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RADIATION AND WORKER HEALTH

National Institute for Occupational Safety and Health

DRAFT REVIEW OF NIOSH'S EVALUATION REPORT FOR PETITION SEC-00219, IDAHO NATIONAL LABORATORY: BURIAL GROUND, 1952–1970

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ABBREVIATIONS AND ACRONYMS

ABRWH	Advisory Board on Radiation and Worker Health
AEC	Atomic Energy Commission
Am	americium
ANC	Aerojet Nuclear Company
anti-C	anti-contamination
ATR	Advanced Test Reactor
CATI	computer-assisted telephone interview
CFA	Central Facilities Area
Co	cobalt
CPP	Chemical Processing Plant
Cs	cesium
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
EE	Energy Employee
ER	evaluation report
ERDA	Energy Research and Development Administration
ETR	Engineering Test Reactor
FAP	fission and activation product
hi-vol	high-volume
HP	health physics
I	iodine
INC	Idaho Nuclear Corporation
INEL	Idaho National Engineering Laboratory
INL	Idaho National Laboratory
LFC	Location File Card
lo-vol	low-volume
µCi/g	microcuries per gram
MFP	mixed fission product
mR	milliroentgen
MTR	Materials Test Reactor
NIOSH	National Institute for Occupational Safety and Health

NOCTS	NIOSH OCAS Claims Tracking System
NRP	Non-Routine Processing form
NRTS	National Reactor Testing Station
OCAS	Office of Compensation Analysis and Support
ORAUT	Oak Ridge Associated Universities Team
OTIB	ORAUT technical information bulletin
PBF	Power Burst Facility
PEQ	Personnel Exposure Questionnaire
Pu	plutonium
RFP	Rocky Flats Plant
RWMC	Radioactive Waste Management Center
SEC	Special Exposure Cohort
SOP	Standard Operating Procedure
Sr	strontium
SRDB	Site Research Database
SWP	Safe Work Permit
TAN	Test Area North
TBR	Temporary Badge Report
TRA	Test Reactor Area
TRU	transuranic
U	uranium
WBC	whole body count

1.0 INTRODUCTION

This review builds on, and supersedes, an earlier preliminary review that SC&A issued in July 2015 (SC&A 2015). This revised version adds details of Burial Ground programs and practice that derive from a series of former worker interviews that were conducted in late 2015 through 2016, as well as additional documentation identified during data captures.

The National Institute for Occupational Safety and Health (NIOSH) issued the initial evaluation report (ER) for Petition SEC-00219, for the Idaho National Laboratory (INL) on March 12, 2015. It was tasked for SC&A review by the Advisory Board on Radiation and Worker Health at its meeting of March 25–26, 2015. NIOSH issued subsequent versions of the ER on July 21, 2015 (Revision 1), and February 22, 2017 (Revision 2; NIOSH 2017). This review addresses the most recent revision (NIOSH 2017). SC&A has only addressed that information and those ER revisions that are encompassed by our original Board tasking for 1952–1970 operations at the Burial Ground. For clarification, both the Work Group and SC&A have requested that NIOSH identify, more specifically, what bioassay, air sampling, or other monitoring information it has obtained that would be the basis for its recommended approach for dose reconstructing exposures of Burial Ground workers. NIOSH has indicated that this information will be provided to the Work Group sometime in May 2017, but it was not available in time for this review. For timeliness reasons, SC&A has chosen to address what issues it can, understanding that a more focused review will be necessary once the specifics of NIOSH's intended approach are better known.

While the Board's immediate attention is focused on the proposed Special Exposure Cohort (SEC) class definition proposed for the Idaho Chemical Processing Plant (CPP), SC&A has moved forward to perform a preliminary review of those facilities and time periods for which NIOSH has deemed the available site information adequate to support dose reconstruction with sufficient accuracy. This preliminary review focuses on the ER's treatment of the feasibility of dose reconstruction for the Burial Ground (or Radioactive Waste Management Center [RWMC], as it was later termed) for the period 1952–1970. The starting year was when radioactive wastes were first accepted for burial and the latter is when burial of transuranic (TRU) wastes from Rocky Flats Plant (RFP) ceased (in favor of aboveground retrievable storage). The years of RWMC operation after 1968 had been reserved in the first two versions of this ER review pending further NIOSH research; NIOSH addressed them in its February 2017 ER revision and presented them to the Advisory Board at its meeting on March 22, 2017.

NIOSH's ER basis for deeming dose reconstruction feasible for Burial Ground workers is the availability of "procedural information" and the "data on-hand," from which NIOSH finds that it has "adequate monitoring data" to estimate dose, with sufficient accuracy, from exposure to both internal fission product and "other radionuclides" (most notably, plutonium). In conjunction with these findings, the ER emphasizes the programmatic strength of the prevailing radiological control program at the Burial Ground in 1952–1970 (NIOSH 2017).

Given these stipulations, SC&A's focus is directed at (1) ascertaining the adequacy and completeness of the "data on-hand," including available bioassay data, which are actually available for workers exposed at the Burial Ground, as well as supporting source-term, contamination survey, and air sampling data, and (2) reviewing whether the ER's programmatic description of radiological controls is accurate and representative based on records and former worker accounts of that time period.

2.0 BACKGROUND

2.1 SITE RADIOLOGICAL HISTORY

Solid radioactive waste has been buried in trenches and pits at the Burial Ground since May 1952. These wastes include onsite INL radioactive and non-radioactive wastes, much of it contaminated with mixed fission products (MFPs), as well as TRU-contaminated waste, which was shipped from RFP beginning in 1954. In May 1960, the National Reactor Testing Station (NRTS), the predecessor to INL, was designated as one of the two interim National Burial Grounds for disposal of low-level radioactive waste from various domestic sources, and subsequently received Atomic Energy Commission (AEC), commercial nuclear, and military radioactive waste from across the country during 1960–1963. Based on an AEC task force recommendation, a change in waste management policy took place in March 1970 whereby all wastes containing long-lived TRU nuclides would be segregated and stored in aboveground, covered surface pads, an operation that commenced at RWMC in November 1970. The original 13-acre site for the Burial Ground was progressively expanded to 168 acres in 1970 and to 177 acres at the present. Currently, the RWMC consists of 20 pits, 58 trenches, and 21 soil vault rows (NIOSH, 2007). With regard to TRU wastes, it was established that 148,736 drums and 17,128 cartons and boxes, containing a total of 300–400 kilograms of plutonium and americium, were disposed in pits at the Burial Ground from 1952 to 1970, the vast majority of which originated at RFP ([redacted] 1977).

NRTS waste originating on site was buried uncontained, wrapped in polyethylene, or in cardboard boxes. Waste received from RFP was buried in 30- and 55-gallon drums and wooden boxes. RFP TRU waste was buried in specific pits alongside minor quantities of INL onsite bulk waste (in 1970, the operating contractor, Idaho Nuclear Corporation, was instructed to not mix NRTS onsite waste with RFP waste, unless the principal contaminant in the NRTS waste was plutonium or uranium) (AEC/ID 1970). Although initially stacked in the pits, RFP drums were randomly dumped beginning in 1963 for economic and radiation exposure reduction considerations. There were no AEC or field office criteria specifying the quantity of radioactive material that could be buried, nor were there any documented restrictions concerning the disposal of liquids in the early years (AEC/ID 1970).

While MFPs and RFP plutonium undoubtedly did dominate the radioactive waste being managed at the Burial Ground, the actual radionuclide content of specific onsite and offsite solid waste being handled at any given time was not normally known, particularly in the 1950s and early 1960s. For example, the onsite NRTS waste was nominally described as “mixed fission products” but could consist of a variety of radioactive constituents (AEC/ID 1970). Likewise, for RFP wastes, shipments did not include paperwork describing physical form and radionuclide content until 1964, following an immediate action directive from the AEC that declared RFP waste to be “classified” and subject to more formal handling and recordkeeping (DOE/ID 1985, [redacted] 2016). For nationwide commercial and military radioactive waste received at the Burial Ground in 1960–1963, one former Burial Ground [redacted] found that those offsite shipments arriving at the Burial Ground did not have documentation that identified the waste container contents, and proposed shipments "*seldom, if ever,* [were] *the same as the shipment itself*" (Phillips 1963; May 14, 1963, report).

2.2 RADIOLOGICAL CONTROL AND MONITORING

Routine external personnel dosimetry consisted of the wearing of film badges, and later TLDs, for which individual records are available in electronic form from the U.S. Department of Energy (DOE). There was no routine internal bioassay program at the Burial Ground (RWMC) until 1977, when a formal program of routine and special bioassays was put in place that specified scope, frequency, and trigger criteria for when special bioassays and lung counts were to be taken (EG&G 1978). NRTS site-wide internal monitoring procedures would have applied to the Burial Ground with any suspected intake of radionuclides prompting a "special" bioassay. Fecal analyses for actinides were available site-wide beginning in 1965.

"Air dust" environmental samples were collected near the edges of waste burial pits to ascertain any resuspension in the surrounding air of radioactive particulates. While some of the air dust sampling found resuspension of plutonium contamination, the concentrations measured were usually small fractions of the then National Bureau of Standards guidance levels (Phillips 1963). One exception noted were samples taken on May 9–10, 1962 near Pit #2, which indicated air concentrations of plutonium "*2-3 times the radioactivity concentration guides for a 40 hour week*" (AEC/ID 1962). Respirators were not routinely used, nor alpha contamination routinely surveyed, at the time of this 1962 contamination event.[1] Given the location of these samplers, they (and other perimeter samplers) would not have sampled the immediate working area of the workers working inside or in close proximity to the pits or trenches when positioning drums or cleaning up spills. Also, the constant crushing of waste containers by heavy tractors and the pushing of contaminated soils over them by bulldozers would have led to frequent resuspension of airborne contaminants ([redacted] 2016).

Flooding of the TRU-containing waste pits in 1962 also led to some migration of alpha contamination into the soil in and around those pits (Phillips 1962a). Surface and subsurface soil samples taken in and near Pit #10 in 1969 found gross alpha activities that ranged from 1.3×10^{-5} microcuries per gram (µCi/g) to 2.2×10^{-4} µCi/g at 0–2 inches depth, with plutonium-239 (Pu-239) activity levels between 5.3×10^{-6} and 1.2×10^{-4} µCi/g (AEC/ID 1969a). This conservatively equates to an upper bound occupational dose level of between 7 and 160 mrem/year based on continuous exposure as defined later in the Idaho National Engineering Laboratory's (INEL's) guidelines for residual radioactivity (SAIC 1993), albeit any occupational dose would be considerably lower given the intermittent degree of worker exposure.

While both high-volume (hi-vol) and low-volume (lo-vol) air samplers were available for localized monitoring of waste disposal activities and personnel, this was at the discretion of the assigned area health physicist until it was required in the 1960s for the dumping of RFP wastes (NIOSH 2017). A survey of Safe Work Permits (SWPs) for the Burial Ground for 1961 and 1965 showed that hard hats, coveralls, gloves, and shoe covers were required, but not any special

[1] This is inferred from a directive provided in "Health Physics Practices at the NRTS Burial Ground" (AEC/ID 1962), which required that interim measures be taken in response to this elevated plutonium air concentration that involved the temporary wearing of respirators at the Burial Ground and the alpha contamination monitoring of all personnel, vehicles, and equipment leaving the Burial Ground.

badging, bioassays, or occupational air monitoring; these latter requirements were, again, at the discretion of the health physicist, but no such SWP requirements were found in the sampling of permits reviewed for 1960, 1962, and 1965 (Phillips 1960, Phillips 1962b, Phillips 1965). Based on this sampling review, most of the concerns evoked in the SWPs were directed at external exposure rates and limiting time of exposure for Burial Ground workers.

There is disagreement between former Burial Ground worker interviewees about wearing of anti-contamination (anti-C) clothing, with some ([redacted] 2016, [redacted] 2016) indicating that workers usually dressed in anti-Cs, with respirators as necessary, while others recall only wearing coveralls ([redacted] 2016). Photographs of burial operations in the 1960s (See Appendix B) tend to corroborate the perspective that workers apparently wore either anti-Cs or coveralls, and accompanying health physics technicians or observers wore street clothes (with gloves and shoe covers) (Burial Ground photo 1958, 1961, 1965a, 1965b, 1969b; see Appendix B). This practice was corroborated by at least two former Burial Ground workers ([redacted] 2016, [redacted] 2016). Likewise, a sampling of SWPs for that time period show coveralls, gloves, and shoe covers being required for Burial Ground workers, and as determined by the health physicist, respiratory protection (Phillips 1965a, Phillips 1960).

There is some disparity regarding former worker (including radiological technician) accounts of occupational air sampling performed at the Burial Ground. Some do not recall any routine air sampling ([redacted] 2016, [redacted] 2014) or very limited sampling ([redacted] 2016), while others indicated some air sampling being performed. One reason given for limited air sampling around the waste pits and trenches was the lack of power outlets for the samplers given the remote, open nature of the site ([redacted] 2016), which necessitated portable electrical generators (AEC/ID 1966). A distinction was made between stationary air samplers for environmental monitoring versus portable samplers that the health physics technicians deployed during dumping operations ([redacted] 2016). One radiological technician of that time period noted that air monitoring was very limited during most of subsurface waste disposal and believed it "*unlikely that air sampling was done with every dumping…more likely air sampling would have been done intermittently during some of those activities*" ([redacted] 2016). This was despite indications by a former Burial Ground radiological technician that resuspended airborne contamination was a known concern at the Burial Ground:

> *Resuspension was a concern, but they couldn't monitor it effectively, because the Caterpillar blows cooling air out the front of the vehicle.* [The radiological technician] *felt this air movement would compromise sampling, so he attached sticky paper to the front the [bulldozer] as an alternate monitoring technique.* [[redacted] 2016]

This seems to be borne out by the relative lack of sampling results for the Burial Ground. A review of available air monitoring reporting confirmed onsite and offsite environmental monitoring of airborne gross alpha, gross beta, and iodine-131 (I-131) in the 1960s, but only a few records were located in the Site Research Database (SRDB) of hi-vol and low-vol air sampling results for airborne occupational exposure at the Burial Ground, with most results for CPP, test reactors, and research reactors (AEC/ID 1961a, AEC/ID 1961b, AEC/ID 1968, AEC/ID 1969b, AEC/ID 1969c). These latter results were found to be positive for alpha, beta, and MFPs (using an I-131 marker), but typically only in fractions of the unrestricted Radiation

Concentration Guide values. Given that entries in Central Facilities Area (CFA) logbooks and monthly health physics reports indicate that air sampling was being performed at the Burial Ground, records may exist but have not been identified to date.

Regarding available air sampling data for Burial Ground operations, the ER notes:

> *Routine waste disposal did not require air sampling unless the CFA Health Physicist deemed it necessary. However, air samples were required any time Rocky Flats waste was unloaded (…).* [NIOSH 2017, page 234]

However, a review of SWPs that were also required for disposal of RFP waste found no reference to required routine air sampling during unloading of RFP waste (Phillips 1965, Phillips 1960), albeit this may have been addressed as a routine practice separate from SWP requirements (this appears to be confirmed in monthly Burial Ground reports, e.g., Phillips 1965b). Based on a review of air sampling documentation in the SRDB, the only sampling results found to date pertain to routine environmental monitoring. Even in this context, it should be noted that only relatively "low" volume air sampling was performed at the Burial Ground prior to February 1976; higher volume air samplers were introduced in February 1977 to enable sufficient air volume through the filters to permit adequate plutonium detection analysis to be performed (EG&G 1983).[2] In the earliest years of the Burial Ground (1950s), there does not appear to have been any routine air sampling performed ([redacted] 2016).

From interviews with former workers of that era, there seemed to be agreement that radiological control technicians checked all vehicles and personnel after every job, using a combination of GM-counters, for lower level contamination, and "Cutie Pies" or Juno or Jordan monitors, for higher contamination ([redacted] 2016). While smear samples may have been taken (most likely of the vehicles themselves, upon leaving the Burial Ground) ([redacted] 2016), it was clear that release limits were at the minimum detectable of the instruments used at the time (indicated as around 0.1 mR/hr) ([redacted] 2016). In the years in question, there is general agreement among former Burial Ground workers that although an alpha monitoring instrument was available, they did not routinely look for alpha contamination ([redacted] 2016, [redacted] 2016).

2.3 BIOASSAY MONITORING AND RECORDS

In terms of bioassay monitoring, one former Burial Ground radiological technician interviewed (from the mid-1960s) indicated that nasal swipes were taken and that urine samples were sometimes collected at the direction of health physics personnel (this was non-routine, because "*they weren't finding contaminants, and the high-vols didn't show anything*") ([redacted] 2016). This same rad tech noted that whole body counts (WBCs) were performed on a regular basis from a "*screening*" standpoint.

[2] The Idaho Operations Office issued a Standard Operating Procedure (SOP) for "Hi-Volume (Hi-Vol) Sampling of Airborne Radioactive Materials" on November 15, 1963, but this apparently applied to sampling of beta and gamma emitting particulates; no consideration of alpha emitters is provided (AEC/ID 1963). In any case, as illustrated by the 1976 upgrade in sampling technology, this version of "hi-vol" sampling would have still been inadequate for monitoring airborne plutonium contaminants.

Another radiological technician from that period noted that internal dosimetry was "*not well developed*" at the early period of time at the Burial Ground, that there "*was* [sic] *not a lot of biological samples taken*," and that "*sampling was primarily event-driven*" ([redacted] 2016). This same interviewee indicated that "*there were probably very few bioassays for Burial Ground workers until up into the 1970s*." Another rad tech observed that "*bioassays were only for suspected intakes…he never saw any incidents while he was* [at the Burial Ground]." A Burial Ground worker "*doesn't remember getting urinalyses*," but does recall at least two WBCs ([redacted] 2016).

The ER notes that "*the Analysis Branch of the* [Health and Safety] *division initially provided routine urinalysis of all NRTS personnel with sampling frequency varying between quarterly and yearly, depending on the expected potential for uptake (Horan, 1959)*" (NIOSH 2017, page 179). However, it noted that "*INL did not routinely collect bioassay samples for uranium exposures*" and by 1961, at the commencement of whole body counting, routine urinalyses were abandoned by INL until 1974 for the laboratory, as a whole, and until 1977 for the RWMC. "Special" or non-routine bioassays could be requested by area health physics personnel when workplace indicators indicated that an intake may have occurred, but NIOSH found that although some such bioassays were found in the records, they "*could not be directly related to a contamination event at the Burial Ground*" (NIOSH 2017, page 233). Similarly, while the names of some Burial Ground workers can be found for specific SWPs that entailed bioassay, NIOSH determined that "*it is possible that the monitoring was due to work activities in other areas*" (NIOSH 2017, page 233).

3.0 VALIDATING INTERNAL MONITORING – NOCTS SAMPLING

As a means to characterize internal monitoring practices and gauge the availability of bioassay data for Burial Ground workers, SC&A surveyed the NIOSH OCAS Claims Tracking System (NOCTS) claimant database to identify any Burial Ground workers for the period 1952–1970, and whether *in vivo* and *in vitro* bioassay data could be found for those workers for the period of Burial Ground work. SC&A reviewed the portion of the INL claimant population with covered employment during the relevant period and who had job titles most likely to be associated with Burial Ground work. These job titles included: Equipment Operator, Truck Driver, Laborer, and Yardman (see Appendix A, Figure A-1). At the time of this review, there were 1,016 claims with verified employment prior to 1971. Of those claims, SC&A identified and reviewed the records of 124 claimants who fit the job title criteria.

As detailed in Appendix A, SC&A found that although a significant number of these claimants could have worked in the Burial Ground during the period in question, there was no clear systematic means or evidence that places any individual worker at the Burial Ground by actual periods of work. Specific dosimetry area codes indicating the Burial Ground as a work location do not appear to be in general use until the mid-1970s (corresponding with the advent of a formal bioassay program). Therefore, neither the external dosimetry records nor the specific claimant's Location File Card (LFC) would have indicated a Burial Ground work assignment. Rather, it appears that workers who were assigned to the Burial Ground had external dosimetry badges or internal bioassay identifying them as workers out of CFA. While some of these workers may have had assigned work at the Burial Ground (e.g., heavy equipment operators and yardmen), most appeared to be given work assignments across the INL site, including CPP and the test and research reactors.

SC&A was able to identify 11 claims that could be directly tied to the Burial Ground during a known period of work (detailed in Appendix A by name, claim number, dates of covered employment, known dates of work at the Burial Ground, and any internal monitoring during the Burial Ground work). Overall, SC&A identified 16 instances in which routine beta or gamma or beta/gamma urinalyses was performed at some time after the known Burial Ground work. However, such samples were often taken several months after the known work occurred and were identified with other work areas. In one case, internal monitoring did not occur until over 8 years after the known Burial Ground work occurred. Four instances were identified where special beta or gamma urinalyses and/or WBCs were taken at some time after the identified work. Only one of these four examples had special sampling taken at the very end of Burial Ground exposure. The other three special bioassay/WBCs were taken at 2 weeks, 3 months, and over a year after the identified work and were identified with other site areas (Area Hot Cell, Test Area North [TAN], and CFA, respectively). No claimants had monitoring performed for alpha intakes.

Beyond the 11 workers who had documented work histories at the Burial Ground, SC&A identified other workers (Appendix A, Table A-2) who cited information during their computer-assisted telephone interviews (CATIs) that indicated work at the Burial Ground. However, SC&A was unable to find any corroborating evidence in their individual monitoring records that provides relevant dates and results of bioassays that may have been related to this work. This was despite accounts of work at the Burial Ground that included potential external and internal exposures during activities such as handling and dumping waste, and cleaning up spills.

4.0 SC&A REVIEW OF NIOSH EVALUATION REPORT FOR PETITION 00219

In its February 2017, Revision 2, ER (NIOSH 2017), NIOSH based its conclusion about dose reconstructability for radiation exposures at the Burial Ground from 1952 to 1970 on the following stated positions in the ER. Based on its review of available documentation in the SRDB, SC&A provides the accompanying analysis, preliminary findings and conclusions, and lines of inquiry that the Work Group should consider for resolving these issues. For convenience in analysis and discussion for this report, SC&A has identified NIOSH positions on the Burial Ground found at various locations throughout the ER and has assigned them numbers by topic.

4.1 NIOSH ER POSITION 1

Position 1(a):

> ***The Burial Ground's internal dose monitoring program was based on a strict contamination control program with entry and exit monitoring.*** [NIOSH 2017, page 32]

Position 1(b):

> ***With the exception of Rocky Flats waste, mixed fission products were considered the controlling radionuclides.*** [NIOSH 2017, page 232]

Position 1(c):

> ***When workplace indicators indicated that an intake may have occurred, "special" (non-routine) bioassay would be requested by the area Health Physics staff.*** [NIOSH 2017, page 232]

4.1.1 SC&A Analysis of NIOSH ER Position 1(a)

> ***The Burial Ground's internal dose monitoring program was based on a strict contamination control program with entry and exit monitoring.***

While early disposal practices were designed to limit direct handling and minimize external exposures (e.g., use of cranes to lift containers into trenches and random dumping from trucks), former workers involved in disposal recalled that "*barrels often did not remain intact, i.e., lids popped off the drums and waste spilled into the pits*" (DeWitt 1990). In random dumping, "*waste was put in pits without any concern for alpha contamination*" (DeWitt 1990). For RFP TRU waste, "*the semi-trucks were unloaded simply by dumping the barrels out of the truck…when the barrels hit the ground, they would often break open and pop open; the lids would pop off…the waste from the barrels would be scattered all over the pit*" (DeWitt 1990). A former Burial Ground worker noted that "*dumping jobs never stopped when lids popped off*" ([redacted] 2016), and another recalls about half a dozen drums being broken open during his time there ([redacted] 2016). Although liquid radioactive wastes were prohibited, TRU-related waste drums from RFP were found to be leaking on occasion during transport and handling at the Burial Ground (DeWitt 1990).

In terms of operations, the "strictness" of the contamination control program, and the formality and management of the dumping operation itself, are questionable. Among the various experiences shared by former Burial Ground workers, the following from an account from the summer of 1967 is noteworthy in this regard (DeWitt 1990).

> *As we would unload the semi-truck, we would make a game of unloading the 55-gallon drums. Without any regard to anything else than seeing how far we could make these barrels fly down to the bottom of the pit, or how high they would bounce off of each other, or wanting to see if we could get them to land just right so the tops would come off, or to see how far out we could make the drums bounce and roll. On some of the drums, the lid would pop off as the barrels hit the ground. The barrels would just roll here and there. The waste from the barrels would be scattered all over the pit.*
>
> *During this time period, we were offered no physical protection. We did not wear respirators. We would, at times, wear coveralls and shoe covers.*

> *If we had of* [sic] *only know then what we know now, the barrels would of* [sic] *been unloaded differently and we would have had on protective clothing.*

It was confirmed by this interviewee that this was RFP TRU waste and that when the lids popped off, they observed that "*the drums were filled with a lot of metal shavings, rags, plastics, and cloth materials*" (DeWitt 1990). This interview, and most of the preceding ones, were part of an RWMC "source term" review conducted by the site, involving interviews of a broad range of Burial Ground workers, supervisors, and health physicists in 1990.

As the photos in Appendix B illustrate and as various former Burial Ground workers interviewed recounted, workers handled the waste containers directly and had to sometimes go into the pits and trenches both to position drums and containers and to clean up spills. In those instances, potential and actual contamination would have been more significant, as in the following account gleaned from a claimant from 1966 (see Appendix A, Case [redacted]):

> *He was* [redacted] *"hot waste" in Pit 9 when his clothes became contaminated. The Health Physics Tech surveyed him with a Geiger counter and the Geiger counter showed very high levels of radiation. Because of this, he was not allowed to leave the Site with the clothes that he was wearing. He had to be given a new pair of coveralls and a pair of boots to wear home. His own clothes were confiscated along with all of his personal ID, driver's license, wallet, etc...* [redacted] *and* [redacted] *55 gallon drums of "hot waste" into Waste Pit #9. Pit #9 was the worst as far as contaminated and radioactive waste materials. These drums would come off semi trucks and were filled with contaminated waste from colleges, hospitals, research laboratories, etc.... would have to unload these drums from the truck and roll them down into the Pit. Sometimes the barrels would crack open and spill out material that would have to be handled and cleaned up.* [NOCTS Case [redacted]]

In this instance, the CATI also indicates the worker was monitored externally because of his job, and that he was restricted from further work because he had reached his radiation dose limit. However, his claimant file indicates that INL has no record of any external or internal monitoring. It should be noted that most SWPs for Burial Ground operations required waste handlers to "clean up work area (by group performing job)," which would have entailed retrieval of spilled items and cleanup of any resulting contamination, most likely in the pits or trenches themselves, leading to potential exposure to resuspended TRU contamination (Phillips 1965).

Former workers noted that "*management of waste disposal was very lax at the time*" and that the early contamination monitoring techniques were "primitive"; for example, area monitoring was performed in one account by employing the probe of a GM detector mounted on a broom handle that was driven around the site ([redacted] 2016). Although an alpha monitor was available at CFA, a number of former Burial Ground workers do not recall using one to conduct surveys or only using one occasionally ([redacted] 2016, [redacted] 2016, [redacted], 2016). Several workers do not recall a health physics technician being present during the actual dumping ([redacted] 2016, [redacted] 2016, [redacted] 2016), while others recalled such coverage ([redacted] 2016, [redacted] 2016, [redacted] 2016, [redacted] 2016, [redacted] 2016). Several veterans of the early years (1950s to early 1960s) of Burial Ground operations recalled no health physics coverage of dumping operations at all, but noted that changed over time. ([redacted] 2016, [redacted] 2016).

In terms of exposure, one Burial Ground worker recalled that "*the drivers took showers when they got back to CFA…it was not unusual to get contaminated*" ([redacted] 2016). Another became heavily contaminated handling drums in Pit 9 (see preceding account). Others recalled only occasional contamination, detected typically on coveralls or on shoe covers ([redacted] 2016). Still others did not recall any major contamination ([redacted] 2016, [redacted] 2016, [redacted] 2016).

One former Burial Ground radiological technician encountered elevated contamination levels, including alpha, "many times" ([redacted] 2016). He indicated that contaminated soil was "pushed back [into the pits or trenches] with a bulldozer or front loader." Levels of contamination were not "homogenous"; they would vary "depending upon the specific drums being crushed" ([redacted] 2016). The proximity of workers to these radioactive waste containers and any resulting contamination due to leaks or spills are evident in photos of dumping operations and conditions at the Burial Ground in the 1960s and before (see Appendix B).

As noted earlier regarding personnel protective clothing and equipment, there seems to be some difference in recollection, perhaps as a function of time period at the Burial Ground. Bulldozer operators were said to have worn anti-C clothing, while yardmen, waste handlers, and drivers had not ([redacted] 2016, [redacted] 2016). This is corroborated by photographs and was supported by a yardman who recalled wearing gloves, but no coveralls or booties—essentially street clothes—while dumping waste containers ([redacted] 2016). Another interviewee, a former radiological technician from the 1960s, indicated that all workers handling waste wore anti-Cs (coveralls and shoe covers), with those "really close," getting respirators ([redacted] 2016). Interviewees recalled Burial Ground workers being surveyed after drums were unloaded, with all trucks and other equipment being surveyed upon leaving the site ([redacted] 2016, [redacted] 2016, [redacted] 2016, [redacted] 2016). However, there is some uncertainty about such surveillance in the earliest days of the Burial Ground, with at least one veteran laborer recalling that in the 1950s, they did not have radiological technicians accompanying workers for waste dumping at the Burial Ground and were not monitored for contamination ([redacted] 2016). This seemingly contradicts entries in a 1957 CFA health physics logbook in which regular entries are found for health physics entry and exit monitoring of vehicles and personnel at the Burial Ground (AEC/ID 1957).

By the INL operating contractor's own admission, the capability of the contractor to even administer a valid contamination control program became questionable for the Burial Ground at some point in the 1960s to early 1970s. In an April 5, 1972, internal memorandum within Aerojet Nuclear Company (ANC or Aerojet) (Aerojet 1972), the health physics organization identified poor and outdated instrumentation due to lack of funding as undercutting its program. It noted that a "longstanding" problem existed with outmoded health physics smear counters at CFA, with no smear counting equipment available for the Burial Ground in the period before February 1972. This was considered to be "*a completely intolerable situation which must be corrected as soon as possible if we* [ANC health physics] *are to avoid a serious contamination* *incident*."[3] The health physics organization further stressed that smear counting was the only capability available to them to detect "loose" contamination and to differentiate between beta-gamma and alpha contamination. In its final weighing of potential consequences related to the lack of this equipment, ANC Health Physics makes the following assessment:

> *The Burial Ground has been operating for years without any smear counting equipment and has avoided serious contamination incidents by luck and/or by the experience of well-trained health physicists. The Burial Ground operation cannot comply with present radioactive on-site shipping regulations because of a lack of proper detection equipment. With increased emphasis on contamination control, it is absolutely imperative that state of the art simultaneous smear counting equipment be purchased for the Burial Ground as a minimum.* [Aerojet 1972]

In conclusion, the ANC health physics [redacted] concludes that "*without smear counting equipment, or outdated and inadequate smear counting equipment, there is, at best, only a token effort of contamination control*."

These statements notwithstanding, it is not clear whether smears may have been performed, or not, at the Burial Ground, and counted at CFA or elsewhere on site at the NRTS. Assuming smearing was not adequately performed or was severely hampered at the Burial Ground for some time before 1972, it is not clear how far back that circumstance may have existed. For example, CFA monthly health physics reports routinely estimate hundreds of "smears collected and counted" in the early and mid-1960s, but it is not certain how many of those were taken at the Burial Ground, whether that frequency was maintained as time went on, and how valid those smears may have been given these instrumentation issues.

Compounding these questions is the sensitivity of smear counting at the time. Smear counting capability was a function of the detection thresholds of the monitoring instrumentation available. One radiological technician from the late 1950s observed that "*they did not have any scalers or precise instruments*" and that release limits for swipes were not very sensitive, essentially the minimum detectable of the instrumentation, which was about 0.1 mR/hr[4] at the time. ([redacted] 2016). The significance and implications of inadequate smearing and air sampling are clear, as reflected in a former Burial Ground health physics technician's account:

> *After the burial was complete, the HP* [health physics] *techs surveyed the workers and the vehicles. They tried to check for beta/gamma and alpha, but alpha instruments for use in the field weren't very good in those days. They relied on smear analysis and whatever was on the filters or air samples.* [[redacted] 2016]

The surveillance and decontamination of personnel, equipment, and vehicles would, of course, be suspect given the aforementioned finding about lack of suitable smear counting at the Burial Ground and CFA at some time prior to 1972. However, there is also some question regarding the rigor of INL onsite surveillance and decontamination, generally, given an institutional concern in

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[3] It was noted that as an interim measure, at that time in early 1972, the ANC health physics office would be deploying an Eberline RM-14 with HP 210 probe to count smears at the Burial Ground and would seek a surplus beta-gamma counter as a stop-gap measure.
[4] The interviewee did not reference a rate time period, but it is assumed here to be mR/hour.

the late 1960s over INL roadway contamination. A NRTS-wide survey of road contamination in 1969 implicated the Burial Ground and found the following:

> *The number and intensity of the contaminated areas along the route to the Burial Ground indicates inadequate handling procedures and is a matter of concern. It appears that either waste shipped to the Burial Ground has been improperly packaged or waste unloaded at the Burial Ground was carelessly handled causing contamination of the returning vehicle and then the roadway. Surveys of vehicles and equipment leaving the burial area should indicate if the latter is occurring.* [Voelz 1969]

This 1969 road survey found contamination by various fission product nuclides, including cesium-1337 (Cs-137) and cobalt-60 (Co-60), with measured dose rates (at contact) of recovered particulates as high as 20 and 30 R/hr.

SC&A Preliminary Finding Related to NIOSH ER Position 1(a)

It is questionable whether a "strict" contamination control program existed at the Burial Ground, given the weight of evidence indicating a haphazard and inconsistent approach to limiting contamination when dumping TRU-containing waste drums, inadequate health physics monitoring instrumentation, and little evidence of contamination-driven bioassay.

Suggested lines of inquiry:

What contamination smear data and air sampling results from the Burial Grounds for the pre-1970 era has been identified in NIOSH's data capture and does it include analyses for alpha emitters?

What is NIOSH's position regarding the identified inadequacy of smear-counting capability at the Burial Ground identified in 1972 in terms of its implications for contamination surveying in the 1960s?

What is NIOSH's position regarding the inadequacies of alpha monitoring in the 1950s–1960s at the Burial Ground, and its implications for adequate contamination control, bioassay, and dose estimation for that time period?

How would NIOSH estimate and bound exposures of workers handling waste containers and cleaning up spills if source terms are uncertain, bioassay is lacking, and air sampling is not representative?

Does NIOSH have any examples of special or event-driven bioassays being conducted following a worker contamination at the Burial Ground in the 1952–1970 period?

4.1.2 SC&A Analysis of NIOSH ER Position 1(b)

With the exception of Rocky Flats waste, mixed fission products were considered the controlling radionuclides.

While MFPs and RFP plutonium did undoubtedly dominate the waste being managed at the Burial Ground, the actual radionuclide content of specific onsite and offsite solid waste being handled at any given time was not normally known. For example, the onsite waste from other areas of the NRTS is nominally described as "mixed fission products," but could consist of a variety of radioactive constituents (AEC/ID 1970).

Likewise, for RFP wastes, shipments did not include paperwork describing physical form and radionuclide content until 1964 (DOE/ID 1985), although RFP did provide an end-of-year summary of the total radionuclide content and volume shipped (DOE/ID 1985). The following is a list of radionuclide contaminants present in Rocky Flats waste (as a function of RFP operational origin), some of which may have dominated specific shipments or waste packages and been a source of potential worker exposure over the 17 years of subsurface disposal of more than 140,000 drums and 17,000 containers of TRU waste (Bechtel 2005):

- Am-241
- Ba-133
- Cf-250
- Cm-244
- Cs-137
- H-3
- Gd-148
- Ni-63
- Np-237
- Pb-210
- Pu-238, 239, 240, 241, 242
- Sr-90
- Th-228, 230
- U-232, 233, 234, 235, 236, 238, DU

A number of these source terms are alpha emitters (including alphas with weak gammas) that would not have been easily detected given the instrumentation available in the 1950s–1960s or the limitations of bioassay monitoring and workplace surveying during that timeframe.

For offsite commercial and military radioactive waste received at the Burial Ground in 1960–1963, it was found that these offsite shipments did not have documentation that identified the waste container contents, and proposed shipments "*seldom, if ever,* [were] *the same as the shipment itself*" (Phillips 1963). This waste, which was usually mingled with the RFP waste in the pits, included reactor shielding from the Air Force contaminated with Co-60; a commercial heat exchanger contaminated with various isotopes of cobalt, iron, and aluminum; drums from the Army containing material contaminated with radium-226, polonium-210, strontium-90 (Sr-90), and Co-60; and many other contaminated wastes from hospitals, universities, Energy

Research and Development Administration (ERDA) laboratories, and even from the SL-1 accident onsite (EG&G 1977). As noted, the exact radiological content and activity level of these wastes were often unknown or incorrectly reported upon receipt and disposal.

While MFPs and direct radiation were always of concern, there were instances of airborne contamination with plutonium. For example, a 1962 INL memo raises concerns over health physics practices at the Burial Ground in light of elevated plutonium air concentration levels near Pit 2, calling for interim control measures to be taken including respirators and "*more extensive exit monitoring of personnel, equipment and vehicles*" (AEC/ID 1962). A 1973 environmental surveillance assessment found that "*because of the existing Pu and Am background* [at the Burial Ground]*, it is imperative that we establish continuous air monitoring at several locations in the major downwind direction…we need to be certain that we can obtain prompt action on requests that we make of radiochemical analyses of soil air filter and bioassay samples if we are able to control the problem associated with the alpha contaminants that obviously exist within and around the burial ground*" (Aerojet 1973).[5]

In terms of alpha monitoring, one interviewee described "alpha" contamination as "*not being a specific concern*" ([redacted] 2016), while another did not recall any alpha surveying, noting that alpha survey instruments were limited in the early years ([redacted] 2016). This was corroborated by an account by a Burial Ground [redacted] health physicist, who noted:

> *At that time, the alpha portable monitors were hard to come by and were not really reliable. There was probably a lot more beta-gamma monitoring done than alpha. The portable detectors were available and were sometimes used; they were just not well developed.* [[redacted] 2016]

This recollection was echoed by a Burial Ground radiological technician from the mid-1960s, who noted that "*they tried to check for beta/gamma and alpha, but alpha instruments for use in the field weren't very good in those days*" ([redacted] 2016).

While the so-called "Breached Box" incident in 1988 at RWMC post-dated the pre-1970 waste retrieval era at the Burial Ground, the comprehensive Type "A" investigation conducted was a first-of-its-kind for the Burial Ground, coupling an inquiry into both direct and managerial root causes of a significant onsite plutonium contamination incident. The DOE field office manager receiving the investigation report emphasized that "*the present situation* [radiological program deficiencies] *at the RWMC* [was] *the result of practices over the years*." It is particularly instructive that as late as 1988, it was found that "*personnel survey procedures did not exist for alpha monitoring as required…, practical knowledge of alpha contamination was not adequate…*, [and] *monitors were inadequate for the detection of alpha contamination*" (DOE/ID 1988).

<u>SC&A Preliminary Finding for NIOSH ER Position 1(b)</u>

It is not clear whether a suitable source term can be derived for what radionuclides workers may have been exposed to during specific waste shipments, and whether such exposures can be

[5] While this finding is from an assessment a few years after the 1970 cutoff in the ER, it pertains to a persistent background of resuspended alpha particulates and is cited for that reason.

bounded by existing NIOSH methods that may rely on assumed radioactive constituency inventories for multiple shipments over longer periods of time.

Radioactive waste was not specifically identified for many drums, boxes, and other containers received at the Burial Ground for disposal. A substantial amount of offsite waste was received from commercial, university, ERDA, and military sources when the NRTS was a national radioactive waste site; some of this waste was identified as to radionuclide content and activity levels, but much of it was not. The RFP waste was dominated by plutonium, but also contained a spectrum of radionuclides, including americium, thorium, and uranium, that would have been difficult to monitor given that lack of adequate monitoring and bioassay, and the prevalence of specific radionuclides would have differed by shipment.

Suggested lines of inquiry:

How does NIOSH reconcile the presence of offsite waste (e.g., commercial and military) and Rocky Flats waste containing a spectrum of radionuclides besides plutonium in terms of assigning "dominance" of MFPs and plutonium, respectively, for developing an approach for bounding worker doses at the Burial Ground?

What about the incomplete or inaccurate inventories of waste shipments in the early years?

If actinides were inadequately monitored and quantitatively measured, how can dose contribution be adequately apportioned for the thousands of Rocky Flats shipments?

4.1.3 SC&A Analysis of NIOSH ER Position 1(c)

> ***When workplace indicators indicated that an intake may have occurred, "special" (non-routine) bioassay would be requested by the area Health Physics staff.***

First and foremost, the ER confirms that "*special bioassay also exists, but the results could not be directly related to a contamination event at the Burial Ground*" (NIOSH 2017, page 233), which apparently means that while such a policy may have existed at INL, site-wide, it is not possible to verify its implementation at the Burial Ground for exposures that took place there. The only site-specific procedure that was identified for the conduct of non-routine bioassays at RWMC/Burial Ground were the EG&G procedures for the RWMC bioassay program that were put in place in 1978, following the commencement of a routine bioassay program for RWMC workers in 1977.

An incomplete, preliminary version of INL's "Electronic External and Internal Records" was made available to SC&A for review, but it is similarly inconclusive regarding what bioassays were conducted for suspected Burial Ground exposures during the time period in question. Interviewed workers are split on the extent they were asked to leave a urinalysis sample following a contamination event; some do not ever recall doing so ([redacted] 2016), while others noted that "*urine samples were sometimes collected, at the direction of HP supervisors*" ([redacted] 2016). Another indicated that "*bioassay was only done for suspected intakes,*" but that he "*never saw an incident that required bioassay while he was there* [in the mid-1960s]" ([redacted] 2016). Most recalled having a regular WBC during their employment, including the

Burial Ground ([redacted] 2016, [redacted] 2016). It should be noted that these workers, while deployed to the Burial Ground for dumping activities, were also assigned out of CFA to other INL facilities (including CPP and the reactors) for duties that involved potential radiation exposure, and may have received special bioassays related to those exposures.

Regarding the Burial Ground bioassay program, a [redacted] Burial Ground health physicist of the time observed:

> *The saddest thing is that the insight for internal dosimetry was not well developed at the early period of time; there were not a lot of biological samples taken in the early days of the burial ground. Sampling was primarily event-driven, and they didn't really have events that would be considered accidents with the solid waste disposal during the early years.* [[redacted] 2016]

This observation is telling in that actual radiological "accidents" or "events" would not have been recognized or defined, as such, in a waste dumping operation where contamination may have been released in the pits and trenches but would not necessarily have been considered of concern to the workers involved, including the heavy equipment operators, who would have handled the waste or buried it. In this context, even the spilling of the contaminated contents of RFP drums during dumping would not have been considered a contamination "event" triggering a special bioassay, but rather an expected experience of routine dumping operations. Of particular concern is the one significant burial worker contamination in 1966 identified in the aforementioned CATI interview (Claim [redacted]); in that case, no exposure records exist for that worker during the time period in question.

It is also questionable, given the review history of the site, whether alpha contamination was given adequate attention in terms of contamination surveying, monitoring, and control. Leaking RFP drums were not uncommon (as cited in, for example, INC 1971, AEC/ID 1971a, and DeWitt 1990), but alpha monitoring was performed infrequently. The infrequent use of alpha monitors and apparent lack of available smear counting at the Burial Ground prior to 1972 would have compromised the ability of the health physics staff to detect removable or "loose" contamination on personnel, equipment, and containers, thereby negating a key workplace indicator.

SC&A Preliminary Finding for NIOSH ER Position 1(c)

While special or event-driven bioassays may have been the practice at INL at the time, there is no evidence (i.e., actual results traceable to exposure at the Burial Ground) that this practice was implemented at the Burial Ground, despite repeated instances where potential contamination was released during dumping operations. The infrequent use and unreliability of available alpha monitoring instruments and apparent lack of a suitable smear-counting capability at the Burial Ground, at least in the period immediately before 1972, would have removed or severely impaired "workplace indicators" for indicating a potential intake and the need for a "special" bioassay.

Suggested lines of inquiry:

Has NIOSH identified any "special bioassays" related to exposure at the Burial Ground for 1952–1970?

Has NIOSH identified any Burial Ground contamination events for which a "special bioassay" was requested by the area health physicist?

4.2 NIOSH ER POSITION 2

> ***NIOSH has determined that internal exposures at the Burial Ground were directly related to the materials being disposed of in the grounds. Up to the point in time that drum retrieval commenced in 1969, exposure potential was virtually all from mixed fission products in the INL waste being buried, and plutonium for the Rocky Flats Plant waste that was received for disposal. Internal monitoring data are available for the workers who supported the waste disposal activities and drum retrieval activity in 1969.*** [NIOSH 2017, page 5]
>
> ***For the Burial Ground, mixed fission and activation products were the primary internal dose hazards of concern. For urine samples only analyzed for gross beta, gross gamma, and/or strontium radioactivity, NIOSH will assess missed Sr-90 and/or Cs-137 intakes in accordance with ORAUT-OTIB-0054 and ORAUT-OTIB-0060. Similarly, NIOSH will assess missed Cs-137 intakes when using in-vivo data in accordance with ORAUT-OTIB-0060. Based on the procedural information and the data on-hand, NIOSH finds that it has adequate monitoring data to allow for sufficiently accurate estimation of internal fission product doses for workers during the period from January 1, 1953 through December 31, 1968.*** [NIOSH 2017, page 235]

4.2.1 SC&A Analysis of NIOSH ER Position 2

NIOSH's claim that "*exposure potential was virtually all from mixed fission products in the INL waste being buried, and plutonium for the Rocky Flats Plant waste*" is undercut by the lack of waste-content records in the early years (particularly before 1964 for RFP waste). While the identity of radionuclide constituents can be surmised, in aggregate, from operational source information available at INL, RFP, and in monthly and annual summaries, for much of the radioactive waste received at the Burial Ground in the early years, the radiological source terms of individual drums, boxes, and casks were unknown at the time. Onsite INL waste was routinely assumed to be MFPs and RFP waste assumed to be TRU, but without any specific verification. The contribution of military and commercial waste disposed of in the period 1060–1963, as well as SL-1 waste, is not included, as well as that of other RFP radionuclide constituents such as americium, thorium, uranium, and neptunium.

NIOSH's dose reconstruction approach assumes it has identified the dominant MFP constituents in order to apply ORAUT-OTIB-0054 and ORAUT-OTIB-0060, but it is clear from recent SC&A evaluations coupled with the uncertain content of received offsite radiological wastes that this overriding assumption is not necessarily valid. NIOSH assumes that by using a bioassay indictor radionuclide (Sr-90 and/or Cs-137), all other significant fission and activation product (FAP) intakes can be assigned by using the ratio method. However, as noted in SC&A's June 2016 and January 2017 evaluations of Cs-137/Sr-90 values and actinides using INL waste reports (SC&A 2016, 2017), Cs-137/Sr-90 values were found not to be sufficiently constant to assume a ratio of unity, as provided by ORAU-OTIB-0054. Using these results may lead to differences in assigned mixed fission and activation product uptake. In that assessment, of the 315 monthly data points analyzed for Cs-137/Sr-90 from the 1961–1998 INL waste reports, 47.5% fell within a range of 0.5 to 2.0, and 59.7% fell within a range of 0.33 to 3.0, of the recommended ratio of 1.0. Some ratio values were several orders of magnitude above or below unity (SC&A 2017).

For actinides, NIOSH likewise assumes that by using a bioassay indictor radionuclide (Sr-90 and/or Cs-137), all significant actinide (alpha-emitter) intakes can be assigned by the ratio method. SC&A found in its evaluations (SC&A 2016, 2017) that similar inconsistencies are also found in a more limited evaluation of actinide-to-Sr-90 and actinide-to-Cs-137 ratios, where only a small fraction of the resulting values matched the values recommended in ORAUT-TKBS-0007-5, Tables 5-22 and 5-23 (NIOSH 2010). As concluded by SC&A in its January 2017 evaluation:

> *Many of the measured actinide to Sr-90 or Cs-137 values were greater, and a few were less, than the recommended values in ORAUT-TKBS-0007-5, Tables 5-22 and 5-23. Some ratios were orders of magnitude above, and a few were orders of magnitude below, those recommended, with considerable scatter. Relatively few values fell within the 0.5 to 2.0 ratio (or the 0.33 to 3.0 ratio) range. For the most important (from a dose consideration) radionuclide, Pu-238, an average of 48% of the total 40 monthly and 8 annual measured Pu-238 to Sr-90 values compared to the recommended value of 1.5E-2 were equal to or below the recommended value within a factor of 2.0. Similar results were obtained for Am-241 and U-234, but there were fewer data pairs and much more scatter in the ratio values. Actinide/Cs-137 results were similar. SC&A found that measured actinide/Sr-90 or actinide/Cs-137 values are difficult to obtain, because FAPs are generally not analyzed when actinide samples are taken. Therefore, verification of the actinide ratios is not feasible from the data analyzed.* [SC&A 2017]

Arguably, even these data from INL operational waste streams would have more radionuclide constituent consistency than those of radioactive waste from diverse offsite AEC, military, and commercial sources, and of often unknown or uncertain operational origins and content. More variability, not less, would be expected from a similar quantitative sampling of actual Burial Ground radionuclide constituents, if that were even feasible (keeping in mind that manifests were either lacking or inaccurate in the early years, and wastes from various sources were co-mingled). Unlike alpha monitoring and actinide analysis that were conducted for operational material streams at CPP, the reactors, and other INL facilities, little such monitoring was conducted at the Burial Ground in the 1950s and 1960s despite the large and growing inventory of actinides from RFP. For such waste constituents, it is plausible that workers handling radioactive waste from these sources were exposed to radionuclides that are not adequately addressed for their exposure contribution by either INL monitoring and dosimetry or NIOSH methods.

SC&A Preliminary Finding for NIOSH ER Position 2

While internal exposures at the Burial Ground were relatable to the material being disposed of, it is not demonstrable that potential dose can apportioned to MFP and plutonium given the source term uncertainties cited earlier coupled with issues surrounding the application of ORAUT-OTIB-0054 and ORAU-OTIB-0060 using indicator radionuclides such as Sr-90 and Cs-137.

Suggested lines of inquiry:

With what quantitative data regarding Burial Ground waste constituents does NIOSH intend to demonstrate a bounding dose contribution from MFPs and plutonium?

How would ORAUT-OTIB-0054 and ORAUT-OTIB-0060 be applied as proposed? What is NIOSH's response to SC&A's two reviews of their application at INL (SC&A 2016, 2017), as they would pertain to the Burial Ground?

4.3 NIOSH ER POSITION 3

> ***The radiological monitoring program at the Burial Ground included the presence of a health physicist, safe work permits for all waste disposals, personnel surveys upon completion of work, air monitoring, and decontamination of vehicles at CPP if they were found to be contaminated.... This defense-in-depth approach was adequate to ensure that unmonitored intakes of plutonium did not occur.*** [NIOSH 2017, page 236]

4.3.1 SC&A Analysis of NIOSH ER Position 3

As referenced earlier, there is some doubt as to the rigor and effectiveness of the radiological monitoring program at the Burial Ground, given the notable health physics program weaknesses already cited.

Health physics personnel were assigned to the Burial Ground to perform monitoring, but they also fulfilled a prime operational role for managing the radioactive waste disposal at the Burial Ground. This operational role encompassed initiating and receiving work requests for Burial Ground operation, reporting on costs for operations to the AEC, developing and recording plot plans for pits and trenches, and witnessing and maintaining a log of all burials, in addition to routine radiological surveillance functions (Phillips 1962c). This dual responsibility of Idaho Nuclear Corporation's (INC's) Health and Safety Branch for both operations and safety of the Burial Ground was found to be an organizational conflict of interest and led to a lowered performance rating for INC in an audit conducted by the AEC in 1971.[6] It was also manifest in how radiological technicians needed to balance their programmatic role with their health physics one:

[6] Due to leaking barrels received at the Burial Ground from RFP in 1970, the AEC requested that Burial Ground operations be suspended pending an independent internal review of health physics procedures, which found this organizational conflict to be a contributing problem (AEC/ID 1971b).

> *To distinguish TRU from naturally occurring radiation in the field, HP Techs would have to wait a few hours and recount the smear or soil sample (allowing for decay of short-lived radon, thorium, and uranium daughters). An HP could get into conflicts if he held up work to verify the source of positive readings.* [[redacted] 2016]

Following this AEC review, this conflict was resolved by assigning line management responsibility to a Waste Management Division and making health physics oversight an independent function.

SWPs were prepared for certain dumping operations, but a cursory review of those for RFP waste disposal from the 1960s shows a wide range of work controls prescribed, from no controls or precautions identified (except for steel toe guards), to a wide range of provisions calling for tool checks, hand and foot counting, intermittent surveying, and final monitoring with an alpha survey meter (Phillips 1965, Phillips 1964). Generally, the SWPs for RFP waste dumping required a hard hat, coveralls ("no street clothes"), gloves and shoe covers, with none found in the sample years 1961 and 1966 requiring special dosimetry ("metering") or bioassay (Phillips 1965, Phillips 1960). In fact, the SWP form had no checkoff box for a followup bioassay requirement.

No Burial Ground SWPs were found for 1964, although RFP waste was being received that year (AEC/ID 1964). One worker indicated that SWPs were reserved for "unusual" Burial Ground jobs but does not recall them being used in earlier "AEC" days ([redacted] 2016). This may explain the lack of SWPs in the earlier time frame before 1965.

A February 1970 appraisal conducted by AEC's Idaho Field Office of the NRTS solid waste disposal program (AEC/ID 1970) found that the "*operation of the burial ground was not considered a priority function of INC management until late 1969*." This finding comports with the aforementioned lack of funding for needed smear monitoring equipment at CFA and the Burial Ground prior to the early 1970s. A later 1973 radiological exposure incident investigation found that a "*near miss*" involving a radiation exposure "*raises basic questions as to the adequacy of Burial Ground supervision, health physics coverage, documentation, and employee training* [and] *demonstrates the need for more stringent radiological safety measures in the operation of the Burial Ground*" (AEC/ID 1973).

<u>SC&A Preliminary Finding for NIOSH ER Position 3</u>

Given this checkered radiological program history recounted above and in preceding sections, a programmatic basis alone is not sufficient to claim Burial Ground historic practices would have precluded any unmonitored plutonium uptake in the early years up to 1970. A "defense-in-depth" approach to radiological control was not evident at the Burial Ground.

The ER emphasizes a programmatic basis (i.e., strength of the health physics program) to support its contention that no plutonium intake would have gone unmonitored. However, a number of investigations, program appraisals, and internal communications related to the Burial Ground during the early years have found fundamental shortcomings in that very program, particularly as it pertains to the detection, monitoring, and control of contamination. This record shows the AEC's concern over the conflicted role of health physicists at the Burial Ground, who were essentially responsible for much of its operation as well as radiation protection. It also finds lack of management support for the Burial Ground, generally, and for funding needed for contamination detection equipment, specifically. While some of these findings come from documents just after the 1970 cutoff in the current ER version, they nonetheless represent significant program deficiencies that transcend time periods at the Burial Ground and raise serious doubt about the so-called "defense-in-depth" approach taken by the Burial Ground in the 1950s–1970s. This body of documentation is supported by former Burial Ground worker accounts cited earlier.

5.0 SC&A PRELIMINARY CONCLUSION

The NIOSH ER concludes that worker exposures at the Burial Ground can be dose reconstructed for 1952–1970 on the basis of stringent contamination controls, a radiation control program for plutonium exemplifying a "defense-in-depth" approach, and available internal dose data for known radioactive waste source terms that lend themselves to standard dose reconstruction methods (e.g., ORAUT-OTIB-0054 and ORAUT-OTIB-0060). SC&A finds all of these basic tenets fall short given a review of available SRDB documentation and an extensive series of former worker interviews.

Instead, SC&A finds that the Burial Ground (1) was considered a low priority by INL management and was so underfunded that needed health physics smear instrumentation was lacking; (2) apparently lacked a management culture that supported disciplined operations and a formality of radiological controls to minimize unnecessary contamination; (3) dealt with high-exposure MFPs and transuranics that were often unidentified as to specific isotopic content, activity levels, and physical form and quantity; (4) lacked adequate alpha monitoring capability; and (5) lacked adequate bioassay and occupational air sampling responsive to Burial Ground contamination. From worker interviews, radiological incidents, and photographs of dumping operations, it is clear that an exposure potential existed for waste handlers, and that personal contamination was experienced during both waste handling and cleanup. It is also clear that airborne contamination may not have been detected and necessary bioassay followup would not have occurred given the lack of alpha monitoring, lack of both routine and special bioassay monitoring, limited workplace air monitoring, and the apparent lack of smear counting instrumentation during certain time periods. From a sampling review of NOCTS claimants, there does not likewise appear to be any clear means or evidence that even places an individual worker at the Burial Ground for specific periods of time—it was typically a collateral task among many such assignments for workers at CFA.

For the feasibility of internal dose reconstruction, NIOSH concluded that:

> *the available bioassay data are such that internal radiation doses received from intakes of mixed fission and activation products, and other applicable radionuclides, can be completely reconstructed with sufficient accuracy for the Burial Ground from 1952 through 1970.* [NIOSH 2017, page 237]

However, SC&A finds that bioassay data for potential exposures of workers at the Burial Ground are lacking; what SC&A was able to review in the SRDB was listed for the CFA, without distinction made for the Burial Ground.[7] When routine bioassays can be found for CFA workers with Burial Ground assignments, they appear unrelated to that assignment and typically lag the actual work assignment by months, as detailed in Appendix A.

[7] As noted previously, urinalyses for workers located at CFA have been identified for all time periods, but specific bioassay results for Burial Ground exposures are not identified as such. The Work Group and SC&A have requested that NIOSH clarify what “data” it has “on-hand” in this regard, as indicated by the ER.

6.0 REFERENCES

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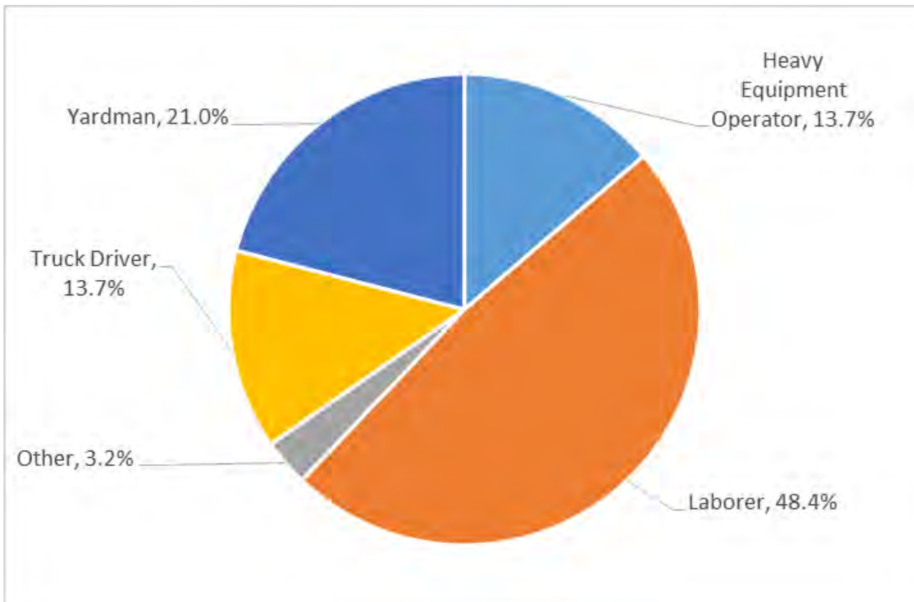
APPENDIX A: INTERNAL CLAIMANT MONITORING AT THE BURIAL GROUND

In order to characterize the internal monitoring practices for workers most likely to have worked at the Burial Ground prior to 1971, SC&A reviewed the portion of the INL claimant population with covered employment during the relevant period and who had job titles most likely to be associated with Burial Ground work. These job titles included: Equipment Operator, Truck Driver, Laborer, and Yardman. At the time of this study, there were 1,016 claims with verified employment prior to 1971. Of those claims, SC&A identified and reviewed the records of 124 claimants that fit the job title criteria. A breakdown of reviewed claims by job type is shown in Figure A-1.

Figure A-1. Overview of Claimant Job Titles Included in SC&A Study



As seen in Figure A-1, the “Laborer” category constitutes the largest portion of reviewed claims, followed by “Yardman.” The proportions of “Truck Driver” and “Heavy Equipment Operator” reviewed were essentially equal. Included in the study was a small portion of job types labelled as “Other,” which included an inspector, asbestos worker, warehouseman, and groundman.

Although there is a significant number of claims who potentially could have worked at the Burial Ground, specific evidence indicating the exact dates of such work are difficult to identify. Specific dosimetry area codes indicating the Burial Ground do not appear to have been in general use until the mid-1970s. Thus neither the external dosimetry records nor the specific claimant’s LFC would indicate the Burial Ground until this time.

Rather, it appears that workers who were assigned to the Burial Ground generally had external dosimetry badges and/or internal monitoring identifying them as workers from the CFA. Many of the cases that directly identified with the Burial Ground were the result of incidents, such as a lost dosimeter, in which external exposures had to be estimated by health physics personnel. One such example is shown in Figure A-2, which displays a “Personnel Exposure Questionnaire” in which the dosimeter was lost during documented work at the Burial Ground. In some cases, temporary badges were issued that specifically identified the Burial Ground; however, these instances appear to be the exception rather than the rule.

Figure A-2. Example of a Personnel Exposure Questionnaire Identifying the Work Area as the Burial Ground

FORM IHP-24

PERSONNEL EXPOSURE QUESTIONNAIRE

[redacted]

Date 9-8-54

Name of employee [redacted] Badge Number [redacted] Exposure Date 8-29-9-4-54

Area CFA Supervisor in charge

Reason for Instigation:

( ) A reportable weekly daily pocket meter reading total of

( ) Weekly film total of 300 mr or more.

(X) Lost Reading

30-1177

Film total covers period extending from 8-29-54 through 9-4-54

FILM RESULTS

SENSITIVE FILM				INSENSITIVE FILM			
Open Window		Shield		Open Window		Shield	
DENS.	BETA	DENS.	GAMMA	DENS.	MR	DENS.	GAMMA
Lost Reading							

Remarks Lost Badge

EXPOSURE RESUME

WEEK ENDING	Meters	SUN	MON	TUES	WED	THUR	FRI	SAT	TOTALS
9-4-54	Pocket Meters	-	-	-	-	-	-	-	-
	Badge Meters						Lost Reading		

Investigation

a. Findings of Health Physics Representative and/or Supervisor.

This film badge was lost at the burial ground. No pencils were worn by either man working on the hot waste truck for the day on which the badge was lost. Basing exposure strictly on the film badge of [redacted] who was on the same job - the exposure for [redacted] would be zero beta and zero gamma.

A.1. ELEVEN IDENTIFIED BURIAL GROUND CLAIMS

Of the 124 claimants reviewed as part of this study, only 11 claims could be directly tied to the Burial Ground during a known period of work. These claims are described in the following section and are labelled as Cases A through K for ease of reference. Provided with each of the 11 claims is the following information:

- Full name of claimant
- NIOSH claim ID number
- Relevant dates of covered employment (i.e., employment prior to 1971)
- Known dates of work at the Burial Ground
- Internal monitoring occurring during or right after the known Burial Ground work
- Additional information relevant to the individual case

This last category generally contains a description of the documentation used to identify the Burial work, any additional information about what work was actually done, and statements made by the Energy Employee (EE) or survivor that are relevant to the Burial Ground.

Case A

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment: [redacted]/1954–[redacted]/1992
Burial Ground Date(s): [redacted]/1963–[redacted]/1963
Relevant Internal Monitoring:

- Special Gamma/Strontium Urinalysis (4/19/1963 labelled as "TAN")
- Routine WBC (5/2/1963 labelled as "TAN")

Additional Information:
Burial Ground work was identified in a "Personnel Exposure Questionnaire" (PEQ), which indicates the EE's badge could not be read and states the following: "*During the period of* [redacted]*/1963 through* [redacted]*/1963* [redacted] *two hot shipments to the burial grounds. One consisted of shielded casks on semi-truck reading 35 mr/hr in cab of truck. The other shipment was on a low boy with shielded casks containing 4 fiber barrels reading 700 R/hr at surface, 3 R/hr at 25 ft*." The CATI was performed with the EE and stated the following concerning routine duties: "[redacted] *workers, who had reached their dose limit, who were digging a deep trench in which to bury high level wastes*."

Case B

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment: [redacted]/1967–[redacted]/1968
Burial Ground Date(s): Summer of 1967[8]
Relevant Internal Monitoring:

- Termination Gross Beta Urinalysis (5/1/1968 labelled as CFA)
- Termination WBC (5/1/1968 labelled as CFA)

Additional Information:
CATI was performed with the EE and describes relevant work activities as follows: "[redacted] *radioactive waste materials from Three Mile Island and Rocky Flats, into Pit 9 and other locations…*[redacted] *radioactive materials (55-gallon drums), excavation*."

Case C

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]

[8] Letter contained in the EE's monitoring record states: "*there were 6-8 entries in the Health Physics log books indicating that temporary badges were issued to* [redacted] *during the summer of 1967 at the RWMC*." The actual temporary badging records were not included in the available monitoring records.

Relevant Employment:

- [redacted]/1957–[redacted]/1960
- [redacted]/1961–[redacted]/1963
- [redacted]/1964–[redacted]/1995

Burial Ground Date(s): [redacted]/1962, [redacted]/1962, [redacted]/1962
Relevant Internal Monitoring: Routine Gamma Urinalysis (2/7/1963 labelled as CFA)
Additional Information:
The CATI was performed with a claimant survivor who did not mention work at the Burial Ground. The LFC for the individual does not indicate assignment to the Burial Ground until after 1970.

<u>Case D</u>

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment: [redacted]/1950–[redacted]/1981
Burial Ground Date(s):

- [redacted]/1954–[redacted]/1954
- [redacted]/1964

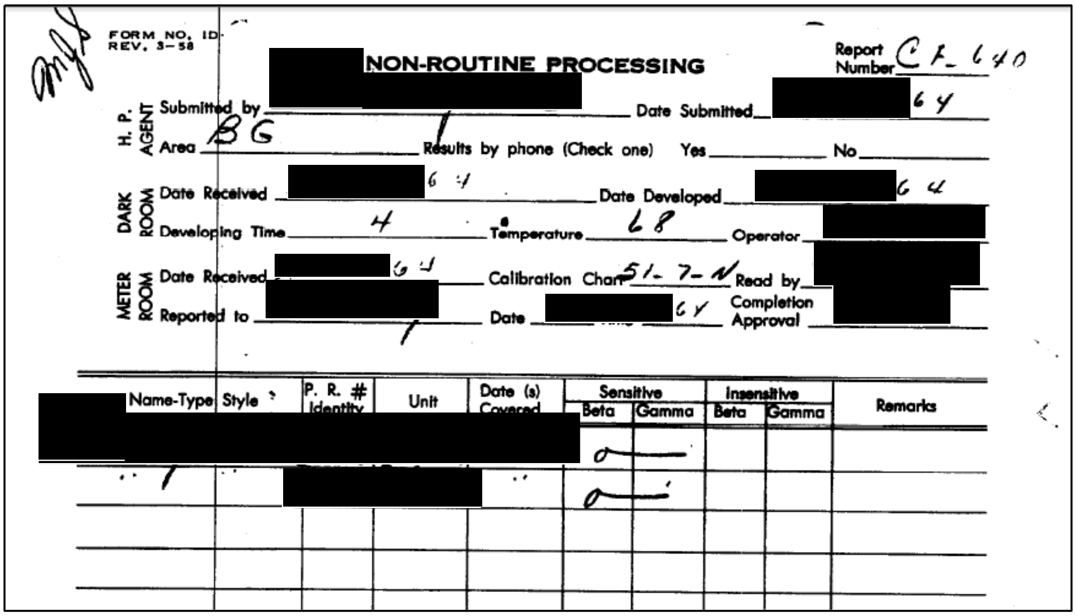
Relevant Internal Monitoring:

- Routine Beta Urinalysis (2/21/1955 labelled CFA)
- Routine Gamma/Strontium Urinalysis (2/3/1965 labelled as CFA)

Additional Information:
The CATI was performed with the EE and lists the Burial Ground as well as CFA, Materials Test Reactor (MTR), SL-1, and "CPT" (assumed to be CPP). The identification of the 1954 Burial Ground work was based on a PEQ that stated the following: "*This film badge was lost at the burial ground. No pencils were worn by either man working on the hot waste* [redacted] *for the day on which the badge was lost. Basing exposure strictly on the film badge of* [redacted] *who was on the same job – the exposure for* [redacted] *would be zero beta and zero gamma*."

The identification of the 1964 Burial Ground work was based on a "Non-Routine Processing" form (NRP), which indicated the work location as "BG." The NRP is shown below as Figure A-3 and indicates monitoring of the "hat" and "hands" of the EE.

Figure A-3. Non-Routine Processing form Indicating Possible Monitoring of the "Hat" and "Hands" of the Claimant at the Burial Ground ("BG")



FORM NO. ID-
REV. 3-58

[redacted] NON-ROUTINE PROCESSING

Report Number C F- 640

H. P. AGENT — Submitted by [redacted] Date Submitted [redacted] 64
Area BG Results by phone (Check one) Yes No

DARK ROOM — Date Received [redacted] 64 Date Developed [redacted] 64
Developing Time 4 Temperature 68 Operator [redacted]

METER ROOM — Date Received [redacted] 64 Calibration Chart 51-7-N Read by [redacted]
Reported to [redacted] Date [redacted] 64 Completion Approval [redacted]

Name-Type	Style	P. R. # Identity	Unit	Date (s) Covered	Sensitive Beta	Sensitive Gamma	Insensitive Beta	Insensitive Gamma	Remarks
[redacted]					0				
		[redacted]			0				

Case E

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment: [redacted]/1957–[redacted]/1963
Burial Ground Date(s): [redacted]/1962, [redacted]/1963
Relevant Internal Monitoring:

- Routine Gamma Urinalysis (2/12/1963 labelled CFA)
- Routine WBC (12/10/1963 labelled MTR)

Additional Information:
The CATI was performed with the claimant survivor and indicates the work location as "Central Utilities, Burial Grounds" and also mentions that the EE had "buried hot waste." The 1962 and 1963 Burial Ground work was identified based on Temporary Badge Reports (TBRs) that specified "Burial Ground" and "CFA (Burial Grounds)," respectively.

Case F

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment:

- [redacted]/1951–[redacted]/1951
- [redacted]/1955–[redacted]/1958
- [redacted]/1958–[redacted]/1962

Burial Ground Date(s): [redacted]/1956–[redacted]/1956

Relevant Internal Monitoring: Gross Beta Urinalysis (8/15/1956)[9]
Additional Information:
The Burial Ground work was identified based on a PEQ which noted that the weekly external dose was greater than 300 mrem. The PEQ states the following: "*this exposure was received during non-routine burial of hot waste material in burial ground. Exposure was received before trench was covered and during covering operations. Very high background before trench was covered.*"

The CATI was performed with the claimant survivor who stated: "[redacted] *most of the burial in the Idaho National burial grounds consisting of control rods, spent fuel rods and miscellaneous radioactive material. These were put into perforated 30-gallon trash cans and placed in pre-dug trenches by a cherry picker or crane. Some materials without their knowledge exceeded the maximum reading possible with existing equipment... Security -- Oversaw some of the burial ground as* [redacted]."

Case G

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment: [redacted]/1962–[redacted]/1989
Burial Ground Date(s): [redacted]/1963, [redacted]/1963
Relevant Internal Monitoring:

- Routine Gamma Urinalysis (9/5/1963 labelled MTR)
- Routine WBC (10/12/1963 labelled MTR)

Additional Information:
CATIs were performed with [redacted] different claimant survivors, who indicate work locations of CPP, Test Reactor Area (TRA), and CFA. The Burial Ground work in [redacted] 1963 was based on a PEQ, which indicates the EE's badge did not contain an actual film, and the external exposure was estimated as zero mrem. The Burial Ground work on [redacted] 1963, is based on a TBR, which listed the Burial Ground in parenthesis after the EE's employer. The TBR registered 20 and 25 mrem for beta and gamma, respectively.

Case H

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment:

- [redacted]/1950–[redacted]/1953
- [redacted]/1953–[redacted]/1989

Burial Ground Date(s): [redacted]/1964, [redacted]/1965
Relevant Internal Monitoring:

- Routine Gamma/Strontium Urinalysis (2/3/1965 labelled CFA)
- Routine WBC (2/3/1965 labelled CFA)

[9] The reason for the urinalysis sample is not provided, and the location is simply given as "AEC – H&S"

- Routine Gamma Urinalysis (9/2/1965 labelled CFA)
- Special WBC (9/12/1966 labelled CFA)

Additional Information:
Identification of the 1964 Burial Ground work was based on a PEQ, which stated that the EE did not wear a film badge that day. Specifically, the PEQ states: "*Film not worn at time of exposure at burial ground. Field of radiation at trench was 50 to 90 mr/min. for a period estimated as one to two minutes. Dosimeter was worn however, reading approximately 180 mr. Regular film badge had not yet been worn since film change on 6/2/1964, according to tag left attached to film badge by Personnel Metering*." (SC&A Note: "dosimeter" is assumed to refer to a "pencil dosimeter" or other monitoring device in the context of this quote).

The second Burial Ground work in [redacted] of 1965 was identified via a TBR, which listed "Burial Ground" in parenthesis after the employer was listed. The exposure for that day was 125 mrem gamma with no recorded beta dose.

The CATI was performed with the EE and stated the following: "*said over the years he was exposed to a lot of different types of radiation from burial grounds, pits, reactors tops, and experiment rooms that was related to his work…. worked in maintenance a lot; he was a* [redacted] *working with the reactor tops, and did a lot of decontamination of cells, spills, etc..... Later on he did a lot of work in the waste management area (RWMC - Reactor Waste Management Facility)*." It should be noted that the EE also had external dosimetry results indicating the RWMC in December 1975.

Case I

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment: [redacted]/1956–[redacted]/1982
Burial Ground Date(s): [redacted]/1956–[redacted]/1956
Relevant Internal Monitoring: Routine Gross Beta Urinalysis (8/31/1956 labelled as CPP)
Additional Information:
The CATI was performed with the EE; however, only CPP and SPERT were listed as work locations. The Burial Ground work in [redacted] and [redacted] 1956 was based on a PEQ, which stated the following: "[redacted] *lost his film badge in the ditch while working at the burial ground. He was working with* [redacted] *on this assignment and* [redacted]*'s film meter indicated a 40 mr exposure for the week. Since this was the only job involving significant radioactivity for these two men during this period,* [redacted] *probably also received approximately a 40 mr exposure*."

Case J

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment:

- [redacted]/1961–[redacted]/1966
- [redacted]/1966–[redacted]/1971

Burial Ground Date(s): [redacted]/1962, [redacted]/1964[10]
Relevant Internal Monitoring:

- Routine Gamma Urinalysis (6/4/1963 labelled as MTR)
- Special Gamma/Strontium Urinalysis (1/24/1964 labelled CFA)
- Special Gamma Urinalysis (1/27/1964 labelled as Area Hot Cell)
- Special WBC (1/28/1964 labelled as CFA)

Additional Information:
Both work periods at the Burial Ground were identified via a TBR. The TBR from [redacted] 1962 indicated an exposure of 0 and 20 mR for beta and gamma, respectively. The TBR from [redacted] 1964 indicated exposures of 0 and 50 mR for beta and gamma, respectively. The CATI was performed with the claimant survivor and does not mention the Burial Ground specifically. However, the CATI does state: "*The radioactive waste liquid was piped over and put in the ground and more drums were stacked on top.*"

Case K

Name: [redacted]
NOCTS Claim ID: [redacted]
Job Title(s): [redacted]
Relevant Employment:

- [redacted]/1950–[redacted]/1950
- [redacted]/1953–[redacted]/1954
- [redacted]/1954–[redacted]/1955
- [redacted]/1955–[redacted]/1956
- [redacted]/1956–[redacted]/1980

Burial Ground Date(s):

- [redacted]/1958–[redacted]/1958
- [redacted]/1962–[redacted]/1963
- [redacted]/1968

Relevant Internal Monitoring:

- Special Beta/Gamma Urinalysis (12/29/1958 with no location label)
- Routine Gamma Urinalysis (6/28/1963 labelled CFA)
- Routine WBC (10/13/1976 Labelled CFA)

Additional Information:
The first observed Burial Ground work in 1958 was based on a PEQ, which noted that the dosimeter badge had been lost. Specifically, the PEQ states: "*An estimated 100 mr gamma should be added to this man's record during the period above. This estimate is believed to be great enough to cover exposures which might have been received during* [redacted] *at IDO burial grounds. A film badge exposure of 420 Beta and 320 Gamma, presumably received at CPP, has already been recorded*." Available

[10] The actual date of the temporary badge appears to read "[redacted]-63," but is assumed to be a typo based on surrounding badge dates on the record. The correct date is assumed to be [redacted]/1964, which would be consistent with the other entries on the TBR.

records confirm that the EE was assigned 100 mrem of gamma exposure assigned as CFA, with the other doses assigned to a CPP badge.

The Burial Ground work in [redacted] 1962 and [redacted] 1963 was also based on a PEQ that requests exposure information but does not specify why normal badging was unavailable. The report states: "*Only exposure found probable would have been at the burial grounds. Exposure would be less than 50 mrem gamma according to past exposure record*." The third period of Burial Ground work ([redacted]/1968) was based on a "Medical/First Aid Case" report in which the EE injured their [redacted] while threading cable on a scraper at the Burial Ground.

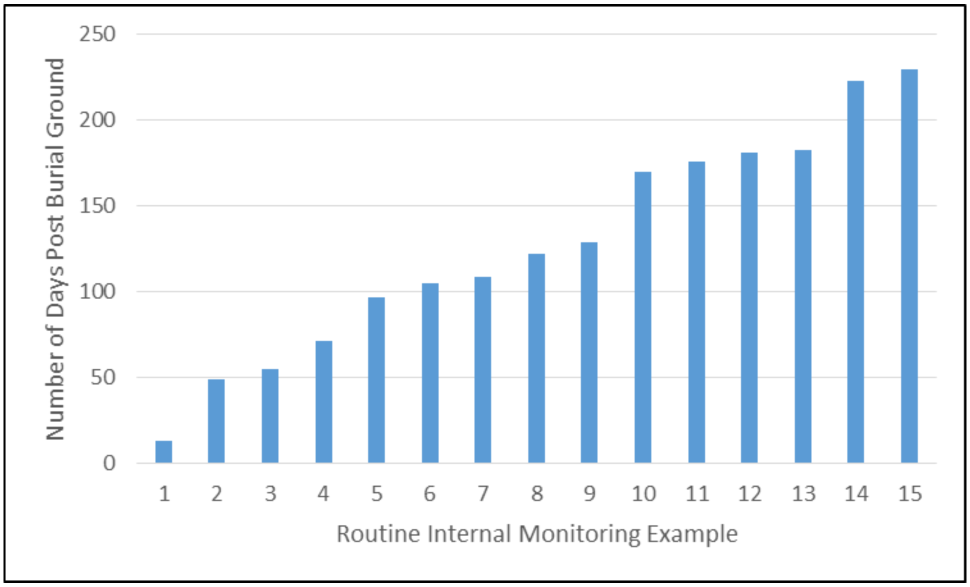
The CATI with the EE stated the following: "*He worked a lot in the burial grounds. But he didn't wear a badge. He was told where the badges were but they were badges that had already been used. Also, the badges weren't always at the same place. Sometimes they were just outside the work locations and sometimes they were in central facilities or in another location.... They were pulling barrels out of the ground and the barrels would break open*."

A.2. GENERAL DISCUSSION OF 11 IDENTIFIED BURIAL GROUND CASES

It is clear from the monitoring records for the 11 claimants discussed in the previous section that internal bioassay and/or WBCs were available *at some point* following potential exposures at the Burial Ground. However, such internal monitoring often occurred several months after the known Burial Ground work and were associated with other site areas, including CFA and the reactor areas. Therefore, it is logical to infer that such internal monitoring was not conducted as a result of the Burial Ground work but rather incidental as part of the site-wide routine monitoring program. Figure A-4 plots the amount of time between the identified Burial Ground work and the next routine internal monitoring result.[11] As seen in the figure, two thirds of the examples had more than 100 days elapsed between the known Burial Ground work and the next routine internal monitoring result.

[11] One example is not shown in Figure A-4 because over 8 years elapsed between the known Burial Ground work and the next routine internal monitoring result.

Figure A-4. Number of Elapsed Days between Burial Ground Work and Next Routine Sample



While SC&A did identify four examples in which "special" or "non-routine" internal monitoring occurred at some point after Burial Ground work (see Table A-1 for a description of these examples), only one such example appears likely to be directly associated with the Burial Ground (see example Claim [redacted] in Table A-1). In the first two examples (Claims [redacted] and [redacted]), the special monitoring did not occur until 3 months and over a year after the known Burial Ground work. For the third example (Claim [redacted]), three different special monitoring samples were taken between 10 and 14 days after the Burial Ground work. However, there is indication that the work that prompted the samples may have been associated with the "Area Hot Cell." It seems likely that if special internal monitoring was required as a result of an incident at the Burial Ground, it would have occurred sooner than 10 days after the known Burial Ground work ceased.

Table A-1. Description of Four Examples in which Special Internal Monitoring Occurred Sometime After Burial Ground Work

Claim #	Date(s) of Relevant Burial Ground Work	Special Bioassay Description	Other Relevant Routine Bioassay Description
[redacted]	[redacted]/1963–/1963	Gamma/Strontium Urinalysis at TAN on 4/19/1963	Routine WBC from TAN on 5/2/1963
[redacted]	[redacted]/1965	WBC at CFA on 9/12/1966	Routine Gamma Urinalysis at CFA on 9/2/1965
[redacted]	[redacted]/1964	Gamma/Strontium Urinalysis at CFA on 1/24/1964 Gamma Urinalysis at Area Hot Cell on 1/27/1964 WBC at CFA on 1/28/1965	N/A
[redacted]	[redacted]/1958–/1958	Beta/Gamma Urinalysis on 12/29/1958	N/A

A.3. ANECDOTAL EVIDENCE OF BURIAL GROUND WORK CONTAINED IN CLAIMANT INTERVIEWS

In addition to the 11 cases discussed in the previous section, SC&A identified claimants among the reviewed population who provided information in the CATI that indicated work at the Burial Ground. However, SC&A was unable to find corroborating evidence in the individual monitoring records that would allow for temporal assignment and thus evaluation of the internal monitoring practices. These additional claims are described in Table A-2, which provides the Claim ID, name, employment, job type, and relevant statements observed in the CATI.

Table A-2. Overview of Claimant CATI Reports Discussing Work at the Burial Ground

[Table A-2 (pages 44–47) is withheld in its entirety to prevent the disclosure of Privacy Act protected information.]

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A.4. GENERAL DISCUSSION OF 22 ADDITIONAL CLAIMS DESCRIBING BURIAL GROUND ACTIVITY

As demonstrated in Table A-2, SC&A identified 22 examples in which the claimant or claimant survivor indicated that work occurred at the Burial Ground; however, no corroborating evidence could be identified in the monitoring records to affirm when such work may have occurred. Of the 22 claims, 7 specifically mentioned handling the waste received from Rocky Flats Plant (see Claims [redacted], and [redacted]). Three of the 22 claims mentioned that drums would have structural integrity issues and would often "pop open" (see Claims [redacted], and [redacted]).

Two individual claims specifically mentioned contamination issues or an incident that occurred at the Burial Ground. Specifically, Claim [redacted] describes becoming contaminated while unloading material into Pit 9, which was picked up by a Geiger counter. As a result of the incident, the EE's clothing and other items were confiscated before he was allowed to leave the site. Radiation monitoring records supplied by DOE indicate the EE was not monitored internally or externally at INL. The other (Claim [redacted]) describes hauling waste to the Burial Ground and mentioned that the truck that was used had to be washed out on a daily basis. The CATI, which was performed with the survivor specifically says:

> *They washed the truck out every night, but they never seemed to be concerned about any contamination that he may have received.*

However, without further information to allow for the temporal connection of the claimant statements found in Table A-2 to actual Burial Ground work, it is not possible to know what types of precautions and, in particular, internal monitoring might have occurred as a result of potential Burial Ground exposure.

APPENDIX B: BURIAL GROUND PHOTOS

Figure B-1. Workers in Anti-Contamination Clothing Unload 55-Gallon Drums of Rocky Flats TRU Waste, with Observer (a radiological technician?) in Street Clothes (Burial Ground photo 1965b)

Figure B-2. A Derrick Unloads 55-Gallon Drums of Rocky Flats TRU Waste from a Truck into an Excavated Pit (Burial Ground photo 1961)

Figure B-3. A Worker in Street Clothes Appears to Be Inspecting or Monitoring a 55-Gallon Drum of Rocky Flats TRU Waste (Burial Ground photo 1969b)

Figure B-4. Bulldozer Operator in Anti-Contamination Clothing Pushes Soil over a Pile of 55-Gallon Drums of Rocky Flats TRU Waste (Burial Ground photo 1965a)

Figure B-5. Bulldozer Operator Positioned Near Wooden Boxes and 55-Gallon Drums of Rocky Flats TRU Waste inside a Long Pit or Trench (Burial Ground photo 1965a)

Figure B-6. Truck Dumps 55-Gallon Drums of Rocky Flats TRU Waste (Burial Ground photo 1969a)

Figure B-7. Trench Flooded with Spring Rain Runoff with Drums of Rocky Flats TRU Waste both Floating and Beached on the Side of the Pit (Burial Ground photo 1962)

Figure B-8. Workers Wearing Anti-Contamination Clothing Unload and Stack 55-Gallon Drums of Rocky Flats TRU Waste from a Truck (Burial Ground photo 1958)