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April 12, 1971

REPORT OF THE NCSAC AD-HOC

Subcommittee on Safeguards

<u>Subcommittee Membership</u>

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I. INTRODUCTION

The safeguarding of nuclear materials in the domestic power programs from illicit use--the production of nuclear explosives, is presently a substantial activity of the AEC and the nuclear industry. As the use of nuclear power grows (by 12 times from 1970 to 1975 and by another 2.4 times from 1975 to 1980) the amount of material to be safeguarded will also grow in proportion. The national need for effective Safeguards is apparent.

There are many problems encountered in the implementation of Safeguards adequate to eliminate the possibility of clandestine production of nuclear explosives. These problems include: complexity of the national reactor fuel system, variable and sometimes long hold up-times in parts of the system, the uncertainty in production and conversion of nuclear materials within the system, inaccessibility of large quantities of fuel in reactors or cooling ponds for verification purposes, and, underlying all these, the uncertainty or high cost of measurements of the amounts of nuclear materials in each part of the nuclear fuel cycle.

In many cases, there do not exist measurement techniques adequate for the problem. In other cases, such as bulk trash containing nuclear materials, new techniques are just now being proven in field tests. The bulk of nuclear materials assay has been, and probably will always be wet chemical techniques. However, the amount of material in the fuel cycle unmeasurable by such techniques is large, roughly a 3% fabrication loss to waste alone.

Despite the existence of possible nondestructive assay techniques for nuclear materials such as measurement of the gamma rays or neutrons emitted spontaneously or neutron activation techniques, they have not been extensively applied for a number of reasons, including economic disincentives, uncertainty of the assay results, uncertain reliability of available instrumentation, and a lack of techniques that have a broad range of application. Refinement of long existing techniques such as those measuring passive radiations is called for, but enough information on those techniques exists to know that many nuclear materials measurement problems cannot be solved with sufficient accuracy by them. Newer techniques, such as bremsstrahlung or neutron iterrogation, can cover a broader range of problems with higher accuracy, and warrant more intensive development.

The need for nuclear data in the Safeguards R&D programs spans a broad range and has a highly variable priority. Useful data would include high-resolution gamma ray spectra, half-lives for β decay and spontaneous fission, $\bar{\nu}$, delayed neutron yields and spectra, neutron- and photo-fission cross sections.

The Office of Safeguards and Materials Management (OSMM) of the AEC has asked the NCSAC to use its auspices to promote measurements of nuclear data relevant to the Safeguards Program. Mr. W. Bartels from OSMM and Dr. R. L. Bramblett from GRT presented a review of nuclear data needed for the

Safeguards Program at the December 1970 meeting of the NCSAC in Livermore, Ca. (The NCSAC had already received requests for nuclear data informally through its various laboratory representatives.) It was established at the meeting that, in the future, the OSMM will forward a list of requests, after internal deliberations, to the NCSAC for inclusion in a request compilation.

In order to review the existing requests, a nuclear safeguards committee was established with Charles D. Bowman as chairman. In addition the committee was to review the requests submitted to the IAEA by individual requesters in this country.

The membership of the committee consisted of:

R. L. Bramblett	Gulf Radiation Technology
H. E. Jackson	Argonne National Laboratory
B. R. Leonard, Jr.	Battelle Northwest
E. V. Weinstock	Brookhaven National Laboratory
C. R. Weisbin	Los Alamos Scientific Laboratory

The first meeting of the committee with all members present was hosted by R. L. Bramblett at La Jolla on February 18 and 19, 1971. In addition, Mr. L. R. Norderhaug of the OSMM of the AEC attended and Dr. M. P. Fricke of GRT served as recording secretary to the group.

II REVIEW OF THE REQUEST LIST

A major portion of the meeting was devoted to a review of the requests for data needed by the Safeguards program. The requests included all of those data requests submitted to the IAEA by U.S. organizations and any other requests which the NCSAC has reviewed.

The committee began its work in this area with a review of the criteria which were adopted by the IAEA for this purpose. After some discussion the committee modified these criteria slightly to the form given as follows:

Priority I

First priority shall be given to those requests for nuclear data that:

(1) are essential for the development of a new and promising technique for the nondestructive assay and control of Special Nuclear Material in amounts that are significant to the Safeguards System.

(2) are necessary for the refinement of an existing technique in order to bring its accuracy to within acceptable limits for Safeguards purposes.

Priority II

Second priority shall be given to those requests for nuclear data that are essential for the use or interpretation of an existing or proposed technique for nondestructive assay and that are now obtained either by extrapolation or by an empirical method but for which experimental confirmation is desirable.

Priority III

Third priority shall be given to those requests for nuclear data that:

(1) may be needed for the nondestructive assay of materials not now included in the safeguards system but that are likely to be in the future, or

(2) may be needed for the development of new techniques for nondestructive assay for which the required technology does not now exist but which may reasonably be expected to in the future.

Even in their slightly modified form the committee found these criteria difficult to work with, particularly with regard to experiments which might form the basis for new techniques. Nevertheless for lack of time, the committee chose to work with these criteria. We feel that there was sufficient balance in the committee that no gross errors were made in our consideration of priority. Of the 50 requests in the list, which is attached as Appendix A-1, only 8 were given priority I status.

As a result of its experience, the committee has decided that in the future a new list of criteria, which are presented in Appendix A-2, would be easier to work with. We urge the OSMM to adopt these criteria for the use of review committees and of those requesting measurements.

The committee soon found that the WASH-1144 format was somewhat cumbersome and difficult to use for two reasons. First, the committee felt that many measurements requested were new or unusual enough as to be quite confusing unless considerable information was provided in the comment column Second, many measuren would be unfamiliar with many of the intended applications since Safeguards is still a relatively new field to many experimentalists. A section was therefore added for each request in terms of the intended use for the information; in the request list this becomes "justification."

The additional information required made the WASH-1144 format somewhat inconvenient, since only one request could be made per page in many cases. The IAEA format, which is more suitable for the purpose of the Safeguards' requests, was therefore adopted for this request list.

Many of the requests reviewed by the committee were incomplete at the time of our meeting. Nearly every requester has supplied additional information requested by the committee which was not available for the meeting. The committee found that it could not make reasonable judgments on the requests of Dr. Larry Kull of Science Applications Incorporated owing to the lack of information. After a written request for more information was not answered, the committee concluded that those requests should be omitted from the request list.

III GENERAL DISCUSSION OF REQUESTS

In general the requests appear to be reasonable in the sense that techniques either already exist or could almost certainly be developed to obtain the needed data. No new facilities, such as reactors or accelerators are required to carry out these measurements. The requests are related to either of two means of interrogation; (1) bremsstrahlung-induced reactions under consideration at GRT and (2) neutron-induced reactions under consideration at LASL and BNL.

For the photonuclear interrogation the γ-ray transport is well known and no experiments are required; however, the reactions that these γ-rays or bremsstrahlung induce are less well known than the neutron reactions. The requests on bremsstrahlung-induced data can be divided into three classes: prompt-neutron yield, prompt-fission neutrons, and delayed neutrons and γ-rays from fission. Measurements are requested using a tantalum electron-to-bremsstrahlung converter and are made relative to deuterium which is to be used as a standard. The prompt-neutron-yield measurements are needed mainly for determining background for the other experiments. The prompt-fission neutrons allow assay of fissile material when its composition is identified. The delayed neutrons and γ-rays not only permit assav but often will permit discrimination between different fissile materials.

For the neutron interrogation, neutrons are derived primarily from (d,d) or (d,t) generators and often moderated in varying degree depending on the reaction which is of primary interest. The data of interest for neutron interrogation techniques concern both the slowing down process in the sample and the interaction cross section used as the "signature". The neutron reactions of interest consist mainly of delayed neutron and γ-rays from fissile materials. Committee-member Weisbin strongly expressed the feeling that for neutron transport studies in safeguards, evaluations are more urgently needed than any single new piece of data. However the "signature" cross sections need more work. This technique promises to assay known materials with high accuracy and also to identify different materials on the basis of intensities of delayed neutrons and γ-rays.

IV ROLE OF EVALUATION AND DATA COMPILATION

The committee considered the questions regarding the role of evaluation and data compilation in the Safeguards program and the degree of concern which the NCSAC should show in these matters. Evaluations appear to be particularly important for the cross sections required for transport of neutrons used for interrogation and also, to some degree, delayed neutrons. However, since the NCSAC has not concerned itself in the past with evaluations to any significant extent, it seems appropriate for the OSMM to take requests for evaluation, which it cannot handle "in-house," directly to the National Neutron Cross Section Center (NNCSC). The most useful evaluations are almost certainly to be obtained by direct OSMM funding where those aspects of the cross sections of greatest sensitivity to the OSMM are emphasized.

The NNCSC also handles compilation and evaluation of microscopic isotopic neutron data. However, since the evaluations are funded primarily by DRDT, the emphasis of the evaluation of data might not be the most appropriate for safeguards purposes.

For photonuclear data, no active data evaluation or compilation group exists anywhere in this country. With the increasing interest in application of photonuclear reactions for example in isotope production, activation analysis, defense, and Safeguards, it seems appropriate that the subcommittee urge the NCSAC to use its auspices to promote the evaluation and compilation of photonuclear data.

V PROMOTION OF MEASUREMENTS

Each committee member submitted comments on actions which the committee could take or recommend which would promote the measurements required for Safeguards. The committee recommended that the Safeguards requests be included with WASH 1144. The neutron-induced reactions should be included along with the rest of the neutron reaction requests. However, the photonuclear requests should be included as a separate section of the report. Also the committee felt that the Safeguards program would benefit if photonuclear requests from other agencies besides OSMM were also included since greater attention might then be focussed on the photonuclear measurements as a group.

The committee also proposed that the Safeguards requests be published as a group by OSMM or AEC. These requests, with some portions of this report, should be sent to the Safeguards Data Requesters, to the NCSAC request list distribution AEC supporting agencies, and the AEC Safeguards Advisory Committee.

The distribution should also be sent to all institutions with facilities suitable for measuring the requested data. The committee listed the following facilities; electron LINACs, microtrons, betatrons, van de Graaffs, reactors, 14-MeV-neutron generators, cyclotrons and ^{252}Cf sources. The committee was particularly anxious that the nuclear engineering and applied science departments, with suitable facilities, should have these needs for nuclear data brought to their attention.

The degree of effort required for these measurements is significant in the sense that one can use this as the basis of determining when the requests will be satisfied. If we assume that the requests represent only 1/2 the challenge as the average request for neutron cross sections on heavy elements, which were considered by the NCSAC subcommittee on fission, one estimates about 1 man-year of scientific effort per request. For the 50 requests included in this report, approximately 50 man years of effort are estimated to satisfy these requests. At a total cost of about $40,000 per man year, this works out to a funding level from some source of about two million dollars. It therefore appears that twelve scientists working for 4 years and funded at a level of $500,000 per year could satisfy these requests. This figure can be compared with the OSMM funding for FY 1971 of $835,000 for development of active interrogation techniques.

Committee-member Weisbin of Los Alamos expressed a minority view that new data might not be needed for the Safeguards program. The second paragraph of a letter received on this subject follows:

"At the present time there are, in my opinion, at least three factors to be considered before actively embarking upon a measurement program for nuclear safeguards. Foremost among these is the reliance upon standards during the actual assay. For the cases of well defined samples (feed, product material etc.) such a procedure, to first order, effectively eliminates the need for detailed knowledge of cross section behavior. The second point relates to the case for which reliance upon standards might be readily challenged, i.e., the assay of scrap and waste. Here, however, refinement of cross section information usually appears as a second order correction because the materials contained in the sample are frequently unknown. Finally, to my knowledge, there have not been any calculations to indicate the sensitivity of a particular assay result to specific cross section features. The cross section requests reviewed by our committee, including LASL's, were based primarily upon intuition of what probably is important. The limited sensitivity investigations begun at our laboratory indicate that certain specific knowledge relating to the sample is important, e.g., the presence of hydrogen; on the other hand, we have not yet found limitations arising from a lack of fundamental data. I believe that the above three factors played an important part in what seemed to me a general downgrading of priorities for the requests reviewed, i.e., very few priority 1 requests."

The full text of his letter on this subject is included as Appendix A-3. He also pointed out that LASL has facilities and OSMM funds to carry out any measurements of data which it really needs.

In summary the subcommittee feels that the most effective way to promote these measurements is to circulate the request list with attached supporting material to as wide a distribution as possible. This should accomplish the purpose of alerting the nation's scientists to these needs and of ordering the priority.

VI. HANDLING OF FUTURE SAFEGUARDS REQUESTS

The present collection of safeguards requests is a somewhat casual list by comparison to the Wash-1144 compilation and also as evidenced by the changes already made by the committee. A more systematic review by a group representing the requesting organization would give the list more impact and status. A suggested procedure for such requests which is analogous to that used by DRDT would include review by a committee in OSMM which would consider the list from the point of view of the requestors. A subcommittee in the NCSAC would then be charged with determining the status and capability for making the measurement. Presumably the ad hoc NCSAC subcommittee would be replaced by a standing subcommittee on safeguards requests.

The following recommendation was actually made at the last NCSAC committee meeting. "Future safeguard requests should be considered within OSMM by an appropriate review group and priorities established. The resulting list will then be formally transmitted to NCSAC for review by a standing subcommittee." After such a review the requests would be included in the NCSAC cross section compilation and also returned to OSMM to receive whatever additional distribution the OSMM might want to provide.

The subcommittee feels that the justification for its existence is somewhat marginal if the OSMM provides the review outlined above. If the role of this ad hoc committee were expanded to include also the review and promotion of related measurements such as photonuclear cross sections or simply general nuclear data other than cross sections essential to applied programs, there probably would be adequate justification for it to continue to function.

VII. COMMENTS AND RECOMMENDATIONS

1) The committee feels that both neutron and photonuclear reactions will play a significant role both in the discovery and refinement of new techniques useful to the Safeguards Program. The committee urges the NCSAC to use its auspices to promote measurements in both these areas.

2) Neutron cross sections evaluations should play a significant role in the Safeguards Program. However, evaluations funded by agencies other than OSMM probably frequently will be very useful since they will be relevant to those aspects of the cross section related to OSMM needs. The OSMM should fund any evaluations it decides are directed to problems peculiar to Safeguards.

3) Requests for evaluations or information on evaluations should be handled by direct contact between OSMM and the NNCSC.

4) For photonuclear data no active evaluation or compilation group exists anywhere in the country. With the increasing interest in application of photonuclear reactions, for example in isotope production, activation analysis, defense and Safeguards, it seems appropriate that the NCSAC actively encourage the evaluation and compilation of photonuclear data.

5) Future requests for nuclear data should be reviewed for accuracy and priority by OSMM before forwarding the requests to the NCSAC. To implement this the OSMM might consider formation of a group of experts similar to ACRP.

6) The criteria or priority of Appendix 2 appear to be appropriate to Safeguards needs and, in the opinion of the subcommittee, are easy to use in practice.

7) The neutron data requests for Safeguards should be included in NCSAC 35 along with other neutron data requests. The photonuclear requests should be broken out into another section which includes these requests as well as other requests for photonuclear data from other agencies.

8) The committee urges the OSMM to issue its own document which includes all requests for nuclear data relative to Safeguards and distribute it as widely as possible. The requests must be published to attract the measurers' attention to these experiments.

9) The committee estimates that about 50 man-years of effort and an expenditure of two million dollars would be sufficient to satisfy these 50 requests. This works out to the support of about twelve scientists and their support for four years for a total of $500,000 per year.

APPENDIX A-1

COMMENTS

BNL	Req. #392	Subcommittee assigned priority II, requester used I. Used requester's priority.
BNL	Req. #448	Same comment.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	1-D-2	(xγ, n)		I	E_e=threshold-10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70

Comments: Total neutron yield produced by bremsstrahlung required. Absolute 4π yield per electron is required. Emergent neutron energy-flat response. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons.

Status: No useful data and calculations insufficient.

Justification: Standard for non-destructive photonuclear assay.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	4-Be-9	(xγ, n)		II	E_e=threshold-10 MeV ΔE_e=1%	20%	GRT(OSMM)	Bramblett	70

Comments: Total neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: No useful data.

Justification: Background effect on non-destructive photonuclear assay.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	6-C-13	(xγ, n)		II	E_e=threshold-10 MeV ΔE_e=1%	20%	GRT(OSMM)	Bramblett	70

Comments: Total neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: No useful data.

Justification: Background effect on non-destructive photonuclear assay.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	3-Li-6	(xγ, n)		III	E_e=threshold-10 MeV ΔE_e=1%	20%	GRT(OSMM)	Bramblett	70

Comments: Total neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: No useful data.

Justification: Background effect on non-destructive photonuclear assay.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	8-O-17	(xγ, n)		II	E_e=threshold-10 MeV ΔE_e=1%	20%	GRT(OSMM)	Bramblett	70

Comments: Total neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute

Status: No useful data.

Justification: Background effect on non-destructive photonuclear assay

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	90-Th-232	(xγ, n)		II	E_e=threshold-10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70

Comments: 4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: Relative data of Gozani, Trans. Am. Nuc. Soc. 13, p. 707 (1970). Data of Katz, et al, Can. J. Physics 35, (470) 1957.

Justification: To allow non-destructive photonuclear assay of Th mixtures.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	90-Th-232	Delayed-N-Y	N(t)	I	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70

Comments: Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: Relative data of Gozani, Trans. Am. Nuc. Soc. 13, p. 707 (1970). Data of Katz, et al, Can. J. Physics 35, (470) 1957.

Justification: To allow non-destructive photonuclear assay of Th mixtures.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	90-Th-232	Fission Prod. γ-Y 1ms-1hr	E_γ, t	III	E_e=10 MeV ΔE_e=5%	10%	GRT(OSMM)	Bramblett	70

Comments: Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Emergent gamma-ray energies—E=(0.5-5) MeV, with ΔE=3 keV.

Status: Preliminary data of Rundquist, Trans. Am. Nuc. Soc. 13, 746 (1970).

Justification: For non-destructive photonuclear assay of Th mixtures.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-233	$(x\gamma, n)$		I	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to $D(x,\gamma,n)$ yield or may be absolute						
		Status:	Data of Katz, et al, Can. J. Physics 35 (470) 1957).						
		Justification:	To allow non-destructive photonuclear assay of ^{233}U.						
New	92-U-233	Delayed-N-Y	N(t)	I	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to $D(x,\gamma,n)$ yield or may be absolute						
		Status:	No data.						
		Justification:	To allow non-destructive photonuclear assay of this SNM						
New	92-U-233	Fission Prod. γ-Y 1ms-1hr	E_γ, t	II	E_e=10 MeV ΔE_e=5%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of a sufficient thickness to stop electrons. Emergent gamma-ray energies—E=(0.5-5) MeV, with ΔE=3 keV.						
		Status:	No data.						
		Justification:	For non-destructive photonuclear assay of this SNM						
New	92-U-234	$(x\gamma, n)$		II	E_e=threshold - 10 MeV ΔE_e=1%	30%	GRT(OSMM)	Bramblett	70
		Comments:	4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to $D(x,\gamma,n)$ yield or may be absolute						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of ^{233}U and ^{235}U.						

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-234	Delayed-N-Y	N(t)	III	E_e=threshold - 10 MeV ΔE_e=1%	30%	GRT(OSMM)	Bramblett	70

Comments: Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute

Status: No data.

Justification: Effect on non-destructive photonuclear assay of ^{233}U and ^{235}U.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-234	Fission Prod. γ-Y, 1ms-1hr	E_γ, t	III	E_e=10 MeV ΔE_e=5%	30%	GRT(OSMM)	Bramblett	70

Comments: Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Emergent gamma-ray energies—E=(0.5-5) MeV, with ΔE=3 keV. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons.

Status: No data.

Justification: Effect on non-destructive photonuclear assay of ^{233}U and ^{235}U.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-235	(xγ, n)		II	E_e=threshold- 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70

Comments: 4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: Relative data of Gozani, et al, Trans. Am. Nuc. Soc. 13, p. 707 (1970). (γ, n) data above 7 MeV of Bowman, et al, Phys. Rev. 133, B676 (1964).

Justification: For non-destructive photonuclear assay of this SNM.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-235	Delayed-N-Y	N(t)	II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70

Comments: Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.

Status: Relative data of Gozani, et al, Trans. Am. Nuc. Soc. 13, p. 707 (1970).

Justification: For non-destructive photonuclear assay of this U-235.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-235	Fission Prod. γ-Y, 1ms-1hr	E_γ, t	II	E_e=10 MeV ΔE_e=5%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Emergent gamma-ray energies—E=(0.5-5) MeV, with ΔE=3 keV. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons.						
		Status:	Preliminary data of Rundquist, Trans. Am. Nuc. Soc. 13, 746 (1970).						
		Justification:	For non-destructive photonuclear assay of U-235.						
New	92-U-236	(xγ,n)		II	E_e=threshold - 10 MeV ΔE_e=1%	30%	GRT(OSMM)	Bramblett	70
		Comments:	4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x,γ,n) yield or may be absolute.						
		Status:	No data						
		Justification:	Effect on non-destructive photonuclear assay of ^{235}U.						
New	92-U-236	Delayed-N-Y	N(t)	III	E_e=threshold - 10 MeV ΔE_e=1%	30%	GRT(OSMM)	Bramblett	70
		Comments:	Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x,γ,n) yield or may be absolute.						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of ^{235}U.						
New	92-U-236	Fission Prod. γ-Y, 1ms-1hr	E_γ, t	III	E_e=10 MeV ΔE_e=5%	30%	GRT(OSMM)	Bramblett	70
		Comments:	Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Emergent gamma-ray energies, E = (0.5-5) MeV, with ΔE = 3 keV. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons.						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of ^{235}U						

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-238	$(x\gamma, n)$		II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70
		Comments:	4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to $D(x,\gamma,n)$ yield or may be absolute.						
		Status:	Relative data of Gozani, Trans. Am. Nuc. Soc. 13, p. 707 (1970). Data of Katz, et al, Can. J. Physics 35, (470) 1957.						
		Justification:	For non-destructive photonuclear assay of uranium.						
New	92-U-238	Delayed-N-Y	N(t)	II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to $D(x,\gamma,n)$ yield or may be absolute.						
		Status:	Relative data of Gozani, Trans. Am. Nuc. Soc. 13, p. 707 (1970).						
		Justification:	For non-destructive photonuclear assay of uranium.						
New	92-U-238	Fission Prod. γ-Y, 1ms-1hr	E_γ, t	II	E_e=10 MeV ΔE_e=5%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Emergent gamma-ray energies—E=(0.5-5) MeV, with ΔE=3 keV.						
		Status:	Preliminary data of Rundquist, Trans. Am. Nuc. Soc. 13, 746 (1970).						
		Justification:	For non-destructive photonuclear assay of uranium.						
New	94-Pu-239	$(x\gamma, n)$		II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett	70
		Comments:	4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to $D(x,\gamma,n)$ yield or may be absolute.						
		Status:	Relative data of Gozani, Trans. Am. Nuc. Soc. 13, p. 707 (1970).						
		Justification:	For non-destructive photonuclear assay of Pu-239.						

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	94-Pu-239	Delayed-N-Y	N(t)	II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett Comments: Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute Status: Relative data of Gozani, Trans. Am. Nuc. Soc. 13, p. 707 (1970). Justification: For non-destructive photonuclear assay of Pu-239.	70
New	94-Pu-239	Fission Prod. γ-Y, 1ms-1hr	E_γ, t	II	E_e=10 MeV ΔE_e=5%	10%	GRT(OSMM)	Bramblett Comments: Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Emergent gamma-ray energies—E=(0.05-5) MeV, with ΔE=3 keV. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Status: Preliminary data of Rundquist, Trans. Am. Nuc. Soc. 13, 746 (1970) Justification: For non-destructive photonuclear assay of Pu-239.	70
New	94-Pu-240	(xγ, n)		II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett Comments: 4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute. Status: No data. Justification: Effect on non-destructive photonuclear assay of ^{239}Pu.	70
New	94-Pu-240	Delayed-N-Y for t<100sec	N(t)	II	E_e=threshold - 10 MeV ΔE_e=1%	10%	GRT(OSMM)	Bramblett Comments: Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute. Status: No data. Justification: Effect on non-destructive photonuclear assay of ^{239}Pu.	70

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	94-Pu-240	Fission Prod. γ-Y, 1ms-SF background	E_γ, t	II	E_e=10 MeV ΔE_e=5%	10%	GRT(OSMM)	Bramblett	70
		Comments:	Absolute fission product delayed gamma-ray yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Emergent gamma-ray energies—E=(0.5-5) MeV, with ΔE=3 keV.						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of ^{239}Pu.						
New	94-Pu-241	(xγ, n)		III	E_e=threshold - 10 MeV ΔE_e=1%	30%	GRT(OSMM)	Bramblett	[illegible]
		Comments:	4π neutron yield (including fission) produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of Pu.						
New	94-Pu-241	Delayed-N-Y	N(t)	III	E_e=threshold - 10 MeV ΔE_e=1%	30%	GRT(OSMM)	Bramblett	70
		Comments:	Delayed neutron yield produced by bremsstrahlung required. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons. Neutron yield may be relative to D(x, γ, n) yield or may be absolute.						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of Pu.						
New	94-Pu-241	Fission Prod. γ-Y, 1ms-1hr	E_γ, t	III	E_e=10 MeV ΔE_e=5%	30%	GRT(OSMM)	Bramblett	70
		Comments:	Absolute Fission product delayed gamma-ray yield produced by bremsstrahlung required. Emergent gamma-ray energies—E=(0.05-5) MeV, with ΔE=3 keV. Bremsstrahlung converter (preferably Ta) of sufficient thickness to stop electrons.						
		Status:	No data.						
		Justification:	Effect on non-destructive photonuclear assay of Pu.						

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-235	Delayed-N-Y	$\bar{\nu}_d$	II	5-14 MeV	5	LASL	Weisbin & Walton	70

Status: Evaluation of Hunter to 2.5 MeV LA-3527. Measurements of Masters, et al., 3 and 14 MeV ANS 11, 179. Preliminary data of Krick and Evans, LASL to 0.1 to 6.7 MeV. Data desired for extrapolation to 15 MeV.
Justification: Calculations of moderating assemblies for U-235 assays.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	94-Pu-239	Delayed-N-Y	$\bar{\nu}_d$	II	3-14 MeV	10	LASL	Weisbin & Walton	70

Status: Measurements of Masters, et al., LASL, 3 and 14 MeV ANS 11, 179. See Maksjutenko ICD-1, 266 3.8 and 15 MeV. Also Petrzak AE 11, 539. Preliminary data of Krick and Evans, LASL to 0.1 - 6.7 MeV. Data desired for extrapolation to 15 MeV.
Justification: Calculations of moderating assemblies for Pu-239 assays.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
412	92-U-238	Delayed-N-Y	$\bar{\nu}_d$	II	5-14 MeV	5	LASL	Weisbin and Walton	70

Status: Evaluation of Hunter to 2.5 MeV LA-3527. Measurements of Masters et al., at 3 and 14 MeV ANS 11, 179. Preliminary data of Krick and Evans, LASL to 0.1 - 6.7 MeV. Data desired for extrapolation to 15 MeV.
Justification: Calculations of moderating assemblies for background effects on assays of U-235.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
457	94-Pu-240	Delayed-N-Y	$\bar{\nu}_d$	II	0.75-14 MeV	20	LASL	Weisbin and Walton	70

Status: Evaluation up to 2.5 MeV by Hunter LA-3528. 613 MeV data of Diven 61 Vienna 1, 149. Data desired for extrapolation to 15 MeV
Justification: Calculations of moderating assemblies for Pu assays of spent fuel.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
471	94-Pu-241	Delayed-N-Y	$\bar{\nu}_d$	III	Thermal-14MeV	10	LASL	Weisbin and Walton	70

Status: Only work at thermal. See Keepin Nuc 20 8 150 8/62. Data needed for extrapolation to 15 MeV.
Justification: Calculations of moderating assemblies for Pu assays.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
New	92-U-236	Delayed-N-Y	$\bar{\nu}_d$	I	3, 14 MeV	10	LASL	Weisbin and Walton	70

Status: No experimental work to date. Data have been obtained empirically.
Justification: Background correction in U-235 spent fuel assays.

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
478	94-Pu-242	Delayed-N-Y	$\bar{\nu}_d$	III	3, 14 MeV	20	LASL	Weisbin and Walton	70

Status: None
Justification: Calculations of moderating assemblies for Pu assays.

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
	94-Pu-239	Capture γ-ray spectra (also yield γ rays per capture to ~ 20%)	$P(E_g)$ $E_g > 1.2$ MeV	III	Thermal to 100 eV	Ge(Li) resolution (2.5 keV at 1.2 MeV)	LASL	Weisbin and Walton	70
			Status: Recent data at thermal from Jurney (LASL-1970 progress report) γ-ray spectra 3-6 MeV. Justification: Development of new Pu-239 assay technique.						
25	4-Be-9	$(n,p)\ Li^9 \rightarrow Be^9 + n$		II	14 MeV	10	LASL	Weisbin and Walton	70
			Status: Preliminary measurements at LASL, measurement of Alburger PR 132, 128 (1963) at 16 MeV Justification: Background in delayed neutron assays.						
New	92-U-236	Fission neutron spectrum		II	one energy above fission threshold	10	LASL	Weisbin and Walton	70
			Status: Evaluation of Parker AWRE 030/64 Justification: Background corrections in U-235 spent fuel assays.						

Req. No.	Target	Reaction Type Quantity	Reaction Type Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
	92-U-235	Fission-product γ-ray spectra (0.25-5 MeV) and yield (photons/fission-MeV-sec) (1 ms - 12 hrs)	$P(E_g)$	II	Thermal	Ge(Li) resolution 2.5 keV at 1.2 MeV ± 15% for absolute yield	LASL	Weisbin and Walton	70
		Status: See Walton and Sund, Phys. Rev. 178, 1894 (1969); Fisher and Engle, Phys. Rev. 134, B796 (1964); F. C. Maionschein, et al., Geneva Conf., 1968, Vol. 15, 366. Better resolution desired. Associate γ rays with fission products if possible. Justification: Nondestructive assays of U-235.							
448	94-Pu-239	Fission-product γ-ray spectra (0.25-5 MeV) and yield (photons/fission-MeV-sec) (1 ms - 12 hrs)		II	Thermal	Ge(Li) resolution 2.5 keV at 1.2 MeV ± 15% for absolute yield	LASL	Weisbin and Walton	70
		Status: See Phys. Rev. 178, 1894 (1969); Phys. Rev. 134, B796 (1964); Geneva Conf. 1958, Vol. 15, 366. Better resolution desired. Associate γ-rays with fission products if possible. Justification: Nondestructive assays of Pu-239.							

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
348	90-Th-232	Delayed-γ-Y	$P(E_\gamma, T_{\frac{1}{2}})$	II	2 and 14 MeV	35%	BNL(OSMM)	Kouts	69
		Comments:	Accuracy requested refers to relative intensities of delayed gamma rays from neutron induced fission for $E_\gamma > 2$ MeV and 10 μsec $\lesssim T_{\frac{1}{2}} \lesssim 1$ hr. Absolute gamma ray yields to factor of 2 also useful.						
		Status:	R. Chrien (BNL, unpublished) has some data for U^{235} and Pu^{239}; N. R. Large and R. J. Bullock, Proc. 2nd Symp. on Phys. & Chem. of Fission (Vienna, 1969), present some data for U.						
		Justification:	Background effects in assay of U^{233} - Th^{232}						
364	92-U-233	Delayed-γ-Y	$P(E_\gamma, T_{\frac{1}{2}})$	I	2 and 14 MeV	35%	BNL(OSMM)	Kouts	69
		Comments:	Accuracy requested refers to relative intensities of delayed gamma rays from neutron-induced fission for $E_\gamma > 2$ MeV and 10 μsec $\lesssim T_{\frac{1}{2}} \lesssim 1$ hr. Absolute gamma ray yields to factor of 2 also useful.						
		Status:	R. Chrien (BNL, unpublished) has some data for U^{235} and Pu^{239}; N. R. Large and R. J. Bullock, Proc. 2nd Symp. on Phys. & Chem. of Fission (Vienna, 1969), present some data for U.						
		Justification:	Assay of U^{233} fuels						
392	92-U-235	Delayed-γ, Y	$P(E_\gamma, T_{\frac{1}{2}})$	I	2 and 14 MeV	35%	BNL(OSMM)	Kouts	69
		Comments:	Accuracy requested refers to relative intensities of delayed gamma rays from neutron induced fission for $E_\gamma > 2$ MeV and 10 μsec $\lesssim T_{\frac{1}{2}} \lesssim 1$ hr. Absolute gamma ray yields to factor of 2 also useful.						
		Status:	R. Chrien (BNL, unpublished) has some data for U^{235} and Pu^{239}; N. R. Large and R. J. Bullock, Proc. 2nd Symp. on Phys. & Chem. of Fission (Vienna, 1969), present some data for U.						
		Justification:	Assay of U^{235} fuels						
417	92-U-238	Delayed-γ-Y	$P(E_\gamma, T_{\frac{1}{2}})$	II	2 and 14 MeV	35%	BNL(OSMM)	Kouts	69
		Comments:	Accuracy requested refers to relative intensities of delayed gamma rays from neutron induced fission for $E_\gamma > 2$ MeV and 10 μsec $\lesssim T_{\frac{1}{2}} \lesssim 1$ hr. Absolute gamma ray yields to factor of 2 also useful.						
		Status:	R. Chrien (BNL, unpublished) has some data for U^{235} and Pu^{239}; N. R. Large and R. J. Bullock, Proc. 2nd Symp. on Phys. & Chem. of Fission (Vienna, 1969), present some data for U.						
		Justification:	Assay of U fuels						

Req. No.	Target	Reaction Type Quantity	Variable	Priority	Incident Energy	% Accuracy	Lab/Org.	Requestor, Comments, Status	Year
448	94-Pu-239	Delayed-γ-Y	$P(E_\gamma, T_{\frac{1}{2}})$	I	2 and 14 MeV	35%	BNL(OSMM)	Kouts	69
		Comments:	Accuracy requested refers to relative intensities of delayed gamma rays from neutron induced fission for $E_\gamma > 2$ MeV and 10 μsec $\lesssim T_{\frac{1}{2}} \lesssim$ 1 hr. Absolute gamma rays yields to factor of 2 also useful.						
		Status:	R. Chrien (BNL, unpublished) has some data for U^{235} and Pu^{239}; N. R. Large and R. J. Bullock, Proc. 2nd Symp. on Phys. & Chem. of Fission (Vienna, 1969), present some data for U.						
		Justification:	Assay of Pu fuels						
462	94-Pu-240	Delayed-γ-Y	$P(E_\gamma, T_{\frac{1}{2}})$	II	2 and 14 MeV	35%	BNL(OSMM)	Kouts	69
		Comments:	Accuracy requested refers to relative intensities of delayed gamma rays from neutron-induced fission for $E_\gamma > 2$ MeV and 10 μsec $\lesssim T_{\frac{1}{2}} \lesssim$ 1 hr. Absolute gamma ray yields to factor of 2 also useful.						
		Status:	R. Chrien (BNL, unpublished) has some data for U^{235} and Pu^{239}; N. R. Large and R. J. Bullock, Proc. 2nd Symp. on Phys. & Chem. of Fission (Vienna, 1969), present some data for U.						
		Justification:	Assay of Pu fuels.						

APPENDIX A-2

PRIORITIES FOR REQUESTS FOR NUCLEAR DATA FOR SAFEGUARDS PURPOSES

First Priority

First priority shall be given to those requests for nuclear data that

(1) are necessary for the refinement of an existing technique in order to bring its accuracy to within acceptable limits for safeguards purposes, or

(2) are essential for the development of a new and promising technique for the nondestructive assay and control of Special Nuclear Material in amounts that are significant to the safeguards system.

Second Priority

Second priority shall be given to those requests for nuclear data that

(1) are essential for the use or interpretation of an existing or proposed technique for nondestructive assay and that are now obtained either by extrapolation or by an empirical method but for which experimental confirmation is desirable, or

(2) are necessary for the development of a technique for nondestructive assay that may reasonably be expected to be useful for safeguards purposes.

Third Priority

Third priority shall be given to those requests for nuclear data that

(1) may be needed for the nondestructive assay of materials not now included in the safeguards system but that are likely to be in the future, or

(2) are necessary for the assessment or elimination of minor sources of error in the assay of Special Nuclear Material, or

(3) are needed for the exploration of new techniques for nondestructive assay for future applications, or

(4) may be needed for the development of new techniques for nondestructive assay for which the required technology does not now exist but which may reasonably be expected to in the future.

APPENDIX A-3

Weisbin's Letter

"Our experience has shown that a large majority of practical nuclear safeguards problems can be treated by either passive assay or active interrogation with a neutron source. The nuclear data required for the development of instrumentation based upon these techniques is, with some few exceptions, generally available from a technology which is now more than twenty five years old."

"At the present time there are, in my opinion, at least three factors to be considered before actively embarking upon a measurement program for nuclear safeguards. Foremost among these is the reliance upon standards during the actual assay. For the cases of well defined samples (feed, product material etc.) such a procedure, to first order, effectively eliminates the need for detailed knowledge of cross section behavior. The second point relates to the case for which reliance upon standards might be readily challenged, i.e., the assay of scrap and waste. Here, however, refinement of cross section information usually appears as a second order correction because the materials contained in the sample are frequently unknown. Finally, to my knowledge, there have not been any calculations to indicate the sensitivity of a particular assay result to specific cross section features. The cross section requests reviewed by our committee, including LASL's, were based primarily upon intuition of what probably is important. The limited sensitivity investigations begun at our laboratory indicate that certain specific knowledge relating to the sample is important, e.g., the presence of hydrogen; on the other hand, we have not yet found limitations arising from a lack of fundamental data. I believe that the above three factors played an important part in what seemed to me a general downgrading of priorities for the requests reviewed, i.e., very few priority 1 requests."

"I do feel, however, that it is vital to keep an up-to-date evaluated data file for the materials of interest to nuclear safeguards. Such an evaluated file is presently kept by the National Neutron Cross Section Center at Brookhaven supported by DRDT. Newer evaluations are presently available for most of the fissionable and fertile isotopes but, in some cases, information of interest to safeguards (e.g., delayed neutron properties, fission product yield data) has been omitted. Furthermore, the present evaluations for some materials (e.g., Be, Pb, C) could use some reexamination. I under   Pb is presently being evaluated by Oak Ridge but possibly with different support and thus different emphasis on certain cross section features. For example, depending upon who is doing the evaluation, more emphasis might be placed on (n,γ) than $(n,2n)$ spectra. One possible future role for this subcommittee might be to try and influence the choice of materials and description of the type of evaluation desired."

"Finally, a possible role for the subcommittee, in addition to review of fundamental nuclear data request might be to consider the problem of data handling and manipulation in general. This could, in principal, include a library of evaluated microscopic and selectively group averaged neutron and photon information of interest to people working in the safeguards field.

This should not require an extensive amount of work since most of the information is presently available but scattered throughout several labs across the country. Such a program might be mutually beneficial to all concerned."