Response to SC&A's "A Review of ORAUT-OTIB-0092 Correction Factors for Neutron Dose Measured with Nuclear Track Emulsion, Type A Film"

Response Paper

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INTRODUCTION

This response paper addresses the single observation from SC&A's review of the Oak Ridge Associated Universities Team (ORAUT) technical information bulletin *Correction Factors for Neutron Dose Measured with Nuclear Track Emulsion, Type A Film*, ORAUT-OTIB-0092 [ORAUT 2024].

ORAUT issued OTIB-0092 in February 2024 as a method to estimate a dose correction factor (DCF) for Eastman Kodak nuclear track emulsion, Type A (NTA) film, commonly used at Department of Energy (DOE) and Atomic Weapons Employer facilities to measure personnel neutron exposure dose. In March 2025, SC&A issued their comments in *A Review of ORAUT-OTIB-0092 Correction Factors for Neutron Dose Measured with Nuclear Track Emulsion, Type A Film* [SC&A 2025].

SC&A OBSERVATIONS WITH NIOSH RESPONSES

In the section below, NIOSH presents SC&A's observation with a response following.

SC&A Observation 1: Limited applicability of NTA film correction factor

> *Table C-1 provides a wide array of neutron exposures that potentially could be present at DOE facilities, along with the associated SWR* [spectrum-weighted response]*, SWDE* [spectrum-weighted dose equivalent]*, and DE SWR* [dose equivalent spectrum-weighted response] *values to determine an NTA film correction factor. Usually, the neutron energy spectrum of the source used to calibrate neutron detectors at a facility is known with a reasonable degree of accuracy. However, in many cases, the neutron energy spectrum of the exposure in the field will vary. Even if the neutron energy spectrum is measured at several locations in the field, the actual neutron exposure spectrum to the worker can vary, influenced by such factors as:*
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> - *neutron source (especially for changes in voltage and target materials at accelerators)*
> - *shielding materials, thickness, layering, and angle neutrons transverse the shielding*
> - *access ports, seams, and voids in the shielding*
> - *sky shine (reflection of neutrons back down from the atmosphere)*
> - *ground shine (reflection of neutrons up from the ground at an angle from the source)*

- *backscattered neutrons from material behind the worker*

> *These parameters could change significantly as a worker moves around an area. This is further complicated when attempting to determine neutron dose from exposure situations that took place over 40 years ago, when NTA film was used. Some of the parameters for deriving the neutron dose CFs* [correction factors] *have been determined with much greater accuracy than most neutron exposure spectrum can be known. The neutron dose CF should be used with caution because it could lead to a false sense of being able to derive and assign neutron doses with a much greater degree of accuracy than is warranted. Therefore, SC&A recommends that given such uncertainties, only a spectrum CF of equal to or greater than 1 be applied to a worker's recorded neutron dose, unless the previously listed uncertainties are well documented.*

NIOSH Response to SC&A Observation 1

The method described in OTIB-0092 is designed to estimate the amount of under- or overreported neutron dose measured by NTA film. This is done using the neutron energy spectra for the NTA film neutron calibration source and worker exposure source to calculate the DE SWR for NTA film exposed to each source. A ratio of the DE SWR values estimates a dose correction factor that should be applied to the NTA film neutron dose measurement for that environment. A DCF equal to 1 suggests that NTA film correctly measured the environmental neutron dose. A DCF less than 1 suggests NTA film overresponded to the neutron dose and the dose of record should be reduced by the factor indicated. A DCF greater than 1 suggests NTA film under-responded to neutron dose and the dose of record should be increased by the factor indicated.

NIOSH acknowledges that numerous unknown factors affect the true neutron spectrum to which workers were exposed and that this introduces uncertainties into dose calculations. Limiting the method of OTIB-0092 to neutron dose correction factors equal to or greater than 1 would be most conservative and favorable to claimants.

CONCLUSION

SC&A reviewed OTIB-0092 and presented NIOSH a single observation. It is difficult to precisely determine worker neutron exposure doses because numerous facility unknowns exist. These include characteristics of the neutron exposure source, shielding, scatter, and other parameters listed above. Based on these uncertainties, SC&A recommends adopting only neutron dose correction factors equal to or greater than 1 to modify the NTA dose of record - unless the previously listed uncertainties are well documented. NIOSH agrees this recommendation is most favorable to the claimant, and this condition will be implemented in the method described by OTIB-0092.

REFERENCES

ORAUT [2024]. Correction factors for neutron dose measured with nuclear track emulsion, Type A film. Oak Ridge, TN: Oak Ridge Associated Universities Team. ORAUT-OTIB-0092 Rev. 00, February 22. [SRDB Ref ID: 200377]

SC&A [2025]. A review of ORAUT-OTIB-0092 correction factors for neutron dose measured with nuclear track emulsion, type A film. Arlington, VA: SC&A. SCA-TR-2025-PR092 Rev. 0 Draft, March 25. [SRDB Ref ID: 208144]