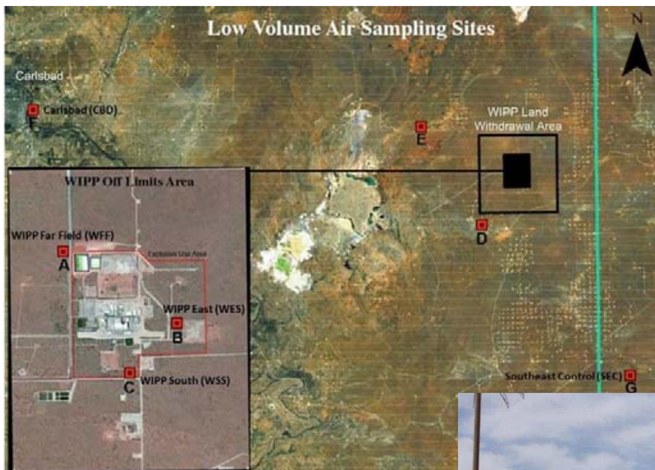
U.S. Department of Energy
Office of Environmental Management

Accident Investigation Report



Phase 1

Radiological Release Event at the Waste Isolation Pilot Plant on February 14, 2014

April 2014

Disclaimer

Phase 1 of this accident investigation report is an independent product of the Accident Investigation Board appointed by Matthew Moury, Deputy Assistant Secretary, Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management. The Board was appointed to perform an Accident Investigation and to prepare an investigation report in accordance with Department of Energy Order 225.1B, *Accident Investigations*.

The discussion of the facts as determined by the Board and the views expressed in the report do not assume and are not intended to establish the existence of any duty at law on the part of the U.S. Government, its employees or agents, contractors, their employees or agents, or subcontractors at any tier, or any other party.

This Phase 1 report neither determines nor implies liability.

Release Authorization

On March 4, 2014, an Accident Investigation Board was appointed to investigate a radiological release event at the U.S. Department of Energy, Waste Isolation Pilot Plant site near Carlsbad, New Mexico, that occurred on February 14, 2014. The Board's responsibilities have been completed with respect to Phase 1 of this investigation. The analysis and the identification of the contributing causes, the root cause and the Judgments of Need resulting from this investigation were performed in accordance with DOE Order 225.1B, *Accident Investigations*.

The Phase 1 report of the Accident Investigation Board has been accepted and the authorization to release this Phase 1 report for general distribution has been granted.

James Hutton
Acting Deputy Assistant Secretary
Safety, Security, and Quality Programs
Office of Environmental Management

4/22/14
Date

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Acronyms

ABSTA	Authorization Basis Senior Technical Advisor
AEOC	Alternate Emergency Control Center
AC	Administrative Control
ALARA	As Low as Reasonably Achievable
ASME	American Society of Mechanical Engineers
CAR	Corrective Action Report
CAS	Contractor Assurance System
CBFO	Carlsbad Field Office
CFM	Cubic Feet Per Minute
CH	Contact Handled
CHAMPS	Computerized History and Maintenance Planning System
CMR	Central Monitoring Room
CMRO	Central Monitoring Room Operator
CMS	Central Monitoring System
CON	Conclusion
CONOPS	Conduct of Operations
CTAC	Carlsbad Technical Assistance Contractor (Portage)
DBA	Design Basis Accident
DF	Design Feature
DOE	U.S. Department of Energy
dP	Differential Pressure
DPTA	diethylenetriamine pentaacetate
DPM	Disintegrations per Minute
DNFSB	Defense Nuclear Facilities Safety Board
DSA	Documented Safety Analysis
EAL	Emergency Action Level
EMCBC	DOE-EM Office of Environmental Management Consolidated Business Center
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
ERO	Emergency Response Organization
EXO	Enriched Xenon Observatory
FR	Facility Representative
FSM	Facility Shift Manager
GCAP	Ground Control Annual Plan
HEPA	High-Efficiency Particulate Air

HSS	DOE Office of Health, Safety and Security
HQ	Headquarters
IC	Incident Commander
ICS	Incident Command System
IEP	Integrated Evaluation Plan
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
ITS	Important to Safety
JON	Judgments of Need
JIC	Joint Information Center
LCO	Limiting Condition for Operations
M&O	Management and Operations
MACCS	MELCOR Accident Consequence Code Systems
NRB	Nuclear Review Board
NWP	Nuclear Waste Partnership LLC
MSHA	Mine Safety and Health Administration
MST	Mountain Standard Time
NaI	Sodium Iodide
OE	Operational Emergency
OH/IS	Occupational Health/Industrial Safety
ORPS	Occurrence Reporting and Processing System
PA	Public Address
PAC	Programmatic Administrative Control
PE-Ci	plutonium$^{239/240}$ equivalent curies
PISA	Potential Inadequacy in the Safety Analysis
QA	Quality Assurance
QAP	Quality Assurance Program
QAPD	Quality Assurance Program Document
RH	Remote Handled
RCDM	Radiological Control and Dosimetry Manager
RCM	Radiological Control Manager
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
REMS	Radiological Effluent Monitoring System
RPP	Radiation Protection Program
SAC	Specific Administrative Control

SC	Safety Class
SCFM	Standard Cubic Feet Per Minute
SER	Safety Evaluation Report
SigCat	Significance Category
SLA	Service Level Agreement
SME	Subject Matter Expert
SMP	Safety Management Program
SS	Safety Significant
SSC	Structures, Systems, and Components
STA	Senior Technical Advisor
TIM	Training Implementation Matrix
TQP	Technical Qualification Program
TRU	Transuranic
TRUPACT	Transuranic Package Transporter
TSR	Technical Safety Requirement
U/G	Underground
USGS	United States Geologic Service
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination
UVS	Underground Ventilation System
WIPP	Waste Isolation Pilot Plant
WTS	Washington TRU Solutions, LLC

Executive Summary

At approximately 2314 Mountain Standard Time (MST) on Friday, February 14, 2014, there was an incident in the underground repository at the Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, which resulted in the release of americium and plutonium from one or more transuranic[1] (TRU) waste containers into the environment. The WIPP is a deep geologic repository, mined out of a thick bed of salt, for the disposal of defense TRU waste generated primarily from the cleanup of DOE sites. The release was detected by an underground (U/G) continuous air monitor (CAM) and then directed through high-efficiency particulate air (HEPA) filter banks located in the surface exhaust building. However, a measurable portion bypassed the HEPA filters via design leakage through two ventilation system dampers and was discharged directly to the environment from an exhaust duct. No personnel were determined to have received external contamination; however, 21 individuals were identified through bioassay to have initially tested positive for low level amounts of internal contamination as of March 28, 2014. Trace amounts of americium and plutonium were detected off-site.

This accident meets the criteria in Appendix A to DOE Order (O) 225.1B, *Accident Investigations*. On February 27, 2014, Matthew Moury, Deputy Assistant Secretary for Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management, formally appointed an Accident Investigation Board (the Board) to investigate the radiological release in accordance with DOE Order 225.1B. The appointment letter was modified on March 4.

The Board began the investigation on March 3, 2014, completed Phase 1 of the investigation on March 28, 2014, and submitted the report to James Hutton, Acting Deputy Assistant Secretary for Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management on April 1, 2014. This report covers the Board's conclusions for the release of TRU from the U/G to the environment, which is considered to be Phase 1 of the investigation. Based upon the evidence gathered in this accident investigation, the Board concluded that the unfiltered above-ground release identified in Phase 1 of the investigation was preventable.

The Board concludes that a thorough and conservatively considered hazard analysis, coupled with a robust, tested and well maintained HEPA filter capable exhaust ventilation system could have prevented the unfiltered above ground release that occurred on February 14, 2014.

Originally, a large release from the underground that would have required crediting the HEPA filtered ventilation system to mitigate was not assumed to occur. Dating back to 2005, the safety basis documents designated the U/G confinement ventilation system (CVS) as a Safety Significant (SS) system based on directing airflow away from facility workers emplacing waste. However, the above ground systems including the exhaust High Efficiency Particulate Air (HEPA) filtration and bypass isolation valves were not credited because the safety controls at the

[1] Transuranic waste (TRU) means waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (A) high-level radioactive waste; (B) waste that the DOE Secretary has determined, with the concurrence of the EPA Administrator, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations. [Public Law 102-579 (1992)]

time consisted of a credited Technical Safety Requirement (TSR) control that required weekly ground control inspections to ensure changing conditions were promptly identified, evaluated and addressed. When the existing Contact-Handled (CH) and Remote-Handled (RH) TRU safety basis documents were combined in September of 2008, the new Documented Safety Analysis (DSA) reduced the classification of the U/G CVS to "Balance of Plant," meaning that it was no longer credited for worker protection from accidents identified in the DSA. Among the bounding accidents identified in this version of the DSA was a roof fall accident in an active panel (Event 030-CH/RH-UG), which resulted in an anticipated frequency with low consequences to facility workers, high consequences to co-located workers (100 meter receptor), and moderate consequences to public.

The primary safety basis control established for the roof fall accident was related to the ground control program. As a result, the release from a roof fall accident was assumed to be adequately prevented by the ground control program, and only relatively smaller releases in the U/G from events such as waste handling accidents were judged to be credible. The ground control program preventive controls were determined to be sufficient, and safety related mitigative controls for the larger releases in the U/G were not deemed necessary. As a result, the HEPA ventilation system and its associated bypass isolation dampers were not designated as credited safety related equipment. Because the isolation dampers were not nuclear safety system credited, the damper design was not required to meet requirements in the nuclear industry ventilation code, ASME AG-1-2012, *Code on Nuclear Air and Gas Treatment*. This decision resulted in the HEPA bypass isolation damper configuration not being equally efficient to the HEPA filters or suitable as a containment boundary, and resulted in the unfiltered release to the environment. The nuclear safety basis is more thoroughly discussed in Chapter 3, Nuclear Safety Program.

The U/G ventilation system originally consisted of three 860 series fans, each rated at 60,000 cfm, capable of providing normal unfiltered airflow to support early mining operations. The system also provided the capability to realign airflow through two banks of HEPA filters using a single 860 series fan to provide the rated airflow for waste emplacement activities. However, in order to align for filtration, two bypass isolation dampers that represent a pathway of unfiltered exhaust into the environment must be closed. These isolation dampers have a design leak rate of up to 1000 cfm. The radiological event that occurred on February 14 with the leakage past the isolation dampers was less than the National Emission Standards for Hazardous Air Pollutants (NESHAP) guidelines for the public and below the limits established by DOE and WIPP for site workers.

As mining activities were increased, the existing fans were no longer able to provide the necessary airflow to support the additional fossil fueled vehicle emissions. Two larger 700 series fans each rated at 260,000 cfm were installed, later followed by a third, that discharged upstream of the 860 series fans and significantly improved air flow capabilities. The ability to use the 860 fans to supplement unfiltered airflow was maintained for flexibility, although the addition of the new fans represented an opportunity to evaluate and improve the overall efficiency of the HEPA filtered system by eliminating the bypass dampers, which would have prevented the unfiltered release. However, since these systems were not credited as safety related, modifications were not subjected to the same level of scrutiny as would have occurred for modifications to credited safety systems. Additionally, there was significant degradation in the material condition of several ventilation system components identified that were not being aggressively pursued.

Since the HEPA ventilation system was not designated as a credited safety system, the CAMs in the U/G whose purpose is to detect a release in the U/G and cause an automatic switch of the ventilation system to filtration mode, were also not credited. The U/G ventilation system is more thoroughly discussed in Chapter 7, NWP Maintenance Program, Chapter 8, Radiation Protection Program and Chapter 9, Underground Ventilation.

The Board also determined that weaknesses in oversight by the contractor, CBFO, Headquarters, and outside organizations missed opportunities to identify inadequacies in the safety basis, as well as the configuration management and maintenance of the U/G ventilation system at WIPP. For example, the accident involving the roof fall in an active panel was removed in error from the latest revision to the DSA. This change was not identified by CBFO during their review, and therefore, the basis for the change was not provided in the DSA or DOE's Safety Evaluation report (SER). Oversight is more thoroughly discussed in Chapter 11, NWP Contractor Assurance System and Chapter 12, DOE Programs and Oversight.

Inability of the Board to access to the U/G following the incident also prohibited definitive determination of the physical cause of the waste container(s) breach/failure. Nuclear Waste Partnership LLC (NWP) and the DOE Carlsbad Field Office (CBFO) will be implementing a detailed recovery plan to systematically reenter the U/G and make an absolute determination as to cause. The Board presumes either the penetration of a waste container or multiple containers by a roof bolt, or partial collapse of the back (roof) and/or ribs (walls) caused the breach and release of contamination. This will be investigated in Phase 2. Phase 2 of the Board investigation will occur after reentry into the U/G and a cause of the release within the U/G is able to be determined.

Accident Description

On Friday, February 14, 2014, at approximately 2314, a "HI HI" radiation alarm was received in the Central Monitoring Room (CMR) at the DOE WIPP facility approximately 27 miles east of Carlsbad, New Mexico. The alarm was triggered from a CAM (Figure ES-1) in the U/G which was monitoring airborne radioactivity levels in air exhausting from Panel 7, an active waste panel where TRU waste was being emplaced for disposal.

The underground ventilation system (UVS) automatically switched to HEPA filtration mode when the airborne radiation alarmed the CAM and the 860 fan vortex damper was manually opened and adjusted to achieve designated airflow. This directed contaminated air from the U/G up through

Figure ES-1: RADOS Continuous Air Monitor

the U/G exhaust shaft, through the HEPA filter banks, and then to the environment from an exhaust duct. There were no employees working in the U/G at the time, but 11 personnel were working on the surface. After receiving the alarm, the Central Monitoring Room Operator (CMRO) notified the Operations and Radiological Control Manager (RCM also known as the Radiological Controls and Dosimetry Manager) and the DOE Facility Representative (FR), who responded to the site early the next morning. At 2342, the CMRO logged, "Disabled U/G CAM-151," which was the only in-service CAM in the U/G, due to a malfunction indication, suspected due to filter plugging. Ventilation continued to run in filtration mode through the HEPA filters, and Radiological Control Technicians (RCTs) collected filters from upstream and downstream effluent sample stations for radiological counting. There were no other CAMs in the U/G or on the surface monitoring the exhaust. The Board determined that there should have been additional CAMs operating. However, the CAMs currently in U/G active disposal panels possess the lowest functional safety classification, Balance of Plant, and can be taken out of service without prior DOE or NWP Nuclear Safety approval, leaving no real-time monitoring capability.

On Saturday, February 15, 2014, the filters were counted at 0715; the RCM reported 4.4 million disintegrations per minute (dpm) alpha contamination on the filters from the effluent sample station upstream from the HEPA filters (Station A) (Figure ES-2). Preliminary data indicated the presence of TRU materials.

Figure ES-2: Exhaust Air Shaft and Effluent Sample Station A

Results from analysis of filters from the effluent sample station downstream of the HEPA filters (Station B) and at the discharge point to the atmosphere (Figure ES-3) were reported at 0915 and indicated 28,000 dpm alpha and 5,900 dpm beta contamination. This was the first indication that there was a release of contamination downstream of the HEPA filters to the environment.

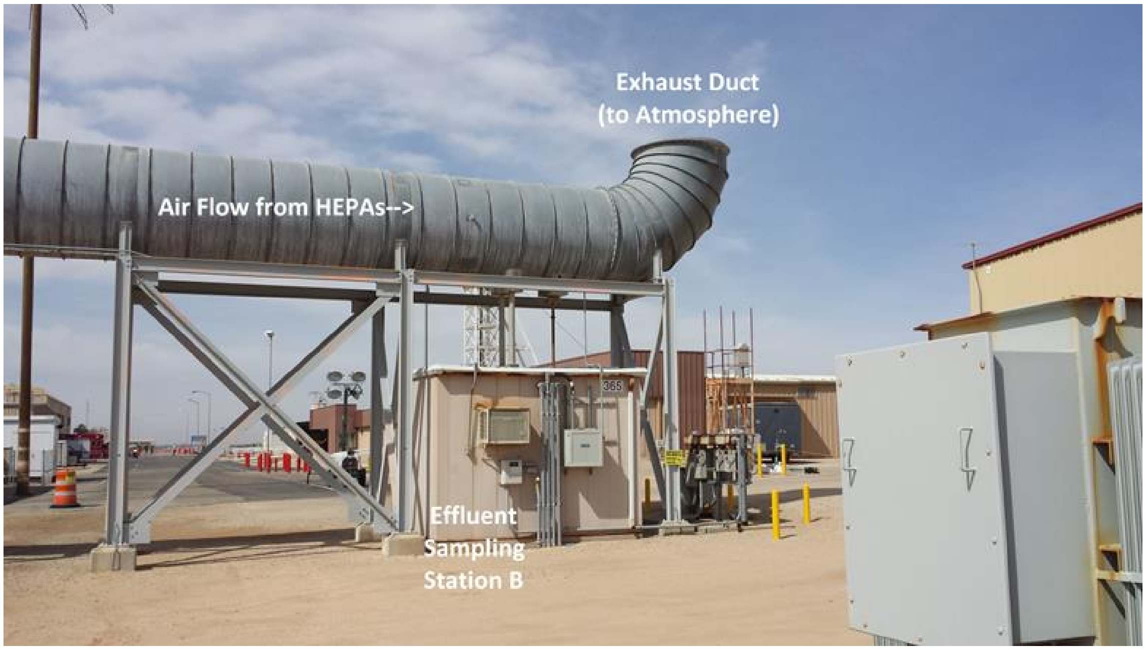

Figure ES-3: Station B and Exhaust Duct

On-site personnel were directed to shelter-in-place at 0934. On-site and off-site surveys were initiated and portable air samplers were installed in selected site areas. A total of 153 people were working on the surface that day, including the backshift personnel and those on-site during the morning and afternoon. No personnel were working in the U/G. The Operations Assistance Team (OAT), Alternate Emergency Operations Center (AEOC) and Joint Information Center (JIC) were activated and at 1449 the AEOC at the CBFO facility in Carlsbad was declared operational.

At 1557, it was reported that site surveys were negative for radiological contamination and at 1612 preliminary analysis of the initial Station A and Station B filters indicated the presence of plutonium$^{239/240}$ (Pu) and americium^{241}(Am). The UVS was still in HEPA filtration mode with no on-site or off-site contamination above background detected at that time. The site parking lot and vehicles were surveyed and found clean at 1557. At 1635, the shelter-in-place order was lifted and non-essential personnel were systematically released, building by building, via surveyed and controlled egress routes. Before they exited the guard gate, personnel underwent whole body radiological surveys (frisk). Radiological data from site surveys, effluent monitoring, portable air samplers and low volume off-site sampling continued to be collected with no indication of a detectable release to the environment. Site access was then restricted to essential personnel only.

The emergency event was terminated at 1917 on February 16, when the JIC and AEOC were deactivated. Bioassay was subsequently performed on approximately 150 personnel to determine if there was any intake of airborne contamination from the event. As of March 28, 2014, 21 personnel were found to have positive bioassay results.

On February 19, radiological results from the Carlsbad Environmental Monitoring and Research Center (CEMRC) high volume air sampling station located approximately 0.6 miles northwest of the site on the WIPP access road were reported. CEMRC is affiliated with New Mexico State University and provides independent monitoring of the WIPP facility. The filter that was counted had been installed at the station prior to the event, on Tuesday, February 11, and was removed on Sunday, February 16. The levels detected at this sampling station indicated a small release of radioactive particles from the WIPP site.

On February 24, DOE reported additional environmental monitoring data from samples collected by WIPP radiological and environmental personnel on February 17 and 18 at numerous locations on and around the site. These results also indicated slightly elevated levels of airborne radioactive concentrations consistent with the waste disposed of at WIPP. These concentrations were well below a level of public or environmental hazard.

On March 6, two ventilation system dampers that were known to have design leakage, and allowed a portion of the radioactive material to bypass the HEPA filters were sealed with a high-density foaming material.

On March 7 and 8, radiological and air quality instruments were lowered into the U/G to check for airborne radioactivity and to determine air quality. The preliminary sample results indicated no detectable radioactive contamination in the air or on the air quality instruments.

On March 18, new air sample data were reported via a DOE press release and indicated a very small radiation release occurred on March 11, but with no expected health impact to the workers, public and environment. A series of workforce and public meetings were held following the February 14 radiological event to communicate what was known about the incident, provide monitoring results, and to provide status on recovery planning. These actions are ongoing, and site access continues to be limited to essential personnel only. Manned entry into the U/G to collect samples and assess conditions is being planned but has not yet been authorized.

Direct, Root, and Contributing Causes

Direct Cause – the immediate events or conditions that caused the accident.

The Board identified the direct cause of this accident to be the breach of at least one TRU waste container in the U/G which resulted in airborne radioactivity escaping to the environment downstream of the HEPA filters. Due to restrictions on access to the U/G following the event, the exact mechanism of container failure, e.g., back or rib fall, puncture by a failed roof bolt, off-gassing, etc., is unknown at this time and must be determined once access to the U/G is restored. This will be investigated in Phase 2.

Root Cause – causal factors that, if corrected, would prevent recurrence of the same or similar accidents.

The Board identified the root cause of Phase 1 of the investigation of the release of radioactive material from underground to the environment to be NWP's and CBFO's management failure to fully understand, characterize, and control the radiological hazard. The cumulative effect of inadequacies in ventilation system design and operability compounded by degradation of key safety management programs and safety culture resulted in the release of radioactive material from the underground to the environment, and the delayed/ineffective recognition and response to the release.

With regard to ventilation system design and operability: the filtration portion of the ventilation system has two HEPA filter bypass isolation dampers that provide a pathway of unfiltered exhaust into the environment. These isolation dampers are not suitable as a containment boundary and reduce the overall efficiency of the HEPA filter system. This is discussed further in Chapter 9, Underground Ventilation. This condition was never identified by the contractor, CBFO, or Headquarters in any of the revisions and updates to the WIPP safety basis documentation.

Contributing Causes – events or conditions that collectively with other causes increased the likelihood or severity of an accident but that individually did not cause the accident. For the purposes of this investigation, contributing causes include those related to the cause of the radiological release to the environment as well as those related to the subsequent response.

The Board identified eight contributing causes to the radiological release to the environment investigated in Phase 1, or resultant response:

1. Implementation of the NWP Conduct of Operations Program is not fully compliant with DOE O 422.1, *Conduct of Operations*, and impacted the identification of abnormal conditions and timely response.
2. NWP does not have an effective Radiation Protection Program in accordance with 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection*, including but not limited to radiological control technician training, qualification and requalification, equipment and instrumentation, and audits.
3. NWP does not have an effective maintenance program. The condition of critical equipment and components, including continuous air monitors, ventilation dampers, fans, sensors, and the primary system status display were degraded to the point where the cumulative impact on overall operational readiness and safety was not recognized or understood.
4. NWP does not have an effective Nuclear Safety Program in accordance with 10 CFR 830 Subpart B, *Safety Basis Requirements*. There has been a reduction in the conservatism in the Documented Safety Analysis (DSA) hazard/accident analysis and corresponding Technical Safety Requirement (TSR) controls over time, commencing with EM Headquarters delegation of safety basis approval authority (SBAA) in late 2009. For example, 15 of 22 design basis accidents were removed from the latest revision without any clear justification, including the elimination of a roof/rib fall event in an open waste panel. Several other examples are provided in Chapter 3, Nuclear Safety Program. In addition, the DSA and TSRs contain errors, there is a lack of DSA linkage to supporting hazard analysis information, and there is confusion over the back fall accident description in a closed versus open panel.
5. NWP implementation of DOE O 151.1C, *Comprehensive Emergency Management System*, was ineffective. Personnel did not adequately recognize, categorize, or classify the emergency and did not implement adequate protective actions in a timely manner.

6. The current site safety culture does not fully embrace and implement the principles of DOE Guide (G) 450.4-1C, *Integrated Safety Management Guide*. There is a lack of a questioning attitude, reluctance to bring up and document issues, and an acceptance and normalization of degraded equipment and conditions. This is supported by the 2012 Safety Conscious Work Environment (SCWE) survey results which indicated a reluctance to report issues to management, indicating a chilled work environment. Execution of the NWP Contractor Assurance System (CAS) in accordance with DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, was ineffective. Execution of the CAS did not identify precursors to this event or the unacceptable conditions and behaviors documented in this Phase 1 report.
7. Execution of CBFO oversight in accordance with DOE O 226.1B was ineffective. CBFO failed to establish and implement adequate line management oversight programs and processes and hold personnel accountable.
8. DOE Headquarters (HQ) line management oversight was ineffective. DOE HQ failed to ensure that CBFO was held accountable for correcting repeated identified issues involving radiological protection, nuclear safety, Integrated Safety Management (ISM), maintenance, emergency management, work planning, and control and oversight.

Conclusions and Judgments of Need

Based upon the conclusions of this accident investigation, the Board concluded that the unfiltered above ground release identified in Phase 1 of the investigation was preventable. The ventilation system has High Efficiency Particulate Air (HEPA) filter bypass isolation dampers that represent a pathway of unfiltered exhaust into the environment. These isolation dampers are not suitable as a containment boundary and reduce the overall efficiency of the HEPA filter system.

Table ES-1 summarizes the Conclusions (CONs) and Judgments of Need (JONs) determined by the Board. The conclusions are derived from the analytical results performed during this accident investigation for determining what happened and why it happened. Also listed are JONs determined by the Board as managerial controls and safety measures necessary to prevent or minimize the probability or severity of a recurrence of this type of accident. Table 4-1 in the body of the report provides more detail, including the causal factors, specific conditions related to the causal factors, and associated CONs and JONs.

Table ES-1: Conclusions and Judgments of Need

Conclusion (CON)	Judgments of Need (JON)
CON 1: The direct cause of the transuranic mixed waste container release could not be definitively determined during Phase 1 of the investigation due to the inability for personnel to access the underground, collect information, and inspect the waste panels/rooms.	**JON 1**: Nuclear Waste Partnership LLC (NWP) and the Carlsbad Field Office (CBFO) need to implement a detailed recovery plan to systematically reenter the underground, collect data and information, and make an absolute determination as to the mechanism of the transuranic waste release. **JON 2**: During Phase 2, the DOE Accident Investigation Board needs to evaluate the data and information collected and provided by NWP and CBFO to determine the mechanism of release and determine the related conditions and causal factors, reach conclusions, and identify additional judgments of need.
Nuclear Safety Program	
CON 2: There has been a reduction in conservatism in the Documented Safety Analysis hazard/accident analysis and Technical Safety Requirement safety controls within safety basis revisions occurring since 2010, i.e., *Documented Safety Analysis/ Technical Safety Requirement*, Revision 1 to Revision 4. This is not consistent with DOE-Standard (STD)-3009, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis* and DOE-STD-5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities.*	**JON 3**: NWP needs to revise the hazard and accident analyses to comply with DOE-Standard-3009, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis* and DOE-STD-5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, regarding not crediting administrative controls in the unmitigated analysis. In particular, some initial assumptions/initial conditions, e.g., compliance with 30 CFR 57, *Safety and Health Standards Underground Metal and Nonmetal Mines* ground control program requirements, should be preventive or mitigative controls derived by the mitigated analysis and should be evaluated for the need for protection with Technical Safety Requirement controls.

Conclusion (CON)	Judgments of Need (JON)
CON 3: The Documented Safety Analysis and Technical Safety Requirement have several errors or omissions that are indicative of lack of rigorous contractor internal review and independent peer-review processes for the development of the safety basis, e.g., quality issues include Documented Safety Analysis and Technical Safety Requirement errors, lack of Documented Safety Analysis linkage to supporting hazard analysis information, confusion over back fall accident description in closed vs. open panel.	**JON 4**: NWP needs to commission an independent assessment of the Documented Safety Analysis/Technical Safety Requirement Revision 4 through corporate assistance or other recognized external resources, and corrective actions implemented that establish appropriate hazard controls and functional classifications.
CON 4: Technical Safety Requirements are not effective in ensuring facility configurations that provide contribution to defense-in-depth for radiological events. The function of the Documented Safety Analysis as articulated in 10 CFR 830, *Nuclear Safety Management Rule*, Appendix A, Section G.4 is as follows: "Technical Safety Requirements establish limits, controls and related actions necessary for the safe operation of a nuclear facility."	**JON 5**: NWP needs to re-evaluate the importance of the suite of available preventive and mitigative controls, e.g., continuous air monitors and underground ventilation system, in the supporting hazards analysis report and the Documented Safety Analysis, Section 3.3 hazard evaluation, and whether they should be considered as major contributors to defense in depth. This may require upgrading of some Structures, Systems, and Components functional classifications.
CON 5: Since neither the CAMs nor the underground ventilation system are pedigreed, i.e., Safety Class, Safety Significant, Important to Safety Structures, Systems, and Components, their importance has not been acknowledged within the Technical Safety Requirements, e.g., no Limiting Conditions for Operation/ Surveillance Requirements. In addition, neither Documented Safety Analysis Safety Management Programs, (Chapter 7 Radiation Protection Program), nor the Technical Safety Requirement Programmatic Administrative Controls consider whether CAMs may provide protection for the facility worker who may be in the exhaust drift.	**JON 6**: NWP needs to re-evaluate the classification of continuous air monitors and the underground ventilation system consistent with the outcome of the revised hazard analysis and develop Technical Safety Requirement controls consistent with that classification.

Conclusion (CON)	Judgments of Need (JON)
CON 6: The Technical Safety Requirement documentation is not being controlled with the rigor normally associated with a Hazard Category 2 nuclear facility.	**JON 7**: NWP needs to revise the Technical Safety Requirements to align with changes to the Documented Safety Analysis, e.g., continuous air monitor and underground ventilation system, correct current errors in the Technical Safety Requirements, and ensure that implementing procedures clearly support consistent interpretations.
CON 7: The NWP Unreviewed Safety Question Determination procedure does not clearly communicate the actions required to evaluate situations that could involve a Potential Inadequacy in the Safety Analysis. In addition, NWP's implementation of Unreviewed Safety Question procedure requirements indicates a lack of recognition that some proposed recovery activities associated with the radiological release event were outside the analyzed safety basis. This is evident from NWP's Unreviewed Safety Question's evaluations or lack there-of, related to impacts on previously analyzed accidents or safety controls; identifying equipment that is important to safety; and completeness of identifying accidents of a new type not previously analyzed.	**JON 8**: NWP needs to commission an independent assessment of the Unreviewed Safety Question process through corporate assistance or other recognized external resources, and implement corrective actions that ensure effectiveness. **JON 9:** NWP needs to strengthen the Unreviewed Safety Question Determination procedure to clarify Potential Inadequacy in the Safety Analysis guidance, including the appropriate timeliness for entrance into the process and decision making.
CON 8: There is an observed lack of robustness in the CBFO technical review of Documented Safety Analysis/Technical Safety Requirement changes/annual updates, e.g., lack of documentation of the technical basis for approval to support development of a Safety Evaluation Report. While the Safety Evaluation Reports are consistent with the format per DOE-Standard-1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, the conclusions do not include adequate rationale for acceptance of the proposed changes.	**JON 10**: CBFO needs to revise Management Procedure 4.11, *Safety Basis Review Procedure*, to require adequate documentation of the technical basis supporting approval of changes to the WIPP Document Safety Analysis or Technical Safety Requirements, consistent with DOE Standard 1104, e.g., regulatory compliance, justification for initial assumptions/initial conditions, reduced conservatisms of the hazards and accident analysis. **JON 11**: CBFO and DOE HQ need to commission an independent assessment of the CBFO safety basis review and approval process and implement corrective actions that ensure effective implementation.

Conclusion (CON)	Judgments of Need (JON)
CON 9: CBFO has insufficient nuclear safety management/staffing since the 2010 timeframe and the retirement of Authorization Basis Senior Technical Advisor and existing Nuclear Safety Specialist staff responsible for multiple subject matter expertise.	**JON 12**: CBFO needs to perform a critical federal staffing analysis focused on Nuclear Safety e.g., Nuclear Safety Specialist, nuclear safety qualified Senior Technical Advisor and supporting CBFO Subject Matter Experts and determine whether existing resources are adequate. **JON 13**: CBFO and DOE HQ need to arrange for temporary DOE senior nuclear safety resources to mentor existing CBFO nuclear safety and supporting resources, and assist as necessary.
Emergency Management	
CON 10: Compensatory measures were not put in place to mitigate issues identified immediately following the February 5, 2014, underground fire event with respect to emergency management. **CON 11**: The emergency management program was not adequately structured and implemented such that personnel did not recognize, categorize, or classify the emergency and implement protective actions in a timely manner. **CON 12**: The Waste Isolation Pilot Plant (WIPP) (NWP and CBFO) emergency management program is not fully compliant with DOE Order 151.1C, *Comprehensive Emergency Management System*, e.g., activation of the Emergency Operations Center, classification and categorization, emergency action levels, implementation of the Incident Command System, training, drills and exercises, etc. Weaknesses in classification, categorization, and emergency action levels were previously identified by both external review and in the response to the underground fire and the radiological release events.	**JON 14**: NWP needs to immediately develop and implement interim compensatory measures to ensure prompt identification, categorization, classification, and response to operational emergencies, e.g., corporate reach-back, training, Senior Management Watch in the Central Monitoring Room, etc. **JON 15**: CBFO needs to take prompt action to fully integrate trained Federal management resources into the emergency response organization and take action to bring their emergency management program into compliance with DOE Order 151.1C, *Comprehensive Emergency Management System*. **JON 16**: NWP needs to correct their activation, notification, classification, and categorization protocols to be in full compliance with DOE Order 151.1C, *Comprehensive Emergency Management System*, Resource Conservation and Recovery Act Contingency Plan and then provide training and drills for all applicable personnel. **JON 17**: NWP needs to revise Emergency Response Organization training to include

Conclusion (CON)	Judgments of Need (JON)
	more supervised hands-on training and drills to enhance the effectiveness of the Emergency Response Organization's response. **JON 18**: NWP needs to fully integrate the Resource Conservation and Recovery Act Contingency Plan activation criteria within the site Emergency Action Levels and to train the applicable personnel to ensure implementation of the Resource Conservation and Recovery Act Contingency Plan. **JON 19**: NWP needs to take prompt action to correct longstanding deficiencies from previous reviews. **JON 20**: CBFO needs to ensure that NWP completes prompt action to correct longstanding deficiencies from previous reviews. **JON 21**: NWP needs to improve the content of site-specific Emergency Action Levels to expand on the information provided in the standard Emergency Action Levels contained in DOE Order 151.1C, *Comprehensive Emergency Management System*. **JON 22**: NWP needs to develop and implement an Incident Command System for the Emergency Operations Center/Central Monitoring Room that is compliant with DOE O 151.1C and is capable of assuming command and control for all anticipated emergencies. **JON 23**: DOE Headquarters (HQ) needs to conduct an effectiveness review of the NWP and CBFO emergency management program implementation within six months of completion of the corrective actions for the Emergency Management Judgments of Need.

<table>
<tr><th>Conclusion (CON)</th><th>Judgments of Need (JON)</th></tr>
<tr><th colspan="2">Safety Culture</th></tr>
<tr><td>CON 13: NWP and CBFO have allowed the safety culture at the WIPP project to deteriorate as evidenced by the workers feedback that they do not feel comfortable identifying issues that may adversely affect management direction, delay mission related objectives, or otherwise affect cost or schedule.

Questioning attitudes are not welcomed by management and many issues and hazards do not appear to be readily recognized by site personnel.</td><td>JON 24: NWP and CBFO need to develop and implement an effective integrated safety management system that embraces and implements the principles of DOE G 450.4-1C, Integrated Safety Management Guide, including but not limited to:
• Demonstrated leadership in risk-informed, conservative decision making
• Improved learning through error reporting and effective resolution of problems
• Line management encouraging a questioning attitude without fear of reprisal and following through to resolve issues identified by the workforce
• Reinforcing the mechanisms, e.g., WIPP Forms, “Notes to Joe,” employee concern program, differing professional opinions, and protocols for communicating issues to NWP and CBFO leadership.

JON 25: DOE HQ needs to engage external safety culture expertise in providing training and mentoring to NWP and CBFO management on the principles of a strong nuclear safety culture and implement any recommendations from these experts.</td></tr>
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Conclusion (CON)	Judgments of Need (JON)
CON 14: DOE has exacerbated the safety culture problem by referring to numbers of ORPS reports and other deficiency reporting documents, rather than the significance of the events, as a measure of performance by Source Evaluation Boards during contract bid evaluations, and poor scoring on award fee determinations. Directly tying performance to the number of occurrence reports drives the contractor to non-disclosure of events in order to avoid the poor score. This practice is contrary to the Department's goals of the development and implementation of a strong safety culture across our projects.	**JON 26**: DOE HQ needs to clearly specify the use of performance reporting results, e.g., Occurrence Reporting and Processing System and non-conformance reports in Past Performance Evaluations, to encourage conservative reporting and communication of Lessons Learned.
Conduct of Operations	
CON 15: Key elements of the NWP Conduct of Operations program were ineffective in driving safe and compliant operation of a Hazard Category 2 nuclear facility.	**JON 27**: NWP needs to strengthen execution of the Conduct of Operations program to be compliant with DOE O 422.1, *Conduct of Operations*. Specific areas of focus must include (but not limited to): • Establishing and reinforcing expectations conveyed in WP 04-CO.01, *Conduct of Operations* series procedures. • Initiate a mentoring program, e.g., senior supervisor watch that provides real time feedback to first and second line supervisors as to their responsibilities regarding compliant execution of operations activities. • Strengthen the structure, content and flow of abnormal response procedures to ensure immediate actions do not require judgment calls prior to execution. • Consider the addition of real time surveillance capability, e.g., video of the active waste panels/rooms. • Establish and execute an operational drill program that evaluates operator

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<tr><td></td><td>response to upset conditions.
Establish a process that heightens awareness and requires deliberate action to reduce the quantity and length of time key pieces of equipment are out of service.
JON 28: CBFO needs to take an active role towards improving NWP conduct of operations through implementation of a structured DOE O 226.1B, Implementation of Department of Energy Oversight Policy, oversight process that includes mechanisms for identifying, reporting, and transmitting issues that tracks corrective actions to effective closure. Specific areas of focus must include, but are not limited to:
Develop and conduct routine oversight of contractor implementation of the WP 04-CO.01, Conduct of Operations series procedures. Oversight needs to include detailed oversight plans that contain specific criteria and lines of inquiry to effectively assess compliance with DOE O 422.1.
Oversight of the NWP mentoring program e.g., senior supervisor watch that provides real time feedback to first and second line supervisors as to their responsibilities regarding compliant execution of operations activities in order to provide feedback on effectiveness.
Oversight of procedure development in order to strengthen the structure, content and flow of abnormal response procedures to ensure immediate actions do not require judgment calls prior to execution.
Overseeing execution of the NWP operational drill program that evaluates operator response to upset conditions.</td></tr>
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<tr><th>Conclusion (CON)</th><th>Judgments of Need (JON)</th></tr>
<tr><td></td><td>Strengthen oversight of NWP processes that monitor equipment status and initiate action to correct deficiencies in order to ensure a reduction in the quantity and length of time key pieces of equipment are out of service.</td></tr>
<tr><td colspan="2">Maintenance Program</td></tr>
<tr><td>CON 16: The current culture at NWP is such that due consideration for prioritization of maintenance of equipment is not given unless there is an immediate impact on the waste emplacement processes.

CON 17: Execution of the NWP engineering process has not been effective in maintaining configuration of key systems at WIPP. Specific examples include:
Conversion of the 860 fan vortex damper actuator from automatic to manual operation;
Functionality of the ventilation system in filtration including evaluation and testing of leakage via the bypass dampers; and
The impact of salt buildup on bypass damper effectiveness.</td><td>JON 29: NWP needs to take action to ensure that the maintenance process effectively considers and prioritizes repairs to achieve and maintain a high state of operational readiness.

JON 30: NWP needs to improve the execution of engineering processes that ensure system configuration management is maintained and that the rigor in processing proposed changes to systems is at a level that ensures system design functionality is maintained. Specific examples include:
Conversion of the 860 fan vortex damper actuator from automatic to manual operation;
Functionality of the ventilation system in filtration including evaluation and testing of leakage via the bypass dampers; and
The impact of salt buildup on bypass damper effectiveness.
JON 31: CBFO needs to take a more proactive role in the configuration management and maintenance programs to ensure that the facility can meet its operational and life time expectancy.

JON 32: DOE HQ Office of Environmental Management and CBFO need to develop an infrastructure improvement plan within six months to identify and prioritize program-wide critical infrastructure upgrades for key systems to ensure continuation of EM's programmatic mission execution at WIPP.</td></tr>
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Conclusion (CON)	Judgments of Need (JON)
	Additionally, DOE HQ Office of Environmental Management needs to coordinate an extent of condition review at other EM sites and take action based on the outcome of that review.
Radiation Protection Program	
CON 18: NWP does not have an effective Radiation Protection Program in accordance with 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection*, including but not limited to radiological control technician training, qualification and requalification, equipment and instrumentation, and audits.	**JON 33**: NWP needs to evaluate the current state of the radiological control program including the current radiological conditions and implement compensatory measures to support recovery and current activities. **JON 34**: NWP needs to perform an extent of condition review of the training program incorporating the results of this event and implement actions to improve radiological control management, Radiological Control Technician, and rad worker proficiency in dealing with contamination, and airborne radioactive material. **JON 35**: NWP needs to perform an extent of condition review for identified weaknesses in the radiological control program and implement corrective actions to fully implement 10 CFR 835. **JON 36**: CBFO needs to determine the effectiveness of the radiation protection program within three months of completion of NWP's corrective actions.

Conclusion (CON)	Judgments of Need (JON)
CON 19: There is an inadequate technical basis for the existing ventilation and airborne monitoring systems. It is unclear that they adequately provide protection to the underground workers, the co-located worker, the public, and the environment from the transuranic mixed waste or hazardous constituents, e.g., reliability of a single CAM to initiate an automatic shift to filtration, acceptability of leakage past the bypass dampers and automatic shift to filtration that now requires manual operation of 860 fan vortex dampers.	**JON 37**: NWP needs to develop a technical basis to implement continuous and reliable/redundant real-time air monitoring with appropriate automatic shift to filtration to protect the workers, the public and the environment. This needs to take into consideration the different ventilation modes, protection of workers in the underground, and release of contaminants to the environment. The technical basis must also consider the hazardous constituents in the transuranic mixed waste, e.g., reliability of a single CAM to initiate an automatic shift to filtration, acceptability of leakage past the bypass dampers and automatic shift to filtration that now requires manual operation of 860 fan vortex dampers.
NWP Contractor Assurance System	
CON 20: NWP has not fully developed an integrated contractor assurance system that provides assurance that work is performed compliantly, risks are identified, and control systems are effective and efficient.	**JON 38**: NWP needs to develop and implement a fully integrated contractor assurance system that provides DOE and NWP confidence that work is performed compliantly, risks are identified, and control systems are effective and efficient.
CON 21: NWP failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE O 226.1B, *Implementation of Department of Energy Oversight Policy,* and hold personnel accountable for implementing those programs and processes. **CON 22**: NWP failed to identify weaknesses in conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. **CON 23**: NWP failed to adequately complete corrective actions from prior assessments to prevent or minimize recurrence. **CON 24**: Comprehensive self-assessments are	**JON 39**: NWP needs to establish and implement line management oversight programs and processes that: • Meet the requirements of DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, and hold personnel accountable for implementing those programs and processes. • Implement effective contractor assurance processes to emphasize conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. • Implement a Contractor Assurance System to ensure that actions from prior

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<tr><td>not being performed by knowledgeable, qualified subject matter experts within the various safety management programs. Contractor Assurance System is implemented primarily through the Quality Assurance program.</td><td>assessments are implemented to prevent or minimize recurrence of identified deficiencies.
• Include self-assessments by knowledgeable, qualified subject matter experts within the various safety management programs.</td></tr>
<tr><td colspan="2">CBFO Oversight</td></tr>
<tr><td>CON 25: CBFO failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE Order 226.1B, Implementation of Department of Energy Oversight Policy, and hold personnel accountable for implementing those programs and processes.

CON 26: CBFO failed to identify weaknesses in oversight processes, conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture.

CON 27: CBFO is lacking adequate qualified staffing in numerous areas related to line management, technical disciplines and oversight functions.

CON 28: CBFO failed to adequately complete corrective actions from prior assessments to prevent or minimize recurrence.</td><td>JON 40: CBFO needs to establish and implement line management oversight programs and processes such that CBFO:
• Verifies that NWP has developed and implemented a DOE Order 226.1B compliant Contractor Assurance System.
• Meets the requirements of DOE Order 226.1B and hold personnel accountable for implementing those programs and processes.
• Implements effective oversight processes to ensure emphasis on conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture.

JON 41: CBFO needs to develop and implement an effective issues management process to document, disposition (including extent of condition), close, track/trend issues, and ensure effectiveness of corrective actions. The process shall also ensure that actions from prior assessments are implemented to prevent or minimize recurrence of identified deficiencies.

JON 42: The CBFO Site Manager needs to institutionalize and communicate expectations for a strong safety culture and the identification, documentation, reporting, and correction of issues without fear of reprisal.

JON 43: CBFO needs to evaluate the</td></tr>
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Conclusion (CON)	Judgments of Need (JON)
	current organizational structure, identify specific staffing needs related to line management, technical discipline and oversight functions, submit those staffing needs to DOE HQ, and effectively manage their resources such that qualified personnel are effectively performing those functions.
DOE Headquarters Oversight	
CON 29: DOE HQ failed to ensure that CBFO was held accountable for correcting repeated identified issues involving radiological protection, nuclear safety, Integrated Safety Management System, maintenance, emergency management, work planning and control and oversight.	**JON 44**: DOE HQ needs to develop and implement a process to ensure repeatedly identified issues related to the safety management programs are confirmed, closed and validated by the local DOE office in a timely manner.
CON 30: DOE HQ management has failed to ensure that adequate resources, full time employees, technical expertise, travel money, adequate budget, etc., are provided to support the WIPP project. **CON 31**: DOE HQ management and staff failed to adequately define and execute roles and responsibilities related to line management, oversight, safety and balanced priorities.	**JON 45**: DOE HQ needs to re-evaluate priorities and allocate the resources, i.e., funding, staffing, infrastructure, etc., applied to the WIPP project to ensure those resources effectively address safety, programmatic, and operational considerations. **JON 46**: DOE HQ needs to better define and execute their roles and responsibilities in order to improve line management ownership, oversight, safety, and resources to ensure site implementation of the radiological protection, nuclear safety, ISMS, maintenance, emergency management, work planning and control and oversight policies and requirements are consistent and effective. **JON 47**: DOE HQ needs to perform an effectiveness review on all corrective actions completed in response to this investigation.

1.0 Introduction

1.1 Appointment of the Board

On February 27, 2014, an Accident Investigation Board (the Board) was appointed by Matthew Moury, Deputy Assistant Secretary, Safety, Security, and Quality Programs, U.S. Department of Energy (DOE) Office of Environmental Management (EM), to investigate the airborne release of radioactive material from the underground (U/G) at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, that occurred on February 14, 2014. The Board's responsibilities have been completed with respect to this investigation. The analysis and the identification of the direct and contributing causes, the root cause Conclusions and Judgments of Need resulting from this investigation were performed in accordance with DOE Order (O) 225.1B, *Accident Investigations,* and are provided later in this Phase 1 report. The appointment letter was revised on March 4.

This accident meets Accident Investigation Criteria 2.d.1 of DOE O 225.1B, Appendix A. The Board began the investigation on March 3, 2014, completed the investigation on March 28, 2014, and submitted the report to the appointing official on April 1, 2014. This report, Phase 1 of the investigation, covers the Board's conclusions for Phase 1, the release of transuranic[2] (TRU) waste from the U/G to the environment. Based upon the conclusions of this accident investigation, the Board concluded that the unfiltered above ground release identified in Phase 1 of the investigation was preventable.

The Board concludes that a thorough and conservatively considered hazard analysis, coupled with a robust, tested and well maintained HEPA filter capable exhaust ventilation system could have prevented the unfiltered above ground release that occurred on February 14, 2014.

Dating back to 2005, the safety basis documents designated the U/G confinement ventilation system (CVS) as a Safety Significant (SS) system based on directing airflow away from facility workers emplacing waste. However, the above ground systems including the exhaust High Efficiency Particulate Air (HEPA) filtration and bypass isolation valves were not credited because the safety controls at the time consisted of a credited Technical Safety Requirement (TSR) control that required weekly ground control inspections to ensure changing conditions were promptly identified, evaluated and addressed. When the existing Contact-Handled (CH) and Remote-Handled (RH) TRU safety basis documents were combined in September of 2008, the new Documented Safety Analysis (DSA) reduced the classification of the U/G CVS to "Balance of Plant," meaning that it was no longer credited for worker protection from accidents identified in the DSA. Among the bounding accidents identified in this version of the DSA was a roof fall accident in an active panel (Event 030-CH/RH-UG), which resulted in an anticipated frequency with low consequences to facility workers, high consequences to co-located workers (100 meter receptor), and moderate consequences to public.

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[2] Transuranic waste (TRU) means waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (A) high-level radioactive waste; (B) waste that the DOE Secretary has determined, with the concurrence of the EPA Administrator, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations. [Public Law 102-579 (1992)]

The primary safety basis control established for the roof fall accident was related to the ground control program. As a result, the release from a roof fall accident was assumed to be adequately prevented by the ground control program, and only relatively smaller releases in the U/G from events such as waste handling accidents were judged to be credible. The ground control program preventive controls were determined to be sufficient, and safety related mitigative controls for the larger releases in the U/G were not deemed necessary. As a result, the HEPA ventilation system and its associated bypass isolation dampers were not designated as credited safety related equipment. Because the isolation dampers were not nuclear safety system credited, the damper design was not required to meet requirements in the nuclear industry ventilation code, ASME AG-1-2012, *Code on Nuclear Air and Gas Treatment*. This decision resulted in the HEPA bypass isolation damper configuration not being equally efficient to the HEPA filters or suitable as a containment boundary, and resulted in the unfiltered release to the environment. The nuclear safety basis is more thoroughly discussed in Chapter 3, Nuclear Safety Program.

The U/G ventilation system originally consisted of three 860 series fans, each rated at 60,000 cfm, capable of providing normal unfiltered airflow to support early mining operations. The system also provided the capability to realign airflow through two banks of HEPA filters using a single 860 series fan to provide the rated airflow for waste emplacement activities. However, in order to align for filtration, two bypass isolation dampers that represent a pathway of unfiltered exhaust into the environment must be closed. These isolation dampers have a design leak rate of up to 1000 cfm. The radiological event that occurred on February 14 with the leakage past the isolation dampers was less than the National Emission Standards for Hazardous Air Pollutants (NESHAP) guidelines for the public and below the limits established by DOE and WIPP for site workers.

As mining activities were increased, the existing fans were no longer able to provide the necessary airflow to support the additional fossil fueled vehicle emissions. Two larger 700 series fans each rated at 260,000 cfm were installed, later followed by a third, that discharged upstream of the 860 series fans and significantly improved air flow capabilities. The ability to use the 860 fans to supplement unfiltered airflow was maintained for flexibility, although the addition of the new fans represented an opportunity to evaluate and improve the overall efficiency of the HEPA filtered system by eliminating the bypass dampers, which would have prevented the unfiltered release. However, since these systems were not credited as safety related, modifications were not subjected to the same level of scrutiny as would have occurred for modifications to credited safety systems. Additionally, there was significant degradation in the material condition of several ventilation system components identified that were not being aggressively pursued.

Since the HEPA ventilation system was not designated as a credited safety system, the CAMs in the U/G whose purpose is to detect a release in the U/G and cause an automatic switch of the ventilation system to filtration mode, were also not credited. The U/G ventilation system is more thoroughly discussed in Chapter 7, NWP Maintenance Program, Chapter 8, Radiation Protection Program and Chapter 9, Underground Ventilation.

The Board also determined that weaknesses in oversight by the contractor, CBFO, Headquarters, and outside organizations missed opportunities to identify inadequacies in the safety basis, as well as the configuration management and maintenance of the U/G ventilation system at WIPP. For example, the accident involving the roof fall in an active panel was removed in error from the latest revision to the DSA. This change was not identified by CBFO during their review, and therefore, the basis for the change was not provided in the DSA or DOE's Safety Evaluation report (SER). Oversight is more thoroughly discussed in Chapter 11, NWP Contractor Assurance System and Chapter 12, DOE Programs and Oversight.

Inability of the Board to access to the U/G following the incident also prohibited definitive determination of the physical cause of the waste container(s) breach/failure. Nuclear Waste Partnership LLC (NWP) and the DOE Carlsbad Field Office (CBFO) will be implementing a detailed recovery plan to systematically reenter the U/G and make an absolute determination as to cause. The Board presumes either the penetration of a waste container or multiple containers by a roof bolt, or partial collapse of the back (roof) and/or ribs (walls) caused the breach and release of contamination. This will be investigated in Phase 2. Phase 2 of the Board investigation will occur after reentry into the U/G and a cause of the release within the U/G is able to be determined.

1.2 Carlsbad Field Office

DOE created the Carlsbad Area Office in Carlsbad, New Mexico, in late 1993 to lead the nation's TRU waste disposal efforts. In September 2000, the office was elevated in status to become the CBFO. As a field office, CBFO has continued its primary mission of operating WIPP in conformance with the WIPP Land Withdrawal Act (Public Law 102-579 as amended by Public Law 104-201). CBFO is responsible for oversight of the management and operating (M&O) contract for the WIPP site and the National TRU Program. CBFO has taken on additional roles to support the DOE-EM, such as serving as an international center for the study of waste management and enabling the unique capabilities of WIPP to be utilized to support basic scientific research. This includes the Enriched Xenon Observatory (EXO) laboratory in the north end of the repository. In addition to operations in southeastern New Mexico, the CBFO coordinates the TRU waste characterization and shipping programs at waste-generating sites and national laboratories around the nation.

The organizational components of the CBFO include the Office of the Manager, and the Offices of Site Operations, the National TRU Program, Environment, Safety and Health, Business, Quality Assurance, and Science and International Programs.

1.3 Nuclear Waste Partnership LLC

NWP is the M&O contractor for operating the WIPP facility and supporting the National TRU Program. DOE awarded the contract to NWP on April 20, 2012. NWP is a partnership between URS Energy and Construction, Inc. (URS), the Babcock and Wilcox Company (B&W), and Areva, Inc. NWP assumed responsibility for management and operation of the WIPP facility October 1, 2012, after a 90-day transition period. The prior M&O was Washington TRU Solutions, LLC (WTS). WTS and its predecessor entities held the contract from 2000 until NWP took over WIPP operations. WTS was an entity comprised of URS and Weston Solutions, Inc.

Upon transition from WTS to NWP, the management of the WIPP facility did not see a substantial change in management personnel. A new site operations manager from B&W was brought in from the Pantex facility. Additionally, a new business manager was brought in from the B&W Oak Ridge operations. NWP also made revisions to the organizational reporting structure. Effective March 17, 2014, NWP was approved to implement a revised organizational structure that created the position of Interim Recovery Project Manager, and to change key personnel. A new President and Project Manager were appointed by NWP. Additionally, the prior President was moved into the position of TRU Waste Program Manager, previously called the Central Characterization Program (CCP) Manager, while the previous CCP Manager filled the new position of Interim Recovery Project Manager.

1.4 Facility Description

DOE was authorized by Public Law 96-164, Department of Energy National Nuclear Security and Military Applications of Nuclear Energy Authorization Act of 1980, to provide a research and development facility for demonstrating the safe, permanent disposal of TRU wastes from national defense activities and programs of the United States exempted from regulations by the U.S. Nuclear Regulatory Commission.

The WIPP Land Withdrawal Act, Public Law 102-579, as amended by Public Law 104-201, authorized the disposal of 6.2 million cubic feet of defense TRU waste at the WIPP facility. The WIPP facility operates in several regulatory regimes. DOE has authority over the general operation of the facility, including radiological operations prior to closure. The U.S. Environmental Protection Agency (EPA), through 40 Code of Federal Regulations (CFR) Parts 191 and 194, certifies the long-term radiological performance of the repository over a 10,000-year compliance period after closure of the facility. The State of New Mexico, through EPA delegation of the Resource Conservation and Recovery Act (RCRA), has issued a Hazardous Waste Facility Permit for the disposal of the hazardous waste component of the TRU waste. Additionally, the Mine Safety and Health Administration (MSHA) is required to perform four inspections per year of WIPP.

WIPP, located in southeastern New Mexico near Carlsbad, was constructed to determine the efficacy of an U/G repository for disposal of TRU waste (Figure 1). Disposal operations began in 1999 and are scheduled to continue for 35 years.

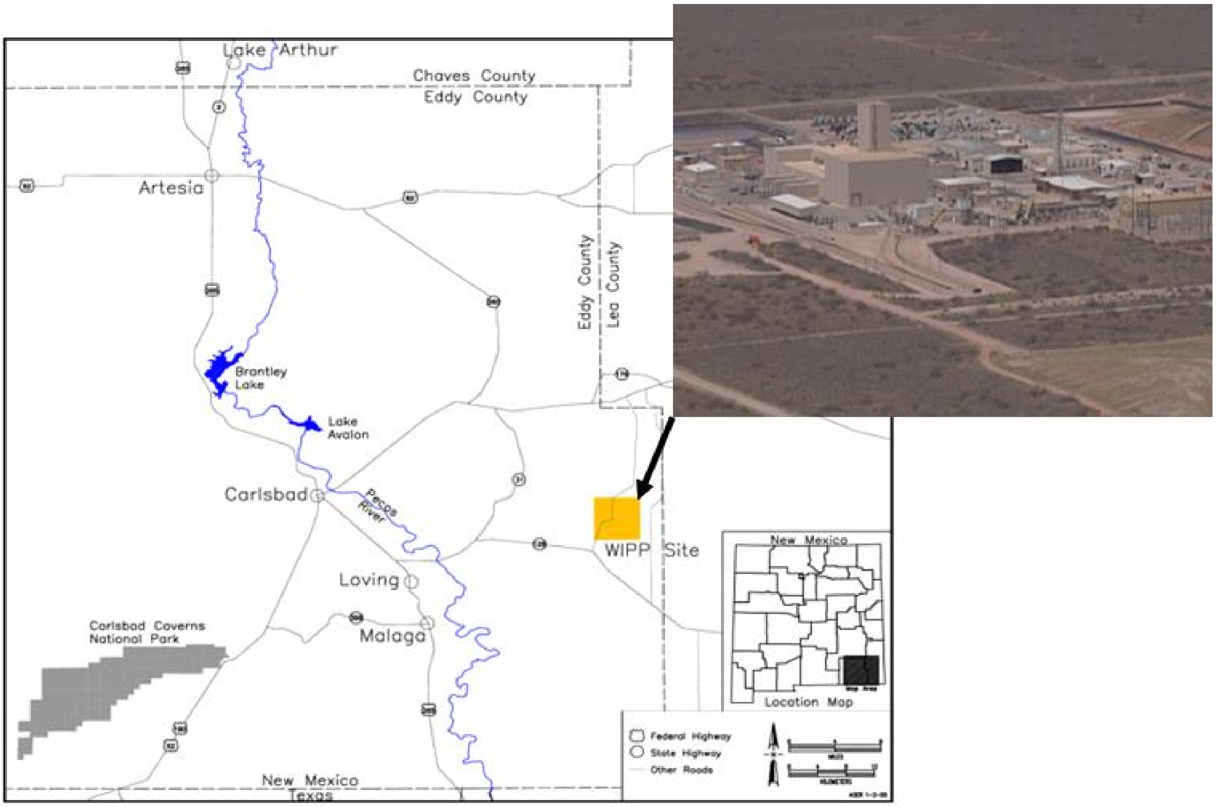


Figure 1: Waste Isolation Pilot Plant near Carlsbad, New Mexico

1.5 Waste Isolation Pilot Plant

The WIPP facility is a deep geologic repository mined within a bedded salt formation. The WIPP repository is mined within a 2,000-foot-thick bedded-salt formation. The U/G is 2,150 feet beneath the ground surface. TRU mixed waste management activities U/G are confined to the southern portion of the 120-acre mined area.

Four shafts connect the U/G area with the surface. The Waste Shaft headframe and hoist are located within the Waste Handling Building and are used to transport TRU mixed waste, equipment, and materials to the repository. The Waste Hoist can also be used to transport personnel and materials. The Air Intake Shaft (AIS) and the Salt Handling Shaft provide ventilation to all areas of the U/G except for the Waste Shaft station. This area is ventilated by the Waste Shaft itself. The Salt Handling Shaft is also used to hoist mined salt to the surface and serves as the principal personnel transport shaft. The Exhaust Shaft serves as a common exhaust air duct for all areas of the U/G (Figure 2).

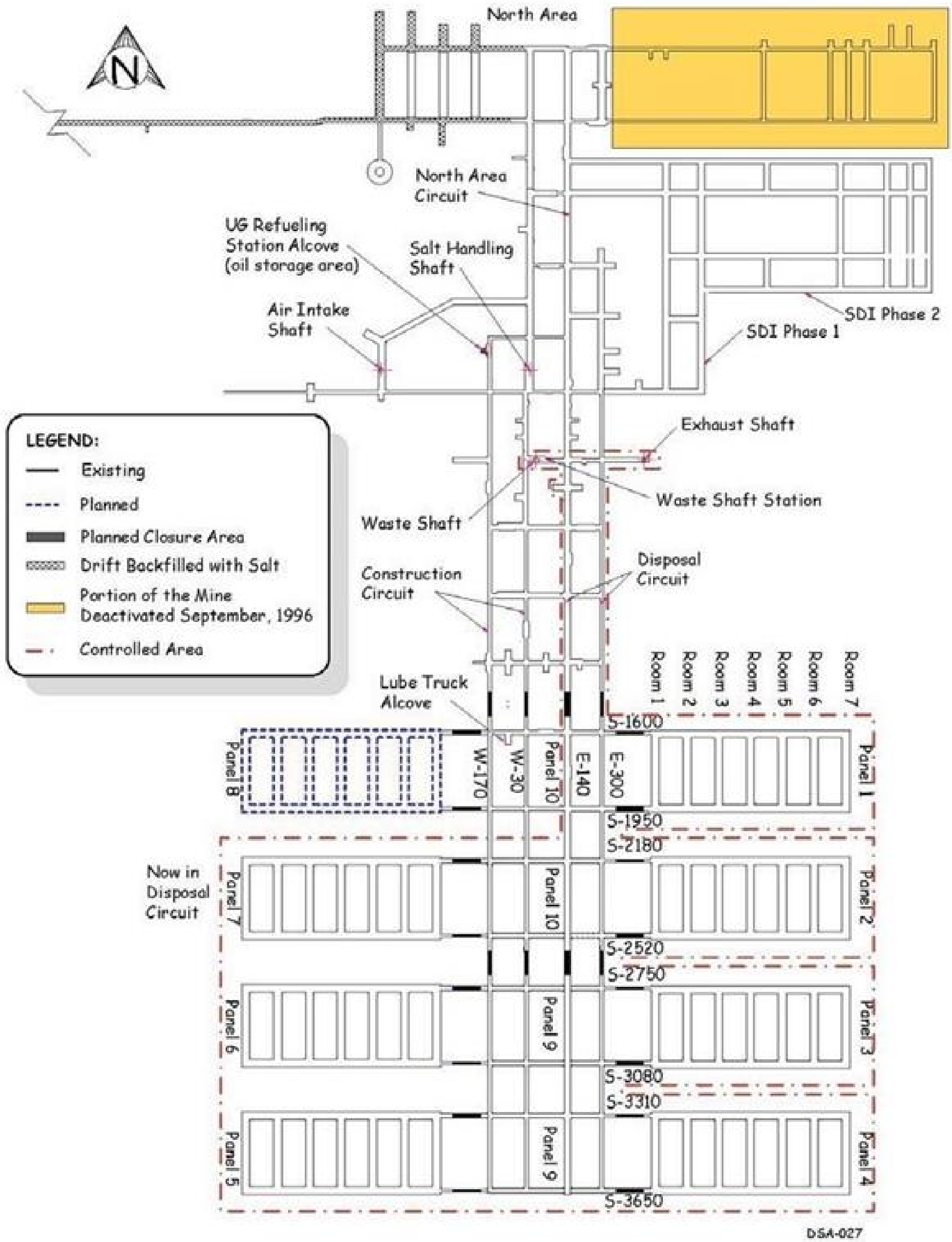


Figure 2: Underground Layout

The WIPP U/G consists of the waste disposal area, construction area, north area, and Waste Shaft station area. The location of the suspected waste container breach at Panel 7 and CAM-151 are shown in Figure 3.

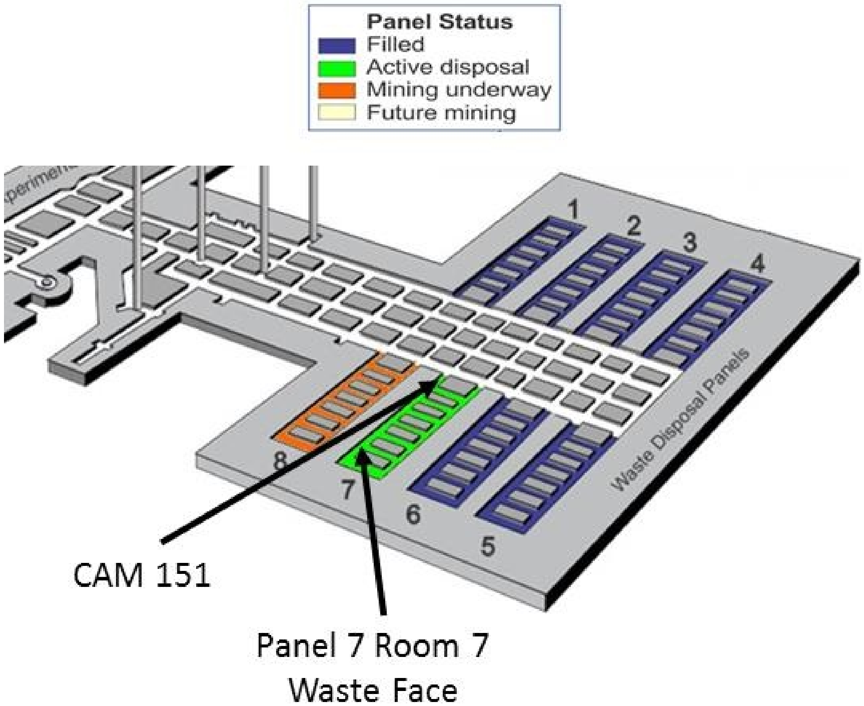


Figure 3: Location of Panel 7 and CAM-151

The principle contact-handled (CH) waste operations at the WIPP involve the receipt and disposal of TRU waste, and the mining of U/G rooms in which the waste is disposed. In the U/G, the waste containers are removed from the waste hoist conveyance, placed on the U/G transporter, and moved to a disposal room. In the disposal rooms, the CH waste containers are removed from the transporter and placed in the waste stack. Remote-handled (RH) waste is placed in boreholes in the walls (ribs) of the disposal rooms.

Much of the TRU waste received at WIPP also contains hazardous constituents that are regulated under RCRA. WIPP has been issued a hazardous waste facility permit by the New Mexico Environment Department for RCRA authorization as a treatment, storage and disposal facility. TRU waste that has hazardous constituents is known as TRU mixed waste.

The site has 55 permanent buildings and four temporary buildings (trailers) in operation, one temporary building (lab trailer) in excess status, and various connexes (used for storage). The site buildings provide a total of 358,647 square feet of office and industrial space. Additional leased office space, the Skeen-Whitlock Building, is located in Carlsbad. Approximately 800 workers are assigned to the WIPP, representing the CBFO, the M&O contractor, the warehouse, the document services subcontractor, the information technologies subcontractor, the CBFO Technical Assistance Contractor, Los Alamos National Laboratory-Carlsbad, Sandia National Laboratories-Carlsbad, and the New Mexico Environment Department-Carlsbad. Prominent features of the WIPP site include:

- **Air Intake Shaft**. The primary source of intake air for the U/G ventilation and also used for emergency egress.

- **Waste Handling Building**. This structure provides a confinement barrier. Ventilation is operated to maintain a negative pressure with high-efficiency particulate air (HEPA) filtration.
- **Waste Hoist**. The Waste Hoist transports waste, material and personnel from the surface to the U/G and is designed to prevent an uncontrolled fall or descent of the waste conveyance into the Waste Shaft.
- **Salt Handling Shaft Hoist**. This hoist transports mined salt to the surface, material, and personnel between the surface and the U/G.
- **Radiation Monitoring**. Consists of CAMs, fixed air samplers (FAS), and other external radiation monitors.
- **Central Monitoring Room**. Provides a monitoring function and must be staffed and operational, with the ability to shift U/G ventilation to filtration.
- **Underground Ventilation System**. Provides acceptable working conditions and a life-sustaining environment during normal operations and off-normal events, including waste handling events.
- **Exhaust Filter Building**. Contains the U/G ventilation exhaust HEPA filtration equipment and is located north of the Exhaust Shaft.
- **Waste Handling Equipment**. Selected items are designated safety class (SC) or safety significant (SS).
- **Emergency Services Bay**. Houses the ambulance, rescue truck, and fire engine.
- **Guard and Security Building**. Houses the security monitoring and alarm systems.
- **Parking Lot**. The east portion of the front parking lot is used for employee parking, and the two west rows of the lot are designated for trailer storage and staging of empty transuranic package transporters (TRUPACTs) for DOE carrier transport to the generator sites and trailer maintenance facility.

1.6 Scope, Purpose and Methodology of the Accident Investigation

The Board began its activities on March 3, 2014, and completed Phase 1 of the investigation on March 28, 2014. Phase 2 of the accident investigation will occur after reentry into the U/G and a cause of the release within the U/G is able to be determined. The scope of the Board's investigation was to identify relevant facts; analyze the facts to determine the direct, contributing, and root causes of the event; develop conclusions; and determine Judgments of Need for actions that, when implemented, should prevent recurrence of the accident. The investigation was performed in accordance with DOE Order 225.1B, using the following methodology:

- Facts relevant to the event were gathered through interviews and reviews of documents and other evidence, including photographs.
- Facts were analyzed to identify the causal factors using event and causal factors analysis, barrier analysis, change analysis, root cause analysis, and Integrated Safety Management (ISM) analysis.

- Judgments of Need for corrective actions to prevent recurrence were developed to address the causal factors of the event.

Figure 4 defines the accident investigation terminology used throughout this Phase 1 report.

Accident Investigation Terminology

A **causal factor** is an event or condition in the accident sequence that contributes to the unwanted result. There are three types of causal factors: direct cause(s), which is the immediate event(s) or condition(s) that caused the accident; root causes(s), which is the causal factor that, if corrected, would prevent recurrence of the accident; and the contributing causal factors, which are the causal factors that collectively with the other causes increase the likelihood of an accident, but which did not cause the accident.

The **direct cause** of an accident is the immediate event(s) or condition(s) that caused the accident.

Root causes are the causal factors that, if corrected, would prevent recurrence of the same or similar accidents. Root causes may be derived from or encompass several contributing causes. They are higher-order, fundamental causal factors that address classes of deficiencies, rather than single problems or faults.

Contributing causes are events or conditions that collectively with other causes increased the likelihood of an accident but that individually did not cause the accident. Contributing causes may be longstanding conditions or a series of prior events that, alone, were not sufficient to cause the accident, but were necessary for it to occur. Contributing causes are the events and conditions that "set the stage" for the event and, if allowed to persist or recur, increase the probability of future events or accidents.

Event and causal factors analysis includes charting, which depicts the logical sequence of events and conditions (causal factors that allowed the accident to occur), and the use of deductive reasoning to determine the events or conditions that contributed to the accident.

Barrier analysis reviews the hazards, the targets (people or objects) of the hazards, and the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.

Change analysis is a systematic approach that examines planned or unplanned changes in a system that caused the undesirable results related to the accident.

Error precursor analysis identifies the specific error precursors that were in existence at the time of or prior to the accident. Error precursors are unfavorable factors or conditions embedded in the job environment that increase the chances of error during the performance of a specific task by a particular individual, or group of individuals. Error precursors create an error-likely situation that typically exists when the demands of the task exceed the capabilities of the individual or when work conditions aggravate the limitations of human nature.

Figure 4: Accident Investigation Terminology

2.0 The Accident

2.1 Description of Work Activity

The WIPP facility is designed for the excavation of eight panels branching off of the main drifts. WIPP uses the concept of "just-in-time excavation" (Figure 5). Just-in-time excavation is based on the concept that when additional room is needed for waste disposal, a new panel would be excavated and ready for use "just in time." This means that each panel would be excavated, filled, and closed in a time frame that would minimize the potential for developing hazardous ground conditions.

Excavation of a new panel is performed by a mining machine that uses rotary head with bits to remove the salt. Salt from mining must be removed from the U/G and salt haul trucks are used to move the salt to the loading pocket where it is dumped and then taken to the surface via the salt hoist.

Panel 7 was completed and certified in late 2013 and CH and RH waste were being disposed in Panel 7 during January and early February 2014.

Panel 8 excavations began after completion of Panel 7 in 2013, and two rooms had been excavated in Panel 8.

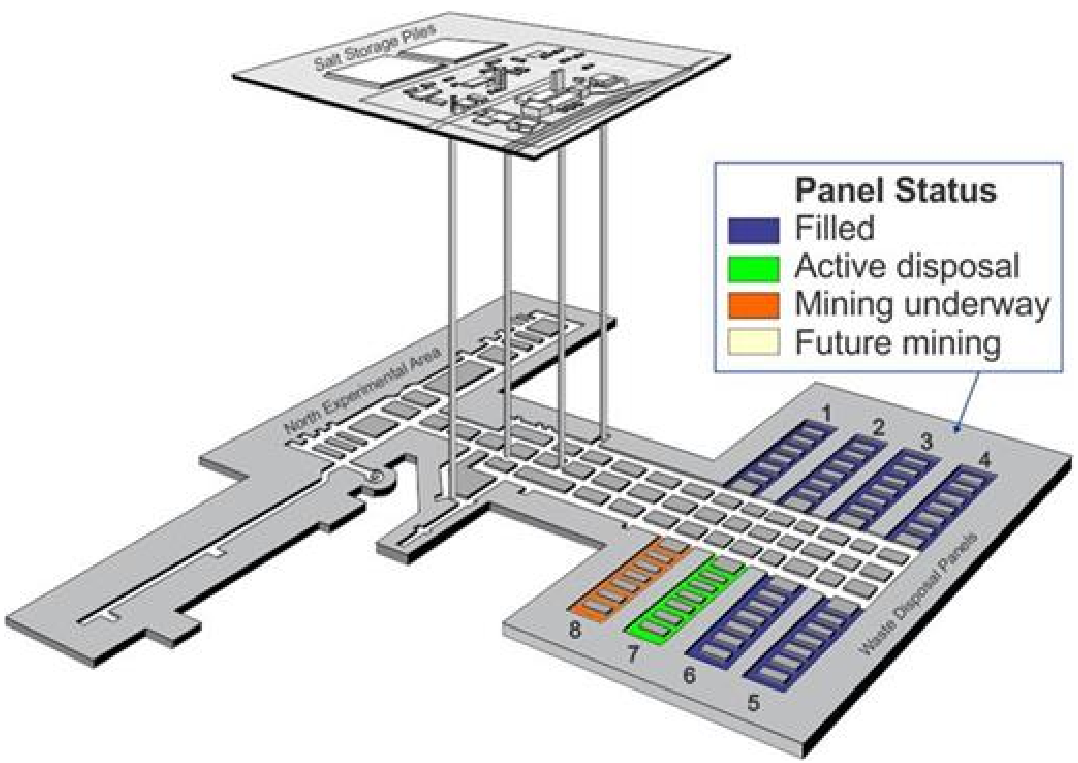


Figure 5: Panel Layout

Following a fire involving a salt haul truck on February 5, 2014, all U/G waste handling activities were suspended pending completion of a DOE Accident Investigation, implementation of critical corrective actions, and development of a recovery plan. A series of entries to the U/G were made to evaluate the fire scene and collect information in support of the Board. On February 10 and 12, two broken roof bolts were found near the mid-pillar of Panel 7 by NWP. This condition was reported to the Mine Maintenance Engineer. On February 13, members of the Board investigating the salt truck fire were in the U/G and observed these same roof bolts and reported protruding roof bolts from the back in Panel 7.

Figure 6 shows cracks in the rib behind mesh and with rock bolts, right side of photo. Figure 6 also shows an area where possible heaving of the bottom has taken place under the second stack of TRU waste on the left side of the photo. Two broken and loose roof bolts above Stack 2 on the left side.

Figure 6: Active Waste Face at Panel 7 Room 7

On the afternoon of February 14, all waste handling activities remained suspended following the fire event. Ventilation was in alternate mode with filtration enabled. One 700 fan was operating and one 860 fan was in standby. Airborne effluent sampling was ongoing with Station A skids A-2 and A-3 in-service, upstream from the HEPA filters; Station B skid B-1 and Station C in-service, exhaust drift from the HEPA filters; and the continuous air monitor (CAM)-151 in-service, monitoring Panel 7 in the U/G.

At 1142, a crew, including a member of the Investigation Board, entered the U/G to collect additional information for the investigation and inspect the waste face. At 1215, they reported to the Central Monitoring Room (CMR) that all radiological conditions at the waste face were normal and that the active waste face was protected with absorbent material. Operations checks on CAM-151, the only CAM monitoring the waste face, were completed at 1415. Prior to leaving the U/G, NWP manually shut BHR-707, the bulkhead regulator. By 1652, all personnel had exited the U/G. This was the last entry before the radiological event.

At 2250, security reported to the CMR that they had observed “green burst” and heard arcing noises at the utility substation. The acting Facility Shift Manager (FSM) responded to the east fence line and heard a “popping noise” from the alternate B feed lines but did not observe any glow. He instructed the Central Monitoring Room Operator (CMRO) to contact Xcel Energy and inform them of the situation. At 2310, the CMRO called Xcel Energy which reported all normal indications on the WIPP utility yard. All Central Monitoring System (CMS) indications were normal at this time and there was no indication of seismic or other unusual activity. The response to the green burst and noise placed the acting FSM in the field near the ventilation system at the time of the accident.

2.2 Accident Description

On February 14, 2014, at 2313, a “HI RAD” alarm from CAM-151 (U/G, monitoring the Panel 7 exhaust drift) was received on the CMS. The “HI RAD” setpoint for this CAM is 30 Derived Air Concentration (DAC) for alpha and beta contamination. Approximately one minute later, a “HI-HI RAD” alarm from CAM-151was received on the CMS. The “HI-HI RAD” setpoint is 50 DAC. The CMS indicated that the CAM reading was 332 DAC. Figure 7 provides a graphical representation of CAM readings during the event.

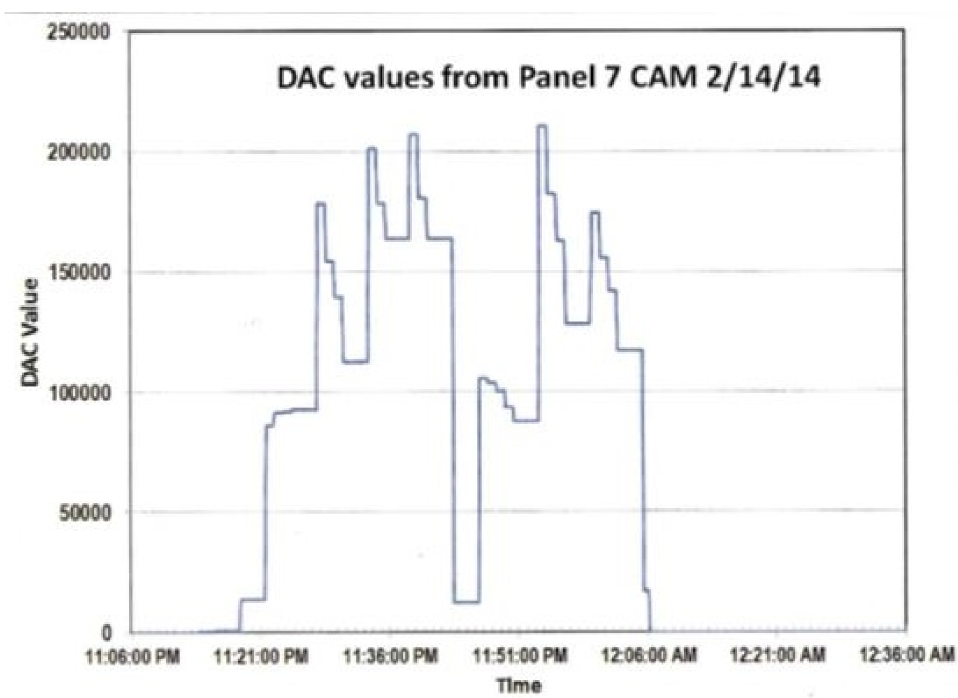


Figure 7: CAM-151 CMS

The U/G ventilation exhaust system automatically switched to HEPA filtration when the CMS received the "HI-HI RAD" alarm, fan 860A operating at 59,000 cubic feet per minute (cfm) flow. The acting FSM manually opened the 860A vortex to direct air from the U/G through the HEPA filters and then to the environment from the surface exhaust filter building exhaust duct. It took 56 seconds from the alarm until flow was initiated in the HEPA exhaust filter. Site personnel began to implement WP 04-VU4605, *UVFS Alarm Response*, and WP 04-EM4200, *Radiological System Alarm Response*. At 2342, the CMRO disabled CAM-151 due to a malfunction indication. The ventilation system continued in filtration.

CON 1: The direct cause of the transuranic mixed waste container release could not be definitively determined during Phase 1 of the investigation due to the inability for personnel to access the underground, collect information, and inspect the waste panels/rooms.

JON 1: Nuclear Waste Partnership LLC (NWP) and the Carlsbad Field Office (CBFO) need to implement a detailed recovery plan to systematically reenter the underground, collect data and information, and make an absolute determination as to the mechanism of the transuranic waste release.

JON 2: During Phase 2, the DOE Accident Investigation Board needs to evaluate the data and information collected and provided by NWP and CBFO to determine the mechanism of release and determine the related conditions and causal factors, reach conclusions, and identify additional judgments of need.

2.3 Accident Response

At 0014, on Saturday, February 15, the CMRO attempted to notify the on-call Radiological Control Technician (RCT) but was unable to reach him. The effluent sample Station A, Skid A-2 and Station D shutdown due to low air flow or clogged filter paper. Effluent sampler Station D, is located in the U/G in E300 before the disposal exhaust joins the exhaust from other areas of the U/G.

The CMRO notified the Radiological Control Manager (RCM) at 0238, the DOE Facility Representative (FR) at 0300, and the Operations Manager at 0330 of the situation.

Because the U/G was under the control of the DOE fire event Accident Investigation Board, the Board Chair was contacted at 0215 to get authorization to break the security seals on the hoist to allow entry to the U/G to troubleshoot CAM-151.

Station A skid A-2 filters upstream of the HEPA filters in the Exhaust Filter Building, were changed out at 0637 by the RCM. It was noted during the change out that the filters had an orange tint. Surveillance checks of the Waste Handling Building were also performed during this period and completed at 0709. Between 0600 and 0700, night personnel were released without contamination surveys and day shift personnel arrived on site.

At 0715, the RCM reported 4.4 million disintegrations per minute (dpm) alpha contamination on one of the Station A skid A-2 filters (filter A-2-3). Based on preliminary indications from the Alpha 6 counter, the RCM believed this indicated the presence of TRU.

At 0807, the CMRO closed the auxiliary air intake tunnel louvers to ensure negative differential pressure.

At 0809, the Engineering Department reported that no seismic activity was reported by the United States Geologic Service (USGS) or by site geotechnical instruments.

Radiological Control (Radcon) personnel changed filters at Station A, skid A-2 and Station B, skid B-1 at 0843. Station A takes suction for sampling just below the surface in the exhaust shaft and Station B takes suction in the exhaust downstream of the HEPA filters and just before release via the exhaust duct. These samples were counted and at 0915 the Station B results were reported at 28,000 dpm alpha and 5,900 dpm beta contamination. The FSM, Operations Manager, and CCP Manager discussed these results and agreed with the FSM to enforce a shelter-in-place order.

At 0934, a public address (PA) announcement was made directing all site personnel to shelter-in-place and secure above-ground building ventilation per procedure WP 12-ER4907, *Evacuation/Sheltering in Place*. Security was also instructed to secure site gates and limit access to the site. The north and south access road gates were not closed. The PA announcement was repeated at 0951.

At 1007, the FSM attempted to activate the Joint Information Center (JIC) and the JIC activated at 1031. At 1019, the Operations Assistance Team (OAT) was successfully activated.

Radcon personnel again changed filters at Station B and the results reported at 1022 were 37,295 dpm alpha and 7,590 dpm beta contamination.

While the CMRO was activating the OAT and JIC, security was performing personnel accountability utilizing a printout from the site access control system. Building wardens worked with security to locate and verify the locations of all personnel and full accountability was achieved at 1104.

Radcon personnel set up portable air samplers between Buildings 451 and 452, one on the north side of Building 452, and one on the north side of Building 486.

At 1120, the shelter-in-place announcement was again repeated.

The RCM and Radcon personnel developed a plan for performing area and personnel frisks so that the workforce could be surveyed and released once it was determined there was no ongoing airborne release. Initial area contamination surveys were performed and 11 locations were initially identified as having surface contamination. These locations were resurveyed and determined clean after it was discovered that the samples had been handled with tweezers contaminated from the Station A filters.

At 1221, the shelter-in-place announcement was again repeated and at 1250 the decision to activate the Emergency Operations Center (EOC) was made. An announcement to activate the Alternate EOC (AEOC) located in the Skeen-Whitlock Building in Carlsbad was made since the WIPP site was sheltered-in-place.

At this point, it was clear that the situation involved more than just a "HI RAD" CAM alarm. At 1300, WP 12-ER4903, *Radiological Event Response*, was implemented. A PA announcement to activate the AEOC was made.

At 1333, the AEOC in Carlsbad was staffed but not declared operational. At 1344, the Crisis Manager provided a briefing to AEOC members and at 1345; the radiological event announcement was repeated. The event had not yet been categorized or classified as an operational emergency (OE). It was subsequently never properly categorized as an OE.

Radiological controls personnel continued to perform surveys and field sampling. Eleven locations were initially reported as contaminated but were resurveyed as clean after it was discovered that samples were handled with contaminated tweezers from the Station A filters that had been collected at 0637. At 1427, Radcon personnel completed surveys of the parking lot and site and reported all results as clean. In addition, filters pulled from Station D on February 14, were recounted on February 15 to verify no release prior to collection.

At 1446, the Radcon off-site survey team completed five surveys enroute to the Far Field air sampler. No unusual activity was detected.

The AEOC was declared operational at 1449.

On-site surveys and monitoring continued during this period. At 1510, portable fixed air samplers were placed between the safety building and the support building, between the Safety Building and the Engineering Building, and north of the Engineering Building. Effluent air monitoring Station A and B filters were again changed and counted: Station A-2-3 filter had 285,193 dpm alpha and 53,633 dpm beta. Samples from Station B-1-3 effluent sample station filters indicated 36,194 dpm alpha, and 7,340 dpm beta.

At 1512, the CMR reported that readings of samples from off-site air samplers (farfield and closer to the site) indicated no release. Consequence assessment continued to evaluate the survey and filter results in support of the AEOC.

By 1534, site personnel had been sheltered-in-place for six hours. The FSM, site operations representative, and personnel in the "War Room," in the Site Support Building where NWP evaluation of the salt haul truck fire event and associated recovery planning were being performed, discussed releasing non-essential personnel.

A PA announcement releasing non-essential personnel was made at 1635. Personnel were released and escorted one building at a time via a specific travel path which had been surveyed clean. Once at the West Guard Gate, personnel underwent whole body and personal item surveys (frisks). Some personal articles were retained due to potential indications of contamination but this was later determined to be radon.

At 1650, the Air Intake Shaft was surveyed, found clean of contamination and then sealed. At 1830, the Salt Shaft was surveyed and sealed and at 1833 was covered with blankets and brattice cloth.

Staffing plans were developed to ensure continuous staffing at the site through a watch bill.

At 2056, the FSM categorized the event in accordance with procedure WP 12-ES3918, *Occurrence Reporting and Processing System*, under criteria 4B(5), Significance Category (SigCat) 4.

Radcon personnel continued to monitor, collect, and analyze filters from the effluent monitoring stations. Alpha and beta contamination continued to be found on filters at skids A-2-3, A-3-3, and B-1-3.

During the afternoon of February 16, a nearby rancher contacted the JIC expressing dissatisfaction with the communication and handling of the event. He stated that he was not notified by WIPP and heard of it through one of his employees. The AEOC followed up with the rancher, apologizing for the lack of notification and then provided information on the event, status, and ongoing surveys and sampling. They then notified other nearby ranches.

February 16 at 1917, the JIC and AEOC were deactivated.

Bioassays were initiated on approximately 150 personnel to determine if there was any uptake of airborne contamination from the event. Results found that, as of March 28, 21 personnel had positive bioassay results.

The initial collection of filters from Station A and Station B on February 15 were sent to an off-site laboratory for further analysis and based on the results were deemed to be characteristic of a breach of a waste container located in either Panel 6 or Panel 7 in the U/G.

On February 19, DOE issued a press release stating that the Carlsbad Environmental Monitoring and Research Center (CEMRC) reported that WIPP access road sample results indicated trace amounts of americium and plutonium.

On February 24, the results from environmental monitoring samples collected between February 17 and 18 from locations on and around the site were reported. These results indicated slightly elevated levels of airborne radioactive concentrations, which were consistent with the waste disposed of at WIPP. These concentrations remain well below a level of public or environmental hazard.

On March 6, two ventilation system dampers that were known to have design leakage, and allowed a portion of the radioactive material to bypass the HEPA filters were sealed with a high-density foaming material. Before sealing the ductwork, a small amount of unfiltered air continued to be released to the environment.

On March 7 and 8, radiological and air quality instruments were lowered down the Salt Handling and the Air Intake Shafts, to check for airborne radioactivity and to determine air quality. The preliminary findings indicated no detectable radioactive contamination in the air or on the equipment lowered and returned to the surface. Air quality results were also normal. These results were expected because the shafts that were sampled were not in the air flow path coming from the area where the radiation release originated.

On March 18, air sampling data were reported via a DOE press release, which indicated a very small radiation release had occurred March 11, but with no expected health impacts to workers, the public or the environment. Engineers believe the contamination was from previous deposits on the inner surface of the exhaust ductwork that became dislodged. Filters collected at the same monitoring station, both prior to and for 72 hours after the release, have indicated background levels.

A series of workforce and public meetings were held to communicate what was known about the February 14, 2014, radiological event, provide monitoring results, and provide status on recovery planning. Manned entry into the U/G is planned and scheduled. This entry will allow personnel to perform inspections and collect additional information necessary to determine the causes of the radioactive material release.

2.4 Event Chronology

Table 1: Chronology of the Radiological Release

Date and Time (MST)	Event
02/05/2014 1048	U/G fire event occurs involving a non-waste handling salt haul truck.
02/06/2014	Timely Order 14:001 issued and U/G ventilation placed in maintenance bypass mode without HEPA filtration.
02/10/2014	Timely Order 14:001 terminated and U/G ventilation placed in HEPA filtration mode.
02/10/2014	U/G ventilation temporarily placed in maintenance bypass mode to allow testing of CAM-151 (failed functional test).
02/10/2014	U/G ventilation system returned to HEPA filtration mode.
02/12/2014	CAM-151 placed back in service.
02/12/2014	Alternate ventilation configuration was established.
02/13/2014	Fire Accident Investigation Board observes two protruding roof bolts in the back on Panel 7.

Date and Time (MST)	Event
02/13/2015 0000	Waste handling and U/G operations remain shut-down pending completion of the DOE fire event investigation.
02/13/2014	Site personnel and fire investigation team members enter U/G to assess the waste face.
02/14/2014 0759	Filters changed at effluent sample Stations A (upstream of HEPA filters) and B (downstream of HEPA filters) at the surface Exhaust Filter Building (EFB).
02/14/2014 1205	Waste handling technician notified CMRO that the active waste face is protected with absorbent material and surveillance is complete.
02/14/2014 1415	Operations checks on CAM-151 by Panel 7 in the U/G are performed and CAM is found satisfactory.
02/14/2014 1452	Filter change was completed on effluent sample Station D.
02/14/2014 1652	All personnel in U/G are accounted for.
02/14/2014 2250	Security reported "green burst" and arcing noise at the utility yard.
02/14/2014 2252	FSM investigated, saw no lights but heard clicking and had CMRO notify Xcel Energy.
02/14/2014 2310	Xcel Energy reported to CMRO normal indications on WIPP utility yard.
02/14/2014 2313	“HI RAD” alarm received in CMR on the CMS from CAM-151 in U/G at Panel 7 exhaust drift.
02/14/2014 2314	“HI-HI RAD” alarm received in CMR on the CMS from CAM-151.
02/14/2014 2314	U/G ventilation system automatically shifted to HEPA filtration upon “HI-HI RAD” CAM alarm.
02/14/2014 2324	FSM is at Building 413 and called on radio to open vortex on fan 860A.

Date and Time (MST)	Event
02/14/2014 2342	CMRO attempted to contact the on-call RCT.
02/14/2014 2342	CMRO disabled U/G CAM-151 due to malfunction indication.
02/15/2014 0034	Clogged Station A filter alarm in CMS.
02/15/2014 ~0035	Alarm on Mod Filter on north HEPA filter bank at 1.0 inch of water.
02/15/2014 0415	Radiological Control Manager (RCM) arrived on-site.
02/15/2014 ~0500	DOE Facility Representative (FR) arrived on-site.
02/15/2014 ~0530	Operations Manager arrived on-site.
02/15/2014 0620	CBFO Manager notified the CMRO that the fire event investigation Board Chair has authorized the security seals on the hoist to be broken to respond to U/G as necessary for CAM alarm.
02/15/2014 0637	Filter change was completed on effluent sample Station A, Skid A-2.
02/15/2014 0715	RCM reports that effluent sample Station A, Skid A-2-3 filter indicates 4.4 million disintegrations per minute (dpm) alpha contamination.
02/15/2014 0809	Engineering Department reported no seismic activity from USGS.
02/15/2014 0915	Station B skid B-1 filter sample result reported as 28,000 dpm alpha.
02/15/2014 0934	Initial public address (PA) announcement was made to shelter-in-place due to high activity at Stations A and B.
02/15/2014 0938	Security secured site gates to limit access.

Date and Time (MST)	Event
02/15/2014 1007	Operations Assessment Team (OAT) was activated.
02/15/2014 1019	There was an attempt to activate the Joint Information Center (JIC).
02/15/2014 1022	Radiological Control Technician (RCT) reports 37,295 alpha dpm and 7,590 beta dpm contamination at Station B.
02/15/2014 1031	Contact is made with JIC member - JIC is activated.
02/15/2014 1104	Full site accountability achieved.
02/15/2014 1104	RCTs set up portable air samplers: one between Buildings 451 and 452, one north side 452, on north side of Building 486.
02/15/2014 1145	Facility Manager Designee (FMD) is notified of potential radiological issue.
02/15/2014 1210	"Four areas" around/near the Training Building were surveyed clean.
02/15/2014 1250	Alternate Emergency Operations Center (AEOC) activation page was made.
02/15/2014 1300	Rad Event announcement was made.
02/15/2014 1333	AEOC was activated but not staffed to be declared operational.
02/15/2014 1359	Field sampling was in progress.
02/15/2014 1403	Eleven locations that were initially reported contaminated were re-surveyed and were found clean by RCTs. RCTs self-identified cross contamination by tweezers during sampling.
02/15/2014 1427	RCTs reported all swipes and direct frisks from parking lot and on site are clean. Filters pulled from U/G Station D on February 14 were recounted and showed no activity.

Date and Time (MST)	Event
02/15/2014 1444	RCTs report preliminary PAS data was less than trigger levels.
02/15/2014 1446	Press release approved and sent from the Secretary of Energy office.
02/15/2014 1446	Off-site survey team performed five surveys en-route to Far Field air sampler noting no activity above background.
02/15/2014 1449	AEOC is declared operational.
02/15/2014 1510	CMRO stated that portable fixed air samplers (FAS) were placed at three locations on site and that filters had been exchanged at Stations A and B at regular intervals.
02/15/2014 1518	CMRO relayed that readings of samples from Far Field and close to the site showed no signs of a release.
02/15/2014 1557	All parking lot vehicle surveys were reported as clean.
02/15/2014 1603	The AEOC consequence assessment representative communicated with CEMRC on the status of the filters being evaluated.
02/15/2014 1607	The FSM, site Operations Representative, and personnel in the "War Room" reported that they were considering releasing non-essential personnel from the site.
02/15/2014 1612	Effluent sample Station B-1-3 filter, 423 dpm alpha, 292 dpm beta, indicates Am^{241} per the CMR log. War Room sample data sheet indicated 36,200 dpm alpha, 7,340 dpm beta.
02/15/2014 1635	PA announcement made releasing non-essential personnel.
02/15/2014 1638	Briefing on samples and readings provided the following: Station A-2-3 285,193 dpm alpha, 53,633 dpm beta; B-1-3 1423 dpm alpha, 292 dpm beta with Am^{241} indicated per the CMR log.
02/15/2014 1650	Air Intake Shaft was covered - security seal put in place.

Date and Time (MST)	Event
02/15/2014 1730	All non-essential personnel were released from the site. Two contaminated jackets are bagged and tagged. Later found to be radon.
02/15/2014 1732	Secured from shelter-in-place.
02/15/2014 1752	Update on consequence assessment plume based on Station A and B readings provided by site consequence assessment radiological engineer.
02/15/2014 1828	CMR communicated that actions are being taken to cover the Air Intake Shaft and the Salt Shaft.
02/15/2014 1830	The FSM and Operations Manager evaluate Occurrence Reporting and Processing System (ORPS) reporting criteria for this event per the AEOC log.
02/15/2014 1833	Salt Shaft was covered with blankets and brattice cloth.
02/15/2014 1903	The War Room requested that the AEOC develop a watch bill for continuous staffing. The CMR also relayed that during frisking, three jackets, one lunch bucket, and clothing from an Emergency Services Technician were confiscated, bagged and tagged. These were later released – radon.
02/15/2014 2056	FSM/FMD categorize occurrence under criteria 4B (5) Safety Evaluation Report SigCat 4 per WP 12-3918
02/16/2014 0045	RCT reported Station A, Skid A-3-3 filter from February 15, 1100 pm reads no detectable counts.
02/16/2014 0230	RCT reports Station A, Skid A-3-3 filter 21.1 dpm alpha, 41.6 dpm beta; Skid A-2-3 filter, 124,000 dpm alpha, 24,000 dpm beta; Skid B-1-3 filter, 707 dpm alpha, 147 dpm beta per the CMR log.
02/16/2014 0230	Station A, Skid A-2-3 filter counted and showed no change.
02/16/2014 0240	Station A, Skid A-2-3 filter counted and no change, Station B, Skid B-1-3 filter, 711 dpm alpha, 155 dpm beta.
02/16/2014 0500	AEOC dayshift staffing is in place.

Date and Time (MST)	Event
02/16/2014 0853	Filter changes complete at Station A.
02/16/2014 0855	CMR contacted the AEOC with plant conditions.
02/16/2014 0904	Filter change completed at Station B.
02/16/2014 1000	FSM stated additional site sampling was ongoing and that samples would be analyzed at CEMRC unless otherwise directed per the AEOC log.
02/16/2014 1000	Station A, Skid A-2-3 filter, 47,283 dpm alpha, 10,558 dpm beta.
02/16/2014 1100	Copies of lab analysis results from CEMRC on the three filters analyzed were emailed to communications personnel and shared with the AEOC.
02/16/2014 1158	RCTs surveys performed at salt collar and AIS collar and found clean.
02/16/2014 1245	EM 40 requested information regarding chemical analysis on samples taken after the U/G fire on February 5, 2014. They also requested information of lab(s) being utilized for analysis of the samples. The Safety Representative provided a response.
02/16/2014 1301	CMRO notified by Radcon that the recount of Station B filter collected at 0904 are 253 dpm alpha and 63 dpm beta.
02/16/2014 1338	Radcon reported that the items that were collected from dirty surveys February15 are clean.
02/16/2014 1340	CMR reported that articles of clothing surveyed on February 15 that were retained and bagged were resurveyed and results indicate no contamination.
02/16/2014 1428	The CMR initiated closure of Ventilation Control Bulkhead 503, located south of the Salt Waste Hoist Station, remotely.
02/16/2014 1430	Filter samples are shipped for chemical analysis to the laboratory at Savannah River Site from Stations A and B: samples from before and after the radiological release, and from Station D prior to the radiological release.

Date and Time (MST)	Event
02/16/2014 ~1435	The late CMR Log entry stated that the JIC was contacted by an area rancher expressing dissatisfaction in the communication and handling of the radiological event.
02/16/2014 1438	Crisis Manager (CM)/AEOC contacted rancher and discussed the event, the survey results, the sample locations, and the lack of radiation detected. The CM/AEOC also apologized for the lack of notification
02/16/2014 1450	AEOC attempted to contact rancher. There was no answer so a message was left
02/16/2014 1508	CMR reported that the Ventilation Control Bulkhead 503 indicated closed.
02/16/2014 1608	Contamination is found under the sampling port at Station A, Skid A2.
02/16/2014 1702	Filter change at effluent sample Station A complete.
02/16/2014 1805	Station B filter count from the 5:05 pm entry: 144 dpm alpha 67 dpm beta.
02/16/2014 1822	CMRO notified that final press release has been approved locally and when it is sent out, the final notifications will be made. In addition, the JIC/AEOC will be deactivated.
02/16/2014 1832	Final press release sent after local and DOE Headquarters (HQ) approval.
02/16/2014 1838	Final termination notifications were made by the Emergency Operations Center (EOC) Safety Representative.
02/16/2014 1854	Final notifications were completed by the EOC Safety Representative Notified the CMRO/FSM.
02/16/2014 1917	EOC and JIC deactivated per AEOC Operations Representative and notified FSM.
02/16/2014 1917	Facility Manager categorized the event as meeting ORPS criteria, Group 10(2) SC2 and Group 10 (4) SigCat 4.

Date and Time (MST)	Event
02/16/2014 2057	RC Engineer reports that samples taken from A-2-3 filters at 1648, indicated 12,215 dpm alpha, 2842 dpm beta, B-1-3 are 144 dpm alpha, 67 dpm beta.
02/18/2014	Timely Order 14-003 issued to inform Facility Operations personnel of the response requirement for changes in differential pressure.
02/18/2014	Timely Order 14-004 issued to inform Facility Operations personnel of the response requirements if there is an unexpected loss of site power.
02/18/2014 1200	Initial Far Field low volume sampler counts found to have Pu and Am - reported to War Room.
02/18/2014 1410	ORPS notification report submitted (EM-CBFO--NWP-WIPP-2014-0002).
02/19/2014	DOE issues press release reporting Carlsbad Environmental Monitoring and Research Center (CEMRC) WIPP access road sample results indicating trace amounts of americium and plutonium.
02/20/2014	Timely Order 14-006 issued to inform Facility Ops personnel of requirements to and process for taking pressure reading at the AIS and salt hoist collars.
02/22/2014 1000	NWP held critique meeting.
02/24/2014 1245	Facility Manager updated ORPS EM-CBFO--NWP-WIPP-2014-0001 and added criteria 10 (1) SigCat 2.
02/26/2014	Thirteen workers tested positive via bioassay (fecal) for americium and plutonium.
02/27/2014	Accident Investigation (AI) Board appointed via Appointment Letter and modified on March 4.
02/28/2014	Unreviewed Safety Question Determination (USQD) performed on proposed foaming activities.
03/04/2014	Accident Investigation Board Chair issued scene preservation letter to the CBFO Manager.
03/06/2014	High-density foam applied to seal the two ventilation dampers.

Date and Time (MST)	Event
03/06/2014	CBFO and NWP hosted a Town Hall meeting.
03/07/2014	USQD performed on unmanned U/G entry.
03/07/2014	Initial U/G survey (unmanned) to bottom of Salt and Air Intake shafts.
03/07/2014	Work begun to fill void between the two dampers on the ventilation system with low-density foam.
03/07/2014	Town Hall meeting with U.S. Congressman, 2nd District, State of New Mexico.
03/08/2014	Unplanned, excessive exothermic reaction occurred during foaming. Foaming was secured. Emergency response personnel called to the scene.
03/08/2014	Four additional personnel tested positive via bioassay (fecal) for americium and plutonium (urinalysis negative).
03/13/2014	Final report on the WIPP Salt Haul Underground Fire was presented at a Town Hall meeting.
03/14/2014	Final report on the WIPP Salt Haul Underground Fire was issued.
03/18/2014	New air sampling data was reported which indicated that a very small additional radiation release occurred March 11, but with no expected health impacts to workers, the public or the environment. Samples collected at the same monitoring station, both prior to and for 72 hours after this release, have indicated background levels.

3.0 Nuclear Safety Program

The Board reviewed the safety basis for compliance with 10 CFR 830, Department of Energy *Nuclear Safety Management*, Subpart B, *Safety Basis Requirements*, to ensure that WIPP, as a Hazard Category 2 nuclear facility, has an established safety basis. Supporting this, the Board analyzed the DOE/WIPP-07-3372, *Documented Safety Analysis* (DSA) to determine whether or not it adequately defined the scope of the work to be performed; identifies and analyzes the hazards associated with the work; and is categorized consistent with DOE requirements. Related to the adequacy of the safety basis, the Board further analyzed the Unreviewed Safety Question (USQ) processes required by 10 CFR 830 to ascertain whether or not it is maintained current to reflect changes in the facility, the work and the hazards. Finally, the Board evaluated the flowdown of the DSA into implementing processes and procedures by analyzing the adequacy of the TSRs to ensure that the overall safety basis provides reasonable assurance of adequate protection of workers, the public, and the environment from adverse consequences, taking into account the work to be performed and the associated hazards.

3.1 WIPP Documented Safety Analysis

The Board reviewed the WIPP DSA to ensure that it is approved and annually updated, as necessary, and adequately captures hazards, accidents and controls related to the recent underground radiological release event.

Specifically, the Board reviewed the most recent DSA, DOE/WIPP 07-3372, Revision 4, and supporting hazard and accident analysis calculations. In addition, the Board reviewed the previous DSAs dating back to 2005 along with the CBFO safety evaluation reports (SER) that approved them. The Board also interviewed key personnel with knowledge and responsibility for managing and maintaining the DSA, including the NWP Nuclear Safety Manager, the NWP Operations Manager, NWP nuclear safety analysis staff, the CBFO manager responsible for nuclear safety, and the CBFO nuclear safety subject matter expert (SME). The key focus of the analysis was to confirm that the DSA adequately evaluated hazards/accidents and established safety controls as related to the U/G radiological release of February 14, 2014. The Board also sought to confirm whether the nuclear safety program ensured the safety basis was kept up to date and was subject to a thorough independent review.

3.1.1 DSA Hazards/Accidents Evaluation and Controls

The DSA Section 3.3 hazard evaluation is missing evaluation of some hazards/accidents evaluated in its supporting hazard analysis report, and consequently does not ensure a comprehensive evaluation of potential preventive or mitigative controls, e.g., Safety Significant, Safety Class, or other equipment that is important to safety that could be relevant to the U/G radiological release event of February 14, 2014.

Analysis

The DSA Chapter 2 descriptions of the underground and operations are consistent with conditions known and understood in Panel 7 Room 7 where TRU waste was being emplaced, and in Panel 6 that is in the process of installing an interim closure barrier, i.e., currently has a chain link and brattice cloth installed, but not the 10 feet of salt and a metal bulkhead as illustrated in Figure 2.4-17 of the DSA.

Access to the underground has been restricted since the event occurred. There is insufficient information for the Phase I investigation regarding the cause of the radiological release. Therefore, the type of accident that occurred, and the effectiveness of preventive or mitigative controls as credited in the DSA hazard and accident analysis, or as identified to provide defense in depth, are unknown.

A comprehensive hazard analysis of a wide range of hazardous conditions that could lead to a release from TRU waste containers has been performed. There are over 650 hazard scenarios qualitatively evaluated in the WIPP-021, *Hazard Analysis for the Waste Isolation Pilot Plant Transuranic Waste Handling Safety Basis,* Revision 2, which could occur in the U/G or above ground during waste handling or staging. These were grouped into about 150 representative and bounding hazard scenarios that are presented in the DSA Section 3.3 hazard evaluation as summarized on its Table 3.3-5. The hazard evaluation identifies available preventive and mitigative controls, and for the most important controls, derives whether any should be designated as SS SSCs or specific administrative controls (SACs) based on two criteria. These criteria are based on either being a major contributor to defense in depth or required for worker safety (facility worker at the accident location or hypothetical co-located worker located at 100 meters from the release).

The hazard evaluation also is used to establish design basis accidents (DBAs) for the primary purpose of determining whether there is a need for SC, SSCs or SACs to protect a hypothetical maximally exposed off-site individual at the site boundary from challenging or exceeding the 25 rem Total Effective Dose (50-yr commitment) Evaluation Guideline. Based on representative or unique DBA selection guidance from DOE Standard (STD)-3009-94, Change Notice 3, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis,* and supplemented with additional guidance from DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities,* the 150 hazard scenarios on Table 3.3-5 were grouped into seven DBAs for quantitative accident analysis in Section 3.4 of the DSA. None of the DBAs identified in the DSA, Revision 4, are applicable to the unoccupied underground, though a DBA involving a back fall in an active panel was included in previous DSA versions. Based on the current DSA, the 150 "hazard scenarios" in Table 3.3-5, as opposed to the seven DBAs, provide the qualitative unmitigated and mitigated analyses of interest for the radiological release of February 14, 2014. The seven DBAs in Section 3.4 of the DSA drive the need for Safety Class controls. None of these are applicable to potential releases in the underground when unoccupied (e.g., fuel spills while operating waste handling equipment). Therefore, we need to consider what the DSA included in its Section 3.3 hazard evaluation of 150 hazard scenarios for the Accident Investigation Board to conclude whether applicable hazard scenarios/accidents related to a release from the underground were previously evaluated.

Regarding the radiological release event, NWP has been evaluating approximately a dozen of these hazard scenarios that were previously analyzed for conditions in the U/G when unoccupied, e.g., deflagration in a CH waste container and roof bolt puncture of a container. Of these possible candidates, the most consequential is a back/rib fall onto 210 CH-TRU waste drums stacked three high in an active Panel. For this event to occur in an active panel, it would imply that the Ground Control Program was not effective as a preventive control. Alternatively, a similar scenario could involve a back/rib fall in Panel 6, or any of the other panels with interim or partial permanent closure barriers, i.e., concrete block wall installed as illustrated in Figure 2.4-16 of the DSA. It is quite possible that in certain areas, regardless of the ground control program efforts, stability may not be maintained. This will be investigated further in Phase 2 once re-entry to investigate and determine the source of the release is possible. It is anticipated that the type of accident will be identified so further investigation of the effectiveness of controls can be evaluated.

The Board examined known information on radiological material released on February 14, 2014, to reconstruct potential consequences to hypothetical receptors on-site and off-site. This was performed in order to make comparisons to bounding DSA consequences estimated for hazards scenarios in the unoccupied underground. The Board used data from Station A samples in the exhaust duct near the surface, Station B samples downstream of the HEPA filters, the bypass isolation dampers that leaked, and far-field environmental air samples. The release has been characterized as involving Pu and Am isotopes, typical of TRU waste from the DOE weapons production complex.

The magnitude of the release was roughly estimated for the purpose of the National Atmospheric Release Advisory Center plume modeling projections using Station B samples, resulting in an estimated 0.0005 plutonium^{239} equivalent curies (PE-Ci) released to the environment. This was performed to support the initial consequence assessment on February 15, 2014, as documented in ORPS report EM-CBFO--NWP-WIPP-2014-0002, *Underground Radiological Event*. This represents the release through a single stage Mod (roughing) filter, a single stage high (roughing) filter, and two stages of HEPA filters, to include leakage through the two closed bypass isolation dampers. The HEPA filters had been tested within the last year, in May 2013, with an acceptance criteria of <0.05 percent reduction (tested 99.95 percent efficiency)[3] per stage after installation, i.e., would expect a reduction of particulate concentration of over six orders of magnitude ([1-0.9995][1-0.9995] = 2.5E-7 Leakpath Factor, or a reduction factor of 4,000,000).

An initial source term released to the environment from breached waste containers was estimated by the Board using sample results before and after the HEPA filters using the Station A samples in the exhaust duct near the surface prior to the HEPA filters, ratioed to the Station B samples downstream of the HEPA filters that included the leakage from the isolation dampers; a rough estimate is that 99.5 percent of the airborne release was captured in the Mod and HEPA filters. The Board estimated that the release in the U/G, e.g., at Panel 7 Room 7, could be on the order of 0.1 PE-Ci. Since the type of accident causing the release is unknown, a direct comparison to the previous accidents analyzed in the DSA cannot be made. However, it should be noted that the scoping calculations for the DSA hazard scenarios have evaluated initial source terms made airborne that are higher than this February 14, 2014, release estimate; therefore, it is likely that the DSA hazard evaluation bounds the release of February 14.

It should be noted that analytical laboratory sample results showed that approximately 90 percent of the alpha activity was Am^{241} and 10 percent was Pu$^{239/240}$. From a consequence assessment

[3] Data per ORPS EM-CBFO--NWP-WIPP-2014-0002, *Underground Radiological Event.*

perspective, the Am and Pu curie estimate from the sample alpha activities does not change estimated doses significantly.

NWP has not completed a USQ determination (USQD) specific to the U/G radiological event because key information related to the location and source of any radiological material release is not yet known. Therefore, a conclusion has not been reached as to whether previously estimated consequences of relevant hazard scenarios are under-estimated in the DSA. However, NWP conservatively defaulted to answering the Question #2 of Potential Inadequacy of the Safety Analysis (PISA) Determination P14-0002, *Occurrence Report EM-CBFO-NWP-2014-0002 - Underground Radiological Event*, as "Yes" in part due to the potential that previously estimated consequences from the event may have been exceeded.

The WIPP design includes mitigation for underground accidents causing a radiological release by use of HEPA filtration for the U/G ventilation system. Normally, the U/G ventilation is discharged to the environment without filtration. In the event of an accidental release, a CAM in the exhaust drift, upon sensing a release, will automatically transfer the airflow through two stages of HEPA filters prior to discharge to the environment. This defense-in-depth protection is acknowledged in the DSA Chapter 2 description and Chapter 7 of DOE/WIPP-95-2054, *WIPP Radiation Protection Program*, Revision 17.

The current Revision 4 DSA hazard and accident analyses do not credit the CAM-initiated automatic transfer to HEPA filtration for the U/G ventilation system. More importantly, the DSA Chapter 3 hazard and accident analysis, and its supporting hazard analysis document, WIPP-021, do not identify CAMs and U/G HEPA filtration as an available mitigative control. This is not consistent with guidance in DOE-STD-3009 regarding identification of all available preventive and mitigative controls so their importance can be further evaluated.

Dating back to 2005, the safety basis documents designated the U/G confinement ventilation system (CVS) as a Safety Significant (SS) system based on directing airflow away from facility workers emplacing waste. However, as mentioned above, the exhaust High Efficiency Particulate Air (HEPA) filtration was not credited. When the existing Contact-Handled (CH) and Remote-Handled (RH) TRU safety basis documents were combined in September of 2008, the new DSA reduced the classification of the U/G CVS to "Balance of Plant," meaning that it was no longer credited for worker protection from accidents identified in the DSA. Among the bounding accidents identified in this version of the DSA was a roof fall accident in an active panel (Event 030-CH/RH-UG), which resulted in an anticipated frequency with low consequences to facility workers, high consequences to co-located workers (100 meter receptor), and moderate consequences to public. The primary safety basis control established for the accident was related to the Ground Control Program.

Based on the automatic transfer to filtration and quick operator response to manually open the 860 fan vortex damper that started flow through the HEPA filters (the operator happened to be nearby at the electrical substation), the magnitude of the release was very low since the release in the underground would take up to about 30 minutes to reach the HEPA filters due to reduced flow when switched to filtration. However, as discussed above, the initial source term airborne at the location of the breach of containers is estimated to be significant.

In addition, the previous hazard analysis of a back/rib fall in an active panel estimated significant consequences such that the hazard scenario should have been further evaluated in the DSA Section 3.3 hazard evaluation. NWP Nuclear Safety acknowledged it was in error for not including the hazard scenario, i.e., event #CH/RH-U/G-30-001b, from the WIPP-021 hazard analysis report in the DSA. This change was not identified by CBFO during their review, and therefore, the basis for the change was not provided in the DSA or DOE's Safety Evaluation report (SER). The current DSA revision 4 evaluates a back/rib fall accident within a "closed panel," event # CH-RH-U/G-30-001f, as the bounding event. The radiological release in a closed panel was estimated to have low consequences to the facility workers, co-located workers, and the public. Therefore, it was erroneously concluded in the DSA that the event no longer required evaluation of the need for Safety Class controls to protect the public. The DSA Revision 3 previously included this type of DBA along with a SAC on the Ground Control Program.

Therefore, there are reasons to question the DSA hazard and accident analyses of the correct set of bounding events to derive appropriate safety classifications and TSR controls, and the DSA conclusion that the U/G HEPA ventilation system was not credited as a SS SSC, or at a minimum, as equipment important to safety (ITS). The back/rib fall in an open panel hazard scenario is further discussed below in the analysis in context with historical changes to the safety basis.

In late 2009, a DOE HQ independent assessment of WIPP CVS evaluations for the Department's Implementation Plan (IP) in response to DNFSB Recommendation 2004-2 was completed. The report concurred that the WHB CH and RH CVS systems were properly categorized as Balance of Plant (BOP) and the U/G CVS classified Safety Significant in accordance with DSA determinations, and all systems met the evaluation criteria for 2004-2 IP. However, the new combined CH/RH DSA was in the process of being implemented and resulted in changed classifications of these systems, i.e., WHB CH and RH CVSs are SS and U/G CVS downgraded to BOP. The nuclear safety basis is more thoroughly discussed in Chapter 3, Nuclear Safety Program.

The DSA Revision 2 acknowledged a reduction in the level of conservatism for evaluating liquid-fuel pool fires. CBFO suggested in the SER that the contractor should consider re-evaluating key assumptions of the pool fire modeling approach used in the DSA Revisions 0 and 1 during the next annual update, especially for such fires that could occur in the U/G with waste-handling equipment. Additional fire modeling was performed to support both the fire hazards analysis and the DSA. Since the fire DBAs resulted in the need for Safety Class controls to protect the public, the Board did not further investigate this change. As related to prevention of fires in the underground, these Safety Class controls include the automatic fire suppression system on waste handling equipment, design of the waste handling equipment to protect combustible liquids from impacts, vehicle/equipment control program of the lube truck and at the waste face, and vehicle pre-operational checks.

Revisions 3 and 4 of the DSA since 2010 were observed by the Board to have resulted in a significant reduction in the level of conservatism. A few examples of changes to the DSA include eliminating the RH hot cell shielding as a Safety Significant Design Feature, eliminating the Ground Control Program SAC, eliminating U/G design features that prevent explosions, eliminating waste hoist inspection SAC, and eliminating 15 of 22 DBAs without providing a justification for the change. Additional changes are discussed later in the TSR section of this Phase 1 report.

Two reasons for this seem to fall within one of two major categories: (1) change in unmitigated analysis methodology, and (2) revision of the dose consequence modeling with MELCOR Accident Consequence Code Systems (MACCS) code.

What is described for some of the changes is compliance with 30 CFR 57 or 10 CFR 835 regulations. Reliance on compliance with Federal (Occupational Safety and Health Administration, EPA and RCRA) and state regulations is a practice that is not consistent with the unmitigated analysis guidance of DOE-STD-3009 and DOE-STD-5506.

Three significant changes were made regarding radiological consequence analysis involving the dispersion analysis and accident release durations. The revised dispersion analysis is due to changes in dry deposition velocity and surface roughness inputs to the MACCS2 code, which are supported by additional technical reports. One of the significant changes is a decrease in the dry deposition velocity as a result of a DOE notice to all sites to address identified concerns. This is documented in WIPP-045, *GENII Version 2 Deposition Velocity for Unmitigated/Unfiltered Release*. This included URS corporate resources to author the calculation and an independent peer review performed by an external recognized industry SME. This change resulted in an increase in the estimated doses. However, a change in the surface roughness value was also made that resulted in a decrease in estimated doses. The contractor calculated the surface roughness value based upon a 2010 environmental monitoring report that used an EPA software tool, AERMET, which utilizes U.S. Geological Survey data, to calculate surface characteristics, such as surface roughness. The SER documents CBFO's concurrence, however, does not discuss a technical basis.

For a short duration release, the net effect of the revised MACCS2 analyses is about a factor of 2.4 increase to estimated consequences to the public, and less than a 10 percent reduction in estimated co-located worker consequences. However, one of the other changes is that instead of assuming a short duration release from the U/G, all releases are now assumed to be a two-hour release. This assumption results in DSA Revision 4 changes that are about the same for public dose estimates as previous accident analyses that were based on short duration releases, but about a factor of 2.6 reduction in estimated co-located worker consequences. Assuming two-hour release from the U/G was not justified in the DSA or SER. The explosion and spill hazard scenarios analyzed in the DSA and hazard analysis report are based on an instantaneous release from breached waste containers, and the fires are generally of short duration due to a shallow fuel pool fire, and subsequent burning of contaminated waste that generally should not be modeled much longer than 20 to 30 minute release duration. The February 14 release also appears to be of short duration based on the rapid particulate loading on the MOD roughing filters starting 20 to 30 minutes after the CAM alarm which is likely due to the travel time from the underground to the surface. Therefore, both co-located worker and public consequences are likely under-estimated in the DSA, Revision 4.

3.1.2 DSA Updates

Sufficient evidence exists to determine that the DSA is kept up to date and has met annual update requirements.

Analysis

The Board determined that three DSA and TSR annual updates have been submitted by NWP and the previous contractor in the last four years. Annual updates are normally submitted around May of each year. Revisions 2 and 3 were submitted by the previous contractor in a timely manner, and CBFO approved them, documenting their approval in SERs. The DSA/TSR Revision 4 annual update was not approved for over a year due to multiple submittals of Revision 4, which raises the concern of a lack of priority being placed on updating the safety basis by both NWP and CBFO.

The following presents a history of safety basis changes made to the WIPP DSA and TSR during the periods covering 2008 to the present time. The DSA/TSR Revisions 0 through 4 were approved during this time period and were selected for comparison because they represent a starting point in which a major safety basis upgrade was initiated, and because they show the evolution of changes made in the hazard/accident analysis and selected controls that occurred since the time of the initial upgrade.

The previous major upgrade to the DSA occurred in 2005 after a DOE Headquarters assessment of the CH DSA Revision 8 in 2004 concluded that improvements were necessary, especially with the DOE issuance of the DOE-STD-1186-2004, *Specific Administrative Controls*. This was considered to be a major step-up of the nuclear safety culture for WIPP and affected many operating and support procedures to implement the new TSRs.

The DSA/TSR Revision 0 was developed and approved in 2008 to implement the DOE-STD-5506 issued in 2007, which provided a consistent approach for the hazard and accident analysis of TRU waste operations within the DOE complex, and selection of safety controls to prevent or mitigate accidents. The DSA/TSR Revision 1 was issued in 2009 to resolve some TSR implementation issues identified with Revision 0. Implementation of the Revision 1 TSRs had a significant impact on the nuclear safety culture at WIPP, because it resulted from a major re-baselining of the hazard/accident analysis and led to a revision of numerous TSR implementing procedures and training to the new requirements.

- The following changes to the DSA in the past few years have been limited to events involving a collapse of the back in a waste disposal room postulated in an active panel. This initial scope of the following discussion is chosen based on suspected events related to a radiation release event occurring in the U/G on February 14. Other DSA/TSR changes were made during this timeframe, but are not covered in this evaluation.
- Revisions 0 and 1 of the DSA/TSR were approved in the 2008 and 2009 timeframe and represented a major upgrade of the safety basis. Among the U/G accidents evaluated in the DSA Section 3.3 hazard evaluation was Event 030-CH/RH-U/G, *Roof Fall*. The unmitigated frequency/consequences of this event were judged to be an anticipated event with low consequences to the facility worker, high consequences to the co-located worker,

and moderate consequences to the public. The primary TSR control credited for this event was a SAC that required weekly ground control inspections to ensure changing conditions are promptly identified, evaluated and addressed. This reduced the frequency of a back/rib fall to unlikely, and lowered the consequence estimates to moderate for the co-located worker and low for the public. The conclusion of low facility worker consequences is the subject of one of two PISAs identified since the event happened.

- Revision 2 of the DSA/TSR was approved in January 2011. The event number of Event 030-CH/RH-U/G, *Roof Fall* was changed to CH/RH-U/G-30-001a. No other changes were made to the unmitigated frequency/consequences or controls credited for the event.
- Revision 3 of the DSA/TSR was approved in May 2011. Event CH/RH-U/G-30-001a was further changed in terms of the mitigated consequences to the maximally exposed off-site individual (increased from low to moderate) and a reduction in the frequency of the event from anticipated to unlikely. The reasons for these changes are unknown and are not discussed in the SER. These changes to the DSA/TSR (Revision 2) were made by the contractor, reviewed by CBFO nuclear safety and approved by the acting CBFO Manager as the delegated SBAA. These changes were not recognized by CBFO during their review, and therefore, the basis for the changes were not discussed in the DOE's Safety Evaluation Report (SER).The previous SAC control was also removed and presented as an initial assumption/initial condition of the analysis. This reduced the unmitigated frequency of the event, which is not consistent with the unmitigated analysis guidance in DOE-STD-3009 and DOE-STD-5506. However, the initial assumption/condition is not protected as a TSR control.
- Revision 4 of the DSA/TSR was approved in August 2013. Event CH/RH-U/G-30-001a was significantly changed in Revision 4. The event title and location was changed to a *Roof Fall in a Closed Panel*. DSA Revision 4 no longer evaluates an accident involving a roof fall in an active panel. The revised event also had significant changes in frequency and consequence. The unmitigated and mitigated frequency is changed to "anticipated." Both unmitigated and mitigated consequences are also reduced to low for all receptors. Through interviews, NWP Nuclear Safety acknowledged it was in error for not including the hazard scenario, i.e., event #CH/RH-U/G-30-001b, from the WIPP-021 hazard analysis report in the DSA. This change was not identified by CBFO during their review, and therefore, the basis for the change was not provided in the DSA or DOE's Safety Evaluation Report (SER). It is not clear in the DSA or the CBFO SER why this change is justified.

CON 2: There has been a reduction in conservatism in the Documented Safety Analysis hazard/accident analysis and Technical Safety Requirement safety controls within safety basis revisions occurring since 2010, i.e., *Documented Safety Analysis/ Technical Safety Requirement*, Revision 1 to Revision 4. This is not consistent with DOE-Standard (STD)-3009, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis* and DOE-STD-5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*.

JON 3: NWP needs to revise the hazard and accident analyses to comply with DOE-Standard-3009, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis* and DOE-STD-5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, regarding not crediting administrative controls in the unmitigated analysis. In particular, some initial assumptions/initial conditions, e.g., compliance with 30 CFR 57, *Safety and Health Standards Underground Metal and Nonmetal Mines* ground control program requirements, should be preventive or mitigative controls derived by the mitigated analysis and should be evaluated for the need for protection with Technical Safety Requirement controls.

3.1.3 DOE Review, Approval, and Oversight Process for the Safety Basis

Evidence of errors in the DSA and TSRs, together with unjustified changes in hazards/accident analysis and controls in various revisions of the documents, are indicative of weak internal and independent peer-review processes.

Analysis

CBFO performs the review and approval of safety basis submittals in accordance with CBFO MP 4.11, *Safety Basis Review Procedure*, Revision 4. This procedure implements the guidance from DOE-STD-1104-2009, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. The MP 4.11 procedure defines the responsibilities for CBFO to review contractor submittals, and document the basis for approval in a SER. The CBFO Manager is the DOE Safety Basis Approval Authority for the DSA and TSRs, as delegated by DOE Headquarters annually since 2010.

A CBFO review team is established comprised of at least one qualified Nuclear Safety Specialist and subject matter experts from other CBFO organizations, supplemented by additional resources from the Carlsbad Technical Assistance Contractor (CTAC) as necessary. Since approximately 2010, CBFO has been relying on a safety basis lead that is a collateral duty with primary responsibility to oversee the Radiation Protection Program. This individual meets the qualifications for both positions. Due to the February 14, 2014, release, there will likely be an increased focus on radiation protection and safety basis that cannot be adequately provided by a single CBFO individual responsible for both programs. It should also be noted that for the past few years, CTAC provided one full time nuclear safety experienced individual to assist in reviews of safety basis submittals.

One unique aspect of this procedure is that the CBFO Manager also relies on advice from a Senior Technical Advisor (STA) who also signs the SER, along with the review team leader and the CBFO Manager. This STA position was originally called an "Authorization Basis STA" created in 2007. However, after that individual retired in 2010, the position was filled with an individual who was not nuclear safety qualified. That individual was subsequently re-assigned in 2011, and since that time, the CBFO Manager has been relying on other senior CBFO staff to serve as the STA on a case-by-case basis for each DSA/TSR major change submittal. CBFO STAs assigned since 2011 were not nuclear safety qualified.

The Board reviewed the SERs for the DSA/TSR Revisions 2, 3 and 4. These SERs clearly summarize the major changes, along with a statement of CBFO concurrence with them. The SERs follow the general format as recommended in DOE-STD-1104, however, the technical basis for approval for them is lacking. Since the technical bases are not described in the SERs, the Board requested the official CBFO Quality Assurance (QA) record file to assess whether the DOE comments and resolutions provide insights regarding why the changes were acceptable. The CBFO QA record retention process was able to retrieve a small percentage of the CBFO Document Review Record (DRR) forms for the DSA/TSR Revision 4, but could not locate the complete record package for it as defined in CBFO procedure CBFO MP 4.2 *Document Review*, Revision 9 or the Revision 2 and 3 CBFO review packages. Therefore, the CBFO Nuclear Safety lead provided unofficial copies of all three reviews. Review of these DRRs show that CBFO challenged some of the major changes, but the responses documented on the DRRs do not provide sufficient explanations as to why CBFO determined that the changes were technically justified.

There have been no formal assessments of the DSA/TSR development process in the past few years by the previous contractor or NWP. This does not meet the expectation of the TSR Section 5.5 requirement for reviews and audits. In the past four years, CBFO performed one formal QA surveillance, S-13-04 of the NWP Nuclear Safety Program. This focused on compliance with the NWP procedures, rather than a critical review of the effectiveness of the program. More frequent assessments of the effectiveness of the contractor and CBFO nuclear safety programs would be normally expected. Other DOE sites have commissioned independent assessments consistent with the continuous improvement principle.

CON 3: The Documented Safety Analysis and Technical Safety Requirement have several errors or omissions that are indicative of lack of rigorous contractor internal review and independent peer-review processes for the development of the safety basis, e.g., quality issues include Documented Safety Analysis and Technical Safety Requirement errors, lack of Documented Safety Analysis linkage to supporting hazard analysis information, confusion over back fall accident description in closed vs. open panel.

JON 4: NWP needs to commission an independent assessment of the Documented Safety Analysis/Technical Safety Requirement Revision 4 through corporate assistance or other recognized external resources, and corrective actions implemented that establish appropriate hazard controls and functional classifications.

3.2 Technical Safety Requirements

The Board analyzed the WIPP safety basis and related processes and procedures to determine whether or not TSRs were developed in coordination with DSA that had relevancy to the radiological release of February 14, 2014, and recovery operations, and whether or not there were historical TSR implementation issues.

Specifically, the Board reviewed the TSR, Revision 4, and implementing procedures for these TSRs. Key personnel were also interviewed with knowledge and responsibility for managing and maintaining the TSRs, i.e., the NWP Nuclear Safety Manager, the NWP Operations Manager, NWP personnel responsible for developing NWP procedures in compliance with the TSRs, or reviewing and approving the TSRs, i.e., the CBFO manager responsible for nuclear safety, the CBFO nuclear safety SME, and the CBFO FRs. The focus of the analysis was to determine which TSRs were applicable to the event and recovery from the event; whether or not new proposed controls have been identified as the result of the event; how the procedures that implement TSR controls protect the DSA assumptions; and the adequacy, consistency and flowdown of the DSA into the TSRs for providing for safe operations.

3.2.1 Applicable Technical Safety Requirements

No TSR controls were identified as being violated as a result of the event or the immediate recovery from the event. Additionally, all controls were implemented as required.

Analysis

Applicable Limiting Conditions for Operations (LCO) and modes included:

- LCO 3.3.5, *Lube Truck Access Control in the Underground*, all times;
- LCO 3.3.8, *Liquid-Fueled Vehicle/Equipment Control in a Disposal Room*, disposal;
- LCO 3.4.2, *Fuel Barrier in the Underground*, all times; and
- LCO 3.7.1, *Noncompliant Container Response*, all times.

Applicable SAC and Programmatic Administrative Controls (PAC) include:

- SAC 5.1.1.1, *Underground Liquid-Fueled Vehicle/Equipment Inspection Program*, waste handling;
- PAC 5.1.2.1, *Training*;
- PAC 5.1.2.2, *Fire Protection Program*; and
- PAC 5.1.2.3, *Safety Management Programs*.

The preexisting LCO in effect just prior to the event was LCO 3.4.2, “Static Waste Face shall be protected.”

3.2.2 New Proposed Controls

Longer range improvements are still being considered but will not be finalized until more details associated with the event are known. Per the 10 CFR 830.203(g)(1) requirement for a PISA, operational restrictions were implemented, e.g., continue to operate the U/G ventilation system in HEPA filtration mode, do not enter Waste Handling Mode in the underground, and other measures. Compensatory measures to the existing safety basis are being proposed by NWP to support short term recovery actions for DOE approval. This approach involves approving recovery activities in phases by submitting an "Evaluation of the Safety of the Situation" that contains discrete milestones and associated controls to perform the work safely. Each recovery milestone would obtain DOE CBFO review and approval.

Analysis

Longer range improvements are still being considered but will not be finalized until more details associated with the event are known. Draft compensatory measures to the existing safety basis proposed by NWP to support short term recovery actions include:

- Do not enter Waste Handling Mode in the Underground;
- Do not operate U/G liquid fueled vehicles without a USQD being performed by Nuclear Safety;
- Continue to operate the Mine Ventilation System in Filtration Mode, and do not operate the system in any other mode without a USQD performed by Nuclear Safety; and
- Do not enter U/G ventilation exhaust drift without a USQD being performed by Nuclear Safety.

Other options under consideration include:

- A change to the current definition of manning of the U/G to allow proposed activities in order to not incur immediate TSR violations upon entry to the U/G; or
- DOE approval of activities on a case-by-case basis. This approach would essentially be a recovery plan submitted with an "Evaluation of the Safety of the Situation" type review that contains discrete steps and associated controls. Each step would obtain DOE CBFO review and approval. In this approach, the TSRs would not have to be modified and then revised again upon completion.

These recovery actions are not considered as part of the scope of TSR Section 5.6.2, "Conditions Outside of the TSR," as this section addressed immediate actions in the event of an emergency.

Further, consideration must be given to considering how to maintain ground control operations, which are an important assumption of the safety basis. The overall safety strategy must consider both U/G and nuclear safety implications.

Any long term improvements should include functional reclassification and upgrades to the U/G confinement ventilation system and radiation monitoring instruments that actuate HEPA filtration. The ventilation system switched to a filtration mode based on an automatic signal from the one operating CAM before radioactivity reached the exhaust fans during the February 14, 2014, radiological event. Essentially all of the radiological materials released from the facility during the February 14, 2014, event resulted from leakage of the bypass isolation dampers. This pathway has been addressed via NWP activities that applied polyurethane foam to areas of leakage. CAMs in U/G active disposal panels currently possess the lowest functional safety classification, Balance of Plant, and can be taken out of service without prior DOE or NWP Nuclear Safety approval leaving no real-time monitoring capability. This was the case regarding the Timely Order issued from February 6 – February 10, 2014. Having no continuous radiation monitoring means that any potential release in the underground would be unfiltered since the CAM is not available to initiate the switch to HEPA filtration.

3.2.3 Implementation of TSR Controls

Procedures that implement TSR controls are controlled via a Linking Document Data Base process, which ties the DSA to Safety Management Program (SMP) requirements, initial conditions and assumptions, LCOs, SRs, Design Features (DF), SACs, and PACs. The NWP Nuclear Safety organization controls the DSA/TSR Linking Document through standard document control. All procedures are reviewed biennially, and additionally the Linking Document is reviewed by Nuclear Safety every time the DSA is revised. Some minor misalignments have been identified and corrected by NWP and the previous contractor nuclear safety group during their assessments.

Analysis

Procedures that implement TSR controls are controlled via a Linking Document Data Base process, which ties the DSA to SMP requirements, initial conditions and assumptions, LCOs, SRs, DFs, SACs, and PACs. NWP Nuclear Safety controls the DSA/TSR Linking Document through standard document control via WP 15-PS3002, *Controlled Document Processing – Management Control Procedure*, Revision 31. All procedures are reviewed biennially and additionally, the Linking Document is reviewed by Nuclear Safety every time the DSA is revised. Some minor misalignments have been identified and corrected by NWP and the previous contractor nuclear safety during their assessments. The section for Administrative Control (AC) 5.5 describes methods for conducting reviews and audits associated with maintaining compliance with the TSR. Only one CFBO surveillance S-13-04, and no contractor reviews associated with TSR compliance have been performed since 2009.

The implementing procedure for LCO 3.3.7, WP 05-WH1025, *Liquid Fuel Vehicles in Disposal Room*, was randomly selected for review. No deficiencies were noted. Personnel receive initial DSA training and periodic training to DSA updates. There have been no TSR violations in the past three years.

It is not clear how the current Revision 4 of the TSR/LCO addressed some issues described in the "Report for Assessing Documentation and Implementation of Specific Administrative Controls at the Waste Isolation Pilot Plant," November 2010, as Revision 3 of the TSRs did. For example, Revision 3 had a DF for the waste hoist as its structure was classified as SC, but it has been eliminated from the current version, Revision 4, without clearly documented justification.

3.2.4 TSR/DSA Flowdown for Safe Operation

While TSRs are consistent with the DSA, they are not effective in ensuring that the facility is operated in a configuration that provides adequate protection from radiological events. The function of the TSRs as articulated in 10 CFR 830 Appendix A, Section G.4 is as follows:

> *"Technical Safety Requirements establish limits, controls and related actions necessary for the safe operation of a nuclear facility."*

Due in part to the fact that neither the CAMs nor the U/G ventilation system are classified as safety, i.e., SC, SS, ITS SSCs, their importance has not been acknowledged through operation and control within the auspices of the TSRs and LCOs.

As a result, operating procedures associated with the CAMs are not required to be linked in any manner to explicit TSRs. In addition, the need for a real-time radiation monitoring capability reveals disconnects in the radiation protection program that is a commitment of the TSR to ensure safe operation.

Analysis

While TSRs are consistent with the DSA, they are not effective in ensuring facility configurations that provide adequate protection from radiological events. The function of the TSRs as articulated in 10 CFR 830, Department of Energy *Nuclear Safety Management Rule*, Subpart B, *Safety Basis Requirements*, Appendix A, "General Statement of Safety Basis Policy," Section G, "Hazards Controls," G.4 is as follows:

> *"Technical Safety Requirements establish limits, controls and related actions necessary for the safe operation of a nuclear facility."*

Due in part to the fact that neither the CAMs nor the ventilation system are classified as safety related in the safety basis, i.e., SC, SS, ITS SSCs, their importance has not been acknowledged through operation and control within the auspices of the TSRs and LCOs. In addition to the need for real-time radiation monitoring capability at this nuclear Hazard Category 2 facility to ensure safe operation, there exist disconnects in the safety management programs (SMPs). The PACs of TSR Section 5.1.2 do not address a Radiation Protection Program, and Chapter 7 of the DSA does not directly refer to the need for CAMs. However, there is a key attribute 7.4 that would require monitoring to ensure safety. Attachment A2 of the Hazardous Waste Permit under Underground Ventilation Modes of Operation, provides the following paragraph on page A2-9 of 47, lines 29 through 38,

> *"In the filtration mode, the exhaust air will pass through two identical filter assemblies, with only one of three Exhaust Filter Building filtration fans operating (all other fans stopped). This system provides a means for removing the airborne particulates that may contain radioactive and hazardous waste contaminants in the reduced exhaust flow before they are discharged through the exhaust stack to the atmosphere. The filtration mode is activated manually or automatically if the radiation monitoring system detects abnormally high concentrations of airborne particulates (an alarm is received from the continuous*

air monitor in the exhaust drift of the active waste panel) or a waste handling incident with the potential for a waste container breach is observed. The filtration mode is not initiated by the release of gases such as VOCs."

However, as a result of not being a credited safety SSC, timely orders that can potentially affect nuclear safety at the facility can be issued not only without DOE review or approval, but also without NWP Nuclear Safety review and approval. One such example is the Long Term Timely Order 14:001, effective February 6, 2014, through 1905 hours on February 10, 2014. The NWP Nuclear Safety group did not review this Order and in general does not review other Timely Orders unless the USQ process is applicable to that particular Order. Timely Orders are initiated through WP 04-CO.01-15, *Timely Orders to Operators*, Revision 2, and consist of Daily and Long Term categories. No other Long Term Timely Orders or Daily Timely Orders associated with the CAMs have been issued in the past three years. Both Daily Timely Orders and Long Term Timely Orders for other reasons do occur periodically, about one to three per year. Timely Order 14:001 allowed unfiltered ventilation of the U/G without CAM indication. In this ventilation maintenance bypass mode of operation, no real-time indication of off-site radiological releases are available and instead the periodic sampling of Station A (daily) and Station B (weekly) would be the primary means to identify radiological releases. (Figures 8 and 9) If an underground release were to occur, personnel would also unknowingly receive a dose if they were in the U/G until Station A readings were processed each morning and the release would have been identified. If the radiological release event of February 14, 2014, had instead occurred in the February 6 – February 10, 2014, timeframe, a more significant off-site and worker radiological event would have resulted.

Figure 8: Ventilation Sample Station A

Figure 9: Ventilation Sample Station B

Figure 10: Waste Hoist Cable

Due to the reduction in the conservatism of the DSA hazard and accident analysis, the TSR coverage of Safety Class, Safety Significant, and other administrative controls has been reduced over time. The ground control SAC has been eliminated from Revision 3 of the TSR and replaced by assumed initial assumptions in the DSA associated with the SMP for U/G mining, which endorses 30 CFR 57, *Safety and Health Standards Underground Metal and Nonmetal Mines*. Likewise, the ventilation system meets 30 CFR 57 for manned entry and continued work, but has no associated TSR requirements. The waste hoist is inspected and operated to 30 CFR 57, Subpart R, *Personnel Hoisting*, which is the basis for initial assumption 12a, 12b, and 12c of the DSA. The use of the initial assumptions in the DSA must be protected and the proper method is accomplished via explicit TSR LCOs, or in other situations, SACs, and not on compliance with other regulatory requirements, which are verified outside of the TSR process. Initial assumptions that strictly rely on reference to SMPs without specificity are not of the pedigree of compliance with explicit TSRs. Initial assumptions are that containers comply with WIPP Waste Acceptance Criteria requirements. DOE-STD-3009 Appendix A does not allow crediting administrative controls as initial condition. However, many DSAs were developed in the DOE Complex that credited an inventory limit as an initial condition, e.g., limiting a nuclear facility to the Hazard Category 3 threshold quantities (e.g., 900 g Pu^{239}). In 2004, DOE-STD-1186 was issued on Specific Administrative Controls, and that standard clarified that unmitigated analyses may credit inventory controls as long as covered by TSRs. The Waste Acceptance Criteria inventory limits fall under this practice. Shipping containers can also be used as initial assumptions even though these adhere to Department of Transportation rather than DOE requirements in that they are physically constructed and verified for compliance. The current controls associated with the Waste Hoist are TSR LCO 3.8.1, applicable only to the brakes. The hoist controls have evolved from credited controls in Revision 2, which included a SAC and DF to TSR/LCO on the brakes and DF in Revision 3 to eventually TSR/LCO on brakes in Revision 4. (Figure 10) Previous revisions of the TSR's had a DF for the waste hoist as its structure was classified as SC but not the current revision.

The Compressed Gas Program has been eliminated in Revision 2 of the TSRs based on the fact that the updated hazard identification did not identify the presence of propane-powered vehicles on-site, thus eliminating the potential boiling liquid expanding vapor explosions and vapor cloud explosions. However, this is not identified as an initial assumption, nor is any prohibition of bringing propane-powered vehicles on-site protected by a TSR SAC.

The requirement for automatic fire suppression on the non-waste-handling vehicles has been removed; however, this control was never a TSR requirement and the contractor nuclear safety group was not involved in the decision process. Removal of the automatic fire suppression on the waste-handling vehicles would however trigger the USQ process and contractor nuclear safety involvement. The recent fire event could shed light on the adequacy of some previously assumed vehicle fire scenarios and an event for entering the PISA process, as discussed later in this section.

The TSR documentation is not being controlled with the rigor normally associated with a safety basis document. For example, in the current version of the TSR a reference is made in section 5.3.1 "Contractor Responsibilities," to perform activities in accordance with TSR Section 1.7. Section 1.7 does not exist in the current version of the TSR. In Board interviews, the contractor was made aware of the lack of Section 1.7 and is rectifying the condition. Other procedures such as WP 04-EM4200 will need to be upgraded for content and clarity consistent with the importance associated with implementing TSR requirements. Terminology in this procedure such as "radiological conditions cannot be verified" will need to be replaced by specific conditions associated with the radiation sensors (e.g., CAMs) in order to eliminate varying interpretations. There are 12 possible combinations of CAM-151 and CAM-152 stated with/without RCT coverage and not all interviewees had the same interpretation of how these states translate to whether "radiological conditions cannot be verified" and subsequent action to switch to filtration. TSR implementing procedures also require sufficient training for effective use which, when used in conjunction with clearer terminology, will result in the desired response.

CON 4: Technical Safety Requirements are not effective in ensuring facility configurations that provide contribution to defense-in-depth for radiological events. The function of the Documented Safety Analysis as articulated in 10 CFR 830, *Nuclear Safety Management Rule*, Appendix A, Section G.4 is as follows: "Technical Safety Requirements establish limits, controls and related actions necessary for the safe operation of a nuclear facility."

JON 5: NWP needs to re-evaluate the importance of the suite of available preventive and mitigative controls, e.g., continuous air monitors and underground ventilation system, in the supporting hazards analysis report and the Documented Safety Analysis, Section 3.3 hazard evaluation, and whether they should be considered as major contributors to defense in depth. This may require upgrading of some Structures, Systems, and Components functional classifications.

CON 5: Since neither the CAMs nor the underground ventilation system are pedigreed, i.e., Safety Class, Safety Significant, Important to Safety Structures, Systems, and Components, their importance has not been acknowledged within the Technical Safety Requirements, e.g., no Limiting Conditions for Operation/ Surveillance Requirements.

In addition, neither Documented Safety Analysis Safety Management Programs, (Chapter 7 Radiation Protection Program), nor the Technical Safety Requirement Programmatic Administrative Controls consider whether CAMs may provide protection for the facility worker who may be in the exhaust drift.

JON 6: NWP needs to re-evaluate the classification of continuous air monitors and the underground ventilation system consistent with the outcome of the revised hazard analysis and develop Technical Safety Requirement controls consistent with that classification.

CON 6: The Technical Safety Requirement documentation is not being controlled with the rigor normally associated with a Hazard Category 2 nuclear facility.

JON 7: NWP needs to revise the Technical Safety Requirements to align with changes to the Documented Safety Analysis, e.g., continuous air monitor and underground ventilation system, correct current errors in the Technical Safety Requirements, and ensure that implementing procedures clearly support consistent interpretations.

3.3 The Unreviewed Safety Question Process

The safety basis is required to be maintained current. This is accomplished by implementing a change control process, and annually updating the DSA and TSRs for those changes that were implemented by the contractor because DOE approval was not required. Annual updates to the DSA are addressed above. This section addresses the element of the NWP configuration management process that evaluates proposed activities or changes (e.g., to facility configuration or plant procedures) through an USQ process. The Board reviewed the nuclear safety management program to ensure that a formal USQ process is approved, adequately implemented, and supported by trained and qualified individuals.

Specifically, the Board reviewed NWP and CBFO USQ processes and procedures and interviewed NWP and CBFO nuclear safety management and subject matter experts to determine whether the existing USQ procedure is approved by DOE and compliant with DOE G 424.1-1B. In addition the Board evaluated whether or not actions to date following the U/G radiological release event have been correct and consistent with the USQ procedure; evidence/history to substantiate if the NWP USQ procedure is being adequately implemented by trained and qualified individuals; and sufficient evidence/history to determine if DOE has trained and qualified nuclear safety personnel to review the NWP USQ Procedure for approval by the CBFO Manager.

3.3.1 Adequacy of NWP USQ Procedure

NWP has a DOE-approved procedure governing the USQ process that includes requirements for evaluating whether proposed new activities are outside of the safety basis and steps following an operational event or discovery of information to determine whether to declare a PISA. The Board identified concerns that some changes to the facility can be evaluated with concurrence from the Nuclear Safety organization. Additionally, potentially confusing steps were identified in the USQ procedure associated with the PISA declaration process.

Analysis

The current NWP procedure for the USQ process is WP 02-AR3001, *Unreviewed Safety Question Determination,* Revision 11. This procedure establishes the process of determining whether proposed facility changes are adequately evaluated relative to the approved safety basis and that those proposed changes determined to involve an USQ are brought to the attention of CBFO for review and approval prior to taking any action that involves a positive USQ. It also provides instructions to evaluate discovery of new information or an occurrence to determine whether there is a PISA.

As required by 10 CFR 830.203(b), CBFO approved this revision of the procedure on August 23, 2013. CBFO did not develop an SER or otherwise document their basis for approval. Comment-responses are documented on the CBFO Document Review Record forms provided by the CBFO Nuclear Safety SME; however, official copies could not be provided by the CBFO QA record retention process.

In accordance with the NWP procedure, USQDs can be performed and approved without the review or concurrence of either the Nuclear Safety organization, the Nuclear Review Board (NRB) or the Chief Nuclear Engineer, provided the conclusion of the USQD is negative, i.e., does not require a change to the DOE approved safety basis. A PISA determination has the same review/concurrence requirements. The Board noted that this process could result in a negative USQD or PISA determination without the concurrence of the safety analysts who are most familiar with DSA assumptions and the basis of hazard/accident analysis calculations.

The Board also noted some potentially confusing steps in the USQD procedure. Section 6, "Process for PISAs," could be interpreted as only allowing the Facility Manager, Facility Manager Designee, or Facility Shift Manager, to determine whether new discoveries or operational events constitute a PISA. This is not the intent based on discussions with the NWP Nuclear Safety Manager. Additionally, the Board noted that the narrow terminology of "accident analysis" is used in the procedure's definitions section and in locations such as Appendix F, "Instructions for PISA Determinations." This usage of this terminology is overly limiting and should refer to a much broader consideration of hazard analyses, safety analysis assumptions, and results in the DSA.

The NWP USQD procedure does not clearly communicate the actions supporting the PISA process, and NWP has demonstrated lack of recognition of the need for CBFO approval of proposed recovery activities that are outside the analyzed safety basis. In addition, the determination of PISAs and evaluation of proposed recovery actions associated with the radiological release involving application of the categorical exclusion criteria, USQ screening, and USQ determinations indicate lack of understanding (e.g., completeness and applicability of responses regarding impact on previously analyzed accidents or safety controls; clearly addressing the scope of the questions such as impact on frequency, consequences, equipment ITS; completeness of identifying applicable accidents previously analyzed, or accident of a new type not previously analyzed).

3.3.2 USQ Procedure Implementation

The Board observed some hesitancy on the part of NWP to initiate a PISA determination in the absence of data related to the U/G radiological release of February 14, 2014. Additionally, weaknesses were observed in USQ evaluations associated with recovery activities.

Analysis

The Board interviewed the NWP Nuclear Safety Manager and Chief Nuclear Engineer on March 6, 2014, in order to understand their roles/responsibilities related to the USQ process, actions taken in response to the radiation event on February 14, 2014, and the NWP basis for various changes made in the safety basis.

The Chief Nuclear Engineer acts in an advisory and independent review role for the NWP President. The NWP Nuclear Safety organization is responsible for DSA/TSR preparation and revision, and USQ process implementation. NWP Nuclear Safety is comprised of four nuclear safety staff and two fire protection engineers. Five of the staff within NWP Nuclear Safety are qualified as USQ evaluators. Overall, approximately 20 USQ-qualified evaluators are on-site within NWP. Qualifications for USQ personnel are established in USQ Procedure WP 02-AR3001, and are consistent with general guidelines in DOE G 424.1-1B.

Discussions with the NWP Nuclear Safety Manager and Chief Nuclear Engineer focused on the process by which NWP considers entering the USQ process through initiation of a PISA declaration, considering one possibility that the facility may have violated an initial assumption of their DSA related to routine activities associated with the Ground Control Program, i.e., not being performed for some period of time following the event. During these discussions both NWP personnel indicated their intent to eventually enter into the PISA process. However they also noted that this would not likely occur until after the physical mechanism for the release was determined after reentry into the underground. Although the NWP procedure requires a determination following five days of discovered information, the “clock” had not yet started on initiation of procedural steps. The concern raised by the Board was that rather than initiating the PISA process based on the “potential” inadequacy, there may have been a misconception and that the site was waiting to initiate the process only after they had confirmed any actual inadequacy.

During the course of the accident investigation, NWP made the decision to convene the NRB to initiate the formal PISA determinations for the “Underground Salt Haul Truck Fire,” PISAD Number P-14-0001, and for the “Underground Radiological Event,” PISAD Number P-14-0002. The NRB was convened March 12, 2014, and the determination that these PISAs were confirmed was made on March 13, 2014. NWP imposed operational restrictions by issuing Management

Directive 1.5 on March 12, 2014, and further actions as defined by their USQ process are planned, including performance of USQDs and "Evaluation of the Safety of the Situation."

Observations from this NRB identified several weaknesses and inconsistencies with sound PISA practices. These included formulating responses in the draft PISA determinations that did not specifically address the question, e.g., did not identify what safety functions were previously credited and instead addressed the non-credited safety function of the U/G HEPA filtration system, which is also important. Feedback from those in attendance at the NRB resulted in adding other clarifications to the PISA determinations.

The Board also reviewed USQ documents prepared in connection with the February 14, 2014, radiological event in the WIPP underground. USQD D14-003, "ECO 13382 and Work Order 140200 for Sealing of Ventilation Dampers 413-HD 056-003A and 413-HD-056-003B," Revision 0, was prepared to support planned high-density foaming activities of the HEPA filtration bypass to seal unfiltered leakage around dampers. NWP determined that the USQD was negative. The Board had significant concerns with the lack of details in the USQD related to the type of foaming materials and associated hazards. This is important given the hazardous constituents of the foaming product, polymeric methylene diphenyl diisocyanate, which has been evaluated at some DOE sites as having the potential for high off-site toxicological consequences. Without this information, the USQD questions are difficult to answer. Revision 1 was subsequently issued to authorize the activity.

The Board had other concerns with the quality of the USQD Revision 1 responses related to a potential exothermic reaction due to a foaming process upset that could result in a fire and subsequent failure of contaminated HEPA filters in the U/G ventilation system due to the fire soot combined with the observed particulate loading on the Mod filters, and this event was not considered in response to Question 5 regarding creating the possibility of an accident of a different type than previously analyzed. Although the safety basis includes a fire involving the Waste Handling Building contaminated HEPA filters, which affects USQD Questions 1 and 2 on potential increase in frequency or consequences, these hazard scenarios were not addressed as bounding or representative for a fire release from the U/G HEPA filters.

An unplanned exothermic accident that could have led to a fire occurred on March 8, 2014, when "reddish-brown" vapors were observed coming from the open ports in the duct (ORPS report EM-CBFO--NWP-WIPP-2014-0003). That activity for low-density foaming of the duct between the two isolation dampers was evaluated per USQD D14-004, "Work Order 14020078, 413HD056003A Seal Duct Between 3A and 3B Dampers." That USQD is very similar to the USQD D14-003 Revision 1, and has the same concerns related to the adequacy of responses to Questions 1, 2, and 5.

The Board also reviewed USQ Screen IS14-0062, "Work Order 1402037C, 371, SH Perform Shaft/Conveyance Habitability Phase 1 of Reentry into Underground," which was performed to support unmanned entry via the Salt Hoist Shaft/Conveyance. This proposed activity was initially evaluated as a Categorical Exclusion established for maintenance procedures. The Board had significant concerns that this activity has never been performed at WIPP and should not be authorized as a Categorical Exclusion. Instead of completing the Categorical Exclusion, NWP completed a USQ Screen and determined that the activity can be authorized without further USQD evaluation.

3.3.3 Annual USQD Submittals

The contractor has provided summaries of USQDs to CBFO annually. However, neither the contractor nor CBFO have recently performed formal assessments of the effectiveness of the USQ process.

Analysis

To meet the requirements of 10 CFR 830.203(f), the contractor has submitted reports of performed USQDs annually, in December of each year. Approximately 15 to 30 USQDs have been completed annually. This total is surprisingly low for a Hazard Category 2 nuclear facility compared to other nuclear facilities in the DOE complex. The low number of USQDs performed annually implies that USQDs are not being prepared when there may have been a need for further in-depth evaluation of proposed changes. There have been no formal assessments of the effectiveness of the USQ process in the past few years by either the contractor or CBFO. However, in the past four years, CBFO performed one "oversight evaluation" of the 2013 annual USQD submittal that was focused on compliance with the WIPP procedure. An assessment of the USQ process and past USQDs to determine whether USQ-qualified evaluators demonstrate a probing and questioning attitude when evaluating changes and discoveries has not been accomplished.

CON 7: The NWP Unreviewed Safety Question Determination procedure does not clearly communicate the actions required to evaluate situations that could involve a Potential Inadequacy in the Safety Analysis. In addition, NWP's implementation of Unreviewed Safety Question procedure requirements indicates a lack of recognition that some proposed recovery activities associated with the radiological release event were outside the analyzed safety basis. This is evident from NWP's Unreviewed Safety Question's evaluations or lack there-of, related to impacts on previously analyzed accidents or safety controls; identifying equipment that is important to safety; and completeness of identifying accidents of a new type not previously analyzed.

JON 8: NWP needs to commission an independent assessment of the Unreviewed Safety Question process through corporate assistance or other recognized external resources, and implement corrective actions that ensure effectiveness.

JON 9: NWP needs to strengthen the Unreviewed Safety Question Determination procedure to clarify Potential Inadequacy in the Safety Analysis guidance, including the appropriate timeliness for entrance into the process and decision making.

CON 8: There is an observed lack of robustness in the CBFO technical review of Documented Safety Analysis/Technical Safety Requirement changes/annual updates, e.g., lack of documentation of the technical basis for approval to support development of a Safety Evaluation Report. While the Safety Evaluation Reports are consistent with the format per DOE-Standard-1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, the conclusions do not include adequate rationale for acceptance of the proposed changes.

JON 10: CBFO needs to revise Management Procedure 4.11, *Safety Basis Review Procedure*, to require adequate documentation of the technical basis supporting approval of changes to the WIPP Document Safety Analysis or Technical Safety Requirements, consistent with DOE Standard 1104, e.g., regulatory compliance, justification for initial assumptions/initial conditions, reduced conservatisms of the hazards and accident analysis.

JON 11: CBFO and DOE HQ need to commission an independent assessment of the CBFO safety basis review and approval process and implement corrective actions that ensure effective implementation.

CON 9: CBFO has insufficient nuclear safety management/staffing since the 2010 timeframe and the retirement of Authorization Basis Senior Technical Advisor and existing Nuclear Safety Specialist staff responsible for multiple subject matter expertise.

JON 12: CBFO needs to perform a critical federal staffing analysis focused on Nuclear Safety e.g., Nuclear Safety Specialist, nuclear safety qualified Senior Technical Advisor and supporting CBFO Subject Matter Experts and determine whether existing resources are adequate.

JON 13: CBFO and DOE HQ need to arrange for temporary DOE senior nuclear safety resources to mentor existing CBFO nuclear safety and supporting resources, and assist as necessary.

4.0 Emergency Management

4.1 Emergency Management Program Implementation

The WIPP Emergency Management Program is implemented through the WP 12-9 series emergency response procedures, and the WP 12-ER series emergency management procedures. These procedures are designed to provide guidance, define the responsibilities for Operational Emergency (OE) categorization and classification, and define the organization structure and responsibilities. The WP 12-9 series identifies actions to activate the emergency response organizations and respond to emergencies, and defines the lines of authority. The Emergency Response Organization (ERO) structure and responsibilities are described in the WP 12-9 and the WP 12-ER series procedures. Additionally, WP 12-ER3906, *Categorization and Classification of Operational Emergencies*, identifies Emergency Action Levels (EAL) that provides the criteria to categorize an OE.

During on-site emergency conditions, the FSM is in control of the facilities, and is considered the Incident Commander, Emergency Director and the RCRA Emergency Coordinator. The FSM has full authority and responsibility for coordinating all emergency response measures. The FSM is also responsible for event categorization and classification, and activates the EOC. When the EOC is activated, a Crisis Manager assists the FSM with emergency actions. WIPP also has a Central Monitoring Room Operator (CMRO) who is responsible for reporting information concerning events to the FSM and notifying WIPP emergency response teams and support groups.

The EOC includes the Crisis Management Team, which consists of a Crisis Manager, Deputy Crisis Manager, Safety Representative, Operations Representative, EOC Coordinator, Consequence Assessment Support and a CBFO Emergency Representative, a DOE delegate. Also, the following support personnel may be located in the EOC: Public Affairs Coordinator, Human Resources Manager, Safety Coordinator, and Security Coordinator.

The contractor's plans do not allow the FSM to transfer the Emergency Director position to a more senior official such as the Crisis Manager in the EOC. Subsequently, this diminishes the ability of the FSM to focus on strategic and tactical response. The present response organization could possibly extend past the recommended Incident Command System (ICS) span of control for the FSM/Incident Commander (IC) position during a large incident and could possibly constrain the FSM in making quick and sound decisions.

Upon notification of a potential for a radiological release, or when unexpected radiological conditions are encountered, the RCM, with support from the Radiological Control Technicians (RCTs), is responsible for site radiological monitoring and assessment activities. During off-shift incidents, a Radiological Control representative is on-call to support the FSM during a radiological incident. Radiological response is governed by implementing procedures WP 12-ER4903, WP 04-EM 4200, and WP 12-HP4000, *Emergency Radiological Control Response*.

The Board reviewed execution of the WIPP Emergency Management Program and identified the following facts via witness statements, personnel interviews, logbook entries, and program documents.

Radiological Response and Protective Actions

The elements of the NWP Emergency Management Program and Radiological Controls response that were reviewed by the Board identified the following issues:

- The Intro alarm and PA announcement was not made per WP 12-ER4903, "Immediate Actions for "HI-HI" Rad alarm from a U/G CAM." Because of this failure, not all personnel on shift (ESTs, Security) were aware of the potential radiological release on February 14, 2014.
- Response procedures lack specificity or were not followed. There are two separate procedures for CAM alarm response based upon reaching the "HI Rad" or "HI-HI Rad" alarm.
- RCTs are not on-site 24 hours. The CMRO had difficulty reaching the on-duty Radiological Control representative, but did eventually make telephone contact with the RCM. The unavailability of Radcon personnel on-site delayed pulling air sample filters until the next morning.
- After obtaining the Station A air sample filter results, the proper personal protective equipment (PPE) was not worn when Radiological Controls management removed the Station B air sample filter around 0835. RCT personnel were aware of the fact that air movement could be felt coming out of the air sample line when removing the air sample filter, expressed this concern to their management and requested PPE guidance in order to pull the air sample filter. Radiological Controls management instead decided to pull the filter and did not wear any radiological PPE.
- Protective action (shelter-in-place for the surface) was directed at 0934 on February 15, 10 hours, 20 minutes after the CAM alarm.
- The AEOC was not activated until several hours after the event and then took approximately two additional hours to become operational with minimum staffing, 15 hours 30 minutes after the CAM alarm.
- NWP had established a "War Room" which consisted of technical and management personnel to develop recovery strategies for the Salt Haul Truck Underground Fire incident when the radiological event occurred. The "War Room" personnel turned their attention to the release event and per interviews gave technical directions to the ERO outside of the accepted ERO structure.
- There were unclear roles and responsibilities of the ERO structure during the event. This was compounded by the NWP War Room (NWP management), which was providing direction to ERO but was operating outside established ERO structure.
- The RCRA Contingency Plan was not implemented, as stated in Step 4.2 of the WP 12-ER4903.
- WP 12-ER4902, *Hazardous Material Spill and Release Response*, requires implementation of the RCRA Contingency Plan if the contents of one standard waste box or two or more

55-gallon drums of CH/RH TRU waste have been spilled. This procedure was not used in response to this event.

- Per interviews it was reported that there is constant trouble, e.g., malfunctioning, with the U/G CAMs.
- Real time airborne monitoring equipment was not in place, e.g., at Station A and Station B and the redundant CAM at Panel 7, to provide the CMR with data to provide for timely, well-informed decisions.
- Radiological Assistance Program (RAP) team equipment was used through the permission of the Regional RAP Coordinator to make up for a lack of portable radiological monitoring equipment on-site.
- The CMR log did not indicate if the CMR emergency ventilation system was utilized during this event. There is no guiding document that directs shifting the CMR HVAC to filtration.

Emergency Categorization and Classification

DOE Order 151.1C and DOE Order 232. 2, Chg1, *Occurrence Reporting and Processing of Operations Information*, both require timely categorization of an event which would result in prompt notifications and in the case of DOE Order 151.1C, rapid implementation of protective actions. During this event the initial categorization was not completed until approximately 22 hours after the "HI-HI Rad" alarm activation, and the event was not categorized as an OE.

One of the basic differences between emergency reporting and occurrence reporting is that occurrence reporting tells what has happened and describes steps so the occurrence may be prevented from happening again in the future. For Emergency Categorization/reporting the categorization of the event does not have to wait for the incident to occur. Events may be categorized on the potential of the incident reaching Emergency Categorization criteria so that protective actions can be put in-place to avoid adverse impacts on workers, co-located workers, and/or the public. DOE Order 151.1C requires that site- and facility-specific EALs must be developed for the spectrum of potential OEs identified by the Emergency Planning Hazards Assessment and must include protective actions corresponding to each EAL.

NWP elected not to categorize/classify the release event as an OE, although WP 12-9 and WP 12-ER3906 provide the following criteria for the FSM to determine if an event is an OE:

- WP 12-9, Section 5.3.3, *Environmental Operational Emergency*, states:

  "Any actual or potential airborne release of radioactive material or hazardous material to the environment that could result in consequences to personnel or the environment."

- WP 12-ER3906, Table 1, states

  "Any facility evacuation in response to an actual occurrence that requires time-urgent response by specialist personnel, such as hazardous material responders or mutual aid groups not normally assigned to the affected facility."

Although shelter in place is not an evacuation, it is a protective action taken in response to an event. Additionally, WIPP had activated the OAT and the JIC; and the AEOC was activated later. One could also argue, had the event occurred during the dayshift with the U/G manned, an evacuation of the U/G would have occurred e.g., facility evacuation.

- WP 12-ER3906, Table 1, states:

  "A Health and Safety related event that based on the opinion, judgment, and/or experience of the FSM should be categorized as a Health and Safety Operational Emergency."

- WP 12-ER3906, Table 7, Generic WIPP Emergency Action Levels, states:

  "The dose from a release of hazardous materials (radiological or non-radiological) expected to exceed the appropriate [protective action criteria] PAC at 30 meters and >1rem TEDE in a facility from an accidental release of radioactive material to WIPP Workers."

NWP maintains a RCRA Contingency Plan in accordance with the Hazardous Waste Facility Permit. The purpose of this document is to define responsibilities, to describe coordination of activities, and to minimize hazards to human health and the environment from fires, explosions, or any sudden or non-sudden release of hazardous waste, or hazardous waste constituents to air, soil, or surface water. The plan consist of descriptions of processes and emergency responses specific to hazardous substances, CH- and RH-TRU mixed waste and other hazardous waste handled at the WIPP facility. The RCRA Contingency Plan states,

> *"The provisions of this Contingency Plan will be immediately implemented whenever there is an emergency event, e.g., a fire, an explosion, or a natural occurrence that involves or threatens hazardous or TRU mixed wastes or a release of hazardous substances, hazardous materials, or hazardous waste that could threaten human health or the environment, or whenever the potential for such an event exists as determined by the RCRA Emergency Coordinator, as required under 20.4.1.500 NMAC (incorporating 40 CFR §264.51(b))."*

The plan defines a Level II incident in D-3.4 as,

> *"Incident Level II: According to NFPA 471, Responding to Hazardous Materials Incidents (See Table D-3). If the product(s) involved in the fire, explosion, spill or leakage meets the following criteria, it will be classified as a Level II incident and the Contingency Plan will be implemented by the RCRA Emergency Coordinator.*
>
> *a. The product requires a DOT placard, is an NFPA 2 for any categories, or is Environmental Protection Agency (EPA) regulated waste (Site-specific: Table D-1 20 and TRU mixed waste) AND*
>
> *b. The incident involves multiple packages.*
>
> *c. There is potential for the fire to spread since the hazardous material's flammability level (rating 2) is below 200 degrees Fahrenheit, or the*

reactivity (rating 2) indicates that violent chemical changes are possible and thus may be explosive.

d. *The release may not be controllable without special resources.*

e. *The incident requires evacuation of a limited area for life safety.*

f. *The potential for environmental impact is limited to soil and air within incident boundaries.*

g. *The container is damaged but able to contain the contents to allow handling or transfer of product."*

WP 12-ER4903, *Radiological Event Response*, step 4.2 states,

> *"FSM, IF the event or accident results in an unfiltered release to the environment,*
>
> THEN, implement WP 12-ER3002, Emergency Operations Center Activation, WP 12-ER4902, Hazardous Material Spill and Release Response, and the RCRA Contingency Plan."

Issues with the NWP Event Categorization and Classification process include:

- The radiological incident occurred at 2313 on February 14, and was not categorized until 2056 on February 15. This exceeded the two-hour requirement for categorization imposed by DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*. The initial categorization for reporting in ORPS in accordance with DOE O 232.2, was Group 4B(5), SigCat 4:

  "A facility operational event which resulted in an adverse effect on safety, such as, but not limited to: a) an inadvertent facility or operations shutdown (i.e., a change of operational mode or curtailment of work or processes), b) a manual facility or operations shutdown due to alarm response procedures, c) an inadvertent process liquid transfer, or d) an inadvertent release of hazardous material from its engineered containment."

  SigCat 4 does not trigger prompt notification. The written notification report is not required to be entered into ORPS until close of business two business days after the event. This was completed on February 18, 2014.

- On February 17, the Facility Manager additionally categorized the event as meeting ORPS criteria, Group 10(2) SigCat 2 and Group 10(4) SigCat 4.

  Group 10(2) SigCat 2: An event, condition, or series of events that does not meet any of the other reporting criteria, but is determined by the Facility Manager or line management to be of safety significance or of concern for that facility or other facilities or activities in the DOE complex.

Group 10(4) SigCat 4: Any occurrence that may result in a significant concern by affected state, tribal, or local officials, press, or general population; that could damage the credibility of the Department; or that may result in inquiries to Headquarters.

This additional ORPS categorization should have triggered prompt notification criteria that required a verbal report within two hours, which was not completed.

- Considering the event of February 14, and the actions taken on February 15, Emergency Categorization was not conservative, resulting in protective actions not being implemented in a timely manner.
- All EALs are event-based, not symptom-based.
- WP-12-4903, Step 4.2 states: "FSM, if the event or accident results in an unfiltered radiological release to the environment, then implement WP 12-ER3002, *Emergency Operations Center Activation*, WP 12-ER4902, *Hazardous Material Spill and Release Response*, and the Contingency Plan." This conditional step was not completed as the FSM did not conclude that an unfiltered release had occurred.

4.2 Training, Qualifications, Drills & Exercise

WP 12-9 states that ERO training is provided to all of the ERO through a formal classroom or self-paced instruction, on-the-job training, drills and exercises, and/or a qualification system.

DOE Order 151.1C requires that the ERO training program must consist of self-study/ homework, training, and drills. Further:

- Both initial training and annual refresher training must be provided for the instruction of and demonstration of proficiency by all personnel, i.e., primary and alternate, comprising the emergency response organization.
- Drills must provide supervised, "hands-on" training for members of emergency response organizations.

The elements of the NWP Emergency Management Program and Radiological Controls training were reviewed by the Board, and the following issues were identified:

- There is no position-specific training for the various EOC roles and responsibilities.
- Categorization/Classification training is needed for the ERO, (e.g., FSM, Crisis Manager, DOE).
- RCTs stated their requalification consists more of general safety items rather than demonstrating radiological controls proficiency and mastery of health physics concepts.
- RCT stated there was a lack of drills/exercises for radiological objectives.
- A review of the FY 2013 Emergency Drill/Exercise schedule and after-action reports determined that most of the drills with radiological objectives were in fact discussion-based (table top) drills. Also, after reviewing the drill After Action Reports it was observed that not all of the drill objectives were addressed in the write-ups, resulting in unclear results of the drill.

- The review of the FY 2013 Emergency Drill/Exercise schedule also noted that 18 drills were rescheduled or cancelled due to a lack of participants or operational conflicts. This could be an indicator that there is a lack of support from management concerning the WIPP Emergency Management Drill/Exercise program.
- The FSM qualification card does not include an On-the-Job Training/Evaluation (OJTE) for WP 12-ER4903.
- Per DOE Order 232.2, Chg 1, the CBFO representative has the responsibility to review and assess reportable occurrence information from facilities under his/her cognizance to determine the acceptability of the Facility Manager's evaluation of the significance, causes, generic implications, and corrective action implementation and closeout, and to ensure that facility personnel involved in these operations perform the related functions. CBFO personnel do not receive refresher training on Categorization/Classification.
- The ERO and RCT Training Programs need to be evaluated to determine their adequacy to properly prepare response personnel to perform their duties.
- Interviews with the RCTs revealed that they felt the training for emergency response drills was mainly discussion based and did not include any hands-on training with the equipment.

4.3 Abnormal Event Response Procedures

During this review, multiple emergency response implementing procedures were evaluated. Some discrepancies were identified in the implementing radiological emergency response procedures including (but not limited to):

- Radiological response procedures: WP 12-ER4903, WP 04-EM4200, and WP 12-HP4000 lacked specificity or were not followed. Some of the sequential steps in the procedures should have been immediate actions.
- WIPP Emergency Planning Hazard Assessment, DOE/WIPP-08-3378, and WP 12-ER3906, *Categorization and Classification of Operational Emergencies* needs to be reviewed and revised to include facility-specific EALs. Also, EALs must be developed for the spectrum of potential OE, which has not been completed at this time. NWP should also consider using symptom-based EALs, e.g., CAMs or other real-time monitoring, to improve the timeliness of categorization of emergency events.

4.4 Facilities and Equipment

The Board assessed the performance of the equipment associated with the AEOC, CMR, and the Radiological Control equipment for field monitoring, for this event. Per interviews, the equipment in the AEOC performed as expected. During this event, the CMR equipment received a "HI Rad" and a "HI-HI Rad" alarm and per all indications, CAM-151 performed as designed. However, implementing procedure WP 04-EM4200, includes a note that states:

> *"Two identical CAMs sample the air in the disposal panel exhaust downstream of the active disposal rooms, providing adjacent monitors for verification of radiological conditions if both CAMS are in service."*

The second CAM (CAM-152) was out of service during this event and would have been very beneficial in the verification of the alarms received initially in the CMR. This could have possibly even resulted in quicker implementation of protective actions based upon two CAM alarms. It was also identified by the Board that the CMR did not utilize the CMR emergency ventilation system during this event. During a release, the CMR air filtration system removes radioactive airborne contaminants and pressurizes the atmosphere inside the building to preclude infiltration of contaminated air into the CMR. Per interviews and a review of maintenance records and logs, problems with the radiological response equipment are as follows:

- The reliability of the U/G CAMs is questionable. Frequent malfunctions with the CAMs have led to personnel losing sensitivity for CAM alarms.
- Two of six counting stations were available for analyzing radiological sample results.
- The Radiological Controls organization did not have sufficient portable radiological monitoring equipment needed to combat the event. The Radiological Assistance Program (RAP) contacted the site to offer assistance and RAP team equipment was used through the permission of the Regional RAP Coordinator to make up for the lack of portable radiological monitoring equipment on-site.

Analysis

The success of the DOE Comprehensive Emergency Management System is dependent upon the timely identification of an emergency that results in the prompt implementation of protective actions. At NWP, the emergency plans and implementing procedures identify the FSM with the responsibility to categorize the incident and to implement protective actions in a timely manner for all emergencies. Therefore, this would require the FSM to have expert knowledge of the site's EALs and the use of general discretionary EALs.

DOE O 151.1C states:

> *"Emergencies involving hazardous materials require time-urgent response actions to minimize or prevent unacceptable consequences."*

The Board determined that NWP implementation of DOE O 151.1C was ineffective in responding to the radiological release and identified the following issues:

- The ERO and RCT Training Programs, including exercises/drills need to be further evaluated to determine the adequacy of properly preparing ERO personnel and RCTs to perform their duties.
- The current response organization does not provide the recommended ICS span of control for the FSM position during a large incident and could constrain the FSM in making quick and sound decisions.
- NWP and CBFO Emergency Management need to review and redefine the ERO structure including roles and responsibilities of the ERO and management.
- NWP elected not to classify the event as an OE, although WIPP procedure WP 12-ER3906 provides criteria for the FSM to do so.

- RCRA Contingency Plan Incident Level II definition should have been triggered. This is attributable to not recognizing the release as unfiltered, which precluded an evaluation of the RCRA Contingency Plan.
- Additionally, NWP failed to ensure that the event had been categorized correctly. This event represented a facility evacuation in response to an actual occurrence that required time-urgent response by specialist personnel.
- NWP EALs lack site-specific detail and ease-of-use, especially for the "Operational Emergency Not Requiring Further Classification" criteria.
- NWP lacked the proper type and quantity of radiological monitoring equipment to ensure the capability to respond to radiological events without the need for off-site equipment.

4.5 Medical Response

There was no medical response to the radiological release. Exposure assessments were conducted by WIPP Radcon personnel for employees present the night of the radiation release and the following day. Those results were subsequently discussed by WIPP with the Radiation Emergency Assistance Center Training Site (REAC/TS) from Oak Ridge which concurred that estimated doses would not be likely to exceed the regulatory levels for protection or thresholds for medical response.

The following medical documentation or information regarding potentially affected employees was made available to the DOE Chief Medical Officer for review:

- DOE Health Care Assets, Mutual Aid Agreements, Terrorism Response-Related Expertise;
- Content of the February 27, 2014, briefing to DOE Headquarters; and
- Content of the March 3, 2014, initial consultation and the March 11, follow-up consultation of REAC/TS by WIPP.

Response

WIPP did not engage its Medical Director or REAC/TS during the preliminary assessment of potential exposures and uptakes, consistent with their professional judgment. The administration of medical countermeasures was not provided based upon the preliminary data collected and analyzed by WIPP.

WIPP was responsive to the requests of DOE HQ for available information regarding worker health, including radiological exposure and uptake information. Consistent with radiation releases in general and as acknowledged in other Accident Investigations, caution was taken in the interpretation of initial bioassays and other tests due to the levels of uncertainty associated with such testing.

WIPP employs written protocols for providing emergency medical services, including the administration of medical countermeasures such as chelating agents. It is unclear how those protocols are effectively integrated into the required DOE O 151.1C, which includes Emergency Medical Support as detailed in Chapter VIII of DOE G 151.1-4, *Response Assets Emergency Management Guide*.

Additionally, NWP maintained health care assets which included medical resources to address first aid at the surface and underground, as well as surface supplies for the management of mass casualties. NWP had enough chelation agent for five at the time of the release and called REAC/TS to get ten additional doses, for a total of 15.

Analyses

The Board identified the following issues:

- WIPP historically has been partially dependent upon emergency medical support from medical facilities which are estimated to be 45 minutes from the site for the management of significant radiological exposures and uptakes, resulting in a potential delay in the timely administration of medical countermeasures when indicated.
- WIPP historically maintains medical staff, i.e., both nurses and EMTs/paramedics with training in the recognition and management of radiological exposures and uptakes. However, it is not clear that WIPP occupational physicians who are located off-site have been provided with the same. The Medical Director at the time of the event had not yet received radiological training.
- It is unclear whether administration of medical countermeasures was not performed due to the lack of a plan or protocol under DOE O 151.1C, OR due to an impression that the radiation release was so small as not to constitute an Operational Emergency.
- Based on the positive bioassay results, NWP did not maintain sufficient chelation resources for the number of people receiving an uptake.
- WIPP is subject to the requirements of DOE O 151.1C, which include Emergency Medical Support as detailed in DOE G 151.1-4, and are intended to address off-site, public health, and interagency concerns and considerations.

CON 10: Compensatory measures were not put in place to mitigate issues identified immediately following the February 5, 2014, underground fire event with respect to emergency management.

CON 11: The emergency management program was not adequately structured and implemented such that personnel did not recognize, categorize, or classify the emergency and implement protective actions in a timely manner.

CON 12: The Waste Isolation Pilot Plant (WIPP) (NWP and CBFO) emergency management program is not fully compliant with DOE Order 151.1C, *Comprehensive Emergency Management System*, e.g., activation of the Emergency Operations Center, classification and categorization, emergency action levels, implementation of the Incident Command System, training, drills and exercises, etc. Weaknesses in classification, categorization, and emergency action levels were previously identified by both external review and in the response to the underground fire and the radiological release events.

JON 14: NWP needs to immediately develop and implement interim compensatory measures to ensure prompt identification, categorization, classification, and response to operational emergencies, e.g., corporate reach-back, training, Senior Management Watch in the Central

Monitoring Room, etc.

JON 15: CBFO needs to take prompt action to fully integrate trained Federal management resources into the emergency response organization and take action to bring their emergency management program into compliance with DOE Order 151.1C, *Comprehensive Emergency Management System*.

JON 16: NWP needs to correct their activation, notification, classification, and categorization protocols to be in full compliance with DOE Order 151.1C, *Comprehensive Emergency Management System*, Resource Conservation and Recovery Act Contingency Plan and then provide training and drills for all applicable personnel.

JON 17: NWP needs to revise Emergency Response Organization training to include more supervised hands-on training and drills to enhance the effectiveness of the Emergency Response Organization's response.

JON 18: NWP needs to fully integrate the Resource Conservation and Recovery Act Contingency Plan activation criteria within the site Emergency Action Levels and to train the applicable personnel to ensure implementation of the Resource Conservation and Recovery Act Contingency Plan.

JON 19: NWP needs to take prompt action to correct longstanding deficiencies from previous reviews.

JON 20: CBFO needs to ensure that NWP completes prompt action to correct longstanding deficiencies from previous reviews.

JON 21: NWP needs to improve the content of site-specific Emergency Action Levels to expand on the information provided in the standard Emergency Action Levels contained in DOE Order 151.1C, *Comprehensive Emergency Management System*.

JON 22: NWP needs to develop and implement an Incident Command System for the Emergency Operations Center/Central Monitoring Room that is compliant with DOE O 151.1C and is capable of assuming command and control for all anticipated emergencies.

JON 23: DOE Headquarters (HQ) needs to conduct an effectiveness review of the NWP and CBFO emergency management program implementation within six months of completion of the corrective actions for the Emergency Management Judgments of Need.

5.0 Safety Culture

Production and prevention practices always compete in the minds of workers. Leaders have to constantly work hard to keep the facility, environment, and personnel safe. Well-informed leadership at all levels of the organization will ensure that the vision, beliefs, and values (prevention-centered attributes) do not conflict with the mission, goals, and processes (production-centered attributes). Consistency and alignment promote both production and prevention behaviors - together generating the desired long-term results.

In normal human behavior, production behaviors naturally take precedence over prevention behaviors unless there is a strong safety culture - nurtured by strong leadership. Sometimes managers err when they *assume* people will be or are safe. Safety and prevention behaviors do not just happen. They are value-driven, and people may not choose the conservative approach because of what is believed or perceived to be a stronger production focus.

It is critically important that the visions, values, and beliefs established by the leadership to support a strong safety culture are clearly communicated, and constantly reinforced. In many cases, management believes that their visions and values have been established and communicated through the development of a policy or procedure, or the posting of signs. That is an initial step and meets minimum compliance requirements, but it takes more than that. Leaders must constantly reinforce these expectations through observation and coaching at all levels of the organization.

Within DOE, most serious events do not occur when performing complex or high hazard operations. They rarely occur when starting up new facilities or performing operations for the first time. That is because everyone is paying close attention, there are lots of people involved, things move slowly, and everyone is very “mindful.” Natural tendency is to primarily focus on what are considered “high hazard” or “high risk” operations. The challenge for leadership is to establish and reinforce the safety culture expectations continuously so that workers are mindful and careful during all operations.

The DOE’s policy related to safety culture is “An organization’s values and behaviors modeled by its leaders and internalized by its members, which serve to make safe performance of work the overriding priority to protect workers, the public, and the environment.”

This Board reviewed available information from the ISMS Declaration, Safety Conscious Work Environment Assessment Survey from 2012 of each the contractor and CBFO. The three ISMS Safety Culture Focus Areas and associated attributes that were considered by the EFCOG/DOE ISMS Safety Culture Task Team to offer the most impact on improvement were selected. Those areas are:

- Leadership
- Clear expectations and accountability
- Management engagement and time in the field
- Risk informed conservative decision making

- Open communication and fostering and environment free from retribution
- Demonstrated safety leadership
- Employee/Worker engagement
- Personal commitment to everyone's safety
- Teamwork and mutual respect
- Participation in work planning and improvement
- Organizational Learning
- Performance monitoring through multiple means
- Use of operational experience
- Trust
- Questioning attitude
- Reporting errors and problems
- Effective resolution of reported problems

5.1 Leadership

The Safety Conscious Work Environment (SCWE) Self-Assessment completed in January 2013 by NWP and by CBFO identified weaknesses in clear expectations and accountability. The 2012 SCWE survey indicated a reluctance of employees to raise safety issues to management and indicates a "chilled" environment. Based on the SCWE survey results, 40 percent of NWP and almost 60 percent of CBFO employees indicated a reluctance to raise issues to management. Since completion and publication of the survey results, NWP has made little progress on corrective actions. The CBFO has not taken substantial action to address SCWE survey results indicative of weak safety leadership, allowing an environment to exist that does not value open communication without fear of retribution.

During interviews, many employees indicated a reluctance to use the WIPP Form process due to a fear of retribution. The most prevalent example of retribution identified by employees was the assignment of undesirable tasks for a couple of weeks after submitting a WIPP Form.

Eighteen emergency management drills and exercises were cancelled in 2013 due to an impact on operations. This issue crosscuts multiple focus areas and attributes. This area most importantly represents a failure in leadership to reinforce expectations related to safety over production. Instead this example represents a production over safety mentality.

Management assessments conducted by the contractor have a primary focus on cost and schedule performance. This is another example of leadership failing to reinforce expectations related to safety of production. Instead the use of management assessments to focus on production and cost sets the expectation that safety is not a priority for management.

Based on a review of entries into the underground, there are very few entries into the underground by NWP management. Additionally, CBFO entries into the U/G indicate a lack of field presence. However, the CBFO Manager's U/G field presence was viewed as exemplary in comparison to his staff. This demonstrates an overall lack of field presence and engagement with the underground workforce.

The Board determined that Revisions 3 and 4 of the DSA since 2010 have resulted in a significant reduction in the level of conservatism. A few examples of changes include eliminating the RH Hot Cell shielding as a Safety Significant Design Feature, eliminating the Ground Control Program SAC, eliminating U/G design features that prevent explosions, eliminating waste hoist inspection SAC, and eliminating 15 of 22 DBAs without providing a justification for the change.

Analysis

Overall, the Board determined that CBFO and NWP safety culture is lacking in the leadership focus area and associated attributes.

5.2 Employee/Worker Engagement

The CBFO conducted a *Waste Isolation Pilot Plant Integrated Safety Management and Quality Assurance Oversight and Implementation Review* dated February 2013. The intent of this review was to address the DOE-EM guidance for making the annual ISMS Declaration. This review was completed with minimal input from workers/employees. The only working level interview was conducted with a United Steel Workers Union Safety Representative.

The SCWE Self-Assessment completed in January 2013 by NWP and CBFO identified weaknesses in teamwork and mutual respect and participation in work planning and control. Other than completing the National Training Center course, SAF-200, *Safety Conscious Work Environment,* in June 2013, no other effective corrective actions have been implemented.

Based on personnel interviews and observation of a nuclear safety planning meeting, there is a lack of consideration of employee feedback and critical thinking.

Analysis

Overall, the Board determined that CBFO and NWP safety culture is lacking in employee/worker engagement and associated attributes.

5.3 Organizational Learning

The SCWE Self-Assessment completed in January 2013 by NWP and CBFO identified weaknesses in effective resolution of reported problems.

Management assessments conducted by the contractor have a primary focus on cost and schedule performance. There is not a focus on identifying organizational weaknesses and correcting issues to improve safety performance.

There have been no formal assessments of the DSA/TSR development process in the past few years by NWP and the previous contractor. This does not meet the expectation of the TSR Section 5.5 requirement for reviews and audits. In the past four years, CBFO performed one formal QA surveillance, S-13-04 of the NWP Nuclear Safety Program. This focused on compliance with the NWP procedures, rather than a critical review of the effectiveness of the program. More frequent assessments of the effectiveness of the contractor and CBFO nuclear safety programs would be normally expected. Other DOE sites have commissioned independent assessments consistent with the continuous improvement principle.

Eighteen emergency management drills and exercises were cancelled in 2013 due to an impact on operations. This issue crosscuts multiple focus areas and attributes. This was a lost opportunity to advance organizational learning to identify and improve on issues related to the emergency management program.

Numerous actions related to the radiological release event were not taken or questioned because of the perception of the impact on the mission. The functional checks on CAMs were often delayed to allow waste-handling activities to continue. The high rate of CAMs failing the functional check negatively impacted production because waste handling activities could not continue unless at least one CAM was in service at the waste face. Functional checks were delayed knowing that the CAM was likely incapable of performing its intended safety function. Instead of fixing the problem with CAM performance, a work-around was implemented that reduced the safety posture of the facility. A WIPP Form was submitted related to this issue in early 2013. No substantive corrective actions were implemented prior to this event but are planned for completion in 2014.

To meet the requirements of 10 CFR 830.203(f), the contractor has submitted reports of performed USQDs annually, in December of each year. Approximately 15 to 30 USQDs are completed annually. This total is surprisingly low for a Hazard Category 2 nuclear facility compared to other nuclear facilities in the DOE complex. The low number of USQDs performed annually implies that USQDs are not being prepared when there may have been a need for further in-depth evaluation of proposed changes. There have been no formal assessments of the effectiveness of the USQ process in the past few years by either the contractor or CBFO. However, in the past four years, CBFO performed one "oversight evaluation" of the 2013 annual USQD submittal that was focused on compliance with the WIPP procedure. An assessment of the USQ process and past USQDs to determine whether USQ qualified evaluators demonstrate a probing and questioning attitude when evaluating changes and discoveries has not been accomplished.

Due to the reduction in the conservatism of the DSA hazard and accident analysis, the TSR coverage of Safety Class, Safety Significant, and other administrative controls has been reduced over time. The ground control SAC has been eliminated from Revision 3 of the TSR and replaced by assumed initial assumptions in the DSA that are associated with the SMP for U/G mining, which endorses 30 CFR 57. Likewise, the ventilation system meets 30 CFR 57 for manned entry and continued work, but has no associated TSR requirements. The waste hoist is inspected and operated to 30 CFR 57, Subpart R, "Personnel Hoisting," which is the basis for initial assumption 12 a, b, and c of the DSA. The use of the initial assumptions in the DSA must be protected and the proper method is accomplished via explicit TSRs LCOs (or in other situations, SACs) and not on compliance with other regulatory requirements, which are verified outside of the TSR process. Initial assumptions that strictly rely on reference to SMPs without specificity are not of the pedigree of compliance with explicit TSRs. Initial assumptions for containers that comply with WIPP Waste Acceptance Criteria requirements, however, can be assumed as these conditions are DOE controlled from other DOE sites. Shipping containers can also be used as initial assumptions even though these adhere to DOT, not DOE, requirements in that they are physically constructed and verified for compliance. The current controls associated with the Waste Hoist are TSR LCO 3.8.1, applicable only to the brakes. The hoist controls have evolved from credited controls in Revision 2, which included a SAC and DF to TSR/LCO on the brakes and DF in Revision 3, to TSR/LCO on brakes in Revision 4. Previous versions of the TSRs had a DF for the waste hoist as its structure was classified as SC but the current version does not. The Compressed Gas Program had been eliminated in the Revision 2 of the TSRs based upon updated hazard identification that did not identify the presence of propane-powered vehicles on-site, thus eliminating the potential boiling liquid expanding vapor explosions and vapor cloud explosions. However, this was not identified as an initial assumption, nor was there any prohibition of bringing propane-powered vehicles on-site protected by a TSR SAC.

Based on interviews conducted across both organizations, the Board noted a wide-spread aversion to reporting deficiencies and issues by NWP and CBFO personnel.

DOE Programs such as the Integrated Safety Management System (ISMS), Quality Assurance Program per DOE O 414.1C, *Quality Assurance*, and the DOE Oversight Program, per DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, require DOE and contractor personnel to assess various programs/performance and to document and resolve issues in a timely manner. In addition, results are to be shared for lessons learned and to support continuous learning and improvement. Additionally, one of the objectives of DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*, is "To promote organizational learning consistent with DOE's Integrated Safety Management System goal of enhancing mission safety, and sharing effective practices to support continuous improvement and adaptation to change."

Contrary to the requirements listed above, the Board heard from numerous workers, both NWP and CBFO employees, that there were perceived repercussions and reprisals for identifying issues on WIPP Forms, ORPS reports, nonconformance reports, and oversight reports from CBFO. Workers from both NWP and CBFO expressed a reluctance to report issues due to observation of or perceived fear of reprisals. In addition, several workers complained of a lack of management action to address the observed issues or deficiencies. The Board noted several instances of reported deficiencies that were either not issued, or for which corrective action plans were not developed or acted on for months.

The Board also observed that DOE appears to have exacerbated the problem with reluctance of contractors to report issues by using information provided on ORPS reports and other deficiency-identifying documents/mechanisms for purposes other than the original intent. Examples include poor scoring on "Past Performance" evaluations by Source Evaluation Boards during contract bid evaluations, and poor scoring on award fee determinations. The Board reviewed Policy Flash 2010 Attachment L and found evidence of "performance indicators" that have been used in DOE's procurement process. Two examples are listed below:

- *S14. Number of events reported into the DOE Occurrence Reporting Processing System (ORPS). List the Report No., Reporting Criteria, and Significance Category for each event.*

- *Q4. Number of nonconformance reporting or other inspection systems resulting in corrective or improvement actions taken. Include summary of corrective action(s), and date(s).*

This practice is contrary to the Department's goals of the development and implementation of a strong safety culture across our projects.

The Board reviewed the following occurrence reports in relationship to the radiological release event:

EM-CBFO--WTS-WIPP-2008-0009
(Summarized from the occurrence report)

On the morning of August 3, 2008, an underground radiological control technician notified the Central Monitoring Room (CMR) that a 55-gallon drum was breached in Room 3 Panel 4. During confirmation that a breach had occurred, the Radiological Control Technician (RCT) took three swipes of the breached area and a leg of the nearby Magnesium Oxide (MgO) support structure. He notified personnel in the area to evacuate. Additionally, he contacted the CMR and requested that the underground ventilation be placed in filtration. Appropriate notifications were made to secure diesel equipment in the underground. The area was evacuated and affected personnel were frisked prior to exiting the controlled area and showed no signs of contamination. The three swipes were also surveyed and showed no signs of contamination. Filters at Station A and Station B were evaluated and also showed no signs of contamination. The breach opening is approximately 1 to 2 inches in length. During the course of the event the Emergency Operations Center (EOC) was activated.

UPDATE September 17, 2008: The Operational Emergency (OE) categorization will remain as an OE because the event was addressed and exited as such. After the event was exited, further investigations revealed that damage to the outer metal drum had occurred but the inner poly liner was intact.

EM-CBFO--WTS-WIPP-2012-0006
(Summarized from the occurrence report)

On June 19, 2012, at approximately 1300, Contact Handled (CH) Waste Handling Operations (WHO) personnel were performing normal waste emplacement activities in the underground. A forklift attachment (Harder) came in contact with the emplaced waste drum container which breached the drum. The breach was approximately 2 to 3 inches in length and approximately 7 inches from the bottom of the drum. The Facility Shift Manager (FSM) was notified. Personnel in the area were directed to leave the immediate area through the intake air travel path. Personnel were frisked before they left the area. No contamination was detected. The FSM directed a shift to filtration, through the HEPA system, on the underground ventilation system and for Radiation Control Operations to pull air monitoring filters for counting purposes. The FSM began evaluating WIPP Procedure, WP 12-ER3906, *Operational Emergencies* (OE) against the facts known at that time. At 2314, the FM determined the event was not an Operational Emergency but took a conservative approach and categorized the event as a Near Miss based on the information known at that time.

An OE would be categorized if a forklift punctures a waste container AND a release of radioactive material occurred that poses a significant hazard to safety, health, and/or the environment that requires a time-urgent response.

On June 20, 2012, at 1355, the Facility Manager re-categorized the Near Miss as a Management Concern. This change was initiated after document reviews and event details identified that no radiological release had occurred and if there had been a release it would have been concentrated in a small area due to the waste type (super-compacted debris waste). Additionally, a release would not have posed a significant hazard to employees or environment because of established process barriers (emplacement and abnormal response procedures, filtration, ventilation, etc.).

EM-CBFO--WTS-WIPP-2014-0002
(Summarized from the occurrence report)

On February 14, 2014 at 2314, a radiation alarm was received from a CAM in the underground. The underground ventilation exhaust system automatically switched to HEPA filtration mode when airborne radiation was detected. There were no employees working underground at the time. On February 15, 2014, at 0715, the underground exhaust system monitoring filters were exchanged, monitored and indicated 4 million disintegrations per minute (dpm) alpha. The filters were sent to a laboratory for further analysis. Site and off-site surveys were initiated and portable air samplers were installed in site areas. As a precaution, site personnel were sheltered in place. The operations assistance team and joint information center were activated. At 1449, the alternate Emergency Operations Center was operational. At 1557, it was reported that site surveys and personnel surveys were negative for radiological contamination. At 1612, Preliminary analysis of underground exhaust filter samples indicated the presence of Pu239/240 and Am241. At 16:35, the shelter-in-place was lifted and non-essential personnel were released from the site. Access to the underground continues to be restricted pending the development of a recovery plan.

On February 15, 2014 at 2056, the underground radiological event was categorized as Group 4B(5) SigCat 4. On February 17, 2014 at 1415, the Facility Manager additionally categorized the event as meeting ORPS criteria, Group 10(2) SigCat 2 and Group 10 (4) SigCat 4.

The three events cited above represent similar occurrences where the first instance was declared an Operational Emergency. After obtaining additional information, the original categorization was maintained, only because the OE was declared initially. A subsequent event four years later was first categorized conservatively as a Near Miss, but after later determining a release had not occurred, the Facility Manager downgraded it to a Management Concern, even though the only barrier remaining was the waste container itself. The Board viewed the two earlier events as missed opportunities to further evaluate existing processes in order to be better prepared to respond to similar events. Although the Board was unable to identify a clear source, interviews indicated that the 2008 event resulted in FSM’s hesitance to declare an OE was because of negative feedback received from management.

Analysis

Overall, the Board determined that CBFO and NWP safety culture is lacking in organizational learning and associated attributes. The performance issues observed during response to the radiological event are the outcome of the inadequate safety culture. Some examples are provided below but are not an all inclusive list:

- Failure to recognize the release (10+ hours to get to sample station B);
- Failure to don the proper PPE at sample station B;
- Failure to declare an Operational Emergency and activate the Emergency Operations Center;
- Failure to recognize/notify site personnel to shelter (15 hours+ hours after release);
- Reluctance to document operation problems because "nothing ever changes" stated in Conduct of Operations section;
- Failure to follow procedures in response to alarms stated in Conduct of Operations;
- Out of service equipment noted in Maintenance and Conduct of Operations; and
- Failure to properly implement RPP.

Additionally, communication of the contents of lessons learned systems such as ORPS, is being misrepresented in "Past Performance" evaluations by Source Evaluation Boards during contract bid evaluations, poor scoring on award fee determinations, etc. Referring to ORPS as the source of the information drives the contractor to non-disclosure of events in order to avoid the poor score. A mechanism that rewards conservative reporting in ORPS could help alleviate this trend.

CON 13: NWP and CBFO have allowed the safety culture at the WIPP project to deteriorate as evidenced by the workers feedback that they do not feel comfortable identifying issues that may adversely affect management direction, delay mission related objectives, or otherwise affect cost or schedule.

Questioning attitudes are not welcomed by management and many issues and hazards do not appear to be readily recognized by site personnel.

JON 24: NWP and CBFO need to develop and implement an effective integrated safety management system that embraces and implements the principles of DOE G 450.4-1C, *Integrated Safety Management Guide*, including but not limited to:

- Demonstrated leadership in risk-informed, conservative decision making;
- Improved learning through error reporting and effective resolution of problems;
- Line management encouraging a questioning attitude without fear of reprisal and following through to resolve issues identified by the workforce; and
- Reinforcing the mechanisms, e.g., WIPP Forms, "Notes to Joe," employee concern program, differing professional opinions, and protocols for communicating issues to NWP

and CBFO leadership.

JON 25: DOE HQ needs to engage external safety culture expertise in providing training and mentoring to NWP and CBFO management on the principles of a strong nuclear safety culture and implement any recommendations from these experts.

CON 14: DOE has exacerbated the safety culture problem by referring to numbers of ORPS reports and other deficiency reporting documents, rather than the significance of the events, as a measure of performance by Source Evaluation Boards during contract bid evaluations, and poor scoring on award fee determinations. Directly tying performance to the number of occurrence reports drives the contractor to non-disclosure of events in order to avoid the poor score. This practice is contrary to the Department's goals of the development and implementation of a strong safety culture across our projects.

JON 26: DOE HQ needs to clearly specify the use of performance reporting results, e.g., Occurrence Reporting and Processing System and non-conformance reports in Past Performance Evaluations, to encourage conservative reporting and communication of Lessons Learned.

6.0 Conduct of Operations

NWP implements DOE O 422.1, *Conduct of Operations,* through WP 04-CO.01, *Conduct of Operations*, Revision 2. WP 04-CO.01 and the supporting WP 04-CO.01-xx series documents constitute the WIPP Conduct of Operations Manual. The WP 04-CO.01-xx series documents include procedures for Shift Routines and Operating Practices, Logkeeping, Communications, Control of On-Shift Training, Notifications, Control of Equipment and System Status, Logkeeping, and Operations Procedures. WP 04-CO.01 also includes a Conduct of Operations Implementation Matrix that invokes the applicable portions of DOE O 422.1. As required by DOE O 422.1, NWP has a CBFO-approved Conduct of Operations Implementation Matrix.

The Board reviewed the NWP Conduct of Operations program and identified the following facts related to the Conduct of Operations Implementation Matrix:

- Requirement 2.a(2) – Adequate material and personnel resources to accomplish operations:
  - WP 04-CO.01-1, *Operations and Organization Administration*, Section 3.2.2 states that adequate Technical Support staffing is available to support Operations and budgeting for personnel is typically included in budget planning cycle. Additionally, it relies upon management to document any inadequacies.
  - Requests were made for current staffing plans and any technical basis for “minimum staffing” for technical support personnel, specifically RCTs. None were received beyond the TSR AC 5.3.3, Minimum Operations Shift (reference Table 5.3.3-1).
  - Interviews conducted with workers and line management indicated that personnel were not aware of the existence of a current staffing plan or any required “minimum staffing” specified to safely conduct operations beyond that specified in TSR AC 5.3.3. The common response was that “staffing is based upon the current shipment schedule.” Interviews with Radiological Controls personnel revealed that the current RCT staffing level leaves very little flexibility to account for personal leave, call-ins, training, etc., without relying upon overtime to adequately staff routine operations for the day. Additionally, interviews with personnel indicated that the terminology “operations” primarily referred to those daily activities, resources, management, and communication needed to support TRU waste-handling operations.
- Requirement 2.a.(3) – Monitoring and self-assessment of operations:
  - Interviews with workers indicated that there is reluctance to document operating problems using the NWP WIPP Form process because “nothing ever changes,” “never receive feedback on the disposition of WIPP Forms that they had submitted,” and a few individuals expressed a perceived potential for retaliation when WIPP Forms were submitted.
  - A review of contractor Operations self-assessments performed in the past 6 months identified that the self-assessments mostly dealt with process improvements in waste handling and work control document generation requirements. No targeted assessments of specific Conduct of Operations tenets were provided to the Board.

- Requirement 2.b.(6).c – Operators take prompt action to investigate and correct abnormal conditions:
  - On February 14, 2014 at 2313 hours, a "HI-HI RAD" Alarm was received from CAM-151. At 2324 hours, the CMRO was unsuccessful in an attempt to make telephone contact with the on-call Radiological Controls person (no answer). However, the CMRO did make contact with the RCM, who stated he would come in early to have a Station A sample pulled. At 2342 hours, the CMRO disabled CAM-151 due to a malfunction indication. Operations and Radiological Controls personnel stated this had become a standard practice over time, so they therefore did not consider that an actual airborne radioactivity event may be occurring. The RCM arrived on site at 0427 hours on February 15, 2014. The Station A air sample filter was pulled and counted at 0637 hours. The sample read 4.4 million dpm alpha. The RCM confirmed air filter results at 0715 hours. Interviews and the CMRO logbook did not convey any sense of urgency in regard to resolving the "HI-HI Rad" Alarm condition other than the standard malfunctioning CAM response.
  - There are no operations drills outside of the emergency management program. Scheduled EM drills were cancelled 18 times during the past year. This is discussed in more detail under the Emergency Management section of this report.
  - There is no real-time capability, e.g., video cameras, for the CMRO to observe and understand the condition of the active waste panels/rooms in order to determine if a breach of a waste container(s) had occurred, or if there was any anomaly to the U/G structures, e.g., back fall, rib fracture at the active waste panel.
- Requirement 2.d – Communication

  The communications used by the CMRO, FSM and RCM to discuss the alarms and conditions failed to ensure that accurate, unambiguous communications occurred amongst themselves to convey the exact nature of the airborne radioactivity release and appropriate immediate actions as outlined in WP 04-CO.01-4, *Communications*. Since Radiological Control personnel were not on the site, the CMRO attempted to contact the on-call Radiological Control Representative for support but was unsuccessful. The RCM was notified at approximately 0142 hours on February 15, 2014, but due to the misunderstanding of the information passed to him by the CMRO, he decided to wait until the morning shift to bring in any RCT staff. Therefore the air sample filters were not pulled until 0631 hours. Per interviews, once RCT staff pulled the filters and analyzed them, it was decided to implement protective actions (shelter-in-place) per procedure WP 12-ER4907, at 0934 hours, approximately 10 hours after the "HI-HI Rad" alarm. The CMR log did not indicate if the CMR emergency ventilation system was activated, which may have been an appropriate action for this event. The ineffective communications had a direct result in personnel implementing the appropriate corrective actions.
- Requirement 2.h – Control of Equipment and System Status:
  - WP 04-CO.01-8, Control of Equipment and System Status, identifies multiple methods for controlling equipment and system status at WIPP. The current methods being employed to document equipment deficiencies consist of tags, logs, and documenting them in work control via action requests (AR). Temporary

modifications are controlled by administrative means such as written authorization, appropriate engineering review and approval, etc.

- The following represents a sample listing of equipment that was out of service or otherwise out of normal configuration:
    - 700A fan out of service;
    - 700B fan damper actuators out of service;
    - BHR-707 bulkhead door regulator;
    - CAM-152 monitoring the Panel 7 exhaust drift;
    - Mechanical latches installed on 860 vortex manual hand wheels;
    - Auto operation of all 860 vortex fans out of service;
    - Electrical distribution system breakers found out of position due to perceived interference on the CMS caused by external access to view distributed control system (DCS) data; and
    - 308 bulkhead regulator cannot be remotely operated from the CMR due to the regulator being in local control. This bulkhead is located between the Waste Shaft and the exhaust shaft.

- Requirement 2.k – Logkeeping:
    - WP 04-CO.01-11, *Logkeeping*, Section 3.14 identifies Radiological Controls as a key position requiring a narrative log for the recording of information. The Radiological Controls Technicians are not maintaining a narrative log. Requests were made for the Radiological Controls organization's narrative logs relating to the radiological release event; none were received. Interviews with RCTs and their immediate supervisors confirmed that a narrative log is not being maintained by the RCTs.
    - If the Radiological Controls organization had maintained a narrative log, a better recreation of the radiological status of the facility prior to and after the event could have been provided.
    - A review of the CMRO narrative log for the period from December 31, 2012, through February 10, 2014, revealed that although the 0000 entry for the start of each day did document the status of the major components/systems, the format was not consistent from day-to-day.

- Requirement 2.l – Turnover and Assumption of Responsibilities:
    - WP 04-CO.01-12, *Turnover and Assumption of Responsibilities,* Section 2.3 requires that personnel who complete their shift in a position that may or may not be staffed for several hours are responsible for providing sufficient information in the form of a checklist, log or written communication to enable on-coming personnel to understand facility/equipment status. Section 3.1.2 identifies Radiological Controls as a key position requiring a turnover process. The RCT position does not use a formal turnover checklist or a log. Items of interest are sometimes listed on an office whiteboard. Interviews confirmed that the RCTs do not have or use a turnover

checklist. Additionally, interviews indicated that shift briefs generally consisted of making job assignments and generally did not cover the status of key plant equipment and parameters.

- Requirement 2.p – Operating Procedures:
  - WP 04-CO.01-16, *Operations Procedures*, Section 3.1 and 3.2 lay out the clear expectation that operators will use written procedures for operating plant equipment or performing operational evolutions; and procedures will be developed for all anticipated operations, evolutions, tests and abnormal or emergency situations.
  - On February 14, 2014, the FSM, who happened to be outside in the vicinity of the ventilation exhaust ducting, heard the 860A ventilation fan start. He immediately recognized the need to open the vortex for the operating 860 fan. WP 04-VU1001, *Surface Underground Ventilation and Filtration System Operation*, does not contain a section for manual action required by operators to enter filtration upon automatic initiation. Maintenance records and interviews indicated that a hand wheel latch had been installed on the 860 fan vortex dampers to prevent vibration from closing the vortex during operation. Operation of these latches was not proceduralized in WP 04-VU1001. Additionally, there is not consistent crosswalk to WP 04-VU1608, *Underground Ventilation and Filtration System Operation*, for actions associated with shifting into filtration. The WP 04-VU1608 procedure contains a precaution that states, "The U/G louver control panels have a manual and an Auto setting. In Manual the louvers can be manually adjusted locally. In Auto, the CMR has control. The control panel for 313 and 707 **SHALL** be kept in Auto." The Board was informed by NWP that BHR-707 is not able to be operated in Auto and had been manually shut prior to leaving the U/G on February 14, 2014, to facilitate the ability to achieve filtration mode should it be required.
  - WP 04-CO.01-16, *Operations Procedures*, Section 3.2.2 states that procedures will be developed for abnormal or emergency situations, and Section 3.2.3 states the expectation that response procedures will guide the operator in verifying abnormal conditions or changes in plant status and provide the appropriate corrective actions when alarm panels annunciate.
  - Issues noted with WP 04-EM4200, *Radiation Monitoring System Alarm Response*, include (but are not limited to):
    - A section that discusses actions to be taken for an U/G CAM reaching the "HI Rad" set point but does not give direction for a response when reaching the "HI-HI Rad" set point. At a minimum, it should refer to WP 12-ER4903, which addresses this condition.
    - The Note at the start of the Immediate Actions states "The following Immediate Actions are performed if the U/G is manned. If the U/G is not manned, then the CMRO is to immediately contact the FSM when an alarm is received." This direction effectively removes one of the Immediate Actions to make an announcement to have all personnel exit the disposal exhaust airway and remain clear of the disposal exhaust airway, which potentially allows personnel to be

downstream of the ventilation exhaust and be exposed to potential airborne radioactivity.

- The "Subsequent Actions" direct the FSM to shift the Underground Ventilation System to "Filtration Mode" and evacuate personnel downwind of the active disposal room(s) if the radiological conditions cannot be verified.

- On February 14, at 2314, a "HI-HI Rad" alarm was received in the CMR and the CMRO began taking the immediate actions per WP 12-ER4903. Issues noted with WP 04-ER4903 include (but are not limited to):
  - WP 12-ER4903 attempts to combine several distinct radiological events (e.g., Underground CAM "HI-HI RAD" Alarm, Surface or Underground CAM alarm caused by a release from a TRU waste container, actual or suspected breach of one or more CH- or RH-TRU waste container, or a failure of shielding in a shielded waste container) into an "all-in-one" document. The immediate action to "shelter-in-place" was not included in all scenarios of section 3.
  - Interviews with personnel and a review of the CMRO log indicated that some Immediate Actions were not taken and/or completed (e.g., INTRO alarm was not sounded, PA announcements were not made).
  - Under the "Subsequent Actions," the telephone discussion between the FSM and RCM failed to clearly convey the significance of the event, indications and alarms received, and that there was the potential for an unfiltered radiological release. This resulted in a seven-hour delay to implement the "Subsequent Actions" and did not adequately inform all personnel on site (ESTs, Security) of the potential release.
- Additional examples of inadequacies in procedures relating to emergency response are documented in the Emergency Management Program section of this report.

Analysis

The elements of the NWP Conduct of Operations program reviewed by the Board indicate weaknesses in implementation and re-enforcement of management expectations. NWP has not reinforced the requirements specified in procedures and processes:

- Staffing plans were not produced and technical support line management was unable to state what was considered "minimum staffing" for safe operations.
- Personnel are reluctant to fill out WIPP Forms to document deficient conditions based upon line management's lack of demonstrated response.
- Operations and Radiological Controls line management and staff have failed to maintain a high sensitivity to abnormal conditions and have become conditioned over time that CAM alarms are a malfunction event and not an indicator of potential airborne radioactivity events.
- Cumulative impact of out-of-service equipment was not recognized.
- Operators use written procedures for operating plant equipment or performing operational evolutions; procedures have not been developed for all anticipated operations, evolutions, tests and abnormal or emergency situations.

- Not all communications are accurate and unambiguous to convey vital information.
- Key positions do not always maintain a narrative log.
- Key positions do not always utilize turnover checklists.

The Board determined that the NWP Conduct of Operations program, although well defined in the Conduct of Operations Implementation Matrix, has not been effectively implemented; management is not actively establishing and re-enforcing clear expectations to ensure that safe, compliant operations are conducted at the WIPP facility. Interviews with personnel indicated that the terminology "operations" primarily referred to those daily activities, resources, management, and communication needed to support TRU waste-handling operations. This disconnect has reduced the level of rigor applied to operations that are not directly attributed to TRU waste handling.

CON 15: Key elements of the NWP Conduct of Operations program were ineffective in driving safe and compliant operation of a Hazard Category 2 nuclear facility.

JON 27: NWP needs to strengthen execution of the Conduct of Operations program to be compliant with DOE O 422.1, *Conduct of Operations*. Specific areas of focus must include (but not limited to):

- Establishing and reinforcing expectations conveyed in WP 04-CO.01, *Conduct of Operations* series procedures.
- Initiate a mentoring program, e.g., senior supervisor watch that provides real time feedback to first and second line supervisors as to their responsibilities regarding compliant execution of operations activities.
- Strengthen the structure, content and flow of abnormal response procedures to ensure immediate actions do not require judgment calls prior to execution.
- Consider the addition of real time surveillance capability, e.g., video of the active waste panels/rooms.
- Establish and execute an operational drill program that evaluates operator response to upset conditions.
- Establish a process that heightens awareness and requires deliberate action to reduce the quantity and length of time key pieces of equipment are out of service.

JON 28: CBFO needs to take an active role towards improving NWP conduct of operations through implementation of a structured DOE O 226.1B, *Implementation of Department of Energy Oversight Policy,* oversight process that includes mechanisms for identifying, reporting, and transmitting issues that tracks corrective actions to effective closure. Specific areas of focus must include, but are not limited to:

- Develop and conduct routine oversight of contractor implementation of the WP 04-CO.01, *Conduct of Operations* series procedures. Oversight needs to include detailed oversight plans that contain specific criteria and lines of inquiry to effectively assess compliance with DOE O 422.1.

- Oversight of the NWP mentoring program e.g., senior supervisor watch that provides real time feedback to first and second line supervisors as to their responsibilities regarding compliant execution of operations activities in order to provide feedback on effectiveness.
- Oversight of procedure development in order to strengthen the structure, content and flow of abnormal response procedures to ensure immediate actions do not require judgment calls prior to execution.
- Overseeing execution of the NWP operational drill program that evaluates operator response to upset conditions.
- Strengthen oversight of NWP processes that monitor equipment status and initiate action to correct deficiencies in order to ensure a reduction in the quantity and length of time key pieces of equipment are out of service.

7.0 NWP Maintenance Program

Maintenance at WIPP is governed by WP 10-WC3011, *Work Control Process*, Revision 31, effective October 18, 2013, and WP 10-WC3010, *Preventive Maintenance Controlled Document Processing*. Preventive maintenance is initiated through the Computerized History and Maintenance Management System (CHAMPS), based on required frequency. Work planners, along with a planning team in some cases, further develop the activity level work control document and participate in development of a job hazard analysis. Corrective maintenance is initiated via submission of an Action Request (AR). The action request is screened, validated, and prioritized at the plan of the day meeting. If accepted, the scope is developed, an optimum work window is assigned, and the level of rigor in planning is determined (minor maintenance, expedited work or planned work). Work planners, along with a planning team in some cases, further develop the activity level work control document and participate in development of a job hazard analysis. The Board requested the Master Equipment List as part of the investigation. At the conclusion of the investigation, the list was not produced.

7.1 Underground Continuous Air Monitor Maintenance

The CAMs are RADOS Technology, RAM 31 Alpha/Beta Aerosol Monitor with a multi-channel analyzer (MCA) capability. The underground CAM equipment identification numbers are:

534-CAM-001-149 (CAM-149)

534-CAM-001-150 (CAM-150)

534-CAM-001-151 (CAM-151)

534-CAM-001-152 (CAM-152)

CAM-149 and CAM-150 were removed from the Waste Handling Building and were placed in service in the underground (U/G) at Panel 4 in January of 2007. After Panel 4 was filled, the CAMs were moved to Panel 6 in March of 2011. Records indicate that these two CAMs generally operated well while installed at Panel 6. CAM-149 was suffering spectrum issues at the end of Panel 6 emplacement on January 21, 2014. CAM-149 and 150 were turned off at the time of the radioactive release event on February 14, 2104. On January 28, 2014, CAM-150 was identified to be a viable candidate to replace CAM-152.

CAM-151 and CAM-152 were placed in service at Panel 5 in March of 2009. After Panel 5 was filled, the CAMs were taken out of service in July of 2011, until the CAMs were moved to Panel 7 in August of 2013. CAM-152 has been out of service for a considerable period of time, only operational three days according to CMR log entries since being placed into operation to support waste placement in Panel 7 between September 26, 2013 and February 5, 2014. The CAM units used in the underground are exposed to a high dust environment. These CAMs are generally designed for use in a relatively dust-free environment. CAM-151 was in operation and functioned as designed to initiate an automatic shift to filtration mode upon detection of the release at 2314 on February 14.

RTS Instruments provides an Operation and Maintenance Manual for the RAM-31 Continuous Air Monitor for Alpha and Beta. The recommended maintenance regimen is as follows:

- Verify the filter sections on a six month basis (filter movements, filter hold up and down, related sensors and motors).
- Maintain the system clean. Clean units lightly with cotton swabs and soft air pressure.
- Verify the air sampling circuit (flow-rate measurement and regulation) on a yearly basis.
- Verify calibrations on a yearly basis.
- Verify the pump on a yearly basis and substitute the pump kit if necessary. The substitution should not be necessary before at least 10,000 hours of pump operation. This was not applicable to these models.

NWP performs the following preventive maintenance at the below specified intervals:

- WP 12-HP1318, *RADOS Continuous Air Monitor,* details a series of operability checks of the RADOS RAM 31 CAM. The NWP procedure requires this check to be performed at least ONCE PER DAY when the system is in use.
- WP 12-HP1319, *RADOS RAM 31 Functional Check*, details the process for performing a functional check of the RADOS RAM 31 CAM. The NWP procedure requires this check to be performed at least once per MONTH.
- PM041109, *RADOS Continuous Air Monitor (CAM) Vacuum Pumping System*, provides instruction for pumping system maintenance to be performed EVERY SIX MONTHS. Specifically, this work will accomplish the following:
    - Vacuum pump efficiency testing;
    - Vacuum pump replacement (if required);
    - Preventive maintenance on the CAM Vacuum Pumping Systems; and
    - Back-up power testing.
- IC534000, *RAM-31 ALPHA/BETA Continuous Air Monitor Annual Calibration*, provides instructions for performing the ANNUAL calibration validation of RAM-31 Alpha/Beta CAM instrumentation.

A review of the CHAMPS database performed to identify maintenance that had been performed on the RADOS CAMs over the past three years revealed:

- Several completed maintenance work orders for the CAMs identified multiple instances where the provided “place keeping” checkboxes were not checked or marked as “N/A.”
- WP 12-HP1319, *RADOS RAM 31 Functional Check*, has several steps that require “Make an entry in the RC Logbook” for any steps that result in an “UNSAT” condition during the performance of the functional check. The RCT position does not maintain a narrative log.
- Work Orders 1401784 and 1305413 did not specify any post-maintenance testing (PMT).

- Work orders reviewed where the CAM internals were accessed did not demonstrate that Radiological Controls personnel performed any radiological surveys to verify that no contamination was present.
- CHAMPS records do not demonstrate that monthly performance of WP 12-HP1319 to perform functional testing is consistently completed within the prescribed periodicity stated in the precautions and limitations. Individuals stated in interviews that performance testing was delayed in some instances based upon fear that it would fail and result in stopping waste emplacement activities.
- The RADOS CAMs' most common failure mode was due to failing the alpha efficiency portion of the monthly functional checks. The alpha efficiency determination failure was attributed to dust/dirt buildup on the detector head. The Instrument & Control Technicians developed a method of cleaning the RADOS Cam detector heads without having to remove them from the unit. This cleaning is conducted via a work order and usually precedes performance of WP 12-HP1319.
- The Board was not provided with a record to support that a functional test was performed prior to CAM-152 being placed in service on October 16, 2013.
- The other repetitive issue was associated with the filter advance mechanism.

7.2 Underground Ventilation System Maintenance

The U/G exhaust air creates a harsh environment for the ventilation system mechanical components. The salt and moisture entrained from the underground inhibits normal operation due to coating components with salt and contributes to accelerated component degradation due to the associated corrosion. Key maintenance issues impacting operation of the underground ventilation system include the following:

- Approximately ten years ago, the facility experienced issues associated with the actuation of the vortex dampers to the 860 fans. Automatic operation of the vortex dampers relied on input from a flow sensor. The flow sensor was failing when exposed to the harsh conditions and prevented the vortex actuator from operating properly preventing the automatic opening of the damper during fan startup. As the condition persisted, a work-around was implemented requiring an operator to be dispatched to open the damper manually at the fan inlet to allow fan startup. (Figure 11)

Figure 11: 860 Vortex Manual Hand Wheel

- The BHR-707 bulkhead regulator remote control has not been in operation for approximately one year due to component malfunctions. BHR-707 is required to be closed upon shifting to filtration. Therefore, manual closure is required. As a compensatory measure, NWP has adopted a non-formalized practice to close it before the last occupant leaves the underground.
- Main exhaust fan 41-B-700A has been out of service since January of 2014 due to bearing issues. A review of CMR logs indicated that a “HI-HI” bearing alarm had been intermittent since early 2013.
- Main exhaust fan 41-B-700B has been out of service since May of 2013 due to issues with the actuators on the isolation dampers.
- A review of the CMR log identified that testing of the automatic shift to filtration failed on three consecutive weeks in January 2013 due to a stuck damper on one occasion, failure of the selected 860 fan to start on another, and an unspecified reason for the third.
- All three 860 fan vortexes were documented to experience closing while the fan was in operation due to vibration. A latch was installed as a system modification to prevent inadvertent closure during 860 fan operation.
- Water infiltration into the exhaust shaft was discussed in various geotechnical reports dating back as early as 1995. For example, while a July 2011- June 2012 report discusses the probability of corrosion and deterioration of utility hangers and brackets, it does not address any potential impact on the exhaust ventilation system components.

Additionally the Board identified several sensor malfunctions as indicated on the CMS. Examples include:

- An airflow sensor in the underground was indicating in excess of a 100,000 cfm flow, which would normally have been very low, approximately 5000 cfm.
- The airflow through fan 41-B-700A indicated greater than 150,000 cfm even though the fan was secured and the isolation dampers were closed.

- The CMS display indicates that fan 41-B-700B has an open flow path although the fan is secured and the dampers are closed.
- The CMS has not been updated to reflect the current underground configuration with new construction of Panel 8 and adjacent bulkhead locations. (Figure 12)

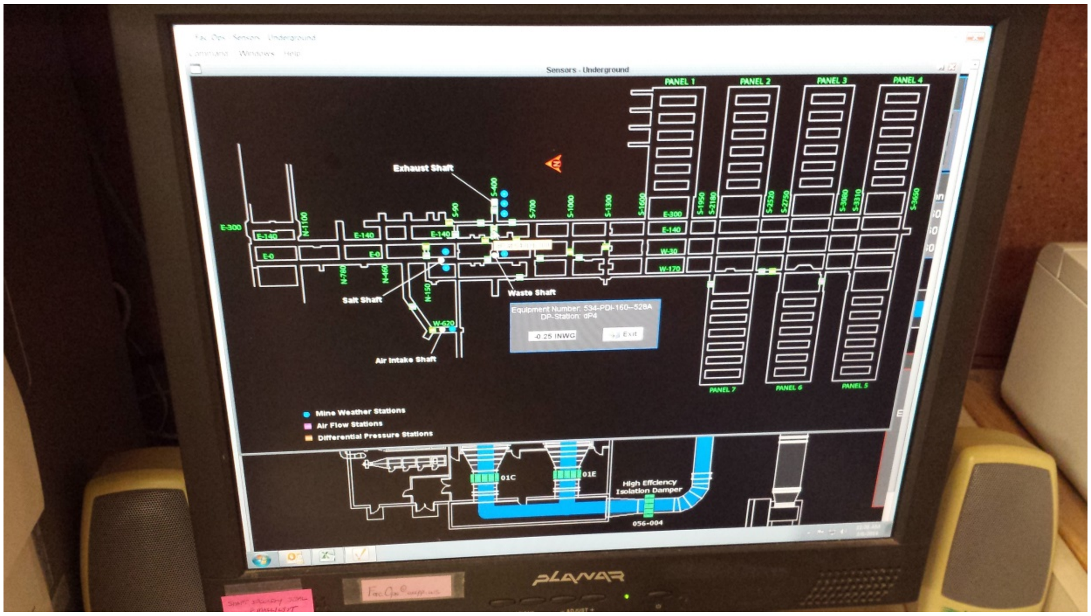


Figure 12: CMS Illustration of Airflow Path

7.3 Other Ventilation Maintenance Related Issues

Numerous additional components of the U/G ventilation system were out of service or have been otherwise impaired for an extended period of time, some since installation:

- 401 bulkhead door has been chained open for a long period of time. It could not be operated remotely from the CMR in the chained condition. This is the bulkhead door from the Air Intake Shaft.
- EXO regulator was not functioning. The garage door was opened about two feet, and allowed smoke in the EXO space during the fire event. In its current configuration, this regulator cannot be remotely operated from the CMR.
- 504 bulkhead door was chained open for a long period of time. It cannot be operated remotely from the CMR in the chained condition. This is the bulkhead door to the Salt Handling Shaft.

Additionally, the electrical distribution system lineup was found to be in an abnormal configuration, due to problems related to external view-only access to the DCS.

Analysis

The Board determined that the NWP maintenance and engineering programs have not been effective in keeping critical pieces of equipment in a high state of operational readiness. The cumulative impact of the combination of degraded equipment on overall facility operational readiness was not adequately considered. There is an acceptance to tolerate or otherwise justify (e.g., lack of funding) out-of-service equipment.

Additionally, configuration management was not being maintained or adequately justified when changes were made. The Board reviewed the equipment status and condition in the CMR and the U/G. The condition of critical pieces of equipment, such as the 700 exhaust fans, indicated that management had not taken prompt action to resolve longstanding deficiencies. The accelerated corrosion of components in the U/G ventilation system enhanced by water intrusion below the surface in the exhaust shaft has not been effectively evaluated and mitigated. Many items have been out of service or in a reduced status for more than six months. It was not clear that NWP had a clear approach to prioritizing maintenance activities in regard to critical equipment or that there is an effective formal process to identify compensatory measures other than a fire watch for impaired safety-related equipment. Additionally, the equipment and components that affect normal operation of the mine ventilation system did not appear to have been effectively evaluated and dispositioned regarding their impact on system operation.

CON 16: The current culture at NWP is such that due consideration for prioritization of maintenance of equipment is not given unless there is an immediate impact on the waste emplacement processes.

CON 17: Execution of the NWP engineering process has not been effective in maintaining configuration of key systems at WIPP. Specific examples include:

- Conversion of the 860 fan vortex damper actuator from automatic to manual operation;
- Functionality of the ventilation system in filtration including evaluation and testing of leakage via the bypass dampers; and
- The impact of salt buildup on bypass damper effectiveness.

JON 29: NWP needs to take action to ensure that the maintenance process effectively considers and prioritizes repairs to achieve and maintain a high state of operational readiness.

JON 30: NWP needs to improve the execution of engineering processes that ensure system configuration management is maintained and that the rigor in processing proposed changes to systems is at a level that ensures system design functionality is maintained. Specific examples include:

- Conversion of the 860 fan vortex damper actuator from automatic to manual operation, and
- Functionality of the ventilation system in filtration including evaluation and testing of leakage via the bypass dampers.
- The impact of salt buildup on bypass damper effectiveness.

JON 31: CBFO needs to take a more proactive role in the configuration management and maintenance programs to ensure that the facility can meet its operational and life time expectancy.

JON 32: DOE HQ Office of Environmental Management and CBFO need to develop an infrastructure improvement plan within six months to identify and prioritize program-wide critical infrastructure upgrades for key systems to ensure continuation of EM's programmatic mission execution at WIPP.

Additionally, DOE HQ Office of Environmental Management needs to coordinate an extent of condition review at other EM sites and take action based on the outcome of that review.

8.0 Radiation Protection Program

In accordance with 10 CFR 835, *Occupational Radiation Protection*, NWP has a DOE-approved program, DOE/WIPP 95-2054, *Radiation Protection Program* (RPP), Revision 17. CBFO approved the RPP on June 27, 2013. The RPP is implemented through a series of program documents and implementing procedures that are identified in the RPP and the WP 12-5, *NWP Radiation Safety Manual* (RSM), Revision 17. In addition, NWP has radiological control emergency response procedures that also implement the RPP. The RSM captured many, but not all, of the requirements of DOE-STD-1098-99, *DOE Radiological Control*, but emphasized that the RPP takes precedence.

8.1 Radiation Protection Program Implementation

The Board reviewed the RPP, RSM, and radiological control procedures for implementation and program contents. After interviews and documentation review, the Board identified the following facts:

- Radiological control personnel are typically scheduled to only work on day shift. This resulted in no on-site radiological control personnel at the time of the event. On-call radiological control personnel were not immediately available upon notification of the radiological release from the CMRO as required by WP 12-ER4903.
- The RCM did not initiate timely whole body frisks, nasal smears, or direct bioassay sampling after the radiological release as required by WP 12-ER4903.
- Radiological Controls personnel did not notify Occupational Health/Industrial Safety (OH/IS) upon discovery that a TRU waste container had been potentially breached as required by WP 12-ER4903.
- The Radiological Assistance Program (RAP) was not contacted for support as required by WP 12-ER4903 when it was determined that the radiological release extended 300 meters past the U/G exhaust.
- Personnel sheltered in place during the radiological release were not informed of prohibition on eating, drinking, and/or smoking without first determining if the shelter location is free from contamination. Not required by RPP procedures.
- NWP did not initiate a timely bioassay sampling initiative as required by NWP manual WP 12-3 *Dosimetry*, Section 3.7, Revision 21. In addition, this manual refers to actions levels in the RSM, Appendix A, that require bioassay. The Board identified that Appendix A does not exist in the RSM. In addition, no action levels were listed in the RSM.
- During the event, 11 locations that were initially reported as contaminated were later determined to be clean after it was discovered that the Radiological Controls Technician (RCT) handled the smears with a contaminated tweezers. This issue was self-identified by NWP.
- During the event, as described by corporate reach-back observers, RCTs did not demonstrate adequate techniques and knowledge to perform contamination surveys and establish control of potential, or real contaminated areas.

- Interviews with WIPP RCTs and RCT Supervisors identified that they had little to no experience with removable radiological contamination, proficient knowledge of radiation protection regulatory and program requirements and technical health physics.
- The RCT qualification/requalification process does not require practical demonstration of the use of ion chamber radiological surveys (open window/closed window), performance of contamination surveys, methods to prevent cross-contamination, and control of contaminated areas.
- As required by the RSM and verified by interviews, Radiological Control personnel are not maintaining logbooks to document radiological occurrences, status of work activities, and other relevant radiological control information.
- The RCTs do not use a formal shift turn-over process, e.g., turn-over checklist or system status checklist to ensure that plant systems/status/current radiological conditions and RCT equipment status are understood at the beginning/end of their assigned shift.
- The position of Radiological Control Superintendent, as identified in several procedures, is not an identified position in the RPP or the RSM.
- Emergency drills do not include an evaluation of radiological control personnel proficiency in making bioassay determinations, controlling contaminated areas, and making notification to OH/IS in the case of a ruptured TRU waste container.
- WP 12-HP3200, *Radioactive Material Control*, Revision 17, is not flowed down into implementing procedures. The work control document that provides the instruction to clean and inspect a CAM does not reference the procedure requirements for radioactive source handling and control, specifically, PPE and training requirements to use sealed sources. Interviews with instrumentation and control technicians demonstrate that they understood radioactive source control and handling, including PPE requirements. Additionally, the work control documents did not include any requirements to perform any radiological surveys to verify the radiological status of the CAM internal surfaces prior to starting work.
- Triennial RPP internal audits, as required by 10 CFR 835.102, are performed to demonstrate compliance with the NWP Quality Assurance Program Document (QAPD) and DSA. These reviews are performed by personnel independent of the RPP organization; however, are primarily performed by Quality Assurance professionals. The internal audits generally do not identify findings of the RPP program implementation.
- Management assessments of RCT training and qualifications concluded that RCTs were well qualified and had completed a rigorous training program.
- DOE-STD-1128-2008, *Good Practices for Occupational Radiation Protection in Plutonium Facilities*, is not referenced in any command media of the NWP RPP.
- In response to the event, there was no typical radiological control equipment readily available for radiological control personnel use. For example, battery powered CAMs, battery powered portable air samplers, portable sodium iodide (NaI) detectors, etc.
- Most individuals interviewed expressed a perception that there is retribution associated with submitting a WIPP Form. The perception is workers are assigned the least desirable jobs for a couple of weeks after submitting a WIPP Form.

- WIPP Forms related to CAM reliability in the underground were not acted on in a timely manner. WF13-030 related to RADOS CAM reliability issues was submitted on February 20, 2013. No effective corrective actions had been taken prior to the radiological release event.

CAM-151 and CAM-152 monitor the exhaust flow from Panel 7. RH-TRU waste emplacement in Panel 7 began on September 26, 2013, and the CH-TRU waste emplacement in Panel 7 Room 7 began on January 22, 2014. A review of the CMRO logs revealed that CAM-152 was operational and in-service for only three days from September 26, 2013, through to the underground haul truck fire event on February 5, 2014. During this same time period, CAM-151 was operational and in-service with the exception of one 20-hour period when a malfunction occurred and was corrected.

The CY2012 *As Low as Reasonably Achievable (ALARA)/Radiological Performance Indicator Annual Report*, dated September 30, 2013, identified that the CAM is down for 30 percent of the time.

Analysis:

The Board has concluded that NWP does not have an effective RPP. The RPP implementing procedures and program documents do not effectively implement the DOE-approved RPP. Decision points throughout program documents and procedures are written for Radiological Control personnel, e.g., RCM, RCT, to make expert-based decisions. Multiple action requirements in procedures and program documents end with the statement "as applicable." During the radiological event, radiological control staff had to make expert-based decisions for the administration of bioassays, facility air sampling, performing radiological surveys of areas and personnel, and controlling contamination sources.

RPP triennial internal audits are performed by personnel that do not have strong, technical knowledge of 10 CFR 835 requirements. The internal audits focus on the radiation protection Key Attributes identified in Chapter 7 of the NWP DSA, and NWP procedure implementation. The Board reviewed the most recent triennial audit and concluded the internal audits are not technical, and focus on meeting procedural requirements. RPP independent internal audits generally did not find issues with the RPP. Management assessments also did not find issues with the RPP, and reported that the program is effective. The RPP lacks an independent audit by technically qualified personnel with radiological control experience.

8.1.1 Radiological Control Staff Qualifications and Training

NWP implements the DOE O 426.2, Administrative Change 1, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, through a Training Implementation Matrix (TIM), Revision 9, with an effective date of April 17, 2012, and WP 14-TR.01, *WIPP Training Program*, Revision 13, effective December 12, 2012. In accordance with DOE O 426.2 Ch1, NWP has a CBFO-approved TIM. The TIM identifies CH RCT and RH RCT as Technical Staff positions.

The Board reviewed the RCT Training program and associated records, and identified the following:

Radiological Controls Technician Qualification Card, RCT-01, Revision 9, approved May 10, 2008 comments:

- No practical demonstration for beta (Open Window & Closed Window) radiation survey.
- No practical demonstration for a direct contamination survey.
- No discussion and/or practical demonstration for preventing cross-contamination of samples/items.
- No practical demonstration for setting up a temporary counting station.
- No practical demonstration for setting up a "bench top contamination area."
- No practical demonstration for generating a Radiation Work Permit (RWP) based upon a radiation and airborne radioactivity scenarios (has contamination driven scenario only).
- No practical demonstration for responding to a radiation event scenario (does have a respond to a contamination event scenario and respond to an airborne event scenario).

RCT Study Guide, CL 2-12, *Shipment/Receipt of Radioactive Material*, Revision 3, has many outdated references. For example:

- DOE O 5480.5 (cancelled in 1994);
- DOE G 441.1-10 (cancelled in 1999);
- DOE O 460.1A currently on .1C (approved in 1997);
- DOE O 460.2 and currently on .2A (approved in 2004); and
- DOE-STD-1098-99 and currently on -2008, etc.

The Board reviewed the WIPP Task-To-Training Matrix for RCTs and identified the following:

- Task CEO-183, *Escort Waste Packages/Radioactive Material*, dated May 23, 2002. The task does not discuss radiological surveys required for escorting waste/radioactive material.
- Task CDO-042, *Perform Routine Checks/Audits on Radiation Emergency Equipment and Kits*, dated May 23, 2002. The title does not match the content. The content deals with actions associated with a contaminated, injured person.
- Task CDO-043, *Respond to an Airborne Radioactivity Event*, dated May 23, 2002, appears to lead one to believe that the only source of an airborne radioactivity event is a temperature inversion.

The Board reviewed the RCT Requalification Standard, RCT-02, Revision 3, approved March 18, 2003, and identified the following:

- Several Job Performance Measures (JPM) require the individual to "Complete RCT log book entry" with a performance method of "Perform." As discovered by the Board, the

RCTs do not maintain a logbook so it is not clear how this performance item on the JPM is being signed off as satisfactory.

- JPM CDO-043, *Respond to an Airborne Radioactivity Event*, Revision 6. Performance items are allowed to be signed off as a Perform, Simulate, and Discuss (PSD). A majority of the records reviewed show that this JPM was predominantly completed by discussion.
- JPM CDO-049, *Respond to a Radioactive Contamination Event*, Revision 5. Performance items are allowed to be signed off as a PSD. A majority of the records reviewed documented that this JPM was predominantly completed by discussion.
- Several completed JPMs did not have the performance method, PSD, used to complete the JPM documented.

During the interview of the NWP Training Manager (TM), the TM stated that he had completed a management assessment of the Training Program in late September 2012. The Board asked for and was provided a copy of the assessment. A review of the assessment, MA-HR/TECH TRAINING 0001-12, with associated interoffice correspondence dated September 27, 2012, indicated that the assessment was predominantly centered on records management compliance rather than health of the training program.

Analysis

The issues identified by the Board indicate that NWP has not performed an effective assessment of the RCT Training Program. This is substantiated by inadequate performance of the RCTs during the radiological release.

8.1.2 Radiological Air Monitoring

Through the DOE-approved RPP, Section 10 CFR 835.403, *Air Monitoring*, NWP commits to monitoring airborne radioactivity with a CAM that detects alpha, beta, and gamma, and using fixed air samplers. Automatic shift to filtration operability requiring the radiation monitoring system to be operating is detailed in EA 04 AD3001-0-0, *Facility Site Operations and Infrastructure Mode Checklist*. CAMs have historically been used for both environmental purposes and worker protection. NWP has two models of the CAMs, the RADOS (older) and Canberra *i*CAM™ (newer). The RADOS model CAM is currently used in the underground, and the Canberra *i*CAM™ is used in the Waste Handling Building.

The RADOS CAMs at the WIPP were purchased in the 1990s. The Canberra *i*CAM™ was purchased in 2006. When the RADOS CAMs were originally purchased, they provided real-time air monitoring at Station A (upstream) and Station B (downstream). The RADOS CAMs were removed from the exhaust effluent system in 1995/1996, and EPA later concluded in 1998 that real-time effluent air monitoring is not required. The RADOS CAMs were then placed into the Waste Handling Building. After the Canberra *i*CAMs™ were purchased, they replaced the RADOS in the Waste Handling Building and the RADOS were used in the underground.

The CAMs have a critical function in the underground. When a CAM alarms, the ventilation system is supposed to automatically switch to a filtered exhaust ventilation mode known as

Filtration Mode. The Board later determined that the mode change to Filtration is no longer truly automatic, but requires opening the 860 vortex and positioning the BHR-707 bulkhead regulator.

The DSA discusses use of CAMs during waste-handling activities but CAMs were not required to be in operation at the time of the event. During this event, four CAMs were in the U/G. These CAMs are identified as 151, 152, 150, and 149. Of the four CAMs, only CAM-151 was operating as designed. It was located at Panel 7. CAM-152 was also located at Panel 7, but tagged out of service. CAM-150 was located at Panel 6, was operable but turned off. CAM-149, also located at Panel 6, was not used because it had spectrum issues.

CAMs have had a difficult time performing their designed functions in the U/G. It was not uncommon for CAMs to alarm from a malfunction due to the build-up of salt dust, and become inoperable. During 2013, there were seven documented manual shifts to filtration resulting from CAM malfunctions. These malfunctions have contributed to CMROs not always believing the alarm was real. The Board identified WIPP Forms in which functional tests of operating CAMs were avoided due to the fear that the CAM would not be functional, resulting in the suspension of waste operations. During this event, when CAM-151 alarmed at both the “HI RAD” alarm and “HI-HI RAD” alarm, the indication was not believed by the CMRO and the RCM (via telecom). It was only after the RCM arrived on site and saw the data, that it was believed to be real. The “HI RAD” alarm set point is 30 DAC and the “HI-HI RAD” alarm set point is 50 DAC. The CAM indicated approximately 208,000 DAC before being disabled by the CMRO.

Analysis

The Board identified that the NWP use of the CAM as a key element of the radiation protection program is not fully recognized. The preservation of the CAM operability is not a priority for NWP. NWP developed work-arounds to operate in the underground when the CAM is not functional and to delay functional tests when the CAM was operating. Due to multiple occurrences of CAM inoperability and CAM alarms as identified in both ORPS and WIPP Forms (condition reports), NWP has become desensitized to CAM alarms and they are viewed as more of a nuisance than an actual indicator of radiological conditions.

8.1.3 Dosimetry Program

The external and internal dosimetry program is described and implemented per WP 12-3, *NWP Dosimetry*, Revision 21. The external and internal dosimetry program is DOELAP accredited. This document describes roles and responsibilities to execute the external and internal dosimetry program.

For internal dosimetry, the program description provides no direction on the bioassay methodology, e.g., fecal, urine, chest, and the frequency, e.g., initial, 3-day post, 7-day post, in which the bioassays should be administered. This decision-making process is at the discretion of the Radiological Control and Dosimetry Manager (RCDM). Per WP 12-ER4903, it is the RCM, not the RCDM, who determines the bioassay methodology; WP 12-ER4903 also does not specify the bioassay methodology.

The following provides the timeline during which the determination for internal dosimetry expectations was evolving.

A radioactive release occurred at WIPP beginning at 2314 on February 14, 2014. There was a lack of available air monitoring data and bioassay was not initiated immediately after the event. The need for bioassay was not immediately recognized. One worker in the highest potential group requested a bioassay kit a day after the event. This was prior to any determination of the bioassay requirements for potentially exposed workers. Once the need for bioassay was recognized, personnel were grouped into four categories based on the potential for exposure. Listed below are the four groups who participated in the program:

- Highest potential for exposure (14 personnel)
- Elevated potential for exposure (21 personnel[4])
- Remaining personnel at the WIPP site during the release period (118 total)
- Personnel not at WIPP site during the release period but volunteered to participate (26 workers)

Highest Potential: Fourteen personnel were identified to have had the highest potential for internal exposures to the release source term based on work assignments and proximity to the release point. For clarity, this number has been reported as 13 in some communications. One worker left for vacation prior to implementation of radiobioassay, hence only 13 workers were being tracked until that worker returned from vacation. All 14 personnel submitted a single fecal void, and two 24-hour urine samples, and had a 30-minute chest count with high purity germanium (HPGe) detectors. Thirteen of the 14 personnel had low-level positive fecal samples. All urine samples were less than detection level. All chest counts were less than detection level.

- First urine sample requests: February 16 – February 21, 2014
- First urine samples submitted: February 17 – February 22, 2014

- Fecal sample requests: February 19 – February 20, 2014
- Fecal samples submitted: February 20 – February 22, 2014

- Second urine sample requests: February 26, 2014
- Second urine samples submitted: February 26 – February 27, 2014

- Chest counts requests: February 27, 2014
- Chest counted completed: February 27 - March 7, 2014

Elevated Potential: Twenty-one additional workers were identified to have had an elevated potential for internal exposures to the release source term based on potential work activities that could have taken them outside during the release. All workers were required to submit a 24-hour urine sample and have a chest count. One worker requested to submit a fecal sample (worker also submitted a 24-hour urine sample on February 21, 2014).

[4] As of March 28, 2014.

- First urine sample requests: February 26 – February 27, 2014
- First urine samples submitted: February 21 – March 10, 2014
- Chest counts requests: March 5, 2014
- Chest counted completed: March 8, 2014 – ongoing

<u>Workers at WIPP Site during the Release Period</u>: An optional confirmatory bioassay program has been implemented for any of the 118 workers that were identified as having been at the WIPP site during the release period but were not part of the highest potential or elevated potential groups. Participation in this optional program is ongoing. Workers were given the option of participating in any or all of the three bioassay methods (fecal, urine, and chest count). Enrollment has been through contacting WIPP dosimetry or sign-up sheets at All-Hands meetings. As of March 18, 2014, 74 workers have participated in this effort.

<u>Workers NOT at WIPP Site during the Release Period</u>: The optional confirmatory bioassay program is open to any worker, even if they were not at the WIPP site during the release. Twenty-six workers have chosen to take part in this optional program. As previously stated, workers currently have the option of participating in any or all of the three bioassay methods (fecal, urine, and chest count). It also is currently open.

Analysis

For this event, bioassays were not performed timely, and there was confusion on the type of bioassay to require. Personnel were not asked to provide an initial bioassay until several days after the event occurred, and groups were divided into different risks categories for bioassays. These groups were highest potential, elevated potential, workers at WIPP site, and workers not at WIPP site. The bioassay methodology was varied. Some personnel were requested by radiological controls to provide a urine bioassay when others provided fecal, urine, and/or chest bioassay initially. In some cases, individuals provided a fecal bioassay initially but later asked to provide urine, and then later a chest bioassay.

Interviews with radiological control staff determined that the initial decision-making process to determine who to bioassay resulted in an initial conclusion that bioassay was not required because exposure did not meet any of the criteria specified in WP 12-DS1361. After further discussion amongst radiological control staff, it was decided to begin bioassays for 14 people two days post-intake, 21 people 12 days post intake, and then 100 employees several days post intake.

The Board concluded after reviewing the Dosimetry Manual that bioassay was required. The lack of procedure specificity for action levels and the type of bioassay resulted in a delayed response to understanding the extent of personnel radiological exposures. The Board also noted that internal dosimetry decisions did not originate from WIPP Radiological Control, but from URS corporate reach-back expertise. WIPP personnel did not have the expertise and experience to administer an incident response bioassay.

8.1.4 Medical Support

The NWP diethylenetriamine pentaacetate (DPTA) chelation therapy administration protocol was reviewed. The protocol recognizes that time is critical to the successful reduction in dose from an uptake of radioactive metals. It recommends administration within one hour of an uptake. The chelation protocol recommends therapy when internal contamination is suspected or confirmed. Additionally, the protocol allows for a judgment by Radiation Control management if indicators suggest an uptake has or probably has occurred.

DOE O 151.1C requires that medical support must be planned in accordance with DOE O 440.1A for workers contaminated by hazardous material and that medical support must include documented arrangements with on-site and off-site medical facilities to accept and treat contaminated, injured personnel.

There were five doses of DPTA available at the time of the accident. Subsequent to the accident an additional ten doses of DPTA have been made available on-site.

Analysis

Although for this event there were no contaminated injured workers, there were personnel who received a radiological uptake. The evaluation and consideration for chelation therapy was not done in a timely manner. Additionally, chelation therapy is typically not recommended unless the actual or suspected uptake would result in a dose greater than 2 Rem. Although no personnel were in the underground at the time of this event, there was the potential to expose several personnel in excess of 2 Rem if the underground had been occupied. Five doses of DPTA would have been insufficient for that scenario. The Board determined that the response protocol for the implementation of chelation therapy is not consistent with established practices.

8.2 Radiological Effluent Monitoring System (REMS)

The radiation monitoring system includes the plant vacuum system, Fixed Air Samplers (FASs), CAMs, Area Radiation Monitors, the Radiological Effluent Monitoring System (REMS), and portable radiation monitoring equipment.

The REMS consists of effluent samplers installed on the Waste Handling Building and U/G exhaust. The REMS sampling equipment includes a pump, flow controller, sample holder, and delivery piping. The effluent samples for the UVS exhaust are located upstream (Station A) (Figure 13) and downstream (Station B) (Figure 14) of the U/G ventilation system HEPA filters.

Figure 13: Location of Station A

Figure 14: Location of Station B

Station A is located over the U/G ventilation exhaust elbow at the surface and samples using probes that extend 21 feet below the elbow in the Exhaust Shaft. Station B samples from a point downstream from the UVS fans and HEPA filters. Station A contains three sampling skids, each splitting the sample and directing the air into three air samplers per skid. Station B contains two sampling skids, each splitting the sample and directing the air into three air samplers per skid. The effluent samplers collect periodic confirmatory particulate samples from the total volume of air being discharged. The samplers consist of a sample delivery system, a filter holder, and a vacuum supply. (Figure 15)

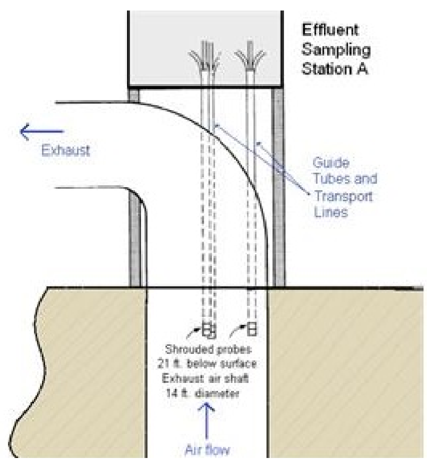


Figure 15: Effluent Sample Station A

Sample locations may have multiple filters to allow parallel sampling for outside agencies. The analysis data from effluent samplers are used for quantifying total airborne particulate radioactivity discharged. This is done to demonstrate compliance with the mandated regulatory requirements contained in 40 CFR 191, Subpart A, "Environmental Standards for Management and Storage." The counting equipment used to analyze FAS filters provides indication of releases at much lower levels than general area samples or CAMs. Effluent sampler Station D is located in the U/G in E300 before the disposal exhaust joins the exhaust from other areas of the U/G.

8.3 Off-Site Environmental Monitoring

In addition to monitoring the waste face, CAMs in the U/G, and airborne effluent (via the REMs), off-site ("near" and "far" field) (Figure 13) radiological environmental monitoring is performed external to the WIPP facilities in accordance with DOE/WIPP 99-2194 to meet the requirements of the DOE O 436.1, *Environmental Protection Program*. Environmental monitoring of air, groundwater, surface water, soils, sediments, and biota is performed to characterize the environment around the WIPP facility.

The purpose of radiological environmental monitoring is to measure the radionuclides in the ambient environment media. This allows a comparison of sample data to results from previous years and to baseline data to determine the impact of the WIPP operations on the surrounding environment. Samples may also be collected following an incident, e.g., waste handling accident, waste container breach, etc. Environmental monitoring results are reported in the Site Environmental Report in compliance with DOE O 231.1B, *Environment, Safety and Health Reporting*, as described in DOE/WIPP 99-2194, *Waste Isolation Pilot Plant Environmental Monitoring Plan*. The location of air sampling stations is shown in Figure 16.

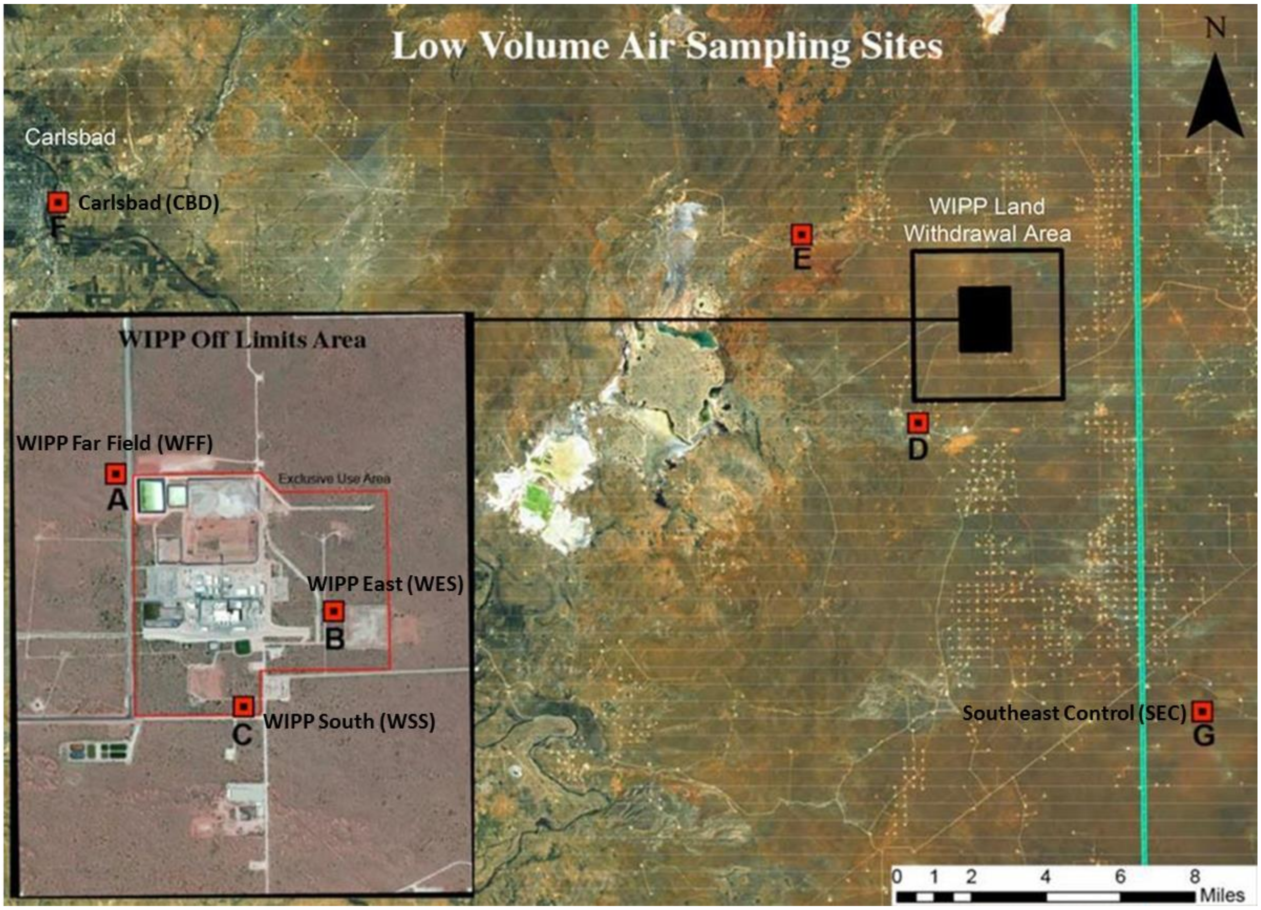


Figure 16: Offsite Air Sample Locations

CON 18: NWP does not have an effective Radiation Protection Program in accordance with 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection*, including but not limited to radiological control technician training, qualification and requalification, equipment and instrumentation, and audits.

JON 33: NWP needs to evaluate the current state of the radiological control program including the current radiological conditions and implement compensatory measures to support recovery and current activities.

JON 34: NWP needs to perform an extent of condition review of the training program incorporating the results of this event and implement actions to improve radiological control management, Radiological Control Technician, and rad worker proficiency in dealing with contamination, and airborne radioactive material.

JON 35: NWP needs to perform an extent of condition review for identified weaknesses in the radiological control program and implement corrective actions to fully implement 10 CFR 835.

JON 36: CBFO needs to determine the effectiveness of the radiation protection program within three months of completion of NWP's corrective actions.

CON 19: There is an inadequate technical basis for the existing ventilation and airborne monitoring systems. It is unclear that they adequately provide protection to the underground workers, the co-located worker, the public, and the environment from the transuranic mixed waste or hazardous constituents, e.g., reliability of a single CAM to initiate an automatic shift to filtration, acceptability of leakage past the bypass dampers and automatic shift to filtration that now requires manual operation of 860 fan vortex dampers.

JON 37: NWP needs to develop a technical basis to implement continuous and reliable/redundant real-time air monitoring with appropriate automatic shift to filtration to protect the workers, the public and the environment. This needs to take into consideration the different ventilation modes, protection of workers in the underground, and release of contaminants to the environment. The technical basis must also consider the hazardous constituents in the transuranic mixed waste, e.g., reliability of a single CAM to initiate an automatic shift to filtration, acceptability of leakage past the bypass dampers and automatic shift to filtration that now requires manual operation of 860 fan vortex dampers.

9.0 Underground Ventilation

9.1 Ventilation Overview

The U/G ventilation system (UVS) serves all underground facilities and provides the equipment, controls, and monitoring necessary to provide a suitable environment for underground personnel and equipment during normal activities. It also provides confinement and channeling of potential airborne radioactive material in the event of an accidental release or smoke and fumes in the event of an underground fire. It further provides high-efficiency particulate air (HEPA) filtration of exhaust air to minimize any doses to on-site and off-site personnel. Under normal operating conditions, the effluent exhaust is not filtered. The status of the system equipment is continuously monitored, and the data is provided to the CMR, as well as local stations underground.

The air is supplied to the underground at 2,150 feet below the surface, through three shafts and exhausted through a single shaft by exhaust fans located on the surface. The fresh air supply is divided into four separate streams. The air drawn down the Air Intake Shaft and the Salt Handling Shaft is split into three separate air streams serving the construction, north area and waste disposal areas. The air drawn down the Waste Shaft serves the Waste Shaft station operation and is exhausted directly to the Exhaust Shaft station where it joins the exhaust streams of the other three areas. The combined exhaust streams are drawn up the Exhaust Shaft, and discharged directly to the atmosphere under normal operation or via the HEPA filtration system under certain off-normal conditions. Standby HEPA filtration, located on the surface, is engaged upon detection of radioactive particulates by local continuous air monitors in the waste disposal exhaust stream adjacent to Panel 7. Pressure differentials in the underground are maintained between flow paths to assure that air leakage is always from areas of lower to higher contamination potential. Pressures and flows in the underground are controlled through the use of bulkheads (walls), ventilation doors and air regulators (ventilation louvers). (Figure 17)

The exhaust fans serving the underground ventilation are located on the surface. A combination of six fans provides airflow for the U/G ventilation system. Three large main (700) fans rated nominally at 260,000 cfm discharge directly to the atmosphere. Three smaller 860 fans, rated nominally at 60,000 cfm, draw ventilation through HEPA filtration and discharge to a small stack monitored for radiological release. The 860 fans can also exhaust the underground directly through a filtration bypass duct. (Figure 18 and Figure 19)

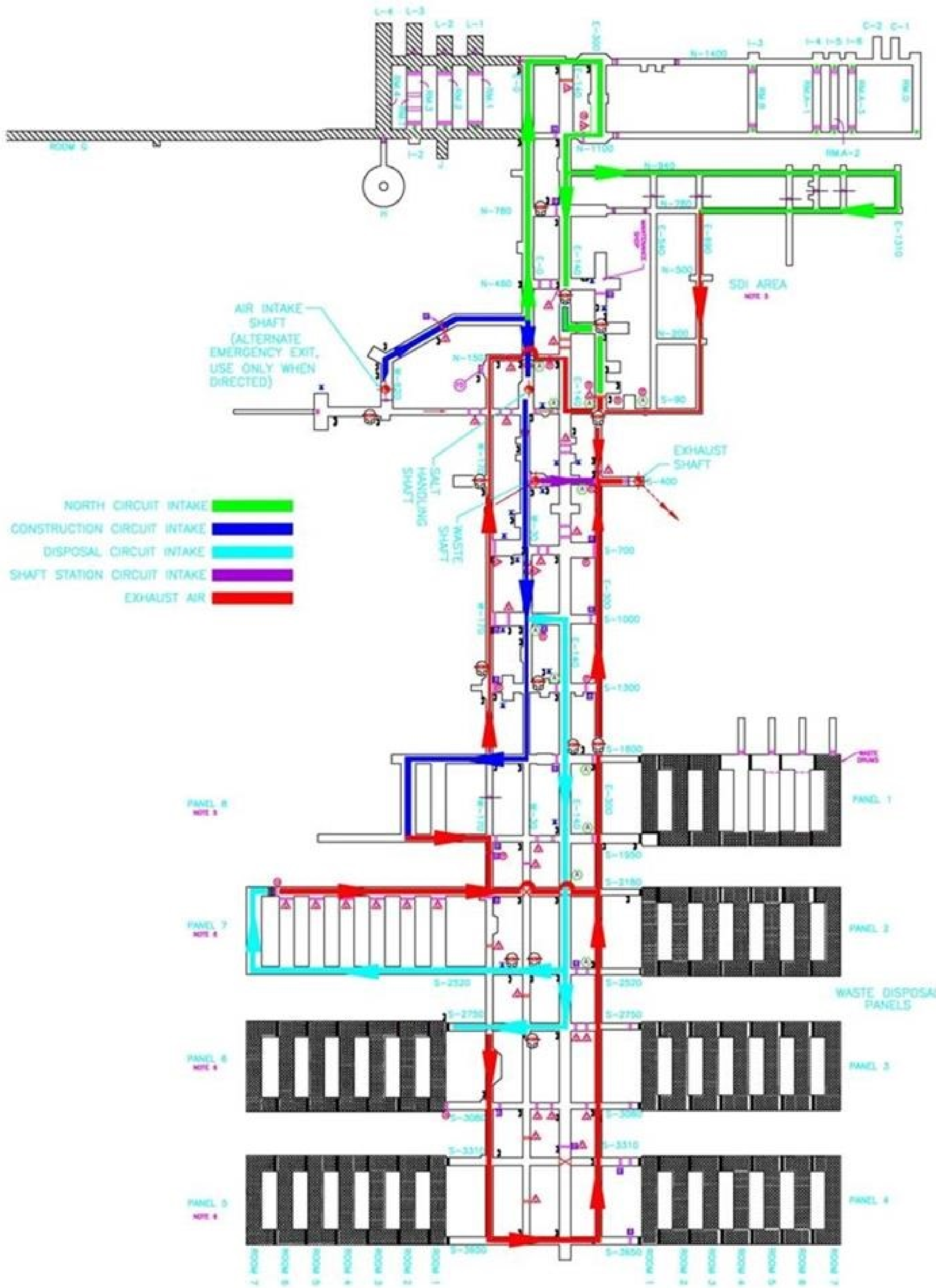


Figure 17: Normal Underground Airflow

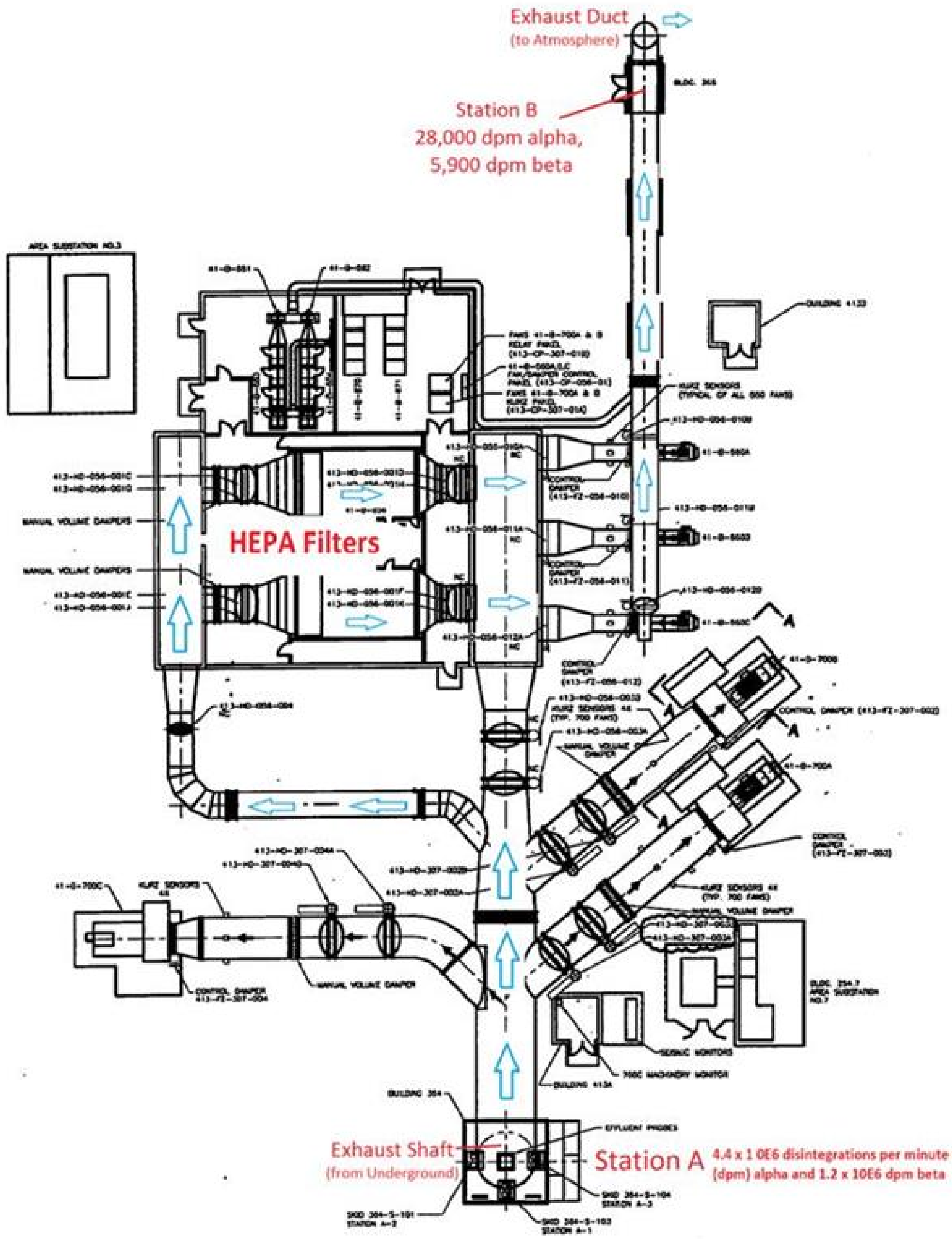


Figure 18: Exhaust Filter Building Ventilation Components Plan View

Figure 19: Ventilation Fans 700A and 700B

9.2 Underground Ventilation Design History

During the initial design phase of WIPP, the surface portion of the underground ventilation system utilized three 860 fans (nominal 60,000 cfm capacity) to exhaust air from the U/G. In general, U/G operations were limited and considered serial activities. During waste handling activities, one fan was utilized to exhaust air from the underground through the HEPA filter trains prior to discharging to the atmosphere. The filtration system was sized for the 60,000 cfm flow. During mining activities, two fans were utilized (120,000 cfm) exhausting air directly to the atmosphere via a filtration bypass. The filtration bypass was sized to accommodate the airflow capacity of all three 860 fans if necessary to provide unfiltered airflow in support of mining operations and abnormal situations, i.e., fires. Isolation dampers were designed into the installation to ensure air flows through the intended pathway. The filter plenum inlet isolation damper prevents air from flowing through the filters while in filter bypass operation. Conversely, the filter bypass isolation dampers were designed into the installation to prevent air flow from exhausting directly to the atmosphere while in filtration mode. As isolation is critical to preventing an unfiltered release during a radiological event, two dampers in series were installed in the bypass duct. The filter bypass isolation dampers are 120” dampers rated each at 210,000 cfm with a designed allowable leakage of 1000 cfm each when exposed to a differential pressure of 10 inches of water. The exhaust filter building houses the HEPA filter trains. Two parallel HEPA filter trains, (856 and 857) each with a rated air flow capacity of 30,000 cfm, provide a total capacity of 60,000 cfm. Each train consists of four stages of 21 filters each rated at 1500 cfm. The first stage contains moderate efficiency (60 percent efficient) prefilters known as the “MOD” filters. The second stage contains high-efficiency (90 percent efficient) prefilters. The third and fourth stages contain HEPA filters tested at 99.95 percent efficient. The filter trains were designed to American Society of Mechanical Engineers (ASME) N509, *Nuclear Power Plant Air-Cleaning Units and Components.*

After the first few years of mining operations (waste operations were not scheduled for years to come), additional fans were installed to add underground ventilation airflow capacity accommodating increased mining operations. The two new fans (700 series) were significantly larger (rated at 260,000 cfm) and installed in the exhaust duct between the exhaust shaft and the split to the exhaust filter building and the bypass dampers. These fans exhausted the underground directly to the atmosphere. Shortly after, a third 700 series fan exhausting directly to the atmosphere was installed adding redundant fan capacity.

9.3 Underground Ventilation Maintenance History

Throughout the underground ventilation system operational history mechanical conditions dictated how the system was operated. WIPP U/G exhaust air creates a harsh environment in which the mechanical components are exposed. The salt and moisture from the U/G carried by the airstream, hampers normal operation by coating components, and also hastens component degradation due to material corrosion. Key maintenance issues affecting operation of the underground ventilation system are discussed below:

Approximately ten years ago, the facility was experiencing issues associated with the actuation of the vortex dampers to the 860 fans. Automatic operation of the vortex damper relied on input from a flow sensor. The flow sensor was failing when exposed to the harsh condition and prevented the actuator from operating properly. This condition prevented the automatic opening of the damper for fan startup. The condition persisted and a work-around was implemented requiring an operator to be dispatched to open the damper manually at the fan inlet to allow fan startup.

The 707 bulkhead regulator remote control has not been in operation for approximately one year due to component malfunctions. As this regulator is required to close when shift to filtration is activated, manual closure is currently required. It was reportedly a common practice to close it before the last occupant left the underground. It was in the closed position when the radiological event occurred on February 14, 2014.

Main exhaust fan 700B has been out of service since May 2013 due to issues with the actuators on the isolation dampers. Main exhaust fan 700 A has been out of service since January 2014 due to bearing issues. Current plans are to replace all the major components, i.e., bearings, shaft, rotor, etc. Both fans are currently out of service. (Figure 20)

Figure 20: 700 A and 700 B Removed

Additionally during the investigation, several sensor malfunctions were noted while observing the CMS. Examples include an airflow sensor in the underground that was indicating in excess of a 100,000 cfm flow, which should have been very low (approximately 5000 cfm). Another example includes the airflow through fan 700A, which is indicating greater than 150,000 cfm even though the fan was secured and the isolation dampers closed. Also, the CMS display indicates that the 700B fan is operating (open flow path) when the fan is secured and the dampers are closed. Additionally, the CMS has not been updated to reflect the current underground configuration with new construction of Panel 8 and adjacent bulkhead locations. (Figure 21)

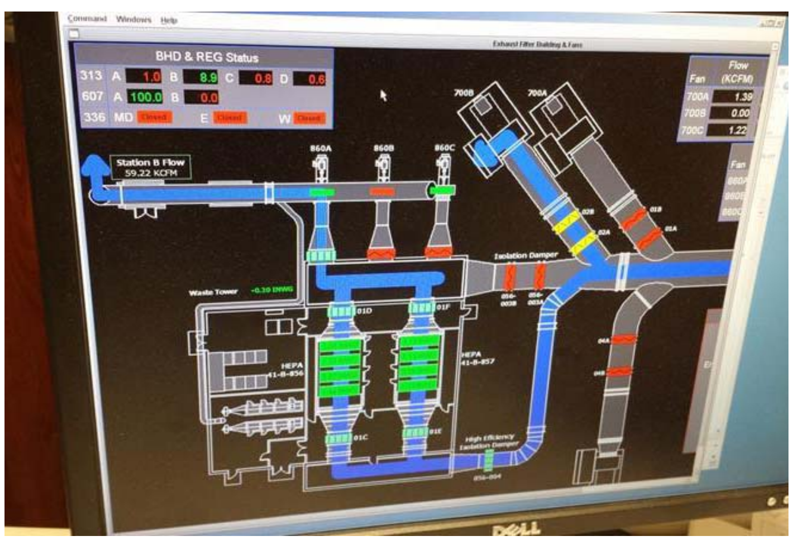


Figure 21: Central Monitoring System (CMS)

9.4 Underground Ventilation Operation

The Normal Mode of ventilation is provided with a combination of fans directly to the atmosphere via the main fans and/or the filtrations fans with the filtration system bypassed. Five different levels of Normal Mode ventilation can be established to provide five different air flow quantities. These five levels of air flow are achieved by the use of the various combinations of exhaust fans as follows:

Normal Ventilation: Two of three main exhaust fans operating to provide 425,000 standard cubic feet per minute (scfm) unfiltered.

Alternative Ventilation: Any one of the three main exhaust fans operating to provide 260,000 scfm unfiltered.

Reduced Ventilation: Any two of three filtration fans operating as ventilation fans to provide 120,000 scfm unfiltered.

Minimum Ventilation: Any one of three filtration fans operating as a ventilation fan to provide 60,000 scfm unfiltered.

Maintenance Ventilation: Any one or two of the three main exhaust fans operating in parallel with one or two of the filtration fans to provide approximately 260,000 scfm to 425,000 scfm.

9.4.1 Filtration Mode

The filtration mode of ventilation is designed to confine airborne radiological contamination released by a breached waste container in the underground, minimizing any release to the environment. Filtration is automatically initiated by detection of radioactive airborne contaminants above the set point. A single 860 Series filtration fan provides up to 60,000 scfm in filtration mode exhausted through the HEPA bank.

9.4.2 Shift to Filtration Process

Upon receipt of an underground CAM "HI HI RAD" alarm signal or manual activation from the central monitoring room (CMR), all operating fans (any 860 and/or 700) are de-energized and the selected 860 fan (Fan 860A for this event) is started. At the same time the corresponding fan isolation dampers are closed and the bypass isolation dampers are closed. The 700 fans have two isolation dampers in series which are slow closing dampers to prevent a pressure wave from being pushed back down the exhaust shaft and potentially pressuring the air intake/salt/waste shafts. It was reported to take between 60 and 90 seconds to fully close. Also, upon initiation of shift to filtration several bulkheads doors/regulators in the underground are closed to ensure most of the air flows from the waste shaft to the exhaust shaft and to maintain confinement of the waste disposal areas. The bulkhead door 336 isolates the north end, bulkhead regulator 313 isolates the waste panel area air intake and the regulator in bulkhead 707 isolates the construction area. When the selected 860 fans is energized, the filtration bypass isolation dampers are closed, one of the two 700 fan isolation damper has closed and the filter inlet plenum is negative 0.5 inch water, and the filter plenum inlet damper is opened providing exhaust flow through the HEPA filter trains and the selected 860 fan.

9.4.3 Dynamic Pressure Effects

The underground ventilation system is basically a steady state system. When it becomes necessary to make a change in operating mode there are dynamic pressure changes which must be considered. These are primarily only in ventilation, such as a shift to filtration which may cause temporary localized pulses. The magnitude and location of these may be affected by the proximity of the shafts.

9.4.4 Shift to Filtration Process during the Event

On February 14, 2014, the ventilation was in the alternate ventilation mode with fan 700C in operation. The filter inlet isolation damper was closed, filter bypass isolation dampers were closed and the 860 fans secured with Fan 860A designated as the selected fan for “shift to filtration.” When personnel last evacuated the underground, the 707 bulkhead/regulator was closed. At 2314 underground CAM (151) “HI-HI RAD” alarm was received and initiated the shift to filtration. As expected, the 700C isolation dampers closed and fan 860A was energized. The FSM was in the proximity of the 860 fan and heard the fan 860A start. After radioing the CMRO not to send an operator, he approached the fan and opened the fan vortex damper to allow flow through the fan and provide the requisite negative on the filter inlet plenum to open the inlet isolation damper. Once flow was established the vortex damper was adjusted to obtain approximately 60,000 cfm. It was reported that the shift to filtration was completed in 56 seconds.

Approximately 15 minutes later the MOD filters differential pressure began to rise. At the start of the event the 856 HEPA filter train MOD filter differential pressure was approximately 0.5 inches water and the 857 HEPA filter train MOD filter differential pressure was approximately 0.45 inches water. At 0142, February 15, 2014, the 856 “filter clogging” alarm indicating that the 856 MOD filter differential pressure reached 1.0 inch of water. Later that morning around 0907, the 857 “filter clogging” alarm was received. Both MOD filters differential pressure continued to rise throughout the day, leveling off the following day, February 16. The 856 Mod filter differential pressure (dP) reached 1.65 inches of water and the 857 reached 1.25 inches of water. The prefilters and the HEPA filters exhibited a very minimal dP increase during the same timeframe. The alarm response procedure WP 04-VU4605, Revision 8, has since been revised to raise the alarm limit to 2.0 inches of water based on the manufacturer’s reported structural limit of 4 inches of water.

Analysis

The design of the underground ventilation system includes a HEPA filtration bypass to allow operation of the 860 fans to directly exhaust ventilation from the underground to the atmosphere. This bypass is equipped with isolation dampers to be activated and closed during filtration mode. Any leakage through these bypass isolation dampers represents a pathway for unfiltered exhaust. These dampers were part of the original design and rated at 210,000 cfm to allow directly exhausting the underground using multiple fans when required. The damper design leakage is specified by drawing no. QA-5858-6, *Butterfly Dampers*, Revision A to be a maximum of 1,000 cfm at 10 inches of water.

The Board determined that this damper selection is inappropriate for isolation dampers that are part of a confinement barrier. The damper design does not meet requirements in the nuclear industry ventilation code, ASME AG-1-2012, *Code on Nuclear Air and Gas Treatment*, for Leakage Class 0 – zero leakage (bubble tight) or Leakage Class I-low leakage (calculated at 1 scfm per ft^2 or 78.5 cfm). The design leakage for this damper more fits more closely in the Leakage Class II – moderate leakage. For perspective, the DOE-HDBK-1132-99, *DOE Handbook Design Considerations*, states "To reduce migration of contamination, ….seals should have an integrity equal to or greater than the barrier itself." This would mean the leakage should be as efficient as the HEPA filters. For one HEPA filter stage (99.95 percent efficient) this would result in a leakage of 105 cfm (0.0005 * 210,000) as damper design flow or 30 cfm (0.0005 * 60,000) at filtration mode system flow. Even with two dampers in series under the current conditions, the design leakage has been estimated by calculation at 225 cfm.

Operation in the harsh U/G environment will further degrade the damper performance. In the recent years with two 700 fans out of service, reliance on the 860 fans and the filter bypass has been increased and the 860 fans (and the isolation dampers) are more exposed to the harsh environment. Periodic maintenance (inspection and cleaning) has been performed; in addition, the dampers are routinely cycled (opened then closed) to reduce salt/scale buildup and ensure the dampers operate correctly. Even with this maintenance, the interior of the damper exhibited substantial corrosion. Therefore the leakage is likely to be greater than the design allowed. While air leakage has been detected, primarily through sound, the actual leakage is currently unknown. Filter bypass airflow, i.e., damper leakage, has not been tested. ASME N511-2007, *In-Service Testing of Nuclear Air Treatment HVAC systems*, specifies dampers be leak tested every two years. Monitoring damper leakage is essential to maintaining isolation integrity. The current configuration and condition of the filtration bypass isolation dampers is inappropriate for minimizing a radiological release. The Radcon organization was not aware of the potential for leakage around the HEPA filters with the bypass isolation dampers closed.

Maintenance of the U/G ventilation system has failed to keep up with system degradation and has impacted operation of the system. As discussed in the maintenance history paragraph above, inadequate maintenance of the 860 fan inlet vortex actuator has forced manual vortex operation to achieve shift to filtration. This has been normal operation for years. Although it is well understood by the facility operations staff, it has not been instituted in the alarm response procedures. If operations staff is not readily available to open the damper, the startup of the filtration system is delayed. With the two 700 fans out of service, the use and resulting wear on the 860 fans will increase.

The 707 bulkhead regulator remote control has not been in operation for approximately one year due to component malfunctions. As this regulator is required to close when shift to filtration is activated, manual closure is required.

With the sensor failures and the inaccurate CMS display, the facility operators are forced to rely on memory regarding the actual configuration and condition of the facility. Therefore the operator may not be able to react and appropriately respond to all abnormal conditions or events.

Inadequate maintenance has left the underground ventilation system in a degraded condition where the reliability in responding to an upset condition, particularly one requiring a shift to filtration, has been reduced.

The identification of the U/G ventilation system as a confinement system will be reevaluated as part of the classification of the UVS consistent with the revised hazards analysis of the DSA. Conclusions and Judgments of Need associated with the ventilation system are identified in the Maintenance (CON 17 and JON 30) and Radiation Protection Program (CON 19 and JON 37) chapters of the report.

10.0 Ground Control

10.1 Ground Control for WIPP

This section is based on the review of DOE/WIPP-02-3212 *Ground Control Annual Plan* (GCAP) Revision 12, for WIPP in compliance with Title 30 Code of Federal Regulations (CFR) Part 57, Subpart B, "Ground Control." The mechanical requirements for roof and rock bolts are specified in ASTM F432-95, *Standard Specification for Roof and Rock Bolts and Accessories*.

The purpose of the GCAP is to ensure that Hazardous Waste Facility Permit (HWFP) requirements specific to WIPP ground control activities are met. The HWFP, A2-5a (1), states:

> "The ground control program at the WIPP facility will ensure that any room in a hazardous waste disposal unit (HWDU) in which waste will be placed will be sufficiently supported to assure compliance with the applicable portion of the WIPP Land Withdrawal Act (LWA) which requires a regular review of roof-support plans and practices by the Mine Safety and Health Administration (MSHA). Support is installed to the requirements of 30 CFR Part 57, Subpart B."

WIPP is designed to permanently dispose of TRU radioactive waste left over from the research and production of nuclear weapons. The project facilities include disposal rooms excavated in an ancient, stable salt formation 2,150 feet underground. This deep geologic setting requires that a comprehensive ground control program be in place to monitor and assure the stability of the underground openings and address issues of concern. (Figure 22)

The primary objective of the WIPP Ground Control Program is to provide a safe environment for personnel and equipment in a manner that is consistent with the primary facility operational objective of waste disposal.

The fundamentals on which the ground control program is based are as follows:

- Safe access is maintained as long as access is required.
- Regular ground control maintenance is required to maintain safe access.
- Ground control maintenance efforts increase with the age of the openings.
- Ground control plans are specific but flexible.
- Regulatory requirements are met.

Current ground control projections for the disposal panels call for adding additional ground control only as needed and, preferably, immediately prior to waste emplacement in a specific area. Ground control projections are tentative, based on evaluations of current conditions, and prioritized based on safety.

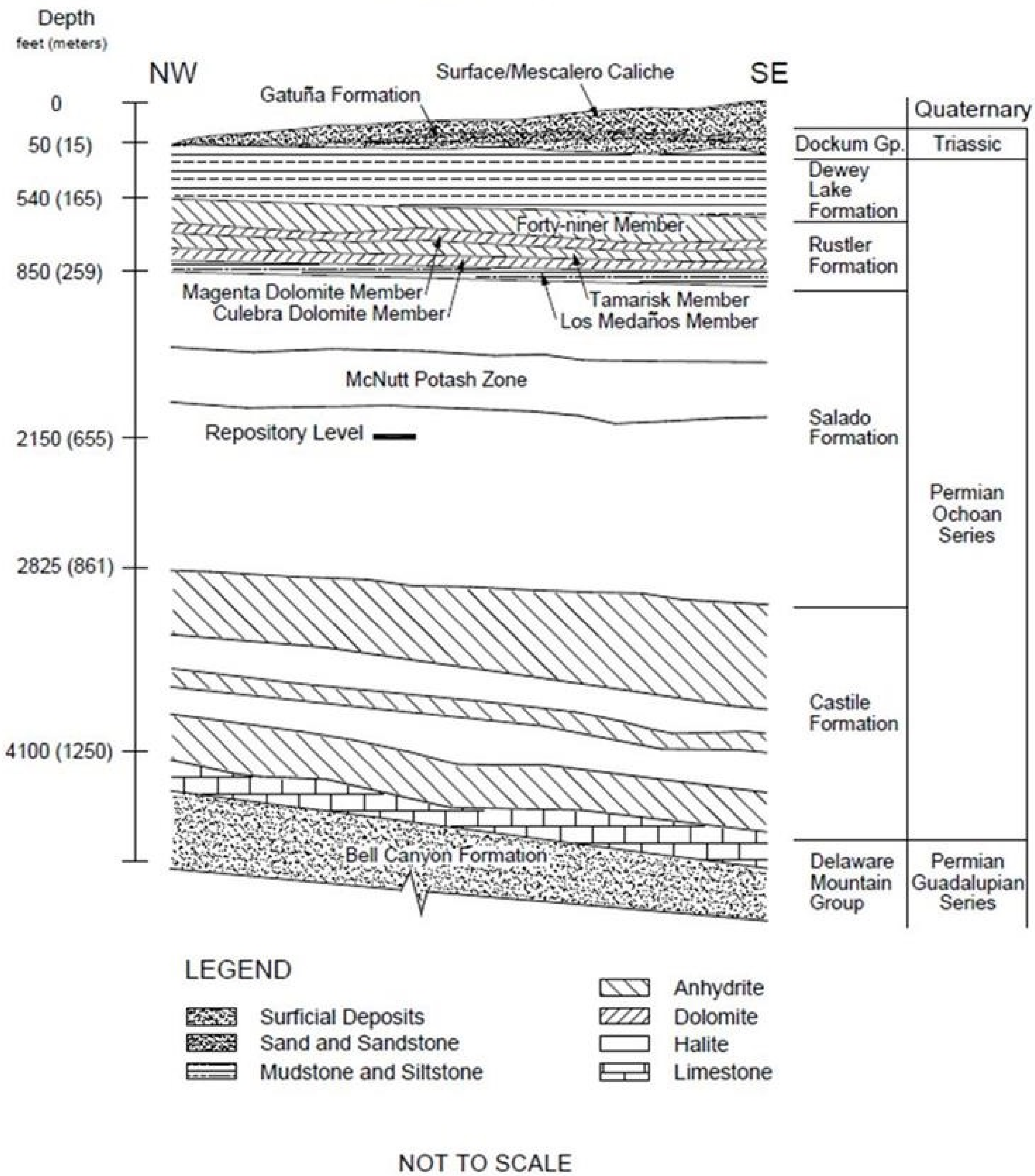


Figure 22: Regional Geography

10.1.1 Method

Three basic options are available to address unstable ground conditions: (1) support the ground, (2) remove the ground, or (3) discontinue access. The first two options are engineering alternatives while the third option is an administrative decision. The ground control design criteria are based on long-term objectives, experience, and performance of existing systems, laboratory and in situ tests of selected ground control components and/or systems.

Ground control systems and components are installed and field tested in accordance with MSHA and industry standards. Underground pull tests are performed to determine the anchorage capacity and displacement characteristics of the support for the anchor length and type of support used. If the anchor length or type is modified, additional anchorage tests are conducted to test the new configuration. (Figure 23)

Figure 23: Ground and Rib Control in the Underground

10.1.2 Monitoring and Evaluation

The assessment and evaluation of the condition of WIPP excavations is an interactive, continuing process involving a wide variety of data. These evaluations can be as simple as the required daily visual checks by personnel working in an area or as complex as an expert panel review of specific design or programmatic changes.

The Geotechnical and Mine Engineering group periodically gathers and evaluates data from various sources. A monthly internal underground geotechnical assessment report is prepared, as is the annual Geotechnical Analysis Report. An in-depth evaluation of all of the accessible underground is performed on an annual basis and reported in the Ground Control Annual Plans. These evaluations are based on visual observations, analyses of instrumentation data, observation borehole data, and ground control performance.

Special assessments are performed as needed. For example, assessments are performed prior to waste emplacement to ensure that areas are ready for waste disposal operations. Limited areas are examined and evaluated and, if appropriate, recommended for emplacement operations for a specific time period.

10.1.3 Overall Geotechnical Evaluation Process

One of the more difficult aspects of ground control is determining and evaluating the criteria that dictate when ground control actions should be initiated. The identification of potential instabilities is essential to maintaining a safe underground environment. Ground control can be expensive and, in some instances, ground control measures can actually have an adverse effect on in situ conditions (e.g., the breakup of a roof beam associated with installation of rigid roof bolts). Therefore, it is prudent to be as rigorous as possible in determining when to initiate ground control actions and what those actions should be.

The process followed at WIPP includes evaluation of general categories of information. These categories include:

- Collection and analysis of geomechanical instrumentation data.
- Evaluation of the performance of installed ground support systems.
- Evaluation of physical observations.
- WIPP-specific experience.

Each category is evaluated independently and comparatively to the other categories. With respect to the disposal panels and the waste haulage routes leading to the panels, emplacement schedules must also be considered for logistic purposes. Criteria for corrective action are continually reevaluated and reassessed based on total performance to date. Actions taken are based on these analyses and planned use of the excavation.

Collection and Analyses of Geomechanical Instrumentation Data

Instrumentation data provide quantitative information on rock movement into and around openings. Convergence and extensometer data are collected on a continuing basis. This information is typically plotted as displacement versus time and as rate of displacement versus time. These data are analyzed concentrating on trends in rates and changes in patterns as indicators of instability. For example, long-term data may indicate a consistent closure rate in a particular area. A significant acceleration in this rate may be a sign of developing instability.

Evaluation of the Performance of Installed Ground Support Systems

Installed support systems are monitored for performance through various means. Visual inspections are performed on a regular basis. In most cases, one component of a system will show evidence of strain before failures are seen in a system. For example, as support systems age it is typical to observe dimpling or cracking of bearing plates before roof bolt or other component failures. In addition, selected support components may be instrumented to monitor system integrity. Roof bolt or component failures are closely tracked, and the failed roof bolt or component can then be replaced when it is a part of the active ground support system.

Roof bolt or component failures alone do not necessarily indicate an unstable situation. Due to creep deformation, it is known and expected that roof bolts and support components will fail through time. The age of the in-place ground support system, as well as the roof beam expansion rates and relative stratigraphic offset rates for the area of interest, must be considered when evaluating the total system performance.

Knowledge of the mechanical properties of support system components and experience with the systems in the WIPP environment allows projection of how the system should perform under specific conditions. When a ground support system is performing in a manner inconsistent with expectations, attention is increased and appropriate actions taken.

10.1.4 Evaluation of Visual Observations

Visual observations generally identify surface fractures, fractures or separations within boreholes, offsets in boreholes, spalling, and any other visually detectable behavior of the ground condition. Similar to the other data, anomalous behavior, such as changes in fracture density and development or increased slabbing, can be an indicator of potential instability.

Mining Operations Travel Way Weekly Visual Inspections

On a weekly basis Mining Operations personnel visually inspect travel way roof bolts, back and rib for:

- Loose or broken roof bolts.
- Deformed or broken roof bolt plates and roof mats.
- Excessive loading, gaping or tears in chain link mesh.
- Cracks and separations in the back and ribs.
- Ground Control Engineering is informed of the results of the weekly visual inspection.

Mining Operations Underground Facility Annual Physical Inspections

On an annual basis Mining Operations personnel physically inspect all accessible areas of the underground. This inspection is an expanded version of the weekly inspection incorporating physical sounding of the ribs and back with a scaling bar. The results from this inspection are forwarded to Ground Control Engineering for further evaluation and action if necessary.

10.1.5 WIPP-Specific Experience

With site-specific experience dating from 1982 at the WIPP facility, many of the ground conditions have been encountered previously. Patterns and behavior are observed and compared to qualitative and quantitative expectations. Deviations of any type are investigated and resolved.

Waste Disposal Area Evaluation and Acceptability

The process for determining acceptability of an area for waste emplacement operations and disposal involves an evaluation of projected geotechnical conditions of an area for a specific period of time. Each determination considers performance of the underground excavation, the geomechanical instrument data results, performance of any installed ground support, and other physical observations. Expected overhead, rib to rib clearance and floor stability are also documented.

Acceptability of an area for waste emplacement is determined upon completion of the evaluation process. If the area is found to be acceptable, a time period is determined during which emplacement operations may proceed before another detailed, specific area acceptability evaluation is required. Present plans assume that no more than two areas at a time will be cleared for emplacement and acceptability periods will not exceed one year. Waste receipt rates will affect the size of the areas cleared, i.e., low waste receipt rates will result in smaller areas being cleared as acceptable for emplacement.

Geomechanical monitoring, support system monitoring, and physical observations will continue as long as physically possible during the waste emplacement operation. A reevaluation of an acceptable area will be performed immediately should conditions or data show unexpected behavior of the ground. This evaluation process is common at WIPP. It supports planning and integration of operations processes relating to waste emplacement and room closure.

Visual Assessment

The annual in-depth evaluation includes a visual assessment of all accessible areas of the underground facility and is normally conducted by a two-person team from Geotechnical Engineering. The conditions of the back, ribs, and floor are qualitatively assessed in each ground control zone and are graded on a relative basis. A summary of these evaluations are presented in the Ground Control Annual Plans.

The back is evaluated with respect to low-angle or en echelon fractures, scaling, and longitudinal (sub-parallel and parallel) or transverse (rib-to-rib) vertical fractures, and then graded. The ribs are evaluated on their general condition, and it is noted if they had been mechanically scaled. The floor is evaluated with respect to heaving and fracturing. It is also noted if the floor has been milled or mined to provide a smooth traveling surface. As a general rule, scaling and milling activities remove small amounts of ground and are unlikely to have a significant effect on closure rates and the overall stability of the area.

Figure 24: Roof Bolter Drilling to Install Roof Bolts

The back of an area is taken as a whole with regard to longitudinal or transverse vertical fractures. A few vertical fractures may be an indicator of advancing deterioration, but they do not constitute reason for immediate remediation. Areas containing vertical fractures are closely monitored visually and with geomechanical instrumentation. The type and extent of these fractures will affect the ground control system chosen for a given area. An area with only a few longitudinal fractures could probably be supported with a standard roof bolt system, whereas an area with extensive, connected fracturing, suggesting a breakup of the beam, might require a more extensive supplemental support system. (Figure 24) Areas receiving lesser ratings, based on the visual assessments, warrant closer monitoring. In these cases, the ground conditions are monitored more frequently, and additional instrumentation is installed when appropriate. When it is determined that ground conditions have reached a point where a safety hazard could develop in the short term, mitigation actions are implemented.

Observation Boreholes

The presence of horizontal offsetting (visible in boreholes) confirms lateral movements in the roof beam. Horizontal offsets usually occur in association with fractures, clay seams, and separations. The greatest rate, and magnitude, of the observed offsets is typically near the ribs, and they generally decrease toward the longitudinal centerline of the room. Observations indicate that initially, the lower portion of the borehole from the collar to the offset moves toward the center of the excavation. It is not unusual for the back of a highly fractured area to exhibit significant asymmetric lateral movement. For example, at the lower horizon once low-angle fracturing on one side of the room extends to the first clay seam, the entire beam then usually is shifted toward that side of the room. The majority of failed roof bolts at WIPP have some loading effect due to lateral movements in the roof beam.

The identification of the presence of anhydrite stringers within the roof beam increased the understanding of the roof beam failure mechanism in the upper horizon. The detection of separations along the stringers is a precursor to roof beam sag and tension crack formation. Ground support is most effective when installed prior to separation along the stringers. Ground support installed post separation has been shown to slow the development of existing separations and limit the development of new separations.

10.1.6 Geotechnical Instrumentation

The purpose of the geomechanical monitoring program is to provide in situ data to support continuing assessments of the behavior of the underground facilities.

Specifically, the program provides:

- Early detection of conditions that could compromise safety.
- Evaluation of room closure that could affect operational performance.
- Guidance for design modifications and remedial actions.
- Data for interpreting the actual behavior of underground openings, in comparison with established design criteria.
- Data on which to base an accurate assessment of the mechanisms of deformation and fracturing that is taking place.

Geotechnical data collected from each specific area in the underground are evaluated to determine if conditions exist which warrant closer (or possibly immediate) attention from a ground control standpoint. Back expansion rates and the expected life of the area are important criteria to be considered when selecting ground control measures for a specific area.

Measurements of back-to-floor and rib-to-rib closure are taken throughout the underground on a routine basis. In addition to closure data, extensometer data are also collected. Extensometer data, combined with information from observation holes, assist in assessing separations at clay seams and expansion within salt roof beams.

Ground Support System Monitoring

Monitoring of ground support systems is also an integral aspect of the ground control program. Typical ground control instrumentation in use includes load cells and joint meters in addition the failure of individual component of the ground support system can also provide clues as to the ground conditions. Roof bolts tend to fail where lateral offset within the roof beam is greatest. Roof plate deformation indicates the roof bolt is loading and may require additional roof bolts be installed to properly support the area. Torn roof mats indicated movement across tension cracks and roof beam sag.

Load Cells

Load cells provide a quantitative measurement of the axial load on an individual roof bolt or other components of a ground support system. Load cells are installed on selected roof bolts throughout the underground to measure the rate of loading on the roof bolt. Load cells are also installed as part of a long term anchorage test on roof bolts that had been previously pull tested.

Joint Meters

The joint meters used at WIPP serve primarily to monitor displacement across a fracture. Joint meters can also be used to monitor strain in the cables of cable support systems.

The ground control program has been established, implemented, and is maintained to initiate remedial actions for unstable ground conditions and to characterize, monitor, and trend salt behavior. The approach used in the ground control program at WIPP uses experience gained from observations and analyses of salt behavior underground. This experience allows various projections to be made regarding future ground support requirements. The ground control program provides routine monitoring and evaluation of underground conditions by visual or physical examination, geomechanical data analysis, and performance of installed ground support. The program is designed to detect conditions that indicate instability and initiate corrective actions. The ground control program minimizes the likelihood of falling objects from the underground facility, i.e., back and ribs, and provides early warning to prevent a roof fall event in the underground areas. Weekly ground control inspections ensure that changing conditions are promptly identified, evaluated, and addressed appropriately. Specific plans and layouts are prepared and are based on a detailed evaluation of each area.

The Board reviewed the Geotechnical Analysis Report for July 2011 – June 2012, and all the supporting data. The report indicates that there are 18 Piezometers, 62 Extensometers, 360

Convergence Points and 68 Fractures that are monitored to produce this report as well as the Geotechnical Assessments that are produced on a monthly basis.

The Board reviewed the Geotechnical Assessments for the months of November 2013, December 2013 and January 2014. These reports indicate convergence points with greater than 20 percent increase.

The areas of concern that were mentioned to the Board during the In-Brief for the radiological event were based on the materials disposed in the two locations that would be capable of producing the results of the sampling that were discovered following the release. The areas were identified as Panel 7 Room 7 and Panel 6 Room 1. Based on the Geological Assessments, the areas that have exceeded the 20 percent convergence and are in or near the areas of concern that are mentioned in the In-Brief are S2750 W285 and S3080 W285.

The November report shows S2750 W285 had convergence of 6.2 in/yr or a 28 percent increase. S3080 West 285 was 3.6 in/yr, which is a convergence increase of 21 percent.

The December Convergence for S2750 W285 was 7.0 in/yr, which is a 34 percent increase from the prior year. This area was bolted during the November reporting period and reportedly indicated an immediate decline of 20 percent in response. S2750 W285 is immediately in front of the Panel 6, Room 1.

The January Convergence for S2750 W285 was 8.0 in/yr, or a 44 percent convergence increase from the year prior.

The January Convergence Assessment further states that adjacent extensometer readings permit estimation of expansion in the immediate roof beam of 67 percent of total convergence. Bolts in the area continue to provide adequate support to the roof beam. Visual observations indicate that the immediate beam is rapidly deteriorating. It is likely that it will soon be unable to offer significant resistance to horizontal pillar loading, at which point the vertical displacement is anticipated to decline.

Based on the results of these Convergence Assessments, the area directly in front of the Panel 6 Closure Area has had some movement and it appears that there is an anticipation that the vertical displacement will decline.

To further the investigation, the Board was able to review the data provided by a third party Professional Engineer who provided approval for disposal of TRU waste in Panel 7 Room 7 based on visual examinations and the data provided by the NWP Engineering Department. The Professional Engineer concluded that Panel 7 can be operated in compliance with the permit.

Analysis

During Phase 1, the Board can only base its investigation into the Ground Control Program on the evidence provided within the reports, assessments and historical data produced and reviewed by the Professional Staff in the Engineering Department and Underground Operations. The Phase 1 report covers the Board’s analysis and conclusion for the release of TRU from the U/G to the environment. The Ground Control Program will be investigated further in Phase 2 after reentry into the U/G and a cause of the release within the U/G is able to be determined.

11.0 NWP Contractor Assurance System

The NWP Contractor Assurance System (CAS) is described in the NWP QAPD, Section 1.1.9. This section captures the criteria specified in the Contracts Requirements Document of DOE O 226.1B. The CAS commits to ensuring that work performance meets the applicable requirements for environment, safety, and health; integrated safety management; safeguards and security; and emergency management. The CAS states that it is designed to identify deficiencies and opportunities for improvement, report deficiencies to responsible managers, complete corrective actions, and share in lessons learned.

The Contractor Requirements Document of DOE O 226.1B requires the contractor to submit to DOE for approval a CAS description document. The contractor, NWP, utilizes the QAPD to meet this requirement. The QAPD does not refer to other procedures or processes on how the CAS is executed.

The Board reviewed additional resources and found that NWP has numerous policies, procedures and tools for conducting supervision and oversight of work. The Board reviewed several mechanisms on the WIPP Intranet such as lessons learned (many types and databases), trending reports, surveillance plans, and environment, safety and health tools, i.e., automated job hazards analysis, radcon, health services, industrial safety, and industrial hygiene databases. NWP also implements other oversight and management processes like quality assurance, Conduct of Operations (CONOPS), WIPP forms/logs, root cause analysis, and environmental management systems.

As previously identified in Section 3.0, Nuclear Safety, there have been no formal assessments of the DSA/TSR development process in the past few years by NWP and the previous contractor. This does not meet the expectation of the TSR Section 5.5 requirement for reviews and audits. Other DOE sites have commissioned independent assessments consistent with the continuous improvement principle.

The Board reviewed the NWP CAS implementation and found the following issues that have not been corrected:

- Multiple external reviews have identified deficiencies in Work Planning & Control, Emergency Management, Issues Management, and Fire Protection.
- Post-drill emergency exercises did not identify deficiencies in the emergency response program, e.g., functionality of egress strobe lights, reflectors, PA system, donning SRs and SCSRs.
- The Emergency Program triennial program assessment was not performed, and it is indeterminate when the last assessment was conducted.
- Combustible material was allowed to exceed specified quantities in some areas of the U/G.
- Over 30 emergency lights in the Waste Handling Building have been inoperable for as long as two years.
- Twelve of 40 mine phones tested were found to be non-functional in a spot check by the Board.

- Pre-operational underground vehicle check list did not include performance criteria from the owner's manual.
- There were over 10 red tags related to critical safety equipment posted in the CMR. Some were seven months old. Critical safety equipment includes, but is not limited to, ventilation fans, fire suppression systems, bulkhead doors, and continuous air monitors.
- Lessons Learned from previous U/G vehicle fires were not applied prior to the February 5 salt haul truck fire.
- Surveillances and oversight are more focused on waste-handling and certification activities and less on maintenance activities and the safe operation of the U/G.
- The CAS is primarily implemented through the QA program rather than through self-assessments conducted by knowledgeable, qualified SMEs within the various management programs.

11.1 NWP Supervision and Oversight of Work

NWP has numerous policies, procedures and tools for conducting supervision and oversight of work. The Board reviewed several mechanisms on the WIPP Intranet such as lessons learned (many types and databases), trending reports, surveillance plans, and environment, safety and health tools, for example: automated job hazards analysis, radcon, health services, industrial safety, and industrial hygiene databases. NWP also implements other oversight and management processes like quality assurance, CONOPS, WIPP forms/logs, root cause analysis, and environmental management systems.

An area that the Board specifically reviewed was the Management Assessment Program for NWP. The data that were analyzed included an interview with the Performance Assurance Manager as well as information provided on the WIPP intranet. This manager's duties include occurrence reporting processing system, and there is a Facility Management Designee (FMD) who fulfills and has ownership of this program. The FMD also has the Directive Management Processes to ensure and track the implementation of the DOE Directives within the NWP contract. The FMD told the Board that this includes Lessons Learned Program, the Root Cause Analysis Process, and that the FMD is also the Chairman of the Senior Managers Corrective Action Review Board. The Price-Anderson Amendments Act Coordinator also reports to the FMD and has combined responsibility for Security, Nuclear Safety, and Worker Safety. Each of the group's managers was responsible for performing the assessments for their own group.

Overall, NWP expends considerable resources performing oversight activities, most of which are focused on waste management and quality assurance activities to ensure permit requirements are met.

Analysis

The Board determined that the progress toward effectively implementing Work Planning & Control, Emergency Management, Issues Management, Conduct of Operations, Nuclear Safety, Radiation Protection, and Fire Protection programs is inadequate. In addition, issues identified with safety culture were not addressed in their CAS. NWP has not fully developed a CAS that provides assurance to both DOE and NWP that work is performed compliantly, risks are identified and managed, and control systems are effective and efficient. The NWP CAS did not identify precursors to this event. Corrective actions from previously identified assessments were not effective in preventing or minimizing recurrence.

The Board concluded that the management assessments were ineffective and focused primarily on cost and schedule.

Overall, NWP expends considerable resources performing oversight activities, most of which are focused on waste management and quality assurance activities to ensure permit requirements are met.

CON 20: NWP has not fully developed an integrated contractor assurance system that provides assurance that work is performed compliantly, risks are identified, and control systems are effective and efficient.

JON 38: NWP needs to develop and implement a fully integrated contractor assurance system that provides DOE and NWP confidence that work is performed compliantly, risks are identified, and control systems are effective and efficient.

CON 21: NWP failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE O 226.1B, *Implementation of Department of Energy Oversight Policy,* and hold personnel accountable for implementing those programs and processes.

CON 22: NWP failed to identify weaknesses in conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture.

CON 23: NWP failed to adequately complete corrective actions from prior assessments to prevent or minimize recurrence.

CON 24: Comprehensive self-assessments are not being performed by knowledgeable, qualified subject matter experts within the various safety management programs. Contractor Assurance System is implemented primarily through the Quality Assurance program.

JON 39: NWP needs to establish and implement line management oversight programs and processes that:

- Meet the requirements of DOE O 226.1B, *Implementation of Department of Energy Oversight Policy,* and hold personnel accountable for implementing those programs and processes.
- Implement effective contractor assurance processes to emphasize conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture.
- Implement a Contractor Assurance System to ensure that actions from prior

assessments are implemented to prevent or minimize recurrence of identified deficiencies.

- Include self-assessments by knowledgeable, qualified subject matter experts within the various safety management programs.

12.0 DOE Programs and Oversight

12.1 DOE Program and Oversight Facts

The CBFO provides primary oversight to the site contractor NWP and its subcontractors. Day-to-day oversight of field activities at the site is mostly completed by the CBFO staff from the Office of Site Operations and the Office of Environment, Safety, and Health within the CBFO. The FRs report to the Office of Site Operations but have a "dotted line" responsibility to report issues to the CBFO Manager through regularly scheduled meetings and periodic impromptu reports. Since arrival, the CBFO Manager has implemented a practice to be at the site at least twice a week.

CBFO oversight staff members include a diverse set of talents and backgrounds including: FRs, systems engineering, U/G operations, waste operations, work control, quality assurance, electrical safety, environmental protection, regulatory specialist, RCRA, compliance, emergency management, fire protection, health physics, maintenance, nuclear safety, industrial safety, and safety. CBFO develops an annual Integrated Evaluation Plan (IEP) that is used to plan and track evaluations and assessments across many project-related areas. The Board reviewed several IEPs from past years.

CBFO has several policies and procedures that address oversight activities such as QA audits, surveillances, and other project verifications. CBFO is required to implement an oversight program in accordance with DOE O 226.1B. CBFO also implements a Technical Qualification Program (TQP) in accordance with DOE O 426.1, *Federal Technical Capability*.

Per the CBFO Integrated Safety Management System Description, DOE/CBFO 09-3442, Revision 3, *Introduction*:

> *"The CBFO mission is to provide safe, compliant, and efficient characterization, transportation, and disposal of defense transuranic (TRU) waste. CBFO is committed to fulfilling its mission in a manner that affords protection of the public, our Federal, contractor, and subcontractor worker, and the environment. CBFO is dedicated to performing its mission in compliance with the statutes enacted by Congress for the protection of workers, the public, and the environment, and for exercising good stewardship of public property. This protection is put into operation at all levels (site, facility, task, and activity) by requiring and routinely verifying that work is conducted following the five ISM Core Functions in a manner consistent with the seven ISM Guiding Principles established in DOE P 450.4.[5]"*

The Board interviewed CBFO management and oversight staff and reviewed supporting documentation during the course of this investigation. Periodically, oversight is also performed by DOE Headquarters (HQ), Defense Nuclear Facilities Safety Board (DNFSB), DOE Office of

[5] DOE P 450.4A, *Integrated Safety Management Policy*

Environmental Management Consolidated Business Center (EMCBC), MSHA, and other outside entities to ensure safe and compliant operations at the facility.

The Board also reviewed records to determine frequency of entrance to the U/G by CBFO management and staff. Records from the last year indicated that many of the CBFO technical/oversight staff had only been in the U/G a few times, sometimes with a tour group.

CBFO and EMCBC have signed a Service Level Agreement (SLA) that describes support functions to be provided by EMCBC in order for CBFO to be able to focus its resources on project and technical management, and oversight of CBFO contractors. The SLA describes EMCBC functions such as support in the areas of regulatory compliance, safety management systems, quality assurance, lessons learned, contractor assurance, technical support, and DOE oversight assistance. The SLA also states the EMCBC can provide preparation, review and issuance of program procedures and plans, as required to support the mission and conduct/support audits and surveillances per DOE management guidance.

The CBFO Manager reports to the Office of Environmental Management at headquarters. The Board surveyed several DOE headquarters managers and support staff to gain a better understanding of roles and responsibilities as they relate to overseeing or supporting the WIPP project. Several of the interviewees indicated that they had a role in influencing actions such as how much funding or other resources are to be provided and how resources are allotted but few indicated that they were responsible for ensuring adequacy of their actions related to project performance. In addition, both EM HQ and EMCBC responses indicated that resources, e.g., FTEs, travel budgets, etc., have been declining for the last several years and that “assist” visits and support have been affected.

DOE Headquarters provides support to WIPP in the form of policies, DOE orders, resources (budget and human capital), mission support, emergency management, quality assurance, nuclear safety, security, independent oversight, etc.

The Board also reviewed the last four years of budget requests by CBFO, by EM, and the actual budget received. The Board also reviewed communications between CBFO and EM HQ requesting additional staffing in 2012. The Board noted that facility operations received less funding than requested in two of those four years. While the Board recognizes that there is a negotiation process with all projects during budget formulation each year, given the issues with maintenance and configuration management related to this accident, the Board concluded that DOE should review these processes and determine if improvements need to be addressed.

Analysis

The CBFO organization has undergone several changes over the last few years. Prior to the current organizational structure that has a full time Manager for the last two years, and a full time Deputy Manager for the last three months, the Manager performed most of the managerial duties on his own for most of his two-year tenure. Prior to the current Manager’s selection, a different Deputy Manager was hired and placed in an “Acting Manager” role for nearly the next two years. During the “Acting Manager’s” tenure, several of the CBFO staff and managers were placed on “details” to other positions within the organization and other positions were reorganized or abolished. Feedback from many of the CBFO personnel indicated that the working environment was very unpleasant. Results from the 2011 Employee Value Survey indicated that over 71 percent of employees did not have a high level of respect for CBFO senior leaders. Many of the staff interviewed by the Board indicated that the current Manager and Deputy Manager are working to turn around the negative effects of past organizations but there are still some challenges with directors giving up "old" practices.

The Board reviewed the CBFO Integrated Evaluation Plans from FY11 to the present to assess the completion status of planned assessments. Evaluations within the Integrated Evaluation Plans not completed as scheduled include senior management walkthroughs, Safety System Oversight for ventilation, nuclear safety management program review, Office of Site Operations management assessment, vital safety systems walk down of CAMS systems, TQP assessments, maintenance procedure assessment, and Fire Hazards Analysis/Baseline Needs Assessment. While several of the scheduled assessments were completed, many did not provide supporting documentation.

Related to nuclear safety, CBFO is comprised of at least one qualified Nuclear Safety Specialist and subject matter experts from other CBFO organizations, supplemented by additional resources from the Carlsbad Technical Assistance Contractor (CTAC) as necessary. Since approximately 2010, CBFO has been relying on a safety basis lead that is a collateral duty with primary responsibility to oversee the Radiation Protection Program. As identified in Section 3, Nuclear Safety, there is an observed lack of robustness in the CBFO technical review of DSA/TSR changes/annual updates. In addition, the Board concluded that CBFO has insufficient nuclear safety management/staffing since the 2010 timeframe addressing the retirement of ABSTA and existing Nuclear Safety Specialist staff responsible for multiple subject matter expertise.

Based on the review of the log sheets from the last year, the Board also determined that many of the CBFO technical/oversight staff made infrequent trips to the U/G as part of the oversight activities.

In addition, from interviews with several CBFO staff members, there is a strong perception that contractor and CBFO directors do not welcome negative findings or observations and that CBFO staff have to individually follow up on corrective actions from NWP, rather than getting timely responses in accordance with site corrective action processes, in order to ensure effective actions have been taken. It was not apparent that follow-up is pursued in all cases by CBFO staff. Several CBFO staff members indicated that they can convey issues verbally to the contractor with mixed results for correction; however, there is not an effective mechanism to convey documented issues to the contractor. In addition, from review of the recent Safety Conscious Work Environment employee survey, 59 percent of the CBFO staff members that completed the survey answered "somewhat" to "yes" on the question of the existence of a chilled work environment.

CBFO staff members have been required to use the Office of Quality Assurance corrective action report (CAR) system to identify nonconformances. Interviews with several CBFO staff members indicate that this process is cumbersome, administratively burdensome, and many do not use it. In reviewing CAR submittals since the beginning of FY2012, the Board found that only 15 CARS have been generated by site staff outside of the CBFO QA group. Only one CAR has been generated by a FR in the last year.

The FR program has been reviewed several times over the last few years. Deficiencies have been identified related to staffing not meeting the staffing analysis, procedures that are incomplete and not used, no structured surveillance/oversight program, and no clear mechanism being used to communicate issues to management and the contractor. While CBFO management has brought in supplemental support from HQ and EMCBC to try to correct these issues, the FR program is still not effectively implemented.

Several externally generated oversight documents [DOE HQ, DNFSB, Office of Health, Safety and Security (HSS), EMCBC, etc.] that contained findings, observations, and opportunities for improvement for the CBFO and WIPP site were reviewed by the Board. In many cases, no corrective action plans were developed or implemented, corrective action responses were not developed in a timely manner (for example, a year lapsed between the assessment and development of a corrective action plan), or implementation of corrective actions was either incomplete or ineffective. Several of the deficiencies have been identified numerous times. Table 2 includes examples of external oversight reports that were reviewed by the Board.

The Board interviewed several DOE HQ management and support staff to gain an understanding of roles and responsibilities related to line management and support of the WIPP project. Several of the interviewees indicated that they had a role in influencing actions such as how much funding or other resources are to be provided and how resources are allotted but few indicated that they were responsible for ensuring adequacy of their actions related to project performance. The Board noted that roles and responsibilities (and the associated impact on balanced project priorities) were not clearly understood and executed. While the Board recognizes that there is a negotiation process with all projects during budget formulation each year, given the issues with maintenance and configuration management related to this accident, the Board concluded that DOE should review these processes and determine if improvements need to be addressed. The Board also reviewed correspondence related to CBFO requests for additional FTE and the response that additional FTE were not available. The requests for additional FTE included additional oversight staff (which has been noted as a weakness). The Board also noted that it took over a year to fill the Deputy Manager position.

The Board also reviewed documentation, including programmatic change requests, that established additional needs for support for the project for program support and improvements in areas such as maintenance and work control, conduct of operations, and project performance. It was noted that CBFO management has actively pursued additional resources for key areas of the project with limited success.

The Board concluded that DOE HQ Line Management and Oversight was inadequate in lack of line management responsibility and follow through; failure to enforce and ensure that issues are corrected in the areas of emergency management, radiological protection, nuclear safety, maintenance, work control, ISMS; availability of resources to perform oversight have been reduced over last several years; and roles and responsibilities are not clearly understood. Based upon the declining resources that were identified through DOE HQ interviews and document reviews, the Board recommends that DOE HQ and the EM Sites perform an "extent of condition review" to determine the adequacy of resources designated for maintenance, configuration management and infrastructure upgrades.

DOE HQ and CBFO has not critically evaluated and prioritized investments for improving facility infrastructure to support expected performance of the WIPP facility. This issue is addressed in Section 7.0, Maintenance.

Table 2: Reviews of the WIPP Project

Date of External Assessment	Organization	External Assessment Title	Areas Evaluated
January 31, 2008	EM	EM Assessment of CBFO and Washington TRU Solutions WTS	For CBFO, the main issues were the informal nature of CBFO oversight, lack of processes to trend, identify and respond to operational trends and an issue with the qualification process for SSOs. For WTS, the main issues were implementation of CONOPS administrative processes, approval of the CONOPS matrix by CBFO and training and proficiency requirements for facility shift managers.
July 28, 2008	EM-60/62	Approval of Corrective Action Plan for assessments with the exception of the CONOPS portion.	Several of the CONOPS deficiencies identified in the Finding were not addressed in the corrective action provided in the originally submitted CAP.
January 26 – 30, 2009	EM-43	Environmental Management Quality Assurance Audit Department Of Energy Carlsbad Field Office Washington TRU Solutions and Central Characterization Project EM-PA-09-013	Quality Assurance (QA) audit of Planning and Control

Date of External Assessment	Organization	External Assessment Title	Areas Evaluated
March 31, 2009	EM-64 (EM-43)	Environmental Management Quality Assurance Program Audit of the Waste Isolation Pilot Plant Transmittal Letter	Flowdown of requirements; adequacy of CBFO oversight of the QA program; appropriateness of the interface controls; adequacy of purchase items; and adequacy of identifying conditions adverse to quality.
March 9-12, 2010	EM-22 (EM-42)	Waste Isolation Pilot Plant Washington TRU Solutions, LLC EM-22 Office of Safety Operations Assurance Assessment Report	Ongoing and regular evaluation of the effectiveness of the WIPP operations. Evaluated CONOPS, Radiological Protection, Work Planning and Control Programs, and CBFO oversight.
February 15-17, 2011	EM-22 (EM-42)	EM-22 Office of Safety Operations Assurance Waste Isolation Pilot Plant Review	Evaluate Washington TRU CONOPs, Work Planning and Control and Contractor Assurance System processes. Follow-up to March 2010 EM-22 assessment.
June 24, 2011	DNFSB	Forwarding the Staff Issue report for a staff review conducted January 25-26, 2011, on the fire protection program at WIPP, including both above-ground and underground operations.	Identified issues with the Fire Hazard Analysis, contractor's fire protection program, CBFO oversight, WIPP fire brigade, baseline needs assessment, and CBFO's emergency management program.

Date of External Assessment	Organization	External Assessment Title	Areas Evaluated
September 7, 2011	HSS	Office of Enforcement and Oversight conducted an orientation visit to the DOE Carlsbad Field Office (CBFO) and the nuclear facility at the Waste Isolation Pilot Plant (WIPP).	The purpose of the visit was to discuss the nuclear safety oversight strategy, describe the site lead program, increase HSS personnel's operational awareness of the site's activities, and identify specific activities that HSS can perform to carry out its independent oversight and mission support responsibilities.
May 7-10, 2012	MSHA	Mine Safety and Health Administration (MSHA) inspection of surface and underground safety systems	9 underground Compliance Assistance Visit (CAV) notices and 9 surface CAV notices.
June 27, 2012	DNFSB	Forwarding the Staff Issue Report for an on-site review conducted during the week of March 5, 2012, on the WIPP maintenance program.	Deficiencies were identified by the staff with respect to quality of and compliance with maintenance work control documents, post-maintenance testing, pre-job reviews, annual system walk downs, maintenance resources, placekeeping, and DOE oversight.
July 23-26, 2012	EM-42	EM-22 Office of Safety Operations Assurance Waste Isolation Pilot Plant Maintenance Management Review	Evaluate the Washington TRU Solutions Maintenance Management Program and the CBFO oversight of this program. Prompted by June 27, 2012 letter from DNFSB to Senior Advisor for EM detailing safety issues with the site.

Date of External Assessment	Organizatio n	External Assessment Title	Areas Evaluated
October 5, 2012	EMCBC	The assessment was completed at the request of the CBFO Manager, and was covered over a period of time of August 6-9, 2012.	The review was conducted on safety programs and oversight implementation in response to a previous organizational assessment and due to concerns reported through the EMCBC Employee Concern Program.
November 12-15, 2012	EM-42	EM-42 Office of Operational Safety Waste Isolation Pilot Plant Maintenance Management Assist Visit	Evaluate the status of commitments made by EM Senior Advisor for EM in September 2012 in response to the DNFSB June 24, 2012, letter detailing actions taken and planned to correct to issues with the WIPP maintenance management program.
November 29, 2012	HSS	Independent Oversight review of Site Preparedness for Severe Natural Phenomena Events at the Waste Isolation Pilot Plant – November 2012	Office of Enforcement and Oversight independent oversight review of the WIPP emergency management program during June 5 –July 12, 2012. The HSS Office of Safety and Emergency Management Evaluations performed this review to evaluate the processes for identifying emergency response capabilities and maintaining them in a state of readiness in case of a severe NPE.

Date of External Assessment	Organization	External Assessment Title	Areas Evaluated
January 14-18, 2013	HS-12 (VPP)	DOE-HSS evaluation of security Walls Voluntary Protection Program (VPP)	Security Walls (security contractor under Washington TRU Solutions (WTS)) had received the Star Level under VPP but gave it up when they became a part of NWP. NWP has a transition plan in place as part of the new contract and received a legacy award in August 2013 for the transition plan. They will need to meet additional criteria including completing the ISMS implementation verification and validation reviews.
April 2013	EM-43	Follow-Up Assessment of QAP Implementation at the Department of Energy Environmental Management Carlsbad Field Office in Carlsbad, New Mexico, EM-PA-12-14, January 28-31, 2013	Follow up assessment of implementation of the QAP.
April 2013	HSS	Report documenting 2 onsite reviews: first on June 25-28, 2012, and a follow-up visit on January 22-24, 2013.	Objectives of the Independent Oversight review were to evaluate selected portions of 1) CBFO's oversight of the contractor's effectiveness review documentation; and 2) CBFO's performance of the annual ISMS declaration review of the contractor's work planning and control element.

Date of External Assessment	Organization	External Assessment Title	Areas Evaluated
June 2013	EM-42	WIPP CBFO Oversight And Management Assist Visit	The team found continued immaturity in the CBFO oversight and issues management processes which resulted in a burdensome process for FR issues to be transmitted to the CBFO management and contractor.
June 11-13, 2013	EM-42	EM-42 Office of Operational Safety Waste Isolation Pilot Plant Carlsbad Field Office Oversight and Maintenance Management Assist visit	Provide assistance to the DOE Carlsbad Office in improving its oversight of NWP operations at WIPP.
July 2013	EM-42	Triennial Assessment of the CBFO Facility Representative Program	EM-42 staff was requested by the CBFO to perform this assessment in accordance with DOE-STD-1063.
August 19-29, 2013	EM-44	Verification of WIPP Assessment for HS-45 and EM-44 Corrective Actions	Review of corrective actions identified by HS-45 and EM-44 regarding the implementation of an integrated and comprehensive Emergency Management Program
August 22, 2013	DNFSB	DNFSB Staff visit on WIPP Status	Areas of discussion included work planning and control, fire protection, plans and concepts for WIPP's future, DOE-CBFO contractor oversight program, and underground and above-ground tours.
January 28-30, 2014	MSHA	MSHA inspection of surface and underground safety systems	CAV notices have been transmitted to CBFO but have not yet been processed into corrective actions by CBFO.

At the request of the CBFO manager, EMCBC provided a Line Management Oversight Review in October 2012 that identified several weaknesses in oversight programs and implementation. Subsequent to the issuance of this report, there has been inadequate follow up to ensure that CBFO was provided the necessary technical and oversight support functions as described in the SLA.

Overall, CBFO needs to establish and implement an effective line management oversight program and processes that meet the requirements of DOE O 226.1B and hold personnel accountable for implementing those program and processes.

CON 25: CBFO failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*, and hold personnel accountable for implementing those programs and processes.

CON 26: CBFO failed to identify weaknesses in oversight processes, conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture.

CON 27: CBFO is lacking adequate qualified staffing in numerous areas related to line management, technical disciplines and oversight functions.

CON 28: CBFO failed to adequately complete corrective actions from prior assessments to prevent or minimize recurrence.

JON 40: CBFO needs to establish and implement line management oversight programs and processes such that CBFO:

- Verifies that NWP has developed and implemented a DOE Order 226.1B compliant Contractor Assurance System.
- Meets the requirements of DOE Order 226.1B and hold personnel accountable for implementing those programs and processes.
- Implements effective oversight processes to ensure emphasis on conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture.

JON 41: CBFO needs to develop and implement an effective issues management process to document, disposition (including extent of condition), close, track/trend issues, and ensure effectiveness of corrective actions. The process shall also ensure that actions from prior assessments are implemented to prevent or minimize recurrence of identified deficiencies.

JON 42: The CBFO Site Manager needs to institutionalize and communicate expectations for a strong safety culture and the identification, documentation, reporting, and correction of issues without fear of reprisal.

JON 43: CBFO needs to evaluate the current organizational structure, identify specific staffing needs related to line management, technical discipline and oversight functions, submit those staffing needs to DOE HQ, and effectively manage their resources such that qualified personnel are effectively performing those functions.

CON 29: DOE HQ failed to ensure that CBFO was held accountable for correcting repeated identified issues involving radiological protection, nuclear safety, Integrated Safety Management System, maintenance, emergency management, work planning and control and oversight.

JON 44: DOE HQ needs to develop and implement a process to ensure repeatedly identified issues related to the safety management programs are confirmed, closed and validated by the local DOE office in a timely manner.

CON 30: DOE HQ management has failed to ensure that adequate resources, full time employees, technical expertise, travel money, adequate budget, etc., are provided to support the WIPP project.

CON 31: DOE HQ management and staff failed to adequately define and execute roles and responsibilities related to line management, oversight, safety and balanced priorities.

JON 45: DOE HQ needs to re-evaluate priorities and allocate the resources, i.e., funding, staffing, infrastructure, etc., applied to the WIPP project to ensure those resources effectively address safety, programmatic, and operational considerations.

JON 46: DOE HQ needs to better define and execute their roles and responsibilities in order to improve line management ownership, oversight, safety, and resources to ensure site implementation of the radiological protection, nuclear safety, ISMS, maintenance, emergency management, work planning and control and oversight policies and requirements are consistent and effective.

JON 47: DOE HQ needs to perform an effectiveness review on all corrective actions completed in response to this investigation.

13.0 Safety Programs

13.1 Integrated Safety Management Systems

NWP is contractually required to implement a Safety Management System in accordance with 48 CFR 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*. The requirement states that in performing work, the contractor shall perform work safely, in a manner that ensures adequate protection for employees, the public, and the environment, and shall be accountable for the safe performance of work. The contractor shall ensure that management of Environment, Safety and Health functions and activities becomes an integral but visible part of the contractor's work planning and execution processes. The five core safety management functions provide the necessary structure for any work activity, including emergency management, which could potentially affect the public, the workers, and the environment.

At the facility level, NWP and CBFO have established safety management programs with the intent of integrating safety into operations while focusing on continuous improvement, consistent with the guiding principles of Integrated Safety Management (ISM). The nuclear safety program has been established and maintained through the "safety basis," which provided the foundation for ensuring that the appropriate hazards and accidents are identified, evaluated, and controlled. Tailoring hazard controls to the work being performed through identification of safety structures, systems and components (SSCs) and administrative controls provide a basis upon which the facility is designed and maintained to protect against bounding accident scenarios. Finally, ensuring the implementation of the safety basis through a robust set of technical safety requirements, DOE/WIPP-07-3373, *Technical Safety Requirements*, (TSRs) maintain nuclear safety-related operations within safe limits and restrictions authorized by DOE.

To date, NWP has not had its ISMS program verified through the DOE ISMS verification process. The ISMS verification was originally scheduled for May 2013, and later rescheduled for September of 2013. The NWP ISMS verification is currently scheduled for May 2014.

NWP and CBFO completed a joint ISMS and QA Declaration for FY12. This declaration concluded that ISMS and QA programs have been implemented and are effective at ensuring safety and quality performance. This declaration was based on multiple external and internal reviews. A joint external review conducted by the DOE Office of Health, Safety and Security (HSS) and CBFO identified 82 issues with NWP's implementation of Work Planning and Control. This external review also identified a finding in which CBFO did not follow its internal process for documenting findings.

NWP and CBFO had not yet completed their FY13 annual ISMS and QA declaration. However, NWP reached back to URS corporate to conduct an assessment of the Work Planning and Control process that concluded improvements in the Work Planning and Control program.

Analysis

The Board identified the following deficiencies in the context of the five core functions (CF) and the applicable guiding principles (GP).

Define the Scope of Work (CF-1)
Line Management is Responsible for Safety (GP-1)
Competence Commensurate with Responsibilities (GP-3)
Balanced Priorities (GP-4)
Identification of Safety Standards and Requirements (GP-5)

- The NWP Conduct of Operations program, although well defined in the Conduct of Operations Implementation Matrix, has not been effectively implemented, management is not actively establishing and re-enforcing clear expectations to ensure that safe, compliant operations are conducted at the WIPP facility.
- NWP and CBFO have not established a work environment where the requirements for nuclear safety, radiological safety, and U/G safety are effectively integrated and clearly understood by their employees.
- Staffing plans were not produced and technical support line management was unable to state what was considered "minimum staffing" for safe operations.
- The cumulative impact of the combination of degraded equipment on overall facility operational readiness was not adequately considered.
- Operations and Radiological Controls line management and staff have failed to maintain a high sensitivity to abnormal conditions and have become conditioned over time that CAM alarms are a malfunction event and not an indicator of potential airborne radioactivity events.
- NWP and CBFO did not ensure that emergency training and drills were conducted such that employees were able to effectively respond to radiological emergency conditions.

Identify and Analyze the Hazards Associated with the Work (CF-2)
Identification of Safety Standards and Requirements (GP-5)
Hazard controls tailored to work performed (GP-6)

- NWP has not effectively analyzed and developed response plans for plausible emergency scenarios.

Develop and Implement Hazard Controls (CF-3)
Identification of Safety Standards and Requirements (GP-5)
Hazard controls tailored to work performed (GP-6)
Operations authorized (GP-7)

- The RPP implementing procedures and program documents do not effectively implement the DOE-approved RPP.
- The abnormal response procedures did not provide a clear set of immediate actions for radiological events.
- NWP maintenance procedures for Continuous Air Monitors do not adequately address the potential for radioactive contamination.
- The CMR log did not indicate if the CMR emergency ventilation system was utilized during this event. There is no guiding document that directs shifting the CMR building HVAC to filtration.

Perform Work within Controls (CF-4)
Clear Roles and Responsibilities (GP-2)
Competence commensurate with responsibilities (GP-3)
Operations authorized (GP-7)

- There were unclear roles and responsibilities of the ERO structure during the radiological release event. This was compounded by establishment of the NWP War Room (NWP Management) which was providing direction to ERO but was operating outside established ERO structure.
- The current response organization does not provide the recommended incident command structure span of control for the FSM position during a large incident and could constrain the FSM in making quick and sound decisions.
- The Board determined after reviewing the Dosimetry Manual, bioassay was required. The lack of procedure specificity for action levels and the type of bioassay resulted in a delayed response to understanding the extent of personnel radiological exposures.

Feedback and Improvement (CF-5)
Line Management is Responsible for Safety (GP-1)

- NWP has not fully developed a Contractor Assurance System that provides assurance that work is performed compliantly, risks are identified and managed, and control systems are effective and efficient.
- CBFO has not fully established an oversight program that critically evaluates the health and effectiveness of CBFO and NWP management systems. Additionally, the oversight program does not provide for effective issues management such that issues are raised, tracked and trended, and effectively corrected.

13.2 Human Performance Improvement

The goal of Human Performance Improvement (HPI) is to facilitate the development of a facility structure that recognizes human attributes and develops defenses that proactively manage human error and optimize the performance of individuals, leaders, and the organization. The Department's *Human Performance Improvement Handbook*, Volumes 1 and 2 (DOE-HDBK-1028-2009), describe the HPI tools available for use at DOE sites. The Board did not look at HPI from the perspective of program implementation. The Board evaluated Human Performance to determine if it played a part in this accident. Human error is not a cause of failure alone, but rather the effect or symptom of deeper trouble in the system. A review of Human Performance is a review of an individual's abilities, tasks, and operating environment to determine if the organization supports them for success.

The significance, or severity, of a particular event lies in the consequences suffered by the physical plant or personnel, not the error that initiated the event. The error that causes a serious accident and the error that is one of hundreds with no consequence can be the same error that has historically been overlooked or uncorrected. In most cases, for a significant event to occur, multiple breakdowns in defenses must first occur. Whereas human error may trigger an event, it is the number and extent of flawed defenses that dictate the severity of the event. The existence of many flawed defenses is directly attributable to weaknesses in the organization or management control systems. The Anatomy of an Event Model (Figure 25) illustrates the elements that exist before an event occurs and is a very useful model to guide the analysis of an event from an HPI perspective. The elements analyzed are the flawed defenses that allowed the event to occur or did not mitigate the consequences of the event; the error precursors that existed; the latent organizational conditions that allowed those to be in existence; and finally the vision, beliefs and values of management and workers.

Much of the information provided in this section is based on the analysis of the events, conditions, processes, and barrier information presented in this report, Phase 1 of the investigation.

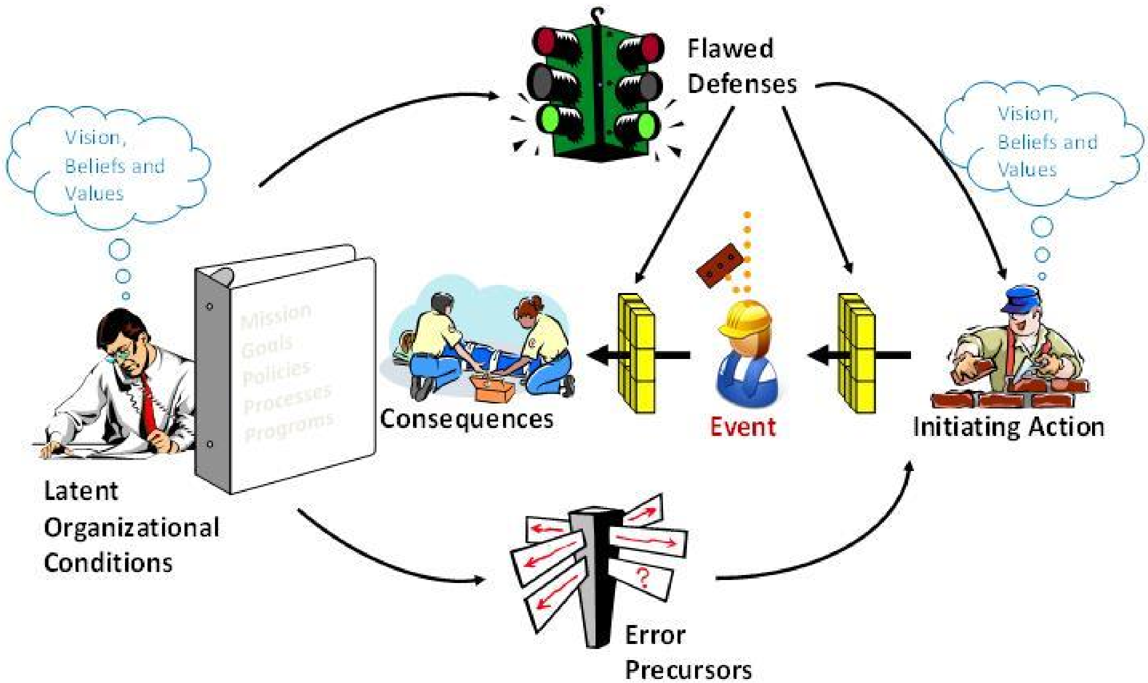


Figure 25: Anatomy of an Event Model

Error Precursors

Error precursors are unfavorable conditions that increase the probability for error during a specific action and create what are known as error-likely situations. An error-likely situation typically exists when the demands of the task exceed the capabilities of the individual or when work conditions exceed the limitations of human nature. Human nature comprises all mental, emotional, social, physical, and biological characteristics that define human tendencies, abilities, and limitations. For instance, humans tend to perform poorly under high stress and undue time pressure. Error-likely situations such as these are also known as error traps. Error precursors exist in the work place before the error occurs, and thus are manageable. If identified before or during the performance of work, the conditions can be changed or managed to reduce the chance for error(s) leading to an event.

Error precursors (conditions) associated with Human Performance attributes were analyzed by the Board to identify specific conditions that may have provoked error and led to the accident (Figure 26).

Human Performance Attributes

Task Demands. Specific mental, physical, and team requirements to perform an activity that may either exceed the capabilities or challenge the limitations of human nature of the individual assigned to the task; for example, excessive workload, hurrying, concurrent actions, unclear roles and responsibilities, or vague standards.

Individual Capabilities. Unique mental, physical, and emotional abilities of a particular person that fail to match the demands of the specific task; for example, unfamiliarity with the task, unsafe attitudes, level of education, lack of knowledge, unpracticed skills, personality, inexperience, health and fitness, poor communication practices, or low self-esteem.

Work Environment. General influences of the workplace, organizational, and cultural conditions that affect individual behavior; for example, distractions, awkward equipment layout, complex tagout procedures, at-risk norms and values, work group attitudes toward various hazards, or work control processes.

Human Nature. Generic traits, dispositions, and limitations of being human that may incline individuals to err under unfavorable conditions; for example, habit, short-term memory, fatigue, stress, complacency, or mental shortcuts.

HUMAN PERFORMANCE ATTRIBUTES

Task Demands. Specific mental, physical, and team requirements to perform an activity that may either exceed the capabilities or challenge the limitations of human nature of the individual assigned to the task; for example, excessive workload, hurrying, concurrent actions, unclear roles and responsibilities, or vague standards.

Individual Capabilities. Unique mental, physical, and emotional abilities of a particular person that fail to match the demands of the specific task; for example, unfamiliarity with the task, unsafe attitudes, level of education, lack of knowledge, unpracticed skills, personality, inexperience, health and fitness, poor communication practices, or low self-esteem.

Work Environment. General influences of the workplace, organizational, and cultural conditions that affect individual behavior; for example, distractions, awkward equipment layout, complex tagout procedures, at-risk norms and values, work group attitudes toward various hazards, or work control processes.

Human Nature. Generic traits, dispositions, and limitations of being human that may incline individuals to err under unfavorable conditions; for example, habit, short-term memory, fatigue, stress, complacency, or mental shortcuts.

Figure 26: Human Performance Attributes

Error Precursor Analysis

The Board conducted an Error Precursor Analysis based on the information obtained from documents and interviews as documented throughout this Phase 1 report. The results of this analysis are presented in Table 3. The following is a discussion of some of the more predominant error precursors.

Human Performance Mode

Human Performance describes three modes in which errors occur. The performance mode in which an error occurs is based on the individual's familiarity with the task being performed. The three modes, progressing from most familiar to the task to the least familiar to the task are: skill based, rules based, and knowledge based. Errors will most likely occur in the knowledge based performance mode.

- **Delay in making decision to take protective actions**. The procedures and past experiences related to false indications delayed all of the expected immediate actions in response to a potential radiological release. The individuals involved in the process of making a decision related to taking protective actions did not have confidence in the data available from the CAM. The procedures are written to expect a false indication and require consultation and confirmation of a release from Radcon, which was not immediately available. This led to the delayed activation of the EOC (13 hours 20 minutes after CAM alarm); delayed AEOC becoming operational (15 hours 30 minutes after CAM alarm); delayed sheltering (10 hours 20 minutes after CAM alarm); and the potential exposure of every individual on-site from February 14 through February 15, 2014.
- **Lack of Proficiency in basic radiological control techniques.** The radiological control organization including the RCTs demonstrated a lack of proficiency in the basic techniques related to contamination control, cross contamination in the laboratory, radiological response to airborne contamination and lack of decisions related to consequence assessment and the need for bioassay. This is primarily due to a lack of practical experience in dealing with loose contamination. The training and qualification program did not adequately prepare the RCTs for radiological release conditions. The RCT training and qualification program did not include demonstrated proficiency and account for the lack of experience in loose and airborne contamination.

Table 3: Error Precursors

TASK DEMANDS			INDIVIDUAL CAPABILITIES		
x[6]	1	Time Pressure (In a hurry)	xx	1	Unfamiliarity with Task/First time
xx	2	High Workload (large memory)	xx	2	Lack of Knowledge (faulty mental model)
x	3	Simultaneous, Multiple Tasks	xx	3	New Technique not used before
	4	Repetitive Actions/Monotony	x	4	Imprecise Communications
x	5	Irreversible Acts	xx	5	Lack of Proficiency/Inexperience
xx	6	Interpretation Requirements		6	Indistinct Problem-solving Skills
xx	7	Unclear goals, Roles, or Responsibilities		7	"Unsafe" Attitudes
xx	8	Lack of or Unclear Standards		8	Illness/Fatigue (general health)

[6] X = single occurrence, xx = multiple occurrences.

WORK ENVIRONMENT (WE)			HUMAN NATURE (HN)		
x	1	Distractions/Interruptions	xx	1	Stress
xx	2	Changes/Departure from Routine	xx	2	Habit patterns
	3	Confusing Displays/Controls	xx	3	Assumptions (inaccurate mental picture)
x	4	Work-arounds	xx	4	Complacency/overconfidence
x	5	Hidden System/Equipment Response		5	Mindset (intentions)
x	6	Unexpected Equipment Conditions	xx	6	Inaccurate Risk Perception
xx	7	Lack of Alternative Indication		7	Mental Shortcuts (biases)
	8	Personality Conflicts		8	Limited Short-term Memory

Task Demands

There were several examples of a lack of clear standards and interpretation of requirements that contributed to the severity of the incident. The procedures are written to assume radiological indications are not accurate and require interpretation by radiological control personnel. Lacking the establishment and reinforcement of clear standards and expectations, workers will establish their own standards of behavior based on their visions, beliefs, and values. The RCTs and RCM did not have the requisite proficiency in effectively responding to the incident.

Work Environment

Only one CAM was functional in the underground and there was no other equipment installed to provide alternate indications of a radiological release. Alternate indications could have given the workers and RCM verification of a release and immediate actions might have been taken in response. If a CAM had been installed at Station B, it could have prompted protective actions much sooner.

Individual Capabilities

There were numerous issues related to individual capabilities in the area of proficiency, first-time use, and a lack of knowledge for the intended task. There are numerous issues related to proficiency in the radiological control training. There is also a lack of practical site experience in dealing with loose or airborne contamination.

Human Nature

There was Inaccurate Risk Perception and assumptions that provided an inaccurate mental picture of the event. Initially all personnel involved assumed the indications were negative and did not take actions based on the potential risk of the event. Even after additional indications that there was a radiological release in the underground, there was no recognition of the potential for the release and risk that was presented above ground. This was particularly evident when collecting Station B filters without PPE. Personnel that have an inaccurate risk perception typically base that on personal appraisal of hazards and uncertainty based on incomplete information or assumptions and/or an unrecognized or inaccurate understanding of a potential consequence or danger. The degree of risk-taking behavior is based on an individual’s perception of the possibility of error and understanding of the consequences.

14.0 Analysis

14.1 Identification of the Accident

The Board determined that the accident was the release of TRU material in the underground that resulted in airborne radioactivity escaping to the environment downstream of the HEPA filters.

14.2 Barrier Analysis

After a basic chronology of events was developed, the Board performed a barrier analysis of the accident. To start the barrier analysis, the Board chose a target (the person or item to be protected) and the hazard (what the person or item is to be protected from). The Board chose the workers and the public as the target and the release of mixed TRU waste as the hazard. The Board also chose to include personnel evacuation and emergency response within the scope of the barrier analysis.

Sixty-three barriers were identified and analyzed by the Board.

The barrier analysis is presented in Appendix B.

14.3 Change Analysis

To further support the development of causal factors, the Board performed a change analysis of the accident, examining the planned and unplanned changes that caused the undesired results or outcomes related to the event.

Twenty-four changes were identified and analyzed by the Board.

The change analysis is presented in Appendix C.

14.4 Event and Causal Factors Analysis

After performing the barrier and change analyses, the Board assigned the results of the various analyses to the conditions that were related to or caused the events in the chronology. Correlating these conditions with events resulted in the events and causal factors chart provided in Appendix D. When the correlation was complete, the Board examined the chart to determine which events were significant, i.e., which events played a role in causing the accident. The Board then assessed the significant events and the conditions of each, to determine the causal factors of the accident.

The causal factors that resulted are described below.

Direct, Root, and Contributing Causes

Direct Cause – the immediate events or conditions that caused the accident.

The Board identified the direct cause of this accident to be the breach of at least one TRU waste container in the U/G which resulted in airborne radioactivity escaping to the environment downstream of the HEPA filters. Due to restrictions on access to the U/G following the event, the exact mechanism of container failure, e.g., back or rib fall, puncture by a failed roof bolt, off-gassing, etc., is unknown at this time and must be determined once access to the U/G is restored. This will be investigated in Phase 2.

Root Cause – causal factors that, if corrected, would prevent recurrence of the same or similar accidents.

The Board identified the root cause of Phase 1 of the investigation of the release of radioactive material from underground to the environment to be NWP's and CBFO's management failure to fully understand, characterize, and control the radiological hazard. The cumulative effect of inadequacies in ventilation system design and operability compounded by degradation of key safety management programs and safety culture resulted in the release of radioactive material from the underground to the environment, and the delayed/ineffective recognition and response to the release.

With regard to ventilation system design and operability: the filtration portion of the ventilation system has two HEPA filter bypass isolation dampers that provide a pathway of unfiltered exhaust into the environment. These isolation dampers are not suitable as a containment boundary and reduce the overall efficiency of the HEPA filter system. This is discussed further in Chapter 9, Underground Ventilation. This condition was never identified by the contractor, CBFO, or Headquarters in any of the revisions and updates to the WIPP safety basis documentation.

Contributing Causes – events or conditions that collectively with other causes increased the likelihood or severity of an accident but that individually did not cause the accident. For the purposes of this investigation, contributing causes include those related to the cause of the radiological release to the environment as well as those related to the subsequent response.

The Board identified eight contributing causes to the radiological release to the environment investigated in Phase 1, or resultant response:

1. Implementation of the NWP Conduct of Operations Program is not fully compliant with DOE O 422.1, *Conduct of Operations*, and impacted the identification of abnormal conditions and timely response.
2. NWP does not have an effective Radiation Protection Program in accordance with 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection*, including but not limited to radiological control technician training, qualification and requalification, equipment and instrumentation, and audits.
3. NWP does not have an effective maintenance program. The condition of critical equipment and components, including continuous air monitors, ventilation dampers, fans, sensors, and the primary system status display were degraded to the point where the cumulative impact on overall operational readiness and safety was not recognized or understood.

4. NWP does not have an effective Nuclear Safety Program in accordance with 10 CFR 830 Subpart B, *Safety Basis Requirements*. There has been a reduction in the conservatism in the Documented Safety Analysis (DSA) hazard/accident analysis and corresponding Technical Safety Requirement (TSR) controls over time, commencing with EM Headquarters delegation of safety basis approval authority (SBAA) in late 2009. For example, 15 of 22 design basis accidents were removed from the latest revision without any clear justification, including the elimination of a roof/rib fall event in an open waste panel. Several other examples are provided in Chapter 3, Nuclear Safety Program. In addition, the DSA and TSRs contain errors, there is a lack of DSA linkage to supporting hazard analysis information, and there is confusion over the back fall accident description in a closed versus open panel.

5. NWP implementation of DOE O 151.1C, *Comprehensive Emergency Management System*, was ineffective. Personnel did not adequately recognize, categorize, or classify the emergency and did not implement adequate protective actions in a timely manner.

6. The current site safety culture does not fully embrace and implement the principles of DOE Guide (G) 450.4-1C, *Integrated Safety Management Guide*. There is a lack of a questioning attitude, reluctance to bring up and document issues, and an acceptance and normalization of degraded equipment and conditions. This is supported by the 2012 Safety Conscious Work Environment (SCWE) survey results which indicated a reluctance to report issues to management, indicating a chilled work environment. Execution of the NWP Contractor Assurance System (CAS) in accordance with DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, was ineffective. Execution of the CAS did not identify precursors to this event or the unacceptable conditions and behaviors documented in this Phase 1 report.

7. Execution of CBFO oversight in accordance with DOE O 226.1B was ineffective. CBFO failed to establish and implement adequate line management oversight programs and processes and hold personnel accountable.

8. DOE Headquarters (HQ) line management oversight was ineffective. DOE HQ failed to ensure that CBFO was held accountable for correcting repeated identified issues involving radiological protection, nuclear safety, Integrated Safety Management (ISM), maintenance, emergency management, work planning, and control and oversight.

The events and causal factors chart is presented in Appendix E.

15.0 Conclusions and Judgments of Need

Conclusions (CONs) are significant deductions derived from the investigation's analytical results. They are derived from and must be supported by the facts plus the results of testing and the various analyses conducted.

Judgments of Need (JONs) are the managerial controls and safety measures determined by the Board to be necessary to prevent or minimize the probability or severity of a recurrence. These JONs are linked directly to the causal factors, which are derived from the facts and analysis. They form the basis for corrective action plans that must be developed by line management. The Board's conclusions and JONs are listed below in Table 4.

Table 4: Conclusions and Judgments of Need

Conclusion (CON)	Judgments of Need (JON)
CON 1: The direct cause of the transuranic mixed waste container release could not be definitively determined during Phase 1 of the investigation due to the inability for personnel to access the underground, collect information, and inspect the waste panels/rooms.	**JON 1**: Nuclear Waste Partnership LLC (NWP) and the Carlsbad Field Office (CBFO) need to implement a detailed recovery plan to systematically reenter the underground, collect data and information, and make an absolute determination as to the mechanism of the transuranic waste release. **JON 2**: During Phase 2, the DOE Accident Investigation Board needs to evaluate the data and information collected and provided by NWP and CBFO to determine the mechanism of release and determine the related conditions and causal factors, reach conclusions, and identify additional judgments of need.
Nuclear Safety Program	
CON 2: There has been a reduction in conservatism in the Documented Safety Analysis hazard/accident analysis and Technical Safety Requirement safety controls within safety basis revisions occurring since 2010, i.e., *Documented Safety Analysis/ Technical Safety Requirement*, Revision 1 to Revision 4. This is not consistent with DOE-Standard (STD)-3009, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis* and DOE-STD-5506, *Preparation of Safety Basis*	**JON 3**: NWP needs to revise the hazard and accident analyses to comply with DOE-Standard-3009, *Preparation Guidance for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis* and DOE-STD-5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, regarding not crediting administrative controls in the unmitigated analysis. In particular, some initial assumptions/initial conditions, e.g., compliance with 30 CFR 57, *Safety and*

Conclusion (CON)	Judgments of Need (JON)
Documents for Transuranic (TRU) Waste Facilities.	*Health Standards Underground Metal and Nonmetal Mines* ground control program requirements, should be preventive or mitigative controls derived by the mitigated analysis and should be evaluated for the need for protection with Technical Safety Requirement controls.
CON 3: The Documented Safety Analysis and Technical Safety Requirement have several errors or omissions that are indicative of lack of rigorous contractor internal review and independent peer-review processes for the development of the safety basis, e.g., quality issues include Documented Safety Analysis and Technical Safety Requirement errors, lack of Documented Safety Analysis linkage to supporting hazard analysis information, confusion over back fall accident description in closed vs. open panel.	**JON 4**: NWP needs to commission an independent assessment of the Documented Safety Analysis/Technical Safety Requirement Revision 4 through corporate assistance or other recognized external resources, and corrective actions implemented that establish appropriate hazard controls and functional classifications.
CON 4: Technical Safety Requirements are not effective in ensuring facility configurations that provide contribution to defense-in-depth for radiological events. The function of the Documented Safety Analysis as articulated in 10 CFR 830, *Nuclear Safety Management Rule*, Appendix A, Section G.4 is as follows: "Technical Safety Requirements establish limits, controls and related actions necessary for the safe operation of a nuclear facility."	**JON 5**: NWP needs to re-evaluate the importance of the suite of available preventive and mitigative controls, e.g., continuous air monitors and underground ventilation system, in the supporting hazards analysis report and the Documented Safety Analysis, Section 3.3 hazard evaluation, and whether they should be considered as major contributors to defense in depth. This may require upgrading of some Structures, Systems, and Components functional classifications.
CON 5: Since neither the CAMs nor the underground ventilation system are pedigreed, i.e., Safety Class, Safety Significant, Important to Safety Structures, Systems, and Components, their importance has not been acknowledged within the Technical Safety Requirements, e.g., no Limiting Conditions for Operation/ Surveillance Requirements. In addition, neither Documented Safety Analysis Safety Management Programs,	**JON 6**: NWP needs to re-evaluate the classification of continuous air monitors and the underground ventilation system consistent with the outcome of the revised hazard analysis and develop Technical Safety Requirement controls consistent with that classification.

Conclusion (CON)	Judgments of Need (JON)
(Chapter 7 Radiation Protection Program), nor the Technical Safety Requirement Programmatic Administrative Controls consider whether CAMs may provide protection for the facility worker who may be in the exhaust drift.	
CON 6: The Technical Safety Requirement documentation is not being controlled with the rigor normally associated with a Hazard Category 2 nuclear facility.	**JON 7**: NWP needs to revise the Technical Safety Requirements to align with changes to the Documented Safety Analysis, e.g., continuous air monitor and underground ventilation system, correct current errors in the Technical Safety Requirements, and ensure that implementing procedures clearly support consistent interpretations.
CON 7: The NWP Unreviewed Safety Question Determination procedure does not clearly communicate the actions required to evaluate situations that could involve a Potential Inadequacy in the Safety Analysis. In addition, NWP's implementation of Unreviewed Safety Question procedure requirements indicates a lack of recognition that some proposed recovery activities associated with the radiological release event were outside the analyzed safety basis. This is evident from NWP's Unreviewed Safety Question's evaluations or lack there-of, related to impacts on previously analyzed accidents or safety controls; identifying equipment that is important to safety; and completeness of identifying accidents of a new type not previously analyzed.	**JON 8**: NWP needs to commission an independent assessment of the Unreviewed Safety Question process through corporate assistance or other recognized external resources, and implement corrective actions that ensure effectiveness. **JON 9:** NWP needs to strengthen the Unreviewed Safety Question Determination procedure to clarify Potential Inadequacy in the Safety Analysis guidance, including the appropriate timeliness for entrance into the process and decision making.
CON 8: There is an observed lack of robustness in the CBFO technical review of Documented Safety Analysis/Technical Safety Requirement changes/annual updates, e.g., lack of documentation of the technical basis for approval to support development of a Safety Evaluation Report. While the Safety Evaluation Reports are consistent with the format per DOE-Standard-1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, the conclusions do not include adequate rationale for acceptance of the	**JON 10**: CBFO needs to revise Management Procedure 4.11, *Safety Basis Review Procedure*, to require adequate documentation of the technical basis supporting approval of changes to the WIPP Document Safety Analysis or Technical Safety Requirements, consistent with DOE Standard 1104, e.g., regulatory compliance, justification for initial assumptions/initial conditions, reduced conservatisms of the hazards and accident analysis.

Conclusion (CON)	Judgments of Need (JON)
proposed changes.	**JON 11**: CBFO and DOE HQ need to commission an independent assessment of the CBFO safety basis review and approval process and implement corrective actions that ensure effective implementation.
CON 9: CBFO has insufficient nuclear safety management/staffing since the 2010 timeframe and the retirement of Authorization Basis Senior Technical Advisor and existing Nuclear Safety Specialist staff responsible for multiple subject matter expertise.	**JON 12**: CBFO needs to perform a critical federal staffing analysis focused on Nuclear Safety e.g., Nuclear Safety Specialist, nuclear safety qualified Senior Technical Advisor and supporting CBFO Subject Matter Experts and determine whether existing resources are adequate. **JON 13**: CBFO and DOE HQ need to arrange for temporary DOE senior nuclear safety resources to mentor existing CBFO nuclear safety and supporting resources, and assist as necessary.
Emergency Management	
CON 10: Compensatory measures were not put in place to mitigate issues identified immediately following the February 5, 2014, underground fire event with respect to emergency management. **CON 11**: The emergency management program was not adequately structured and implemented such that personnel did not recognize, categorize, or classify the emergency and implement protective actions in a timely manner. **CON 12**: The Waste Isolation Pilot Plant (WIPP) (NWP and CBFO) emergency management program is not fully compliant with DOE Order 151.1C, *Comprehensive Emergency Management System*, e.g., activation of the Emergency Operations Center, classification and categorization, emergency action levels, implementation of the Incident Command System, training, drills and exercises, etc. Weaknesses in classification, categorization, and emergency action levels	**JON 14**: NWP needs to immediately develop and implement interim compensatory measures to ensure prompt identification, categorization, classification, and response to operational emergencies, e.g., corporate reach-back, training, Senior Management Watch in the Central Monitoring Room, etc. **JON 15**: CBFO needs to take prompt action to fully integrate trained Federal management resources into the emergency response organization and take action to bring their emergency management program into compliance with DOE Order 151.1C, *Comprehensive Emergency Management System*. **JON 16**: NWP needs to correct their activation, notification, classification, and categorization protocols to be in full compliance with DOE Order 151.1C, *Comprehensive Emergency Management System*, Resource Conservation and

Conclusion (CON)	Judgments of Need (JON)
were previously identified by both external review and in the response to the underground fire and the radiological release events.	Recovery Act Contingency Plan and then provide training and drills for all applicable personnel. **JON 17**: NWP needs to revise Emergency Response Organization training to include more supervised hands-on training and drills to enhance the effectiveness of the Emergency Response Organization's response. **JON 18**: NWP needs to fully integrate the Resource Conservation and Recovery Act Contingency Plan activation criteria within the site Emergency Action Levels and to train the applicable personnel to ensure implementation of the Resource Conservation and Recovery Act Contingency Plan. **JON 19**: NWP needs to take prompt action to correct longstanding deficiencies from previous reviews. **JON 20**: CBFO needs to ensure that NWP completes prompt action to correct longstanding deficiencies from previous reviews. **JON 21**: NWP needs to improve the content of site-specific Emergency Action Levels to expand on the information provided in the standard Emergency Action Levels contained in DOE Order 151.1C, *Comprehensive Emergency Management System*. **JON 22**: NWP needs to develop and implement an Incident Command System for the Emergency Operations Center/Central Monitoring Room that is compliant with DOE O 151.1C and is capable of assuming command and control for all anticipated emergencies. **JON 23**: DOE Headquarters (HQ) needs to conduct an effectiveness review of the NWP and CBFO emergency management program implementation within six months of

Conclusion (CON)	Judgments of Need (JON)
	completion of the corrective actions for the Emergency Management Judgments of Need.
Safety Culture	
CON 13: NWP and CBFO have allowed the safety culture at the WIPP project to deteriorate as evidenced by the workers feedback that they do not feel comfortable identifying issues that may adversely affect management direction, delay mission related objectives, or otherwise affect cost or schedule. Questioning attitudes are not welcomed by management and many issues and hazards do not appear to be readily recognized by site personnel.	**JON 24**: NWP and CBFO need to develop and implement an effective integrated safety management system that embraces and implements the principles of DOE G 450.4-1C, *Integrated Safety Management Guide*, including but not limited to: • Demonstrated leadership in risk-informed, conservative decision making; • Improved learning through error reporting and effective resolution of problems; • Line management encouraging a questioning attitude without fear of reprisal and following through to resolve issues identified by the workforce; and • Reinforcing the mechanisms, e.g., WIPP Forms, "Notes to Joe," employee concern program, differing professional opinions, and protocols for communicating issues to NWP and CBFO leadership. **JON 25**: DOE HQ needs to engage external safety culture expertise in providing training and mentoring to NWP and CBFO management on the principles of a strong nuclear safety culture and implement any recommendations from these experts.
CON 14: DOE has exacerbated the safety culture problem by referring to numbers of ORPS reports and other deficiency reporting documents, rather than the significance of the events, as a measure of performance by Source Evaluation Boards during contract bid evaluations, and poor scoring on award fee determinations. Directly tying performance to	**JON 26**: DOE HQ needs to clearly specify the use of performance reporting results, e.g., Occurrence Reporting and Processing System and non-conformance reports in Past Performance Evaluations, to encourage conservative reporting and communication of Lessons Learned.

Conclusion (CON)	Judgments of Need (JON)
the number of occurrence reports drives the contractor to non-disclosure of events in order to avoid the poor score. This practice is contrary to the Department's goals of the development and implementation of a strong safety culture across our projects.	
Conduct of Operations	
CON 15: Key elements of the NWP Conduct of Operations program were ineffective in driving safe and compliant operation of a Hazard Category 2 nuclear facility.	**JON 27**: NWP needs to strengthen execution of the Conduct of Operations program to be compliant with DOE O 422.1, *Conduct of Operations*. Specific areas of focus must include (but not limited to): • Establishing and reinforcing expectations conveyed in WP 04-CO.01, *Conduct of Operations* series procedures. • Initiate a mentoring program, e.g., senior supervisor watch that provides real time feedback to first and second line supervisors as to their responsibilities regarding compliant execution of operations activities. • Strengthen the structure, content and flow of abnormal response procedures to ensure immediate actions do not require judgment calls prior to execution. • Consider the addition of real time surveillance capability, e.g., video of the active waste panels/rooms. • Establish and execute an operational drill program that evaluates operator response to upset conditions. • Establish a process that heightens awareness and requires deliberate action to reduce the quantity and length of time key pieces of equipment are out of service. **JON 28**: CBFO needs to take an active role towards improving NWP conduct of

Conclusion (CON)	Judgments of Need (JON)
	operations through implementation of a structured DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, oversight process that includes mechanisms for identifying, reporting, and transmitting issues that tracks corrective actions to effective closure. Specific areas of focus must include, but are not limited to: • Develop and conduct routine oversight of contractor implementation of the WP 04-CO.01, *Conduct of Operations* series procedures. Oversight needs to include detailed oversight plans that contain specific criteria and lines of inquiry to effectively assess compliance with DOE O 422.1. • Oversight of the NWP mentoring program e.g., senior supervisor watch that provides real time feedback to first and second line supervisors as to their responsibilities regarding compliant execution of operations activities in order to provide feedback on effectiveness. • Oversight of procedure development in order to strengthen the structure, content and flow of abnormal response procedures to ensure immediate actions do not require judgment calls prior to execution. • Overseeing execution of the NWP operational drill program that evaluates operator response to upset conditions. • Strengthen oversight of NWP processes that monitor equipment status and initiate action to correct deficiencies in order to ensure a reduction in the quantity and length of time key pieces of equipment are out of service.

Conclusion (CON)	Judgments of Need (JON)
Maintenance Program	
CON 16: The current culture at NWP is such that due consideration for prioritization of maintenance of equipment is not given unless there is an immediate impact on the waste emplacement processes.	**JON 29**: NWP needs to take action to ensure that the maintenance process effectively considers and prioritizes repairs to achieve and maintain a high state of operational readiness.
CON 17: Execution of the NWP engineering process has not been effective in maintaining configuration of key systems at WIPP. Specific examples include: • Conversion of the 860 fan vortex damper actuator from automatic to manual operation; • Functionality of the ventilation system in filtration including evaluation and testing of leakage via the bypass dampers; and • The impact of salt buildup on bypass damper effectiveness.	**JON 30**: NWP needs to improve the execution of engineering processes that ensure system configuration management is maintained and that the rigor in processing proposed changes to systems is at a level that ensures system design functionality is maintained. Specific examples include: • Conversion of the 860 fan vortex damper actuator from automatic to manual operation; • Functionality of the ventilation system in filtration including evaluation and testing of leakage via the bypass dampers; and • The impact of salt buildup on bypass damper effectiveness. **JON 31**: CBFO needs to take a more proactive role in the configuration management and maintenance programs to ensure that the facility can meet its operational and life time expectancy. **JON 32**: DOE HQ Office of Environmental Management and CBFO need to develop an infrastructure improvement plan within six months to identify and prioritize program-wide critical infrastructure upgrades for key systems to ensure continuation of EM's programmatic mission execution at WIPP. Additionally, DOE HQ Office of Environmental Management needs to coordinate an extent of condition review at other EM sites and take action based on the outcome of that review.
Radiation Protection Program	

Conclusion (CON)	Judgments of Need (JON)
CON 18: NWP does not have an effective Radiation Protection Program in accordance with 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection*, including but not limited to radiological control technician training, qualification and requalification, equipment and instrumentation, and audits.	**JON 33**: NWP needs to evaluate the current state of the radiological control program including the current radiological conditions and implement compensatory measures to support recovery and current activities. **JON 34**: NWP needs to perform an extent of condition review of the training program incorporating the results of this event and implement actions to improve radiological control management, Radiological Control Technician, and rad worker proficiency in dealing with contamination, and airborne radioactive material. **JON 35**: NWP needs to perform an extent of condition review for identified weaknesses in the radiological control program and implement corrective actions to fully implement 10 CFR 835. **JON 36**: CBFO needs to determine the effectiveness of the radiation protection program within three months of completion of NWP's corrective actions.
CON 19: There is an inadequate technical basis for the existing ventilation and airborne monitoring systems. It is unclear that they adequately provide protection to the underground workers, the co-located worker, the public, and the environment from the transuranic mixed waste or hazardous constituents, e.g., reliability of a single CAM to initiate an automatic shift to filtration, acceptability of leakage past the bypass dampers and automatic shift to filtration that now requires manual operation of 860 fan vortex dampers.	**JON 37**: NWP needs to develop a technical basis to implement continuous and reliable/redundant real-time air monitoring with appropriate automatic shift to filtration to protect the workers, the public and the environment. This needs to take into consideration the different ventilation modes, protection of workers in the underground, and release of contaminants to the environment. The technical basis must also consider the hazardous constituents in the transuranic mixed waste, e.g., reliability of a single CAM to initiate an automatic shift to filtration, acceptability of leakage past the bypass dampers and automatic shift to filtration that now requires manual operation of 860 fan vortex dampers.

Conclusion (CON)	Judgments of Need (JON)
NWP Contractor Assurance System	
CON 20: NWP has not fully developed an integrated contractor assurance system that provides assurance that work is performed compliantly, risks are identified, and control systems are effective and efficient.	**JON 38**: NWP needs to develop and implement a fully integrated contractor assurance system that provides DOE and NWP confidence that work is performed compliantly, risks are identified, and control systems are effective and efficient.
CON 21: NWP failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, and hold personnel accountable for implementing those programs and processes. **CON 22**: NWP failed to identify weaknesses in conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. **CON 23**: NWP failed to adequately complete corrective actions from prior assessments to prevent or minimize recurrence. **CON 24**: Comprehensive self-assessments are not being performed by knowledgeable, qualified subject matter experts within the various safety management programs. Contractor Assurance System is implemented primarily through the Quality Assurance program.	**JON 39**: NWP needs to establish and implement line management oversight programs and processes that: • Meet the requirements of DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, and hold personnel accountable for implementing those programs and processes. • Implement effective contractor assurance processes to emphasize conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. • Implement a Contractor Assurance System to ensure that actions from prior assessments are implemented to prevent or minimize recurrence of identified deficiencies. • Include self-assessments by knowledgeable, qualified subject matter experts within the various safety management programs.
CBFO Oversight	
CON 25: CBFO failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*, and hold personnel accountable for implementing those programs	**JON 40**: CBFO needs to establish and implement line management oversight programs and processes such that CBFO: • Verifies that NWP has developed and implemented a DOE Order 226.1B compliant Contractor Assurance System.

Conclusion (CON)	Judgments of Need (JON)
and processes. **CON 26**: CBFO failed to identify weaknesses in oversight processes, conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. **CON 27**: CBFO is lacking adequate qualified staffing in numerous areas related to line management, technical disciplines and oversight functions. **CON 28**: CBFO failed to adequately complete corrective actions from prior assessments to prevent or minimize recurrence.	• Meets the requirements of DOE Order 226.1B and hold personnel accountable for implementing those programs and processes. • Implements effective oversight processes to ensure emphasis on conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. **JON 41**: CBFO needs to develop and implement an effective issues management process to document, disposition (including extent of condition), close, track/trend issues, and ensure effectiveness of corrective actions. The process shall also ensure that actions from prior assessments are implemented to prevent or minimize recurrence of identified deficiencies. **JON 42**: The CBFO Site Manager needs to institutionalize and communicate expectations for a strong safety culture and the identification, documentation, reporting, and correction of issues without fear of reprisal. **JON 43**: CBFO needs to evaluate the current organizational structure, identify specific staffing needs related to line management, technical discipline and oversight functions, submit those staffing needs to DOE HQ, and effectively manage their resources such that qualified personnel are effectively performing those functions.
DOE Headquarters Oversight	
CON 29: DOE HQ failed to ensure that CBFO was held accountable for correcting repeated identified issues involving radiological protection, nuclear safety, Integrated Safety Management System, maintenance, emergency management, work planning and control and oversight.	**JON 44**: DOE HQ needs to develop and implement a process to ensure repeatedly identified issues related to the safety management programs are confirmed, closed and validated by the local DOE office in a timely manner.

Conclusion (CON)	Judgments of Need (JON)
CON 30: DOE HQ management has failed to ensure that adequate resources, full time employees, technical expertise, travel money, adequate budget, etc., are provided to support the WIPP project. **CON 31**: DOE HQ management and staff failed to adequately define and execute roles and responsibilities related to line management, oversight, safety and balanced priorities.	**JON 45**: DOE HQ needs to re-evaluate priorities and allocate the resources, i.e., funding, staffing, infrastructure, etc., applied to the WIPP project to ensure those resources effectively address safety, programmatic, and operational considerations. **JON 46**: DOE HQ needs to better define and execute their roles and responsibilities in order to improve line management ownership, oversight, safety, and resources to ensure site implementation of the radiological protection, nuclear safety, ISMS, maintenance, emergency management, work planning and control and oversight policies and requirements are consistent and effective. **JON 47**: DOE HQ needs to perform an effectiveness review on all corrective actions completed in response to this investigation.

16.0 Board Signatures

Theodore A. Wyka
DOE Accident Investigation Board Chairman
U.S. Department of Energy, Office of Environmental Management

T.J. Jackson
DOE Accident Investigator and Deputy Chair
U.S. Department of Energy, Office of Environmental Management
Consolidated Business Center

Jack Zimmerman
DOE Accident Investigator and Board Member
U.S. Department of Energy, Office of Environmental Management
Portsmouth/Paducah Project Office

Roger Claycomb
DOE Accident Investigator and Board Member
U.S. Department of Energy, Office of Environmental Management
Idaho Operations Office

Todd N. Lapointe
DOE Accident Investigator and Board Member
U.S. Department of Energy, Office of Environmental Management

17.0 Board Members, Advisors and Consultants

Board Members

Theodore A. Wyka	Board Chair, EM-40 Chief Nuclear Safety Advisor
T.J. Jackson	Board Deputy Chair, EMCBC, Trained Accident Investigator
Roger Claycomb	Board, ID, Trained Accident Investigator
Jack Zimmerman	Board, LEX, Trained Accident Investigator
Todd N. Lapointe	Board, EM-41, Safety Management Director

Advisor/Team Coordinator

Advisor/Consultant	Greg Campbell EMCBC, Emergency Management
Advisor/Consultant	Frank Moussa EM-44, Emergency Management
Advisor/Consultant	Jason Armstrong Oakridge EM, Work Controls
Advisor/Consultant	Richard Lagdon EM-1, DOE HQ, Chief of Nuclear Safety
Advisor/Consultant	William Weaver EM-1, DOE HQ, Chief of Nuclear Safety
Advisor/Consultant	Mark Hahn, PE DOE Richland Operations Office
Advisor/Consultant	Bradley J. Davis Idaho Field Office
Advisor/Consultant	Michael Ardaiz, MD, MPH, CPH, DOE HQ, Chief Medical Officer
Advisor/Consultant	George Hellstrom, CBFO, Legal Counsel
Advisor/Consultant	Lina Pacheco CBFO, Facility Representative
Advisor/Consultant	Don Galbraith CBFO, Mine Operations Project Manager
Advisor/Consultant	Mark Williams Supervisory Mine Safety and Health

Advisor/Consultant	Jeff Woody Link Technologies, Inc.
Advisor/Consultant	Terry Foppe Link Technologies, Inc.
Analyst/Advisor	Jack Gerber MJW Technical Services
Advisor/Consultant	Rick Callor, CSP URS Professional Solutions, Boise
Advisor/Consultant	Rick Fuentes NWP, United Steel Workers Union President
Observer	Brett Broderick, DNFSB Staff
Administrative Coordinator/ Technical Writer	Susan M. Keffer, Project Enhancement Corporation Trained Accident Investigator

Appendix A. Appointment of the Accident Investigation Board

Department of Energy
Washington, DC 20585

MAR 04 2014

MEMORANDUM FOR THEODORE A. WYKA
BOARD CHAIRPERSON
CHIEF NUCLEAR SAFETY ADVISOR

FROM: MATTHEW MOURY [signature] FOR:
DEPUTY ASSISTANT SECRETARY FOR
SAFETY, SECURITY, AND QUALITY PROGRAMS
ENVIRONMNETAL MANAGEMENT

SUBJECT: Radiological Incident into the February 14, 2014 Event at the Waste Isolation Pilot Plant

In accordance with the requirements of the Department of Energy (DOE) Order (O) 225.1B, *Accident Investigations*, I am establishing an Accident Investigation Board (AIB) to investigate the Radiological Incident at the Waste Isolation Pilot Plant (WIPP), which occurred on February 14, 2014. This will be in addition to the February 5, 2014, fire event already being investigated at WIPP. I have determined that this new event meets the criteria for the conduct of an accident investigation delineated in appendix A, DOE O 225.1B.

You are appointed as the Accident Investigation (AI) Chairperson. In a revision to my previous direction, the AI will be composed of the following members:

- Theodore A. Wyka - Office of Environmental Management - Chairperson.
- Timothy Jay Jackson - EMCBC - Deputy Chairperson
- John P. Zimmerman - PPPO - Board Member
- Roger M. Claycomb - ID - Board Member
- Todd N. Lapointe - Office of Environmental Management - Board Member
- Mark Williams - Mine Safety and Health Administration - Advisor
- Richard Lagdon - Chief of Nuclear Safety - Advisor
- William Weaver - Chief of Nuclear Safety - Advisor
- Gregory L. Campbell - EMCBC - Advisor - Emergency Management
- Frank H. Moussa - Office of Environmental Management - Advisor - Emergency Management
- Jason A. Armstrong - OREM - Advisor - Work Controls
- Bradley J. Davis - Idaho Field Office - Advisor - Work Controls and Operations
- Mark H. Hahn - Richard Operations Office - Advisor - Ventilation Systems
- Lina Pacheco - Carlsbad Field Office - Facility Representative
- Don Galbraith - Carlsbad Field Office - Advisor - Mine Operations

- George Hellstrom - Carlsbad Field Office - Legal Advisor

All members of the AI, by this memorandum, are released from their normal regular duty assignment to serve on the AIB, during the period the AI is convened.

The scope of the AI's investigation is to include, but not be limited to, identifying all relevant facts, determining direct, contributing, and root causes of the event, developing conclusions, and determining the judgments of need to prevent recurrence. The scope of the investigation is to include DOE programs and oversight activities.

The AI is expected to provide my office with periodic reports on the status of the investigation. Please submit draft copies of the factual portion of the investigation report to me, the Office of Health, Safety and Security, Carlsbad Field Office, and the affected contractor for factual accuracy review prior to finalization. The final report should be provided to me within 30 days of the date of this memorandum. Discussion of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

If you have any further questions, please contact me, at (202) 586-5151.

cc: Dave Pegram, HS-24
Jose Franco, CBFO
Mark Whitney, ORO
William Murphie, PPPO
James Cooper, ID
David Huizenga, EM-1
James Owendoff, EM-2 (Acting)
Jack Craig, EM-2.1 (Acting)
Candice Trummell, EM-3 (Acting)
Mark Gilbertson, EM-10
Kenneth Picha, Jr., EM-20
Frank Marcinowski, EM-30
James Hutton, EM-40

Department of Energy
Washington, DC 20585
March 24, 2014

MEMORANDUM FOR JAMES OWENDOFF
ACTING PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR ENVIRONMENTAL MANAGEMENT

FROM: MATTHEW B. MOURY
DEPUTY ASSISTANT SECRETARY FOR SAFETY, SECURITY, AND QUALITY PROGRAMS
ENVIRONMENTAL MANAGEMENT

SUBJECT: Delegation of Authority

Mr. James Hutton is authorized to Act for me as the Deputy Assistant Secretary for Safety, Security, and Quality Programs as needed/required, or in my absence. This delegation will extend to all personnel and financial matters.

If you have any questions, please contact me, at (202) 585-5151.

cc: David Huizenga, EM-1(Acting)
Colin Jones, EM-1 (Acting Chief of Staff)
Richard Lagdon Jr., EM-1/CNS
Jack Craig, EM-2.1 (Acting)
Candice Trummell, EM-3 (Acting)
David Borak, EM-3.1 (Acting)
Kristen Ellis, EM-3.2 (Acting)
Mark Gilbertson, EM-10
William Levitan, EM-10
Kenneth Picha, Jr., EM-20
Jay Rhoderick, EM-20
Frank Marcinowski, EM-30
Christine Gelles, EM-30
James Hutton, EM-40
Todd Lapointe, EM-41
Tony Weadock, EM-42 (Acting)
Robert Murray, EM-43
Jimmy McMillian, EM-44
J. E. Surash, EM-50
Thomas Johnson, Jr., EM-50
Teresa Tyborowski, EM-60
Dennis Deziel, EM-60
Melody Bell, EM-70 (Acting)
EM-40 Staff

Appendix B. Barrier Analysis

Barrier analysis is based on the premise that hazards are associated with all tasks. A barrier is any means used to control, prevent, or impede a hazard from reaching a target, thereby reducing the severity of the resultant accident or adverse consequence. A hazard is the potential for an unwanted condition to result in an accident or other adverse consequence. A target is a person or object that a hazard may damage, injure, or fatally harm. Barrier analysis determines how a hazard overcomes the barriers, comes into contact with a target (e.g., from the barriers or controls not being in place, not being used properly, or failing), and leads to an accident or adverse consequence. The results of the barrier analysis are used to support the development of causal factors. This Phase 1 report covers the Board's analysis and conclusion for the release of TRU from the U/G to the environment. Several of the barriers below are unknown at this time and will be analyzed in Phase 2 after reentry into the U/G and a cause of the release within the U/G is able to be determined.

Table B-1: Barrier Analysis

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
Characterization, Confinement, and Protection					
B1.	Confinement in waste container.	Failed	Unknown at this time.	Release of Am and Pu.	Unknown at this time
B2.	Characterization of waste container.	Unknown	Unknown at this time.	Unknown at this time.	Unknown at this time
B3.	Inspection of the container.	Unknown	Unknown at this time.	Unknown at this time.	Unknown at this time

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B4.	Container vent for volatile gasses from radiolysis or chemical reactions.	Unknown	Unknown at this time.	Unknown at this time.	Unknown at this time
B5.	Adequacy of waste characterization program to comply with WAC.	Unknown	Unknown	Unknown at this time.	Unknown at this time
B6.	Intact back/rib.	Unknown	Unknown	Unknown at this time.	Unknown at this time
B7.	Intact roof bolt.	Evidence that some were protruding but not if they impacted or penetrated waste containers, do have lanyards.	Unknown	Unknown at this time.	Unknown at this time
B8.	Protection on top of waste.	There are bags of magnesium oxide on top of some drums – for long term performance, not to protect from penetration.	Unknown	Unknown at this time.	Unknown at this time
B9.	Ground control program.	Unknown	Unknown	Unknown at this time.	Unknown at this time

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B10.	Fall of waste container (stability of three tier stacking).	Unknown	Unknown	Unknown at this time.	Unknown at this time
B11.	Penetration during handling, e.g., puncture by forklift tine.	Unknown	Unknown	Unknown at this time.	Unknown at this time
B12.	Flooding of containers.	Unknown	Not applicable	Not applicable.	Unknown at this time
B13.	Protection from explosion, e.g., battery, methane, refueling station, etc.	No evidence of any explosion.	Not applicable	Not applicable.	Unknown at this time
B14.	Completed Panel closure system (Panel 1, 2, and 5).	Unknown	Unknown	Unknown at this time.	Unknown at this time
B15.	In-process Panel closure (Panels 3 and 4).	Unknown	Unknown	Unknown at this time.	Unknown at this time
B16.	In-process Panel closure (Panel 6), next to Panel 7, door between 6 and 7 may be open.	Unknown	Unknown	Unknown at this time.	Unknown at this time

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
Detection of Released Mixed TRU Waste					
B17.	Continuous Air Monitor 151 (at Panel 7).	Performed as intended.	Did not fail	Detected release, alarmed, and initiated shift to filtration mode.	HPI: N/A ISMS: CF-3, GP-6
B18.	Continuous Air Monitor 152 (at Panel 7).	Out of Service.	Ineffective maintenance, aging (operated only 29 days out of last 22 months), being used in harsh environment.	Was not available to detect release.	HPI: N/A ISMS: CF-3, GP-6
B19.	Continuous Air Monitor 150 (at Panel 6).	Operable but turned off.	Was not used as a replacement for CAM-152.	Was not available to detect release.	HPI: N/A ISMS: CF-3, GP-6
B20.	Continuous Air Monitor 149 (at Panel 6).	Turned off, had spectrum issues.	Not available to be used.	Was not available to detect release.	HPI: N/A ISMS: CF-3, GP-6
B21.	Personnel U/G to observe condition of waste.	No one was underground.	Not typically U/G on back shift, limited operations post fire event.	No one U/G to observe condition of waste.	HPI: N/A ISMS: N/A

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B22.	Sample monitoring Station D at bottom of exhaust shaft.	Enabled but does not provide real-time monitoring.	Did not fail but uses filters only pulled once/day.	Did not affect.	HPI: N/A ISMS: CF-3, GP-6
B23.	Sample monitoring Station A.	Enabled but does not provide real-time monitoring.	Did not fail	First data source after CAM-151, Station A data was first believed indication of a release.	HPI: N/A ISMS: CF-3, GP-6
B24.	CAM at Station A.	Existed pre-radioactive operations but were removed.	Did not exist.	Unable to detect release real-time.	HPI: HN-3,HN-6 ISMS: CF-3, GP-6
B25.	Ability to detect hazardous constituent release.	Only for VOCs.	Hazardous release is primarily tied to radioactive release; does not monitor anything but VOCs.	Did not quantify hazardous constituent release other than VOCs, did not immediately recognize rad release and never recognized potential for hazardous constituent release.	HPI: HN-6 ISMS: CF-3, GP-6

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
Filtration of Mixed TRU Waste After Release					
B26.	Automatic shift to filtration mode on CAM alarm.	Shifted (but not automatically), needed to manually open 860A vortex, adjust 707 damper.	Did not fail.	Directed underground airflow through HEPA filters.	HPI: WE-4,WE-7 ISMS: CF-3, GP-6
B27.	Confinement within the ventilation system.	Failed	Bypass dampers leaked	Allowed radioactive material to bypass HEPA filters and be released to the environment.	HPI: HN-3,HN-4,HN-6 ISMS: CF-3, GP-6
B28.	Central Monitoring System indicators.	Failed	Indicated dampers not fully closed and flow through 700B.	Did not affect accident but indicative of Conduct of Operations inadequacy.	HPI: HN-4,WE-7 ISMS:
B29.	Mod filters (HEPA roughing filters).	Exceeded set point of 1" WG, intact and effective.	Did not fail.	Protected HEPA filters.	HPI: N/A ISMS: CF-3, GP-6

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B30.	HEPA filters.	DOP tested in Oct 2013, intact and effective.	Did not fail.	Treated the airflow that did not bypass via the bypass damper.	HPI: N/A ISMS: CF-3, GP-6
Detection of Mixed TRU Waste After Filtration					
B31.	Sample monitoring Station B.	Enabled but does not provide real-time monitoring.	Did not fail.	Second data source after CAM-151 and first data source of release to the environment, Station B data was first believed indication of a release to the environment.	HPI: HN-3,HN-6 ISMS: CF-3, GP-6
B32.	CAM at Station B.	Existed pre-radioactive operations but were removed.	Did not exist.	Were not able to detect release real-time.	HPI: HN-3,HN-6 ISMS: CF-3, GP-6
B33.	Far Field fixed air samplers (300 meters) at exclusive use area.	Enabled and detected release.	Did not fail	Detected release.	HPI: N/A ISMS: CF-3, GP-6
B34.	Off-site fixed air samplers.	Enabled and detected release.	Did not fail	Detected release	HPI: N/A ISMS: CF-3, GP-6

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
Protection of Personnel Underground					
B35.	Ventilation airflow (minimum 42K cfm) towards the waste face (away from the worker) when in TSR waste handling mode.	Worked as designed.	Did not fail.	No workers underground, not affected.	HPI: N/A ISMS: CF-3, GP-6
B36.	Ventilation airflow (minimum 42K cfm) towards the waste face (away from the worker) when in TSR disposal mode.	Worked as designed.	Did not fail.	No workers underground, not affected.	HPI: N/A ISMS: CF-3, GP-6
B37.	Personal Protective Equipment (PPE), e.g., respirator, supplied air, etc.	Did not exist.	Did not fail - was not utilized.	No personnel U/G so no affect.	HPI: N/A ISMS: CF-3, GP-6
B38.	Continuous Air Monitor alarm at Panel.	Worked as designed.	Did not fail.	No personnel U/G so no affect.	HPI: N/A ISMS: CF-3, GP-6
B39.	Continuous Air Monitor at the waste face.	Did not exist.	Was not utilized.	No personnel U/G so no affect.	HPI: N/A ISMS: CF-3, GP-6

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B40.	Continuous Air Monitors throughout the underground.	Did not exist.	Was not utilized.	No personnel U/G so no affect.	HPI: HN-3, HN-6 ISMS: CF-3, GP-6
B41.	Alarm response procedure to “HI RAD” CAM alarm.	Existed and adequate but not implemented as no personnel in the U/G.	Was not utilized	No personnel U/G so no affect	HPI: HN-3, HN-5 ISMS: CF-3, GP-6
B42.	Alarm response procedure to “HI-HI RAD” CAM alarm.	Existed and adequate but not implemented as no personnel in the U/G.	Was not utilized	No personnel U/G so no affect	HPI: HN-3, HN-5 ISMS: CF-3, GP-6
B43.	Training program – alarm response.	Existed but no OJT for FSM, limited drills and exercises.	Did not fail – no personnel in the U/G.	No personnel U/G so no affect.	HPI: IC-5 ISMS:
B44.	Restriction on personnel being in the exhaust drift during waste handling operations.	Exists	Did not fail – no personnel U/G.	No personnel U/G so no affect.	HPI: N/A ISMS: CF-3, GP-6

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
Protection of Co-located Workers, Workers on Surface					
B45.	Alarm response procedure – CAM alarms.	Failed	Did not believe initial indications.	Did not immediately implement, sheltering not performed until Station B data received 10 hours 20 minutes later.	HPI: IC-5,HN-3, NH-4 ISMS:
Personnel of Response Personnel					
B46.	Radiological worker training.	Failed	Inadequate, no significant experience/training in contamination control, did not believe initial indications.	One personnel skin contamination, some uptakes.	HPI: IC-1,IC-5 ISMS: CF-4; GP-3
B47.	CMR training	Failed	Did not believe indications.	Did not conclude there was a release, did not take immediate protective actions for response personnel or others on-site, did not restrict site access until 10 hours 20 minutes after release.	HPI: IC-1,IC-5 ISMS: CF-4; GP-3

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
B48.	CMR HEPA filtration.	Failed	Not proceduralized and not utilized.	Unknown	HPI: IC-1, IC-3, IC-5 ISMS: CF-3, GP-6
B49.	860A vortex designed to be automatically opened.	Does not automatically open – must be manually opened.	Configuration changed to require manual operation.	Required personnel to enter an area with potential for exposure without PPE.	HPI: HN-3 ISMS: CF-3, GP-6, GP-7
Programs					
B50.	Emergency Management Program.	Ineffective.	Relies on FSM expertise. Does not effectively use Emergency Operations Center (EOC). No integrated command system. Ineffective/non-existent drills and exercises (many tabletops, many cancelled, little hands on).	Did not classify or categorize event as an Operational Emergency (Alert). Delayed activation of the EOC (13 hours 20 minutes after CAM alarm). Delayed AEOC becoming operational (15 hours 30 minutes after CAM alarm). Delayed sheltering (10 hours 20 minutes after	HPI: IC-5,HN-4,HN-6 ISMS: CF-2, GP-5,6; CF-3; GP-2,3,5,6,7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
			Delay in implementing protective actions. Failed to believe initial indications of release. Loss of CAM redundancy.	CAM alarm. Did not implement the RCRA Contingency Plan. Consequence assessment delayed. Did not make required notifications and reports. Did not effectively invoke/utilize the RAP team (release at 300 m).	

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B51.	Conduct of Operations Program	Ineffective.	Failed to believe indicators. Desensitization. Inadequate procedures and compliance. Insufficient logs. No staffing plan. Inadequate equipment and system status (CMS). No operational drills. Inadequate on-shift training.	Delayed response. Delayed activation of OAT, JIC, and EOC. Delayed protective actions. Delayed notifications. Inadequate/incomplete communication of information (RCM, FR).	HPI: IC-2, IC-5, HN-2, HN-4 ISMS: CF-2,3; GP-1,2,5,7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B52.	Ground Control Program	Unknown – mechanism of radiological release is unknown. Inactive extensometer at Panel 6. Panel 6 is not totally sealed and isolated. S2750/W285 was rebolted in November 2013.	Unknown	Unknown	HPI: N/A ISMS: CF-2,3; GP-1,2,5,7
B53.	Maintenance Program	Ineffective (CAMs, 860A vortex, bulkhead 707 regulator, bypass dampers, 700 fan A&B, electrical distribution system.	Acceptance to tolerate out-of-service equipment. Lack of resources (funding for replacement equipment). Configuration management not maintained.	Only one of two operable CAM at the active waste face. 860A vortex did not automatically open. Leakage past bypass damper. Dampers on 700B contacts (CMS sees as flow when dampers are closed).	HPI: HN-4, HN-6 ISMS: CF-2,3; GP-1,2,5,7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
B54.	Nuclear Safety Program – Documented Safety Analysis	Inadequate	Revision 4 Hazard analysis does not adequately evaluate a back fall event in an open panel (selected wrong bounding representative event). General reduction in the level of conservatism between DSA Revision 1 and Revision 4. Reliance on initial conditions and assumptions may not be compliant with STD 3009 unmitigated analysis. Quality issues (conflicting information within and between DSA and TSRs).	Unknown	HPI: TD-6, IC-2, HN-3, HN-6 ISMS: CF-2,3; GP-1,2,5,7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
B55.	Nuclear Safety Program – Technical Safety Requirements.	Inadequate to establish limits, controls and actions for safe operation.	Hazard analysis did not drive the appropriate classification of the UVS. Documentation rigor inconsistent with a Hazard Category 2 nuclear facility.	Unknown	HPI: TD-6, IC-2, HN-3, HN-6 ISMS: CF-2,3; GP-1,2,5,7
B56.	Nuclear Safety Program – Unreviewed Safety Question Determination Process.	Marginally adequate.	USQ screening/ determination preparation does not reflect questioning attitude/sufficient analysis, there appears to be a bias toward negative USQDs. Quality issues (confusion of steps with PISA, quality of determinations).	Unknown	HPI: TD-6, IC-2, HN-3, HN-6 ISMS: CF-2,3; GP-1,2,5,7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
B57.	Nuclear Safety Program – NWP Nuclear Safety Program Oversight.	Inadequate.	No program assessments (TSR section 5.5 requires periodic assessments).	Unknown	HPI: TD-6, IC-2, HN-3, HN-6 ISMS: CF-2,3; GP-1,2,5,7
B58.	Nuclear Safety Program – CBFO Nuclear Safety Program Oversight.	Inadequate.	Lack of robustness in CBFO review process. Lack of assessments (one QA Surveillance report by CBFO in last four years). Four oversight evaluation reports issued by CBFO Nuclear Safety during the year (during 2013). Inadequate resources and need for resources.	Unknown	HPI: TD-6, IC-2, HN-3, HN-6 ISMS: CF-2,3; GP-1,2,5,7
B59.	Radiological Control Program.	Inadequate.	Radcon staffing not available to respond on backshift. Radcon procedures do	Inability to timely and effectively respond, e.g., PPE, postings, use of instrumentation.	HPI: TD-6, IC-1, IC-2, IC-5, HN-3, HN-4, HN-6

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
			not provide specific direction, e.g., bioassay, surveys, hazard recognition, response to emergencies. Radcon training and qualification process does not address proficiency in many areas, e.g., contamination identification and control, cross-contamination control, postings. Triennial assessment program did not perform a comprehensive assessment of all elements of the RPP (not performed by technical assessors, focused on QA aspects). Insufficient quantity	Uptake/possible missed dose. Cross-contamination of samples (did self-recognize and report).	ISMS: CF-2, GP-5, GP-6, GP-7; CF-4; GP-2,3,7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
			and capabilities of instruments, e.g., battery operated CAMs/FASs, portable NaI detector, etc. Inadequate internal dosimetry program - did not provide adequate direction for determination of type and frequency of in-vivo and/or in-vitro bioassay measurement. No narrative logs or checklists per RPP requirements.		

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
B60.	Contractor Assurance System	Inadequate.	Execution of the CAS did not identify precursors to this event. Ineffective management assessments and walkdowns, focus on cost and schedule. No nuclear safety management assessments per TSR 5.5.	Did not identify weaknesses in conduct of operations, maintenance, radcon, nuclear safety, emergency management, and safety culture. Did not identify safety culture concerns.	HPI: N/A ISMS: CF-5; GP-1, 2, 3, 5, 7
B61.	Safety Culture	Inadequate.	Response to WIPP Forms inadequate, e.g., CAM functional checks. Perception of retribution for submitting WIPP Forms (particularly among RCTs). Development and implementation of corrective actions	Issues with CAMs, 860A vortex, dampers, CMS and other equipment not documented and addressed. Delay in recognizing and responding to events, e.g., believing there was a release, delay in sheltering, delay in classifying/categorizing,	HPI: TD-7, IC-7, WE-4, HN-4, HN-5, HN-6 ISMS: CF-5; GP-1

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
			associated with SCWE self-assessment has not been a management priority (NWP and CBFO). Acceptance of degradation of equipment and conditions over time, e.g, emergency egress hardware, fire protection equipment, CAMs, dampers, etc. 2012 SCWE survey indicated reluctance to report issues to management (NWP and CBFO).	etc. Not performing functional check on remaining CAM because failure would shut-down waste handling. Bias for negative conclusions on USQDs. 20-30 USQDs/year is small number when compared to other Cat 2 nuclear facilities. Reluctance to file Occurrence Reporting and Processing System (ORPS) reports. Cancellation of numerous emergency management drills and exercises (18 in 2013) due to impact on operations. Lack of a questioning attitude, e.g., reduction in conservatism in the	

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
				DSA. Management assessments focused on cost and schedule versus program performance. Infrequent presence of NWP management in the U/G and surface. Improvement in CBFO presence in the field since new CBFO Manager arrived.	
B62.	CBFO Oversight	Inadequate.	Lack of robustness of oversight process (many under development for years). Inadequate resolution of externally identified issues. Have not performed required assessment of the emergency management program per DOE O 151.1C.	Did not identify weaknesses in conduct of operations, maintenance, radcon, nuclear safety, emergency management, and safety culture. Did not identify safety culture concerns.	HPI: N/A ISMS: CF-5; GP-1

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	How did barrier perform?	Why did barrier fail?	How did barrier affect accident?	Context: HPI/ISMS
			Objective evidence for completion of several planned assessments was not provided. Insufficient qualified staffing available (FRs, ABSTA, Deputy, rotating staff positions) Inadequate identification, documentation, communication, and resolution of issues.		
B63.	DOE Headquarters Oversight	Inadequate.	Lack of line management responsibility and follow through. Failure to enforce and ensure that issues are corrected. Lack of effectiveness of oversight in several areas, e.g., emergency management, radiological	Identified issues but did not correct many issues directly related to the event, radcon training, classification and categorization of emergencies, conduct of operations weaknesses, maintenance program, oversight, issues management, etc.	HPI: N/A ISMS: CF-5; GP-1, 2, 5, 6, 7

Hazard: Release of Mixed TRU Waste			Target: Workers and the Public		
	Barriers	**How did barrier perform?**	**Why did barrier fail?**	**How did barrier affect accident?**	**Context: HPI/ISMS**
			protection, nuclear safety, maintenance, work control, ISMS. Resources have been reduced over last several years (FTEs, travel money, etc.). Roles and responsibilities are not clearly understood.		

Appendix C. Change Analysis

Change is anything that disturbs the "balance" of a system from operating as planned. Change is often the source of deviations in system operations. Change can be planned, anticipated, and desired, or it can be unintentional and unwanted. Change analysis examines the planned or unplanned disturbances or deviations that caused the undesired results or outcomes related to the accident. This process analyzes the difference between what is normal (or "ideal") and what actually occurred. The results of the change analysis are used to support the development of causal factors.

Table C-1: Change Analysis

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
Waste Characterization, Confinement, and Protection				
C1.	Transuranic (TRU) waste is not confined in waste container.	TRU waste is confined.	TRU waste is not confined.	TRU waste is released in the underground.
Detection of Released Mixed TRU				
C2.	Only Continuous Air Monitor (CAM) 151 monitoring underground.	Multiple CAMs monitoring underground.	Single instrument capability to detect release.	CAM-151 detected release but no redundancy.
C3.	Facility operations assumed alarm was due to CAM malfunction.	Facility operations believe CAM alarm is real.	Did not believe indications.	Delay in response, potential exposure to 153 personnel.
C4.	No CAM at Station A or D.	CAM at Station A or D.	No real-time monitoring of the exhaust before filtration.	Not aware of release beyond CAM-151.

Accident Situation		Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
C5.	No radiological control (Radcon) support on backshift.	Radcon personnel on backshift.	Radcon not available to pull Station A filters immediately after CAM alarm.	Did not have filter count results until Radcon arrived early on February 15.
Filtration of TRU Mixed Waste				
C6.	Airborne contamination leaks past the ventilation isolation dampers 413-HD-056-003A and 413-HD-056-003B.	Airborne contamination does not bypass the ventilation isolation dampers.	Airborne contamination bypasses HEPA filtration.	Airborne contamination was released to the environment.
C7.	CMS display indicates flow through 700B fan exhaust with fan shutdown.	CMS display indicates no flow through 700B fan exhaust with fan shutdown.	CMS display indicates flow through HEPA filters and 700B fan exhaust at same time.	Potential unmonitored leak path direct to the environment.
C8.	860 fans require operator to manually open and regulate the 860 fan vortexes.	860 fan vortexes automatically open upon switch to filtration.	Shift to filtration is not automatic. Requires operator action (which is not proceduralized). Exposes operator to potential contamination.	Delayed flow through HEPA filters. Experienced based opening of vortex, relies on CMR understanding of system and need to open vortex. Potential contamination of operators opening the vortex.

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
Detection of Mixed TRU Waste After Filtration				
C9.	No CAM at Station B.	CAM at Station B.	No real-time monitoring of the exhaust after filtration.	Not aware of release beyond CAM-151.
C10.	Delay in counting the filters at Station B.	Station B filters pulled and counted immediately following CAM-151 alarm.	Delay in understanding there was a release.	Delay in understanding there was a release and in implementing protective actions (restrict site access, sheltering-in-place for 10 hours 20 minutes).
C11.	Far field air monitoring station identified an off-site release.	CAM at Station B.	No real-time monitoring of the exhaust after filtration.	Delay in becoming aware of off-site release.
C12.	Cross-contamination of other swipes from tweezers used to handle filters at Station A.	No cross-contamination of swipes.	False indication of significant contamination spread above ground.	Diverted resources to unnecessary response, sensitized personnel to formality of operations in conducting surveys and handling samples.
Protection of Personnel Underground				
C13.	No personnel were in the underground			

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
Protection of On-site and Off-site Personnel and the Environment				
C14.	Did not recognize the release and implement the Emergency Plan (including the RCRA Contingency Plan).	Recognize there was a release and implement the Emergency Plan (including the RCRA Contingency Plan).	Did not recognize there was a release and take protective actions.	Delayed implementation of the emergency plan and implementing protective actions. Activating the EOC/AEOC. Restricting site access. Invoking sheltering-in-place. Conducting radiological surveys. Counting effluent monitoring station filters. Performing consequence assessment and modeling. Notifications, declarations, and reporting. Allowed personnel to leave site without being monitored.

Accident Situation		Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
				Did not activate the CMR HEPA filtration system.
Emergency Management				
C15.	Lack of an integrated emergency management system.	Contractor developed and implemented a Comprehensive Emergency Management System designed to: • Minimizes the consequences of all emergencies involving or affecting Departmental facilities, and activities; • Protects the health and safety of all workers and the public from hazards associated with DOE operations • Prevents damage to the environment;	Plans were not followed.	Not using all resources that are available. Delay in categorizing, classifying, and implementing protective actions in a timely manner.

Accident Situation		Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
		and • Promotes effective and efficient integration of all applicable policies, recommendations, and requirements, including Federal interagency emergency plans.		
Conduct of Operations Program				
C16.	Program is adequately defined in site procedures, however: Failed to believe indicators • Desensitization; • Inadequate procedures and compliance; • Insufficient logs; • No staffing plan; • Inadequate equipment and system status (CMS); • No operational drills; • Inadequate communication of information; and	Conduct of Operations Program effective. System is compliant with DOE O 422.1, *Conduct of Operations*, and is fully implemented.	Conduct of operations program was not fully implemented.	Impacted timely identification of abnormal condition and response.

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
	• Inadequate on-shift training.			
Ground Control Program				
C17.	Cause of incident is unknown.	Ground Control program is adequately defined and implemented.	Unknown	Unknown
Maintenance Program				
C18.	Acceptance to tolerate out-of-service equipment. Lack of resources (funding for replacement equipment). Configuration management not maintained.	Conduct of Maintenance program is effective.	Equipment was allowed to degrade.	Became used to CAMs routinely malfunctioning – did not believe alarms. CMS display of 700B fan as operating when in filtration. 860 vortex fans require manual operation. Leakage past dampers. Electrical distribution system configuration.
Radiation Protection Program				
C19.	Radiation Protection Program does not implement the DOE approved RPP: • Radcon staffing not available to	Radiological Protection Program is fully compliant with 10 CFR	Radcon program does not fully implement 10 CFR 835 requirements.	Ineffective response to airborne release and contamination control.

Accident Situation		Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
	respond on backshift; • Radcon procedures do not provide specific direction, e.g., bioassay, surveys, hazard recognition, response to emergencies; • Radcon training and qualification process does not address proficiency in many areas, e.g., contamination identification and control, cross-contamination control, postings; • Triennial assessment program did not perform a comprehensive assessment of all elements of the RPP (not performed by technical assessors, focused on QA aspects); Insufficient quantity and capabilities of instruments, e.g., battery operated CAMs/FASs, portable NaI detector, etc.; Inadequate internal dosimetry program - did not provide adequate direction for determination of type and frequency of in-vivo and/or in-vitro bioassay measurement; and No narrative logs or checklists per RPP requirements.	835 and effectively implemented.		

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
Nuclear Safety (DSA, TSR, USQD)				
C20.	There has been a degradation in the conservatism of the safety basis: • Downgrading of the ventilation system classification from Safety Significant (SS) to BOP. • Specific Administrative Controls replaced by initial assumptions, e.g, waste hoist brake inspections and ground control program implementation. • Selection of the design basis accidents, e.g., back fall in an open panel, 22 to 7 analyzed accidents. • Hazard analysis did not drive classification of the underground CAMs, e.g., Safety Class (SC), SS, or ITS. • Lack of critical analysis in execution of the USQD process.	Nuclear safety complies with 10 CFR 830 Subpart B and effectively implemented.	Nuclear safety program does not fully implement 10 CFR 830 Subpart B requirements.	Workers, the public, and the environment may not be adequately protected.

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
Safety Culture				
C21.	The safety culture does not fully embrace and implement the principles of DOE G 540.4-1C. Response to WIPP Forms inadequate, e.g., CAM functional checks: • Perception of retribution for submitting WIPP Forms (particularly among RCTs) • Development and implementation of corrective actions associated with SCWE self-assessment has not been a management priority (NWP and CBFO) • Acceptance of degradation of equipment and conditions over time, e.g, emergency egress hardware, fire protection equipment, CAMs, dampers, etc. • 2012 SCWE survey indicated reluctance to report issues to management (NWP and CBFO)	There is a safety conscious work environment that complies with ISMS Guide DOE G 450.4-1C.	The safety culture does not fully embrace and implement the principles of DOE G 450.4-1C.	Lack of a questioning attitude. Reluctance to report issues to management. Reluctance to report issues that might impact operations. Acceptance of degradation of equipment and operations over time. Work arounds, e.g, manual opening of 860 vortexes, breakers out of position, condition of dampers, etc.
Contractor Assurance System				
C22.	The NWP CAS did not identify precursors	The NWP CAS is fully compliant with DOE O	Could have identified conditions or	Did not identify precursors to this

	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
	to this event. There were ineffective management assessments and walkdowns, focus on cost and schedule. There were no nuclear safety management assessments per TSR 5.5. Corrective actions from prior assessments were not effective in preventing or minimizing recurrence.	226.1B and effectively implemented.	inadequacies that contributed to the response to this event.	incident.
CBFO Oversight				
C23.	CBFO does not have a robust oversight process. There was inadequate resolution of externally identified issues. CBFO has not performed required assessment of the emergency management program per DOE O 151.1C. Objective evidence for completion of several planned assessments was not provided. There is insufficient qualified staffing available (FRs, ABSTA, Deputy, rotating staff positions). There has been inadequate identification,	The CBFO oversight program is fully compliant with DOE O 226.1B and effectively implemented.	Could have identified conditions or inadequacies that contributed to the response to this event.	Did not identify precursors to this incident.

Accident Situation		Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
	documentation, communication, and resolution of issues.			
DOE Headquarters Oversight				
C24.	There is a lack of line management responsibility and follow through. There was failure to enforce and ensure that issues are corrected. There is a lack of effectiveness in issue resolution in several areas, e.g., emergency management, radiological protection, nuclear safety, maintenance, work control, ISMS. Many of these issues were identified in past assessments. Resources have been reduced over last several years (FTEs, travel money, etc.). Roles and responsibilities are not clearly understood.	The DOE HQ oversight program is fully compliant with DOE O 226.1B and effectively implemented.	Could have corrected conditions or inadequacies that contributed to the response to this event.	Did not correct precursors to this incident.

Appendix D. Causal Factors and Related Conditions

Table D-1: Causal Factors and Related Conditions

	Causal Factor	Related Conditions
CC1.	The physical cause of the mixed TRU waste release could not be definitively determined during this investigation.	Based on radiological data, there was a release of mixed TRU waste from a container in the underground. A portion of this release bypassed the HEPA filtration system and was released to the environment.
CC2.	NWP does not have an effective nuclear safety program in accordance with 10 CFR 830 Subpart B. In addition, the CBFO review and approval of the nuclear safety basis also has weaknesses.	The Documented Safety Analysis (DSA) Rev 4 hazard evaluation does not adequately evaluate a roof fall event in an open panel (selected wrong bounding representative event). General reduction in the level of conservatism between DSA Rev 1 and Rev 4, e.g., reduced 22 Design Basis Accidents (DBA) to seven, shifted ground control from a Specific Administrative Control (SAC) to an initial assumption based upon MSHA requirements. Reliance on initial conditions/assumptions may not be compliant with STD 3009 unmitigated analysis, e.g., ground control, waste hoist inspection. Quality issues with (conflicting information within and between DSA and Technical Safety Requirements (TSR), e.g, TSR reference to operating outside the TSRs cites a non-existent section of the TSR. Hazard analysis did not drive the appropriate classification of the UVS and the CAMs. Documentation rigor inconsistent with a Cat 2 nuclear facility, e.g., operating procedures did not flow down TSR requirements. Unreviewed Safety Question (USQ) screening/determination preparation does not reflect questioning attitude/sufficient analysis, there appears to be a bias toward negative USQ determinations (USQD), e.g., unmanned underground entry, damper

	Causal Factor	Related Conditions
		foaming. Quality issues (confusion of steps with Potential Inadequacy in the Safety Analysis (PISA), quality of determinations). Lack of robustness in CBFO review and approval process.
CC3.	Emergency Management NWP implementation of DOE Order 151.1C was ineffective	Relies on FSM expertise Does not effectively use EOC Alternate EOC was not activated until 15 hours 30 minutes The War Room became the de facto EOC but is not a recognized element of the ER program No incident command system (ICS) Ineffective/non-existent drills and exercises (many tabletops, many cancelled, little hands on) Delay in implementing protective actions Sheltering-in-place not implemented until 10 hours 20 minutes after release Did not implement the RCRA Contingency Plan Failed to believe initial indications of release Loss of CAM redundancy in the underground (only one operating CAM at time of event to monitor, detect, and inform of event) Did not classify or categorize event as an operational emergency (alert) Did not make required notifications and reports (DOE HQ, regulators, MSHA, etc.)
CC4.	The safety culture does not fully embrace and implement the principles of DOE G 450.4-1C.	Response to WIPP Forms inadequate, e.g., CAM functional checks. Perception of retribution for submitting WIPP Forms (particularly among RCTs). Development and implementation of

	Causal Factor	Related Conditions
		corrective actions associated with SCWE self-assessment has not been a management priority (NWP and CBFO). Acceptance of degradation of equipment and conditions over time, e.g, emergency egress hardware, fire protection equipment, CAMs, dampers, etc. 2012 SCWE survey indicated reluctance to report issues to management, indicate a chilled work environment (40% NWP, 59% CBFO). Concerns with taking actions that impact mission. Delay in recognizing and responding to events, e.g., believing there was a release, delay in sheltering, delay in classifying/categorizing, etc. Not performing functional check on remaining CAM because failure would shut-down waste handling. Bias for negative conclusions on USQDs. 20-30 USQDs/year is small number when compared to other Cat 2 nuclear facilities. Reluctance to file ORPS reports. Cancellation of numerous emergency management drills and exercises (18 in 2013) due to impact on operations. Lack of a questioning attitude, e.g., reduction in conservatism in the DSA. Management assessments focused on cost and schedule versus program performance. Infrequent presence of NWP management in the U/G and surface.
CC5.	Implementation of the NWP Conduct of Operations Program is not fully compliant with DOE O 422.1 and impacted the identification of abnormal conditions and timely response.	NWP operations procedures create bias for operators to question indications. Upset conditions in procedures: • FSM/CMRO did not believe indications that would have dictated a prompt

	Causal Factor	Related Conditions
		response. • There is no real-time capability, e.g., video cameras, for the CMR to observe and understand the condition of the active waste panels/rooms. • Abnormal response procedures are not structured to drive specific immediate actions but are driven by decision points. • Actions taken by operators to manipulate the ventilation system are not formalized in procedures. Lapses in effective three-way communication of key information about the ventilation trip to the RCM and FR. No CONOPS staffing plan was provided, although required by their matrix. Inadequate equipment and system status (CMS) e.g., 2 of 3 700 fans are out of service, 707 bulkhead door actuator, only one of two CAMs in operation on the Panel 7 waste face, auto operation of all 860 vortex fans out of service, electrical distribution system breaker positions. No operational drill program beyond emergency management. Some key positions are not maintaining narrative logs, e.g., radiological control. Radcon staffing not available to respond on backshift Radcon procedures do not provide specific direction, e.g., bioassay, surveys, hazard recognition, response to emergencies Radcon training and qualification process does not address proficiency in many areas, e.g., contamination identification and control, cross-contamination control, postings Triennial assessment program did not perform a comprehensive assessment of all

	Causal Factor	Related Conditions
		elements of the RPP (not performed by technical assessors, focused on QA aspects) Insufficient quantity and capabilities of instruments, e.g., battery operated CAMs/FASs, portable NaI detector, etc. Inadequate internal dosimetry program - did not provide adequate direction for determination of type and frequency of in-vivo and/or in-vitro bioassay measurement. No narrative logs or checklists per RPP requirements.
CC6.	The NWP maintenance and engineering programs have not been effective in keeping critical pieces of equipment in a high state of operational readiness.	The cumulative impact of the combination of degraded equipment on overall facility operational readiness was not adequately considered. There is an acceptance to tolerate or otherwise justify (e.g., lack of funding) out-of-service equipment. Examples include: • distribution system configuration issues; and • 707 bulkhead • only one of two U/G CAMs operable at the Panel 7 waste face for extended periods of time; • ventilation filter bypass isolation dampers; • 860 fan vortex actuators; • 700 A fan vibration issue; • dampers on 700B fan; • electrical regulator. Configuration management is not being maintained or adequately justified when changes are made. Examples include: • 860 vortex did not automatically open; • Temporary latching mechanism to prevent 860 fan damper hand wheel

	Causal Factor	Related Conditions
		from vibrating open; and • Electrical distribution system lineup due to problems related to external access to the ICS.
CC7.	Execution of the NWP Contractor Assurance System (CAS) was ineffective	Execution of CAS did not identify precursors to this event. No program assessments (TSR section 5.5 requires periodic assessments). Did not identify weaknesses in conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. Did not identify safety culture concerns. Corrective actions from prior assessments were not completed or effective in preventing or minimizing recurrence. CAS is implemented primarily through the QA program rather than through self-assessments conducted by knowledgeable, qualified subject matter experts within the various safety management programs.
CC8.	CBFO Oversight was inadequate.	Lack of nuclear safety assessments since 2009. Four oversight evaluation reports issued by CBFO Nuclear Safety during the year (during 2013). Inadequate nuclear safety expertise. Lack of robustness of oversight process (many under development for years). Did not identify weaknesses in conduct of operations, maintenance, radiological protection, nuclear safety, emergency management, and safety culture. Inadequate resolution of externally identified issues. Have not performed required assessment of the emergency management program per

	Causal Factor	Related Conditions
		DOE O 151.1C. Objective evidence for completion of several planned assessments was not provided. Insufficient qualified staffing available (FRs, ABSTA, Deputy, rotating staff positions). Inadequate identification, documentation, communication, and resolution of issues. CBFO personnel are required to submit deficiencies through the QA organization rather than providing them directly to NWP and CBFO management.
CC9.	DOE Headquarters Line Management and Oversight was inadequate.	Lack of line management responsibility and follow through. Failure to enforce and ensure that issues are corrected. Lack of effectiveness of oversight in several areas, e.g., emergency management, radiological protection, nuclear safety, maintenance, work control, ISMS. Resources have been reduced over last several years (FTEs, technical expertise, travel money, etc.). Roles and responsibilities are not clearly understood.

Appendix E. Event and Causal Factor Analysis

An events and causal factors analysis was performed in accordance with the DOE Workbook, Conducting Accident Investigations. The events and causal factors analysis requires deductive reasoning to determine those events and/or conditions that contributed to the accident. Causal factors are the events or conditions that produced or contributed to the accident, and they consist of direct, contributing, and root causes. The direct cause is the immediate event(s) or condition(s) that caused the accident. The contributing causes are the events or conditions that, collectively with the other causes, increased the likelihood of the accident, but which did not solely cause the accident. Root causes are the events or conditions that, if corrected, would prevent recurrence of this and similar accidents. The causal factors are identified in Figure E-1: Events and Causal Factors Analysis.

To ensure full understanding of events and conditions leading up to, during, and following the event, timelines and events and causal factors were developed for nuclear safety, ground control, ventilation, continuous air monitors, and DOE Headquarters oversight in addition to the overall radiological release timeline.

Nuclear Safety Program Events and Causal Factors....................... Page E-2
Ground Control Program Events and Causal Factors .... Page E-11
Ventilation System Events and Causal Factors .... Page E-14
Continuous Air Monitor Events and Causal Factors .... Page E-18
DOE Headquarters Oversight Events and Causal Factors .... Page E-23
Radiological Release Event Primary Causal Factors .... Page E-28

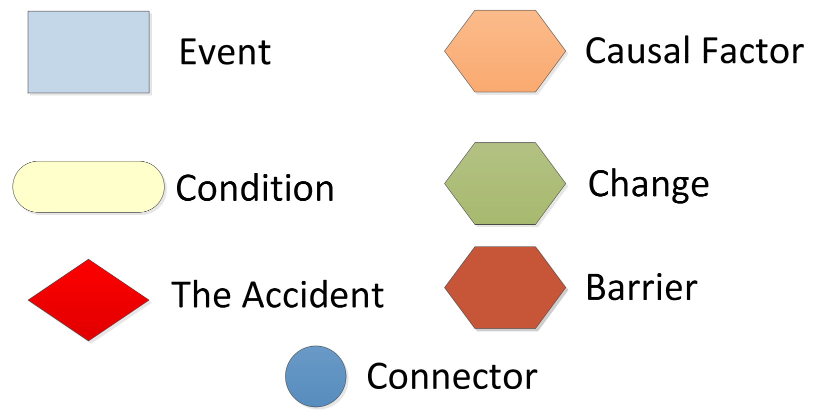
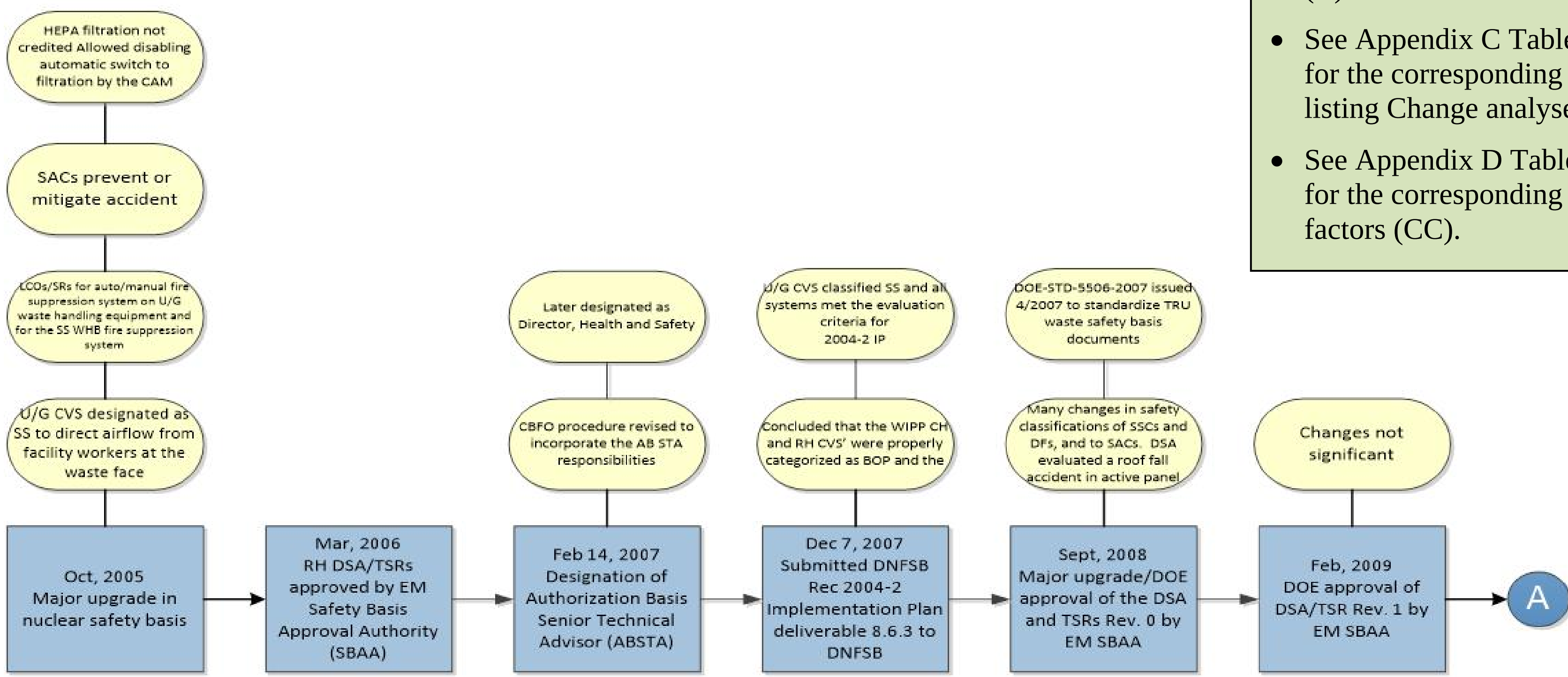


Table E-1: Event and Causal Factors Analysis

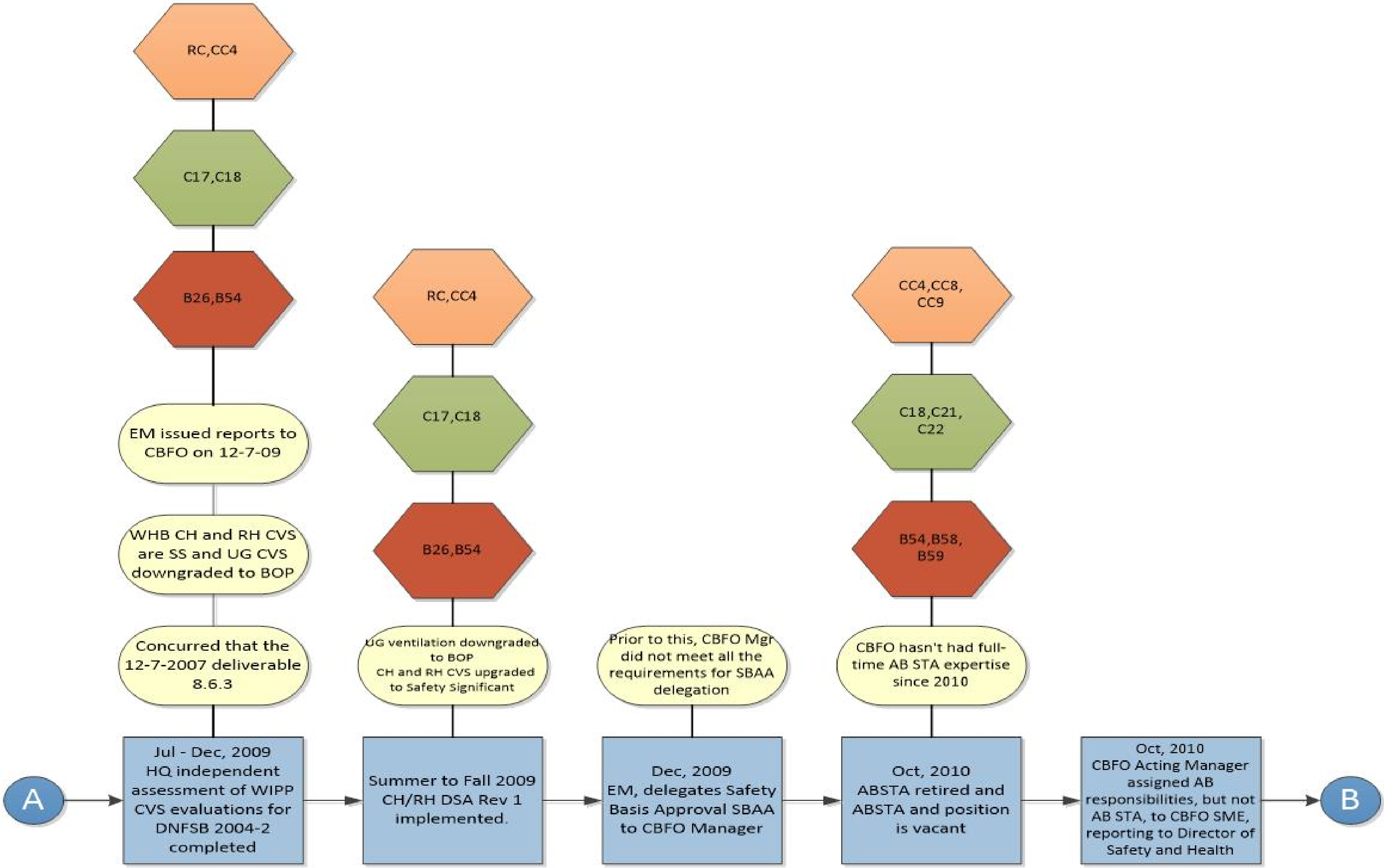
Nuclear Safety Program Events and Causal Factors

NOTE:

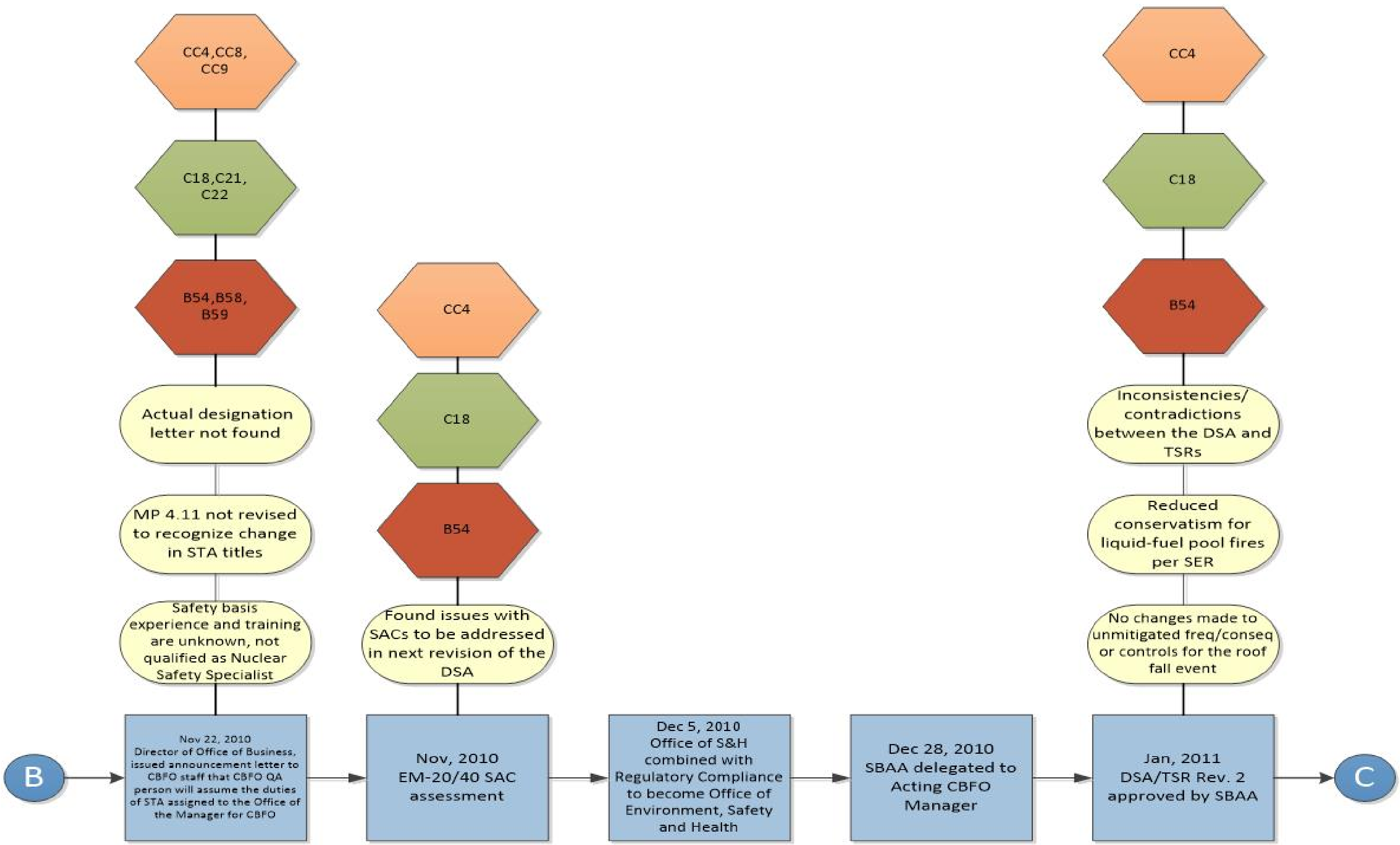
- See Appendix B Table B-1 for the corresponding number listing of the Barrier analysis (B).
- See Appendix C Table C-1 for the corresponding number listing Change analyses (C).
- See Appendix D Table D-1 for the corresponding causal factors (CC).



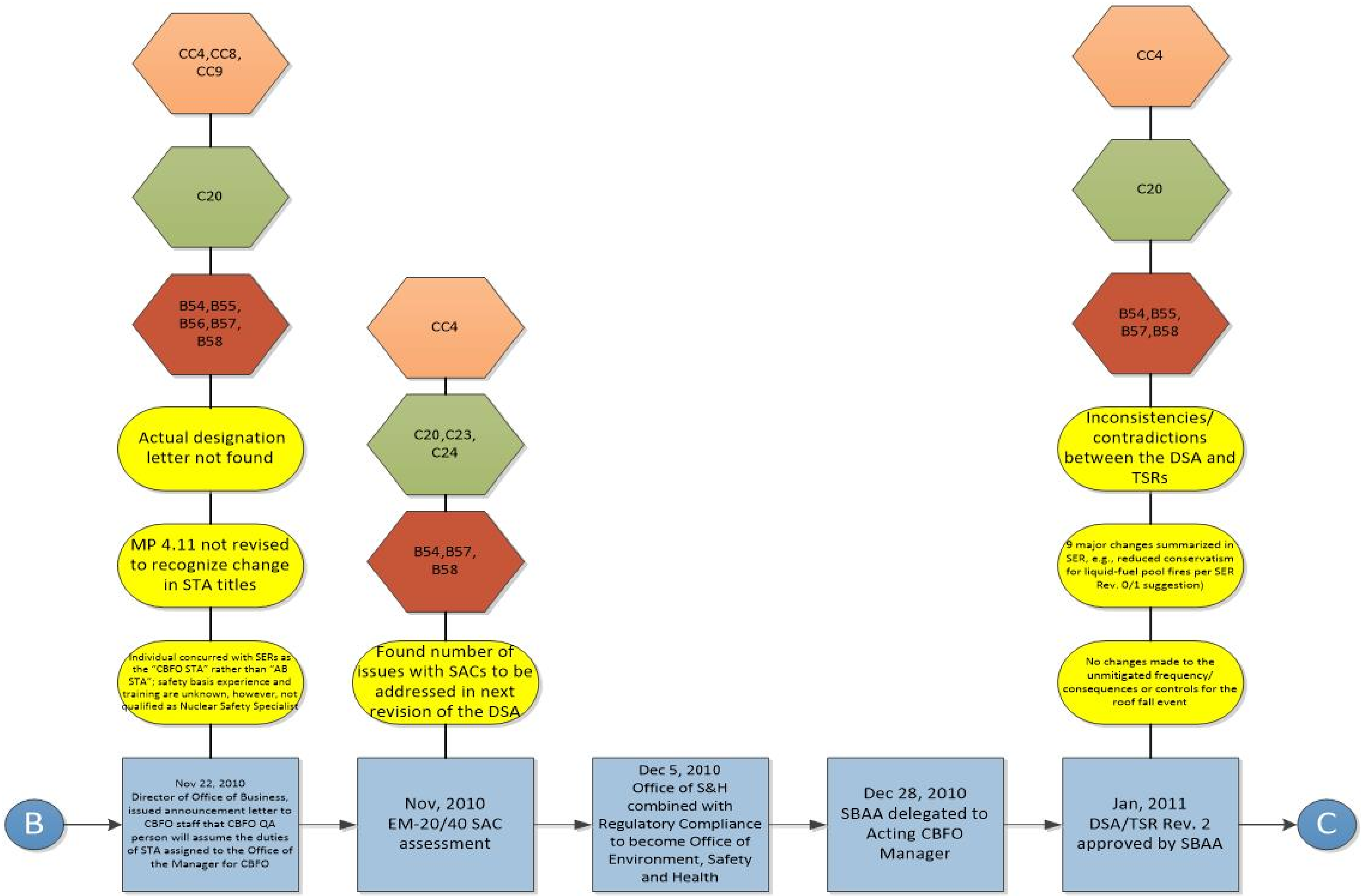
Nuclear Safety Program Events and Causal Factors



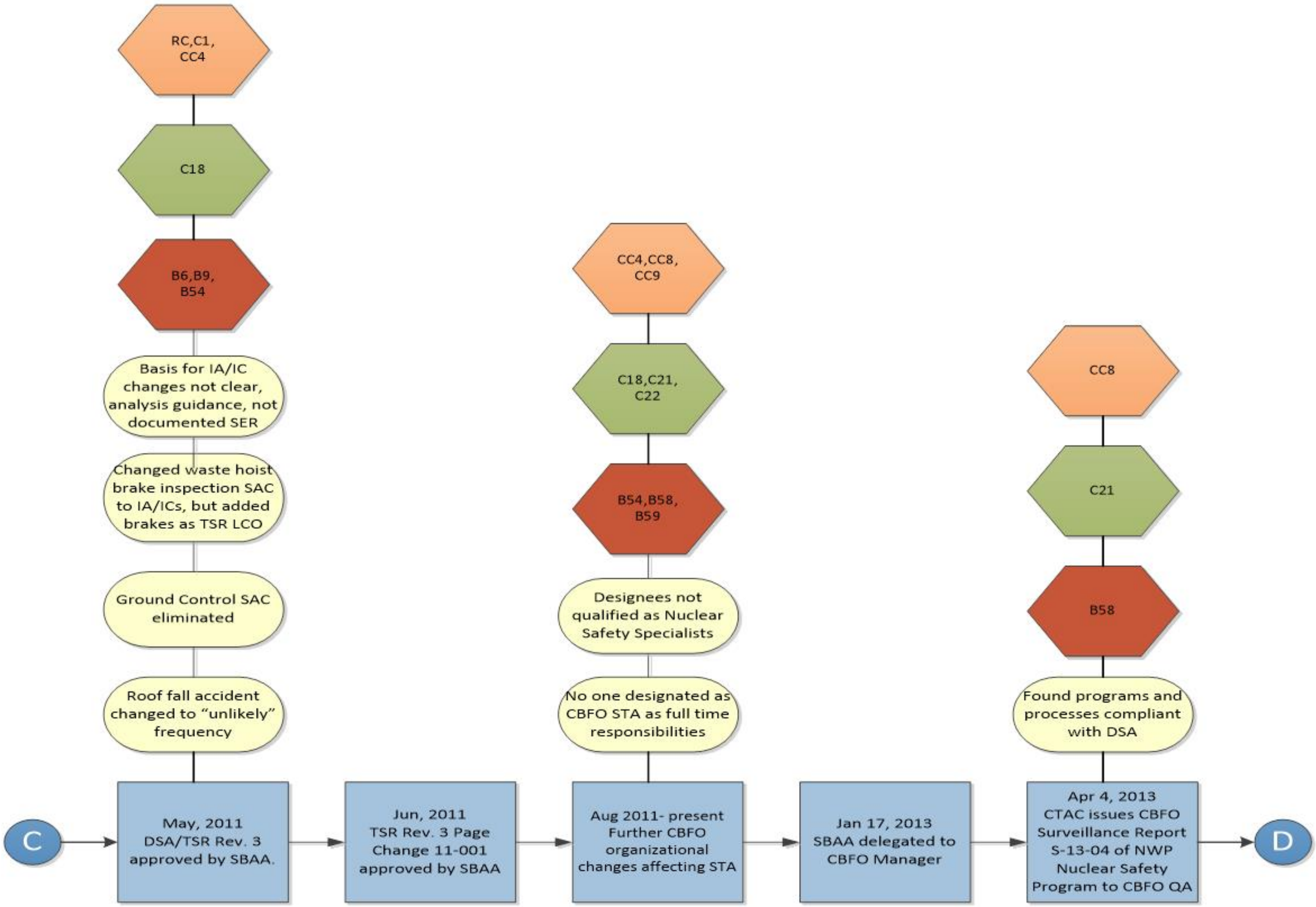
Nuclear Safety Program Events and Causal Factors



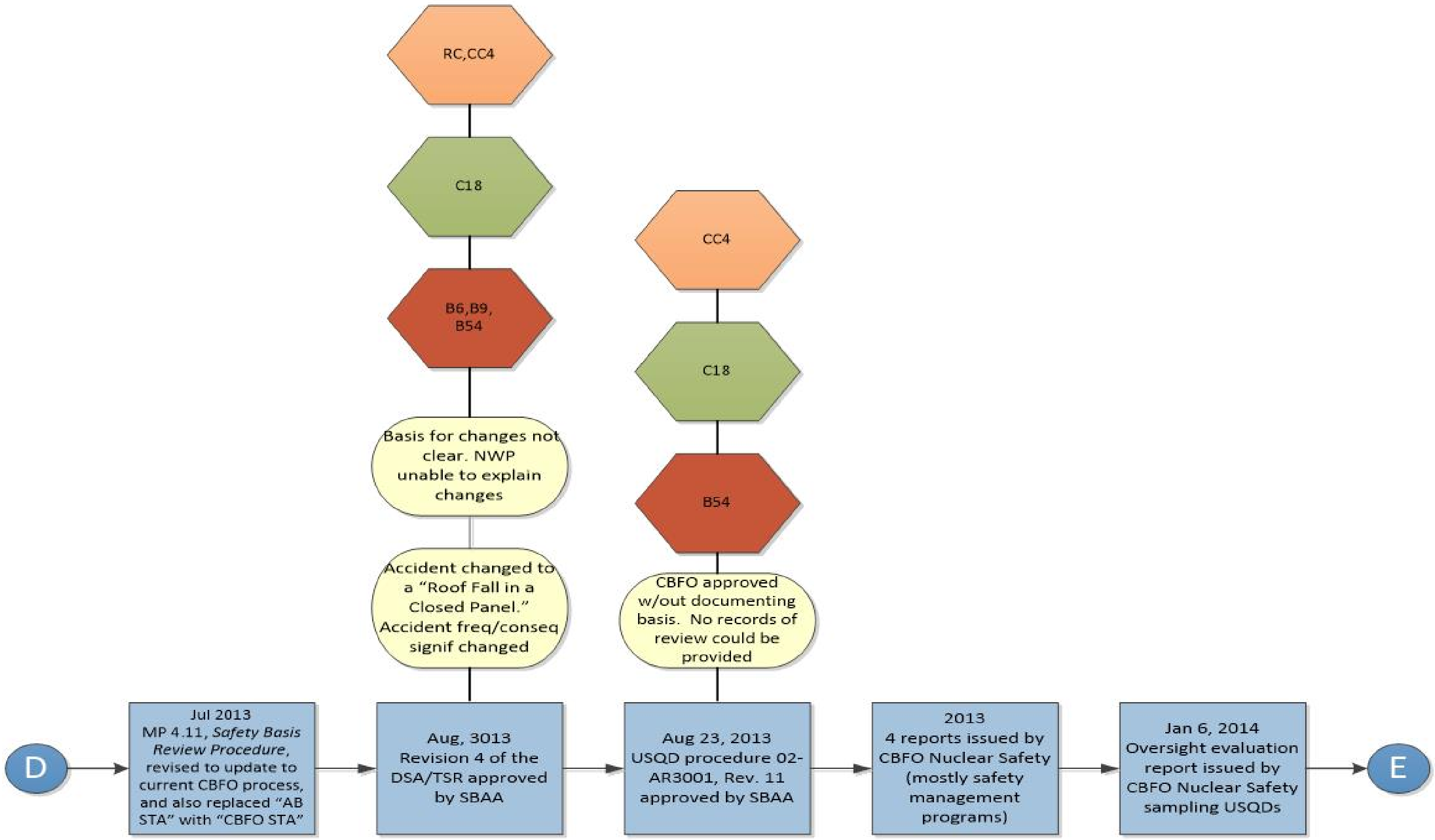
Nuclear Safety Program Events and Causal Factors



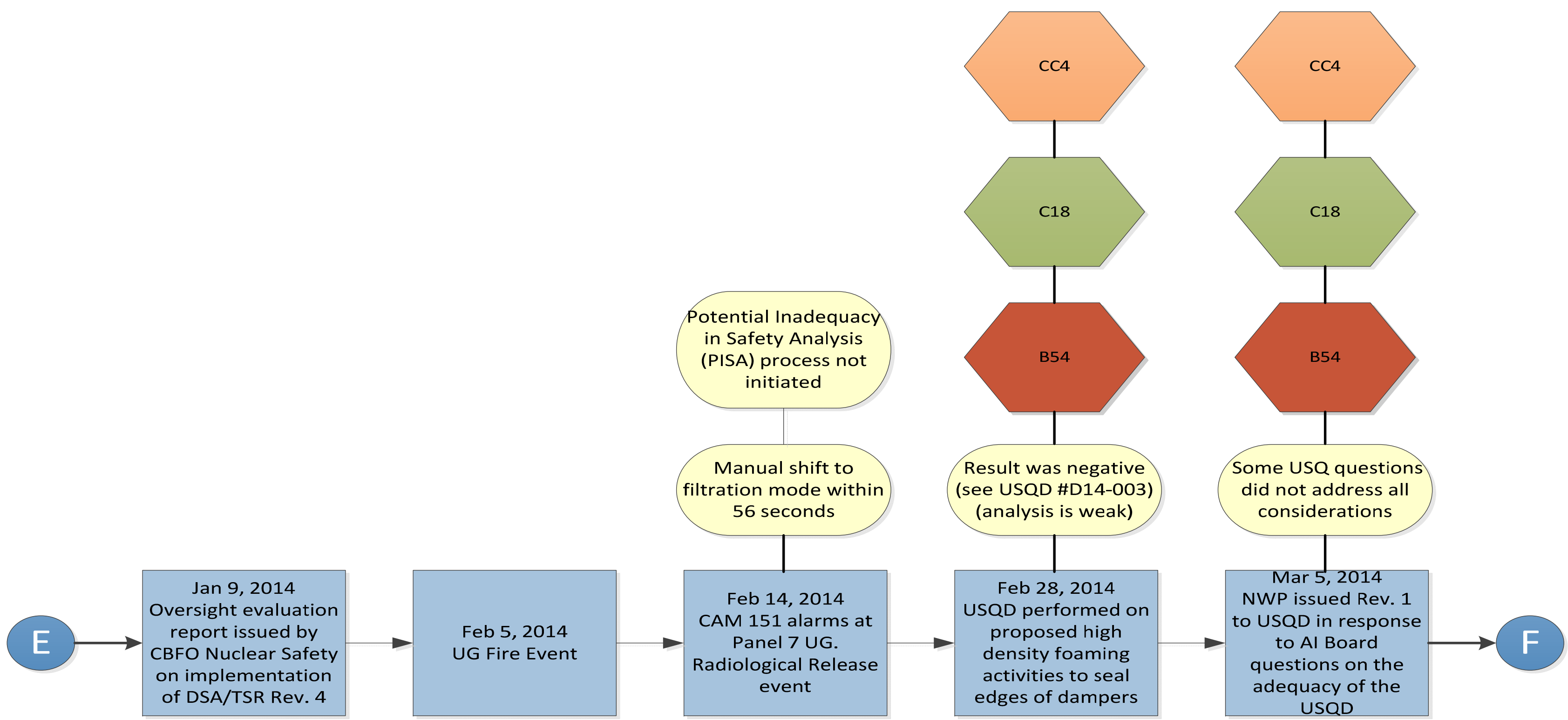
Nuclear Safety Program Events and Causal Factors



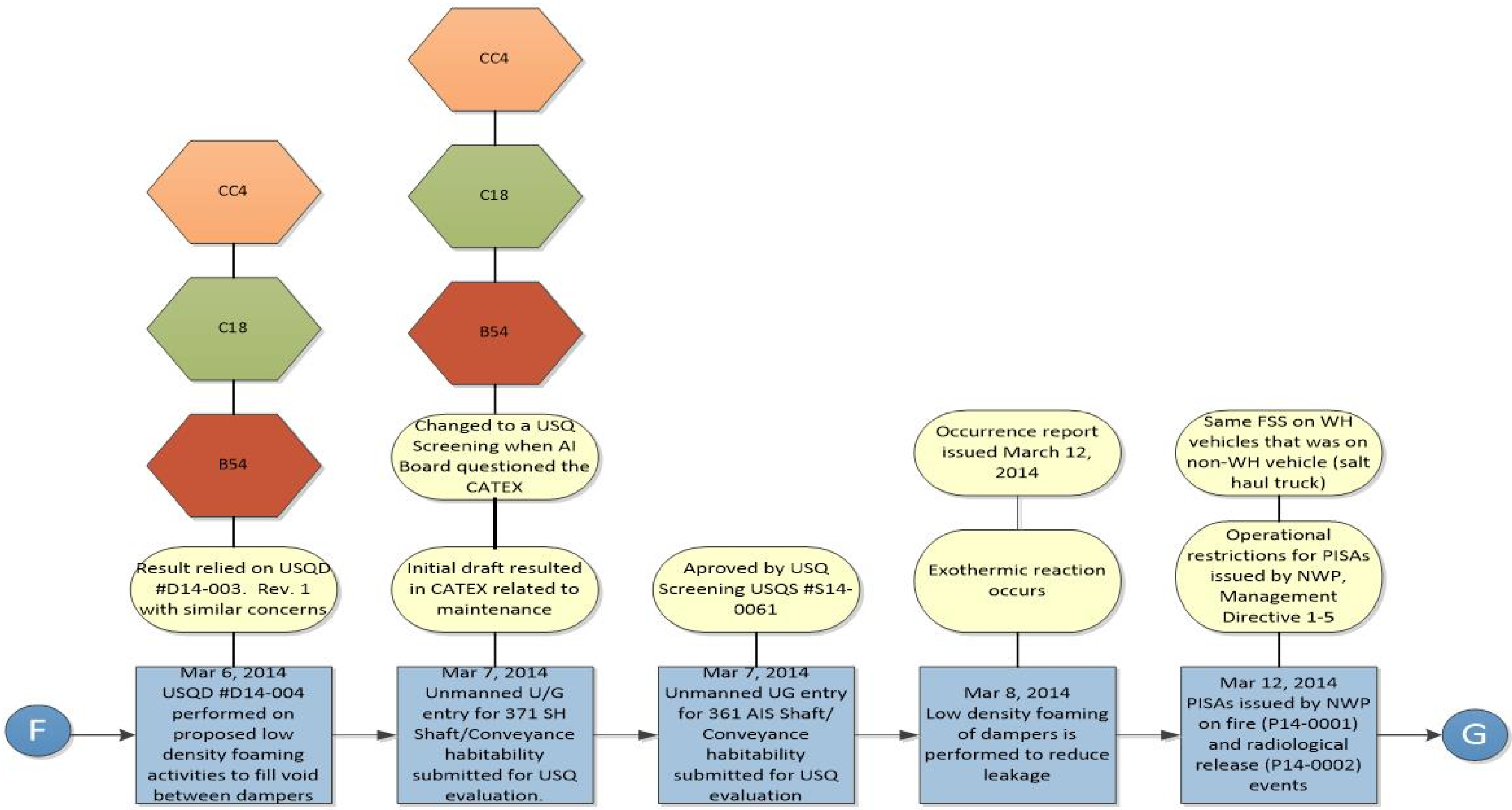
Nuclear Safety Program Events and Causal Factors



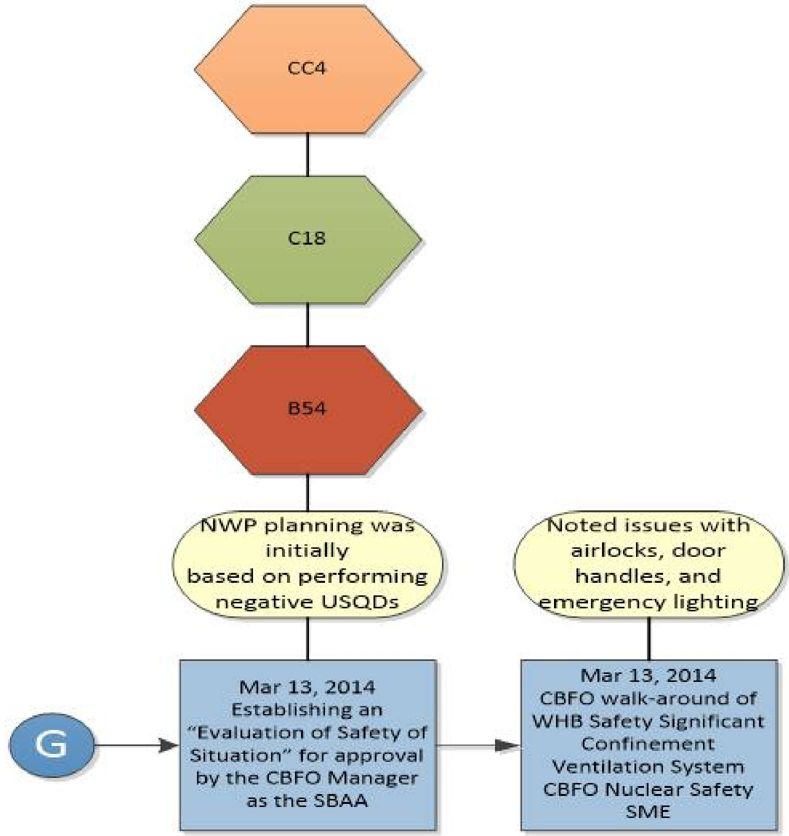
Nuclear Safety Program Events and Causal Factors



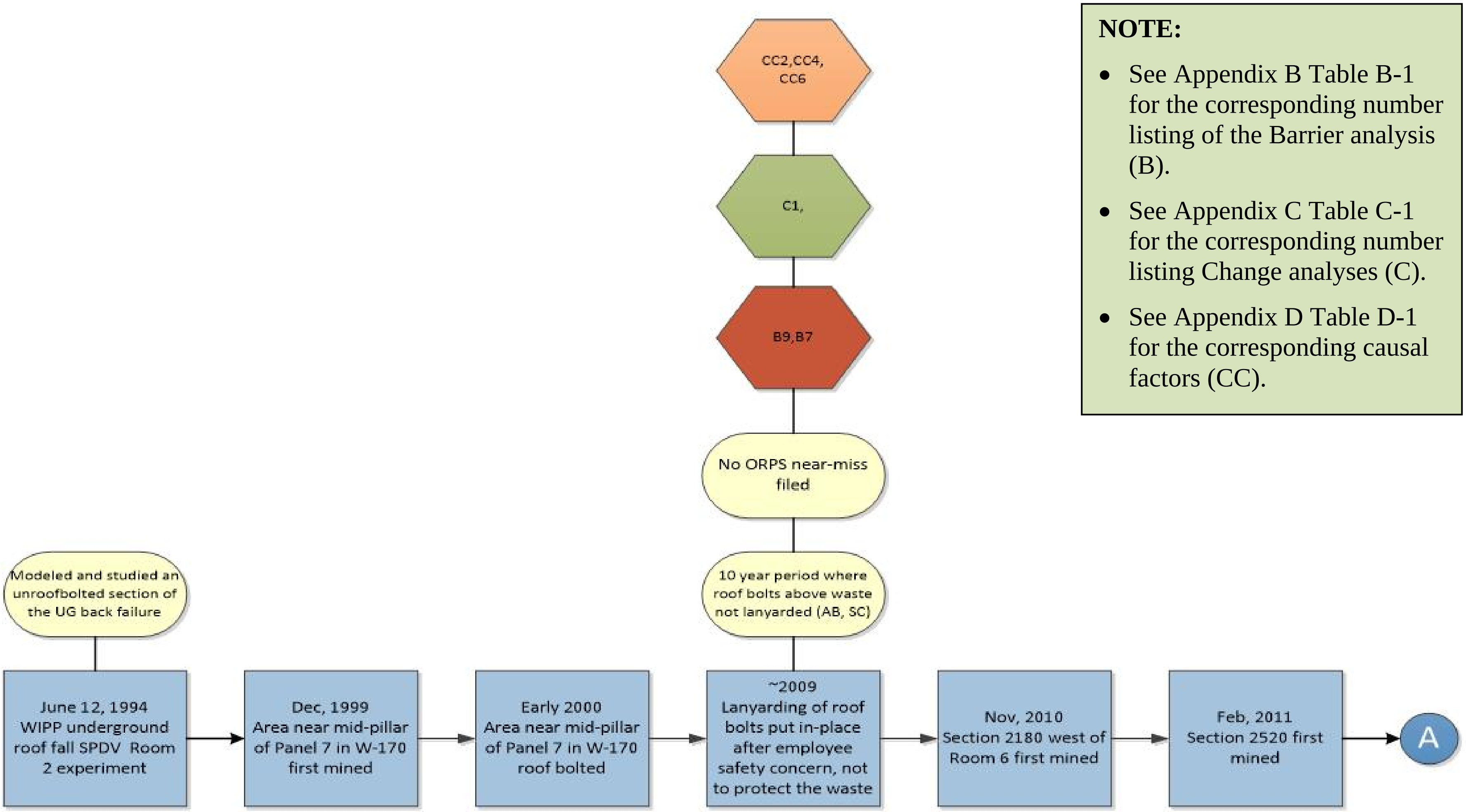
Nuclear Safety Program Events and Causal Factors



Nuclear Safety Program Events and Causal Factors\



Ground Control Program Events and Causal Factors



NOTE:

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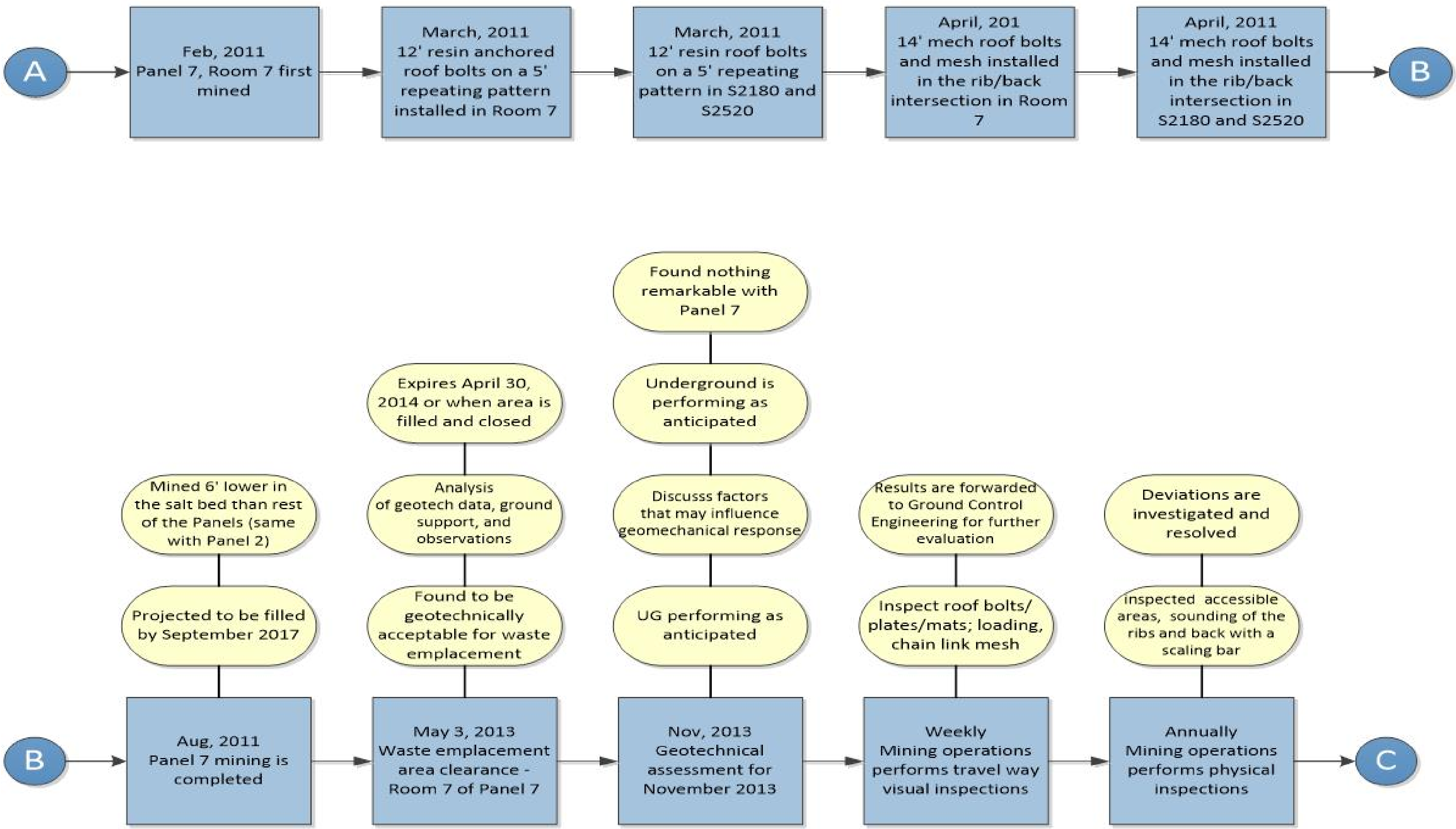
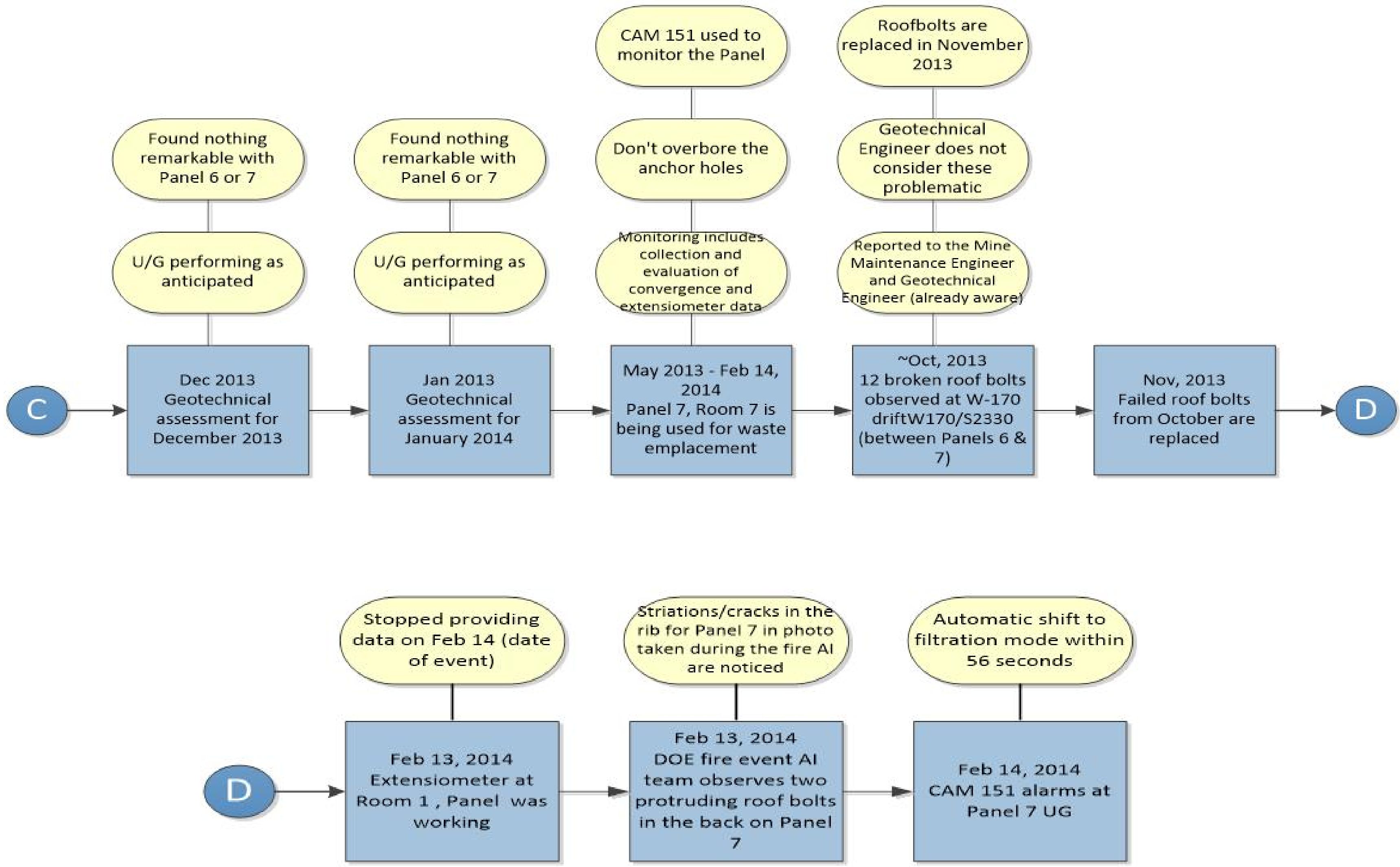
Ground Control Program Events and Causal Factors



Ground Control Program Events and Causal Factors



NOTE:

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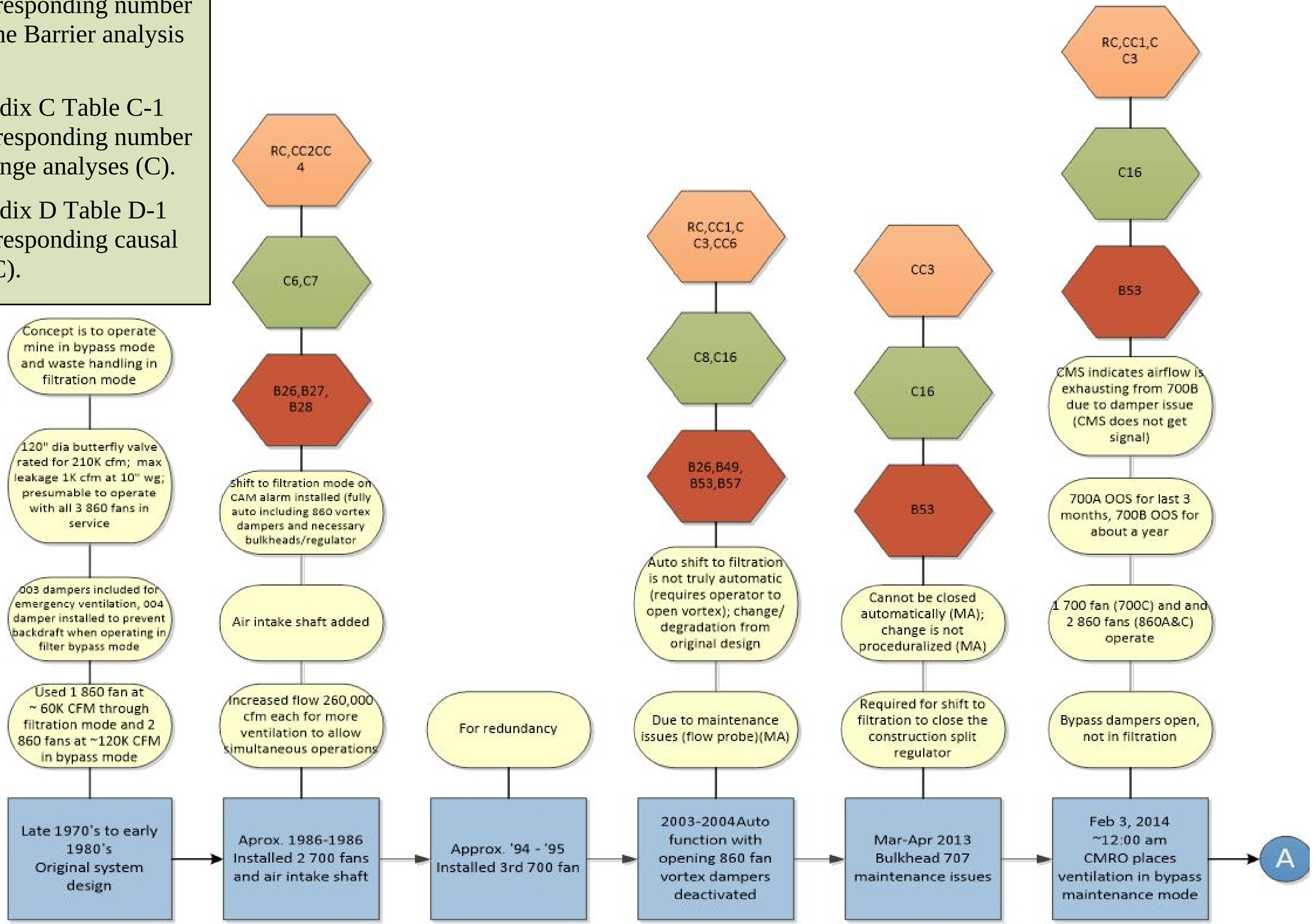
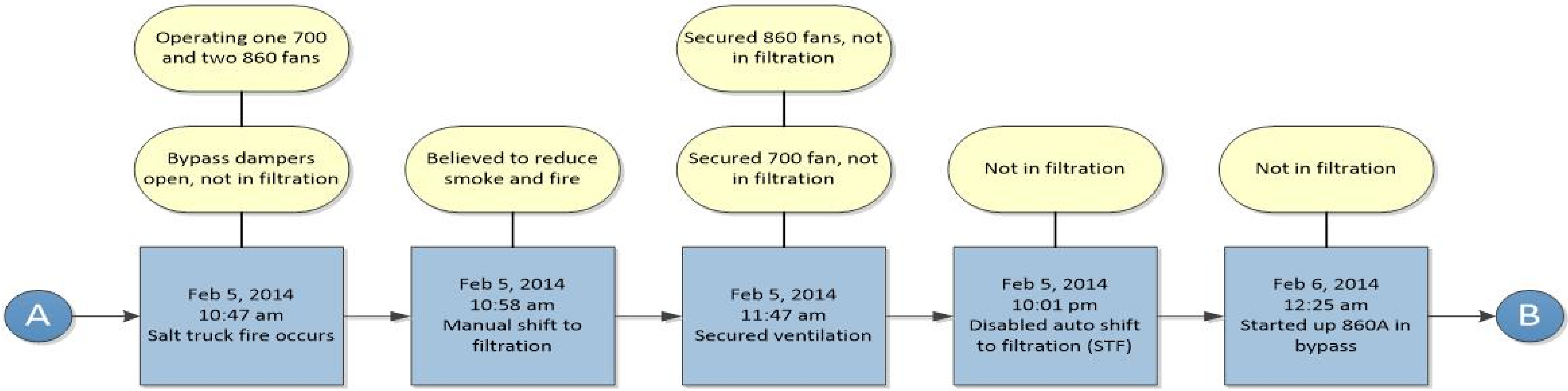
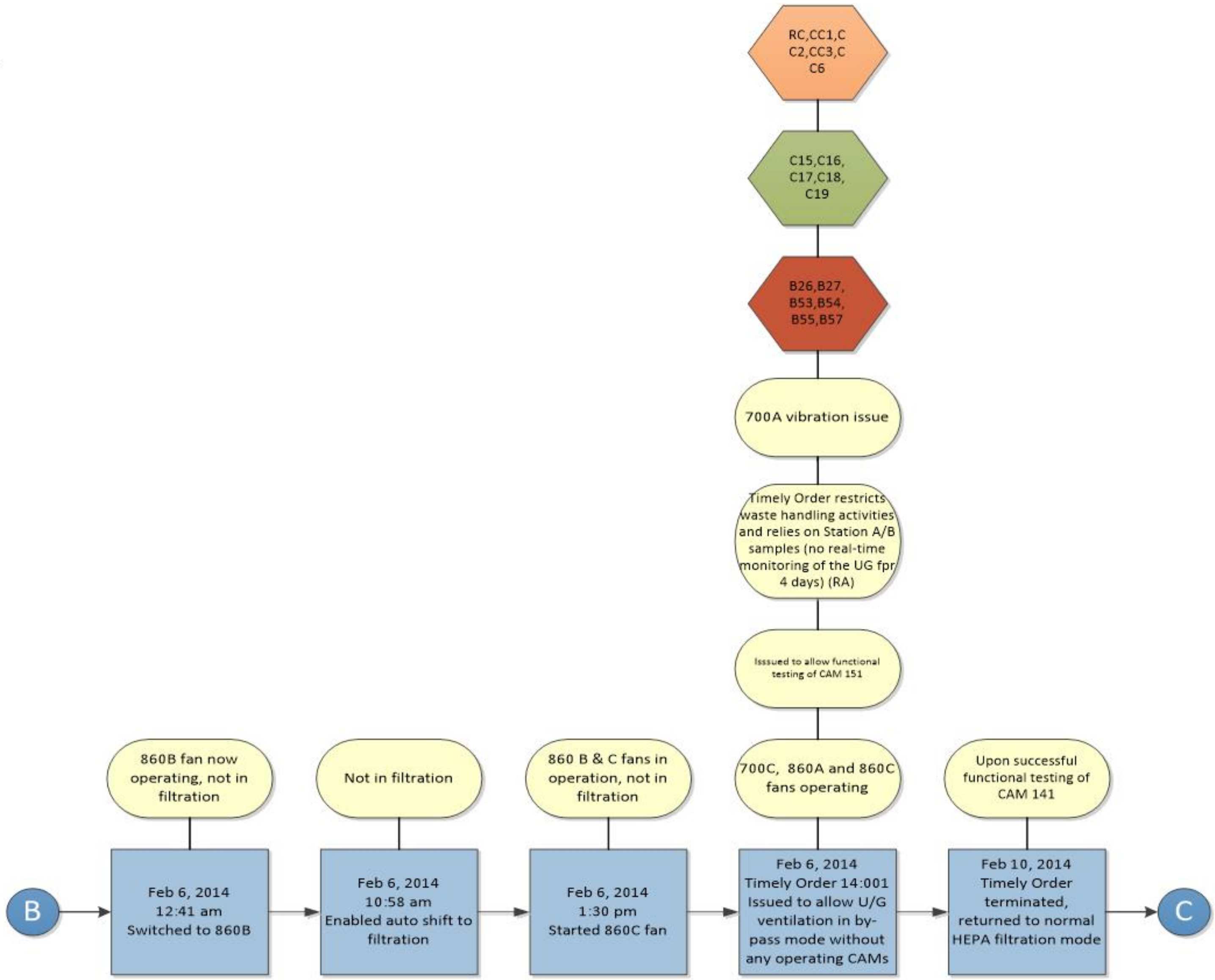
Ventilation System Events and Causal Factors



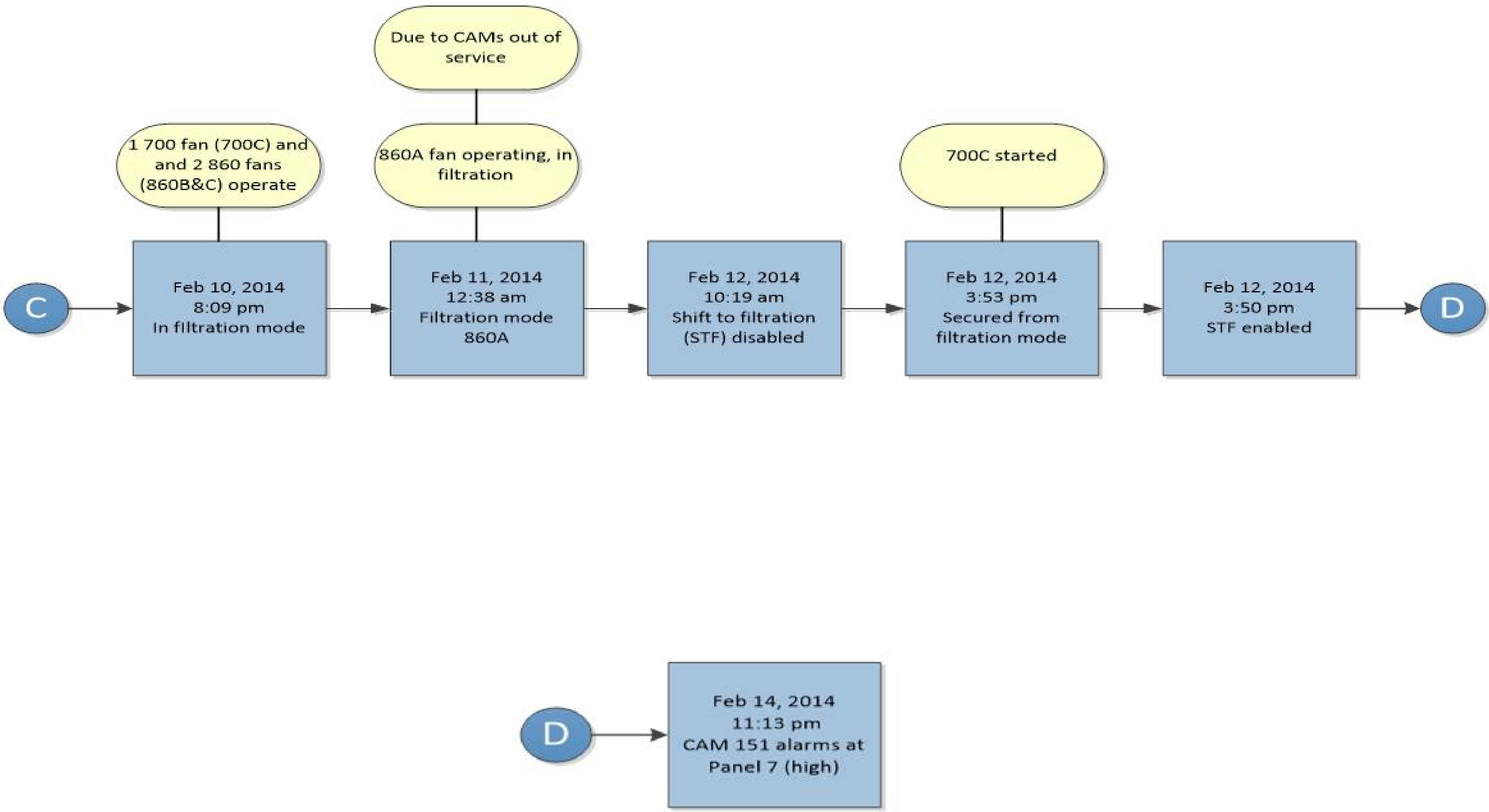
Ventilation System Events and Causal Factors



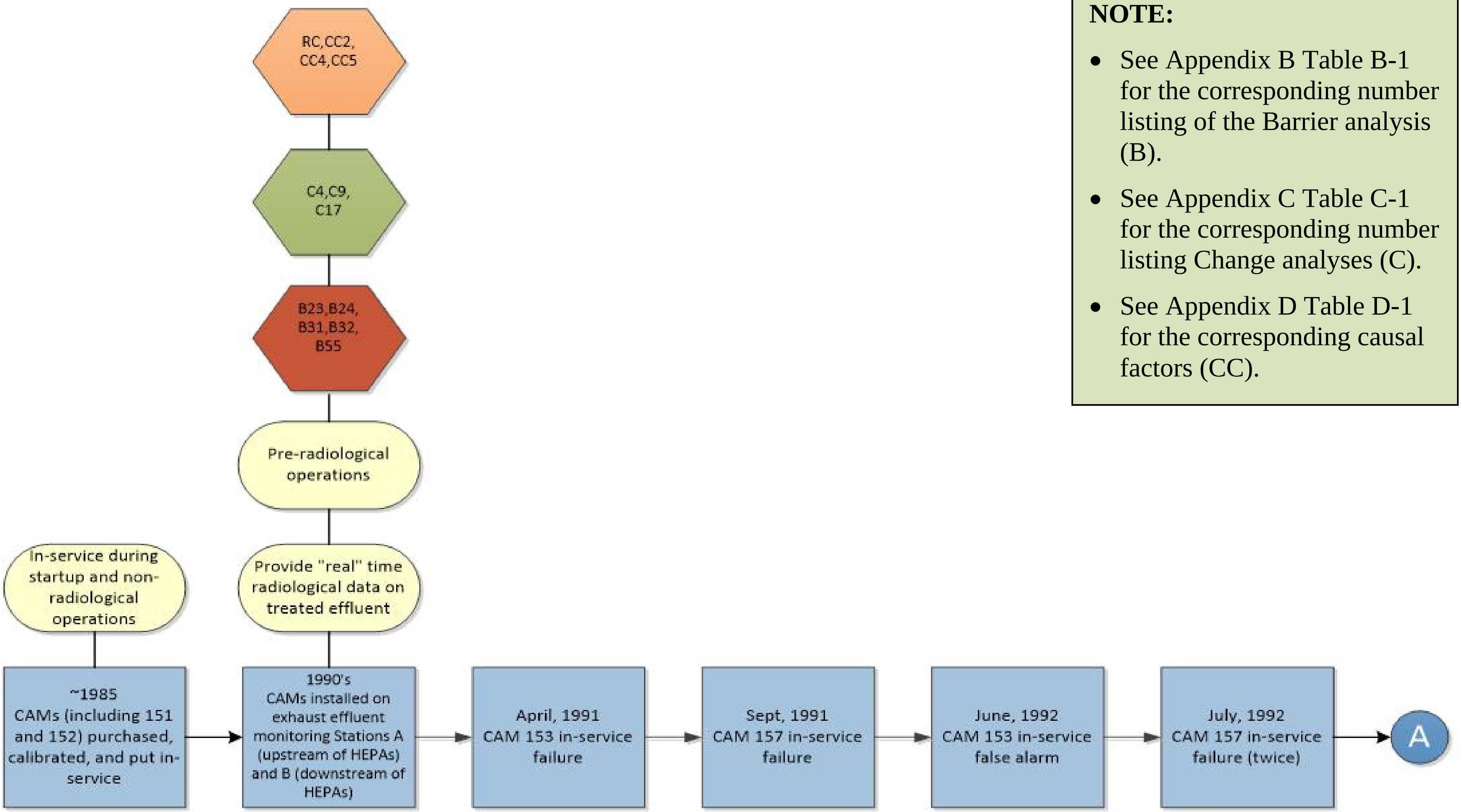
Ventilation System Events and Causal Factors



Ventilation System Events and Causal Factors



Continuous Air Monitor (CAM) Events and Causal Factors



NOTE:

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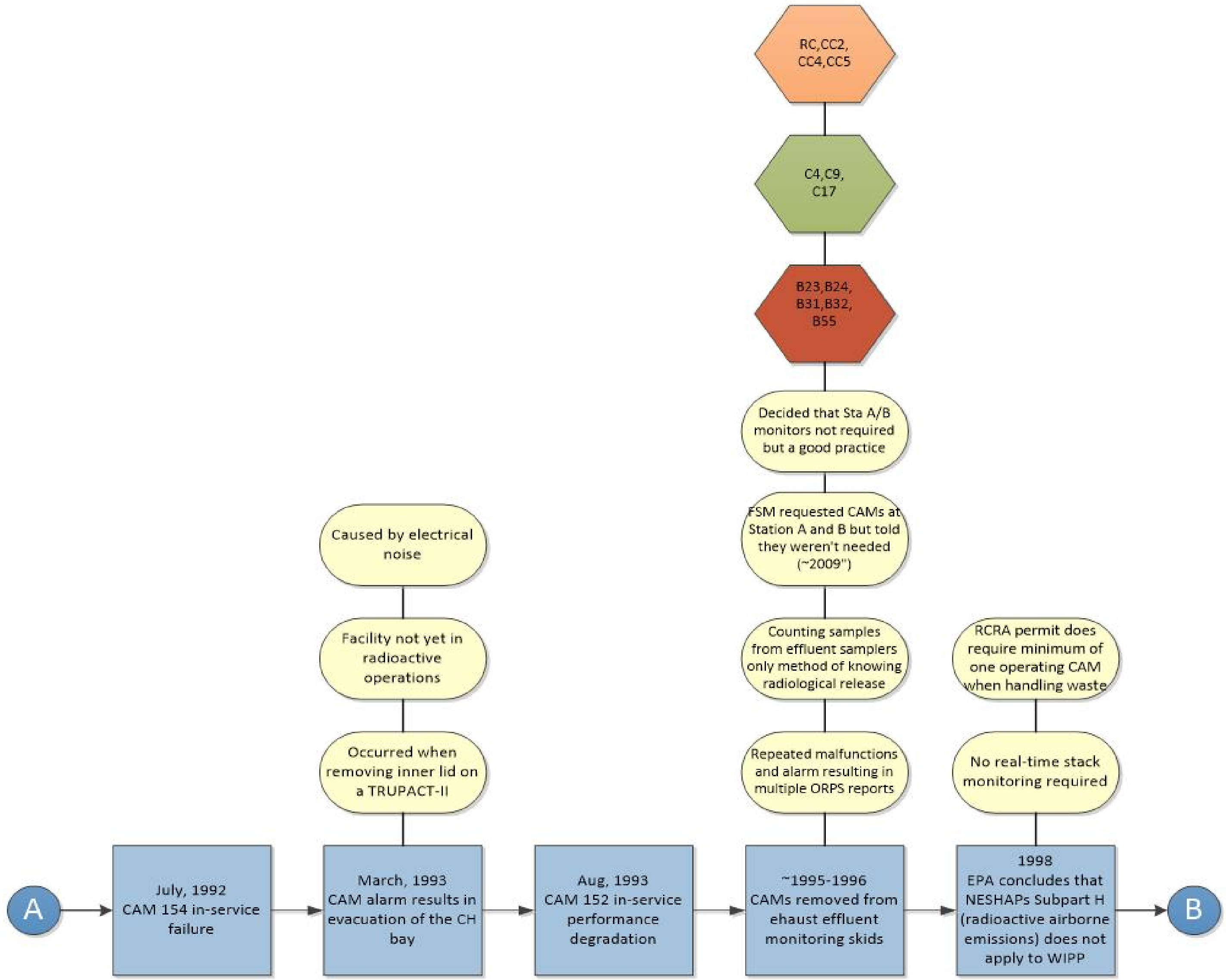
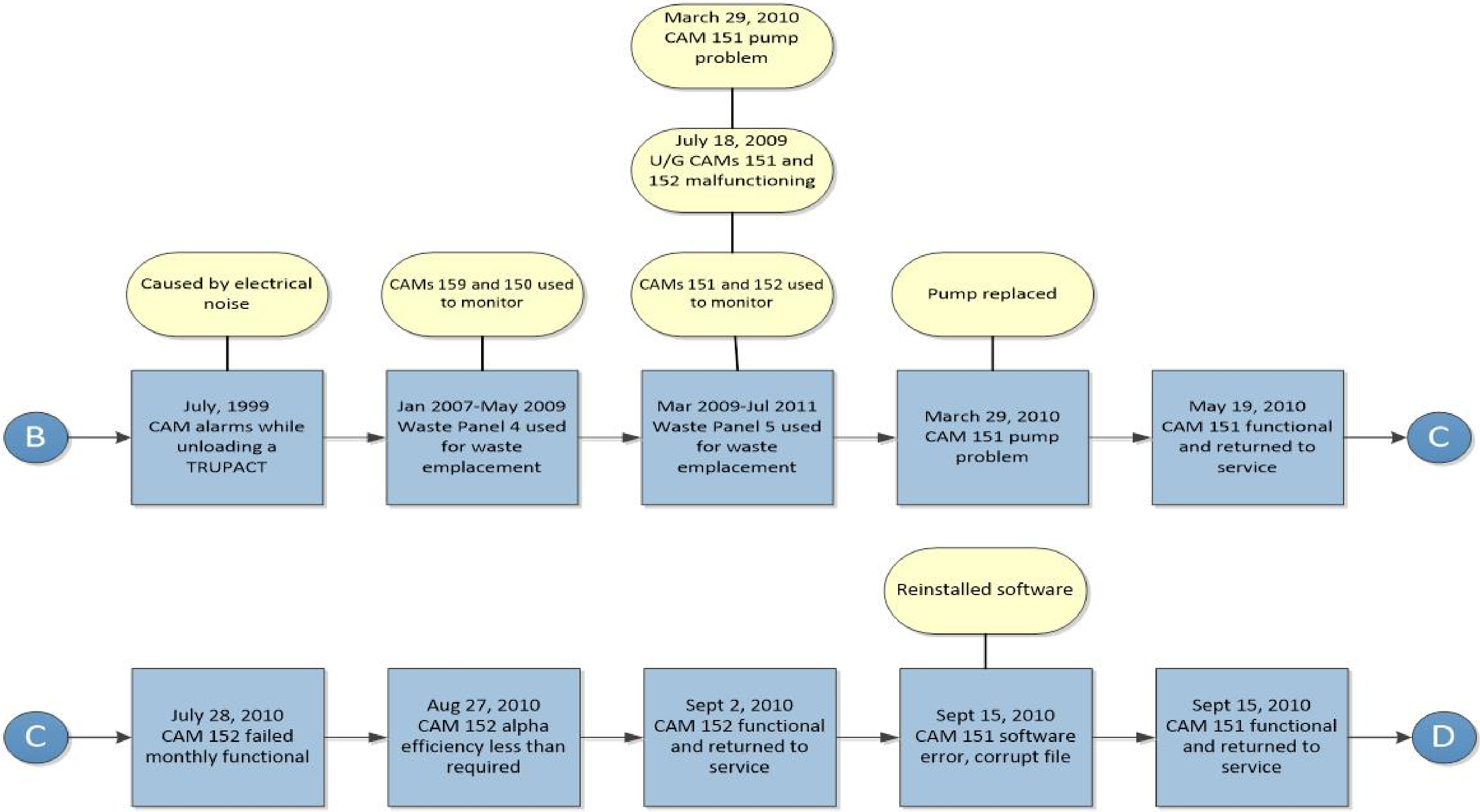
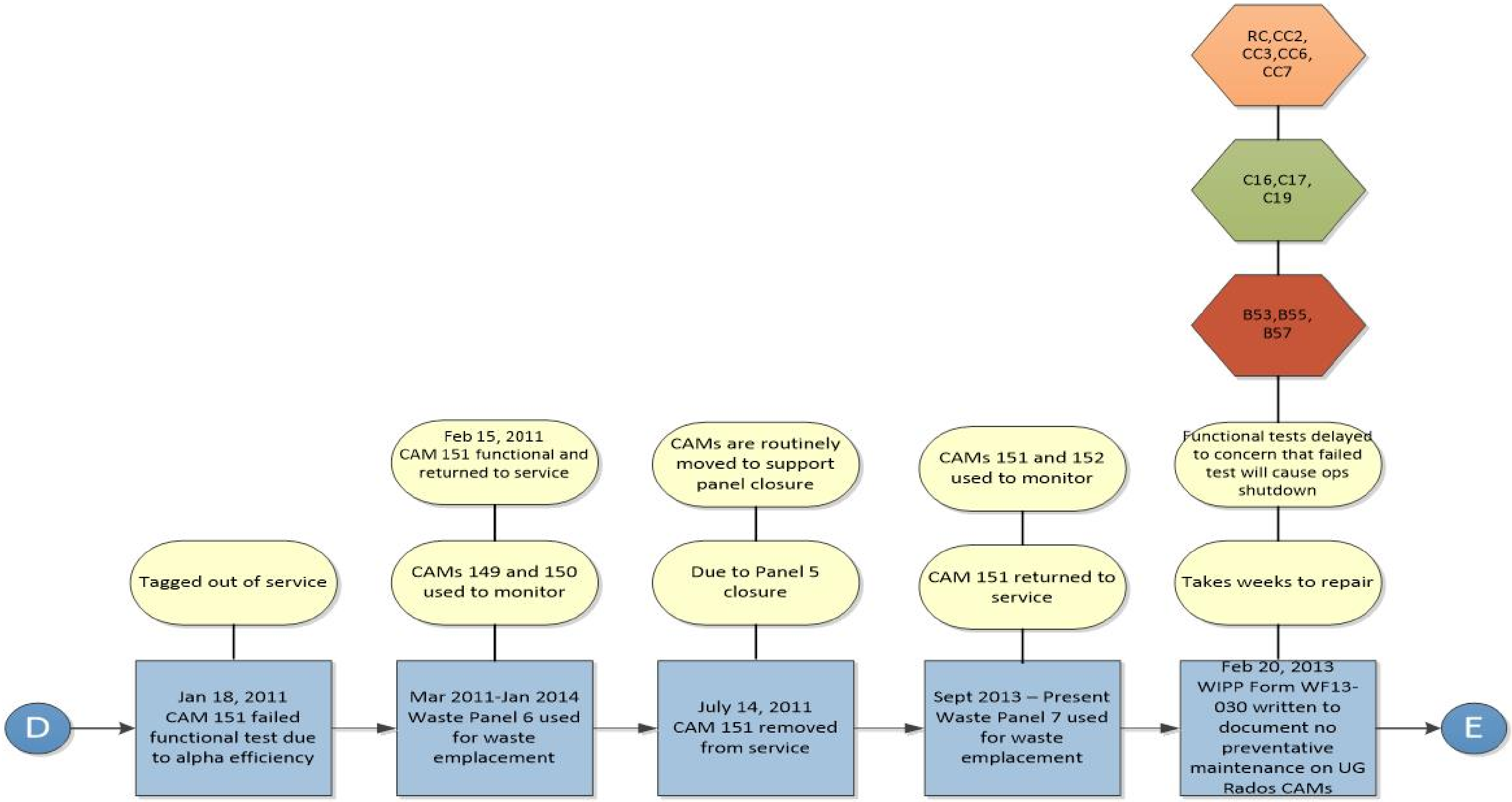
Continuous Air Monitor (CAM) Events and Causal Factors



Continuous Air Monitor (CAM) Events and Causal Factors



Continuous Air Monitor (CAM) Events and Causal Factors



Continuous Air Monitor (CAM) Events and Causal Factors

NOTE:

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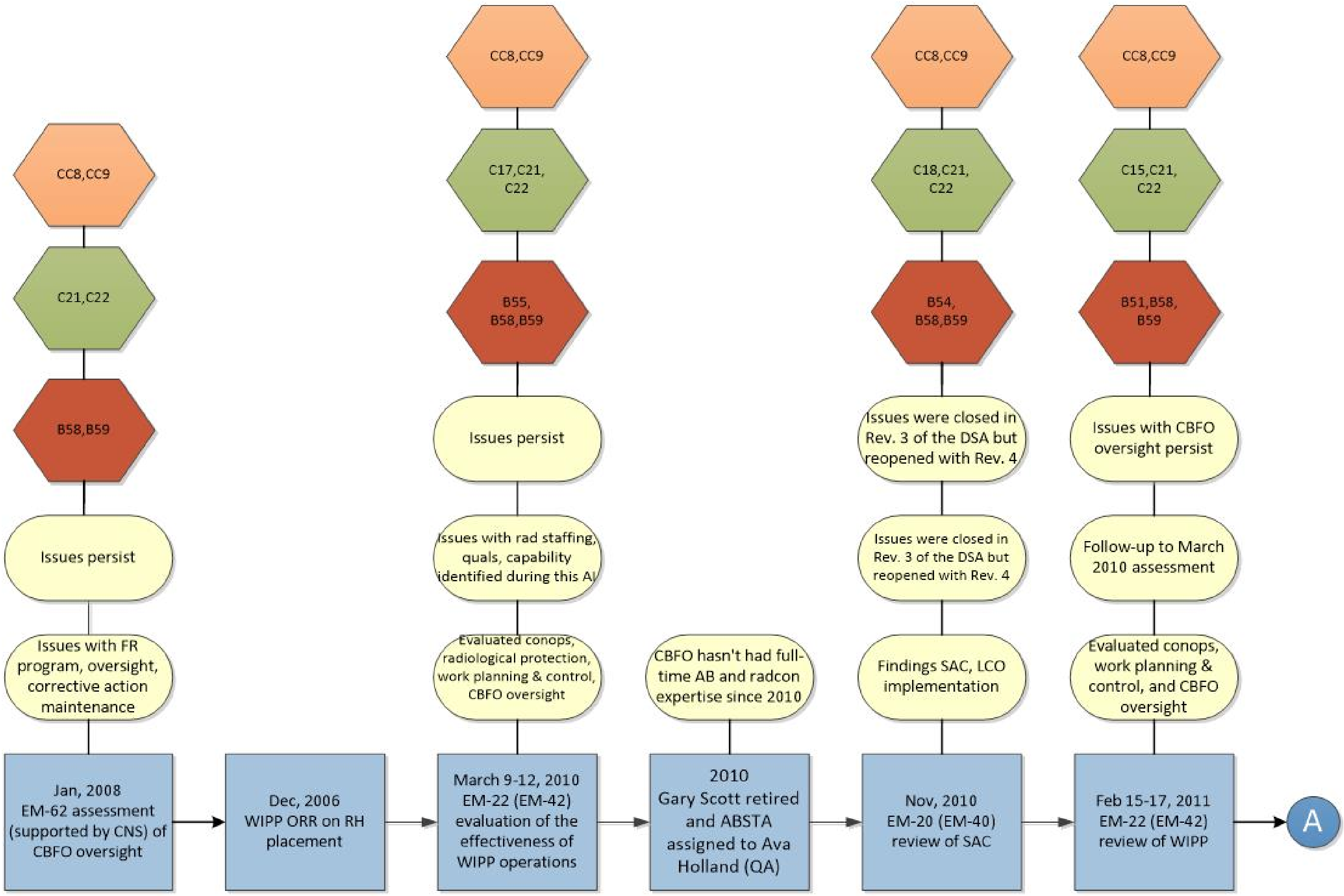
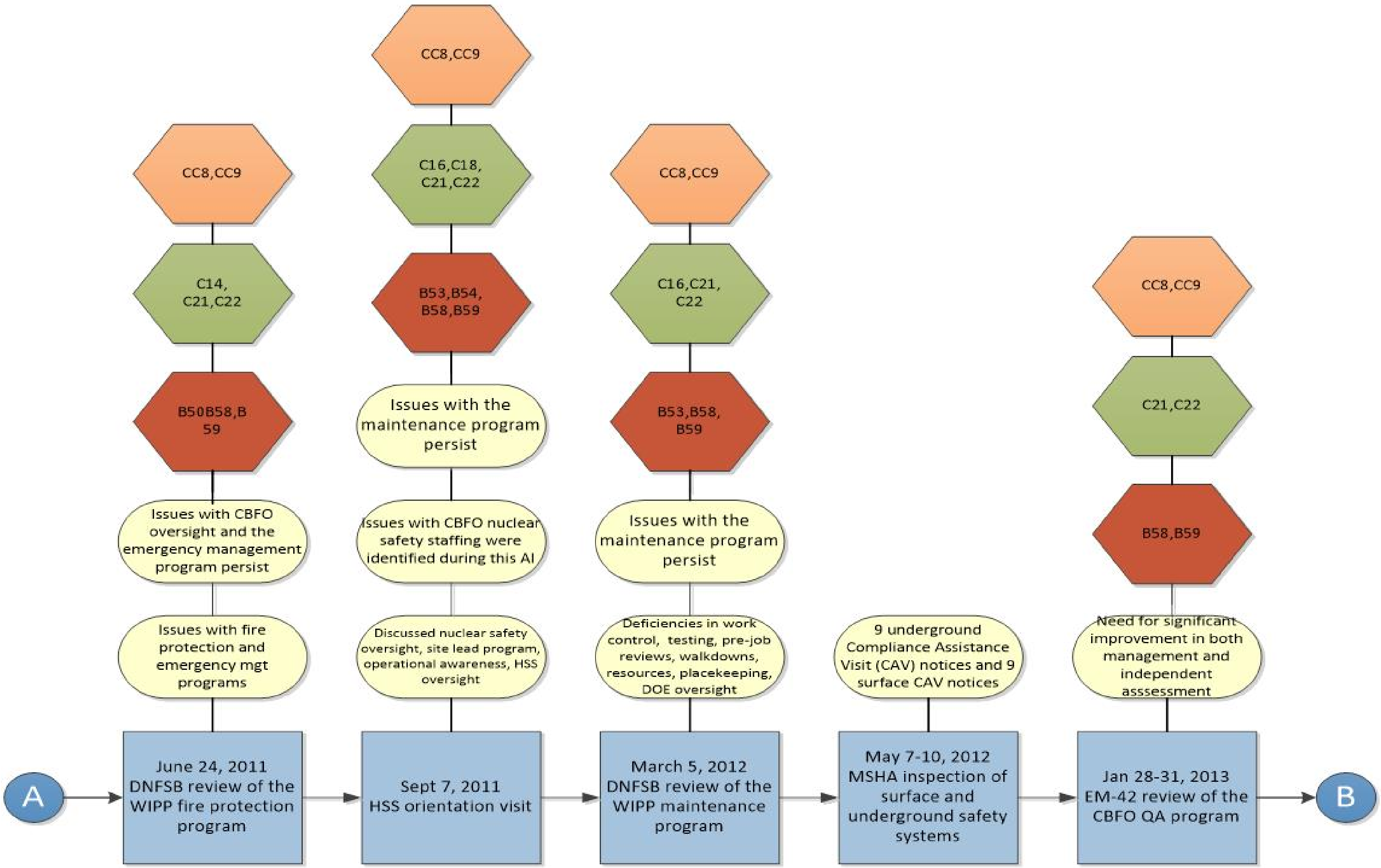
- See Appendix D Table D-1 for the corresponding causal factors (CC).

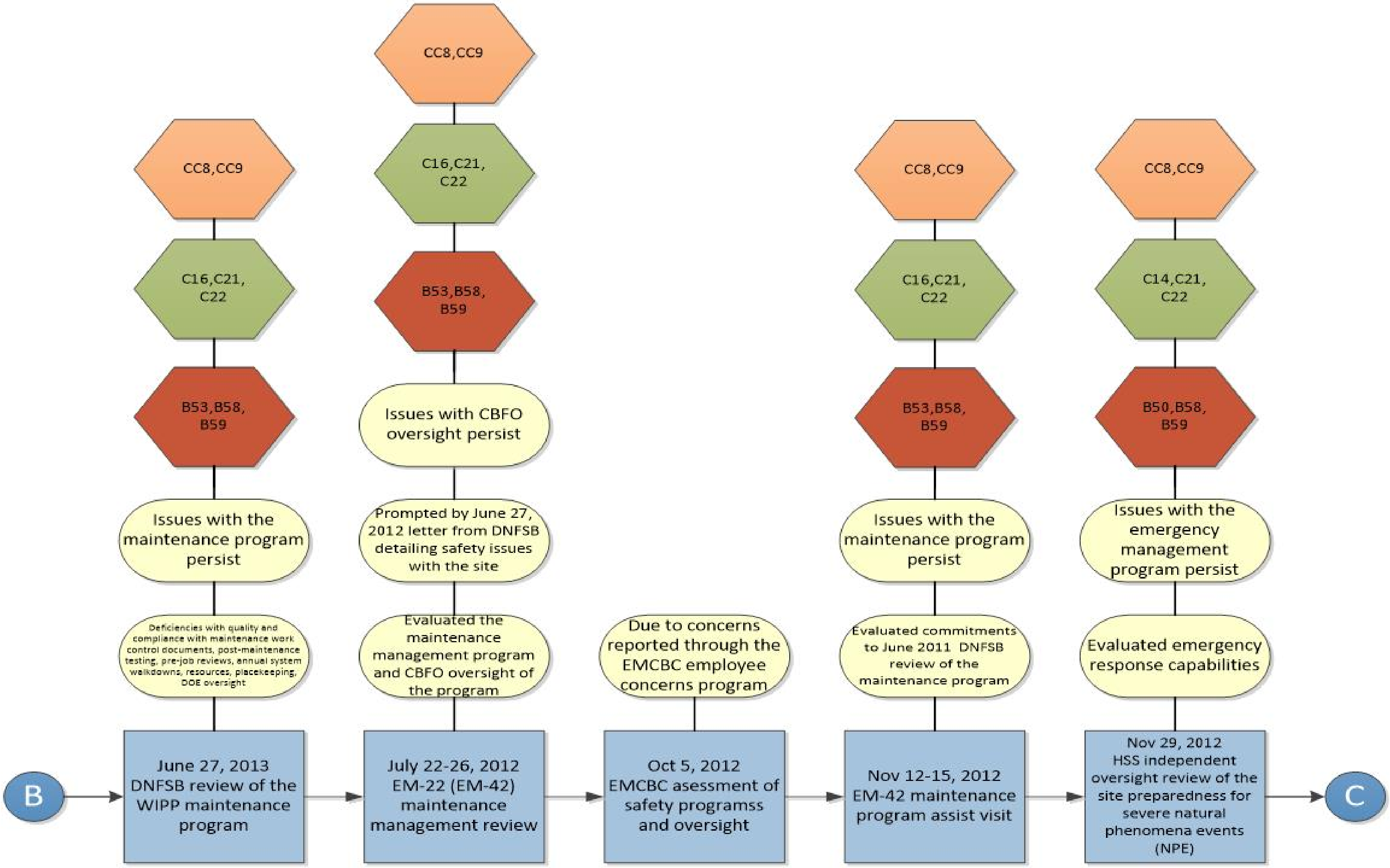
DOE Headquarters Events and Causal Factors



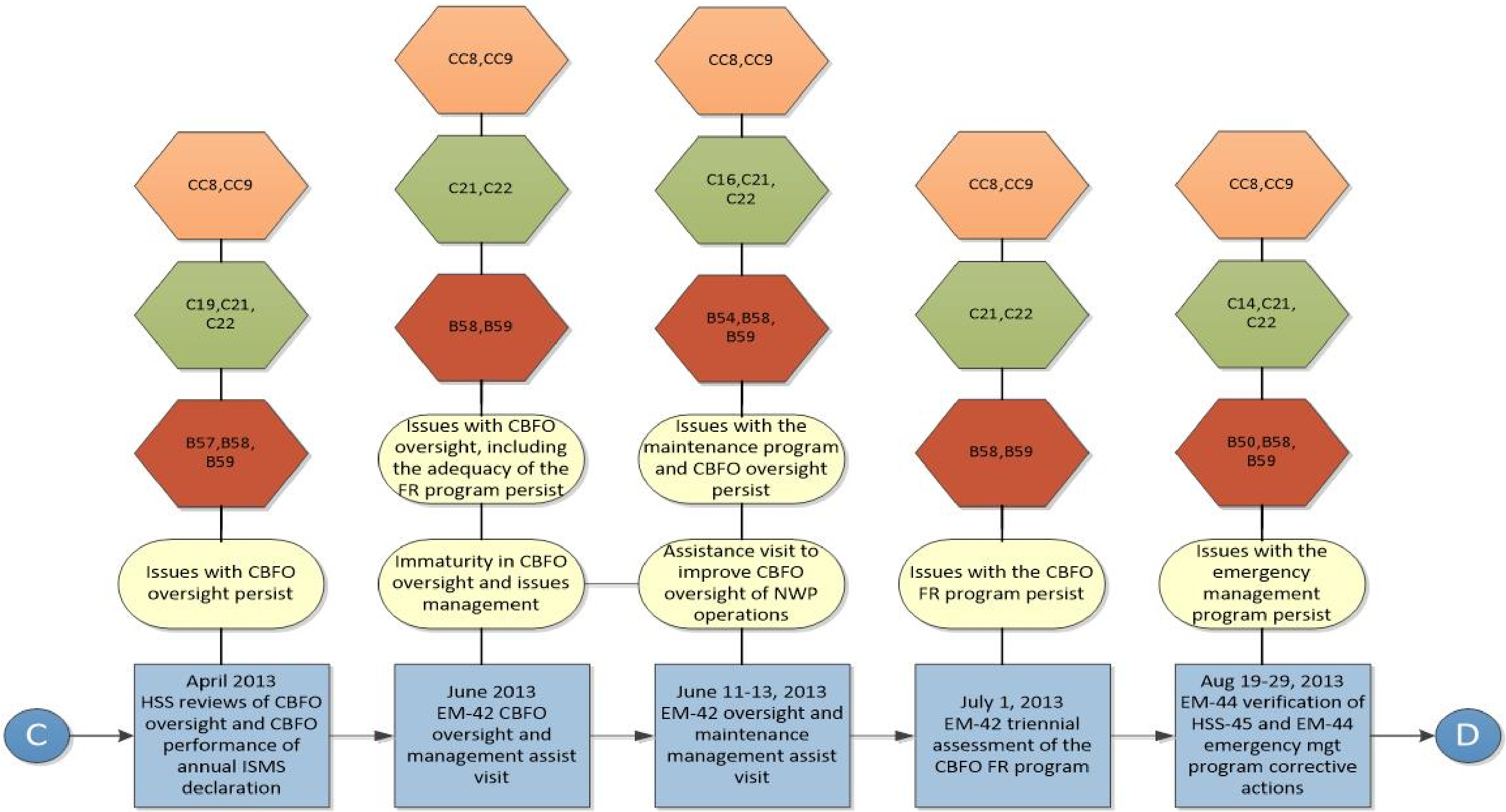
DOE Headquarters Events and Causal Factors



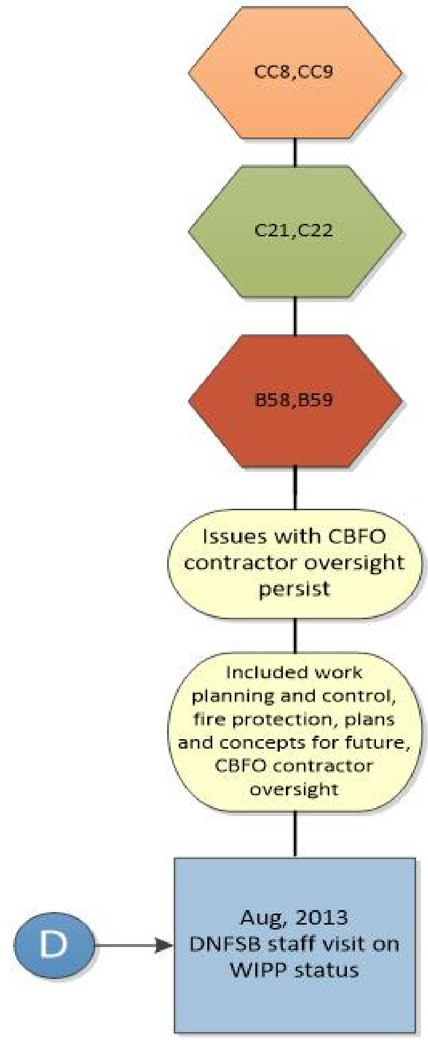
DOE Headquarters Events and Causal Factors



DOE Headquarters Events and Causal Factors



DOE Headquarters Events and Causal Factors



Radiological Event Primary Events and Causal Factors

NOTE:

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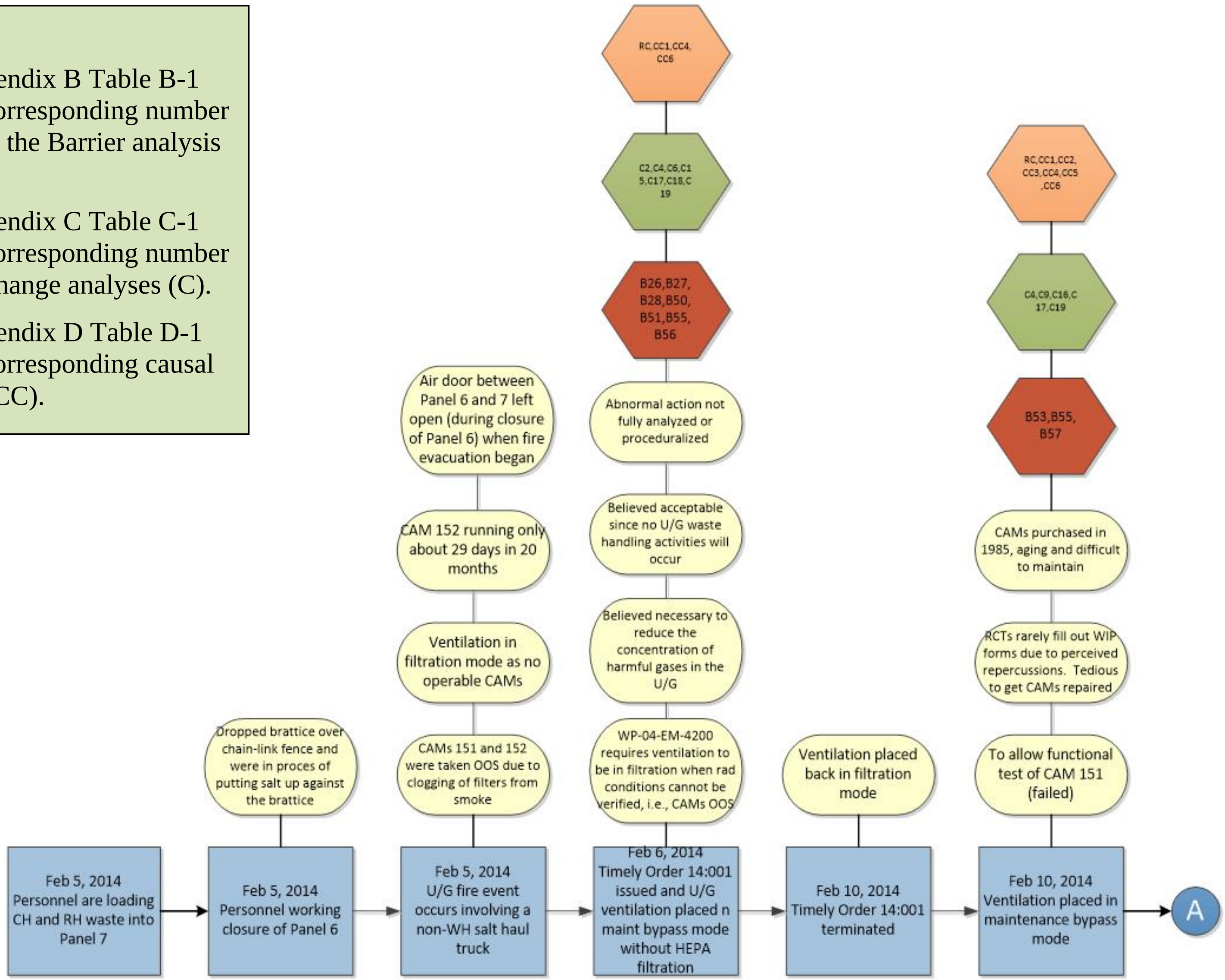
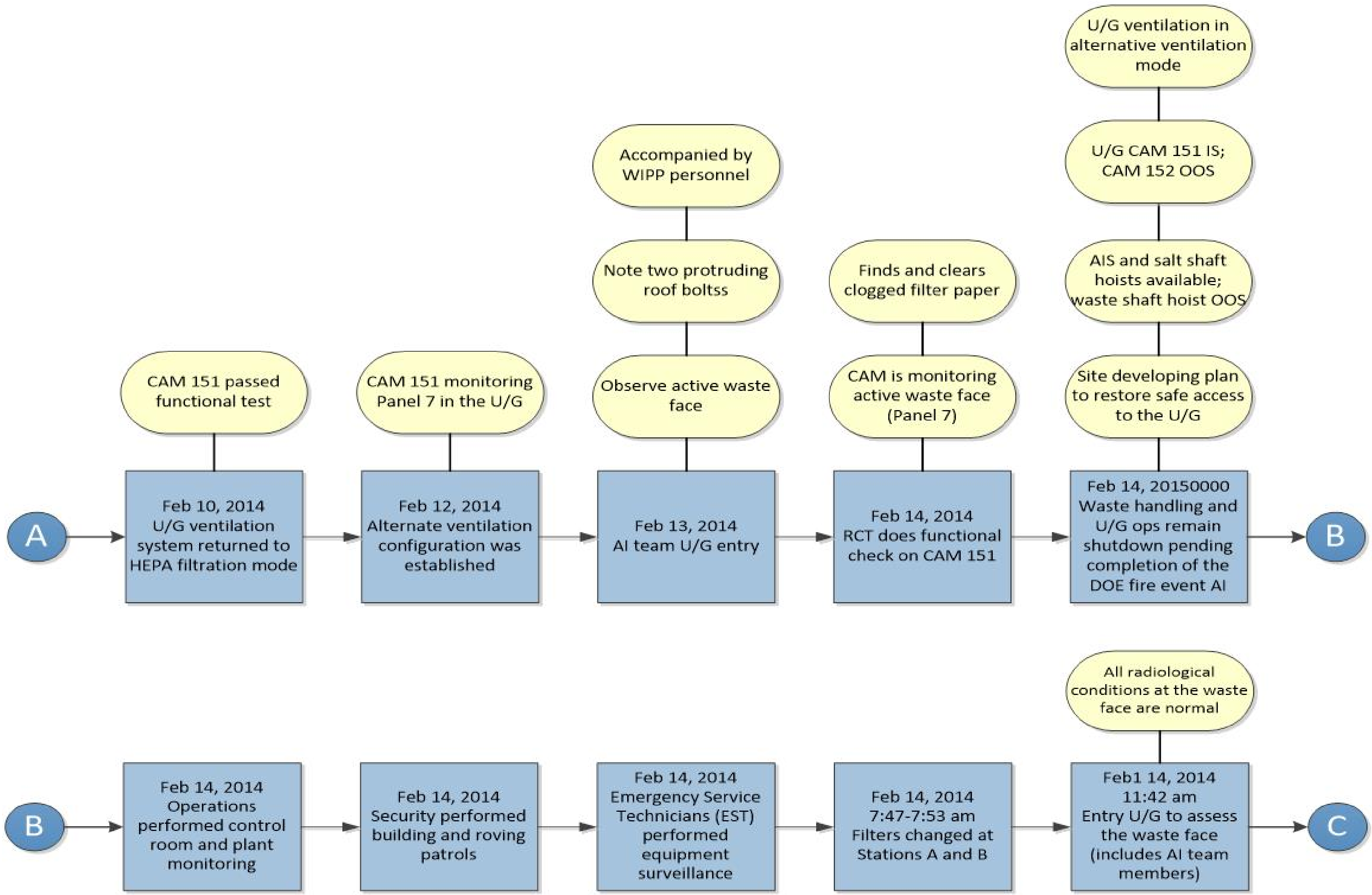
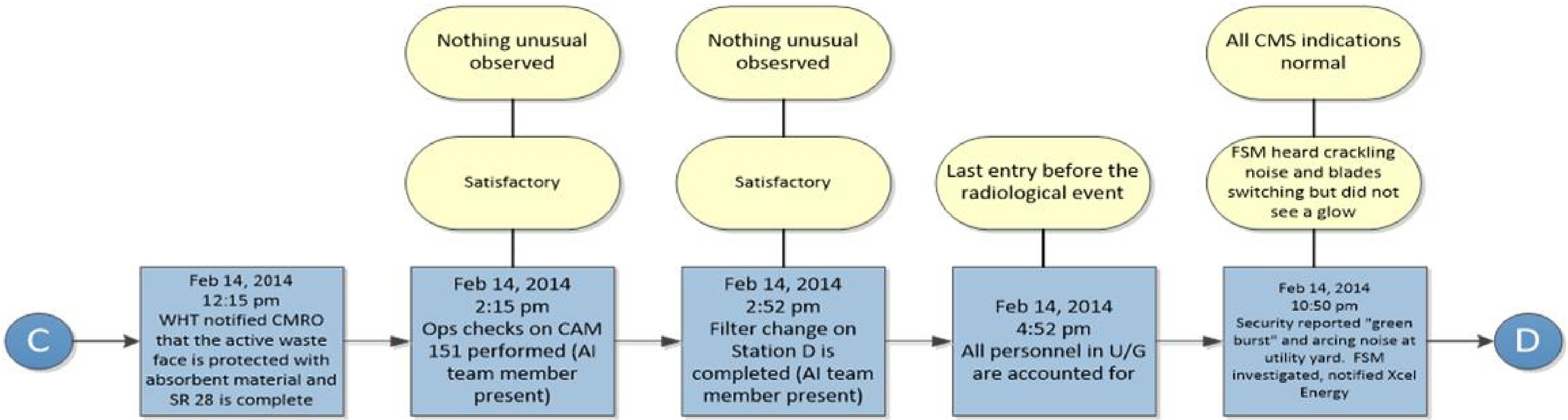
- See Appendix D Table D-1 for the corresponding causal factors (CC).



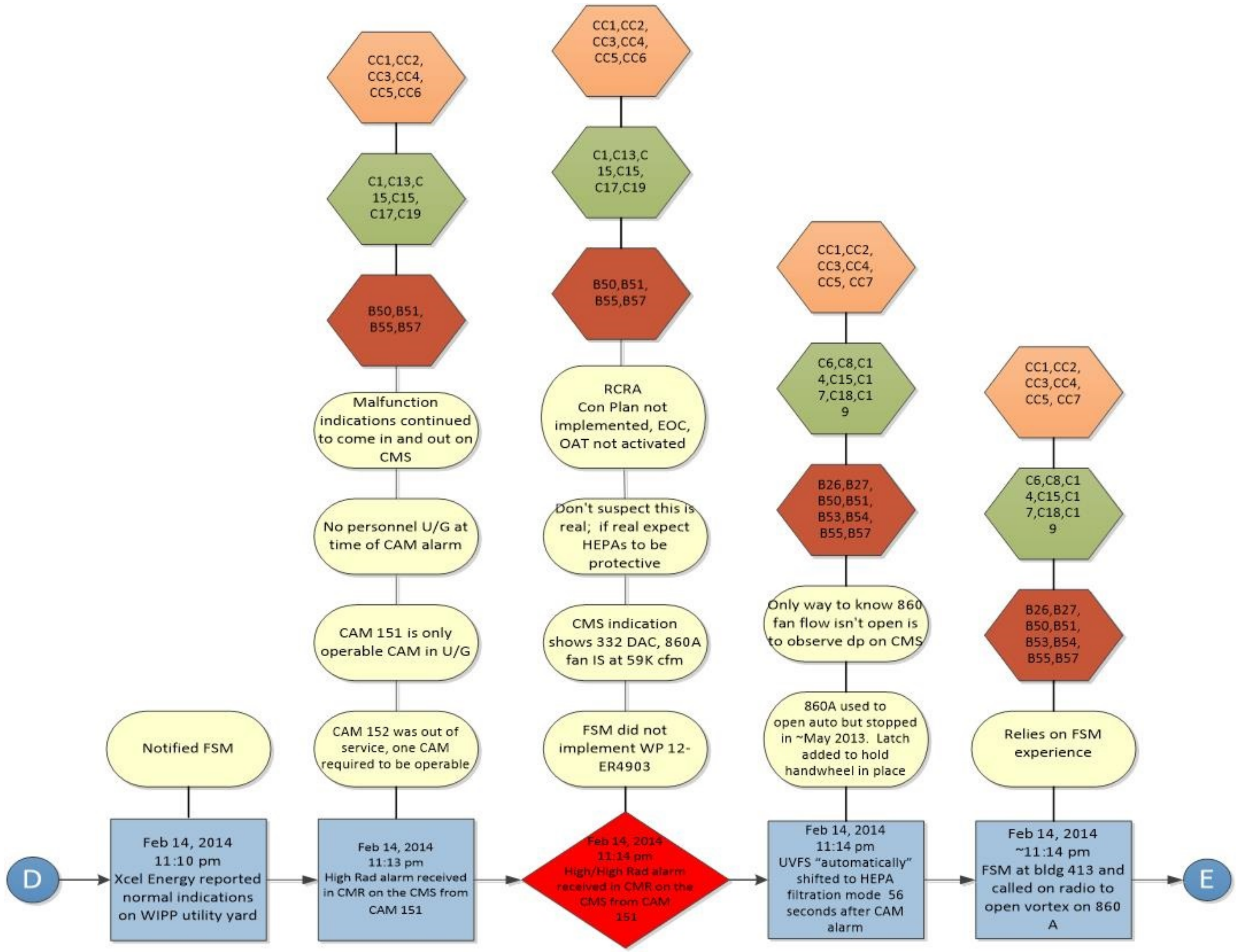
Radiological Event Primary Events and Causal Factors



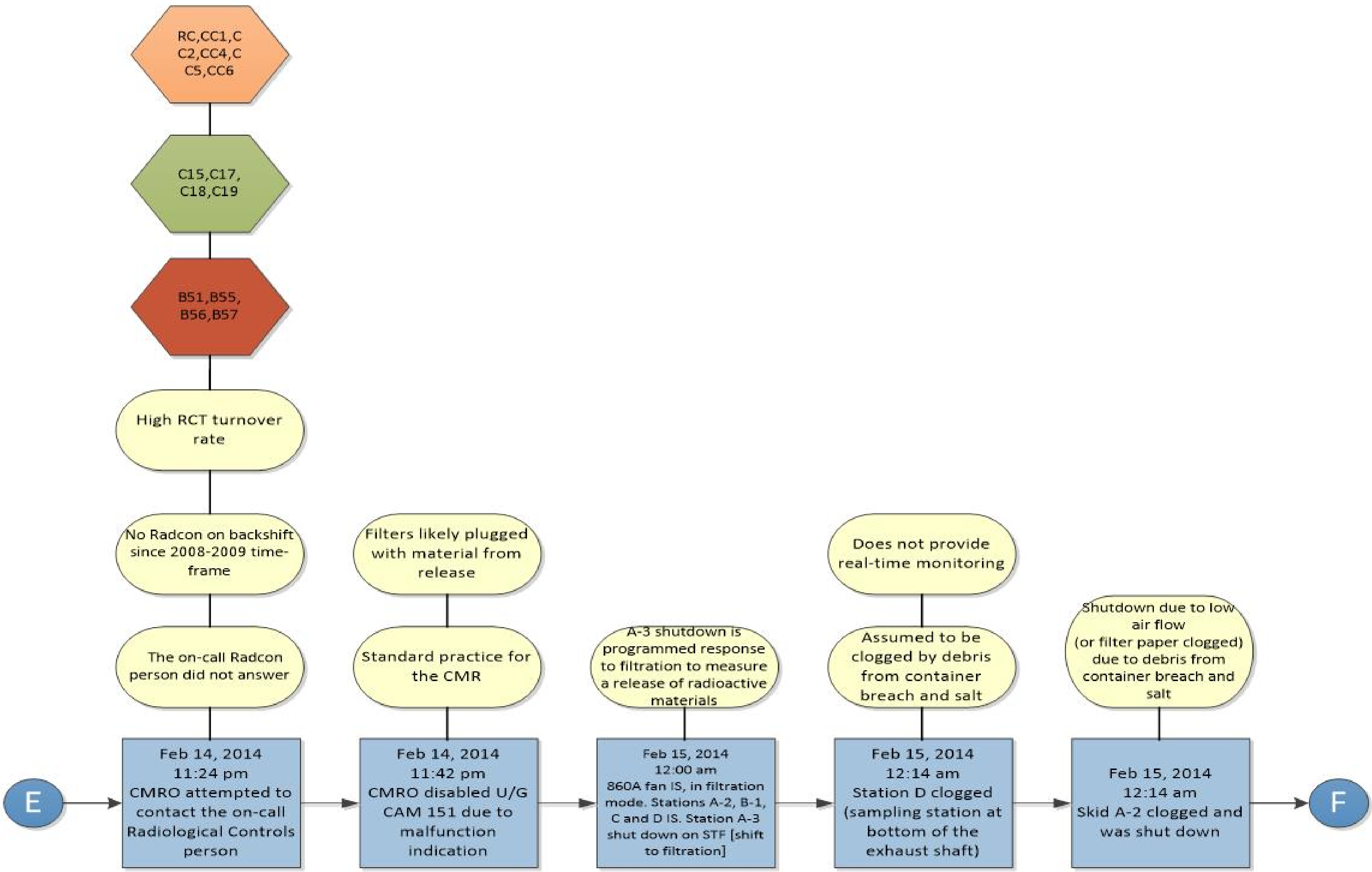
Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors



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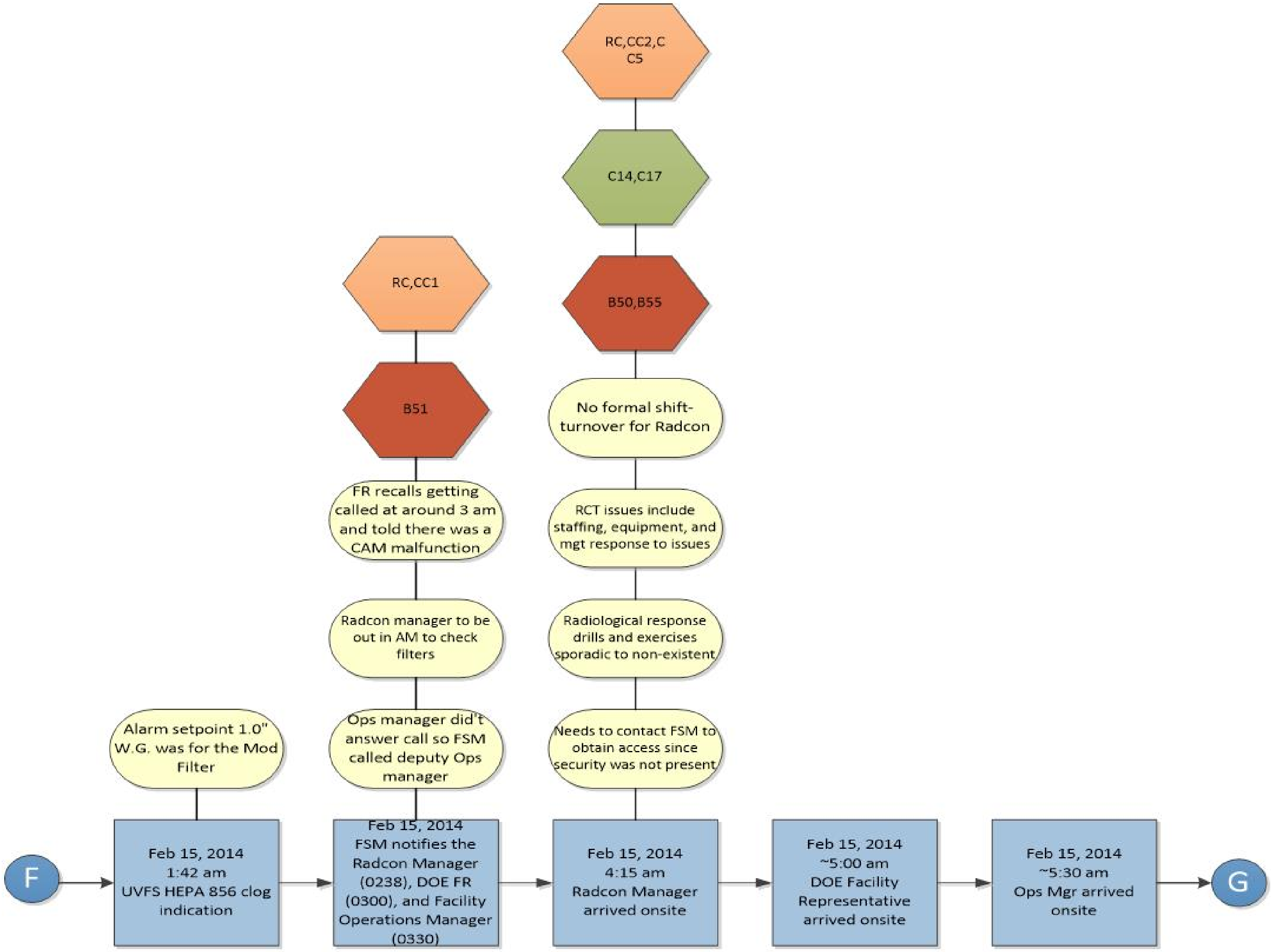
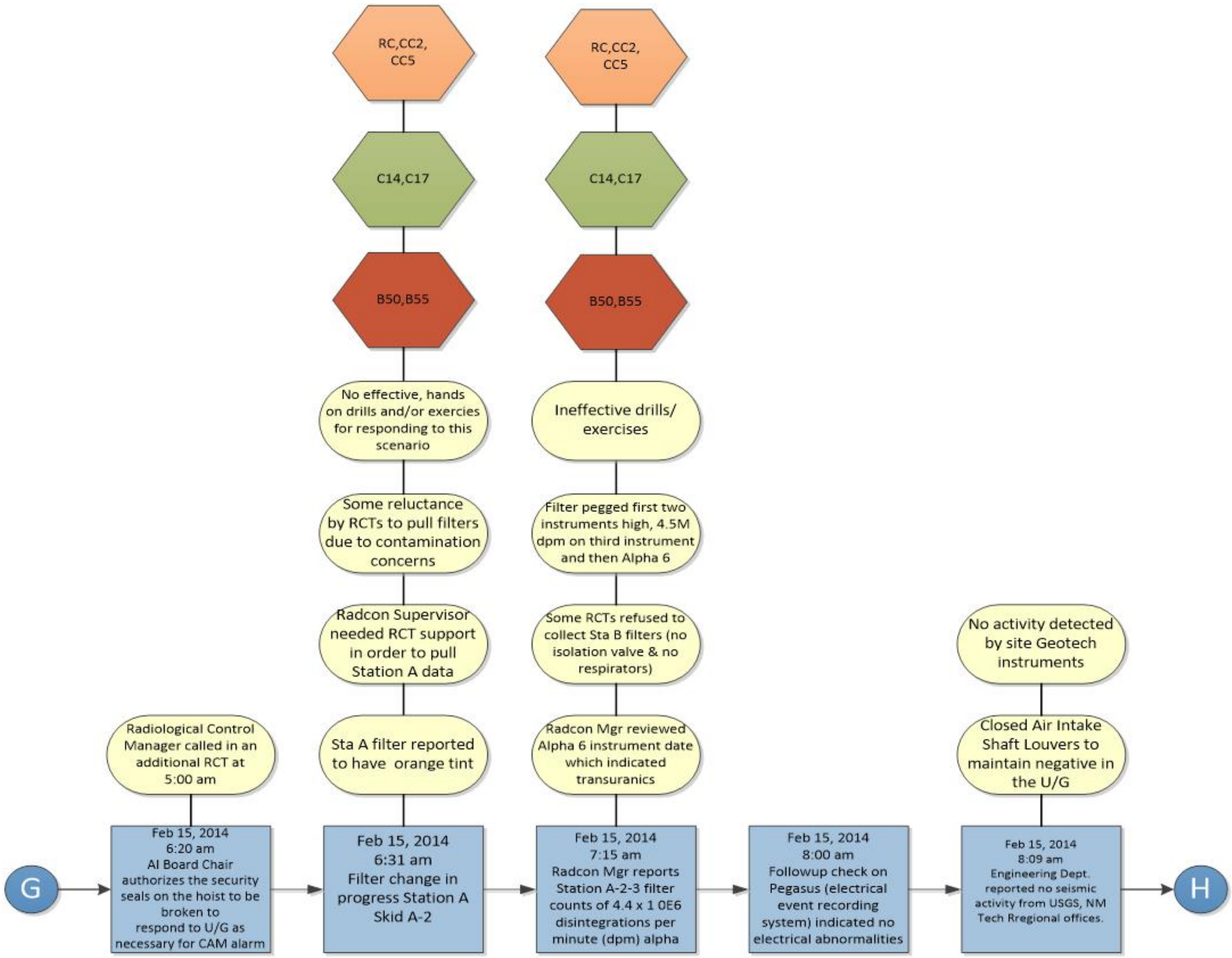
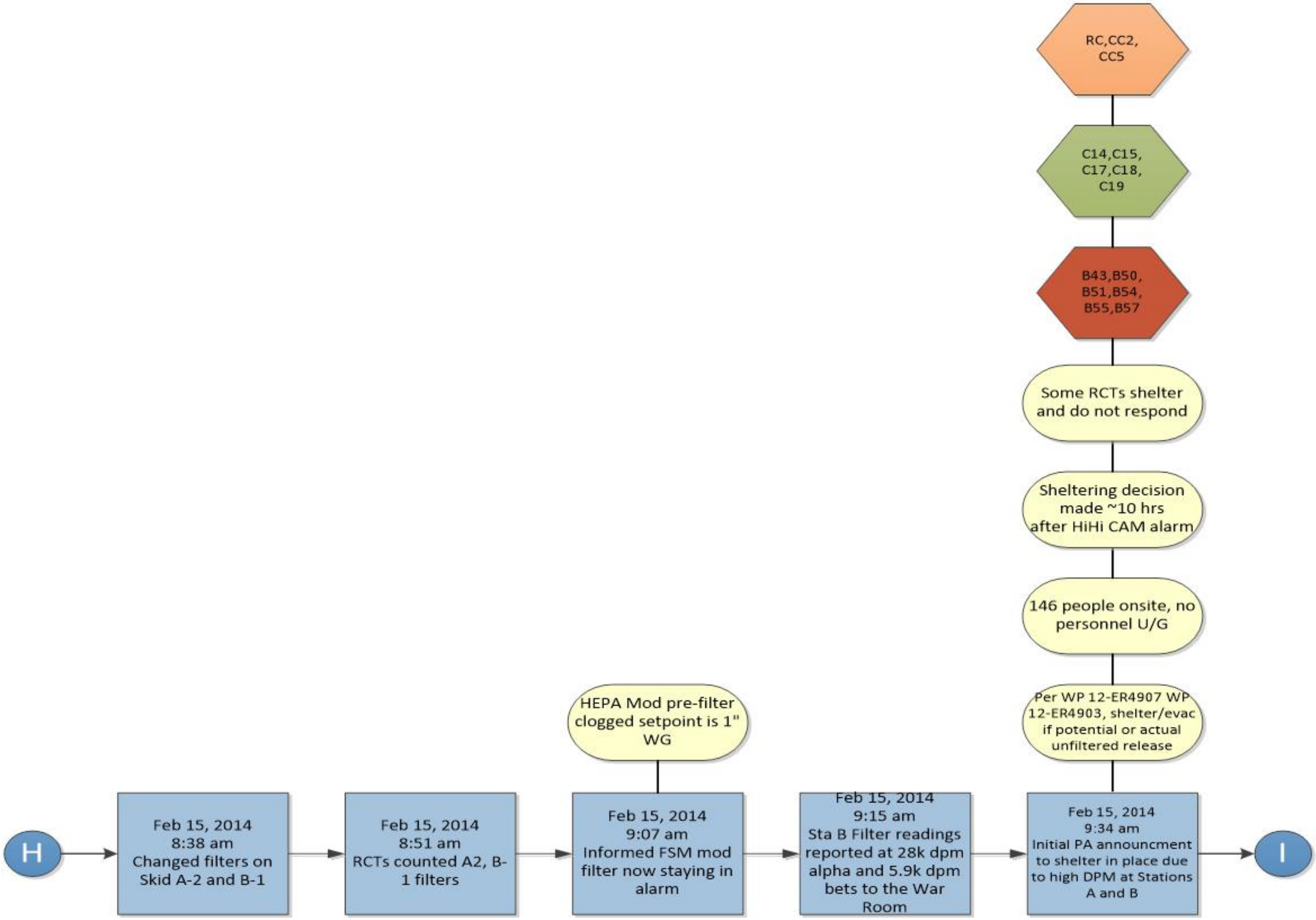


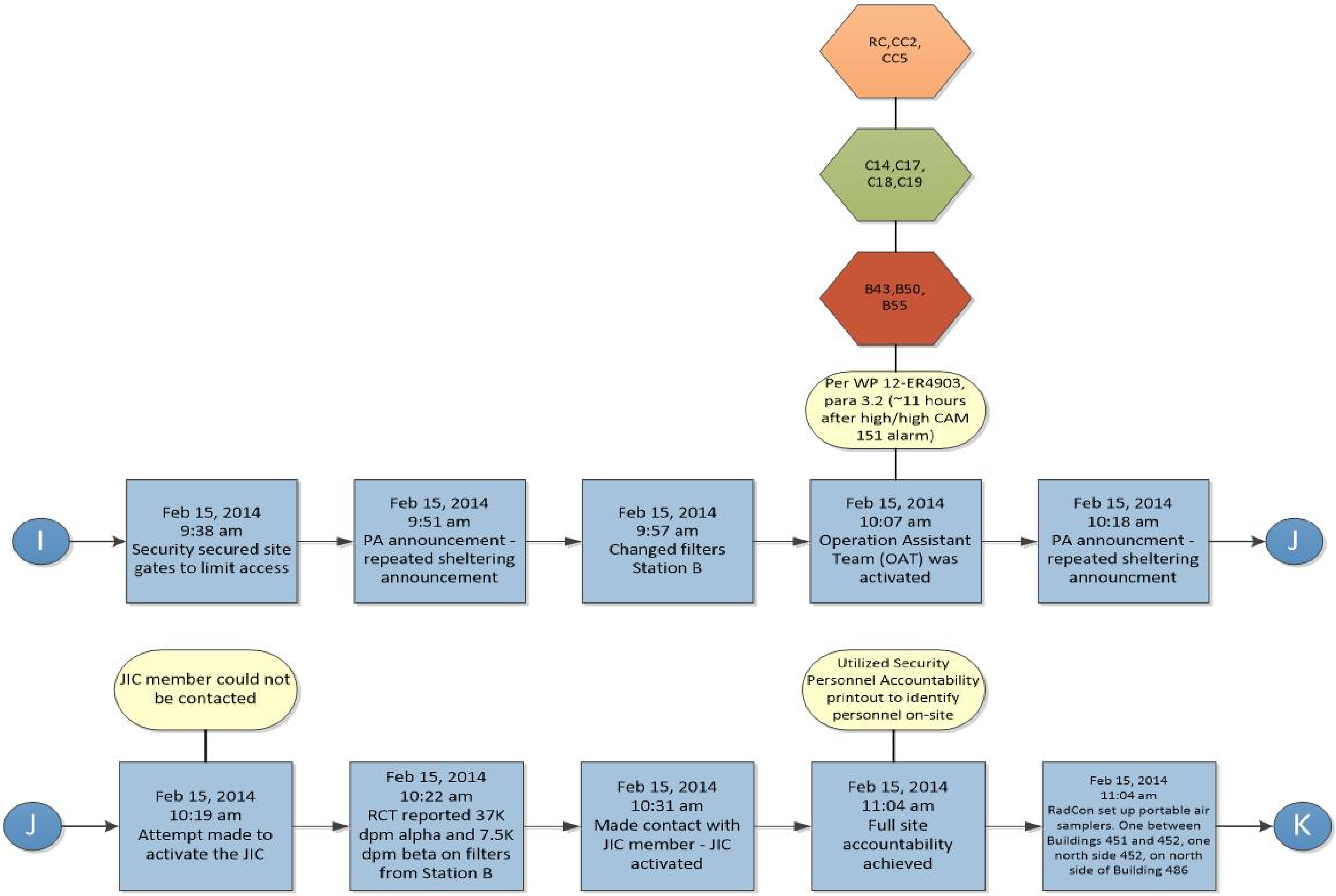
Radiological Event Primary Events and Causal Factors



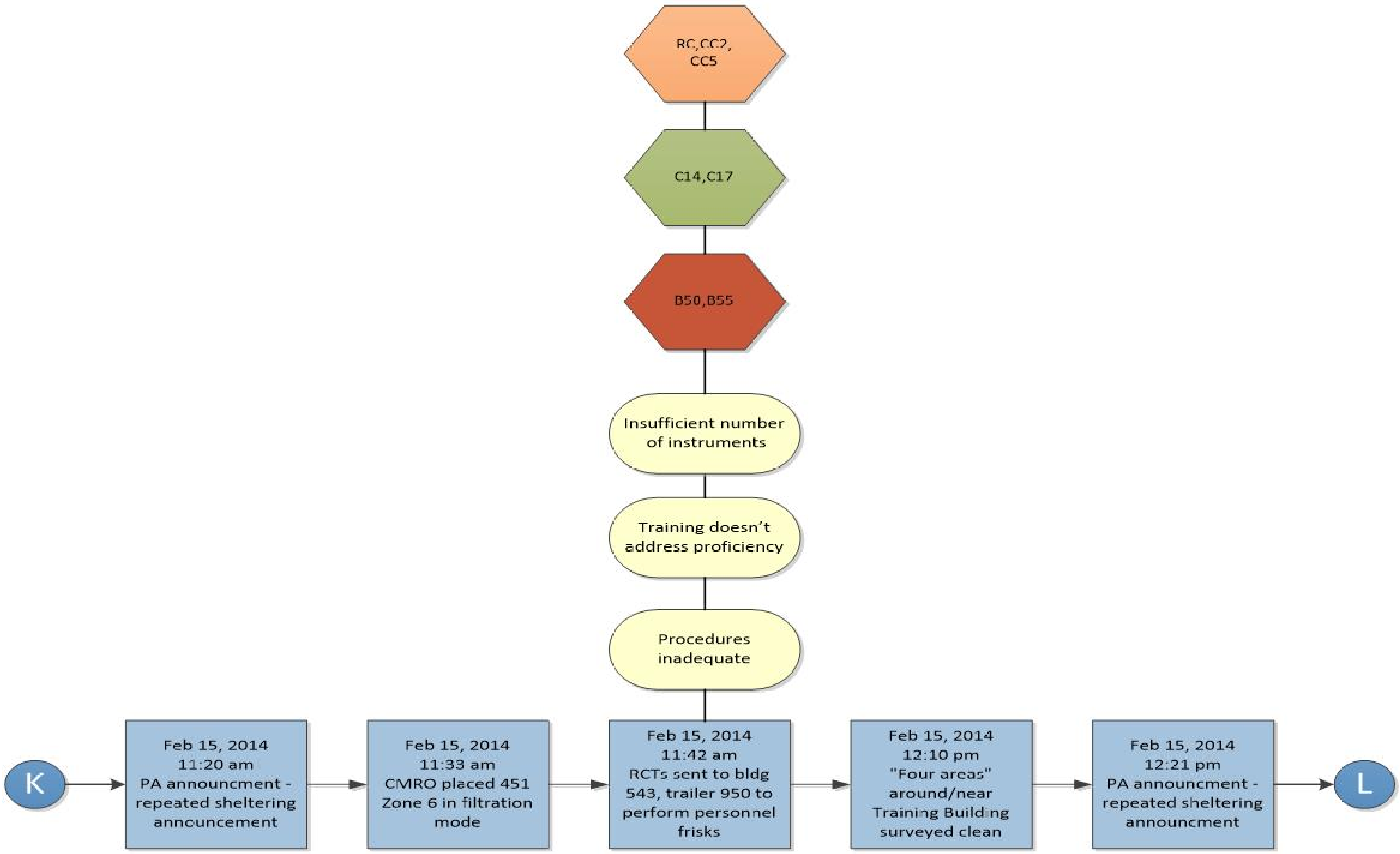
Radiological Event Primary Events and Causal Factors



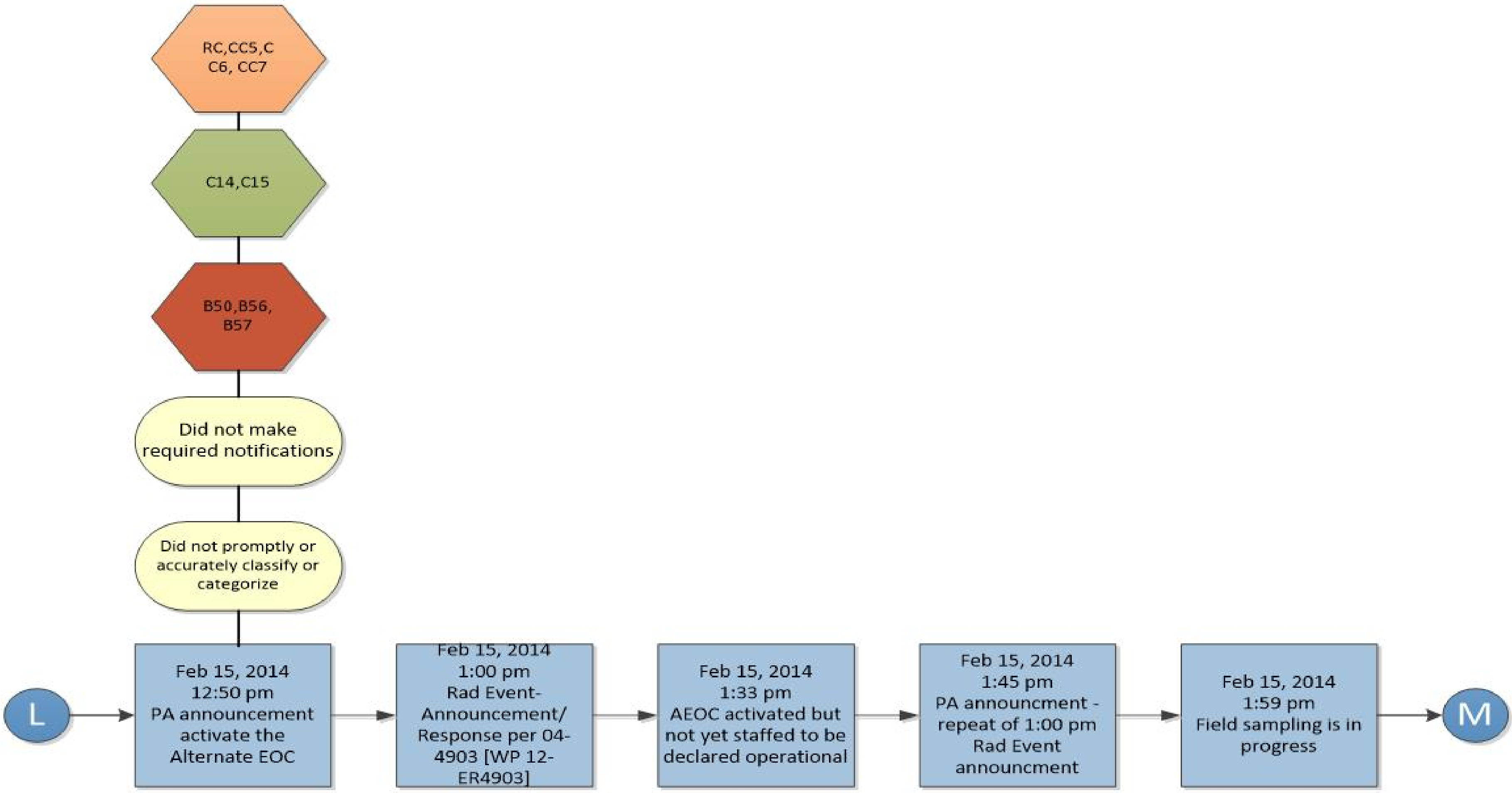
Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors



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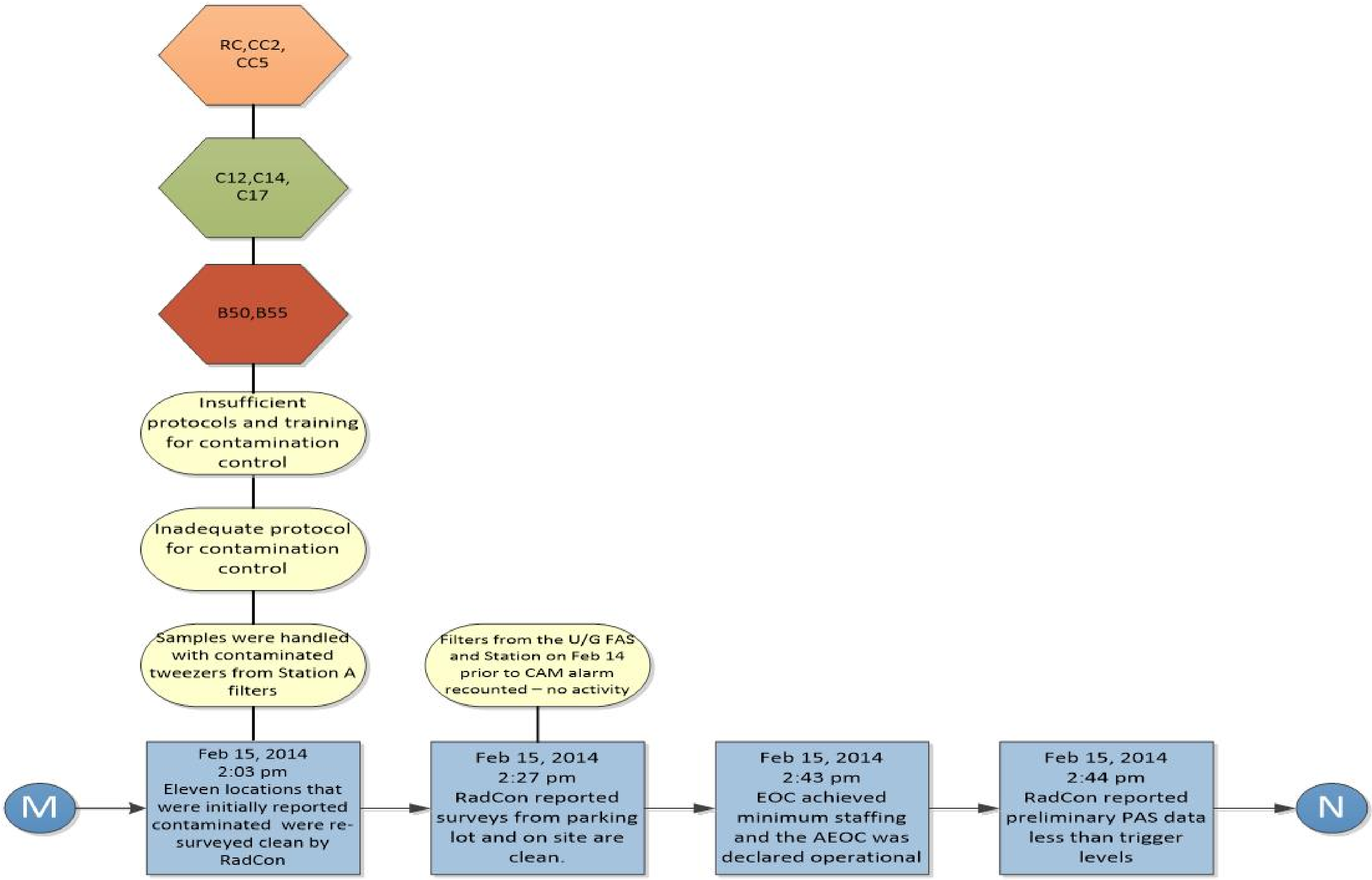
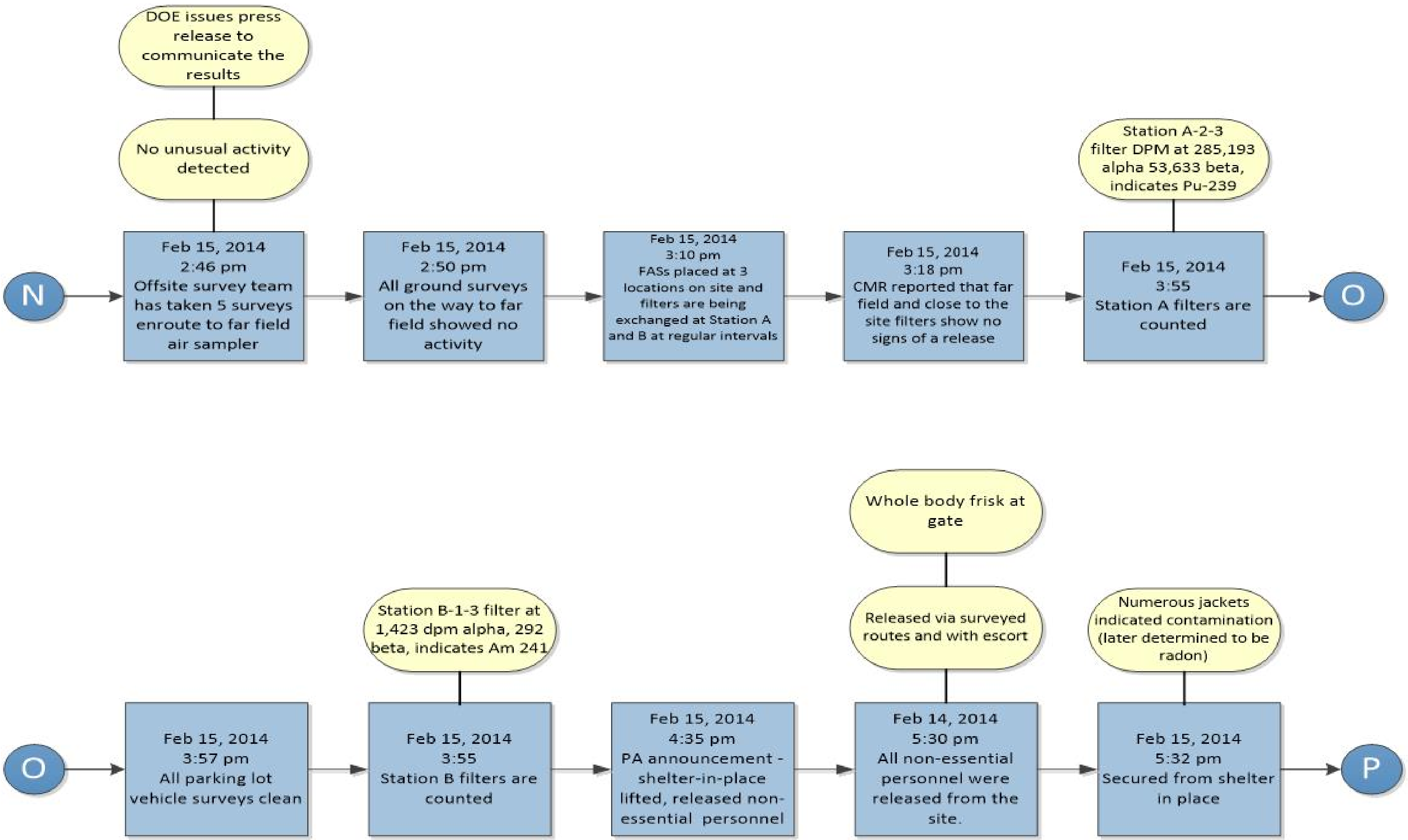
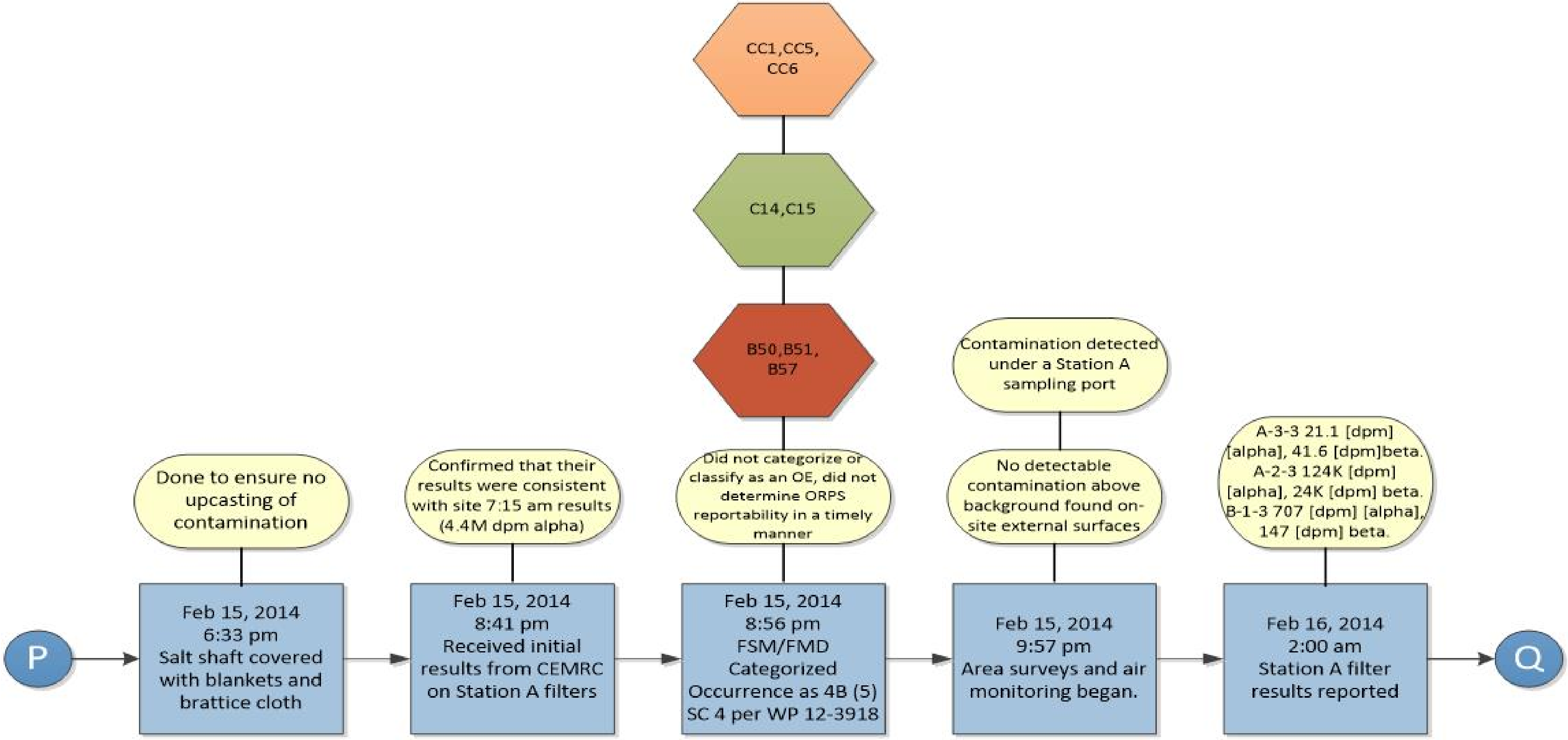


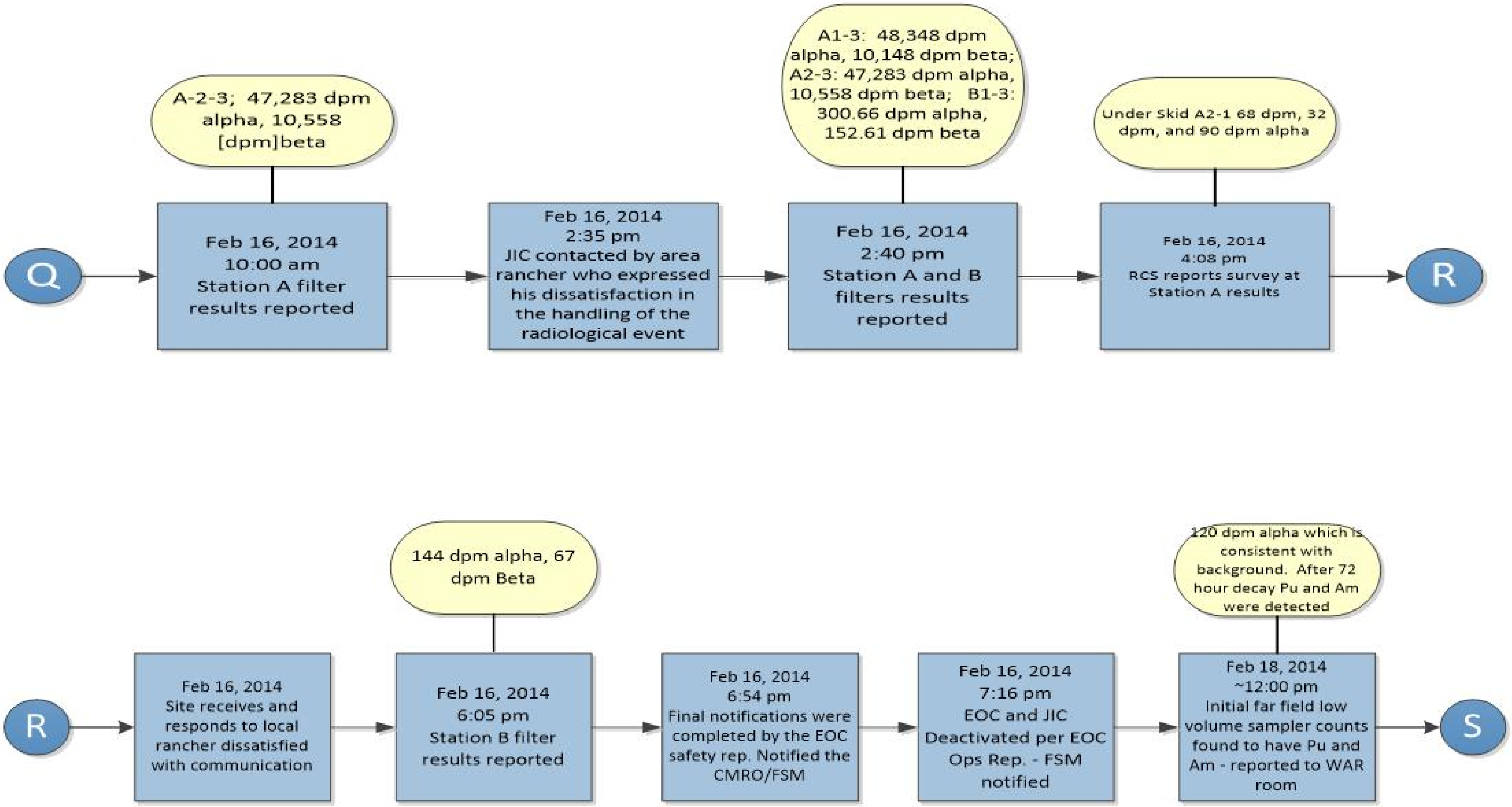
Radiological Event Primary Events and Causal Factors



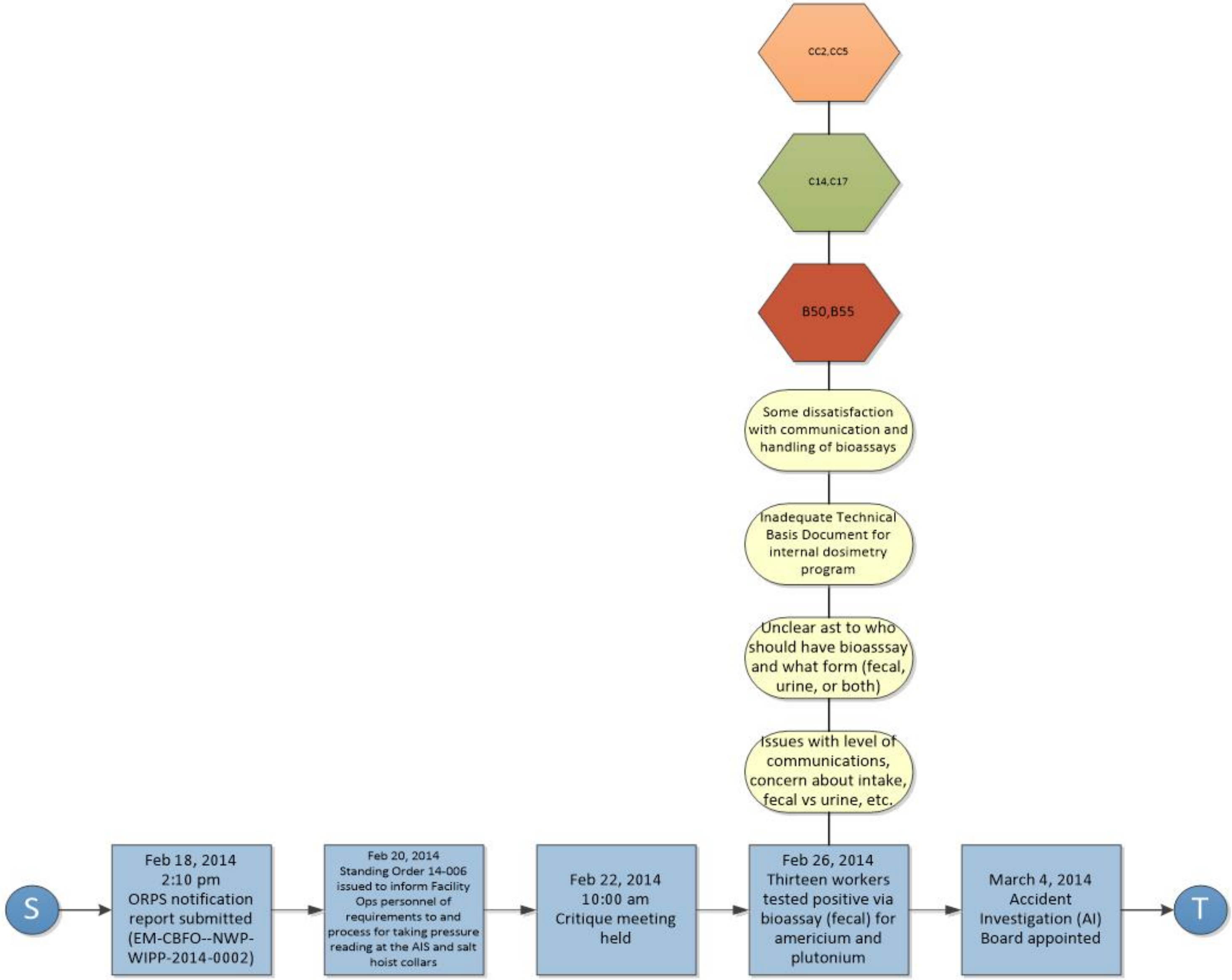
Radiological Event Primary Events and Causal Factors



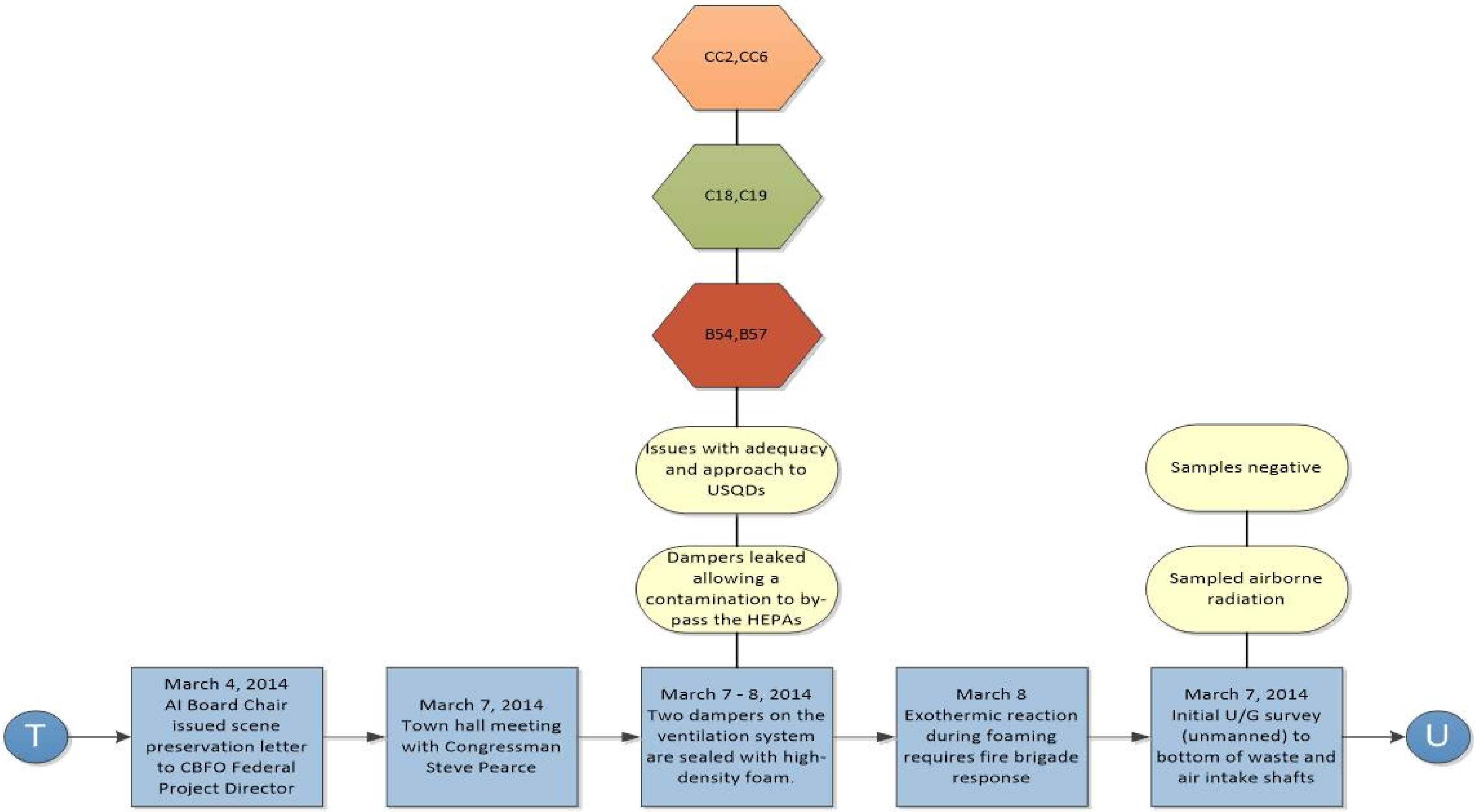
Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors



Radiological Event Primary Events and Causal Factors