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ICAROG:

A PROGRAM FOR CONVERSION OF A DATA LIBRARY IN THE WIMSD/4 FORMAT FROM THE BCD TO THE BINARY CODE AND VICE VERSA

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ICAROG:

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1. INTRODUCTION

The Nuclear Power Division of the Institute of Advanced Studies has lately emphasized the use of the WIMSD/4 program [1] for reactor cell calculations. It is very important for the Nuclear Data Centre to have a detailed knowledge of the basic nuclear data library of this program since the publicly available versions are not normally the most recent and are intended for general purposes.

The objective is to acquire knowledge of the basic library and to determine what nuclear data are required by the program and in what manner they are organized. By developing the ICAROG program, it is intended to meet the second part of the objective.

The WIMSD/4 program library comprises five types of data: general data, burnup data, cross-section data, resonance tables and linearly anisotropic components of the transfer matrix. Each type is discussed in Section 2.

2. ICAROG PROGRAM

ICAROG is the master program which accesses six sub-routines (INDATA, GENDAT, BURDAT, CROSEC, RESTAB and P1SCAT) responsible for the reading of input data and reformatting of the WIMSD/4 program library. Each sub-routine, except INDAT, deals with one well-defined type of data and each of the two possibilities of conversion - from the BCD to the binary code and from the binary to the BCD code - was implemented independently, in order to make it easier to introduce changes in the program.

2.1. INDATA sub-routine

INDATA accepts in a free format and interactively the input data for the ICAROG program. The first data (IOPT variable) relate to the type of conversion to be carried out. If the IOPT value is equal to zero, the conversion is from BCD (TAPE1) to binary (TAPE2). If the IOPT value is different from zero, the conversion is from binary (TAPE2) to BCD (TAPE1). The second data (ISCA variable) are the number of isotopes which will be separated from the library and stored in file 10 (TAPE10). If the ISCA value is equal to zero, no more input data are necessary. But if the ISCA value is different from zero, the total ISCA isotope identifiers to be separated are then read. The order of input of these identifiers should follow the order in the library. It should be emphasized that these identifiers should, when necessary, contain information about the desired resonance table. Thereafter, the information about how many of the ISCA isotopes are fissile and how many are fission products, respectively, is read. Lastly, a title indicator (LABS variable) for file 10 is read. If the LABS value is equal to zero, no titles for separation of data types will be written in file 10. This option is of interest for subsequent execution of the ICAROG program with a view to creating a new, more compact library. However, if the LABS value is different from zero, identifying titles will be written before each data set so that it can be easily located.

2.2. GENDAT sub-routine

GENDAT deals with general data [1-3], namely number of isotopes, number of energy groups, number of groups having fission spectra, number of fast groups, number of resonant groups, number of thermal groups, number of fissile isotopes, number of fission products, identifying numbers for isotopes, group structure and fission spectrum.

If non-zero values are attributed to input variables ISCA and LABS, the title "GENERAL DATA" will be written before the general data in file 10.

2.3. BURDAT sub-routine

BURDAT deals with burnup data [1-3], following the order of the isotope identifiers read by the GENDAT by sub-routine. This block of data supplies the following information: isotope identifier, production by capture, identifier of the isotope formed by capture, decay constant, identifier of the isotope formed by decay, energy released by fission, an indicator of fissile/not fissile/fissionable/fission product and pairs of fission products and their identifiers.

If non-zero values are attributed to variables ISCA and LABS, the title "BURNUP DATA" will be written before such data in file 10.

2.4. CROSEC sub-routine

CROSEC deals with cross-section data [1-3], following the order of the isotope identifiers. Thus, for each isotope the following information is supplied: identifier, atomic weight, atomic number, fissile/resonant indicator, number of temperatures at which the thermal cross-section sets are supplied and number of types of tabulation for resonances. The information supplied next, for epithermal groups (higher resonance and fast regions), is: product of the Goldstein-Cohen intermediate resonance parameter [4] and the potential scattering cross-section, moderating power divided by the lethargy interval, corrected transport cross-section, absorption cross-section, intermediate resonance parameter, product of the average number of neutrons released by fission and the fission cross-section, fission cross-section and transfer matrix. Then come the temperatures at which the thermal cross-section sets are given and, for each temperature, the corrected cross-section, the product of the average number of neutrons released in fission and the fission cross-section, the fission cross-section and the transfer matrix.

If non-zero values are attributed to variables ISCA and LABS the title "CROSS SECTION DATA" is written before such data in file 10.

2.5. RESTAB sub-routine

RESTAB deals with the tables of resonance integrals [1-3] in accordance with the order of the resonant isotope indicators. A resonant isotope can have a capture and fission resonance integral or only a capture resonance integral. So, it supplies for these isotopes tables of resonance integrals

for each lethargy interval as a function of temperature and potential scattering cross-section.

If non-zero values are ascribed to variables ISCA and LABS, the title "RESONANCE TABLES" will be written before those tables in file 10.

2.6. P1SCAT sub-routine

P1SCAT deals with the linearly anisotropic component of the transfer matrix [1-3] for hydrogen, deuterium, oxygen and carbon isotopes, in that order.

If a non-zero value is ascribed to the ISCA variable, this sub-routine will handle the four components in file 10 in the following manner: if any of the identifiers of the isotopes requested is equal to the identifier of one of these four isotopes, the component will be taken from the library. If not, a matrix containing zeros will be given. The purpose of this device is to keep the structure of file 10 identical to the original library in order to facilitate a second run of the ICAROG program considering only the isotopes of interest. If non-zero values are ascribed to the ISCA and LABS variables, the title "P1 SCATTERING" will be written before the anisotropic components in file 10.

3. RESULTS

The ICAROG program was used to generate from the original library a more compact data library containing the recommended or more recent evaluations of the isotopes since the original library contains too much information. This compact library was obtained by two-stage processing by the ICAROG program. First, in file 10 the desired eighty-four isotopes were separated. Then, file 10 was used as the input file (TAPE1) and these data were converted into the binary code. Table 1 of Appendix A shows the isotopes which constitute the compact library. This library has the identification tag IEAENDN with the name TAPE2.

4. FINAL COMMENTS

Knowledge was acquired of the structure of the WIMSD/4 program data library by implementing the ICAROG program. This program can be modified easily if it is necessary to perform any new operation on the library data.

It is recommended that the ICAROG program be used as a standard for implementing the WILMA program [3], which offers a large variety of options with regard to the management of the basic WIMSD/4 program library.

ICAROG is available to the WIMSD/4 program users and can be obtained on request from the Nuclear Data Centre of the Institute of Advanced Studies.

5. ACKNOWLEDGEMENTS

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[2] F. Leszczynski, "Métodos y Usos del Código WIMSD/4", Informe Técnico CNEA CAB-90-38, 1990.

[3] J. Babino et al, "WILMA, WIMS Library Management", Informe Técnico CNEA Re CA-79-10, 1979.

[4] R. Goldstein and E. R. Cohen, "Theory of Resonance Absorption of Neutrons", Nucl. Sci. and Eng., 13, p. 132, 1962.

APPENDIX A

Table 1

Materials constituting the compact library

isótopo (1)	identificador do isótopo (2)	identificador na (3) tabela de ressonâncias	posição na biblioteca (4)
H	2001		1
D	6002		2
He-3	3		3
He-4	4		4
Li-6	6		6
Li-7	7		6
Be-9	9		7
B-10	10		8
	1010		9
B_{nat}	11		10
	1011		11
C	12		12
Danos no grafite (5)	1212		13
N	14		14
O	16		15
F	19		16
Na	23		17
Al	27		18
Si	29		19
Cr	52		20
Mn	55		21
Fe	1056		22
Ni	58		23
Cu	63		24
Zr	91		25
Cd	112		26
Dy-164	164		27
Lu-176	176		28
Hf	178		29
Kr-83	83		30
Mo-95	95		31
Tc-99	99		32
Ru-101	101		33
Ru-103	1103		34
Rh-103	103		35
Rh-105	105		36
Pd-105	1105		37
Pd-108	108		38
Ag-109	109		39
Cd-113	113		40
In-115	115		41
I-127	127		42
Xe-131	131		43
Cs-133	133		44
Cs-134	134		45
Xe-135	135		46
Cs-135	1135		47

isótopo (1)	identificador do isótopo (2)	identificador na (3) tabela de ressonâncias	posição na biblioteca (4)
Nd-143	143		48
Nd-145	145		49
Pm-147	147		50
	1147		51
Sm-147	2147		52
Pm-148m	148		53
Pm-148	1148		54
Sm-149	149		55
Sm-150	150		56
Sm-151	151		57
Sm-152	152		58
Eu-153	153		59
Eu-154	154		60
Eu-155	155		61
Gd-155	1155		62
Gd-157	157		63
Pseudo produto de fissão (6)	902		64
Pb	207		65
Th-232	2232	2232.1	66
U-233	9233		67
Pa-233	1233		68
U-234	234	234.0	69
U-235	235	235.4	70
U-236	236	236.0	71
U-238	2238	2238.4	72
Pu-239	3239	3239.1	73
Pu-240	1240		74
Pu-241	241		75
Pu-242	242		76
Absorvedor + 1/v (7)	1000		77
Absorvedor - 1/v (7)	2000		78
Parte ressonante de absorvedor + 1/v (8)	1999		79
Sb-121	121	121.0	80
Sb-123	123	123.0	81
Cu detetor (9)	1063		82
Er	167		83
Absorvedor puro (10)	3000		84

1. Isotope
2. Isotope identifier
3. Identifier in resonance table
4. Position in the library
5. Damage in graphite
6. Pseudo fission product
7. Absorber
8. Resonant part of absorber
9. Cu detector
10. Pure absorber