

## ANNEX 1

NEANDC-246 'U'  
NEACRP-303 'L'

### INTERNATIONAL COMPARISON STUDY OF CODES USED IN DECAY HEAT CALCULATIONS

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#### 1. INTRODUCTION

Following a discussion at the NEACRP/NEANDC Specialists' Meeting on Data for Decay Heat Predictions, held at Studsvik, Sweden, 7th-10th September 1987, it was decided to perform an inter-comparison of codes used in decay heat calculations. It was shown that the existing codes could not reproduce the experimental data at short cooling times. The main reason for this discrepancy, was thought to be due to lack of good data for short lived fission products. It was nevertheless felt, that a comparison of the summation codes, both analytical and numerical, for the calculation of decay heat would be very useful in order to verify the computational aspect of the problem. The following two benchmark specifications were agreed upon.

#### 2. SPECIFICATION

##### Benchmark no 1:

System: U-235 fission pulse

Input Data: Decay Data: The heavy mass peak A=131-140. The data have been extracted from the Evaluated Nuclear Structure Data File (ENSDF) and translated into the ENDF-5 format at the NEA Data Bank, using a new version of the code RADLST. Delayed neutron data are also included. (File no 1 on tape)

Fission Yields: The file contains data for U-235 and in the ENDF-5 format. Independent yields with uncertainties are given at thermal energy. The corresponding cumulative yields, without uncertainties are also included. (File no 2 on tape)

### Benchmark no 2:

System: Long irradiation (  $3.0 * 10^7$  seconds) of fuel elements composed of 100% U-235. It is assumed that no burn-up will take place.

Input Data: Decay Data: Same as for benchmark no 1.  
Fission Yields: Same as for benchmark no 1.  
Neutron flux: Maxwellian  $_{293}(600^{\circ} \text{ K})$  spectrum of  $5.0 * 10^{13}$  neutrons/cm<sup>2</sup>\*second  
Fission rate:  $1.25 * 10^{15}$  fissions/second  
Capture data: The average one-group capture cross sections has been given in file number 3 on the tape. They have been calculated using the following formula :

$$\langle \sigma_{\text{cap}} \rangle = \frac{2200}{1.128} * \frac{293}{T} + Sc * I_{\text{cap}}$$

where  $T = 600^{\circ} \text{ K}$ ,  $Sc = 0.3$  (Epithermal to thermal flux ratio), and  $I_{\text{cap}}$  is the capture resonance integral.

The data are given in free format, one isotope per line. Each line contains the following information: isotope proton number (Z), isotope mass (A), and the one-group capture cross section.

### 3. WHAT TO CALCULATE

The following quantities should be calculated for both benchmark 1 and 2:

- A. Decay heat for beta, gamma, and beta + gamma in MeV/second, for cooling times: 1, 10,  $10^2$ ,  $10^3$ , .....  $10^{13}$  seconds. (Every decade).
- B. List of fission products and their contribution (in per-cent) to the decay heat at each of the above mentioned cooling times. Only those isotopes contributing more than 1.0 % to the decay heat should be specified.

All calculated values should preferable be given with uncertainties. The answers should contain a reference to what computer code was used, and on what computer it was run. The CPU time used could also be of interest.

#### 4. PARTICIPATION AND RESULTS

Those interested in participating and receiving the input data on tape, should contact:

Claes Nordborg  
NEA Data Bank  
Bat. 445  
91191 GIF-SUR-YVETTE CEDEX  
FRANCE

Telephone: 1-69086094  
Telex: NEADATA 690920F  
Telefax: 1-69413965  
Computer network: NORDBORG at  
FRNEAB51  
(EARN/BITNET)

The results must be returned by 5 May 1989 to the above mentioned address.

RESULTS OF BENCHMARK NO 1

NAME : .....

INSTITUTE : .....

CODE NAME AND TYPE (ANAL. OR NUMER.): .....

CODE REFERENCE : .....

COMPUTER AND CPU-TIME USED : .....

NOTE!! THE CONCENTRATION OF FISSION PRODUCTS SHOULD BE GIVEN SEPARATELY.

DECAY HEAT RESULTS

COOLING seconds	BETA MeV/sec	dBETA %	GAMMA MeV/sec	dGAMMA %	BETA+GAMMA MeV/sec	d(B+G) %
$10^0$						
$10^1$						
$10^2$						
$10^3$						
$10^4$						
$10^5$						
$10^6$						
$10^7$						
$10^8$						
$10^9$						
$10^{10}$						
$10^{11}$						
$10^{12}$						
$10^{13}$						

RESULTS OF BENCHMARK NO 2

NAME : .....  
INSTITUTE : .....  
CODE NAME AND TYPE (ANAL. OR NUMER.) : .....  
CODE REFERENCE : .....  
COMPUTER AND CPU-TIME USED : .....  
NOTE!! THE CONCENTRATION OF FISSION PRODUCTS SHOULD BE GIVEN SEPARATELY.

DECAY HEAT RESULTS

COOLING seconds	BETA MeV/sec	dBETA %	GAMMA MeV/sec	dGAMMA %	BETA+GAMMA MeV/sec	d(B+G) %
10 <sup>0</sup>						
10 <sup>1</sup>						
10 <sup>2</sup>						
10 <sup>3</sup>						
10 <sup>4</sup>						
10 <sup>5</sup>						
10 <sup>6</sup>						
10 <sup>7</sup>						
10 <sup>8</sup>						
10 <sup>9</sup>						
10 <sup>10</sup>						
10 <sup>11</sup>						
10 <sup>12</sup>						
10 <sup>13</sup>						

