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Feb. 26, 2021, TA-55 PF-4

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ANALYSIS OF AN UNEXPECTED REACTION OBSERVED DURING DRUMMOUT ACTIVITIES, FEB. 26, 2021, TA-55 PF-4

CAUSAL ANALYSIS TEAM INVESTIGATION RESULTS AND RECOMMENDATIONS



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EXECUTIVE SUMMARY

1. INTRODUCTION

Background:

On February 26, 2021, at Los Alamos National Laboratory in PF-4, Pit Technologies (PT) programmatic personnel observed sparks emanating from a waste drum into a glovebox. The drum was attached to the glovebox and personnel were dropping items into the drum as part of a drumout evolution. The items had been approved for drumout through a visual inspection (VI) process and a visual examination (VE) process. After placing bagged material into the drum, the involved Operator selected a sealed bag that held a High Efficiency Particulate Air (HEPA) filter, centered the bag above the drum, and dropped that into the drum. The Operator then selected an approved stainless steel container and after centering it over the mouth of the drum, dropped that into the drum on top of the already emplaced bags. Immediately, the Operator and others in the work area observed sparks emanating from the drum. The event and response timelines are detailed in Section 2 of this report.

On March 15, 2021, the Associate Laboratory Director for Weapons Production (ALDWP) chartered a team to investigate the event, including the facts surrounding the event, the organizations, associated processes and procedures, and the effectiveness of corrective actions that followed the 2014 WIPP event.¹ The investigation team charter letter is in Attachment 1 of this document. Submittal of this joint report reflects concurrence on the content by all team members. Individual signature pages will not be included.

The investigation team completed a detailed evaluation of the event, governing operational processes and procedures, associated waste processes and procedures, and previous event and issue corrective actions. The team did not do an exhaustive review of all waste certification activities performed by the Central Characterization Project, (CCP), however the team did review CCP activities where there was overlap with LANL personnel and activities. The following graphic provides a high-level summary of the involved organizations and their related work scope.

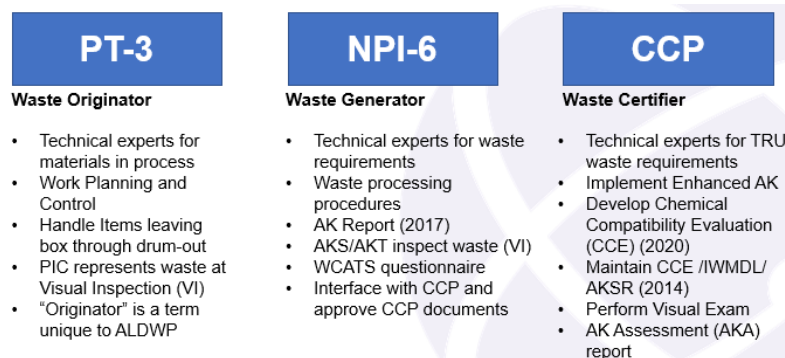


FIGURE 1-SUMMARY WORK SCOPE FOR INVOLVED ORGANIZATIONS

Notes: AKS=Acceptable Knowledge Specialist, AKT=Acceptable Knowledge Technologist
AKSR=Acceptable Knowledge Summary Report, IWMDL=Interface Waste Management Documents List

¹ Department of Energy, Office of Environmental Management, Accident Investigation Report (2015). Phase 2 Radiological Release event at the Waste Isolation Pilot Plant, February 14, 2014. Retrieved from <https://www.energy.gov/ehss/listings/federally-led-accident-investigation-reports>

Conclusions:

The investigation team determined that the event was preventable. The hazard associated with vapor deposited titanium on High Efficiency Particulate Air (HEPA) filters that were removed from an inert atmosphere into a room was not fully evaluated and controlled. Operating processes and procedures and waste management processes and procedures did not prevent the material from getting to the drumout evolution. The sparking event occurred when the unoxidized titanium powder was expelled into the air from the bag that held the HEPA filter. The direct cause of this was that the PT-3 Operator dropped a stainless steel container into the waste drum. The empty container struck the bag and filter rim and generated a small tear in the bag, through which the powder became airborne. Titanium in powder form is a combustible material that exhibits pyrophoric-like characteristics (per NFPA Standard 484). The rapid expulsion of the titanium powder from the bag is believed to have produced sufficient friction to generate sparks. The investigation team identified two root causes that allowed the reactive material to remain unrecognized until the drumout evolution. The first root cause was that PT-3 did not recognize this hazard prior to handling the HEPA filters outside of inert environment. As described by supporting contributing causes, the operational hazards were identified, evaluated, and mitigated with respect to the operations within the inert atmosphere box, but not with regard to welding fume deposited on filter media that would be removed from that inert atmosphere (or be subject to a sudden influx of air in the case of a glove or window failure). The second root cause was that the Los Alamos National Laboratory (LANL or the Laboratory) and CCP waste characterization processes and procedures failed to identify and reject the HEPA filters from reaching the drumout activity, even though the titanium powder was prohibited by waste acceptance criteria and CCP chemical compatibility evaluation (CCP CCE) documentation. As described by the contributing causes, this was primarily due to corrective action implementation following the 2014 WIPP event that did not adequately address upstream activities that support accurate AK and waste characterization for this PT-3 operation. The investigation team identified multiple contributing causes that generated these two root causes. These are detailed in Section 7 of this document.

It is important to note that this report includes the term “reactive,” generally indicating unoxidized metal and is not used to infer or determine that the material should be classified as a RCRA reactive waste (D003).

2. EVENT DESCRIPTION

Event Background:

Pit Technologies (PT) operations (including machining, welding, and assembly of encapsulated nuclear materials) were subject to restart Readiness Reviews in accordance with DOE O 425.1D, Chg 1, in 2015. Referred to as “Pit Flowsheet,” the operations were subject to an internal Management Self-Assessment (MSA) that was completed in July of 2015. The MSA was followed by an independent Contractor Readiness Assessment (CRA) and Federal Readiness Assessment (FRA), both of which were completed by November of 2015. These reviews assessed the following areas: procedures, personnel, equipment and safety features. The readiness reviews provided confirmation that the previously established Pit Flowsheet activities were ready to safely resume operations. An operation-specific Fire Hazard Evaluation (FHE) was developed and approved prior to the FRA. These reviews did not result in identification of a hazard associated with titanium welding fume deposition on the HEPA filters associated with this process glovebox. It should be noted that the PT-3 laser welding operations include

two gloveboxes; one referred to as the “hot” box and the other, the “cold” box. The term “hot” in this case is defined by welding conducted directly on radioactive material. The term “cold” does not refer to the absence of potential contamination, but rather that welding is performed on materials that encase radioactive material.

The MSA identified a labelling finding associated with the Pit Flow Sheet implementation of the “Local Exhaust Ventilation and HEPA Filtration Systems” policy and identified a noteworthy practice as follows: “Transuranic and low-level wastes are segregated in the downdraft enclosure during operations.” It identified no issues associated with waste management from document reviews, interviews or operational activity observations.

In 2015, Revision 0 of a fire hazard evaluation (FHE-FIRE-15-014, *Laser Beam Welder Glovebox Fire Hazards Evaluation*) was also completed. The FHE discussed the hazard of metal welding fumes and noted that the hazard was controlled by maintaining an inert atmosphere, the ventilation system, and the local welding HEPA filtration. The FHE did not discuss a hazard associated with deposition of metal powder from metal welding fumes onto surfaces or the HEPA filter while in the inert glovebox, or any hazards associated with the removal of the HEPA filter from the inert glovebox environment. The FHE was reviewed against the PF-4 facility Fire Hazard Analysis (FHA), which defined 2 different oxygen concentration limits of 2% and 4%, depending on a given glovebox. The CRA report states that “The FHA indicates that the 4% value is derived from the observation that ‘oxygen levels less than 5% are generally sufficient to prevent rapid oxidation and ignition of plutonium’ and 4% is established as the maximum to establish a safety factor.” The CRA concluded that fire protection (FP) procedures were effectively implemented. The TA-55 Safety Management Program, Hazardous Material Protection Program procedures were reviewed as the program that addresses chemical hazards in the PF-4 facility. The CRA report acknowledged that ethanol would be used in small amounts and that the program had sufficient resources to support the welding operations adequately. The FRA scope was did not include a review of waste management processes/procedure implementation.

Overall, the MSA/CRA/FRA all looked at Pit Flow Sheet procedures and concluded that they were fully and effectively implemented for the operations. The CRA report stated that “Adequate procedures are approved and in place for operating the process systems and utility systems associated with PFS.” Note that the laser welding operating procedure, PA-DOP-01127, R3.1, did not include metal welding fume hazards, but that “welding fume hazards missing from these procedures had been evaluated and were well controlled; this issue is a documentation weakness.” The CRA report further noted at the time that “During the pre-job briefings, the workers and RCTs were engaged and participated. Questions were asked by various individual, and answers were provided by the appropriate individuals; this was a positive indication that the team is comfortable asking questions and that they have questioning attitudes.”

During the same period of time, LANL was developing corrective actions primarily associated with directives from the New Mexico Environment Department (NMED) and the Waste Isolation Pilot Plant (WIPP) Accident Investigation Board (AIB) Justification of Needs. These actions were to address waste management issues that resulted in the breach of an emplaced LANL waste drum at the Waste Isolation Pilot Plant (WIPP) facility in February of 2014. The Corrective Action Plan (CAP) developed by the Laboratory addressed the corresponding WIPP event Accident Investigation Board report, Compliance

Order directives from the New Mexico Environment Department, and supplemental evaluation reports. Additional evaluation of these corrective actions is detailed in sections 4 and 6 of this report.

In August of 2016, following a period of management team observations and practice evolutions, the PT organization resumed welding in the inert glovebox per TA55-DOP-1127, *Laser Welding Operations*. The operating procedure contained a section for the controls for chemical and hazardous materials. These controls for chemicals included limited quantities and appropriate storage and labeling. This section identified materials that would include “actinide metals, general metals, and materials, i.e. (Be and plastic).” A fire hazard was identified and described as “Fire due to pyrophoric Special Nuclear Material”, and mitigating controls included: 1) the inert gas flush in the box, maintaining less than 1% oxygen when Special Nuclear Material (SNM) was machined or welded; 2) approved fire suppression materials in the box, and 3) keeping the area free of unnecessary combustibles. Titanium metal and alloys were introduced into the box around this time for practice welds (Note that titanium had been included in welding operations prior to the MSA, CRA, and FRA Readiness Reviews). Welding Operators and Process Engineers for these operations all reported during this investigation that they maintained the inert welding box below 10,000 ppm (equivalent to 1%) oxygen concentration. Operators and Process Engineers reported confirming the oxygen concentration prior to each welding evolution by observing an oxygen monitor display located on the exterior of the box. The atmosphere of the negative pressure glovebox was maintained inert through backfilling with an inert gas such as argon or helium. The welding DOP did not identify the hazard of potentially pyrophoric material deposition on HEPA filters or mitigations and controls to be used in the event the HEPA filters were either removed from the inert box or subjected to a sudden influx of air while in the box.

In April of 2017, an Acceptable Knowledge (AK) Report (TA55-Report-002) was updated and issued by Nuclear Process Infrastructure – 7 (NPI-7²), in which Assembly Operations was documented as: “This waste is nearly always Low Level Waste.” It also indicated that “No TRU waste is anticipated from this process.” The original AK report was developed in August of 2008. The 2017 report was authored based on prior laser welding AK documents. During the AK report generation process, the AK report author (NPI AK Specialist) did not perform walkdowns of laser welding operations or interviews with programmatic line personnel; instead, the AK report was produced based on document reviews, which was in accordance with the NPI AK management procedure (PA-AP-01146, R1). The NPI AK Specialist also indicated that the relevant operations would produce Low-Level Waste (LLW) because the subject glovebox was designated as “cold.” The AK report was subsequently communicated to the Central Characterization Project (CCP). CCP used the information in their Acceptable Knowledge Summary Report and other Enhanced Acceptable Knowledge documents.

In July of 2018, PT began to weld titanium for a specific project that resulted in an increase in the use of titanium material in the glovebox. The welding activities resulted in residue (“soot”) within the glovebox and on the glovebox walls. Consequently, PT initiated and scheduled multiple filter changeouts of both the local Laser Generated Air Contaminants (LGAC) extraction unit HEPA filter within the glovebox and the HEPA filter that is connected to the facility’s Zone 1 ventilation system, which is known to be contaminated. This activity was performed as routine preventive maintenance.

² In November 2017, NPI-7 was separated into two groups NPI-6, Hazardous Waste Management, and NPI-7, Hazardous Materials Shipping.

During filter change-outs, the welding personnel would also remove other materials from the box, such as gloves, wipes used to clean the inside of the box, etc. All items were bagged out and moved by hand and by plant trolley to an intermediate drop box. PT personnel indicated to the investigation team that everything bagged out from the PT gloveboxes, including machining, assembly, and welding, was destined for TRU waste, in part because the glovebox is connected to the facility Zone 1 ventilation, which is known to be contaminated. PT personnel also reported that movement of these items was performed in accordance with the facility-wide material handling and movement operational procedure, TA55-DOP-016, *TA55 Material Handling and Movement*. Other relevant material movement procedures including those for removal from an inert airlock, re-introduction into a hood, and use of the trolley were not used by the team.

Also in July of 2018 (7/13/18), an operating group within the Actinide Material Processing and Power (AMPP) Division at TA-55 experienced an issue with their “cold” laser welding operations similar to the event under review. While performing weld development work in a non-inert glovebox, smoke started to fill the glovebox due to a smoldering filter in a LGAC system. Previous weld development had been performed in an inert environment. It was suspected that welding in a non-inert environment led to the generation of hot particles that ignited the filter media. The causal statement noted that a less than adequate review of the process was performed based on the assumption that the process had not changed. Following this issue, AMPP revised the welding procedure to require an inert environment during welding. Interviews with AMPP staff indicated that they also initiated a filter passivation process prior to removal of the filter from the inert glovebox.

On February 28, 2019, the DOE National TRU Program Central Characterization Project (CCP) issued a Chemical Compatibility Evaluation Memorandum (CCE18 for Waste Stream LA-MHD01.001, R0) that specifically asserted titanium in powder, vapor or sponge form did not exist in the TRU waste streams. The CCE18 for the waste stream LA-MHD01.001 Rev 2 issued on June 3, 2020, included a technical basis that identified a requirement that any unidentified powder in a potentially air-tight container would be excluded from the shippable inventory (CCP CCE18, R2, Technical Evaluation number 8: “Evaluation of potentially pyrophoric material”). As a matter of course, NPI-6 was included as a reviewer of the CCE18, R2, and the final documents were provided by CCP to NPI-6 after approval. These restrictions did not get incorporated into the September, 29, 2020 issuance of PA-AP-01216, R0, Acceptable Knowledge Technologist Procedure (VI procedure) or the December 17, 2020 revision to CCP-TP-113, *CCP Standard Visual Examination*, procedure, Rev 24.

On October 9, 2019, NPI AK Specialists notified CCP that they had discovered the TA-55 impact testing operations (Isotope Fuels Impact Tester, or IFIT) had been using a component made of magnesium alloy, although the NPI AK report reflected aluminum. Subsequent evaluation discussed passivation of the material when removed from an inert glovebox due to the potentially pyrophoric characteristics of the debris. However, this response did not result in an action at TA-55 to evaluate other inert gloveboxes and associated chemical constituents.

On June 3, 2020, based on issues identified by CCP, a technical evaluation was issued that addressed potential pyrophoric materials that required the rejection of items with unidentified powders in potentially airtight containers from the shippable inventory of waste.

Meanwhile, the last welding of titanium in the inert welding box for the related project was completed in the Fall of 2020 . The glovebox remained inert, with both the LGAC and Zone 1 ventilation HEPA filters in situ for more than six months until February 19, 2021.

Event Timeline:

On Friday, February 19, 2021, both the LGAC and Zone 1 ventilation HEPA filters were changed out. The TA55 programmatic maintenance organization (PMDS) under the Facilities Operation Director, used processes described in in TA-55 DOP-068, *Replacing the Glovebox Exhaust HEPA Filter to the Zone 1 Vent* and dropped the ventilation system HEPA filter down into the “cold” laser welding glovebox during backshift. This procedure is owned by the facility programmatic maintenance organization, although it describes multiple apparent legacy performance step instructions for the operating line personnel. It does not mention the risks associated with metal fumes preserved in an inert atmosphere.

Also on February 19, 2021, The PT-3 welding operators bagged the LGAC filter for removal from the glovebox. The LGAC filter changeout is not described in welding operations procedure, TA55 –DOP-1127, *Laser Welding Operations*. It is also not specifically described in the PT-3 box maintenance procedure, PA-IWD-01157, *Laser Welding Maintenance and Testing*, although Operators indicated they considered the activity part of General Maintenance during which they followed a process of segregating like materials prior to bagging the waste out of the laser welding glovebox. A photo of the glovebox is included, below:

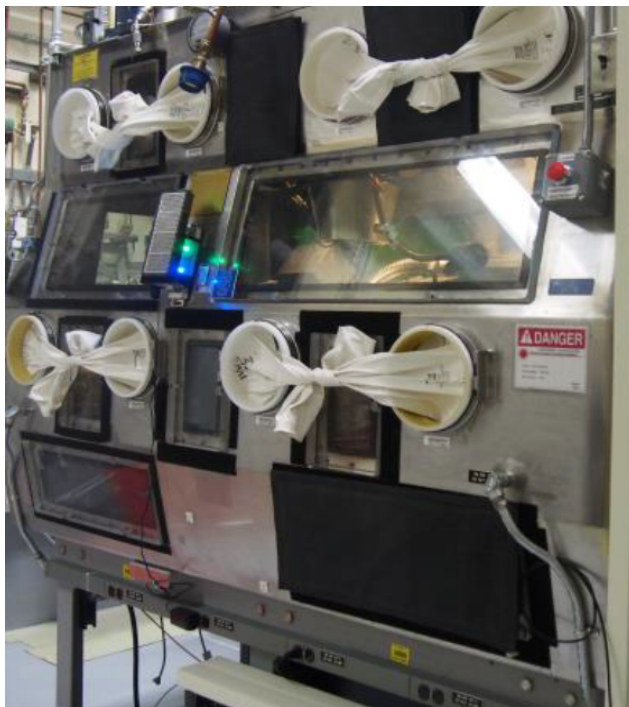


FIGURE 2- COLD LASER WELDING BOX

During the week of February 22, 2021, a series of discussions were held between PT personnel and NPI-6 personnel regarding items located in an intermediate drop box that would be subject to Visual Inspection. These discussions emphasized the need to properly sort material for both Nuclear Material

Control and Accountability (NMCA) purposes and to accurately establish the process history of the material being submitted to VI.

On February 25, 2021, an evolution was performed to move the items, including two inert bagged HEPA filters, from the cold laser glovebox out through an airlock, through an open-front hood to the trolley transfer station, where VI was performed; and then moved to the drumout location. The Person-In-Charge (PIC) did not perform a pre-job for this evolution in accordance with PA-AP-01020, *TA55 Pre-job Briefing and Post-Job Review*, specifically the Use Every Time Attachment was not available to the Investigation Team for review. The welding operators indicated that all material moves were performed under TA55-DOP-016, *TA-55 Material Handling and Movement*.

The investigation team determined from document reviews and interviews that the operators did not remove the bagged filters from the glovebox in accordance with TA55-DOP-902, *Transferring Items Into and Out of an Inert Box Through an Airlock*. The operators did not use TA55-DOP-030, *Introducing Items Through a Pencil Drop or Hood Into Gloveboxes in PF-4*, nor did they use TA55-DOP-024, R9, *Trolley Hoist Conveying System*.

Following the staging of the bagout bags with HEPA filters in the drop-box, additional personnel arrived to complete a Visual Inspection (VI). This activity is described in PA-AP-01216, *Acceptable Knowledge Technologist Procedure*. Note that AP-01216, which is a non-work-controlling document, superseded PA-DOP-01401, *Visual Inspection of TRU Waste* on 9/29/20, which was a P-300 equivalent work control document. This VI activity at the drop-box involved an NPI-6 AK Technologist, a PT-2 Process Engineer and machining operators, and operators from PT-3. The PT-2 Process Engineer and involved operators were present to identify items from their respective processes, to help segregate the items for subsequent waste drumout activities, and to move items from the drop box via another facility trolley to the waste drumout glovebox. Loose wipes that were present in the drop-box were unable to be traced to a particular process and were therefore rejected. The AK Technologist and Process Engineer signed a Waste Compliance and Tracking System (WCATS) Questionnaire, which is used to document TRU waste items that are determined acceptable to move to Visual Exam and drumout operations, be packaged in a drum, and eventually shipped to the WIPP facility. The WCATS Questionnaire instructions define the Waste Originator as the PIC for the operations that created the items. Although the HEPA filters in the drop-box came from the PT-3 operations, the person who signed the WCATS Questionnaire as the Waste Originator was the PT-2 Process Engineer. (Note that a PT-3 PIC was not present for the VI). The WCATS Questionnaire was filled out with “no” to the question, “are unoxidized reactive metals present?”

From there, the welding operators again moved the material in another leg of the facility trolley system that transferred the items from the drop box to a separate room and box where the material was staged until it could be placed in waste drums the next day following Visual Examination (VE).

On February 26, 2021, the PT-3 operator who had been present for the VI arrived to support the drumout activity. The PT-3 operator did not meet the criteria of the PT-2 request for qualified personnel. Drumout is described in TA55-DOP-032, *Introducing and Removing Items from Bagout/Drumout Ports in PF-4*. A PIC from PT-2 was present, as were 2 more PT-2 operators/technicians as well as CCP personnel and a NPI-6 representative. The PIC did not review training and qualifications of those operators/technicians that were present to perform the work, but provided a pre-job briefing to discuss the activity, assign tasks, and release the work in accordance with PA-AP-01020, *Pre-Job*

Briefing and Post-Job Review. Note that in accordance with PA-RD-01026, R2, *ALDWP Conduct of Operations Requirements*, the PIC must ensure that a trained or qualified worker directly supervises untrained, unqualified persons. CCP personnel were also present, but did not participate directly in the drumout procedure pre-job brief, since they would not be present in the room during the drumout evolution. The VE was performed with CCP prior to the drumout activity. During the VE, some items that had been moved over from the drop-box were rejected by CCP from being placed in the drum. Note that none of the items from the PT-3 inert box were rejected. Following the briefing and VE of items that would be allowed into the drum, the CCP personnel departed the room. An RCT provided a brief on the Radiological Work Permit to persons to be conducting the drumout, then donned respiratory protective equipment and re-entered the room. At that point, the PT-3 personnel (in level II PPE and respirators) raised each item to the glovebox window, and the CCP personnel observed from the doorway window, acknowledging each item that was placed into the drum.

The PT-3 operator, who was performing his first drumout activity, then followed the process for placing items into the drum that had been described to him by the PT-2 PIC. This process consisted of first centering items over the top of the drum and then dropping them into the drum. From interviews, it was recognized that this is a standard practice for placing items in drums during drumout, and is largely performed to minimize the potential for damaging the bag liner in the drum and to reduce the ergonomic impact of leaning over with potentially heavy items at arms-length, which is the positioning caused by doing the operation in a glovebox.

Following this process, the PT-3 operator first dropped some “cushioning” material into the bottom of the drum consisting of bags and gloves that were also bagged. The PT-3 operator then raised one of the bags containing a “dirty” HEPA filter for observation. The bagged filter was then dropped into the drum. Following the same process, the PT-3 operator then dropped an empty conflat container made of stainless into the partially filled drum. The conflat fell approximately 3-4 feet from the release point and struck the bag containing the HEPA filter. Personnel described a cone of red, yellow and white “sparks” as soon as the conflat struck the bag.

Event Response:

Immediately following the sparking, the PT-2 PIC and RCT directed evacuation of the room. At this time the drop box fire alarm was not activated by personnel. The PIC directed actuation of the fire alarm in the adjacent corridor and the RCT directed personnel to evacuate to PF-3. Note that personnel are trained to evacuate to the PF-4 North corridor. The response (activation of the corridor fire alarm) resulted in some confusion by the Operations Center as to the exact location of the potential fire, which created a slight delay in their announcement directing personnel to exit to the North corridor. Regardless, personnel exited the area and notifications were made to the Facility Operations Director and the local Los Alamos Fire Department. Upon arrival, LAFD made entry into the area with thermal detection equipment and determined that no fire condition existed. The FOD and Radiation Protection Program personnel determined that no Continuous Air Monitor (CAM) alarms had occurred and there was no presence of contamination outside the gloveboxes. ALDWP paused drumout/bagout operations.

In early to mid-March, additional response actions were taken by NPI and CCP to identify drums of concern. CCP and NPI identified two waste drums containing the same debris that had been shipped to the WIPP facility. NPI and CCP identified four additional drums of concern based on preventive maintenance filter changeout dates and searches in WCATS. Two of four drums were located at PF-4

and two had been transferred to Technical Area 63, the Transuranic Waste Facility (TWF). The two drums at TWF were returned to PF-4. Laboratory personnel further completed fume generation rate calculations to establish titanium loading on filters in drums and calculations regarding passivation of the material over time. These efforts, along with additional calculations for peak potential drum temperature and pressure established that no residual reactive titanium remained in the total six drums of concern and that there was no potential for a drum seal failure. In addition, the FOD entered the NI process, which resulted in the determination that the unexpected reaction was bounded by the facility Safety Basis.

3. OPERATING PROCEDURE AND PROCESS ISSUES

The application of Integrated Work Management (IWM) is integral to the successful development and execution of Work Control Documents (WCDs) (See RC-1). In this case, lack of process specificity in the IWM *Define the Work* element (See CC 1.2) directly contributed to a missed Hazard (See CC 1.1), leading to the lack of Controls in the operating procedures. None of the five (5) WCDs that were used to generate, move, stage, and drumout the items in question recognized the potential for unoxidized titanium or the hazards associated with transition in between an inert and an air environment.

The Integrated Work Management and Conduct of Operations programs at Los Alamos are governed by *P300, R15, Integrated Work Management* and *P315, Conduct of Operations Manual*, respectively. Procedure development is governed by *FSD-315-16-001, Technical Procedure Writer's Manual*. Procedures are managed in ALDWP by *PA-AP-01000, R21 Document Control Process*.

P300, R15, *Integrated Work Management*, governs the management of work at LANL through the five step Integrated Safety Management System process:

1. Define the work.
2. Identify and analyze the hazards.
3. Develop and implement hazard controls and preventative measures.
4. Perform work safely, securely, and in an environmentally responsible manner.
5. Provide feedback and strive for continuous improvement.

P300 also governs the development of Work Control Documents (WCDs), including Integrated Work Documents (IWDs), and allows for the development of IWD-equivalent documents (e.g., Detailed Operating Procedures, or DOPs) in accordance with *Attachment 16 of P315, Conduct of Operations Manual*, and *FSD-315-16-001, Technical Procedure Writer's Manual*.

The primary WCD that is utilized in the Pit Technologies (PT) laser welding process is *PA-DOP-01127, R7, (U) Laser Welding Operations*. This DOP provides the Work Control authority for operating the Laser Welding system. This system is used to perform Laser Welding operations associated with the processing of nuclear and non-nuclear material components and assemblies. Recognizing the complexity of a laser welding operation involving fissionable material, PT has designated this procedure as Moderate-Hazard, with a usage level of Use-Every-Time, requiring application of the Reader-Worker performance method.

Laser Welding Operations are performed in an inert (<1%) atmosphere glovebox with HEPA filtration on the glovebox exhaust stack. There is an additional HEPA filter in the Laser Generated Air Contaminants (LGAC) extraction unit which is located inside the glovebox and is used to capture particulates and vapor

directly from the weld site. *PA-DOP-01127, R7* is used as the WCD for conducting evolutions in both the “hot” and “cold” laser welding boxes. The hazards covered in the procedure include: Ergonomics, Fire due to pyrophoric Special Nuclear Material, ionizing radiation, mechanical entanglement or crushing, noise, non-ionizing (laser) radiation, criticality, sharps, and thermal.

PT failed to recognize and address the hazards associated with non-Special Nuclear Material (SNM) reactive material accumulated on either the stack or LGAC HEPAs, or on other processing equipment (This reflects the first root cause identified by the investigation team: “PT-3 did not recognize the hazard of non-SNM reactive metal prior to handling the HEPA filters outside of inert environment.” The lack of specificity as to the materials and production rate in the welding process contributed to an incomplete *Hazards and Controls* analysis.

P315, R7, Conduct of Operations Manual, Section 16.5.1.f, Hazard Grading and Analysis, requires that:

Work components and processes must be defined in sufficient detail to allow identifying and analyzing hazards and the circumstances in which they could cause harm.

The Scope and Applicability of *PA-DOP-01127, R7* is broad and includes all Laser Welding operations in the associated gloveboxes.

The performance sections of this document apply to any type of nuclear or non-nuclear material components and assemblies handled at TA-55 This includes but is not limited to pits, experimental/developmental assemblies, sub-critical experiments, and non-weapons assemblies that require laser welding...

...The number and sequence of processing activities will be determined by the design agency, management, the engineering group, or customer requirements and may be independent to the sequence of performance sections in this document.

Process specific detail for a particular product line is expected to be found in the Special Processing Instruction (SPI). SPIs are not Work Control documents, do not identify or control hazards, and do not receive the same level of review as WCDs. In this case, the over reliance on SPIs to document the specific materials to be used (i.e. titanium) and increased production rates associated with a particular program may have contributed to the failure to recognize the hazard associated with increased “soot” formation in the glovebox (See CC 1.2).

The laser welding DOP *Hazards and Controls* table addresses a broad suite of hazards associated with *Chemical/Hazardous Materials*:

Materials (e.g. actinide metals, general metals and materials, i.e. (Be and plastic)

NOTE: Hazards include inhalation and/or skin exposure to irritant or toxic chemicals.

PA-DOP-01127 should be revised to include a specific hazard analysis associated with the vapor deposits generated from non-SNM welding in an inert glovebox. It is further recommended that more specificity be added to the procedure regarding the material input and output streams and processing rates, to allow for an appropriate SME review.

PA-IWD-01157, Laser Welding Maintenance and Testing, provides that Work Control authority for the maintenance, troubleshooting, testing, and Post-Maintenance Tests (PMTs) on the programmatic laser welding system. Interviews with operations personnel indicated that section 1.0 *Common Maintenance*

Activities was the procedural requirement used to replace the LGAC extraction unit HEPA filter. PA-IWD-01157 contains no direct mention of the replacement of the LGAC or of the management of the LGAC or stack HEPA filters, and no hazards associated with potential reactive metals is included in the hazard table. The scope of this IWD does not include the movement of material out of the inert environment. Operators indicated that material moves out of the glovebox are performed utilizing TA55-DOP-016. It should be noted that the IWD was past its Extension date at the time of use.

It is recommended that PA-IWD-01157 be revised to include explicit scope associated with management of the LGAC and stack HEPA filters. This could be added as a Common Maintenance Activity or as a unique section. PA-IWD-01157 should also be revised to include the reactive metal hazard in the hazard table. The addition of a section addressing movement of material from the inert atmosphere to air is also recommended, including the associated hazards and controls. Alternatively, TA55-DOP-902, *Transferring Items Into and Out of an Inert Box Through an Airlock*, could be applied in future evolutions.

TA55-DOP-902, R4 *Transferring Items Into and Out of an Inert Box Through an Airlock*, was not used as part of the evolution under review, but is relevant to this causal discussion. As previously mentioned, Operators indicated that material moves out of the glovebox are performed utilizing TA55-DOP-016. TA55-DOP-016, *TA-55 Material Handling and Movement*, is not intended to be the WCD to be used for the operation of programmatic and facility systems (e.g. glovebox airlocks, introduction hoods, trolley) but rather, is the WCD that governs the movement of material (SNM/non-SNM) through these systems. TA55-DOP-902, is the appropriate WCD for authorizing work requiring the use of an airlock. However, it also does not discuss the hazards associated with the removal of reactive metal from an inert atmosphere to an air environment. PICs should be trained on the appropriate use of TA55-DOP-902 and TA55-DOP-016, and TA55-DOP-902 should be revised to include the hazards associated with the removal of reactive metal (including non-SNM) from an inert atmosphere to an air environment, and (3) that TA55-DOP-016 be revised to clarify its scope.

The integration of TA55-DOP-016 and TA55-DOP-902 highlights an ongoing issue with TA55 work control that requires evaluation. In many instances, work evolutions require the use of multiple procedures. FSD-315-16, 001, R1, 5.11, *Technical Procedure Writer's Manual*, refers to this as Branching and Referencing.

Branching routes the procedure users to other action steps or sections within the same procedure or to other procedures, and the users do not return to the original position.

Procedures written with a complete set of Branching steps, especially with regard to integration with TA55-DOP-016, can become cumbersome and confusing to the point that FSD-315-16, 001, R1 states that:

Referencing and branching increases the potential for error with attendant safety and administrative consequences. Therefore, branching and referencing are highly discouraged.

The intent of this statement is that, to the extent practical, WCDs should be standalone procedures containing all the information and direction necessary to complete the described scope. In cases where this is not possible, then PIC training associated with PA-AP-01165, *Programmatic Operations Person-in-Charge (PIC) Program* and PA-AP-01020, *Pre-Job Briefing and Post Job Review* should be evaluated to stress the importance of discussing the use of multiple procedures in the evolution Pre-job.

Because the investigation team determined that other organizations within the Laboratory and even ALDWP had recognized the hazard of potentially pyrophoric materials upon removal from an inert

glovebox and into air, the team also determined that the laser welding community of practice had not effectively shared this knowledge through communications, through entry into the institutional Glovebox Safety Program policy, or through internal laser welding SMEs. (See CC 1.3, 1.4, and 1.5).

4. WASTE CHARACTERIZATION PROCESSES AND PROCEDURE ISSUES

This section provides factors that contributed to Root Cause 2: The prohibited item (titanium in powder form) was not rejected by the LANL/CCP waste characterization process (which relies on Acceptable Knowledge (AK) and Visual Inspection (VI) and Visual Examination (VE)).

Background:

Accurate waste characterization is fundamental to meeting regulatory and WIPP Waste Acceptance Criteria (WAC) requirements. Two basic methods for waste characterization are 1) analysis of representative waste samples, and 2) comprehensive evaluation of the operations that generate waste, including material and chemical inputs, operational processes that modify these inputs, and potential contaminants that might be introduced into the waste products. This second method, called Acceptable Knowledge (AK), is routinely applied to heterogeneous debris waste because it is impractical to take representative waste samples. Inspection of the contents of every waste container is performed using either visual examination or radiography to confirm the AK.

LANL, as the Waste Generator, is responsible for accurate waste characterization for compliance with its RCRA generator requirements (40 CFR 252.11). CCP is responsible for independent validation of the waste characterization and certifying that the waste meets the WIPP WAC before shipment to WIPP.

In response to the 2014 event involving the breach of a LANL waste drum at WIPP due to chemical incompatibility of the waste, additional AK responsibilities were added to the WIPP WAC via Appendix H. Collectively referred to as Enhanced AK, these corrective actions were implemented by LANL and CCP to ensure the AK accurately reflected process operations, and included 1) improved coordination and communication between LANL and CCP, 2) identification of procedures that generate waste, and ensuring such procedures are reviewed by waste management Subject Matter Experts (SMEs), 3) waste management SMEs are engaged in up-stream processes to assure a comprehensive understanding of waste characteristics, and 4) comprehensive chemical compatibility evaluations are performed. The objective of these actions was to assure that the AK information is accurate, sufficient, and updated to support accurate waste characterization and certification.

Waste from Assembly Operations:

Relatively small quantities of waste result from PT-3 Assembly Operations, with a minor fraction of the waste coming from the laser welding operations. The waste consists of common debris (glovebox gloves, housekeeping debris, etc.). As discussed elsewhere in this report, after initiating a titanium welding campaign in 2018, the increased soot produced by the welding operations resulted in periodic HEPA filter changes, resulting in HEPA filters being routinely included in the waste stream. Although the process description in the AK Report for Assembly Operations indicates that waste is nearly always LLW (see below), the items from the welding operations were handled as TRU waste because the laser welding gloveboxes are tied to PF-4 Zone 1 ventilation, which is known to be contaminated.

Organizations involved in LANL Waste Characterization and Certification:

There are three organizations involved in TA-55 TRU waste characterization. The operations organization (in this case, PT-3), is the “Waste Originator,” and has the most complete information about the material inputs to a process, how materials are modified by the process, and the constituents of materials leaving the process. These descriptions are documented in operating procedures, which become source documents for the AK Report. The operations organization moves items to the VI and VE process, and loads approved items into waste drums. During the VI and VE process, the operations organization addresses any questions that are raised regarding items characteristics.

The term “Waste Originator” is unique to ALDWP. The formal “Waste Generator” role is the responsibility of NPI-6, which includes a team of waste experts to assist in accurate and sufficient waste characterization. NPI-6 is responsible for waste processing procedures, and the Waste SME review of operating procedures. NPI-6 AK Specialists are responsible for assembling AK information and documenting this information in an AK Report. NPI-6 AK Technologists perform the VI process to reject items with prohibited characteristics that are visually apparent or confirmed by operations personnel participating in the VI, and participate in the VE process to document the final contents of a drum in the WCATS Questionnaire. NPI-6 provides the primary interface with CCP personnel, and review and concur in key CCP documents. This interface is documented in CCP-PO-012, R17, *CCP/Triad LANL Interface Document* (12/18/2019).

Formal waste certification is performed by CCP. This certification is based on the Enhanced AK process that was implemented after the 2014 WIPP event. An important element of Enhanced AK is the Chemical Compatibility Evaluation (CCE) that provides a comprehensive assessment of potential chemical and material constituents in a waste stream and defines requirements for waste characterization to prevent incompatible waste contents. The Interface Waste Management Documents List (IWMDL) provides the list of LANL waste management procedures that require CCP walkdown and/or review (including all revisions). In addition to the CCE, CCP is responsible for the AK Summary Report (AKSR) and AK Assessment (AKA). The AKSR is required by the WIPP Hazardous Waste Facility Permit (HWFP) and summarizes the AK to meet WIPP HWFP Attachment C requirements. After packaging, CCP evaluates the documented contents of the drum and associated AK documentation to ensure the container is bounded by the existing AKSR and CCE, this evaluation is the AKA. CCP personnel perform the VE process to verify the waste contains no prohibited items listed in Attachment C of the WIPP HWFP and that the physical form of the waste matches the waste stream description as determined in the applicable AKSR. This verification can include visual indications and questioning of the LANL personnel present at the time of VE.

Key Documents for LANL Waste Management (P409, P409-1, TA55-RD-539):

The documents that govern the overall waste management requirements at LANL are P409, R7, Admin. Chg. 5, *LANL Waste Management*, (2/18/2020), and P409-1, R2, *LANL Waste Acceptance Criteria* (1/23/2019). The document that governs the waste management requirements at TA-55 is TA55-RD-539, R9, *TA-55 FOD Waste Management Requirements* (3/8/2021). [Note: at the time of the titanium event, TA55-RD-539, R8 (9/20/2018) was in effect.]

While P409-1 identifies that nonradionuclide pyrophoric materials are not acceptable at WIPP, this prohibition is not flowed down to TA55-RD-539, R9. The revision history of TA55-RD-539 shows important aspects concerning how the TA-55 waste management program has evolved over time.

TA55-RD-539, R5	11/28/2011	<ul style="list-style-type: none"> Requires that PF-4 Annual Access Training includes reading TA55-RD-539. PT-3 (and others) is Waste Generator, who documents AK with walkdowns required
TA55-RD-539, R6	1/26/2016	<ul style="list-style-type: none"> No longer required to read TA55-RD-539 for PF-4 Annual Access Training, PT-3 (and others) is Waste Generator, documents AK with walkdowns required
TA55-RD-539, R7	3/22/2017	<ul style="list-style-type: none"> NPI takes on Waste Generator role, former Waste Generators take on Waste Originator role, Significantly enhanced discussion of Acceptable Knowledge, Added WCATS Questionnaire to document the composition of a TRU waste item and facilitate AK and CCE. AKS responsible for content of AK Reports. Walkdowns are no longer mentioned (PA-AP-01146, R0, 9/6/2017 subsequently required AKS to perform regular walkdowns, PA-AP-01146, R1, 3/12/2020 required AKS to perform walkdowns as necessary).
TA55-RD-539, R8	9/20/2018	Revised Section 1.3 Scope: "This procedure only addresses discarded material that has been determined to be of no programmatic value to DOE and has undergone Termination of Safeguards (ToS) determination."
TA55-RD-539, R9	3/8/2021	<ul style="list-style-type: none"> Revised responsibilities for AKS and added the AKT Added "Waste Originator" definition.

The changes summarized for TA55-RD-539, R7 (3/22/2017) involving NPI taking on the Waste Generator role was a result of the increased rigor and complexity associated with meeting waste certification requirements after the 2014 WIPP event. In order to reliably implement the new requirements, it was considered necessary for NPI waste management expertise to take on this role for the facility. This change, along with the reduced requirement for walkdowns and reduction in training in Revision 6, had the unintended consequence of ineffective communications between PT-3 and NPI-6 regarding AK (See CC 2.3). An April 2017 Generator Site Technical Review (GSTR) evaluated PF-4 operations and waste management activities, and provided some recommendations relating to this structure. The GSTR documented a Noteworthy Practice relating to NPI walkdowns and the WCATS Questionnaire. The GSTR did not include the PT-3 operations. More information from the 2017 GSTR is provided in Section 6 of this report.

In addition, the introduction of the WCATS Questionnaire in TA55-RD-539, R7 (3/22/2017) instead of the previous Waste Acceptance Form, while significantly improving the documentation of characteristics relating to TRU waste certification, reduced the amount of information recorded that could be useful for item traceability back to the originating operation.

Key Documents for LANL Waste Characterization (AK):

The main documents that support the AK process are LANL AK Reports (2017), CCP AK Summary Report (2014), CCE18, R2 *CCE for Waste Stream LA-MHD01.001* (6/3/2020), CCP-TP-005, R32, Att. 9, *Interface Waste Management Document List* (IWMDL, updated quarterly). The relationship between CCP and LANL is documented in CCP-PO-012, R17, *CCP/Triad LANL Interface Document* (12/18/2019).

The LANL AK Reports provide process descriptions for dozens of defined Process Status Codes (PSC) in the Plutonium Facility (PF-4), and identify the waste characteristics expected from these processes (PA-AP-01146, R1, *Acceptable Knowledge Documentation Procedure* 3/12/2020). The primary source of information for the AK Report are documented interviews relating to operations (some dating back ~ 20 years) and review of procedures (including recent revisions). PA-AP-01146, R1 requires NPI personnel to perform walkdowns as necessary, specifically there is no required periodicity for review. There were no walkdowns related to the AO PSC (See CC 2.2). The AK Report that describes the Assembly Operations (AO) PSC is TA55-RPT-002 *Process Acceptable Knowledge for Metal Operations at TA-55*, R1 (4/13/2017). The AO PSC states that the waste is nearly always LLW. The welding procedure, PA-DOP-01127, R0 (9/13/2012), is referenced in the AK Report, but this procedure does not identify titanium as a specific metal to be welded, and does not identify the hazards associated with potentially pyrophoric metals (See CC 2.1). In addition, this procedure is referenced under Welding Operations (WO), not AO.

The LANL AK Reports are used by CCP to develop the AK Summary Report (AKSR) for the 4 TA-55 waste streams (CCP-AK-LANL-006, Rev 13, 2/10/2014). One of these waste streams (LA-MHD01.001), is the waste stream associated with waste from the AO PSC. The AK Summary Report references the source documents used to develop the LANL AK Reports. The AKSR has not been updated since the 2014 WIPP event, because the corrective actions associated with Enhanced AK have Basis of Knowledge evaluations that have captured the new chemical and material characterization related requirements. These documents have been updated to reflect emerging requirements. Relevant to this titanium event, the CCE18, R2 *CCE for Waste Stream LA-MHD01.001* (6/3/2020) issued new requirements relating to potentially pyrophoric materials, requiring the rejection of items with “unidentified powder in potentially air-tight containers.”

The IWMDL contains a list of LANL waste management procedures that require a CCP walkdown and/or review of any revisions. The IWMDL is reviewed quarterly. It contains the procedures involving waste generating, packaging, treatment, inspection, testing, and characterization. It includes the over-arching waste management procedures (P409 and TA55-RD-539), but does not include up-stream operating procedures that are source documents for the LANL AK Report and CCP AK Summary Report.

Key Documents for LANL Waste Characterization (VI/VE):

The main documents that define and execute the VI and VE processes are PA-AP-01216, R0, *Acceptable Knowledge Technologist Procedure* (9/29/2020) and CCP-TP-113, *CCP Standard Contact-Handled Waste Visual Examination*, R24 (12/17/2020). It is important to note that visual examination and radiography are inherently limited to detecting waste characteristics that are visually apparent. Characteristics that are not visually apparent rely solely on AK.

The LANL VI process is governed by PA-AP-01216, R0. The associated WCATS Questionnaire (PA-FM-01016, R4.1, 11/25/2020) is used to document the LANL VI process, and provide a record of final contents in a waste drum. This form had been revised (R4, which was issued on 9/25/2020) to include

the following question: “Are unoxidized reactive metals present? (Reactive Carbides, Ca metal, etc.).” This was answered “No” during the VI process on 2/26/2021. Revision 4 and 4.1 did not update the WCATS Questionnaire to reflect the requirement of CCE18, R2 (6/3/2020). In addition, contrary to the documented instructions for PA-FM-01016, R4.1, as part of the VI process conducted on 2/25/2021, the Waste Originator was not “the PIC where the waste is generated.” It was the PT-2 FLM. The PT-3 personnel involved in the VI process were less experienced and less knowledgeable regarding characteristics of the items (See sub-element 2 of CC 2.2).

CCP-TP-113 CCP Standard Contact-Handled Waste Visual Examination, R24 (12/17/2020), Att. 3 CCP Waste Visual Examination Data Form is used to document the VE process. Relevant to this event, the following question is addressed during VE: “Is there an indication of non-radionuclide pyrophoric materials such as elemental potassium.” The VE process did not reject the HEPA filters in sealed bags. The CCP-TP-113, R24 (12/17/2020) did not update the Att.3 Data Form to reflect the requirement of CCE18, R2 (6/3/2020).

An item of concern came up during the interviews for the Causal Analysis regarding the VE process. On occasion, CCP personnel get “push back” from TA-55 staff on items being rejected during VE. In addition, there were items (unrelated to the HEPA filters) rejected during the 2/26/2021 VE that had been discussed during the 2/25/2021 VI as likely to be rejected, but passed along to VE. Rejections of items during VE should be tracked as a metric that indicates the effectiveness of the VI process.

Narrow Corrective Actions from Earlier Issues:

The previous waste characterization issues resulted in improvements to the LANL waste characterization program, however the improvements were too narrow to encompass the titanium event (See CC 2.4). A few such events are identified and discussed, as follows:

1. An event at Idaho National Laboratory in 2018 involved the over-pressurization of waste drums due to reactive carbides.
2. In late 2019, concerns were raised at LANL regarding the potential to have unreacted calcium in a waste stream. As a result of these issues, the WCATS Questionnaire was revised to include the question “Are unoxidized reactive metals present (Reactive Carbides, Ca metal, etc).” However, these issues did not result in a systematic review of operations at TA-55 that could produce reactive metals.
3. In 2019, there was a discovery that a different material (magnesium alloy) had been in use for an impact testing operation than was documented in the AK Report (aluminum). Upon discovery, the magnesium alloy debris from the impact testing operations was evaluated to confirm that the potentially pyrophoric material had sufficient exposure to oxygen after being removed from an inert environment before being introduced into the waste stream. One of the issues associated with this discovery was that the magnesium alloy component was manufactured at LANL, and therefore did not have an associated SDS that is provided with purchased components. Actions were taken to identify other parts that are manufactured at LANL that might enter the waste stream and properly document their constituents. However, no systematic evaluation was performed of other inert gloveboxes at TA-55 that might produce reactive materials that need to be passivated prior to entering the waste stream.

These issues, in addition to others in the DOE Complex, resulted in the CCP CCE18, R2 Technical Evaluation #8 (6/3/2020) discussed above.

Inconsistencies in Responsibilities in NPI Procedures, and move from DOP to Non-Technical AP:

The NPI procedure that implements the AK Documentation process (PA-AP-01146, R1) was issued on 3/12/2020. Subsequently, the AK Technologist position was created, and some of the AK Specialists responsibilities were assigned to the new AK Technologist under PA-AP-01216, R0 *Acceptable Knowledge Technologist Procedure* (9/29/2020). However, PA-AP-01146, R1 was not revised to update the changed AK Specialist responsibilities. Active procedures with inconsistent responsibilities can cause confusion. Additional discussion on consequences associated with this change is located in Attachment 2 of this document.

5. RELEVANT TRAINING AND QUALIFICATION

The team reviewed the training and qualification requirements for all of the DOPs associated with this incident. The team also reviewed qualifications for Acceptable Knowledge Specialists, Acceptable Knowledge Technologist, and TRU Waste Operators. Note currently, the key positions associated with waste management at TA-55 include “Waste Originators” and NPI-6 “Waste Generators.” Waste Originators are in the programmatic operations groups, and are required to have expert knowledge of the constituents of the wastes. Waste Generators (NPI-6) are expected to have the knowledge associated with compliant waste characterization, management, and disposition to include transfer to waste disposal facilities in accordance with their acceptance criteria. This paradigm should be kept in mind when reviewing training and qualification requirements.

P409 LANL Waste Management details the training requirements for Waste Generators and Waste Management Coordinators (WMC). P409-1 LANL Waste Acceptance Criteria details further waste characterization requirements but has no training requirements other than referencing P409 requirements. The P409 training requirements are contained within CU #256 for RCRA, which is required in the associated qualification for the position. TA55-RD-539 R8 *TA-55 FOD Waste Management Requirements* is the version in effect at time of this incident. While RD-539 references the WCATS questionnaire as attachment A (an outdated revision), the directions for proper filling of the form are notes in the bottom of the form and are not captured in RD-539 or relevant operating procedures. RD-539 also states that the NPI group leader is the Waste Generator for all of TA55 FOD, rather than the larger organization of NPI-6. This indicates another point of confusion or lack of clarity in the document.

On the job training (OJT) developed for each of the associated DOPs utilizes the hazards identified in the DOP itself as the foundation for the specific requirements of the OJT. Therefore it is not surprising that the OJTs do not address such hazards (to include reactive metals).

The causal analysis team reviewed the qualifications of the AKS (PA-QS-01033) and AKT (PA-QS-01057) were reviewed. A side by side comparison of the two qualifications, as indicated by the attachment A requirements, reveals that the AKT qualification is more geared to support performance of the Visual Inspection, while the AKS is the accountable position for ensuring the veracity of the waste constituents and for the proper preparation of waste (absorbent materials used and ratios of liquids to absorbents, for example). The AKS is also responsible for the “process walk downs,” which were not performed as part of the 2017 AK Report for the PT-3 operations.

Additionally, while the AKS qualification standard appropriately requires the AKS to manage, compile, record, review, and submit AK documentation, and to perform waste stream characterization, the AKT qualification based on the description in Attachment A (Acceptable Knowledge Technologist Job Task to Training Matrix) appears to obtain the required acceptable knowledge foundation through direction from the AKS. There are no training requirements that refer AKTs back to the basic references for acceptable knowledge.

The team believes the similarity in qualifications and a lack of a clear roles and responsibilities document for AKS and AKT adds confusion to the limits of authority and responsibility between the AKS and AKT personnel.

The team reviewed PA-QS-01038 TA-55 TRU Waste Operator. TRU Waste Operators are responsible for the safe packaging, handling, and transport of waste up to and including loading shipments for final disposition. They have no qualification requirements that require them to be cognizant of process status codes, chemical compatibility, etc.

Individual DOP reviews:

PA-DOP-01127 is the LASER welding procedure. PA-DOP-01127 contains no hazard associated with potential oxidation of reactive metals when materials are brought from and inert atmosphere to an oxygenated atmosphere. DOP-01127 requires qualification through successful completion of OJT 27144. OJT 27144 states the following under acceptable response for Fire Hazards:

Fire Hazards: Pyrophoric materials, and burns form small scale fires. Engineered control include (sic) including welding at oxygen levels of <500 ppm and the facility fire suppression system. Administrative controls include the use of fire suppression material if safe to do so, avoiding welding with glovebox gloves near welding area, and removing combustibles in the glovebox prior to weld.

The OJT 27144 should be updated as well as the DOP to reflect this hazard and incorporate the lessons learned from this event.

TA55-DOP-902 *Transferring Items Into and Out of an Inert Box Through an Airlock*, requires successful completion of OJT 18842. The DOP does not recognize the potential hazard for bringing reactive materials from an inert atmosphere into an oxygenated atmosphere, and therefore has no controls for this hazard. Therefore, OJT 18842 does not list potential reactions during the introduction of reactive materials into an oxygenated atmosphere as a hazard. There is no discussion of potential fire / pyrophoric events in the OJT. Again, the OJT 18842 should be updated to align with an updated DOP with respect to the lessons learned from this event.

TA55-DOP-030, *Introducing Items through a Pencil Drop or Hood Into Gloveboxes in PF-4*, requires completion of OJT 17349. OJT 17349 makes no mention of any fire or reactive material risk. TA55-DOP-030 makes no mention of fire or pyrophoric events as a hazard.

PA-AP-01146, *Acceptable Knowledge Documentation Procedure*, requires execution by someone qualified to PA-QS-01033, Transuranic Waste Acceptable Knowledge Specialist. There is no formal OJT curriculum called out for this qualification, however, attachment A of this procedure lists training

required, which includes lectures and quizzes. Completion of this is tracked via WQ 8027. The scope of this qualification appears appropriate.

Although PA-AP-01146 is used primarily by NPI AKS personnel, there are responsibilities defined for Waste Originators (e.g., programmatic personnel such as PT-3) in this document. They include:

1. Work with NPI-6 to plan for the compliant documentation of waste generated by an ongoing, new, or changed project or activity, which may include:
2. Identifying wastes to be generated are fully characterized and have an available disposal path.
3. Estimating volumes of waste to be generated.
4. Notifying NPI-6 before processes or chemicals change that could affect waste characteristics.
5. Identifying and characterizing waste accurately and completely to ensure that regulated constituents in waste streams are identified and compatible.
6. Maintaining the characterization document through a formal system, such as an official memorandum or stand-alone document or (least preferably) an e-mail.

Although there are responsibilities described for Waste Originators, there is no training associated with the AP for Originators that addresses the described responsibilities. The “generic” waste training covers items 2 and 4 to a degree.

Note the execution of the VI is done under PA-AP-01146 section 5.1.1, and consists of 5 steps, the last of which is complete the WCATS form. Execution of this procedure is highly dependent on the skill of the AKS. Additionally, these steps do not capture sufficient detail to provide for reliable, accurate completion of the WCATS form. The more recent PA-AP-01216, R0 assigns the execution of the VI to the AK Technologist.

TA55-DOP-032: *Introducing and Removing Items from Bagout/Drumout Ports in PF-4.* Supervision of this DOP requires completion of WQ 9730 – PF-4 Bagout/Drumout Lead. The PIC was qualified to WQ 9730 and was very experienced. Execution of the work requires completion of OJT 17434. Four of the five workers, including the operator who actually executed the work, were NOT qualified to OJT 17434. This DOP lists a hazard of Waste and Residue Management and directs compliance with TA55-RD539, and P409 LANL Waste Management. Therefore, OJT 17434 lists no hazards associated with fire or unoxidized materials with respect to exposure to air.

TA55-DOP-068, *Replacing the Glovebox Exhaust HEPA Filter to the Zone 1 Vent,* is the procedure that maintenance personnel use to replace the HEPA filters that maintain negative ventilation on the glove boxes. Execution of this procedure results in a HEPA filter and spacer being pushed into the affected glove box, which in turn is left for the operating group to dispose of, because of accounting issues within the Local Area Nuclear Material Accountability Software (LANMAS) and/or related Nuclear Material Control and Accountability (NMCA) issues. This replacement activity was performed by qualified personnel. Attachment A, Performance Checklist, is used to certify OJT 46350 completion. It makes no mention of fire or reactive material hazards.

These deficiencies were not determined to be directly causal by the investigation team.

6. CONTRACTOR ASSURANCE AND OVERSIGHT ISSUES

Following the 2014 WIPP drum release event, multiple entities were engaged in developing corrective actions to prevent recurrence of unrecognized, inappropriate treatment of waste. The Laboratory, then under the management of Los Alamos National Security (LANS), LLC, CCP, and the Carlsbad Field Office (CBFO) were all engaged in the response. The Laboratory Corrective Actions included responses to NMED and the WIPP Accident Investigation Board (AIB) report. Of the combined set of responses, the causal analysis team identified AIB Judgements of Need (JONs) 9 and 10 and responses to ACOs 5, 7, and 9 were identified as germane to this drumout event. The institutional actions addressing process and procedure improvements with the greatest potential to have prevented this 2021 event included the following:

1. Actions developed to ensure that procedures were appropriately reviewed by technically-informed RCRA and/or waste management professionals. (AIB JON 9 and 10 and ACO-9)
2. Actions that targeted sound Acceptable Knowledge (AK) reports that captured operational activity wastes and identified corresponding process status codes that were then translated into waste stream profiles. (ACO 5,7)
3. Supporting training for waste management/environmental compliance professional staff and waste generators. (ACO-1)

CCP also generated corrective actions to improve the interface and R2A2s assigned to CCP and the Laboratory and CBFO engaged in Generator Site Technical Reviews.

CAS-Corrective Action Effectiveness:

Responses to #1, above, involved bolstering processes to achieve appropriate reviews of procedures “that have waste management aspects or impacts.” As a result, the institutional waste management procedure was revised (P409, Waste Management), as were multiple procedures for the then affected LANL Associated Directorate for Environmental Programs (ADEP) organization and several tools and related documents within the Laboratory Environment, Safety and Health organization and the institutional Environmental Compliance organization. In addition, a specific action was to “Revise TA-55 Procedures to incorporate ENV-CP reviews.” The evidence cited at the time included the technical procedure use and development process document for TA-55. The manner in which this effort was implemented at TA-55 was insufficient, as PT-3 procedures were not reviewed by a waste SME. The drumout event causal analysis team identified that the primary TA-55 procedure development and use document, PA-AP-01000, *Document Control Processes*, specifically PA-AP-01000 R10, July 2015, was modified such that the document owner/Responsible Line Manager could request a RCRA SME review of a Detailed Operating Procedure (DOP). The same AP later (Rev 21) included the ability to request a Waste Management SME review of an Integrated Work Document (IWD). (Note that the Revision History does not describe the impetus or timing of this second SME review checkbox). The procedure development and use document does not specify criteria for when such a review is required other than the owner/RLM determination that it is needed. PT and NPI-6 personnel indicated in interview, that these reviews would be engaged in the event that the procedure involved “waste.” It is important to note that “waste” was described in TA55-RD-539 as that which has been subject to a completed drumout task, and/or is subject to Termination of Safeguards (TOS), and or is ready to ship to the WIPP facility. Consequently, TA-55 operations RLMs might not determine that their operating procedures needed a waste management or RCRA SME review as they did not consider their materials as “waste.”

In addition, multiple interviewees within PT reflected that training provided to them about waste was of a general overview nature, thereby not informing them about how their operations need to interface with other waste management processes to ensure accurate waste characterization. Therefore, the likelihood that an operating procedure developer would know when to request a RCRA or Waste Management review of their procedure remained small. This is addressed by the causal analysis team through Recommendations to Root Cause #2, bullet 5.

Item #2, above, is addressed in Section 4 of this report and will not be duplicated here, with the exception of noting that the intent of the corrective actions to achieve accurate AK were insufficient for the PT-3 operations.

With respect to item #3 on the above, list, the response was to develop training for waste management/environmental compliance professional staff and waste generators. Multiple live courses were developed for RCRA and technical waste management staff and a required live course and annual refresher for waste generators was developed, course 23263, *Waste Generation Overview Course*. The on-line refresher indicates the following objectives:

- recognize federal, state, and LANL environmental requirements and their impact on waste operations;
- recognize the importance of the cradle-to-grave waste management process;
- identify the roles and responsibilities of key LANL waste management personnel (e.g., Waste Generator, Waste Management Coordinator, Waste Stream Profile approver, and Waste Certification Official);
- characterize a waste stream to determine whether it meets the definition of a hazardous waste, as well as characterize the use and minimum requirements for use of Acceptable Knowledge (AK) for waste characterization and waste compatibility documentation requirements; and
- identify the requirements for setting up and managing temporary waste accumulation areas.

The training target audience includes anyone who generates waste with the exception of office trash. The content reflects the regulatory framework for waste management and characterization as well as the technical complexity involved in accurate characterization. It indicates that the generator is “responsible for waste minimization, characterization, storage, and disposal of the waste they generate.” As noted in Section 4 of this report, the term “Waste Originator” entered the TA55 waste requirements document (RD-539) in the 2017 timeframe, likely to leverage the expertise of the NPI organization to manage the increasingly complex waste characterization and waste management arena. However, the terminology, in conjunction with the generalized training, likely reduced the Waste Originator awareness and understanding of their vital role in the arena of waste management, to include identification and communication of process-related constituents that would inform an accurate AK. Multiple interviewees indicated the training they received did not inform them how their activities would interact with NPI activities to ensure waste was characterized and managed compliantly.

As further detailed in Section 4 above, the previous waste characterization issues from the 2014 WIPP event resulted in improvements to the LANL waste characterization program, but were too narrow to encompass the titanium event (See CC 2.4)

DNFSB TECH-46 report:

In September of 2020, the Defense Nuclear Facilities Safety Board (DNFSB) generated a technical report, Potential Energetic Chemical Reaction Events Involving Transuranic Waste at Los Alamos National Laboratory, or Technical Report number 46. The report stated that:

Some LANL defense nuclear facilities assume inappropriate initial conditions in their accident analyses and do not conservatively estimate the quantity of radioactive material that may be released from an energetic chemical reaction event. As a result, LANL facility safety bases do not contain a bounding analysis that accounts for (1) the types of potential chemicals that could be present in waste drums or (2) the amount of radiological material that could be released from an energetic chemical reaction event.

The report noted that DOE is revising Standard 5506 associated with this weakness and made two relevant recommendations:

In order to fully analyze the hazards from energetic chemical reactions, the Board's staff team has concluded that waste generator sites should incorporate two separate types of evaluations into facility safety bases: (1) a general analysis that assumes that an energetic chemical reaction is possible within waste, without necessarily identifying any specific chemical reaction, and (2) a systematic evaluation of waste streams to identify specific chemical incompatibilities (i.e., a systematic chemical compatibility evaluation).

The Laboratory created three (3) Occurrence Reporting and Processing (ORPS) Reports, indicating that each facility entered the NI process, identified positive USQ Determinations, and initiated immediate actions. For TA-55, the immediate actions were listed as follows in IM Record 2020-1644:

1. TA-55 Safety Basis staff will develop and submit an ESS to NA-LA for approval. [Editorial Note: the acronym, ESS is "Evaluation of the Safety of the Situation"]
2. TA-55 Operations management will enter the ESS and any associated corrective action(s) into the Issues Management Tool for tracking through closure.
3. NPI-6: Ensure that anion exchange resins are rinsed prior to packaging with waste.
4. NPI-6: Perform an extent of condition for existing inventory for the potential presence of TRU waste drums that may contain anion exchange resins that have not been rinsed.
5. NPI-6: Perform an extent of condition for the existing and proposed waste streams for the potential to introduce chemical incompatibilities into TRU waste drums that could, given an exothermic runaway reaction, result in pressurization of the drums to >25psig.

For the TA-55 issues management record, based upon the DNFSB report, two corrective actions were entered:

1. (FA03) Conduct and extent of condition evaluation of closed TRU waste drums in Triad possession to determine if any of them are unsafe to handle and ship because of ion exchange column resin.

2. (FA09) Review the processes in place to determine if the processes can reasonably be expected to protect against ion exchange resin reactions, particularly reactions capable of rendering containers unsafe to handle and ship.

These responses were also recognized as too narrow in scope. In a separate evaluation, one of the members of the causal analysis team provided detailed recommendations to address the DNFSB concerns. As noted by this causal analysis team, one of those recommendations involved the development of a LANL chemical compatibility evaluation of production processes. This causal analysis team further recommended issuing a requirement to develop such evaluation baselines.

These deficiencies collectively point to the team investigation Contributing Cause 2.4.

CAS-Internal and External Oversight Review Effectiveness:

Following the WIPP event and development of corresponding corrective actions, multiple efforts were extended to look at the efficacy of such corrective actions.

As discussed previously, the Carlsbad Field Office and Nuclear Waste Partnership, LLC conducted a Generator Site Technical Review (GSTR), at Los Alamos in 2017. These reviews were intended to examine generator site work activities that support TRU waste preparation, prior to packaging and identify deficiencies that could affect the certification program. GSTR-LA-1-17-01 report included 14 issues, 3 of which were noteworthy practices and 11 deficiencies.

Page 8 of 31 of the GSTR stated that “While it is apparent that LANL is complying with the requirements relative to oversight and assessment activities; it is also acknowledged that the relatively new process known as the Waste Compliance and Tracking System (WCATS) questionnaire, is a work-in-progress not yet instituted throughout all the various facilities. This WCATS and its associated Questionnaire is also recognized as a noteworthy practice for its novel approach in capturing pertinent data in the areas of waste management and operations.” The report indicated it conveyed appropriate recommendations related to this statement. (Issues 1-5 and 1-11).

With respect to training and qualification, the report identified that the TA-55 Training Program Plan (TPP) listed a position of Waste Management Technician with a status of TBD. The TA-55 TPP did not list at that time any of the NPI-7 personnel as qualified Technical Staff, but a qualification standard for TRU Waste AK Specialist (PA-QS-01033) was in development by NPI-7. (Note that since the GSTR NPI-7 evolved into two groups, NPI-6 and NPI-7. NPI-6 currently, would be the organization involved in waste characterization.) The review noted that training for LANL personnel on the CCP program and WIPP-specific training would be beneficial, although NPI-7 at the time, seemed to have a working knowledge of relevant topics.

The GSTR review of CAS processes included 1.) the program elements as described in LANL Program Description and policy documents, 2.) multiple assessments on DOE O 435 “Radioactive Waste Management” compliance, and 3.) RCRA self-assessments and Readiness Assessments, noting that relevant issues were being found and corrected and that lessons learned were being promulgated.

The GSTR team was limited on processing operations that could be observed at the time of the review, as few were resumed at that time. As noted on page 14 of 31, “...the GSTR visit could not review all of

the waste generating processes that could result in TRU waste” and a sample of waste packaging activities were reviewed via simulation.

The GSTR review of procedures included TA55-RD-539, R7, TA-55 FOD Waste Management Requirements, and noted that operations personnel were required to work with (then) NPI-7 to support complete and accurate characterization of waste. The GSTR team noted also that the workers had little exposure to RCRA requirements and instead “...rely entirely on NPI-7 for waste management compliance because the ‘material’ that is sent for disposal is not yet considered ‘waste.’” (p. 16 of 31).

The GSTR noted that the LANL/CCP Interface Agreement and procedures required to be on the IWMDL were adequate and noted that CCP monitors the TA-55 shift orders for procedures that may need to be added.

Finally, the GSTR reviewed the TA-55 aqueous chloride processing AK report (TA55-RPT-0014, R1, effective 3/22/17) and found a noteworthy practice on the integration of NPI-7 with the operating group (I1-11). The team noted that NPI-7 personnel regularly walk down processes, that AK leads engage with operators to “...ensure materials destined to become waste are compliant, are consistent with the process AK, and no unknown constituents are in the waste;” that “the WCATS questionnaire is filled out for each package and signed;” and that “Visual inspections by NPI-7 and visual examination by CCP continue to be integrated activities.” (pp 17-18 of 31).

The GSTR review was thorough, but did not find the discrepancies between the TA-55 metals AK report and the related welding operations.

Waste Management Assessments:

Environmental Compliance interviewees indicated that TA-55 was the first area of revised waste management compliance. Environmental Compliance personnel conducted assessments against the newly revised institutional policy on waste management (P-409). The Laboratory’s Integrated Assessment Schedule (IAS) 2016-130 related the following scope:

The primary focus will be on T A-55 functional areas of quality assurance, chemical, radiological waste characterization, and traceability of waste from the point of generation through transfer to the Central Characterization Program (CCP). P409, LANL Waste Management requires EPC-DO to perform compliance assessments at a facility level against P409, LANL Waste Management; P930-1, LANL Waste Acceptance Criteria, DOE O 435.1, Radioactive Waste Management, DOE M 435.1, Radioactive Waste Management Manual and DOE/WIPP-02- 3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant (WIPP).

The report identified the following Noteworthy Practice: “[Assessment Team Managers] ATMs observed a LLW packaging evolution in the TA-55, PF-4 basement on September 16, 2019. NPI-7 and LANL Waste Certification Personnel were present. Both organizations were knowledgeable, thorough, and professional with regard to their specific job functions.”

The assessment report indicated a review of the VI and VE processes as they were applied to management of TRU and LLW wastes, noting that all requisite personnel were present, that wastes were segregated during VI, that the WCATS questionnaire was used and that objects were observed by the

CCP VE personnel prior to being drummed out. The assessment team further examined waste profile forms, noting it was appropriate for the waste that was drummed out.

The causal analysis team did not identify any assessments from the Laboratory IAS that targeted the evaluation of production process outputs, related chemical constituents, and those inputs into accurate waste characterization. Furthermore, the Laboratory's Issues Management tool information was reviewed with respect to Management Observation and Verification (MOV) activities (also known as "management walk-arounds"). Several MOVs were conducted on waste characterization and management activities by NPI. Notably, a very detailed MOV was documented by the PT Division Leader regarding an October, 2020 drumout activity, (Observation ID 23399). This MOV documented collaborative interaction amongst the involved organizations and personnel, the fact that teams were set up so that less experienced personnel were accompanied by more experienced personnel, that COVID practices were being implemented well, and that pre-job briefings were robust and well communicated. The same observation document included process improvements (both improvement needs identified and improvements recommended). These MOVs demonstrated management presence on the floor and evaluation of process/procedure implementation. The ALDWP MOVs that were reviewed did not include production process outputs and communication of those outputs with NPI to support accurate AK development or waste characterization. Additional MOV guidance cards could be developed to provide a structured focus or lines of inquiry regarding chemicals, items, materials that are inputs to a process, changes from the process, and resulting outputs of the process in a manner that supports accurate waste characterization and management.

7 CONCLUSIONS

The investigation team identified the following causes associated with the February 26, 2021 event:

Direct Cause: Dropping the conflat container resulted in a tear to the bag containing the HEPA filter, thereby releasing unoxidized titanium particulate into glovebox air. As noted, titanium in powder form is a combustible material (requires ignition) that exhibits pyrophoric-like characteristics (NFPA 484). The rapid expulsion of the titanium powder from the bag is believed to have produced sufficient friction to generate sparks.

Root Cause 1: PT-3 did not recognize the hazard of non-SNM reactive metal prior to handling the HEPA filters outside of inert environment. Several contributing causes are associated with Root Cause 1, as follows:

- CC 1.1: PT-3 did not identify and evaluate the hazard of non-SNM reactive metal, and removal from an inert atmosphere during DOP development, Readiness, FHE, or periodic reviews. (ISM/IWM, "Analyze the Hazard.")
- CC 1.2: Less than adequate Questioning Attitude when PT-3 observed significant increase in "soot" produced in operation. A change in scale in production operations was not evaluated (ISM/IWM, "Define the Work.")
- CC 1.3: Lack of integration across the LANL laser welding community of practice prevented addressing titanium powder hazard. (Hazard recognized in PF-5, Sigma)
- CC 1.4: General hazards associated with loss of inert environment or item removal from inert boxes are not addressed in P101-28 *Glovebox Safety Program*

- CC 1.5: PT-3 laser welding expertise should have recognized and communicated the hazard of non-SNM reactive metal

Root Cause 2: This prohibited item (titanium in powder form) was not rejected by the LANL/CCP waste characterization process (AK, VI/VE). Contributing causes associated with this root follow:

- CC 2.1: PT-3 PA-DOP-1127 (reference document in AK Report) did not identify titanium or any non-SNM pyrophoric hazard. (reference RC 1)

CC 2.2: Lack of NPI/CCP walkdowns to understand Assembly Operations (AO) waste. (Does not meet the intent of the Enhanced AK process).

- This situation created an inaccuracy in the process description in the AK Report for the AO process status code, which
- perpetuated the insufficient understanding that PT-3 had regarding the expectations for their role in VI and the fact that titanium in powder form was prohibited by the CCE, and
- prevented the PT Operations personnel from being directly involved in the development of the CCE and/or AK.
- CC 2.3: In 2017, with the creation of the “Waste Originator” role, the responsibilities within RD-539 for AK and walkdowns were removed from operating groups. These responsibilities shifted to NPI, with walkdowns relaxed to “as necessary.” Training requirements for operating groups also were reduced. The unintended consequence of these actions was ineffective communications between PT-3 and NPI-6 regarding AK.
- PT-3 had an inadequate understanding of their VI role and the titanium prohibition.

Furthermore, the adoption of the WCATS Questionnaire for TRU waste in place of the Waste Acceptance Form lost some important detail regarding traceability of TRU waste.

- CC 2.4: Narrow corrective actions from earlier issues did not encompass this event. Notably, the WCATS Questionnaire examples are limited to only Reactive Carbides and calcium. Also, the CCE 18 (for MHD-01) Tech Eval 8 (6/2020) stated to reject any item containing unidentified powders in airtight containers. The lack of questioning attitude regarding the ability of a sealed bag to preserve pyrophoric material did not translate from the magnesium issue to this event.

8. RECOMMENDATIONS

The causal analysis team submits the following recommendations to address identified causal factors and other aspects identified during the investigation that warrant consideration. (Note that an asterisk indicates those recommendations that encompass and extent of condition consideration):

Root Cause 1 Recommendations:

- Pre-jobs that involve working in or removing items/materials from inert gloveboxes must include a discussion of the lessons learned from this event as it applies to the evolution (e.g., the operational process output constituents and their potential hazards and controls.)*

- Ensure potential pyrophoric hazards associated with inert boxes are captured and controlled in corresponding work control documents (DOPs and IWDs). *
- Develop and implement passivation criteria for anything coming out of an inert box with potential pyrophoric hazard (such that it can be demonstrated in a manner that is visible at VI).
- Revise PA-AP-01000 to include required waste reviews.
- Revise P101-28 to more fully address hazards and controls associated with inert gloveboxes. (Glovebox Safety)
- ALDWP must ensure that change control practices are developed and implemented to re-evaluate the hazards and controls associated with changes to processes, including scale-up and modification of materials. These would include changes outside the current scope of TA55-AP-122, *TA-55 New/Revised/Restarted Activity Approval Process*.

Root Cause 2 Recommendations:

- Prior to performing VI within a process status code, programmatic RLMs, NPI-6 (AKS/AKT) and CCP should confirm the AK Report process status code language accurately represents the process. This review should include the input/output materials, chemicals, and the associated process.*
- Ensure all materials removed from or moved between gloveboxes are appropriately marked, labeled, or otherwise documented for traceability.
- Direct line organizations to strictly adhere to the requirements of the VI procedure (PA-AP-01216) and WCATS Questionnaire instructions including that the PIC of waste-originating operation must be present and knowledgeable.*
- To meet waste quality requirements, the operating line, NPI-6, and CCP must perform periodic joint walk-downs of all activities that are important for waste characterization.*
 - Activities surrounding the AK process (walkdowns, VI, VE) should promote a collegial, conservative, and questioning attitude to help identify potential gaps in our characterization processes.
- Establish a training and qualification requirement for programmatic RLMs within ALDWP regarding their responsibilities associated with waste management.
- Provide an Abnormal Events Workshop to underscore learning from recent waste-related events and issues, process and procedure expectations, and the importance of appropriately broad corrective actions.
- Similar to the AMPP DOP (PA-DOP-01918), develop a DOP for waste Originators to transfer items to NPI-6, and return to a DOP for VI. (currently these activities are governed by a non-technical AP or RD).
- Establish a formal process for flowing down requirements from CCE documents to Work Control documents.*

- Develop a requirement to ensure completion of LANL chemical compatibility evaluations (as per ongoing DNFSB Tech-46 response).
- In consultation with LANL RCRA experts, evaluate and adjust as necessary, the terminology used in the ALDWP waste management program regarding “Waste Originator,” “Waste Generator.”

APPENDICES

Appendix A- Events and Causal Factors Chart

Appendix B- Barrier Analysis

APPENDIX A
EVENTS AND CAUSAL FACTORS CHART

Events and Causal Factors Chart: Unexpected Condition Observed During Drum-Out Activity			Legend: Date	Event / Action / Decision
			Continued From last page / On next page	Relevant Condition
2012	2014		2015	
September 13	May 19	December 6	April 16	June
Rev. 0 of PA-DOP-01127, <i>Laser Welding Operations</i> , is issued.	WIPP AIB Commissioned	NMED Admin Compliance Order HWD-14-20 issued	WIPP AIB Phase II Report Issued	R0 of Fire Hazard Evaluation for “hot” & “cold” laser welding generated (<u>FHE -FIRE-15-014, Laser Beam Welder Glovebox Fire Hazards Evaluation</u>)
DOP discussed general metals and minimizing amounts.				FHE discussed the hazard of metal welding fumes and noted that the hazard was controlled by maintaining an inert atmosphere, ventilation and LGAC local HEPA filter
Addresses welding of pyrophoric SNM and indicates control is the inert GB atmosphere				FHE did not discuss hazard associated with metal fines on HEPA filter once removed from inert atmosphere

2015					
July 8	July 8	October 4	October 9	November 18	Post-FRA
Pit Flowsheet MSA Complete	P315 Rev. 6 issued, includes language to “ensure that the Waste Management coordinator is a reviewer for all waste-related activities”.	Pit Flowsheet CRA Complete	WIPP AIB Phase II CAP Approved (integrates AIB, NMED ACO, other investigations)	Pit Flowsheet FRA Complete	PT resumed welding in cold laser box (small number of Ti alloy rings)
Findings: No waste management issues identified.	Vague definition in P315 of “waste-related activity” with no clarification or examples	CRA identified welding fumes were not captured in the procedure, but had been evaluated and well controlled	WIPP corrective actions significantly improved communications between NPI and CCP surrounding waste characterization and AK	FRA did not review waste management	PT Process and Product Engineers were involved in the operation (maintaining glovebox O ₂ concentration, laser settings, etc.) and communicating about these processes with operations personnel.
		CRA evaluation did not identify the hazard associated with removal of fumes on HEPA from inert glovebox	Corrective actions included CCP developing Enhanced AK, to ensure waste characterization experts were integrated with operations. This involved NPI review of CCP documents.		Qual Std CSE-QS-004-R3 for Process Engineer & CSE does not cover waste
			CBFO corrective actions included initiation of Generator Site Technical Reviews to evaluate upstream activities		
			Corrective actions did not sufficiently address the interactions between NPI and PT-3 surrounding waste characterization or AK		
			Corrective actions did not result in walkdowns with NPI AK personnel and PT-3 personnel		

2017				
February 9	March 22	March 23	April 13	April
WIPP AIB CAP Closure packages approved	RD-539, R7, TA55 FOD Waste Management Requirements, was issued	PA-AP-01000 incorporated checkbox for RCRA SME review on DARs	AK Report Issued TA55-RPT-002	GSTR performed at TA55
	NPI assumed role of “Waste Generator”	This revision clarified requirements for a RCRA reviewer	AK report was built upon previous AK report for laser welding (previous Rev in Aug 2008)	GSTR identified a notable practice relating to NPI walkdowns of PF-4 operations
	Operating organizations assumed the role of “Waste Originator”	Per RCRA SME: RCRA reviews are performed on waste procedures, not upstream processes	States that AO generates nearly always LLW, not TRU	PT-3 operations were not included in the GSTR
	This allowed NPI to apply their waste knowledge and expertise to waste generation and characterization processes		Author did not consult programmatic operations personnel and/or perform walkdowns as part of revising the AK report	GSTR noted that the waste management structure at TA-55 resulted in little exposure to workers to RCRA, who had to rely entirely on NPI to support waste compliance, and placed a heavy burden on NPI.
	R7 of RD-539 (as did R6) removed the requirement for annual training associated with PF-4 access		AK report was based on procedure reviews, including DOP-1127 for welding. AO process status code does not include Ti and does not prohibit Ti fines, etc. (not identified in DOP-01127).	

2018		2019	
July 9	September 18	January 28 - 31	February 10
PT began welding for a specific project that required more welding than was anticipated during readiness.	Zone 1 and LGAC filter changeout occurs	CBFO and NWP conducted a GSTR scoping / assist visit with TRIAD and N3B	Zone 1 and LGAC filter changeout occurs
Quantity of Ti processed increased	PT-3 personnel did not recognize the hazard of removing the material from the inert box	Discussions primarily focused on transition issues and interfaces, but briefly included NO ₃ 's, combustibles and Ca reactivity testing.	Hazard continues to be unidentified
PT continued to use DOP 1127 for welding of general metals	PT-3 programmatic line operations personnel believed local filter changeout fell within the purview of related box maintenance activities described in PA-IWD-01157		No reaction during drum-out
DOP-1127 does not identify the hazard of fine Ti particles accumulated on the HEPA filter for either LGAC or Zone 1 filter, and does not address removing these filters or particles from an inert box to ambient atmosphere.	Box maintenance IWD did not describe filter changeout or related hazards, including filter particulate or removal from inert atmosphere		
PT-3 did not recognize changes ("soot") as needing re-evaluation	Because the box is attached to Zone 1 ventilation, PT-3 managed the removed items as TRU		
PA-AP-01146, R1, AK Documentation procedure, section 4 indicates NPI review of AK in the case field conditions change, but this change was not identified	The PT-3 welding operator qualification does not address waste		
	The discrepancy between PT-3 (TRU) and the AK report (nearly always LLW) was not recognized by PT-3, NPI-6, or CCP		
	PMDS performs Zone 1 filter changeout per DOP-0068, which does not identify the potential pyrophoric hazard		
	DOP-0068 did not require waste mgmt or RCRA review on DAR		
	Eventually, these removed filters passed through VI and VE (hazard over time is passivated and no reaction was observed)		

2019			2020	
October 9	October 15	November	January 18	June 3
AK specialists notify CCP of the use of Mg alloy in the IFIT process instead of Al. Al was described in related TA-55 AK report.	Zone 1 and LGAC filter changeout occurs	LANL AK specialists notify CCP of Ca issue.	Zone 1 and LGAC filter changeout occurs	CCEM specific technical evaluation addressed potential pyrophoric materials
Evaluation of magnesium issue included the passivation of material when removed from an inert glovebox because magnesium debris is pyrophoric	Hazard continues to be unrecognized and no reaction was observed	As a result of the January 2018, GSTR, additional testing had been conducted on potential for unreacted calcium to be in the waste	Hazard continues to be unrecognized and no reactions observed	Evaluation required the rejection of items with unidentified powders in potentially airtight containers from the shippable inventory
This recognition did not result in an action to review other inert boxes and potential pyrophoric characteristics in PF-4		CCP had not been made aware of the testing initiated as a result of the GSTR		

2020			2021		
June 26	Fall	September 25	February 19	February 25	
Zone 1 and LGAC filter changeout occurs	PT-3 completes special project Cold laser Ti welding operations completed	WCATS Questionnaire was updated	PMDS changes out Zone 1 HEPA filter during back shift.	PT removes Zone 1 and LGAC HEPA filters from cold welding box.	Cold welding box HEPA filters introduced into introduction hood
Hazard continues to be unrecognized and no reactions were observed	No indications of sparking occurred throughout this project	WCATS Questionnaire was revised to include “are unoxidized reactive metals present? (reactive carbides, calcium metal, etc.)”	Hazard continues to be unidentified	DOP-016 was used to remove items from box through movement to drum-out location, w/out a pre-job	DOP-030, <i>Introducing Items Through a Pencil Drop or Hood Into Gloveboxes in PF-4</i> , was not used.
		Did not flow down specific requirement from CCE 18 R2, Technical Evaluation 8, dated 6/3/2020.	Zone 1 filter changeout completed by PMDS on backshift	Hazard associated with removal of items from inert atmosphere not recognized	
			PT-3 changed out LGAC HEPA (inside box) on day-shift	DOP-902, <i>Transferring Items Into and Out of an Inert Box Through an Airlock</i> , was not used.	

2021

February 25

February 26

Cold welding box HEPA filters moved via trolley to intermediate drop box

Visual Inspection (VI) occurs in intermediate drop box

Cold welding box HEPA filters moved via crosstown trolley to drum out location

CCP performs Visual Examination (VE) on waste items (CCP-TP-113)

Drop box included items / material expected to enter waste from welding machining, possibly D&D and CMM inspection.

VI performed under PA-AP-01216 (this document superseded DOP-01401), documented on WCATs Questionnaire, PA-FM-01016, R4.1

Drum out box allowed staging of "waste" for 24 hours

VE provided last opportunity to segregate items and ask questions regarding material on filters

VI included:

- PT-2 PIC
- PT-3 operator
- Three PT-2 operators
- AK Technologist

CCP VE personnel confirm per CCP-TP-113 that there is no indication of non radioactive pyrophoric material.

Items in drop box were not labeled with identifying information.

No documented pre-job briefing available from this evolution

Waste Originator was not "the PIC where the waste is generated", instead was PT-2

CCE18, R2 Technical Evaluation 8 required to "reject items with unidentified powder in sealed container" was not flowed down to VE process

Items included loose wipes with no originating location identifiers

VI observed:

- Many loose items
- 2 bags w/ blackened HEPA filters
- Metal items

VE Operator was aware of MgO aspect of CCP CCE18, R2 Tech 8, but did not recognize the application to these HEPA filters

PA-AP-01216 includes no specific performance instructions on how to determine the absence of unoxidized reactive material

CCP uses waste stream (not process code) to determine if acceptable to drum out. In this case, debris waste stream allows HEPA filters.

PT personnel and the VI Technologist had inadequate training and qualification to successfully execute the VI process expectations

WCATS Questionnaire answered "No" to "are unoxidized reactive metals present?"

VI & VE concluded HEPA filters ok to go drum out

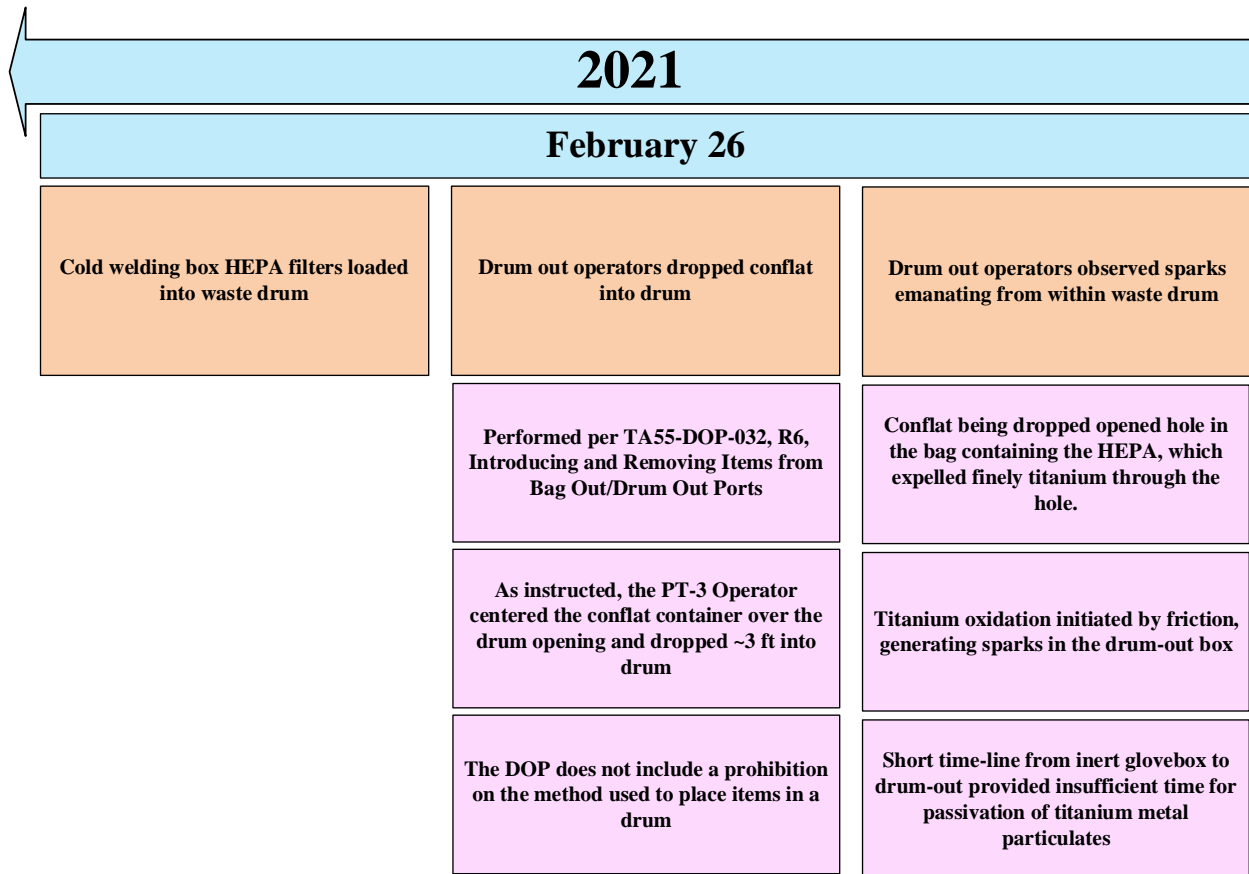
CCE18, R2 Technical Evaluation 8 required to "reject items with unidentified powder in sealed container" was not flowed down to VI process. The AP includes no reference to the CCP CCE.

Interviewees indicated that small compressed gas cylinders were passed through VI to VE, knowing they would likely be rejected at VE

VE rejected small compressed gas cylinders that had been passed on from VI

AP asserts determination of chemical compatibility through completion of the WCATS Questionnaire

PT personnel unaware of AK report and VI Tech had not confirmed AK report specifics prior to event



APPENDIX B
BARRIER ANALYSIS

Item	Barrier Category	Identified Barrier	How did the barrier perform?	What allowed the barrier to fail?	Impact of barrier performance on the event
	Physical Barriers				
1		Inert atmosphere in operating glovebox	Functioned with respect to fire mitigation in box	Barrier was degraded upon removal of bagged items from the inert glovebox	Allowed the materials to stay reactive
2		drumout box	Functioned	Provided a barrier between the sparking event and Operators	Protected Operators
3		Limited Ti quantities on operating box filters	Functioned with respect to limiting oxidation reaction	There were no controls specified to limit the quantity of titanium	Limited quantities (highest filter at 3.54 grams) restricted the scale of the event.
4		Plastic bag holding HEPA filters	Functioned until struck by conflat container	<p>Barrier was lost upon conflat container impact</p> <p>No requirement was established or implemented to allow sufficient time for diffusion to occur</p>	<p>Barrier prevented sudden influx of air/oxygen contact with titanium fines on the HEPA filter until conflat container struck the filter rim, resulting in a tear in the bag.</p> <p>The lost barrier allowed a discharge of titanium powder into ambient air resulting in oxidation reaction and visible sparks, preventing the drumout from being completed with prohibited characteristics.</p>

Item	Barrier Category	Identified Barrier	How did the barrier perform?	What allowed the barrier to fail?	Impact of barrier performance on the event
	Operating Procedures and Implementation				
5		Welding DOP 1127, <i>Laser Welding Operations</i>	The DOP failed to prevent prohibited items from entering into waste management processes (VI and VE)	<p>The DOP didn't identify the hazard associated with non radioactive pyrophoric material (reactive metal) being generated from the processing operation.</p> <p>There was no waste SME review required by the RLM on the DAR for the laser welding procedure</p> <p>DOP 1127 didn't identify the type and form of material that could potentially enter the waste stream (e.g., titanium fines or powder).</p> <p>DOP-1127 does not reference DOP-902, and does not include a consideration of the inherent hazard of the material and/or where it originated.</p>	<p>Potentially pyrophoric titanium fines were present on the LGAC filter, which were oxidized after the bag was damaged during drumout.</p> <p>Had hazard been identified in this procedure, the pyrophoric materials entering the waste stream may have been anticipated and controlled.</p>
6		PMDS DOP-068, <i>Replacing the Glovebox Exhaust HEPA Filter to the Zone 1 Vent</i>	Partially functioned	The procedure did not include a control to ensure that IF a filter was changed in an inert glovebox, VERIFY that the material on the HEPA filter has been passivated (or use vented bag, or notify NPI-6 to ensure...)	Had hazard been identified in this general use procedure, the pyrophoric materials entering the waste stream may have been anticipated and controlled.

Item	Barrier Category	Identified Barrier	How did the barrier perform?	What allowed the barrier to fail?	Impact of barrier performance on the event
				<p>The document did not describe the materials that could potentially enter the waste stream</p> <p>The procedure was not fully executed -Section 5.8 of DOP-068 assigned tasks to non-PMDS personnel</p> <p>The PMDS procedure was executed on the back shift prior to February 19, 2021 day-shift. PMDS did not brief the PT-3 personnel on performance steps assigned to them.</p> <p>The PMDS procedure includes completion of a non-existent waste form.</p> <p>The PMDS procedure does not capture hazards for working in an inert glovebox in which the box is breached.</p>	
7		TA55-DOP-016, <i>TA55 Material Handling and Movement</i>	DOP 016 partially functioned	The DOP was inappropriately being used by the line operations personnel as the sole document to remove items that would become waste and go to	Had DOP-016 included a note to not use it to move material from an inerted box, it would not have been inappropriately applied and

Item	Barrier Category	Identified Barrier	How did the barrier perform?	What allowed the barrier to fail?	Impact of barrier performance on the event
				<p>the locations for VI and VE. (Needed to use the procedures for removal from an airlock and use of trolley)</p> <p>DOP-016 does not address hazards and controls for moving materials out of an inerted glovebox, into an ambient air glovebox, and through the trolley line.</p> <p>DOP-016 does not include a note indicating it is not to be used for inerted gloveboxes.</p> <p>DOP-016, does not currently contain any hazards and controls associated with the movement or transfer of potentially reactive materials.</p>	the titanium fines may not have entered into VI or VE.
8		Does Not Exist (gap)	No barrier	No PT-3 procedure existed to instruct line operations personnel to take specific steps that would support traceability of processing material outputs.	Items coming out of MA and AO process status codes were comingled in the intermediate drop box without good traceability. (NOTE THAT AMPP-1 has developed a procedure that addresses this deficiency)

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9		PT-3 maintenance of box IWD 1157	The procedure failed	<p>The IWD did not identify the potential for loss of inert atmosphere</p> <p>It did not have adequate hazard analysis in that it did not identify titanium as a hazard.</p> <p>The IWD did not describe the activity of changing out the filter nor did it describe materials that could potentially enter the waste stream.</p> <p>The IWD does not reference DOP-902, and does not include a consideration of the inherent hazard of the material and/or where it originated.</p>	Had hazard been identified in this procedure, the pyrophoric materials entering the waste stream may have been anticipated and controlled.
10		DOP-902, <i>Transferring Items Into and Out of an Inert Box Through an Airlock</i>	Failed	<p>Was not utilized by line operations personnel when removing filters from inert glovebox.</p> <p>PT-3 personnel believed DOP-016 applied.</p> <p>DOP-902 does not address hazards associated with</p>	Had this procedure been used, the hazard would still have entered the drumout activity, as it does not include controls to mitigate the hazards associated with removing material from an inert environment.

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				removing material from an inert glovebox into an oxygenated atmosphere (to include potentially pyrophoric material)	Titanium fines were present during drumout.
11		DOP-030, <i>Introducing Items Through a Pencil Drop or Hood Into Gloveboxes in PF-4</i>	Failed	DOP -030 was not utilized by line operations personnel when introducing through a hood into gloveboxes DOP-030 does not reference DOP-902, and does not include a consideration of the inherent hazard of the material and/or where it originated.	The pyrophoric like material was present while introducing the items through the hood into gloveboxes. The hazard was not recognized and could have been exposed to air during this evolution.
12		DOP 032 Drumout	Failed	The DOP, and guidance provided on the day of the event (i.e., how materials are dropped or lowered into drums), did not provide adequate detail on how to “carefully lower items into the drum” to maintain the integrity of the waste packaging during drumout	The integrity of the waste packaging was compromised, allowing titanium fines to enter the air.

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	Waste Policies / Procedures and Implementation				
13		WIPP –WAC, Rev 10, August 2020	The waste characterization process defined in the WIPP WAC, R.10, as implemented, failed to identify a prohibited characteristic of the LGAC filter	<p>Enhanced AK (chapter 18.4.2.1) was intended to place the AK Experts in contact with the waste generators. It did not explicitly describe the situation of an entity like NPI-7 (now NPI-6) serving as the generator. At LANL TA-55, NPI served as the waste generator.</p> <p>H.2-and H.5-Interface Waste Management Documents List (IWMDL) and Acceptable Knowledge Assessments. The way that CCP and LANL interprets this is to include only waste management and packaging procedures. This approach has been audited and accepted by CBFO.</p> <p>H.3-Certified Program Enhanced Chemical Compatibility Evaluation-assessing potential reactions between constituents. The intent of the Enhanced CCE was to look at all potential reactive interactions.</p>	The spirit and intent of these elements, following the WIPP event and AIB, was to get CCP in direct contact with procedures and activities that create items/material that could eventually become waste. The combination of AK experts (CCP and NPI) did not have adequate interaction with the PT-3 personnel who created the LGAC filter.

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				<p>In CCE18, R2, <i>Chemical Compatibility Evaluation For Waste Stream LA-MHD01.001 Full Waste Stream</i>, June 3, 2020, there was a general acknowledgement of activities in the facility involving welding, had the potential to generate pyrophoric materials, and in Technical Evaluation #8, established a generic control to assert that pyrophoric materials would not be present in the waste. This control was not effectively implemented.</p> <p>However, to date, there has been no evaluation with respect to the inert gloveboxes specifically to prevent the presence of reactive metals in waste. Instead, now, the CCE asks what chemicals there are.</p>	
14		P409-1	Failed to verify effective flow down of a LANL WAC requirement	P409-1 addresses prohibited items in waste to include non-radioactive pyrophoric materials.	PT-3 generated an item with pyrophoric characteristics without recognizing its presence or the need to remove the prohibited characteristics.

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				<p>General Awareness training was developed to support implementation of the policy</p> <p>The implementation of P409 and 409-1 should have included a flow-down verification of requirements.</p>	ALDWP violated the LANL WAC by placing the prohibited item into a drum
15		RD-539	Failed to capture LANL WAC requirements, and adequately inform operations personnel of specific waste management responsibilities and processes	<p>NOTES: RD-539 did not flow down the explicit prohibited items from P409-1. The Revision history log states that they “removed guidance already provided in P409...”</p> <p>RD-539, Scope, it states “This requirements document only addresses discarded material that has no programmatic value and has undergone Termination of Safeguards.”</p> <p>This scope statement reinforced the concept with TA55 Originators and NPI that items removed from a glovebox are not considered waste until Termination of Safeguards and therefore, RD-539 did not apply</p>	<p>PT-3 personnel were not sufficiently informed of requirements and expectations and therefore did not reach out to NPI-6 to develop a detailed process description that would support compliant management of items submitted for potential discard.</p> <p>There was inadequate interaction between waste management SMEs (i.e., NPI and EPC-WMP) and Originators (e.g., PT-3) to identify and compliantly manage items/material that would eventually become waste.</p> <p>Generally speaking, TA-55 waste Originators (a) do not consider</p>

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				<p>to PT-3 and their items removed from the glovebox.</p> <p>This distinction results in a very limited set of procedures that are captured in the IWMDL and a limited set of procedures that are requested to have Waste SME reviews (LANL RCRA, NPI-6, and CCP)</p> <p>RD-539 training did not convey (a) how waste acceptance criteria are flowed down to Originators, (e.g., the WIPP WAC), (b) how the implementing framework is different at LANL/TA-55, (i.e., Originators vs. Generators, roles and responsibilities of each, etc.), (c) how TA-55 Originators compliantly interface with the waste management program to identify, track, and remove items to be submitted for potential discard from their point of origin.</p> <p>Revision 8 of RD-539, which was effective at the time of this incident, was not implemented in a required reading</p>	<p>themselves as waste generators and (b) consider waste requirements as something that starts VI/VE and drumout activities.</p> <p>Revision 8 was not systematically disseminated and reviewed by potentially impacted personnel.</p>

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				<p>assignment because the RLM input into the SAT evaluation documented without any "training."</p> <p>Does not sufficiently inform operations personnel with what they need to know about engaging with NPI and the interface between operation and waste characterization processes</p>	Multiple levels of PT-3 personnel indicated a lack of understanding as to how waste is managed to get it compliantly out of 55.
16		LANL AK Report (TA55-RPT-002), <i>Process Acceptable Knowledge Report for Metal Operations at TA55, R1</i>)	Failed to prevent the introduction of prohibited items into drumout	<p>The AK report references DOP-1127 welding procedure, but DOP-1127 does not provide information relating to titanium or anticipated waste.</p> <p>The AK report failed to identify the actual field conditions; it incorrectly reflects that AK Report section 2.6.3.3, states "this waste is nearly always LLW." Same section states "no TRU waste is anticipated from this process." Tables in back (process inputs and outputs table) indicates waste is LLW. Figures at back of report indicate that No TRU waste is expected to be generated.</p>	<p>Deficiencies in the AK report were subsequently incorporated into the AKSR.</p> <p>The compendium of information in the AK document system for AO did not identify titanium, titanium fines, or associated potentially pyrophoric hazards. The level of specificity of the AO process status code is insufficient to identify important waste characteristics</p> <p>Titanium fines, although prohibited by the CCP CCE, were entered into the waste stream</p>

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				<p>The AK Specialist who authored the AK report did not perform a walkdown to validate the hazardous waste codes, LLW, and Process Status Code. The report was based upon older documentary and interview input. The AK report pre-dates the ramp-up of the titanium welding activity.</p> <p>PT-3 Originators were unaware of this AK Report and its importance for supporting their operations through waste management.</p>	PT Operations were suspended in part because of the inaccuracies in the AK Report
17		PA-AP-01146, AK Documentation Procedure)	Failed to maintain an accurate LANL AK report	<p>Procedure states in section 5.4, Acceptable Knowledge Report Contents, that the "AK Report should include material inputs or other information that identifies chemical contents of the waste stream and physical waste form (i.e., PMFD, WCATS Questionnaires)</p> <p>NPI did not appropriately execute section 5.2.2 to accurately maintain the accuracy of the AO process</p>	<p>The procedure, as written, implies a narrow set of inputs to understand the chemical contents and physical waste form, although it states that AK Specialists walk down processes to ensure they meet the requirements of WIPP.</p> <p>Items/material items that were submitted for potential discard, were not documented in AK</p>

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				<p>status code through regular walkdowns of processes in operational areas, etc.)</p> <p>NPI was aware that AK reports needed to be updated, but lacked sufficient resources to accomplish that in a timely manner. NPI failed to recognize the risk associated with dated AK report content.</p> <p>PA-AP-01146 pre-dates the AK Technologist position. PA-AP-01216 was issued later. The two AP documents are unclear or contradictory with respect to duties/responsibilities of the AK Technologist and the AK Specialist. The 01146 document further describes the TRU Technician as being the one responsible for ensuring proper waste characterization. It is not clear that this position has any qualifications for waste characterization.</p>	<p>Reports and evaluated from the point of origin.</p> <p>Contrary to the CCP CCE prohibition on titanium in powder, sponge-form or vapor, CCP was not made aware of the titanium fines present on HEPA filters.</p> <p>Insufficient compensatory measures were applied to manage the gap until reports were updated. (e.g., covering process status code language during VI pre-job briefs)</p> <p>The two procedures may leave doubt as to which set of responsibilities is in effect and which set to implement.</p>
18		CCP AK Summary Report	Failed to accurately reflect the field conditions	The AKSR discusses Assembly Operations, indicating that the waste from AO is “nearly always LLW, but some TRU waste may be generated.” The “...but some	The AKSR reflects a more expansive interpretation of what may be seen at VE.

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				<p>TRU waste may be generated” was not in the LANL AK Report.</p> <p>The most recent revision to the LANL TA-55 for waste streams MHD01, CIN01, is dated February of 2014.</p>	<p>The AKSR did not identify the AO process status code as involving titanium.</p> <p>Event-specific impact: At VE, the CCP VE Operator is looking to see that the visible characteristics match those in the waste stream description and the absence of prohibited items. For this event, the waste items appeared to fit the waste stream description and there was no visual indication of a prohibited item.</p> <p>CCP is currently relying upon Enhanced AK for the newly generated waste and the AKSR, but the Enhanced AK relied upon NPI-6 and LANL AK report accuracy.</p>
19		CCP-TP-005, <i>CCP Acceptable</i>		CCP-TP-005, <i>CCP Acceptable Knowledge Documentation,</i>	At Los Alamos, the IWMDL does not include Originator procedures/processes, so these

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		<i>Knowledge Documentation</i>		requires walkdowns by CCP on documents listed in the IWMDL.	<p>are not typically walked down by CCP to update the accuracy of the AKSR.</p> <p>At LANL TA-55, the CCP relies upon NPI to serve as the Generator and includes NPI waste processing procedures in the IWMDL.</p> <p>Because Originator procedures that create items for potential discard are not included in the IWMDL, there is a greater reliance of CCP on the LANL AKS walkdowns, LANL AK Report accuracy, and the LANL VI process.</p>
20		VI Procedure (PA-AP-01216, <i>AK Technologist Procedure</i> , and process implementation	VI process failed to prevent a prohibited item from passing VI	<p>The procedure is inherently limited as it assumes that either the items/material entering VI have been adequately evaluated for prohibitions and/or chemical compatibility or that the non-compliance will be visually detectable.</p> <p>The procedure states the AK Technologist ensures there are no prohibited items. Procedure</p>	<p>The WCATS Questionnaire yes / no checkbox for the presence of unoxidized reactive metals was answered as “no.”</p> <p>A HEPA filter that contained Ti fines passed VI and was approved for drumout.</p>

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				<p>does not describe how to achieve that objective.</p> <p>This procedure does not require use/reference of the AK report, yet the procedure relies on the report for any non-visible prohibited items.</p> <p>As implemented, the VI Technologist is relying upon the Originator operators to identify items from their processing locations, but this is insufficient information to achieve the intent of the VI process. (operators can typically identify whether the item came from one of their gloveboxes, but cannot articulate potential hazards associated with the items)</p> <p>The PT-3 operators present, had insufficient knowledge to relate important characteristics of the item (e.g. titanium fines)</p> <p>CCE18 Technical evaluation #8 provisions to exclude any container with un-identified powder from the shippable</p>	

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				<p>inventory was not flowed down into the VI procedure.</p> <p>Although visible blackness on the filters was identified by the AK Technologist, it was not recognized as a significant finding or indicative of a potentially prohibited material.</p> <p>The procedure invokes the completion of the WCATS Questionnaire, including whether or not un-oxidized reactive metals are present, which is not reliably detectable by visual observation. (WCATS Questionnaire examples are reactive carbides and calcium metal, which are related to previous problems, not potential situations. The questions are very pointed, based on other unexpected outcomes alone).</p> <p>Implementation of the VI process did not result in a detection that the process status code associated with welding was “nearly always LLW” per the AK Report</p>	

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				The PT-3 PIC for the inert cold laser welding box (waste origination point), as specified in the WCATS Questionnaire instructions, was not present at the VI.	
21		CCP-TP-113, <i>Standard Contact-Handled Waste Visual Examination</i>		<p>The VE procedure is inherently limited to detecting prohibited items through a visual indication.</p> <p>CCE Technical evaluation #8 provisions to exclude any container with un-identified powder from the shippable inventory was not flowed down into the VE procedure.</p> <p>VE asks the VE Operator to confirm “is there an indication of non-radionuclide pyrophoric materials?” although this may not be visually detectable</p> <p>The AK Summary Report (AKSR) did not reflect the presence of titanium fines.</p> <p>The VE did include a verification that the items were MHD01,</p>	VE Operators observed no indications of non-radioactive pyrophoric materials, and the LGAC was allowed to proceed to the drumout operation.

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				debris, which is allowed per WCATS Waste Stream ID 45311	
	Other Procedures and Implementation				
22		PA-AP-01000	Under current requirements (Rev 17) both IWDs and DOPs get a RCRA review if checked. IWDs get a waste review if checked, DOPs do not get this review.	<p>P315, Conduct of Operations Manual, R6, Attachment 16, dated 7/8/15, states, "The Waste Management Coordinator (WMC) is a reviewer for all waste-related activities..."</p> <p>P315 likely did not draw the distinction that a WMC engages for LLW and a RCRA for TRU waste.</p> <p>Although the RCRA review checkbox was added after the 2014 WIPP event, selecting the SME review is left to RLM discretion.</p> <p>Existing language reinforces the regulatory concept of waste. . Better wording is generates material intended for discard.</p>	<p>PA-AP-1000 never incorporated the WMC as a reviewer for DOPs, but only for IWDs</p> <p>A RCRA review was not performed for the welding DOP. A WMC review for the welding DOP was not performed.</p>
	Training and Qualification and Knowledge	PT personnel	Failed	PT personnel were not assigned RD-539 training.	PT personnel

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				Waste Generation Overview training is a LANL general training and does not cover TA55 specific wastes and management of those wastes. It addresses primarily general waste categories and general waste minimization.	
23		NPI AK Technologist	Failed	The training for the AK Technologist did not include a pairing with an assigned AK Specialist, who ensured the Technologist understood the entirety of a specific AK Report and the corresponding process operations.	<p>The AK Technologist was not fully aware of the contradictions between the metals AK Report and the way items for discard were managed.</p> <p>The AK Technologist did not recognize that he could not, in an informed manner, answer the WCATS Questionnaire "Are un-oxidized reactive metals present?" based on what he could observe and the fact the PT-3 Operator could tell him an item came from the PT-3 box.</p>
	Hazard Identification and Analysis				
24		DOP-01127, Laser Welding	Failed to identify the hazard associated with the accumulation of finely divided titanium on	<p>The laser welding DOP did not identify the titanium fines hazard</p> <p>The ramp-up in production was not considered a change that</p>	The titanium fines hazard was not controlled when HEPA filters were removed from the inert glovebox

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			surfaces and components inside the glovebox	<p>would result in a re-evaluation of the potential for metal fines and removal of HEPA filters with fines from the inert glovebox.</p> <p>When PT operations personnel observed conditions change (sooty residue in the box), they did not recognize the associated hazard associated with metal fines and removal of the HEPA filters from the inert box.</p> <p>A good process description was not developed such that it described “credible off-normals” and/or the fact that while the cold laser welding box contained oxygen and could passivate materials, oxygen was not flowing across the LGAC when not welding.</p> <p>Other laser welding experts within ALDWP who have recognized this hazard related to removal of items from an inert box, were not consulted during the DOP development.</p>	The PT personnel recognized the accumulation of welding “soot” getting on the box and filters, but did not recognize the hazard of removing that material from the glovebox.
25		FHE	Failed	The FHE acknowledged presence of fines, but did not recognize	The technical analysis served strictly to inform the laser

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				the hazard associated with removal of the fines on filters from an inert glovebox	welding operating procedure with respect to maintaining an inert atmosphere during welding. It did not address related activities in terms of the metal fines hazard.
26		Readiness Reviews	Failed	Readiness reviews did not systematically and comprehensively evaluate waste management to include management of items items submitted for potential discard.	The potentially pyrophoric material was not recognized and documented following readiness.
27		DOP-068	Failed	<p>The filter change-out procedure did not identify the potential hazards associated with removing filters from inert gloveboxes.</p> <p>The procedure was not implemented in such a way as to ensure that all responsibilities were fully briefed.</p> <p>The procedure retained legacy waste management performance steps/content.</p>	PMDS was not informed about how to manage the hazard when pushing the Zone 1 filter into an inert box.
28		New Activity Review Process/procedure	Performed within its current scope, which does not address the changes in volume of titanium for welding project	The changes currently captured by this document include those changes that potentially affect the facility safety basis. While this may or may not be the document for capturing the	

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				changes to the welding activity, another change control document is warranted.	
	CAS- Event and Organizational Learning				
29		AIB JONs and ACO corrective actions	Failed to achieve the objective of understanding upstream impacts of operations on waste	<p>TA-55 AK Reports were not systematically evaluated and updated to accurately reflect operations and items intended to become waste from the point of origin.</p> <p>NPI walkdowns, although observed in a 2017 GSTR, were not systematically performed and sustained to identify and manage prohibited items and/or chemical compatibility issues. AK Specialists did not continue to perform process walkdowns with procedures and AK Reports in hand.</p> <p>Corrective actions primarily addressed processes and procedures for waste processing, not processes and procedures affecting items and materials upstream of waste processing.</p>	<p>The failure to recognize and manage items/material submitted for potential discard</p> <p>The TA55 metals AK Report was not corrected to account for all TRU waste, or for the titanium fines output</p>

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				<p>Although the WCATS Questionnaire was developed to aid in proper evaluation of items/material at VI, it was not fully evaluated for ability to be executed as written.</p> <p>SME reviews (RCRA and Waste Management) were insufficiently applied such that reviews primarily targeted waste processing procedures and not operating process procedures that created outputs that would be discarded.</p>	
30		P409 assessments	Failed to understand processes upstream of waste management	<p>Assessments continued to emphasize management of waste after it was deemed waste.</p> <p>Observations of VI and VE processes did not result in identification of issues identified with VI by this investigation</p>	The failure to recognize and manage items/material submitted for potential discard
31		Management Assessments	Failed	Management assessments did not examine the impact of TA-55 operations on the waste stream.	This element of CAS did not target the upstream operational activities and the associated potential impacts on the waste stream.
32		MOVs	Failed	MOVs were conducted, including PT management. A	MOVs did not capture the upstream operations processing

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				<p>specific MOV was conducted on bag-out activities and the fact that some improvements were needed to ensure that outputs of operations resulted in accurate and informed inputs to the VI.</p> <p>MOVs did not reflect an evaluation/observation of operations and their impact on the waste stream.</p>	activities and the associated potential impacts on the waste stream.

ATTACHMENT 1, CHARTER MEMO



Memorandum

**Associate Laboratory Director
Weapons Production**

To: Marc Clay, MISSASSUR, MS A102
From: Dave Eyer, ALDWP, MS E598
Phone: 505-667-5522
Symbol: ALDWP:21-0663
Date: March 15, 2021

Subject: Charter for Investigation of February 26, 2021 Drum-Out Event

Per LANL Procedure 322-3 Section 3.6, I am appointing you to investigate the events concerning the February 26, 2021 drum-out event. Your investigation should include people and processes as well as any other matter that in your professional judgement are pertinent to understanding the circumstances of this event and associated root causes.

Necessary outcomes of your investigation should include:

- A comprehensive articulation of the facts including timeline, involved organizations, actions, and outcomes.
- An assessment of the facts and circumstances, to include pre-work consideration of potential waste stream impacts for new work, and recommendations regarding any corrective actions needed. As part of this assessment, review LANL procedures for introduction of materials into the glove box production stream and determine whether the process for waste disposal or remediation is adequate.
- An assessment of the abnormal event response, and recommendations regarding any corrective actions needed.
- A review of the corrective actions from the WIPP waste incident to determine if corrective actions implemented from that event should have prevented this occurrence.
- A determination of the extent of condition, specifically other processes existing within PF-4 at risk of a lack of adequate waste characterization and/or disposition.

Your report is to include a briefing to ALDWP and LANL leadership and should be complete by April 23, 2021. Please provide a preliminary results briefing to Lab leadership and the Los Alamos Field Office prior to completion.

Support from within ALDWP can be coordinated with my office. Please invite the Field Office personnel into all of the lines of inquiry and utilize their expertise to support the investigation.

The following personnel are available to support you in this investigation:

Team Members

David Costa, contract to LANL
Randy Erickson, DDOPS

Dave Haar, contract to LANL
Rita Henins, ORI-2
Brian McIlvaine, ORI-DO
David Moody, contract to LANL
Ken Picha, NPI-6
Ron Reeves, Nuclear Waste Partnership, LLC
Laura Turner, CCP for LANL
Justin Williams, IQPA-PA

Observers

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