

ATOMICS INTERNATIONAL  
REACTOR COMPUTATIONAL SYSTEM

By  
R. A. BLAINE

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## I. INTRODUCTION

A computational system has been developed at AI to reduce the time required for reactor design and analysis. This system operates under the control of the user and is implemented as a multistep job under our current operating system, OS/360. The system is open ended in the sense that any number of additional programs can be incorporated at little cost.

At present, the following programs have been incorporated into this system: CAESAR<sup>1,2,3</sup>, CLIO II<sup>4</sup>, EXPERT<sup>5</sup>, AILMOE<sup>6,7,8</sup>, and GRISM<sup>9</sup>. These programs can be run individually or in any combination as long as required data is available from some source. Data is supplied in several ways: input stream, disk, tape, or calculated by preceding step. Calculated data can be saved on tape, disk, or punched cards for use in succeeding steps or jobs and restart of the system is possible.

The system was developed specifically for the region dependent spectra project (Reactor Physics Program) at the request of F. L. Fillmore to automate an iterative calculation requiring several weeks' elapsed time. The spectrum iteration calculation requires about 90 minutes of IBM/360 Model 50 time and now can be run overnight. Since this calculation is a good example of the capability of the system, it is described in what follows.

- A. CAESAR is run using an available library. The library may have been produced by an earlier GRISM run using a spectrum typical of the reactor under investigation or it may be a standard library. In addition to the usual physics data, CAESAR will punch and leave multigroup total bucklings on disk for each region in the reactor for use in AILMOE and will also leave the library on disk for later use by GRISM and CAESAR. Normally one case is run. Any feature of CAESAR can be used; e.g., resonance table look-up, perturbation calculation, etc.
- B. Next AILMOE, using the multigroup total bucklings, performs fast spectrum calculations for each specified region and leaves flux and current spectra for each region on tape or disk for input to GRISM. Normally one AILMOE calculation is done for each region; however, this is not required.
- C. GRISM generates the remainder of the spectra and produces a new CAESAR cross section library averaged over the spectrum appropriate to each region. These libraries are used to create a region-dependent library tape for use by CAESAR. In addition, decimal cards and hexadecimal libraries can be written on tape or punched. One GRISM case is run for each region using any of the spectra generated by AILMOE; e.g., the core spectrum could be used in averaging the cross sections in the blanket.
- D. CAESAR is rerun with the option to use the region-dependent library tape for generation of the macroscopic group constants; the original library is also required and is available on disk from the preceding CAESAR step. Any number of cases can be run using any features of the code. CLIO II can be run to obtain

few group cross sections. The computation can be terminated at this point in order to compare results with the first CAESAR run using space independent cross sections or can be continued; i.e., rerun AILMOE, GRISM, etc. Since multigroup bucklings are punched, the calculation can be restarted at a later time.

Section II discusses the input and output data sets used in this system and illustrates how the various codes can be linked. Section III is a tabulation of the data for each code which controls the flow of data. Section IV contains job set-up information and illustrates what DD cards and production decks are used in running the various combinations.

## II. DATA PROCESSING - DATA FLOW

### A. OVERALL

Each code in the system has several kinds of required input data and produces several kinds of output. For example, each requires case data and produces printed output. However certain of the output data from one code can be stored on disk or tape and used as input to another in the same job. The total bucklings calculated by CAESAR are an example; these can be placed on disk and picked up directly by AILMOE.

Figure 1 illustrates all of the data which is input to or output from the codes which presently comprise this computational system.

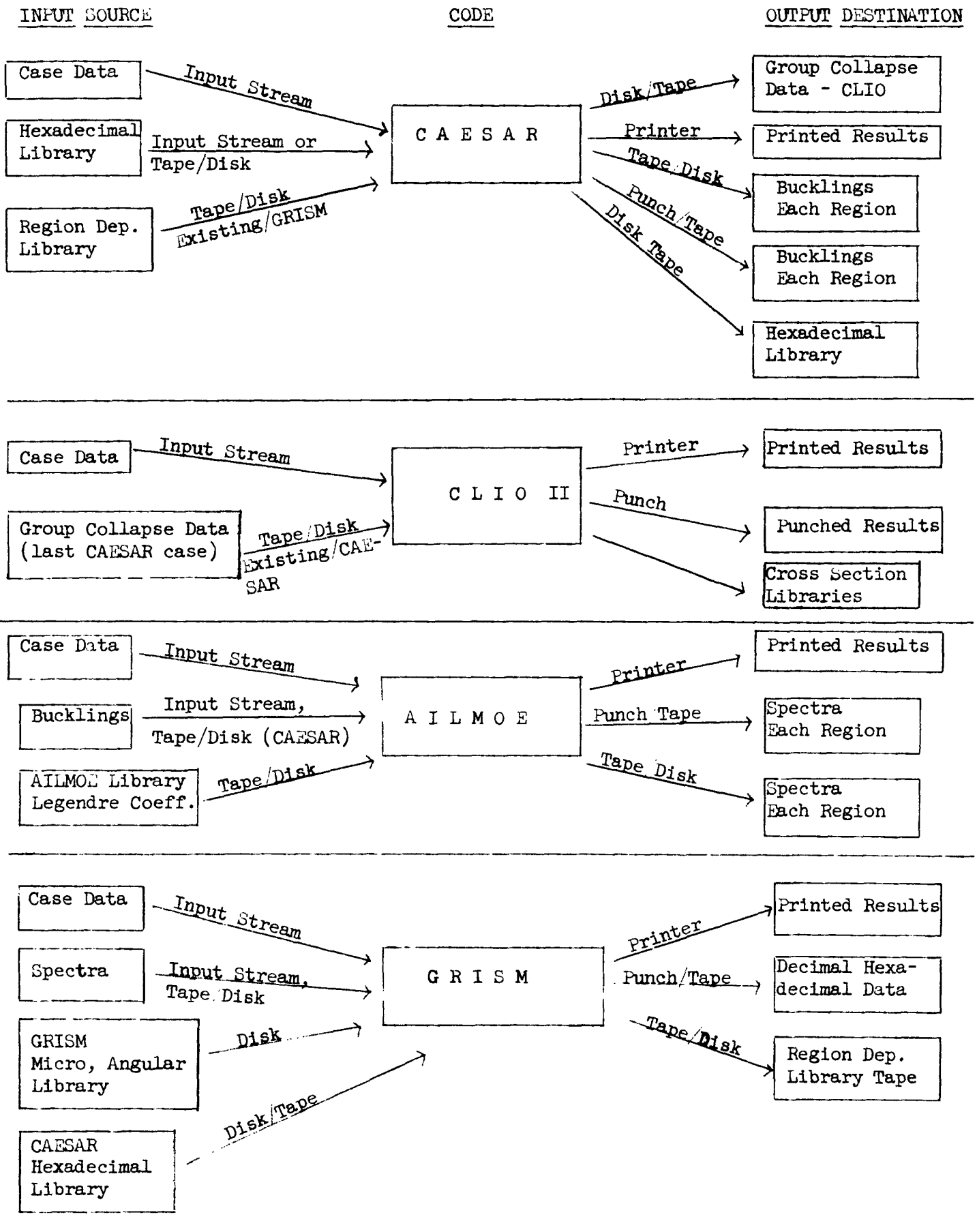


FIGURE 1  
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## B. CODE LINKAGES

The figures which follow illustrate how data can be passed from one code to another. These examples do not exhaust all the possible linkages but serve to illustrate commonly used ones. Any code which uses data output from or produces input to any code in the system can be added.

### 1. CAESAR - CLIO II

The purpose for running CAESAR and CLIO II together is to produce few group macroscopic or microscopic cross sections. On option, CAESAR places all information needed by CLIO II to perform a few group reduction on disk; this data includes micro and macroscopic data by region, fluxes, and adjoint fluxes. Although not illustrated in any other example, CLIO II can be run any time CAESAR is run.

Figure 2 illustrates the data flow.

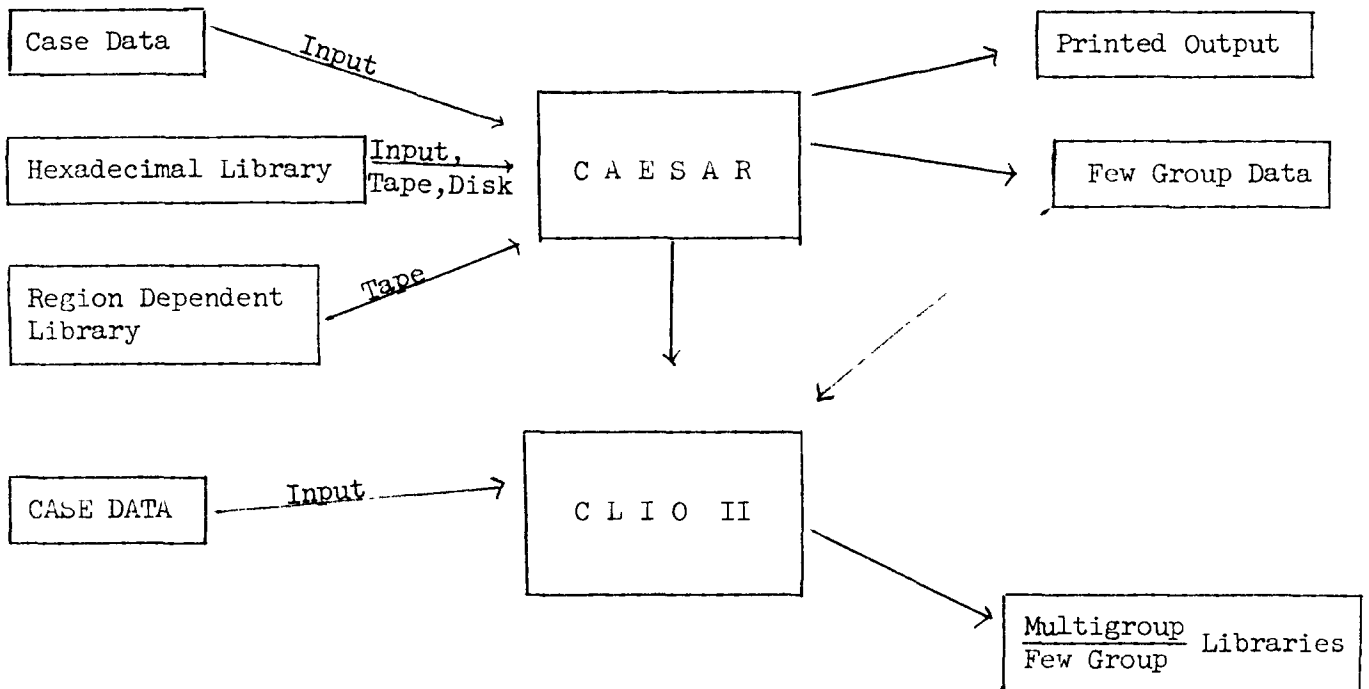


FIGURE 2

AI-AEC-MEMO-12735

## 2. CAESAR - AILMOE

The purpose for running CAESAR and AILMOE together is to generate one or more spectra using total bucklings calculated by CAESAR. On option, CAESAR generates total bucklings for each region in the reactor and punches and places them on disk for AILMOE. Multiple AILMOE cases are run corresponding to the first N regions in the reactor, each case using the total bucklings appropriate to a region. The spectra can be punched or written on tape or disk.

Figure 3 illustrates the data flow.

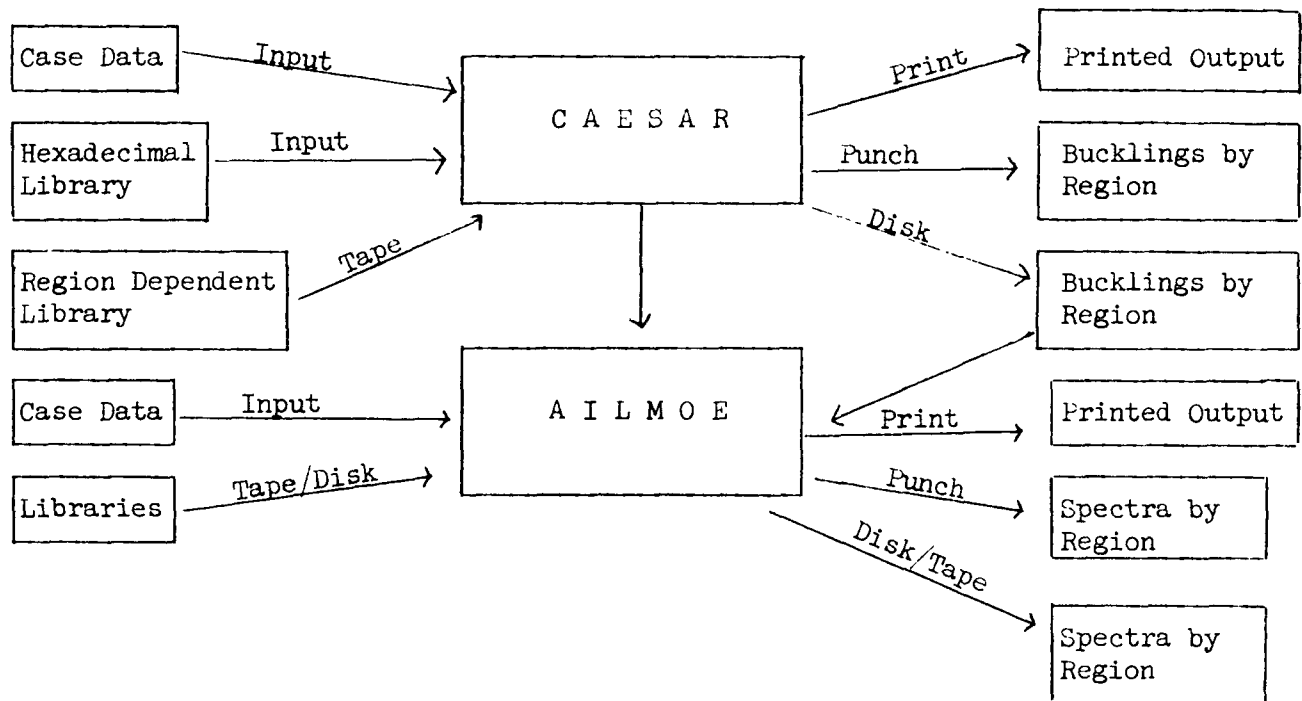


FIGURE 3

AI-AEC-MEMO-12735

### 3. AILMOE - GRISM

The purpose for running AILMOE and GRISM together is to generate one or more cross section libraries and/or the CAESAR region-dependent library tape. It is assumed that the bucklings are available from a prior CAESAR calculation or any source. If the region-dependent library tape is to be made, then a CAESAR hexadecimal library may be required to reside on disk.

Any spectrum generated by AILMOE can be used for averaging the cross sections for a particular library. Libraries in one or more formats may be created in each case. Figure 4 illustrates the data flow.

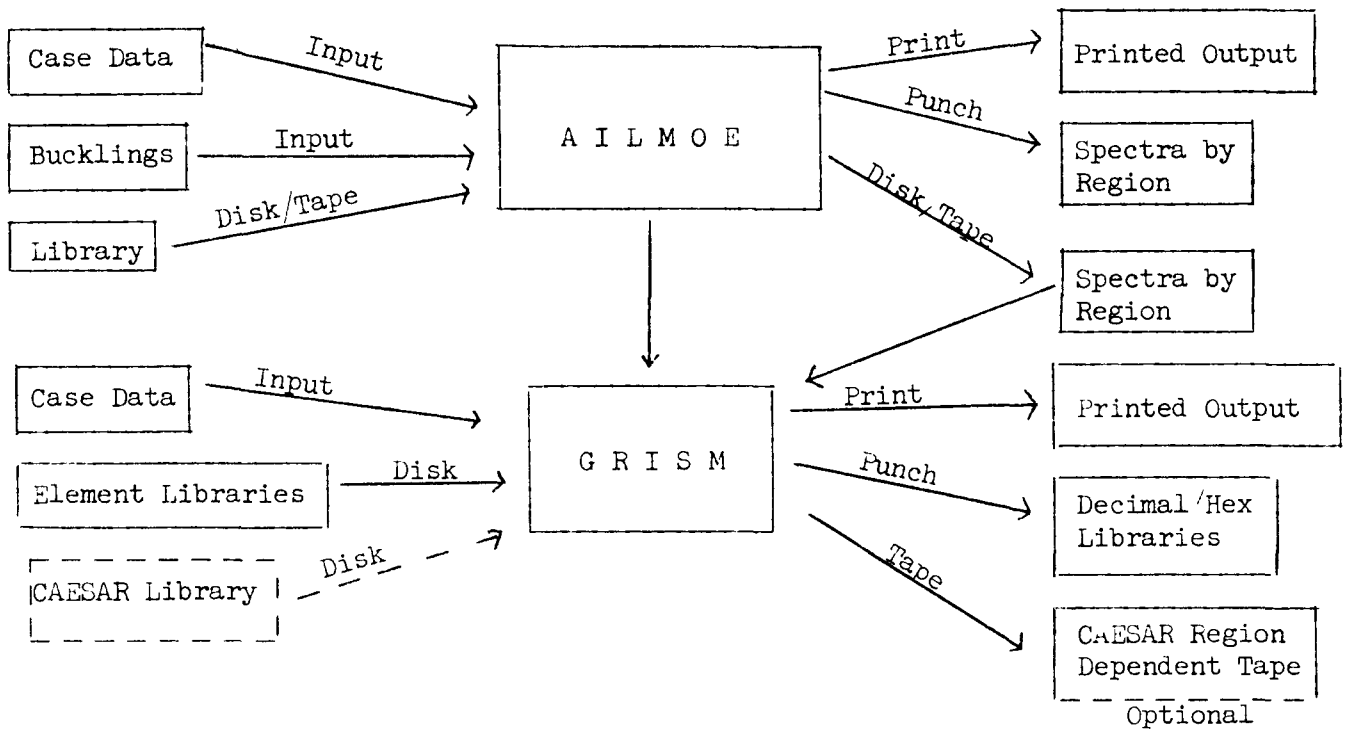


FIGURE 4  
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4. CAESAR - AILMOE - GRISM

The purpose for running CAESAR, AILMOE, and GRISM is to produce one or more cross section libraries using spectra of any of the region(s) starting from a base CAESAR library. Thus the final library(ies) is(are) better than the original.

One CAESAR case is run; this case produces bucklings for each region and places them on disk for AILMOE as well as the hexadecimal library. One or more AILMOE cases are run using the bucklings from disk and produce one or more spectra on disk for input to GRISM. Using any of the spectra, GRISM produces one or more libraries, and if desired, the region-dependent library tape for input to CAESAR. Figure 5 illustrates the data flow.

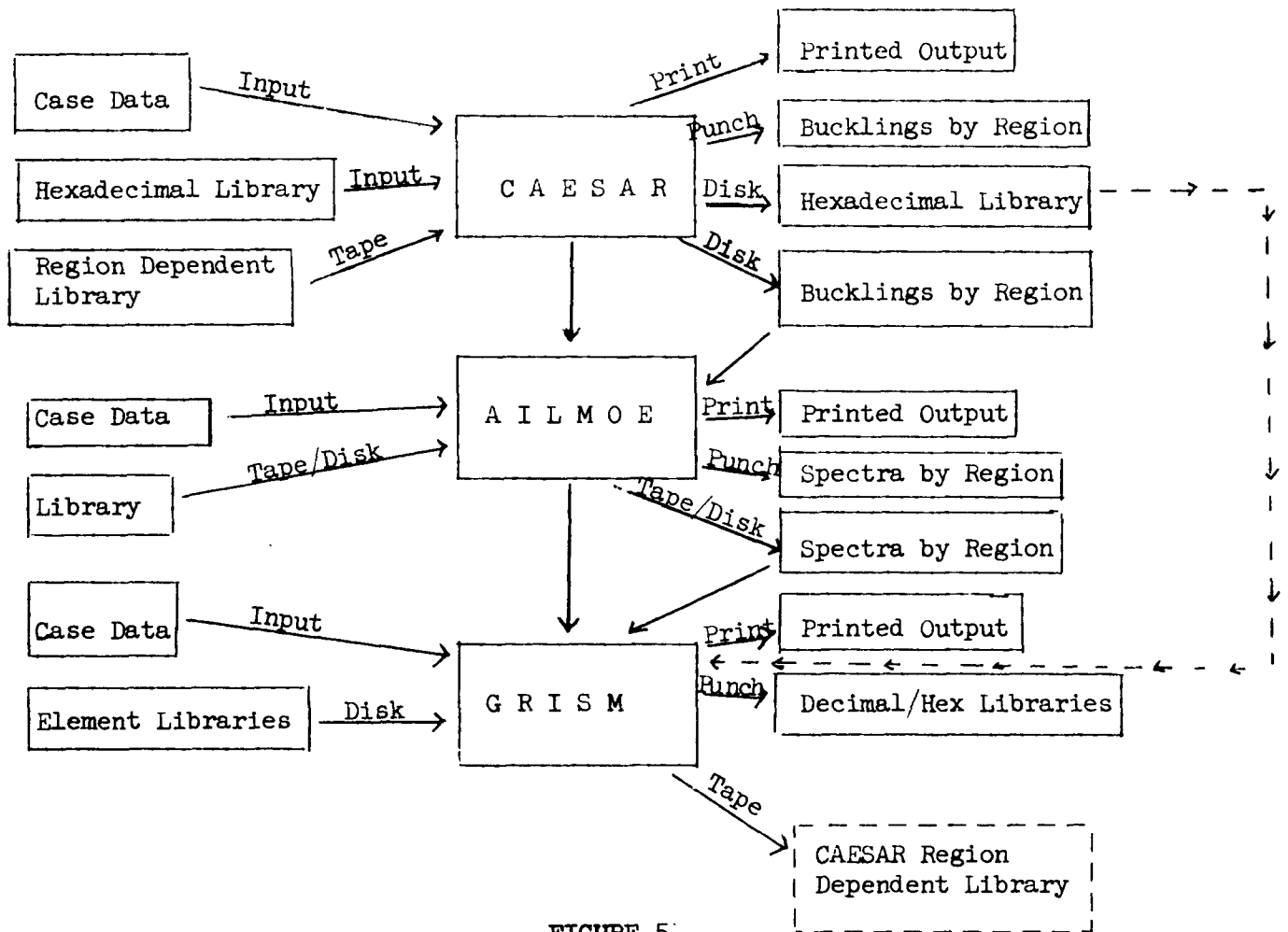


FIGURE 5

5. AILMOE - GRISM - CAESAR

The purpose for running AILMOE, GRISM, and CAESAR is to run one or more CAESAR calculations based on a region-dependent library produced in the same run where the buckling input to AILMOE is available. One or more AILMOE cases are run to produce spectra on disk for input to GRISM. One or more GRISM cases are run to produce the region-dependent library tape for input to CAESAR (as well as decimal and hexadecimal libraries). Using the region-dependent library tape, multiple cases can be run on CAESAR. Figure 6 illustrates the data flow.

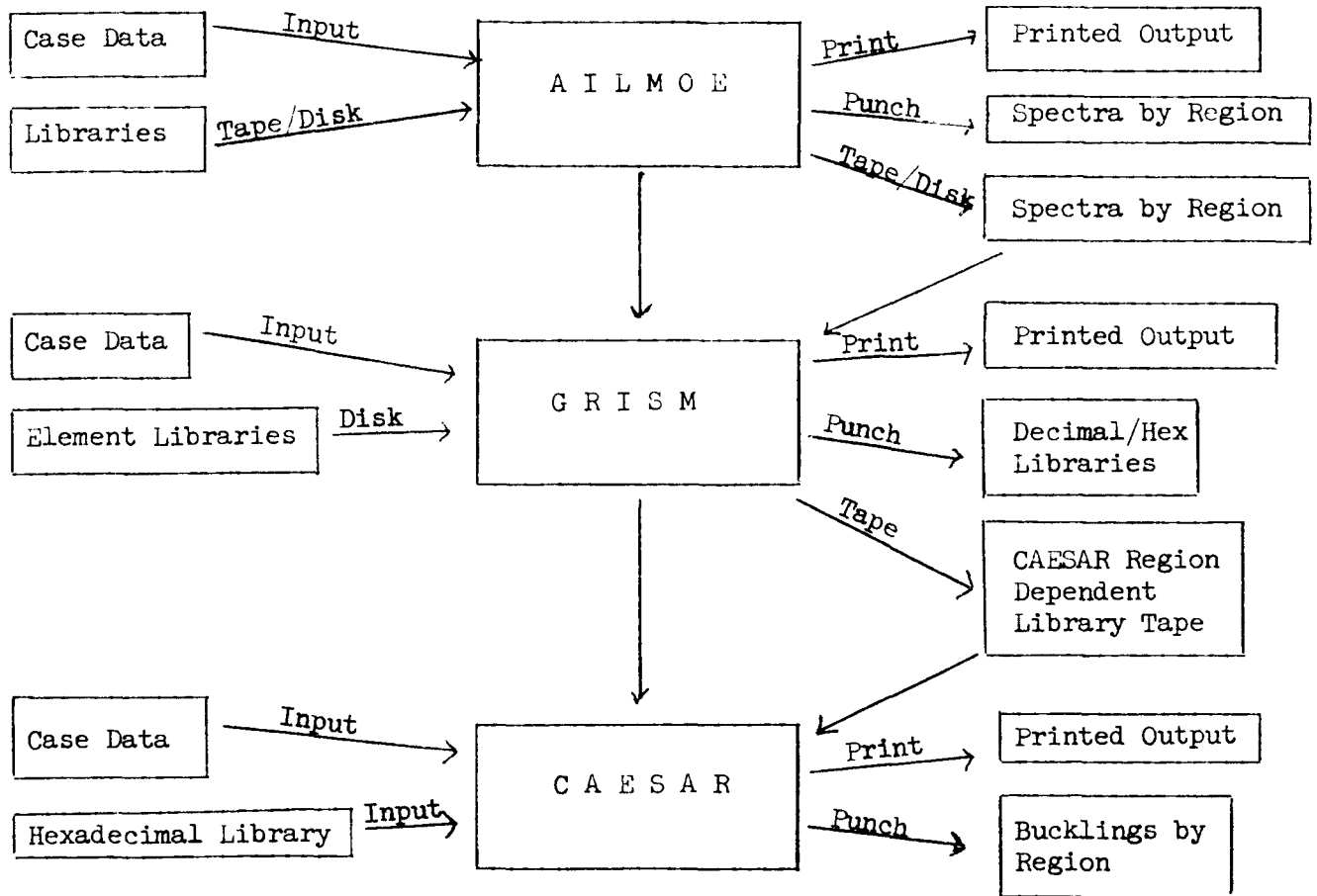


FIGURE 6

AI-AEC-MEMO-12735

6. CAESAR - AILMOE - GRISM - CAESAR

The purpose of this run is the same as the previous, but in addition the bucklings for AILMOE are to be calculated by CAESAR. In the last CAESAR step the hexadecimal library is obtained from the first CAESAR step. Figure 7 illustrates the data flow.

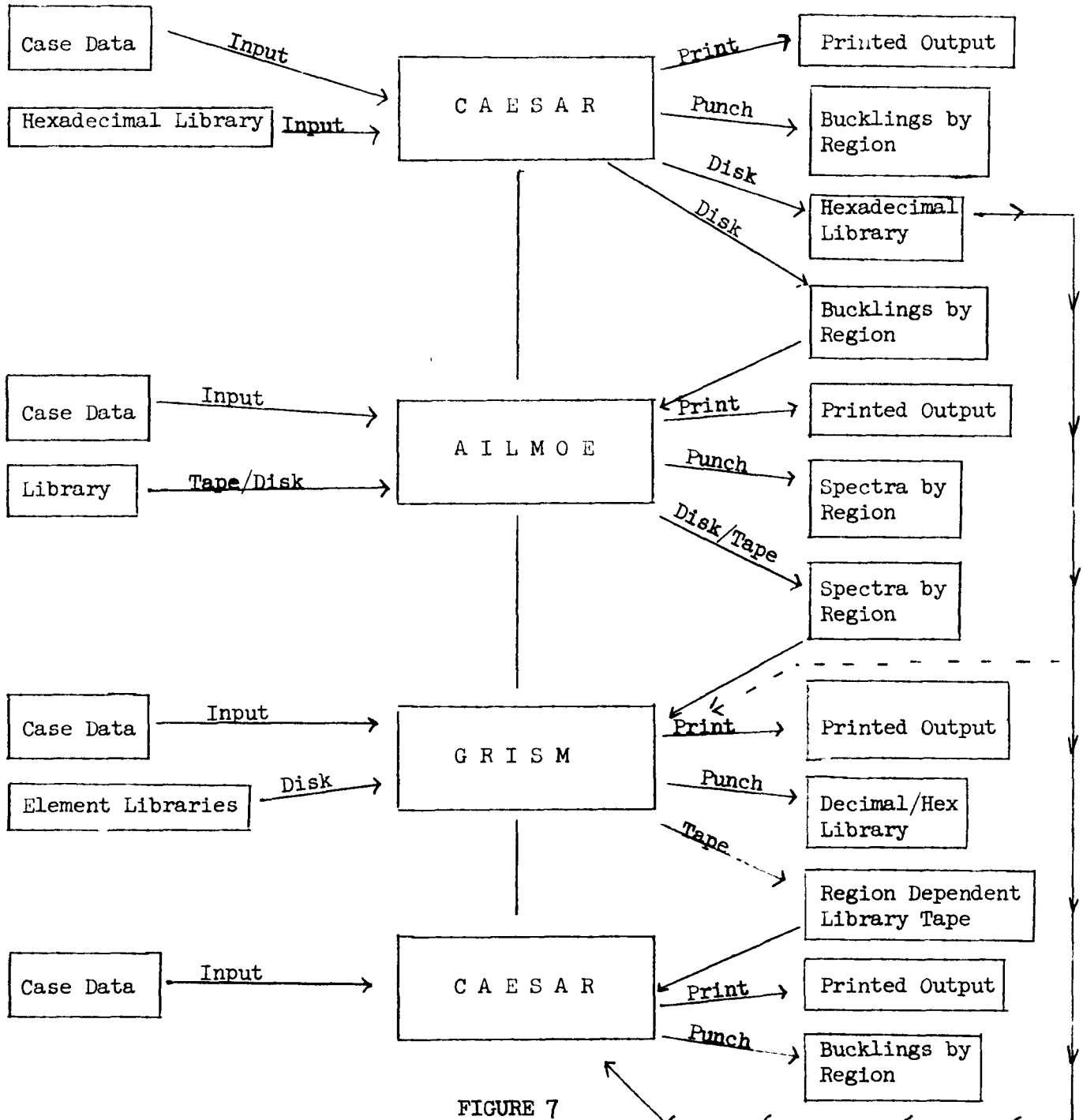


FIGURE 7  
AI-AEC-MEMO-12735

7. CAESAR - PERT (EXPERT)

EXPERT is an exact perturbation theory calculation formulated by F. L. Fillmore. It can be shown that if fluxes, adjoints and cross section data are available from both the unperturbed and the perturbed problem the exact perturbation result is obtained. This is accomplished by executing two CAESAR steps to get the two sets of data and then the stand-alone version of PERT. The adjoint fluxes are from the unperturbed problem while the flux and production cross section are from the perturbed problem. The diffusion coefficient is replaced by the square root of the product of that from the unperturbed problem and the perturbed problem.

Figure 8 illustrates the data flow.

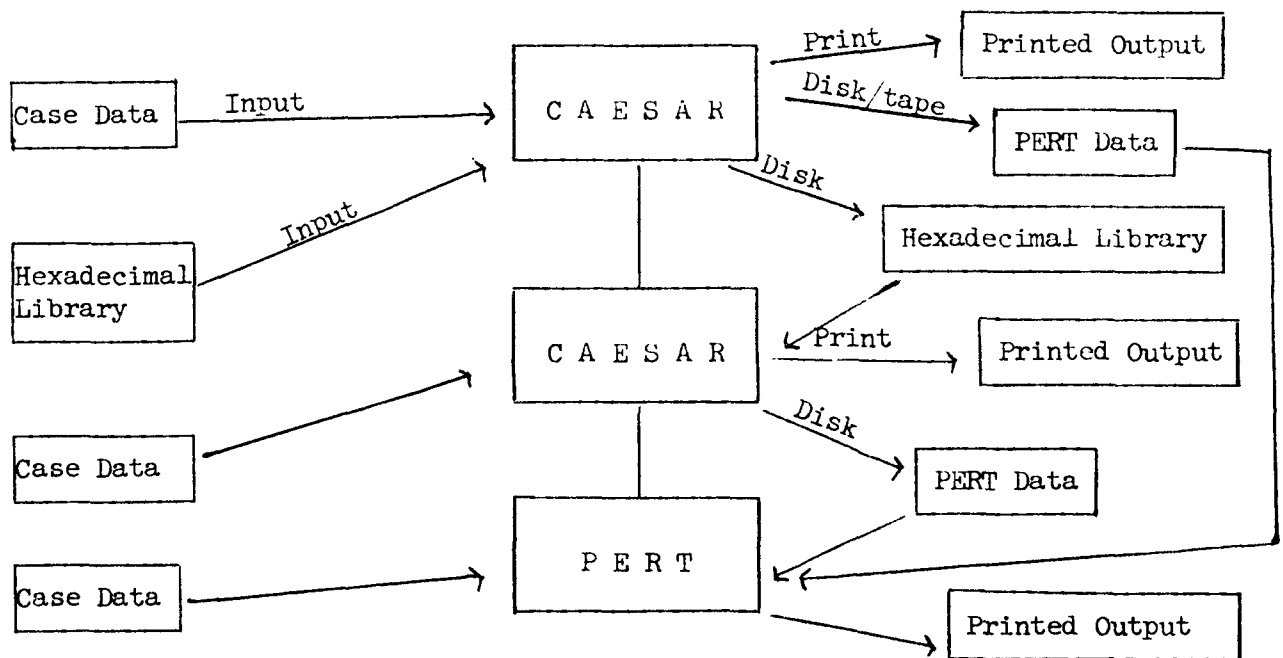


FIGURE 8

AI-AEC-MEMO-12735

### III. CHANGES/ADDITIONS TO DATA

#### A. CAESAR (See Reference 3)

##### 1. Option to Save Bucklings

Data Edit Option - N21 (Item 7, p. 24, Reference 3)

(Column 12, Card 15 of Sheet 1 - Item 29 A(19102) p. 94 of Reference 3)

N21 = 0, Do not compute and print edit.

- 1, Compute and print data edit for reactor only (includes integrated fluxes in summary of results - Item 5, p. 24).
- 2, Compute and print data edit for reactor plus data by mesh point (Item 6 - p. 24).
- 3, Same as N21 = 1 and print, punch and save total bucklings on disk.
- 4, Same as N21 = 2 and print, punch and save total bucklings on disk.

##### 2. Option to Input Hexidecimal Library from Disk

This option can be used only if the hexidecimal library already exists on disk; e.g., if this is the second, third, ... time CAESAR is executed in this job.

A card containing "DISK" in columns 2 - 5 may be used in place of the hexadecimal library to indicate that the library already exists on disk.

##### 3. Option to Save Data for Few Group Reduction Using CLIO

(Column 50, Card 1 FAIM Sheet 1, p. 85, Reference 3)

Blank or Zero - Option not used.

+1 - Save data for use with CLIO.

## B. CLIO II

These changes are fully documented in Reference 4 but are repeated herein for the user's convenience. (See Reference 6)

<u>Card</u>	<u>Column</u>	<u>Symbol</u>	<u>Definition</u>
1	59-60	NOG2	0, Option not used. $\neq 0$ , Perform macroscopic few group reduction. $ \text{NOG2}  = \text{number of groups in the new structure} \leq 12$ .  If $\text{NOG2} > 0$ , use direct flux weighting of transport cross section. If $\text{NOG2} < 0$ , use reciprocal weighting of transport cross section.

If  $\text{NOG2} \neq 0$ , the following cards are required; otherwise omit.

### Card 2 Format (20I2)

This card will contain a list of regions in which the few group reduction is desired ( $\text{MREG}(I), I = 1, \text{M2}$ ) where  $\text{M2} \leq M$ , the total number of regions.

### Card 3 Format (20I2)

This card contains the lowest energy multi-group contained in each of the new few group ( $\text{JGR}(I), I = 1, \text{NOG2}$ ),  $\text{NOG2} \leq 12$ .

All integer data is right adjusted in its field.

C. AILMOE  
(See Reference 7)

1.  $|IC| = 1$ , No fine group (spectra) output
  - 2, Print spectra
  - 3, Print spectra and put on tape or disk

If  $IC > 0$  do not punch.

If  $IC < 0$  punch.

Note that this option applies to all cases.

2.  $BB\cancel{O}PT = 0.0$  Buckling iteration
  - 1.0 Multigroup bucklings input on card set 10
  - 1.0 Multigroup bucklings input from disk (requires CAESAR step)
3. Omit card set 10 (bucklings) if  $BB\cancel{O}PT \neq 1.0$

D. GRISM  
(See Reference 9)

1.	NSAME		Must be 0 (same energies)
2.	<u>Card Column</u>	<u>Symbol</u>	<u>Meaning</u>
	49	-	Not used.
	50	INREC	AILMOE spectrum option. Number of AILMOE spectrum to be used (0 unless IREG = 0); e.g., 1, 2, 3, ...
	51	MATNØ	Material-dependent tape option. Material (case) number of library to be added to the CAESAR material-dependent library tape.

For the first material, MATNØ may be 0 or 1. MATNØ = 0 indicates that a CAESAR hexadecimal library is available and that those elements which are not calculated by GRISM are to come from the existing hexadecimal library; thus only those elements required need be computed. This avoids having to calculate all elements to satisfy the requirement that the libraries on the CAESAR material-dependent library tape must have the same elements as the hexadecimal library which was input. No new elements can be added. The number of groups in the GRISM calculation must agree with the CAESAR library.

If MATNØ = 1, only those elements calculated by GRISM will be in the first library on the tape.

For MATNØ > 1, those elements which are not calculated by GRISM are taken from the first library on the tape. No new elements can be added, and the number of groups in the GRISM calculation must agree with the CAESAR library.

3. Card Set 3: Isotope ID Numbers

These must be in one-to-one correspondence with the first  $n_j$  pairs of element DD cards. Each GRISM case uses the first  $n_j$  pairs where  $n_j$  is the number of elements to be processed in the  $j^{\text{th}}$  case.

The same ID may appear more than once if distinct resonance region calculations are desired. For example: 049, 062, 928, 928, ..., 928, 940 is permissible. Note that repeated ID numbers must be adjacent and that the DD cards naming this isotope must also be repeated and adjacent. Each repetition must be counted in determining NELEMENTS, the number of isotopes to be group averaged, and if it is a resonance isotope, NOREL.

4. IREG                      Meaning
1.                              Maxwell Boltzman spectrum
  2.                               $1/E^D$  spectrum
  3.                              Cranberg fission spectrum
  4.                              Tabular input of spectrum (cards)
  5.                              Power series - coefficients are input
  6.                              U235 spectrum -  $T = 1.280 \times 10^6$ ;  $\phi(E) \propto \sqrt{E} \exp(-E/1.28 \times 10^6)$
  7.                              Pu spectrum -  $T = 1.374 \times 10^6$ ;  $\phi(E) \propto \sqrt{E} \exp(-E/1.374 \times 10^6)$
  8.                              Tabular input from tape or disk (AILMOE)
- Omit card set 7 data: IPTS,KEP,KPHI and card set 8:J  
for this region.

5. DTF Data

Since publication of Reference 9, a change has been made to generalize the structure of the DTF/ANISN library cards independent of the use of GRISM as part of the computational system.

CONTRACT will produce a library for any number of groups, NOG, and down-scatter, NDS, and in addition allows reaction cross sections to precede the required cross sections. The card will be punched with the following fields.

Reaction cross sections (0 - 10),  $\sigma_a$ ,  $\nu\sigma_f$ ,  $\sigma_{tr}$ ,  $\sigma_{gg}$ ,  $\sigma_{g-1 \rightarrow g}$ , ...

$\sigma_{g-NDS \rightarrow g}$

and will require a variable number of cards.

The required input for DTF is as follows:

- a) (LIST(I), I = 1,10) where each item is the GRISM option number as specified on p. 52 of Reference 9; e.g.,

$\sigma_t - 1$ ,  $\sigma_f - 4$ ,  $\sigma_{n,p} - 9$ , etc.

The format is 10I2.

If the card is blank, no reaction cross sections will be punched.

- b) If  $IOP > 0$ , specify the transport cross sections.

E. EXPERT

(See References 12 and 13)

Card 1

Column 12	IØP	0 The fluxes, radii, etc., are on tape/disk. 1 The fluxes, radii, etc., are in the input stream (IPURT=0 only).
Column 24	IPURT	0 Normal, perturbation theory. 1 EXPERT calculation; CAESAR Case 1 is the unperturbed case. 2 EXPERT calculation; CAESAR Case 2 is the unperturbed case.

#### IV. DECK SET-UP

This section illustrates the deck set-up for the code linkages shown in Section II B. Only DD cards and job control language (JCL) pertinent to code linkage are shown; optional DD cards are as shown in the reference documents.

Several features regarding the control cards need further explaining; these are

a) Continuation of Job Card

In order to prevent execution of following codes in the event that an earlier one detects a catastrophic error, the condition parameter is used to terminate the entire job. Also it is advisable to use the MSGLEVEL parameter to assist in detecting errors. The continuation card is as follows:

```
Column 1           16  
//                      MSGLEVEL=1,COND=(99,EQ)
```

Either parameter can be omitted; the other must start in column 16.

If this card is used, "Continuation" must be checked on the Job Request card.

b) JØBLIB Card

This card is required only when GRISM is to be executed and is written as follows:

```
//JØBLIB DD          DSNAME=HELLMØD,DISP=(ØLD,PASS)
```

c) EXEC Card

For each of the four codes presently comprising this system, the user may substitute the following card for the deck on file in D/792:

```
//NAME      EXEC      WOXXXX,TIME.G=T
```

Where NAME:

is any identifier of eight or less characters beginning with an alphabetic character; e.g., the name of the code.

WOXXXX

is the deck number.

T

is a time limit in minutes after which the step is to be terminated. The time limit on the job card should be at least as large as the largest step limit, whereas the expected time must be at least as large as the sum of the limits for the individual steps. Times shown are for one case.

The use of the "EXEC" card will simplify the deck set-up by reducing the number of decks from the D/792 file.

A. INDIVIDUAL CODES

Although CAESAR, CLIO II, PERT IV, AILMOE, and GRISM can be linked together for a computational system, each code can be used independently as in the past, with no knowledge of their coupling. This is a result of the fact that most of the OS job control language resides on disk in the form of cataloged procedures and that the programs reside on disk in load module form. Thus no change to the published operating instructions is necessary to use an individual code.

B. CAESAR - CLIO II

No DD cards are required for this case other than those described in References 3 and 4. Although not shown in any of the following cases, CLIO II can be run following any CAESAR calculation as shown below. CLIO II will use the data from the last (or only) CAESAR case; multiple CLIO II cases can, however, be run.

1. //CAESAR1 EXEC W00008,TIME.G=6
2. Optional DD cards as indicated in Reference 3
3. //G.SYSIN DD \*
4. Hexadecimal Library
5. CAESAR Case Data
6. /\*
7. //CLIO2 EXEC W00126,TIME.G=5
8. Optional DD cards as indicated in Reference 4
9. //G.SYSIN DD \*
10. CLIO Case Data
11. /\*





The number of pairs of DD cards must equal the highest number of elements used in any GRISM case (case 1 normally has the maximum). Each GRISM case uses the first  $n_j$  pairs where  $n_j$  is the number of elements to be processed. The DD cards are as follows:

```
//G.FT13FOO1    DD        DSNAME=XELMT1
//              DD        DSNAME=AELMT1
//G.FT13FOO2    DD        DSNAME=XELMT2
//              DD        DSNAME=AELMT2
.
.
.
```

12. "Punched cards" may be handled in several ways depending on the following DD cards.

a. Suppressed

```
//G.FT14FOO1    DD        DUMMY
```

b. Written on Tape for Optional Punch Out at a Later Time -

See Reference 12

```
//G.FT14FOO1    DD        DSNAME=PUNCH,UNIT=TAPES,          X
//              DISP=(,KEEP),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
```

c. Punched Cards

Omit the DD card

13. The DD card describing the spectra is as follows:

```
//G.FT18FOO1    DD        VOLUME=REF=*.AIRM/E.G.FT18FOO1,DISP=OLD
```

14. //G.SYSIN DD \*

15. Case Data

16. /\*



17. A set of DD cards is required to describe the elements to be used by GRISM. Two cards are required per element; the first gives the name of the cross section data (generated by MOMUS<sup>10</sup>), the second names the angular data (generated by TOAD<sup>10</sup>).

The number of pairs of DD cards must equal the highest number of elements used in any GRISM case (case 1 normally has the maximum). Each GRISM case uses the first  $n_j$  pairs where  $n_j$  is the number of elements to be processed. The DD cards are as follows:

```
//G.FT13FOO1      DD      DSNAME=XELMT1
//                DD      DSNAME=AELMT1
//G.FT13FOO2      DD      DSNAME=XELMT2
//                DD      DSNAME=AELMT2
.
.
.
```

18. "Punched cards" may be handled in several ways, depending on the following DD cards.

a. Suppressed

```
//G.FT14FOO1      DD      DUMMY
```

b. Written on Tape For Optional Punch Out at a Later Time -

See Reference 11

```
//G.FT14FOO1      DD      DSNAME=PUNCH,UNIT=TAPE9,          X
//                DISP=(,KEEP),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
```

c. Punched Cards

Omit the DD card

19. The DD card describing the spectra is as follows:

```
//G.FT18FOOL DD VOLUME=REF=*.A1LMØE.G.FT18FOOL,DISP=ØLD
```

20. The following DD card is required if, for the first case, the CAESAR region-dependent library is to be generated and the first library is to be based on the elements in the hexadecimal library used in the CAESAR step (MATNO=0); otherwise omit

```
//G.FT19FOOL DD DBNAME=&XLIB,DISP=(ØLD,PASS)
```

21. //G.SY5IN DD \*

22. Case Data

23. /\*



The number of pairs of DD cards must equal the highest number of elements used in any GRISM case (case 1 normally has the maximum). Each GRISM case uses the first  $n_j$  pairs where  $n_j$  is the number of elements to be processed. The DD cards are as follows:

```
//G.FT13FO01    DD        DSNAME=XELMT1
//              DD        DSNAME=AELMT1
//G.FT13FO02    DD        DSNAME=XELMT2
//              DD        DSNAME=AELMT2
.
.
.
```

12. "Punched cards" may be handled in several ways, depending on the following DD cards.

a. Suppressed

```
//G.FT14FO01    DD        DUMMY
```

- b. Written on Tape For Optional Punch Out at a Later Time -  
See Reference 11

```
//G.FT14FO01    DD        DSNAME=PUNCH,UNIT=TAPE9,          X
//              DISP=(,KEEP),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
```

c. Punched Cards

Omit the DD card

13. The DD card describing the spectra is as follows:

```
//G.FT18FO01    DD        VOLUME=REF=*.A1LM0E.G.FT18FO01,DISP=OLD
```

- 14. //G.SYSIN DD \*
- 15. Case Data
- 16. /\*
- 17. //CAESAR1 EXEC W00008,TIME.G=6
- 18. Optional DD cards as described in Reference 3. If used, the FT12FOO1 DD card must be as follows:
  - //G.FT12FOO1 DD VOLUME=REF=\*.GRISM.G.FT12FOO1,DISP=OLD
- 19. //G.SYSIN DD \*
- 20. Hexadecimal Library
- 21. Case Data
- 22. /\*



17. A set of DD cards is required to describe the elements to be used by GRISM. Two cards are required per element; the first gives the name of the cross section data (generated by MOMUS<sup>10</sup>), the second names the angular data (generated by TOAD<sup>10</sup>).

The number of pairs of DD cards must equal the highest number of elements used in any GRISM case (case 1 normally has the maximum). Each GRISM case uses the first  $n_j$  pairs where  $n_j$  is the number of elements to be processed. The DD cards are as follows:

```
//G.FT13FO01    DD        DSNAME=XELMT1
//              DD        DSNAME=AELMT1
//G.FT13FO02    DD        DSNAME=XELMT2
//              DD        DSNAME=AELMT2
                .
                .
                .
```

18. "Punched cards" may be handled in several ways depending on the following DD cards.

a. Suppressed

```
//G.FT14FO01    DD        DUMMY
```

- b. Written on Tape for Optional Punch Out at a Later Time -  
See Reference 11.

```
//G.FT14FO01    DD        DSNAME=PUNCH,UNIT=TAPE9,          X
//              DISP=(,KEEP),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
```

c. Punched Cards

Omit the DD card.

19. The DD card describing the spectra is as follows:

```
//G.FT18FOO1 DD VOLUME=REF=*.A1LMØE.G.FT18FOO1,DISP=ØLD
```

20. The following DD card is required in order that all the elements on the hexadecimal library appear in each library in the region-dependent library tape.

```
//G.FT19FOO1 DD DSNAME=&XLIB,DISP=(ØLD,PASS)
```

21. //G.SYSIN DD \*

22. Case data

23. /\*

24. //CAESAR2 EXEC W00008,TIME.G=6

25. //G.FT02FOO1 DD DSNAME=&XLIB,DISP=(ØLD,PASS)

26. // Optional DD cards indicated in Reference 3

27. //G.FT12FOO1 DD VOLUME=REF=\*.GRISM.G.FT12FOO1,DISP=ØLD

28. //G.SYSIN DD \*

29. A card containing 'ØDISK' is used in place of the hexadecimal library.

30. Case data

31. /\*

H. CAESAR - PERT (EXPERT)

The following JCL cards are required.

1. // MSGLEVEL=1,COND=(99,EQ)
2. //CAESAR1 EXEC W00008,TIME.G=6
3. DD Card for PERT "SAVE TAPE"
  - a. Temporary (on disk)  
//G.FT09FOOL DD DSN=ME=W0004101
  - b. Permanent (on tape)  
//G.FT09FOOL DD DSN=ME=W0004101,UNIT=TAPE9,DISP=(,KEEP), X  
// VOLUME=(PRIVATE,RETAIN)
4. //G.FT17FOOL DD DISP=(,DELETE)
5. //G.SYSIN DD \*
6. Hexadecimal Library
7. Case Data (specify CL10 II output - 1 in Column 50, Card 1)
8. /\*
9. //CAESAR2 EXEC W00008,TIME.G=6
10. DD Card for PERT "SAVE TAPE"
  - a. Temporary (on disk)  
//G.FT09FOOL DD DSN=ME=W0004102
  - b. Permanent (on tape)  
//G.FT09FOOL DD DSN=ME=W0004102,DISP=(,KEEP), X  
// VOLUME=REF=\*.CAESAR1.G.FT09FOOL, X  
// LABEL=2
11. Material-Dependent Library Tape (if used)  
//G.FT12FOOL DD UNIT=TAPE9,DISP=(OLD,PASS)
12. //G.SYSIN DD \*
13. 'DISK'
14. Case Data (if execution changes were made in CAESAR1, repeat them here)
15. /\*

16. Insert W00067 (PERT IV) from D/792 files.
17. //G.FT09FOO1 DD DSNAME=W0004101,DISP=OLD, X  
 // VOLUME=REF=\*.CAESAR1.G.FT09FOO1
18. //G.FT09FOO2 DD DSNAME=W0004102,DISP=OLD,LABEL=2, X  
 // VOLUME=REF=\*.CAESAR2.G.FT09FOO1
19. If the material-dependent cross section tape was used
- //G.FT12FOO1 DD DSNAME=W0000801,DISP=OLD
20. //G.FT13FOO1 DD DSNAME=&XLIBTRN,DISP=OLD
21. //G.FT19FOO1 DD DSNAME=&C0LLPDE,DISP=OLD
22. //G.SY5IN DD \*
23. Data
24. /\*

The microscopic cross sections used by PERT are taken from the second CAESAR step. If the cross sections from the first CAESAR step are desired, add the following DD card after Item 11.

//G.FT13FOO1 DD DSNAME=&ANY

## V. RESTART

In a system as large and complex as this, occasional errors will be made in the input data and/or job set up. In order to minimize lost computer time, the remainder of the job will be deleted if in an earlier step an error is detected which will obviously prevent successful execution of the remainder of the job. In addition, OS/360 provides automatic termination of the remainder of the job for a variety of reasons as insufficient data, improper DD cards, etc. A third class of errors cannot be detected; i.e., the wrong number density, element number, etc.

Restart capability is inherent in the computational system provided that the user saves certain data. In several instances data is output in three forms: printed, punched (or card images on tape) and tape or disk. The bucklings from CAESAR and the spectra from AILMOE are prime examples. The bucklings are always punched, whereas the spectra from AILMOE are best written on tape and saved (the tape can be scratched if the run is successful).

The following table indicates what action can be taken to restart the calculation assuming that the bucklings were punched, the AILMOE spectra were saved on tape, and if used, the CAESAR material-dependent library tape was kept.

POINT OF TERMINATION

ACTION: CORRECT ERROR AND -

1. CAESAR - before bucklings have been punched.

Restart with CAESAR - no change to data or DD cards.

2. AILMOE

a. Before completion of first case.

Restart with the AILMOE step. Change BBØPT to 1 and insert the punched bucklings (from CAESAR) into the data for each case (region). No change is required to the DD cards.

b. Before last case is run.

Restart with the AILMOE step, starting with the case that failed. Change BBØPT to 1 and insert the punched bucklings (from CAESAR) into the data for the remaining cases. Change NTIMES to indicate the new number of cases. Change the DD card in AILMOE which defines the spectra as follows:

```
//G.FT18FOO1 DD VØLUME=WAXXXX, X
//                               UNIT=TAPE9, X
//                               DISP=MØD
```

WAXXXX is the serial number of the tape containing the spectra.

POINT OF TERMINATION

ACTION: CORRECT ERROR AND -

3. GRISM

a. Before first case is complete (hexlib not punched).

Restart with the GRISM step with no change to the data, but change the DD card describing the spectra as follows:

```
//G.FT18FO01 DD VØLUME=SER=WAXXXX,UNIT=TAPE9
```

where WAXXXX is the serial number of the tape containing the spectra.

b. Before last case is complete.

Restart with the GRISM step, starting with the case that failed. Change the DD card in GRISM which defines the material-dependent library tape as follows:

```
//G.FT12FO01 DD DISP=ØLD,VØLUME=SER=WAXXXX,  
UNIT=TAPE9
```

where WAXXXX is the serial number of the material-dependent library tape.

Change the DD card describing the spectra as follows:

```
//G.FT18FO01 DD VØLUME=SER=WAXXXX,UNIT=TAPE9
```

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