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FORIG: A Modification of the ORIGEN2 Isotope-Generation and Depletion Code for Fusion Problems

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FORIG: A Modification of the ORIGIN2 Isotope-Generation and Depletion Code for Fusion Problems

Abstract

This report describes how to use the FORIG computer code to solve isotope-generation and depletion problems in fusion and fission reactors. FORIG is an adaptation of ORIGIN2 to run on a Cray-1 computer, and to accept more extensive activation cross sections.

Introduction

ORIGIN2 is a widely used computer code¹ for calculating the buildup, decay, and processing of radioactive materials in fission reactors. This report documents changes made in the ORIGIN2 code to permit use of an LLNL Cray-1 computer. With only slight changes in the input file, any of the standard fission problems can run at LLNL as they do at Oak Ridge and elsewhere. In addition, the code has been modified to read activation-cross-section libraries appropriate for fusion reactor design problems. If the flux-weighted cross

sections are constant in time, a single FORIG run can calculate activation and decay in a fusion reactor component. To address fission-fusion hybrid reactor designs, FORIG will require further modification to account for actinide burnup and fission product buildup. This may be done in a manner similar to the fission reactor treatment in ORIGIN2, or it may be accomplished by alternately using a neutron flux code, a cross-section collapsing code, and FORIG.

Fusion Reaction Cross Sections

The ORIGIN2 code cross-section library includes six standard reactions for non-fissionable nuclides:

$(n,2n) (n,2n)_{exc} (n,p) (n,\alpha) (n,\gamma) (n,\gamma)_{exc}$,

where "exc" indicates the daughter is in an excited state. Additional reactions may be added in a separate file called "odd reactions" in the ORIGIN2 manual. For fission reactors, there are few additional reactions. However, fusion reactor problems require an odd reaction file many times larger than the standard file because of the higher-energy neutrons. Further, ORIGIN2 ignores helium and hydrogen isotope production from odd reactions.

The neutron-energy spectrum varies between regions in a single fusion reactor design, and between designs. ORIGIN2 requires flux-averaged

(i.e., energy-weighted) cross sections. Hence, multiple cross-section libraries are required for fusion reactors and even for different regions of any specific design. The ORLIB code² has been written at LLNL to utilize the ACTL cross section library³ and the TART neutronics code⁴ to produce a one-energy-group cross section library for any region of a fusion reactor. The ORLIB output includes a cross section file with 11 standard reactions:

$(n,2n) (n,2n)_{exc} (n,3n) (n,np) (n,n\alpha) (n,p) (n,d) (n,t) (n,\alpha) (n,\gamma) (n,\gamma)_{exc}$.

ORLIB also produces an odd reaction file. Table 1 lists the 26 reaction types processed by the code. FORIG will accept these files if the library number is set ≥ 700 . If the library number is less than 700,

Table 1. Reaction types available from the ORLIB code.

Type No.	Reaction	Type No.	Reaction
12	(n,2n)	29	(n,2np) α
13	(n,3n)	30	(n, γ n) α
14	(n,4n)	31	(n,2np α) α
15	(n,fiss)	37	(n,2 α) α
20	(n,np)	38	(n, ³ He α) α
21	(n,pn)	39	(n,tp) α
22	(n,nd)	40	(n,p)
23	(n,nd α) α	41	(n,d)
24	(n,nt)	42	(n,t)
25	(n,n ³ He)	43	(n,t α) α
26	(n,n α)	44	(n, ³ He)
27	(n,n2 α) α	45	(n, α)
28	(n,nt α) α	46	(n, γ)

FORIG Source and Controllee Files

The amount of memory required to solve a FORIG or ORIGEN2 problem is determined by the number of nuclides, cross sections, etc. To prevent excessive use of memory, the source file is divided into a small main program (FORIGM) and a large file containing all the subroutines required by the main program. The subroutines do not change from problem to problem, but the dimensions set up in FORIGM must be predetermined by the user. A listing of the main program is provided in Fig. 1. The figure also provides information required to set the dimensions of the arrays. Once this is done, the program can be compiled.

At LLNL, the appropriate files are available in J. Blink's take directory:

```
XPORT / t v
.RD .08u975:ORIGEN2 [FORIG FORIGM
FORIGMG FORIGS BFORIGS]
(XPORT is a file transport routine at LLNL).
```

FORIG is the controllee set up for a pure fusion problem with less than 800 nuclides in the decay library. If the problem of interest does not require actinides or fission products, and if the ex-

isting standard ORIGEN2 cross-section format is accepted. FORIG also calculates helium and hydrogen isotope production from both standard and odd reactions.

FORIG, like ORIGEN2, divides problems into three parts: light nuclides (also called activation products), actinides, and fission products. In some problems, a nuclide may appear in two categories, and the code will treat the two separately. In pure fusion problems, there are no actinides or fission products, and no libraries are input for these categories. In this case, zeros are entered in the appropriate blocks in the LIB and PHO commands of the input file. (All the FORIG commands are discussed later in this report.)

isting decay library is adequate, then only FORIG need be read, and no compiling process is needed.

FORIGS is the file containing all the FORIG subroutines. This file is only required if the subroutines must be changed. Once the changes have been made, FORIGS is compiled into a library:

```
RCFT I=FORIGS / t v
```

The compiler, RCFT, produces the library file BFORIGS. If no changes are to be made in the subroutines, BFORIGS may be read directly from the take directory.

FORIGMG is the main program with generalized dimensions. After it is read and its dimensions adjusted, it may be renamed FORIGM and compiled:

```
RCFT I=FORIGM,X=FORIG,
LIB=(BFORIGS,FORTLIB) / t v.
```

The FORIGM file in the take directory is set up for a pure fusion problem with less than 800 nuclides. The controllee is named FORIG.

AAAA	(13)	No. output vectors	IIII	(2000)	Maximum No. nonzero matrix elements for long-lived nuclides
BBBB	(800)	Maximum No. nuclides	JJJJ	(10)	No. storage vectors
CCCC	(16)	Maximum No. nonzero cross-section and decay reactions per nuclide (cannot exceed 15 without redimensioning the subroutines)	KKKK	(300)	No. nonzero natural abundances
DDDD	(2000)	Total No. nonzero matrix elements	LLLL	(3300)	No. nonzero photon yields
EEEE	(4)	No. nonzero fission-product yields	MMMM	(800)	Maximum No. light nuclides
FFFF	(4)	Maximum No. fission products	NNNN	(4)	Maximum No. variable multipliers (i.e. RMULV)
GGGG	(4)	Maximum No. actinides + 1	PPPP	(3)	No. actinides with both direct fission-product yields and a variable fission cross section (usually 3; can be 4 for plutonium-enriched thorium fuels)

```

c * generalized main program for the forig code on the lnl cray-1 * fml
c forig is origen2 modified for fusion problems. fml
c columns 74-77 contain information indicating the source of that line fml
c orig is the original oak ridge origen2 fml
c 'o' is a sandia albuquerque modification fml
c 'l' is a lawrence livermore modification fml
c forig is an oak ridge modification for fusion problems fml
c 'l' is a lawrence livermore modification for fusion problems fml
c this main has been modified for a fusion library by allowing forig
c for up to 15 non-zero reactions per nuclide. variables coeff, fml
c nprod, dum1, dum2, and lc are affected. forig
c program origen2 fml
c logical long fml
c dimension nnew(AAAA,BBBB),coeff(CCCC,BBBB),nprod(CCCC,BBBB), fml
c $max(BBBB),kop(BBBB) fml
c dimension stlfpb(JJJJ,10),istoli(JJJJ,03),is(JJJJ),rstoli(JJJJ) fml
c dimension dr(NNNN),er(NNNN),lr(NNNN) fml
c dimension yield(EEEE),nyield(FFFF),rmulv(NNNN,3) fml
c dimension alphi(GGGG),nucan(GGGG),nucsfu(GGGG),ny(GGGG),yy(GGGG), fml
c $fst(GGGG),lfa(GGGG) fml
c common /junk/err,idm(1),i,ite,iact,ilp,itol,ilmax,iomax,ifmax, fml
c $ilmax,izmax,oxn,qxn,flux,power,index, pbav(4),iphmax fml
c common /main03/nstp,anmul,anexp,nabmax, icemax,iapmax,itymax fml
c 1766 words are necessary in /nudscr/ beginning with s fml
c /nudscr/ is used for multiple purposes. fml
c common /nudscr/dum1(CCCC,BBBB),dum2(CCCC,BBBB),i(2),cinn(BBBB), fml
c $csun(BBBB),nonp(BBBB),na(BBBB),xp(BBBB),xpar(BBBB),xtemp(BBBB), fml
c max allowable size of reduced matrix increased from 1300 to 1111. fml
c $d(BBBB),ap(IIII),locp(IIII),long(BBBB) fml
c increase the number of matrix elements per nuclide. fml
c common /big/nuc1(BBBB),q(BBBB),fg(0004),locap(BBBB),genneu(GGGG), fml
c $alphon(GGGG),spont(GGGG),stnu(GGGG),fiss(GGGG),nucab(BBBB), fml
c $ompc(BBBB),wnpc(BBBB),xstore(JJJJ,BBBB),dis(BBBB),b(BBBB), fml
c $abund(KKKK),nono(BBBB),kd(BBBB),loc(DDDD),ngf(BBBB),ngn(BBBB), fml
c $ngr(LLLL),ggr(LLLL),a(DDDD),laca(DDDD),nudfp(FFFF,PPPP) fml
c dr,er, and lr provide a convenient mechanism for initializing variable fml
c multiplier array rmulv. fml
c equivalence (di(1),rmulv(1,1)),(er(1),rmulv(1,2)), fml
c $(lr(1),rmulv(1,3)) fml

```

Figure 1. FORIG main source. The dimensions are set using the comments above the listing. Dimensions chosen for a pure fusion problem with less than 800 nuclides are listed parenthetically.

```

c these equivalences have been realigned.
      equivalence (dum1(1,1),coeff(1,1)).(dum2(1,1),nprod(1,1)).
      $(temp(1),mmax(1)).(kap(1,d(1)).(xnew(1,1),dum1(1,1))
      equivalence (ap(1),alphn(1)).(alphn(GGGG),nucan(1)).(nucan(GGGG),
      $nucsfu(1)).(nucsfu(GGGG),ny(1)).(ny(GGGG),yy(1)).(yy(GGGG),
      $fst(1)).(fst(GGGG),yield(1)).(yield(EEEE),nyield(1))
      call dropfile('forig')
c orinput is instructions, tape8 cross sections, tape9 decay library,
c tape10 photon library, and tape3 add reactions.
      call open(5,'orinput',2,nerr)
      if(nerr .lt. 0) call exit(1)
      call open(8,'tape8',2,nerr)
      if(nerr .lt. 0) call exit(1)
      call open(9,'tape9',2,nerr)
      if(nerr .lt. 0) call exit(1)
      call open(10,'tape10',2,nerr)
      if(nerr .lt. 0) call exit(1)
      call open(3,'tape3',2,nerr)
      if(nerr .lt. 0) call exit(1)
c orout is main output, tape7 is exit material compositions,
c tape11 is alternate main output, tape12 is tape6 contents,
c tape13 is tape11 contents, tape15 is debug and error info,
c tape16 is variable actinide cross section info, and tape50
c is a working file.
      call create(6,'orout',3,200000)
      call create(7,'tape7',3,200000)
      call create(11,'tape11',3,200000)
      call create(12,'tape12',3,200000)
      call create(13,'tape13',3,200000)
      call create(15,'tape15',3,200000)
      call create(16,'tape16',3,200000)
      call create(50,'tape50',2,200000)
c initialize page counter
      npage=page(0)
      call nudoc(6)
      ix= 1111
      mx= AAAA
      lc= CCCC
      ilmx= MMMM
      lamax= GGGG
      ifmax= FFFF
      rmax= BBBB
      r2max= DDDD
      rhmax= LLLL
      apmax= IIII
      ifymax= EEEE
      hbmmax= KKKK
      icnmax= PPPP
      iid= FFFF
      lom= NNNN
c neutrons/neutron-induced fissior  0=thermal spectrum; 1=fast spectrum
      nytl=1
      nytl=0
c call subroutine to read card input from unit 5, print it on unit 6, &
c write it on unit 50. unit 50 is then rewound and origen2 reads the
c data from unit 50.
      call listit(5,6,50)
      rewind 50
c main1 handles the miscellaneous initialization data
      1 call main1(nytl,sfnu,alphn,nucan,nucsfu,ny,yy,anmul,anexp)
c main2 reads the origen2 commands
      2 call main2(nstlp)
c main3 executes the origen2 commands
      3 call main3(
      $ long,slfipb,isloli,islsteli, ix, mx, lc,ifd,
      $ nucab,nan0,kd,loc,ngl,ngn,ngr,nyield,nanp,nq,locp,mmax,kap,
      $ loca,nludlp, cimm,csun, s,
      $ nucl,q,lg,locap,genneu,olphon,spont,sfnu,fiss,ompc,wmpc,store,
      $ dis,b,ggg,yield,a xp,xpar,xtemp,d,ap,coeff,nprod, xnew,
      $ olphon,nucan,nucsfu,ny,yy,fst,ffa,abund,rmtv,lom)
c this "go to" provides the mechanism for executing multiple problems
c within a single job.
      go to (1,2,3,4),nstlp
      4 continue
      stop 100
      end

```

Figure 1. (Continued)

FORIG Input Files

FORIG requires the following input files:

TAPE8 - cross-section library
TAPE3 - odd reaction library
TAPE9 - decay library
TAPE10 - photon library
ORINPUT - instruction list.

These files are very similar to those used with ORIGEN2. The changes are as follows:

(1) In ORIGEN2, TAPE9 includes both the decay and cross-section libraries. For fission reactor problems, Oak Ridge provides them separately, and the user must merge them (or concatenate them, according to the ORIGEN2 manual). In FORIG, the two files are kept separate.

(2) When the library number ≥ 700 , FORIG expects TAPE3 and TAPE8 to be in the ORLIB format.

(3) The first line of the instruction file is a new line (not used in ORIGEN2). If the line contains a negative integer, FORIG will not print neutron sources from spontaneous fission, neutron-induced fission, or (α, n) reactions. These tables are not applicable to pure fusion problems.

(4) The LIB command has been changed to accommodate the separate cross-section and decay library files.

(5) The ORIGEN2 code has a maximum of seven loss paths (by activation or decay) for each nuclide. Additional loss paths are omitted and the program continues after printing a warning. FORIG uses up to 15 loss paths and error-exits if this maximum is exceeded. In this case, either the cross-section files must be altered to reduce the paths, or both the sources (FORIGM and FORIGS) must be redimensioned and recompiled.

(6) ORIGEN2 reads 80-character lines, FORIG reads 120-character lines.

TAPE8: Cross-Section Library

If the library number is < 700 , the standard ORIGEN2 library is used:

```

NLB TITLE (For the light nuclide segment)
NLB ZZAAAI Sny Sn2n Sna Snp Snyx
Sn2nx -1.0
      .
      .
-1
NLB TITLE (For the actinide segment)
NLB ZZAAAI Sny Sn2n Sn3n Snf Snyx
Sn2nx -1.0
      .
      .
-1
NLB TITLE (For the fission product segment)
NLB ZZAAAI Sny Sn2n Sna Snp Snyx
Sn2nx 1.0
Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8)
      .
      .
-1

```

where

NLB is the library number for each segment;
ZZAAAI is the nuclide identification;
Sny is the cross section for the (n, γ) reaction;

Sn2nx is the cross section for the $(n, 2n)$ reaction leaving an excited daughter;
Y(1) through Y(8) are the fission product yield in percent from up to 8 actinides as specified in Table 5.2 of the ORIGEN2 manual. The Y(1) through Y(8) line is omitted if the previous line ends in a negative number.

If the light nuclide library number is ≥ 700 , the ORLIB format is used. For a pure fusion problem,

```

NLB TITLE
Comment line
ZZAAAI Sn2n Sn2nx Sn3n Snp Sna Snp
Snd Snt Sna Sny Snyx
      .
      .
-1

```

This example includes no cross sections for actinides or fission products. If the problem includes either, they are entered in the original ORIGEN2 format following the light nuclide segment.

In both formats, the code will error exit if cross sections are entered for nuclides not in the appropriate decay-library segment.

TAPE3: Odd Reaction Library

If the light nuclide library number is <700, the odd reactions are added in the ORIGEN2 format

ZAAAI ZZAAAI SIGMA

:

where the first and second entries on each line are the parent and daughter nuclide identifications. When this format is used, hydrogen and helium isotope production are not followed for the odd reactions.

If the light nuclide library number is ≥ 700 , the odd reactions are added in the ORLIB format:

NLIB TITLE

Comment Line

ZZAAAI ZZAAAI SIGMA TYPE
ZZAAAI ZZAAAI SIGMA TYPE

:

where TYPE is the reaction type number (Table 1). With this format, hydrogen and helium isotope production is followed for both the odd and the standard reactions.

In either format, each odd reaction is added to the first library segment (light nuclide, actinide, fission product) that includes the parent in the decay library. Also, if replacement decay or cross section lines are to be inserted in any of the six library segments, these lines *precede* the odd reaction formats shown above. (The LIB and LPU commands force the code to read each line in its proper format, as is discussed later.)

TAPE9: Decay Library

This library is input in the ORIGEN2 format.

NLB TITLE (For the light nuclide segment)

NLB ZZAAAI IU THALF $F\beta x$ $F\beta + EC$

$F\beta + ECx$ $F\alpha$ Fit

NLB Fsf Fnb QREC ABUND ARCG WRCC

:

-1

NLIB TITLE (For the actinide segment)

:

-1

NLIB TITLE (For the fission product segment)

:

-1

where

IU indicates the time units for the half life, THALF;

$F\beta x$ is the fraction of all decays by negatron (beta) emission with an excited daughter;

$F\beta + EC$ is the fraction of all decays by positron emission or electron capture;

$F\beta + ECx$ is the fraction of all decays by positron emission or electron capture with an excited daughter;

$F\alpha$ is the fraction of all decays by alpha emission;

Fit is the fraction of all decays by internal transition;

Fsf is the fraction of all decays by spontaneous fission;

Fnb is the fraction of all decays by (neutron plus beta) decay;

QREC is the total recoverable energy (not including neutrinos) released per decay, in MeV;

ABUND is the natural isotopic abundance;

ARCG is the radioactivity concentration guide (RCG) for continuous inhalation in unrestricted areas as given in Table II, Column I, 10CFR20 using the lower of the soluble and insoluble values, and

WRCC is the RCG for continuous ingestion from Column II of the same table in 10CFR20.

The fraction of negatron beta decays with a ground state daughter is calculated from the above fractions. Since the decay library is used to produce the nuclide list for the calculation, both radioactive and stable nuclides of interest must be included.

TAPE10: Photon Library

This library is input in the ORIGEN2 format.

```
NLB TITLE (For the light nuclide segment)
NLB ZZAAAI NGP(1) RPH(1) • • • NGP(J)
RPH(J)
  NGP(J + 1) RPH(J + 1) • • • NGP(18)
RPH(18) - 1
•
•
- 1
```

where

NGP is the group number, a::d

RPH is the photon intensity per disintegration.

Only nonzero entries need be made. If actinides and fission products are used in the problem, their segments should be added to the example above.

ORINPUT: Instruction File

The input begins with four lines, each usually consisting of "- 1." The negative entries suppress neutron source printing, decline to replace default individual element fractional recovery efficiencies, decline to replace default element group fractional recovery efficiencies, and decline to replace element group membership assignments.

The file continues with the individual commands, which are listed below by category. More detailed explanations are available in the ORIGEN2 manual.

Comment and Termination Commands

RDA prints comments in the command list. (Comments may also be added at the end of most command lines.)

TIT specifies the title to be printed on the output table pages.

BAS prints a comment line on the output table pages. For example, the comment can indicate that the calculation is based on one metric ton of steel in the reactor.

HED allows a time column heading to be changed from the actual time to a 10-character alphanumeric heading.

STP allows a new case to begin with new commands, libraries, and/or initialization data.

END terminates execution.

Library Commands

LIB inputs the decay and cross section libraries. The format of this command has been

one additional input. The FORIG format is

LIB NLIB(1) • • • NLIB(13)

where

NLIB(1) is >0 if printing of the reaction rate matrix is desired (i.e., the production rate from each parent, the decay rate, and the removal rate by activation are printed for each nuclide);

NLIB(2) is the light nuclide decay library number;

NLIB(3-4) are the actinide and fission product decay library numbers (0 for pure fusion problems);

NLIB(5-7) are the three cross section library numbers; (Note: If a decay or cross-section library number is negative, replacement cards will also be read later for that library.)

NLIB(8) is the input unit number for the cross section library file (use 8);

NLIB(9) is the input unit number for the decay library file (use 9);

NLIB(10) is the input unit number for the replacement decay and cross-section lines, and for reading odd reactions (use 3);

NLIB(11) is the number of odd reactions to be read. If **NLIB(11)** is negative, the read will be on unit **NLIB(10)**. If **NLIB(11)** is positive, the read will be on unit **NLIB(8)**. Use negative **NLIB(11)**.

NLIB(12) determines the set of actinides having direct fission product yields (use 0 for fusion problems); and

NLIB(13) determines the set of variable actinide cross sections to be used (use 0 for fusion problems).

- IPU** identifies nuclides requiring replacement lines in decay or cross section library segments. One LPU command must precede the LIB command for each negative library number in the LIB command.
- PHO** inputs the photon libraries.
- LIP** determines whether the decay, cross-section, and photon libraries are printed. The LIP command must precede the LIB command.

Material Input Commands

- INP** forces the code to read the input material compositions. The program is set up to read the compositions at the end of the input command file (ORINPUT). However, a previous FORIG run could have produced an output file in the proper format for input to this problem. If this file is to be used directly, it should be named "TAPE4," and "TAPE4" should be opened in the MAIN program. The INP command also allows input of continuous feed rates and continuous removal rates. The data for these rates follows the initial composition input at the end of ORINPUT.
- WAC** allows material to be continuously removed from the reactor with element dependent efficiency. This removed waste can then be decayed.
- PRO** allows a material to be processed at a given time into two segments with element dependent efficiency.

Material Manipulation Commands

FORIG maintains the material composition as a vector at each time step. Since only those vectors required for output or subsequent calculation need be kept, it is sometimes convenient to manipulate the vectors.

- MOV** allows a material composition to be moved from one vector to another. The command allows a constant multiplier to be applied to the composition. The heading is also moved.

- ADD** allows addition of one material to a second material. The command also allows the material being added to be multiplied by a constant prior to the addition. The heading for the first vector will be moved to the second vector with this command.
- KEQ** allows two materials to be blended until the resultant material has an infinite multiplication factor that matches either a third material or an input value.
- FAC** calculates the sum, product, or ratio of the total fission product plus actinide mass of two vectors or of a vector and an input constant. The resulting constant factor can then be used as a multiplier in subsequent ADD or MOV commands.

Commands That Take a Time Step

- DEC** allows a composition vector to decay for a specified time.
- IRF** allows activation and decay of a composition vector in a constant neutron flux for a specified time.
- IRP** allows activation and decay of a composition vector at a constant power for a specific time (only applies to fission problems).
- BUF** calculates the average burnup, flux, and specific power for an irradiation period (only applies to fission problems).

Loop Commands

- DO** sets up a do loop through a set of instructions.
- CON** ends a do loop.
- REC** counts the number of times a do loop has been executed (for printing in the output tables).

Output Commands

- OUT** specifies composition vectors to be printed.
- OPTL** specifies output data to be printed for light nuclides for each vector in the OUT command (options include composition,

activity, thermal decay power, inhalation and ingestion biological hazard potential, chemical ingestion hazard, neutron absorption rate, neutron induced fission rate, α radioactivity, α -induced neutron production, spontaneous fission neutron production, and photon emission rate). The OPTL command also specifies the units of the various tables and whether the output will be by nuclide, element, and/or in a condensed format. The OPTL command must precede the OUT command.

OPTA same as OPTL for actinides.
OPTF same as OPTL for fission products.
CUT defines cutoff limits for condensed output tables. If the output for a particular nuclide is less than the cutoff fraction times the total output at that time step, and if this is true for each time step being output, then the nuclide is omitted.
PCH creates an output file containing the material composition in a format readable by future FORIG calculations.

FORIG Output

The majority of the output is written in a file named OROUT (called TAPE6 in the ORIGEN2 manual). A table of contents for OROUT is written in file TAPE12. The OUT command can also specify sending output to a second file (TAPE11 with table of contents TAPE13); this is handy when an early, condensed hard-copy file is desired with a full microfiche output to follow.

TAPE7 is an optional output composition file written by the PCH command. TAPE15 contains debug information and error messages. TAPE16 contains variable actinide cross section information. Finally, TAPE50 is a working file set up and used by FORIG.

Sample FORIG and ORIGEN2 Files

At LLNL, J. Blink's take directory contains a number of FORIG, ORLIB, and ORIGEN2 files:

CONTENTS is a directory table of contents.
 ORLIB, ORLIBS, EORLIBJN, AC820312 and ADEX8203, are ORLIB files (see Ref. 2).

FORIGS, BFORIGS, FORIGMG, FORIGM, and FORIG are FORIG source and controller files.
 EORINPUT, ETAPE3, ETAPE8, ETAPE9, and ETAPE10 are example input and data files for a FORIG problem.

OR01C is the table of contents for the Oak Ridge supplied file list for ORIGEN2.

OR03C-OR18C are sample ORIGEN2 main

programs for various fission reactors. OR03C has been modified to run on FORIG.

OR21C is the ORIGEN2 decay library.

OR22C-OR44C are the ORIGEN2 cross-section libraries for various fission reactors.

OR45C is the ORIGEN2 photon library for UO_2 Bremsstrahlung.

OR46C is the ORIGEN2 photon library for H_2O Bremsstrahlung.

OR47C is the ORIGEN2 photon library for vacuum (no Bremsstrahlung).

OR48C-OR54C are sample ORIGEN2 output files for a single fission reactor problem (TAPES 6, 7, 11, 12, 13, 15, and 16).

Summary

The ORIGEN2 code has been modified to run at LLNL on a Cray-1 computer. The modified code, FORIG, will accept cross sections in both the ORIGEN2 format and the ORLIB format. The expanded cross section library available through

ORLIB permits use of FORIG to directly treat a wide variety of pure fusion reactor geometries. By iterating between a flux code, ORLIB, and FORIG, fusion-fission hybrid reactor geometries can also be handled.

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