

# Review of Pantex Radiation Safety Department 2020 Backup Dosimetry Processing Methodology

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## Executive Summary

In the first quarter (Q1) of Calendar Year 2020, the Pantex Radiation Safety Department (Pantex) experienced various issues and failures with their dosimeter processing equipment. Efforts to repair the equipment resulted in limited functionality without the ability to process dosimeters assigned to personnel for monitoring dose. As a result of the impairments to the dosimeter processing equipment, Pantex called upon Nevada National Security Site (NNSS) for support, as their designated backup processor.

In January of 2021, LLNL Subject Matter Experts in External Dosimetry started an NNSA-requested review of Pantex's personnel doses in Q1 2020. Its focus was the technical validity of the means and methods used by Pantex and its conclusions and provide a level of confidence to National Nuclear Security Administration (NNSA) that the resulting personnel doses were reasonable, conservative, and defensible.

The review resulted in the following recommendations, each requiring explicit documentation:

- A. Ensure all actions necessary to complete a dose calculation are documented in detail.
- B. Ensure all logic driving decisions and statements regarding dosimetry for personnel dose are clearly documented.
- C. Ensure that dosimeter element reviews are explicitly documented.

Based on the high levels of conservatism inherent across the methods chosen by the Pantex Radiation Safety Department, even without implementation of the preceding recommendations, the calculation of the Q1 2020 personnel dose and the resulting personnel dose assignments were observed to be reasonable, conservative, and technically defensible.

With the implementation of the recommendations, the authors believe that the methods used by the Pantex Radiation Safety Department will provide sufficient information regarding the documentation of and data associated with personnel dose to be in compliance with 10 Code of Federal Regulations (CFR) 835 Sections 702(c), 702(g) and 703(b).

## Discussion

In Q1 2020, the Pantex Radiation Safety Department (Pantex) experienced various issues and systemic failures with their dosimeter processing equipment. Efforts to repair the equipment resulted in limited functionality without the ability to process dosimeters assigned to personnel for dose. In addition, the failures resulted in the 1) remaining dosimeter supplies were issued for personnel monitoring for Q2 of 2020 and 2) subsequent extension of those dosimeters for monitoring personnel over Q3 of 2020. As a result of the impairments to the dosimeter processing equipment, Pantex called upon NNSS as their designated backup processor. NNSS processed the first quarter employee dosimeters in June of 2020.

While the dosimetry equipment used by Pantex and NNSS are similar, processing differences by the two sites were identified by Pantex. This discovery prompted the retention of Stanford Dosimetry, Inc (Stanford, the original developer of the Pantex dose assessment software) to develop a method to adjust for the identified differences in processing between the two dosimetry systems and associated equipment.

Stanford also performed the personnel dose calculations for Pantex. During the analysis of the first quarter 2020 personnel doses, it was identified that the resulting assigned person-rem was greater than expected, given those of previous monitoring periods.

A general timeline of Pantex dosimetry over the first calendar quarter 2020 is:

- A. Pantex systems became unavailable for personnel dosimeter processing.
- B. Pantex performed testing for data compatibility with NNSS.
- C. NNSS processed Pantex Q1 2020 personnel dosimeters.
- D. NNSS processed Pantex visitor dosimeters.
- E. Stanford recommended and completed additional compatibility testing.
- F. Stanford performed personnel dose calculations.

In January of 2021, LLNL external dosimetry SME volunteers started an NNSA-requested review of the means and methods used by Pantex to assess personnel dose in Q1 2020. Its focus was the technical validity of the means and methods used by Pantex and its conclusions provide a level of confidence to NNSA that the resulting personnel doses are reasonable, conservative, and defensible.

An important outcome of the review was to ensure that the documentation and data of assigned personnel dose were in compliance with 10CFR835 Sections 702(c), 702(g) and 703(b).

The review of means and methods began with a logical analysis of the process established by Stanford to correct for the differences between the NNSS and Pantex dosimetry systems. Its intent was to ensure that the logic used by Stanford could be followed and the derived doses could be replicated.

Additional analyses included a review of the method for evaluating irregular dosimetry results, a comparison of first quarter 2020 assigned doses to previous monitoring periods, and the factors affecting the dose assessment. Inquiries were made to obtain clarification and amplifying data regarding the following, even though the method for deriving the correction factor between the two programs is valid:

- A. testing and irradiations completed prior to processing;
- B. handling, modification, and use of Element Correction Factors (ECFs);
- C. continued limited use of Pantex processing equipment;
- D. dosimetry program operational details, e.g.:
  - a. dosimeter issuing criteria
  - b. dosimeter take-home policy;
- E. background dose subtraction methods
  - a. inclusion of the difference in backgrounds of Pantex and NNSS;
- F. logic regarding data review during process derivation;
- G. origin of uncertainty estimates;
- H. expectation for changes in worker assigned doses (expected person-rem);
- I. compensations for longer than expected monitoring periods, e.g. dosimeter fade; and
- J. transit dose monitoring.

Pantex responded to inquires in part with direct answers, and in part through the delivery of additional data and documents; the latter are listed as References 3 and 4 below.

The SMEs evaluated the direct answers and deliverables; some inquiries were resolved out-right, others developed into recommendations. As an example, one inquiry and standing recommendation stems from the Stanford Dosimetry Report. The report indicated that the background subtraction was calculated using a Pantex-specific background function. This is an approved alternative method to that of using control dosimeters in accounting for non-occupational background dose. The background for Q1 2020 dosimeters was integrated over the period of the anneal date at Pantex to the read date at NNSS. The calculated background neither considered contributions from background during transit of the dosimeters to NNSS nor changes in background due to the time the dosimeters spent at NNSS before processing. While the Pantex background function may not explicitly consider these effects, some of the dose from transit and NNSS background may be incorporated implicitly into the calculation. Still, variations in background doses can lead to significant changes in a final dose; i.e., the dose of unaccounted background will manifest as elevated doses to personnel.

## Recommendations

The review resulted in the following recommendations, each requiring explicit documentation:

- A. Ensure that the actions taken to complete the Q1 2020 calculations of personnel dose are documented in detail; actions would include at least: data extraction/mining, correction factor calculation, data migration (to from the various entities), and the final dose calculation.
- B. Ensure that all logic driving the decisions and statements assessing and affecting the processing by Stanford Dosimetry LLC regarding dosimetry for personnel dose are well understood and clearly documented.

- C. Ensure that the noted dosimeter element review is explicitly documented.

## Conclusion

The first conclusion of this review is that, based on the high levels of conservatism inherent across the methods chosen by the Pantex Radiation Safety Department, even without implementation of the preceding recommendations, the calculation of first quarter 2020 personnel dose and the resulting personnel dose assignments were found to be reasonable, conservative, and technically defensible.

The second conclusion of this review is that with the implementation of recommendations discussed above, it is believed that the methods used by the Pantex Radiation Safety Department will provide sufficient information regarding the documentation and data of assigned personnel dose to be in compliance with 10CFR835 Sections 702(c), 702(g) and 703(b).

## References:

1. RPT-0027, Calculation of Employee Dose With Dosimetry Data Produced at NNSS, CNS, LLC., December 2020
2. Pantex External Dosimetry Q1 2020, Stanford Dosimetry LLC, December 2020
3. RSD-PAP-0010, Calendar Year 2020 Irregular Dosimetry Reports, Pantex Radiation Safety Department, CNS LLC., January 2021 Issue 00
4. RSD-RPT-0252, Analysis of First Quarter Calendar Year 2020 Personnel Dosimetry Results, Pantex Radiation Safety Department, February 2021 Issue 00
5. Email and verbal correspondences from January 2021 thru March 2021: Daniel K. Stone, Chad E. Hopponen, David Bytwerk, and Matthew Buchholz.