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

April 23, 1991

NRC INFORMATION NOTICE NO. 91-30: INADEQUATE CALIBRATION OF THERMOLUMINESCENT DOSIMETERS UTILIZED TO MONITOR EXTREMITY DOSE AT URANIUM PROCESSING AND FABRICATION FACILITIES

Addressees:

All fuel cycle licensees and other licensees routinely handling unshielded uranium materials.

Purpose:

This information notice is being provided to alert addressees to potential problems resulting from inadequate calibration of thermoluminescent dosimetry (TLD) utilized to monitor extremity dose. It is expected that licensees will review the information for applicability to their facilities, distribute it to radiation safety personnel, and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this Information Notice do not constitute new U.S. Nuclear Regulatory Commission (NRC) requirements; therefore, no specific action or written response is required.

Description of Circumstances:

During August-September 1990, an NRC licensee conducted evaluations of extremity exposures to beta particles for selected personnel handling unshielded uranium materials. The evaluation included both extremity monitoring for workers handling the materials and a determination of the dose rate from unshielded uranium material (pellets). Monitoring was conducted using single chip TLDs mounted in plastic finger rings. Pellet dose rates were determined by exposing TLDs to the unclad material for a known period. TLDs were supplied and subsequently processed by a vendor laboratory. The licensee had verbally discussed with the vendor that the monitoring with the finger ring TLDs was conducted to determine employee beta extremity dose from the unshielded uranium materials. In addition, the licensee included instructions stating the type of radioactive materials which were to be monitored with their purchase agreement accompanying the TLDs to the processing vendor laboratory.

Based on vendor reports for TLDs affixed to uranium pellets for a set amount of time, the licensee calculated dose rates of 38 and 40 mrem/hr through an absorber thickness of 7 milligrams per square centimeter (mg/cm^2). Initially, the licensee assumed the pellet dose reports to be accurate and no additional calculations were made to support the vendor measurements. However, in response to NRC inquiries, independent calculations were made which indicated that the

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minimum dose rate from the pellet material exceeded the values derived from the vendor reports by a factor of approximately 2.

During discussion of the dose measurements with the TLD vendor, the licensee was informed that the TLDs were calibrated with a cesium-137 (Cs-137) source. The vendor had a calibration factor for TLDs exposed to a slab of natural uranium and noted that a correction factor was required to convert from a cesium-based to uranium-based shallow (skin) dose. Review of the licensee dose data indicated that the appropriate correction factor was not applied to the original results provided by the vendor. A beta-correction factor of approximately 2.0 was required, and higher dose values were subsequently assigned to personnel handling unclad uranium materials.

Subsequently, NRC contacted four other fuel fabrication facilities regarding their evaluations of extremity dose from depleted or low enriched unshielded uranium. These facilities used single chip TLDs processed by vendor laboratories. Among the facilities, three different vendors were represented in providing and processing the TLDs. During discussions with these vendors, it was determined that a correction factor of approximately 2.0 should have been applied to the reported results. In all cases, this value had not been applied to any of the actual TLD measurements. As a result, extremity exposures had been underestimated by a factor of approximately 2.

Discussion:

At fuel fabrication facilities, as well as at facilities handling natural and depleted uranium, selected operational processes potentially require extensive handling of unshielded uranium materials by employees. Depending on the facility processes, dose rates to the skin of the extremity from unclad uranium materials can increase significantly during operations. At fuel fabrication facilities following introduction of uranium hexafluoride (UF_6) into the process, the major contributor to the skin dose results from ingrowth of the beta-emitting metastable protactinium-234 (Pa-234m) isotope. Dose rates through 6-7 mg/cm^2 absorbers of approximately 200 millirem per hour (mrem/hr) for exposure to depleted, natural, or low-enriched unshielded uranium materials in equilibrium with short-lived daughter isotopes have been reported (References 1-2). It is the licensee's responsibility to properly evaluate the potential dose to the skin of the extremity to determine the need for extremity monitoring, and to verify that no individual exceeds the exposure limits specified in 10 CFR Part 20. In using TLD's for extremity monitoring, licensees should verify that the appropriate correction factor for the different TLD response between uranium and the calibration source is used.

No specific action or written response is required by this information notice. If you have questions about this matter, please contact the technical contacts listed below or the appropriate regional office.

Richard E. Cunningham, Director
Division of Industrial and
Medical Nuclear Safety, NMSS
Office of Nuclear Material Safety
and Safeguards

Technical Contacts: George B. Kuzo, Region II
(404) 331-2560

John Potter, Region II
(404) 331-5571

Attachments:
1. References
2. List of Recently Issued NRC Information Notices
3. List of Recently Issued NMSS Information Notices

REFERENCES

1. Coleman, R. L., C. G. Hudson, and P. A. Plato, 1983. "Depth-dose Curves for Sr-90 and Natural and Depleted Uranium in Mylar." Health Phys. 44(4):395-402.

2. U. S. Department of Health Education and Welfare (DHEW). 1970. Radiological Health Handbook. Public Health Service Publication, Rockville, Maryland.

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
86-21, Supp. 2	Recognition of American Society of Mechanical Engineers Accreditation Program for N Stamp Holders	04/12/91	All holders of OLs or CPs for nuclear power reactors and all recipients of NUREG-0040, "Licensee Contractor and Vendor Inspection Status Report" (White Book).
91-29	Deficiencies Identified During Electrical Distribution System Functional Inspections	04/15/91	All holders of OLs or CPs for nuclear power reactors.
91-28	Cracking in Feedwater System Piping	04/15/91	All holders of OLs or CPs for pressurized water reactors (PWRs).
91-27	Incorrect Rotation of Positive Displacement Pump	04/10/91	All holders of OLs or CPs for nuclear power reactors.
89-90, Supp. 1	Pressurizer Safety Valve Lift Setpoint Shift	04/10/91	All holders of OLs or CPs for nuclear power reactors.
91-26	Potential Nonconservative Errors in the Working Format Hansen-Roach Cross-Section Set Provided with The Keno and Scale Codes	04/02/91	All fuel cycle licensees and other licensees, including all holders of operating licenses for nuclear power reactors, who use physics codes to support criticality safety in the use of fissile material.
91-25	Commercial-Grade Structural Framing Components Supplied As Nuclear Safety-Related Equipment	04/01/91	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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91-26	Potential Nonconservative Errors in the Working Format Hansen-Roach Cross-Section Set Provided with The Keno and Scale Codes	04/02/91	All fuel cycle licensees and other licensees, including all holders of operating licenses for nuclear power reactors, who use physics codes to support criticality safety in the use of fissile material.
91-23	Accidental Radiation Overexposures to Personnel due to Industrial Radiography Accessory Equipment Malfunctions	03/26/91	All Nuclear Regulatory Commission (NRC) licensees authorized to use sealed sources for industrial radiography.
91-16	Unmonitored Release Pathways from Slightly Contaminated Recycle and Recirculation Water Systems At A Fuel Facility	03/06/91	All fuel cycle facilities
91-14	Recent Safety-Related Incidents at Large Irradiators	03/05/91	All Nuclear Regulatory Commission (NRC) licensee authorized to possess and use sealed sources at large irradiators.
91-03	Management of Wastes Contaminated with Radioactive Materials ("Red Bag" Waste and Ordinary Trash)	01/07/91	All medical licensees.
91-02	Brachytherapy Source Management	01/07/91	All Nuclear Regulatory Commission (NRC) medical licensees authorized to use byproduct material for medical purposes.

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that the appropriate correction factor was not applied to the original results provided by the vendor. A beta-correction factor of approximately 2.0 was required, and higher dose values were subsequently assigned to personnel handling unclad uranium materials.

Subsequently, NRC contacted four other fuel fabrication facilities regarding their evaluations of extremity dose from depleted or low enriched unshielded uranium. These facilities used single chip TLDs processed by vendor laboratories. Among the facilities, three different vendors were represented in providing and processing the TLDs. During discussions with these vendors, it was determined that a correction factor of approximately 2.0 should have been applied to the reported results. In all cases, this value had not been applied to any of the actual TLD measurements. As a result, extremity exposures had been underestimated by a factor of approximately 2.

Discussion:

At fuel fabrication facilities, as well as at facilities handling natural and depleted uranium, selected operational processes potentially require extensive handling of unshielded uranium materials by employees. Depending on the facility processes, dose rates to the skin of the extremity from unclad uranium materials can increase significantly during operations. At fuel fabrication facilities following introduction of uranium hexafluoride (UF_6) into the process, the major contributor to the skin dose results from ingrowth of the beta-emitting metastable protactinium-234 (Pa-234m) isotope. Dose rates through 6-7 mg/cm^2 absorbers of approximately 200 millirem per hour (mrem/hr) for exposure to depleted, natural, or low-enriched unshielded uranium materials in equilibrium with short-lived daughter isotopes have been reported (References 1-2). It is the licensee's responsibility to properly evaluate the potential dose to the skin of the extremity to determine the need for extremity monitoring, and to verify that no individual exceeds the exposure limits specified in 10 CFR Part 20. In using TLD's for extremity monitoring, licensees should verify that the appropriate correction factor for the different TLD response between uranium and the calibration source is used.

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cesium-based to uranium-based shallow (skin) dose. Review of the licensee exposure data indicated that the appropriate correction factor was not applied to the original results provided by the vendor. For the 1990 data, a beta-correction factor of approximately 1.89 was required and higher exposure values were subsequently assigned to personnel handling unclad uranium materials. Further discussion with the TLD vendor laboratory indicated that in addition to the revisions for the 1990 study, an appropriate correction factor was not applied to similar measurements conducted by the licensee in 1983 regarding unshielded uranium material dose rate studies.

Discussion:

At fuel fabrication facilities, as well as at facilities handling natural and depleted uranium, selected operational processes potentially require extensive handling of unshielded uranium materials by employees. Dependent on the facility processes, dose rates to the skin from unclad uranium materials can change significantly during operations. At fuel fabrication facilities following introduction of uranium hexafluoride (UF_6) into the process, the major contributor to the skin dose results from ingrowth of the beta-emitting metastable protactinium-234 (Pa-234m) isotope. The ingrowth of the relatively short-lived Pa-234m radioisotope (1.17 minute physical half-life) follows the decay of the longer-lived (24.1 day physical half-life) thorium-234 (Th-234) parent radionuclide. Dose rates through 6-7 mg/cm^2 absorbers of approximately 200 millirem per hour (mrem/hr) for exposure to depleted, natural, or low-enriched unshielded uranium materials in equilibrium with short-lived daughter isotopes have been reported (References 1-2). Proper evaluation of the potential dose to the skin of the extremity is required to determine the threshold for extremity monitoring, and to verify that no individual exceeds the exposure limits specified in 10 CFR Part 20. In selecting TLD's for extremity monitoring licensees should verify that the appropriate correction factor for differential TLD response to the uranium and calibration source beta energies are utilized.

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provided by the vendor. For the 1990 data, a beta-correction factor of approximately 1.89 was required. Applying the correction factor resulted in dose rates of 72 and 76 mrem/hr for the monitored unshielded results. Further discussion with the TLD vendor laboratory indicated that in addition to the revisions for the 1990 study, an appropriate correction factor was not applied to similar measurements conducted by the licensee in 1983 regarding unshielded uranium material dose rate studies.

Discussion:

Selected processes at fuel fabrication facilities as well as natural and depleted uranium facilities potentially require extensive handling of unshielded uranium materials by employees. Following introduction of uranium hexafluoride (UF_6) into the fabrication process, the major contributor to the skin dose results from ingrowth of the beta-emitting metastable protactinium-234 (Pa-234m) isotope. The ingrowth of the relatively short-lived Pa-234m radioisotope (1.17 minute physical half-life) follows the decay of the longer-lived (24.1 day physical half-life) thorium-234 (Th-234) parent radionuclide. Dose rates through 6-7 milligrams per square centimeter (mg/cm^2) absorbers ranging from approximately 100 to 200 millirem per hour (mrem/hr) for exposure to depleted, natural, or low-enriched unshielded uranium materials in equilibrium with short-lived daughter isotopes have been reported (References 1-3). Proper evaluation of the potential dose to the skin of the extremity is required to determine the threshold for extremity monitoring, and to verify that no individual exceeds the exposure limits specified in 10 CFR Part 20. In selecting TLD's for extremity monitoring licensees should verify that the appropriate correction factors are utilized.

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