UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON D.C. 20555

March 25, 1996

NRC INFORMATION NOTICE 96-18: COMPLIANCE WITH 10 CFR PART 20 FOR AIRBORNE THORIUM

Addressees

All material licensees authorized to possess and use thorium in unsealed form.

Purpose

This notice is provided to alert recipients to radiological problems that may be encountered in using thorium in unsealed form. These problems were identified by U.S. Nuclear Regulatory Commission (NRC) inspectors, during inspections of the approximately 120 licensees authorized to use unsealed thorium, some of which are engaged in processing and manufacturing activities that pose a potential for generating significant airborne radioactive contamination. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

NRC inspections at facilities using thorium in unsealed form revealed a number of programmatic weaknesses in the control and monitoring of airborne thorium hazards at an unexpectedly high proportion of these facilities. One of the areas of weakness frequently encountered was worker intake monitoring programs that did not appear capable of adequately quantifying intakes for purposes of demonstrating compliance with the requirements of 10 CFR Part 20, particularly the annual limits on intake (ALI). A second area of concern was the frequent lack of adequate licensee efforts to maintain exposures as low as reasonably achievable (ALARA), as required by 10 CFR 20.1101(c). NRC inspectors repeatedly observed intakes and resulting organ doses that appeared to be unnecessary, or avoidable, in view of the potential to reduce them by implementation of relatively simple ALARA measures. Some of the intakes in these cases were evaluated and produced organ doses in the 0.2 to 0.3 Sv (20 - 30 rem) range in a year. Such high doses, representing a substantial fraction of the maximum permissible organ doses, cannot be viewed as acceptable unless justified by a thorough ALARA analysis. In most of the observed cases, however, an adequate ALARA assessment had not been performed.

Demonstration of compliance with dose limits to members of the public, from airborne thorium, was also found, in some cases, to have been less than adequate. In some cases, the licensees were found to have no adequate monitoring systems for their airborne effluents, and in others the methods used to quantify these effluents did not possess sufficient sensitivity to enable demonstration of compliance.

In response to the regulatory violations noted above, NRC issued Confirmatory Action Letters (CALs) to a number of licensees, confirming commitments to taking specific actions to correct these deficiencies. Notices of Violation and other enforcement actions were also taken by NRC, in some cases. These actions, as well as extensive discussions with licensees, to alert them to the problems, have resulted in substantial improvements in most licensees' programs.

Discussion

The programs that licensees should develop for control of airborne hazards arising from the use of unsealed thorium do not differ in any basic respect from those needed in the case of programs to control the hazards from any airborne radioactive material. Facilities using thorium, however, must make allowances for certain constraints imposed by the nature of the thorium decay chain. The major constraint is the difficulty of measuring thorium-232 (Th-232) in the body after an intake using bioassay methods, either in vivo, such as whole body counting, or in vitro, such as urine analysis. This is caused, in part, by the relatively low ALI for Th-232, which is 37 Bq (1 nCi) for class W, and 111 Bq (3 nCi) for class Y aerosols, as well as the type of radiation emissions from the thorium decay chain, which are mostly alpha and beta radiations, with only relatively low-intensity gamma radiations.

The difficulties regarding the use of bioassay methods were increased after implementation of the revised 10 CFR Part 20, which became mandatory for all licensees on January 1, 1994. Intakes of Th-232 by inhalation before the Part 20 revisions were limited to 520 MPC-hours per quarter, where MPC was the maximum permissible concentration tabulated in the old Appendix B to 10 CFR Part 20. This was equivalent to an intake of about 700 Bq (19 nCi) per quarter for both the soluble and insoluble forms of thorium, or about 2800 Bq (75 nCi) per year. The revised Part 20 lowered that limit to ALIs of about 40 Bq (1 nCi) and 100 Bq (3 nCi) for classes W and Y aerosols, respectively. Therefore, bioassay methods that may have been capable of detecting intakes that were a small fraction of the allowable limits in the old Part 20 were no longer capable of the same performance under the revised Part 20 limits, and could therefore not serve the same monitoring functions in a routine airborne radioactivity control program as they did previously.

Although bioassay techniques are still useful in assessing relatively large intakes, they are not capable of providing routine monitoring for intakes substantially below the ALI. The air monitoring program therefore usually must assume a much greater importance at facilities using unsealed thorium than for other radionuclides. Facilities using thorium need to rely on accurate air sampling to estimate intakes that cannot be detected by bioassay techniques, which, in effect includes all intakes other than those that approach or exceed the ALI. Because of this reliance on air sampling to show compliance and assess internal doses, the air sampling program must be carefully designed to provide accurate intake estimates for all occupationally exposed workers, as well as members of the public who may be exposed to airborne thorium as a result of licensed operations. However, appropriate bioassay procedures should be established and available for use in assessing accidental or suspected high exposures, and for use in cases where adequate air sampling was inadvertently not provided. In this latter case, bioassay would provide an upper limit on the magnitude of any intake that may have occurred, even though it may not be capable of quantifying intakes below an ALI.

Air Sampling

The major deficiencies noted in air sampling programs at some of the inspected facilities included programs that did not provide samples that are representative of the intake by each exposed worker, monitoring frequencies that were far too low to be capable of detecting changes in air concentrations over time, and counting techniques that did not possess adequate sensitivity for their intended purpose.

One of the factors that led to non-representative samples was the excessive reliance on general area air sampling to monitor worker intakes in that area. Studies have repeatedly shown that air concentrations in a work area can vary by several orders of magnitude over distances of only a few feet, and a general area sample is most likely to grossly underestimate the intake of a worker involved in activities that generate aerosols. With rare exception, the most reliable method of assessing worker intakes is by use of personal air samplers. In the case of effluent sampling, the method chosen should be capable of obtaining a representative sample from the exhaust duct or other outlet. For aerosols, this usually means use of isokinetic sampling methods, and licensees should determine, for their particular case, whether such sampling methods are needed.

The choice of method of analysis should also be given careful consideration. This includes choice of the filter medium to use in the air sampler, air flow rates, as well as choice of counting techniques. These factors should be

selected to ensure that the desired monitoring sensitivity, expressed as a lower limit of detection (LLD), is achieved. A good guide as to the appropriate LLD to use in any application is that it should not exceed 10 percent of the value to which compliance is to be demonstrated.

ALARA

Licensees are required, by 10 CFR 20.1101(b), to demonstrate that the doses received by their workers, or by members of the public, as a result of their activities, are ALARA. The most effective method to maintain internal doses ALARA is usually to contain the radioactive material and prevent it from entering the air in the work space. Other methods might be use of wet processes, which have the effect of preventing or minimizing the generation of aerosols, or use of other engineering controls, depending on the details of the aerosol-generating process and the configuration of the workplace. Regardless of the choice of engineering controls, their use must include periodic maintenance to ensure continued effectiveness, as well as periodic checks to ensure that the systems remain effective.

If engineering controls fail to maintain airborne concentrations at sufficiently low levels, then other methods may be used, such as limiting stay times, or restricting access to the contaminated areas. Alternatively, respirators may be used to limit intakes during periods when other measures are not sufficiently effective. It should be noted, however, that 10 CFR Part 20 specifies that respirators are to be used only when other methods of control of intake fail to achieve the desired result or are impractical.

The above discussion on air sampling and ALARA is not exhaustive, and only highlights some of the most frequently encountered problems. Licensees should thoroughly evaluate their operations, and design and implement programs that would properly protect the workers, minimize intakes, and show compliance with applicable regulations. These evaluations are not one-time efforts, but should be ongoing and integral parts of the overall radiation protection program on site.

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1. List of Recently Issued NMSS Information Notices
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LIST OF RECENTLY ISSUED NMSS INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-04	Incident Reporting Requirements for Radiography Licensees	01/10/96	All Radiography Licensees and Manufacturers of Radiography Equipment
95-58	10 CFR 34.20; Final Effective Date	12/18/95	Industrial Radiography Licensees.
95-55	Handling Uncontained Yellowcake Outside of a Facility Processing Circuit	12/6/95	All Uranium Recovery Licensees.
95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material	10/27/95	All material and fuel cycle licensees.
95-50	Safety Defect in Gammamed 12i Bronchial Catheter Clamping Adapters	10/30/95	All High Dose Rate Afterloader (HDR) Licensees.
95-44	Ensuring Combatible Use of Drive Cables Incorporating Industrial Nuclear Company Ball-type Male Connectors	09/26/95	All Radiography Licensees.
95-39	Brachytherapy Incidents Involving Treatment Planning Errors	09/19/95	All U.S. Nuclear Regulatory Commission Medical Licensees.
95-29	Oversight of Design and and Fabrication Activities for Metal Components Used in Spent Fuel Dry Storage Systems	06/07/95	All holders of OLs or CPs for nuclear power reactors. Independent spent fuel storage installation designers and fabricators.

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Information Notice No.	Subject	Date of Issuance	Issued to
95-03 Supp. 1	Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition	03/25/96	All holders of OLs or CPs for PWR power plants
96-17	Reactor Operation Inconsistent with the Updated Final Safety Analysis Report	03/18/96	All holders of OLs or CPs for nuclear power reactors
96-16	BWR Operation with Indicated Flow Less Than Natural Circulation	03/14/96	All holders of OLs or CPs for boiling-water reactors
96-15	Unexpected Plant Performance During Performance of New Surveillance Tests	03/08/96	All holders of OLs or CPs for nuclear power reactors
96-14	Degradation of Radwaste Facility Equipment at Millstone Nuclear Power Station, Unit 1	03/01/96	All holders of OLs or CPs for nuclear power reactors
96-13	Potential Containment Leak Paths Through Hydrogen Analyzers	02/26/96	All holders of OLs or CPs for nuclear power reactors
96-12	Control Rod Insertion Problems	02/15/96	All holders of OLs or CPs for nuclear power reactors
96-11	Ingress of Demineralizer Resins Increases Potential Stress Corrosion Cracking of Control Rod Drive Mechanism Penetrations	02/14/96	All holders of OLs or CPs for pressurized water nuclear power reactors

OL = Operating License
CP = Construction Permit

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The above discussion on air sampling and ALARA is not exhaustive, and only highlights some of the most frequently encountered problems. Licensees should thoroughly evaluate their operations, and design and implement programs that would properly protect the workers, minimize intakes, and show compliance with applicable regulations. These evaluations are not one-time efforts, but should be ongoing and integral parts of the overall radiation protection program on site.

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An ALARA analysis should be completed for all activities that have the potential for generating significant airborne activities. There are no uniform criteria currently in use to provide guidance on the airborne activity level that may be considered significant, but a frequently used guide is to establish ALARA goals that are less than the applicable regulatory limit for the mode of exposure under consideration. Procedures should be established to ensure that all activities are carefully examined for possible implementation of ALARA measures. Facility modifications, process design, and equipment purchases should also include ALARA as an integral stage of the project or activity.

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