

BOARD OF INVESTIGATION FINAL REPORT

Double Contractor Employee Fatality Mishap

Mount Newall, Antarctica

Date of Event – December 12, 2018

Date of Final Report: November 6, 2019

MILITELLO.ANTHON
Y.JUDE^{(b) (6)} Digitally signed by
MILITELLO.ANTHON.YJUDE^{(b) (6)}
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Mr. Anthony Jude Militello, P.E., CSP (Board Chair)
Director, Occupational Safety and Health
Department of the Navy.

BAILEY.JAMES.MIC
HAEL^{(b) (6)} Digitally signed by
BAILEY.JAMES.MICHAEL^{(b) (6)}
Date: 2019.11.08 10:12:04 -05'00'

Mr. James Michael Bailey (Board Member)
Afloat Mishap Investigator
Naval Safety Center

^{(b) (6)} Digitally signed by
KERR.MICHAEL.D^{(b) (6)}
2019.11.07 07:56:10 -06'00'

Mr. Michael Kerr, CSP (Board Member)
Chief, Safety and Occupational Health Office
United States Army Corps of Engineers, Tulsa District

WOITYRA.WILLIAM.C.
^{(b) (6)} Digitally signed by
WOITYRA.WILLIAM.C^{(b) (6)}
Date: 2019.11.06 19:03:02 -08'00'

Commander William Woityra (Board Member)
Executive Officer, USCGC POLAR STAR (WAGB 10)
United States Coast Guard

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Date of Report: November 6, 2019

Executive Summary

A Board of Inquiry, comprised of subject matter experts from the Department of the Navy, United States Army Corps of Engineers, and United States Coast Guard, was conducted to determine causes and make recommendations associated with a fatal mishap which occurred on December 12, 2018 at Mount Newall, Antarctica.

Two fire systems technicians were fatally injured when the carbon dioxide (CO₂) fire suppression system on which they were performing annual maintenance procedures was activated. The technicians were employed by PAE, a subcontractor to Leidos, and provided operational support to the National Science Foundation. The fire suppression system was protecting an unoccupied remote facility operated by Air Force Technical Applications Center.

Board of Inquiry Authorization

National Science Foundation, Office of Polar Programs, Appointment of Board of Investigation (BOI), Issued 19 December 2018

Board of Inquiry Members

Mr. Anthony Jude Militello, P.E., CSP (Board Chair)
Director, Occupational Safety and Health
Department of the Navy
anthony.j.militello@navy.mil

Mr. James Michael Bailey (Board Member)
Afloat Mishap Investigator
Naval Safety Center
James.Bailey@navy.mil

Mr. Michael Kerr, CSP (Board Member)
Chief, Safety and Occupational Health Office
United States Army Corps of Engineers, Tulsa District
Mike.D.Kerr@usace.army.mil

Commander William Woityra (Board Member)
Executive Officer, USCGC POLAR STAR (WAGB 10)
United States Coast Guard
William.C.Woityra@uscg.mil

Commander Thomas Janisko, MS, MSS, PA-C, EMT-T (Board Medical Advisor - United States Public Health Service)
Command Surgeon

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Director, Critical Incident Stress Management Team
United States Army Corps of Engineers
Thomas.Janisko@usace.army.mil

Accident Classification: Double Fatality

Mishap Victim #1

Name: Carl Jeff Norris
Age: 44
Occupation: Fire systems technician foreman
Equipment Involved: Carbon dioxide fire suppression system
Date of accident: December 12, 2018
Name of employer: PAE
Name of project: United States Antarctic Support Contract (ASC); Solicitation DACS08P2215
Location of project: Mount Newall, Antarctica

Mishap Victim #2

Name: Bobby Ray Pentecost
Age: 60
Occupation: Fire systems technician
Equipment Involved: Carbon dioxide fire suppression system
Date of accident: December 12, 2018
Name of employer: PAE
Name of project: United States Antarctic Support Contract (ASC); Solicitation DACS08P2215
Location of project: Mount Newall, Antarctica

Background

Mount Newall (77° 30' 00" S, 162° 42' 00" E) is a 7000ft high mountain peak remotely located in the Taylor Glacier Dry Valley of Antarctica, and located approximately 60 miles from McMurdo Station (77° 51' 00" S, 166° 40' 00" E), which serves as a logistics and research hub of the United States Antarctic Program. The Mount Newall Repeater Remote Operating Facility is operated by Air Force Technical Applications Center and contains equipment that supports the International Monitoring System as part of the Comprehensive Test Ban Treaty Organization.

The Mount Newall Repeater Remote Operating Facility is a normally unoccupied 36 feet by 11 and a half feet aluminum frame container that houses power and communication equipment, including a generator, fuel tank and battery bank. The structure is protected by a Kidde-Fenwal CO₂ fire suppression system, which requires periodic maintenance. The Statement of Work between the National Science Foundation Office of Polar Programs and Air Force Technical Applications Center for Support of a Seismic Station in Wright Valley, Antarctica includes a

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provision that National Science Foundation will maintain [the] fire suppression system (CO₂).

On December 12, 2018, two fire systems technicians traveled to the Mount Newall Remote Operating Facility for the purpose of performing thirty three tasks associated with the annual fire suppression system (CO₂) maintenance procedures. Immediately prior to arriving at the Mount Newall Remote Operating Facility, the two fire systems technicians performed similar fire suppression system (CO₂) maintenance procedures without incident at the Bull Pass Remote Operating Facility.

The McMurdo Weather Forecast Information for Wednesday, December 12, 2019 was fair most of the day, with a period of passing low clouds with a maximum of 32°F and a minimum with wind chill of 18°F. Flight hazards identified at McMurdo Station included light to occasional moderate icing and freezing fog in higher elevations associated with intermittent cloud cover advecting over the dry valleys. At Bull Pass, surface winds were variable between 0 and 6 knots, visibility was unrestricted and no hazards were identified. At Mount Newall, surface winds were variable between 0 and 6 knots, visibility was unrestricted, with hazards of light to moderate icing up to 2,500 feet.

Incident Summary

17 January 2013 – MAPCON work order 728878 completed. Description of work: Bull Pass and Mount Newall complete annual service for Group G-078. Comments: Completed 12-year annual testing and service. Replaced CO₂ cylinders and hoses. Returned discharge cylinders for hydro and refill. *(Note: This is the last documented CO₂ system inspection or maintenance procedure.)*

28 December 2017 – Mishap Victim 1 (MV1) recommended for hire.

09 May 2018 – Mishap Victim 2 (MV2) recommended for hire.

24 July 2018 – MV1 completed Winter Over Survival Training

21 August 2018 – MV2 completed General Safety Awareness Training

28 August 2018 – MV2 completed Lock-Out/Tag-Out Training

30 August 2018 – MV2 completed Antarctic Field Safety Training and the Helicopter Safety Video

29 October 2018 – MV1 completed Master List Orientation Training

30 October 2018 – Both MVs completed the Helicopter Safety Video

12 December 2018

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0819 – MVs were weighed, manifested, briefed, and loaded onto helicopter with the assistance of the helicopter flight technicians. Participant 1 (P1), helicopter pilot, ensured positive communications via intercom system, briefed the route of flight, travel time, and advised the MVs that they would be performing all loading and unloading operations with the helicopter rotors fully stopped.

0825 – Helicopter departed McMurdo Station and began travelling towards Bull Pass.

0855 – Helicopter landed at Bull Pass and shut down. All cargo and survival bags were unloaded.

0900 – P1 talked MVs through a radio check with the Helicopter Operations dispatch via the Wright Valley repeater and with the helicopter via the Helicopter Operations Channel. P1 instructed MVs to call Helicopter Operations dispatch to inform them when work has been completed. P1 communicated that he was to return at approximately 1200.

0913 – P1 and Helicopter departed Bull Pass to complete other assigned tasks.

MV's reported having completed the prescribed maintenance procedures for the fire suppression system (CO₂). The amount of time MV's spent performing each of the 33 tasks is unknown. (Note: When the system was visited by investigators, it was discovered that the pin was out of the electronic control head on the CO₂ bottle as seen in Figure 1)

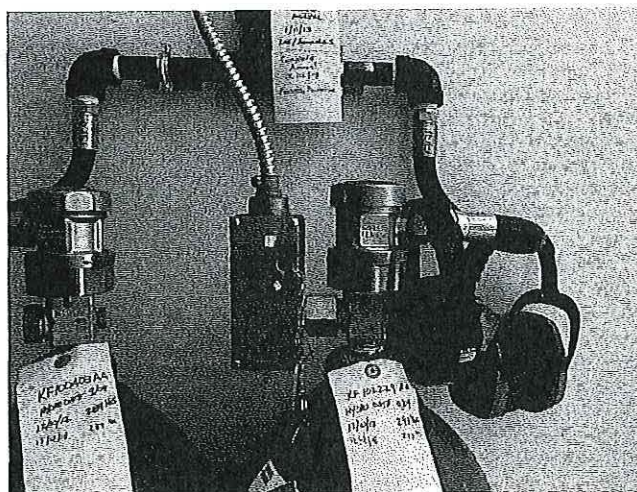


Figure 1: Bull Pass Fire Suppression System (CO₂) with locking pin removed from manual release lever

1127 – Helicopter returned to Bull Pass, landed, and shut down. MVs, cargo, and survival bags were loaded.

1135 – Helicopter departed Bull Pass and began travelling toward Mount Newall.

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1156 – Helicopter landed at Mount Newall, shutdown, and unloaded cargo. P1 informed MVs that he did not intend to leave Mount Newall. P1 informed MVs that he would take a walk along the ridge. All agreed to stay in radio contact via the helicopter operations channel.

1200 – P1 had a brief conversation with MVs regarding terrain hazards on the ridge between the helicopter and the white hut. MVs then staged a few items near the green survival hut.

1201 – MVs walked towards the Air Force Technical Applications Center facility.

1204 – P1 began his walk around the ridge.

MV's began performing annual fire suppression system (CO₂) maintenance tasks.

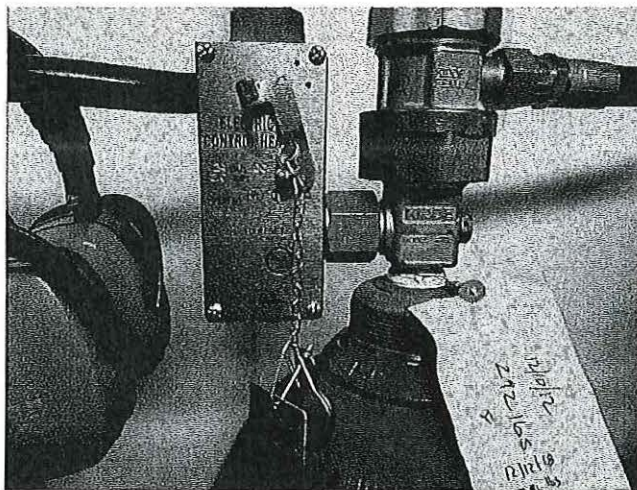


Figure 2: CO₂ Fire Suppression System (center bottle) at Mount Newall with locking pin out, manual release turned left, and system activation indicator in the "released" position.

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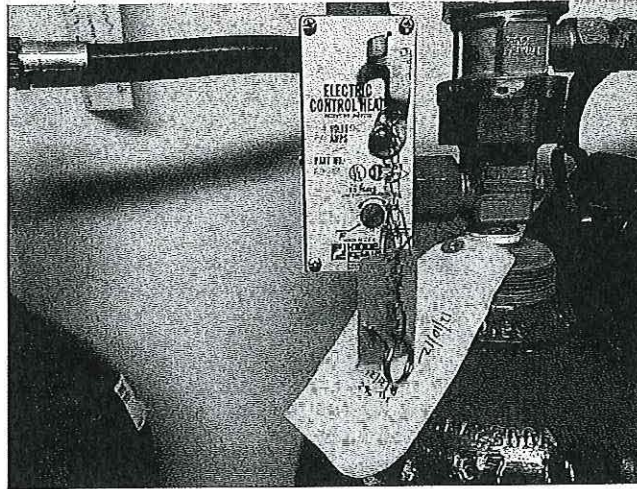


Figure 3: CO₂ Fire Suppression System (right bottle) at Mount Newall with locking pin out, manual release straight up, and system activation indicator in the "set" position.

1315 – P1 returned to the helicopter pad.

1340 – P1 started helicopter to warm engines and transmission oil.

1342 – P1 shut down helicopter.

[Note: There is no way to determine exactly when the fire suppression system (CO₂) was actuated. Given new weights written on the bottle tags, the Board of Inquiry assumes the MVs completed the required maintenance tasks. Due to MV2 having his Extreme Cold Weather (ECW) gear on and MV1's ECW being found very close to him, the Board of Inquiry assumes that they were in the process of completing their tasks and exiting the facility when the system was activated.]

Initial Response

[Note: Medical and Flight Tower reports provide detailed and amplifying timeline information not captured in the Initial Response information summarized below.]

12 December 2018

1343 – P1 walked to Air Force Technical Applications Center facility to evaluate the status of the maintenance tasks.

1345 – P1 arrived at the facility door and heard a faint alarm. P1 attempted to open door with negative results.

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1346 – P1 attempted to open door again, and was successful in opening the door about approximately 45° from the closed position. P1 tasted and smelled a sharp acrid and metallic vapors.

1347 – P1 retreated to an area with fresh air to address situation. P1 observed MV2 laying on his back just inside the door. P1 also observed a flashing light with the words “Agent.”

1348 – P1 yelled to MV2 with negative results.

1350 – P1 activated the SOS feature on InReach and called for help on the SAT phone.

1350 – P1 noticed the toxic odor seemed to have dissipated and he could see MV1 through the crack on the hinge side of the door. P1 entered the facility and dragged MV2 completely out of the facility and onto flat ground. P1 checked for a carotid and radial pulse, opened MV2’s airway, and checked for breathing. P1 did not find a pulse or breathing. P1 began mouth-to-mouth cardiopulmonary resuscitation.

1355 – Helicopter 7PH landed at Lake Hoare to pick up medical supplies and Participant 2 (P2), field camp manager, then immediately departed for Mount Newell.

1425 – Helicopter 7PH landed at Mount Newall. P2 went to the hut where P1 was conducting cardiopulmonary resuscitation to assess the situation with Participant 3 (P3), the pilot of Helicopter 7PH.

Consequence: The fire suppression system was removed from service.

Investigation Methodology

The investigation was governed by the requirements of PESH-POL_2000.10a, NSF Office of Polar Programs Safety and Occupational Health Policy, of August, 2018.

In accordance with the requirements of Appendix 3, the investigation team that served on the board of investigation travelled to McMurdo Station, Antarctica to visit the scene of the accident. The investigation team: visited, photographed and video recorded the Mount Newall Remote Operating Facility; conducted interviews with witnesses, support staff, supervisors, colleagues, medical staff, hiring and human resources personnel, safety professionals, and fire and emergency services staff; reviewed hiring and employment documents, operations and maintenance manuals, CO₂ system design drawings, manufacturer’s literature, and National Fire Protection Association (NFPA) Standards; and conducted initial deliberative discussions of incident causes and possible corrective actions.

The Board of Investigation was informed and advised by non-voting technical advisors specializing in medical care and fire protection engineering.

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An independent third-party fire protection engineering firm conducted a forensic evaluation, inspection, and non-destructive testing of the CO₂ electric control heads.

The Board of Investigation performed an analysis to achieve a consensus on mishap causal factors.

Findings of fact

REFERENCE: SUPPRESSION SYSTEM HEAD FORENSIC ANALYSIS

REFERENCE: MEDICAL REPORT

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Barrier Analysis

Name of BARRIER	BARRIER Type	Purpose of BARRIER	Performance of BARRIER	Effect on Mishap
CO ₂ Electric Control Head Pins	Engineering	Prevent inadvertent displacement of emergency manual system activation lever	Barrier not provided (e.g. not installed).	Inadvertent manual displacement of the emergency manual system activation lever is believed to be a direct cause of the mishap.
CO ₂ System	Engineering	To provide a heavy blanket of gas (CO ₂) that reduces the oxygen level to a point where combustion cannot occur.	System worked as designed.	Total discharge of the system occurred as system worked as designed.
Location of CO ₂ Bottles/Piping	Engineering	CO ₂ cylinders should not be located where they will be exposed to fire or explosion.	The bottles were located in the same space they were providing protection. This configuration, which permissible by the governing standard at the time of installation, does not comply with current design standards for new installations.	If the cylinders were not located in the same space as the system discharge nozzles, the MVs would not have been exposed to the CO ₂ during an inadvertent activation of the system.
Electric Control Heads	Engineering	To provide for electric and local manual activation of the CO ₂ cylinder valve.	The bottles were located in the same space they were providing protection. This configuration, which permissible by the governing standard at the time of installation, does not comply with	Having the ability inadvertently actuate the CO ₂ system while performing maintenance on it is a risk. This is exacerbated when the system

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			current design standards for new installations.	discharges in the same location the work is being performed.
Inward opening doors	Engineering	To access the spaces in Antarctica. Doors typically open inward due to snow drifts.	The doors are designed to open inward and they worked properly.	The board believes that once the CO ₂ system was actuated, the MVs attempted to exit the building. However, the pressure created by the discharge of the CO ₂ created extra pressure preventing the MVs from opening the door.
Training of personnel	Administrative	To ensure personnel are properly trained for the tasks they are being assigned to complete	NFPA 12 4.3.1.3.2 states that personnel training shall be provided.	Allowed personnel with little or no CO ₂ type training to work on CO ₂ fire suppression systems.
Qualifications of personnel	Administrative	To hire personnel who are qualified/certified for the positions they are being hired for and the jobs they are performing	Not Used Properly...Based on review of MV's resumes, it appears they had limited experience working with fire suppression systems and the majority of their experience was in fire alarm systems.	Allowed personnel with limited experience to work on CO ₂ fire suppression systems.

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Name of BARRIER	BARRIER Type	Purpose of BARRIER	Performance of BARRIER	Effect on Mishap
Response of first responders	Physical	To provide immediate assistance to injured personnel	Based on third-party physician's opinion, the first responders responded adequately and nothing further could have been done.	In the Board's opinion, all efforts were satisfactory
Lockout Valves	Engineering	Lock out valves and use of lock out devices prevent these type of systems from discharging during maintenance.	System was not retrofitted with lockout valves in accordance with current standards.	Based on the fact that it is unclear exactly when the system discharged and what the fire service technicians were doing at the time of the event, these valves may have prevented the mishap.
Annual Maintenance not completed since 2012	Physical	Required CO ₂ cylinder weight test had not been accomplished in several years	Potential knowledge gap on the specific steps of the maintenance activity.	This could possibly have prevented the mishap based on more AF, NSF, KTR personnel having experience working with CO ₂ systems.

Conclusions

Causes (present and contributing)

Contractor Leadership/Supervision/Oversight Inadequate. The availability, competency, quality or timeliness of leadership, supervision or oversight did not meet task demands and created an unsafe situation.

1. *Technician qualification(s), selection, and task assignment:* The prime and sub-contractors hiring processes did not include an evaluation or cross-reference validation between the applicants' skills and competencies and the tasks required to be performed. The prime and subcontractor provided no evidence that training was available, provided or offered to close any employee skill or competency gaps. Employee supervision and quality control of employee tasks was insufficient to identify employee skill and competency gaps.

Recommendation 1a: The support contractor employment processes (i.e. position description, solicitation, resume review, interview process, employee selection, pre-deployment training) should ensure employees have adequate skills, knowledge, and abilities to perform anticipated work tasks, especially those that pose a high risk for adverse consequences.

Recommendation 1b: Employee performance oversight processes should be established to validate the competency of the employees and the accuracy of the work being performed.

Training Issues/Programs: An unsafe condition is created when one-time or recurrent training programs, upgrade programs, transition programs or any other training is inadequate or unavailable.

2. *Inadequate hazard identification training or processes:* The execution of required fire suppression system (CO₂) maintenance tasks exposes employees to inherent hazards. There was no evidence the employees completed one-time hazard identification training prior to their employment or local hazard identification training prior to the assignment or completion of the fire suppression system (CO₂) maintenance tasks

Recommendation 2: Supervisory personnel should evaluate employee knowledge, skills and abilities associated with the scope of assigned tasks to validate adequate competency exists to perform work safely. Where employees do not possess the requisite knowledge, skills or abilities to perform assigned tasks, supervisors shall ensure adequate training shall be provided prior to performing work about which the employee is unfamiliar. Supervisors shall not assign work to unqualified employees without appropriate risk mitigation strategies (i.e. working alongside qualified employees in a mentor-protégé relationship)

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Procedural Guidance/Publications. Written direction, checklists, graphic depictions, tables, charts or other published guidance was inadequate, misleading or inappropriate and created an unsafe situation.

- Incomplete, unclear, impractical or non-existent task procedures:* The fire suppression system (CO₂) manufacturer's literature and the electric control head do not clearly indicate the purpose and normal state of the safety pins. A hand written job aid found at the mishap site incorrectly indicated the normal position of the safety pin. Interviews revealed that a commonly held and communicated belief is that the safety pins are installed during maintenance and removed to "arm system." There was no evidence at the mishap scene that indicated the mishap victims had or used written directions, checklists, graphic depictions or published guidance to complete the fire suppression system (CO₂) maintenance tasks.

Recommendation 3: Processes shall be established to provide employees with all required procedural guidance and publications for assigned tasks. Employees should be required to possess all required documentation at the site of work tasks.

Mission Planning. Mission planning is a factor when an individual, crew or team fails to complete all preparatory tasks associated with planning the mission, resulting in an unsafe situation. Planning tasks include information collection and analysis, coordinating activities within the crew or team and with appropriate external agencies, contingency planning, and risk assessment.

- Inadequate risk assessment and job-hazard analysis:* There was no evidence of a risk assessment or job hazard analysis documentation being provided to the technicians to identify hazards associated with the fire suppression system (CO₂) maintenance tasks. There was no evidence the technicians conducted and documented a risk assessment or job-hazard analysis associated with the fire suppression system (CO₂) maintenance tasks.

Recommendation 4: Risk assessments or job hazard analyses shall be developed and documented for fire protection system maintenance tasks. The documentation shall be provided at the time of work task assignment, shall be required to be reviewed by the supervisor and employee prior to work task being accomplished.

Design Policies and Processes

- System component installation and configuration:* The board considered the design of the CO₂ fire suppression system as a contributing factor. The system was designed to be activated by either smoke/heat detectors, manual pull stations at the exit door and emergency window, or by the local manual release lever on the electronic control head itself. The first two have a time delay associated with their release allowing personnel to exit the space. The local manual release does not have a time delay and release is immediate. There has been no

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explanation found to explain why the bottles with this local manual release lever were located in the same space the CO₂ fire suppression system was protecting. While compliant with the governing National Fire Protection Association (NFPA) standard at the time of installation, current NFPA standards prohibit the configuration preset at the time of the mishap.

Recommendation 5a: Recommend a joint NSF-AFTAC risk and hazard analysis of protected assets to evaluate fire suppression system requirements and system design options.

Recommendation 5b: Review all required CO₂ total flooding fire suppression systems and conduct a risk hazard analysis to determine any necessary risk mitigation strategies (i.e. redesign/retrofitting, increased training, additional placards/signage, alteration of maintenance protocols, requirement for personal protective equipment (e.g. respirators)) to avoid recurrence of subject mishap.

6. *Facility design:* The board considered the doors opening into the space as a contributing factor. In Antarctica doors are designed to open in to allow egress from a building in case snow drifts occur while the door is closed. In this incident it is believed the extra pressure on the door prevented the MVs from opening the door and exiting the building thus trapping them inside.

Recommendation 6: Recommend fire protection engineering life safety code review and analysis of the facility means of egress configuration and location.

Inadvertent Operation. Inadvertent Operation is a factor when individual's movements inadvertently activate or deactivate equipment, controls or switches when there is no intent to operate the control or device. This action may be noticed or unnoticed by the individual.

7. *Manually triggered release of CO₂ system.* The forensic analysis of the electric control head determined that it was unlikely the manual release switch was activated by a mechanism other than human means.

Recommendation 7: Validating employment, training, and hazard analysis processes are in place to mitigate the risks associated with fire suppression system (CO₂) maintenance tasks.

Causal But Not Contributing

National Science Foundation Technical Oversight. The availability and timeliness of leadership or oversight by technical subject matter expertise was inadequate.

8. *Limited technical oversight of processes associated with hazardous work.* Contractor work inherently and intentionally relies upon the rules and regulations of the Federal Acquisition

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Regulation to ensure all work is performed safely. Quantities of government technical experts and geographic isolation of the work site limit oversight and potential for regular or routine validation of safe work practices by qualified subject matter experts.

Recommendation 8: National Science Foundation should evaluate the staffing quantities and reporting relationships of safety and occupational health subject matter expertise.

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