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IBM System/360 Operating System Assembler [F] Programmer's Guide

Program Number 360S-AS-037

This publication complements the IBM System/360 Operating System Assembler Language publications. It provides a guide to program assembling, linkage editing, executing, interpreting listings, assembler programming considerations, diagnostic messages, and object output cards.

PREFACE

This publication is oriented to the F level assembler program (the assembler) functioning in the IBM System/360 Operating System (Primary Control Program, MFT, and MVT).

This publication is divided into an introduction and four sections which describe the following:

1. Assembler options and data set requirements.
2. Use of IBM-provided cataloged procedures for assembling; assembling and linkage editing; assembling, linkage editing, and executing assembler language source programs.
3. Use and interpretation of the assembler listing.
4. Programming considerations.

In addition, the appendixes provide a procedure for dynamic invocation of the assembly, a list and explanation of object output cards, and a sample program listing.

Other System Reference Library publications in the IBM System/360 Operating System series provide fuller, more detailed discussions of the topics introduced in this publication: a careful reading of the publication IBM System/360 Operating System: Concepts and Facilities, Form C28-6535, is recommended. Knowledge of the assembler language is assumed. Where appropriate, the reader is directed to the following publications:

IBM System/360 Operating System: Job Control Language (Form C28-6539)

IBM System/360 Operating System: Storage Estimates (Form C28-6551)

IBM System/360 Operating System: Linkage Editor (Form C28-6538)

IBM System/360 Operating System: Supervisor and Data Management Services (Form C28-6646)

IBM System/360 Operating System: Supervisor and Data Management Macro Instructions (Form C28-6647)

IBM System/360 Operating System: TESTRAN (Form C28-6648)

IBM System/360 Operating System: Messages, Completion Codes, and Storage Dumps (Form C28-6631)

IBM System/360 Operating System: Assembler Language (Form C28-6514)

IBM System/360 Operating System: Utilities (Form C28-6586)

IBM System/360 Operating System: FORTRAN IV (E), Library Subprograms (Form C28-6596)

IBM System/360 Operating System: System Programmer's Guide (Form C28-6550)

IBM System/360 Operating System: FORTRAN IV (E) Programmer's Guide (Form C28-6603)

IBM System/360 Operating System: COBOL (E) Programmer's Guide (Form C24-5029)

References to these publications are usually by a short title, e.g., Linkage Editor or Data Management Services.

Fourth Edition (November, 1968)

This is a major revision of, and obsoletes, C26-3756-2 and Technical Newsletter N26-0567. The major changes are addition of Model 91 programming information, improvement in several error message descriptions, and corrections of illustration errors. Changes to the text, and small changes to illustrations, are indicated by a vertical line to the left of the change; changed or added illustrations are denoted by the symbol ● to the left of the caption.

Specifications contained herein are subject to change from time to time. Any such changes will be reported in subsequent revisions or Technical Newsletters.

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ILLUSTRATIONS

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Through the medium of job control statements, the programmer specifies job requirements directly to the operating system, thus eliminating many of the functions previously performed by the operating personnel. The job consists of one or more job steps. For example, the job of assembling, linkage-editing, and executing a source program involves three job steps:

1. Translating the source program, i.e., executing the assembler component of the operating system to produce an object module.
2. Processing the output of the assembler, i.e., executing the linkage-editor component of the operating system to produce a load module.
3. Executing the assembled and linkage-edited program, i.e., executing the load module.

A procedure is a sequence of job control language statements specifying a job. Procedures may enter the system via the input stream or from a library of procedures, which are previously defined and contained in a procedure library. The input stream is the flow of job control statements and, optionally, input data entering the system from one input device. At the sequential scheduling system level of the operating system, only one input stream may exist at a time. (For a description of the operating system environment see IBM System/360 Operating System: Concepts and Facilities.)

The job definition (JOB), execute (EXEC), data definition (DD), and delimiter (/*) job control statements are shown in this publication as they are used to specify assembler processing. Detailed explanations of these statements are given in IBM System/360 Operating System: Job Control Language.

Operating system factors influencing program preparation, such as terminating the program, saving and restoring general registers, and linking of independently produced object modules, are discussed in Programming Considerations, as are guides to determine whether assembler dictionary sizes and complexity limitations of source statements will be exceeded.

ASSEMBLER OPTIONS AND DATA SET REQUIREMENTS

ASSEMBLER OPTIONS

The programmer may specify the following assembler options in the PARM= field of the EXEC statement. They must appear between two apostrophes, separated by commas with no imbedded blanks. They can appear in any order and, if an entry is ommitted, a standard setting will be assumed as shown below under Default Entry.

```
       'DECK    LOAD,    LIST    TEST,   XREF,              RENT'
PARM=    or      or       or      or      or    LINECNT=nn,  or
      'NODECK,NOLOAD,NOLIST,NOTEST,NOXREF,                 NORENT'
```

These options are defined as follows:

DECK -- The object module is placed on the device specified in the SYSPUNCH DD statement.

LOAD -- The object module is placed on the device specified in the SYSGO DD statement.

NOTE: Specification of the parameter LOAD causes object output to be written on a data set with ddname SYSGO. This action occurs independently of the output on SYSPUNCH caused by the parameter DECK. The output on SYSGO and SYSPUNCH is identical except that SYSPUNCH is closed with a disposition of LEAVE, and SYSGO is closed with a disposition of REREAD.

LIST -- An assembler listing is produced.

TEST -- The object module contains the special source symbol table required by the test translator (TESTRAN) routine.

XREF -- The assembler produces a cross-reference table of symbols as part of the listing.

RENT -- The assembler checks for a possible coding violation of program reenterability.

The prefix NO is used with the above options to indicate which options are not wanted. If contradictory options are entered (e.g., LIST, NOLIST), the rightmost option, NOLIST, is used.

LINECNT=nn This parameter specifies the number of lines to be printed between headings in the listing. The permissible range is 01 to 99 lines.

The following is an example of specifying assembler options:

```
EXEC  PGM=IEUASM,PARM='LOAD,NODECK,TEST'
```

DEFAULT ENTRY

If no options are specified, the assembler assumes the following default entry.

```
PARM='NOLOAD,DECK,LIST,NOTEST,XREF,LINECNT=55,NORENT'
```

The cataloged procedures discussed in this guide assume the default entry. However, the programmer may override any or all of the default options (see Overriding Statements in Cataloged Procedures).

ASSEMBLER DATA SET REQUIREMENTS

The assembler requires the following four data sets:

- SYSUT1, SYSUT2, SYSUT3 -- utility data sets used as intermediate external storage.
- SYSIN -- an input data set containing the source statements to be processed.

In addition to the above, four additional data sets may be required:

- SYSLIB -- a data set containing macro definitions (for macro definitions not defined in the source program) and/or source coding to be called for through COPY assembler instructions.
- SYSPRINT -- a data set containing output text for printing (unless NOLIST option is specified).
- SYSPUNCH -- a data set containing object module output usually for punching (unless NODECK option is specified).

- SYSGO -- a data set containing object module output usually for the linkage editor (only if LOAD option is specified).

The above data sets are described in the following text. The ddname that must be used in the DD statement describing the data set appears as the heading for each description.

Ddnames SYSUT1, SYSUT2, SYSUT3

These utility data sets are used by the assembler as intermediate external storage devices when processing the source program. The input/output device(s) assigned to these data sets must be capable of sequential access to records. The assembler does not support multi-volume utility data sets. Refer to the Storage Estimate manual for the space required.

Ddname SYSIN

This data set contains the input to the assembler -- the source statements to be processed. The input/output device assigned to this data set may be either the device transmitting the input stream, or another sequential input device designated by the programmer. The DD statement describing this data set appears in the input stream. The IBM-supplied procedures do not contain this statement.

Ddname SYSLIB

From this data set, the assembler obtains macro definitions and assembler language statements to be called by the COPY assembler instruction. It is a partitioned data set and each macro definition or sequence of assembler statements is a separate member, with the member name being the macro instruction mnemonic or COPY code name. The data set may be defined as SYS1.MACLIB or a user's private macro definition or COPY library. SYS1.MACLIB contains macro definitions for the system macro instructions provided by IBM. A user's private library may be concatenated with SYS1.MACLIB. The two libraries must have the same attributes, i.e., the same blocking factors, block sizes, and record formats. The Job Control Language publication explains the concatenation of data sets.

Ddname SYSPRINT

This data set is used by the assembler to produce a listing. Output may be directed to a printer, magnetic tape, or DASD. The assembler uses the machine code carriage-control characters for this data set.

Ddname SYSPUNCH

The assembler uses this data set to produce the object module. The input/output unit assigned to this data set may be either a card punch or an intermediate storage device (capable of sequential access).

Ddname SYSGO

This is a DASD, magnetic tape, or card punch data set used by the assembler. It contains the same output text as SYSPUNCH. It is used as input for the linkage editor and may also be used as a punch device (see NOTE under Assembler Options).

DEFINING DATA SET CHARACTERISTICS

Before a data set can be made available to a problem program, descriptive information defining the data set must be placed into a data control block for the access routines. Sources of information for the data control block are keyword operands in the DCB macro instruction or, in some cases, the DD statement, data set label, or user's problem program. General information concerning data set definition is contained in the Data Management Services manual (see Preface). Characteristics of data sets supplied by the DCB macro instruction are described in the Data Management Macro-Instructions manual (see Preface).

The specific information that must be supplied depends upon the data set organization and access method. The following access methods are used to process the assembler data sets:

Access Method	Data Sets
QSAM (Queued Sequential)	SYSPRINT, SYSPUNCH, SYSGO, SYSIN
BSAM (Basic Sequential)	SYSUT1, SYSUT2, SYSUT3
BPAM (Basic Partitioned)	SYSLIB

Table 1 summarizes the assembler capabilities and restrictions on record length

●Table 1. Data Set Characteristics

	SYSIN	SYSLIB	SYSPRINT	SYSPUNCH	SYSGO	SYSUT1 SYSUT2 SYSUT3
LRECL	Fixed at 80	Fixed at 80	Fixed at 121	Fixed at 80	Fixed at 80	N/A
RECFM ①	User must specify in LABEL or DD card F, FS, FBS, FB, FBST, FBT	User must specify in LABEL or DD card F, FS, FBS, FB, FBST, FBT	Set by assembler: if BLKSIZE=LRECL, RECFM=FSM; if BLKSIZE>LRECL, RECFM=FBSM	Set by assembler: if BLKSIZE=LRECL, RECFM=FS; if BLKSIZE>LRECL, RECFM=FBS	Set by assembler: if BLKSIZE=LRECL, RECFM=FS; if BLKSIZE>LRECL, RECFM=FBS	Fixed for U
BLKSIZE ②	User must specify in LABEL or DD card, must be a multiple of LRECL	User must specify in LABEL or DD card, must be a multiple of LRECL	Optional, but must be a multiple of LRECL; if omitted BLKSIZE=LRECL	Optional, but must be a multiple of LRECL; if omitted BLKSIZE=LRECL	Optional, but must be a multiple of LRECL; if omitted BLKSIZE=LRECL	User can not specify; maximum of 4000, minimum of 1739
BUFNO	Optional; if omitted 2 is used	Set by assembler to 1	Optional; if omitted 2 is used	Optional; if omitted 3 is used for unit record and 1 for other devices	Optional; if omitted 3 is used for unit record and 1 for other devices	User can not specify; either 1 or 2
For 44K availability	BLKSIZE times BUFNO can not be greater than 3600	BLKSIZE can not be greater than 3600	BLKSIZE times BUFNO can not be greater than 1210	BLKSIZE times BUFNO can not be greater than 400	BLKSIZE times BUFNO can not be greater than 400	
For calculating core requirements	L1 = BLKSIZE times BUFNO	L2 = BLKSIZE	L3 = BLKSIZE times BUFNO	L4 = BLKSIZE times BUFNO	L5 = BLKSIZE times BUFNO	

③ Minimum core required for the assembler is the largest of the following:
(1) 45056
(2) $L_1 + L_2 + 37000$
(3) $L_3 + L_4 + L_5 + 37000$

③ Maximum core that the assembler can effectively use = $L_4 + L_5 + 535,000$

① U = undefined, F = fixed length records, B = blocked records, S = standard blocks, T = track overflow, M = machine code carriage control

② Blocking is not allowed on unit record devices. Blocking on other direct access can not be greater than the track size unless T is specified on RECFM

③ For MVT environment add 5,000 for core required and format, as well as the blocksize buffering facilities available to the user. The values shown in Table 1 are based upon the minimum core requirements of Assembler F (44K), which will allow a symbol table length of approximately 7000 bytes. If more than 44K is available, the block sizes and buffer numbers can be increased. However, if the user specifies a combination of blocking and buffering which does not leave room for the symbol table, abnormal termination of the task may occur (ABEND 804) when the assembler attempts to issue a GETMAIN macro instruction.

In addition to the data set characteristics shown in Table 1, the following options are available to the user (refer to the Supervisor and Data Management Macro-Instructions publication). Options not shown below are fixed by the assembler and cannot be specified.

Data Sets	Options
SYSIN, SYSPUNCH, SYSPRINT, SYSGO	DEVD (device type) BFALN (buffer boundary alignment) BUFL (buffer length) EROPT (error option)
SYSUT1, 2, 3	DEVD (device type) OPTCD (optional service for validity checking and chained scheduling)

RETURN CODES

Table 2 shows the return codes issued by the assembler for use with the COND= parameter of JOB or EXEC statements. The COND= parameter is explained in the Job Control Language publication.

The return code issued by the assembler is the highest severity code that is:

1. Associated with any error detected by the assembler (see Appendix A for diagnostic messages and severity codes).
2. Associated with MNOTE messages produced by macro instructions.
3. Associated with an unrecoverable I/O error occurring during the assembly.

If a permanent I/O error occurs on any of the assembler files or a DD card for a required data set is missing, a message is printed on the operator's console and a return with a user return code of 20 is given by the assembler. This terminates the assembly.

Table 2. Return Codes

Return Code	Explanation
0	No errors detected
4	Minor errors detected; successful program execution is probable
8	Errors detected; unsuccessful program execution is possible
12	Serious errors detected; unsuccessful program execution is probable
16	Critical errors detected; normal execution is impossible
20	Unrecoverable I/O error occurred during assembly or missing data sets; assembly terminated

CATALOGED PROCEDURES

This section describes three IBM-provided cataloged procedures: a procedure for assembling (ASMFC), a procedure for assembling and linkage editing (ASMFCL), and a procedure for assembling, linkage editing, and executing (ASMFCLG). The procedures rely on conventions regarding the naming of device classes. These conventions, shown in Table 3, must be incorporated into the system at system generation time.

Table 3. Device Naming Conventions

Device Classname	Devices Assigned
SYSSQ	Any devices allowing sequential access to records for reading and writing
SYSDA	Direct-access devices
SYSCP	Card punches

To use cataloged procedures, EXEC statements naming the desired procedures are placed in the input stream following the JOB statement. Subsequently, the specified cataloged procedure is brought from a procedure library and merged into the input stream.

The System Programmer's Guide discusses the placing of procedures in the procedure library.

CATALOGED PROCEDURE FOR ASSEMBLY (ASMFC)

This procedure requests the operating system to load and execute the assembler. The name ASMFC must be used to call this procedure. The result of execution is an object module, in punched card form, and an assembler listing.

In the following example, input enters via the input stream. The statements entered in the input stream to use this procedure are:

```
//jobname      JOB
//stepname     EXEC PROC=ASMFC
//ASM.SYSIN    DD    *
                |
                |
     source program statements
                |
                |
/*   (delimiter statement)
```

The statements of the ASMFC procedure are brought from the procedure library and merged into the input stream.

Figure 1 shows the statements that make up the ASMFC procedure.

```
1 //ASM        EXEC  PGM=IEUASM,REGION=50K

2 //SYSLIB     DD    DSNAME=SYS1.MACLIB,DISP=SHR

3 //SYSUT1     DD    UNIT=SYSSQ,SPACE=(1700, (400,50))

4 //SYSUT2     DD    UNIT=SYSSQ,SPACE=(1700, (400,50))

5 //SYSUT3     DD    UNIT=(SYSSQ,SEP=(SYSUT2,SYSUT1,SYSLIB)),              X
  //                 SPACE=(1700,(400,50))

6 //SYSPRINT   DD    SYSOUT=A

7 //SYSPUNCH   DD    SYSOUT=B
         ----------
         ----------
```

1 PARM= or COND= parameters may be added to this statement by the EXEC statement that calls the procedure (see Overriding Statements in Cataloged Procedures). The system name IEUASM identifies Assembler F.

2 This statement identifies the macro library data set. The data set name SYS1.MACLIB is an IBM designation.

3 4 5 These statements specify the assembler utility data sets. The device classname used here, SYSSQ, may represent a collection of tape drives, or direct-access units, or both. The I/O units assigned to this name are specified by the installation when the system is generated. A unit name, e.g., 2311 may be substituted for SYSSQ.

The SEP= subparameter in statement 5 and the SPACE= parameter in statements 3, 4, and 5 are effective only if the device assigned is a direct-access device: otherwise they are ignored. The space required is dependent on the make-up of the source program.
The Job Control Language publication explains space allocation.

6 This statement defines the standard system output class, SYSOUT=A, as the destination for the assembler listing.

7 This statement describes the data set that will contain the object module produced by the assembler.

Figure 1. Cataloged Procedure for Assembly (ASMFC)

CATALOGED PROCEDURE FOR ASSEMBLY AND LINKAGE EDITING (ASMFCL)

This procedure consists of two job steps: assembling and linkage editing. The name ASMFCL must be used to call this procedure. Execution of this procedure results in the production of an assembler listing, a linkage editor listing, and a load module.

The following example assumes input to the assembler via the input job stream. It also makes provision in the //LKED job step for concatenating the input to the linkage editor from the //ASM job step with any additional linkage editor input in the input job stream. This additional input can be a previously produced object module which is to be linked to the object module produced by job step //ASM.

An example of the statements entered in the input stream to use this procedure is:

```
//jobname        JOB
//stepname       EXEC PROC=ASMFCL
//ASM.SYSIN      DD    *
                 |
                 |
  source program statements
                 |
                 |
/*               |
//LKED.SYSIN     DD     *  }
                 |         }
                 |         }  necessary only if linkage
   object module or        }  editor is to combine modules
   linkage editor          }  or read linkage editor control
   control statements      }  information from the job stream
/*
```

The procedure is brought from the procedure library and merged into the input stream.

Figure 2 shows the statements that make up the ASMFCL procedure. Only those statements not previously discussed are explained.

```
  //ASM       EXEC  PGM=IEUASM,PARM=LOAD,REGION=50K

  //SYSLIB    DD    DSNAME=SYS1.MACLIB,DISP=SHR

  //SYSUT1    DD    UNIT=SYSSQ,SPACE=(1700,(400,50))

  //SYSUT2    DD    UNIT=SYSSQ,SPACE=(1700,(400,50))

  //SYSUT3    DD    UNIT=(SYSSQ,SEP=(SYSUT2,SYSUT1,SYSLIB)),           X
  //                SPACE=(1700,(400,50))

  //SYSPRINT  DD    SYSOUT=A

  //SYSPUNCH  DD    SYSOUT=B
1
  //SYSGO     DD    DSNAME=&LOADSET,UNIT=SYSSQ,SPACE=(80,(100,50)),     X
  //                DISP=(MOD,PASS)
2
  //LKED      EXEC  PGM=IEWL,PARM=(XREF,LIST,NCAL),REGION=96K,         X
  //                COND=(8,LT,ASM)
3
4 //SYSLIN    DD    DSNAME=&LOADSET,DISP=(OLD,DELETE)
  //          DD    DDNAME=SYSIN
5
  //SYSLMOD   DD    DSNAME=&TEMP(PDS),UNIT=SYSDA,SPACE=(1024,(50,20,1)), X
  //                DISP=(MOD,PASS)
6
  //SYSUT1    DD    UNIT=(SYSDA,SEP=(SYSLIN,SYSLMOD)),SPACE=(1024,(50,20))
7
  //SYSPRINT  DD    SYSOUT=A,DCB=(,BLKSIZE=121)
       ------------
```

[1] In this procedure the SYSGO DD statement describes a temporary data set -- the object module -- which is to be passed to the linkage editor.

[2] This statement initiates linkage editor execution. The linkage editor options in the PARM= field cause the linkage editor to produce a cross-reference table, module map, and a list of all control statements processed by the linkage editor. The NCAL option suppresses the automatic library call function of the linkage editor.

[3] This statement identifies the linkage editor input data set as the same one produced as output by the assembler.

[4] This statement is used to concatenate any input to the linkage editor from the input stream with the input from the assembler.

[5] This statement specifies the linkage-editor output data set (the load module). As specified, the data set will be deleted at the end of the job. If it is desired to retain the load module, the DSNAME parameter must be respecified and a DISP parameter added. See Overriding Statements in Cataloged Procedures. If the output of the linkage editor is to be retained, the DSNAME parameter must specify a library name and member name where the load module is to be placed. The DISP parameter must specify either KEEP or CATLG.

[6] This statement specifies the utility data set for the linkage editor.

[7] This statement identifies the standard output class as the destination for the linkage editor listing.

●Figure 2. Cataloged Procedure for Assembling and Linkage Editing (ASMFCL)

CATALOGED PROCEDURE FOR ASSEMBLY, LINKAGE EDITING, AND EXECUTION (ASMFCLG)

This procedure consists of three job steps: assembling, linkage editing, and executing.

Figure 3 shows the statements that make up the ASMFCLG procedure. Only those statements not previously discussed are explained in the figure.

The name ASMFCLG must be used to call this procedure. Assembler and linkage editor listings are produced.

The statements entered in the input stream to use this procedure are:

```
//jobname      JOB
//stepname     EXEC PROC=ASMFCLG
//ASM.SYSIN    DD    *
                |
                |
     source program statements
                |
                |
/*              |                    )
//LKED.SYSIN   DD    *               |
                |                    |  necessary only if linkage
                |                    |  editor is to combine modules
        object module or             |  or read linkage editor control
        linkage editor               |  information from the job stream
        control statements           )
/*              |
//GO.ddname    DD    (parameters)    )
//GO.ddname    DD    (parameters)    |
//GO.ddname    DD    *               |  only if
                |                    |  necessary
                |                    |
    problem program input            )
                |
/*              |
```

```
   //ASM       EXEC  PGM=IEUASM,PARM=LOAD,REGION=50K

   //SYSLIB    DD    DSNAME=SYS1.MACLIB,DISP=SHR

   //SYSUT1    DD    UNIT=SYSSQ,SPACE=(1700,(400,50))

   //SYSUT2    DD    UNIT=SYSSQ,SPACE=(1700,(400,50))

   //SYSUT3    DD    UNIT=(SYSSQ,SEP=(SYSUT2,SYSUT1,SYSLIB)),             X
   //                SPACE=(1700,(400,50))

   //SYSPRINT  DD    SYSOUT = A

   //SYSPUNCH  DD    SYSOUT=B

   //SYSGO     DD    DSNAME=&LOADSET,UNIT=SYSSQ,SPACE=(80,(100,50)),       X
   //                DISP=(MOD,PASS)
1  //LKED      EXEC  PGM=IEWL.PARM=(XREF,LET,LIST,NCAL),REGION=96K,        X
   //                COND=(8,LT,ASM)

   //SYSLIN    DD    DSNAME=&LOADSET,DISP=(OLD,DELETE)
   //          DD    DDNAME=SYSIN

2  //SYSLMOD   DD    DSNAME=&GOSET(GO),UNIT=SYSDA,SPACE=(1024,(50,20,1)), X
   //                DISP=(MOD,PASS)

   //SYSUT1    DD    UNIT=(SYSDA,SEP=(SYSLIN,SYSLMOD)),SPACE=(1024,(50,20))

   //SYSPRINT  DD    SYSOUT=A,DCB=(,BLKSIZE=121)

3  //GO        EXEC  PGM=*.LKED.SYSLMOD,COND=((8,LT,ASM) , (4,LT,LKED))
       ----------
       ----------
```

[1] The LET linkage-editor option specified in this statement causes the linkage editor to mark the load module as executable even though errors were encountered during processing.

[2] The output of the linkage editor is specified as a member of a temporary data set, residing on a direct-access device, and is to be passed to a succeeding job step.

[3] This statement initiates execution of the assembled and linkage edited program. The notation *.LKED.SYSLMOD identifies the program to be executed as being in the data set described in job step LKED by the DD statement named SYSLMOD. When running with MVT (Option 4) the REGION parameter can be calculated with the help of the Storage Estimates publication (see preface).

Figure 3. Cataloged Procedure for Assembly, Linkage Editing and Execution (ASMFCLG)

OVERRIDING STATEMENTS IN CATALOGED PROCEDURES

Any parameter in a cataloged procedure can be overridden except the PGM= parameter in the EXEC statement. Such overriding of statements or fields is effective only for the duration of the job step in which the statements appear. The statements, as stored in the procedure library of the system, remain unchanged.

Overriding for the purposes of respecification, addition, or nullification is accomplished by including in the input stream statements containing the desired changes and identifying the statements to be overridden.

EXEC Statements

The PARM= and COND= parameters can be added or, if present, re-specified by including in the EXEC statement calling the procedure the notation PARM.stepname=, or COND.stepname=, followed by the desired parameters. "Stepname" identifies the EXEC statement within the procedure to which the modification applies. Overriding the PGM= parameter is not possible.

If the procedure consists of more than one job step, a PARM.stepname= or COND. stepname= parameter may be entered for each step. The entries must be in order, i.e., PARM.step1=, PARM.step2=, etc.

DD Statements

All parameters in the operand field of DD statements may be overridden by including in the input stream (following the EXEC card calling the procedure) a DD statement with the notation //stepname.ddname in the name field. "Stepname" refers to the job step in which the statement identified by "ddname" appears.

Examples

In the assembly procedure ASMFC (Figure 1), the production of a punched object deck could be suppressed and the UNIT= and SPACE= parameters of data set SYSUT1 re-specified, by including the following statements in the input stream:

```
//stepname      EXEC      PROC=ASMFC,              X
//                        PARM.ASM=NODECK

//ASM.SYSUT1    DD        UNIT=2311,               X
//                        SPACE=(200,(300,40))

//ASM.SYSIN     DD        *
```

In procedure ASMFCLG (Figure 3), suppressing production of an assembler listing and adding the COND= parameter to the EXEC statement, which specifies execution of the linkage editor, may be desired. In this case, the EXEC statement in the input stream would appear as follows:

```
//stepname    EXEC    PROC=ASMFCLG,                    X
//                    PARM.ASM=(NOLIST,LOAD),          X
                      COND.LKED=(8,LT,stepname.ASM)
```

NOTE: Overriding the LIST parameter effectively deletes the PARM=LOAD so this must be repeated in the override statement.

For current execution of procedure ASMFCLG, no assembler listing would be produced, and execution of the linkage editor job step //LKED would be suppressed if the return code issued by the assembler (step ASM) was greater than 8. Using the procedure ASMFCL (Figure 2) to:

1. Read input from a non-labeled 9-track tape on unit 282 that has a standard blocking factor of 10.
2. Put the output listing on a labeled tape VOLID=TAPE10, with a data set name of PROG1 and a blocking factor of 5.
3. Block the SYSGO output of the assembler and use it as input to the linkage editor with a blocking factor of 5.
4. Link edit the module only if there are no errors in the assembler, i.e., COND=0.
5. Link edit on to a previously allocated and cataloged data set USER.LIBRARY with a member name of PROG, the input stream appears as follows:

```
//jobname         JOB
//stepname        EXEC   PROC=ASMFCL,                             X
//                       COND.LKED=(0,NE,stepname.ASM)
//ASM.SYSPRINT    DD     DSNAME=PROG1,UNIT=TAPE,                  X
//                       VOLUME=SER=TAPE10,DCB=(BLKSIZE=605)
//ASM.SYSGO       DD     DCB=(BLKSIZE=400)
//ASM.SYSIN       DD     UNIT=282,LABEL=(,NL),                    X
//                       DCB=(RECFM=FSB,BLKSIZE=800)
//LKED.SYSIN      DD     DCB=stepname.ASM.SYSGO
//LKED.SYSLMOD    DD     DSNAME=USER.LIBRARY(PROG),DISP=OLD
/*
```

NOTE: The order of appearance of ddnames within job steps ASM and LKED has been preserved. Thus, SYSPRINT precedes SYSGO within step ASM. The ddname ASM.SYSIN was placed last since SYSIN does not occur at all within step ASM. These points are covered in the section Using Cataloged Procedures in the Job Control Language manual.

To assemble two programs, link edit the two assemblies into one load module and execute the load module. Entering at PROC, the input stream appears as follows:

```
//stepname1     EXEC    PROC=ASMFC,PARM.ASM='LOAD'
//ASM.SYSGO     DD      DSNAME=&LOADSET,UNIT=SYSSQ,          X
//                      SPACE=(80,(100,50)),                 X
//                      DISP=(MOD,PASS),DCB=(BLKSIZE=400)
//ASM.SYSIN     DD      *
                        .
                        .
                        .
                        source program 1 statements
                        .
                        .
/*                      .
//stepname2     EXEC    PROC=ASMFCLG
//ASM.SYSGO     DD      DCB=(BLKSIZE=400),DISP=(MOD,PASS)
//ASM.SYSIN     DD      *
                        .
                        .
                        .
                        source program 2 statements
                        .
                        .
                        .
/*                      .
//LKED.SYSLIN   DD      DCB=(RECFM=FB,BLKSIZE=400)
//LKED.SYSIN    DD      *
                ENTRY   PROG
/*
//GO.ddname             dd cards for GO step
```

The overriding step with ddname =LKED.SYSLIN is necessary whenever output from an assembler and output from at least one or more processors(including the assembler) is placed on SYSLIN. The DCB=(RECFM=FB,...) allows the linkage editor to process all the blocked input. Otherwise it will stop reading SYSLIN whenever it encounters a partial block. Such a situation arises if, say, the first assembly produces 22 cards. These 22 cards result in 4 full blocks of 400 bytes (5 times 80) plus 1 partial block of 160 bytes (2 times 80).

The Job Control Language and System Programmer's Guide publications provide additional description of overriding techniques.

The assembler listing (Figure 4) consists of five sections, ordered as follows: external symbol dictionary items, the source and object program statements, relocation dictionary items, symbol cross reference table, and diagnostic messages. In addition, three statistical messages may appear in the listing:

1. After the diagnostics, a statements-flagged message indicates the total number of statements in error. It appears as follows: nnn STATEMENTS FLAGGED IN THIS ASSEMBLY.
2. After the statements-flagged message, the assembler prints the highest severity code encountered (if non-zero). This is equal to the assembler return code. The message appears as follows: nn WAS HIGHEST SEVERITY CODE.
3. After the severity code, the assembler prints a count of lines printed, which appears as follows: nnn PRINTED LINES. This is a count of the actual number of 121-byte records generated by the assembler; it may be less than the total number of printed and blank lines appearing on the listing if the SPACE n assembler instruction is used. For a SPACE n that does not cause an eject, the assembler inserts n blank lines in the listing by generating n/3 blank 121-byte records -- rounded to the next lower integer if a fraction results; e.g., for a SPACE 2, no blank records are generated. The assembler does not generate a blank record to force a page eject.

In addition to the above items, the assembler prints the deck identification and current date on every page of the listing. If the timer is available, the assembler prints the time of day to the left of the date on page 1 of the ESD listing. This is the time when printing starts, rather than the start of the assembly, and is intended only to provide unique identification for assemblies made on the same day. The time is printed as hh.mm, where hh is the hour of the day (midnight beginning at 00), and mm is the number of minutes past the hour.

EXTERNAL SYMBOL DICTIONARY (ESD)

This section of the listing contains the external symbol dictionary information passed to the linkage-editor in the object module. The entries describe the control sections, external references, and entry points in the assembled program. There are six types of entries, shown in Table 4, along with their associated fields. The circled numbers refer to the corresponding heading in the sample listing (Figure 4). The Xs indicate entries accompanying each type designation.

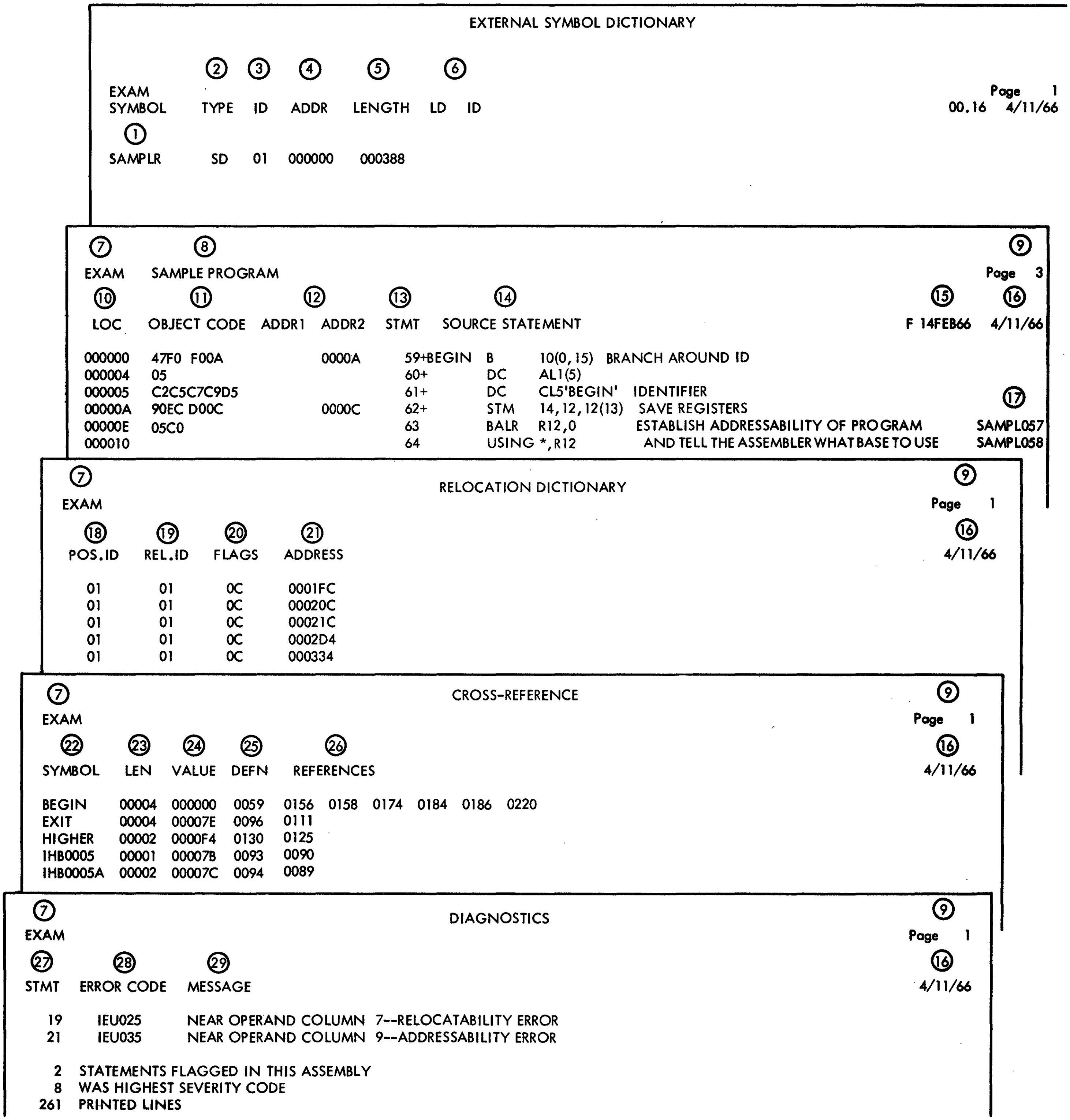
Table 4. Types of ESD Entries

①	②	③	④	⑤	⑥
SYMBOL	TYPE	ID	ADDR	LENGTH	LD ID
X	SD	X	X	X	-
X	LD	-	X	-	X
X	ER	X	-	-	-
-	PC	X	X	X	-
-	CM	X	X	X	-
X	XD	X	X	X	-

1. This column contains the name of every external dummy section, control section, entry point, and external symbol.
2. This column contains the type designator for the entry, as shown in the table. The type designators are defined as:

   SD--Names section definition. The symbol appeared in the name field of a CSECT or START statement.
   LD--The symbol appeared as the operand of the ENTRY statement.
   ER--External reference. The symbol appeared as the operand of an EXTRN statement, or was defined as a V-type address constant.
   PC--Unnamed control section definition.
   CM--Common control section definition.
   XD--External dummy section.

3. This column contains the external symbol dictionary identification number (ESDID). The number is a unique two-digit hexadecimal number identifying the entry. It is used by the LD entry of the ESD and by the relocation dictionary for cross-referencing the ESD.
4. This column contains the address of the symbol (hexadecimal notation) for SD- and LD-type entries, and zeros for ER-type entries. For PC- and CM-type entries, it indicates the beginning address of the control section. For



1
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```
                              EXTERNAL SYMBOL DICTIONARY

EXAM                                                                    Page    1
SYMBOL    TYPE  ID   ADDR     LENGTH   LD  ID                          00.16  4/11/66

SAMPLR     SD   01   000000   000388
```

```
EXAM     SAMPLE PROGRAM                                                              Page  3

LOC      OBJECT CODE  ADDR1  ADDR2   STMT    SOURCE STATEMENT                   F 14FEB66  4/11/66

000000   47F0 F00A           0000A   59+BEGIN  B      10(0,15)  BRANCH AROUND ID
000004   05                          60+       DC     AL1(5)
000005   C2C5C7C9D5                  61+       DC     CL5'BEGIN'  IDENTIFIER
00000A   90EC D00C           0000C   62+       STM    14,12,12(13)  SAVE REGISTERS
00000E   05C0                        63        BALR   R12,0       ESTABLISH ADDRESSABILITY OF PROGRAM       SAMPL057
000010                               64        USING  *,R12        AND TELL THE ASSEMBLER WHAT BASE TO USE  SAMPL058
```

```
EXAM                               RELOCATION DICTIONARY                    Page    1

POS.ID   REL.ID   FLAGS   ADDRESS                                           4/11/66

 01       01       0C     0001FC
 01       01       0C     00020C
 01       01       0C     00021C
 01       01       0C     0002D4
 01       01       0C     000334
```

```
EXAM                             CROSS-REFERENCE                          Page    1

SYMBOL     LEN     VALUE    DEFN   REFERENCES                             4/11/66

BEGIN      00004   000000   0059   0156  0158  0174  0184  0186  0220
EXIT       00004   00007E   0096   0111
HIGHER     00002   0000F4   0130   0125
IHB0005    00001   00007B   0093   0090
IHB0005A   00002   00007C   0094   0089
```

```
EXAM                               DIAGNOSTICS                            Page    1

STMT   ERROR CODE   MESSAGE                                               4/11/66

  19    IEU025      NEAR OPERAND COLUMN  7--RELOCATABILITY ERROR
  21    IEU035      NEAR OPERAND COLUMN  9--ADDRESSABILITY ERROR

   2  STATEMENTS FLAGGED IN THIS ASSEMBLY
   8  WAS HIGHEST SEVERITY CODE
 261  PRINTED LINES
```

Figure 4. Assembler Listing

XD-type entries, it indicates the alignment by printing a number one less than the number of bytes in the unit of alignment, e.g., 7 indicates double word alignment.

5. This column contains the assembled length, in bytes, of the control section (hexadecimal notation).
6. This column contains, for LD-type entries, the identification (ID) number assigned to the ESD entry that identifies the control section in which the symbol was defined.

SOURCE AND OBJECT PROGRAM

This section of the listing documents the source statements and the resulting object program.

7. This is the four-character deck identification. It is the symbol that appears in the name field of the first TITLE statement. The assembler prints the deck identification and date (item 16) on every page of the listing.
8. This is the information taken from the operand field of a TITLE statement.

   NOTE: TITLE, SPACE and EJECT statements will not appear in the source listing unless the statement is continued onto another card. Then the first card of the statement is printed. However, any of these three types of statements, if generated as macro instruction expansion, will never be listed regardless of continuation.

9. Listing page number. Each section of the listing starts with page 1.
10. This column contains the assembled address (hexadecimal notation) of the object code.
11. This column contains the object code produced by the source statement. The entries are always left-justified. The notation is hexadecimal. Entries are machine instructions or assembled constants. Machine instructions are printed in full with a blank inserted after every four digits (two bytes). Constants may be only partially printed (see the PRINT assembler instruction in the Assembler Language publication).
12. These two columns contain effective addresses (the result of adding together a base register value and displacement value):

    a. The column headed ADDR1 contains the effective address for the first operand of an SS instruction.
    b. The column headed ADDR2 contains the effective address of the second operand of any instruction referencing storage.

    Both address fields contain six digits; however, if the high-order digit is a zero, it is not printed.
13. This column contains the statement number. A plus sign (+) to the right of the number indicates that the statement was generated as the result of macro instruction processing.
14. This column contains the source program statement. The following items apply to this section of the listing:

    a. Source statements are listed, including those brought into the program by the COPY assembler instruction, and including macro definitions submitted with the main program for assembly. Listing control instructions are not printed, except for the following case: PRINT is listed when PRINT ON is in effect and a PRINT statement is encountered.
    b. Macro definitions obtained from SYSLIB are not listed.
    c. The statements generated as the result of a macro instruction follow the macro instruction in the listing.
    d. Assembler or machine instructions in the source program that contain variable symbols are listed twice: as they appear in the source input, and with values substituted for the variable symbols.
    e. Diagnostic messages are not listed inline in the source and object program section. An error indicator, ***ERROR***, follows the statement in error. The message appears in the diagnostic section of the listing.
    f. MNOTE messages are listed inline in the source and object program section. An MNOTE indicator appears in the diagnostic section of the listing for MNOTE statements other than MNOTE*. The MNOTE message format is severity code, message text.
    g. The MNOTE* form of the MNOTE statements results in an inline message only. An MNOTE indicator does not appear in the diagnostic section of the listing.
    h. When an error is found in a programmer macro definition, it is treated the same as any other assembly error: the error indication appears after the statement in error, and a diagnostic is placed in the list of diagnostics. However, when an error is encountered during the expansion of a macro instruction (system- or programmer-defined), the error indication appears in place of the erroneous statement, which is not listed. The error indication follows the last statement listed before the

erroneous statement was encountered, and the associated diagnostic message is placed in the list of diagnostics.

i. Literals that have not been assigned locations by an LTORG statement appear in the listing following the END statement. Literals are identified by the equal (=) sign preceding them.

j. If the END statement contains an operand, the transfer address appears in the location column (LOC).

k. In the case of COM, CSECT, and DSECT statements, the location field contains the beginning address of these control sections, i.e., the first occurrence.

l. In the case of EXTRN, ENTRY, and DXD instructions, the location field and object code field are blank.

m. For a USING statement, the location field contains the value of the first operand.

n. For LTORG and ORG statements, the location field contains the location assigned to the literal pool or the value of the ORG operand.

o. For an EQU statement, the location field contains the value assigned.

p. Generated statements always print in normal statement format. Because of this, it is possible for a generated statement to occupy three or more continuation lines on the listing. This is unlike source statements, which are restricted to two continuation lines.

15. This column contains the identifier of the assembler (F) and the date when this version was released by Systems Development Division to DPD Program Information Department.

16. Current date (date run is made).

17. Identification-sequence field from the source statement.

RELOCATION DICTIONARY

This section of the listing contains the relocation dictionary information passed to the linkage editor in the object module. The entries describe the address constants in the assembled program that are affected by relocation.

18. This column contains the external symbol dictionary ID number assigned to the ESD entry that describes the control section in which the address constant is used as an operand.

19. This column contains the external symbol dictionary ID number assigned to the ESD entry that describes the control section in which the referenced symbol is defined.

20. The two-digit hexadecimal number in this column is interpreted as follows:

<u>First Digit</u>. A zero indicates that the entry describes an A-type or Q-type address constant. A one indicates that the entry describes a V-type address constant. A three describes a CXD entry.

<u>Second Digit</u>. The first three bits of this digit indicate the length of the constant and whether the base should be added or subtracted:

Bits 0 and 1	Bit 2
00 = 1 byte	0 = +
01 = 2 bytes	1 = -
10 = 3 bytes	
11 = 4 bytes	

21. This column contains the assembled address of the field where the address constant is stored.

CROSS REFERENCE

This section of the listing information concerns symbols which are defined and used in the program.

22. This column contains the symbols.

23. This column states the length (decimal notation), in bytes, of the field occupied by the symbol value.

24. This column contains either the address the symbol represents, or a value to which the symbol is equated.

25. This column contains the statement number of the statement in which the symbol was defined.

26. This column contains the statement numbers of statements in which the symbol appears as an operand. In the case of a duplicate symbol, the assembler fills this column with the message:

****DUPLICATE****

The following notes apply to the cross-reference section:

- Symbols appearing in V-type address constants do not appear in the cross-reference listing.

- A PRINT OFF listing control instruction does not affect the production of the cross-reference section of the listing.

- In the case of an undefined symbol, the assembler fills columns 23, 24, and 25 with the message:

  ****UNDEFINED****.

DIAGNOSTICS

This section contains the diagnostic messages issued as a result of error conditions encountered in the program. The text, severity code, and explanatory notes for each message are contained in Appendix A.

27. This column contains the number of the statement in error.
28. This column contains the message identifier.
29. This column contains the message, and, in most cases, an operand column pointer that indicates the vicinity of the error. In the following example, the approximate location of the addressability error occurred in the 9th column of the operand field:

    Example:

```
STMT  ERROR CODE  MESSAGE

 21   IEU035      NEAR OPERAND COLUMN 9 -- ADDRESSABILITY ERROR
```

The following notes apply to the diagnostic section:

- An MNOTE indicator of the form MNOTE STATEMENT appears in the diagnostic section if an MNOTE statement other than MNOTE* is issued by a macro instruction. The MNOTE statement itself is inline in the source and object program section of the listing. The operand field of an MNOTE* is printed as a comment, but does not appear in the diagnostic section.

- A message identifier consists of six characters and is of the form: IEUxxx

  IEU identifies the issuing agent as Assembler F, and xxx is a unique number assigned to the message.

NOTE: Editing errors in system macro instructions are discovered at the time the macro instruction is read from the library, i.e., after the END statement. To determine the location of these errors it is necessary to punch all system macro instructions, including inner macro instructions, and insert them in the source program as programmer macro instructions. To aid in debugging, it is advisable to run all macro instructions as programmer macro instructions before incorporating them as system macro instructions.

PROGRAMMING CONSIDERATIONS

This section consists of a number of discrete subjects about assembler language programming.

SAVING AND RESTORING GENERAL REGISTER CONTENTS

A problem program should save the values contained in the general registers upon commencing execution and, upon completion, restore to the general registers these same values. Thus, as control is passed from the operating system to a problem program and, in turn, to a subprogram, the status of the registers used by each program is preserved. This is done through use of the SAVE and RETURN system macro instructions.

The SAVE macro instruction should be the first statement in the program. It stores the contents of registers 14, 15, and 0 through 12 in an area provided by the program that passes control. When a problem program is given control, register 13 points to an area in which the general register contents should be saved.

If the program calls any subprograms, or uses any operating system services other than GETMAIN, FREEMAIN, ATTACH, and XCTL, it must first save the contents of register 13 and then load the address of an 18 full-word save area into register 13. This save area is in the problem program and is used by any subprograms or operating system services called by the problem program.

At completion, the problem program restores the contents of general registers 14, 15 and 0-12 by use of the RETURN system macro instruction (which also indicates program completion). The contents of register 13 must be restored before execution of the RETURN macro instruction.

The coding sequence that follows illustrates the basic process of saving and restoring the registers. A complete discussion of the SAVE and RETURN macro instructions and the saving and restoring of registers is contained in the Data Management Services and Data Management Macro-Instructions publications (see Preface).

Name	Operation	Operand
BEGIN	SAVE	(14,12)
	.	
	.	set up base register
	.	
	ST	13,SAVEBLK+4
	LA	13,SAVEBLK
	.	
	.	
	L	13,SAVEBLK+4
	RETURN	(14,12)
SAVEBLK	DC	18F'0'

PROGRAM TERMINATION

Completion of an assembler source program is indicated by using the RETURN system macro instruction to pass control from the terminating program to the program that initiated it. The initiating program may be the operating system or, if a subprogram issued the RETURN, the program that called it.

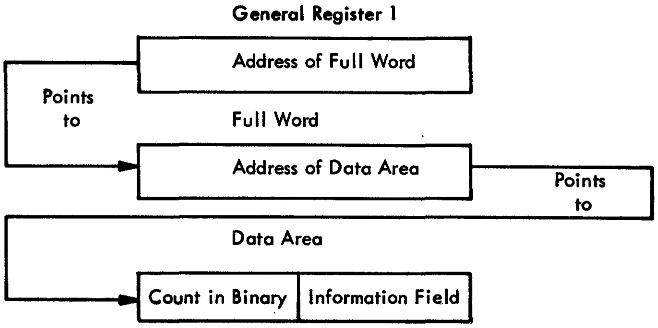
In addition to indicating program completion and restoring registers, the RETURN macro instruction may also pass a return code -- a condition indicator that may be used by the program receiving control. If the return is to the operating system, the return code is compared against the condition stated in the COND= parameter of the JOB or EXEC statements. If return is to another problem program, the return code is available in general register 15, and may be used as desired. Register 13 should be restored before issuing the RETURN macro instruction.

The RETURN system macro instruction is discussed in detail in the Supervisor and Data Management Macro Instructions publication.

PARM FIELD ACCESS

Access to information in the PARM field of an EXEC statement is gained through general register 1. When control is given to the problem program, general register 1 contains the address of a full word which, in turn, contains the address of the data area containing the information.

The data area consists of a halfword containing the count (in binary) of the number of information characters, followed by the information field. The information field is aligned to a full-word boundary. The following diagram illustrates this process.



MACRO DEFINITION LIBRARY ADDITIONS

Source statement coding, to be retrieved by the COPY assembler instruction, and macro definitions may be added to the macro library. The IEBUPDTE utility program is used for this purpose. Details of this program and its control statements are contained in the Utilities publication. The following sequence of job control statements can be used to call the utility program and identify the needed data sets. It is assumed that the job control statements, IEBUPDTE program control statements, and data are to enter the system via the input stream.

```
//jobname     JOB
//stepname    EXEC   PGM=IEBUPDTE,PARM=MOD
//SYSUT1      DD     DSNAME=SYS1.MACLIB,DISP=OLD
//SYSUT2      DD     DSNAME=SYS1.MACLIB,DISP=OLD
//SYSPRINT    DD     SYSOUT=A
//SYSIN       DD     *
               .
               .
               .
IEBUPDTE control statements and source statements or
macro-definitions to be added to the macro-library
(SYS1.MACLIB)
               .
               .
               .
/* (delimiter statement)
```

LOAD MODULE MODIFICATION - ENTRY POINT RESTATEMENT

If the editing functions of the linkage editor are to be used to modify a load module, the entry point to the load module must be restated when the load module is reprocessed by the linkage editor. Otherwise, the first byte of the first control section processed by the linkage editor will become the entry point. To enable restatement of the original entry point, or designation of a new entry point, the entry point must have been identified originally as an external symbol, i.e., appeared as an entry in the external symbol dictionary. External symbol identification is done automatically by the assembler if the entry point is the name of a control section or START statement; otherwise, an assembler ENTRY statement must be used to identify the entry point name as an external symbol.

When a new object module is added to or replaces part of the load module, the entry point is restated in one of three ways:

- By placing the entry point symbol in the operand field of an EXTRN statement and an END statement in the new object module.

- By using an END statement in the new object module to designate a new entry point in the new object module.

- By using a linkage editor ENTRY statement to designate either the original entry point or a new entry point for the load module.

Further discussion of load module entry points is contained in the Linkage Editor publication.

OBJECT MODULE LINKAGE

Object modules, whether Assembler-, FORTRAN-, or COBOL-generated, may be combined by the linkage editor to produce a composite load module, provided each object module conforms to the data formats and linkage conventions required. This topic discusses the use of the CALL system macro instruction to link an assembler language "main" program to subprograms produced by FORTRAN and COBOL. The Supervisor and Data Management Macro Instructions publication contains additional details concerning linkage conventions and the CALL system macro instruction.

Figure 5 shows the statements used to establish the assembler program linkage to the called subprograms.

If any input/output operations are performed by called subprograms, appropriate DD statements for the data sets used by the subprograms must be supplied. See the FORTRAN IV (E) Programmer's Guide publication for explanation of the DD statements used to describe data sets for FORTRAN programs and a description of the special FORTRAN data set record formats. The COBOL (E) Programmer's Guide publication provides DD statement information for COBOL programs.

DICTIONARY SIZE AND SOURCE STATEMENT COMPLEXITY

This section describes the composition of the assembler dictionaries and their entry sizes, and describes methods for determining if the limits on source statement complexity will be exceeded.

Dictionary entries, e.g., sequence symbol names, prototype symbolic parameters, vary in length. Therefore, the number of entries a dictionary can hold is determined by the types of entries.

Source statement complexity -- the number of symbols, characters, operators, delimiters, references to length attributes, self-defining terms, literals, and expressions appearing in a source statement -- determines whether or not the source statement can be successfully processed.

```
                SAVE    (14,12)
                .
                .       set up base register
                .
1               ST      13,SVAREA+4
                LA      15,SVAREA
                ST      15,8(13)
                LR      13,15
                .
                .
                .
2               CALL    name,(V1,V2,V3),VL
                .
                .
                .
                L       13,SVAREA+4
                RETURN  (14,12)
3   SVAREA      DC      18F'0'
4   V1          DC      (data)
5   V2          DC      (data)
6   V3          DC      (data)
                END
```

[1] This is an example of OS linkage convention. See the publication Supervisor and Data Management Services for details.

[2] The symbol used for "name" in this statement is:

a. The name of a subroutine or function, when the linkage is to a FORTRAN-written subprogram.

b. The name defined by the following COBOL statements in the procedure division:

ENTER LINKAGE. ENTRY'name .

c. The name of a CSECT or START statement, or a name used in the operand field of an ENTRY statement in an assembler subprogram.

The order in which the parameter list is written must reflect the order in which the called subprogram expects the argument. If the called routine is a FORTRAN-written function, the returned argument is not in the parameter list: a real or double precision function returns the value in floating point register zero; an integer function returns the value in general purpose register zero.

CAUTION: When linking to FORTRAN-written subprograms, consideration must be given to the storage requirements of IBCOM (FORTRAN execution-time I/O and interrupt handling routines) which accompanies the compiled FORTRAN subprogram. In some instances the call for IBCOM is not automatically generated during the FORTRAN compilation. The FORTRAN IV Library publication provides information about IBCOM requirements and assembler statements used to call IBCOM.

FORTRAN - written subprograms and FORTRAN library subprograms allow variable-length parameter lists in linkages which call them; therefore all linkages to FORTRAN subprograms are required to have the high-order bit in the last parameter in the linkage set to 1. COBOL-written subprograms have fixed-length calling linkages; therefore, for COBOL the high-order bit in the last parameter need not be set to 1.

[3] This statement reserves the save area needed by the called subprogram. When control is passed to the subprogram, register 13 contains the address of this area.

4 5 6 When linking to a FORTRAN or COBOL subprogram, the data formats declared in these statements are determined by the data formats required by the FORTRAN or COBOL subprograms.

Figure 5. Linkage Statements

DICTIONARIES USED IN CONDITIONAL ASSEMBLY AND MACRO INSTRUCTION EXPANSION

To accomplish macro instruction expansion and conditional assembly, the assembler constructs a general dictionary consisting of two parts: one global dictionary for the entire program, and an area for all of the local dictionaries.

The global dictionary contains one entry for each machine operation code, extended mnemonic operation code, assembler operation code, macro instruction, and global SET variable symbol.

The local dictionary area consists of one local dictionary for each different macro definition in the program, and one local dictionary for the main portion of the program (those statements not within a macro definition, also called "open code."). The contents of the local dictionaries are described in subsequent paragraphs.

The capacity of the general dictionary (global dictionary and all local dictionaries) is up to 64 blocks of 1024 bytes each. The division of the dictionary into global and local sections is done dynamically: as the global dictionary becomes larger, it occupies blocks taken from the local dictionary area. Thus, the global dictionary is always core resident. As it expands into the local dictionary area, the local dictionaries may overflow onto a utility file. The size of the dictionaries in core depends upon core availability. The minimum core allocation is three blocks for the global dictionary and two blocks for each local dictionary.

Each block in the global and local dictionaries contains complete entries. Any entry not fitting into a block is placed in the next block; the remaining bytes in the current block are not used.

The global and local dictionaries take two forms: one when the dictionary entries are collected, i.e., picked up during the initial scan of the source program, and one during the actual conditional assembly and macro generation, i.e., generation time. The following text describes the global and local dictionaries at both collection time and generation time.

Global Dictionary at Collection Time

One global dictionary is built for the entire program. It contains machine operation codes, extended mnemonic operation codes, assembler operation codes, macro instruction mnemonics, and global SET variable symbols. One entry is made for each. The size of each type of entry is shown in Table 5.

Table 5. Global Dictionary Entries at Collection Time

Entry	Size
Each machine operation code**	5 bytes plus mnemonic*
Each extended mnemonic operation code or assembler operation**	6 bytes plus mnemonic*
Each macro mnemonic operation code	10 bytes plus mnemonic*
Each global SET variable symbol	6 bytes plus name*

*One byte is used for each character in the name or mnemonic.

**For the first two types of entries, a total of $06FE_{16}$ (1790_{10}) bytes of core is required.

Fixed overhead for this dictionary is:
- 8 bytes for the first block
- 4 bytes for each succeeding block
- 5 bytes for the last block

Local Dictionaries at Collection Time

For the main portion of the program (those statements not within a macro definition), one local dictionary is constructed in which ordinary symbols, sequence symbols, and local SET variable symbols are entered. In addition, one local dictionary is constructed for each different macro definition in the program. These local dictionaries contain one entry for each local SET variable symbol, sequence symbol, and prototype symbolic parameter declared within the macro definition. If a sequence symbol is defined before it is referenced, an extra entry for the symbol is made. Table 6 shows the size of each type of entry.

Table 6. Local Dictionary Entries at Collection Time

Entry	Size
Each sequence symbol	10 bytes plus name*
Each local SET variable symbol	6 bytes plus name*
Each prototype symbolic parameter	5 bytes plus name*
Each ordinary symbol appearing in the main portion of the program.	10 bytes plus name*

*One byte is used for each character in the name or mnemonic.

Fixed overhead for this dictionary is:
- 8 bytes for the first block (if in the main program)
- 32 bytes for the first block (if in a macro definition)
- 4 bytes for each succeeding block
- 5 bytes for the last block

Global Dictionary at Generation Time

The sizes of the global dictionary entries at generation time are shown in Table 7.

Table 7. Global Dictionary Entries at Generation Time

Entry	Size
Each macro mnemonic operation code	3 bytes
Each global SETA symbol (dimensioned)	1 byte plus 4N*
Each global SETA symbol (undimensioned)	4 bytes
Each global SETB symbol (dimensioned)	1 byte plus (N/8)* (N/8 is rounded to the next highest integer)
Each global SETB symbol (undimensioned)	1 bit
Each global SETC symbol (dimensioned)	1 byte plus 9N*
Each global SETC symbol (undimensioned)	9 bytes

*N = dimension

Fixed overhead for this dictionary is 4 bytes plus word alignment.

Local Dictionaries at Generation Time

Table 8 shows the sizes of the various entries appearing in the local dictionaries at generation time.

Table 8. Local Dictionary Entries at Generation Time·

Entry	Size
Each sequence symbol	5 bytes
Each local SETA symbol (dimensioned)	1 byte plus 4N*
Each local SETA symbol (undimensioned)	4 bytes
Each local SETB symbol (dimensioned)	1 byte plus (N/8)* (N/8 is rounded to the next highest integer)
Each local SETB symbol (undimensioned)	1 bit
Each local SETC symbol(dimensioned)	1 byte plus 9N*
Each local SETC symbol (undimensioned)	9 bytes
Each ordinary symbol appearing in the main portion of the program.**	5 bytes

*N=dimension
**These entries appear only in the main program local dictionary.

Fixed overhead for this dictionary is 20 bytes plus word alignment.

Additional Dictionary Requirements

The generation time global dictionary and the generation time local dictionary for the main portion of the program must be resident in main storage.

In addition, if the program contains any macro instructions, main storage is required for the largest local dictionary of the macro definitions being processed. Furthermore, during processing of macro definitions containing inner macro instructions, main storage is required for the generation time local dictionaries for the inner macro instructions contained within the macro definition.

In addition to those requirements specified for the local dictionary of the main portion of the program, each macro definition local dictionary requires space for entries shown in Table 9.

Table 9. Macro Definition Local Dictionary Parameter Table

Entry	Size
Each character string (1)	3 bytes plus L
Each hexadecimal, binary, decimal, and character self-defining term (2)	7 bytes plus L
Each symbol (3)	9 bytes plus L
Each sublist	9 bytes plus 3N bytes plus Y

L = Length of BCD entry in bytes
N = Number of entries in sublist
Y = $E_1 + E_2 + E_3 + \ldots E_n$
where E = size of an entry (formats 1,2, and 3 above)

Fixed overhead for the macro definition local dictionary parameter table is 22 bytes. Each nested macro instruction also requires space in its local dictionary for the following:

Parameter pointer list	8 bytes plus 2N (N = the number of operands)
Pointers to parameter pointer list and parameter table	8 bytes plus word alignment

Correction of Dictionary Overflow

If an assembly is terminated at collection time with either a GLOBAL DICTIONARY FULL message (IEU053) or a LOCAL DICTIONARY FULL message (IEU054), the programmer can take one or more of the following steps:

1. Split the assembly into two or more parts and assemble each separately.
2. Allocate more core for the assembler (the global and local dictionaries together can occupy up to 64K).
3. Run the assembly under Assembler E. Due to its dictionary building algorithm, Assembler E can handle more symbols with a given size dictionary than can Assembler F.)

If the assembly is terminated at generation time with a GENERATION TIME DICTIONARY AREA OVERFLOWED message (IEU068), the programmer should allocate more core to the assembler and re-assemble his program. If he cannot allocate more core to the assembler, the programmer should split the assembly into two or more parts and assemble each separately.

SOURCE STATEMENT COMPLEXITY

The complexity of a source statement is limited both by the macro generator and the assembler portions of the assembler. The following topics provide the information necessary to determine if statement-complexity limitations for either portion of the assembler are being exceeded.

Macro Generation and Conditional Assembly Limitation

For any statement which

1. Is a conditional assembly statement,
2. Is a DC or DS statement,
3. Is an EXTRN statement,
4. Contains a sequence symbol or a variable symbol,
5. Is not a macro instruction or prototype statement,

the total number of explicit occurrences of

1. Ordinary symbols (includes machine mnemonics, assembler mnemonics, conditional assembly mnemonics, and macro instruction mnemonics),
2. Variable symbols,
3. Sequence symbols,

must not exceed 50 for the entire statement.

For macro instructions and prototype statements the number of occurrences of ordinary symbols, variable symbols, and sequence symbols must not exceed 50 in the name and operation fields combined; or in each operand unless the operand is a sublist, in which case the limit is applied to each sublist operand. In any operand if a character string has the same form as a symbol, it is counted as a symbol.

Examples of Counts:

```
&B2 SETB (T'NAME EQ 'W')'count=3 (&B2,SETB,NAME)
EXTRN A,B,C,&C          count=5 (EXTRN,A,B,C,&C)
```

Assembler Portion Limitations

1. Generated statements may not exceed 236 characters. Statement length includes name, operation, operand, and comments. If a comments field exists, the blank separating the operand and comments field is included in the statement length. The statement is truncated if it exceeds 236 characters.
2. DC, DS, DXD, and literal DCs cannot contain more than 32 operands per statement.

SYSTEM/360 MODEL 91 PROGRAMMING CONSIDERATIONS

The assembly language programmer should be aware of the operational differences between the Model 91 and other System/360 models. The Model 91 requires a simulation routine to execute most decimal instructions and it yields different floating-point instructions execution results. The Model 91 also decodes and executes instructions concurrently and nonsequentially.

These and other coding and timing considerations are discussed in detail in IBM System/360 Model 91 Functional Characteristics, Form A22-6907. Additional information on how to control sequential and nonsequential instruction execution is given below.

Controlling Instruction Execution Sequence

The CPU maintains a logical consistency with respect to its own operations, including the beginning and ending of I/O operations, but it does not assume responsibility for such consistency in the operations performed by asynchronous units. Consequently, for any asynchronous unit that depends upon a strict adherence to sequential (or serial) execution, a problem program must set up its own procedures to ensure the proper instruction sequence.

For a program section that requires the serial or sequential execution of instructions, the following 'no-operation' instruction:

```
BCR   M,0      where M = 0
```

causes the instruction decoder to halt, and the instructions that have already been decoded to be executed. (This action is called a pipe-line drain.) On the Model 91, this instruction ensures that all the instructions preceding it are executed before the instruction suceeding it is decoded. Use of this instruction should be minimized since it may affect the performance of the Model 91.

Isolating an instruction by preceding it and succeeding it with a BCR instruction eliminates multiple imprecise interruptions from more than one instruction by virtue of the pipe-line drain effect. However, since multiple exceptions may occur in one instruction, this technique does not eliminate a multiple imprecise interruption nor does it change an imprecise interruption into a precise interruption. The use of the BCR instruction does not assure a programmer that he can fix up an error situation. In general, the only information available will be the address of the BCR instruction. The length of the instruction preceding the BCR instruction is not recorded, and generally there is no way to determine what that instruction is.

Code	Message	Explanation	Severity Code
IEU001	DUPLICATION FACTOR ERROR	A duplication factor is not an absolute expression, or is zero in a literal: * in duplication factor expression; invalid syntax in expression.	12
IEU002	RELOCATABLE DUPLICATION FACTOR	A relocatable expression has been used to specify the duplication factor.	12
IEU003	LENGTH ERROR	The length specification is out of permissible range or specified invalidly; * in length expression: invalid syntax in expression; no left-parenthesis delimiter for expression.	12
IEU004	RELOCATABLE LENGTH	A relocatable expression has been used to specify length.	12
IEU005	S-TYPE CONSTANT IN LITERAL	Self-explanatory.	8
IEU006	INVALID ORIGIN	The location counter has been reset to a value less than the starting address of the control section; ORG operand is not a simply relocatable expression or specifies an address outside the control section.	12
IEU007	LOCATION COUNTER ERROR	The location counter has exceeded $2^{24}-1$, or passed out of control section in negative direction (3 byte arithmetic).	12
IEU008	INVALID DISPLACEMENT	The displacement in an explicit address is not an absolute value within the range of 0 to 4095.	8
IEU009	MISSING OPERAND	Self-explanatory	12
IEU010	INCORRECT REGISTER SPECIFICATION	The value specifying the register is not an absolute value within the range 0-15, an odd register is specified where an even register is required, or a register was used where none can be specified.	8
IEU011	SCALE MODIFIER ERROR	The scale modifier is not an absolute expression or is too large, negative scale modifier for floating point, * in scale modifier expression; invalid syntax or illegally specified scale modifier.	8
IEU012	RELOCATABLE SCALE MODIFIER	A relocatable expression has been used to specify the scale modifier.	8
IEU013	EXPONENT MODIFIER ERROR	The exponent is not specified as an absolute expression or is out of range; * in exponent modifier expression; invalid syntax; illegally specified exponent modifier.	8
IEU014	RELOCATABLE EXPONENT MODIFIER	A relocatable expression has been used to specify the exponent modifier.	8

Code	Message	Explanation	Severity Code
IEU015	INVALID LITERAL USAGE	A valid literal is used illegally, e.g., it specifies a receiving field or a register, or it is a Q-type constant.	8
IEU016	INVALID NAME	A name entry is incorrectly specified, e.g., it contains more than 8 characters, it does not begin with a letter, or has a special character imbedded.	8
IEU017	DATA ITEM TOO LARGE	The constant is too large for the data type or for the explicit length; operand field for packed DC exceeds 32 characters and for zoned DC exceeds 16 characters (excluding decimal points).	8
IEU018	INVALID SYMBOL	The symbol is specified invalidly, e.g., it is longer than 8 characters.	8
IEU019	EXTERNAL NAME ERROR	A CSECT and DSECT statement have the same name, or a symbol is used more than once in an EXTRN or the name field of DXD statements.	8
IEU020	INVALID IMMEDIATE FIELD	The value of the immediate operand exceeds 255, or the operand requires more than one byte of storage, or the operand is not an acceptable type.	8
IEU021	SYMBOL NOT PREVIOUSLY DEFINED	Self-explanatory.	8
IEU022	ESDTABLE OVERFLOW	The combined number of control sections and dummy sections plus the number of unique symbols in EXTRN statements and V-type constants exceeds 255. (A DSECT which appears as XD makes two entries).	12
IEU023	PREVIOUSLY DEFINED NAME	The symbol which appears in the name field has appeared in the name field of a previous statement.	8
IEU024	UNDEFINED SYMBOL	A symbol being referenced has not been defined in the program.	8
IEU025	RELOCATABILITY ERROR	A relocatable or complex relocatable expression is specified where an absolute expression is required, an absolute expression or complex relocatable expression is specified where a relocatable expression is required, or a relocatable term is involved in multiplication or division.	8
IEU026	TOO MANY LEVELS OF PARENTHESES	An expression specifies more than 5 levels of parentheses.	12
IEU027	TOO MANY TERMS	More than 16 terms are specified in an expression.	12
IEU028	REGISTER NOT USED	A register specified in a DROP statement is not currently in use.	4

Code	Message	Explanation	Severity Code
IEU029	CCW ERROR	Bits 37-39 of the CCW are set to non-zero.	8
IEU030	INVALID CNOP	An invalid combination of operands is specified.	12
IEU031	UNKNOWN TYPE	Incorrect type designation is specified in a DC, DS, or literal.	8
IEU032	OP-CODE NOT ALLOWED TO BE GENERATED	Operation code allowed only in source statement has been obtained through substitution of a value for a variable symbol.	8
IEU033	ALIGNMENT ERROR	Referenced address is not aligned to the proper boundary for this instruction, e.g., START operand not a multiple of 8.	4
IEU034	INVALID OP-CODE	Syntax error, e.g., more than 5 characters in operation field, not followed by blank on first card, missing.	8
IEU035	ADDRESSABILITY ERROR	The referenced address does not fall within the range of a USING instruction.	8
IEU036	(No message is assigned to this number)		
IEU037	MNOTE STATEMENT	This indicates that an MNOTE statement has been generated from a macro definition. The text and severity code of the MNOTE statement will be found in line in the listing.	Variable
IEU038	ENTRY ERROR	A symbol in the operand of an ENTRY statement appears in more than one ENTRY statement, it is undefined, it is defined in a dummy section or in blank common, or it is equated to a symbol defined by an EXTRN statement.	8
IEU039	INVALID DELIMITER	This message can be caused by any syntax error, e.g., missing delimiter, special character used which is not a valid delimiter, delimiter used illegally, operand missing, i.e., nothing between delimiters, unpaired parentheses, imbedded blank in expression.	12
IEU040	GENERATED RECORD TOO LONG	There are more than 236 characters in a generated statement.	12
IEU041	UNDECLARED VARIABLE SYMBOL	Variable symbol is not declared in a defined SET symbol statement or in a macro prototype.	8
IEU042	SINGLE TERM LOGICAL EXPRESSION IS NOT A SETB SYMBOL	The single term logical expression has not been declared as a SETB symbol.	8
IEU043	SET SYMBOL PREVIOUSLY DEFINED	Self-explanatory.	8
IEU044	SET SYMBOL USAGE INCONSISTENT WITH DECLARATION	A SET symbol has been declared as undimensioned, but is subscripted, or has been declared dimensioned, but is unsubscripted.	8

Code	Message	Explanation	Severity Code
IEU045	ILLEGAL SYMBOLIC PARAMETER	An attribute has been requested for a variable symbol which is not a legal symbolic parameter.	8
IEU046	AT LEAST ONE RELOCATABLE Y TYPE CONSTANT IN ASSEMBLY	One or more relocatable Y-type constants in assembly; relocation may result in address greater than 2 bytes in length.	1
IEU047	SEQUENCE SYMBOL PREVIOUSLY DEFINED	Self-explanatory.	12
IEU048	SYMBOLIC PARAMETER PREVIOUSLY DEFINED OR SYSTEM VARIABLE SYMBOL DECLARED AS SYMBOLIC PARAMETER	Self-explanatory.	12
IEU049	VARIABLE SYMBOL MATCHES A PARAMETER	Self-explanatory.	12
IEU050	INCONSISTENT GLOBAL DECLARATIONS	A global SET variable symbol, defined in more than one macro definition or defined in a macro definition and in the source program, is inconsistent in SET type or dimension.	8
IEU051	MACRO DEFINITION PREVIOUSLY DEFINED	Prototype operation field is the same as a machine or assembler instruction or a previous prototype. This message is not produced when a programmer macro matches a system macro. The programmer macro will be assembled with no indication of the corresponding system macro.	12
IEU052	NAME FIELD CONTAINS ILLEGAL SET SYMBOL	SET symbol in name field does not correspond to SET statement type.	8
IEU053	GLOBAL DICTIONARY FULL	The global dictionary is full, assembly terminated. See <u>Correction of Dictionary Overflow</u>.	12
IEU054	LOCAL DICTIONARY FULL	The local dictionary is full, current macro aborted. If in open code, assembly terminated. See <u>Correction of Dictionary Overflow</u>.	12
IEU055	INVALID ASSEMBLER OPTION(S) ON THE EXECUTE CARD	Self-explanatory.	8
IEU056	ARITHMETIC OVERFLOW	The intermediate or final result of an expression is not within the range of -2^{31} to $2^{31}-1$.	8
IEU057	SUBSCRIPT EXCEEDS MAXIMUM DIMENSION	&SYSLIST or symbolic parameter subscript exceeds 200, or is negative, or zero, or SET symbol subscript exceeds dimension.	8
IEU058	RE-ENTRANT CHECK FAILED	An instruction has been detected, which, when executed, might store data into a control section or a common area. This message is generated only when requested via control cards and merely indicates a possible reentrant error.	4
IEU059	UNDEFINED SEQUENCE SYMBOL	Self-explanatory.	12
IEU060	ILLEGAL ATTRIBUTE NOTATION	L', S', or I' requested for a parameter whose type attribute does not allow these attributes to be requested.	8

Code	Message	Explanation	Severity Code
IEU061	ACTR COUNTER EXCEEDED	Self-explanatory, conditional assembly terminated.	12
IEU062	GENERATED STRING GREATER THAN 255 CHARACTERS	Self-explanatory.	8
IEU063	EXPRESSION 1 OF SUB-STRING IS ZERO OR MINUS	Self-explanatory.	8
IEU064	EXPRESSION 2 OF SUB-STRING IS ZERO OR MINUS	Self-explanatory.	8
IEU065	INVALID OR ILLEGAL TERM IN ARITHMETIC EXPRESSION	The value of a SETC symbol used in the arithmetic expression is not composed of decimal digits, or the parameter is not a self-defining term.	8
IEU066	UNDEFINED OR DUP-LICATE KEYWORD OPERAND OR EXCESSIVE POSITIONAL OPERANDS	The same keyword operand occurs more than once in the macro instruction; a keyword is not defined in a prototype statement; in a mixed mode macro instruction, more positional operands are specified than are specified in the prototype.	12
IEU067	EXPRESSION 1 OF SUB-STRING GREATER THAN LENGTH OF CHARACTER EXPRESSION	Self-explanatory.	8
IEU068	GENERATION TIME DICTIONARY AREA OVERFLOWED	See Correction of Dictionary Overflow and Dictionary Size and Source Statement Complexity.	12
IEU069	VALUE OF EXPRESSION 2 OF SUBSTRING GREATER THAN 8	Self-explanatory.	8
IEU070	FLOATING POINT CHARACTERISTIC OUT OF RANGE	Exponent too large for length of defining field, exponent modifier has caused loss of all significant digits.	12
IEU071	ILLEGAL OCCURRENCE OF LCL, GBL, OR ACTR STATEMENT	LCL, GBL, or ACTR statement is not in proper place in the program.	8
IEU072	ILLEGAL RANGE ON ISEQ STATEMENT	Self-explanatory.	4
IEU073	ILLEGAL NAME FIELD	Either a statement which requires a name is blank, or a statement has a name which should be blank, or a name entry required to be a sequence symbol is not a sequence symbol.	8
IEU074	ILLEGAL STATEMENT IN COPY CODE OR SYSTEM MACRO	Self-explanatory.	8

Code	Message	Explanation	Severity Code
IEU075	ILLEGAL STATEMENT OUTSIDE OF A MACRO DEFINITION	Statement allowed only in a macro definition encountered in OPEN code, e.g., period asterisk (.*), mnote statement.	8
IEU076	SEQUENCE ERROR	Self-explanatory.	12
IEU077	ILLEGAL CONTINUATION CARD	Either there are too many continuation cards, or there are non-blanks between the begin and continue columns on the continuation card, or a card not intended as continuation was treated as such because of punch in continue column of preceding card.	8
IEU078	(No message is assigned to this number)		
IEU079	ILLEGAL STATEMENT IN MACRO DEFINITION	This operation is not allowed within a macro definition.	8
IEU080	ILLEGAL START CARD	Statements affecting or depending upon the location counter have been encountered before a START statement.	8
IEU081	ILLEGAL FORMAT IN GBL OR LCL STATEMENTS	An operand is not a variable symbol.	8
IEU082	ILLEGAL DIMENSION SPECIFICATION IN GBL OR LCL STATEMENT	Dimension is other than 1 to 255.	8
IEU083	SET STATEMENT NAME FIELD NOT A VARIABLE SYMBOL	Self-explanatory.	8
IEU084	ILLEGAL OPERAND FIELD FORMAT	Syntax invalid, e.g., AIF statement operand does not start with a left parenthesis; operand of AGO is not a sequence symbol; operand of PUNCH, TITLE, MNOTE not enclosed in quotes.	8
IEU085	INVALID SYNTAX IN EXPRESSION	Invalid delimiter, too many terms in expression, too many levels of parentheses, two operators in succession, two terms in succession, or illegal character.	8
IEU086	ILLEGAL USAGE OF SYSTEM VARIABLE SYMBOL	A system variable symbol appears in the name field of a SET statement, is used in a mixed mode or keyword macro definition, is declared in a GBL or LCL statement, or is an unsubscripted &SYSLIST in a context other than N'&SYSLIST.	8
IEU087	NO ENDING APOSTROPHE	There is an unpaired apostrophe or ampersand in the statement.	8
IEU088	UNDEFINED OPERATION CODE	Symbol in operation code field does not correspond to a valid machine or assembler operation code or to any operation code in a macro prototype statement.	12
IEU089	INVALID ATTRIBUTE NOTATION	Syntax error inside a macro definition, e.g., the argument of the attribute reference is not a symbolic parameter.	8

Code	Message	Explanation	Severity Code
IEU090	INVALID SUBSCRIPT	Syntax error, e.g., double subscript where single subscript is required or vice versa; not right parenthesis after subscript.	8
IEU091	INVALID SELF-DEFINING TERM	Value is too large or is inconsistent with the data type, e.g., severity code greater than 255.	8
IEU092	INVALID FORMAT FOR VARIABLE SYMBOL	The first character after the ampersand is not alphabetic, or the variable symbol contains more than 8 characters, or failure to use double ampersand in TITLE card or character self-defining term.	8
IEU093	UNBALANCED PARENTHESIS OR EXCESSIVE LEFT PARENTHESES	End of statement or card encountered before all parenthesis levels are satisfied. May be caused by embedded blank or other unexpected terminator, or failure to have a punch in continuation column.	8
IEU094	INVALID OR ILLEGAL NAME OR OPERATION IN PROTOTYPE STATEMENT	Name not blank or variable symbol, or variable symbol in name field is subscripted, or violation of rules for forming variable symbol (must begin with ampersand (&) followed by 1-7 letters and/or numbers first of which must be a letter), or statement following 'MACRO' is not a valid prototype statement.	12
IEU095	ENTRY TABLE OVERFLOW	Number of ENTRY symbols, i.e., ENTRY instruction operands, exceeds 100.	8
IEU096	MACRO INSTRUCTION OR PROTOTYPE OPERAND EXCEEDS 255 CHARACTERS IN LENGTH	Self-explanatory.	12
IEU097	INVALID FORMAT IN MACRO INSTRUCTION OPERAND OR PROTOTYPE PARAMETER	This message can be caused by: 1. Illegal "=". 2. A single "&" appears somewhere in the standard value assigned to a prototype keyword parameter. 3. First character of a prototype parameter is not "&". 4. Prototype parameter is a subscripted variable symbol. 5. Invalid use of alternate format in prototype statement, e.g., 10 16 72 PROTO &A,&B, or PROTO &A,&B, X &C 6. Unintelligible prototype parameter, e.g., "&A*" or "&A&&." 7. Illegal (non-assembler) character appears in prototype parameter or macro instruction operand.	12
IEU098	EXCESSIVE NUMBER OF OPERANDS OR PARAMETERS	Either the prototype has more than 200 parameters, or the macro instruction has more than 200 operands.	12
IEU099	POSITIONAL MACRO INSTRUCTION OPERAND, PROTOTYPE PARAMETER OR EXTRA COMMA FOLLOWS KEYWORD	Self-explanatory.	12

Code	Message	Explanation	Severity Code
IEU100	STATEMENT COMPLEXITY EXCEEDED	More than 32 operands in a DC, DS, DXD, or literal DC, or more than 50 terms in a statement.	8
IEU101	EOD ON SYSIN	EOD before END card.	12
IEU102	INVALID OR ILLEGAL ICTL	The operands of the ICTL are out of range, or the ICTL is not the first statement in the input deck.	16
IEU103	ILLEGAL NAME IN OPERAND FIELD OF COPY CARD	Syntax error, e.g., symbol has more than 8 characters or has an illegal character.	12
IEU104	COPY CODE NOT FOUND	The operand of a COPY statement specified COPY text which cannot be found in the library.	12
IEU105	EOD ON SYSTEM MACRO LIBRARY	EOD before MEND card.	12
IEU106	NOT NAME OF DSECT OR DXD	Referenced symbol expected to be DSECT name, but it is not.	8
IEU107	INVALID OPERAND	Invalid syntax in DC operand, e.g., invalid hexadecimal character in hexadecimal DC; operand string too long for X, B, C, DC's; operand unrecognizable, contains invalid value, or incorrectly specified.	4
IEU108	PREMATURE EOD	Indicates an internal assembler error; should not occur.	16
IEU109	PRECISION LOST	Self-explanatory.	8
IEU110	EXPRESSION VALUE TOO LARGE	Value of expression greater than -16777216 to +16777215. Expressions in EQU and ORG statements are flagged if (1) they include terms previously defined as negative values, or (2) positive terms give a result of more than three bytes in magnitude. The error indication may be erroneous due to (1) the treatment of negative values as three-byte positive values, or (2) the effect of large positive values on the location counter if a control section begins with a START statement having an operand greater than zero, or a control section is divided into subsections.	8
IEU111	SYSGO DD CARD MISSING NOLOAD OPTION USED	Self-explanatory.	16
IEU112	SYSPUNCH DD CARD MISSING NODECK OPTION USED	Self-explanatory.	16
IEU997	SYSPRINT DD CARD MISSING NOLIST OPTION USED	Self-explanatory. Printed on console typewriter.	0
IEU998	ASSEMBLY TERMINATED. MISSING DATA SET FOR (ddname)	Self-explanatory. Printed on console typewriter.	20
IEU999	ASSEMBLY TERMINATED, jobname, stepname, unit address, device type, ddname, operation attempted, error description	Indicates a permanent I/O error. This message is produced by a SYNADAF macro instruction and printed on the console typewriter.	20

TEXT (TXT) CARD FORMAT

The format of the TXT cards is as follows:

Columns	Contents
1	12-2-9 punch
2-4	TXT
5	Blank
6-8	Relative address of first instruction on card
9-10	Blank
11-12	Byte count -- number of bytes in information field (cc 17-72)
13-14	Blank
15-16	ESDID
17-72	56-byte information field
73-76	Deck ID (from first TITLE card)
77-80	Card sequence number

RLD CARD FORMAT

The format of the RLD card is as follows:

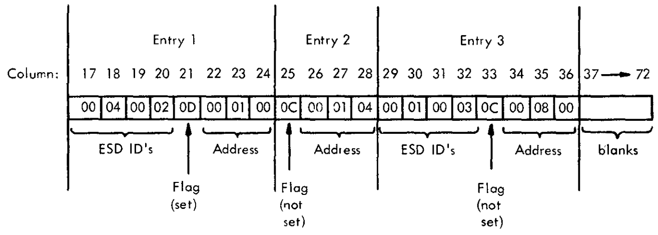
Columns	Contents
1	12-2-9 punch
2-4	RLD
5-10	Blank
11-12	Data field count -- number of bytes of information in data field (cc 17-72)
13-16	Blank
17-72	Data field:
17-18	Relocation ESDID
19-20	Position ESDID
21	Flag byte
22-24	Absolute address to be relocated
25-72	Remaining RLD entries
73-76	Deck ID (from first TITLE card)
77-80	Card sequence number

If the rightmost bit of the flag byte is set, the following RLD entry has the same Relocation ESDID and Position ESDID, and this information will not be repeated; if the rightmost bit of the flag byte is not set, the next RLD entry has a different Relocation ESDID and/or Position ESDID, and both ESDIDs will be recorded.

For example, if the RLD Entries 1, 2, and 3 of the program listing (Appendix C) contain the following information:

	Pos. ESDID	Rel. ESDID	Flag	Address
Entry 1	02	04	0C	000100
Entry 2	02	04	0C	000104
Entry 3	03	01	0C	000800

Columns 17-36 of the RLD card would appear as follows:



Column:	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37 → 72
	00	04	00	02	0D	00	01	00	0C	00	01	04	00	01	00	03	0C	00	08	00	

ESD CARD FORMAT

The format of the ESD card is as follows:

Columns	Contents
1	12-2-9 punch
2-4	ESD
5-10	Blank
11-12	Variable field count -- number of bytes of information in variable field (cc 17-64)
13-14	Blank
15-16	ESDID of first SD, XD, CM, PC, or ER in variable field
17-64	Variable field. One to three 16-byte items of the following format: 8 bytes -- Name, padded with blanks 1 byte -- ESD type code 3 bytes -- Address 1 byte -- Alignment if XD; otherwise blank 3 bytes -- Length, LDID, or blank
65-72	Blank
73-76	Deck ID (from first TITLE card)
77-80	Card sequence number

END CARD FORMAT

The format of the END card is as follows:

Columns	Contents
1	12-2-9 punch
2-4	END
5	Blank
6-8	Entry address from operand of END card in source deck (blank if no operand)

9-14	Blank
15-16	ESDID of entry point (blank if no operand)
17-72	Blank
73-76	Deck ID (from first TITLE card)
77-80	Card sequence number

TESTRAN (SYM) CARD FORMAT

If requested by the user, the assembler punches out symbolic information for TESTRAN concerning the assembled program. This output appears ahead of all loader text. The format of the card images for TESTRAN output is as follows:

Columns	Contents
1	12-2-9 punch
2-4	SYM
5-10	Blank
11-12	Variable field count -- number of bytes of text in variable field (cc 17-72)
13-16	Blank
17-72	Variable field (see below)
73-76	Deck ID (from first TITLE card)
77-80	Card sequence number

The variable field (columns 17-72) contains up to 56 bytes of TESTRAN text. The items making the text are packed together, consequently only the last card may contain less than 56 bytes of text in the variable field. The formats of a text card and an individual text item are shown in Figure 6. The contents of the fields within an individual entry are as follows:

1. Organization (1 byte)
   Bit 0:
   0 = non-data type
   1 = data type
   Bits 1-3 (if non-data type):
   000 = space
   001 = control section
   010 = dummy control section
   011 = common
   100 = instruction
   101 = CCW
   Bit 1 (if data type):
   0 = no multiplicity
   1 = multiplicity (indicates presence of M field)
   Bit 2 (if data type):
   0 = independent (not a packed or zoned decimal constant)
   1 = cluster (packed or zoned decimal constant)
   Bit 3 (if data type):
   0 = no scaling
   1 = scaling (indicates presence of S field)
   Bit 4:
   0 = name present
   1 = name not present
   Bits 5-7:
   Length of name minus one
2. Address (3 bytes) - displacement from base of control section
3. Symbol Name (0-8 bytes) - symbolic name of particular item

NOTE: The following fields are only present for data-type items.

4. Data Type (1 byte) - contents in hexadecimal
   00 = character
   04 = hexadecimal
   08 = binary
   10 = fixed point, full
   14 = fixed point, half
   18 = floating point, short
   1C = floating point, long
   20 = A-type or Q-type data
   24 = Y-type data
   28 = S-type data
   2C = V-type data
   30 = packed decimal
   34 = zoned decimal
5. Length (2 bytes for character, hexadecimal, or binary items; 1 byte for other types) - length of data item minus 1
6. Multiplicity - M field (3 bytes) - equals 1 if not present
7. Scale - signed integer - S field (2 bytes) - present only for F, H, E, D, P and Z type data, and only if scale is non-zero.

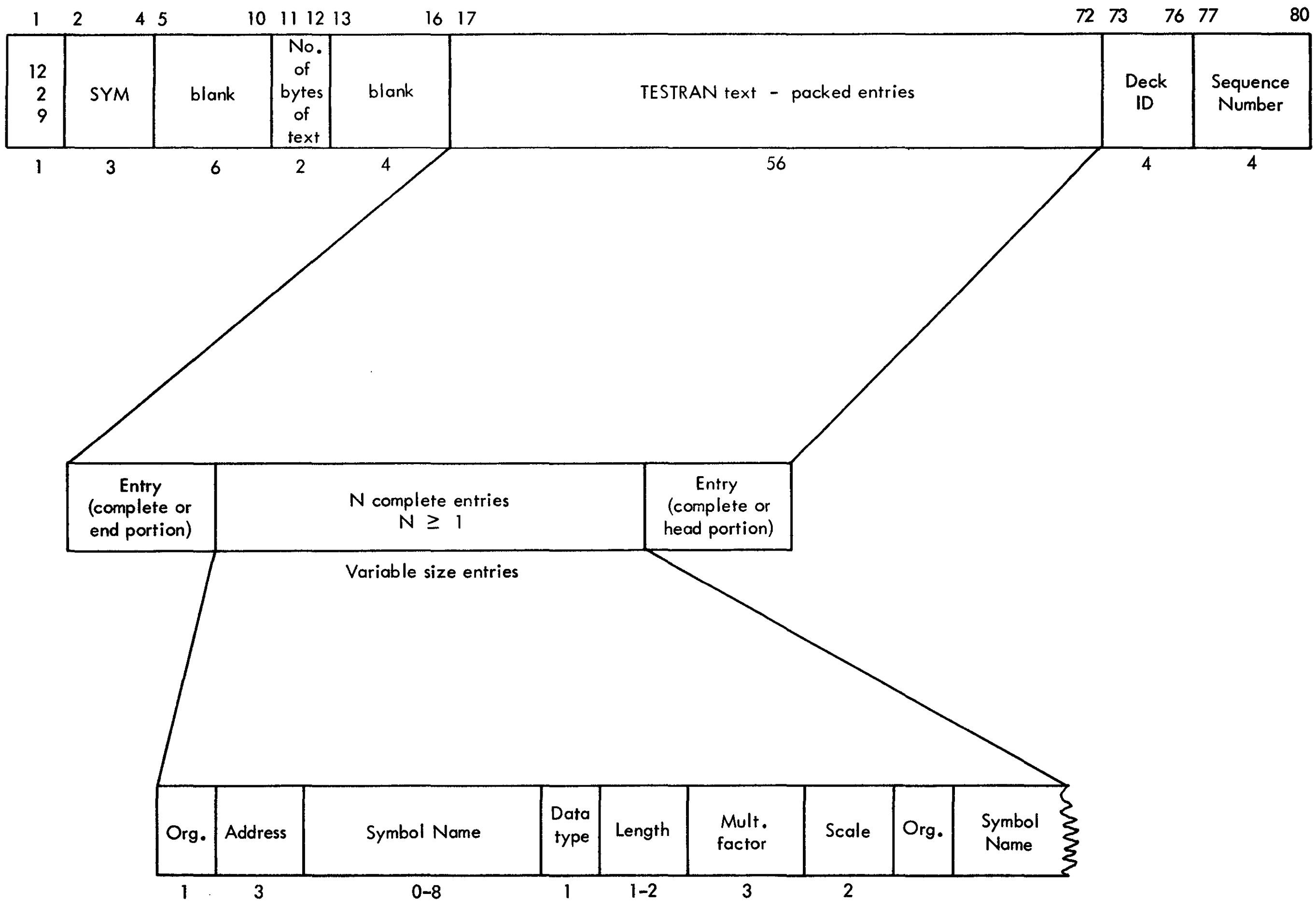
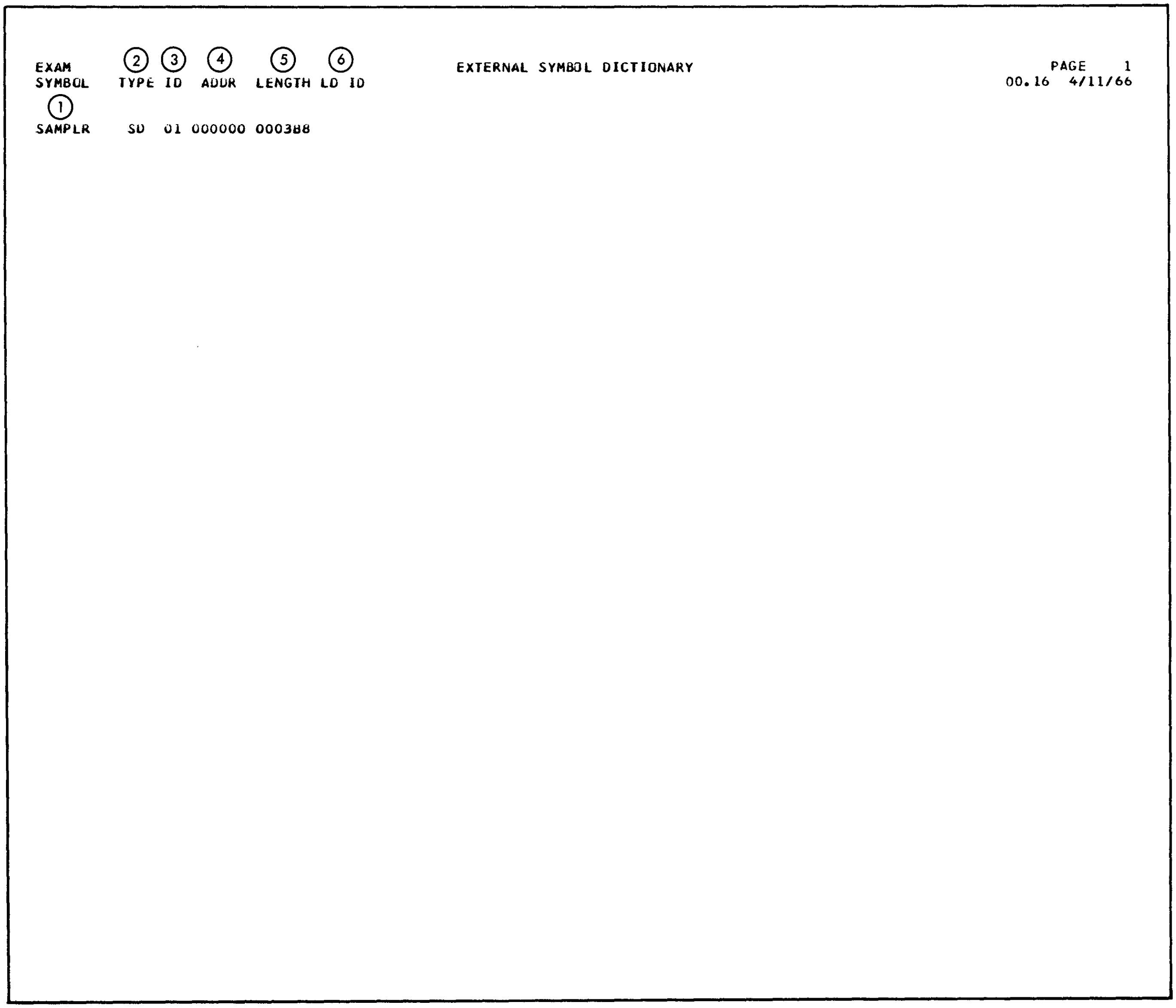


Figure 6. TESTRAN SYM Card Format

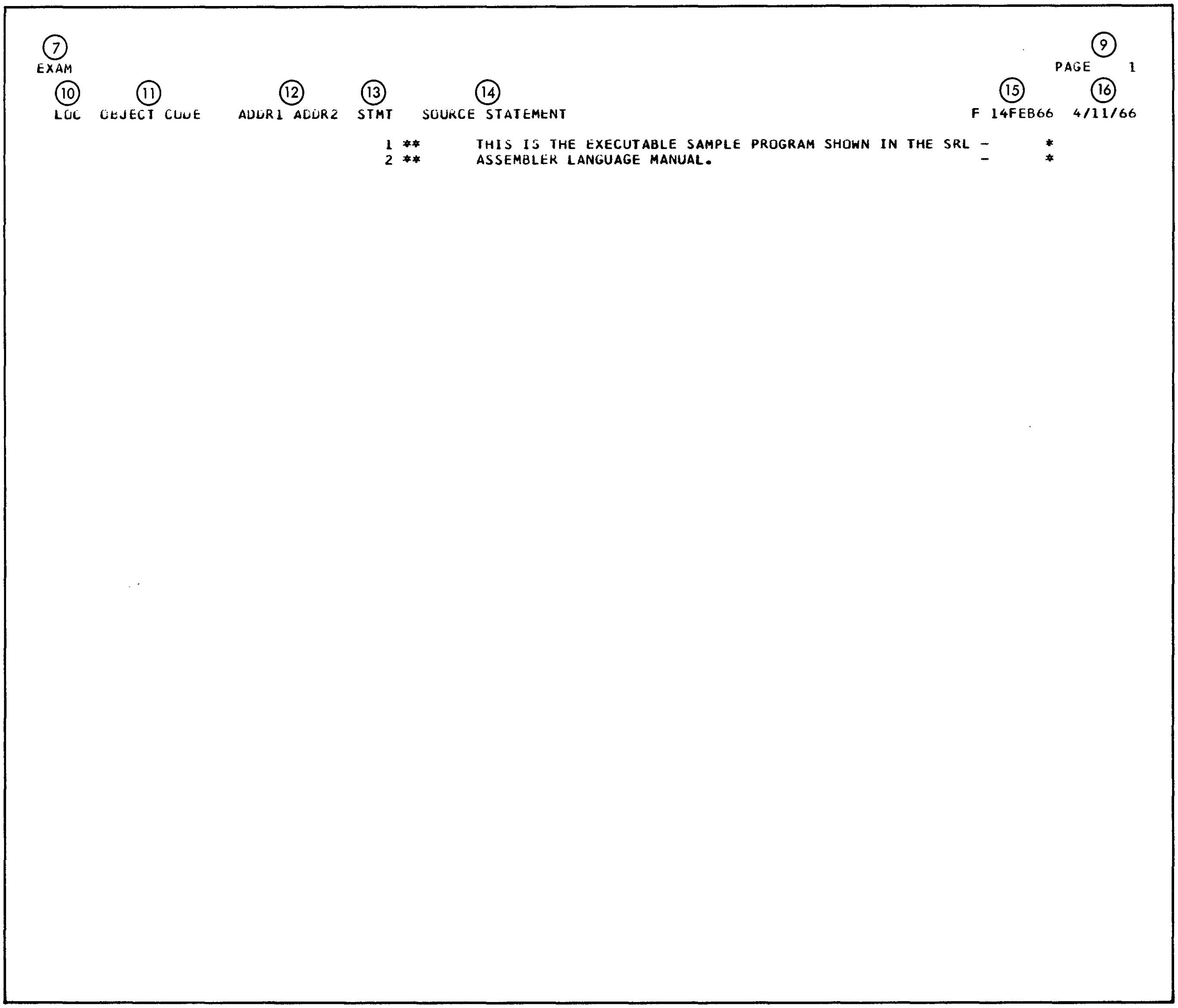
APPENDIX C. ASSEMBLER F PROGRAM LISTING

The Assembler F listing shown in this appendix results from assembling the source program documented in an appendix to the Assembler Language publication. For easy reference to the explanations that appear in the section The Assembler Listing, the headings on the listing are numbered.

Since there were no errors in the assembly, a diagnostic list was not produced. Each of the following pages represents one printer-produced listing page.



```
EXAM       ② ③  ④     ⑤     ⑥               EXTERNAL SYMBOL DICTIONARY                                 PAGE    1
SYMBOL    TYPE ID  ADDR  LENGTH LD ID                                                                   00.16  4/11/66
  ①
SAMPLR     SD  01 000000 000388
```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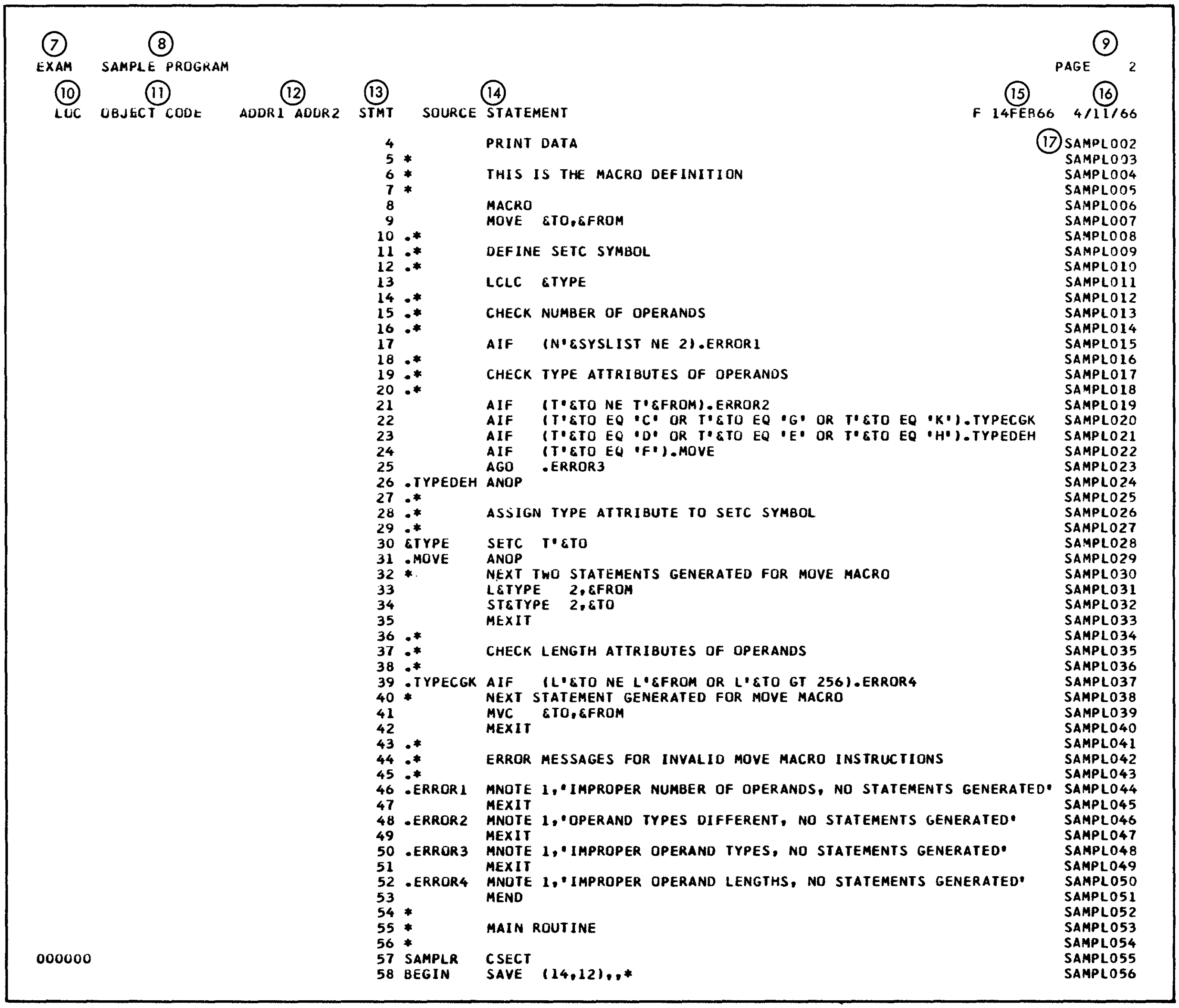
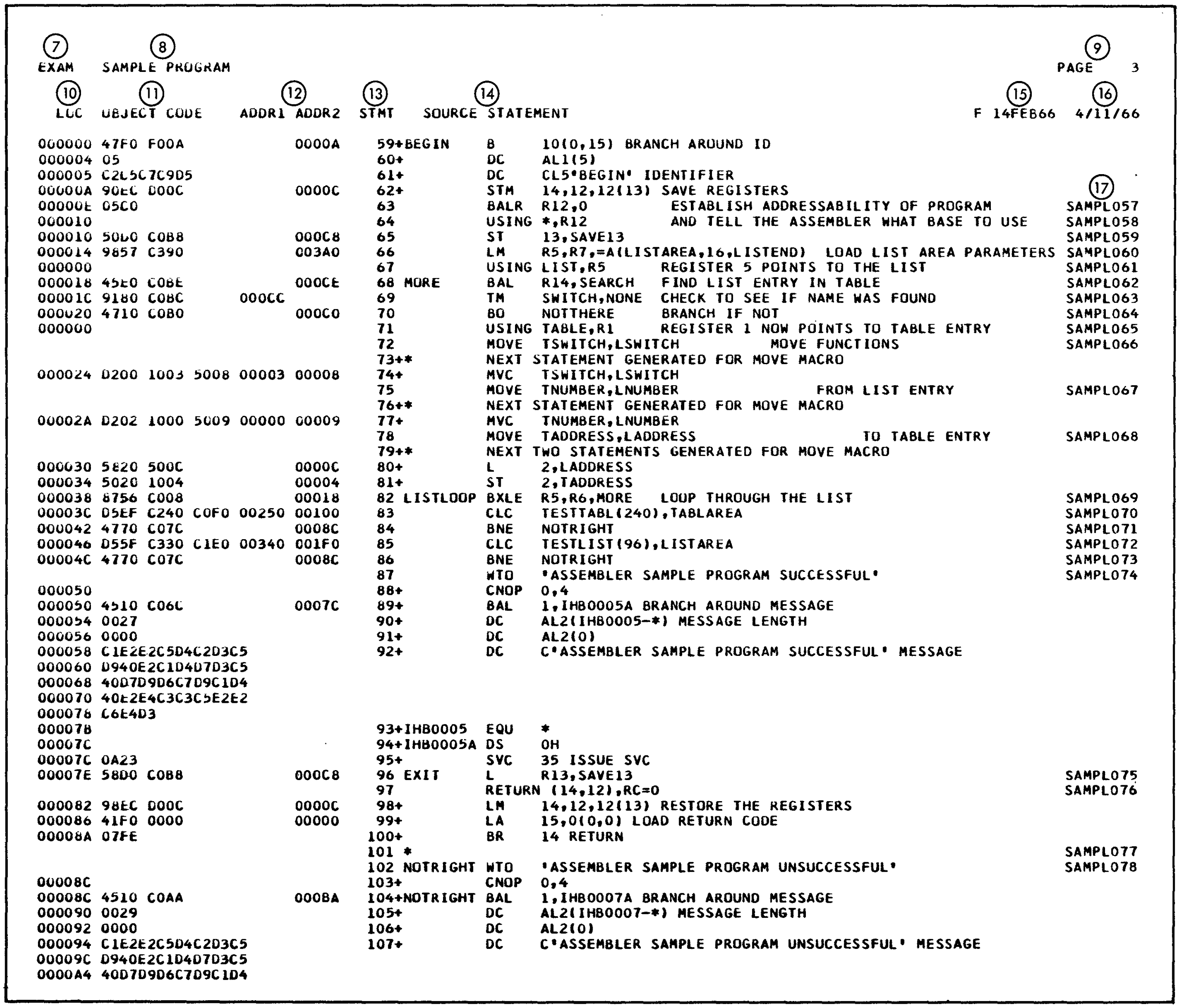
```
EXAM                                                                                                PAGE    1
 LOC  OBJECT CODE     ADDR1 ADDR2 STMT   SOURCE STATEMENT                                F 14FEB66  4/11/66
                                    1 **      THIS IS THE EXECUTABLE SAMPLE PROGRAM SHOWN IN THE SRL -      *
                                    2 **      ASSEMBLER LANGUAGE MANUAL.                              -      *
```

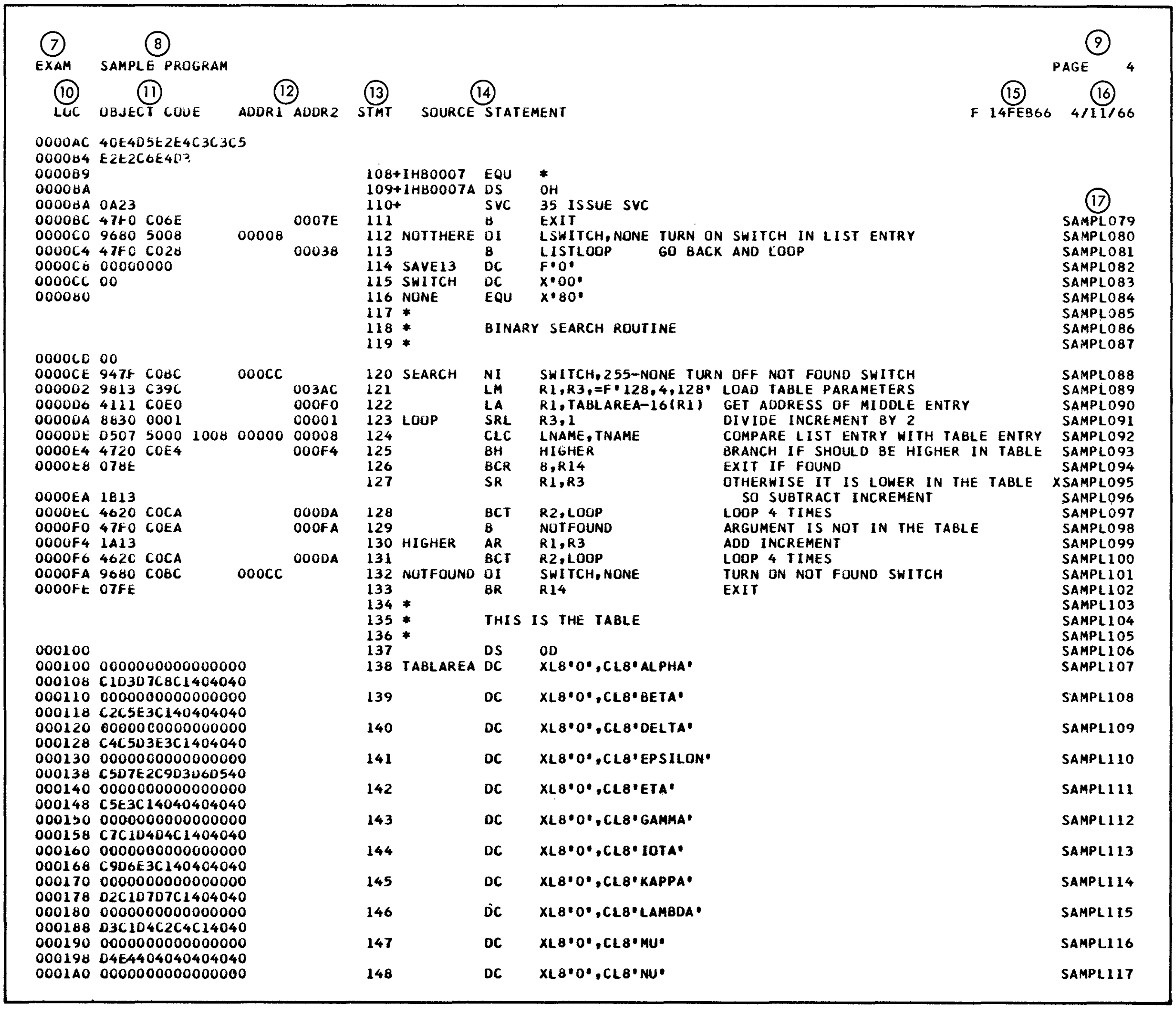


```
EXAM   SAMPLE PROGRAM                                                                                  PAGE    2
 LOC  OBJECT CODE     ADDR1 ADDR2  STMT    SOURCE STATEMENT                                    F 14FEB66  4/11/66
                                               4          PRINT DATA                                                     SAMPL002
                                               5 *                                                                       SAMPL003
                                               6 *        THIS IS THE MACRO DEFINITION                                   SAMPL004
                                               7 *                                                                       SAMPL005
                                               8          MACRO                                                          SAMPL006
                                               9          MOVE  &TO,&FROM                                                SAMPL007
                                              10 .*                                                                      SAMPL008
                                              11 .*       DEFINE SETC SYMBOL                                             SAMPL009
                                              12 .*                                                                      SAMPL010
                                              13          LCLC  &TYPE                                                    SAMPL011
                                              14 .*                                                                      SAMPL012
                                              15 .*       CHECK NUMBER OF OPERANDS                                       SAMPL013
                                              16 .*                                                                      SAMPL014
                                              17          AIF   (N'&SYSLIST NE 2).ERROR1                                 SAMPL015
                                              18 .*                                                                      SAMPL016
                                              19 .*       CHECK TYPE ATTRIBUTES OF OPERANDS                              SAMPL017
                                              20 .*                                                                      SAMPL018
                                              21          AIF   (T'&TO NE T'&FROM).ERROR2                                SAMPL019
                                              22          AIF   (T'&TO EQ 'C' OR T'&TO EQ 'G' OR T'&TO EQ 'K').TYPECGK   SAMPL020
                                              23          AIF   (T'&TO EQ 'D' OR T'&TO EQ 'E' OR T'&TO EQ 'H').TYPEDEH   SAMPL021
                                              24          AIF   (T'&TO EQ 'F').MOVE                                      SAMPL022
                                              25          AGO   .ERROR3                                                  SAMPL023
                                              26 .TYPEDEH ANOP                                                           SAMPL024
                                              27 .*                                                                      SAMPL025
                                              28 .*       ASSIGN TYPE ATTRIBUTE TO SETC SYMBOL                           SAMPL026
                                              29 .*                                                                      SAMPL027
                                              30 &TYPE    SETC  T'&TO                                                    SAMPL028
                                              31 .MOVE    ANOP                                                           SAMPL029
                                              32 *        NEXT TWO STATEMENTS GENERATED FOR MOVE MACRO                   SAMPL030
                                              33          L&TYPE   2,&FROM                                               SAMPL031
                                              34          ST&TYPE  2,&TO                                                 SAMPL032
                                              35          MEXIT                                                          SAMPL033
                                              36 .*                                                                      SAMPL034
                                              37 .*       CHECK LENGTH ATTRIBUTES OF OPERANDS                            SAMPL035
                                              38 .*                                                                      SAMPL036
                                              39 .TYPECGK AIF   (L'&TO NE L'&FROM OR L'&TO GT 256).ERROR4                SAMPL037
                                              40 *        NEXT STATEMENT GENERATED FOR MOVE MACRO                        SAMPL038
                                              41          MVC   &TO,&FROM                                                SAMPL039
                                              42          MEXIT                                                          SAMPL040
                                              43 .*                                                                      SAMPL041
                                              44 .*       ERROR MESSAGES FOR INVALID MOVE MACRO INSTRUCTIONS             SAMPL042
                                              45 .*                                                                      SAMPL043
                                              46 .ERROR1  MNOTE 1,'IMPROPER NUMBER OF OPERANDS, NO STATEMENTS GENERATED' SAMPL044
                                              47          MEXIT                                                          SAMPL045
                                              48 .ERROR2  MNOTE 1,'OPERAND TYPES DIFFERENT, NO STATEMENTS GENERATED'     SAMPL046
                                              49          MEXIT                                                          SAMPL047
                                              50 .ERROR3  MNOTE 1,'IMPROPER OPERAND TYPES, NO STATEMENTS GENERATED'      SAMPL048
                                              51          MEXIT                                                          SAMPL049
                                              52 .ERROR4  MNOTE 1,'IMPROPER OPERAND LENGTHS, NO STATEMENTS GENERATED'    SAMPL050
                                              53          MEND                                                           SAMPL051
                                              54 *                                                                       SAMPL052
                                              55 *        MAIN ROUTINE                                                   SAMPL053
                                              56 *                                                                       SAMPL054
000000                                        57 SAMPLR   CSECT                                                          SAMPL055
                                              58 BEGIN    SAVE  (14,12),,*                                               SAMPL056
```



```
  ⑦          ⑧                                                                                                    ⑨
EXAM   SAMPLE PROGRAM                                                                                         PAGE    3
   ⑩        ⑪               ⑫        ⑬           ⑭                                                    ⑮        ⑯
  LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT                                     F 14FEB66  4/11/66

000000 47F0 F00A            0000A    59+BEGIN    B     10(0,15) BRANCH AROUND ID
000004 05                            60+         DC    AL1(5)
000005 C2C5C7C9D5                    61+         DC    CL5'BEGIN' IDENTIFIER
00000A 90EC D00C            0000C    62+         STM   14,12,12(13) SAVE REGISTERS                                 ⑰
00000E 05C0                          63          BALR  R12,0         ESTABLISH ADDRESSABILITY OF PROGRAM        SAMPL057
000010                               64          USING *,R12         AND TELL THE ASSEMBLER WHAT BASE TO USE    SAMPL058
000010 50D0 C0B8            000C8    65          ST    13,SAVE13                                                SAMPL059
000014 9857 C390            003A0    66          LM    R5,R7,=A(LISTAREA,16,LISTEND)  LOAD LIST AREA PARAMETERS SAMPL060
000000                               67          USING LIST,R5      REGISTER 5 POINTS TO THE LIST               SAMPL061
000018 45E0 C0BE            000CE    68 MORE     BAL   R14,SEARCH   FIND LIST ENTRY IN TABLE                    SAMPL062
00001C 9180 C0BC      000CC          69          TM    SWITCH,NONE  CHECK TO SEE IF NAME WAS FOUND              SAMPL063
000020 4710 C0B0            000C0    70          BO    NOTTHERE     BRANCH IF NOT                               SAMPL064
000000                               71          USING TABLE,R1     REGISTER 1 NOW POINTS TO TABLE ENTRY        SAMPL065
                                     72          MOVE  TSWITCH,LSWITCH          MOVE FUNCTIONS                  SAMPL066
                                     73+*        NEXT STATEMENT GENERATED FOR MOVE MACRO
000024 D200 1003 5008 00003 00008    74+         MVC   TSWITCH,LSWITCH
                                     75          MOVE  TNUMBER,LNUMBER               FROM LIST ENTRY            SAMPL067
                                     76+*        NEXT STATEMENT GENERATED FOR MOVE MACRO
00002A D202 1000 5009 00000 00009    77+         MVC   TNUMBER,LNUMBER
                                     78          MOVE  TADDRESS,LADDRESS                  TO TABLE ENTRY        SAMPL068
                                     79+*        NEXT TWO STATEMENTS GENERATED FOR MOVE MACRO
000030 5820 500C            0000C    80+         L     2,LADDRESS
000034 5020 1004            00004    81+         ST    2,TADDRESS
000038 8756 C008            00018    82 LISTLOOP BXLE  R5,R6,MORE   LOOP THROUGH THE LIST                       SAMPL069
00003C D5EF C240 C0F0 00250 00100    83          CLC   TESTTABL(240),TABLAREA                                   SAMPL070
000042 4770 C07C            0008C    84          BNE   NOTRIGHT                                                 SAMPL071
000046 D55F C330 C1E0 00340 001F0    85          CLC   TESTLIST(96),LISTAREA                                    SAMPL072
00004C 4770 C07C            0008C    86          BNE   NOTRIGHT                                                 SAMPL073
                                     87          WTO   'ASSEMBLER SAMPLE PROGRAM SUCCESSFUL'                    SAMPL074
000050                               88+         CNOP  0,4
000050 4510 C06C            0007C    89+         BAL   1,IHB0005A BRANCH AROUND MESSAGE
000054 0027                          90+         DC    AL2(IHB0005-*) MESSAGE LENGTH
000056 0000                          91+         DC    AL2(0)
000058 C1E2E2C5D4C2D3C5              92+         DC    C'ASSEMBLER SAMPLE PROGRAM SUCCESSFUL' MESSAGE
000060 D940E2C1D4D7D3C5
000068 40D7D9D6C7D9C1D4
000070 40E2E4C3C3C5E2E2
000078 C6E4D3
00007B                               93+IHB0005  EQU   *
00007C                               94+IHB0005A DS    0H
00007C 0A23                          95+         SVC   35 ISSUE SVC
00007E 58D0 C0B8            000C8    96 EXIT     L     R13,SAVE13                                               SAMPL075
                                     97          RETURN (14,12),RC=0                                            SAMPL076
000082 98EC D00C            0000C    98+         LM    14,12,12(13) RESTORE THE REGISTERS
000086 41F0 0000            00000    99+         LA    15,0(0,0) LOAD RETURN CODE
00008A 07FE                         100+         BR    14 RETURN
                                    101 *                                                                       SAMPL077
                                    102 NOTRIGHT WTO   'ASSEMBLER SAMPLE PROGRAM UNSUCCESSFUL'                  SAMPL078
00008C                              103+         CNOP  0,4
00008C 4510 C0AA            000BA   104+NOTRIGHT BAL   1,IHB0007A BRANCH AROUND MESSAGE
000090 0029                         105+         DC    AL2(IHB0007-*) MESSAGE LENGTH
000092 0000                         106+         DC    AL2(0)
000094 C1E2E2C5D4C2D3C5             107+         DC    C'ASSEMBLER SAMPLE PROGRAM UNSUCCESSFUL' MESSAGE
00009C D940E2C1D4D7D3C5
0000A4 40D7D9D6C7D9C1D4
```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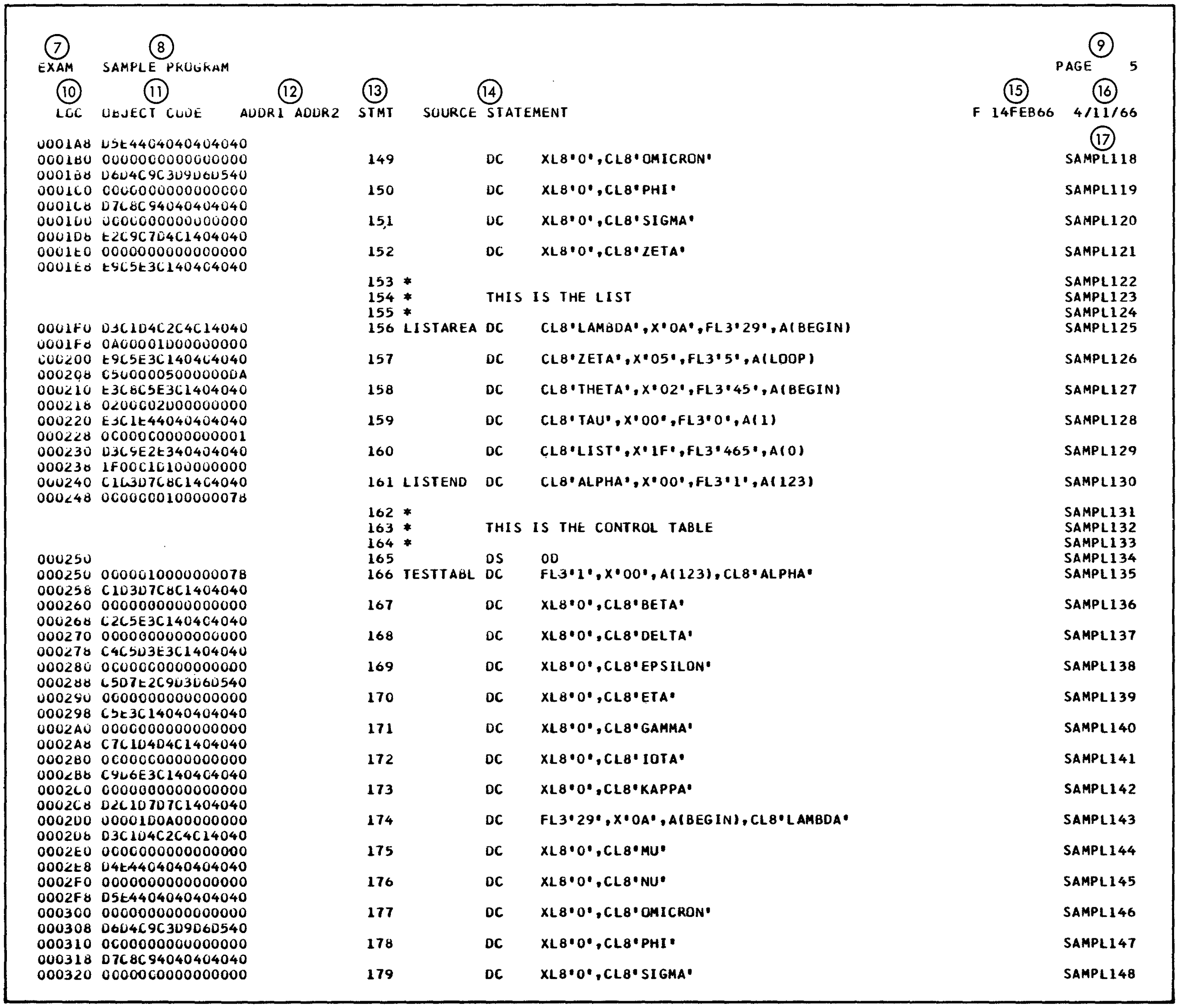
```
EXAM   SAMPLE PROGRAM                                                                          PAGE    4
  LOC  OBJECT CODE     ADDR1 ADDR2  STMT   SOURCE STATEMENT                                            F 14FEB66  4/11/66

0000AC 40E4D5E2E4C3C3C5
0000B4 E2E2C6E4D3
0000B9                              108+IHB0007  EQU   *
0000BA                              109+IHB0007A DS    0H
0000BA 0A23                         110+         SVC   35 ISSUE SVC
0000BC 47F0 C06E            0007E   111          B     EXIT                                                     SAMPL079
0000C0 9680 5008      00008         112 NOTTHERE OI    LSWITCH,NONE TURN ON SWITCH IN LIST ENTRY                SAMPL080
0000C4 47F0 C028            00038   113          B     LISTLOOP     GO BACK AND LOOP                            SAMPL081
0000C8 00000000                     114 SAVE13   DC    F'0'                                                     SAMPL082
0000CC 00                           115 SWITCH   DC    X'00'                                                    SAMPL083
000080                              116 NONE     EQU   X'80'                                                    SAMPL084
                                    117 *                                                                       SAMPL085
                                    118 *        BINARY SEARCH ROUTINE                                          SAMPL086
                                    119 *                                                                       SAMPL087
0000CD 00
0000CE 947F C0BC      000CC         120 SEARCH   NI    SWITCH,255-NONE TURN OFF NOT FOUND SWITCH                SAMPL088
0000D2 9813 C39C            003AC   121          LM    R1,R3,=F'128,4,128' LOAD TABLE PARAMETERS                SAMPL089
0000D6 4111 C0E0            000F0   122          LA    R1,TABLAREA-16(R1)  GET ADDRESS OF MIDDLE ENTRY           SAMPL090
0000DA 8830 0001            00001   123 LOOP     SRL   R3,1                DIVIDE INCREMENT BY 2                SAMPL091
0000DE D507 5000 1008 00000 00008   124          CLC   LNAME,TNAME         COMPARE LIST ENTRY WITH TABLE ENTRY  SAMPL092
0000E4 4720 C0E4            000F4   125          BH    HIGHER              BRANCH IF SHOULD BE HIGHER IN TABLE  SAMPL093
0000E8 078E                         126          BCR   8,R14               EXIT IF FOUND                        SAMPL094
                                    127          SR    R1,R3               OTHERWISE IT IS LOWER IN THE TABLE  XSAMPL095
0000EA 1B13                                                                  SO SUBTRACT INCREMENT              SAMPL096
0000EC 4620 C0CA            000DA   128          BCT   R2,LOOP             LOOP 4 TIMES                         SAMPL097
0000F0 47F0 C0EA            000FA   129          B     NOTFOUND            ARGUMENT IS NOT IN THE TABLE         SAMPL098
0000F4 1A13                         130 HIGHER   AR    R1,R3               ADD INCREMENT                        SAMPL099
0000F6 462C C0CA            000DA   131          BCT   R2,LOOP             LOOP 4 TIMES                         SAMPL100
0000FA 9680 C0BC      000CC         132 NOTFOUND OI    SWITCH,NONE         TURN ON NOT FOUND SWITCH             SAMPL101
0000FE 07FE                         133          BR    R14                 EXIT                                 SAMPL102
                                    134 *                                                                       SAMPL103
                                    135 *        THIS IS THE TABLE                                              SAMPL104
                                    136 *                                                                       SAMPL105
000100                              137          DS    0D                                                       SAMPL106
000100 0000000000000000             138 TABLAREA DC    XL8'0',CL8'ALPHA'                                        SAMPL107
000108 C1D3D7C8C1404040
000110 0000000000000000             139          DC    XL8'0',CL8'BETA'                                         SAMPL108
000118 C2C5E3C140404040
000120 0000000000000000             140          DC    XL8'0',CL8'DELTA'                                        SAMPL109
000128 C4C5D3E3C1404040
000130 0000000000000000             141          DC    XL8'0',CL8'EPSILON'                                      SAMPL110
000138 C5D7E2C9D3D6D540
000140 0000000000000000             142          DC    XL8'0',CL8'ETA'                                          SAMPL111
000148 C5E3C14040404040
000150 0000000000000000             143          DC    XL8'0',CL8'GAMMA'                                        SAMPL112
000158 C7C1D4D4C1404040
000160 0000000000000000             144          DC    XL8'0',CL8'IOTA'                                         SAMPL113
000168 C9D6E3C140404040
000170 0000000000000000             145          DC    XL8'0',CL8'KAPPA'                                        SAMPL114
000178 D2C1D7D7C1404040
000180 0000000000000000             146          DC    XL8'0',CL8'LAMBDA'                                       SAMPL115
000188 D3C1D4C2C4C14040
000190 0000000000000000             147          DC    XL8'0',CL8'MU'                                           SAMPL116
000198 D4E4404040404040
0001A0 0000000000000000             148          DC    XL8'0',CL8'NU'                                           SAMPL117
```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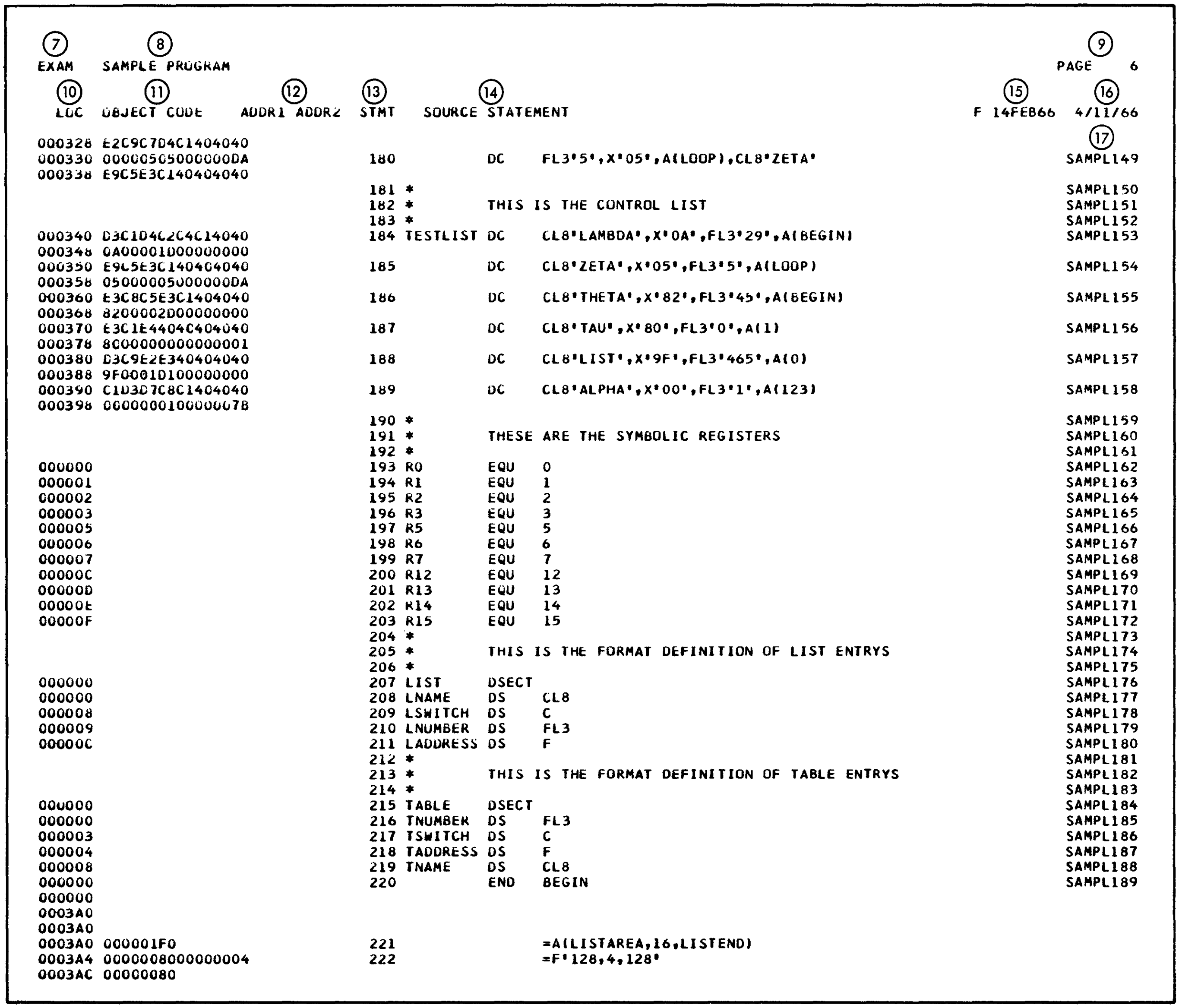
```
EXAM   SAMPLE PROGRAM                                                                                    PAGE    5
  LOC  OBJECT CODE      ADDR1 ADDR2  STMT   SOURCE STATEMENT                                      F 14FEB66  4/11/66

0001A8 D5E4404040404040
0001B0 0000000000000000               149          DC     XL8'0',CL8'OMICRON'                                SAMPL118
0001B8 D6D4C9C3D9D6D540
0001C0 0000000000000000               150          DC     XL8'0',CL8'PHI'                                    SAMPL119
0001C8 D7C8C94040404040
0001D0 0000000000000000               151          DC     XL8'0',CL8'SIGMA'                                  SAMPL120
0001D8 E2C9C7D4C1404040
0001E0 0000000000000000               152          DC     XL8'0',CL8'ZETA'                                   SAMPL121
0001E8 E9C5E3C140404040
                                      153 *                                                                 SAMPL122
                                      154 *        THIS IS THE LIST                                         SAMPL123
                                      155 *                                                                 SAMPL124
0001F0 D3C1D4C2C4C14040               156 LISTAREA DC     CL8'LAMBDA',X'0A',FL3'29',A(BEGIN)                 SAMPL125
0001F8 0A00001D00000000
000200 E9C5E3C140404040               157          DC     CL8'ZETA',X'05',FL3'5',A(LOOP)                     SAMPL126
000208 05000005000000DA
000210 E3C8C5E3C1404040               158          DC     CL8'THETA',X'02',FL3'45',A(BEGIN)                  SAMPL127
000218 0200002D00000000
000220 E3C1E44040404040               159          DC     CL8'TAU',X'00',FL3'0',A(1)                         SAMPL128
000228 0000000000000001
000230 D3C9E2E340404040               160          DC     CL8'LIST',X'1F',FL3'465',A(0)                      SAMPL129
000238 1F0001D100000000
000240 C1D3D7C8C1404040               161 LISTEND  DC     CL8'ALPHA',X'00',FL3'1',A(123)                     SAMPL130
000248 000000010000007B
                                      162 *                                                                 SAMPL131
                                      163 *        THIS IS THE CONTROL TABLE                                SAMPL132
                                      164 *                                                                 SAMPL133
000250                                165          DS     0D                                                 SAMPL134
000250 000001000000007B               166 TESTTABL DC     FL3'1',X'00',A(123),CL8'ALPHA'                     SAMPL135
000258 C1D3D7C8C1404040
000260 0000000000000000               167          DC     XL8'0',CL8'BETA'                                   SAMPL136
000268 C2C5E3C140404040
000270 0000000000000000               168          DC     XL8'0',CL8'DELTA'                                  SAMPL137
000278 C4C5D3E3C1404040
000280 0000000000000000               169          DC     XL8'0',CL8'EPSILON'                                SAMPL138
000288 C5D7E2C9D3D6D540
000290 0000000000000000               170          DC     XL8'0',CL8'ETA'                                    SAMPL139
000298 C5E3C14040404040
0002A0 0000000000000000               171          DC     XL8'0',CL8'GAMMA'                                  SAMPL140
0002A8 C7C1D4D4C1404040
0002B0 0000000000000000               172          DC     XL8'0',CL8'IOTA'                                   SAMPL141
0002B8 C9D6E3C140404040
0002C0 0000000000000000               173          DC     XL8'0',CL8'KAPPA'                                  SAMPL142
0002C8 D2C1D7D7C1404040
0002D0 00001D0A00000000               174          DC     FL3'29',X'0A',A(BEGIN),CL8'LAMBDA'                 SAMPL143
0002D8 D3C1D4C2C4C14040
0002E0 0000000000000000               175          DC     XL8'0',CL8'MU'                                     SAMPL144
0002E8 D4E4404040404040
0002F0 0000000000000000               176          DC     XL8'0',CL8'NU'                                     SAMPL145
0002F8 D5E4404040404040
000300 0000000000000000               177          DC     XL8'0',CL8'OMICRON'                                SAMPL146
000308 D6D4C9C3D9D6D540
000310 0000000000000000               178          DC     XL8'0',CL8'PHI'                                    SAMPL147
000318 D7C8C94040404040
000320 0000000000000000               179          DC     XL8'0',CL8'SIGMA'                                  SAMPL148
```



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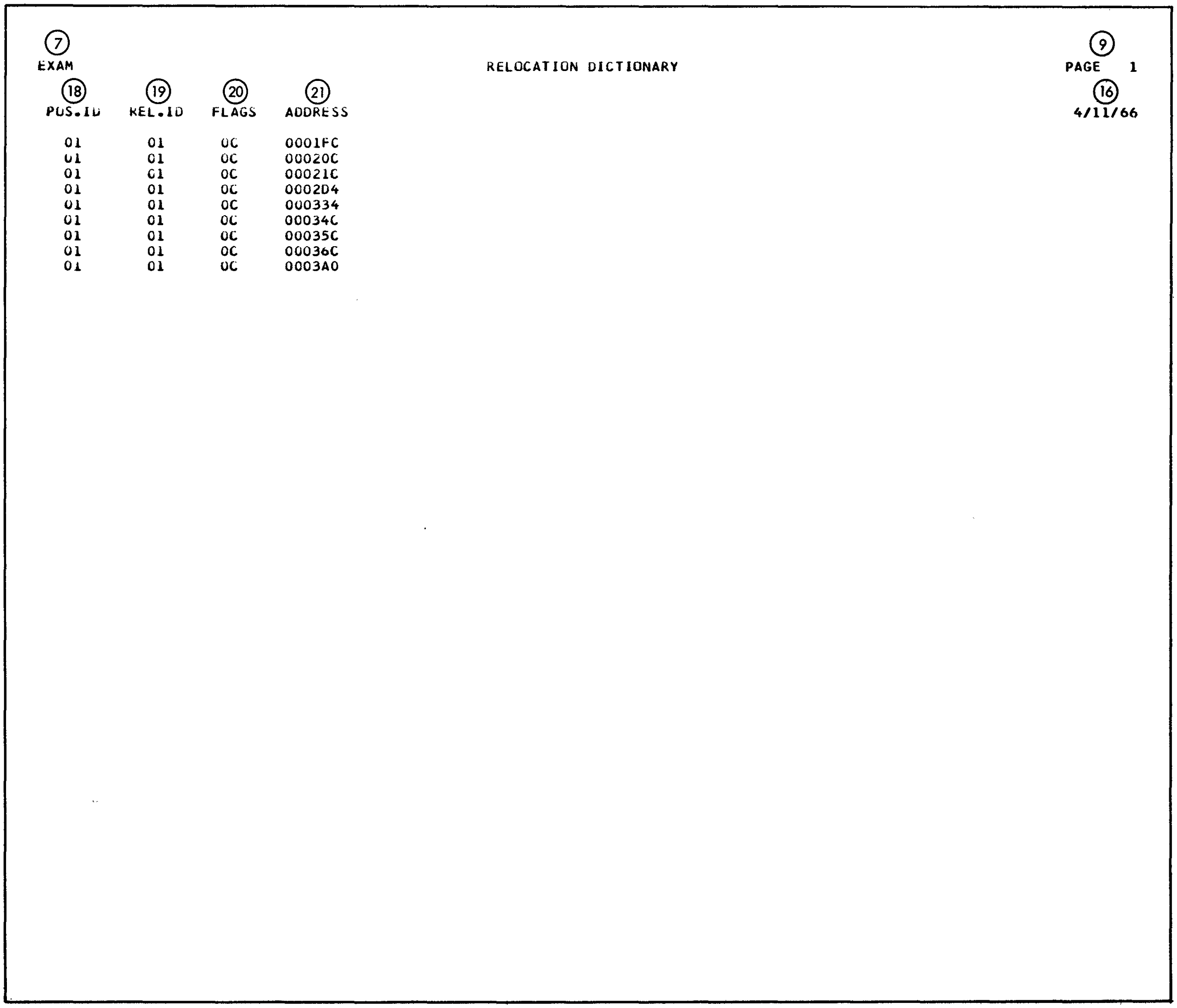
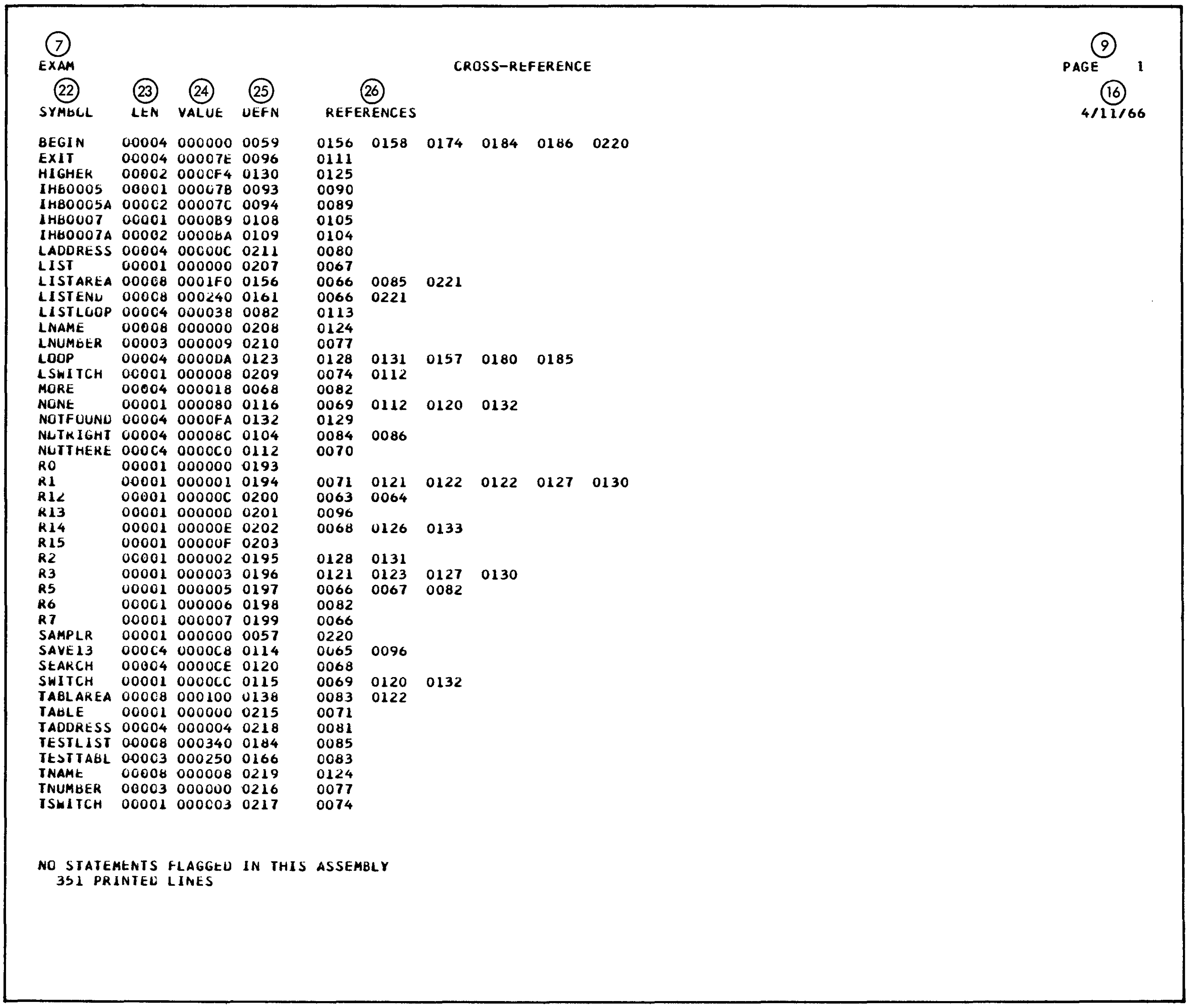
 ⑦       ⑧                                                                                                    ⑨
EXAM    SAMPLE PROGRAM                                                                                       PAGE    6
  ⑩         ⑪                ⑫          ⑬          ⑭                                                   ⑮          ⑯
  LOC   OBJECT CODE      ADDR1 ADDR2  STMT    SOURCE STATEMENT                                       F 14FEB66  4/11/66
                                                                                                                ⑰
000328 E2C9C7D4C1404040
000330 00000505000000DA              180            DC     FL3'5',X'05',A(LOOP),CL8'ZETA'                    SAMPL149
000338 E9C5E3C140404040
                                     181 *                                                                   SAMPL150
                                     182 *          THIS IS THE CONTROL LIST                                 SAMPL151
                                     183 *                                                                   SAMPL152
000340 D3C1D4C2C4C14040              184 TESTLIST DC     CL8'LAMBDA',X'0A',FL3'29',A(BEGIN)                 SAMPL153
000348 0A00001D00000000
000350 E9C5E3C140404040              185            DC     CL8'ZETA',X'05',FL3'5',A(LOOP)                    SAMPL154
000358 05000005000000DA
000360 E3C8C5E3C1404040              186            DC     CL8'THETA',X'82',FL3'45',A(BEGIN)                 SAMPL155
000368 8200002D00000000
000370 E3C1E44040404040              187            DC     CL8'TAU',X'80',FL3'0',A(1)                        SAMPL156
000378 8000000000000001
000380 D3C9E2E340404040              188            DC     CL8'LIST',X'9F',FL3'465',A(0)                     SAMPL157
000388 9F0001D100000000
000390 C1D3D7C8C1404040              189            DC     CL8'ALPHA',X'00',FL3'1',A(123)                    SAMPL158
000398 000000010000007B
                                     190 *                                                                   SAMPL159
                                     191 *          THESE ARE THE SYMBOLIC REGISTERS                         SAMPL160
                                     192 *                                                                   SAMPL161
000000                               193 R0         EQU    0                                                 SAMPL162
000001                               194 R1         EQU    1                                                 SAMPL163
000002                               195 R2         EQU    2                                                 SAMPL164
000003                               196 R3         EQU    3                                                 SAMPL165
000005                               197 R5         EQU    5                                                 SAMPL166
000006                               198 R6         EQU    6                                                 SAMPL167
000007                               199 R7         EQU    7                                                 SAMPL168
00000C                               200 R12        EQU    12                                                SAMPL169
00000D                               201 R13        EQU    13                                                SAMPL170
00000E                               202 R14        EQU    14                                                SAMPL171
00000F                               203 R15        EQU    15                                                SAMPL172
                                     204 *                                                                   SAMPL173
                                     205 *          THIS IS THE FORMAT DEFINITION OF LIST ENTRYS             SAMPL174
                                     206 *                                                                   SAMPL175
000000                               207 LIST       DSECT                                                    SAMPL176
000000                               208 LNAME      DS     CL8                                               SAMPL177
000008                               209 LSWITCH    DS     C                                                 SAMPL178
000009                               210 LNUMBER    DS     FL3                                               SAMPL179
00000C                               211 LADDRESS DS     F                                                   SAMPL180
                                     212 *                                                                   SAMPL181
                                     213 *          THIS IS THE FORMAT DEFINITION OF TABLE ENTRYS            SAMPL182
                                     214 *                                                                   SAMPL183
000000                               215 TABLE      DSECT                                                    SAMPL184
000000                               216 TNUMBER    DS     FL3                                               SAMPL185
000003                               217 TSWITCH    DS     C                                                 SAMPL186
000004                               218 TADDRESS DS     F                                                   SAMPL187
000008                               219 TNAME      DS     CL8                                               SAMPL188
000000                               220            END    BEGIN                                             SAMPL189
000000
0003A0
0003A0
0003A0 000001F0                      221                   =A(LISTAREA,16,LISTEND)
0003A4 0000008000000004              222                   =F'128,4,128'
0003AC 00000080
```


7
9
18
19
20
21
16

```
EXAM                                              RELOCATION DICTIONARY                                              PAGE    1

POS.ID     REL.ID    FLAGS    ADDRESS                                                                                4/11/66

  01         01        0C     0001FC
  01         01        0C     00020C
  01         01        0C     00021C
  01         01        0C     0002D4
  01         01        0C     000334
  01         01        0C     00034C
  01         01        0C     00035C
  01         01        0C     00036C
  01         01        0C     0003A0
```



7
9
22
23
24
25
26
16

```
EXAM                                          CROSS-REFERENCE                                            PAGE   1

SYMBOL     LEN   VALUE  DEFN     REFERENCES                                                             4/11/66

BEGIN     00004 000000 0059     0156  0158  0174  0184  0186  0220
EXIT      00004 00007E 0096     0111
HIGHER    00002 0000F4 0130     0125
IHB0005   00001 00007B 0093     0090
IHB0005A  00002 00007C 0094     0089
IHB0007   00001 0000B9 0108     0105
IHB0007A  00002 0000BA 0109     0104
LADDRESS  00004 00000C 0211     0080
LIST      00001 000000 0207     0067
LISTAREA  00008 0001F0 0156     0066  0085  0221
LISTEND   00008 000240 0161     0066  0221
LISTLOOP  00004 000038 0082     0113
LNAME     00008 000000 0208     0124
LNUMBER   00003 000009 0210     0077
LOOP      00004 0000DA 0123     0128  0131  0157  0180  0185
LSWITCH   00001 000008 0209     0074  0112
MORE      00004 000018 0068     0082
NONE      00001 000080 0116     0069  0112  0120  0132
NOTFOUND  00004 0000FA 0132     0129
NOTRIGHT  00004 00008C 0104     0084  0086
NOTTHERE  00004 0000C0 0112     0070
R0        00001 000000 0193
R1        00001 000001 0194     0071  0121  0122  0122  0127  0130
R12       00001 00000C 0200     0063  0064
R13       00001 00000D 0201     0096
R14       00001 00000E 0202     0068  0126  0133
R15       00001 00000F 0203
R2        00001 000002 0195     0128  0131
R3        00001 000003 0196     0121  0123  0127  0130
R5        00001 000005 0197     0066  0067  0082
R6        00001 000006 0198     0082
R7        00001 000007 0199     0066
SAMPLR    00001 000000 0057     0220
SAVE13    00004 0000C8 0114     0065  0096
SEARCH    00004 0000CE 0120     0068
SWITCH    00001 0000CC 0115     0069  0120  0132
TABLAREA  00008 000100 0138     0083  0122
TABLE     00001 000000 0215     0071
TADDRESS  00004 000004 0218     0081
TESTLIST  00008 000340 0184     0085
TESTTABL  00003 000250 0166     0083
TNAME     00008 000008 0219     0124
TNUMBER   00003 000000 0216     0077
TSWITCH   00001 000003 0217     0074


NO STATEMENTS FLAGGED IN THIS ASSEMBLY
  351 PRINTED LINES
```

The Assembler can be invoked by a problem program at execution time through the use of the CALL, LINK, XCTL, or ATTACH macro instructions. If the XCTL macro instruction is used to invoke the Assembler, then no user options may be stated. The Assembler will use the standard default, as set during system generation, for each option.

If the Assembler is invoked by CALL, LINK, or ATTACH, the user may supply:

1) The Assembler options
2) The ddnames of the data sets to be used during processing

Name	Operation	Operand
[symbol]	CALL	IEUASM, (optionlist [,ddnamelist]), VL

	{LINK
	ATTACH}
		EP=IEUASM,
		PARAM=(optionlist
		[,ddnamelist]), VL=1

EP - specifies the symbolic name of the Assembler. The entry point at which execution is to begin is determined by the control program (from the library directory entry).

PARAM - specifies, as a sublist, address parameters to be passed from the problem program to the Assembler. The first word in the address parameter list contains the address of the option list. The second word contains the address of the ddname list.

optionlist - specifies the address of a variable length list containing the options. This address must be written even if no option list is provided.

The option list must begin on a halfword boundary. The first two bytes contain a count of the number of bytes in the remainder of the list. If no options are specified, the count must be zero. The option list is free form with each field separated by a comma. No blanks or zeros should appear in the list.

ddnamelist - specifies the address of a variable length list containing alternate ddnames for the data sets used during compiler processing. If standard ddnames are used then this operand may be omitted.

The ddname list must begin on a halfword boundary. The first two bytes contain a count of the number of bytes in the remainder of the list. Each name of less than eight bytes must be left-justified and padded with blanks. If an alternate ddname is omitted, the standard name will be assumed. If the name is omitted within the list, the 8-byte entry must contain binary zeros. Names can be omitted from the end merely by shortening the list. The sequence of the 8-byte entries in the ddname list is as follows:

Entry	Alternate Name
1	not applicable
2	not applicable
3	not applicable
4	SYSLIB
5	SYSIN
6	SYSPRINT
7	SYSPUNCH
8	SYSUT1
9	SYSUT2
10	SYSUT3
11	SYSGO

VL - specifies that the sign bit is to be set to 1 in the last word of the address parameter list.

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