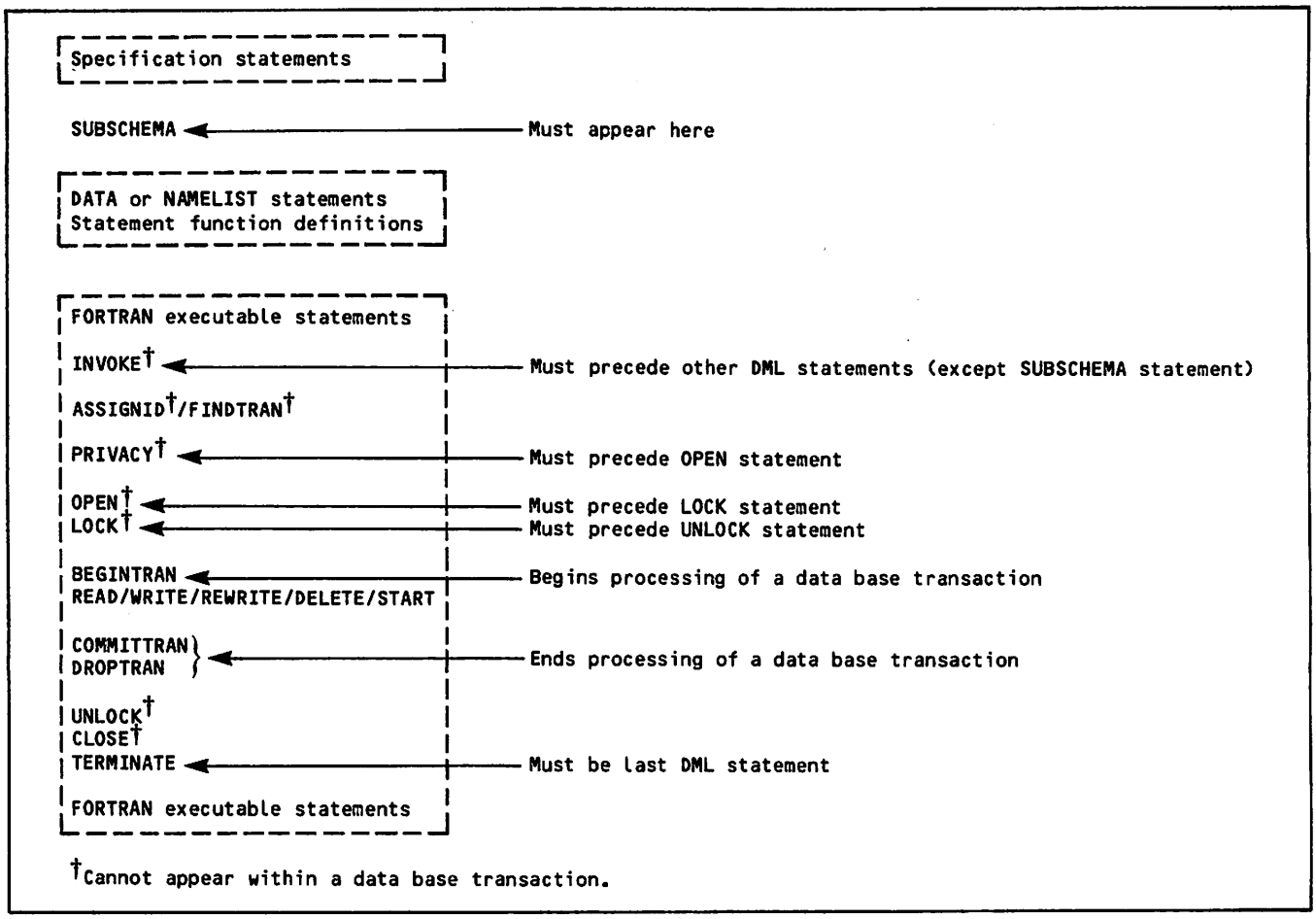


Figure 2-3. DML Statement Positioning

Processing data base files within the DMS-170 environment involves several steps. These steps are:

1. Obtain a current listing of the sub-schema from the data administrator so you can have the names and descriptions of the data your program will be referencing.

2. Obtain the name of the appropriate sub-schema library from the data administrator. You will need to attach this library for preprocessing your program.

3. Ask the data administrator if any realms in the sub-schema are defined in the schema as having controlled access. When access is controlled, you must know the privacy key.

4. Ask the data administrator if any constraints exist in the schema. When constraints exist, CDCS enforces them by not allowing updates that violate constraints.

5. Code the FORTRAN program and include appropriate Data Manipulation Language (DML) statements for opening, closing, and processing sub-schema realms.

6. Preprocess and compile the FORTRAN program. Include, in the job stream before the FTN5 control statement, an ATTACH control statement naming the sub-schema library and a DML control statement to execute the DML preprocessor.

7. When compilation is successful, execute the FORTRAN program. Include an LDSET control statement to load the DMS-170 library.

DML statements are available to perform a variety of operations on data base items described in a FORTRAN sub-schema. This section describes these statements and presents them in the following sequence:

Data Base Access
- SUBSCHEMA
- INVOKE
- PRIVACY
- OPEN
- LOCK/UNLOCK
- CLOSE
- TERMINATE

Data Base Manipulation
- WRITE
- READ
- START
- REWRITE
- DELETE

Relation Access
- OPEN
- CLOSE
- READ
- START

For purposes of illustration, a new sub-schema named AVERAGE is shown in figure 3-1. This sub-schema is referenced in subsequent examples. The examples show portions of program MODEL which illustrate statements necessary for particular data base operations.

The sub-schema provides the following information:

- The realm (file) to be accessed is named CFILE.
- The record is named CRECORD.
- A character item named IDENT is the primary key.
- A character item named STUDENT is an alternate key.
- A character item named COURSE is an alternate key.
- A real item named GRADE is an alternate key.

The handwritten notation on the listing indicates the sub-schema is stored on a library named SSLIB. The notation also indicates CFILE has controlled access and requires a privacy key of XX99.

USING DML TO ACCESS THE DATA BASE

To access a data base, a FORTRAN program must identify the sub-schema that the program uses, establish an interface with CDCS, satisfy privacy requirements, and perform the usual functions of opening and closing files. The following paragraphs describe these functions and the DML statements that you include in your program to provide these functions.

IDENTIFYING THE SUB-SCHEMA

To identify the sub-schema, you must include a SUBSCHEMA statement in your program. This must be the first DML statement to appear in your program. The format is:

```
SUBSCHEMA(sub-schema-name)
```

The SUBSCHEMA statement is required. You must position the statement in the program as follows:

- After the specification statements
- Before the first DATA or NAMELIST statement
- Before any statement function
- Before any executable statement

At the point where the DML preprocessor encounters the SUBSCHEMA statement, the DML preprocessor copies into the source program the text declaration and DATA statements resulting from the sub-schema

```
AVERAGE                          * SOURCE LISTING *   (80351)  DDLF 1.2+538.

                 00001              SUBSCHEMA AVERAGE,SCHEMA=UNIVERSITY
                 00002
                 00003              ALIAS(REALM)  CFILE=CURRICULUM
                 00004              ALIAS(RECORD) CRECORD=CURR-REC
                 00005              ALIAS(ITEM)   STUDENT=STUDENT-ID.CURR-REC
                 00006              ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC
                 00007
                 00008              REALM CFILE
                 00009
                 00010              RECORD CRECORD
                 00011
** WITHIN CFILE
                 00012              CHARACTER*14 IDENT
** ORDINAL    1
                 00013              CHARACTER*11 STUDENT
** ORDINAL    2
                 00014              CHARACTER*6 COURSE
** ORDINAL    3
                 00015              REAL GRADE
** ORDINAL    4
                 00016              END
                 00017
                 *****         END OF SUB-SCHEMA SOURCE INPUT

 PRIMARY KEY     00012         IDENT FOR AREA CFILE
 ALTERNATE KEY   00013         STUDENT FOR AREA CFILE
 ALTERNATE KEY   00014         COURSE FOR AREA CFILE
 ALTERNATE KEY   00015         GRADE FOR AREA CFILE
                 *****         RECORD MAPPING IS NEEDED FOR REALM -   CFILE

                                Library name SSLIB.
                                Privacy key 'XX99' needed for CFILE.
```

Figure 3-1. Sub-Schema AVERAGE

compilation. In this way, DML provides your program with the ability to reference all records, data items, and relations that are described in the sub-schema.

In a program using the sample sub-schema AVERAGE, the SUBSCHEMA statement appears as shown in figure 3-2.

```
PROGRAM MODEL
.
.
.
CHARACTER ...
DIMENSION ...
.
.
.
SUBSCHEMA(AVERAGE)
DATA ...
DO ...
.
.
.
END
```

Figure 3-2. Identifying the Sub-Schema

ESTABLISHING THE INTERFACE WITH CDCS

To establish the interface with CDCS, you must include an INVOKE statement in your program. This must be the second DML statement to appear in your program. The format is:

```
INVOKE
```

The INVOKE statement is required. The statement must appear in the program before any other DML statement except SUBSCHEMA.

When the INVOKE statement is executed, CDCS automatically attaches for use by the program all realms described in the sub-schema identified by the program.

In a program using the sample sub-schema AVERAGE, the INVOKE statement appears as shown in figure 3-3.

SATISFYING PRIVACY REQUIREMENTS

If a realm is defined in the schema as having controlled access, your program must provide a privacy key to access the realm. To provide the privacy key, you must include the PRIVACY statement in your program. The format is:

```
      PROGRAM MODEL
      .
      .
      .
      CHARACTER ...
      DIMENSION ...
      .
      .
      .
      SUBSCHEMA(AVERAGE)
      DATA ...
      DO ...
      .
      .
      .
      INVOKE
      .
      .
      .
      END
```

Figure 3-3. Establishing the Interface With CDCS

PRIVACY(realm-name, [MODE=mode,]
PRIVACY=privacy key)

where

mode = I (access allowed for input)

IO (access allowed for both input and output, called input/output; default)

O (access allowed for output)

privacy key = character constant, variable name, unsubscripted array name

A privacy key can be from 1 through 30 characters in length. If you use a character constant to specify a privacy key, enclose the character string in apostrophes. If you use a variable name to specify a privacy key, define the variable as type CHARACTER*30. Ensure that the privacy key is left-justified and blank filled in the field of the variable. If you use an array name to specify the privacy key, define the array as a 3-word array. Ensure that the privacy key is left-justified and blank filled in the field of the array.

The PRIVACY statement is required when access is controlled. A separate PRIVACY statement is required for each realm defined with controlled access. The PRIVACY statement must be executed before the statement that opens the realm.

The handwritten notation on the sample sub-schema listing (figure 3-1) indicates access to the realm is controlled and a privacy key called XX99 is required. In a program using the sample sub-schema AVERAGE, the required PRIVACY statement appears as shown in figure 3-4.

OPENING A REALM

Before your program can access any data records in an existing realm, the program must open the realm. To open the realm, you must include the OPEN statement in your program. The format is:

OPEN(realm-name [,MODE=mode] [,ERR=s])

```
      PROGRAM MODEL
      .
      .
      .
      SUBSCHEMA(AVERAGE)
      .
      .
      .
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      .
      .
      .
      END
```

Figure 3-4. Satisfying Privacy Requirements

where

mode = I (open for input only)

IO (open for both input and output, called input/output; default)

O (open for output only; valid only for creating a new file)

s = label of an executable statement to which control transfers on open error

For a realm with controlled access, the mode of access indicated in the PRIVACY statement must provide for the access mode indicated in the OPEN statement. For example, if you open a realm for input (MODE=I) you can specify MODE=IO in the PRIVACY statement.

If a separate privacy key is required for input (MODE=I) and another privacy key is required for output (MODE=O), two PRIVACY statements are required to open a realm for input/output (MODE=IO).

In a program using the sample sub-schema AVERAGE (figure 3-1), the OPEN statement appears as shown in figure 3-5. The MODE option is not included, indicating a default to input/output.

```
      PROGRAM MODEL
      .
      .
      .
      SUBSCHEMA(AVERAGE)
      .
      .
      .
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      .
      OPEN(CFILE,ERR=100)
      .
      .
      .
  100 PRINT *, 'ERROR ON OPEN'
      .
      .
      .
      END
```

Figure 3-5. Opening a Realm

Both the PRIVACY and OPEN statements indicate the same mode, input/output. If an error occurs on open, program execution continues at statement 100.

LOCKING/UNLOCKING A REALM

Whenever your program issues a read request on a realm that is open for input/output, CDCS automatically locks the record that was read (the current record) against update by another user. Through DML, however, your progam can prevent other jobs from performing update operations anywhere within a realm by issuing a request that CDCS lock the entire realm. To issue the lock request, you must include the LOCK statement in your program. The format is:

```
LOCK (realm-name [,TYPE=lock-type [,ERR=s]])
```

where

lock-type = character constant or variable

s = label of an executable statement to which control transfers on lock error

Two types of locking are permitted: exclusive or protected. Exclusive locking prohibits concurrent access to the realm for read or update operations; protected locking allows concurrent access to the realm for read operations but prohibits concurrent update operations.

Lock-type can be specified as either a character constant or a variable. The lock-type option must specify either the value EXCLUSIVE or the value PROTECTED. The lock-type is 9 characters long. If you use a character constant to specify the lock-type, enclose the character string in apostrophes. If you use a variable to specify the lock-type, define the variable as type CHARACTER*9.

The LOCK statement should be executed before any read request with intent to update the record.

CDCS releases the realm lock held for your program when the program issues an unlock request. To issue the unlock request, you must include an UNLOCK statement in your program. The format is:

```
UNLOCK(realm-name [,ERR=s])
```

where

s = label of an executable statement to which control transfers on unlock error

You should judiciously use a realm lock. A realm lock limits other users' access to the realm (file). Additionally, a realm lock overrides the CDCS record locking mechanism, which provides a checking capability on rewriting and deleting records (for additional information, see the paragraphs Rewriting a Record and Deleting a Record).

In a program using the sample sub-schema AVERAGE (figure 3-1), the LOCK and UNLOCK statements appear as shown in figure 3-6. If an error occurs during the lock or unlock process, program execution continues at statement 200 or 300, respectively.

```
      PROGRAM MODEL
      .
      .
      .
      SUBSCHEMA(AVERAGE)
      .
      .
      .
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      .
      OPEN(CFILE,ERR=100)
      .
      .
      LOCK(CFILE,ERR=200)
      .
      .
      .
      UNLOCK(CFILE,ERR=300)
      .
      .
      .
200   PRINT *, 'ERROR ON LOCK'
      .
      .
      .
300   PRINT *, 'ERROR ON UNLOCK'
      .
      .
      .
      END
```

Figure 3-6. Locking/Unlocking a Realm

CLOSING A REALM

When your program has completed processing on a realm, the program must close the realm. To close the realm, you must include the CLOSE statement in your program. The format is:

```
CLOSE(realm-name [,ERR=s])
```

where

s = label of an executable statement to which control transfers on close error

Once a program closes a realm, the program can perform no further processing on the realm until it reopens the realm.

In a program using the sample sub-schema AVERAGE (figure 3-1), the CLOSE statement appears as shown in figure 3-7. If an error occurs on close, program execution continues at statement 400.

TERMINATING THE INTERFACE WITH CDCS

To terminate the interface with CDCS, you must include a TERMINATE statement in your program. The format is:

```
TERMINATE
```

Once the TERMINATE statement is executed, no further data base processing can take place without execution of another INVOKE statement.

In a program using the sample sub-schema AVERAGE (figure 3-1), the TERMINATE statement appears as shown in figure 3-8. This statement must be executed before the FORTRAN END or STOP statement.

```
      PROGRAM MODEL
      .
      .
      .
      SUBSCHEMA(AVERAGE)
      .
      .
      .
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      .
      OPEN(CFILE,ERR=100)
      .
      .
      LOCK(CFILE,ERR=200)
      .
      .
      .
      UNLOCK(CFILE,ERR=300)
      .
      .
      CLOSE(CFILE,ERR=400)
      .
      .
400   PRINT *, 'ERROR ON CLOSE'
      .
      .
      .
      END
```

Figure 3-7. Closing a Realm

```
      PROGRAM MODEL
      .
      .
      .
      SUBSCHEMA(AVERAGE)
      .
      .
      .
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      .
      OPEN(CFILE,ERR=100)
      .
      .
      .
      CLOSE(CFILE,ERR=400)
      .
      .
      .
100   PRINT *, 'ERROR ON OPEN'
      .
      .
      .
400   PRINT *, 'ERROR ON CLOSE'
      .
      .
      .
      TERMINATE
      .
      .
      END
```

Figure 3-8. Terminating the Interface With CDCS

USING DML TO MANIPULATE DATA

DML statements are available to create, read, position, and modify data base records. The following paragraphs describe these functions and the DML statements that you must include in your program to provide these functions.

WRITING A RECORD

To write a complete record, you must include a WRITE statement in your program. The format is:

```
WRITE(realm-name [,ERR=s])
```

where

s = label of an executable statement to which control transfers on write error

Before the WRITE statement is executed, the program must set the primary key and all alternate keys to appropriate values. A sub-schema does not always reflect all data items that appear in the schema record; therefore, before allowing the new record to be written to the data base, CDCS gives null values to those schema data items that are not defined in the sub-schema.

In a program using the sample sub-schema AVERAGE (figure 3-1), the WRITE statement appears as shown in figure 3-9. The program sets the primary key IDENT and alternate keys STUDENT, COURSE, and GRADE to appropriate values before the WRITE statement is executed. If an error occurs on write, program execution continues at statement 500.

```
      PROGRAM MODEL
      SUBSCHEMA(AVERAGE)
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      OPEN(CFILE,MODE=IO,ERR=100)
      IDENT='122-13-6704-09'
      STUDENT='122-13-6704'
      COURSE='PSY136'
      GRADE=3.7
      WRITE(CFILE,ERR=500)
      .
      .
      .
500   PRINT *, 'ERROR ON WRITE'
      .
      .
      .
900   CLOSE(CFILE)
      TERMINATE
      END
```

Figure 3-9. Writing a Record

This example shows a program writing a record to an existing file, CFILE. Before the program writes to this file, the PRIVACY and OPEN statements establish access for input/output (MODE=IO). If the program were creating this file, the OPEN and PRIVACY statements would have to establish access for output only (MODE=O).

READING A RECORD

To read a record, you must include a READ statement in your program. The format is:

```
READ(realm-name [,KEY symbol item-name]
    [,ERR=s] [,END=s])
```

where

symbol = = .EQ. .GT. .GE.

item-name = primary or alternate key

s = label of an executable statement to which control transfers on read error (ERR)

label of an executable statement to which control transfers on end-of-file (END)

When you omit the KEY option, the read operation is sequential. When you include the KEY option, the read operation is random.

The END option is valid only for a sequential read operation.

Sequential Read

A sequential read accesses the record occurrence located at the current record position. Successive read operations return record occurrences by position. Indexed sequential files are sequenced in ascending primary key order, actual key files are sequenced by block and record slot within the block, and direct access files are sequenced by position in home blocks.

Typical FORTRAN 5 statements issued outside of a data base environment terminate with a fatal error if EOF is sensed and a test for EOF status is not included in the FORTRAN READ statement. If EOF status is not tested in DML, program execution continues with the next statement. Consequently, it is necessary to test for EOF on a DML sequential read operation. You can handle this test in one of two ways:

- Include the END option on the READ statement. When EOF is sensed, program execution continues at the statement specified in the option.
- Test for an EOF value of 100_8 in the data base status block. This option is described in section 4.

In a program using the sample sub-schema AVERAGE (figure 3-1), a sequential read appears as shown in figure 3-10. If an error occurs on read, program execution continues at statement 600. The READ statement includes the END option to test for EOF. When EOF is reached, program execution continues at statement 900.

Random Read

A random read accesses a record occurrence by the value of a referenced primary or alternate key. The program must set the value of the referenced key before the READ statement is executed.

```
      PROGRAM MODEL
      SUBSCHEMA(AVERAGE)
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      OPEN(CFILE,ERR=100)
      READ(CFILE,ERR=600,END=900)
      .
      .
      .
600   PRINT *, 'ERROR ON READ'
      .
      .
      .
900   CLOSE(CFILE)
      TERMINATE
      END
```

Figure 3-10. Reading Sequentially

In a program using the sample sub-schema AVERAGE (figure 3-1), a random read appears as shown in figure 3-11. The program sets the alternate key GRADE to the value 4.0. This read returns from CFILE the first record occurrence in which the alternate key GRADE has the value 4.0. If an error occurs on read, program execution continues at statement 600.

```
      PROGRAM MODEL
      SUBSCHEMA(AVERAGE)
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      OPEN(CFILE,ERR=100)
      GRADE=4.0
      READ(CFILE,KEY.EQ.GRADE,ERR=600)
      .
      .
      .
600   PRINT *, 'ERROR ON READ'
      .
      .
      .
900   CLOSE(CFILE)
      TERMINATE
      END
```

Figure 3-11. Reading Randomly

POSITIONING A REALM

To position a realm for subsequent sequential read operations, you must include a START statement in your program. The format is:

```
START(realm-name [,KEY symbol item-name]
    [,ERR=s])
```

where

symbol = = .EQ. .GT. .GE.

item-name = primary or alternate key

s = label of an executable statement to which control transfers on start error

Before the START statement is executed, the program must have opened the realm for input or input/output.

When you omit the KEY option, the realm is positioned by primary key value; the realm is positioned to the record occurrence with a primary key value equal to the current value of the primary key item. When you include the KEY option, the realm is positioned to the first record occurrence with a matching key value.

In a program using the sample sub-schema AVERAGE (figure 3-1), both forms of the START statement appear as shown in figure 3-12. If an error occurs on start, program execution continues at statement 700.

```
      PROGRAM MODEL
      SUBSCHEMA(AVERAGE)
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      OPEN(CFILE,ERR=100)
      IDENT='122-13-6704-01'
      START(CFILE,ERR=700)
      READ(CFILE,ERR=600,END=900)
      .
      .
      .
700   PRINT *, 'ERROR ON START'
      .
      .
      .
      COURSE='PSY100'
      START(CFILE,KEY.GE.COURSE,ERR=700)
      READ(CFILE,ERR=600,END=900)
      .
      .
      .
900   CLOSE(CFILE)
      TERMINATE
      END
```

Figure 3-12. Positioning a Realm

The first START statement omits the KEY option, which means CFILE will be positioned by primary key. The program sets the primary key (IDENT) to the value 122-13-6704-01 before the START statement is executed; the realm will be positioned to the record occurrence with the matching primary key value.

The second START statement includes the KEY option. The program sets the alternate key COURSE to the value PSY100. The first record occurrence in CFILE with an alternate key COURSE greater than or equal to PSY100 will be the one to which CFILE is positioned.

REWRITING A RECORD

To rewrite a record, you must include a REWRITE statement in your program. The format is:

```
REWRITE(realm-name [,ERR=s])
```

where

s = label of an executable statement to which control transfers on rewrite error

When a record is rewritten, the current values of those variables defined in the sub-schema are rewritten to the specified data base record. Data items defined in the schema but not defined in the sub-schema remain unchanged.

Before your program can rewrite a record, your program must have locked the record either with a record lock or with a realm lock. Typically, the record lock is used.

For a rewrite using a record lock, the program establishes the record locking mechanism by opening the realm for input/output. To rewrite the record, the program must include the following steps:

1. Read the record to the program's working storage area by executing a DML READ statement.
2. Set the value of each data item being changed to the appropriate new value.
3. Rewrite the record by executing a REWRITE statement.

When the realm is opened for input/output and the read is executed, CDCS expects an update operation and consequently locks the record. CDCS allows rewriting of only the locked record.

The program must not change the value of the primary key between the read and the rewrite of the record. The following example illustrates a processing sequence to avoid:

```
IDENT='100-22-5860-04'
READ(CFILE,KEY=IDENT)
IDENT='200-44-7863-01'
REWRITE(CFILE)
```

Assuming a rewrite using a record lock, CDCS does not allow the rewrite in this example to be performed because the record is not locked; record 100-22-5860-04 is locked, but the rewrite is attempted on record 200-44-7863-01. CDCS issues an error diagnostic on the rewrite.

If an update requires that the value of a primary key be changed, the program must first delete the record with the old primary key value and then write the record with the new primary key value.

For a rewrite using a realm lock, the program establishes the realm lock by executing the LOCK statement. Then to rewrite a record, the program needs only to set the value of the primary key to the value of the record being rewritten and execute the REWRITE statement. The recommended rewriting procedure, however, includes more steps than these. The recommended procedure is the same as for a rewrite using a record lock: read the record, change the appropriate values, then rewrite the record. By reading the record, the program can test for an error on the read and, thereby, protect the integrity of the data base. With the realm lock, it is your responsibility to ensure that the program does not change the value of the primary key between the read and the rewrite of the record.

You should judiciously use a realm lock when rewriting records because the realm lock overrides the record lock and the checking capability available through the record lock.

In a program using the sample sub-schema AVERAGE (figure 3-1), the REWRITE statement appears as shown in figure 3-13. The program performs the rewrite by using a record lock. The program reads the record occurrence with a primary key value of 100-22-5860-04, changes the value of data item GRADE to the value 3.8, and then rewrites the record. In the rewritten record, all other values in the record occurrence remain unchanged. If an error occurs on rewrite, program execution continues at statement 800.

```
      PROGRAM MODEL
      SUBSCHEMA(AVERAGE)
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      OPEN(CFILE,ERR=100)
      IDENT='100-22-5860-04'
      READ(CFILE,KEY=IDENT,ERR=600)
      GRADE=3.8
      REWRITE(CFILE,ERR=800)
      .
      .
      .
600   PRINT *, 'ERROR ON READ'
      .
      .
      .
800   PRINT *, 'ERROR ON REWRITE'
      .
      .
      .
900   CLOSE(CFILE)
      TERMINATE
      END
```

Figure 3-13. Rewriting a Record

DELETING A RECORD

To delete a record, you must include a DELETE statement in your program. The format is:

```
DELETE(realm-name [,ERR=s])
```

where

s = label of an executable statement to which control transfers on delete error

Before your program can delete a record, your program must have locked the record either with a record lock or with a realm lock. Typically, the record lock is used.

For a delete using a record lock, the program establishes the record locking mechanism by opening the realm for input/output. To delete the record, the program must include the following steps:

1. Read the record by executing a DML READ statement.
2. Delete the record by executing a DELETE statement.

When a realm is opened for input/output and the read is executed, CDCS expects an update operation and consequently locks the record. CDCS allows deletion of only the locked record.

The program must not change the value of the primary key between the read and the delete of the record. The following example illustrates a processing sequence to avoid:

```
IDENT='100-22-5860-04'
READ(CFILE,KEY=IDENT)
IDENT='400-23-1248-07'
DELETE(CFILE)
```

Assuming a delete using a record lock, CDCS does not allow the delete in this example to be performed because the record is not locked; record 100-22-5860-04 is locked, but the delete is attempted on record 400-23-1248-07. CDCS issues an error diagnostic on the delete.

For a delete using a realm lock, the program establishes the realm locking mechanism by executing the LOCK statement. Then to delete a record, the program needs only to set the value of the primary key to the value of the record being deleted and execute the DELETE statement. The recommended procedure for deleting a record, however, includes more steps than these. The recommended procedure is the same as for a delete using a record lock: read the record and then delete the record. By reading the record, the program can test for an error on the read and, thereby, protect the integrity of the data base. With the realm lock, it is your responsibility to ensure that the program does not change the value of the primary key between the read and the delete of the record.

You should judiciously use a realm lock when deleting records because the realm lock overrides the record lock and the checking capability available through the record lock.

In a program using the sample sub-schema AVERAGE (figure 3-1), the DELETE statement appears as shown in figure 3-14. The program performs the delete by using a record lock. The program reads from CFILE the record occurrence with a primary key (IDENT) equal to 100-22-5860-04 and then deletes that record. If an error occurs on delete, program execution continues at statement 850.

USING DML TO PROCESS RELATIONS

Relation processing greatly simplifies programming when several related realms are required by the application program. Realms that have common data items can be joined in a relation. When a relation is included in a sub-schema, the relation can be accessed and read through DML. This means that a single relation read request by an application program returns a relation occurrence, which consists of one qualifying record from each of the realms comprising the relation.

```
      PROGRAM MODEL
      SUBSCHEMA(AVERAGE)
      INVOKE
      PRIVACY(CFILE,MODE=IO,PRIVACY='XX99')
      OPEN(CFILE,ERR=100)
      IDENT='100-22-5860-04'
      READ(CFILE,KEY=IDENT,ERR=600)
      DELETE(CFILE,ERR=850)
      .
      .
      .
600   PRINT *, 'ERROR ON READ'
      .
      .
      .
850   PRINT *, 'ERROR ON DELETE'
      .
      .
      .
900   CLOSE(CFILE)
      TERMINATE
      END
```

Figure 3-14. Deleting a Record

DML statements are available to provide for processing relations. The functions involved in relation processing are opening and closing the realms of the relation, positioning a relation through a start operation, and reading the relation. Paragraphs that follow describe these functions and the DML statements that you must include in your program to provide the functions. First, however, it is necessary to examine the structure of a relation and the manner in which CDCS returns records to the program's working storage area.

STRUCTURE OF A RELATION

A relation can be described as a hierarchical tree structure. The root of the tree is the realm through which the relation is entered; this is the first realm listed for a relation in the sub-schema. A data item in the realm at the root of the structure joins the realm to a common data item in the next realm listed for the relation. When the relation is entered, the value of the data item in the root realm record leads to a record in the second realm. More than one record in the second realm can contain the same value; thus one record in the root realm can lead to several records in the second realm.

The second realm in the relation can be joined to a third realm through a common data item. Once again, a record in the second realm can lead to several records in the third realm. This branching out from the root of the tree continues through each realm in the relation.

The tree structure of the three-realm relation REL3 of the university data base is illustrated in figure 3-15. The tree structure is normally pictured upside down, with the root at the top and branches going down. The first realm, PFILE, which is the root of the structure, consists of a master record for each professor. The second realm, CRSFILE, consists of a master record for each course. The third realm, CFILE, consists of curriculum records. The common data item joining the first and second realms is the professor identification; the common data item joining the second and third realms is the course identification.

Realms in a relation are numbered consecutively as ranks. The first realm entered (called the root realm) is always assigned rank 1. The rank is incremented by 1 for each successive realm in the relation. The value of the rank of a realm contrasts with the placement of the realm in the tree structure. The lower the rank, the higher the realm is shown in the tree structure; i.e., rank 1 (the lowest rank) is shown at the top of the tree structure. Figure 3-15 also shows ranks in the relation REL3.

When a relation is read, a record occurrence from each realm in the relation is returned to the program. A relationship exits between record occurrences in a relation: a parent/child relationship. A record occurrence that has another record occurrence at the next numerically higher rank in the relation is referred to as the parent record

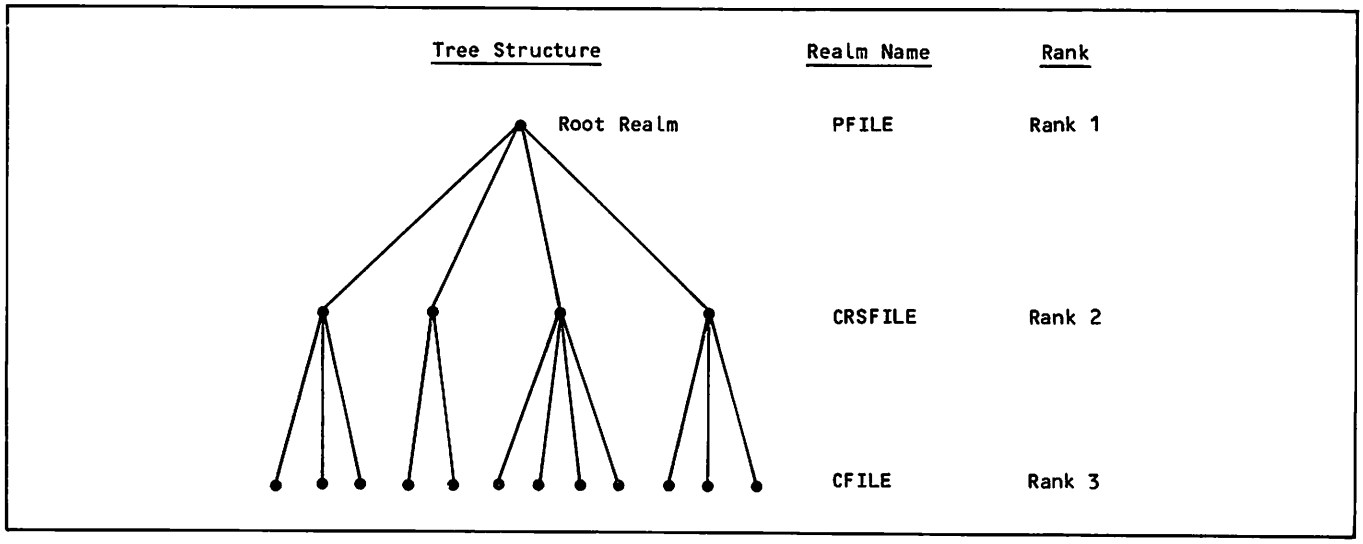


Figure 3-15. Tree Structure and Ranks of a Three-Realm Relation

occurrence. A record occurrence that has another record occurrence at the next numerically lower rank in the relation is referred to as the child record occurrence. In a parent/child relationship in relation REL3, a record occurrence in PFILE would represent the parent with corresponding record occurrences of CRSFILE representing the children. Additionally, a record occurrence in CRSFILE would represent the parent with corresponding record occurrences in CFILE representing the children.

USING THE SUB-SCHEMA

The structure of a relation is defined when the schema is created. A relation that is available to an application program is included in the sub-schema. The sub-schema listing provides the names of the realms in the relation. A new sample sub-schema named COMPARE, which makes available a three-realm relation, is shown in figure 3-16.

The sub-schema listing provides the following information:

- A relation is available to DML because the RELATION statement is included in the sub-schema.

- Three schema areas are joined by relation named REL3. The areas are named PROFESSOR, COURSE, and CURRICULUM in the schema; they are renamed as realms PFILE, CRSFILE, and CFILE in the sub-schema. The order in which the areas (realms) appear in the Relation Statistics portion of the listing indicates the ranks of the realms: the first realm listed has the rank 1; the second, rank 2; and so forth.

- PFILE has a primary key named PROFID; CRSFILE has an alternate key named PROF. Looking at the listing of aliases, you can see these fields both appear as PROF-ID in the schema. Obviously these fields represent unique professor identification and are common to both realms. You can assume that these items join the realms . The data administrator, however, should provide the common data items if they are not obvious and if programming considerations require that you know them.

- CRSFILE has a primary key named CRSID; CFILE has an alternate key named COURSE. Looking at the listing of aliases, you can see these fields both appear as COURSE-ID in the schema. Obviously these fields represent unique course information and are common to both realms. You can assume that these items join the realms. The data administrator, however, should provide the joining data items under the conditions indicated previously.

- A restriction is placed on CRECORD. A relation occurrence will not be returned unless data item CODE contains the character C. Before a relation occurrence is returned to the program's working storage area, CDCS checks for restrictions and enforces any restrictions. CDCS allows only qualifying records to be returned.

OPENING A RELATION

Before your program can access any data records in an existing relation, the program must open the appropriate realms. To open all the realms in a relation, you can include a relation OPEN statement in your program. The format is:

```
OPEN(relation-name [,MODE=mode] [,ERR=s])
```

where

mode = I (open for input only)

IO (open for both input and output, called input/output; default)

s = label of an executable statement to which control transfers on open error

Your program should normally open a relation for input (MODE=I). The program should open the relation for input/output (MODE=IO) under two circumstances:

- Processing requirements indicate that the program should lock the records to prevent update during the relation read.

- The program updates individual realms in the relation following the relation read.

If your program is opening a relation in which one or more realms have controlled access, you must include in the program a PRIVACY statement for each realm that has controlled access.

The following statement opens for input the realms joined in relation REL3, which is shown in sample sub-schema COMPARE (figure 3-16). If an error occurs on open, program execution continues at statement 50:

```
OPEN(REL3,MODE=I,ERR=50)
```

If you have included an OPEN statement in your program for each realm in the relation, you do not need to include a relation OPEN statement.

CLOSING A RELATION

When your program has completed relation processing, the program must close the appropriate realms. To close all the realms of a relation, you can include a relation CLOSE statement in your program. The format is:

```
CLOSE(relation-name [,ERR=s])
```

where

s = label of an executable statement to which control transfers on close error

The following statement closes the realms joined in relation REL3, which is shown in sample sub-schema COMPARE (figure 3-16). If an error occurs on close, program execution continues at statement 60:

```
CLOSE(REL3,ERR=60)
```

If you include a CLOSE statement in your program for each realm in the relation, you do not need to include a relation CLOSE statement.

```
COMPARE                          * SOURCE LISTING *   (80351)  DDLF 1.2+538.

                 00001           SUBSCHEMA COMPARE,SCHEMA=UNIVERSITY
                 00002
                 00003           ALIAS(REALM)  PFILE=PROFESSOR
                 00004           ALIAS(RECORD) PRECORD=PROF-REC
                 00005           ALIAS(ITEM)   PROFID=PROF-ID.PROF-REC
                 00006           ALIAS(ITEM)   PNAME=PROF-NAME
                 00007
                 00008           ALIAS(REALM)  CRSFILE=COURSE
                 00009           ALIAS(RECORD) CRSREC=COURSE-REC
                 00010           ALIAS(ITEM)   CRSID=COURSE-ID.COURSE-REC
                 00011           ALIAS(ITEM)   CRSNAME=COURSE-NAME
                 00012           ALIAS(ITEM)   PROF=PROF-ID.COURSE-REC
                 00013           ALIAS(ITEM)   FIELD=ACADEMIC-FIELD
                 00014
                 00015           ALIAS(REALM)  CFILE=CURRICULUM
                 00016           ALIAS(RECORD) CRECORD=CURR-REC
                 00017           ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC
                 00018           ALIAS(ITEM)   CODE=COMPLETE-CODE
                 00019           ALIAS(ITEM)   DATE=COMPLETE-DATE
                 00020
                 00021           REALM PFILE
                 00022           REALM CRSFILE
                 00023           REALM CFILE
                 00024
                 00025           RECORD PRECORD
** WITHIN PFILE
                 00026           CHARACTER*8 PROFID
** ORDINAL    1
                 00027           CHARACTER*30 PNAME
** ORDINAL    2
                 00028           CHARACTER*20 FIELD
                 00029
** ORDINAL    3
                 00030           RECORD CRSREC
** WITHIN CRSFILE
                 00031           CHARACTER*6 CRSID
** ORDINAL    1
                 00032           CHARACTER*20 CRSNAME
** ORDINAL    2
                 00033           CHARACTER*8 PROF
                 00034
** ORDINAL    3
                 00035           RECORD CRECORD
** WITHIN CFILE
                 00036           CHARACTER*14 IDENT
** ORDINAL    1
                 00037           CHARACTER*6 COURSE
** ORDINAL    2
                 00038           CHARACTER*1 CODE
** ORDINAL    3
                 00039           CHARACTER*8 DATE
** ORDINAL    4
                 00040           REAL GRADE
                 00041
** ORDINAL    5
                 00042                   RELATION REL3
 PRIMARY KEY     00026       PROFID FOR AREA PFILE
 ALTERNATE KEY   00028       FIELD FOR AREA PFILE
 PRIMARY KEY     00031       CRSID FOR AREA CRSFILE
 ALTERNATE KEY   00033       PROF FOR AREA CRSFILE
 PRIMARY KEY     00036       IDENT FOR AREA CFILE
 ALTERNATE KEY   00037       COURSE FOR AREA CFILE
 ALTERNATE KEY   00040       GRADE FOR AREA CFILE
                 *****       RECORD MAPPING IS NOT NEEDED FOR REALM -   PFILE
                 *****       RECORD MAPPING IS NEEDED FOR REALM -   CRSFILE
                 *****       RECORD MAPPING IS NEEDED FOR REALM -   CFILE
                 00043                   RESTRICT CRECORD (CODE .EQ. 'C')
                 00044                   END
```

Figure 3-16. Sub-Schema COMPARE (Sheet 1 of 2)

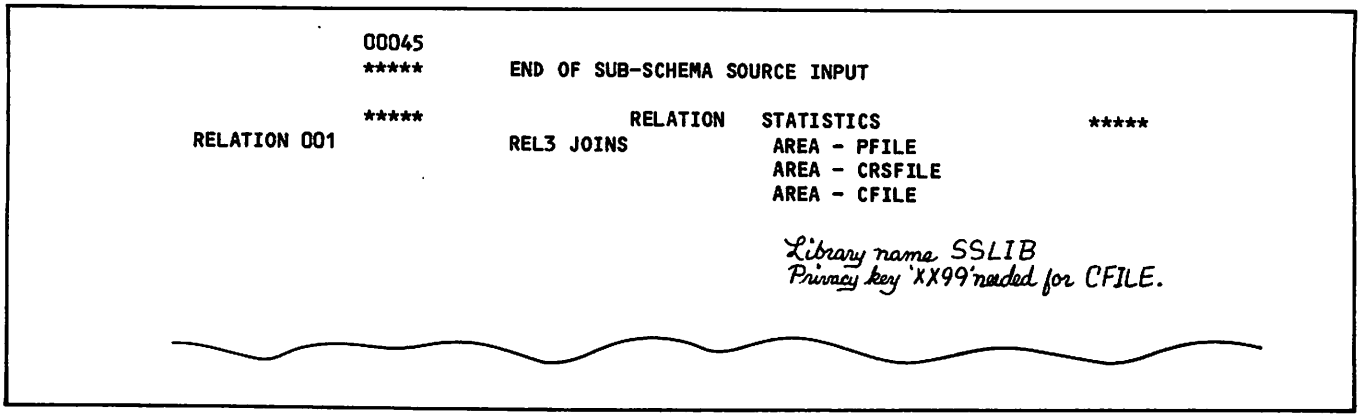


Figure 3-16. Sub-Schema COMPARE (Sheet 2 of 2)

READING A RELATION

To read a relation, you must include a relation READ statement in your program. The format is:

```
READ(relation-name [,KEY symbol item-name]
   [,ERR=s] [,END=s])
```

where

symbol = = .EQ. .GT. .GE.

item-name = primary or alternate key

s = label of an executable statement to which control transfers on read error (ERR)

label of an executable statement to which control transfers on end-of-file (END)

When you omit the KEY option, the read operation is sequential. When you include the KEY option, the read operation is random.

The END option is valid only for a sequential read operation.

Sequential Relation Read

A sequential relation read accesses the relation occurrence located at the current relation position. Successive read operations return relation occurrences by position of the root realm, which is the first realm listed for the relation in the Relation Statistics portion of the sub-schema listing. Indexed sequential files are sequenced in ascending primary key order, actual key files are sequenced by block and record slot within the block, and direct access files are sequenced by position in home blocks.

A relation occurrence is composed of record occurrences. A tree structure of record occurrences for relation REL3 is shown in figure 3-17. Assuming that A1 is the first record in PFILE, the first and subsequent sequential reads return record occurrences to the working storage area in the following order: A1B1C1, A1B1C2, A1B1C3, A1B2C4, and so forth. When record occurrences in CRSFILE and CFILE are exhausted, a subsequent sequential read returns the next record (A2, not shown) in PFILE and associated records in CRSFILE and CFILE as the operation repeats.

Typical FORTRAN 5 statements issued outside of a data base environment terminate with a fatal error if EOF is sensed and a test for EOF status is not included in the FORTRAN READ statement. If EOF status is not tested in a DML READ statement and EOF is sensed, program execution continues with the next statement. Consequently, it is necessary to test for EOF on a DML sequential read operation. This can be handled in one of two ways:

- Include the END option on the READ statement. When an EOF is sensed, program execution continues at the statement specified in the option.
- Include a test for an EOF value of 100_8 in the data base status block. This option is described in section 4.

In a program using sample sub-schema COMPARE (figure 3-16), a sequential read appears as shown in figure 3-18. If an error occurs on read, program execution continues at statement 600. The END option is included on the READ statement to test for EOF. When EOF is reached, program execution continues at statement 900.

The sequential read returns the first record in PFILE and the first corresponding record occurrences in CRSFILE and in CFILE. Successive reads return qualifying record occurrences as indicated in the preceding discussion of the tree structure of record occurrences. If EOF is sensed on PFILE, the relation read transfers control to the statement specified by the END option.

Notice the PRIVACY statement. Since CFILE is joined in the relation and has controlled access, the privacy key for that realm is required.

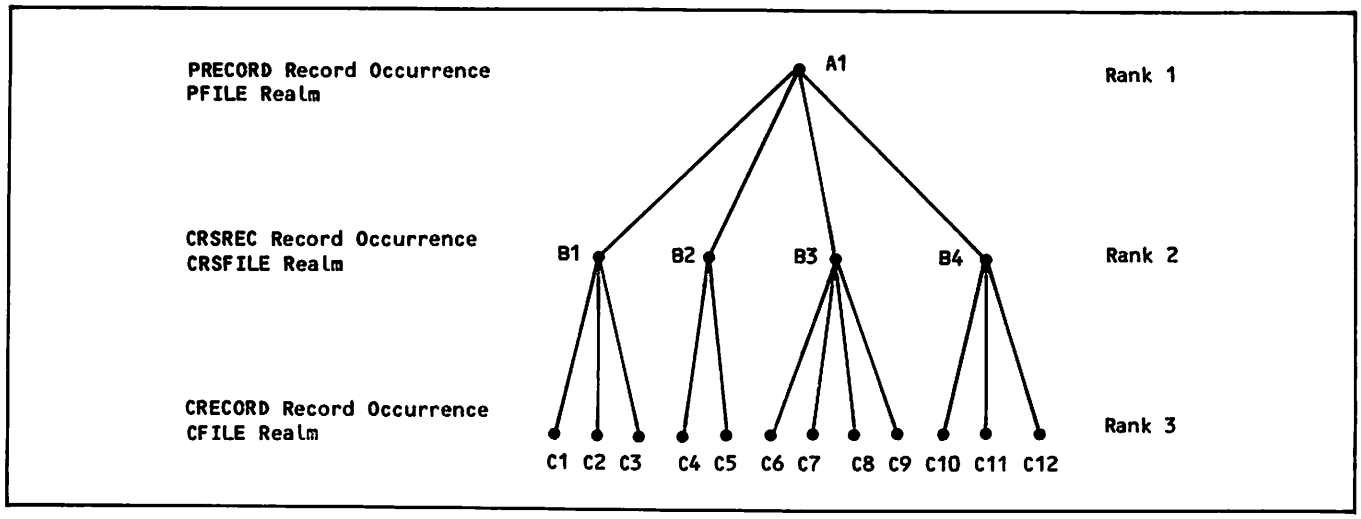


Figure 3-17. Tree Structure of Record Occurrences

```
        PROGRAM RELMOD
        SUBSCHEMA(COMPARE)
        INVOKE
        PRIVACY(CFILE,MODE=I,PRIVACY='XX99')
        OPEN(REL3,MODE=I,ERR=100)
        READ(REL3,ERR=600,END=900)
        .
        .
        .
  900   CLOSE(REL3)
        TERMINATE
        END
```

Figure 3-18. Reading a Relation Sequentially

```
        PROGRAM RELMOD
        SUBSCHEMA(COMPARE)
        INVOKE
        PRIVACY(CFILE,MODE=I,PRIVACY='XX99')
        OPEN(REL3,MODE=I,ERR=100)
        PROFID='RSS00860'
        READ(REL3,KEY=PROFID,ERR=600)
        .
        .
        .
  900   CLOSE(REL3)
        TERMINATE
        END
```

Figure 3-19. Reading a Relation Randomly

Random Relation Read

A random relation read accesses a relation occurrence by the value of a referenced primary or alternate key. The referenced key must be in the root realm. For a program using the sample sub-schema COMPARE, the key named in the READ statement must be associated with PFILE (the root realm) rather than CRSFILE or CFILE. The program must set the value of the referenced key before the READ statement is executed.

In a program using sub-schema COMPARE (figure 3-16), a random read appears as shown in figure 3-19. The program sets the primary key PROFID of PFILE to RSS00860. The random read returns the record occurrence in PFILE that has PROFID equal to RSS00860 and the first corresponding record occurrences in CRSFILE and CFILE.

Control Break

A control break occurs when a new record occurrence is read for a parent realm in a relation. Control break status, however, is returned for the realm of the child. Therefore, if a realm in a relation has control break status after execution of a sequential read, the record occurrence read for this realm is a child record occurrence for a new parent record occurrence.

In the example shown in the tree structure of record occurrences (figure 3-17), control break occurs when A1 is first read (when A1B1C1 is returned). In this situation, control break status is returned for CRSFILE (rank 2) and for CFILE (rank 3). A control break occurs when B2 is first read (when A1B2C4 is returned), when B3 is first read (when A1B3C6 is returned), and so forth. In these situations, control break status is returned for CFILE, which is rank 3 of the relation.

The presence of a control break and the rank of the realm that is the lowest ranked realm with control break status can be determined by checking the data base status block. Status checking is described in section 4.

Null Occurrence

A null occurrence denotes that either no record occurrence qualifies for a read or that a record occurrence does not exist at a given level in a relation.

A read relation operation produces a null occurrence when one of the following is true:

- A parent record occurrence qualifies for the read, but no child record occurrence qualifies.
- A parent record occurrence qualifies for the read, but no child record occurrence exists.

If a null record occurrence is returned for each realm in a relation except the root realm, another READ statement must be executed to obtain the next set of record occurrences.

A null occurrence consists of a display code right bracket ( ]) in each character position of the record in the working storage area. The presence of a null occurrence and the lowest rank on which it occurred can be detected by checking the data base status block. Status checking is described in section 4.

Some examples of null record occurrences returned are shown in figure 3-20. In the first example, the lowest rank with a null record occurrence is rank 2. In the second and third examples, the lowest rank with a null record occurrence is rank 3.

POSITIONING A RELATION

To position a relation for subsequent sequential read operations, you must include a START statement in your program. The format is:

```
START(relation-name [,KEY symbol item-name]
    [,ERR=s])
```

where

symbol = = .EQ. .GT. .GE.

item-name = primary or alternate key defined in the root realm

s = label of an executable statement to which control transfers on start error

Before the START statement is executed, the realm must have been opened for input or input/output.

When you omit the KEY option, the relation is positioned by primary key value of the root realm; the root realm is positioned to the record occurrence with a primary key value equal to the current value of the primary key item. When you include the KEY option, the root realm is positioned to the first record occurrence with a matching key value.

In a program using the sample sub-schema COMPARE (figure 3-16), both forms of the START statement appear as shown in figure 3-21. If an error occurs on start, program execution continues at statement 700.

The first START statement omits the KEY option, which means the relation ocurrence will be positioned by the root realm primary key. The primary key (PROFID) of the root realm is set to the value MLN00840 before the START statement is executed; the relation is positioned to the root realm record occurrence with the matching primary key.

The second START statement includes the KEY option. Alternate key FIELD is set to the value PSYCHOLOGY. The first record occurrence in PFILE with an alternate key equal to PSYCHOLOGY is the one to which root realm PFILE is positioned. The subsequent sequential reads reference the alternate key FIELD. These reads return record occurrences in the root realm in alphabetical order (collating sequence order) according to the value of the alternate key FIELD.

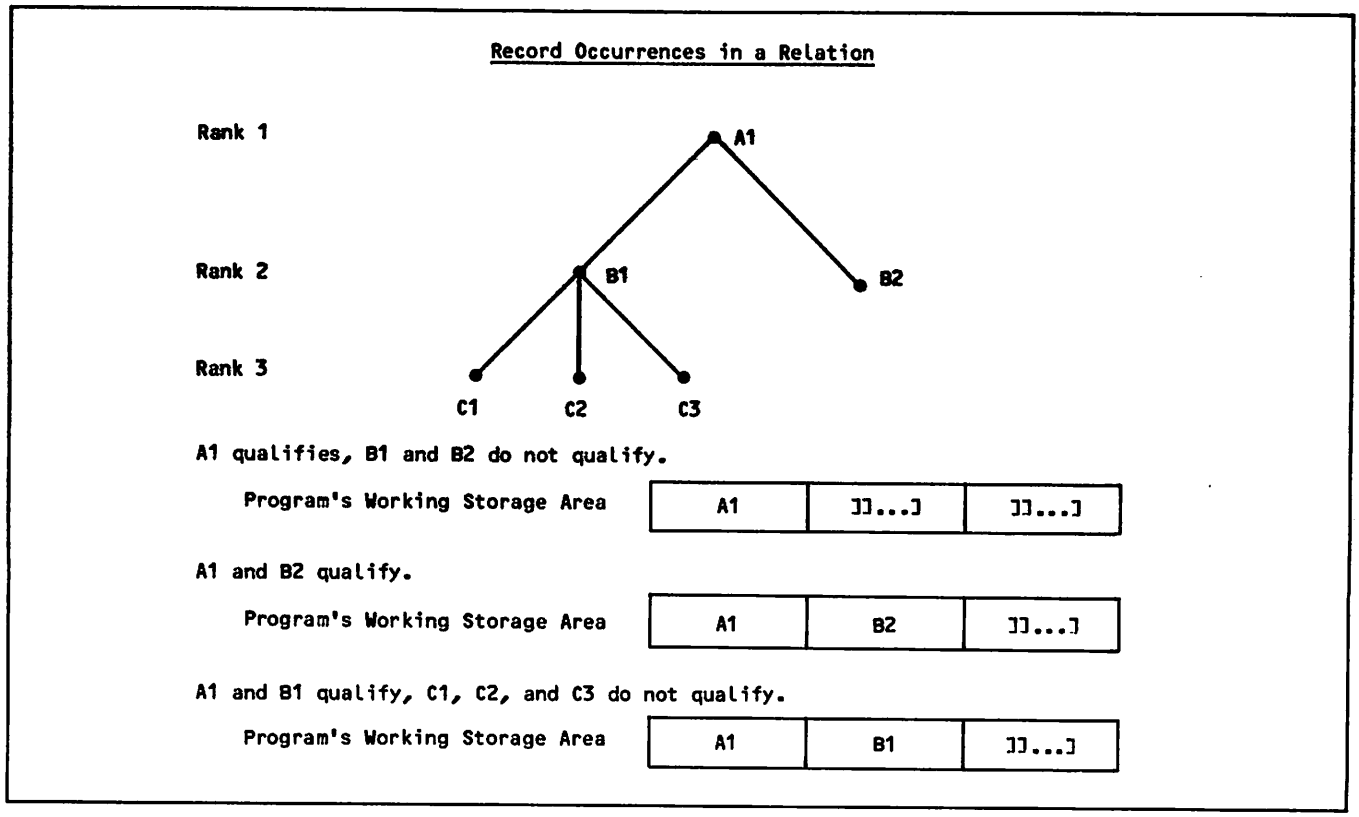


Figure 3-20. Null Record Occurrence Examples

```
      PROGRAM RELMOD
      SUBSCHEMA(COMPARE)
      INVOKE
      PRIVACY(CFILE,MODE=I,PRIVACY='XX99')
      OPEN(REL3,MODE=I,ERR=100)
      PROFID='MLN00840'
      START(REL3,ERR=700)
      READ(REL3,ERR=600,END=900)
      .
      .
      .
      FIELD='PSYCHOLOGY'
      START(REL3,KEY.EQ.FIELD,ERR=700)
      READ(REL3,ERR=650,END=750)
      .
      .
      .
900   CLOSE(REL3)
      TERMINATE
      END
```

Figure 3-21. Positioning a Relation

UPDATING REALMS JOINED IN A RELATION

Realms joined in a relation can be updated, but care should be exercised. Related files are joined in the schema by a common data item to form a parent/child relationship. The schema contains a JOIN clause in which a data item in one realm is equated with an identical data item in another realm. This common data item is called a join item.

CDCS normally does not monitor update operations that would alter the underlying relationship between related files. The exception is when constraints have been incorporated in the schema by the data administrator, as described in section 4.

Assuming constraints are not present, the following precautions should be noted:

- Modification of join item values can change parent/child relationships.
- Deletion of parent record occurrences can make all child record occurrences of the deleted parent record occurrence inaccessible when a relation is read.

Important rules to remember for relation update are:

- Always delete a child occurrence before deleting the parent record occurrence.
- Always write the parent record occurrence before writing a child record occurrence.
- Be aware of file positioning; input/output operations could alter positions on the files joined in the relation while within a sequential read relation loop.

USING DML TO PROCESS DATA BASE TRANSACTIONS

Data base transactions can be used when you have many interrelated updates to perform on one or more data base files. These updates all need to be processed and made permanent to ensure the data is correct before other users access the updated records. A data base transaction is a convenient way for processing coordinated updates.

A group of updates for which the application program specifies the beginning and the completion is referred to as a data base transaction. At first, all updates within a data base transaction are considered temporary. These updates are considered permanent when the application program specifies the completion of the data base transaction (called committing a data base transaction). Figure 3-22 shows the sequence of operations in a data base transaction.

If an application program does not commit a data base transaction, but instead drops the data base transaction or terminates execution, each record that was updated within the data base transaction is restored to the state it was in just before the beginning of the data base transaction, and CDCS issues an informative diagnostic. There are several situations in which data base transactions are not committed. For example, program logic can determine that the data base transaction should not be committed and can cancel (drop) the data base transaction. System failure or program failure can occur during the application program's processing of the data base transaction. In each of these situations, updates made within the uncommitted data base transactions are reversed.

The application program can perform data base transactions only if transaction recovery files have been defined for the schema in the master directory. When a FORTRAN application program begins a data base transaction, CDCS processes subsequent update operations by that program in transaction mode. When processing in transaction mode, CDCS uses the exclusive record locking mechanism that prevents other users from accessing records updated within an uncommitted data base transaction.

PROCESSING OPERATIONS

FORTRAN DML statements provide for the operations involved in data base transactions. Three of these operations, which are directly involved in the program code dealing with updates, are described in the following paragraphs.

- Begin a data base transaction

  Designates the beginning of a data base transaction and communicates a transaction identifier to CDCS. This causes CDCS to begin processing in transaction mode for the application program.

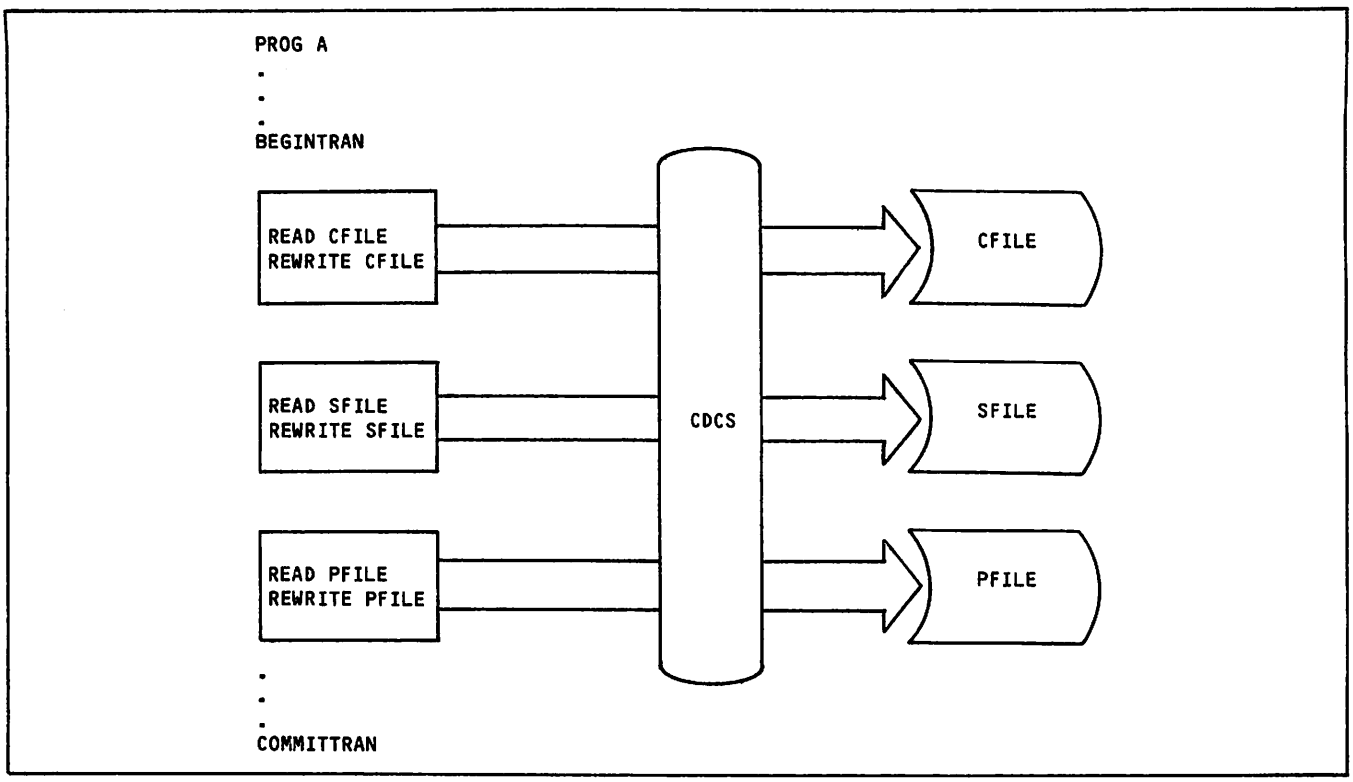


Figure 3-22. Data Base Transaction Flow

- Commit a data base transaction

  Designates the end of a data base transaction and indicates that the updates within the data base transaction are to be committed. This causes all the updates made within the data base transaction to be considered permanent.

- Drop a data base transaction

  Designates the end of a data base transaction and indicates that the updates already made within the data base transaction are to be cancelled. This causes each record updated within the data base transaction to be restored to the state it was in just before the beginning of the data base transaction.

Beginning a Data Base Transaction

To begin a data base transaction, you must use a BEGINTRAN statement. The format is:

```
BEGINTRAN (tran-id [,ERR=s])
```

where

tran-id = character constant or variable

s = label of an executable statement to which control transfers on begin error

A tran-id can be from 1 through 10 characters in length. If you use a character constant to specify a tran-id, enclose the character string in apostrophes. If you use a variable name to specify a tran-id, define the variable as type CHARACTER*10. Ensure that the tran-id is left-justified and blank filled in the field of the variable.

Records that are subsequently updated remain exclusively locked until the data base transaction is either completed or dropped. Updates are considered temporary until the data base transaction is successfully completed. If your program attempts to begin a data base transaction when the data administrator has not defined a transaction recovery file for the schema, a fatal error occurs.

Committing a Data Base Transaction

To commit a data base transaction, you must use a COMMITTRAN statement. The format is:

```
COMMITTRAN [(,ERR=s)]
```

where

s = label of an executable statement to which control transfers on commit error

Execution of this statement causes all updates of the present data base transaction to become permanent; all record locks are released so that the records become available for access by other application programs (unless a realm lock applies).

In a program using sample sub-schema COMPARE (figure 3-16), the BEGINTRAN and COMMITTRAN statements appear as shown in figure 3-23. The program uses the BEGINTRAN statement to begin the data base transaction. The program sets the primary key PROFID of PFILE to WLSNO855. PFILE is read randomly and the occurrence of this record is deleted. A new record is then written to PFILE. The CRSFILE is read randomly for any occurrence of the deleted PROF value. Each record with PROF=WLSNO855 is updated and rewritten with the PROF value of the new record. After all updates have been performed, the COMMITTRAN statement is executed and all updates become permanent.

```
      PROGRAM RELMOD
      CHARACTER TRANID *10
      SUBSCHEMA(COMPARE)
      DATA TRANID/'1234567890'/
      INVOKE
      PRIVACY (PFILE,MODE=IO,PRIVACY='XX99')
      OPEN(PFILE,MODE=IO,ERR=600)
      OPEN(CRSFILE,MODE=IO,ERR=600)
      BEGINTRAN (TRANID,ERR=900)
      PROFID='WLSNO855'
      READ(PFILE,KEY=PROFID,ERR=600)
      DELETE(PFILE)
      PROFID='MRHT1234'
      PNAME='HAUS, M.T.'
      FIELD='CHEMISTRY'
      WRITE(PFILE,ERR=600)
      DO 400, II=1,10
      PROF='WLSNO855'
      READ(CRSFILE,KEY=PROF,END=500,ERR=600)
      PROF='MRHT1234'
  400 REWRITE(CRSFILE,ERR=600)
  500 COMMITTRAN(ERR=600)
      .
      .
      .
  900 CLOSE(PFILE)
      CLOSE(CRSFILE)
      TERMINATE
      END
```

Figure 3-23. Committing a Data Base Transaction

Dropping a Data Base Transaction

To cancel the current data base transaction, you must use a DROPTRAN statement. The format is:

```
DROPTRAN [(,ERR=s)]
```

where

s = label of an executable statement to which control transfers on cancel error

Execution of the DROPTRAN statement causes CDCS to restore the records updated within the data base transaction to their original states that existed just before the data base transaction was initiated and also causes CDCS to release all record locks.

In a program using sample sub-schema COMPARE (figure 3-16), the BEGINTRAN and DROPTRAN statements appear as shown in figure 3-24. The program uses the BEGINTRAN statement to begin the data base transaction. If an error occurs in the program, execution continues at line 600 and the DROPTRAN statement is executed, causing the current data base transaction to be cancelled.

```
      PROGRAM RELMOD
      CHARACTER TRANID *10
      SUBSCHEMA(COMPARE)
      DATA TRANID/'1234567890'/
      INVOKE
      PRIVACY (PFILE,MODE=IO,PRIVACY='XX99')
      OPEN(PFILE,MODE=IO,ERR=600)
      OPEN(CRSFILE,MODE=IO,ERR=600)
      BEGINTRAN (TRANID,ERR=900)
      .
      .
      .
      READ(PFILE,KEY=PROFID,ERR=600)
      .
      .
      .
      WRITE(PFILE,ERR=600)
      .
      .
      .
  600 PRINT*, 'TRANSACTION ERROR'
      DROPTRAN
  900 CLOSE(PFILE)
      CLOSE(CRSFILE)
      TERMINATE
      END
```

Figure 3-24. Dropping a Data Base Transaction

PROCESSING CONSIDERATIONS

The following rules and considerations apply to data base transactions:

- Only one data base transaction can be in progress at a time within a particular application program. That is, there can be no nesting of data base transactions.
- The data administrator defines the maximum number of concurrent data base transactions allowed for all users of the schema. If this number is exceeded, CDCS issues a nonfatal diagnostic. The application program can try the data base transaction request later.
- File locks are not recommended for use with data base transactions.

USING DML FOR PROGRAM RESTART

FORTRAN DML statements provide for the operations involved in restarting programs. The restart component of data base transactions allows an application program to determine the point at which to begin a data base transaction following a system failure. An application program can determine whether or not a data base transaction was committed before the system failed. With this information available, the program can determine the point at which to resume a data base transaction.

The application program can perform a restart operation only if the data administrator has defined both a transaction recovery file and a restart identifier file in the schema.

PROCESSING OPERATIONS

The following paragraghs describe the operations used for program restart if a system failure occurs:

- Obtain a restart identifier

  Communicates with CDCS to obtain a restart identifier for the application program. The application program must save the restart identifier for subsequent use in a restart operation. If program restart capability is desired, this operation must be performed before the first data base transaction is begun.

- Inquire about the status of the last data base transaction

  Communicates to CDCS a restart identifier and obtains from CDCS the transaction identifier for the last completed data base transaction associated with that restart identifier. CDCS then assigns the restart identifier obtained to the program. This operation provides for restarting an application program. Application program logic then uses the transaction identifier to determine with which data base transaction to resume processing. The application program should contain the logic necessary to be restartable.

Assigning a Restart Identifier

To obtain the restart identifier assigned to this program by CDCS, you must use the ASSIGNID statement. The format is:

```
ASSIGNID (restart-id [,ERR=s])
```

where

restart-id = variable

s = label of an executable statement to which control transfers on assign error

A restart-id can be from 1 through 10 characters in length. A variable name must be used to specify a restart-id and must be defined as type CHARACTER*10.

The restart identifier obtained by the ASSIGNID statement can then be used by the FINDTRAN statement; the program can then determine the status of a data base transaction when a system failure occurs. The restart identifier should not be saved on a data base file because it could be lost if failure occurs. The application program should contain the logic necessary to save the identifier outside of the program.

ASSIGNID should be specified before any updates are attempted within a data base transaction. ASSIGNID must not be specified within a data base transaction.

Performing a Restart Operation

To obtain information for a program restart operation after system failure, you must use the FINDTRAN statement. This statement is normally issued in the restart unit of the program. The format is:

```
FINDTRAN (restart-id, tran-id [,ERR=s])
```

where

restart-id = character constant or variable

tran-id = variable

s = label of an executable statement to which control transfers on find error

Restart-id identifies the 1- through 10-character restart identifier that was assigned to the program by the ASSIGNID statement before the system failure. If you use a character constant to specify restart-id, enclose the character string in apostrophes. If you use a variable name to specify restart-id, define the variable as type CHARACTER*10.

Tran-id receives the transaction identifier of the last completed data base transaction; this identifier is returned only if the application program had begun a CDCS data base transaction prior to a system failure. The transaction identifier is not returned if no data base transaction has been committed for the specified restart identifier. A variable name must be used to specify tran-id and must be defined as type CHARACTER*10.

Tran-id receives the characters ********** (10 asterisks) if the restart identifier is unknown to CDCS. The restart identifier is unknown to CDCS if the wrong value is specified for restart-id or if the program terminated normally. If the program terminated normally, a new restart identifier must be obtained.

Tran-id receives a value of 10 blanks if the restart identifier is known to CDCS but no data base transaction had been completed prior to the system failure. The FINDTRAN statement executes normally, and a new restart identifier does not need to be obtained. The restart identifier specified as restart-id is reassigned to the program.

If a transaction identifier is returned, a new restart identifier does not need to be obtained. The restart identifier specified as restart-id is reassigned to the program.

In a program using sample sub-schema COMPARE (figure 3-16), the ASSIGNID and FINDTRAN statements appear as shown in figure 3-25. This program is run interactively, and the user must enter one of the three options given. If the initial option is chosen, the ASSIGNID statement obtains the restart identifier assigned by CDCS. Include in the job stream the control statements needed to create a file to save the restart identifier in case a system failure occurs. If the restart option is chosen, the FINDTRAN statement is executed, and the program can determine the status of the data base transaction when the system failure occurred. The file containing the restart identifier must be attached in the job stream when the restart option is chosen. If the end option is chosen, program execution is terminated.

```
      PROGRAM RELMOD
      CHARACTER RESTID *10
      CHARACTER TRANID *10
      CHARACTER OPTION *7
      SUBSCHEMA (COMPARE)
      INVOKE
      OPEN(2,FILE='RESTART')
10    PRINT*, 'ENTER: INITIAL, RESTART, OR END'
      READ*, OPTION
      IF (OPTION .EQ. 'INITIAL') THEN
           ASSIGNID (RESTID,ERR=50)
           WRITE(2,'(A10)') RESTID
           CLOSE(2)
           GO TO 25
      ELSE IF (OPTION .EQ. 'END') THEN
           GO TO 60
      ELSE IF (OPTION .EQ. 'RESTART') THEN
           READ(2,'(A10)') RESTID
           FINDTRAN (RESTID,TRANID,ERR=50)
           IF (TRANID .EQ. '**********') THEN
                PRINT*, ' RESTART UNSUCCESSFUL OR UNNECESSARY'
                GO TO 60
           ELSE
      .
      .
      .
60    TERMINATE
      END
```

Figure 3-25. Restarting a Data Base Transaction

ERROR PROCESSING AND STATUS HANDLING TECHNIQUES

DMS-170 offers a variety of error and status processing mechanisms. Each serves a specific purpose in the operating environment. These mechanisms are summarized in table 4-1 and detailed in the following paragraphs.

USING ERR AND END PROCESSING OPTIONS

A transfer of control to special processing for error or end-of-file (EOF) conditions can be specified in your program. This is accomplished by including the ERR and END options in the appropriate DML statements.

The ERR option can appear in most statements, as shown in the formats in section 3. The END option can appear in the sequential READ statement.

The formats for the ERR and END options are:

```
ERR=statement-label

END=statement-label
```

When the ERR or END option is executed, control transfers to the statement identified by statement-label. The identified statement must be executable.

Assume an input/output error occurred during execution of the following statement:

```
OPEN(FILEX,ERR=50)
```

Execution of the OPEN statement is terminated, status is set to the appropriate error code as described later in this section, and program execution continues at statement 50.

TABLE 4-1. ERROR AND STATUS PROCESSING MECHANISMS

Mechanism	Definition	Programmer Action
Error processing option	Syntax option that passes control to program logic on an error condition. Control is not passed when a CDCS relation condition indicating a null record occurrence or control break occurs.	Include ERR option in appropriate DML statements.
End-of-file processing option	Syntax option that passes control to program logic on an EOF condition.	Include END option in appropriate DML statements.
Status block	An array to which CDCS returns data base status information.	Include the following operations in the program: establishing the data base status block, calling subroutine DMLDBST once, and testing the status block contents at appropriate points.
Constraint handling	A method of avoiding situations in which constraints could be violated.	Be aware of constraints, and follow the rules for modifying the files on which constraints have been imposed.
Deadlock processing	A method of recovering from a situation in which programs are contending for locked resources.	If the program must have simultaneous locks on several resources, include a test for deadlock status and provide program logic to reestablish any released locks.
Restart processing	A method of allowing an application program to determine the point at which to begin processing following a system or program failure.	Include the ASSIGNID statement and the FINDTRAN statement in the application program to determine the status of a data base transaction after a system or program failure occurs.
Dropping a data base transaction	The capability to cancel a data base transaction.	Include the DROPTRAN statement in the application program.

Assume an EOF was sensed during execution of the following statement:

```
READ(FILEX,END=75)
```

Execution of the READ statement is terminated and execution continues at statement 75.

Several examples of this type of error and end-of-file processing appear throughout section 3.

ESTABLISHING A DATA BASE STATUS BLOCK

An array called a data base status block can be established in your program to receive data base status information. When the status block is included in your program, CDCS updates the block after every operation on a realm or a relation.

The minimum length of the data base status block is one word; the maximum length is 11 words. You can include some or all of the words for testing purposes. The content of the status block is shown in table 4-2.

The following rules apply to the status block:

- Only one status block can exist at a time in the program.
- The status block must be declared as type INTEGER.
- The length of the block must be sufficient to completely include each desired portion of status information.

TABLE 4-2. STATUS BLOCK CONTENT

Word	Content	Comments
1	The CDCS or CRM octal error code for the last data base operation on a realm or a relation.	Only error codes are returned. Status codes indicating null occurrences or control breaks are not returned in this word. A zero value indicates no error occurred. Use O format for printing.
2†	A sub-schema item ordinal for CDCS errors occurring at the item level.	Item-level errors are associated with data validation and data base procedures established by the data administrator in the schema, and with CDCS record mapping. A zero value indicates no error occurred. Use I format for printing.
3†	A CRM octal code indicating file position of the realm when the last data base operation was performed. The code is returned for open, close, read, and start operations. For a relation operation, the code indicates the file position of the root realm.	Code values are: 01_8 Beginning-of-information. 10_8 End-of-keylist. The last primary key value associated with a given alternate key was returned during a read operation using an alternate key value. 20_8 End-of-record. A record was returned during a read operation. 100_8 End-of-information. A sequential read operation was attempted after the previous operation returned the last record in the realm. Use O format for printing.
4†	The severity of an error that occurred during the last data base operation.	A zero value indicates no error occurred or a non-fatal error occurred. A value of one indicates a fatal error occurred. Use O or I format for printing.
5	The name of the function being performed when an error or relation condition occurred; the name is left-justified and blank filled.	If no error has occurred, this word contains no valid information. Use A10 format for printing.

TABLE 4-2. STATUS BLOCK CONTENT (Contd)

Word	Content	Comments
6††	The rank of the realm on which a CDCS or CRM error occurred during a relation operation. (The ranks of realms joined in a relation are numbered consecutively, with the root realm having rank 1.)	A zero value indicates no error occurred. Use I format for printing.
7††	The lowest rank on which a control break occurred during a relation operation.	All realms in the relation with a rank greater than the rank stored in this word also have control breaks or null status. (Null status overrides control break status.) A zero value indicates no control break occurred. Use I format for printing.
8††	The lowest rank for which there was a null record occurrence during a relation operation.	All realms in the relation with a rank greater than the rank stored in this word also have null occurrences. A zero value indicates no null occurrence. Use I format for printing.
9,10,11	The name of the realm on which an error occurred; the name is left-justified and blank filled.	A blank value indicates no error occurred; a blank value also can indicate the error occurred on an operation not associated with input/output or occurred on an input/output operation not explicitly requested by the application program. Use A30 format for printing.

†Words 2, 3, and 4 are treated as a single unit by CDCS; length must be provided for all three words if information for any portion of the unit is to be returned.

††Words 6, 7, and 8 must all be defined to obtain any one word of relation status information.

The following declaration would provide a complete status block:

```
INTEGER STATUS(11)
```

The following declaration would provide a 5-word status block reflecting all information except that pertaining to relation processing:

```
INTEGER STAT(5)
```

The location and length of the status block are conveyed to CDCS through a call to the DMLDBST routine. The routine can be called at any point in the program after the INVOKE statement. The format of the call is:

```
CALL DMLDBST(block-name,length)
```

where

block-name = name of the status block

length = length in words of the status block

The following rules apply to the DMLDBST routine:

- The routine needs to be called one time only.
- The call to DMLDBST should appear before the first DML statement after INVOKE. Positioning of the DMLDBST call is important because the call initializes the status block to zeros and blanks.
- If DMLDBST is called more than once in a program, the status block defined in the last call is the one that is updated by CDCS.

In a program using the sample sub-schema COMPARE shown in section 3, a data base status block declaration appears as shown in figure 4-1. The formats for printing the contents of the data base status block are also shown in the figure.

```
      PROGRAM DBSEXMP
      INTEGER STATBLK(11)
      SUBSCHEMA(COMPARE)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,MODE=I,PRIVACY='XX99')
      OPEN(REL3,MODE=I,ERR=100)
      PFOFID='MLN00840'
      READ(REL3,ERR=600,END=900)
      .
      .
      .
600   PRINT *, 'ERROR ON READ'
      PRINT 700, STATBLK
700   FORMAT (1X, 'STATUS BLOCK' /
     1         1X,04,2X,I5,2X,03,2X,01,2X,
     1         A10,2X,I5,2X,I5,2X,I5,2X,A30)
900   CLOSE(REL3)
      TERMINATE
      END
```

Figure 4-1. Establishing a Data Base Status Block

ERROR CHECKING

Error checking should be performed after every operation on a realm or relation. Two methods are available:

- Test the error code in word 1 of the data base status block after every operation. For example:

```
OPEN(CFILE)
IF(STATBLK(1) .NE. 0)...
```

- Include the ERR option on the DML statement as appropriate and handle status block printing in one specific section of the program. For example:

```
      OPEN(CFILE,ERR=50)
      .
      .
      .
50    PRINT 60,STATBLK
```

STATUS CHECKING

Status checking should be performed as appropriate during relation processing to determine control breaks and null occurrences. Testing is performed on words 7 and 8, respectively, of the data base status block. (For more information about control break and null occurrence, see section 3.)

Word 7 indicates the lowest rank on which a control break occurred. A nonzero value in this word indicates a control break. To test for a control break, you can include a test on word 7 in your program. For example:

```
READ(CFILE)
IF(STATBLK(7) .NE. 0)...
```

Word 8 indicates the lowest rank for which there was a null occurrence. A nonzero value in this word indicates a null occurrence. Since the right bracket character ( ]) is stored in a null record, you would probably want your program to bypass printing or move spaces to the print line. To test for a null occurrence, you can include a test on word 8 in your program. For example:

```
READ(CFILE)
IF(STATBLK(8) .NE. 0)...
```

AVOIDING CONSTRAINT VIOLATIONS

The data administrator incorporates constraints in the schema for the purpose of protecting interdependent data. Constraints can be defined for two logically associated items within a single file (single-file constraint) and for two logically associated items within two files (two-file constraint).

Consider an employment file in which each record occurrence contains an employee number and a manager number, where the manager number conforms to the structure of the employee number. Figure 4-2 illustrates this concept. Assume, for example, the data administrator designed the schema with the following single-file constraint:

```
MNGR-NO DEPENDS ON EMP-NO
```

In this example, MNGR-NO (the dependent item) is dependent upon EMP-NO (the dominant item). This means that no occurrence of the dependent record can exist in the data base unless an occurrence of the dominant record also exists with the same value of the associated data item. Also, no dominant record can be deleted if a dependent record exists with the same value of the associated data item.

The dominant item in a single-file constraint is always a primary key or an alternate key with no duplicates; the dependent item is a primary key or an alternate key, and the alternate key can have duplicates. You would violate the constraint presented in the example if you attempted to do any of the following:

- Store an employee EMPLOYMENT record if an EMPLOYMENT record for the referenced manager does not exist. (An organization could not recognize a manager who was not first an employee.)
- Change the value of the dominant item (EMP-NO) if a corresponding dependent item (MNGR-NO) exists. (An organization could not change an employee number as long as references to the old number existed.)
- Delete a manager EMPLOYMENT record if an employee EMPLOYMENT record with the corresponding manager number exists. (An organization could not remove a manager while an employee was still reporting to that individual.)

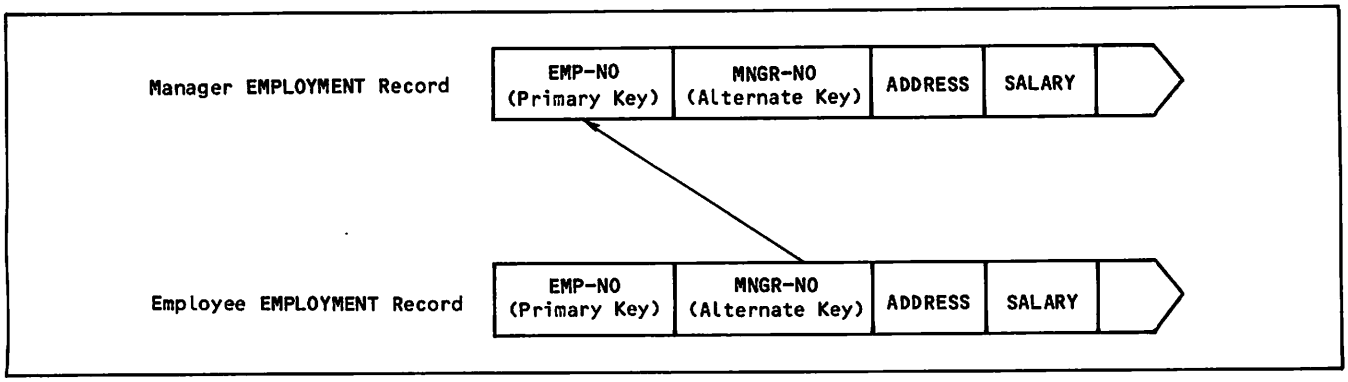


Figure 4-2. Single-File Constraint Example

In a single-file constraint, at least one record exists that has no dominant record. This situation occurs in the single-file constraint example for the employee who has no manager. The record for this employee must have the same value for both EMP-NO and MNGR-NO.

If you are creating a file on which a single-file constraint has been imposed, take the following steps in the order given:

1. Create the file with record occurrences of the items that have no dominant record.
2. Close the file.
3. Reopen the file for input/output and add the record occurrences of the dependent items. (Ensure that a dominant record occurrence exists before adding any corresponding dependent item.)

For a situation involving a two-file constraint, consider a course file and a curriculum file. Assume that the data administrator designed the schema with the following two-file constraint:

```
COURSE-ID OF CURR-REC DEPENDS ON
    COURSE-ID OF COURSE-REC
```

The records of the two files and the data items associated in the constraint are shown in figure 4-3. CURR-REC (the dependent record) is dependent upon COURSE-REC (the dominant record) if there is a correspondence between them. A correspondence exists if the dependent record and the dominant record each contain the same value for the common item, which is COURSE-ID in this example.

You would violate the constraint presented in the two-file constraint example if you attempted to do any of the following:

- Delete a COURSE-REC occurrence if a corresponding CURR-REC occurrence exists. (The university could not drop a course from its curriculum while a student was still enrolled.)
- Change the COURSE-ID value of a COURSE-REC occurrence if a corresponding CURR-REC occurrence exists. (The university could not change the identification code of a course as long as a student's record still uses that code.)
- Add a CURR-REC occurrence if a corresponding COURSE-REC occurrence does not exist. (A student could not be enrolled in a course that was not being offered by the university.)

If you are modifying the common item of a file on which a two-file constraint has been imposed and the common item is a primary key, take the following steps in the order given:

1. Write the dominant record with the new value in the common item.
2. Read a dependent record, and change the value of the common item to the new value of the dominant record. Rewrite the dependent record. (Perform this step for each dependent record of the dominant record.)
3. Delete the dominant record with the old value.

If you are modifying the common item of a file on which a two-file constraint has been imposed and the common item is an alternate key, take the following steps in the order given:

1. Write each dependent record containing the old value of the item to a temporary file.
2. Delete each dependent record containing the old value of the item from the data base.
3. Read the dominant record, and change the value of the data item to the new value. Rewrite the dominant record.
4. Read a dependent record from the temporary file, and change the value of the common item to the new value of the dominant record. Write the dependent record to the data base. (Perform this step for each dependent record of the dominant record.)

Since constraints are established in the schema and not indicated in any way in the sub-schema, it is the responsibility of the data administrator to supply you with this information. By being aware of constraints, you can anticipate violations and prevent them from occurring in your application program.

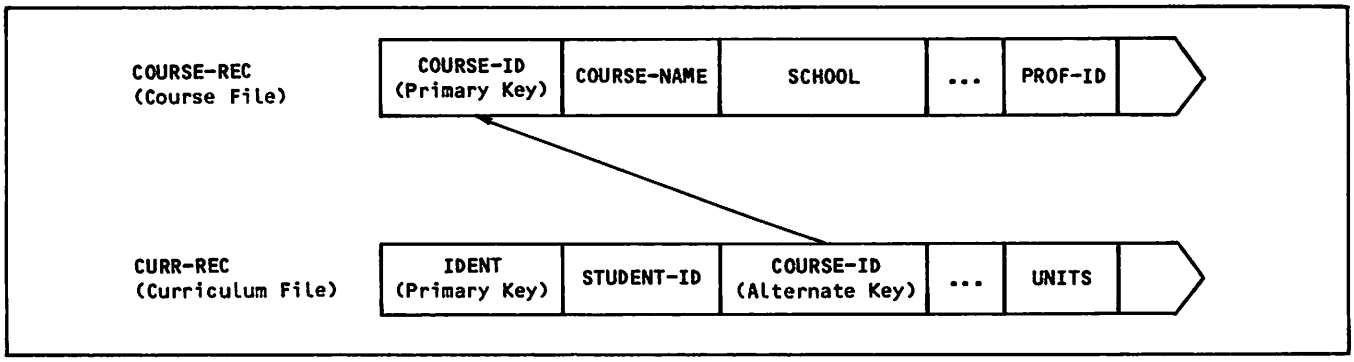


Figure 4-3. Two-File Constraint Example

When a constraint is violated, CDCS aborts the particular operation, returns a nonfatal 601_8 error code, and continues processing. The error message identifies the record on which the attempted violation occurred. Whenever you are writing, deleting, or rewriting a record, the appropriate data base status block entry should be tested.

Two general rules to remember for constraint processing are:

- Always delete a dependent record occurrence before deleting the dominant record occurrence.
- Always write the dominant record occurrence before writing a dependent record occurrence.

ANTICIPATING DEADLOCK SITUATIONS

CDCS allows concurrent access to a data base. This means that two or more application programs can access the same file (realm) at the same time. The following can take place:

- Two or more application programs can open the same file for input and perform simultaneous read operations.
- One application program can open a file for input/output and perform update operations, while other programs can open the same file for input and perform simultaneous read operations.
- Two or more application programs can open the same file for input/output, but only one program can gain immediate access to a particular record to perform update operations.

The integrity of the data base is maintained through CDCS locking mechanisms: the record locking mechanism and the file locking mechanism. CDCS holds a lock (either protected or exclusive) for an application program and prevents update of the locked file or record by any other program.

Exclusive locking prohibits read and update operations on the realm. Protected locking prohibits only update operations (allows read operations). See the CDCS 2 Application Programming reference manual for detailed information about locking.

Whenever two or more application programs contend for locked resources, which are files or records, a deadlock situation can occur. Contention occurs when two programs, each having at least one resource locked, attempt to lock a resource that is locked by the other program. Neither program can continue processing, because neither program can obtain the necessary locks. CDCS automatically releases the locked resources of one program. The other program then can obtain the locks it requires and can continue processing.

When CDCS has detected a deadlock situation and has released the locked resources of an application program, CDCS issues the deadlock error status code 663_8 to that program. If the application program established the data base status block, the program can check the first word for the deadlock code.

If your program must have locks on several resources, your program should always test for deadlock status before attempting to update a file. If deadlock occurs, your program should reestablish the locks that it held before continuing further processing.

An example illustrating deadlock processing appears in figure 4-4. Files joined in relation REL3 are opened for input/output. The program presumably is reading a record prior to update and CDCS has locked all records in the relation occurrence. The example includes a test of word 1 in the status block to enter a loop in case of deadlock. In the loop, the program attempts to reestablish the locks and checks for deadlock.

```
      PROGRAM DEADLCK
      INTEGER STATBLK(11)
      SUBSCHEMA(COMPARE)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,PRIVACY='XX99')
      OPEN(REL3,ERR=100)
      PROFID='JMS00160'
 30   READ(REL3,KEY=PROFID)
      IF(STATBLK(1) .EQ. 0"663") GO TO 30
      .
      .
      .
 900  CLOSE(REL3)
      TERMINATE
      END
```

Figure 4-4. Deadlock Processing

TABLE 4-3. LOCKING OPERATIONS

Operation	Effect
An application program opens a realm for input/output and includes a DML LOCK statement. (This should be avoided whenever possible.	CDCS locks the entire realm against update by other users. An unlock or close operation by that program releases the lock.
An application program opens a realm for input/output without including a DML LOCK statement.	CDCS locks the record on the read operation. A rewrite, delete, or another read operation by that program releases the lock.
An application program opens a realm for output without including a DML LOCK statement.	CDCS locks the entire realm. A close operation by that program releases the lock.
An application program opens a relation for input/output.	CDCS locks all records in a given relation occurrence. A rewrite or delete operation by the program releases the lock on the record updated. The next relation read operation by that program releases the record locks on the files for which a new record has been read.

Whenever two or more application programs contend for locked resources, which are files or records, a deadlock situation can occur. Contention occurs when two programs, each having at least one resource locked, attempt to lock a resource that is locked by the other program. Neither program can continue processing, because neither program can obtain the necessary locks. CDCS automatically releases the locked resources of one program. The other program then can obtain the locks it requires and can continue processing.

When CDCS has detected a deadlock situation and has released the locked resources of an application program, CDCS issues the deadlock error status code 663_8 to that program. If the application program established the data base status block, the program can check the first word for the deadlock code.

If your program must have locks on several resources, your program should always test for deadlock status before attempting to update a file. If deadlock occurs, your program should reestablish the locks that it held before continuing further processing.

An example illustrating deadlock processing appears in figure 4-5. Files joined in relation REL3 are opened for input/output. The program presumably is reading a record prior to update and CDCS has locked all records in the relation occurrence. The example includes a test of word 1 in the status block to enter a loop in case of deadlock. In the loop, the program attempts to reestablish the locks and checks for deadlock.

```
      PROGRAM DEADLCK
      INTEGER STATBLK(11)
      SUBSCHEMA(COMPARE)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,PRIVACY='XX99')
      OPEN(REL3,ERR=100)
      PROFID='JMS00160'
 30   READ(REL3,KEY=PROFID)
      IF(STATBLK(1) .EQ. 0"663") GO TO 30
      .
      .
      .
 900  CLOSE(REL3)
      TERMINATE
      END
```

Figure 4-5. Deadlock Processing

FORTRAN application programming in the DMS-170 environment relieves you of several responsibilities. For example:

- You do not have to describe data within your program; the data administrator incorporates data descriptions in the schema and sub-schema. Data descriptions in a sub-schema are included in your program.
- You do not have to write conversion routines; CDCS handles all conversion for you.
- You do not have to write all routines that perform validity checking; the data administrator generates data base procedures, which are specified in the schema and called at appropriate times.
- You do not have to write separate logging and recovery utilities; the data administrator provides for data base restoration by specifying logging operations in the master directory.
- You do not have to be concerned with the details of input/output; CDCS handles them.

DEVELOPING AN APPLICATION PROGRAM

To develop a DMS-170 application program, you must do the following:

- Obtain a listing of the sub-schema from the data administrator.
- Obtain the name of the sub-schema library from the data administrator.
- Obtain the appropriate privacy keys from the data administator.
- Be aware of any constraints that have been incorporated in the schema.
- Include appropriate DML statements in your FORTRAN program.
- Obtain information on whether data base transactions can or should be used.

COMPILING AND EXECUTING THE SOURCE PROGRAM

To compile and execute a DMS-170 FORTRAN application program, you must do the following:

1. Attach the sub-schema library for DML preprocessing of the source program.
2. Include a DML control statement for DML preprocessing of the source program.
3. Include an FTN5 control statement that specifies the DML output file as the input file for the FORTRAN 5 compiler.
4. Include an LDSET control statement for loading the system library for execution of the source program.
5. Include the name of the file containing the relocatable binary program (LGO is the default name) to execute the program.
6. Be sure that CDCS is active or use CDCSBTF under the direction of the data administrator.

DML statements are preprocessed before source program compilation. The DML preprocessor translates the DML statements into appropriate FORTRAN statements. When translation is complete, the DML preprocessor writes the FORTRAN source program to an output file with the default name DMLOUT. This output file, complete with translated DML statements, becomes the input file to the FORTRAN compiler. A block diagram illustrating FORTRAN/DML preprocessing is shown in figure 5-1.

The DML control statement calls the DML preprocessor. A list of DML control statement parameters is shown in figure 5-2.

The statements required to execute the DML preprocessor and to compile the source program are shown in figure 5-3.

The statements required to execute the DML preprocessor and to compile and execute the source program are shown in figure 5-4. An LDSET control statement naming the system library, DMSLIB, must be included for program execution.

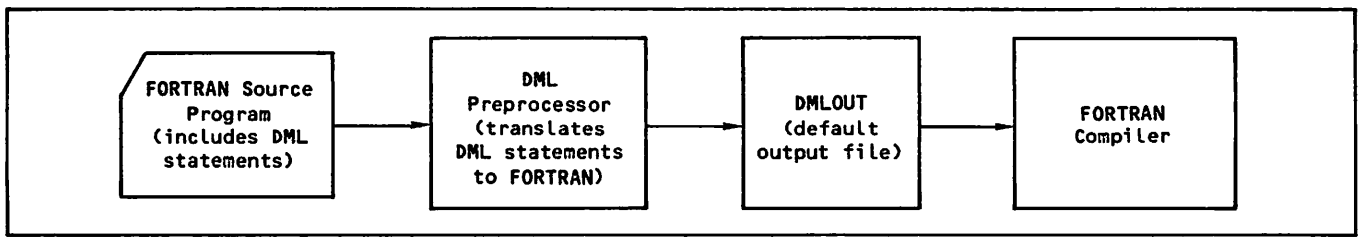


Figure 5-1. FORTRAN DML Preprocessing

DML(p1,p2,p3,p4,p5,p6,p7)

p1 SB=lfn Name of file containing sub-schema library.

SB Same as SB=SBLFN.

SB=0 Not allowed.

omitted Same as SB=SBLFN.

p2 LV=F5 Specifies FORTRAN 5.

LV Same as LV=F5.

omitted Dependent on installation.

p3 I=lfn Name of file containing FORTRAN source program with added DML statements to be preprocessed by DML.

I Same as I=COMPILE.

omitted Same as I=INPUT.

I=0 Not allowed.

p4 O=lfn Name of file to which translated version of FORTRAN source program is to be written. DML statements appearing in FORTRAN program are translated into FORTRAN statements before being written to this file.

O Same as O=DMLOUT.

omitted Same as O=DMLOUT.

O=0 No output is produced.

p5 E=lfn Name of file to which error diagnostics are to be written.

E Same as E=ERRS.

omitted Same as E=OUTPUT.

p6 ET=op Error termination code. Four levels of errors are defined; if an error of the specified level or higher takes place, the job is aborted to an EXIT(S) control statement (NOS/BE) or EXIT control statement (NOS). The abort does not take place until DML is finished. The possible values for op, in increasing order of severity, are as follows:

T Trivial. The syntax of the usage is correct, but it is questionable.

W Warning. The syntax is incorrect, but the processor has been able to recover by making an assumption about what was intended.

F Fatal. An error prevents DML from processing the statement in which it occurs. Unresolvable semantic errors also fall into this category. Processing continues with the next statement.

C Catastrophic. Compilation cannot continue; however, DML advances to the end of the current program unit and attempts to process the next program unit.

ET Same as ET=F.

omitted Same as ET=0.

ET=0 The job step is not to be aborted even if errors occur (except for control statement errors).

T and W errors do not invalidate the output file produced by DML (the file specified by the O option). The translated code on the file can still be compiled (barring any errors not related to DML), but the results might not be what the user intended. F and C errors, however, produce an output file that cannot be successfully compiled by FORTRAN.

p7 DS Directive suppression. Listing control directives are not generated; all FORTRAN statements generated by DML preprocessing appear in the FORTRAN source listing.

omitted Listing control directives are generated; FORTRAN statements generated by DML preprocessing of the SUBSCHEMA and INVOKE statements do not appear in the FORTRAN source listing.

FORTRAN CALL statements generated as a result of executable DML statements always appear on the FORTRAN source listing regardless of DS specification.

Figure 5-2. DML Control Statement

```
Job statement
USER statement  }
CHARGE statement }  <-------- NOS only
ATTACH(sub-schema-library)
DML(SB=sub-schema-library,LV=F5)
FTN5(I=DMLOUT)
End-of-record
FORTRAN source program containing DML statements
End-of-information
```

Figure 5-3. Executing DML and Compiling the Source Program

```
Job statement
USER statement  }
CHARGE statement }  <-------- NOS only
ATTACH(sub-schema-library)
DML(SB=sub-schema-library,LV=F5)
FTN5(I=DMLOUT)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
FORTRAN source program containing DML statements
End-of-information
```

Figure 5-4. Compiling and Executing the Source Program

SAMPLE PROGRAMS

Sample programs appear in the remainder of this section. Each program uses the data base environment that is established and illustrated in appendix C. You should read this appendix to become familiar with the schema, sub-schemas, and stored data before examining the FORTRAN programs.

When the DML preprocessor translates DML statements into FORTRAN statements, the FORTRAN statements can be printed out or suppressed, depending on the setting of the DS parameter on the DML control statement. When the DS parameter is included, all FORTRAN statements generated by the DML preprocessor appear in the FORTRAN source listing. When the DS parameter is omitted, listing control statements are generated and inserted immediately after the SUBSCHEMA and INVOKE statements; therefore, the FORTRAN statements generated by DML preprocessing of these statements do not appear in the FORTRAN source listing.

Listing control directives appear in the sample program source listings in the following form:

```
C$    LIST(ALL=0)
C$    LIST(ALL)
```

These directives are generated automatically by the DML preprocessor. They appear because the DS parameter in each DML control statement was omitted. Notice, however, that CALL statements generated as a result of executable DML statements appear regardless of the DS parameter setting.

Each sample program is illustrated by including the control statements, the source program statements, the compilation listing, and the output of program execution. The programs are:

Program RATING	Figure 5-5
Program INDAVGE	Figure 5-6
Program RELATE	Figure 5-7
Program CHARGES	Figure 5-8
Program ADMIT	Figure 5-9
Program TRANPRG	Figure 5-10

Program TRANPRG, shown in figure 5-10, is an interactive job. The file description and input file for this program appear as shown in figure 5-11.

The figures show the sample programs (listed above) being executed when CDCS is active at system control point. CDCS Batch Test Facility (CDCSBTF) can also be used. When using CDCSBTF, replace the LDSET and the LGO control statements with the following control statements:

```
LIBRARY,DMSLIB.
CDCSBTF(LGO/MDPFN=MSTRDIR,UN=xx)
```

Control Statements

```
Job Statement
USER statement
CHARGE statement
ATTACH(SSLIB)
DML(SB=SSLIB,LV=F5)
FTN5(I=DMLOUT)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
```

Source Program

```
      PROGRAM RATING
C
C  THIS PROGRAM READS ALL STUDENT GRADES AND CALCULATES THE
C  AVERAGE FOR THE SCHOOL.  THE PROGRAM PERFORMS A SEQUENTIAL
C  READ OF ALL STUDENT GRADES.  THE END PARAMETER ON THE DML
C  READ STATEMENT TRANSFERS CONTROL TO STATEMENT 70 ON EOF.
C  THE PROGRAM THEN CALCULATES THE AVERAGE AND PRINTS OUT
C  THE SOLUTION.
C
      INTEGER STATBLK(11)
      SUBSCHEMA(AVERAGE)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,PRIVACY='XX99')
      OPEN(CFILE,ERR=50)
      N=0
      TOTAL=0
20    READ(CFILE,ERR=50,END=70)
      IF(GRADE.EQ.0.0) GO TO 20
      N=N+1
      TOTAL=TOTAL + GRADE
      GO TO 20
50    PRINT 60,STATBLK
60    FORMAT (1X,'STATUS BLOCK' /
     1        1X,04,2X,I5,2X,03,2X,I2,2X,
     1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
      GO TO 80
70    TOTAL=TOTAL / N
      PRINT 75,TOTAL
75    FORMAT (1X, 'AVERAGE IS' /
     1        1X,F4.1)
80    CLOSE(CFILE)
      TERMINATE
      END
End-of-record
```

Figure 5-5. Program RATING (Sheet 1 of 3)

Compilation Listing

```
      PROGRAM RATING     76/176  OPT=0                          FTN 5.1+538


 1                PROGRAM RATING
 2           C
 3           C  THIS PROGRAM READS ALL STUDENT GRADES AND CALCULATES THE
 4           C  AVERAGE FOR THE SCHOOL.  THE PROGRAM PERFORMS A SEQUENTIAL
 5           C  READ OF ALL STUDENT GRADES.  THE END PARAMETER ON THE DML
 6           C  READ STATEMENT TRANSFERS CONTROL TO STATEMENT 70 ON EOF.
 7           C  THE PROGRAM THEN CALCULATES THE AVERAGE AND PRINTS OUT
 8           C  THE SOLUTION.
 9           C
10                INTEGER STATBLK(11)
11           **   SUBSCHEMA(AVERAGE)
12           C$   LIST(ALL=0)
55           C$   LIST(ALL)
56           **   INVOKE
57           C$   LIST(ALL=0)
61           C$   LIST(ALL)
62                CALL DMLINV(0001,DBF0001,10HAVERAGE   ,10H
63               +10H          ,0"35514310376143061021")
64                CALL DMLDBST(STATBLK,11)
65           **   PRIVACY(CFILE,PRIVACY='XX99')
66                CALL DMLPRV(1,1,0,0001,
67               +0"60","XX99      ","          ","          ")
68           **   OPEN(CFILE,ERR=50)
69                CALL DMLOPN(DBF0001,0001,2HIO,*50   )
70                N=0
71                TOTAL=0
72           **   READ(CFILE,ERR=50,END=70)
73           20   CALL DMLRD(DBF0001,0001,1,1,*50   ,*70   )
74                IF(GRADE.EQ.0.0) GO TO 20
75                N=N+1
76                TOTAL=TOTAL + GRADE
77                GO TO 20
78           50   PRINT 60,STATBLK
79           60   FORMAT (1X,'STATUS BLOCK' /
80               1        1X,04,2X,I5,2X,03,2X,I2,2X,
81               1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
82                GO TO 80
83           70   TOTAL=TOTAL / N
84                PRINT 75,TOTAL
85           75   FORMAT (1X, 'AVERAGE IS' /
86               1        1X,F4.1)
87           **   CLOSE(CFILE)
88           80   CALL DMLCLS(DBF0001,0001)
89           **   TERMINATE
90                CALL DMLEND
91                END
```

Figure 5-5. Program RATING (Sheet 2 of 3)

```
--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE     -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  COURSE      2B  /DB0001/                    CHAR*6                  DBR0001    11B  /DB0000/                    INTEGER          3
  DBF0001    15B  /DB0000/                    INTEGER         35      DBSCNAM     4B  /DB0000/                    INTEGER          3
  DBI0001     0B  /DB0001/  EQV               CHAR*1                  DBSTAT      3B  /DB0000/                    INTEGER
  DBREALM     0B  /DB0000/                    INTEGER          3      DBS0001    14B  /DB0000/                    INTEGER
  DBRELST    10B  /DB0000/                    INTEGER          1      DBT0001    60B  /DB0000/                    INTEGER          2
  DBRUID      7B  /DB0000/                    INTEGER                 GRADE       0B  /D0001AA/                  REAL
  IDENT       0B  /DB0001/  EQV               CHAR*14                 STUDENT     1B  /DB0001/                  CHAR*11
  N         220B                              INTEGER                 TOTAL     221B                            REAL
  STATBLK   205B                              INTEGER         11


--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----      -NAME------TYPE--------ARGS------CLASS-----

  DMLCLS                   2      SUBROUTINE      DMLOPN                   4      SUBROUTINE
  DMLDBST                  2      SUBROUTINE      DMLPRV                   8      SUBROUTINE
  DMLEND                   0      SUBROUTINE      DMLRD                    6      SUBROUTINE
  DMLINV                   6      SUBROUTINE      LOCF      GENERIC        1      INTRINSIC


--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF      -LABEL-ADDRESS-----PROPERTIES----DEF

     20     40B                     73          70     61B                    83
     50     56B                     78          75    121B      FORMAT       85
     60    110B      FORMAT         79          80     66B                    88


--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  RATING      5B     0


--STATISTICS--

  PROGRAM-UNIT LENGTH           222B =  146
  SCM LABELLED COMMON LENGTH     67B =  55
  SCM STORAGE USED            60700B =  25024
  COMPILE TIME                0.039 SECONDS

Output From Program Execution

 AVERAGE IS
  3.6
```

Figure 5-5. Program RATING (Sheet 3 of 3)

Control Statements for Interactive Job

```
ATTACH(FTNRUN)
ATTACH(SSLIB)
DML(SB=SSLIB,LV=F5,I=FTNRUN)
FTN5(I=DMLOUT)
ATTACH(INTRAN)
FILE(INTRAN,RT=Z,BT=C)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
```

Source Program

```
      PROGRAM TRANPRG
C
C     THIS PROGRAM DEMONSTRATES THE USE OF TRANSACTIONS AND
C     PROGRAM RESTART.  FIRST THE PROGRAM DETERMINES IF THE
C     RUN IS AN INITIAL RUN OR A RESTART OPERATION BY
C     REQUESTING INPUT FROM A TERMINAL.
C
C     THEN THE PROGRAM READS TRANSACTIONS FROM FILE INTRAN
C     (SHOWN IN FIGURE 5-11), BEGINS TRANSACTION
C     PROCESSING, AND UPDATES TWO REALMS:  SFILE AND CFILE.
C
C     DURING RESTART PROCESSING, THE PROGRAM POSITIONS FILE
C     INTRAN BY READING AND DISGARDING RECORDS THAT WERE
C     SUCCESSFULLY PROCESSED BEFORE THE FAILURE.
C
      INTEGER STATBLK(11)
      CHARACTER RESTID *10
      CHARACTER TRANID *10
      CHARACTER INID *10
      CHARACTER INSTID *11
      CHARACTER INMJR *20
      CHARACTER OPTION *7
      SUBSCHEMA (RELATION)
      DATA TRANID/'0000000000'/
      INVOKE
      CALL DMLDBST(STATBLK,11)
      OPEN(5,FILE='INTRAN',STATUS='OLD',ACCESS='SEQUENTIAL')
      OPEN(2,FILE='RESTART')
   10 PRINT*, ' ENTER: INITIAL, RESTART, OR END'
      READ*, OPTION
      IF (OPTION .EQ. 'INITIAL') THEN
           ASSIGNID (RESTID,ERR=50)
           WRITE(2,'(A10)') RESTID
           CLOSE(2)
           GO TO 25
      ELSE IF (OPTION .EQ. 'RESTART') THEN
           READ(2,'(A10)') RESTID
           FINDTRAN (RESTID,TRANID,ERR=50)
           IF (TRANID .EQ. '**********') THEN
                PRINT*, ' RESTART UNSUCCESSFUL OR UNNECESSARY'
                GO TO 60
           ELSE
   15           READ (5,*,ERR=60,END=60) INID,INSTID,INMJR,NUM
                DO 20 II=1,NUM
   20           READ (5,*,ERR=60,END=60) IDENT,COURS,GRADE,
     1                                      CODE,DATE,UNITS
                IF (INID .EQ. TRANID) THEN
                     GO TO 25
                ELSE
                     GO TO 15
                END IF
           END IF
```

Figure 5-10. Program TRANPRG (Sheet 1 of 5)

```
      ELSE IF (OPTION .EQ. 'END') THEN
           GO TO 60
      ELSE
           GO TO 10
      END IF
C
C     BEGIN DATA BASE PROCESSING
C
  25  PRIVACY (CFILE,PRIVACY='XX99')
      OPEN (SFILE,MODE=IO,ERR=50)
      OPEN (CFILE,MODE=IO,ERR=50)
C
C     MAIN LOOP BEGINS.  THIS READS AND PROCESSES FILE INTRAN.
C
      DO 35 JJ=1,9999
      READ (5,*,ERR=45,END=55) TRANID, INSTID,INMJR,NUM
      BEGINTRAN (TRANID,ERR=45)
      STID=INSTID
      READ (SFILE,KEY=STID,ERR=45)
      INMJR=MAJOR
      REWRITE (SFILE,ERR=45)
      CSTID=STID
      DO 30, II=1,NUM
      READ (5,*,ERR=45,END=45) IDENT,COURS,GRADE,
     1                         CODE,DATE,UNITS
  30  WRITE (CFILE,ERR=45)
  35  COMMITTRAN (ERR=45)
C
C     MAIN LOOP ENDS.
C
  45  PRINT*, ' TRANSACTION ERROR, TRANID = ', TRANID
  50  PRINT 98, STATBLK(1),STATBLK(2),STATBLK(3)
      DROPTRAN
  55  PRINT*, 'DATA BASE PROCESSING COMPLETED'
      CLOSE (SFILE)
      CLOSE (CFILE)
  60  TERMINATE
      CLOSE (5,STATUS='DELETE')
  90  FORMAT (A10,A11,A20,I1)
  92  FORMAT (A14,A6,F3.1,A1,A8,I1)
  98  FORMAT (1X,'STATUS BLOCK'/1X,04,2X,I5,2X,A10)
      END
 End-of-Record
```

Compilation Listing

```
 PROGRAM TRANPRG  74/74   OPT=0

    1       PROGRAM TRANPRG
    2 C
    3 C     THIS PROGRAM DEMONSTRATES THE USE OF TRANSACTIONS AND
    4 C     PROGRAM RESTART.  FIRST THE PROGRAM DETERMINES IF THE
    5 C     RUN IS AN INITIAL RUN OR A RESTART OPERATION BY
    6 C     REQUESTING INPUT FROM A TERMINAL.
    7 C
    8 C     THEN THE PROGRAM READS TRANSACTIONS FROM FILE INTRAN
    9 C     (SHOWN IN THE PRECEDING FIGURE), BEGINS TRANSACTION
   10 C     PROCESSING, AND UPDATES TWO REALMS:  SFILE AND CFILE.
   11 C
   12 C     DURING RESTART PROCESSING, THE PROGRAM POSITIONS FILE
   13 C     INTRAN BY READING AND DISGARDING RECORDS THAT WERE
   14 C     SUCCESSFULLY PROCESSED BEFORE THE FAILURE.
   15 C
```

Figure 5-10. Program TRANPRG (Sheet 2 of 5)

```
      INTEGER STATBLK(11)
      CHARACTER RESTID *10
      CHARACTER TRANID *10
      CHARACTER INID *10
      CHARACTER INSTID *11
      CHARACTER INMJR *20
      CHARACTER OPTION *7
**    SUBSCHEMA (RELATION)
C$    LIST(ALL=0)
C$    LIST(ALL)
      DATA TRANID/'0000000000'/
**    INVOKE
C$    LIST(ALL=0)
C$    LIST(ALL)
      CALL DMLINV(0002,DBF0001,10HRELATION  ,10H          ,
     +10H          ,0"7671046433226153670 3")
      CALL DMLDBST(STATBLK,11)
      OPEN(5,FILE='INTRAN',STATUS='OLD',ACCESS='SEQUENTIAL')
      OPEN(2,FILE='RESTART')
 10   PRINT*, ' ENTER: INITIAL, RESTART, OR END'
      READ*, OPTION
      IF (OPTION .EQ. 'INITIAL') THEN
**         ASSIGNID (RESTID,ERR=50)
      CALL DMLGTID(RESTID ,*50   )
           WRITE(2,'(A10)') RESTID
           CLOSE(2)
           GO TO 25
      ELSE IF (OPTION .EQ. 'RESTART') THEN
           READ(2,'(A10)') RESTID
**         FINDTRAN (RESTID,TRANID,ERR=50)
      CALL DMLFIND(RESTID ,TRANID ,*50   )
           IF (TRANID .EQ. '**********') THEN
                PRINT*, ' RESTART UNSUCCESSFUL OR UNNECESSARY'
                GO TO 60
           ELSE
 15             READ (5,*,ERR=60,END=60) INID,INSTID,INMJR,NUM
                DO 20 II=1,NUM
 20             READ (5,*,ERR=60,END=60) IDENT,COURS,GRADE,
     X                                    CODE,DATE,UNITS
                IF (INID .EQ. TRANID) THEN
                     GO TO 25
                ELSE
                     GO TO 15
                END IF
           END IF
      ELSE IF (OPTION .EQ. 'END') THEN
           GO TO 60
      ELSE
           GO TO 10
      END IF
C
C     BEGIN DATA BASE PROCESSING
C
**    PRIVACY (CFILE,PRIVACY='XX99')
 25   CALL DMLPRV(1,1,0,0002,
     +0"60","XX99      ","          ","          ")
**    OPEN (SFILE,MODE=IO,ERR=50)
      CALL DMLOPN(DBF0001,0001,2HIO,*50   )
**    OPEN (CFILE,MODE=IO,ERR=50)
C
C     MAIN LOOP BEGINS.  THIS READS AND PROCESSES FILE INTRAN.
C
      CALL DMLOPN(DBF0002,0002,2HIO,*50   )
      DO 35 JJ=1,9999
      READ (5,*,ERR=45,END=55) TRANID, INSTID,INMJR,NUM
**    BEGINTRAN (TRANID,ERR=45)
      CALL DMLBEG(TRANID      ,*45   )
      STID=INSTID
**    READ (SFILE,KEY=STID,ERR=45)
      CALL DMLRDK(DBF0001,0001,00001,0001,1,0011,0,0000,00,
     +STID   ,*45   )
```

Figure 5-10. Program TRANPRG (Sheet 3 of 5)

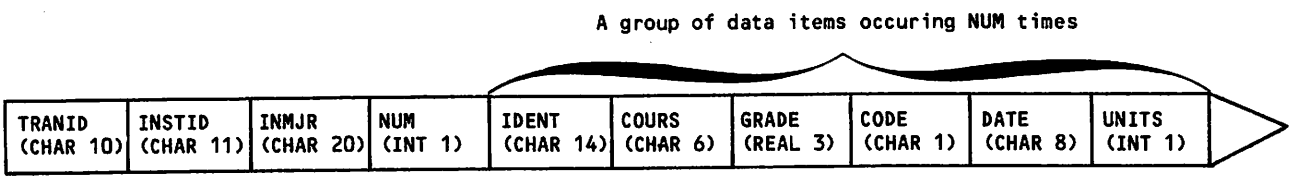
```
  183        INMJR=MAJOR
  184 **     REWRITE (SFILE,ERR=45)
  185        CALL DMLREW(DBF0001,0,0001,00001,*45   )
  186        CSTID=STID
  187        DO 30, II=1,NUM
  188        READ (5,*,ERR=45,END=45) IDENT,COURS,GRADE,
  189       X                          CODE,DATE,UNITS
  190 **     WRITE (CFILE,ERR=45)
  191    30  CALL DMLWRT(DBF0002,0,0002,00001,*45   )
  192 **     COMMITTRAN (ERR=45)
  193 C
  194 C      MAIN LOOP ENDS.
  195 C
  196    35  CALL DMLCMT(*45   )
  197    45  PRINT*, ' TRANSACTION ERROR, TRANID = ', TRANID
  198    50  PRINT 98, STATBLK(1),STATBLK(2),STATBLK(3)
  199 **     DROPTRAN
  200        CALL DMLDRP
  201    55  PRINT*, 'DATA BASE PROCESSING COMPLETED'
  202 **     CLOSE (SFILE)
  203        CALL DMLCLS(DBF0001,0001)
  204 **     CLOSE (CFILE)
  205        CALL DMLCLS(DBF0002,0002)
  206 **     TERMINATE
  207    60  CALL DMLEND
  208        CLOSE (5,STATUS='DELETE')
  209    90  FORMAT (A10,A11,A20,I1)
  210    92  FORMAT (A14,A6,F3.1,A1,A8,I1)
  211    98  FORMAT (1X,'STATUS BLOCK'/1X,04,2X,I5,2X,A10)
  212        END


--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  CODE         0B  /D0002AB/                 CHAR*1
  COURS        2B  /DB0002/                  CHAR*6
  CSTID        1B  /DB0002/                  CHAR*11
  DATE         0B  /D0002AB/                 CHAR*8
  DBA0001    706B                            INTEGER        3
  DBF0001     16B  /DB0000/                  INTEGER       35
  DBF0002     67B  /DB0000/                  INTEGER       35
  DBI0001      0B  /DB0001/  EQV             CHAR*1
  DBI0002      0B  /DB0002/  EQV             CHAR*1
  DBN0001    134B  /DB0000/                  INTEGER        3
  DBREALM      0B  /DB0000/                  INTEGER        3
  DBRELST     10B  /DB0000/                  INTEGER        2
  DBRUID       7B  /DB0000/                  INTEGER
  DBR0001     12B  /DB0000/                  INTEGER        3
  DBR0002     63B  /DB0000/                  INTEGER        3
  DBSCNAM      4B  /DB0000/                  INTEGER        3
  DBSTAT       3B  /DB0000/                  INTEGER
  DBS0001     15B  /DB0000/                  INTEGER
  DBS0002     66B  /DB0000/                  INTEGER
  DBT0001     61B  /DB0000/                  INTEGER        2
  DBT0002    132B  /DB0000/                  INTEGER        2
  GRADE        0B  /D0002AA/                 REAL
  IDENT        0B  /DB0002/  EQV             CHAR*14
  II         712B                            INTEGER
  INID       700B                            CHAR*10
  INMJR      703B                            CHAR*20
  INSTID     701B                            CHAR*11
  JJ         714B                            INTEGER
  MAJOR        1B  /DB0001/                  CHAR*20
  NUM        711B                            INTEGER
  OPTION     705B                            CHAR*7
  RESTID     676B                            CHAR*10
  STATBLK    663B                            INTEGER       11
  STID         0B  /DB0001/  EQV             CHAR*11
  TRANID     677B                            CHAR*10
  UNITS        0B  /D0002AC/                 INTEGER
```

Figure 5-10. Program TRANPRG (Sheet 4 of 5)

```
--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----

  DMLBEG                    2      SUBROUTINE
  DMLCLS                    2      SUBROUTINE
  DMLCMT                    1      SUBROUTINE
  DMLDBST                   2      SUBROUTINE
  DMLDRP                    0      SUBROUTINE
  DMLEND                    0      SUBROUTINE
  DMLFIND                   3      SUBROUTINE
  DMLGTID                   2      SUBROUTINE
  DMLINV                    6      SUBROUTINE
  DMLOPN                    4      SUBROUTINE
  DMLPRV                    8      SUBROUTINE
  DMLRDK                   11      SUBROUTINE
  DMLREW                    5      SUBROUTINE
  DMLWRT                    5      SUBROUTINE
  LOCF      GENERIC         1      INTRINSIC


--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF

     10     46B                    131
     15    112B                    147
     20  INACTIVE   DO-TERM        149
     25    146B                    166
     30  INACTIVE   DO-TERM        191
     35  INACTIVE   DO-TERM        196
     45    255B                    197
     50    257B                    198
     55    263B                    201
     60    271B                    207
     90    345B     FORMAT         209
     92    350B     FORMAT         210
     98    354B     FORMAT         211


--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  TRANPRG     5B     0


--I/O UNITS--(LO=A)
 -NAME--- PROPERTIES------------

  TAPE2   AUX/FMT/SEQ
  TAPE5   AUX/FMT/SEQ


--STATISTICS--

  PROGRAM-UNIT LENGTH            717B =  463
  CM LABELLED COMMON LENGTH      152B =  106
  CM STORAGE USED              63600B =  26496
  COMPILE TIME                 0.185 SECONDS


Output and Interactive Response From Program Execution


  ENTER: INITIAL, RESTART, OR END
? 'initial'
 DATA BASE PROCESSING COMPLETED
```

Figure 5-10. Program TRANPRG (Sheet 5 of 5)

File Description With Corresponding Read Statements




```
READ (5,*,ERR=45,END=55)                READ (5,*,ERR=45,END=45)
 TRANID,INSTID,INMJR,NUM                 IDENT,COURS,GRADE,CODE,DATE,UNITS
```

Data

```
'A000000001' '100-22-5860' 'PSYCHOLOGY' 3
'100-22-5860-05' 'PSY136' 4.0 'C' '9/30/80' 3
'100-22-5860-06' 'BUS001' 3.0 'C' '9/30/80' 3
'100-22-5860-07' 'PSY003' 3.5 'C' '9/30/80' 3
'A000000002' '122-13-6704' 'BUSINESS' 2
'122-13-6704-03' 'BUS017' 4.0 'C' '9/30/80' 3
'122-13-6705-04' 'PSY003' 3.0 'C' '9/30/80' 3
'A000000003' '687-14-2100' 'BIOLOG' 2
'687-14-2100-05' 'PSY002' 4.0 'C' '9/30/80' 3
'687-14-2100-06' 'BUS017' 3.5 'C' '9/30/80' 3
```

Figure 5-11. Input File INTRAN and File Description for Program TRANPRG

Control Statements

```
Job statement
USER statement
CHARGE statement
ATTACH(SSLIB)
DML(SB=SSLIB,LV=F5)
FTN5(I=DMLOUT)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
```

Source Program

```
      PROGRAM INDAVGE
C
C  THIS PROGRAM READS ALL STUDENT GRADES AND CALCULATES
C  INDIVIDUAL AVERAGES.  THE FIRST READ SAVES THE FIRST
C  STUDENT ID.  WHEN THE STUDENT ID CHANGES, THE PROGRAM
C  CALCULATES AND PRINTS THE AVERAGE, THEN CONTINUES TO
C  READ THE FILE UNTIL EOF IS SENSED.  TESTING THE THIRD
C  WORD OF STATBLK CHECKS FOR EOF.
C
      INTEGER STATBLK(11)
      CHARACTER FINAL*3
      CHARACTER OLDID*11
      SUBSCHEMA(AVERAGE)
      FINAL='NO'
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,PRIVACY='XX99')
      OPEN(CFILE,ERR=50)
      READ(CFILE,ERR=50)
      IF(STATBLK(3) .EQ. O"100") GO TO 40
10    N=0
      TOTAL=0.0
      OLDID=STUDENT
20    IF(GRADE .GE. 1.0) THEN
         N=N+1
         TOTAL=TOTAL+GRADE
      ENDIF
      READ(CFILE,ERR=50)
      IF(STATBLK(3) .EQ. O"100") THEN
         FINAL='YES'
      ELSE
         IF(STUDENT .EQ. OLDID) GO TO 20
      ENDIF
      IF(N .EQ. 0) GO TO 30
      TOTAL=TOTAL / N
      PRINT 25, OLDID,TOTAL
25    FORMAT ("0",9X,A11,3X,F4.1)
30    IF(FINAL .EQ. 'NO') GO TO 10
      GO TO 100
40    PRINT *, 'EMPTY INPUT FILE'
50    PRINT 60,STATBLK
60    FORMAT (1X,'STATUS BLOCK' /
     1        1X,04,2X,I5,2X,03,2X,I2,2X,
     1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
100   CLOSE(CFILE)
      TERMINATE
      END
End-of-record
```

Figure 5-6. Program INDAVGE (Sheet 1 of 4)

Compilation Listing

```
      PROGRAM INDAVGE    76/176  OPT=0                          FTN 5.1+538


  1                PROGRAM INDAVGE
  2           C
  3           C  THIS PROGRAM READS ALL STUDENT GRADES AND CALCULATES
  4           C  INDIVIDUAL AVERAGES.  THE FIRST READ SAVES THE FIRST
  5           C  STUDENT ID.  WHEN THE STUDENT ID CHANGES, THE PROGRAM
  6           C  CALCULATES AND PRINTS THE AVERAGE, THEN CONTINUES TO
  7           C  READ THE FILE UNTIL EOF IS SENSED.  TESTING THE THIRD
  8           C  WORD OF STATBLK CHECKS FOR EOF.
  9           C
 10                INTEGER STATBLK(11)
 11                CHARACTER FINAL*3
 12                CHARACTER OLDID*11
 13           **   SUBSCHEMA(AVERAGE)
 14           C$   LIST(ALL=0)
 57           C$   LIST(ALL)
 58                FINAL='NO'
 59           **   INVOKE
 60           C$   LIST(ALL=0)
 64           C$   LIST(ALL)
 65                CALL DMLINV(0001,DBF0001,10HAVERAGE   ,10H
 66               +10H          ,0"3551431037614306102l")
 67                CALL DMLDBST(STATBLK,11)
 68           **   PRIVACY(CFILE,PRIVACY='XX99')
 69                CALL DMLPRV(1,1,0,0001,
 70               +0"60","XX99      "," "          "," "          ")
 71           **   OPEN(CFILE,ERR=50)
 72                CALL DMLOPN(DBF0001,0001,2HIO,*50   )
 73           **   READ(CFILE,ERR=50)
 74                CALL DMLRD(DBF0001,0001,1,0,*50   )
 75                IF(STATBLK(3) .EQ. 0"100") GO TO 40
 76           10   N=0
 77                TOTAL=0.0
 78                OLDID=STUDENT
 79           20   IF(GRADE .GE. 1.0) THEN
 80                   N=N+1
 81                   TOTAL=TOTAL+GRADE
 82                ENDIF
 83           **   READ(CFILE,ERR=50)
 84                CALL DMLRD(DBF0001,0001,1,0,*50   )
 85                IF(STATBLK(3) .EQ. 0"100") THEN
 86                   FINAL='YES'
 87                ELSE
 88                   IF(STUDENT .EQ. OLDID) GO TO 20
 89                ENDIF
 90                IF(N .EQ. 0) GO TO 30
 91                TOTAL=TOTAL / N
```

Figure 5-6. Program INDAVGE (Sheet 2 of 4)

```
 92                PRINT 25, OLDID,TOTAL
 93          25    FORMAT ("0",9X,A11,3X,F4.1)
 94          30    IF(FINAL .EQ. 'NO') GO TO 10
 95                GO TO 100
 96          40    PRINT *, 'EMPTY INPUT FILE'
 97          50    PRINT 60,STATBLK
 98          60    FORMAT (1X,'STATUS BLOCK' /
 99               1        1X,04,2X,I5,2X,03,2X,I2,2X,
100               1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
101          **    CLOSE(CFILE)
102          100   CALL DMLCLS(DBF0001,0001)
103          **    TERMINATE
104                CALL DMLEND
105                END
```

```
--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE     -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  COURSE      2B  /DB0001/                    CHAR*6                  DBT0001    60B  /DB0000/                    INTEGER          2
  DBF0001    15B  /DB0000/                    INTEGER         35      FINAL     314B                             CHAR*3
  DBI0001     0B  /DB0001/  EQV               CHAR*1                  GRADE       0B  /D0001AA/                  REAL
  DBREALM     0B  /DB0000/                    INTEGER          3      IDENT       0B  /DB0001/  EQV               CHAR*14
  DBRELST    10B  /DB0000/                    INTEGER          1      N         317B                             INTEGER
  DBRUID      7B  /DB0000/                    INTEGER                 OLDID     315B                             CHAR*11
  DBR0001    11B  /DB0000/                    INTEGER          3      STATBLK   301B                             INTEGER         11
  DBSCNAM     4B  /DB0000/                    INTEGER          3      STUDENT     1B  /DB0001/                  CHAR*11
  DBSTAT      3B  /DB0000/                    INTEGER                 TOTAL     320B                             REAL
  DBS0001    14B  /DB0000/                    INTEGER


--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----      -NAME------TYPE--------ARGS------CLASS-----

  DMLCLS                  2      SUBROUTINE       DMLOPN                  4      SUBROUTINE
  DMLDBST                 2      SUBROUTINE       DMLPRV                  8      SUBROUTINE
  DMLEND                  0      SUBROUTINE       DMLRD                   5      SUBROUTINE
  DMLINV                  6      SUBROUTINE       LOCF      GENERIC       1      INTRINSIC


--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF       -LABEL-ADDRESS-----PROPERTIES----DEF

    10     50B                      76          40    120B                     96
    20     55B                      79          50    122B                     97
    25    154B      FORMAT         93          60    157B      FORMAT         98
    30    114B                     94         100    124B                    102
```

Figure 5-6. Program INDAVGE (Sheet 3 of 4)

```
--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  INDAVGE     5B     0


--STATISTICS--

  PROGRAM-UNIT LENGTH            3218 =  209
  SCM LABELLED COMMON LENGTH      678 =  55
  SCM STORAGE USED             607008 =  25024
  COMPILE TIME                 0.052 SECONDS
```

Output From Program Execution

100-22-5860	3.5
120-44-3760	3.1
122-13-6704	4.0
124-33-5780	3.8
197-11-2140	3.6
437-56-8943	3.3
120-44-3760	3.5
553-89-2021	3.8
678-12-1144	4.0
687-14-2100	3.9

Figure 5-6. Program INDAVGE (Sheet 4 of 4)

Control Statements

```
Job statement
USER statement
CHARGE statement
ATTACH(SSLIB)
DML(SB=SSLIB,LV=F5)
FTN5(I=DMLOUT)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
```

Source Program

```
      PROGRAM RELATE
C
C  THIS PROGRAM READS BY RELATION AND PRINTS GRADES FOR
C  STUDENT ID 120-44-3760.  THE FIRST READ IS RANDOM
C  FOLLOWED BY A TEST FOR NULL RECORD.  THE SECOND READ IS
C  SEQUENTIAL FOLLOWED BY A TEST FOR CONTROL BREAK.
C
      INTEGER STATBLK(11)
      CHARACTER SAVEKEY*11
      SUBSCHEMA(RELATION)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,PRIVACY='XX99')
      OPEN(REL1,ERR=50)
      STID='120-44-3760'
10    READ(REL1,KEY=STID,ERR=50)
      SAVEKEY=STID
      IF(SAVEKEY.EQ.']]]]]]]]]]') GO TO 70
15    PRINT 20, CSTID,GRADE
20    FORMAT (1HO,9X,A11,3X,F4.1)
25    READ(REL1,ERR=50,END=70)
      IF(STATBLK(7).NE.0) GO TO 70
      GO TO 15
50    PRINT 60,STATBLK
60    FORMAT (1X,'STATUS BLOCK' /
     1        1X,04,2X,I5,2X,03,2X,I2,2X,
     1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
70    CLOSE(REL1)
      TERMINATE
      END
End-of-record
```

Figure 5-7. Program RELATE (Sheet 1 of 4)

Compilation Listing

```
PROGRAM RELATE     76/176  OPT=0                          FTN 5.1+538

  1                    PROGRAM RELATE
  2              C
  3              C  THIS PROGRAM READS BY RELATION AND PRINTS GRADES FOR
  4              C  STUDENT ID 120-44-3760.  THE FIRST READ IS RANDOM
  5              C  FOLLOWED BY A TEST FOR NULL RECORD.  THE SECOND READ IS
  6              C  SEQUENTIAL FOLLOWED BY A TEST FOR CONTROL BREAK.
  7              C
  8                    INTEGER STATBLK(11)
  9                    CHARACTER SAVEKEY*11
 10              **   SUBSCHEMA(RELATION)
 11              C$   LIST(ALL=0)
 99              C$   LIST(ALL)
100              **   INVOKE
101              C$   LIST(ALL=0)
109              C$   LIST(ALL)
110                   CALL DMLINV(0002,DBF0001,10HRELATION  ,10H          ,
111                  +10H          ,0"767104643322615367O3")
112                   CALL DMLDBST(STATBLK,11)
113              **   PRIVACY(CFILE,PRIVACY='XX99')
114                   CALL DMLPRV(1,1,0,0002,
115                  +0"60","XX99      ","          ","          ")
116              **   OPEN(REL1,ERR=50)
117                   CALL DMLOPNR(DBN0001,DBA0001,2HIO,*50   )
118                   STID='120-44-3760'
119              **   READ(REL1,KEY=STID,ERR=50)
120              10   CALL DMLRLK(DBN0001,0001,00001,0001,1,0011,0,0000,00,STID   ,
121                  + 0001,*50   )
122                   SAVEKEY=STID
123                   IF(SAVEKEY.EQ.']]]]]]]]]]') GO TO 70
124              15   PRINT 20, CSTID,GRADE
125              20   FORMAT (1HO,9X,A11,3X,F4.1)
126              **   READ(REL1,ERR=50,END=70)
127              25   CALL DMLRL(DBN0001,0001,1,1,*50   ,*70   )
128                   IF(STATBLK(7).NE.0) GO TO 70
129                   GO TO 15
130              50   PRINT 60,STATBLK
131              60   FORMAT (1X,'STATUS BLOCK' /
132                  1        1X,O4,2X,I5,2X,O3,2X,I2,2X,
133                  1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
134              **   CLOSE(REL1)
135              70   CALL DMLCLSR(DBN0001,DBA0001)
136              **   TERMINATE
137                   CALL DMLEND
138                   END
```

Figure 5-7. Program RELATE (Sheet 2 of 4)

```
--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE     -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  CODE        0B  /D0002AB/                  CHAR*1                  DBI0002     0B  /DB0002/  EQV          CHAR*1
  COURS       2B  /DB0002/                   CHAR*6                  DBN0001   134B  /DB0000/               INTEGER         3
  CSTID       1B  /DB0002/                   CHAR*11                 DBREALM     0B  /DB0000/               INTEGER         3
  DATE        0B  /D0002AB/                  CHAR*8                  DBRELST    10B  /DB0000/               INTEGER         2
  DBA0001   276B                             INTEGER         3       DBRUID      7B  /DB0000/               INTEGER
  DBF0001    16B  /DB0000/                   INTEGER        35       DBR0001    12B  /DB0000/               INTEGER         3
  DBF0002    67B  /DB0000/                   INTEGER        35       DBR0002    63B  /DB0000/               INTEGER         3
  DBI0001     0B  /DB0001/  EQV              CHAR*1                  DBSCNAM     4B  /DB0000/               INTEGER         3
  DBSTAT      3B  /DB0000/                   INTEGER                 IDENT       0B  /DB0002/  EQV          CHAR*14
  DBS0001    15B  /DB0000/                   INTEGER                 MAJOR       1B  /DB0001/               CHAR*20
  DBS0002    66B  /DB0000/                   INTEGER                 SAVEKEY   274B                         CHAR*11
  DBT0001    61B  /DB0000/                   INTEGER         2       STATBLK   261B                         INTEGER        11
  DBT0002   132B  /DB0000/                   INTEGER         2       STID        0B  /DB0001/  EQV          CHAR*11
  GRADE       0B  /D0002AA/                  REAL                    UNITS       0B  /D0002AC/               INTEGER


--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----      -NAME------TYPE--------ARGS------CLASS-----

  DMLCLSR                  2      SUBROUTINE      DMLPRV                   8      SUBROUTINE
  DMLDBST                  2      SUBROUTINE      DMLRL                    6      SUBROUTINE
  DMLEND                   0      SUBROUTINE      DMLRLK                  12      SUBROUTINE
  DMLINV                   6      SUBROUTINE      LOCF       GENERIC       1      INTRINSIC
  DMLOPNR                  4      SUBROUTINE


--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF      -LABEL-ADDRESS-----PROPERTIES----DEF

     10 *NO REFS*                  120          50    103B                    130
     15      67B                   124          60    137B      FORMAT        131
     20     134B      FORMAT       125          70    105B                    135
     25 *NO REFS*                  127


--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  RELATE       5B      0


--STATISTICS--

  PROGRAM-UNIT LENGTH            301B =  193
  SCM LABELLED COMMON LENGTH     152B =  106
  SCM STORAGE USED             60700B =  25024
  COMPILE TIME                 0.057 SECONDS
```

Figure 5-7. Program RELATE (Sheet 3 of 4)

```
Output From Program Execution

120-44-3760    2.0
120-44-3760    3.0
120-44-3760    4.0
120-44-3760    3.5
120-44-3760    3.5
```

Figure 5-7. Program RELATE (Sheet 4 of 4)

Control Statements

```
Job statement
USER statement
CHARGE statement
ATTACH(SSLIB)
DML(SB=SSLIB,LV=F5)
FTN5(I=DMLOUT)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
```

Source Program

```
      PROGRAM CHARGES
C
C  THIS PROGRAM DEMONSTRATES SUBSCRIPTING AND THE DML
C  REWRITE CAPABILITY.  RELATION REL2 ASSOCIATES FILES
C  STUDENT AND ACCOUNT.  FILE ACCOUNT IS DEFINED IN THE
C  SCHEMA AS HAVING REPEATING ITEMS.  THIS PROGRAM PERFORMS A
C  RANDOM READ TO SELECT STUDENT ID 197-11-2140 AND
C  WRITE REAL VALUES INTO THREE FIELDS.  A TOTAL IS CALCULATED
C  AND PRINTED OUT ALONG WITH THE NAME OF THE STUDENT.
C
      INTEGER STATBLK(11)
      SUBSCHEMA(BURSAR)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      TOTAL=0
      OPEN(REL2,ERR=70)
      STID='197-11-2140'
      READ(REL2,KEY=STID,ERR=70)
      TUITION(1)=1400
      LAB(1)=75
      BOOKS(1)=146
      REWRITE(ACCOUNT,ERR=70)
      TOTAL=TUITION(1) + LAB(1) + BOOKS(1)
50    PRINT 60,NAME,TOTAL
60    FORMAT("0",9X,A30,3X,F8.2)
      GO TO 90
70    PRINT 80,STATBLK
80    FORMAT (1X,'STATUS BLOCK' /
     1        1X,04,2X,I5,2X,03,2X,I2,2X,
     1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
90    CLOSE(REL2)
      TERMINATE
      END
End-of-record
```

Figure 5-8. Program CHARGES (Sheet 1 of 3)

Compilation Listing

```
PROGRAM CHARGES    76/176  OPT=0                          FTN 5.1+538

  1                PROGRAM CHARGES
  2          C
  3          C  THIS PROGRAM DEMONSTRATES SUBSCRIPTING AND THE DML
  4          C  REWRITE CAPABILITY.  RELATION REL2 ASSOCIATES FILES
  5          C  STUDENT AND ACCOUNT.  FILE ACCOUNT IS DEFINED IN THE
  6          C  SCHEMA AS HAVING REPEATING ITEMS.  THIS PROGRAM PERFORMS A
  7          C  RANDOM READ TO SELECT STUDENT ID 197-11-2140 AND
  8          C  WRITE REAL VALUES INTO THREE FIELDS.  A TOTAL IS CALCULATED
  9          C  AND PRINTED OUT ALONG WITH THE NAME OF THE STUDENT.
 10          C
 11                INTEGER STATBLK(11)
 12          **    SUBSCHEMA(BURSAR)
 13          C$    LIST(ALL=0)
106          C$    LIST(ALL)
107          **    INVOKE
108          C$    LIST(ALL=0)
116          C$    LIST(ALL)
117                CALL DMLINV(0002,DBF0001,10HBURSAR    ,10H          ,
118               +10H          ,0"1664375314100771604 6")
119                CALL DMLDBST(STATBLK,11)
120                TOTAL=0
121          **    OPEN(REL2,ERR=70)
122                CALL DMLOPNR(DBN0001,DBA0001,2HIO,*70   )
123                STID='197-11-2140'
124          **    READ(REL2,KEY=STID,ERR=70)
125                CALL DMLRLK(DBN0001,0001,00001,0001,1,0011,0,0000,00,STID   ,
126               + 0001,*70   )
127                TUITION(1)=1400
128                LAB(1)=75
129                BOOKS(1)=146
130          **    REWRITE(ACCOUNT,ERR=70)
131                CALL DMLREW(DBF0002,0,0002,00001,*70   )
132                TOTAL=TUITION(1) + LAB(1) + BOOKS(1)
133          50    PRINT 60,NAME,TOTAL
134          60    FORMAT("0",9X,A30,3X,F8.2)
135                GO TO 90
136          70    PRINT 80,STATBLK
137          80    FORMAT (1X,'STATUS BLOCK' /
138               1        1X,04,2X,I5,2X,03,2X,I2,2X,
139               1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
140          **    CLOSE(REL2)
141          90    CALL DMLCLSR(DBN0001,DBA0001)
142          **    TERMINATE
143                CALL DMLEND
144                END
```

Figure 5-8. Program CHARGES (Sheet 2 of 3)

```
--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE     -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  ADDR        4B  /DB0001/                  CHAR*20                  DBI0001     0B  /DB0001/  EQV             CHAR*1
  ASTID       0B  /DB0002/  EQV             CHAR*11                  DBI0002     0B  /DB0002/  EQV             CHAR*1
  BOOKS      40B  /D0002AA/                 REAL           16        DBN0001   134B  /DB0000/                 INTEGER          3
  CITY        6B  /DB0001/                  CHAR*10                  DBREALM     0B  /DB0000/                 INTEGER          3
  DBA0001   255B                            INTEGER         3        DBRELST    10B  /DB0000/                 INTEGER          2
  DBF0001    16B  /DB0000/                  INTEGER        35        DBRUID      7B  /DB0000/                 INTEGER
  DBF0002    67B  /DB0000/                  INTEGER        35        DBR0001    12B  /DB0000/                 INTEGER          3
  DBR0002    63B  /DB0000/                  INTEGER         3        MISC       60B  /D0002AA/                REAL            16
  DBSCNAM     4B  /DB0000/                  INTEGER         3        NAME        1B  /DB0001/                 CHAR*30
  DBSTAT      3B  /DB0000/                  INTEGER                  STATBLK   242B                           INTEGER         11
  DBS0001    15B  /DB0000/                  INTEGER                  STATE       7B  /DB0001/                 CHAR*2
  DBS0002    66B  /DB0000/                  INTEGER                  STID        0B  /DB0001/  EQV             CHAR*11
  DBT0001    61B  /DB0000/                  INTEGER         2        TOTAL     260B                           REAL
  DBT0002   132B  /DB0000/                  INTEGER         2        TUITION     0B  /D0002AA/                REAL            16
  LAB        20B  /D0002AA/                 REAL           16        ZIP         7B  /DB0001/                 CHAR*5

--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----      -NAME------TYPE--------ARGS------CLASS-----

  DMLCLSR                  2      SUBROUTINE      DMLOPNR                  4      SUBROUTINE
  DMLDBST                  2      SUBROUTINE      DMLREW                   5      SUBROUTINE
  DMLEND                   0      SUBROUTINE      DMLRLK                  12      SUBROUTINE
  DMLINV                   6      SUBROUTINE      LOCF      GENERIC        1      INTRINSIC

--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF

     50 *NO REFS*                  133
     60    135B      FORMAT       134
     70    105B                   136
     80    140B      FORMAT       137
     90    107B                   141

--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  CHARGES     5B     0


--STATISTICS--

  PROGRAM-UNIT LENGTH           261B =  177
  SCM LABELLED COMMON LENGTH    251B =  169
  SCM STORAGE USED            60700B =  25024
  COMPILE TIME                0.056 SECONDS


Output From Program Execution

      CAREN NIELSON                1621.00
```

Figure 5-8. Program CHARGES (Sheet 3 of 3)

Control Statements

```
Job statement
USER statement
CHARGE statement
ATTACH(SSLIB)
DML(SB=SSLIB,LV=F5)
FTN5(I=DMLOUT)
LDSET(LIB=DMSLIB)
LGO.
End-of-record
```

Source Program

```
      PROGRAM ADMIT
C
C  THIS PROGRAM DEMONSTRATES THE USE OF SUBROUTINES.
C  WHEN AN INCOMPLETE(I) CODE IS FOUND IN FILE CFILE,
C  SUBROUTINE PRNTSUB IS CALLED TO PRINT THE STUDENT ID
C  AND COURSE ID.  NOTICE THAT THE SUBROUTINE REQUIRES
C  A SUBSCHEMA AND INVOKE STATEMENT.  THESE STATEMENTS
C  ARE REQUIRED IN EVERY PROGRAM UNIT TO ENSURE THE SAME
C  DATA IS BEING REFERENCED IN COMMON.
C
      INTEGER STATBLK(11)
      SUBSCHEMA(ADMISSIONS)
      INVOKE
      CALL DMLDBST(STATBLK,11)
      PRIVACY(CFILE,PRIVACY='XX99')
      OPEN(CFILE,ERR=70)
10    READ(CFILE,ERR=70,END=100)
      IF(CODE .EQ. 'I') CALL PRNTSUB
      GO TO 10
70    PRINT 80,STATBLK
80    FORMAT (1X,'STATUS BLOCK' /
     1        1X,04,2X,I5,2X,03,2X,I2,2X,
     1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
100   CLOSE(CFILE)
      TERMINATE
      END
C
      SUBROUTINE PRNTSUB
      SUBSCHEMA(ADMISSIONS)
      INVOKE
      PRINT 50,STUDENT,CCID
50    FORMAT("0",9X,A11,3X,A6)
      RETURN
      END
End-of-record
```

Figure 5-9. Program ADMIT (Sheet 1 of 5)

Compilation Listing

```
      PROGRAM ADMIT      76/176  OPT=0                    FTN 5.1+538

 1                PROGRAM ADMIT
 2           C
 3           C  THIS PROGRAM DEMONSTRATES THE USE OF SUBROUTINES.
 4           C  WHEN AN INCOMPLETE(I) CODE IS FOUND IN FILE CFILE,
 5           C  SUBROUTINE PRNTSUB IS CALLED TO PRINT THE STUDENT ID
 6           C  AND COURSE ID.  NOTICE THAT THE SUBROUTINE REQUIRES
 7           C  A SUBSCHEMA AND INVOKE STATEMENT.  THESE STATEMENTS
 8           C  ARE REQUIRED IN EVERY PROGRAM UNIT TO ENSURE THE SAME
 9           C  DATA IS BEING REFERENCED IN COMMON.
10           C
11                INTEGER STATBLK(11)
12           **   SUBSCHEMA(ADMISSIONS)
13           C$   LIST(ALL=0)
88           C$   LIST(ALL)
89           **   INVOKE
90           C$   LIST(ALL=0)
96           C$   LIST(ALL)
97                CALL DMLINV(0002,DBF0001,10HADMISSIONS,10H
98               +10H          ,0"5606531337754230761O")
99                CALL DMLDBST(STATBLK,11)
100          **   PRIVACY(CFILE,PRIVACY='XX99')
101               CALL DMLPRV(1,1,0,0002,
102              +0"60","XX99      "," "          "," "          ")
103          **   OPEN(CFILE,ERR=70)
104               CALL DMLOPN(DBF0002,0002,2HIO,*70   )
105          **   READ(CFILE,ERR=70,END=100)
106          10   CALL DMLRD(DBF0002,0002,1,1,*70   ,*100  )
107               IF(CODE .EQ. 'I') CALL PRNTSUB
108               GO TO 10
109          70   PRINT 80,STATBLK
110          80   FORMAT (1X,'STATUS BLOCK' /
111              1        1X,04,2X,I5,2X,03,2X,I2,2X,
112              1        A10,2X,I5,2X,I5,2X,I5,2X,A30)
113          **   CLOSE(CFILE)
114          100  CALL DMLCLS(DBF0002,0002)
115          **   TERMINATE
116               CALL DMLEND
117               END
```

Figure 5-9. Program ADMIT (Sheet 2 of 5)

```
--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE     -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  CCID        2B  /DB0002/                   CHAR*6                  DBSTAT      3B  /DB0000/                   INTEGER
  CID         0B  /DB0001/  EQV              CHAR*6                  DBS0001    14B  /DB0000/                   INTEGER
  CODE        3B  /DB0002/                   CHAR*1                  DBS0002    65B  /DB0000/                   INTEGER
  DBF0001    15B  /DB0000/                   INTEGER         35      DBT0001    60B  /DB0000/                   INTEGER          2
  DBF0002    66B  /DB0000/                   INTEGER         35      DBT0002   131B  /DB0000/                   INTEGER          2
  DBI0001     0B  /DB0001/  EQV              CHAR*1                  IDENT       0B  /DB0002/  EQV              CHAR*14
  DBI0002     0B  /DB0002/  EQV              CHAR*1                  NAME        0B  /DB0001/                   CHAR*20
  DBREALM     0B  /DB0000/                   INTEGER          3      PREREQ      4B  /DB0001/                   CHAR*6
  DBRELST    10B  /DB0000/                   INTEGER          1      SCHOOL      2B  /DB0001/                   CHAR*20
  DBRUID      7B  /DB0000/                   INTEGER                 STATBLK   177B                           INTEGER         11
  DBR0001    11B  /DB0000/                   INTEGER          3      STUDENT     1B  /DB0002/                   CHAR*11
  DBR0002    62B  /DB0000/                   INTEGER          3      UNITS       0B  /D0001AA/                 INTEGER
  DBSCNAM     4B  /DB0000/                   INTEGER          3


--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----      -NAME------TYPE--------ARGS------CLASS-----

  DMLCLS                   2      SUBROUTINE      DMLPRV                   8      SUBROUTINE
  DMLDBST                  2      SUBROUTINE      DMLRD                    6      SUBROUTINE
  DMLEND                   0      SUBROUTINE      LOCF       GENERIC       1      INTRINSIC
  DMLINV                   6      SUBROUTINE      PRNTSUB                  0      SUBROUTINE
  DMLOPN                   4      SUBROUTINE


--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF

     10     44B                      106
     70     60B                      109
     80    106B      FORMAT          110
    100     62B                      114


--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  ADMIT       5B     0


--STATISTICS--

  PROGRAM-UNIT LENGTH            212B =  138
  SCM LABELLED COMMON LENGTH     146B =  102
  SCM STORAGE USED             60700B =  25024
  COMPILE TIME                 0.046 SECONDS
```

Figure 5-9. Program ADMIT (Sheet 3 of 5)

```
      SUBROUTINE PRNTSUB    76/176  OPT=0                    FTN 5.1+538


       1          C
       2                SUBROUTINE PRNTSUB
       3          **    SUBSCHEMA(ADMISSIONS)
       4          C$    LIST(ALL=0)
      79          C$    LIST(ALL)
      80          **    INVOKE
      81          C$    LIST(ALL=0)
      87          C$    LIST(ALL)
      88                CALL DMLINV(0002,DBF0001,10HADMISSIONS,10H          ,
      89               +10H          ,0"5606531337754230761O")
      90                PRINT 50,STUDENT,CCID
      91          50    FORMAT("0",9X,A11,3X,A6)
      92                RETURN
      93                END


--VARIABLE MAP--(LO=A)
 -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE     -NAME---ADDRESS--BLOCK-----PROPERTIES-------TYPE---------SIZE

  CCID        2B  /DB0002/                   CHAR*6                  DBSCNAM     4B  /DB0000/                   INTEGER          3
  CID         0B  /DB0001/  EQV              CHAR*6                  DBSTAT      3B  /DB0000/                   INTEGER
  CODE        3B  /DB0002/                   CHAR*1                  DBS0001    14B  /DB0000/                   INTEGER
  DBF0001    15B  /DB0000/                   INTEGER         35      DBS0002    65B  /DB0000/                   INTEGER
  DBF0002    66B  /DB0000/                   INTEGER         35      DBT0001    60B  /DB0000/                   INTEGER          2
  DBI0001     0B  /DB0001/  EQV              CHAR*1                  DBT0002   131B  /DB0000/                   INTEGER          2
  DBI0002     0B  /DB0002/  EQV              CHAR*1                  IDENT       0B  /DB0002/  EQV              CHAR*14
  DBREALM     0B  /DB0000/                   INTEGER          3      NAME        0B  /DB0001/                   CHAR*20
  DBRELST    10B  /DB0000/                   INTEGER          1      PREREQ      4B  /DB0001/                   CHAR*6
  DBRUID      7B  /DB0000/                   INTEGER                 SCHOOL      2B  /DB0001/                   CHAR*20
  DBR0001    11B  /DB0000/                   INTEGER          3      STUDENT     1B  /DB0002/                   CHAR*11
  DBR0002    62B  /DB0000/                   INTEGER          3      UNITS       0B  /D0001AA/                  INTEGER


--PROCEDURES--(LO=A)
 -NAME------TYPE--------ARGS------CLASS-----

  DMLINV                    6      SUBROUTINE
  LOCF       GENERIC        1      INTRINSIC


--STATEMENT LABELS--(LO=A)
 -LABEL-ADDRESS-----PROPERTIES----DEF

     50      44B      FORMAT          91
```

Figure 5-9. Program ADMIT (Sheet 4 of 5)

```
--ENTRY POINTS--(LO=A)
 -NAME---ADDRESS--ARGS---

  PRNTSUB     4B      0


--STATISTICS--

  PROGRAM-UNIT LENGTH              67B =  55
  SCM LABELLED COMMON LENGTH      146B =  102
  SCM STORAGE USED              60700B =  25024
  COMPILE TIME                  0.033 SECONDS
```

Output From Program Execution

```
100-22-5860   PSY002
122-13-6704   PSY136
387-14-1232   MATH10
387-14-1232   CHM005
387-14-1232   PSY136
387-14-1232   BUS017
678-12-1144   HIS103
```

Figure 5-9. Program ADMIT (Sheet 5 of 5)

This user's guide assumes that CDCS is active and available for your job. This method of operation implies established schemas, appropriate sub-schema libraries, and successfully implemented applications. Any change in the data base environment, such as the addition of a new file definition, forces the data administrator to terminate CDCS and to reinitiate CDCS with a new master directory file attached. By using the CDCS Batch Test Facility, you can have CDCS running as a normal batch job. Each time you run your job, you attach a new version of the master directory file.

The CDCS Batch Test Facility is an absolute program called CDCSBTF. The program resides on the system library and is called into execution by the CDCSBTF control statement. The format and parameters of the CDCSBTF control statement are shown in figure 6-1. The CDCSBTF control statement cannot exceed 80 characters in length. A slash (/) indicates the end of the list of user program file names and the beginning of the parameter list.

When CDCS is executing as the Batch Test Facility, the name of the output file produced by CDCS is CDCSOUT.

DIRECTIVE FILE

An optional directive file can be used to contain the parameters in addition to or instead of the parameters in the CDCSBTF control statement. Using a directive file allows specification of a parameter list that is longer than that allowed in the control statement. With the exception of the MFL parameter, which cannot be specified in either the control statement or the directive file. The same parameter cannot, however, be specified in both the control statement and the directive file. Parameters can be specified in any order in the directive file. Any of the parameters, except MFL or DIR, that are valid in the CDCSBTF control statement are also valid in the directive file. Parameters can be specified in the directive file in columns 1 through 80. The first parameter specified in a line must begin in column 1. Parameters can either be placed in separate lines or combined in a line with commas acting as separators. Parameters cannot be split across lines.

PARAMETERS

All the parameters (figure 6-1) of the CDCSBTF control statement are optional and can be specified in any order. The CDCSBTF parameters provide information for the following functions:

- Allocation of maximum pooled buffer space
- Adjustment of accounting charges
- Allocation of the maximum field length that CDCSBTF is allowed to use
- Specification of information required to attach the master directory; these parameters must be given if online dumping of journal log files is desired
- Specification of a directive file that can contain any of the CDCSBTF control statement parameters except MFL and DIR

```
CDCSBTF(lfn-1 [,lfn-2] ...[/p][,p] ...)

lfn    Specifies the logical file name of a
       relocatable binary file containing a user
       program.  Up to 16 files can be specified.

/      The end of the user program list and the
       beginning of the parameter list

p      A parameter; the parameters are as follows:

          DIR=lfn              Directive file for
                               CDCSBTF control
                               statement parameters

          BL=nn                Maximum pooled buffer
                               space

          CP=t1                Central processor time

          IO=t2                Input/output time

          MFL=fl               Maximum field length
                               for CDCSBTF

          CRM=fs1[/fs2]...     Load CRM capsules
                               where fs is a file
                               structure as follows:

                                  AK
                                  DA
                                  IS
                                  MIP or MP

          MDPFN=pfn
          UN=user-name
          ID=user-name
          PW=pwrd1[/pwrd2]...  } Permanent file
          FAM=family-name      } information for
          PN=pack-name         } master directory
          DT=device-set        } file
          SN=set-name
```

Figure 6-1. CDCSBTF Control Statement Format

If the CP and IO parameters are specified either in the CDCSBTF control statement or in the directive file, the accounting values return to the user's dayfile are different from the accounting values returned when the same application executes with CDCS at the system control point. When CDCSBTF executes, the accounting values returned include the application's execution time as well as the central processor and input/output time charged by CDCS.

The parameters available for the CDCSBTF control statement are the same as the parameters available for the CDCS control statement. See the CDCS Data Administrator's reference manual for more information about the parameters.

REQUIREMENTS

When you are running application programs with the CDCSBTF program, you must meet certain requirements. These requirements are:

- Attach the master directory file. It can be attached in two ways: either by information provided in the CDCSBTF control statement or directive file or by an ATTACH control statement that precedes execution of CDCSBTF. If the ATTACH control statement is used, the master directory file must be specified with the local file name MSTRDIR. However, using this method of attaching the master directory prevents online dumping of journal log files from being performed by CDCSBTF.

- Have the application program in relocatable binary format as a local or a permanent file.

- Assign unique names to non-CDCS files. Do not use any of the following names:

  INPUT
  OUTPUT
  MSTRDIR
  CDCSOUT
  Fnnnnnn
  Jnnnnnn
  Pnnnnnn
  Qnnnnnn } (where n is any six digits)
  Rnnnnnn
  Tnnnnnn
  Xnnnnnn
  A name beginning with ZZZZZ
  A log file name

- Be sure your application program executes a DML TERMINATE statement before a FORTRAN STOP or END statement. Failure to do this would discontinue processing for all programs specified in the CDCSBTF control statement that have not completed execution.

- Set the DB parameter in the FTN5 control statement equal to 0. Multiple copies of CDCSBTF can be run concurrently, and as many as 16 user programs can be run with a copy of CDCSBTF. If more than two concurrent calls to the RECOVR routine are made, CDCS aborts processing.

OBTAINING LOAD MAPS

You can obtain load maps by setting sense switches 1 through 4 prior to execution of the CDCSBTF control statement. Each sense switch setting corresponds to different information on the load map. The settings and the associated types of information are shown in table 6-1.

TABLE 6-1. LOAD MAP SWITCH SETTINGS

Setting	Load Map Information
SWITCH(1)	Statistics (S)
SWITCH(2)	Block maps (B)
SWITCH(3)	Entry point maps (E0)
SWITCH(4)	Entry point cross-reference maps (X).

EXECUTING THE CDCS BATCH TEST FACILITY

You need to include a number of control statements when executing the CDCS Batch Test Facility for your FORTRAN application program. Figure 6-2 provides a sample list of statements. Parameters correspond to the application that appears in appendix C.

NOS Operating System	NOS/BE Operating System	
Jobname,CMfl.	Jobname,CMfl.	Names the job and specifies maximum field length.
USER statement		Identifies the user.
CHARGE statement		Specifies the account to which the job's use of system resources is logged.
ATTACH,SSLIB/UN=xxx.	ATTACH,SSLIB,ID=xxx.	Attaches the sub-schema.
DML,SB=SSLIB,LV=F5	DML,SB=SSLIB,LV=F5	Preprocesses the DML statements in the FORTRAN program and writes to DMLOUT.
FTN5,I=DMLOUT,DB=0.	FTN5,I=DMLOUT,DB=0.	Compiles the FORTRAN program on DMLOUT and places it on the LGO file.
SWITCH,2.	SWITCH,2.	Requests block map on program-initiated load.
SWITCH,3.	SWITCH,3.	Requests entry point map on program-initiated load.
SWITCH,4.	SWITCH,4.	Requests entry point cross reference map on program-initiated load.
LIBRARY,DMSLIB.	LIBRARY,DMSLIB.	Specifies that library DMSLIB is to be used to satisfy externals.
CDCSBTF,LGO/MDPFN=MSTRDIR,UN=xxx.	CDCSBTF,LGO/MDPFN=MSTRDIR,ID=xxx.	Executes CDCSBTF and passes the master directory permanent file information as parameters..
REWIND,CDCSOUT.	REWIND,CDCSOUT.	Rewinds the CDCSBTF output file.
COPY,CDCSOUT,OUTPUT.	COPY,CDCSOUT,OUTPUT.	Prints the CDCSBTF output file.
CRMEP.	CRMEP.	Prints the CRM error file.
EXIT.	EXIT.	Establishes processing if error occurs.
DMD.	DMP.	Dumps the exchange package.
DMD,377000.	DMP,377000.	Dumps the contents of the field length.
CRMEP.	CRMEP.	Prints the CRM error file.
REWIND,CDCSOUT.	REWIND,CDCSOUT.	Rewinds the CDCSBTF output file.
COPY,CDCSOUT,OUTPUT.	COPY,CDCSOUT,OUTPUT.	Prints the CDCSBTF output file.

Figure 6-2. Sample FORTRAN 5 Execution of CDCS Batch Test Facility

TABLE A-3. ASCII CHARACTER SET COLLATING SEQUENCE

Collating Sequence Decimal	Collating Sequence Octal	ASCII Graphic Subset	Display Code	ASCII Code	Collating Sequence Decimal	Collating Sequence Octal	ASCII Graphic Subset	Display Code	ASCII Code
00	00	blank	55	20	32	40	@	74	40
01	01	!	66	21	33	41	A	01	41
02	02	"	64	22	34	42	B	02	42
03	03	#	60	23	35	43	C	03	43
04	04	$	53	24	36	44	D	04	44
05	05	%	63†	25	37	45	E	05	45
06	06	&	67	26	38	46	F	06	46
07	07	'	70	27	39	47	G	07	47
08	10	(	51	28	40	50	H	10	48
09	11	)	52	29	41	51	I	11	49
10	12	*	47	2A	42	52	J	12	4A
11	13	+	45	2B	43	53	K	13	4B
12	14	,	56	2C	44	54	L	14	4C
13	15	-	46	2D	45	55	M	15	4D
14	16	.	57	2E	46	56	N	16	4E
15	17	/	50	2F	47	57	O	17	4F
16	20	0	33	30	48	60	P	20	50
17	21	1	34	31	49	61	Q	21	51
18	22	2	35	32	50	62	R	22	52
19	23	3	36	33	51	63	S	23	53
20	24	4	37	34	52	64	T	24	54
21	25	5	40	35	53	65	U	25	55
22	26	6	41	36	54	66	V	26	56
23	27	7	42	37	55	67	W	27	57
24	30	8	43	38	56	70	X	30	58
25	31	9	44	39	57	71	Y	31	59
26	32	:	00†	3A	58	72	Z	32	5A
27	33	;	77	3B	59	73	[	61	5B
28	34	<	72	3C	60	74	\	75	5C
29	35	=	54	3D	61	75	]	62	5D
30	36	>	73	3E	62	76	^	76	5E
31	37	?	71	3F	63	77	_	65	5F

†In installations using a 63-graphic set, the % graphic does not exist. The : graphic is display code 63.

NOS Operating System	NOS/BE Operating System	
Jobname,CMfl.	Jobname,CMfl.	Names the job and specifies maximum field length.
USER statement		Identifies the user.
CHARGE statement		Specifies the account to which the job's use of system resources is logged.
ATTACH,SSLIB/UN=xxx.	ATTACH,SSLIB,ID=xxx.	Attaches the sub-schema.
DML,SB=SSLIB,LV=F5	DML,SB=SSLIB,LV=F5	Preprocesses the DML statements in the FORTRAN program and writes to DMLOUT.
FTN5,I=DMLOUT,DB=0.	FTN5,I=DMLOUT,DB=0.	Compiles the FORTRAN program on DMLOUT and places it on the LGO file.
SWITCH,2.	SWITCH,2.	Requests block map on program-initiated load.
SWITCH,3.	SWITCH,3.	Requests entry point map on program-initiated load.
SWITCH,4.	SWITCH,4.	Requests entry point cross reference map on program-initiated load.
LIBRARY,DMSLIB.	LIBRARY,DMSLIB.	Specifies that library DMSLIB is to be used to satisfy externals.
CDCSBTF,LGO/MDPFN=MSTRDIR,UN=xxx.	CDCSBTF,LGO/MDPFN=MSTRDIR,ID=xxx.	Executes CDCSBTF and passes the master directory permanent file information as parameters..
REWIND,CDCSOUT.	REWIND,CDCSOUT.	Rewinds the CDCSBTF output file.
COPY,CDCSOUT,OUTPUT.	COPY,CDCSOUT,OUTPUT.	Prints the CDCSBTF output file.
CRMEP.	CRMEP.	Prints the CRM error file.
EXIT.	EXIT.	Establishes processing if error occurs.
DMD.	DMP.	Dumps the exchange package.
DMD,377000.	DMP,377000.	Dumps the contents of the field length.
CRMEP.	CRMEP.	Prints the CRM error file.
REWIND,CDCSOUT.	REWIND,CDCSOUT.	Rewinds the CDCSBTF output file.
COPY,CDCSOUT,OUTPUT.	COPY,CDCSOUT,OUTPUT.	Prints the CDCSBTF output file.

Figure 6-2. Sample FORTRAN 5 Execution of CDCS Batch Test Facility

STANDARD CHARACTER SETS A

Control Data operating systems offer the following variations of a basic character set:

- CDC 64-character set
- CDC 63-character set
- ASCII 64-character set
- ASCII 63-character set

The set in use at a particular installation was specified when the operating system was installed or (for NOS only) dead started.

Depending on another installation option, the system assumes an input deck has been punched either in 026 or in 029 mode (regardless of the character set in use). Under NOS/BE, the alternate mode can be specified by a 26 or 29 punched in columns 79 and 80 of the job statement or any 7/8/9 card. The specified mode remains in effect through the end of the job unless it is reset by specification of the alternate mode on a subsequent 7/8/9 card.

Under NOS, the alternate mode can be specified also by a 26 or 29 punched in columns 79 and 80 of any 6/7/9 card, as described previously for a 7/8/9 card. In addition, 026 mode can be specified by a card with 5/7/9 multipunched in column 1, and 029 mode can be specified by a card with 5/7/9 multipunched in column 1 and a 9 punched in column 2.

Graphic character representation appearing at a terminal or printer depends on the installation character set and the terminal type. Characters shown in the CDC Graphic column of the standard character set table (table A-1) are applicable to BCD terminals; ASCII graphic characters are applicable to ASCII-CRT and ASCII-TTY terminals.

Standard collating sequences for the two printer character sets are shown in tables A-2 and A-3.

TABLE A-1. STANDARD CHARACTER SETS

Display Code (octal)	CDC			ASCII		
	Graphic	Hollerith Punch (026)	External BCD Code	Graphic Subset	Punch (029)	Code (octal)
00†	: (colon) ††	8-2	00	: (colon) ††	8-2	072
01	A	12-1	61	A	12-1	101
02	B	12-2	62	B	12-2	102
03	C	12-3	63	C	12-3	103
04	D	12-4	64	D	12-4	104
05	E	12-5	65	E	12-5	105
06	F	12-6	66	F	12-6	106
07	G	12-7	67	G	12-7	107
10	H	12-8	70	H	12-8	110
11	I	12-9	71	I	12-9	111
12	J	11-1	41	J	11-1	112
13	K	11-2	42	K	11-2	113
14	L	11-3	43	L	11-3	114
15	M	11-4	44	M	11-4	115
16	N	11-5	45	N	11-5	116
17	O	11-6	46	O	11-6	117
20	P	11-7	47	P	11-7	120
21	Q	11-8	50	Q	11-8	121
22	R	11-9	51	R	11-9	122
23	S	0-2	22	S	0-2	123
24	T	0-3	23	T	0-3	124
25	U	0-4	24	U	0-4	125
26	V	0-5	25	V	0-5	126
27	W	0-6	26	W	0-6	127
30	X	0-7	27	X	0-7	130
31	Y	0-8	30	Y	0-8	131
32	Z	0-9	31	Z	0-9	132
33	0	0	12	0	0	060
34	1	1	01	1	1	061
35	2	2	02	2	2	062
36	3	3	03	3	3	063
37	4	4	04	4	4	064
40	5	5	05	5	5	065
41	6	6	06	6	6	066
42	7	7	07	7	7	067
43	8	8	10	8	8	070
44	9	9	11	9	9	071
45	+	12	60	+	12-8-6	053
46	-	11	40	-	11	055
47	*	11-8-4	54	*	11-8-4	052
50	/	0-1	21	/	0-1	057
51	(	0-8-4	34	(	12-8-5	050
52	)	12-8-4	74	)	11-8-5	051
53	$	11-8-3	53	$	11-8-3	044
54	=	8-3	13	=	8-6	075
55	blank	no punch	20	blank	no punch	040
56	, (comma)	0-8-3	33	, (comma)	0-8-3	054
57	. (period)	12-8-3	73	. (period)	12-8-3	056
60	≡	0-8-6	36	#	8-3	043
61	[	8-7	17	[	12-8-2	133
62	]	0-8-2	32	]	11-8-2	135
63	% ††	8-6	16	% ††	0-8-4	045
64	≠	8-4	14	" (quote)	8-7	042
65	←	0-8-5	35	_ (underline)	0-8-5	137
66	∨	11-0	52	!	12-8-7	041
67	∧	0-8-7	37	&	12	046
70	↑	11-8-5	55	' (apostrophe)	8-5	047
71	↓	11-8-6	56	?	0-8-7	077
72	<	12-0	72	<	12-8-4	074
73	>	11-8-7	57	>	0-8-6	076
74	≤	8-5	15	@	8-4	100
75	≥	12-8-5	75	\	0-8-2	134
76	¬	12-8-6	76	^ (circumflex)	11-8-7	136
77	; (semicolon)	12-8-7	77	; (semicolon)	11-8-6	073

†Twelve zero bits at the end of a 60-bit word in a zero byte record are an end of record mark rather than two colons.

††In installations using a 63-graphic set, display code 00 has no associated graphic or card code; display code 63 is the colon (8-2 punch). The % graphic and related card codes do not exist and translations yield a blank (55_8).

TABLE A-2. CDC CHARACTER SET COLLATING SEQUENCE

Collating Sequence Decimal	Collating Sequence Octal	CDC Graphic	Display Code	External BCD	Collating Sequence Decimal	Collating Sequence Octal	CDC Graphic	Display Code	External BCD
00	00	blank	55	20	32	40	H	10	70
01	01	≤	74	15	33	41	I	11	71
02	02	%	63 †	16 †	34	42	∨	66	52
03	03	[	61	17	35	43	J	12	41
04	04	→	65	35	36	44	K	13	42
05	05	≡	60	36	37	45	L	14	43
06	06	∧	67	37	38	46	M	15	44
07	07	↑	70	55	39	47	N	16	45
08	10	↓	71	56	40	50	O	17	46
09	11	>	73	57	41	51	P	20	47
10	12	≥	75	75	42	52	Q	21	50
11	13	¬	76	76	43	53	R	22	51
12	14	.	57	73	44	54	]	62	32
13	15	)	52	74	45	55	S	23	22
14	16	;	77	77	46	56	T	24	23
15	17	+	45	60	47	57	U	25	24
16	20	$	53	53	48	60	V	26	25
17	21	*	47	54	49	61	W	27	26
18	22	-	46	40	50	62	X	30	27
19	23	/	50	21	51	63	Y	31	30
20	24	,	56	33	52	64	Z	32	31
21	25	(	51	34	53	65	:	00 †	none†
22	26	=	54	13	54	66	0	33	12
23	27	≠	64	14	55	67	1	34	01
24	30	<	72	72	56	70	2	35	02
25	31	A	01	61	57	71	3	36	03
26	32	B	02	62	58	72	4	37	04
27	33	C	03	63	59	73	5	40	05
28	34	D	04	64	60	74	6	41	06
29	35	E	05	65	61	75	7	42	07
30	36	F	06	66	62	76	8	43	10
31	37	G	07	67	63	77	9	44	11

†In installations using the 63-graphic set, the % graphic does not exist. The : graphic is display code 63, External BCD code 16.

TABLE A-3. ASCII CHARACTER SET COLLATING SEQUENCE

Collating Sequence Decimal	Collating Sequence Octal	ASCII Graphic Subset	Display Code	ASCII Code	Collating Sequence Decimal	Collating Sequence Octal	ASCII Graphic Subset	Display Code	ASCII Code
00	00	blank	55	20	32	40	@	74	40
01	01	!	66	21	33	41	A	01	41
02	02	"	64	22	34	42	B	02	42
03	03	#	60	23	35	43	C	03	43
04	04	$	53	24	36	44	D	04	44
05	05	%	63†	25	37	45	E	05	45
06	06	&	67	26	38	46	F	06	46
07	07	'	70	27	39	47	G	07	47
08	10	(	51	28	40	50	H	10	48
09	11	)	52	29	41	51	I	11	49
10	12	*	47	2A	42	52	J	12	4A
11	13	+	45	2B	43	53	K	13	4B
12	14	,	56	2C	44	54	L	14	4C
13	15	-	46	2D	45	55	M	15	4D
14	16	.	57	2E	46	56	N	16	4E
15	17	/	50	2F	47	57	O	17	4F
16	20	0	33	30	48	60	P	20	50
17	21	1	34	31	49	61	Q	21	51
18	22	2	35	32	50	62	R	22	52
19	23	3	36	33	51	63	S	23	53
20	24	4	37	34	52	64	T	24	54
21	25	5	40	35	53	65	U	25	55
22	26	6	41	36	54	66	V	26	56
23	27	7	42	37	55	67	W	27	57
24	30	8	43	38	56	70	X	30	58
25	31	9	44	39	57	71	Y	31	59
26	32	:	00†	3A	58	72	Z	32	5A
27	33	;	77	3B	59	73	[	61	5B
28	34	<	72	3C	60	74	\	75	5C
29	35	=	54	3D	61	75	]	62	5D
30	36	>	73	3E	62	76	^	76	5E
31	37	?	71	3F	63	77	_	65	5F

†In installations using a 63-graphic set, the % graphic does not exist. The : graphic is display code 63.

Access Control -
Protection of data from unauthorized access or modification.

Actual Key -
A file organization in which records are stored according to their system-assigned key values.

Advanced Access Methods (AAM) -
A file manager that processes indexed sequential, direct access, and actual key file organizations and supports the Multiple-Index Processor. See CYBER Record Manager.

Alias -
A data name used in the sub-schema in place of a schema data name.

Area -
A uniquely named schema data base subdivision that contains data records; identified in the sub-schema as a realm; a file in the operating system.

Automatic Recovery -
CDCS initiated recovery operations that make a data base usable and consistent after some type of software or hardware failure (but not media failure).

Basic Access Methods (BAM) -
A file manager that processes sequential and word addressable file organizations. See CYBER Record Manager.

CDCS -
See CYBER Database Control System.

CDCS Batch Test Facility -
A facility that allows an application to simulate a data base environment without impacting any other CDCS users on the system.

Child Record Occurrence -
For relation processing, a record occurrence that has another record occurrence (the parent record occurrence) at the next numerically lower rank in the relation.

Common Item -
A data item that appears in two or more files joined in a relation; in each instance, the data item contains the same value.

Concurrency -
Simultaneous access to the same data in a data base by two or more application programs during a given span of time.

Constraint -
A control imposed on records in related files or on items in a single file for the purpose of protecting the integrity of data in a data base during update operations. A constraint is defined in the schema and is based on the common item in the records.

Control Break -
A condition that occurs during a relation read to signify a new record occurrence was read for the parent file.

CRM -
See CYBER Record Manager.

CYBER Database Control System (CDCS) -
The controlling module that provides the interface between the application program and the data base.

CYBER Record Manager (CRM) -
A generic term relating to the common products BAM and AAM, which run under the NOS and NOS/BE operating systems and allow a variety of record types, block types, and file organizations to be created and accessed. The execution time input/output of the DMS-170 products is implemented through CRM. All CRM file processing requests ultimately pass through the operating system input/output routines.

Data Administrator -
A person who defines the format and organization of the data base.

Data Base -
A systematically organized, central pool of information; organization is described by a schema.

Data Base Procedure -
A special-purpose routine that performs a predefined operation; specified in the schema and initiated by CDCS.

Data Base Status Block -
An array defined within an application program to which CDCS returns information concerning the status of operations on data base files and relations. The status block is updated after each CDCS operation.

Data Base Transaction -
A series of update operations identified by a user-assigned transaction identifier. A data base transaction is bracketed by a begin transaction operation and either a commit or drop operation. Data base transactions also provide a program restart capability that can be used for restarting an application program after a system failure.

Data Base Version -
A set of data files that is described by a schema. Data base versions are defined in the master directory. When data base versions are used, a schema (the description of the data base) can be used with more than one set of files (each set of files being a data base version).

Data Description Language (DDL) -
The language used to structure the schema and the sub-schema.

Data Item -
A unit of data within a record; can be a variable or an array in the FORTRAN sub-schema.

Data Manipulation Language (DML) -
The extensions to FORTRAN that provide access to a DMS-170 data base.

DDL -
See Data Description Language.

Deadlock -
A situation that arises in concurrent data base access when two or more application programs, each with locked resources, are contending for a resource that is locked by one of the other application programs, and none of the programs can proceed without that resource.

Dependent Record Occurrence -
A record occurrence that is the dependent member of a condition defined by a constraint.

Direct Access -
In the context of CRM, one of the five file organizations. The organization is characterized by the system hashing of the unique key within each file record to distribute records randomly in blocks called home blocks of the file.

In the context of NOS permanent files, a file that is accessed and modified directly, as contrasted with an indirect access permanent file.

DML -
See Data Manipulation Language.

Dominant Record Occurrence -
A record occurrence that is the dominant member of a condition defined by a constraint.

Exclusive Locking -
Locking mechanism that allows one program access to a realm or record and prohibits all access by other users. Contrast with Protected Locking.

File -
A collection of records treated as a unit; an area in the schema; a realm in the sub-schema.

Hierarchical Tree Structure -
A representation that commonly illustrates record occurrences for files joined in a directed relation. The root of the tree is a record occurrence in the root file, and each successive level represents the record occurrences in each joined file.

Home Block -
Mass storage allocated for a file with direct access organization at the time the file is created.

Indexed Sequential -
A file organization in which records are stored in ascending order by key.

Keyword -
A word that is required in a source program statement.

Log Files -
Files that hold historical records of operations performed by users on data base areas.

Mapping -
The process by which CDCS produces a record or item image conforming to the schema or sub-schema description.

Master Directory -
A file created by the data administrator and used by CDCS in processing. This information consists of schema and sub-schema tables, media parameters, and data base procedure library and logging specifications.

Multiple-Index Processor -
A processor that allows AAM files to be accessed by alternate keys.

Null Record Occurrence -
A record occurrence composed of the display code right bracket symbol in each character position. The null record occurrence is used in a relation occurrence to denote that no record occurrence qualifies or that a record occurrence does not exist at a given level in the relation.

Operation -
A particular function performed on units of data; for instance, opening or closing an area, or storing or deleting a record.

Parent Record Occurrence -
For relation processing, a record occurrence that has another record occurrence at the next numerically higher rank in the relation.

Permanent File -
A file that resides on a mass storage permanent file device and can be retained for longer than a single job. The file is protected against accidental destruction and can be protected against unauthorized access.

Privacy Key -
A character constant, variable name, or unsubscripted name that is included in a FORTRAN DML PRIVACY statement to gain access to a particular realm.

Protected Locking -
Locking mechanism that allows one program access to a realm or record for update operations and prohibits update operations (allows read operations) by other users. Contrast with Exclusive Locking.

Rank -
The rank of a file in a relation corresponds to the position of the file in the schema definition of the relation. The ranks of the files joined in a relation are numbered consecutively, with the root file having a rank of 1.

Realm -
A uniquely named sub-schema data base subdivision that contains data records; identified in the schema as an area; a file.

Realm Ordinal -
A unique identifier assigned to each realm in a sub-schema when the sub-schema is compiled. Sub-schema realm ordinals are used in conjunction with the data base status block.

Record -
A named collection of one or more data items that are treated as a unit.

Record Occurrence -
An actual data base record that conforms to a record description in the schema.

Record Type -
The description of the attributes of a record; record layout.

Recovery -
A process that makes a data base useful after some type of software or hardware failure has occurred.

Relation -
A group of files that are related by common data items; therefore the files can be opened, closed, or read by a single request. Relations are defined in the schema.

Relation Occurrence -
The logical concatenation of a record occurrence from each record type specified in the relation.

Restart Identifier -
A unique identifier for a run-unit that is maintained by CDCS for program restart operations in data base transactions.

Restart Identifier File -
A random permanent file used internally by CDCS to support program restart operations for programs that request a restart identifier.

Restriction -
Criteria that must be satisfied by a record occurrence in a relation before it can be made available to the application program. Restrictions are defined in the sub-schema.

Root Realm -
The first realm listed in a relation; the root realm has the rank of 1 in a relation; record occurrences of the root realm are pictured as the root of a tree in a hierarchical tree structure.

Schema -
A detailed description of the internal structure of the complete data base.

Status Block -
See Data Base Status Block.

Sub-Schema -
A detailed description of the portion of the data base to be made available to one or more application programs.

Sub-Schema Item Ordinal -
An identifier, unique within a record, assigned to each item in a sub-schema when the sub-schema is compiled. Sub-schema item ordinals are used in conjunction with the data base status block.

Sub-Schema Library -
A permanent file containing one or more sub-schemas.

Transaction -
See Data Base Transaction.

Transaction Identifier -
A user-assigned identifier for a data base transaction. The identifier is used for program restart operations in data base transactions.

THE SAMPLE APPLICATION C

This appendix contains the source programs and control statements used to generate the data base environment for the university application presented in this user's guide. Although all programs reflect operation under the NOS operating system, conversion to the NOS/BE operating system could be accomplished by making the following changes:

- Substitute the NOS/BE REQUEST and CATALOG control statements for the NOS DEFINE control statement.
- Substitute the NOS/BE file identification parameter ID for the NOS file identification parameter UN. This substitution applies to the source input for the master directory.

Setting up a DMS-170 data management environment is a data administrator responsibility; the process is shown here, however, to allow the reader to duplicate the application and use it to gain an understanding of DMS-170 FORTRAN application programming. The source input for the jobs shown in this appendix illustrates the university application being created by a series of batch jobs. The source input for each job is shown exactly as required for processing on NOS with two exceptions:

- End-of-record is indicated by the statement end-of-record and a blank line that is inserted to improve readability of the text.
- End of input for the job is indicated by the statement end-of-information.

The steps the data administrator takes to establish the application are listed in appropriate order as follows:

1. Design, write, compile, and store the schema definition as a permanent file. A schema named UNIVERSITY is stored as a permanent file named UNIVERS. See figure C-1.
2. Design, write, compile, and store sub-schema definitions as a permanent file library. A FORTRAN sub-schema library is stored as a permanent file named SSLIB. Input consists of four separate sub-schemas (AVERAGE, RELATION, ADMISSIONS, BURSAR); the sub-schemas follow each other with no intervening end-of-records. See figure C-2 for both source input and the listing that results from compilation. The FORTRAN sub-schema CREATES is used to create the data base and is stored in a permanent file library named CREATES. See figure C-3.
3. Generate a master directory through the DBMSTRD utility. A master directory is stored as a permanent file named MSTRDIR. See figure C-4.
4. Initialize log or recovery files specified for the schema in the master directory. The master directory specifies a transaction recovery file and a restart identifier file for schema UNIVERSITY. The DBREC utility is used to initialize these files. For processing on NOS/BE, the series of control statements that must be executed for each log and recovery file before the DBREC control statement is executed is as follows: REQUEST, REWIND, CATALOG, AND RETURN. See figure C-5.
5. Write a program to store the data base. A FORTRAN program creates five data base files (PROFESSOR, COURSE, STUDENT, CURRICULUM, ACCOUNTING) using the FORTRAN sub-schema CREATES, and defines the appropriate index files assigned in the master directory. See figure C-6. CDCSBTF is used to run this program; therefore, CDCS does not have to be active. For processing on NOS/BE, the series of control statements that must be executed for each area and index file before the FTN5 control statement is executed is as follows: REQUEST, REWIND, CATALOG, and RETURN.
6. Establish CDCS as an active system. This must be done by the data administrator; the process is not shown in this guide. If CDCS is not established as an active system CDCSBTF can be used.

```
Job statement
USER statement
CHARGE statement
FILE(PROFESS,FO=IS,XN=PNDX)
FILE(COURSE,FO=IS,XN=CRSNDX)
FILE(STUDENT,FO=IS,XN=SNDX)
FILE(CURRICU,FO=IS,XN=CRNDX)
FILE(ACCOUNT,FO=IS)
DEFINE(UNIVERS=UNIVERS/CT=PU,M=R)
DDL3(DS,SC=UNIVERS)
End-of-record

SCHEMA NAME IS UNIVERSITY.

AREA NAME IS PROFESSOR.
RECORD IS PROF-REC WITHIN PROFESSOR.

    PROF-ID           TYPE CHARACTER 8.
    PROF-NAME         PICTURE "X(30)".
    ACADEMIC-FIELD    TYPE CHARACTER 20.

AREA NAME IS COURSE.
RECORD IS COURSE-REC WITHIN COURSE.

    COURSE-ID         TYPE CHARACTER 6.
    COURSE-NAME       PICTURE "X(20)".
    SCHOOL            PICTURE "X(20)".
    PROF-ID           TYPE CHARACTER 8.
    PREREQUISITE      TYPE CHARACTER 6.
    UNITS             TYPE DECIMAL.

AREA NAME IS STUDENT.
RECORD IS STUDENT-REC WITHIN STUDENT.

    STUDENT-ID        TYPE CHARACTER 11.
    STUDENT-NAME      PICTURE "X(30)".
    STREET-ADDRESS    PICTURE "X(20)".
    CITY              PICTURE "X(10)".
    STATE             PICTURE "A(2)".
    ZIP-CODE          PICTURE "X(5)".
    PHONE             PICTURE "X(12)".
    MAJOR             TYPE CHARACTER 20.

AREA NAME IS CURRICULUM
ACCESS-CONTROL LOCK IS "XX99".
RECORD IS CURR-REC WITHIN CURRICULUM.

    IDENT             TYPE CHARACTER 14.
    STUDENT-ID        TYPE CHARACTER 11.
    COURSE-ID         TYPE CHARACTER 6.
    GRADE             TYPE FLOAT
                        CHECK VALUE 0.0 THRU 4.0.
    COMPLETE-CODE     TYPE CHARACTER 1.
    COMPLETE-DATE     TYPE CHARACTER 8.
    UNITS             TYPE DECIMAL.

AREA NAME IS ACCOUNTING.
RECORD IS ACCT-REC WITHIN ACCOUNTING.

 01 STUDENT-ID        TYPE CHARACTER 11.
 01 TUITION           TYPE FLOAT OCCURS 16 TIMES.
 01 LAB-FEES          TYPE FLOAT OCCURS 16 TIMES.
 01 BOOKS             TYPE FLOAT OCCURS 16 TIMES.
 01 MISC-FEES         TYPE FLOAT OCCURS 16 TIMES.

DATA CONTROL.

AREA NAME IS PROFESSOR
    KEY IS PROF-ID OF PROF-REC
       DUPLICATES ARE NOT ALLOWED
    KEY IS ALTERNATE ACADEMIC-FIELD
       DUPLICATES ARE ALLOWED.

AREA NAME IS COURSE
    KEY IS COURSE-ID OF COURSE-REC
       DUPLICATES ARE NOT ALLOWED
    KEY IS ALTERNATE PROF-ID OF COURSE-REC
       DUPLICATES ARE ALLOWED.

AREA NAME IS STUDENT
    KEY IS STUDENT-ID OF STUDENT-REC
       DUPLICATES ARE NOT ALLOWED
    KEY IS ALTERNATE MAJOR
       DUPLICATES ARE ALLOWED.

AREA NAME IS CURRICULUM
    KEY IS IDENT
    KEY IS ALTERNATE STUDENT-ID OF CURR-REC
       DUPLICATES ARE ALLOWED
    KEY IS ALTERNATE COURSE-ID OF CURR-REC
       DUPLICATES ARE ALLOWED
    KEY IS ALTERNATE GRADE
       DUPLICATES ARE ALLOWED.

AREA NAME IS ACCOUNTING
    KEY IS STUDENT-ID OF ACCT-REC
         DUPLICATES ARE NOT ALLOWED.

CONSTRAINT NAME IS CON1
    STUDENT-ID OF CURR-REC DEPENDS ON
    STUDENT-ID OF STUDENT-REC.

CONSTRAINT NAME IS CON2
    STUDENT-ID OF ACCT-REC DEPENDS ON
    STUDENT-ID OF STUDENT-REC.

CONSTRAINT NAME IS CON3
    COURSE-ID OF CURR-REC DEPENDS ON
    COURSE-ID OF COURSE-REC.

RELATION NAME IS REL1
    JOIN WHERE STUDENT-ID OF STUDENT-REC
    EQ STUDENT-ID OF CURR-REC.

RELATION NAME IS REL2
    JOIN WHERE STUDENT-ID OF STUDENT-REC
    EQ STUDENT-ID OF ACCT-REC.

RELATION NAME IS REL3
    JOIN WHERE PROF-ID OF PROF-REC
    EQ PROF-ID OF COURSE-REC
    COURSE-ID OF COURSE-REC
    EQ COURSE-ID OF CURR-REC.
End-of-record

End-of-information
```

Figure C-1. The UNIVERSITY Schema

Source Input

```
Job statement
USER statement
CHARGE statement
ATTACH(UNIVERS)
DEFINE(SSLIB/CT=PU,M=W)
DDLF(F5,SB=SSLIB,SC=UNIVERS)
End-of-record

      SUBSCHEMA AVERAGE,SCHEMA=UNIVERSITY

      ALIAS(REALM)  CFILE=CURRICULUM
      ALIAS(RECORD) CRECORD=CURR-REC
      ALIAS(ITEM)   STUDENT=STUDENT-ID.CURR-REC
      ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC

      REALM CFILE

      RECORD CRECORD

      CHARACTER*14 IDENT
      CHARACTER*11 STUDENT
      CHARACTER*6 COURSE
      REAL GRADE
      END

      SUBSCHEMA COMPARE,SCHEMA=UNIVERSITY

      ALIAS(REALM)  PFILE=PROFESSOR
      ALIAS(RECORD) PRECORD=PROF-REC
      ALIAS(ITEM)   PROFID=PROF-ID.PROF-REC
      ALIAS(ITEM)   PNAME=PROF-NAME

      ALIAS(REALM)  CRSFILE=COURSE
      ALIAS(RECORD) CRSREC=COURSE-REC
      ALIAS(ITEM)   CRSID=COURSE-ID.COURSE-REC
      ALIAS(ITEM)   CRSNAME=COURSE-NAME
      ALIAS(ITEM)   PROF=PROF-ID.COURSE-REC
      ALIAS(ITEM)   FIELD=ACADEMIC-FIELD

      ALIAS(REALM)  CFILE=CURRICULUM
      ALIAS(RECORD) CRECORD=CURR-REC
      ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC
      ALIAS(ITEM)   CODE=COMPLETE-CODE
      ALIAS(ITEM)   DATE=COMPLETE-DATE

      REALM PFILE
      REALM CRSFILE
      REALM CFILE

      RECORD PRECORD
      CHARACTER*8 PROFID
      CHARACTER*30 PNAME
      CHARACTER*20 FIELD

      RECORD CRSREC
      CHARACTER*6 CRSID
      CHARACTER*20 CRSNAME
      CHARACTER*8 PROF

      RECORD CRECORD
      CHARACTER*14 IDENT
      CHARACTER*6 COURSE
      CHARACTER*1 CODE
      CHARACTER*8 DATE
      REAL GRADE

      RELATION REL3
      RESTRICT CRECORD (CODE .EQ. 'C')
      END
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 1 of 8)

```
SUBSCHEMA RELATION,SCHEMA=UNIVERSITY

ALIAS(REALM)  SFILE=STUDENT
ALIAS(RECORD) SRECORD=STUDENT-REC
ALIAS(ITEM)   STID=STUDENT-ID.STUDENT-REC

ALIAS(REALM)  CFILE=CURRICULUM
ALIAS(RECORD) CRECORD=CURR-REC
ALIAS(ITEM)   CSTID=STUDENT-ID.CURR-REC
ALIAS(ITEM)   COURS=COURSE-ID.CURR-REC
ALIAS(ITEM)   PROF=PROF-NAME
ALIAS(ITEM)   CODE=COMPLETE-CODE
ALIAS(ITEM)   DATE=COMPLETE-DATE

REALM SFILE
REALM CFILE

RECORD SRECORD
CHARACTER*11 STID
CHARACTER*20 MAJOR

RECORD CRECORD
CHARACTER*14 IDENT
CHARACTER*11 CSTID
CHARACTER*6 COURS
REAL GRADE
CHARACTER CODE
CHARACTER*8 DATE
INTEGER UNITS
RELATION REL1
RESTRICT CRECORD(CODE.EQ.'C')
END

SUBSCHEMA ADMISSIONS,SCHEMA=UNIVERSITY

ALIAS(RECORD) CRSREC=COURSE-REC
ALIAS(ITEM)   CID=COURSE-ID.COURSE-REC
ALIAS(ITEM)   NAME=COURSE-NAME
ALIAS(ITEM)   PREREQ=PREREQUISITE

ALIAS(REALM)  CFILE=CURRICULUM
ALIAS(RECORD) CURREC=CURR-REC
ALIAS(ITEM)   STUDENT=STUDENT-ID
ALIAS(ITEM)   CCID=COURSE-ID.CURR-REC
ALIAS(ITEM)   CODE=COMPLETE-CODE

REALM COURSE
REALM CFILE

RECORD CRSREC
CHARACTER*6 CID
CHARACTER*20 NAME
CHARACTER*20 SCHOOL
CHARACTER*6 PREREQ
INTEGER UNITS

RECORD CURREC
CHARACTER*14 IDENT
CHARACTER*11 STUDENT
CHARACTER*6 CCID
CHARACTER CODE
END
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 2 of 8)

```
      SUBSCHEMA BURSAR,SCHEMA=UNIVERSITY

      ALIAS(RECORD) STREC=STUDENT-REC
      ALIAS(ITEM)   STID=STUDENT-ID.STUDENT-REC
      ALIAS(ITEM)   NAME=STUDENT-NAME
      ALIAS(ITEM)   ADDR=STREET-ADDRESS
      ALIAS(ITEM)   ZIP=ZIP-CODE

      ALIAS(REALM)  ACCOUNT=ACCOUNTING
      ALIAS(RECORD) ACCTREC=ACCT-REC
      ALIAS(ITEM)   ASTID=STUDENT-ID.ACCT-REC
      ALIAS(ITEM)   LAB=LAB-FEES
      ALIAS(ITEM)   MISC=MISC-FEES

      REALM STUDENT
      REALM ACCOUNT

      RECORD STREC
      CHARACTER*11 STID
      CHARACTER*30 NAME
      CHARACTER*20 ADDR
      CHARACTER*10 CITY
      CHARACTER*2 STATE
      CHARACTER*5 ZIP

      RECORD ACCTREC
      CHARACTER*11 ASTID
      REAL TUITION(16)
      REAL LAB(16)
      REAL BOOKS(16)
      REAL MISC(16)

      RELATION REL2
      END
End-of-record

End-of-information
```

Compilation Source Listings

```
          AVERAGE                    * SOURCE LISTING *   (80351)  DDLF 1.2+538.

              00001          SUBSCHEMA AVERAGE,SCHEMA=UNIVERSITY
              00002
              00003          ALIAS(REALM)  CFILE=CURRICULUM
              00004          ALIAS(RECORD) CRECORD=CURR-REC
              00005          ALIAS(ITEM)   STUDENT=STUDENT-ID.CURR-REC
              00006          ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC
              00007
              00008          REALM CFILE
              00009
              00010          RECORD CRECORD
              00011
** WITHIN CFILE
              00012          CHARACTER*14 IDENT
** ORDINAL    1
              00013          CHARACTER*11 STUDENT
** ORDINAL    2
              00014          CHARACTER*6 COURSE
** ORDINAL    3
              00015          REAL GRADE
** ORDINAL    4
              00016          END
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 3 of 8)

```
                00017
                *****       END OF SUB-SCHEMA SOURCE INPUT

PRIMARY KEY     00012       IDENT FOR AREA CFILE
ALTERNATE KEY   00013       STUDENT FOR AREA CFILE
ALTERNATE KEY   00014       COURSE FOR AREA CFILE
ALTERNATE KEY   00015       GRADE FOR AREA CFILE
                *****       RECORD MAPPING IS NEEDED FOR REALM -   CFILE


                -----       BEGIN SUB-SCHEMA FILE MAINTENANCE              -----

          SUBSCHEMA                              CHECKSUM
          AVERAGE                                3551431037614306102l

                -----       END OF FILE MAINTENANCE                -----
DDLF COMPLETE.          0 DIAGNOSTICS.
  476008 CM USED.      0.064  CP SECS.



          COMPARE                        * SOURCE LISTING *   (80351)  DDLF 1.2+538.

                00001                 SUBSCHEMA COMPARE,SCHEMA=UNIVERSITY
                00002
                00003                 ALIAS(REALM)  PFILE=PROFESSOR
                00004                 ALIAS(RECORD) PRECORD=PROF-REC
                00005                 ALIAS(ITEM)   PROFID=PROF-ID.PROF-REC
                00006                 ALIAS(ITEM)   PNAME=PROF-NAME
                00007
                00008                 ALIAS(REALM)  CRSFILE=COURSE
                00009                 ALIAS(RECORD) CRSREC=COURSE-REC
                00010                 ALIAS(ITEM)   CRSID=COURSE-ID.COURSE-REC
                00011                 ALIAS(ITEM)   CRSNAME=COURSE-NAME
                00012                 ALIAS(ITEM)   PROF=PROF-ID.COURSE-REC
                00013                 ALIAS(ITEM)   FIELD=ACADEMIC-FIELD
                00014
                00015                 ALIAS(REALM)  CFILE=CURRICULUM
                00016                 ALIAS(RECORD) CRECORD=CURR-REC
                00017                 ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC
                00018                 ALIAS(ITEM)   CODE=COMPLETE-CODE
                00019                 ALIAS(ITEM)   DATE=COMPLETE-DATE
                00020
                00021                 REALM PFILE
                00022                 REALM CRSFILE
                00023                 REALM CFILE
                00024
                00025                 RECORD PRECORD
** WITHIN PFILE
                00026                 CHARACTER*8 PROFID
** ORDINAL    1
                00027                 CHARACTER*30 PNAME
** ORDINAL    2
                00028                 CHARACTER*20 FIELD
                00029
** ORDINAL    3
                00030                 RECORD CRSREC
** WITHIN CRSFILE
                00031                 CHARACTER*6 CRSID
** ORDINAL    1
                00032                 CHARACTER*20 CRSNAME
** ORDINAL    2
                00033                 CHARACTER*8 PROF
                00034
** ORDINAL    3
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 4 of 8)

```
                00035               RECORD CRECORD
** WITHIN CFILE
                00036               CHARACTER*14 IDENT
** ORDINAL    1
                00037               CHARACTER*6 COURSE
** ORDINAL    2
                00038               CHARACTER*1 CODE
** ORDINAL    3
                00039               CHARACTER*8 DATE
** ORDINAL    4
                00040               REAL GRADE
                00041
** ORDINAL    5
                00042                       RELATION REL3
 PRIMARY KEY    00026          PROFID FOR AREA PFILE
 ALTERNATE KEY  00028          FIELD FOR AREA PFILE
 PRIMARY KEY    00031          CRSID FOR AREA CRSFILE
 ALTERNATE KEY  00033          PROF FOR AREA CRSFILE
 PRIMARY KEY    00036          IDENT FOR AREA CFILE
 ALTERNATE KEY  00037          COURSE FOR AREA CFILE
 ALTERNATE KEY  00040          GRADE FOR AREA CFILE
                *****          RECORD MAPPING IS NOT NEEDED FOR REALM -   PFILE
                *****          RECORD MAPPING IS NEEDED FOR REALM -   CRSFILE
                *****          RECORD MAPPING IS NEEDED FOR REALM -   CFILE
                00043                  RESTRICT CRECORD (CODE .EQ. 'C')
                00044                  END
                00045
                *****          END OF SUB-SCHEMA SOURCE INPUT

                *****                   RELATION   STATISTICS                *****
RELATION 001                   REL3 JOINS          AREA - PFILE
                                                   AREA - CRSFILE
                                                   AREA - CFILE


                -----          BEGIN SUB-SCHEMA FILE MAINTENANCE            -----

          SUBSCHEMA                                 CHECKSUM
          COMPARE                                   7111140453045665357 6

                -----          END OF FILE MAINTENANCE                -----
DDLF COMPLETE.              0 DIAGNOSTICS.
  50600B CM USED.         0.146  CP SECS.
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 5 of 8)

```
RELATION                    * SOURCE LISTING *   (80351)  DDLF 1.2+538.

                00001               SUBSCHEMA RELATION,SCHEMA=UNIVERSITY
                00002
                00003               ALIAS(REALM)  SFILE=STUDENT
                00004               ALIAS(RECORD) SRECORD=STUDENT-REC
                00005               ALIAS(ITEM)   STID=STUDENT-ID.STUDENT-REC
                00006
                00007               ALIAS(REALM)  CFILE=CURRICULUM
                00008               ALIAS(RECORD) CRECORD=CURR-REC
                00009               ALIAS(ITEM)   CSTID=STUDENT-ID.CURR-REC
                00010               ALIAS(ITEM)   COURS=COURSE-ID.CURR-REC
                00011               ALIAS(ITEM)   PROF=PROF-NAME
                00012               ALIAS(ITEM)   CODE=COMPLETE-CODE
                00013               ALIAS(ITEM)   DATE=COMPLETE-DATE
                00014
                00015               REALM SFILE
                00016               REALM CFILE
                00017
                00018               RECORD SRECORD
** WITHIN SFILE
                00019               CHARACTER*11 STID
** ORDINAL    1
                00020               CHARACTER*20 MAJOR
                00021
** ORDINAL    2
                00022               RECORD CRECORD
** WITHIN CFILE
                00023               CHARACTER*14 IDENT
** ORDINAL    1
                00024               CHARACTER*11 CSTID
** ORDINAL    2
                00025               CHARACTER*6 COURS
** ORDINAL    3
                00026               REAL GRADE
** ORDINAL    4
                00027               CHARACTER CODE
** ORDINAL    5
                00028               CHARACTER*8 DATE
** ORDINAL    6
                00029               INTEGER UNITS
** ORDINAL    7
                00030               RELATION REL1
 PRIMARY KEY    00019       STID FOR AREA SFILE
 ALTERNATE KEY  00020       MAJOR FOR AREA SFILE
 PRIMARY KEY    00023       IDENT FOR AREA CFILE
 ALTERNATE KEY  00024       CSTID FOR AREA CFILE
 ALTERNATE KEY  00025       COURS FOR AREA CFILE
 ALTERNATE KEY  00026       GRADE FOR AREA CFILE
                *****       RECORD MAPPING IS NEEDED FOR REALM -   SFILE
                *****       RECORD MAPPING IS NEEDED FOR REALM -   CFILE
                00031               RESTRICT CRECORD(CODE.EQ.'C')
                00032               END
                00033
                *****       END OF SUB-SCHEMA SOURCE INPUT

                *****                RELATION   STATISTICS                *****
RELATION 001                REL1 JOINS           AREA - SFILE
                                                 AREA - CFILE


                -----       BEGIN SUB-SCHEMA FILE MAINTENANCE             -----

          SUBSCHEMA                              CHECKSUM
          RELATION                               7671046433226153670 3

                -----       END OF FILE MAINTENANCE                       -----
DDLF COMPLETE.          0 DIAGNOSTICS.
  50500B CM USED.      0.128  CP SECS.
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 6 of 8)

```
          ADMISSIONS                    * SOURCE LISTING *   (80351)  DDLF 1.2+538.

                00001                   SUBSCHEMA ADMISSIONS,SCHEMA=UNIVERSITY
                00002
                00003                   ALIAS(RECORD) CRSREC=COURSE-REC
                00004                   ALIAS(ITEM)   CID=COURSE-ID.COURSE-REC
                00005                   ALIAS(ITEM)   NAME=COURSE-NAME
                00006                   ALIAS(ITEM)   PREREQ=PREREQUISITE
                00007
                00008                   ALIAS(REALM)  CFILE=CURRICULUM
                00009                   ALIAS(RECORD) CURREC=CURR-REC
                00010                   ALIAS(ITEM)   STUDENT=STUDENT-ID
                00011                   ALIAS(ITEM)   CCID=COURSE-ID.CURR-REC
                00012                   ALIAS(ITEM)   CODE=COMPLETE-CODE
                00013
                00014                   REALM COURSE
                00015                   REALM CFILE
                00016
                00017                   RECORD CRSREC
** WITHIN COURSE
                00018                   CHARACTER*6 CID
** ORDINAL    1
                00019                   CHARACTER*20 NAME
** ORDINAL    2
                00020                   CHARACTER*20 SCHOOL
** ORDINAL    3
                00021                   CHARACTER*6 PREREQ
** ORDINAL    4
                00022                   INTEGER UNITS
                00023
** ORDINAL    5
                00024                   RECORD CURREC
** WITHIN CFILE
                00025                   CHARACTER*14 IDENT
** ORDINAL    1
                00026                   CHARACTER*11 STUDENT
** ORDINAL    2
                00027                   CHARACTER*6 CCID
** ORDINAL    3
                00028                   CHARACTER CODE
** ORDINAL    4
                00029                   END
                00030
                *****       END OF SUB-SCHEMA SOURCE INPUT

PRIMARY KEY     00018       CID FOR AREA COURSE
PRIMARY KEY     00025       IDENT FOR AREA CFILE
ALTERNATE KEY   00026       STUDENT FOR AREA CFILE
ALTERNATE KEY   00027       CCID FOR AREA CFILE
                *****       RECORD MAPPING IS NEEDED FOR REALM -   COURSE
                *****       RECORD MAPPING IS NEEDED FOR REALM -   CFILE


                -----       BEGIN SUB-SCHEMA FILE MAINTENANCE              -----

          SUBSCHEMA                              CHECKSUM
          ADMISSIONS                             5606531337754230761O

                -----       END OF FILE MAINTENANCE                -----
DDLF COMPLETE.          0 DIAGNOSTICS.
  50000B CM USED.     0.109  CP SECS.
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 7 of 8)

```
BURSAR                          * SOURCE LISTING *   (80351)  DDLF 1.2+538.

                00001               SUBSCHEMA BURSAR,SCHEMA=UNIVERSITY
                00002
                00003               ALIAS(RECORD) STREC=STUDENT-REC
                00004               ALIAS(ITEM)   STID=STUDENT-ID.STUDENT-REC
                00005               ALIAS(ITEM)   NAME=STUDENT-NAME
                00006               ALIAS(ITEM)   ADDR=STREET-ADDRESS
                00007               ALIAS(ITEM)   ZIP=ZIP-CODE
                00008
                00009               ALIAS(REALM)  ACCOUNT=ACCOUNTING
                00010               ALIAS(RECORD) ACCTREC=ACCT-REC
                00011               ALIAS(ITEM)   ASTID=STUDENT-ID.ACCT-REC
                00012               ALIAS(ITEM)   LAB=LAB-FEES
                00013               ALIAS(ITEM)   MISC=MISC-FEES
                00014
                00015               REALM STUDENT
                00016               REALM ACCOUNT
                00017
                00018               RECORD STREC
** WITHIN STUDENT
                00019               CHARACTER*11 STID
** ORDINAL    1
                00020               CHARACTER*30 NAME
** ORDINAL    2
                00021               CHARACTER*20 ADDR
** ORDINAL    3
                00022               CHARACTER*10 CITY
** ORDINAL    4
                00023               CHARACTER*2 STATE
** ORDINAL    5
                00024               CHARACTER*5 ZIP
                00025
** ORDINAL    6
                00026               RECORD ACCTREC
** WITHIN ACCOUNT
                00027               CHARACTER*11 ASTID
** ORDINAL    1
                00028               REAL TUITION(16)
** ORDINAL    2
                00029               REAL LAB(16)
** ORDINAL    3
                00030               REAL BOOKS(16)
** ORDINAL    4
                00031               REAL MISC(16)
                00032
** ORDINAL    5
                00033               RELATION REL2
PRIMARY KEY     00019       STID FOR AREA STUDENT
PRIMARY KEY     00027       ASTID FOR AREA ACCOUNT
                *****       RECORD MAPPING IS NEEDED FOR REALM -   STUDENT
                *****       RECORD MAPPING IS NOT NEEDED FOR REALM -   ACCOUNT
                00034               END
                *****       END OF SUB-SCHEMA SOURCE INPUT

                *****                RELATION   STATISTICS                *****
RELATION 001                REL2 JOINS           AREA - STUDENT
                                                 AREA - ACCOUNT


                -----       BEGIN SUB-SCHEMA FILE MAINTENANCE             -----

          SUBSCHEMA                               CHECKSUM
          BURSAR                                  16643753141007716046

                -----       END OF FILE MAINTENANCE                 -----
DDLF COMPLETE.            0 DIAGNOSTICS.
  50500B CM USED.       0.107  CP SECS.
```

Figure C-2. The FORTRAN Sub-Schema Library (Sheet 8 of 8)

```
Job statement
USER statement
CHARGE statement
ATTACH,UNIVERS.
DEFINE(CREATES/CT=PU,M=W)
DDLF(F5,SB=CREATES,SC=UNIVERS)
End-of-Record

      SUBSCHEMA CREATES,SCHEMA=UNIVERSITY

      ALIAS(REALM)  PFILE=PROFESSOR
      ALIAS(RECORD) PRECORD=PROF-REC
      ALIAS(ITEM)   PROFID=PROF-ID.PROF-REC
      ALIAS(ITEM)   PNAME=PROF-NAME
      ALIAS(ITEM)   FIELD=ACADEMIC-FIELD

      ALIAS(REALM)  CRSFILE=COURSE
      ALIAS(RECORD) CRSREC=COURSE-REC
      ALIAS(ITEM)   CRSID=COURSE-ID.COURSE-REC
      ALIAS(ITEM)   CRSNAME=COURSE-NAME
      ALIAS(ITEM)   PROF=PROF-ID.COURSE-REC
      ALIAS(ITEM)   PREREQ=PREREQUISITE

      ALIAS(RECORD) STREC=STUDENT-REC
      ALIAS(ITEM)   STID=STUDENT-ID.STUDENT-REC
      ALIAS(ITEM)   NAME=STUDENT-NAME
      ALIAS(ITEM)   ADDR=STREET-ADDRESS
      ALIAS(ITEM)   ZIP=ZIP-CODE

      ALIAS(REALM)  CFILE=CURRICULUM
      ALIAS(RECORD) CRECORD=CURR-REC
      ALIAS(ITEM)   CSTID=STUDENT-ID.CURR-REC
      ALIAS(ITEM)   COURSE=COURSE-ID.CURR-REC
      ALIAS(ITEM)   CODE=COMPLETE-CODE
      ALIAS(ITEM)   DATE=COMPLETE-DATE
      ALIAS(ITEM)   CRUNITS=UNITS.CURR-REC

      ALIAS(REALM)  ACCOUNT=ACCOUNTING
      ALIAS(RECORD) ACCTREC=ACCT-REC
      ALIAS(ITEM)   ASTID=STUDENT-ID.ACCT-REC
      ALIAS(ITEM)   LAB=LAB-FEES
      ALIAS(ITEM)   MISC=MISC-FEES

      REALM PFILE
      REALM CRSFILE
      REALM STUDENT
      REALM CFILE
      REALM ACCOUNT
      RECORD PRECORD
      CHARACTER*8 PROFID
      CHARACTER*30 PNAME
      CHARACTER*20 FIELD

      RECORD CRSREC
      CHARACTER*6 CRSID
      CHARACTER*20 CRSNAME
      CHARACTER*20 SCHOOL
      CHARACTER*8 PROF
      CHARACTER*6 PREREQ
      INTEGER UNITS

      RECORD STREC
      CHARACTER*11 STID
      CHARACTER*30 NAME
      CHARACTER*20 ADDR
      CHARACTER*10 CITY
      CHARACTER*2 STATE
      CHARACTER*5 ZIP
      CHARACTER*12 PHONE
      CHARACTER*20 MAJOR

      RECORD CRECORD
      CHARACTER*14 IDENT
      CHARACTER*11 CSTID
      CHARACTER*6 COURSE
      REAL GRADE
      CHARACTER*1 CODE
      CHARACTER*8 DATE
      INTEGER   CRUNITS

      RECORD ACCTREC
      CHARACTER*11 ASTID
      REAL TUITION(16)
      REAL LAB(16)
      REAL BOOKS(16)
      REAL MISC(16)

      END
End-of-Record

End-of-Information
```

Figure C-3. The FORTRAN Sub-Schema Library CREATES

```
Job statement
USER statement
CHARGE statement
DEFINE(MSTRDIR/CT=PU)
ATTACH(UNIVERS)
ATTACH(SSLIB)
ATTACH(CREATES)
DBMSTRD(NMD=MSTRDIR,LD)
End-of-record

SCHEMA NAME IS UNIVERSITY
    FILE NAME IS UNIVERS
    TRANSACTION RECOVERY FILE
        PFN IS "FTNTRF" UN IS "DBID001"
    RESTART IDENTIFIER FILE
        PFN IS "FTNRIF" UN IS "DBID001".

AREA NAME IS PROFESSOR
    PFN IS "PROFESS" UN IS "DBID001"
       INDEX FILE ASSIGNED
      PFN "PNDX" UN IS "DBID001".

AREA NAME IS COURSE
    PFN IS "COURSE" UN IS "DBID001"
       INDEX FILE ASSIGNED
      PFN "CRSNDX" UN IS "DBID001".

AREA NAME IS STUDENT
    PFN IS "STUDENT" UN IS "DBID001"
       INDEX FILE ASSIGNED
       PFN "SNDX" UN IS "DBID001".

AREA NAME IS CURRICULUM
    PFN IS "CURRICU" UN IS "DBID001"
       INDEX FILE ASSIGNED
       PFN "CRNDX" UN IS "DBID001".

AREA NAME IS ACCOUNTING
    PFN IS "ACCOUNT" UN IS "DBID001".

SUBSCHEMA NAME IS AVERAGE
    FILE NAME IS SSLIB.

SUBSCHEMA NAME IS COMPARE
    FILE NAME IS SSLIB.

SUBSCHEMA NAME IS RELATION
    FILE NAME IS SSLIB.

SUBSCHEMA NAME IS ADMISSIONS
    FILE NAME IS SSLIB.

SUBSCHEMA NAME IS BURSAR
    FILE NAME IS SSLIB.

SUBSCHEMA NAME IS CREATES
    FILE NAME IS CREATES.
End-of-Record

End-of-Information
```

Figure C-4. The Master Directory Build

```
Job Statement
USER statement
CHARGE statement
DEFINE,FTNTRF1,FTNRIF/CT=PU.
RETURN,FTNTRF1,FTNRIF.
ATTACH,MSTRDIR.
DBREC.
End-of-Record

    SCHEMA NAME IS UNIVERSITY
    ALLOCATE
      TRANSACTION RECOVERY FILE IS FTNTRF1
      RESTART IDENTIFIER FILE IS FTNRIF
End-of-Record

End-of-Information
```

Figure C-5. Log File Initialization

```
Job statement
USER statement
CHARGE statement
ATTACH(CREATES)
ATTACH(PDATA,CRSDATA,SDATA,CDATA,ACCDATA)
DEFINE(PROFESS,PNDX/CT=PU,M=W)
DEFINE(COURSE,CRSNDX/CT=PU,M=W)
DEFINE(STUDENT,SNDX/CT=PU,M=W)
DEFINE(CURRICU,CRNDX/CT=PU,M=W)
DEFINE(ACCOUNT/CT=PU,M=W)
RETURN(PROFESS,PNDX,COURSE,CRSNDX)
RETURN(STUDENT,SNDX,CURRICU,CRNDX,ACCOUNT)
DML(LV=F5,SB=CREATES)
FTN5(I=DMLOUT,DB=0)
LIBRARY,DMSLIB.
CDCSBTF(LGO/MDPFN=MSTRDIR,UN=xx)

End-of-record

      PROGRAM BUILD
      SUBSCHEMA(CREATES)
      INVOKE
      PRIVACY(CFILE,MODE=0,PRIVACY='XX99')
      OPEN(PFILE,MODE=0,ERR=900)
      OPEN(1,FILE='PDATA')
  100 READ(1,FMT='(A8,A30,A20)',END=199) PROFID,PNAME,FIELD
      WRITE(PFILE,ERR=900)
      GOTO 100
  199 CLOSE(PFILE,ERR=900)
      CLOSE(1,STATUS='DELETE')
      OPEN(CRSFILE,MODE=0,ERR=900)
      OPEN(1,FILE='CRSDATA')
  200 READ(1,FMT='(A6,A20,A20,A8,A6,I2)',END=299) CRSID,CRSNAME,SCHOOL,
     +    PROF,PREREQ,UNITS
      WRITE(CRSFILE,ERR=900)
      GOTO 200
  299 CLOSE(CRSFILE,ERR=900)
      CLOSE(1,STATUS='DELETE')
      OPEN(STUDENT,MODE=0,ERR=900)
      OPEN(1,FILE='SDATA')
  300 READ(1,FMT='(A11,A30,A20,A10)',END=399) STID,NAME,ADDR,CITY
      READ(1,FMT='(A2,A5,A12,A20)', END=399) STATE,ZIP,PHONE,MAJOR
      WRITE(STUDENT,ERR=900)
      GOTO 300
  399 CLOSE(STUDENT,ERR=900)
      CLOSE(1,STATUS='DELETE')
      OPEN(CFILE,MODE=0,ERR=900)
      OPEN(1,FILE='CDATA')
  400 READ(1,FMT='(A14,A11,A6,F3.1,A1,A8,F3.1)',END=499) IDENT,CSTID,
     +    COURSE,GRADE,CODE,DATE,CRUNITS
      WRITE(CFILE,ERR=900)
      GOTO 400
  499 CLOSE(CFILE,ERR=900)
      CLOSE(1,STATUS='DELETE')
      OPEN(ACCOUNT,MODE=0,ERR=900)
      DO 510 I=1,16
         TUITION(I)=0.0
         LAB(I)=0.0
         BOOKS(I)=0.0
  510    MISC(I)=0.0
      OPEN(1,FILE='ACCDATA')
  550 READ(1,FMT='(A11)',END=599) ASTID
      WRITE(ACCOUNT,ERR=900)
      GOTO 550
  599 CLOSE(ACCOUNT,ERR=900)
      CLOSE(1,STATUS='DELETE')
  900 TERMINATE
      END

End-of-Record

End-of-Information
```

Figure C-6. The FORTRAN Data Base Creation Program (Sheet 1 of 3)

File PDATA--(Input data for PFILE)

```
CRLN0080CARLIN, W.L.                HISTORY
DVS00575DAVIS, M.E.                 PSYCHOLOGY
JCKSN750JACKSON, U.B.               BUSINESS
JMS00160JAMES, H.L.                 PSYCHOLOGY
MLN00840MALONE, R.E.                HISTORY
RSS00860ROSS, W.R.                  BUSINESS
SMTH0455SMITH, P.R.                 MATHEMATICS
WLSN0855WILSON,G.R.                 CHEMISTRY
YMD00170YMADA, J.V.                 BUSINESS
```

File CRSDATA--(Input data for CRSFILE)

```
CHM103BIOCHEMISTRY          SCIENCE          CRLN0080CHM0053
CHM005QUANTITATIVE ANAL     SCIENCE          WLSN0855N/A   4
CHM110LINEAR OPTIMIZATION   SCIENCE          WLSN0855MATH103
PSY136SOCIAL PSYCHOLOGY     LIBERAL ARTS     JMS00160N/A   3
PSY002GENERAL PSYCHOLOGY    LIBERAL ARTS     JMS00160N/A   3
PSY003PSYCHONOMICS          LIBERAL ARTS     DVS00575PSY0023
HIS103GREEK HISTORY         LIBERAL ARTS     MLN00840N/A   3
BUS017CONSUMER LAW          BUSINESS ADMIN   JCKSN750N/A   3
BUS001ACCOUNTING I          BUSINESS ADMIN   YMD00170N/A   3
BUS002ACCOUNTING II         BUSINESS ADMIN   RSS00860BUS0013
MATH10COLLEGE ALGEBRA       SCIENCE          SMTH0455N/A   3
```

File SDATA--(Input data for STUDENT)

```
122-13-6704WALTER HILL                  1960 MONTANA ST.     MINNEAPOLI
MN55112612-143-1760HISTORY
100-22-5860GUY RICHARDS                 143 E. LAKE BLVD.    MINNEAPOLI
MN55440612-715-9187BIOLOGY
124-33-5780BARBARA YOUNG                413 MAPLE AVE.       MINNEAPOLI
MN55440612-731-4632HISTORY
120-44-3760JERI ADAMS                   1400 W. OAK LANES    MINNEAPOLI
MN55112612-625-7913CHEMISTRY
553-89-2021PAUL JOHNSON                 137 MARKET ST.       MINNEAPOLI
MN55104612-649-1377PSYCHOLOGY
687-14-2100PATRICIA ANDREWS             100 KAUREL DR.       MINNEAPOLI
MN55112612-436-8750BIOLOGY
197-11-2140CAREN NIELSON                12 MORRIS ST.        MINNEAPOLI
MN55104612-136-9800CHEMISTRY
678-12-1144MARK PETERSEN                1372 PARKVIEW DR.    MINNEAPOLI
MN55112612-143-9877PSYCHOLOGY
387-14-1232LLOYD DAVIS                  692 FIRST ST. APT. 1MINNEAPOLI
MN55104612-993-4773CHEMISTRY
437-56-8943JANET ANDERSON               986 SINCLAIRE AVE.   MINNEAPOLI
MN55112612-997-6160BIOLOGY
```

Figure C-6. The FORTRAN Data Base Creation Program (Sheet 2 of 3)

File CDATA--(Input data for CFILE)

```
122-13-6704-01122-13-6704HIS1034.0C09/22/803.0
122-13-6704-02122-13-6704PSY1360.0I        3.0
100-22-5860-01100-22-5860CHM1033.0C05/30/793.0
100-22-5860-02100-22-5860CHM0054.0C09/22/794.0
100-22-5860-03100-22-5860MATH103.5C05/18/793.0
100-22-5860-04100-22-5860PSY0020.0I        3.0
124-33-5780-01124-33-5780HIS1033.5C09/22/803.0
124-33-5780-02124-33-5780BUS0014.0C02/24/803.0
124-33-5780-03124-33-5780BUS0024.0C09/22/803.0
120-44-3760-01120-44-3760CHM0052.0C09/22/794.0
120-44-3760-02120-44-3760CHM1033.0C05/30/803.0
120-44-3760-03120-44-3760MATH104.0C05/30/803.0
120-44-3760-04120-44-3760CHM1103.5C09/22/803.0
553-89-2021-01553-89-2021PSY1363.5C05/30/803.0
553-89-2021-02553-89-2021PSY0024.0C05/30/803.0
553-89-2021-03553-89-2021PSY0033.5C09/22/803.0
687-14-2100-01687-14-2100CHM0054.0C09/22/794.0
687-14-2100-02687-14-2100CHM1033.5C05/30/803.0
687-14-2100-03687-14-2100MATH104.0C05/30/803.0
687-14-2100-04687-14-2100CHM1104.0C05/30/803.0
197-11-2140-01197-11-2140CHM0053.0C05/30/804.0
197-11-2140-02197-11-2140CHM1033.5C09/22/803.0
197-11-2140-03197-11-2140CHM1104.0C09/22/803.0
197-11-2140-04197-11-2140MATH104.0C05/30/803.0
678-12-1144-01678-12-1144PSY1364.0C05/30/803.0
678-12-1144-02678-12-1144BUS0174.0C05/30/803.0
678-12-1144-03678-12-1144HIS1030.0I        3.0
387-14-1232-01387-14-1232MATH100.0I        3.0
387-14-1232-02387-14-1232CHM0050.0I        4.0
387-14-1232-03387-14-1232PSY1360.0I        3.0
387-14-1232-04387-14-1232BUS0170.0I        3.0
437-56-8943-01437-56-8943MATH103.0C05/30/803.0
437-56-8943-02437-56-8943CHM0053.5C05/30/804.0
437-56-8943-03437-56-8943PSY0023.5C05/30/803.0
```

File ACCDATA--(Input data for ACCOUNT)

```
122-13-6704
100-22-5860
124-33-5780
120-44-3760
553-89-2021
687-14-2100
197-11-2140
678-12-1144
387-14-1232
437-56-8943
```

Figure C-6. The FORTRAN Data Base Creation Program (Sheet 3 of 3)

INDEX

COMMENT SHEET

MANUAL TITLE: CYBER Database Control System Version 2 FORTRAN Application Programming User's Guide

PUBLICATION NO.: 60483500 REVISION: B

NAME:

COMPANY:

STREET ADDRESS:

CITY: STATE: ZIP CODE:

This form is not intended to be used as an order blank. Control Data Corporation welcomes your evaluation of this manual. Please indicate any errors, suggested additions or deletions, or general comments below (please include page number references).

___ Please reply ___ No reply necessary

NO POSTAGE STAMP NECESSARY IF MAILED IN U.S.A.

FOLD ON DOTTED LINES AND TAPE

TAPE

TAPE

FOLD

FOLD

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 8241 MINNEAPOLIS, MINN.

POSTAGE WILL BE PAID BY

CONTROL DATA CORPORATION

Publications and Graphics Division

215 Moffett Park Drive
Sunnyvale, California 94086

CUT ALONG LINE

FOLD

FOLD