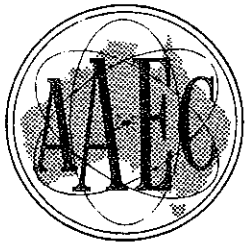
AAEC/E389

AAEC/E389



AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT

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May 1976

ISBN 0 642 99748 9

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ABSTRACT

AUSED is a loading and editing module for AUS cross section data pools and is part of the AUS modular code scheme for reactor systems. The fitting of subgroup parameters for the resonance theory of the module MIRANDA has been included as an option. Emphasis has been placed on flexibility and free format style input.

National Library of Australia card number and ISBN 0 642 99748 9

The following descriptors have been selected from the INIS Thesaurus to describe the subject content of this report for information retrieval purposes. For further details please refer to IAEA-INIS-12 (INIS: Manual for Indexing) and IAEA-INIS-13 (INIS: Thesaurus) published in Vienna by the International Atomic Energy Agency.

A CODES; BURNUP; COMPUTER CALCULATIONS; CROSS SECTIONS; DATA; NEUTRONS; REACTORS; SCATTERING

CONTENTS

1. INTRODUCTION

The module AUSED may be used to load, edit, copy, punch or list either a general purpose cross section library for one of the AUS data preparation modules [Robinson 1975] or a data set containing cross sections for some particular reactor system. A cross section data set or library with n materials consists of n+1 pseudo files all on a single sequential disk or tape file. Pseudo file 1 consists of library heading records, an index of materials on the library and group energies, lethargies and velocities. The n material files contain burnup information, group cross sections and scattering matrices. AUSED may also be used to convert from type 2 resonance data (group resonance integrals per unit lethargy tabulated against potential scattering due to hydrogen) to type 3 resonance data with subgroup parameters for the resonance theory of the MIRANDA module [Robinson 1976].

The POW routines DTAV [Pollard 1974] have been used to enable flexible free style input. Most variables have default values and hence are optional. Editing, in general, may be done at vector level, *e.g.* a group or reaction at a time.

This report should be used in conjunction with the description of the AUS cross section data pool given by Robinson [1975].

2. CONTROL LANGUAGES

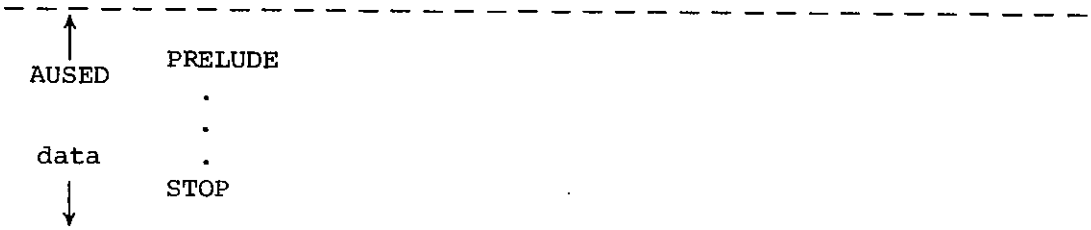
The control languages used to run AUSED at the Australian Atomic Energy Commission Research Establishment (AAECRE) are the IBM360 Job Control Language (JCL) and the AUS system, AUSYS. The following is intended as a guide for the control cards required at the AAECRE:

JCL data

```
//Your Job Card
// CLASS=J,TIME=7
// EXEC AUS,XS1='AUS.BVHLIB1',DISPXS1=OLD,
// XS2='AUS.BVHLIB2',DISPXS2=NEW
//GO.SYSIN DD *
```

AUSYS data

```
*DD1
STEP *
     LINK AUSED
     END
STOP
*DD2
```



//

NOTE: For the JCL data, the user should supply his own data set names unless temporary data sets suffice, in which case data set names, etc. are not required.

3. AUSED DATA FORMAT

Input data required by AUSED is punched in free FORMAT style with keywords indicating the data type, *e.g.*

```
SP      0.8     0.2     0.      0.
```

designates data for the fission spectrum. The data are read using the subroutine DTAV [Pollard 1974] which incorporates the subroutine SCAN [Bennett & Pollard 1967]. The features of DTAV and SCAN relevant to running AUSED are summarised below:

Data Feature	Comments
Card columns	normally 1 to 72 unless otherwise specified.
Keywords	normal FORTRAN variable names (except that up to 8 characters are permitted).
Modes	numeric data may be punched in any mode, *e.g.* 1, 1., 1.-3 ≡ 1.E-3 ≡ 1.D-3 = 10^{-3} and alphanumeric data consists of FORTRAN variable type names which are not keywords.
Extents of data	different keywords require different extents of data to trail them, *e.g.* for a 4-group library the fission spectrum keyword, SP, would require four numbers to follow.
Repeats	to save punching, we may use: 4*0. ≡ 0. 0. 0. 0.
Increment	to save punching, we may use: 1(2)7 ≡ 1 3 5 7
Readability	additional special characters may be interspersed throughout the data, *e.g.* SP = 0.8, 0.2, 2*0

Data Feature	Comments
Comments	a card punched with * in column 1 is treated as a comment card and is not scanned for data. Cards with ** in columns 1 and 2 are treated as comment cards for the current data file (see Section 6.4).

4. PRELUDE DATA

PRELUDE data set the dimensions of variably dimensioned arrays used in AUSED. They must precede all other AUSED data. The default values are given in Table 1. If the user wishes to change any of the default values, he must provide the required data between the keywords PRELUDE and END, *e.g.*

```
PRELUDE MAXG=55, MSCATT=4, MAXP=1, PRINT, END
```

If, however, the default values are satisfactory, PRELUDE data may be omitted altogether, and the AUSED data must then begin with the keyword START (see Section 5.1).

TABLE 1

PRELUDE DATA

Keyword	Standard Value	Description
PRELUDE		The first word of PRELUDE data
MAXG	128	Maximum number of energy groups
MAXP	2	Maximum number of P_0, P_1,...P_{n-1} weighted scattering matrices
MSCATT	1	Maximum number of scattering temperatures
MSCATP	1	Maximum number of scattering tabulations against potential scattering
MXSD	1	Maximum number of cross section temperatures
MXSDP	11	Maximum number of cross section tabulations against potential scattering
MLAY	100	Maximum number of input nuclides (including all nuclides on the input library plus those completely provided on cards)
MREAC	11	Maximum number of reactions
MC	30	Maximum number of comment cards of any pseudo data file required on output
MAXLV	128	Maximum length of a scattering vector
PRINT		Causes the printing of array dimensions
END		Indicates the end of PRELUDE data

NOTE: Except for MLAY and MC, the maximum may be determined by considering only those nuclides being changed or supplied on cards (i.e. those with layout (i) = 2 or 3; see Section 5.2).

5. AN AUSED RUN

An AUSED run consists of all the data and resulting operations between and including the keywords START and END. In this section only 'task' data are described, that is, data defining input and output units, error conditions for terminating a run, and which nuclides are to be modified, copied or loaded from cards. 'File 1' data and 'nuclide' data, *i.e.* actual AUS library data for loading or editing,are described in Sections 6 and 7 respectively. 'Subgroup' data to be used for conversion of type 2 resonance data to type 3 is described in Section 8, and data for the editing of output in Section 9.

5.1 START and END of an AUSED Run

An AUSED run begins with

START ℓ, m, n, p

where ℓ is the FORTRAN disk (or tape) reference number for the input AUS library (binary). FORTRAN units 10, 11, 12 correspond to the cross section data sets XS1, XS2, XS3 respectively (Section 2). For a first loading of a library set, ℓ=0. For ℓ<0, the input library $|\ell|$ is not rewound before reading.

m is the FORTRAN reference number for the output unit. For m=2, card image output is produced(with data for each pseudo file ending with UNIT=1) in a FORMAT suitable for re-input to AUSED (see Section 5.3). For m=3, printed output is produced. For m>3, output is a binary library (m=ℓ is permitted, *i.e.* input and output libraries may be on the same FORTRAN unit).

n is an error condition (default value 0) such that for n=1, the run is terminated if an error occurred in the previous run.

p is an error condition (default value 0) such that for p=1 and m>3 should an error occur, the current run is terminated before writing on FORTRAN unit m.

A run ends with the keyword END.

5.2 LAYOUT for Merging of Cross Section Files

The merging of nuclide data on cards with the input library ℓ is controlled as follows:

LAYOUT (layout(i),i=1,n)

where $n \leq$ MLAY

The default values (layout(i)=1, i=1, MLAY) are then wholly or partly overwritten by LAYOUT data.

For layout(i)=0 input for the i^{th} nuclide is on the input library ℓ and is to be deleted for output purposes.

layout(i)=1 input for the i^{th} nuclide is on the input library ℓ and is required unchanged for output.

layout(i)=2 input for the i^{th} nuclide is on input library ℓ and is to be modified using card data following the corresponding DATA keyword (Section 7).

layout(i)=3 input for the i^{th} nuclide is on cards.

The special option layout(i)=-1 may be used, provided m=2 or 3, to produce file 1 (Section 6) output only.

5.3 UNIT, for Card Input

The 'card' input may be transferred from one FORTRAN unit to another as follows:

UNIT iunit

where iunit is the FORTRAN reference number for the 'card' input data and has a default value of 1.

NOTE: UNIT data may be supplied anywhere in a run subsequent to PRELUDE data.

6. FILE 1 DATA

Data for pseudo file 1 is optional, with the exception that for a library which is being loaded completely from cards, the number of groups must be specified (Section 6.1).

6.1 Heading Records

The library heading and description may be set as follows:

HEADING name, description

where the keyword HEADING is punched in columns 1 to 7,

name (columns 9 to 16) is the library identifier (default - AUSED), and

description (columns 17 to 72) may be used to describe the data pool.

Data for the second library heading record may be set with

PARAMETERS id, nn, ng, mnreac, mnxst, mnsp, mnscatt, mnscsp, mnp, indres

where id is added to the previous library update number (default value 1),

nn is the number of nuclides on the output library,

ng is the number of energy groups,

mnreac maximum number of reactions ($\leqslant 20$),

mnxst maximum number of cross section temperatures,

mnsp maximum number of potential scattering values for resonance tabulations of cross sections,

mnscatt maximum number of scattering temperatures,

mnscsp maximum number of potential scattering values for scattering data,

mnp maximum number of P_0, P_1, P_2 ...P_{n-1} weighted scattering matrices, and

indres indicator for the type (1, 2 or 3) of tabular data supplied as a function of σ_p for resonance groups (default value 1)

For a library which is not loaded entirely from cards, all the above parameters are deduced by AUSED. Note, however, that the maximums are deduced by including nuclides to be deleted.

6.2 Group Boundaries

Group lethargy and energy boundaries may be set using either of the following:

LETHARGY $(u_i, i=1,ng+1)$

where u_i is the i^{th} lethargy boundary (in ascending order of lethargies), and

ng is the number of groups.

ENERGY $(e_i, i=1,ng+1)$

where e_i is the i^{th} energy boundary in eV (in descending order of energies).

6.3 Group Velocities

Group velocities may be set thus:

VELOCITY $(V_i, i=1, ng)$

where V_i is the velocity (cm x 10^8 s^{-1}) for group i.

6.4 Comments

Cards with ** in columns 1 and 2 are treated as library comments and are scanned for data up to column 80. Those preceding the first DATA card are taken to be file 1 comments; those following each DATA card are used as comments for the corresponding nuclide file.

The number of comment 'cards', n, required from the input library for a particular pseudo data file may be set thus:

NCOMTS n

Then for a file which is being modified, if m comment cards are provided, these are treated as the $(n+1)^{th}$, $(n+2)^{th}$,...$(n+m)^{th}$ comment cards. If the default value (n=0) is not satisfactory, the above data must be provided

before the comment cards to which they apply and, if necessary, they must be redefined for the next pseudo file. If there are no comment cards for a given pseudo file, then all library comments for that file are used unchanged.

7. NUCLIDE DATA

Data for nuclide N, that is for pseudo file N+1, must follow the keyword DATA and are terminated either by DATA or END. Nuclide data must consist of at least the keyword DATA, all other nuclide data being optional. Nuclide data must be provided corresponding to each 'layout(i)' (Section 5.2) with a value of 2 or 3 in the order required for the updated library. For layout(i)=2, nuclide data are first read from the pseudo data file on the input library and then modified using card data. For nuclide comments see Section 6.4.

7.1 DATA, Beginning of Nuclide Card Data

Card data for a nuclide file begins with

DATA name, source, mod, nd, nxst, nsp, nscatt, nscsp, np,

where
- name ≡ material name (up to 8 characters, *e.g.* AL),
- source ≡ data source (up to 8 characters, *e.g.* ENDFB4),
- mod ≡ extent of update (up to 4 characters, *e.g.* MOD1)
- nd ≡ number such that for nuclides with the same name, the one with the highest nd is recommended data,
- nxst ≡ number of cross section temperatures,
- nsp ≡ number of σ_p values for cross section tabulations,
- nscatt ≡ number of scatter matrix temperatures,
- nscsp ≡ number of σ_p values for scatter matrix tabulations, and
- np ≡ number of P_0, P_1 ...P_{np-1} weighted scattering matrices

For layout(n)=3 the default values are:

MATTOn, AUSED, ORIG, 1, 1, 1, 1, 1, 1

or part thereof if an incomplete list of data follows the keyword DATA.

7.2 BURNUP and Mass Information

BURNUP (st(k),k=1,20)

where
- st(1),st(2) ≡ name of nuclide produced by decay,
- st(3),st(4) ≡ name of nuclide produced by reaction 7,
- st(5),st(6) ≡ name of nuclide produced by reaction 8,
- st(7) ≡ integer between 0 and 6 inclusive to indicate fuel type,
- st(8) ≡ the decay constant ($1/10^{24}$ s),

st(9) to st(14) ≡ yields from fuel types 1 to 6,

st(15) ≡ fission energy release (joules per fission),

st(16) ≡ atomic mass of first isotope in the material,

st(17) ≡ atomic mass of second isotope in the material,

st(18) ≡ fraction of potential scatter due to first isotope,

st(19) ≡ fraction of potential scatter due to second isotope, and

st(20) ≡ burnup order indicator.

7.3 SP, Fission Spectrum

The fission spectrum may be set with

SP $(x_i, i=1,ng)$

where $\underset{\sim}{x}$ is the normalised fission spectrum.

7.4 Temperature and Potential Scatter

These may be set as indicated in Table 2.

TABLE 2

TEMPERATURE AND POTENTIAL SCATTER DATA

KEYWORD and Data	Description	Default Values
XSDTEMP $(xsdt_i, i=1,nxst)$	$xsdt_i$ are temperatures K at which cross sections are tabulated.	all 300
XSDSIGP $(xsdp_i, i=1,nsp)$	$xsdp_i$ are values of σ_p (σ_{tot} for type 3 data) at which cross sections are tabulated.	all 1.E+20
SCATTEMP $(sctt_i, i=1,nscatt)$	$sctt_i$ are temperatures at which scattering matrices are tabulated.	all 300
SCATSIGP $(sctp_i, i=1,nscatp)$	sctp is the potential scatter array for scatter matrix tabulations.	all 1.E+20

7.5 Cross Section Data

Cross section data on an AUS library consists of cross section records and, for a type 3 library, subgroup parameter records. Cross section records include the data $(r_i, i=1,nreac)$

where nreac is the number of reactions,

r_1 is the transport cross section,

r_2 is the absorption cross section,

r_3 is the fission emission cross section,

r_4 is the scattering cross section (if only one record for the group) or potential scattering cross section (if complete tabulation),

r_5 is the total cross section,

r_6 is the fission cross section,

r_7 is the first burnup reaction, usually the capture cross section,

r_8 is the second burnup reaction or the (n,2n) cross section,

.
.
.

r_{nreac} these additional reactions depend on the library type.

Subgroup parameter records include the data:

(a) $(w_i, i=1,3)$ for non-fissile nuclides

where w_1 is the subgroup weight for absorption,

w_2 is the subgroup weight for resonance scattering, and

w_3 is the subgroup weight for the ratio of group flux to asymptotic group flux.

(b) $(w_i, i=1,5)$ for fissile nuclides

where w_1 is the subgroup weight for absorption,

w_2 is the subgroup weight for resonance scattering,

w_3 is the subgroup weight for fission,

w_4 is the subgroup weight for fission emission, and

w_5 is the subgroup weight for the ratio of group flux to asymptotic group flux.

A type 1 or 2 library consists of cross section records only. In a type 3 library, for a group with nxst x nsp records, the first nxst are cross section records and the rest are subgroup parameter records.

Cross section data in AUSED is stored in an array of the form $\sigma(i,j,k,\ell)$:

where i is the group number,

j is the reaction number,

k is the temperature index, and

ℓ is the potential scatter index.

The input requirements below are given in terms of these indices. Cross section data may be supplied or modified by group:

GROUP idgp, f, idtemp, idsp, XSD (x_i,i=1,nr)

or by reaction

REAC idreac, f, idtemp, idsp, XSD (x_i,i=1,mng)

where idgp is the group number (default 1),

idreac is the reaction number (default 1),

idtemp is the temperature index (default 1),

idsp is the potential scatter index (default 1)

mng $\leq$ ng x MREAC,

nr $\leq$ nreac x MAXG,

x_i is an entered cross section or subgroup parameter,

f (default 0) is used to modify the cross section array $\sigma(i,j,k,\ell)$ (which has been set to zero for nuclides corresponding to layout(i)=3) as follows.

Modified cross sections are denoted by a prime.

If $x_i=0$, then $\sigma' = \sigma$

If $x_i \neq 0$, then for $f \leq 0$, $\sigma' = |f|\sigma + x_i$,

and for $f > 0$, $\sigma' = f\sigma x_i$,

where σ is the input library cross section corresponding to x_i.

(If $|x_i| \leq$ 1.E-40, then x_i is replaced by 0 in the above equations. This option is required to obtain $\sigma'=0$ when modifying a nuclide file.)

The keyword XSD must always be preceded by GROUP or REAC. Cross section data for a number of values of temperature and potential scatter may follow the keyword XSD. Then, if the number of reactions on card input 'nreac' differs from the number on the nuclide data file, the following data is required:

NREAC nreac

For a library loaded from cards, the default value for 'nreac' is 'mnreac' (Section 6.1) and, if still zero, MREAC (Section 4).

For data by group, the x array corresponds to the cross section array in the following order:

(((σ(idgp,j,k,ℓ), j=1,nreac), k=idtemp,nxst) ℓ=idsp,nsp)

and for data by reaction in the order

(((σ(i,idreac,k,ℓ), i=1,ng), k=idtemp,nxst), ℓ=idsp,nsp).

Since 'nreac' also determines the number of reactions on the output library, it may need to be reset following card cross section data.

For a type 3 data pool and a fissile nuclide supplied on cards, the keyword FISSILE indicates that there are subgroup parameters for fission and fission emission.

7.6 Scattering Data

This may be supplied as follows:

GROUP idgp, f, idtemp, idsp, idp, SCAT ℓss, ℓv, (x_i,i=1,ℓv)

where idgp ≡ the group number,
idtemp ≡ position in scattering temperature array,
idsp ≡ position in potential scatter array,
idp ≡ order of P_n weighting (idp=n+1),
ℓss ≡ position of self-scatter
ℓv ≡ length of scattering vector,
x_i ≡ vector of out-scatters from the group, and
f, x_i are used in the same way as for cross sections (Section 7.5)

Note that for f>0, ℓss and ℓv must have the same values on the input data as on the library data.

8. SUBGROUP PARAMETER FIT

AUSED may be used to convert type 2 resonance data (RI/δU tabulated against potential scattering due to hydrogen) to type 3 data, with a tabulation of subgroup parameters for the resonance theory of the AUS module MIRANDA [Robinson 1976]. The input library is a type 2 library and the output is a type 3 library.

8.1 Subgroup Data

The following data are necessary for each nuclide, and must follow the DATA card for that nuclide:

SIGTFIT (σ_T(i),i=1,nsigt)

where σ_T is the total resonance cross section array to be used in the parameter fit. Negative values of σ_T are permissible and for resonance scatterers they are necessary.

For each group with shielding, the following data are used to set the value of λ (for hydrogen λ=1) to be used in the fitting of subgroup parameters (Section 8.3):

GROUP ng,p_1,p_2

where ng is the group number.

The parameters p_1,p_2 may take the following values:

(a) $\bar{\sigma}_o \, , \left(\frac{\overline{2E_r}}{\Gamma_r}\right)$ for $p_1>0$, $p_2>0$.

The bar denotes some reasonable estimate of the group average values and

σ_o is the peak microscopic total resonance cross section,

E_r is the resonance energy, and

Γ_r is the total level width of the resonance.

A form of the Hill & Schaefer [1962] λ method is used, with λ for the nuclide set as follows:

$$\lambda = 1 - \alpha \frac{2C}{x} \arctan \frac{x}{C(1+\alpha)} \quad ,$$

where $$\alpha = \left(\frac{A'-1}{A'+1}\right)^2 \quad ,$$

$$A' = A/1.008665 \quad ,$$

$$C = \left(1 + \frac{\bar{\sigma}_o}{\sigma_p + r_4}\right)^{\frac{1}{2}} \quad ,$$

$$x = \frac{2E_r}{\Gamma} \quad ,$$

A ≡ atomic mass ,

r_4 ≡ potential scattering cross section, and

σ_p ≡ potential scattering excluding the nuclide itself.

(b) 0,0 implies narrow resonance theory and the setting of λ=1 for the nuclide.

(c) $-\sigma_{inel}$,0 implies narrow resonance theory, the setting of λ=1 for the nuclide and the addition of inelastic scattering.

(d) 1,0 implies a very wide resonance extending over many groups. In this case λ is set to

$$\lambda = \left(1 + \frac{\alpha \log \alpha}{1-\alpha}\right) \frac{E(ng)}{E(ng)-E(ng+1)} \quad ,$$

where E(ng), E(ng+1) are the energy boundaries of the group.

For a fissile material, the keyword FISSILE must follow DATA and precede SIGTFIT. This results in subgroup parameters being fitted to the fission reaction and those for fission emission being derived by multiplying by ν, where $\nu = r_3/r_6$.

To set a group number lr (default value MAXG), beyond which the groups are to be treated as non-resonance groups, LIMRES lr is used.

If the scattering matrices on the input library are σ_p dependent, they are retabulated against $\hat{\sigma}_p$ (Section 8.3) for the output library. The retabulation may be done to an arbitrary set of $\hat{\sigma}_p$, by using the data

SCATFIT $(\hat{\sigma}_p(i), i=1,n)$ where $n \leq$ MSCATP.

8.2 The Non-isolated Resonance Correction

Word 17 of the BURNUP vector should be set to $-\bar{D}$ (average resonance spacing) if the MIRANDA type [Robinson 1976] non-isolated resonance correction is to be removed before fitting subgroup parameters. The correction may be stopped for all groups preceding group nc with the data NIRC nc. This directive distinguishes the groups for which resonance integrals have been computed as a sum of J functions from those for which the resonance integrals have been derived from a numerical solution of the slowing down equations.

8.3 Fitting of Subgroup Parameters

For each group with shielding, for each temperature the following quantities are derived from the AUS data pool:

$I_a(\sigma_p) = r_2(\sigma_p)$ (absorption)

$I_{tot}(\sigma_p) = r_5(\sigma_p) - r_4 - \sigma_{inel}$ (total)

$I_f(\sigma_p) = r_6(\sigma_p)$ (fission - for a FISSILE nuclide only)

$$\hat{\sigma}_p = \begin{cases} (\sigma_p+\lambda r_4)\,\dfrac{I_a(\infty)+I_{sres}(\infty)}{I_a(\infty)+\lambda I_{sres}(\infty)} & \text{, if } I_{sres}(\infty) \geq 0 \\ \sigma_p+\lambda r_4 & \text{, if } I_{sres}(\infty)<0, \text{ and absorption is predominant,} \\ \dfrac{\sigma_p+\lambda r_4}{\lambda} & \text{, if } I_{sres}(\infty)<0, \text{ and resonance scatter is predominant.} \end{cases}$$

where I denotes resonance integral per lethargy unit,

$I_{sres}(\sigma_p) = I_{tot}(\sigma_p) - r_2(\sigma_p)$, and

λ is defined in Section 8.1.

The ratio of the group flux to the asymptotic group flux $F(\sigma_p)$ is derived for group i as follows:

(a) for i<nc, $F(\sigma_p) = 1 - \frac{I_{tot}(\sigma_p)}{\sigma_p}$; and

(b) for i $\geqslant$ nc, $F(\sigma_p)$ is taken directly from information produced by a slowing down code, *e.g.* PEARLS [Chiarella 1971].

Using a modification of the Russian subgroup method [Nikolaev *et al.* 1971], the quantities $I_a(\sigma_p)$, $I_{tot}(\sigma_p)$, $I_f(\sigma_p)$ and $F(\sigma_p)$ can be approximated by a sum of the form:

$$I(\sigma_p) = \sum_{i=1}^{nsigt} \frac{A_i \hat{\sigma}_p}{\sigma_T(i)+\hat{\sigma}_p} ,$$

where $A_i \geqslant 0$ except when fitting I_{tot} in which case $A_i\sigma_T(i) \geqslant 0$. The subgroup parameters are fitted using a method developed by G. Trimble and described by Doherty [1972]. The subgroup parameters for resonance scattering are then obtained as the difference between total and absorption subgroup parameters. For a FISSILE nuclide, the subgroup parameters for fission emission are obtained by multiplying the fission parameters by ν.

9. EDITING OF OUTPUT

9.1 Unit 2 or 3 Output

For card or printed output, nuclide data may be selected or deleted as follows:

OUTPUT (iopt(i),i=1,ng) (default values all 1)

where ng is the number of groups, and for group i, if

iopt(i)= 0 no output is produced
1 cross section and scattering data is produced
2 cross section data only is produced
3 scattering data only is produced

NUCLIDE (nucld(i),i=1,8) (default values all 0)

then if nucld(i)=-1, no output will be produced for the i^{th} item in the following list:

DATA, BURNUP, SP, XSDTEMP, XSDSIGP, SCATTEMP, SCATSIGP

and comments (Section 6).

To generate and print group resonance integrals at various values of σ_p

from a type 3 library, use

CHECK followed by the required values of σ_p.

The printing of input nuclide data cards (except for the DATA card itself) can be switched off using

PRINT iprint (default value 1)

where iprint=0 switches the printing off,

iprint=1 switches the printing on.

9.2 Reordering of Cross Section and Scattering Data

In Table 3 below, xsdt, xsdp, sctt and sctp are temperature and potential scatter arrays (Section 7.4). Numbers may be read into the arrays libxt, inxt, libsp, *etc.* for editing purposes. Data is then reordered so that, for example, cross section data with a temperature index i on input, become the set with index libxt(i) on output:

TABLE 3

REORDERING OF CROSS SECTION AND SCATTERING DATA

Keyword and Data	Library Data	On Input Tabulated Against	On Output Tabulated Against
LIBXT (libxt(i),i=1,nxst)	cross sections on binary library	xsdt(i)	xsdt(libxt(i))
INXT (inxt(i),i=1,nxst)	cross sections on cards	xsdt(i)	xsdt(inxt(i))
LIBXP (libxp(i),i=1,nsp)	cross sections on binary library	xsdp(i)	xsdp(libxp(i))
INXP (inxp(i),i=1,nsp)	cross sections on cards	xsdp(i)	xsdp(inxp(i))
LIBST (libst(i),i=1,nscatt)	scattering data on binary library	sctt(i)	sctt(libst(i))
INST (inst(i),i=1,nscatt)	scattering data on cards	sctt(i)	sctt(inst(i))
LIBSP (libsp(i),i=1,nscsp)	scattering data on binary library	sctp(i)	sctp(libsp(i))
INSP (insp(i),i=1,nscsp)	scattering data on cards	sctp(i)	sctp(insp(i))

The default values are set at the beginning of each run so that libxt(i)=i, inxt(i)=i, *etc.* for all i. The values may be changed as often as necessary within a run.

As an example, consider the addition of cross section data on cards at a temperature (say 600 K) that lies between two existing temperature tabulations (say 900 K and 300 K) on a data file. The following cards would be used:

```
XSDTEMP 900.      600.      300.      (section 7.4)
LIBXT 1   3
INXT  2
  :   cross section data at 600 K
  .
```

10. EXAMPLES

Input data for two AUSED runs follows. The first is a run to load from cards and lists a 4-group cross section data set for a particular reactor system. The second fits subgroup parameters to type 2 resonance data and punches the output cross section data for resonance groups onto cards.

LOADING A 4-GROUP LIBRARY FROM CARDS

```
// EXEC AUS,XS1='AUS.BVHLIB1',DISPXS1=OLD
//GO.SYSIN DD *
*DD1
STEP *
      LINK AUSED
      END
STOP
*DD2
START 0 10 0 LAYOUT 4*3
PARAMETERS 1 4 4 6 6*1
DATA FUEL     POW      ORIG     1    1    1    1    1    1
SP 7.37974E-01 2.62026E-01 0.0         0.0
GROUP   1  0  1  1 XSD
 1.39655E-01 6.12998E-03 4.13424E-04 2.13421E-01 2.14093E-01 1.53221E-04
GROUP   1  0  1  1  1 SCAT
    1    2 6.88494E-02 6.46760E-02
GROUP   2  0  1  1 XSD
 2.26558E-01 3.61234E-03 1.07439E-03 2.79754E-01 2.80489E-01 4.42536E-04
GROUP   2  0  1  1  1 SCAT
    1    2 2.11149E-01 1.17967E-02
GROUP   3  0  1  1 XSD
 2.02767E-01 8.51265E-03 1.01061E-02 2.45901E-01 2.52547E-01 4.17055E-03
GROUP   3  0  1  1  1 SCAT
    1    2 1.82533E-01 1.17212E-02
GROUP   4  0  1  1 XSD
 3.13441E-01 5.54827E-02 1.08876E-01 3.08199E-01 3.64712E-01 4.49441E-02
GROUP   4  0  1  1  1 SCAT
    2    2 3.71245E-04 2.57587E-01
DATA D2OAL    POW      ORIG     1    1    1    1    1    1
SP 7.37974E-01 2.62026E-01 0.0         0.0
GROUP   1  0  1  1 XSD
 1.21698E-01 5.20229E-03 0.0         1.84546E-01 1.84908E-01 0.0
GROUP   1  0  1  1  1 SCAT
    1    2 8.77454E-02 2.87499E-02
GROUP   2  0  1  1 XSD
 1.35870E-01 3.00783E-03 0.0         2.01007E-01 2.01310E-01 0.0
GROUP   2  0  1  1  1 SCAT
    1    2 1.29067E-01 3.79600E-03
GROUP   3  0  1  1 XSD
 1.12594E-01 2.90870E-03 0.0         1.26075E-01 1.27081E-01 0.0
GROUP   3  0  1  1  1 SCAT
    1    2 1.06200E-01 3.48550E-03
GROUP   4  0  1  1 XSD
 1.33091E-01 4.45161E-03 0.0         1.39984E-01 1.46584E-01 0.0
GROUP   4  0  1  1  1 SCAT
    2    2 4.74451E-04 1.28165E-01
DATA CONTROL  POW      ORIG     1    1    1    1    1    1
GROUP   1  0  1  1 XSD
 1.35395E-01 1.20185E-04 0.0         2.06585E-01 2.07057E-01 4.22895E-03
GROUP   1  0  1  1  1 SCAT
    1    2 7.89040E-02 5.63710E-02
GROUP   2  0  1  1 XSD
 2.01695E-01 1.87125E-04 0.0         2.55690E-01 2.55877E-01 2.57401E-03
GROUP   2  0  1  1  1 SCAT
    1    2 1.90240E-01 1.12679E-02
GROUP   3  0  1  1 XSD
 1.75171E-01 5.97861E-04 0.0         2.15586E-01 2.16184E-01 1.99007E-03
GROUP   3  0  1  1  1 SCAT
    1    2 1.65361E-01 9.21154E-03
GROUP   4  0  1  1 XSD
```

```
 2.19510E-01 3.82067E-03 0.0          2.52994E-01 2.56814E-01-1.48911E-03
GROUP    4  0  1  1  1 SCAT
    2    2 7.13749E-04 2.14976E-01
DATA D2O       POW       ORIG      1    1    1    1    1    1
GROUP    1  0  1  1 XSD
 1.38961E-01-1.58906E-04 0.0          2.20631E-01 2.21857E-01 2.71785E-03
GROUP    1  0  1  1  1 SCAT
    1    2 6.48159E-02 7.43040E-02
GROUP    2  0  1  1 SD
 2.70787E-01 7.07805E-08 0.0          3.43416E-01 3.43416E-01 1.31713E-03
GROUP    2  0  1  1  1 SCAT
    1    2 2.23321E-01 4.74664E-02
GROUP    3  0  1  1 XSD
 2.68223E-01 3.58373E-06 0.0          3.48414E-01 3.48418E-01 1.16845E-03
GROUP    3  0  1  1  1 SCAT
    1    2 2.32346E-01 3.58732E-02
GROUP    4  0  1  1 XSD
 4.13283E-01 3.51332E-05 0.0          4.77639E-01 4.77674E-01 2.24344E-04
GROUP    4  0  1  1  1 SCAT
    2    2 1.48143E-06 4.13246E-01
END
START 10 3 1 LAYOUT 4*1 END
/*
```

A SUBGROUP PARAMETER FIT

```
// EXEC AUS,XS1='AUS.BVHLIB1',DISPXS1=OLD,
//          XS2='AUS.BVHLIB2',DISPXS2=OLD
//GO.SYSIN DD *
*DD1
STEP *
      LINK AUSED
      END
STOP
*DD2
PRELUDE MAXG=127,MREAC=10,MAXP=1,MXSOP=23,PRINT,END
START 11 10 1 LAYOUT 2
DATA PU241 JPGYM767 MOD1
BURNUP AM241 PU242 NO0 5 1.69+15 6*0. 3.316E-11 241.056 3*0. 0942410
FISSILE
SIGTFIT ,625 2.5 10. 40. 160. 640. 2560.
GROUP 57 1.37+3 1.31+2
GROUP 59 1.21+3 1.15+2
GROUP 61 5.17+2 1.15+1
GROUP 62 1.61+2 1.03+2
GROUP 63 6.47+2 7.43+1
GROUP 64 2.20+3 6.96+1
END START 10 2 1 NUCLIDE 8*-1
OUTPUT 56*0 2 0 2 0 4*2 63*0
LAYOUT 1
END
/*
//
```

11. ACKNOWLEDGEMENTS

Thanks are due to G.S. Robinson and J.P. Pollard for guidance and advice.

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