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Extension of the Program CHECKER

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ABSTRACT

The program CHECKER has been extended to process the ENDF/B version II photon production files 12-16. This work is supplemental to that already completed by the National Neutron Cross Section Center at Brookhaven National Laboratory.

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INTRODUCTION

CHECKER[1] is a program distributed by the National Neutron Cross Section Center (NNCSC), Brookhaven National Laboratory to check the data on an ENDF/B[2] card image tape. In August and September of 1970, at the request of the NNCSC, the version of CHECKER in use at that time was extended at ORNL to process the ENDF/B Version II Photon Production Files 12-16. In December of 1970 a revised version of CHECKER was received from the National Neutron Cross Section Center and has also been made operational on ORNL's IBM 360 computers and extended to process the Photon Production files. This document describes only the work done at ORNL to accomplish the above tasks and should be regarded as a supplement to reference 1.

PROGRAM ADDITIONS AND REVISIONS

CHECKER is organized such that a MAIN (calling program) calls a unique subroutine for each ENDF/B file to be chekked. Two entirely new subroutines CKF12 and CKF13 were added to CHECKER to check ENDF/B files 12 and 13. Minor changes in the calling program were made to accommodate these new routines. Routines for checking files 14 and 15 (CKF14, CKF15) were received with CHECKER but they were replaced by routines written at ORNL because the formats and procedures had changed. Subroutine CKF16 for checking ENDF/B file 16 was not modified except for the dimension changes discussed in a later paragraph.

The error message flagging a negative distribution in subroutine NEGTIV was expanded to give the energy of the offending data. This required minor changes in subroutines CKF4, and CKF14, and CKF24 to provide the data for the error message.

Double precision arithmetic is required on IBM 360 computers to accurately perform the possibility and positivity checks on legendre expansion coefficients.

Appropriate variables were declared double precision, REAL*8, in subroutines CKF4, CKF14, CKF24, LEGCK, LEGEND, POSTIV, GETMUS, A, NEGTIV, GENSTR, LEGDRV, STERM, FUNCT, FINDRT, and PRBINT. It was also necessary to rearrange labeled COMMONS in these same routines to avoid boundary alignment problems that can occur with FORTRAN IV programs on IBM 360 computers when both 4 byte and 8 byte words appear in a COMMON statement. An error in subroutine LEGEND was corrected.

Equivalence statements containing dimensioned variables were modified when necessary to avoid the wrath of the IBM complier. For example, if B and X are dimensioned variables the statement, EQUIVALENCE (X,B) must be written as EQUIVALENCE(X(1), B(1)) to placate the IBM compiler currently in use at ORNL.

The dimensions X(3000), Y(3000), and B(3000) were changed to X(5000), Y(5000) and B(5000) in all applicable routines. The statement CALL TEST1(NP,2,3000,KNP,2) in SUBROUTINE RDTAB1 was modified to read CALL TEST1(NP,2,5000,KNP,2). These changes were necessary to accommodate current ENDF/B version II data.

The following sections describe the detailed checking performed in files 12-15.

Test for File 12 - Photon Production Data, Multiplicities and Transition Probability Arrays - Subroutine CKF12

Condition	Type of Test	Explanation	Test n Subroutine
Any MT	Is MT acceptable?	ENDF/B Version II	2
ANY MT	Is MF=12 and above MT in index table?	---	10
ANY MT	$1 \leq LO \leq 2$	LO=1, Flag for data given as multiplicities. LO=2, Flag for data given as transition probability arrays	1
LO=1	$1 \leq LF \leq 2$	The Photon energy distribution law number	1
LO=1	$1 \leq NR \leq 10$	Number of interpolation ranges	1
LO=1	$1 \leq NP \leq 1000$	Number of multiplicities given	1
LO=1	If LF=1, EG_k=0?	Consistency check	CKF12
LO=1	Are EG_k in decreasing order?	Photon energy for the kth subsection	5B
LO=1	Does the total yield table, Y(E), exactly span the same energy range as the combined energy range of all the $y_k(E)$?		CKF12
LO=1	Is NK < 2 and LF=0?	Test determines if the TAB1 record containing the total yield, Y(K), is omitted when the total number of discrete photons and photon continua is one.	CKF12

LO=2	$1 \leq LG \leq 2$	LG=1, simple case (all transitions are γ emission) LG=2, complex case (internal conversion or other competing processes occur)	1
LO=2	Are ES_i in decreasing order?	Energy of the ith level	5B
LO=2	$0 < TP_i \leq 1.0$	TP, check range of each transition probability	CKF12
LO=2 and LG=2	$0 < GP_i \leq 1.0$	GP, check range of each conditional probability of photon emission	CKF12
LO=2	$\sum_{i=1}^{NT} TP_i = 1 \pm 10^{-5}$	TP, transition probabilities	CKF12

Test for File 13 - Photon Production Cross Sections - Subroutine CKF13

Condition	Type of Test	Explanation	Test n Subroutine
Any MT	Is MT acceptable?	ENDF/B Version II	2
Any MT	Is MF=13 and above MT in index table?		10
Any MT	$1 \leq LF \leq 2$	The Photon energy distribution law number	1
Any MT	$1 \leq NR \leq 10$	Number of interpolation ranges	1
Any MT	$1 \leq NP \leq 1000$	Number of cross sections given	1
Any MT	If LF=1, EG_k=0?	Consistency check	CKF13
Any MT	Are EG_k in decreasing order?	Photon energy for the kth subsection	5B
Any MT	Is $NK < 2$ and LF=0?	Test determines if the TAB1 record containing the total cross section is omitted when the total number of photons and photon continua is one.	CKF13

Test for File 14 - Photon Angular Distributions - Subroutine CKF14

Condition	Type of Test	Explanation	Test n Subroutine
Any MT	Is MT acceptable?	ENDF/B Version II	2
Any MT	Is MF=14 and above MT in index table?		10
Any MT	$0 \leq LI \leq 1$	Flag for isotropic distribution	1
LI=0	$1 \leq NK \leq 1000$	Number of subsections	1
LI=0	NI=NK?	NI, the number of isotropic subsections NI=NK is strongly discouraged; this condition is better described by LI=1	1
LI=0	$1 \leq LTT \leq 2$	Flag for representation used	1
LI=0	$1 \leq NE \leq 3000$	No. of neutron energies given	1
LTT=1	$-1.0 \leq f_\ell(E) \leq +1.0$	---	7
LTT=1	Are energies in increasing order?	Neutron energies	5
LTT=1	Angular dist. everywhere possible and positive?		LEGCK
LTT=2	Are energies in increasing order?	Neutron energies	5
LTT=2	$-1.0 \leq \mu_i \leq +1.0$		7
LTT=2	$\int_{-1}^{+1} P(\mu_i, E_i) d\mu = 1 \pm 10^{-4}$		9
LTT=2	INT=1,2, or 3?	Interpolation type	CKF14

Tests for File 15, - Continuous Photon Energy Spectra -
Subroutine CKF15

Condition	Type of Test	Explanation	Test n Subroutine
Any MT	Is MT acceptable?	ENDF/B version II	2
Any MT	Is MF=15 and above MT in index table?		10
Any MT	Is LF=1?	The only continuous energy distribution law defined at present for file 15	1
LF=1	$\int g(E_\gamma \leftarrow E_i) dE_\gamma = 1 \pm 10^{-4}$	All E_i	9
LF=1	Are energies in increasing order?	Neutron energies	5
LF=1	INT=1,2, or 3	Interpolation type	CKF15

References

1. H. C. Honeck and J. Felberbaum, "Description of the ENDF/B Processing Codes and Retrieval Subroutines", BNL, ENDF-110 (1967) Revised by Odelli Ozer, BNL August 1970).

2. H. C. Honeck, "ENDF/B, Specifications for an Evaluated Nuclear Data File for Reactor Applications", BNL 50066, USAEC(1966). Revised by S. Pearlstein, BNL(1967).

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