

Evaluation Report Addendum for SEC-0221: Lawrence Livermore National Laboratory 1990-1995

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LLNL Site Background and Description

LLNL Site History

- DOE covered facility from 1950 to present
- Original mission was thermonuclear weapons development and diverse scientific and engineering research activities
- Activities include:
 - Nuclear weapons design, testing, and associated research
 - Atomic Vapor Laser Isotope Separation (AVLIS) process development
 - Fusion research
 - Global security research (arms control, treaty verification, etc.)
 - Strategic defense and national security research

LLNL Site

- LLNL is comprised of two sites:
 - 1.5-square-mile Main Laboratory Site located at 7000 East Avenue in Livermore, CA; and
 - Site 300: an 11-square-mile Explosive Test Site located 15 miles southeast of Livermore, near Tracy, CA
- The Main Laboratory consists of approximately 500 buildings and structures
 - Approximately 50 of the operational buildings contained radiological materials areas

LLNL SEC Petition History

LLNL SEC Class Designation History

- SEC-092: Class added to the SEC for 1950 through 1973 based on infeasibility to reconstruct internal doses from intakes of mixed fission or activation product isotopes
 - Class was limited to workers “who were monitored or should have been monitored”
- SEC-0163: Class added to the SEC to eliminate the “who were monitored or should have been monitored” distinction for 1950 through 1973
- SEC-0221: Class added to the SEC for 1974 through 1989 based on infeasibility to reconstruct internal doses from U-233 exposures in Building 251

Initial Evaluation of SEC-0221 (1/3)

- Petition SEC-0221—DCAS qualified the petition due to concerns about the adequacy of LLNL's urinalysis methods for gross alpha and uranium
- The evaluation period was from 1974-1995
- The initial ER was approved on February 12, 2016. In the interest of timeliness, the scope was limited to presenting a dose reconstruction infeasibility for potential intakes of U-233 in Building 251 from 1974-1989
- The specific concern was fabrication of bomb fraction tracers that contained U-233. That work was only performed in Building 251.
- The infeasibility bases were a lack of uranium urinalyses for Building 251 workers and the inability to determine if U-233 intakes would have been detected by routine in vivo counts. Air monitoring was deemed insufficient.

Initial Evaluation of SEC-0221 (2/3)

- The evaluation was truncated after 1989 due to a change in U-233 usage in Building 251, based on material accountability records
- March 24, 2016: the Advisory Board voted to add a class to the SEC for all workers and all areas (including Site 300) for 1974–1989
 - There was no formal Work Group during the initial evaluation
- The initial Evaluation Report (ER) reserved the evaluation of internal dose contributors other than U-233 for 1974–1989 and all internal dose contributors for 1990–1995

Initial Evaluation of SEC-0221 (3/3)

- The initial ER stated that external doses could likely be reconstructed for all members of the evaluated class (1974–1989) but reserved a formal determination
- The initial ER determined that medical doses could be reconstructed for 1974–1989. A medical dose determination for 1990–1995 was reserved

SEC-0221 Petition Evaluation Report Addendum

Scope of the SEC-0221 ER Addendum (1/2)

- Given the all-inclusive nature of the SEC class for 1974–1989, the reserved items from the initial ER amount to an evaluation for all dose contributors for 1990–1995
- Site records captured following the initial evaluation included daily logs kept by the Building 251 Radiation Control Technician (RCT)
- Reviews of the daily logs showed U-233 tracer fabrication continued post-1989, albeit very infrequently

Scope of the SEC-0221 ER Addendum (2/2)

- Additional evaluation was needed to:
 - Determine if doses from potential intakes of U-233 by workers in Building 251 could be bounded for the period 1990–1995
 - Determine if there were other internal dose contributors for which internal dose could not be adequately reconstructed or bounded during 1990–1995
 - Confirm external dose reconstruction feasibility for 1990–1995
 - Confirm medical dose reconstruction feasibility for 1990–1995
- Emphasis remained on internal dose contributors. No external dose reconstruction issues were identified

Site Research Following the Initial Evaluation

- Six site visits in all, starting in 2017
- NIOSH captured and reviewed records from:
 - The Building Files collection maintained by the Hazards Control group
 - The LLNL Archives
 - The LLNL Records Center
 - Material accountability records held by the Materials Management group
 - ES&H records provided by the LLNL Radiation Protection group
- Held an in-person meeting with leads of the LLNL Nuclear Test Data group
- Conducted onsite interview with a cognizant expert regarding [redacted]

Synopsis of Available Site Data

- Over 8,000 LLNL-related documents are in the SRDB. The available site records include:
 - Site-wide and facility-specific radiation protection program records
 - Facility safety procedures and related documents
 - The “Symphony” dataset, which contains *in vitro* bioassay results from the evaluation period
 - A chronological log of *in vivo* counts performed from 1988 through 1995
 - Lists individuals and type of count performed by date
 - A reference compiled by the LLNL Nuclear Test Data group that gives consolidated trace constituent data for bomb fraction tracer isotopes
 - A summary of the January 2024 interview with a cognizant expert describing the [redacted]

Key LLNL Facilities and Operations (1/2)

- Building 251 Heavy Element Facility
 - Fabrication of tracer sets for nuclear weapons testing
 - Tracer fabrication was infrequent after 1989
 - Tracer fabrication ceased after 1992
- Building 151 Dissolving Wing
 - Preparation and analysis of core and gas samples from nuclear device tests at the Nevada Test Site
- AVLIS Process Research: Buildings 175, 177, 490, and 491
- Building 321 Complex
 - Fabrication operations involving uranium (natural or depleted)
- Building 331 Tritium Research Facility

Key LLNL Facilities and Operations (2/2)

- Building 332 Plutonium Facility
 - Fabrication and metallurgy research
- Hazardous Waste Management Complex: Buildings 419, 514, and 612
- Site 300 Explosive Test Area
 - Contains firing bunkers equipped with accelerators or flash X-ray devices
 - Non-nuclear testing of explosives and proxy devices containing depleted uranium and tritium
- Other R&D Facilities: Building 131, Building 222, Building 231 Complex, Building 281, and Building 343

Internal Monitoring 1990–1995

- Internal dose monitoring was governed by the LLNL Internal Dosimetry Program Manual
 - Purpose was to ensure internal doses were as low as reasonably achievable (ALARA) and internal monitoring was compliant with DOE Order 5480.11
- Routine urinalyses were performed for:
 - Gross alpha
 - Gross beta
 - Plutonium
 - Elemental uranium
 - Tritium
- Routine *in vivo* counting: whole body, chest, and lung
- Workers were identified for bioassay by the field teams/resident RCTs

Internal Monitoring Data for 1990–1995

- Symphony dataset
 - *In vitro* bioassay results only (through 1995)
 - Includes results for tritium but may be incomplete
 - Tritium data were recorded in a separate data system
 - Tritium data are present in claim records
- No consolidated source of *in vivo* bioassay results
 - The chronological log allows us to verify *in vivo* counts received by specific individuals

Review of *In Vitro* Bioassay Data for 1990–1995

- The bioassay results in the Symphony dataset show:
 - Both routine and incident-related bioassay
 - Most bioassay results within each year were for uranium. The number of results for plutonium, gross alpha, and gross beta were similar.
 - Workers in the principal facilities of interest received routine urinalyses (*i.e.*, all facilities were represented).
 - Analytes were appropriate for the potential sources
- Tabulated data (by calendar year) are included in the addendum

Evaluation for Potential Intakes of U-233 1990–1995 (1/4)

- Tracer sets were fabricated in Building 251 until 1992
 - Fabrications occurred infrequently during 1990–1992 as the U.S. Nuclear Testing Program wound down
- The trace constituent data for tracer isotopes provided by LLNL provide the U-232 content of the U-233 oxide used
- The U-232 content was used to determine the committed lung dose associated with an acute intake of U-232+U-233, resulting in a U-232 lung burden equal to the minimum detectable activities (MDA) for the LLNL lung counter after six months
 - Pb-212 was assumed to be in equilibrium with the U-232, so the MDA for Pb-212 was used; also assumed the U-232 remained bound to the U-233 in the lung
 - Committed lung dose was 49 rem and highest non-metabolic organ dose was less than 100 mrem (over 50-year period)

Evaluation for Potential U-233 Intakes (2/4)

- DCAS asked the ORAU Team to confirm if workers with the highest internal exposure potential from U-233 also received routine chest counts
- The Building 251 RCT logs were reviewed page-by-page to determine who worked with [redacted]; there were only [redacted] individuals
- The *in vivo* counting log was used to verify those individuals received annual chest counts
- DCAS asked the ORAU Team to interview the [redacted] individuals to determine if there were others that had exposure potential

Evaluation for Potential U-233 Intakes (3/4)

- The ORAU Team worked with LLNL to arrange for interviews
 - [Redacted] the individuals were deceased, but [redacted] agreed to be interviewed
- The interview took place at LLNL in January 2024 in a secure conference room; NIOSH, ORAU, and a member of the ABRWH were present
- The individual interviewed was an expert in [redacted]
- The following information was obtained:
 - U-233 tracer sets were fabricated in manipulator cells
 - There was no internal exposure potential until the sealed capsules were passed out
 - Respiratory protection was worn during pass-out operations
 - The individual did not recall any contamination events that involved U-233

Evaluation for Potential U-233 Intakes (4/4)

- The individual stated the workers with the greatest internal exposure potential were the radiochemists
- The individual stated the Building 251 staff received chest counts annually and whole body counts every two years
- The individual stated they also submitted routine urine samples
- DCAS was satisfied the Building 251 workers that had the greatest internal exposure potential received routine chest counts

Ambient Dose Reconstruction Feasibility (1990–1995)

- LLNL performed ambient air monitoring on the main campus and Site 300
- The LLNL Environmental Dose TBD provides annual median air concentrations for plutonium, uranium, and tritium for 1971–2005
 - Separate tabulations are provided for the main campus and Site 300
- There are no dose reconstruction infeasibility issues for ambient internal dose

Internal Dose Reconstruction Feasibility (1990–1995)

- Routine urinalysis data showed:
 - Both routine and incident-related analyses
 - Principal facilities were represented
 - Analytes were appropriate for the potential internal exposure sources
- Unknown intakes of U-233 were detectable via chest counting at a reasonable level of committed dose
- Routine chest counts were verified for workers that had the highest internal exposure potential from U-233
- Ambient internal doses can be reconstructed using the Environmental Dose TBD
- Conclusion: Dose can be estimated with sufficient accuracy for all internal dose contributors during 1990–1995

External Dose Reconstruction Feasibility (1990–1995)

- The initial ER determined external dose could likely be reconstructed for 1974–1989
 - No external dose infeasibility issues were ever raised
- LLNL replaced film badges with TLDs in the late 1960s
- DOELAP compliance was mandatory before 1990
- The External Dose TBD provides facility-specific information for applicable beta/gamma and neutron energy bins, including for Site 300
- Area monitoring was performed on both the main campus and at Site 300
- The Environmental Dose TBD provides annual average and maximum gamma and neutron doses for the main campus and Site 300
- No external dose contributors for which dose cannot be reconstructed with sufficient accuracy

Medical Dose Reconstruction Feasibility (1990–1995)

- The initial ER determined medical dose could be reconstructed for 1974–1989 using the Occupational Medical Dose TBD
- Two upgrades to LLNL’s occupational X-ray equipment occurred in 1990–1995
- The upgrades are documented and accounted for in the Occupational Medical X-ray Dose TBD
- Occupational medical X-ray dose can be reconstructed for 1990–1995

Feasibility Findings for the SEC-0221 Addendum: Internal Sources

Internal Source of Exposure	Dose Reconstruction Feasible
Uranium-233	Yes (1990-1995)
Plutonium and americium	Yes
Mixed fission products	Yes
Elemental uranium	Yes
Tritium	Yes

Feasibility Findings for the SEC-0221 Addendum: External Sources

External Source of Exposure	Dose Reconstruction Feasible
Beta-Gamma	Yes
Neutron	Yes
Occupational Medical X-ray	Yes

Questions?



Contact Information

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

