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MEMORANDUM TO: Hipolito J. Gonzalez, Chief
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Division of Material Safety, State, Tribal, and Rulemaking Programs
Office of Nuclear Materials Safety and Safeguards

FROM: Rebecca M. Tadesse, Chief ***/RA Terry A. Brock for/***
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SUBJECT: REVIEW OF THE ADEQUACY OF THE ELECTRONIC ALARMING DOSIMETER TO SERVE AS A DUAL-FUNCTION DEVICE TO PROVIDE A DIRECT READING DOSIMETER AND AN OPERATING ALARM RATEMETER IN INDUSTRIAL RADIOGRAPHY APPLICATIONS

This memorandum serves as a response to your request to have my staff review the adequacy of the electronic alarming dosimeter (EAD) (also known as an electronic personal dosimeter) to serve as a dual-function device to provide both a direct reading dosimeter and an operating alarm ratemeter in industrial radiography operations as required in 10 CFR Part 34(a). Concurrently, this issue is part of an existing petition for rulemaking (PRM-34-7) under consideration by our staff. Our analysis and recommendation were provided to you in a presentation on March 9, 2017, (ML17095A321) by Dr. Terry Brock of my staff. If you have any questions on our analysis, please feel free to contact Dr. Brock at tab2@nrc.gov or 301-415-1793.

Analysis

In an NRC operating experience context, our finding is that EADs have a proven track record in the nuclear power arena where they have provided adequate protection and have been used routinely and reliably for over 25 years as a secondary dosimeter. This memo is not addressing whether or not the EAD replaces the primary dosimeter, such as the thermo-luminescent dosimeter (TLD) or optically stimulated luminescence (OSL) dosimeter that is read offsite and recorded as the dose of record. A staff review of the recent literature, NRC documents, and discussions with NRC, military, and industry health physicists with EAD experience, did not find any evidence of generic performance problems with EADs in an industrial setting. My staff could not find any discernable adverse trends that would preclude their use as a dual-function device in industrial radiography operations to meet the requirements in 10 CFR 34.47 (a) that state:

(a) The licensee may not permit any individual to act as a radiographer or a radiographer's assistant unless, at all times during radiographic operations, each individual wears, on

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> the trunk of the body, a direct reading dosimeter, an operating alarm ratemeter, and a personnel dosimeter that is processed and evaluated by an accredited National Voluntary Laboratory Accreditation Program (NVLAP) processor. At permanent radiography installations where other appropriate alarming or warning devices are in routine use, the wearing of an alarming ratemeter is not required.

NRC materials inspectors have interpreted this to mean that three distinct devices are required to provide the functions of a direct reading dosimeter, an operating alarm ratemeter, and a personnel dosimeter. This may have been a proper interpretation at the time when the rule was written in 1997 (NRC 1997), but today the EAD is a mature and proven technology.

The NRC reactor arena has considerable operational experience with EADs as the secondary dosimeter with direct reading and dose rate alarming capabilities. This suggests that the current interpretation of 10 CFR 34 (a) in industrial radiography is a regulatory artifact and unnecessary because it requires two distinct devices to address the functional requirements mentioned. In addition, the EAD has gained national and international acceptance worldwide in the medical and academic arenas for use as a secondary and, in some cases, a primary dosimeter replacing the OSL or TLD (IAEA 2007). EADs come with the capability in one device of providing (1) multiple functions of a direct reading dosimeter, (2) a visual and audible dose rate alarm, and (3)—missing and equally or more important in the current industrial radiography regulations—a visual and audible integrated dose alarm.

The current 10 CFR 34 (a) regulations do not require the audio/visual integrated dose alarm function. However, this function is a bonus and would add a layer of protection by alerting the user when a pre-set dose limit has been triggered without requiring a visual check (as is done with a self-reading dosimeter only [e.g., PIC]). As such, by enforcing the current requirements under the current technical interpretation, workers are not profiting from the integrated dose alarm warning found in most EADs to assist them in preventing overexposures.

The operating environment of a nuclear power reactor is as varied as would be experienced in industrial radiography (e.g., extreme temperatures, humidity, physical labor, high-radiation areas) and has performed adequately for this function with no subsequent degradation in safety. Modern EADs come with internal electronic checks and low battery alarms that are easily displayed to the end user to notify of failure or time to replace a battery.

Why EADs

Operating experience from the early 1990s shows that commercial nuclear power plants started to phase-out personal ion chambers (PICs) in favor of the EAD. The EAD was selected to replace the PICs as the secondary dosimeter for the following reasons:

- The PIC is known to be sensitive to shock and can be read off-scale if handled too roughly in industrial environments.

- It goes off-scale and can be unreadable if exposed to a very high dose of radiation.

- The PIC can be difficult to read and to discern the dose received with any granularity, usually to the 10s of mR.

- The PIC needs to be placed on the eye to read, and potential radioactive contamination exists if working in such environments—admittedly, this is unlikely for typical industrial radiography applications in the field, but it is possible (e.g., industrial radiographers working at a nuclear power facility).

In contrast, the EAD is very simple to read (usually in a tenth-of-a-mrem increment on a digital display). This means it is not necessary to place it next to the eye to read, which removes the contamination risk. The EAD integrated dose and dose rate alarms can be set daily by the radiation safety officer through a networked Access Control System or a stand-alone reader device that allows daily tracking on individual and collective doses to gauge ALARA performance. Another advantage of the EAD is the use of wireless technology that allows a radiation safety officer to monitor a worker's dose and dose rates from a remote location outside of any radiation areas, thus reducing dose to radiation protection personnel. Initial problems did exist with the EAD regarding radiofrequency interference with the electronics; however, the manufacturers have eliminated this issue through shielding and updates in product design.

What happens if the EAD malfunctions?

Some concern exists that failure of the EAD dual-device could result in the industrial radiographer losing both the direct reading dosimeter and alarm ratemeter function versus the failure of each single device. However, the industrial radiographer is still required to have a survey meter to determine dose rates and to wear a primary dosimeter (e.g., TLD or OSL) that can be processed in case of an EAD malfunction. Therefore, the industrial radiographer will still have the ability to characterize the radiation dose rate and measure their own personal dose to ensure that no dose limits are exceeded.

Summary

Based on our review of the recent literature, NRC documents, operating experience, and discussions with NRC, military, and industry health physicists with EAD experience, we recommend the use of the EAD to perform as the dual-function device. The many years of operational experience in the reactor arena has demonstrated that the EAD is an effective device for monitoring dose and dose-rate and for providing visual/audible alarms for pre-set thresholds. We suggest the materials inspectors hold a one-day workshop with the reactor inspectors to familiarize themselves with the technology and inspection procedures used in the reactor arena. For now, the materials inspector should refer to the Office of Nuclear Reactor Regulation's Inspection procedure 71124, Attachment 04 "Occupational Dose Assessment" to familiarize themselves with how the inspections are performed (NRC, 2016).

References used to prepare this memo

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