

Hanford – White Paper - Assessment of Certain Special Exposure Cohort-Related Issues

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SEC Evaluation History at Hanford

- (Petition 57 part 1) Oct. 1, 1943 through Aug. 31, 1946, for selected areas
- (Petition 57 part 2) Sept. 1, 1946 through Dec. 31, 1968, for selected areas
- (Petition 152) Oct. 1, 1943 through Jun 30, 1972, for all areas
 - this class subsumed previous two classes
- (Petition 155) Class was not added to the SEC
 - NIOSH found no evidence of falsification of rad. records during the period
- (Petition 201) July 1, 1972 through December 31, 1983, for all areas
 - SEC-00201 Evaluation Report (ER) determined that dose reconstruction was feasible from 1984 onward
 - This echoed the same conclusion previously drawn in ER for SEC-00057-2

SEC Evaluation History at Hanford, cont.

- March 2015 83.14 petition evaluation (SEC-00226)
- Class Definition for SEC-00226
 - Contractors and subcontractors (excluding employees of the following Hanford prime contractors during the specified time periods: Battelle Memorial Institute, January 1, 1984 through December 31, 1990; Rockwell Hanford Operations, January 1, 1984 through June 28, 1987; Boeing Computer Services Richland, January 1, 1984 through June 28, 1987; UNC Nuclear Industries, January 1, 1984 through June 28, 1987; Westinghouse Hanford Company, January 1, 1984 through December 31, 1990; and Hanford Environmental Health Foundation, January 1, 1984 through December 31, 1990) who worked at the Hanford site in Richland, Washington, during the period from January 1, 1984 through December 31, 1990

Prime Contractor Consolidation (Mid-1987)

- A consolidation took place in mid-1987
 - The prime contractor responsibilities formerly executed by Rockwell Hanford, Boeing Computer Services, and United Nuclear were all brought under a single contract executed by Westinghouse Hanford Company.
 - Previously, United Nuclear was the operating contractor for the N Reactor and associated facilities in 100 Area
 - Previously Rockwell managed operations in 200 Area
 - Including the PUREX Plant and the Plutonium Finishing Plant

Hanford Work Group Recent Efforts for (Prime Contractors 1984-1990)

- (November 2017) NIOSH and the ABRWH contractor provided the Hanford WG
 - Consensus recommendations of status and scope of outstanding Hanford issues
 - Captured all unresolved SEC-related and dose reconstruction issues
- (October 26, 2018) Hanford WG met to consider the joint recommendations
 - Each issue was discussed individually
 - Some issues were closed
- (November 2018) NIOSH placed all issues into the Board Review System (BRS)
- Since October 26, 2018 WG Meeting:
 - NIOSH team reviewed and evaluated all holdings
 - NIOSH team documented summary of findings into a White Paper
 - “Assessment of Hanford SEC Issues” dated 01/07/20

Background Information for White Paper (WP)

- The white paper captures and represents the extensive site research activities accomplished since the approval of SEC petition SEC-00201
- White paper purpose:
 - Provides the status of the assessment of dose reconstruction feasibility for several Special Exposure Cohort (SEC)-related issues
 - Reflects the current state of knowledge based on extensive site research actions accomplished since the approval of SEC petition SEC-00201 in 2012
- White paper addresses only potential SEC issues not dependent on the implementation of the revised guidance for co-exposure methods

Hanford Radiation Protection Program (1984-1990)

- Radiation protection was implemented as a site-wide services function administered and operated by Pacific Northwest Laboratory (PNL)
- Each prime contractor was responsible for its own radiation protection plans and the field portion of its internal monitoring program using guidance supplied by PNL
- The Hanford Internal Dosimetry Program Manual spelled out contractor responsibilities for identifying when bioassays were needed and for which nuclides
- The white paper focused on control and monitoring of internal dose since that was the concern for most issues
- Workplace monitoring was the primary means for identifying internal exposures. Routine bioassay was considered secondary to workplace monitoring.
 - Internal exposures were infrequent and typically occurred only as a result of the failure of a protective system

Workplace Monitoring Incidents of Potential Internal Dose

- PNL's guidance to the contractors was "Internal Dosimetry should be contacted whenever an intake of radioactivity is suspected, or when the dosimetric-significance of an observation or event is in doubt". Several examples of such circumstances were provided.
- Annual reports from the internal dosimetry program included summary statistics for site-wide incidents that had a potential for internal exposure. PNL began publishing those reports in 1987.
- Review of these reports showed that
 - PNL's guidance for incident reporting had been adopted site-wide
 - Hanford's workplace monitoring methods were capable of identifying radiological occurrences at a level below those of internal dose significance
 - Events of internal dose significance were rare
- Radiological occurrences of internal dose significance were significant events that would have been recognized in the workplace

Routine Internal Monitoring

- Routine monitoring was provided in the form of both *in-vivo* and *in-vitro* bioassay. *In-vivo* bioassay, consisting of routine whole body and chest counts, was a key element of Hanford internal monitoring program.
- Whole body counts were performed as an element of a worker's annual physical. Whole body counts were also performed when employees were newly hired, terminated, or at the beginning or end of special projects.
 - The purpose of the routine whole-body counting program was “to document the absence of radioactivity in most radiation workers and to determine the amount, distribution, and retention of radioactivity for those few employees who become internally contaminated” [Palmer 1986]
- Routine chest counts were performed when there was potential for lung depositions of radionuclides having gamma energies less than 200 keV. Individuals that received routine chest counts also received routine whole body counts.

Internal Monitoring Data 1984-1990

- Internal monitoring data are stored in the Radiation EXposure (REX) database. REX contains both *in-vitro* and *in-vivo* bioassay data.
- Review of the REX database for the evaluation period showed participation in the routine whole-body count program by employees from all of the prime contractors
- REX also showed participation in the routine chest counting program by employees from all prime contractors

Observations from Review of Internal Dosimetry Program

- Prime contractors reported incidents of potential internal dose significance to PNL for evaluation. Minor incidents were not of internal dose significance and workplace monitoring was backstopped by the routine bioassay program.
- Appropriate bioassay methods were in place for all radionuclides of concern
- The routine *in-vivo* monitoring program was sensitive to the presence of unexpected radionuclides in monitoring results, such as Th-232
- There was participation in the routine *in-vivo* monitoring program by employees from all site prime contractors, particularly those responsible for radiological operations
- No chronic sources of radionuclides of concern were identified. Any previously unknown sources of chronic intake would have been apparent in routine bioassay results.

Hanford SEC issues addressed in white paper

- Issue 3: Thorium-232 Internal Exposure Potential
- Issue 4: HEU - Uranium Intake Estimation
- Issue 7: U-233 Intakes
- Issue 9: Np-237 Intakes
- Issue 10: Tritium Intake Estimation
- Issue 20: Skin Contamination at N Reactor
- Issue 22: Radiological Incidents
- Issue 27: Building 324 Leaks

Issue 3: Thorium-232 Internal Exposure Potential

- This SEC issue relates to:
 - Potential thorium exposures during remediation of certain areas
 - Potential use of thorium in nuclear fuel fabrication and related operations within the 300 Area during 1984 through 1990; and
 - Possible thorium use in other areas at Hanford during that time

Issue 3: Thorium-232 Internal Exposure Potential

- The likelihood of intakes of Th-232 at Hanford during 1984 – 1990 appears small
- An Internal Dosimetry Program expert did not recall any incidents or exposure concerns involving thorium
- If an intake potential existed, any dosimetrically significant intakes would have resulted from incidents that would have been recognized in the field
- Site research and interviews to investigate the potential for unmonitored intakes of Th-232 by Hanford prime contractor employees during 1984 through 1990 have not identified any information contrary to the determination made in SEC-00201 and SEC-00057-2 that dose reconstruction is feasible

Issue 4: HEU - Uranium Intake Estimation

- This SEC issue pertains to whether workers who potentially received intakes of HEU during the post-1983 period were monitored by alpha spectrometry (for urinalysis) or by other appropriate means
- This issue is contingent upon the identification of a potential source of HEU intakes by Hanford workers from 1984 through 1990

Issue 4: HEU – Potential Source Terms

- 200 Area: site research activities determined there were no significant operations involving HEU
 - The vaults at PFP were used to store HEU materials on behalf of others, but there was no processing of HEU at PFP or the PUREX plant
- 300 Area: site research activities identified potential use of HEU in nuclear fuel R&D activities in the 308 Building
 - Research into fast reactor fuels in the late 1980s: oxide, metal, and mixed-oxide fuels.
 - Intermittent fuel pin fabrication using fuel pellets produced elsewhere (ANL-W and LANL)
 - MC&A data indicated the presence of HEU powders in 308 Building, but no records indicating the use of these materials were identified

Issue 4: HEU - Radiation Protection 308 Building

- 2017 Interview with a Rad. Monitor expert for Westinghouse 300 Area
 - Stated that nuclear materials in 308 included plutonium and uranium
 - Various types of air monitoring were used
 - 308 Building was solely a Westinghouse facility, not shared with PNL
 - Monitoring practices were stringent
 - Workers received routine whole-body and chest counts, *in-vitro* bioassay, and nasal smears when needed
 - Procedures were in place for responding to incidents
- Interviews July 2013 involved several workers from 308 Building (1970s - 1980s)
 - The individuals stated that operations were performed in gloveboxes and
 - Contamination surveys and air monitor testing were performed daily

Issue 4: HEU - Summary

- Reactor fuel pin assembly in 308 Building was the only operation involving enriched uranium that was identified
 - Batch process for R&D projects: no routine operations with HEU were identified
- Operations were performed in gloveboxes in what was described as a well-controlled environment that included daily surveys and various types of air monitoring
 - Internal exposure from HEU would only have resulted from radiological incidents
- It seems unlikely that an incident would have gone unrecognized; especially given that 308 Building was considered an alpha facility
- Procedures were in place for responding to incidents, including sending individuals for *in-vivo* counting, as needed

Issue 4: HEU - Conclusion

- Workers in the 308 Building
 - Received routine bioassays including whole-body and chest counting
 - U-235 was one of the isotopes routinely reported in chest-count results
 - Transuranic materials in the 308 Building required a rigorous internal monitoring and workplace surveillance program
 - Appropriate bioassay measures (both *in-vivo* and *in-vitro*) were available in the event of an incident involving HEU
 - Unknown intakes would have been detected by routine chest counting
- Site research and interviews to investigate the potential for unmonitored intakes of highly-enriched uranium by Hanford prime contractor employees during 1984 - 1990 have not identified any information contrary to the determination made in SEC-00201 that dose reconstruction is feasible for those workers during that time

Issue 7: U-233 Intakes

- This SEC issue pertains to potential sources of U-233 intakes during 1984 through 1990, and the adequacy of Hanford's internal monitoring practices for U-233 in the event such sources existed
- This issue is contingent upon the identification of a potential source of U-233 intakes by Hanford workers from 1984 through 1990
- With respect to intake potential
 - Site research and interviews provide no indications of any sources or usage of U-233 from 1984 through 1990
- A recommendation to the Hanford WG is that this issue be closed would, therefore, seem appropriate

Issue 9: Np-237 Intakes – Possible Sources

- Site research actions were accomplished to investigate
 - Potential exposures associated with the Multi-Isotope Production (MIP) Test performed in the FFTF
 - Potential exposures associated with nuclear waste characterization research
 - Potential exposures at the PUREX plant associated with the side-pocketing of impure neptunium solutions, and from legacy materials in Q Cell
- The white paper goes into detail to discuss the potential sources and concludes it's unlikely such activities would have resulted in unknown intakes of purified Np-237

Np-237 Summary

- With respect to chronic intake potential, there were no significant sources of purified Np-237 at Hanford (1984 – 1990)
- What little intake potential that existed for purified Np-237 during that time appears to have been limited to infrequent activities involving small quantities within the 300 Area
 - Any intakes would have been the result of radiological incidents
- An incident involving a potential intake of Np-237 that apparently occurred in July 1989 confirmed that appropriate bioassay methods were available and used
- Site research and interviews completed to investigate the potential for unmonitored intakes of purified Np-237 by Hanford prime contractor employees during 1984 through 1990 have not identified any information contrary to the determination made in SEC-00201 that dose reconstruction is feasible for those workers during that time

Issue 10: Tritium Intake Estimation

- This issue pertains to tritium dose assignment in the event that sources of Special Tritium Compounds (STCs) are identified that present a potential for worker intakes during the period 1984 through 1990
- It appears this issue was prompted by a statement in the Hanford site profile that metal tritides were potentially present as part of the Tritium Target Program that began in 1988 (ORAUT-TKBS-0006-5 Hanford site - occupational internal dose)
- Presumably, this refers to post-irradiation examinations of test assemblies for light water reactor-based tritium production performed by PNL in 300 Area

Issue 10: Tritium Intake Estimation

- NIOSH has not identified any sources of metal tritide exposure at Hanford from 1984 through 1990
- NIOSH has developed methods for assigning dose from intakes of special tritium compounds
- ORAUT-OTIB-0066, Calculation of dose from intakes of special tritium compounds
- Conclusion:
 - No dose reconstruction infeasibility related to intakes of special tritium compounds has been identified

Issue 20: Skin Contamination at N Reactor

- This issue pertains to the adequacy of monitoring data for skin contamination that resulted from radiological incidents involving primary cooling water at the Hanford N Reactor. Site data indicate considerable potential for skin contamination during maintenance work at N Reactor.
- Formal monitoring and recording of skin contamination events at N Reactor were in place well prior to 1984
 - Site used a skin contamination form
 - Portal monitors were in use as of 1984

Issue 20: Skin Contamination at N Reactor, cont.

- The skin contamination forms included:
 - Maximum contamination levels and exact location
 - Estimate of time
 - If sent for whole-body counting
- NIOSH reviewed several skin contamination forms in the SRDB and 2,200 Hanford claims in the 1984-1990 period
- Conclusion:
 - No internal or external dose reconstruction infeasibility related to insufficient monitoring for skin contamination events at N Reactor has been identified
 - The site had portal monitors, a formal system in place for identifying and documenting skin contaminations and for prescribing follow-up actions as appropriate. This system was in place prior to and throughout (1984 – 1990).

Issue 22: Radiological Incidents

- Issue pertains to whether sufficient bioassays were taken to account for potential worker internal exposures from minor radiological incidents during 1984-1990
- Hanford's guidance to site contractors was:
 - Refer employees for internal dosimetry evaluation
 - When an incident/workplace indication that suggested a potential for a radiological intake based on workplace monitoring data
- NIOSH/ORAU team reviewed numerous site references and conducted interviews
- Reviews of the numerous examples of contractor radiological incident reports available in the SRDB show that the prime contractors had systems in place for:
 - Recognizing and documenting radiological incidents in the field
 - Further investigating potential exposures and notifying PNL when required
- No dose reconstruction infeasibility associated with insufficient attention to internal dose from workplace radiological incidents was identified

Issue 27: Building 324 Leaks

- There were leaks of high-level waste in B-Cell, Building 324 (including a major spill), reportedly in 1986. Decontamination of B cell began in the late 1980s. There were earlier leaks under A-Cell and C-Cell. The soil under B-Cell was found to be contaminated in 2010.
- The BRS reads, “The adequacy and completeness of monitoring data have been evaluated and determined to be sufficient for dose reconstruction. Documentation of those findings is pending.”
- Evaluation of pertinent radiological incidents that occurred within the 324 Building did not identify any personnel monitoring deficiencies or indications of unmonitored internal dose
- No dose reconstruction infeasibility associated with cell leakage events at 324 Building has been identified for Hanford prime contractor employees from 1984 through 1990

OVERALL CONCLUSIONS

- DCAS/ORAU Team has found nothing contrary to the determination made in the SEC-00201 ER that dose reconstruction was feasible from 1984 onward for employees of the prime contractor organizations, (see SEC-00226 class definition)
- Extensive site research completed subsequent to SEC-00201 has not identified any evidence of large-scale use of radionuclides of concern (ROCs) or any cases where those materials would represent a potential chronic source of intake
- Internal exposure from ROCs would only have occurred as a result of radiological incidents
- A lack of nuclide-specific routine monitoring data for a non-chronic source does not equate to a dose reconstruction infeasibility

OVERALL CONCLUSIONS, CONT.

- Minor workplace incidents were not significant internal dose contributors
- Workplace monitoring with the intent of identifying and reporting radiological incidents of potential internal dose significance appeared sufficient across the site prime contractors
- Site-wide guidance for consulting the internal dosimetry program in cases of suspected or indicated radiological intake was in place and followed
- Appropriate bioassay methods were available for all ROCs and used when needed
- Workplace monitoring was backstopped with routine bioassay and by the routine *in-vivo* monitoring program in particular