Independent Oversight Review of the Los Alamos National Laboratory Radiological Controls Activity-Level Implementation

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Acronyms

ADEP	Associate Director for Environmental Programs
ALARA	As Low As Reasonably Achievable
ARA	Airborne Radiation Area
CA	Contamination Area
CAM	Continuous Air Monitor
CFR	Code of Federal Regulations
CHP	Certified Health Physicist
CRAD	Criteria, Review, and Approach Document
DAC	Derived Air Concentration
DOE	U.S. Department of Energy
dpm	decades per minute
DSESH	Deployed Services Environment Safety & Health
EPACS	Experimental Personnel Access Control System
ES&H	Environment, Safety, and Health
ESP	Eberline Smart Portable
EWMO	Environmental and Waste Management Operations
FRPR	Facility Radiation Protection Requirements document
HCA	High Contamination Area
HSS	DOE Office of Health, Safety and Security
IH	Industrial Hygiene
IWD	Integrated Work Document
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
LANSCE	Los Alamos Neutron Science Center
LFO	LANSCE Facility Operations
MAR	Material At Risk
MRA	Material Risk Assessment
NNSA	National Nuclear Security Administration
OFI	Opportunity for Improvement
ORPS	Occurrence Reporting and Processing System
PACS	Personnel Access Control System
Pb	Lead
PCM	Personnel Contamination Monitor
POD	Plan of the Day
PPE	Personal Protective Equipment
RAS	Radiochemical Alpha Spectroscopy
RCT	Radiological Control Technician
RP	Radiation Protection
RPP	Radiation Protection Program
RWP	Radiological Work Permit
SSSR	Sort, Segregate, Size Reduce
TA	Technical Area
TBD	Technical Basis Document
Tc	Technetium
TIMS	Thermal Ionization Mass Spectrometry
TLD	Thermoluminescent Dosimeter
TRU	Transuranic

WIPP	Waste Isolation Pilot Project
WNR	Weapons Neutron Research Facility

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1.0 PURPOSE

The Office of Enforcement and Oversight (Independent Oversight), within the Office of Health, Safety and Security (HSS), conducted a review of radiological protection program (RPP) activity-level implementation performed by Los Alamos National Security LLC (LANS) and its subcontractors at Los Alamos National Laboratory (LANL), Los Alamos Neutron Science Center (LANSCE), and Environmental and Waste Management Operations (EWMO) Area G facilities.

The HSS Office of Safety and Emergency Management Evaluations conducted the review within the broader context of ongoing targeted assessments of radiological control programs, with an emphasis on the implementation of radiological work planning and control across U.S. Department of Energy (DOE) sites that have hazard category 1, 2, and 3 facilities. The purpose of this set of facility-specific Independent Oversight targeted reviews is to evaluate the flowdown of occupational radiation protection requirements (as expressed in facility RPPs) into work planning, control, and execution processes, such as radiological work authorizations that include radiological work permits (RWPs) and other technical work documents. To meet the goals of the targeted review, Independent Oversight performs assessments that are primarily driven by activity-level observations. After a set of facility-specific review is completed, HSS will develop a report with a compiled analysis of the performance of RPP activity-level implementation throughout the DOE complex.

This targeted review was performed at LANL from August 19-29, 2013. This report discusses the scope, background, methodology, results, and conclusions of the review, as well as opportunities for improvement (OFIs) and items identified for further follow-up by Independent Oversight.

2.0 SCOPE

The scope of this review included activity-level implementation of radiological control activities associated with operations at LANSCE and EWMO Technical Area (TA)-54 Area G that are conducted under the LANL RPP.

At LANSCE, Independent Oversight's review included the Lujan Center and the Weapons Neutron Research Facility (WNR). The Lujan Center is a national facility for defense and civilian research in nuclear and condensed-matter sciences, hosting scientists from national laboratories, universities, industry, and international research facilities. WNR also conducts fundamental and national security research, utilizing methods that include neutron induced reactions, single pulse experiments, lead slowing-down spectrometry, high power target testing, and isotope production measurements.

EWMO performs a variety of low-level radioactive and transuranic (TRU) waste management operations within TA-54 Area G. Independent Oversight observed work in a number of Area G waste storage and processing domes, including buildings 231, 375, and 412. Several major EWMO facilities at TA-50 and TA-54 were not operational or were only partially operational during the onsite portion of the review, including the Low-Level Waste Operations; the Central Characterization Project; the Waste Characterization, Reduction, and Repackaging Facility; and the Radioassay and Nondestructive Testing facility. Independent Oversight also observed a variety of work activities within EWMO Area G, including the glovebox decontamination process activities (i.e., sort, segregate, size reduce; also

known as SSSR) and repackaging of TRU waste into Waste Isolation Pilot Project (WIPP) compliant packages for shipment to WIPP. Additionally, Independent Oversight observed two glovebox disassembly operations and one drum repackaging activity location. Activities that were observed included unpacking previously stored waste containers and fiberglass reinforced plywood boxes, assessing and/or breaching the glovebox integrity, and dismantling certain glovebox components to access the interior in order to facilitate performance of the necessary decontamination and/or volume reduction).

The scope of this review did not include a review of NNSA Los Alamos Field Office processes for laboratory oversight of radiological work planning and control as originally intended and described in *Plan for the Independent Oversight Targeted Review of Radiological Controls Activity Level Implementation at the Los Alamos National Laboratory*, dated July 12, 2013. This review area will be conducted and reported separately at a later date.

3.0 BACKGROUND

LANL's primary mission is to develop and apply science and technology to ensure the safety, security, and reliability of the U.S. nuclear deterrent; reduce global threats; and solve other emerging national security challenges. For more than 70 years, LANL has served as a research center in the world of science, technology, and engineering, and has made achievements that focus on safety, security, environmental stewardship, nuclear deterrence, threat reduction, operations, communications, and community involvement. LANS, a partnership that includes the University of California, the Babcock and Wilcox Company, Bechtel National, Inc., and URS Corporation, has held the contract to manage and operate LANL since 2006.

The Independent Oversight program is designed to enhance DOE safety and security programs by providing DOE and contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements, and the effectiveness of DOE and contractor line management performance in safety and security and other critical functions as directed by the Secretary of Energy. The program is described in and governed by DOE Order 227.1, *Independent Oversight Program*, and a comprehensive set of internal protocols, and Criteria, Review, and Approach Documents (CRADs).

Radiological controls activity level implementation was identified as an Independent Oversight targeted review area for 2013 in a HSS memorandum from the Chief Health, Safety and Security Officer to DOE senior line management, *Independent Oversight of Nuclear Safety – Targeted Review Areas Starting in FY 2013*, dated November 6, 2012. This review is further described in the *Plan for the Independent Oversight Targeted Review of the Radiological Controls Activity Level Implementation at Los Alamos National Laboratory*, dated July 12, 2013, which defines the specific focus at LANL for this targeted review area.

Title 10 CFR Part 835, *Occupational Radiation Protection*, establishes the requirements for developing, implementing, and maintaining an RPP. Title 10 CFR 835.101(a), *Occupational Radiation Protection*, states that "A DOE activity shall be conducted in compliance with a documented radiation protection program (RPP) as approved by the DOE." Each DOE site that works with radiological material has developed an RPP and supporting implementing procedures for radiological control.

The LANL RPP is documented in a LANL document entitled *Los Alamos National Laboratory 10 CFR 835 Radiation Protection Program*, Rev. 7.0, June 1, 2011, approved by Los Alamos Field Office May 31, 2011. LANL defines the scope of applicability for the RPP as all LANL radiological activities not

specifically excluded in §835.1(b); therefore, the LANL RPP covers the operations reviewed during this assessment.

4.0 METHODOLOGY

This review was guided by selected lines of inquiry associated with activity level work control contained in Sections A, B, and C of HSS CRAD 45-35, Rev. 1, *Occupational Radiation Protection Program Inspection Criteria, Approach, and Lines of Inquiry*. This targeted review area assesses contractor implementation of RPP radiological work planning and control commitments by observing the conduct of work activities involving radiological hazards. Observed radiological work activities and practices are reviewed against site radiological control implementing procedures, the RPP, and 10 CFR 835, as indicated in HSS CRAD 45-35, Rev. 1.

5.0 RESULTS

During this review, Independent Oversight reviewed the effectiveness of the flowdown of occupational radiation protection requirements to work planning, control, and execution processes at LANL TA-53 (LANSCE) and TA-54 (EWMO Area G). Results of this review are based on a sampling of data and work that was ongoing at the time of the review and are not intended to represent a full programmatic review of the site RPP.

Radiation Protection Organization and Administration

Radiation protection program design including organizational structure and administration are sufficient to provide for effective implementation and control of all radiological protection activities. (10 CFR 835.101)

The LANL Radiation Protection (RP) Organization is in the midst of a recent environment, safety, and health (ES&H) transformation, which created both Core and Deployed Divisions for all ES&H functions (including radiation protection, occupational safety and health, and other ES&H functions). This transformation is intended to streamline, simplify, and improve processes; strengthen the focus of ES&H Core Divisions; create and align an ES&H Deployed Division; and enable professional development.

The functions of the former RP organizations (known as RP-1, RP-2, and RP-3) have been transformed into two separate divisions: Radiation Protection Division and ES&H Deployed Services Division. The Radiation Protection Division is led by a Division Leader who reports to the Associate Director for Environment, Safety and Health. The RP Division Leader manages two groups: Radiation Protection Programs and Radiation Protection Services. These groups are led by group leaders who are responsible for maintaining the radiation protection infrastructure support that includes 10 CFR 835 programs, internal and external dosimetry (Radiation Protection Programs), instrumentation and calibration and Health Physics Analysis Laboratories (Radiation Protection Services). Some of the functions of the RP Organization formerly known as RP-1 Health Physics Operations have been reorganized and operational radiation protection support is now provided by ES&H Deployed Services Division, led by a Division Leader, who also reports to the Associate Director for Environment, Safety and Health. The ES&H Deployed Services Division consists of seven ES&H group leaders who cover ES&H across all Laboratory areas and facilities. ES&H deployed services, including RP, are matrixed to the line organizations for program support. Each ES&H group has a radiation protection lead who serves as the technical point of contact for the RPP for his/her assigned areas.

At LANSCE, deployed services are provided by the LANL Associate Director for Experimental Physical Sciences, Deployed Services Environment Safety & Health (DSESH), LANSCE Facility Operations (DSESH-LFO). For G-Area, deployed services are provided by the LANL Associate Director for Environmental Programs (ADEP), Deployed Services Environment Safety & Health, Environmental & Waste Management Operations (DSESH-EWMO).

Both RP Core ES&H Deployed Services Divisions were staffed by qualified and experienced radiation protection personnel. A number of managers and staff have professional certifications and/or advanced degrees in health physics or related disciplines, as well as years of applied radiation protection experience. At LANSCE and Area G, local implementation of the LANL RPP and support and oversight of programmatic radiological work is the responsibility of the respective radiation protection team leads, who are both certified health physicists (CHPs). These individuals report to their respective ES&H group leads. The ES&H group lead at Area G is also a CHP, and one other technical support member also holds health physics certification. Deployed radiation protection team leads are supported by various radiological support staff, including health physicists, supervisors, and field radiological control technicians (RCTs). LANSCE currently has three full-time health physicists, two of whom are certified and the other is pursuing certification. One of the LANSCE CHPs has many years of experience at the facility and was determined, by the Independent Oversight team, to be an integral part of ensuring the safety of operations due to his breadth of knowledge of accelerator design and associated operational hazards.

Because the organizational structure changes are relatively new, personnel continue to refer to the old radiation protection organizations, and information on the LANL Intranet does not fully reflect the current organizational structure. For example, the RP Intranet home page still contains links to RP-1, RP-2, and RP-3, and contains a very outdated and inaccurate RP contact listing. The LFO homepage is similarly outdated, with references to the old organizational structure, including an Environment, Safety, Health and Quality organization chart; dated 2006 (see **OFI-1**).

The LANL RPP is documented in *Los Alamos National Laboratory 10 CFR 835 Radiation Protection Program*, Rev. 7.0, dated June 1, 2011. LANL has developed appropriate programmatic radiological protection documentation, including management policy statements, implementing procedures, and technical basis documents (TBDs). However, most of this information is not explicitly linked to the DOE-approved RPP and does not explicitly link mechanisms that implement each of the RPP compliance commitments (see **OFI-2**).

The following non-mandatory guidance, excerpted from the DOE Guide 441.1-1C, *Radiation Protection Programs Guide*, Section 3.1, provides one means for demonstrating compliance with 10 CFR 835:

> *The approved RPP details how a DOE activity shall be in compliance with 10 CFR 835 and should identify the functional elements appropriate for that activity. Additional documentation should be developed and maintained to supplement the approved RPP to demonstrate that an RPP can be effectively managed and administered to achieve compliance with 10 CFR 835. This documentation typically includes a site radiological control manual developed to the guidance contained in the RCS [Radiological Control Standard, DOE-STD-1098-99], as well as detailed implementing procedures, appropriate management policy statements, and technical basis documentation. While this documentation need not be part of the RPP, it should be clearly linked to the compliance commitments contained in the RPP.*

Radiological Work Planning, Exposure, and Contamination Control

Radiological work planning processes are formally defined, designed, and implemented in a manner that adequately defines work scopes, integrates with other safety and health disciplines, minimizes the potential for spread of contamination, and ensures radiological exposures to personnel are maintained as low as reasonably achievable (ALARA). (10 CFR835.101)

LANSCE

Engineered controls for LANSCE accelerator operations are robust and effectively used to prevent inadvertent access to radiological areas during beam operations. These controls include the Radiation Security System, which automatically terminates beam delivery in response to faults from predefined inputs. Inputs include the Personnel Access Control System (PACS) and Experimental Personnel Access Control System (EPACS), which control personnel access to areas where radiation hazards from an accelerated beam could be present. PACS controlled areas are primary beam line areas and are posted as "Very High Radiation Areas" during beam operations. These systems are controlled by the Central Control Room in conjunction with a radiation protection deployed services key core. Normally, users do not access primary beam lines except during operations at two areas: pRad and a target area referred to as the Blue Room. Accelerator operating modes can be made up when PACS areas are secured. In the event of an unauthorized attempt to enter one of these areas, the beam would shut down. When PACS is in the unsecured mode, beam operations are not permitted. During a non-run cycle or maintenance period, radiation protection maintains control of all PACS keys at the Health Physics Field Office. LANSCE uses the EPACS system to ensure that no one is in a high-radiation area while the beam shutter is open to an experiment flight path. The EPACS are experimental area PACS systems for secondary beam line flight paths in which the experimental scientists control entry and exit. The flight path shutter will not open until all of the sweep keys are in place and EPACS shows that it is safe. A violation of an EPACS interlock shuts down all beams to eliminate the hazard.

The Lujan Center is a busier facility than WNR due to its larger number of experimental flight paths available for beam line experiments. Lujan Center flight path 4 was the site of a technetium-99 (Tc-99) contamination event in August 2012 that resulted in a formal Federal accident investigation and associated report. In response to the findings in that report, the Lujan Center has implemented a number of corrective actions, including a very rigorous and comprehensive sample handling and management program to ensure positive control of all experimental samples. Independent Oversight conducted random checks of storage cabinets and real time source inventories and movement, and found the sample management system to be effectively implemented with no anomalies noted. Some notable system attributes include:

- All experimental samples are bar-coded upon receipt and stored in locked cabinets, each of which has defined lists of authorized users who can access locked storage cabinets and handle samples.
- Each move of a sample is accompanied by a barcode scan associated with a specific action, such as "sample placed in flight path." In this manner, the current sample location and custodian is immediately updated in the sample management database.
- Labeling and survey requirements exist for all irradiated samples prior to being released.
- All samples require evaluation and assignment of a material risk assessment (MRA), denoted as MRA 0, 1, and 2 for the three hazard levels. The most stringent controls are required for MRA-2 samples, which includes samples that are intrinsically radioactive, like the Tc-99 samples that were involved in the contamination event. These types of samples now require dedicated storage

cabinets separate from other MRAs, limits on who can handle such samples, and dedicated RCT coverage for introduction and removal of the samples from the beam line experimental area.

Integrated work documents (IWDs) serve as the primary work control documents governing experimental research activities at both Lujan Center and WNR flight paths. In general, these documents adequately bounded the scope of observed activities and identified applicable hazards and appropriate controls. For example, facility and training requirements for users were well defined and discussed and verified at observed pre-job briefs. During development of IWDs, a formal group technical and safety review is conducted to aid in the hazard analysis, including "what if" analysis scenarios to identify worst case impacts from potential failures. The Independent Oversight team observed a safety review meeting and found it to be effective in analyzing hazards and possible alternatives to mitigate the hazard.

Separate plan-of-the-day meetings (PODs) are held each day for LANSCE and Lujan Center to provide status updates, and work and resource allocation for the upcoming day. The LANSCE POD covers all facilities, including WNR. However, due to its size and workload, Lujan Center has a separate POD following the LANSCE POD, where facility-specific flight path activities and resource needs are further discussed. PODs were found to be formal, informative, and effective.

While a number of positive attributes were noted during observation of Lujan Center and WNR work, the Independent Oversight team observed several weaknesses regarding proper application of institutional and facility radiological requirements. In particular, in some cases, radiological work was conducted without an RWP, or the work was not adequately bounded by the facility radiation protection requirement (FRPR) document, as required by LANL Procedure P121, Rev. 2, *Radiation Protection*. In other cases, when RWPs were used, the associated IWD did not include clear linkage to that RWP, as required by LANL Procedure P300, Rev. 4, *Integrated Work Management*. For example:

- Data acquisition system (DAQ) rack component work at flight path 4 included unplanned breaching of a contamination area (CA) boundary without an RWP or an FRPR that identified the hazards and needed controls, as required by P121. While the area was posted with a requirement for Level 1 personal protective equipment (PPE), only lab coats, booties, and gloves were worn, resulting in a personnel contamination vulnerability based on the nature of the work and contact with potentially contaminated surfaces. The IWD did not adequately break down specific work tasks such that tasks in the Radiological Control Area-C controlled area of flight path 4 (that had different radiological hazards and controls than the posted CA) were properly identified and controlled. After consultation, the LANL health physicist paused the work and instructed the workers to don Level 1 PPE as indicated on the posting. However, the work was not stopped to correct the IWD or generate an RWP. The IWD was later updated to include a requirement for Level 1 PPE when breaching a CA boundary, and a radiation protection observation was generated (see **Finding F-1**, **OFI-3**, and **OFI-7**).
- An RCT initial entry into the Blue Room to characterize radiological conditions after beam shutdown was not covered by an RWP or specifically addressed by the FRPR, as required by P121. The purpose of the RCT entry was to characterize the radiological conditions and to properly post the room prior to other personnel accessing it. P121 requires entry under either a specific RWP or the FRPR, provided that the controls for the entry are included in the FRPR and that radiological conditions are stable and well characterized. This was an initial entry into a radiological area following beam operations with the intent of characterizing the radiological conditions. The FRPR did not discuss specific requirements for such entries, other than referring to the accelerator operations manual for primary beam entries. The RCT was wearing gloves, a lab coat, and booties, but this PPE was not specified in any work control document. A Blue Room entry procedure was posted on the door to the Blue Room. This procedure includes a responsibilities section that assigns

responsibility to the RCT to conduct "appropriate monitoring," but the body of the procedure contains no steps for the RCT to implement the assigned responsibility (see **Finding F-1**, **OFI-3**, and **OFI-7**).

- The RWPs and IWDs covering 1L target flow sensor and TWS work did not provide adequate linkage. The IWDs did not reference the specific RWPs for the work, referencing instead "current" RWP. This is inconsistent with P300 expectations for clear linkage to associated work documents (see **Finding F-2** and **OFI-7**).
- Neither P300 nor P121 require formal review and evaluation to ensure that the FRPR contains sufficient information on hazards and controls for the intended work scope prior to use as the governing radiological work authorization in lieu of an RWP (see **Finding F-1**, **OFI-3**, and **OFI-7**).

The Independent Oversight team also noted poor doffing practices when workers exited the flight path 4 work area, including failure to remove exposed tape, which resulted in ripping PPE while doffing. Workers at LANL are not required to demonstrate Radworker II practical proficiency every two years when renewing Radworker II qualifications. Once the initial practical is completed successfully, the only requirement for requalification is a written test (see **OFI-4**).

An isolated weakness in experimental protocol was identified where a nonstandard radioactive material label was present on a plastic bottle of Gd2O3 paint in one area (FP-2). Use of this paint was not identified in the IWD, and contamination controls for painting were not used. The label is used to warn of potential activation if the labeled item is located in the flight path area, but there is no reason to store the bottle in the flight path, as it is only used when the beam is down. The IWD did not address this material, which also contains organic solvents (see **OFI-8**).

The Independent Oversight team noted some weaknesses in radiological posting and labeling. In these cases, radiological posting and labeling lacked standardization and consistency, resulting in possible confusion and a need to interpret the meaning and required actions (see **OFI-9**). For example:

- CA entry requirements were different on separate postings covering the same area.
- The use of the words "FRPR or RWP required for entry" may be misleading, as this statement could be interpreted that if an FRPR exists, then entry is authorized. The Independent Oversight team identified a few instances where the FRPR did not cover the intended activity, and no RWP was in place.
- Radioactive material labels covering the same area contained different wording. One version did not have the instruction to contact RP prior to work.
- A flammable cabinet was used to store flammable and non-flammable radioactive materials in the chemistry laboratory.

Area G

Engineering controls at Area G facilities are robust and are used extensively to mitigate radiological hazards associated with operations. PermaCon containment structures are the principal engineered controls and contain the glovebox decontamination process activities (i.e., SSSR) and repackaging of TRU waste into WIPP-compliant packages for shipment to WIPP. During this review, the Independent Oversight team observed work in two glovebox disassembly operations and one drum repackaging activity location, which included unpacking previously stored waste containers and fiberglass reinforced plywood boxes, assessing and/or breaching the glovebox integrity, and dismantling certain glovebox components to access the interior in order to facilitate performance of the necessary decontamination.

Within the ADEP organization, the Independent Oversight team observed several work evolutions in which hazard controls were employed without incident, including waste box line sorting and segregation; metal box cutting; TRU waste shipment preparation; and RCT coverage of work in CAs, high contamination areas (HCAs), and airborne radiation areas (ARAs). Administrative and computer-based access controls, electronic dosimeter, and RWP issuance are used to confirm training status and ensure individuals are made aware of and acknowledge RWP requirements prior to conducting radiological work. Additionally, training qualification was confirmed through UTrain, which is a database system that tracks the cadre of courses, the training requirements of workers, and workers' status in completing training. Supervisors, persons in charge, and others can access worker training records to ensure training is complete prior to the start of jobs. Independent Oversight confirmed several workers' training and qualifications by spot checking their current status in UTrain.

The ADEP has also implemented a comprehensive mix of engineering, administrative, and PPE as controls. New activity As Low As Reasonably Achievable (ALARA) reviews were conducted for the work in Dome 231 (TRU Box Line in Cell #1 and Cell #2) and Dome 375 TRU Box Line (Cell 2 operations). This process includes sections for a new activity screening and a radiological hazard and control analysis, as well as approval by appropriate subject matter expert and DSESH-EWMO team leader.

Independent Oversight identified a few examples where institutional requirements were not specifically followed during work planning, resulting in the potential for unnecessary exposure and/or issues with conflicting ALARA information or inaccuracies in RWPs and work instructions. For example:

- After a shift turnover, new workers in Building 231 entered the HCA to continue glovebox load out from the prior crew's work activity without lead (Pb) aprons, despite available information that dose rates were greater than 25mR/hr, which requires Pb apron use. Neither the shift turnover briefings (observed on 08-20-2013) nor the daily pre-job radiation surveys communicated the high glovebox exposure rates driving the RWP requirement for workers to don Pb aprons. Independent Oversight observed that workers appropriately dressed out based on information provided by line supervision and the supporting RCT (including wearing their dosimetry within PPE coveralls). Almost immediately following entry into the HCA, a RadCon survey noted a dose rate high enough to require wearing Pb aprons and necessitated surveying the crew out of the HCA and removing their dosimetry for placement on the outer surface of the Pb aprons as required by the RWP and Procedure RP-1-DP-67, *Using Lead Aprons*. This evolution not only resulted in a lapse in work efficiency, but caused workers to enter the HCA/ARA while wearing respiratory protection, unnecessarily placing physiological stress on workers (see **OFI-10**).
- On August 20, 2013, response to a continuous air monitor (CAM) alarm in Building 231 resulted in the evacuation of individuals who were not wearing respiratory protection from the facility, including those in the control room monitoring work in the HCA/ARA. Workers within the HCA/ARA wearing respiratory protection were directed to pause work and remain in the area. Although operator actions taken were in accordance with the abnormal operating procedures, these actions left no one in the control room to monitor ventilation system performance or the potential rate of rise of derived air concentration (DAC) in the HCA/ARA. Also, communication with the individuals who remained in the area was not maintained. RCTs, who donned respiratory protection, subsequently determined that conditions were sufficient to allow workers to doff PPE and exit the facility. A critique was conducted the following day by the FOD, subcontractor representatives, and deployed Area G ES&H management and a determination was made that there was a need for further action to address what management deemed an unnecessary evacuation. The need for additional direction (potentially procedure revision) and training/discussion on facility-specific alarm response was discussed.

However, ALARA consideration for individuals in the HCA/ARA (while wearing respiratory PPE) was not addressed for future action (see **OFI-10**).

- The Independent Oversight team observed a worker using poor doffing techniques while exiting a radiological area (Area G Reduction System Building 412, Contamination Area); the employee touched modesty clothing (including lanyard and ID badges/thermoluminescent dosimeters TLDs) with gloved hands after touching the outer surfaces of anti-contamination coveralls and shoe covers. No doffing instructions were posted in the area to assist workers in their doffing. This observation is consistent with previously identified concerns at DSESH-EWMO. Plans are currently underway to develop a contamination control training facility, including the subsequent development and posting of TA-54 procedures for donning and doffing (see **OFI-12**).
- A recent revision in the Area G basis for interim operation was implemented without adequate consideration of appropriate actions to be taken in the event of a CAM alarm. The change resulted in the establishment of a fire watch during SSSR operations where material at risk (MAR) is not covered with flame retardant plastic. During observation of shift turnover, Independent Oversight noted that during the prior night, a CAM alarm required evacuation of the work area. Workers questioned operations supervision regarding the appropriate actions to be taken in light of this new requirement (i.e., evacuate immediately or take time to cover MAR to avoid a technical safety requirement violation). Based on RCT direction, the initial response was to place the MAR in safe condition (cover) if safe to do so. This interaction, although appropriate, was indicative of a planning and/or communication lapse in the implementation of this change in the hazard control set. In a subsequent observation, an individual assigned fire watch in the HCA/ARA in Building 231 was observed assisting workers in donning Pb aprons (while MAR was uncovered) in conflict with the assigned fire watch duties (see **OFI-10**).
- Independent Oversight observed a discrepancy in bioassay requirements and actual work practices in Dome 231 and 375. New activity ALARA reviews for work in Dome 231 (TRU Box Line in Cell #1 and Cell #2) and Dome 375 TRU Box Line (Cell 2 operations), and the associated RWPs, included requirements for bioassay including annual americium (Am) Radiochemical Alpha Spectroscopy (RAS) urine sample and an annual plutonium (Pu)/Am in vivo, semiannual PU RAS, and a thermal ionization mass spectrometry (TIMS) urine sample. However, actual enrollment indicated that individuals only receive an annual AM RAS urine sample and an annual Am in vivo (Pu no longer conducted), and while a semiannual PU RAS is conducted, the TIMS urine sample is only collected on an annual basis (see **OFI-11**).
- Many implementing procedures used by DSESH-EWMO (including RWPs and the FRPR) are in need of revision, as they reference LANL organizations (i.e., RP-1) that either no longer exist by that name or whose function has been reassigned as part of the deployed services related reorganization (see **OFI-11**) .

Radiological Surveys and Monitoring

Adequate routine and non-routine radiological surveys and monitoring are performed for external radiation, fixed and removable contamination, and airborne radioactivity, as needed to characterize radiological conditions and ensure safety of personnel. (10 CFR 835.401; 10 CFR 835.403)

LANSCE

Potential external radiation exposures to gamma and neutron radiation are being appropriately monitored through use of gamma and neutron sensitive TLDs, coupled with a specialized high energy track etch neutron dosimeter, known as the LANL PN3 Detector. The PN3 provides more accurate quantifiable

assessment of high energy neutron doses not possible with the traditional albedo neutron TLDs used for assessment of low and intermediate energy neutron doses. The PN3 is composed of special track-etch plastic foils placed in a hemispherically shaped ABS plastic case and is read differently than the TLD.

Neutron dose rates that might be present during beam operations are also monitored by a network of fixed neutron detectors that have local and remote readouts in areas of the Lujan Center and WNR that have potential for significant neutron dose rates during beam operations. While airborne radioactivity is not generally a concern during beam operations and flight path experiments, air monitoring with a giraffe air sampler was required by the health physicist during the experiment technical safety review for the WNR Chi Nu experiment involving use of a 100mg Pu-239 sample. The health physicist conducted appropriate hazard analysis in accordance with the institutional RP air monitoring procedure that indicated air sampling should be performed due to the calculated airborne hazard index associated with this sample. During a walkdown of the flight path, the giraffe air sampler was in place and functional.

While experimental areas at LANSCE do not meet regulatory thresholds for CAs that would require self-survey, personnel exit monitoring is being performed as a conservative measure and as one of the improvements in response to the Tc-99 contamination event at the Lujan Center. Hand and foot monitors are installed at the Lujan Center and are required to be used by personnel exiting the facility. A personnel contamination monitor (PCM) is also available in the Lujan Center and must be used by personnel who access areas posted as Radiological Control Area-C in flight path 4. PCMs are also available at other locations that support Lujan and WNR operations, where contamination potential exists during Blue Room operations and maintenance evolutions. Radiological surveys are required by the FRPR for all items being removed from flight path experimental areas, despite low potential for activation of items that are not directly located in the beam path.

Radiological survey records reviewed for LANSCE were generally legible and complete. However, in some cases, it was difficult to determine the location where smear samples were taken because maps are not always used. In addition, for contamination measurements taken with the Eberline Smart Portable Model, ESP-1 GM detector, all survey data sheets reviewed listed an instrument efficiency of 30 percent, which is a value published in the ESP Instrument Manual. However it was noted that this value was not accurate as the actual calibration constant programmed into the ESP is different for each instrument/probe combination and varies significantly (see **OFI-5**). In a related matter, RP instrument manual procedures (such as the ESP-1) contain outdated and, in some cases, inaccurate information regarding beta efficiencies (see **OFI-6**).

Area G

Radiological survey and monitoring systems in use at Area G are comprehensive and take advantage of state-of-the-art technology, allowing for quick and effective evaluation of airborne radioactivity and surface contamination levels. Air monitoring is accomplished through a system that consists of a network of Canberra Alpha CAMs (ASM 1000) located in each of the processing areas (positioned based on work activity, smoke testing, and/or known airflow) and networked to a CAM manager that is used to record and calculate DAC and/or DAC hour airborne concentrations, as well as low volume air samplers (LV-14M air samplers) located throughout the radiological buffer areas.

The possible presence of alpha and beta-gamma contamination on surfaces and dose rates associated with TRU waste containers are evaluated in accordance with RWP requirements, facility-specific pre-job survey requirements, as well as during RCT job coverage. This assessment is accomplished by taking smear samples in representative locations and evaluating the smears by Berthold low background gas flow proportional counters. Direct surface measurements are taken for alpha and beta-gamma particles with handheld survey instruments with scintillation detectors (Eberline E-600 SHP-380 AB) and external

dose with handheld neutron detectors (Eberline E-600 SNRD). Independent Oversight observations of work indicated that RCTs provided effective job coverage and documentation for observed work with potential for changing radiological conditions. Radiological survey records associated with RCT job coverage and routine surveys were found to be legible and complete.

Weaknesses were also identified in the following areas:

- Independent Oversight observed an RCT conducting whole body survey of individuals exiting a radiological area (Area G Reduction System Building 412, Contamination Area) using a scan rate not slow enough to ensure detection of potential contamination, without pausing as required by LANL training. The actual survey conduct indicated whole body scan times of less than two minutes, sometimes without appropriate pause time at the nose and mouth. LANL Radiological Worker II Training, Unit 5, Radioactive Contamination Control, states "Take a minimum or 2-3 minutes to complete a whole body frisk." While it is acknowledged that additional surveys of individuals may be conducted when exiting the area/facility with hand and foot monitors or PCM-type counters, these additional surveys are not always in the immediate area and/or may be unavailable (i.e., out of service), placing additional emphasis on appropriate survey conduct (see **OFI-12**).
- RWPs for observed SSSR work require ongoing radiological monitoring and indicate (under tasks for decontamination activities) that "Small areas of localized removable contamination exceeding RWP limits are permitted if the RCT believes that the contamination can be immediately and effectively decontaminated." Additionally, work instructions contain statements such as "If radiological contamination levels exceed the RWP during evolutions or as directed by the RCT, then follow the direction of the RCT and RWP" (EP-AREAG-WO-DOP-0211, R.25). While observed measurements appeared to be conducted at an appropriate frequency, an interview with an RCT indicated that this localized cleanup practice applied to all tasks and that no upper limit of the contamination levels or definition of small or localized was clearly defined (i.e., could be as small as a cup full or puddle) (see **OFI-11**).
- Monitoring of airborne concentrations of radionuclides within the ARA is conducted primarily by CAM; however, a recent decision to utilize the DAC mode for system alarm set points, versus the use of DAC hour tracking, has resulted in implementation uncertainties. As a result, some RWPs contain hold points for which additional guidance may be needed to assist RCTs and first line supervisors in the conduct of appropriate airborne monitoring and meeting ALARA. For example:

  - The statement "If CAM DAC exceeds 1000 DAC (5E-9 uCi/ml), pause work, monitor DAC reading, if reading stabilizes, change CAM filter, attempt to determine source of airborne, and return to work."
  - The interpretation of stabilize, based on interviews, could be a return to below 1000 DAC or a stop in the upward trend. Although highly unlikely, if certain interpretations were strictly applied, individuals could be working in airborne concentrations up to 4999 DAC.
  - The DSESH-EWMO RP team lead indicated that, in practice, the above provision has not been used much, because an immediate alarm usually precedes an immediate decrease (puff release).
  - RP management also indicated that they are not entirely sure of the CAM response in the DAC mode, but they have been very satisfied with the immediate indication of problems they have observed. Notwithstanding the benefits of the immediate indication, there is sometimes great confusion concerning the alarm (advertised as occurring at 5000 DAC) and the reported value, which is often less due to the rapid drop in DAC indication because of the rapid clearing of the breathing zone (actually the CAM "zone").

Given this potential confusion of instrument/alarm response and lack of a good definition for the term "stabilize," additional guidance for this hold point is warranted (see **OFI-13**).

6.0 CONCLUSIONS

LANL has a sound radiation protection infrastructure and has developed appropriate programmatic radiological protection documentation, including management policy statements, implementing procedures, and TBDs. The LANL RP Organization recently underwent an ES&H transformation, which created Core and Deployed Divisions for all ES&H functions including radiation protection. Both RP Core Deployed Services Divisions are staffed by qualified and experienced radiation protection personnel. A number of managers and staff have professional certifications and/or advanced degrees in health physics or related disciplines, as well as years of applied radiation protection experience.

Both LANSCE and Area G make effective use of robust engineering controls to mitigate hazards associated with radiological operations. Appropriate levels of external and internal radiological exposure control measures are in place, including external and internal dosimetry and radiological surveys and monitoring, based on the specific radiological hazards encountered at each facility. The Lujan Center has also effectively defined and implemented a number of corrective actions to a recent Tc-99 contamination event, including a very rigorous and comprehensive sample handling and management program to ensure positive control of all experimental samples.

While a number of positive attributes were noted during observation of LANSCE and Area G work, Independent Oversight also found examples of weaknesses in proper application of institutional and facility radiological requirements in some areas. These weaknesses included use of RWPs and FRPRs, consistency and clarity of radiological posting and labeling, proper PPE doffing and contamination control, and response to abnormal operations. Additional effort in these areas should be exercised in order to maintain effectiveness in meeting all radiological control program objectives.

7.0 FINDINGS

Findings indicate significant deficiencies or safety issues that warrant a high level of management attention. If left uncorrected, such findings could adversely affect the DOE mission, the environment, the safety or health of workers or the public or national security. Findings may identify aspects of a program that do not meet the intent of DOE policy.

Finding F-1: Two instances were identified where LANSCE did not ensure that RWPs were developed, or that FRPRs used in lieu of RWPs adequately bound hazards and controls for work in radiological areas, consistent with P121 requirements.

Finding F-2: Two instances were identified where LANSCE did not ensure that IWDs governing radiological work contain clear linkage to specific RWPs for the work, consistent with P300 requirements.

8.0 OPPORTUNITIES FOR IMPROVEMENT

Independent Oversight identified the following opportunities for improvement. These recommendations are not intended to be mandatory. Rather, they are to be reviewed and evaluated by the responsible line management organization and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

Institutional

OFI-1: Consider development of an implementation plan and timeline for updating LANL Intranet information and procedure/work planning document references to match the Core and Deployed Services organizational structure.

OFI-2: Establish explicit linkage between LANL RPP document hierarchy and the formally documented RPP. Specifically, consider supplementing the existing RPP with a compliance matrix showing the linkage and flowdown of each regulatory requirement to specific implementing mechanisms and TBDs. (NOTE: This OFI applies both to LANL RPP managers and DOE management reviewers/approvers.)

OFI-3: Consider modifying P121 and/or P300 to ensure that there is a formal requirement that ensures review of FRPR against intended work scope to ensure adequacy of hazard information and controls, prior to using FRPR in lieu of an RWP, as authorized by P121.

OFI-4: Improve personnel donning and doffing practices to minimize the potential for spread of contamination when removing PPE. Specific actions to consider include:

- Consider instituting a periodicity for workers to repeat Radiation Worker II practical factors.
- Consider a requirement for posting donning and doffing procedures.
- Consider facility-specific training and implementing practical factors proficiency training at each facility.

OFI-5: When calibrating smart instruments that read out in dpm, such as the ESP-1, consider providing information for the RCT performing the survey to make appropriate energy corrections.

OFI-6: Consider reviewing and revising RP Instrument Manuals to ensure current and accurate information is provided on instrument efficiencies.

LANSCE

OFI-7: Improve radiological work planning associated with use of RWPs, FRPRs, and IWDs. Specific actions to consider include:

- Review FRPR to ensure that all radiological activities that are not normally governed by an RWP are adequately defined and bounded by the FRPR, and that the specific radiological controls are provided.
- When referencing RWPs for the radiological controls in an IWD, ensure the specific RWP numbers are provided.

- When referencing FRPR as the radiological controls in an IWD, ensure the specific sections intended to cover the work scope are identified, or that the specific controls from the FRPR are listed in the IWD.

OFI-8: Consider inspecting Lujan and WNR flight path experimental areas to determine if materials and supplies are being stored unnecessarily in areas that may result in activation, and whether IWDs adequately address all hazards (i.e., solvents) associated with experimental work within the flight path.

OFI-9: Consider standardizing wording of signs and labels used for radiological posting and marking to avoid unnecessary confusion over meaning or intent.

Area G

OFI-10: Improve the rigor of work planning and the integration between radiological controls and work instructions. Specific actions to consider include:

- Provide additional training to RCT staff on the expectations for responses to abnormal events, including facility-specific CAM alarms, compliance with hold points, and response to detection of contamination in excess of RWP void limits.
- Revise abnormal operating procedures and RWPs to address facility-specific CAM alarm response, taking into consideration respective air spaces and air flow pathways.
- Ensure shift turnover briefings and daily pre-job radiation surveys communicate radiological status to incoming crews in sufficient detail to address the donning of additional PPE when needed.
- Ensure that RWP briefings review any applicable lessons learned and operational experience from similar work evolutions.

OFI-11: Improve the clarity and accuracy of RWPs to include clearly defined terminology for specific radiological controls applicable to the work. Specific actions to consider include:

- Provide specific guidance to RCT hold point implementation and better define the terms small, localized, or stabilized to assist RCTs and first line supervisors in meeting ALARA.
- Revise RWPs to ensure that required bioassay analyses and frequencies are the same as the testing requirements currently offered and provide details regarding which individuals are expected and required to receive them.
- Review radiological controls embedded in work instructions or procedures to ensure that they are consistent with current RWP requirements for the same task.
- Revise RWPs, FRPR, and procedures, as needed, to ensure that they accurately reflect organizational names or proper entities assigned functions to support radiation protection.
- Review a sampling of RWPs to identify if there are additional errors and inconsistencies that warrant an extent-of-condition review. Revise and re-issue deficient RWPs as appropriate.

OFI-12: Reinforce training provided to both RCTs and Operations personnel on proper personnel survey conduct, as well as donning and doffing techniques. Specific actions to consider include:

- Continue efforts that are underway to establish additional donning and doffing procedures, training facilities, and postings.
- Consider testing of practical factors for both donning and doffing, as well as performing personnel surveys (both self-survey and surveys conducted by RCTs).

OFI-13: Improve technical bases associated with radiation monitoring and/or calibrations. Specific actions to consider include:

- Consider development of written technical bases for use of CAMs in DAC mode, as well as delineation of expectations for responses for airborne concentration between 1000 and 5000 DAC.

9.0 ITEMS FOR FOLLOW-UP

Independent Oversight will follow up on actions and satisfactory closure of the findings identified in this report.

APPENDIX A
Supplemental Information

Review Dates

August 19-29, 2013

Office of Health, Safety and Security Management

Glenn S. Podonsky, Chief Health, Safety and Security Officer
William A. Eckroade, Principal Deputy Chief for Mission Support Operations
John S. Boulden III, Director, Office of Enforcement and Oversight
Thomas R. Staker, Deputy Director for Oversight
William E. Miller, Deputy Director, Office of Safety and Emergency Management Evaluations

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Independent Oversight Site Lead for LANL/LLNL

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Robert Freeman
Mario Vigliani, CHP
Joseph Lischinsky, CHMM

APPENDIX B
Documents Reviewed

- LANL, DSESH-EWMO, LANSCE Radiological Protection (RP) Organization Charts
- LANL, *10 CFR 835 Radiation Protection Program*, Rev. 7.0, June 1, 2011
- LANL Rad Worker II Training Manual, dated April 2012
- LANL Procedure P-121, Rev. 2, *Radiation Protection*, June 01, 2011
- LANL Procedure P300, Rev 4, *Integrated Work Management*, March 30, 2012
- Lujan, *Safety Review*, June 2013
- LANSCE, *Facility Centered Assessment*, January 10, 2013
- LANSCE-ST-121-004.R4 TA-53 *Facility Radiation Protection Requirements*, July. 2013
- LANSCE-ST-101-001.5 *Technical and Safety Review of User Experiments at LANSCE*
- *Accident Investigation into Contamination at the Los Alamos Neutron Science Center on or about August 21, 2012*
- LANL, *Facility Centered Assessment of Waste Disposition Project*, July 29, 2011
- PSM, *Management Assessment Report Radiological Protection*, November 1, 2012
- NNSA Federal Accident Investigation Report, *Accident Investigation into Contamination at the Los Alamos Neutron Science Center on or about August 21, 2012*,September 2012
- LANL, *Summary Corrective Actions for Lujan Center Contamination Event (PFITS #2012-3165)*
- LANL,TA53-PL-320-003.1, *Lujan Center Resumption and Operations Plan (LANSCE,)* 1-18-13
- ORPS and RPO Reports, *Group 6 ORPS reports since 01/2011 and RPOs since 01/2012*
- EP-AREAG-FO-AP-0105, Rev. 0, *Radiation Protection Requirement*, 03/01/2012
- LANSCE-ST-121-003.R3, *Radiation Protection Requirements*, 02-01-2012
- RP-3-06-PR-01.8, *Radioactive Sealed Source Control Procedure*
- RP-3-06-PR-05.3, *Radiological Design Review Procedure*
- RP-3-06-PR-07.1, *ALARA Optimization Analysis Procedure*
- Select Health Physics Operations (RP-1) Procedures (including documents relating to), *Quality, Administration and Training, Emergency Response, Work Control, Work Process, Instrumentation, Instruments, Technical Basis*
- Select Health Physics Measurements (RP-2) Procedures (including documents relating to), *Administrative, Internal Dosimetry, External Dosimetry, Radiation Instrumentation/Calibration and HPAL*
- EP-AREAG-WO-DOP-0211, R.25, *TA-54 Area G TRU SWB/Drum Operations*, 8-8-2013
- EP-AREAG-WO-DOP-0227, R.23, *TA-54 Area G TRU Oversized Container SSSR Activities*, 8-8-2013
- New Activity ALARA Review (NAAR), *Activity: Dome 231 TRU Boxline Work in Cell #1 and Cell #2*. Dated 2/4/13
- New Activity ALARA Review (NAAR), *Activity: Dome 375 TRU Box Line (Cell 2 Operations)*. Dated 2/14/13
- Radiological Work Permit, RWP ID 2013- 0110, Rev.2, *Denesting/overpacking empty parent drum in 412*, 6/10/2013
- Radiological Work Permit, RWP ID 2012- 0176, Rev.9, *SSSR and repackage TRU in 375*, 8/22/2013
- Radiological Work Permit, RWP ID 2012- 0175, Rev.15, *SSSR and repackage TRU in 231*, 8/22/2013
- Radiological Work Permit, RWP ID 2013- 0036, Rev.1, *Radioactive Sealed source Handling*, 2/21/2013

- Various Contamination/Radiation Survey Reports associated with RWP Number 2012-0176 Rev.8
- Various Contamination/Radiation Survey Reports associated with RWP Number 2012-0175 Rev.15
- Various Contamination/Radiation Survey Reports associated with RWP Number 2010-0444
- Select RP-1 Pre-Job RWP Briefing Logs associated with 2013-0110, 2012-0175 and 2015-0176
- Select IH/S-RPP-OP-01, R3, *LANL Powered Air Purifying Respirator Issue Forms*
- DOE Guide 441.1-1C, dated 5/19/08, *Radiation Protection Program Guide*
- Selected RP staff resumes, training and experience records
- Air Sampling and Accountable Sealed Source Databases for Area G
- IWD#: RP-1-IED-01, Revision#: 04, *Surveys, inspections and radiological protection activities in radiological areas,* 2/28/2013
- IWD# LANSCE-NS-26, version #: 8, *Flight Path 1F14 (DANCE) Neutron Beam Experiments at LANSCE/Lujan Center,* 7/30/2013
- IWD# LANSCE-NS-34, version #: 7, *Use of alpha, beta and gamma emitting samples at DANCE,* 7/30/2013
- IWD# LANSCE-NS-39, version #: 7, *Testing and Operation of PPAC fission tagging detectors with actinide targets at DANCE,* 7/30/2013
- IWD# FP4-DAQ-RACK, revision #: 1, *Maintenance on FP4 DAQ racks such as removing power supplies, modules or work on cooling fans,* 8/22/2013
- Various Radiological Survey Forms associated with RP-1 Survey Number 29146612