Running Jobs at NCAR

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This guide is one of a set of introductory user guides to the NCAR Computing Facility. It contains information on how to run programs on NCAR's Control Data Corporation 7600 computer and Cray Research, Incorporated, CRAY-1 computer. There are three sections. The first, Submitting and Monitoring Jobs, describes the Computing Facility's procedures for running jobs: how to submit decks, where to retrieve output, and how to monitor jobs. The second section, Deck Structure, compares deck structures for programs which will run on one or both of the NCAR mainframes. The last section, Reading Printed Output, is a description, with examples, of printed output from the two computers.

The NCAR CDC 7600 computer is used largely for data processing; it handles all I/O processing at NCAR. It is also used as the front end machine for the CRAY-1 computer; there is no direct user access to the CRAY-1.

The CRAY-1 computer is best suited for solving problems which require extensive numerical computations (e.g. large CPU time and small PPU time).

Users may wish to refer to some or all of the other NCAR documents which are referenced in this guide. They are:

- "Overview of the Scientific Computing Division"
- the NCAR 7600 Primer manual
- "Storing, Retrieving and Editing Programs"
Submitting a Job Over the Counter

Submitting job decks and retrieving output are done in the Input/Output area in the Computing Facility. The map in the user guide, "Overview of the Scientific Computing Division" shows the I/O area with the input counter and the various output storage areas. At NCAR, job decks are returned to users as soon as they have been read in. An operator reads in a deck within a few minutes of the time it is placed on the counter under the INPUT sign. After that, the operator places the deck on one of the shelves under the OUTPUT sign. These shelves are labeled alphabetically and the deck is placed on the shelf which corresponds to the first letter in the name field on the *JOB card (see below, 7600 Job Decks). There are two or three shelves for each letter: card decks are placed on the upper shelf, printed output on the lower ones. Large decks, submitted in boxes or trays, are stored in the right-most shelves under the OUTPUT sign.

Cards and Forms

There are several forms or cards that users should fill out to aid the Operations staff in running jobs at NCAR. Three of these forms are related to the use of tapes, both in-house (B-tapes) and outside or visitor (V-tapes). All tapes used at NCAR must have an NCAR number and a user name assigned to them, regardless of where they were generated.

TAPE ASSIGN CARD. This card is used to sign out NCAR tapes. Users may have up to five NCAR tapes for use while visiting the Computing Facility. Visitors who know they will need more than this number are asked to include this information in their request for resources. The name on the card will be put on the external tape label. This name is the only one which can be used in the name field on the *JOB card of a program which will write the tape.

VISITOR TAPE ASSIGN CARD. This card is for assigning numbers to tape(s) visitors bring with them to NCAR.

TAPE RELEASE AUTHORIZATION. This card allows users to remove NCAR tapes from the tape library.

These three forms are available at the input counter from an operator. Instructions on filling them out are posted at the input counter.

OPERATOR REQUEST CARD. This card must be used to convey messages to the Operations staff about various operational procedures. These include such things as cleaning tapes, certifying tapes, releasing
tapes, changing or adding user names to tapes, running jobs at particular times, and, of course, dropping jobs. As one example, if a user is going to require the use of three or more tapes during a day, the Operations staff appreciates the use of this card to list all the tape numbers so that the tapes can be retrieved from the library in one trip—ready for use when they are called by the job.

REQUEST FOR VSN MOVES. VSN, in mass-store context, stands for volume serial name—it is the acronym applied to volumes of data, programs, routines, etc. stored on the Ampex Terabit Memory System (TMS-4), NCAR's mass storage device (MSD). The request card is used to move volumes from one mass store tape to another. A mass store tape is known by the acronym MVN—mass store volume name. Although volumes are automatically moved from offline mass store tapes to online ones, this form is useful when users know ahead of time that they will be using several offline VSNs for a job. For example, an operator can move the volumes to the online tape overnight and they will be ready for use in the job; or, in the case of archiving of data, operators can move an online volume to offline storage.

**Picking Up Output**

Printout When a job has run, all physical output is returned to various locations in the I/O area. As mentioned above, printed output is placed on the lower shelf under the initial of the name in the *JOB* card name field. To the far left, at the bottom of the first stack of output shelves, are two shelves where punched output is returned. This output is identified by date and sequence number only.

Printed output, card decks, and boxed/tray decks are moved from the output shelves and placed in the shelves across the room several times a day as space is needed. Each evening, all shelves under the OUTPUT sign are cleared and the contents placed in the shelves across the room. Output and card decks remain there for a 24-hour period. Then they are moved to another group of shelves along the same wall (near the double doors) labeled by days of the week. Output and decks are placed here according to the day the job ran; they remain here for one week. Any output left longer than one week is recycled.

The page limit for printed output (as set by the operator) is usually 75 pages during the day, Monday through Friday, and 250 at all other times (i.e., evenings, weekends, and holidays). Jobs trying to print more than this
limit are automatically sent to dd80 microfilm.

Film and Fiche

Both microfilm and microfiche output are available at NCAR. Microfilm, produced on the Control Data dd80 graphics device, may be picked up from the rack on the wall just around the corner from the output shelves. The boxes containing film are identified with the *JOB card name and sequence number. A microfilm reader/printer is available in the I/O area (as well as in other locations, such as the visitor carrel area) so film output may be examined immediately.

Users can expect some delay in getting back microfilm output. Usually film is processed once every two hours or every 1,000 frames during the day, but sometimes, if a large quantity of film has been exposed, processing is done more frequently. Film processing is less frequent in the evenings and on weekends.

Microfiche output, as well as 35mm film, is available from the DICOMED graphics device. Users wishing to run jobs which produce DICOMED output, regardless of the type, are asked to complete a DICOMED REQUEST form for Operations. Please ask for this form when submitting a job.

The NCAR operating system automatically identifies output from the dd80 graphics device by inserting a header frame at the beginning of the film. All other graphics output—for example, output from the DICOMED—must be identified by a user-supplied statement in the job. The library routine NAMEFR writes a header frame to the program's graphics output file. A call to this routine should initiate all graphics jobs not intended for the dd80.

Microfiche is returned in a small white envelope and may be picked up from the microfilm rack. A fiche reader is available in the Consulting Office (room 9c in the I/O area).

Submitting a Job Through RJE

Batch processing of jobs can be done by remote access to NCAR's mainframes via the MODCOMP II buffer computer (MODular COMPUTER Systems, Inc.). The MODCOMP is the scheduler for incoming remote jobs and enqueues jobs returning from the mainframes after execution for transmission back to remote sites.

All output produced at NCAR by RJE sites is mailed back to sites twice a day, once in the morning, once in the afternoon. Punched output cannot be obtained from a remote site.
In-House Terminal

There is a remote access terminal available at NCAR for public use. An INCOTERM (which simulates a UT200) is located in the keypunch room (room 22). It is equipped with a line printer and a card reader. It is sometimes helpful to use this terminal for submitting jobs in the evenings and on weekends when the Operations staff is at a reduced level. The INCOTERM can also read ASCII decks. Instructions for use of this terminal are posted nearby; if there are problems, the Operations supervisor can help.

There is no logon procedure for the NCAR terminal. There are documents near the INCOTERM which describe the use of the terminal and NCAR's RJE terminal language commands. Printed output can be directed to either the NCAR MODCOMP printer or to the printer at the terminal location. If output is sent to the MODCOMP printer, or if a job produces film or fiche output, this is returned in the I/O area.

Monitoring the Job

After submitting a job, its progress through the NCAR system can be monitored using the monitoring scopes positioned throughout the CF and NCAR. There is only one CRAY-1 monitoring scope; it is located in the I/O area. Next to it is one of several 7600 scopes; others are located in the visitor area and the keypunch room in the first basement, and in room 100 on the first floor.

The 7600 Scope

The 7600 monitor display looks like this:

```
Write ring status

*JOB card name

Tape label

7-track tape drive unit number

Control point number

9-track tape drive unit number

Page 0
CP  SEQ  PROG  PTTG  TTG  SSW  STATUS  D/S  O/D  T1 T0 T1 T0 M
05  1234  SMITHJ  002M  09S  ...  EXEC HOLD
06  1246  USER2  012M  025M  ...  TAPE HOLD
07  1534  JONES  002S  065S  ...  SYS HOLD
08  1813  SMITHH  014M  038M  ...  EXEC HOLD
10  1251  ROGER  008S  003S  ...  TRANSFER >>>>>>>>>>>>>>>>>>>>>>>>>>>>
11  1278  USER1  005M  002M  ...  TAPE HOLD TIL SIGNAL
12  1279  JMJD05  036S  011S  ...  EXEC
13  1291  JRLO04  000S  000S  ...  OUTPUT HOLD <<<<<<<<<<<<<<<<<<<<
14  1301  ASTRIK  000S  000S  ...  PRINTER
```

Figure 1. The 7600 Scope

The two lists of numbers from 03 to 07 at the top of the display are tape drive numbers, and the information by any one of these numbers tells the operators what tape
numbers have been requested for mounting on one of the tape units. The left-hand list is for 7-track tape drives, the right-hand list is for 9-track tape drives; both lists display the same kind of information.

When the tape has been mounted by an operator, the information to the left of the tape drive number disappears from the display. When the job has finished using the tape and the drive is no longer needed, the information to the right disappears. The tape drive number is always displayed.

In the example, the number next to the user name is the NCAR-assigned tape label.

The write ring is a device inserted into a 1/2" tape reel to tell the machine whether a tape may be written. If a write ring is out, the tape may only be read; if the ring is in, the tape may also be written. The write ring status is displayed on the 7600 scope, next to the tape label.

After the tape drive portion of the display, the next line contains the page number of the 7600 scope display and the column titles for the remainder of the display.

| CP  | Control point number |
| SEQ | Sequence number (assigned by the system) |
| PROG | The *JOB card name |
| PTTG | Peripheral time to go |
| TTG | Processor (CPU) time to go |
| SSW | Sense switch setting |
| STATUS | Job status or phase |

The control point number (CP) is used by the Operations staff to identify a job. If a user wishes to drop a job, the control point number, sequence number, and *JOB card name must be supplied to an operator on an OPERATOR REQUEST CARD. The SSW (sense switch) information is used when the Operations staff must abort jobs under conditions which occur only rarely (see Appendix A of this guide).

Job status is shown next. Note the symbols (arrows and dots) used to indicate the movement of a 7600 job to or from some other machine; e.g., the MODCOMP or the CRAY-1. A complete list of possible job status conditions is
shown in Appendix A of this guide.

Underneath the page number on the far left of the screen, a fast changing number at the beginning of a line displays the instruction counters for a job that is executing. A star at the beginning of a line indicates a job that is in memory.

On the right side of the line which displays the column titles is some system information. D/S-Dxx gives the number of the current deadstart (system) tape; this is followed by the time of the last system deadstart using that tape. The T1= number is significant. It is the time limit set by Operations for controlling the job flow. Jobs whose total time at job initiation is less than T1 can enter the system and run without operator assistance. (Users set time limits with a *LIMIT job control statement.) For a complete explanation of how T1 affects job scheduling, see the section below, Job Scheduling.
The CRAY-1 Scope

The CRAY-1 monitoring scope looks like this:

![CRAY-1 Scope Diagram]

The first line of information at the top of the CRAY-1 scope is used by Cray engineers to isolate faulty memory modules; it is not of interest to most users. The information in the line which reads STATUS EIORS is used mainly by the Operations staff. These are selectable options for displaying jobs in various job phases. Normally all jobs in the system are displayed.

The titles of the various columns are as follows.

**JSQ**

The job sequence number is a unique number sequentially assigned by the system as jobs enter and as datasets are created. It is used for operator control (such as dropping a job, changing priority, etc.).

**DC**

Disposition code indicates that a job is in input phase or indicates where a job, or dataset, is being sent after execution on the CRAY-1.

**DATASET**

This name is either a sequence number or a dataset name. This column and the DC column together give information about the status of jobs or datasets before and after
Execution on the CRAY-1.

A complete list of possible job status conditions is shown in Appendix B of this guide.

This number indicates job priority. The digit(s) to the left of the point indicate the general category of priority. 10 means foreground; 5 means background; 7 or 14 indicates that a dataset has transfer priority, that is, it is coming back to the front end machine from the CRAY-1. The digits to the right of the point show a calculated priority within the category.

The TIME LIMIT is obtained from the JOB card or is set to the default value. The TIME USED is the number of seconds in CPU used by the job; this number changes as the job executes.

This is the octal number of blocks, where a block is 1000 words, required for memory. This number may change as the system makes adjustments for memory requirements for an executing job.

This identifies the front end machine where the job originated.

The two numbers indicate either the 7600 computer (99) or a remote site. The name is the JOB card name field.

Remote users can also check on the status of their jobs by accessing the MODCOMP terminal display with the DIS,SIT MODCOMP command. Status information about machines and jobs for that site appears in a scope display. The following status information is available using the DIS,SIT command:

- Status of the 7600; whether the 7600 is accepting input; the number of jobs from a site
- Status of the site printer; status of the NCAR printer
- Status of the site card reader
- Tape information, such as number of tapes assigned and number of jobs waiting for tape drives
site number, port number

Detailed information about all jobs currently running on the 7600 in foreground mode from a site.

Information on RJE jobs running in background mode is available with two MODCOMP commands: DIS,BQ7,x (for 7600) and DIS,BQC,x (for CRAY-1), where x is a page number. Page one shows the number of jobs in the queue and the time the queue information was updated. Subsequent pages list job names, sequence numbers, and job position in the queue.

Machine Status

A sign on the input counter displays information when a machine is down. Every fifteen minutes during the day, operational information is displayed for three minutes on the 7600 scope. This includes the name of the shift supervisor, the dates and times of machine restarts for the 7600 and the CRAY-1 for the last two days, and messages about any machines which are down. If the 7600 is down, the message appears on the scope until the 7600 comes back up.

Information about machine status is also available over the phone. Between 8:30 a.m. and 5:00 p.m., the NCAR phone number 303-494-5151, extension 313 gives recorded information concerning current machine status. (If users call that extension in the evening or on weekends, the recording says to call extension 536, which is the machine room.) Users may also call the Consulting Office, at extension 579, to obtain hardware status information. On weekends or at night, machine status information is available by calling the machine room directly (extension 536).

Other User Information

In the I/O area, there are a number of listings and notices which are of interest to users. The Daily Bulletin, which lists system changes, operational procedures, and other timely notices of interest to users, is posted under the monitoring scopes and in the Consulting Office. (The Daily Bulletin is available to remote users, also, through the MODCOMP NEWS command.)

The bulletin board next to the Consulting Office door contains daily accounting information for the 7600, the CRAY-1, and all remote terminals; there is also a listing showing cumulative totals for resources used.

In the hall between the secretary's office and the mail room are three sets of listings associated with the use of VSNs (volume serial name). These lists show VSNs by user number, by project number, and by mass store volume name (MVN). (These same lists are available in the Con-
A program called TBMVSN is available to provide VSN listings by user number and/or project number. All users may run this program to obtain status information on their VSNs; the information can include, if desired, the date of last access of all VSNs.

On a large bulletin board near the input counter, Operations posts a listing of the current 7600 job load. This shows the status of jobs currently running in foreground and the background queues for both the 7600 and the CRAY-1. Information contained in this list may be used, for example, to drop a job in background mode. The OPERATOR REQUEST CARD must contain the background job number obtained from this list, as well as the name of the machine and the user name. The 7600 job load listing is posted every half hour during the day and every two to three hours on weekends and holidays.

There are two other lists posted on this same bulletin board that show the results of the latest CRAY-1 "disk scrub," the procedure which removes datasets from the CRAY-1 disks. One list, posted at the beginning of the day, shows all datasets residing on the CRAY disks. The second list shows what unique datasets were removed during a disk scrub (early editions of all datasets are removed but this does not appear on this list). Disk scrubbing is scheduled to occur every three hours during the day and every four hours on the night shifts and on weekends. During heavy disk usage, scrubbing occurs very frequently—sometimes it is a matter of only ten or fifteen minutes.

In the visitor carrel area, there is yet another bulletin board which contains notices of interest to visitors, a copy of the Daily Bulletin, and daily accounting information for non-NCAR projects.

How Operations Can Help

The Operations staff can be very helpful to users in all aspects of running their programs at the NCAR Computing Facility. Users can get answers quickly by talking with the supervisor on duty. Operations works in three shifts: from 8:00 a.m. until 4:00 p.m., from 4:00 p.m. until midnight, and from midnight until 8:00 a.m., seven days a week including holidays. The supervisor changes with each shift; the supervisor's name is displayed on the wall behind the output shelves at the end near the input counter.

The work characteristics of the shifts are as follows:

- 8:00 a.m.-4:00 p.m.: the emphasis is on check-out and debugging runs.
4:00 p.m.-12:00 midnight: the larger (production) jobs are run. Check-out and debugging jobs are also run periodically.

12:00 midnight-6:00 a.m.: scheduled times are allocated for the larger users and short-term visitors. Any available time not assigned is used for production runs.

6:00 a.m.-8:00 a.m.: Monday through Friday is set aside for preventive maintenance and systems software check-out.

Operations provides keypunch and unit record equipment service to all users. A small keypunch staff is available to perform keypunching service and to provide assistance in the operation of keypunch machines, the sorter, and other equipment.

Questions about graphics output, e.g., microfilm and fiche, may be directed to the microfilm processing staff in room 24D or by phone. The phone number is 303-494-5151 extension 535.

During regular hours, questions about 1/2" tapes and VSNs should be directed to the tape librarian in room 5 (that's in the same area as the visitor carrels); the phone number for the tape librarian is 303-494-5151, extension 450. In the evenings or on weekends, the Operations staff can answer most questions about tapes and VSNs. Their telephone extension is 536.

Remote users can communicate with the Operations staff in two ways. To talk with the supervisor on duty in the machine room, the phone number is 303-494-5151, extension 536. It may be convenient to simply type in a message from the site terminal to the Operations staff. Using the OPR MODCOMP command, messages of up to 40 characters at a time may be exchanged with the operators.

The Operations staff makes every effort to contact users personally if there is a problem running a job. However, if an operator is unable to locate the user, a pink slip will accompany the printed output which is returned to the user. The slip contains a message describing the nature of the problem and, if the job was dropped, why. The Operations staff can also communicate with users on the CRAY-1 by inserting a message in the printout of the CRAY-1 logfile (see below, CRAY-1: Logfile, in the section called Reading Printed Output).
Job Scheduling

Generally, the priority of jobs running on the CDC 7600 is determined by the time of day the job entered the system, the status or job phase, and the total initial time limits as set on the *LIMIT card. The total time—central processor unit (CPU) plus peripheral processor unit (PPU) times—is compared with the value of $T_1$ as set by Operations; those jobs whose time limits are less than $T_1$ are allowed to enter the system immediately. $T_1$ is usually set low (2 minutes or less) during the day to allow small, quick jobs to run. On second and third shifts $T_1$ is set progressively higher by Operations, until all jobs submitted that day have run on a first in/first out basis.

After a job has entered one of the NCAR computers, job priority may shift, depending upon the job phase and the length of time the job has been running, and jobs may exchange positions within memory. The schedulers for both the 7600 and the CRAY-1 use a system of rolling jobs in and out of core as priorities change on executing jobs. This allows short, quick jobs to run and prevents large jobs from monopolizing the machines.

On the CRAY-1, jobs enter the system either as foreground mode (priority status 10) or background (priority status 3) jobs. Then, according to a calculated priority and the time of day, jobs are input for execution.

The MODCOMP II computer is the scheduler for incoming remote jobs. All the MODCOMP does, however, is to enqueue jobs as they arrive and send them on to the 7600. If input from the MODCOMP to the 7600 is held, the MODCOMP enqueues remote entry jobs based on their time limits. However, when the channel to the 7600 is open, all jobs proceed immediately from the MODCOMP to the 7600, including all jobs in the MODCOMP queue.

Background jobs are scheduled into the system manually by the operators. Background jobs run only when all foreground work is complete. NOTE: Turnaround on background jobs is sometimes very slow.

A description of the scheduling algorithms for the CDC 7600 and the CRAY-1 is contained in Appendix C of this guide.
Regardless of which computer is to execute the program, jobs always enter the NCAR batch system through the Control Data 7600 computer; therefore all NCAR Computing Facility users should be acquainted with the use of the 7600 job control language (JCL). Because the 7600 operating system was developed at NCAR, the 7600 JCL is not similar to JCL on other Control Data machines. 7600 JCL statements all start with an asterisk in column one and fields are separated by commas. Reading of JCL statements is terminated when a blank is encountered; therefore, 7600 JCL statements must not contain embedded blanks. Below is a list of all the required 7600 JCL statements and a few more of the most frequently used ones. Certain JCL cards have a required position in the job deck; if the statement takes arguments, this fact is noted in parentheses.

** *JOB**

The first card in the user deck. It is **REQUIRED**. The *JOB card is the link between the user program and the NCAR system. The *JOB card requires a special format: 

```
*JOB,uuuu,pppppppp,username
```

where **uuuu** is an assigned four-digit user number and **pppppppp** is an assigned eight-digit project number. While a name on the *JOB card is not required by the NCAR operating system, it is needed by Operations in many ways. The name on the *JOB card should match the name on the external label of any tapes to be written. The same name must be on all decks so that they (and the resulting output) can be alphabetically shelved and returned to users. It is advisable to use a name which is recognized easily so that, in case of problems, the Operations staff can put a user and his job together. The NCAR CF provides white, preformatted *JOB cards—please use them. For convenience they are kept near all keypunch machines.

** *BACKGND76**

designates the job to be entered into the 7600 background queue. (Background rate is charged at 1/3 of foreground rate.) Significant only on the 7600, it must immediately follow the *JOB card.

** *BACKGND1**

designates the job to be entered into the CRAY-1 background queue which is kept in the 7600. It must follow the *JOB card and there must be a *CRAY1 card somewhere in the JCL stream.
*LIMIT  This card sets limits on the 7600 for paper (PR), punched cards (PU), film (ddSO), memory (C), and central (T) and peripheral (PT) processing times. To set limits on the 7600, the *LIMIT card must precede a *CRAY1 card. To set time or memory limits on the CRAY-1, a LIMIT card must follow the *CRAY1 card.

*CRAY1  (arguments) Without an argument, the deck following this card is to be translated into CRAY JCL and sent to the CRAY-1 computer. With an argument, what follows is assumed to be CRAY JCL, is not translated, and only needs to be shipped to the CRAY-1.

*FORTRAN  invokes the FORTRAN compiler.

*RUN  load and go on the 7600

*END  puts an end-of-file (EOF) on the input stream and signals the end of a job on the 7600. This card follows data cards, if any, and is REQUIRED to be the last card of a deck.

Job decks returned after reading contain a *SEQUENCE card before the *JOB card. This card is added by an operator or by the MODCOMP before the deck is read in and consists of a number which is used for accounting purposes.

A job deck which is to run only on the CDC 7600 might be constructed in this fashion:

*JOB,...
*LIMIT,...
*FORTRAN,...
    (FORTRAN statements)
*RUN,...
    (data card images)
*END

This example shows the position of FORTRAN programs and data in a 7600 job deck. All FORTRAN program cards appear after the *FORTRAN card and before the *RUN card. Data cards appear after the *RUN card and before the *END card.

The addition of the *CRAY1 card changes the way a deck is interpreted on the 7600. A *CRAY1 JCL statement indicates that subsequent control cards apply to execution on the CRAY-1 computer. 7600 control statements following the *CRAY1 card are translated into CRAY-1 JCL by the 7600 link translator. Thus, by adding the *CRAY1 card to a job deck, a program may run on the CRAY-1 computer.
Instead of the CDC 7600.

*JOB,...
*CRA Y1
*LIMIT,...
*FORTRAN,...
(FORTRAN statements)
*RUN,...
(data card images)
*END

**CRAY Job Deck**

Users may exercise more control of how their programs are executed on the CRAY-1 computer by using CRAY JCL. Its use in a job deck is signaled by the *CRAY1 card with a modifier (*CRAY1[,char]). Cards which follow a *CRAY1[,char] card should be written in CRAY JCL format. If char is CH, cards following are assumed to be Hollerith punch and appropriately translated to ASCII; if char is CA, the cards following are ASCII punch.

There are options on the CRAY-1 computer which are available to the user only through CRAY JCL. Use of CRAY JCL adds flexibility in running on the CRAY-1 and makes it possible to use the latest version of Cray operating system software. Using CRAY-1 JCL also makes available libraries and CRAY-1 utilities that are not usable through the 7600 link translator software.

CRAY JCL contains no asterisk in column one and each statement (called a system verb in Cray parlance) either terminates with a period or must be enclosed in parentheses; fields are separated by commas. Comments may be included after the terminator. CRAY jobs are arranged as a sequence of files, each file is terminated with a special statement: \EOF (end-of-file). An \EOD, for end-of-data, is analogous to the *END statement in 7600 JCL. The first file always contains the CRAY JCL statements which direct what is to happen to each subsequent file.

In the short example below, there are three files. The first contains the required JOB card, a CRAY FORTRAN statement (CFT.) (which is equivalent to a 7600 *FORTRAN statement) and a CRAY loader statement (LDR.) (which is equivalent to a 7600 *RUN statement). The second file contains the FORTRAN program; the third file contains data.
*JOB,...
*CRAY1,CH
JOB.
CFT.
LDR.
\EOF
  (FORTRAN statements)
\EOF
  (data card images)
\EOD
*END
7600 Header

Printed output from the CDC 7600 begins with a header which contains the sequence number (as assigned by the system) with the date and the time the job was read into the 7600, and, on the second line, the *JOB card. Then CRU/CCU accounting information is shown for the project number given on the *JOB card. (CRU means Computer Resource Unit; CCU means CRAY Charging Unit.) These accounting numbers do not reflect the most recent resource usage, but rather the usage as of the date indicated.

*SEQUENCE,079638
2 *JOB,1234,87654321,USERNAME
CRUS ALLOCATED = 500000.00
CRUS USED = 972.05 UPDATED 05/27/80
CCUS ALLOCATED = 500.00
CCUS USED = .3

Figure 3. 7600 Header
The NCAR 7600 operating system does not automatically produce a FORTRAN listing in the printed output. It must be user-requested, using the FL option on the *FORTRAN card. On the NCAR 7600, a FORTRAN list numbers all the cards, including comment and continuation cards; if the job contains subroutines in addition to the main program, these cards are listed with continuous numbering. These numbers are useful for editing purposes. At the end of the FORTRAN list, the remainder of the 7600 compiler output shows program locations, length of routines, variable assignments, subroutines called, common blocks and lengths, and compile time.

```
0 PROGRAM LISTOPS
0 DIMENSION A(10)
C PURPOSE TO SHOW 7600 OUTPUT WITH FL OPTION
C INITIALIZE A
DO 10 I=1,10
   A(I)=0.
10 CONTINUE
C COMPUTE A AND OUTPUT 2 RECORDS
DO 200 J=1,2
   DO 100 I=1,10
      A(I)=A(I)+FLOAT(I)*J
100 CONTINUE
C WRITE A ON PRINTER UNIT 6
WRITE (6,6000)(A(I),I=1,10)
C WRITE A ON UNITS 7,8 AND 9 TO SHOW TAPE ACTIVITY SUMMARY
WRITE (7)A
WRITE (8)A
WRITE (9)A
200 CONTINUE
ENDFILE 7
ENDFILE 8
ENDFILE 9
6000 FORMAT (1H PRINT A/1X, 10E12.5)
END
```

Figure 4. 7600: FORTRAN Compiler Listing
7600: Compiler Errors

Compiler errors are printed in the same area where compiler output normally appears; a compiler error message appears immediately following the listing of the routine which contains the error. Note, in the example, there is no indication to show whether these compiler errors were fatal or non-fatal.

**Figure 5. 7600: Compiler Errors**
When a *RUN card is encountered, the system is given the signal to load and go, and program execution begins. The loader map is printed following the compiler output.

The first line of the loader map, PROGRAM SPACE IS, gives the total octal number of words needed to store all routines and common blocks in the program. This is followed by a table of entry points, including those for system library routines. For each routine, the origin, as well as the location of all entry points, is listed. If common blocks are used in the program, they are also listed by location.

The section of the loader map labeled OVERALL CORE USE STATISTICS (DECIMAL) shows small core memory (SCM) and large core memory (LCM) allocations. The first line shows SCM words available to the user. The next two lines give SCM requirements for loading and executing the program. The last two lines show LCM available and used by the program at load time.

The table labeled LCM AREA MAP BY BUFFER TYPE gives a detailed breakdown of how much LCM space has been allocated by the system for each of the buffers required by the program and/or the system.

```
INPUT -- *RUN,1
+-------------------------+---------------------------+-------------+
<table>
<thead>
<tr>
<th>ORIGIN</th>
<th>ENTRY POINTS AND LOCATIONS</th>
<th>OTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>LISTOPS 16</td>
<td></td>
</tr>
<tr>
<td>136</td>
<td>ENDFIL 136</td>
<td></td>
</tr>
<tr>
<td>163</td>
<td>EXIT 176</td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>OUTPTB 203</td>
<td></td>
</tr>
<tr>
<td>1565</td>
<td>KORDER 1565</td>
<td></td>
</tr>
<tr>
<td>2621</td>
<td>OUTPTC 2621</td>
<td></td>
</tr>
<tr>
<td>3436</td>
<td>QORDER 3436</td>
<td></td>
</tr>
<tr>
<td>3451</td>
<td>QOSIOU 3451</td>
<td></td>
</tr>
<tr>
<td>3706</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>163</td>
<td></td>
<td></td>
</tr>
<tr>
<td>203</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1565</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2621</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3451</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3706</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OVERALL CORE USE STATISTICS (DECIMAL)

THE MAXIMUM SCM IS 54272
THE PROGRAM CURRENTLY USES 2006
THE LOADING PROCESS USED 17533
THE MAXIMUM LCM IS 451456
THE PROGRAM CURRENTLY USES 83243

LCM AREA MAP BY BUFFER TYPE

<table>
<thead>
<tr>
<th>BUFFER</th>
<th>SCM</th>
<th>LCM</th>
<th>RANPO</th>
<th>RD</th>
<th>DISK</th>
<th>DISK</th>
<th>DISK</th>
<th>DISK</th>
<th>DISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>2240</td>
<td>8384</td>
<td>64</td>
<td>2240</td>
<td>8384</td>
<td>8384</td>
<td>8384</td>
<td>8384</td>
<td>8384</td>
</tr>
<tr>
<td>SYSLBD</td>
<td>258</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
</tr>
<tr>
<td>SYSLB11</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
</tr>
</tbody>
</table>
```

Figure 6. 7600: Loader Map
7600: Loader

Load failures are printed at the end of the loader map where an error message indicates the nature of the failure.

Figure 7. 7600: Loader Errors
Immediately following the loader map, the results of program execution are printed.

An execution error produces not only an error message but also an error panel in the printout. The panel appears after the loader map or after program output up to the point of termination and shows the contents of various registers; this information may be used in debugging. There is a discussion of panel and error messages in the NCAR 7600 Primer manual.

The remainder of the 7600 printout is the trailer. Accounting information includes date and time of running, central processor unit (CPU) and peripheral processor unit (PPU) time, physical resources used (such as pages printed, dd80 frames exposed, cards punched), and total 7600 resources used.

The DISK BLOCK USAGE SUMMARY contains information about 7600 disk usage. It is organized by odd and even units.

The TAPE ACTIVITY SUMMARY is a listing of all I/O activity, including activity on system units as well as on magnetic 1/2" tape and the NCAR mass storage device (MSD). The heading TAPE LABEL refers to system peripheral devices as well as user volumes. Letters may be appended to the volume names. The information on the line with a volume name followed by the letter B reflects the logical I/O activity for that volume. An M appended to a volume name indicates mass store activity. If nothing is appended to a volume name, it indicates tape activity.

The final portion of the trailer contains system information about the current version of the system tape and routines which were modified to create that tape.
Figure 9. 7600: Trailer
The IM option on the *FORTRAN card gives the user a list of modifications made to FORTRAN programs. In the example, the IM option produced a list of mods to PROGRAM MAIN; the FL option listed PROGRAM MAIN. The mod, LIST 12034 then turned off the FORTRAN list option so that only the mod and subroutine name were printed for SUBROUTINE TEST(I,K).

```
INPUT -- *FORTRAN,S=1IB,SN=DEMOANN,LM,FL
VERSION 0 FILE GENERATED ON 05/16/80 AT 9.11
INPUT -- INSERT 13
INPUT -- LIST 12034
-_-+-+-+-+-+-+-+-+-+-+-+-+ EDITOR TERMINATING
7/100 SECONDS IS ELAPSED TIME

<table>
<thead>
<tr>
<th>CARD NUMBER</th>
<th>PROGRAM LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PROGRAM MAIN</td>
</tr>
<tr>
<td>2</td>
<td>I=1</td>
</tr>
<tr>
<td>3</td>
<td>K=1</td>
</tr>
<tr>
<td>4</td>
<td>WRITE(6,100)I,K</td>
</tr>
<tr>
<td>5</td>
<td>100 FORMAT(1H <em>BEFORE TEST</em>,2I10)</td>
</tr>
<tr>
<td>6</td>
<td>CALL TEST(I,K)</td>
</tr>
<tr>
<td>7</td>
<td>WRITE(6,2001)I,K</td>
</tr>
<tr>
<td>8</td>
<td>200 FORMAT(1H <em>AFTER TEST</em>2I10)</td>
</tr>
<tr>
<td>9</td>
<td>K=200</td>
</tr>
<tr>
<td>10</td>
<td>WRITE(6,100)I,K</td>
</tr>
<tr>
<td>11</td>
<td>CALL TEST(100,K)</td>
</tr>
<tr>
<td>12</td>
<td>WRITE(6,2001)I,K</td>
</tr>
<tr>
<td>13</td>
<td>END</td>
</tr>
</tbody>
</table>

LENGTH OF ROUTINE MAIN: 73
VARIABLE ASSIGNMENTS: I - 61; K - 60
SUBROUTINES CALLED: OUTPTC TEST EXIT
COMPILE TIME = 23 MILLISECS

<table>
<thead>
<tr>
<th>CARD NUMBER</th>
<th>PROGRAM LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>LIST 12034</td>
</tr>
<tr>
<td>14</td>
<td>SUBROUTINE TEST(I,K)</td>
</tr>
</tbody>
</table>
```

Figure 10. 7600: Listing Mods
The 7600 Editor, which may be invoked with the *EDIT card is used for file manipulation. Options on the *EDIT card can produce complete output listings (OL) or listings of input only (IL). Editor activity can be quickly spotted in a printout by the distinctive ++++++ pattern which appears each time the Editor terminates. The message END OF FILE FOUND IN CONTROL CARD SCAN indicates that the Editor has read the *END card. Card numbers of the input file are printed in the column at the left of the Editor listing; modifications to the output file are indicated in the column at the right of the Editor listing. Further discussion of the 7600 Editor is contained in the user guide, "Storing, Retrieving and Editing Programs."

---

INPUT -- *EDIT,S=PLIB,SN=DEMOANN,D=PLIB,DN=DEMOANN2,AF,OL

VERSION 0

FILE GENERATED ON 05/16/80 AT 9.11

1 --- PROGRAM MAIN
2 --- 1=1
3 --- C THIS IS A MOD CARD INSERTED AT RUN TIME
4 --- C IN THE PLIB FILE NAMED DEMOANN AND MADE A PERMANENT MOD TO THE
5 --- C FILE NAMED DEMOANN2
6 --- E=
7 --- WRITE(6,1001),K
8 --- 100 FORMAT(1HBEFORE TEST*,2110)
9 --- CALL TEST(1,K)
10 --- WRITE(6,2001),K
11 --- 200 FORMAT(1HAFTER TEST*,2110)
12 --- K=200
13 --- WRITE(6,1001),K
14 --- CALL TEST(100,K)
15 --- WRITE(6,2001),K
16 --- END
17 --- SUBROUTINE TEST(I,K)
18 --- WRITE(6,1001),K
19 --- 100 FORMAT(1HIN TEST*,2110)
20 --- I=I+9
21 --- RETURN
22 --- END

THE DESTINATION DATASET IS ABOUT TO BE WRITTEN
THE DESTINATION DATASET HAS NOW BEEN WRITTEN

------------ EDITOR TERMINATING
SYSTEM - END OF FILE FOUND IN CONTROL CARD SCAN

9/100 SECONDS IS ELAPSED TIME

---

Figure 11. 7600: Editor Listing

CRAY-1 Printout When a user submits a job to the CRAY-1 for execution, it enters the NCAR system through the CDC 7600. A job executed on the CRAY-1 produces at least two pieces of printed output. All output from a CRAY-1 job has the same sequence number as assigned by the system. The 7600 output contains the results of any activity on the 7600 prior to shipping the job to the CRAY-1, the results of the 7600/CRAY-1 link processor activity, and trailer information containing 7600 accounting information. Notice the line which reads VOLUME $IN STAGED TO REMOTE COMPUTER. At this point in the printout, a message is printed which states whether volumes, requested by the user, were shipped (staged) to the CRAY-1 computer. Note also the entry in the TAPE ACTIVITY SUMMARY where an L has been
append to CRAY1; L indicates 7600/CRAY-1 link translator activity.

Figure 12. CRAY-1: 7600 Output
CRAY-1: FORTRAN Compiler Listing

The CRAY-1 FORTRAN compiler is invoked by the CFT card. CFT, by default, provides a FORTRAN listing; this can be turned off by use of an option, L=0. In contrast with the FORTRAN listing on the 7600, comment and continuation cards are not numbered and each new subroutine begins again with the number 1. The numbers in the CRAY FORTRAN listing cannot be used for editing purposes as they can be on the 7600; however, the numbers are useful in program debugging.

Following the listing of the FORTRAN program is a table which shows the correlation between the FORTRAN code in the user's executing program and its location in binary blocks in the CRAY-1 core. This table is a useful tool in debugging programs.

Next in the listing is a TABLE OF STATEMENT NUMBERS which lists all FORTRAN statement labels contained in the program. Statement labels referenced by branching are also listed here. A table of statement numbers appears after each program and subroutine listing in the CRAY-1 printout.

The TABLE OF NAMES ENCOUNTERED, called the symbol table, gives information about all entry points, arrays and variables, and external routines used in the program. A symbol table is printed following each FORTRAN listing of a main program or subroutine in a job.
1. PROGRAM DEMOS
2. COMMON WORK(2000)
3. COMMON /ONE/ C(1000)
4. DIMENSION A(10)
5. DO 100 I=1,10
6. A(I)=0.0
7. 100 CONTINUE
C CALCULATE A
8. DO 200 I=1,10
9. A(I)=A(I)+I*10.0
10. 200 CONTINUE
C CALCULATE C AND WORK
11. DO 300 I=1,1000
12. WORK(I)=0.0
13. C(I)=0.0
14. 300 CONTINUE
C OUTPUT A TO UNIT 6 (DEFAULT PRINTER)
15. WRITE (6,6001)(A(I),I=1,10)
16. 6001 FORMAT (1H 7HPRINT A 10E12.4)
17. CALL TESTSUB (A)
C WRITE A AFTER IT HAS BEEN RECOMPUTED IN TESTSUB
18. WRITE(6,6002)(A(J),J=1,10)
19. 6002 FORMAT(1H 27HA AFTER RETURN FROM TESTSUB/1X,10E12.4)
20. END

---

**Figure 14. CRAY-1: FORTRAN Compiler Listing**

---

**TABLE OF STATEMENT NUMBERS (ALL ADDRESSES IN TABLES ARE IN OCTAL)**

<table>
<thead>
<tr>
<th>STATEMENT NUMBER</th>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 -SN</td>
<td>44A</td>
</tr>
<tr>
<td>200 -SN</td>
<td>47B</td>
</tr>
<tr>
<td>300 -SN</td>
<td>73D</td>
</tr>
<tr>
<td>400 -SN</td>
<td>10C</td>
</tr>
<tr>
<td>401 -SN</td>
<td>12C</td>
</tr>
<tr>
<td>402 -SN</td>
<td>149A</td>
</tr>
<tr>
<td>403 -SN</td>
<td>162C</td>
</tr>
</tbody>
</table>

**TABLE OF NAMES ENCOUNTERED (ADDRESS FOR DUMMY ARGUMENT IS THE ARGUMENT NUMBER)**

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE MAIN USAGE BLOCK</th>
<th>ADDRESS NAME</th>
<th>TYPE MAIN USAGE BLOCK</th>
<th>ADDRESS NAME</th>
<th>TYPE MAIN USAGE BLOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>$END</td>
<td>EXTERNAL</td>
<td>21 A</td>
<td>R 1DIM ARRAY</td>
<td>33 I</td>
<td>I VARIABLE</td>
</tr>
<tr>
<td>$MAIN</td>
<td>ENTRY</td>
<td>0 C</td>
<td>R 1DIM ARRAY</td>
<td>40 J</td>
<td>I VARIABLE</td>
</tr>
<tr>
<td>$WFP</td>
<td>EXTERNAL</td>
<td>40 DEMOS</td>
<td>R ENTRY</td>
<td>TESTSUB</td>
<td>R EXTERNAL</td>
</tr>
<tr>
<td>$WFI</td>
<td>EXTERNAL</td>
<td>FLOAT</td>
<td>R ST. FUNCTION</td>
<td>0 WORK</td>
<td>R 1DIM ARRAY</td>
</tr>
<tr>
<td>$WIV</td>
<td>EXTERNAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BLOCK NAMES AND LENGTHS IN OCTAL**

- DEMOS: 6-478
- #TB: 3720-//
- ONE: 1750-ONE

---
The following example shows the FORTRAN list of a subroutine on the CRAY-1. Notice that numbering begins again at 1 and that it contains a table of block locations, a table of statement numbers, and a symbol table.
CRAY-1: Relocatable Load

An option for the LDR command, MAP, produces a loader table which gives information on memory locations of user programs and common blocks, and CRAY library routines. The loader map, if requested, is printed immediately before the program results. If the link translator is used in the program to produce CRAY JCL, a loader table is printed by default. A complete loader map with cross reference of variables can be requested by the user (MAP=FULL). The complete map is very useful in debugging; however, the partial map is adequate most of the time.

Figure 16. CRAY-1: Relocatable Load

Execution Immediately following the loader table, the results of program execution are printed.

CRAY-1: Logfile The section below the printing of results is called the logfile. The logfile is a summary of activity on the CRAY-1 computer as the job executed. The three columns of numbers on the left show approximate wall clock time, elapsed CPU time in seconds, and the executing system process at the time. To the right of these three columns, printed lines show the progress of the job. The first five lines are for the automatic header; the sixth
line is the Cray version of the *JOB card. JN is the 7600 sequence number, and US is the result of concatenating the user number and the project number. T is CPU time; M is the octal number of 1,000-word blocks of memory assigned to the job; and P is job priority. OLM specifies a decimal count of 512-word blocks allowed for printer output. (This parameter is equivalent to a printer limit where one block is approximately one page.)

The lines to the right, describing the progress of the job, line up with the times at the left and the length of time for various stages of the job, from beginning to end, can be seen. Any line ending with a period is an echo of a JCL card from the user's program. The Cray CFT card is equivalent to the 7600 *FORTRAN,FL card. The Cray LDR command is equivalent to the 7600 *RUN command; END OF JOB indicates that execution is complete. Lines which begin with two letters followed by three numbers are output messages from the currently executing process.

The summary of resources used is printed at the completion of the job.

Figure 17. CRAY-1: Logfile
CRAY-1: Compiler Errors

Compiler errors are indicated in two places in the CRAY-1 output. The FORTRAN list gives an error message immediately following the statement which contains the error (note the lines of ******** in the example). Also, the logfile indicates the number of compiler errors in the FORTRAN program and gives the name of the routine which contains the error. The logfile states that the user's job has been aborted.

![Image of CRAY-1: Compiler Errors]

Figure 18. CRAY-1: Compiler Errors
Loader errors on the CRAY-1 are shown in the logfile. It indicates a job abort and supplies an error message. In the example, the line beginning with a series of ********** states that the LDR initiated the abnormal termination of this program.

Figure 19. CRAY-1: Loader Errors
Execution errors are indicated in the CRAY-1 logfile. The example shows that execution began, an error was encountered, and the job step was aborted. The number following P= is the location of the error; this location can be found using the relocatable load map. An error trace is provided; it identifies the routine which contains the error, gives its location, and gives the location of the calling routine(s).

Figure 20. CRAY-1: Error Trace
Following the logfile is a 7600 trailer. It shows the total number of CCU (CRAY Charging Units) used by the CRAY job. The activity listed in this trailer shows 7600 activity when the CRAY job is shipped back after execution. The 7600 resources used simply reflects charges for printing the CRAY output on the 7600 printer.

| Total CRAY Charge Units Used: | 0.0000 |
| Termination Date: | 06/05/80 |
| Termination Time: | 13:43:05 |
| Total CPU Time in Milliseconds: | 97 |
| PPU Time in Milliseconds: | 187 |
| Total 7600 Resources Used: | 0.67 |

**Disk Block Usage Summary**

<table>
<thead>
<tr>
<th>Odd Units</th>
<th>Even Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk 0</td>
<td>Disk 1</td>
</tr>
<tr>
<td>Limit on Blocks Allowed:</td>
<td>256</td>
</tr>
<tr>
<td>Maximum Blocks Used:</td>
<td>0</td>
</tr>
<tr>
<td>PIB Blocks for This Project:</td>
<td>0</td>
</tr>
</tbody>
</table>

**Tape Activity Summary**

<table>
<thead>
<tr>
<th>Tape</th>
<th>Physical Label</th>
<th>Channel</th>
<th>Parity</th>
<th>Errors</th>
<th>Read Errors</th>
<th>Write Errors</th>
<th>Records</th>
<th>Words Read</th>
<th>File Marks Read</th>
<th>Words Written</th>
<th>File Marks Written</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PR B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>256</td>
<td>0</td>
</tr>
<tr>
<td>PH D</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
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<td>1</td>
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<td>CRAY1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
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<td>0</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>ACCNT</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SLIB D</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>2578</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SYSTAPB</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5632</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RD D</td>
<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RANFO D</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>SSCRO D</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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</tr>
<tr>
<td>3567 D</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**System Tape D85 Generated 05/30/80 At 12:23 From Source Tape E85**

**List of Routines Modified**

<table>
<thead>
<tr>
<th>Routine</th>
<th>BTC</th>
<th>CTC</th>
<th>SAM</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

Figure 21. CRAY-1: 7600 Trailer
CRAY-1: Post Processing

Post processing on the 7600 as a result of job execution on the CRAY-1 produces additional 7600 printouts. These printouts all have the same sequence number as the executing job and give information similar to that contained in 7600 trailer information. Operations which can result in post processing printouts might be such things as shipping datasets to be written on the mass storage device or shipping graphics datasets for plotting offline on the dd50 or DICOMED device. Each post processing operation results in a separate piece of output.

---

**Figure 22. CRAY-1: 7600 Post Processing Output**
<table>
<thead>
<tr>
<th>Status Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSEMBLE</td>
<td>Job is in assembling phase</td>
</tr>
<tr>
<td>COMPILE</td>
<td>Job is compiling</td>
</tr>
<tr>
<td>EXEC HOLD</td>
<td>Job was executing but is rolled out for higher priority job</td>
</tr>
<tr>
<td>EXEC PAUSE ERROR RD</td>
<td>Parity error reading tape job will be dropped</td>
</tr>
<tr>
<td>EXEC PAUSE ERROR WR</td>
<td>Parity error writing tape job will be dropped</td>
</tr>
<tr>
<td>EXECUTION</td>
<td>Job is executing</td>
</tr>
<tr>
<td>INPUT</td>
<td>Job is in input phase from a terminal</td>
</tr>
<tr>
<td>LOAD</td>
<td>Object deck is loading in preparation for execution</td>
</tr>
<tr>
<td>LOCKED OUT</td>
<td>Hardware or system software problem. Job has been removed from the system. There will be no output, and the user should resubmit</td>
</tr>
<tr>
<td>LSTn CONFLICT</td>
<td>Data path to remote computer is not available (n=0 is CRAY-1 computer)</td>
</tr>
<tr>
<td>MSD CONFLICT</td>
<td>Trying to read or write on the mass storage system, and (1) it is busy, or (2) the requested VSN is not on the currently mounted mass store tape</td>
</tr>
<tr>
<td>ON DD80</td>
<td>Job is currently producing microfilm</td>
</tr>
<tr>
<td>ON PRINTER</td>
<td>Job is currently printing</td>
</tr>
<tr>
<td>ON PUNCH</td>
<td>Job is currently punching</td>
</tr>
<tr>
<td>ON READER</td>
<td>Job is currently being read on card reader</td>
</tr>
<tr>
<td>OUTPUT HOLD</td>
<td>Processing is complete; job is waiting for an output device</td>
</tr>
<tr>
<td>PAUSE::: BKGND HOLD TILL SIGNAL</td>
<td>Background job is making initial request for tape. This requires operator intervention.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SYS LABEL PAUSE</td>
<td>Label card does not match tape label. (Operator will try to cause job to</td>
</tr>
<tr>
<td></td>
<td>continue, if this fails, the job is dropped.)</td>
</tr>
<tr>
<td>SYS</td>
<td>Job is moving data from mass storage, tape, or disk. The 7600 also operates</td>
</tr>
<tr>
<td></td>
<td>in SYS phase.</td>
</tr>
<tr>
<td>SYS HOLD</td>
<td>Job is awaiting tape assignment, PLIB/TLIB availability, or initial TTG+</td>
</tr>
<tr>
<td></td>
<td>PTTG is greater than T1</td>
</tr>
<tr>
<td>SYS PAUSE ERROR RD</td>
<td>Error reading tape (PLIB or TLIB). Operator will try to continue job, if</td>
</tr>
<tr>
<td></td>
<td>this fails job is dropped</td>
</tr>
<tr>
<td>SYS PAUSE ERROR WR</td>
<td>Parity error writing a tape in system phase</td>
</tr>
<tr>
<td>TAPE CONFLICT</td>
<td>Waiting for tape already in use by another job</td>
</tr>
<tr>
<td>TAPE HOLD</td>
<td>Tape has been requested, awaiting operator assignment</td>
</tr>
<tr>
<td>TERM HOLD</td>
<td>Waiting for availability of output device (dd30, tape, mass storage dev-</td>
</tr>
<tr>
<td></td>
<td>ice)</td>
</tr>
<tr>
<td>TERMINATING</td>
<td>Execution complete, writing PLIB, TLIB, mass storage, or tape</td>
</tr>
<tr>
<td>TLIB CONFLICT</td>
<td>Waiting for a volume already in use by another job</td>
</tr>
<tr>
<td>TMS-4 CONFLICT</td>
<td>Communication with the mass storage device has been lost</td>
</tr>
<tr>
<td>TRANSFER</td>
<td>Job is in transition to or from CRAY-1</td>
</tr>
<tr>
<td>TRANSFER HOLD</td>
<td>Same as transfer except the transition has been interrupted</td>
</tr>
<tr>
<td>WAITING FOR DRIVES</td>
<td>All tape drives are in use</td>
</tr>
<tr>
<td>Sense Switch Numbers</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>SSW1</td>
<td>Abort dd80 film job</td>
</tr>
<tr>
<td>SSW2</td>
<td>Abort a job reading or writing tape if job is in SYS or TERMINATING phase</td>
</tr>
<tr>
<td>SSW3-5</td>
<td>Used only on Operations diagnostics jobs</td>
</tr>
<tr>
<td>SSW6</td>
<td>Initiate a tape SAVE routine and terminate the job. The SAVE program must be contained in the user program</td>
</tr>
<tr>
<td>Status</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Awaiting Event</td>
<td>Temporary suspension of job awaiting completion of some system function</td>
</tr>
<tr>
<td>Awaiting Memory</td>
<td>Rolled out to disk, awaiting memory</td>
</tr>
<tr>
<td>Awaiting Xfer</td>
<td>Dataset waiting for transfer to front end computer</td>
</tr>
<tr>
<td>Executing</td>
<td>Job is currently in CRAY-1 CPU</td>
</tr>
<tr>
<td>Operator Susp.</td>
<td>Operator has suspended job by console command; job has been rolled to disk</td>
</tr>
<tr>
<td>Queued for Exec</td>
<td>Job is on the disk awaiting availability of an execution control point</td>
</tr>
<tr>
<td>Recovery Susp.</td>
<td>System has been restarted, job has been recovered and it is awaiting operator release</td>
</tr>
<tr>
<td>Rolling In</td>
<td>Job is in the process of rolling in from disk</td>
</tr>
<tr>
<td>Rolled Out</td>
<td>Job has been rolled out on disk and is awaiting an ACQUIRE from the front end computer</td>
</tr>
<tr>
<td>Rolling Out</td>
<td>Job is in the process of rolling out to disk</td>
</tr>
<tr>
<td>System Susp.</td>
<td>Job is temporarily suspended awaiting system function or system resource</td>
</tr>
<tr>
<td>Transferring</td>
<td>Dataset is transferring to/from the front end computer</td>
</tr>
<tr>
<td>Wait Time Event</td>
<td>Job is waiting for dataset which has been accessed for exclusive use by another job</td>
</tr>
<tr>
<td>Waiting for CPU</td>
<td>Job is in memory and waiting for an execution time slice</td>
</tr>
<tr>
<td>Waiting for I/O</td>
<td>Job is in memory and is awaiting completion of input/output operation</td>
</tr>
</tbody>
</table>
Job Scheduling on the 7600

There are four general states or phases for jobs on the Control Data 7600. They are initial input phase, system phase, execution phase, and termination phase.

When a job enters the 7600, the sum of the CPU (T=) and PPU (PT=) times specified on the *LIMIT card is computed. If this sum is greater than or equal to an operator-set time limit (T1), the job will be put into system hold status. These jobs will not be able to continue processing through the other job phases until the value for T1 is increased by the operator. The T1 value is displayed on the 7600 monitor scope. (See the discussion, above, of the 7600 scope.)

If a job's total time limit is less than T1, then the job will enter system phase. It is in this phase that input MSD volume staging, editing, compiling, assembling, and/or loading takes place.

When a user's job contains a FORTRAN or assembly language program which is to be executed on the 7600, then the job will enter execution phase after system phase in order to execute. The time limits specified on the *LIMIT card are used for the execution phase only. A user is charged for all of the resources which are used during each phase of processing, but the user-specified time limits are only considered during execution phase. An executing job may be temporarily rolled out to the disk when its time slice has expired or when it requests resources which are not immediately available. Rolling jobs into and out of memory is a procedure whereby an executing job may be sent temporarily to disk to allow a waiting job to begin execution.

Finally, all jobs go through a termination phase. At this point, any printed output is put into the printer output queue, dd80 instructions are sent to the dd80 graphics device, and all output volume staging is performed.

The order in which several jobs which are in the same phase are processed is different for each phase and the algorithms used for each phase are usually dependent on many factors. Also, these algorithms are sometimes modified to respond to changes in the job mix and Computing Facility hardware; therefore, the specific algorithms are not given in this guide.

A job which requests background status on the 7600 is initially entered into the 7600 background queue. Jobs in this queue must be manually released into the system by
the computer operator. Once a job is released from the background queue, it enters the initial input phase and proceeds through the other phases in foreground mode.

Jobs wait in the CRAY-1 input queue until space becomes available in the table of executing jobs. At NCAR, there are 32 possible entries in this table. At the time space becomes available in the job execution table, jobs with the highest initial priority value are entered into the table first.

For jobs in the execution table, the CRAY-1 scheduling procedure is a multiprogramming system which schedules as many user programs into memory as is possible.

On the CRAY-1, the priority values of jobs in the execution table and jobs in execution phase fluctuate continually. As a job waits for memory, its priority increases; when a job is initiated or rolled in, its priority begins to decrease. The recalculation of priority value is a function of many variables, such as time already used, memory required, number of I/O requests, and so forth. Based on the continually changing values, jobs are rolled in and out of memory by the job scheduler. Rolling jobs in and out of memory is a procedure whereby an executing job may be sent temporarily to disk to allow a job with higher priority to run. If several jobs of equal priority are waiting for memory, the largest job that will fit is chosen.

All jobs returning to the 7600 from the CRAY-1 are processed in foreground mode in order to clear them through the system as quickly as possible. Print output files, or datasets, receive a higher priority (14) than all other output files, which are assigned priority value 7.

CRAY-1 background jobs are immediately entered into a CRAY background queue kept on the 7600. When an operator releases a job from the CRAY background queue, it then runs in foreground mode on the 7600 while performing any required 7600 tasks. Then the job is sent to the CRAY-1
with an initial parity of $3 \cdot n$ where $n$ is determined on the CRAY-1 as described above.
APPENDIX D:
TELEPHONE NUMBERS

CONSULTING OFFICE (303) 494-5151 extension 579
MACHINE STATUS (303) 494-5151 extension 313
OPERATIONS STAFF (303) 494-5151 extension 536
TAPE LIBRARIAN (303) 494-5151 extension 450
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