

MAY 10 1967

UNCLASSIFIED

CLASSIFICATION LEVEL
(S, C OR U)

MASTER



ATOMICS INTERNATIONAL
A Division of North American Aviation Inc.

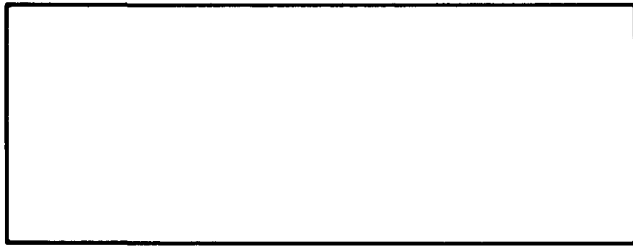
NAA-SR-MEMO COVER SHEET

REPORT TITLE **COMPARISON OF BERYLLIUM PHOTONEUTRON DECAY SETS
USING EXPERIMENTAL SNAP REACTOR DATA**

AUTHOR
E. H. Ottewitte

NAA-SR-MEMO 12347

(This Document Contains _____ Pages.)
(This is Copy _____ of _____ Series _____)



CLASSIFICATION TYPE
(RD OR DI)

*NAA-SR-MEMOs are working papers and may be expanded,
modified, or withdrawn at any time, and are intended for
internal use only.*

THIS REPORT MAY NOT BE PUBLISHED WITHOUT THE APPROVAL OF THE PATENT BRANCH, AEC.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

UNCLASSIFIED

CLASSIFICATION LEVEL
(S, C OR U)

DO NOT REMOVE THIS SHEET

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ATOMICS INTERNATIONAL A Division of North American Aviation, Inc. TECHNICAL DATA RECORD		NAA-SR- TDR NO 12347	APPROVALS <i>H. Rood</i>
		PAGE 1 OF 6	
AUTHOR E.H. Ottewitte		DEPT & GROUP NO. 731-14	DATE 2/22/67
		GO NO 7697	
TITLE Comparison of Beryllium Photoneutron Decay Sets Using Experimental SNAP Reactor Data.		S/A NO 22121	TWR
		SECURITY CLASSIFICATION	
PROGRAM General Supporting Technology		(CHECK ONE BOX ONLY)	
SUBACCOUNT TITLE Reactor Theory and Method Development		(CHECK ONE BOX ONLY)	
DISTRIBUTION		UNCL. <input checked="" type="checkbox"/> AEC <input type="checkbox"/> DOD <input type="checkbox"/>	RESTRICTED DATA <input type="checkbox"/>
L.S. Mims -2		CONF. <input type="checkbox"/>	DEFENSE INFO. <input type="checkbox"/>
D.J. Cockeram-2		SECRET <input type="checkbox"/>	
R.J. Gimera -2		AUTHORIZED CLASSIFIER SIGNATURE <i>H. Rood</i> DATE	
H. Rood -2			
Nuclear Analysis Unit (10)			
STATEMENT OF PROBLEM		Compare beryllium photoneutron decay sets using experimental SNAP reactor data.	
ABSTRACT		The Rottor " core " set was found to be particularly advantageous over the conventionally-used Keepin set.	

COMPARISON OF BERYLLIUM PHOTONEUTRON DECAY SETS
 USING EXPERIMENTAL SNAP REACTOR DATA

The portion of photoneutrons which return to a subcritical SNAP reactor core from its beryllium reflector constitute its "unmultiplied" photoneutron source strength, N_0 . Once they reach the core, these "first generation" photoneutrons are multiplied in successive generations by the reproduction factor k . In the absence of other neutron sources, the neutron population in a subcritical reactor converges then to

$$N_0 \left(1 + \sum_{n=1}^{\infty} k^n \right) = \frac{N_0}{1-k}$$

The magnitude of N_0 will depend on the time and power level of previous reactor operation (fission product buildup and magnitude) and on the time since shutdown (fission product decay). Knowing the unmultiplied photoneutron source strength and an associated set of suitable decay constants and yields, one can predict a given reactor's neutron population for all operating histories, time of shutdown, and degrees of subcriticality of interest.

Sets of photoneutron decay constants are extracted by analysis of careful experiments. Each set is therefore tuned to a particular reactor. Keepin has shown¹ his set to better fit available data than sets of earlier workers. No comparison was found for two later sets of Rotter².

The suitability of each set to a SNAP reactor was measured by its ability to fit the SNAP experimental data of interest. For comparison purposes, all available data were corrected with each set to the same N_0 : at the time of shutdown from infinite operation at one thermal watt. The data spread, and/or the percentage deviation from the mean value

*Work supported by AEC Contract AT(04-3)-701

$$\left\{ \frac{\sum_{i=1}^N \left[\frac{x_i}{\bar{x}} \right]^2 - N^2}{N-1} \right\}^{1/2}$$

indicate the set suitability.

Figure 1 compares set suitability for SNAP 8 data. The error bands reflect uncertainty in detector position. Additional uncertainty, not shown, is due to uncertainty in $(1-k)$:

$$N_o = N_{\text{measured}} (1-k)_{\text{measured}}$$

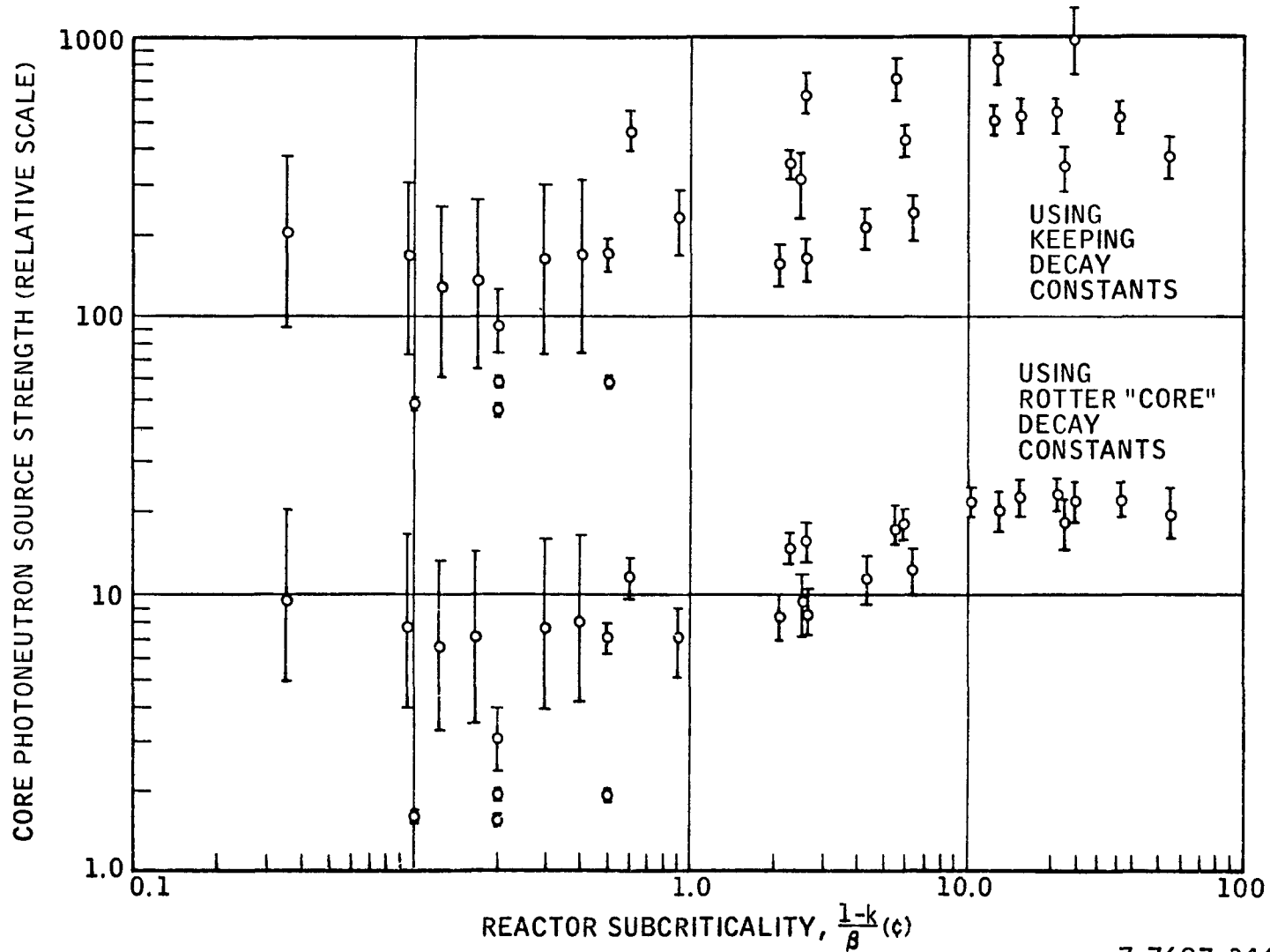
(As one approaches $k=1$, it becomes increasingly difficult to maintain the same number of significant figures.) Table 1 compares the data correlations above $(1-k/\beta) = 10\%$ (region of minimal $(1-k)$ uncertainty). Both short and long term buildup and decay are represented. The Rotter "core" set is clearly more suitable here than the Keepin set.

The SNAP 10A data is a particularly strong test of the short-lived components. The Rotter sets again appear more suitable. The SNAP 2 data does not contain as much extreme short- and/or long-lived contributions. The Rotter sets offer only slight improvement in that correlation.

In summary, the Rotter "core" set is most suitable to analysis of SNAP reactor data. It appears particularly advantageous where extreme short- or long-lived contributions exist.

CORRELATION OF SNAP 8 EXPERIMENTAL PHOTONEUTRON DATA

DATA HAVE BEEN CORRECTED WITH THE INDICATED DECAY CONSTANTS TO THE CORE "UNMULTIPLIED" SOURCE STRENGTH AT THE TIME OF SHUTDOWN FROM SATURATED BUILDUP REACTOR OPERATION.



7-7697-044-1

-3-

Table 1. ANALYSIS OF SNAP DATA

<u>Reactor</u>	<u>Prior Operation</u>	<u>Measurement Times, from Point of Shutdown</u>	<u>Number Data Points</u>	<u>% Deviation</u>		
				<u>Keepin</u>	<u>Rotter "core"</u>	<u>Rotter "reflector"</u>
SNAP 8 (data for $\frac{1-k}{\beta} > 104$)	up to 4500 hours at variable powers	4-234 hours	8	30.5	7.4	22.2
SNAP 10A	300 sec transient	1-20 hours	12	46.3	26.0	25.4
SNAP 2	600 hrs at constant power	12-100 hours	94	22.4	21.5	22.0

-4-

REFERENCES

1. G.R. Keepin, Nuclear Data for Reactor Kinetics, Nucleonics 20, No. 8, 150 (1962)
2. W. Rotter, Delayed Photoneutrons in the Beryllium Reactor BR 02, AI-TRANS-225. Translation of Nukleonik 5, 227 (1963) by E.H. Ottewitte (to be published)