

ARP V Drum Event



Fluor
IDAHO

*Discussion with Citizens Advisory Board
October 2018*



Topics

- ◆ **ARP V Layout**
- ◆ **Sludge Waste History**
- ◆ **Process**
- ◆ **Event Response**
- ◆ **Technical Investigation**
- ◆ **Causal Analysis**
- ◆ **Recovery**

Accelerated Retrieval Project (ARP) V

Since beginning sludge waste mission in 2013, ARP V processed over 9,500 drums without incident

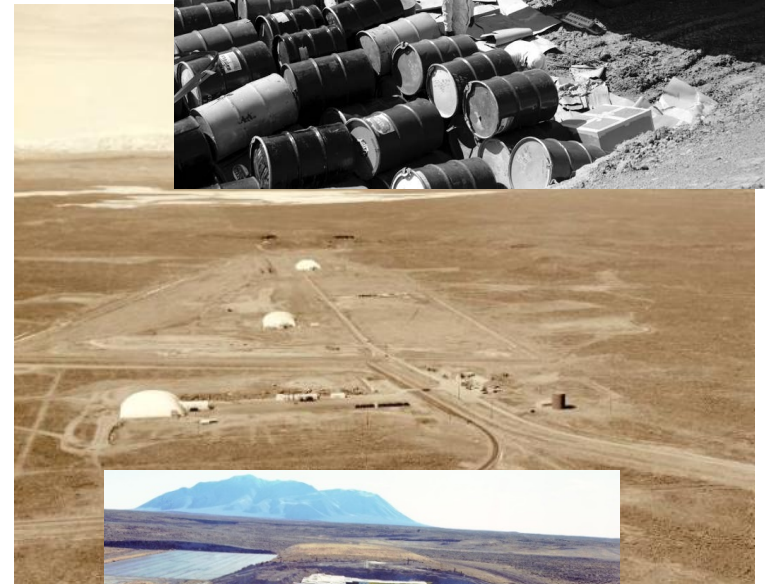
- First containers assigned Item Description Code (IDC) SD-176 in February 2013
- Initiated processing IDC SD-176 in March 2016

ARP V Facility at Radioactive Waste Management Complex (RWMC)

ARP V Airlock

Sludge Waste History

- ◆ **1950s through end of 1960s**
 - Waste sent to Idaho for disposal (burial) in the Subsurface Disposal Area (SDA)
- ◆ **1974-1978**
 - **Drums retrieved from the SDA**
 - Initial Drum Retrieval (IDR) Project.
 - 20,262 drums removed from Pits 11/12.
 - **Wastes were repackaged into cargo containers and re-located to Transuranic Storage Area Retrieval Enclosure.**
 - Placed on asphalt pad, covered with tarps, and buried under an earthen berm.
- ◆ **2009**
 - **Cargo containers unearthed**
- ◆ **2011-2016**
 - **Drums removed from Cargo containers**
 - **Initiated Sludge repackaging**



(Top) Waste drums stacked in SDA Pit 1 circa 1958; (Middle) Overhead view of the SDA looking West circa 1978; (Bottom) Waste stored on Pad R

Process – Sludge Repack

- ◆ **Waste containers evaluated for treatment**
 - **Real-time radiography (RTR)**
 - Determines waste category
 - Indicates presence of prohibited items
 - **Non-Destructive Assay (NDA)**
 - Determines radiological content
 - **Acceptable Knowledge (AK) review and approved for processing**

- ◆ **Acceptable Containers processed at ARP V**
 - **Remove/Correct prohibited conditions and absorb liquids**
 - **Waste placed in trays for Visual Examination (VE)**
 - **Authorized contents placed into new 55-gallon drum**
 - **Container transferred to Advanced Mixed Waste Treatment Project (AMWTP) for characterization**



Real-time radiography at AMWTP (top); and
sludge waste processing at ARP V (bottom)

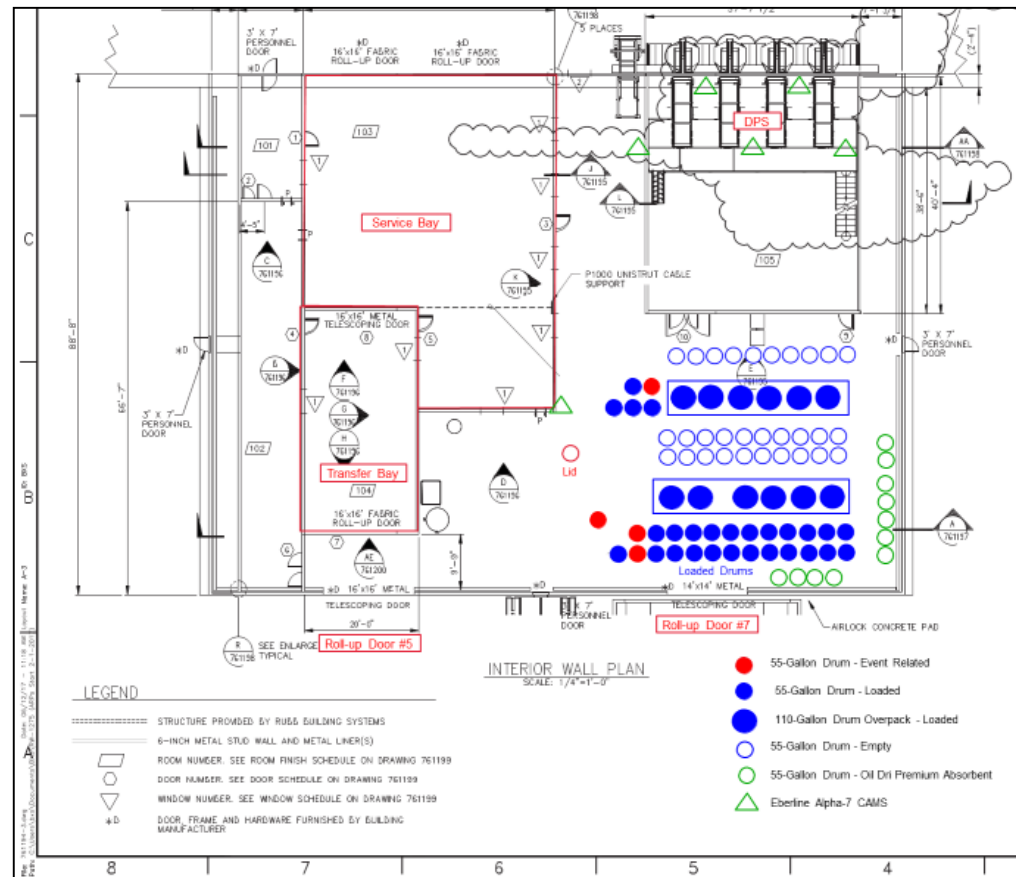
Event Response

➤ Firefighters responded to a smoke alarm in ARP V – 2230 on April 11, 2018

- ARP V was unmanned at the time
- Observed smoldering contents from a waste drum
- Applied two fire extinguishers
- Exited facility

Immediate Actions

- Secured all work in affected facility
- Verified ventilation operational
- Ensured structural integrity of facility
- Activated Emergency Response Organization (ERO) & Resource Conservation and Recover Act (RCRA) Contingency Plan
- Secured access to all waste storage buildings
- Established 24-hour facility monitoring
 - Two-hour fire watch
 - Radiological surveys of exterior perimeter
 - Continuously monitored facility ventilation
- Suspended Waste Isolation Pilot Plant (WIPP) shipments and similar waste treatment operations.



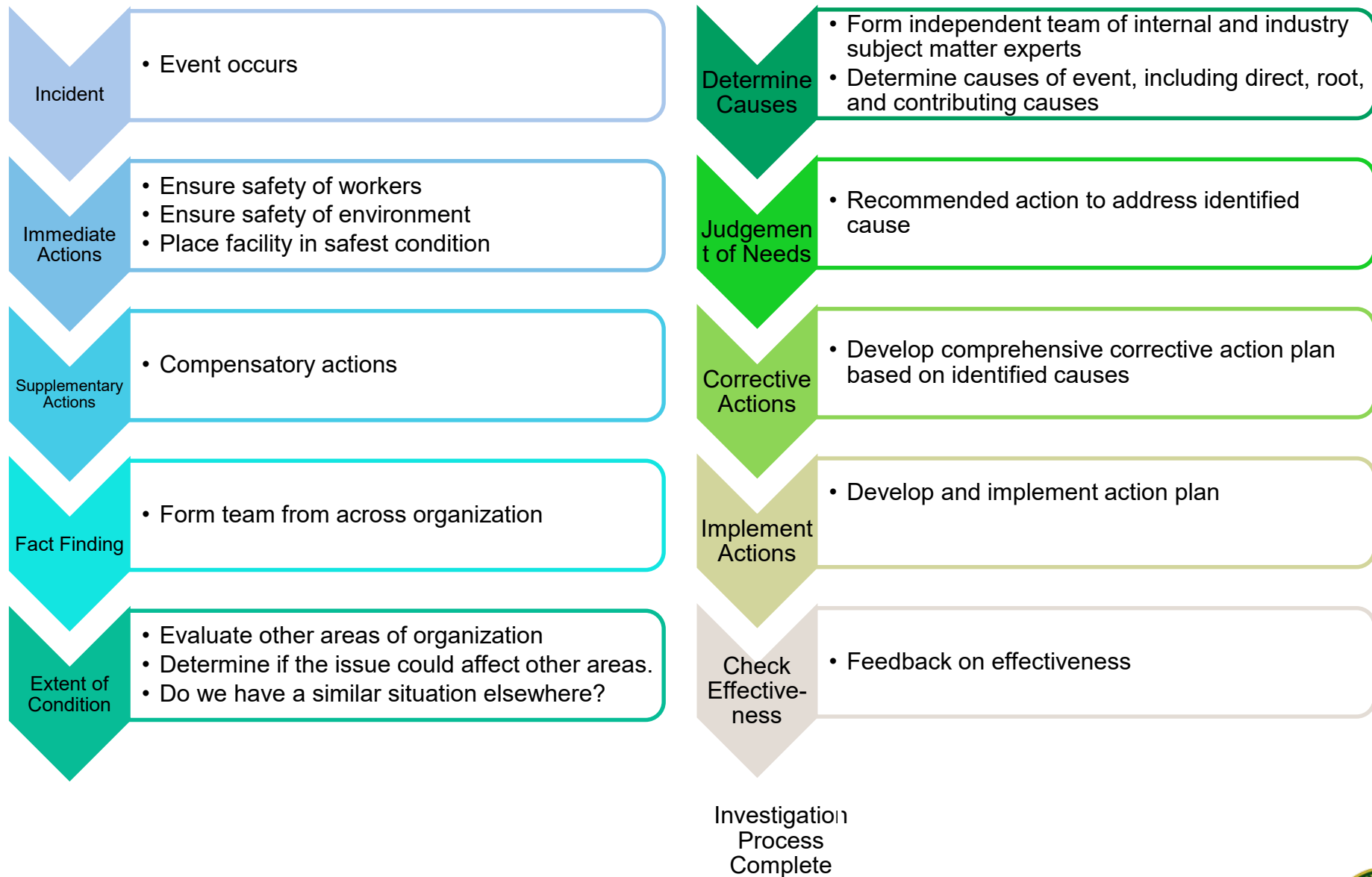
Drum location and Interior of ARP V immediately following the April 11 event

Event Response (continued)

Supplementary Actions

- No contamination detected outside the facility footprint
- Reviewed process work on these drums
 - Operations personnel noted nothing unusual
 - Reviewed AK history
- Entered Potential Inadequacy of the Safety Analysis (PISA) process
 - Placed facility into safest possible configuration (warm standby)
- Provided employee briefings for employee awareness
- Preserved the scene for forensic investigation
- Performed controlled entry into facility in a timely manner
 - Confirmed four drums with expelled lids and contents
 - Contamination levels ranged from 200K to 5000K disintegrations per minute (dpm)/100cm² alpha
- Continuous monitoring of facility to ensure safe for the environment and workers
 - Smoke test to evaluate air flow direction
 - Pre-filters replaced to optimize air flow from the Airlock Area into the Retrieval Area
 - High Efficiency Particulate Air (HEPA) filtered ventilation system remained in operation

Event Response – Investigation Process



Event Response – Teams

➤ Formed three teams for investigation and recovery

- Technical Team
- Independent Causal Analysis Team
- Recovery Team



Crews used specialized vacuums early in the cleanup process to remove contaminants from the floor within ARP V

Technical Investigation

◆ Developed hypothesis on reaction

- Metals within waste reacted with air introduced during processing and began to heat up, which accelerated secondary reactions
- Pressure built up inside drums
- Lids and some contents ejected



Ejected material from the affected waste drums coated the floor and other surfaces (left); waste samples collected for analysis (right)



◆ Developed path forward to confirm hypothesis

- Enlisted Idaho National Laboratory (INL) experts
- Selected two independent laboratories to support analysis and testing
- Established sampling plan
 - Continuous Air Monitor (CAM) filter elements
 - Radiological smears of various items and surfaces in the facility
 - Ejected material collected from the floor area surrounding drums
 - Contents of the event drums
 - Large particles discovered during cleanup activities
 - Table, tray, sister drums, similar legacy drum



Sample collection following the event

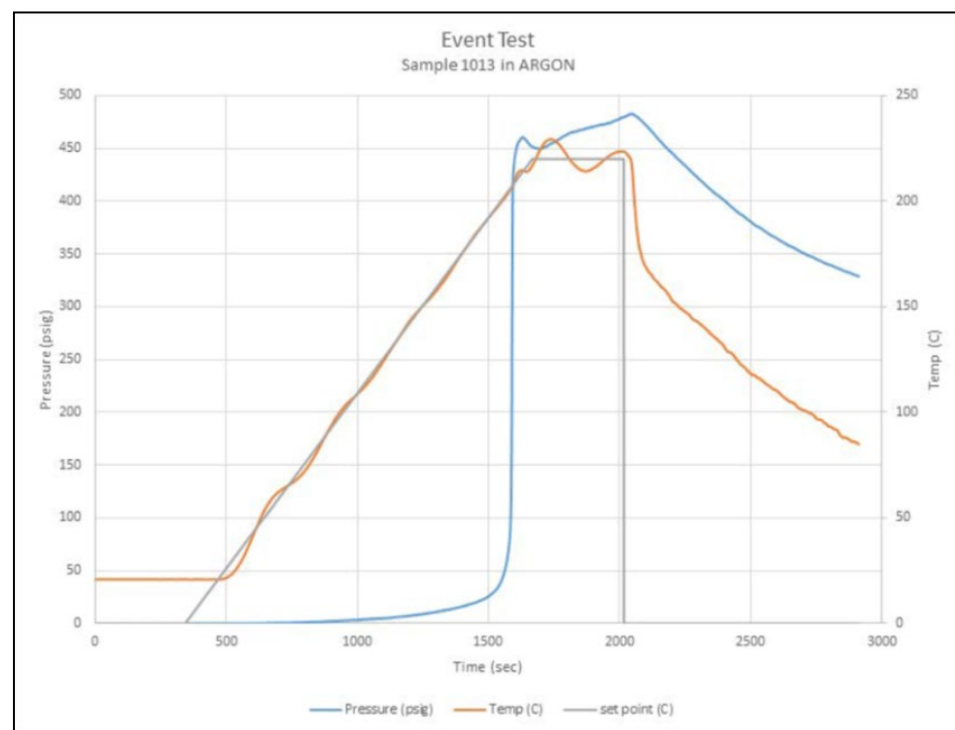
Technical Investigation (continued)

◆ Results

- Dozens of samples analyzed
- Confirmed reactive metal as uranium
- Organic compounds had no contribution to reaction
- Confirmed high methane from beryllium carbide (Be_2C)

◆ Conclusions:

- Heat slowly developed from metals reacting with air
 - Process aerated the waste
- Material in drum was excellent insulator – accelerated the reaction
- Beryllium carbide reacted with water vapor and heat to produce significant quantities of methane gas
 - Byproduct of Rocky Flats operations
 - Sampling determined significantly higher beryllium content than expected



Event Test Pressure (psig) and Temperature (degrees C) versus Time (sec)

Causal Analysis

- ◆ **Independent Causal Analysis**
 - Similar to report format used on the WIPP radiological event
 - Interviewed ~100 personnel involved in activities leading up to event
- ◆ **Reviewed all documents**
 - Procedures/Safety documents/Historical documents
 - Permits/Correspondence
- ◆ **Detailed Technical Analysis conducted**
 - Analytical results were validated
- ◆ **Various causal analysis methodologies were used**
 - Event & Causal Factor Chart
 - Barrier Analysis
 - Change Management Analysis
- ◆ **Causal Analysis report issued on October 1, 2018**
 - One Direct Cause (DC)
 - Two Root Causes (RC)
 - Eight Contributing Causes (CC)
 - Fourteen Conditions Adverse to Quality (CAQ)
 - 26 Judgements of Need (JONs)

Causal Analysis – DIRECT CAUSE

◆ Direct Cause:

- The breach of four transuranic (TRU) waste containers in the ARP V building resulting from the mixing of waste containing reactive uranium from Container #10595963 with additional parent drum material in the repackaging process.
- The uranium initiated an exothermic reaction that ultimately led to an over pressurization and subsequent expulsion of material from four containers.
- The initiating mechanism (heat source), based on sample results, was oxidation of the uranium metal which then supported secondary chemical reactions.
- The breaches resulted in airborne radioactivity escaping to a filtered, uncontaminated area normally occupied by workers.

Causal Analysis – ROOT CAUSE

- ◆ **RC-1, Management failed to fully understand, characterize, establish and implement adequate process controls for treating waste which lacked documented origin or process information.**
 - Evaluate existing processes
 - Revise processes for treating waste that is from unknown generators
 - Review and revise the documents in support of the acceptable knowledge
 - Conduct additional chemical compatibility studies to support safe operations
 - Review the existing regulatory requirements for implementation
- ◆ **RC-2, Management failed to continue to develop the safety culture over a number of years.**
 - Conduct an independent comprehensive review of the nuclear safety culture
 - Based on results of the review, develop improvement actions and initiatives

Causal Analysis – CONTRIBUTING CAUSE

- ◆ **CC-1: A change-management process was ineffective to identify, evaluate, and disposition the existing vulnerabilities for processing SD-176.**
- ◆ **CC-2: A documented plan or path to disposal was not established as required by DOE O 435.1, “Radioactive Waste Management,” prior to processing SD-176.**
- ◆ **CC-3: Management did not effectively analyze extent of condition following the December 2017 box line fire event and apply lessons learned to relevant ongoing activities outside of AMWTP, which could have identified the presence of reactive material other than roaster oxides in containerized waste.**
- ◆ **CC-4: Oversight of the Sludge Repackaging Project (SRP) was ineffective in identifying process failures that caused and/or contributed to the ARP V event.**

Causal Analysis – CONTRIBUTING CAUSE

- ◆ **CC-5: An effective integrated human performance improvement program has not been implemented.**
- ◆ **CC-6: Action in applying lessons learned from the 2014 WIPP event was not effective in strengthening processes such that major contributors to the drum event were able to be identified and mitigated.**
- ◆ **CC-7: The project failed to provide an adequate number of trained Acceptable Knowledge (AK) personnel to support the daily activities along with providing effective program oversight.**
- ◆ **CC-8: The Tenant Use Agreement was inappropriately used when initiating the Sludge Repackaging Project (SRP).**

Causal Analysis – CORRECTIVE ACTION

◆ Multi-disciplinary team assembled to:

- Evaluate the Judgement of Needs (JONs) and develop corrective actions.
- Includes management, supervisors, and workers.
- Across organization:

Performance Assurance
Radiological Controls
Environmental

Operations
TRU Programs
Safety and Health

Engineering

◆ Corrective actions to address the following areas:

- Processes
- Procedures
- Change management
- Strategic implementation of human performance principles

◆ Evaluating potential new controls

Recovery

◆ Bulk cleanup complete

- All loose materials cleaned up and placed in 55-gallon drums

◆ Decontamination complete

- Remains contaminated but under standard radiological controls

◆ DOE approved resumption of waste exhumation operations in ARP VIII with revised Safety Basis

- Raking and thermal monitoring of exhumed sludge waste is now required prior to repackaging
- Thermal check occurs at the 24-hour hold points
- Constant advisory support from Technical Team
- This ensures unreacted uranium is reacted

◆ Discussions continue with external partners/regulators:

- Idaho Department of Environmental Quality
- State of Idaho officials
- Defense Nuclear Facilities Safety Board
- Waste Isolation Pilot Plant

◆ Corrective Action Development Continues



The affected area before bulk cleanup (top) and the affected area following bulk cleanup (bottom)

Recovery - Path forward

◆ Operations Team

- Continue reducing contamination levels
- Utilize lessons learned from the investigation to revise the treatment process

◆ Technical Investigation Team

- Publish the investigation report

◆ Corrective Action Team

- Develop corrective actions
- Ensure Corrective Action prevents recurrence

◆ Complete recovery operations

- Safety Basis updated/implemented
- Removal of all waste from facility
- Modify applicable permits

◆ Resume sludge processing

Summary

- ◆ **Exceptional employee support after incident**
 - First entry into ARP V for extent of conditions completed safely – one week after event
 - Sampling successfully completed
 - Bulk material cleanup within the facility completed without incident
 - A large waste transfer tent fabricated, installed, and successfully utilized to transfer a scissor lift into the facility & remove numerous waste boxes
 - All horizontal and vertical surfaces are now free from visible contamination
- ◆ **Facilities proven to be robust in protecting the environment, public, workers**
- ◆ **Remaining waste is the most difficult to process**
- ◆ **Controls/Corrective Action will be robust so no uncontrolled reactions occur in the future**
- ◆ **Posture going forward is “Abundance of Caution” and “Overt Questioning Attitude”**
 - Additional safety controls Evaluation of the Safety of the Situation (ESS)
 - Assume all Uranium is unreacted