

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: J. W. Troan

SUBJECT: Report on DOE Implementation Guide for Sealed Radioactive Source Accountability and Control

1. **Purpose:** This memorandum documents the Defense Nuclear Facilities Safety Board (DNFSB) technical staff and outside expert review of the U.S. DOE Implementation Guide for Sealed Radioactive Source Accountability and Control, G-N 5400.9/M1 - Rev.0 dated December 1993.
2. **Summary:** The DOE Implementation Guide for Sealed Radioactive Source Accountability and Control identifies all significant program elements of a sealed source accountability and control program. In general, the Implementation Guide presents instructional guidance in a logical sequence. However, there are some technical features that may result in controls that are less stringent than those provided by commercial industrial standards for similar radioactive materials. These shortfalls appear to be a consequence of less demanding standards or a lack of specificity. For example, under DOE's definition of activity, quantities of some radionuclides that are exempt from source accountability are up to 30 times higher than quantities that are exempt under NRC licensing requirements for byproduct material. Furthermore, the guidance for measuring "contact radiation levels" appears incomplete for some types of sources.
3. **Background:** Although 10 CFR Part 835, *Occupational Radiation Protection* regulations, the DOE Radiological Control Manual, and DOE Notice N 5400.9, *Sealed Radioactive Source Accountability* contain basic requirements that organizations and individuals performing DOE activities must meet, the regulations and requirements, in general, do not contain specific directives on how to comply with these requirements. DOE, recognizing that there is a need to communicate what the DOE considers acceptable compliance, has issued, or intends to issue, guidance documents covering specific topical areas. These documents may include: (1) guides for implementing the provisions of the 10 CFR Part 835 final rule and (2) guides providing technical clarification. The Implementation Guide for Sealed Radioactive Source Accountability and Control is intended to provide an acceptable methodology for establishing and operating a sealed radioactive source accountability and control program that will comply with the DOE regulations and requirements.

4. Discussion/Observations: The following highlights are based on the review of the U.S. DOE Implementation Guide for Sealed Radioactive Source Accountability and Control, G-N 5400.9/M1 - Rev.0 dated December 1993, hereafter referred to as the IG, and review comments provided by DNFSB outside experts:

a. The Discussion section of the IG summarizes the applicable requirements contained in the DOE Notice N 5400.9, *Sealed Radioactive Source Accountability*, and the DOE Radiological Control Manual (Manual). A key discussion topic involves values in Appendix B of the IG. It is the DNFSB staff's opinion that the basis as well as the methodology for establishing values defined in Appendix B are debatable. Specifically, in deriving these threshold values, the specific assumptions regarding conditions of exposure may be inappropriate, and the annual dose criteria may be excessive.

1) Exemption of Sealed Radioactive Sources - Appendix B identifies radioisotopes and their exempt quantity values (i.e., radionuclide-specific activity values for exemption of sealed radioactive sources from inventory accountability and integrity testing). The following comparison shows some notable differences with the exempt quantities defined by the IG:

A comparison of "exempt" quantities defined in Appendix B of the IG to quantities of byproduct material that are exempt from NRC domestic licensing requirements, as defined by 10 CFR 30, reveals that there are 47 radionuclides for which the quantity exempted from inventory control and integrity testing by the DOE exceeds the NRC licensing thresholds (refer to Attachment (1) for a comparison). Eleven of the DOE-specified exempt quantities exceed NRC licensing threshold values by a factor of 30.

2) Assumptions and the Basis for Selecting a 10 mrem Dose Level for "Exempt" Quantities. Exemption values cited in Appendix B of the IG are based in part on the committed effective dose equivalent of 10 mrem or less to members of the general public for a "credible radiological incident."

The DNFSB staff believes that the basic assumption regarding the conditions of internal exposure for a "credible" incident involving a lost sealed source may not be sufficiently realistic (i.e., 1% inhalation of the source material). DOE has not provided the basis for the specific assumptions regarding conditions of exposure, and there is no discussion of internal exposure involving the ingestion of material from a lost source by a child or other member of the general public.

The selection of a 10 mrem dose (total effective dose equivalent) was viewed in context of other standards. DOE has selected this dose to be consistent with policies in DOE Order 5400.5, *Radiation Protection of the Public and Environment* (DOE,

1990), and guidelines published by the International Atomic Energy Agency (IAEA) Safety Series No. 89. *Principles for the Exemption of Radiation Sources and Practices from Regulatory Control (IAEA, 1988)*. However, the selection of a 10 mrem external and internal dose was viewed by the DNFSB Staff in context of potentially applicable regulatory dose limits and some situations were found where dose limits were less. For example, 10 CFR 32, *Specific Domestic Licenses to Manufacture or Transfer Certain Items Containing Byproduct Material* gives lower limits for annual exposure. Licensees under § 32.22 are required to demonstrate that the product is designed and will be manufactured so that:

"In normal use and disposal of a single exempt unit, it is unlikely that the external radiation dose in any one year, or the dose commitment resulting from the intake of radioactive material in any one year, to a suitable sample of the group of individuals expected to be most highly exposed to radiation or radioactive material from the product will exceed the dose to the appropriate organ, as specified in Column I of the table in § 32.24 of this part." (emphasis added)

Column I in the § 32.24 Table of organ doses limits: 1) The whole body; head and trunk; active blood-forming organs; gonads; or lens of the eye to 1 mrem. 2) Hands and forearms; feet and ankles; localized areas of skin averaged over areas no larger than 1 square centimeter to 15 mrem. 3) Other organs to 3 mrem.

These assumptions and basis for determining the threshold values for exempt quantities for radionuclides have led DOE to define some quantities that are 30 times the NRC exemption limit for licensing byproduct material.

- b. Section IV of the IG is the main body of the guide, and contains discussion and instructional guidance for the following programmatic elements: 1) Organization and Responsibility, 2) Receipt, 3) Labeling and Storage, 4) Inventory, 5) Integrity Testing, and 6) Handling and Disposal. The significant weaknesses noted by the DNFSB staff include:

- 1) Labeling and Storage - A detailed list of information that must be affixed by means of a label to a source or container is given in this section. In general, the information required on labels affixed to sealed sources or containers is sufficiently comprehensive, meets the intent of source accountability, and with some exception, ensures radiological safety. The DNFSB staff believes that the following statement in the IG recommendation which includes:

". . . labels should include the contact radiation levels . . ."

requires some clarification (Note: This recommendation is also contained in Article 412.4 of the Manual). The term contact radiation levels is not defined in the IG or the

Manual, and a reasonable interpretation equates "contact radiation levels" with surface dose rates. However, conventional instruments are not capable of accurately measuring surface dose rates from point sources. The IG does not present guidance for calculating or measuring contact levels for point beta sources to avoid potentially underestimates of skin or extremity exposures to individuals handling such sources.

Although the IG specifies the need for controlling access to sealed sources, it does not specify the role of the source custodian in this effort or the need for maintaining a logbook or similar system for establishing a record of sources accessed by individual users. It is the DNFSB staff's opinion that such records can be a useful source of information relating to potential radiological incidents and that a well conducted system of record usage may serve to reduce the unauthorized use, or the loss, of sealed sources.

- 2) Inventory - The DOE requirement for semi-annual accounting of non-exempt sources through a physical verification process is consistent with relevant NRC regulations involving nuclear material, special nuclear material, and byproduct material, and in the recommendations of the National Council on Radiation Protection and Measurements (NCRP) (NCRP Report No 57). Physical verification, however, may be difficult or impossible in instances where a source is an internal component of a laboratory instrument or other measuring device. The IG does not provide instructions for acceptable indirect verification protocols in such instances.
- 3) Integrity Testing - The frequency of leak testing and criteria for defining a "leaking" source are identical to the NRC regulations (10 CFR 31.5) pertaining to licensing requirements for byproduct material. Unlike 10 CFR 31.5, however, which requires investigative action, remedial action, and notification in instances of a failed source, the IG only recommends such actions.
- 4) Handling and Disposal - Surveys, posting, shielding, and personnel monitoring requirements are specified for sources that can generate dose rates in excess of 100 mrem/hr at 30 cm. In instances of a lost accountable source, the IG specifies notification requirements and recommendations for formal searches and investigations. The IG recommends that the disposal of accountable sources be carried out in accordance with Radiological Control Organization (RCO) instructions.

Guidance for safe handling of sealed sources is limited to sources capable of producing dose rates of 100 mrem/hr or more at 30 cm (i.e., strong gamma or neutron emitters). DOE provides neither guidance relating to beta-emitting sources that may have the potential for causing significant doses to the skin, extremities, or lens of the eye, nor justification for its omission.

DOE's definition of exempt levels will result in no accountability for some radioactive sources that would be subject to NRC accountability requirements were they radioactive material regulated by the NRC.

- 5. Future Staff Actions:** The DNFSB staff intends to monitor implementation of the guide.

ATTACHMENT (1)

COMPARISON OF EXEMPT QUANTITIES

Table 1. Comparison of Exempt Quantities

Radionuclide*	"Exempt" Quantity (μ Ci)		Ratio DOE/NRC
	DOE*	NRC*	
C-14	300	100	3
S-35	300	100	3
Ca-45	300	10	30
Fe-55	300	100	3
Ni-59	300	100	3
Ni-63	300	10	30
As-73	300	100	3
Rb-87	300	10	30
Tc-99	300	10	30
In-115	300	10	30
Cs-135	300	10	30
Ce-141	300	100	3
Tm-171	300	10	30
W-181	300	10	30
W-185	300	100	3
Tl-204	300	10	30
Cl-36	30	10	3
Fe-59	30	10	3
Se-75	30	10	3
Sr-85	30	10	3
Sr-89	30	1	30
Y-91	30	10	3
Zr-95	30	10	3
Nb-93m	30	10	3
Nb-95	30	10	3

Table 1. Comparison of Exempt Quantities (continued)

Radionuclide*	"Exempt" Quantity (μCi)		Ratio DOE/NRC
	DOE*	NRC*	
Ru-103	30	10	3
Ag-105	30	10	3
In-114m	30	10	3
Sn-113	30	10	3
Te-125m	30	10	3
Te-127m	30	10	3
Te-129m	30	10	3
I-125	30	1	30
Pm-147	30	10	3
Sm-151	30	10	3
Eu-155	30	10	3
Gd-153	30	10	3
Tm-170	30	10	3
Hf-181	30	10	3
Hg-203	30	10	3
Co-60	3	1	3
Ru-106	3	1	3
Ce-144	3	1	3
Eu-152	3	1	3
Eu-154	3	1	3
Bi-210m	3	1	3
Sr-90	0.3	0.1	3

*Only those radionuclides are cited in which DOE "exempt" quantities defined in DOE Notice N 5400.9/M1 exceed NRC "exempt" quantities defined in 10 CFR 30.71, Schedule B.