

**U.S. Department of Energy
Office of Health, Safety and Security**

Accident Investigation Report



**Fatality at the Strategic Petroleum Reserve
Bryan Mound Site, September 13, 2011**

November 2011

Disclaimer

This report is an independent product of the Accident Investigation Board appointed by Glenn S. Podonsky, Chief Health, Safety and Security Officer, Office of Health, Safety and Security. The Board was appointed to perform an Accident Investigation and to prepare an investigation report in accordance with Department of Energy (DOE) 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 report neither determines nor implies liability.

Release Authorization

On September 19, 2011, an Accident Investigation Board was appointed to investigate the Fatality at the Strategic Petroleum Reserve Bryan Mound Site, September 13, 2011. The Board's responsibilities have been completed with respect to 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 report of the Accident Investigation Board has been accepted and the authorization to release this report for general distribution has been granted.

A handwritten signature in black ink, appearing to read 'G. Podonsky', with a large, stylized flourish at the end.

Glenn S. Podonsky
Chief Health, Safety and Security Officer,
Office of Health, Safety and Security



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Legend

Mower 1	Mower #1, John Deere Model 1435 Front Mower Series II
ES&H Manager	DM Environment, Safety and Health Manager (Corporate)
ES&H/TS Manager	DM Environment, Safety and Health/Technical Services Manager (Bryan Mound)
GC1	Grass Cutter #1
GC2	Grass Cutter #2
GC3	Grass Cutter #3
GC4	Grass Cutter #4
SMT	DM Bryan Mound Site Maintenance Technician
SSS	DM Bryan Mound Site Safety Specialist

Acronyms

AED	Automated External Defibrillator
APM	Accident Prevention Manual
BM	Bryan Mound Site
CAIRS	Computerized Accident/Incident Reporting System
CEO	Chief Executive Officer
CON	Conclusion
CPR	Cardiopulmonary Resuscitation
CRO	Control Room Operator
DM	DM Petroleum Operations Company (formerly DynMcDermott Petroleum Operations)
DOE	Department of Energy
ECF	Events and Causal Factors
EMS	Emergency Medical Services
ERT	Emergency Response Team

ES&H	Environment, Safety and Health
ES&H/TS	Environment, Safety and Health Technical Services
FE	Office of Fossil Energy
HPI	Human Performance Improvement
HSS	Office of Health, Safety and Security
ISM	Integrated Safety Management
JHA	Job Hazard Analysis
JON	Judgment of Need
NOLA	New Orleans, Louisiana
OCC	Operations Control Center
OJT	On-the-Job Training
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
PMO	Project Management Office
PSM	Process Safety Management
PTO	Power Take Off
ROPS	Roll Over Protection Structure
RPM	revolutions per minute
SPR	Strategic Petroleum Reserve
SPR-BM	Strategic Petroleum Reserve Bryan Mound Site
SPR-HQ	Office of Petroleum Reserves (FE-40)
SWP	Safe Work Permit
TAAR	Training Activity Attendance Report
WSI-BM	Wackenhut Security Inc. Bryan Mound

Executive Summary

Introduction

On September 13, 2011, a recently-hired, untrained subcontractor employee struck three large elevated pipes while operating a front deck mower at the Cavern 5 area of the Strategic Petroleum Reserve Bryan Mound (SPR-BM) site. The employee was pronounced dead shortly after the accident by medical authorities. This accident meets the Department of Energy's (DOE) Accident Investigation Criteria 2.a. (1) of DOE Order 225.1B, *Accident Investigations*, Appendix A: “*Any injury or chemical or biological exposure that results in or is likely to result in, the fatality of an employee or member of the public.*” On September 14, 2011, based on the severity of this accident and the requirements of DOE Order 225.1B, the Office of Health, Safety and Security (HSS), in consultation with the Office of Fossil Energy (FE), began assembling an accident investigation team. On September 19, 2011, Glenn S. Podonsky, Chief Health, Safety and Security Officer, formally appointed an Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1B. The Board began its investigation on September 20, 2011, completed its onsite activities on September 30, 2011, and submitted its final report to the Chief Health, Safety and Security Officer on October 19, 2011.

Accident Description

On the morning of September 13, 2011, DM Petroleum Operations Company subcontractor employees were performing grass cutting activities at the Cavern 5 area of the SPR-BM site. At about 1125 hours, a front deck mower operated by a recently-hired, untrained subcontractor employee struck three large elevated pipes. The accident condition was quickly discovered and reported by one of the co-workers cutting grass in the vicinity, who found the employee pinned between the mower and an elevated pipe. The onsite Emergency Response Team (ERT) was activated and offsite emergency medical services were requested. Cardiopulmonary resuscitation was initiated by trained ERT members within about five minutes, and that treatment continued until the employee was placed into a Surfside ambulance that had arrived at the accident scene. The employee was pronounced dead by medical authorities at about 1220 hours. On September 14, 2011, the Galveston County Medical Examiner's Office issued a preliminary cause of death statement identifying the cause of death as blunt force trauma.

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 as: an untrained subcontractor employee struck three large elevated pipes with significant force while operating a front deck mower.

Root Cause(s) - causal factors that, if corrected, would prevent recurrence of the same or similar accidents. The Board identified two root causes of this accident: failure by the untrained subcontractor employee to follow the supervisor's direction to stay off the mower; and failure of the SPR-BM site stop work policy and its implementation in addressing less than imminent danger situations.

Contributing Causes – events or conditions that collectively with other causes increased the likelihood of an accident but that individually did not cause the accident. The Board identified five contributing causes to this accident:

1. Less than adequate work control process (Job Hazard Analysis, Safe Work Permit, pre-job briefing, work assignments),
2. The employee's lack of competency in operating the mower,
3. The recently-hired employee had previous experience at the SPR-BM site,
4. Unavailability of the supervisor due to other duties, and
5. The employee was left alone with the mower when two of his co-workers left the worksite.

Conclusions and Judgments of Need

Based upon the findings of this accident investigation, the Board concluded that this accident and the resulting fatality were preventable.

Table ES-1 summarizes the Conclusions (CONs) and Judgments of Need (JONs) determined by the Board. The conclusions are those that the Board considered significant and are based on the facts and pertinent analytical results. Judgments of Need are managerial controls and safety measures believed by the Board to be necessary to prevent or minimize the probability or severity of a recurrence of this type of accident resulting in a fatality. Judgments of Need are derived from the conclusions and causal factors and are intended to assist managers in developing corrective actions and fostering continuous improvement.

Although the final cause of death has not yet been determined by the Medical Examiner's Office, the deficiencies associated with the CONs and JONs presented in this report are significant and warrant immediate management attention and appropriate corrective actions. Further, based on the Board's review of previously identified and completed corrective actions for the SPR-BM site from 2000 to present, which included actions in response to a subcontractor worker fatality at the site on July 8, 2010, the Board concluded that long-standing issues associated with specific elements of the site's work planning and control process were also evident in this accident. Additionally, it is noteworthy that the DOE Independent Review Board that evaluated the July 8, 2010, fatality identified several opportunities for improvement in understanding of and adherence to safety requirements, oversight programs, and other areas that are pertinent to this accident.

Accordingly, the Board recommends that FE's Office of Petroleum Reserves, FE-40 (SPR-HQ); the SPR Project Management Office; and the SPR-BM site Federal and contractor organizations ensure that the results of this accident investigation are integrated into a comprehensive corrective action plan to improve safety at the SPR-BM site, and other SPR sites as appropriate. The Board also strongly recommends that, in accordance with DOE Order 225.1B, SPR-HQ directs an extent-of-condition review for specific issues resulting from this accident investigation that might be applicable to other work locations under the authority of SPR-HQ.

Table ES-1: Conclusions and Judgments of Need

Conclusion	Judgment of Need
<p>Work Planning and Control:</p> <p>The Board concluded that the DM Job Hazard Analysis (JHA) process for large and small tractor mowing lacked an inclusion of applicable hazards from equipment manufacturer operator’s manuals and other identified applicable hazards and controls (e.g., heat stress).</p> <p>The Board concluded that the DM JHA process lacked specific requirements for periodic worker review, mechanisms for integration into the work control process (e.g., morning meeting), and that the controls specified in some JHAs were not followed by workers (e.g., use of qualified operators).</p> <p>The Board concluded that the DM Safe Work Permit (SWP) process did not adequately integrate the hazards and controls of the applicable JHAs.</p> <p>The Board concluded that the DM SWP did not have an adequate mechanism for authorizing work.</p> <p>The Board concluded that DM lacked a policy and guidance for the conduct of pre-job briefings.</p>	<p>DM needs to ensure that hazards listed in equipment manufacturer operator’s manuals and other relevant references are included in the JHAs.</p> <p>DM needs to revise the JHA procedure of the Accident Prevention Manual (APM) to include a requirement for workers to periodically review JHAs to ensure an understanding of the hazards and controls.</p> <p>DM needs to revise the SWP process to specifically include a review of the JHAs for the work to be performed and to confirm adequate controls are in place.</p> <p>DM needs to revise the SWP process to require the initiator to verify that assigned workers are qualified to perform the work, and that DM Operations has confirmed readiness before authorizing work to commence.</p> <p>DM needs to develop a pre-job briefing process that establishes a minimum set of requirements to be addressed at each pre-job briefing commensurate with the hazards and complexities of the work.</p> <p>The Office of Petroleum Reserves, FE-40 (SPR-HQ) needs to evaluate DM’s effectiveness in implementing improvements in JHA, SWP, and pre-job briefing processes.</p>

Conclusion	Judgment of Need
<p>Training:</p> <p>The Board concluded that the on-the-job training (OJT) program for Grass Cutters (GC) was not equipment-specific. For example, completing training/qualification on one lawn mower qualifies an individual on all lawn mowers (large or small).</p> <p>The Board concluded that the OJT program for Grass Cutters lacked sufficient documentation with respect to content (e.g., elements of the equipment operator’s manuals, equipment postings and warnings), and did not distinguish between new hire and refresher training.</p> <p>The Board concluded that the training and qualification documentation did not provide sufficient guidance to personnel conducting OJT.</p> <p>The Board concluded that Grass Cutter #1 (GC1) was not qualified to operate the John Deere 1435 Front Mower (Mower 1) since GC1 had not completed the required training for his position nor the OJT required to operate the mower.</p>	<p>DM needs to revise its OJT and qualification program so that the OJT is specific to equipment and processes that are significantly unique.</p> <p>DM needs to provide sufficient guidance in the OJT materials to ensure that consistent, task-specific training is conducted and documented.</p> <p>The DM OJT program needs to ensure relevant work documents such as equipment operator’s manuals, JHAs, and equipment warnings are addressed and documented in the OJT record.</p> <p>DM needs to ensure the necessary OJT and other required training are properly completed and documented before assigning an employee to perform a particular task.</p> <p>SPR-HQ needs to evaluate DM’s effectiveness in implementing training improvements for OJT, and DM’s process for verifying that training is complete before employees are assigned tasks.</p>

Conclusion	Judgment of Need
<p>Stop Work Authority:</p> <p>The Board concluded that the DM stop work policy does not incorporate the requirements of DOE Order 422.1, <i>Conduct of Operations</i>, resulting in a policy that is limited to “imminent danger” and lacking sufficient instruction and training to ensure workers are knowledgeable of the policy.</p> <p>The Board concluded that a stop work process/authority was not utilized by the workers at the job site to prevent GC1 from operating Mower 1.</p>	<p>DM needs to augment its current stop work policy by incorporating a graded approach to stop work that encourages workers to initiate a “stop when unsure,” “pause” or “timeout” process.</p> <p>DM needs to develop and implement stop work training that includes situations and scenarios that will help workers identify when to stop work at lower thresholds.</p> <p>DM needs to identify mechanisms (e.g., monthly safety meetings, pre-job briefings) to routinely communicate and reinforce the expectations for stop work at lower thresholds.</p> <p>SPR-HQ needs to evaluate DM’s effectiveness in implementing a graded approach for stop work including training and mechanisms to reinforce expectations for stop work.</p>
<p>Equipment Inspection and Maintenance:</p> <p>The Board concluded that important information identified in the Mower 1 equipment Operator’s Manual had not been included in pre-operational checklists for this equipment, and that the daily equipment checks were not consistently performed and/or documented.</p> <p>The Board concluded that important information identified in the Mower 1 equipment Operator’s Manual had not been included in the maintenance programs for this equipment, and that there were several pre-existing equipment deficiencies for Mower 1.</p>	<p>DM needs to revise daily equipment operating checklists to ensure consistency with the equipment operator’s manual for such equipment.</p> <p>DM needs to ensure that daily equipment checks are performed and documented.</p> <p>DM needs to revise the DM equipment maintenance program to ensure that DM equipment is maintained consistent with the requirements in equipment manufacturer operator’s manuals.</p>

Conclusion	Judgment of Need
<p>Accident Scene Preservation:</p> <p>The Board concluded that the accident scene was not adequately preserved, since DM management and staff were allowed access to Mower 1 following the accident.</p>	<p>DM needs to review its accident investigation process and ensure that there are adequate requirements and guidance to prevent the disturbance of an accident scene. The requirements and guidance need to be clearly communicated.</p> <p>DM needs to establish a more stringent control process at the scene of an event to ensure that no evidence is disturbed, and if evidence is disturbed, it is promptly documented and reported.</p>
<p>Human Performance Improvement (HPI):</p> <p>The Board concluded that there were numerous error precursors in existence on the day of the accident, and identifying and addressing these error precursors may have prevented the accident.</p> <p>The Board concluded that DM would benefit from the application of HPI tools and techniques to help manage and defend against human error.</p> <p>The Board concluded that clear performance expectations were not always communicated and/or reinforced to the workers.</p>	<p>DM needs to implement HPI principles that address the application of HPI tools and techniques to help manage and defend against human error.</p> <p>DM needs to include the identification and subsequent addressing of error precursors as part of the SWP and pre-job brief process.</p> <p>DM needs to ensure that performance and safety-related expectations are clearly defined, communicated, and understood by all workers and routinely reinforced by leadership.</p>

Conclusion	Judgment of Need
<p>Lessons Learned/ Feedback and Improvement:</p> <p>The Board concluded, based on a review of completed corrective actions at the Strategic Petroleum Reserve Bryan Mound (SPR-BM) site, and a worker fatality at this site a year ago, that long-standing problems have existed at the SPR-BM site with respect to daily equipment pre-operational checks, integrating hazards into SWPs, and not understanding or strictly complying with health and safety requirements.</p> <p>The Board concluded that, to the Board’s knowledge, DOE and DM organizations at the SPR-BM site did not effectively review and utilize information available through DOE’s operating experience programs and reporting systems, resulting in a missed opportunity to continuously learn and improve their grass cutting operations – and other operations at the SPR-BM site.</p>	<p>SPR-HQ and DM need to ensure that DOE operating experience programs and reporting systems are used to continuously improve operations.</p> <p>SPR-HQ needs to provide oversight of the resolution of corrective actions related to this accident and the corrective actions associated with the prior 2010 fatality at the SPR-BM site to ensure effective implementation and to prevent recurrence.</p>
<p>Fitness for Duty:</p> <p>The Board concluded, based on evidence presented to the Board through interviews, that GC1 was fit for duty on the morning of the accident.</p>	<p>No action required.</p>
<p>Emergency Response:</p> <p>The Board concluded that ERT response was timely and appropriate, and the ability of the ERT to continue cardiopulmonary resuscitation (CPR) for the period it did was commendable.</p> <p>The Board concluded that the DM policy that employees contact their supervisor instead of directly calling 911 in emergency medical situations unnecessarily delays medical response.</p>	<p>DM needs to revise its policy for requiring supervisor permission to make a 911 call when it is obvious that medical assistance is required.</p>

Conclusion	Judgment of Need
<p>Supervision:</p> <p>The Board concluded that the Grass Cutters did not follow the instruction of the DM Site Maintenance Technician (SMT).</p> <p>The Board concluded that, on the day of the accident, the DM escort policy was not implemented as required by DM Manual ASI5600, <i>Security Operations Manual</i>.</p>	<p>DM needs to reaffirm the roles and responsibilities of supervisors, and emphasize that supervisory direction is to be followed whether or not the supervisor is present.</p> <p>DM needs to provide additional guidance to supervisors and workers with respect to implementation of the DM escort policy.</p>
<p>Safety Organization:</p> <p>The Board concluded that DM employees were not implementing some requirements of the DM APM, or in some cases the manual was unclear and resulted in inconsistent implementation of safety requirements.</p>	<p>DM needs to revise the JHA and SWP sections of the APM to address the Board’s concerns as expressed in Sections 2.6.2.1 and 2.6.2.2 of this report.</p> <p>DM needs to implement a clear policy stressing the importance of following procedures including work permits and the safety and health requirements of the DM APM.</p> <p>SPR-HQ needs to evaluate DM’s effectiveness in ensuring management and workers are complying with DM safety and health requirements as written in the DM APM, JHA, and SWP.</p>

1.1. Background

1.1.1. Strategic Petroleum Reserve

The Strategic Petroleum Reserve (SPR) is the world's largest supply of emergency crude oil. The Federally-owned oil stocks are stored in large underground salt caverns along the coastline of the Gulf of Mexico. SPR currently operates and maintains four major oil storage facilities in the Gulf Coast regions of the United States. These four operating sites, Bayou Choctaw, West Hackberry, Big Hill, and Bryan Mound, are located along the Gulf Coast of Louisiana and Texas and have a combined oil storage capacity of 727 million barrels and a drawdown capability of 4.4 million barrels per day.

All oil stored in SPR's oil storage facilities is in large underground storage caverns which have been developed in salt dome formations. Salt dome storage technology provides maximum security and safety for the Nation's stockpile of crude oil.

The SPR Project Management Office (PMO), based outside of New Orleans, LA, (NOLA) is responsible for carrying out the operational aspects of SPR's mission. The PMO oversees the day-to-day operations of the major crude oil storage sites and logistical facilities for the nation's emergency oil stockpile. The SPR PMO is managed by the Office of Petroleum Reserves, FE-40 (SPR-HQ) in Washington, D.C.

1.1.2. Bryan Mound Site

The Strategic Petroleum Reserve Bryan Mound (SPR-BM) site is located in Brazoria County, Texas, approximately three miles southwest of Freeport, Texas. Figure 1-1 provides an aerial view of the SPR-BM site. The site has 20 storage caverns with both storage capacity and inventory of 254 million barrels and drawdown capability of 1,500 thousand barrels per day. The SPR-BM site was completed in 1986 and has been fully operational since that time. Although Bryan Mound is an underground storage facility, design and function of the site requires above ground pipes that traverse the site.



Figure 1-1: Bryan Mound Site, Brazoria County, Texas

1.1.3. Accident Investigation Process

The Board began its investigation on Tuesday, September 20, 2011, completed a factual accuracy review on September 29, 2011, completed onsite activities on September 30, 2011, and submitted the final report for acceptance to the Appointing Official on October 19, 2011, in accordance with the Appointment Memorandum (Appendix A).

The Board conducted its investigation using the following methodology:

- Facts relevant to the accident were gathered through interviews, document and evidence reviews, and examination of physical evidence,
- Event and causal factor charting, along with barrier analysis, change analysis techniques, and error precursor analysis were used to analyze the facts and identify the cause(s) of the accident, and
- Based on the analysis of information gathered, judgments of need were developed for corrective actions to prevent recurrence.

Figure 1-2 describes the accident investigation terminology used throughout this 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 re-occur, 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 1-2: Accident Investigation Terminology

2.0 Facts and Analysis

2.1. Accident Description

On the morning of September 13, 2011, subcontractor employees were performing grass cutting activities at the Cavern 5 area (Figure 2-1) of the SPR-BM site using two front deck mowers. At about 1125 hours a front deck mower (Mower 1) operated by a recently-hired untrained subcontractor employee, Grass Cutter #1 (GC1), struck three large elevated pipes.



Figure 2-1: Cavern 5 at Bryan Mound

The accident condition was quickly discovered and reported by a co-worker. The onsite Emergency Response Team (ERT) was activated and offsite emergency medical services were requested. Cardiopulmonary resuscitation (CPR) was initiated by trained ERT members within about five minutes, and that treatment continued until the employee was placed into a Surfside ambulance that had arrived at the accident scene. The employee sustained significant internal injuries as a result of the accident and was pronounced dead by medical authorities at about 1220 hours.

2.2. Chronology of Events

On Monday, September 12, 2011, GC1 began employment at the SPR-BM site as an employee of Ashton, Inc., a subcontractor to DM Petroleum Operations Company (DM). GC1 had been previously employed by DM at the SPR-BM site from 1985 to 2008 as a painter and mechanic, and he occasionally performed grass cutting. GC1 was reported to have had experience on other mowers but not the John Deere Model 1435 Front Mower (Mower 1). GC1 reported to the SPR-BM site at about 1400 hours after completing a new employee physical examination. An Ashton, Inc., representative called the DM Site Maintenance Technician (SMT) on the evening of September 12, 2011, and reported that the results of the new employee physical were satisfactory and that GC1 was ready to perform work.

On Tuesday, September 13, 2011, one of the grass cutting activities scheduled was mowing operations at the Cavern 5 area (Figure 2-2) under Safe Work Permit (SWP) 345686. At 0632 the SMT initiated an Addendum for SWP 345686, "*Perform grass cutting, weedeating, and the applic of herb.*" The SWP Addendum was approved by DM Operations prior to the daily meeting but the time was not recorded. GC1 was not listed on the SWP as a craftsman assigned to perform work at Cavern 5.

At about 0645 hours, GC1 reported to the SPR-BM site for the workday. The four Grass Cutters (GC1, GC2, GC3, and GC4) discussed among themselves who would perform specific tasks during the workday. The Grass Cutters had all worked together before at the SPR-BM site, and immediately accepted GC1 into the group as a peer. GC1 told the other Grass Cutters that he did not want to mow and wanted to use a weedeater.

From about 0730 to 0745 hours the SMT conducted a morning meeting for all four Grass Cutters (GC1, GC2, GC3, and GC4). The SMT was the DM employee assigned as the work supervisor for the Ashton, Inc., employees, which included the Grass Cutters and Painters. The SMT had about eight years of experience with the grass cutting crew and was familiar with GC1 because he had served as GC1's supervisor prior to GC1's leaving the SPR-BM site in 2008. The SWP was discussed, but the three Job Hazard Analyses (JHAs) associated with mowing, weedeating, and herbicide application activities were not included. No issues or concerns were identified with the planned activities. The SMT clearly communicated that GC1 would be performing weedeating and would not be involved in mowing activities. GC1 had not completed formal on-the-job training (OJT) for weedeating, but based on previous experience with GC1, the SMT directed GC1 to perform weedeating activities. GC1 was not authorized by the SMT to perform mowing activities, and other Grass Cutters confirmed that it was standard DM practice to require completion of OJT for Large and Small Tractor Mowing before being allowed to use a mower without direct supervision.

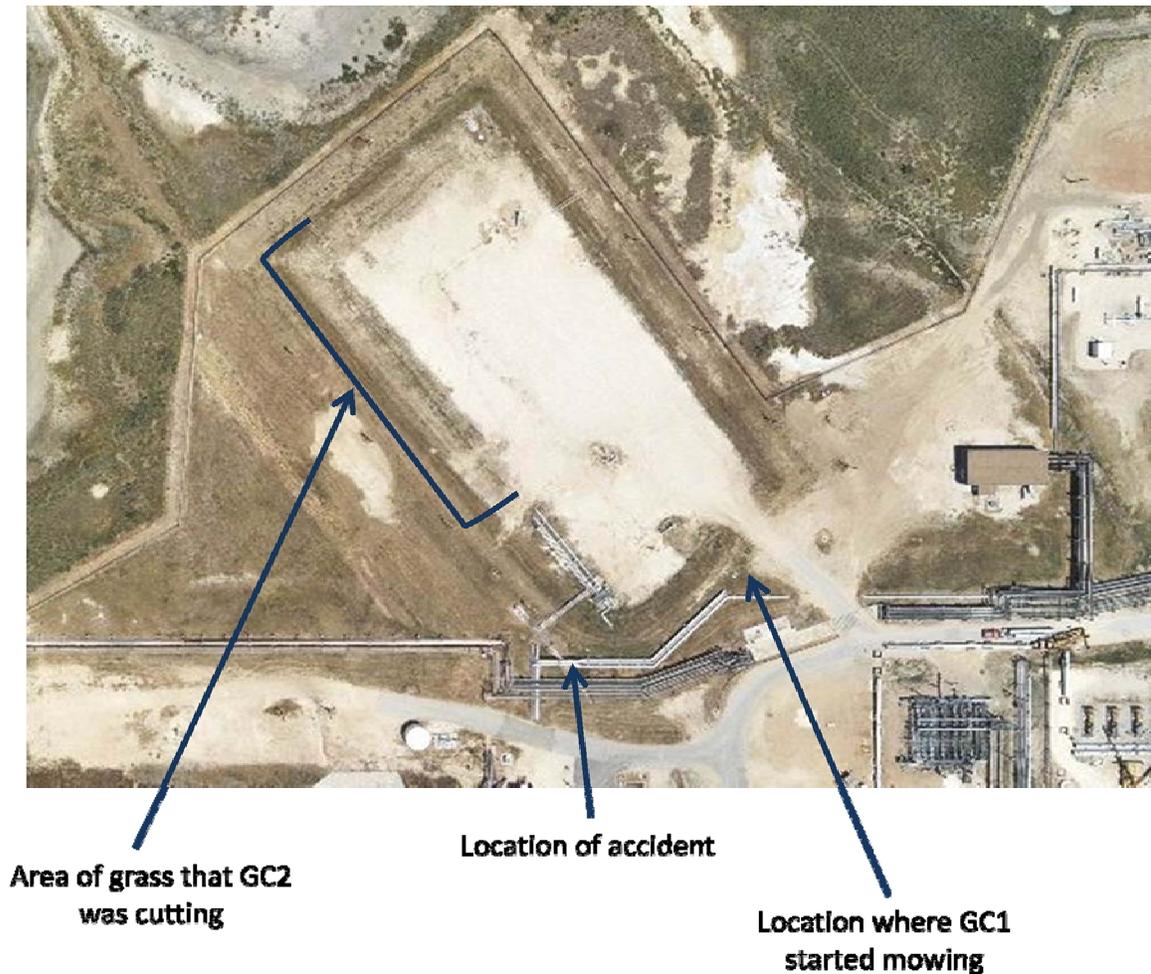


Figure 2-2: Location of Cavern 5 on the SPR-BM Site

The SMT informed the Grass Cutters that there were rumors that an ERT drill was scheduled to be held sometime during the day. At about 0745 hours after the morning meeting, the SMT asked GC1 to remain in the office area to view a safety orientation video (ESSH0050).

At about 0800 hours, GC2, GC3, and GC4 departed the Maintenance Shop to obtain the grass cutting equipment. GC4 performed Daily Checklist Powered Mowers for ELN: BMEQ-315 (Mower 1), which required a check of the body condition, fuel/oil level, safety shields, tires and wheels, and hydraulic fluids. The daily check identified that there was a loose wheel on the mowing deck. The daily checklist did not include several safety inspection items specified in the equipment Operator's Manual.

At about 0800 hours, GC1 completed the safety orientation video, and together with the SMT completed a Training Activity Attendance Report (TAAR). The SMT then assigned GC1 to work on the application necessary to obtain a permanent security badge until about 0830 when the ERT drill was initiated.

At about 0830 hours, in response to the ERT drill, the SMT called GC3 and asked him to come to the Maintenance Shop to pick up GC1. Because it was close to morning break time (0900 hours), GC2, GC3, and GC4 all came to the Maintenance Shop to pick up GC1. With all four Grass Cutters present, the SMT reiterated that GC1 was to stay off the mowers and to use a weedeater until the Grass Cutters were off Cavern 5. The SMT also told GC2, GC3, and GC4 to take care of GC1 and to call if they had any problems. During the morning break, GC1 was observed to be interacting and communicating normally with other workers. It was also observed that GC1 ate food and drank liquid.

Sometime between 0915 and 0930 hours the four Grass Cutters left the Maintenance Shop together for a nearby area to complete grass cutting and then to move the equipment to Cavern 5. Because of the ERT drill the SMT was not available to provide supervision at the worksite.

At approximately 1100 hours, GC2 and GC4 drove two mowers to the entrance of Cavern 5. GC4 drove Mower 1 and noted that one of two front wheels on the mowing deck vibrated excessively and needed to be replaced. GC4 had used Mower 1 for several days immediately prior to the accident and had performed daily inspections on September 12 and 13, 2011. With the exception of the front wheel on the mowing deck, GC4 stated that Mower 1 did not appear to have any steering or maintenance problems. GC4 also stated that Mower 1 had not recently been used in a brushy area. At about 1100 hours, GC2 took the other mower at Cavern 5 and began cutting grass to the north and was not present to observe subsequent communication between GC1 and GC3 and GC4.

At about 1100 hours, GC1 and GC3 returned from the Maintenance Shop with tools and a spare wheel to repair the Mower 1 attachment, and at about 1110 hours, GC3 and GC4 completed changing the wheel on the Mower 1 attachment. After completing the wheel change GC3 and GC4 recognized they needed to depart Cavern 5 for separate reasons. GC3 had been directed to act as an escort for a tire company representative and GC4 needed to go to the main gate to pick up his lunch. Lunch was scheduled to start at 1130 hours.

GC3 then noticed that GC1 was taking an interest in and walking around Mower 1. GC1 told GC3 and GC4 that he wanted to get acquainted with and operate the mower. GC3 and GC4 told GC1 not to worry about operating the mower, and continued several times to discourage GC1 from getting on the mower. GC1 continued to state he wanted to get acquainted with the mower, and sat on the mower. GC 3 told GC1 that if he was going to sit on the mower, to stay right here, saying, *“If you want to turn it on, that’s up to you, but don’t go anywhere or cut anywhere else. Don’t mow. Don’t do nothing. Just turn it on and you can kind of mess with the levers here so you can get acquainted with it.”* GC1, GC3, and GC4 were peers and none had the positional supervisory authority to direct another. GC3 and GC4 encouraged GC1 to leave with them.

Upon leaving the area to depart for their errands, GC3 and GC4 heard the mower running in low revolutions per minutes (RPM) at the entrance of Cavern 5, with GC1 in the same spot they had left him. GC3 told GC4, *“Well, that’s fine. You got to get your lunch. I’ve got to get this escort [tire delivery]. There’s not much more time we can just stand around and waste time with it.”* By default GC2 (who was mowing in an adjacent area) was the escort (GC1 was onsite under an escort badge) and Buddy System partner for GC1, but GC2 had not been informed of those duties. GC3 and GC4 later indicated that GC1’s physical condition appeared normal.

Sometime between 1120 and 1125 hours, GC1 began to operate Mower 1. The path cut in grass (Figure 2-3) indicates that GC1 mowed west about 128 feet, then southwest about 173 feet, then west about 90 feet before making about an 18 foot radius turn for about 200 degrees around an unmarked concrete obstruction before Mower 1 contacted three large elevated pipes oriented east and west. The path cut in the grass indicated that GC1 was in control of Mower 1 and that he made straight cuts and accurate turns before contacting the pipes (Figure 2-3). After completing a 180 degree turn around the unmarked concrete obstruction, GC1 was about eight feet from the nearest above ground pipe and needed to either stop or quickly maneuver Mower 1 to prevent contact with the pipe. The reason GC1 did not stop or maneuver Mower 1 before contacting the pipes was not determined. Sometime between 1125 and 1130 hours, Mower 1 and GC1 struck three large elevated pipes with significant force (Figure 2-4).

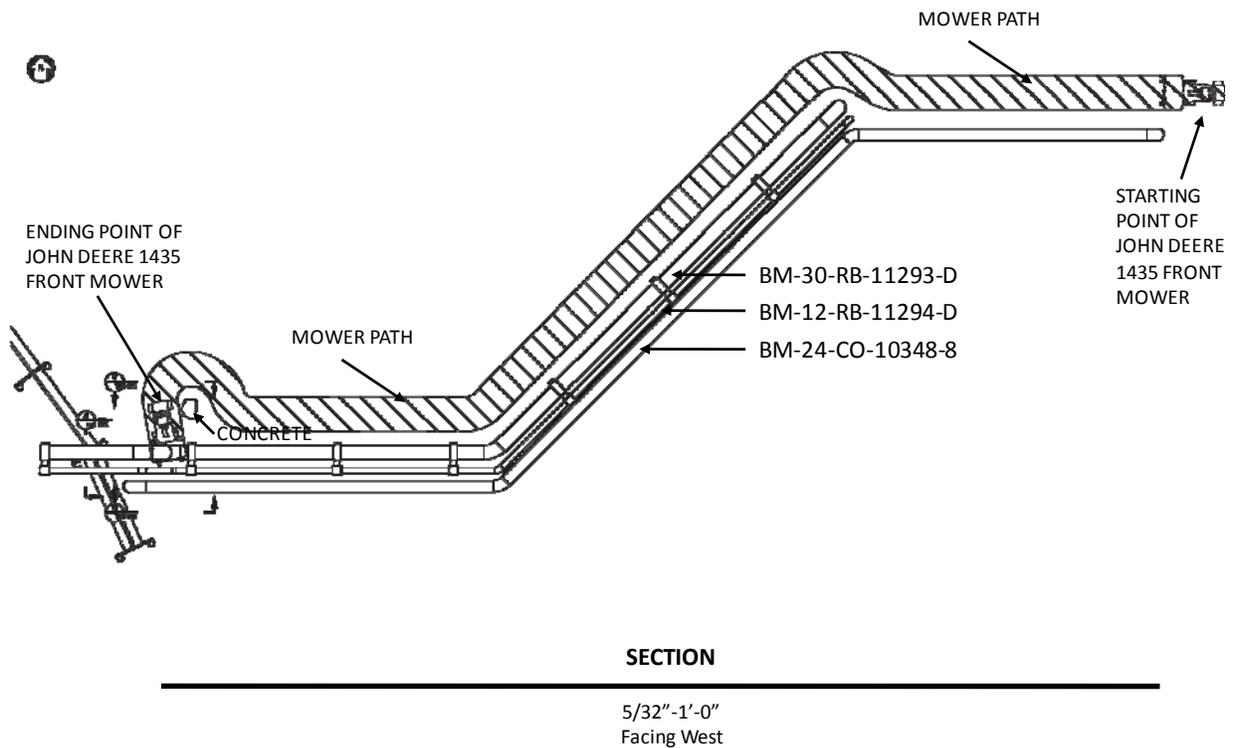


Figure 2-3: Path of Mower along Pipes



Figure 2-4: Photograph of Section of Pipes Struck by GC1

The steering wheel of Mower 1 passed under the largest pipe at an elevation of 4 feet 0 inches above grade and Mower 1 continued south-southeast until the right vertical part of the Roll Over Protection Structure (ROPS), located behind the driver's seat, contacted the nearest pipe (Figure 2-5). When the right vertical part of the ROPS contacted the nearest pipe, Mower 1 pivoted horizontally until the left vertical part of the ROPS contacted the same pipe and stopped forward motion. Sufficient energy remained that when forward motion stopped Mower 1 pivoted on the right and left vertical parts of the ROPS and lifted the mowing attachment with sufficient force to strike the farthest pipe. In that position there were only a few inches of clearance between the seat and the pipe. At the time this report was finalized, the final autopsy report had not been issued, but preliminary verbal and written reports from the Galveston County Medical Examiner's Office indicated that GC1 had sustained significant blunt force trauma that resulted in a severed spinal cord and internal bleeding.

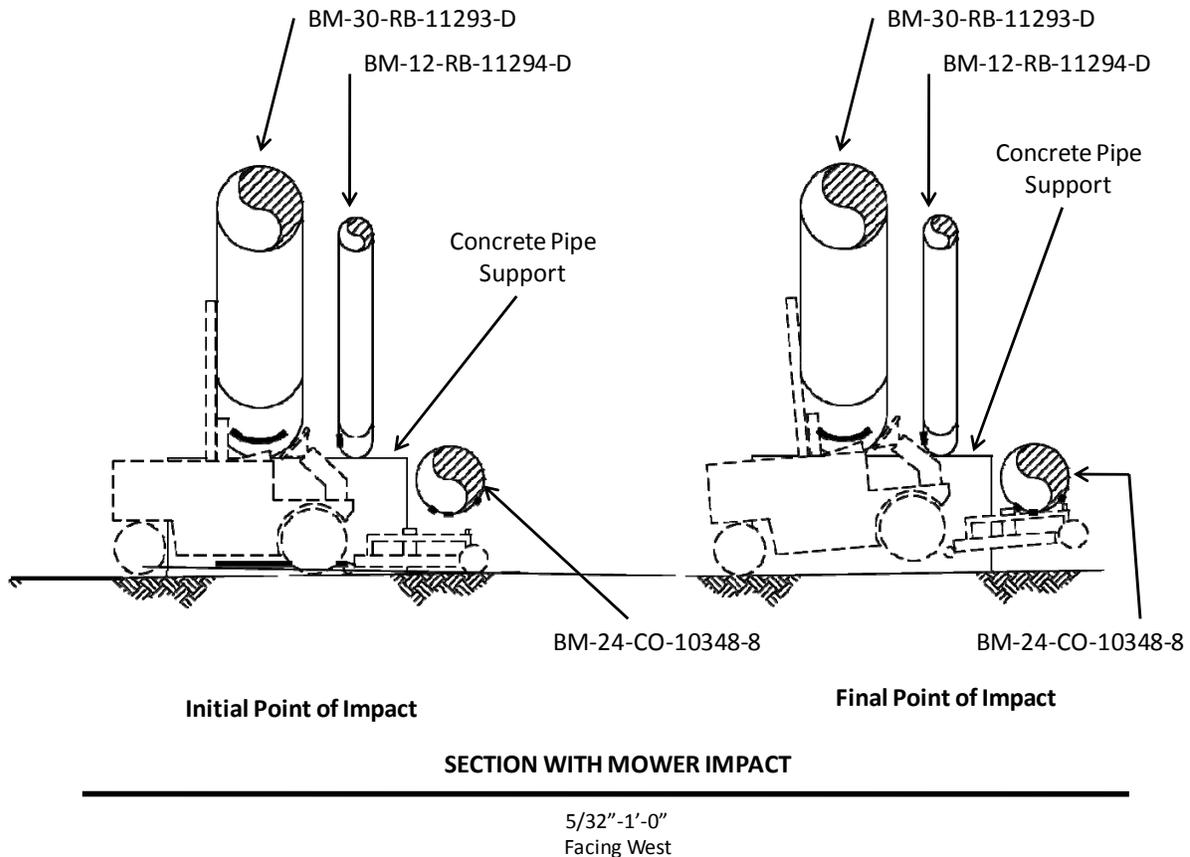


Figure 2-5: Position of Mower at Maximum Impact

DM was aware that some areas of the SPR-BM site are difficult to mow and had applied herbicide to eliminate the need to mow. The area under the pipes that were contacted by Mower 1 had been treated with herbicide and did not require mowing. GC4 later stated that if he had been mowing in the same area he would have gone slow, and would have used the steering wheel and not the turn brakes to steer Mower 1.

Sometime between 1125 and 1130 hours, GC2 noticed GC1 on Mower 1 facing south in the southwest corner of the Cavern 5 area. GC2 continued mowing, and soon after first noticing GC1 on Mower 1, observed GC1 from a different angle that allowed him to see that GC1 had not moved and that he was leaned over to the right side of the mower.

At about 1132 hours, GC2 approached GC1 and found him pinned between Mower 1 and a pipe. In accordance with the SPR-BM site policy GC2 called the SMT by cellular phone and reported the accident. When GC2 arrived at the accident scene he found the engine of Mower 1 running and the blades of the mowing deck stopped.

The SMT hurried out of the Maintenance Shop and drove a vehicle to Cavern 5 where he located GC2 at the scene of the accident.

At about 1133 hours, soon after arriving at the scene of the accident the SMT, a qualified ERT member, checked GC1 and immediately radioed the Control Room Operator (CRO) to request ERT and ambulance assistance. The SMT found GC1 without a pulse, nonresponsive, and without any obvious external injuries or marks. Soon after the SMT arrived at the accident scene, GC2 placed Mower 1 in reverse and moved Mower 1 away from the pipes. The SMT and GC2 then removed GC1 from Mower 1 and laid him on the ground so the SMT could perform CPR.

ERT members began to arrive at the scene and assisted with CPR and other emergency response actions.

At 1136 hours the CRO called 911.

At 1137 hours, the CRO notified Wackenhut Security Inc. Bryan Mound (WSI-BM) that an ambulance would be arriving onsite. WSI-BM had monitored the Operations radio channel, had heard the initial call for emergency assistance, and had initiated their own procedures for responding to the scene and preparing for arrival of offsite emergency vehicles.

At 1140 hours, the site fire truck arrived at the scene with emergency equipment. At 1145 hours, the ERT placed an Automated External Defibrillator (AED) on GC1. The AED did not detect conditions requiring the delivery of a shock and no shocks were administered.

At 1148 hours, the CRO called the Freeport Fire and Emergency Medical Services (EMS) Dispatch to obtain an estimated time of arrival for the ambulance. Freeport Fire and EMS Dispatch advised the CRO that Freeport EMSs were on calls and that they had dispatched Surfside EMS and off duty EMSs from Clute and Freeport who would be responding in private vehicles.

At 1157 hours, a county medical unit and a Freeport EMS arrived at the accident scene, and at 1203 hours, a Clute EMS arrived at the accident scene. At 1210 hours, EMS personnel placed GC1 on a backboard in preparation for transfer to an ambulance. At 1215 hours, a Surfside ambulance arrived on scene, at 1217 hours, GC1 was placed in the ambulance, and at 1220 hours, the ambulance departed the SPR-BM site for Brazosport Memorial Hospital.

At about 1235 hours, SPR-BM site WSI-BM set up containment of the accident scene area, and at about 1325 hours, they photographed the accident scene and collected the AED for evidence.

Between 1255 and 1315 hours, two Brazoria County Sherriff representatives, a Lieutenant and an Investigator, conducted an investigation of the scene of the accident. Between 1310 and 1325 hours, a Brazoria County Sherriff Crime Scene Investigator photographed the scene of the accident.

At about 1500 hours, the Brazoria County Sheriff's Department notified the DM Site Protection and Physical Security Specialist that the time of death for GC1 was 1220.

Between 1648 and 1720 hours, ten DM and WSI-BM employees entered the scene of the accident. At least two individuals were allowed access to Mower 1, and some controls were

changed from the “as found” condition. This fact was not disclosed to the Board until September 28, 2011.

On September 14, 2011, between 1015 and 1700 hours, a Department of Labor Occupational Safety and Health Administration (OSHA) principal investigator visited the SPR-BM site and investigated the scene of the accident and interviewed DM management, the owner of Ashton, Inc., and subcontractor employee Grass Cutters.

On September 21, 2011, at ~1452 hours, the Board received permission from the OSHA principal investigator to physically inspect, analyze, and move Mower 1.

On September 21, 2011, GC1’s lunchbox was found to contain two prescription medications, one labeled that it may cause dizziness.

On September 30, 2011, the Board released custody of the scene of the accident.

Table 2-1: Chronology of Events

Date and Time (hours)	Event
9/12/2011	GC1 began employment at the SPR-BM site.
9/12/2011 Evening	An Ashton, Inc., representative informed DM that GC1 passed employee physical and was ready to perform work.
9/13/2011 0632 hours	SMT initiated an addendum for the SWP for grass cutting operations at Cavern 5.
9/13/2011 ~0645 hours	GC1 reported to the SPR-BM site for the workday.
9/13/2011	The four Grass Cutters discussed who would perform specific tasks during the workday.
9/13/2011 ~0730 - 0745 hours	The SMT conducted a morning meeting for all four Grass Cutters.
9/13/2011 ~0800 hours	GC2, GC3 and GC4 departed the Maintenance Shop to get the grass cutting equipment and perform the daily Checklist for Mower 1.
9/13/2011 ~0830 hours	In response to the ERT drill, the SMT called GC3 and asked him to come to the Maintenance Shop to pick up GC1. Because it was close to morning break time (0900 hours), GC2, GC3, and GC4 all came to the Maintenance Shop to pick up GC1.

Date and Time (hours)	Event
9/13/2011 ~0900 - 0930 hours	During the morning break GC1 was observed to be interacting and communicating normally with other workers. It was also observed that GC1 ate food and drank liquid.
9/13/11 ~0915 - 0930 hours	The four Grass Cutters left the Maintenance Shop together for the Pig Launch area to complete grass cutting and then to move the equipment to Cavern 5.
9/13/2011 ~1100 hours	GC4 drove Mower 1 to Cavern 5 and noted that one of two front wheels on the mowing deck vibrated and needed to be replaced.
9/13/2011 ~1100 hours	GC2 took the other mower at Cavern 5 and began cutting grass to the north and was not present to observe subsequent communication between GC1 and GC3 and GC4.
9/13/2011 ~1110 hours	After completing the wheel change GC3 and GC4 recognized they needed to depart Cavern 5 for separate reasons.
9/13/2011 ~1120 hours	GC3 noticed that GC1 was taking an interest in and walking around Mower 1. GC3 and GC4 tried to convince GC1 to leave with them.
9/13/2011 ~1120 hours	When departing the area GC3 and GC4 heard the mower running in low RPM with GC1 in the same spot they had left him.
9/13/2011 ~1120 - 1125 hours	GC1 began to operate Mower 1.
9/13/2011 ~1125 - 1130 hours	At about 1125 hours Mower 1 and GC1 contacted three large elevated pipes.
9/13/2011 ~1125 - 1130 hours	GC2 noticed GC1 on Mower 1 facing south in the southwest corner of the Cavern 5 area.
9/13/2011 ~1130 hours	GC2 noticed GC1 on Mower 1 near the pipes and observed that GC1 had not moved and that he was leaned over to the right side of the mower.
9/13/2011 ~1132 hours	GC2 approached GC1 and found him pinned between Mower 1 and a pipe. GC2 called the SMT by cellular phone and reported the accident.

Date and Time (hours)	Event
9/13/2011 ~1132 hours	The SMT hurried to Cavern 5.
9/13/2011 ~1133 hours	The SMT, a qualified ERT member, immediately radioed the CRO to request ERT and ambulance assistance.
9/13/2011 ~1134 hours	GC2 placed Mower 1 in reverse and moved it away from the pipe. The SMT and GC2 placed GC1 on the ground so the SMT could perform CPR.
9/13/2011 ~1134 hours	ERT members began to arrive at the scene and assisted with CPR and other emergency response actions.
9/13/2011 1136 hours	The CRO called 911.
9/13/2011 1137 hours	The CRO notified WSI-BM that an ambulance would be arriving onsite.
9/13/2011 1145 hours	An ERT placed an AED on GC1. The AED did not detect the physical conditions suitable for delivering a shock and no shocks were administered.
9/13/2011 1145 hours	The CRO called the Freeport Fire and EMS Dispatch to obtain an estimated time of arrival for the ambulance.
9/13/2011 1157 hours	A County medical unit and an off-duty Freeport EMS arrived at the accident scene.
9/13/2011 1203 hours	An off-duty Clute EMS arrived at the accident scene.
9/13/2011 1210 hours	EMS personnel placed GC1 on a backboard in preparation for transfer to an ambulance.
9/13/2011 1215 hours	Surfside ambulance arrived on scene.
9/13/2011 1217 hours	GC1 was placed in the ambulance.
9/13/2011 1220 hours	The ambulance departed the SPR-BM site for Brazosport Memorial Hospital.
9/13/2011 1255 - 1315 hours	Two Brazoria County Sherriff representatives, a Lieutenant and an Investigator, conducted an investigation of the scene of the accident.

Date and Time (hours)	Event
9/13/2011 1310 - 1325 hours	A Brazoria County Sherriff Crime Scene Investigator photographed the scene of the accident.
9/13/2011 ~1500 hours	Brazoria County Sheriff's Department informed DM that the time of death for GC1 was 1220 hours.
09/13/2011 1648 - 1720 hours	Ten DM and WSI-BM employees entered the scene of the accident. At least two individuals were allowed access to Mower 1, and some controls were changed from the "as found" condition. This fact was not disclosed to the Board until September 28, 2011.
09/14/2011 1015 - 1700 hours	A Department of Labor OSHA principal investigator visited the SPR-BM site and investigated the scene of the accident and interviewed DM management, the owner of Ashton, Inc., and subcontractor employee Grass Cutters.
9/21/2011 ~1452 hours	The Board received permission from the OSHA principal investigator to physically inspect, analyze, and move Mower 1.
9/30/2011	The Accident Investigation Board released custody of the scene of the accident.

2.3. Contractor and DOE Management Response

2.3.1. Contractor

The Occurrence Reporting and Processing System (ORPS) report for this event (FE--SPRO-SPR-BM-2011-0001) was categorized on September 13, 2011, at 1406 CTZ as an ORPS 2A(1) SC1, *Any injury or chemical or biological exposure that results in or is likely to result in, the fatality of an employee or member of the public.* The ORPS report met the requirements of DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information.* The SPR-BM site's immediate actions were included in the occurrence report.

On September 13, 2011, at 1342 hours, the DM NOLA Operations Control Center (OCC) sent an Event Notification via email indicating they had been notified of a medical emergency involving a Grass Cutter at the SPR-BM site, and directing the immediate suspension of all grass cutting activities at SPR sites until further notice. At 1622 hours, the DM NOLA OCC sent an SPR Crosstalk Information Exchange Program notice via email to all SPR users regarding the SPR-BM site accident that communicated several safety messages on the importance of safety at work, and guidance on recognition and prevention of pinch point situations and potential for injuries.

On September 13, at 1420 hours, the DM Environment, Safety and Health (ES&H)/Technical Services (TS) Manager phoned the Houston OSHA office to notify them and provide information concerning the accident. OSHA indicated that an OSHA representative would arrive at the site at approximately 0830 hours on September 14, 2011.

2.3.2. DOE

On September 13, 2011, at 1455 hours, the Project Officer from the SPR PMO in NOLA provided an update on actions and information concerning the accident via email to DOE SPR managers at the SPR-BM site and SPR-HQ that included the DM action of all SPR mowing activity being suspended until further notice, and that the DOE Office of Health, Safety and Security (HSS) would be notified later that day and advised of the accident and steps taken by DM and the SPR PMO.

On September 20, 2011, the SPR-BM Site Senior Representative issued an Observation Report (BM-MO-2011-58) to DM identifying the current DM inventory of seven mowers and documenting that, not including the mower involved in the September 13, 2011, accident, no maintenance deficiencies were found for these mowers based upon the review of preventative maintenance records. Several opportunities for correction (e.g., to include flat tires on two mower units; outdated maintenance tags attached to one mower) were identified; work orders and estimated completion dates for these corrections were requested by October 4, 2011.

2.4. Investigative Readiness and Scene Preservation

The scene of the accident was secured by WSI-BM law enforcement officers at about 1235 hours, shortly after GC1 was transported from the scene via ambulance. WSI-BM completed a 360 degree containment of the scene including officers posted at the entrance of Cavern 5 with direction to contact the DM Site Security Specialist to gain approval for anyone attempting to enter the area. Around 1325 hours, the DM Site Security Specialist began taking photos of the scene and documenting the items used during the SPR-BM site ERT response and items that would be used during the investigation.

The scene was first controlled by posted WSI-BM security officers through September 21, 2011, and from September 21 through September 30, 2011, the scene was continually monitored by security camera. The Board received permission from the OSHA principal investigator, who was conducting an investigation for OSHA under their legal authority, at 1452 hours via email on September 21, 2011, to physically inspect, analyze, and move Mower 1. The Board retained custody of the scene through September 30, 2011.

The Board determined through additional interviews that the accident scene was not adequately preserved directly following the accident, and that the Mower 1 brake pedal was engaged after the accident by DM management personnel reviewing the scene. The Board Chairperson was not informed of this until September 28, 2011. The Board spent time needlessly trying to determine why the brake pedal would have been depressed at the time of the accident.

The Board concluded that the accident scene was not adequately preserved, since DM management and staff were allowed access to Mower 1 following the accident.

2.5. Accident Analysis

2.5.1. 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 GC1 as the target and contact with a large elevated pipe as the hazard. There were 12 barriers identified and analyzed by the Board:

- B1) Supervision,
- B2) Morning Meeting,
- B3) Safe Work Permit,
- B4) Job Hazard Analysis,
- B5) On-The-Job Training,
- B6) Preventive Maintenance,
- B7) Daily Maintenance Checklist,
- B8) Escort Requirements,
- B9) Buddy System,
- B10) Stop Work Policy,
- B11) Equipment Safety Features (e.g., steering, brakes, controls), and
- B12) Warning Postings on Mower 1.

The analysis indicated that all the barriers played a role in directly exposing the target to the hazard in this accident. The Barrier Analysis is presented in Appendix B.

2.5.2. Change Analysis

To further support the development of causal factors, the Board performed a Change Analysis of the accident. The Board examined the planned and unplanned changes that caused the undesired results or outcomes related to the event. The changes that related to this accident were:

- C1) Before the job was completed GC3 was called away to perform escort duties and GC4 decided to go with him,
- C2) Wheel on Mower 1 mowing deck needed to be replaced,
- C3) GC1 was mowing in an area that contained many obstacles (e.g., pipes, electrical boxes, above grade concrete structures),
- C4) GC1 was a new employee who had been onsite less than 24 hours, but had previous experience at the SPR-BM site,
- C5) Because of an ERT drill the SMT was not able to remain with GC1,
- C6) GC1 did not follow the SMT's direction to not use a mower,
- C7) GC1 had not completed OJT and was not qualified to operate Mower 1,
- C8) SWP did not include GC1 as a craftsman assigned to perform grass cutting in Cavern 5, and
- C9) Peers did not stop or suspend work and allowed work to be performed outside established control boundaries.

The Change Analysis is presented in Appendix C.

2.5.3. Error Precursor Analysis

To further support the development of causal factors, the Board also performed an Error Precursor Analysis of the accident. Like the Barrier Analysis and the Change Analysis, the Error Precursor Analysis is another tool used in the examination of evidence to determine the causes of an accident and to help prevent recurrence. A more detailed description of error precursors and the analysis are found in Section 2.12, *Human Performance Improvement*.

Using a checklist of potential error precursors in four categories, the Board reviewed each error precursor and identified if and where it was in existence in relation to the accident. The analysis resulted in the identification of 16 different error precursors on the day of the accident. Four of the identified error precursors existed more than one time that day. The error precursors identified were:

- P1-A) Time Pressure,
- P1-F) Interpretation of Requirements,

- P1-G) Unclear Goals, Roles, or Responsibilities,
- P1-H) Lack of or Unclear Standards,
- P2-A) Distractions/Interruptions,
- P2-B) Changes/Departure from Routine,
- P2-D) Work-Around/Out-of-Service Instrumentation,
- P2-J) Excessive Group Cohesiveness/Peer Pressure,
- P3-A) Unfamiliarity with Task/First Time,
- P3-B) Lack of Knowledge (faulty mental model),
- P3-C) New Technique not used before,
- P3-E) Lack of Proficiency/Inexperience,
- P4-F) Inaccurate Risk Perception,
- P4-P) “Something is not right” (gut feeling),
- P4-R) Social Deference (excessive courtesy), and
- P4-X) Imprecise Physical Actions.

The Error Precursor Analysis is presented in Appendix D.

2.5.4. Event and Causal Factors Chart

After performing the barrier, change, and error precursor analyses, the Board assigned results from each analysis to events on the chronology of events. This involved assigning analysis results as conditions that were related to or caused the events on the chronology. Assigning these conditions with events resulted in the Events and Causal Factors (ECF) chart in Appendix E. Once conditions were assigned, the Board examined the ECF 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 were:

Direct Cause:

1. Mower 1 and GC1 struck elevated pipes.

Root Cause:

1. GC1 failed to follow supervisor's direction to stay off mower, and
 2. Organizational Stop Work policy and its implementation did not address less than imminent danger situations.

Contributing Causes:

1. Less than adequate Work Control Process (JHA, SWP, pre-job briefing, work assignments),
 2. GC1's lack of competency in operating Mower 1,
 3. GC1 was a new employee with previous experience at the SPR-BM site,
 4. Unavailability of the supervisor due to other duties, and
 5. GC1 was left alone with Mower 1 when GC3 and GC4 left the worksite.

2.6. Examination of Evidence

The Board arrived at the SPR-BM site on September 20, 2011, seven days after the accident occurred. Documents, combined with oral interviews, provided the Board with valuable information pertaining to work control, other management systems, and industrial safety practices that were in place at the time of the accident. Interviews with personnel also provided a detailed description of the activities that occurred on the day of the accident and during emergency response. There were no witnesses to the actual accident itself. The Board examined physical evidence that was directly related to the accident – in particular evidence at the scene of the accident.

2.6.1. Physical Evidence

The Board visited the accident scene on September 20, 2011, to examine the scene and physical evidence. At that time the Board noted the following:

- Mower 1 was backed away from the largest pipe with the mower deck still extended under the two additional pipes (Figure 2-6),

- The left and right turn brake pedals were abnormally depressed compared to the “normal” position depicted in the John Deere Operator’s Manual. The left turn brake pedal was also depressed further to the floor than the right turn brake pedal,



Figure 2-6: Position of Mower after Accident

- There was an unmarked concrete obstruction near Mower 1 that GC1 steered around prior to impacting the pipes (Figure 2-7),
- The mower seat appeared to be bent back when compared with the drawing in the John Deere Operator’s Manual,
- The steering column was bent down – probably as a result of the impact,
- There were a number of scratches and scrapes on the mower and the piping that appeared to result from the mower impact,



**Figure 2-7: Location of Unmarked Concrete Obstruction
GC1 Maneuvered Around**

- There was a tie rod directly below the left and right turn brake pedals and underneath the Mower 1 frame that was disconnected. A stick of approximately 3/4 inch diameter and over a foot in length was wedged near the disconnected tie rod. A smaller stick was also wedged below the larger stick (Figure 2-8),



Figure 2-8: Disconnected Tie Rod (and Missing Pin) with Stick Wedged in Frame

- Half of the Power Take Off (PTO) shield was missing from under the mower. This was also observed by an independent expert/consulting engineer on agricultural and grounds maintenance equipment. Inspecting the shields is a maintenance item identified in the John Deere Operator's Manual that is not in the SPR-BM Maintenance Requirement Card for this Mower 1, and
- There was a hard hat and a pair of safety glasses on the mower deck, and a pair of safety glasses on the ground near the mower.

On September 28, 2011, the Board revisited the accident scene along with a representative from John Deere and an independent expert/consulting engineer on agricultural and grounds maintenance equipment to further inspect and test Mower 1. The John Deere representative stated that she could make no comments unless there was a specific safety issue with the mower. The John Deere representative did an inspection, took numerous photographs for the apparent use of John Deere only, and started the mower but did not operate it. At the time the John Deere representative departed, she stated that there were no safety issues with Mower 1.

The independent expert/consulting engineer on agricultural and grounds maintenance equipment also conducted an inspection, took photographs, and operated the mower under a variety of conditions at the request of the Board. During these two inspections, the Board noted the following additional information:

- The mower was on level ground,
- The throttle was in the “mid” position,
- The parking brake was partially engaged,
- The left side of the ROPS was bent back about 1/2 inch,
- All of the designed safety features and interlocks were functioning,
- The linkage pin in the left turn brake was missing and appeared, based on rust and corrosion, to have been missing before the accident occurred. The pin was not located at the accident site. The left turning brake did not function,
- The right turn brake functioned but not well. When fully pushed it did not lock the right wheel,
- Mower 1 operated in the forward and reverse directions with no problems. When the foot was removed from the forward or reverse pedal the mower immediately stopped without applying the brake (this is as designed), and
- The steering wheel and steering functions using the wheel worked as designed.

On September 29, 2011, the Board requested that DM provide a qualified operator for Mower 1 so that they could conduct additional operating inspections. At that time the Board noted the following additional information:

- When the parking brake is depressed about one-third of the way, the PTO disengages (this is a design safety feature). The parking brake cannot be locked in place at this point but can be locked at the first ratchet notch after pushing it down approximately 1/2 inch further,
- The PTO will not engage if the parking brake is on (this is a design safety feature), and
- The mower will back up with the parking brake set at any position but very slowly. It requires a great deal of force on the pedal with a foot or hand even with the parking brake locked only at the first ratchet notch. The operator of the second mower, GC2, who was one of the first responders at the scene and helped to back up Mower 1 to remove GC1, stated he believed that was much greater force than the SMT used to push the pedal and back up the mower.

The additional testing on September 29, 2011, was done to try to account for how Mower 1 was moved or operated with the parking brake on (as found condition). Upon further investigation that day, the Board determined through additional interviews with DM employees and the DM

Chief Executive Officer (CEO) that the accident scene was not adequately preserved and the brake pedal was engaged after the accident by DM management personnel gaining access and reviewing the scene after the accident.

Analysis

The Board determined that although there were maintenance issues with Mower 1, there were no defective design safety features or other features on the mower that would have directly caused the accident if the mower had been operated by a qualified operator.

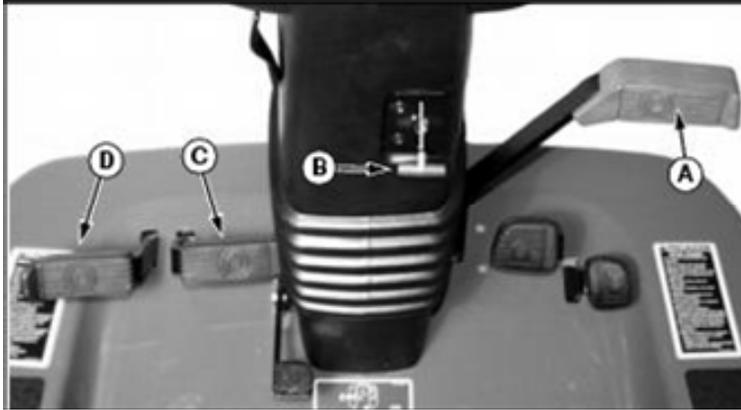
As noted in the physical evidence, the left turn brake was not operable because of a missing pin from the linkage. It could not be positively determined if this was caused by the accident but there was corrosion on the internal area of the linkage that would indicate that the pin had been missing prior to the accident and a search of the accident scene did not produce the missing pin. The right turn brake was functioning but out of adjustment. In addition, half of the PTO shield was missing and was not found at or near the accident scene. These apparent long-standing deficiencies with the brakes and PTO shield could be attributed to the DM maintenance program which did not maintain the braking system or the PTO shield in accordance with the John Deere Operator's Manual as further described in Section 2.6.5.3. Figure 2-9, taken from the John Deere Operator's Manual, portrays information regarding the purpose and operation of the brakes on Mower 1.

Although the Board identified maintenance issues with the turning brakes, they are operated by independent brake pedals that are not used to stop the mower, but to assist in making tight turns with the mower. The master brake, which was out of adjustment but functioning, is used for emergency stopping. This function was verified as operational by the Board.

The independent expert/consulting engineer on agricultural and grounds maintenance equipment determined that for some unknown reason GC1 may have mistakenly pushed the forward operating pedal and that action caused the impact of Mower 1 with the pipes. Based on a review of the physical evidence, the Board has not found any evidence to dispute that conclusion. See Section 2.12.1.1, *Individual Capabilities*, for more discussion on this determination.

Using Brakes

Using Master Brake Pedal



1. Push the master brake pedal (A) down to hold the machine stationary on a slope, or for an emergency stop. PTO will disengage when master brake pedal is depressed, and PTO switch will have to be recycled once brake is released to restart PTO.

Using Park Brake

1. Lock the park brake by pulling the park brake lock lever (B) upwards, and fully depressing the master brake pedal (A). The pedal should stay locked down.
2. Unlock the park brake by depressing the master brake pedal, and pushing the park brake lock lever down. Release the master brake pedal.

Using Turn-Brakes

The turn-brakes are used to change direction quickly within the width of the machine. Avoid locking the tire with turn-brake in areas where turf damage is not acceptable. Turn-brakes will not turn machine if differential lock is engaged.

1. Depress the right turn-brake pedal (C) to slow or stop the right front wheel, while power is applied to the left wheel. The machine will turn to the right. Release the turn-brake pedal to resume driving in a straight line.
2. Depress the left turn-brake pedal (D) to turn to the left.

Figure 2-9: “Using Brakes” from the John Deere Operator’s Manual for the Model 1435 Front Mower Series II

2.6.2. Work Control

2.6.2.1. Safe Work Permit

Anyone performing work on the SPR-BM site or SPR right-of-way is required to obtain a SWP for hot work, safe clearance, confined space entry and work authorization. According to Section 30, *Safe Work Permits*, of the DM Accident Prevention Manual (APM), the purpose of the permit is to “*create and sustain a working environment as free of hazards as possible; a ‘safety envelope’ in which to perform the work.*” By issuing the permit, DM Operations validates that they have made the work area as safe as possible and have authorized the work to be performed based on the description of work. By initiating and accepting the permit, contractors and subcontractors are committing to perform the work in accordance with the permit requirements. On the day of the accident, in addition to a SWP for general work areas around the SPR-BM site, there were two SWPs that had been authorized by DM Operations for work to be performed by the Grass Cutters.

The SWP form used at the SPR-BM site includes a space for listing the location/description of work, a box to check if there is a JHA for work listed, a space to list the craftsman assigned to maintain the SWP at the work site, a table to list the results of atmospheric testing including oxygen and hydrogen sulfide (H₂S) gas concentration levels, and a work authorization section to be signed by the initiator and DM Operations.

APM Section 30, *Safe Work Permits*, states that typically the Subcontract Manager’s Technical Representative for the work to be performed by a subcontractor fills out the SWP and presents it to DM Operations for review and approval. Section 30 further states that work authorization implemented by this approval meets the requirements of Integrated Safety Management (ISM) Principle 7, Operations Authorization. APM Section 38, *Integrated Safety Management*, defines authorizations by stating that all work activities will be subject to authorization based on the appropriate review and readiness to perform work.

APM Section 30.3, *Training*, requires that all personnel including subcontractors that are affected by a SWP receive SWP training by the M&O contractor and that the training be documented on a Training Activity Attendance Report (TAAR). The Grass Cutters did not remember having taken this training and no TAARs were provided for the Grass Cutters. The SMT stated that he had given the Grass Cutters this training in the past. This training was not listed on the Grounds Maintenance Training Matrix provided to the Board.

APM Section 30.5.2, *Operations Manager or Designee*, requires that the Operations Manager review the description of work activity in detail before authorizing the SWP. The initiator of the SWP, as required by Section 30.5.3, *Training*, ensures a JHA is available for the task and reviews the JHA requirements with the employees assigned to perform the task covered by the SWP. Section 30.5.5, *All Personnel Performing Work*, requires all personnel performing work to review, understand, and comply with the SWP and the JHA associated with the task. The JHA that addresses Large and Small Tractor Mowing identifies potential hazards for mowing, and under recommended controls, lists “qualified operator.”

GC1 had not completed required OJT and therefore would not have been a “qualified operator” for using Mower 1. Interviews with the SMT, and GC3 and GC4 indicated that GC1 was only directed by the SMT to operate a weedeater.

The SWP form includes a “check box” for JHA, but has no provisions to list the applicable JHA(s). Thus there was no indication that the three (weedeating, mowing, and herbicide application) JHAs would be part of the SWP and which would apply to GC1. The Grass Cutters stated that the last time they had read the JHA for grass cutting was during the previous initial training for a newly-hired worker in 2010 when they sat in on the training. The Grass Cutters were not aware that the JHA had the requirements to be a “qualified operator.”

On the day of the accident, in addition to a SWP for general work areas around the site, there were two SWPs that had been authorized by DM Operations for work to be performed by the Grass Cutters. These SWPs were for work in the Tank Farm (number 345692) and at Cavern 5 (number 345686), the scene of the accident. The description of work in both SWPs was “*Perform Grass cutting, weed-eating, and the applic of herb.*” The Tank Farm Permit was dated September 13, 2011 (the day of the accident) and the craftsmen listed were GC2, GC3, & GC4, as well as GC1. The Cavern 5 SWP, which was the permit applicable to the grass cutting at the time of the accident, was dated September 8, 2011, with a SWP update/additional reading form attached which had been signed by the initiator (SMT) and DM Operations on both September 12, 2011 and September 13, 2011. GC1 was not listed on the SWP for Cavern 5; only GC2, GC3, and GC4 and an additional Grass Cutter not working on September 13, 2011, were listed on the SWP.

When asked about the craftsmen listed, the GC2, GC3 and GC4 stated that only those listed as “Craftsman Assigned” were allowed to perform the work described on the SWP. However, APM Section 30.5.5 only requires that the “Craftsman Assigned” ensure the SWP is maintained at the work site and returned to the initiator at the end of the work. Interviews with both the Environment, Safety and Health Technical Services (ES&H/TS) Manager and the Site Safety Specialist (SSS) confirmed the intent of “Craftsman Assigned” was as defined by APM Section 30.5.5.

APM Section 30.5.4, *Site Safety Specialist*, requires that the SSS conduct a weekly review of selected SWPs and perform onsite inspections. In addition, the SSS is to conduct at least one inspection weekly of all work areas to ensure that work is being performed safely in compliance with the SWP. The result of these inspections is to be documented on the SWP in Section IV, *Walkthrough Inspection of Area*. Neither SWP had any signatures in the *Walkthrough Inspection of Area* in Section IV. However, the Grass Cutters stated that the SSS routinely checked on them during their work and these inspections had been noted on previous SWPs. This was confirmed in a review of SWPs for earlier grounds maintenance work.

Analysis

Although the SWP does not specifically state that by signing the SWP the initiator and DM Operations certify that the controls listed on the JHA have been met, the JHA would be the tool for defining the conditions to be met for readiness to work, with a key condition being that those named on the SWP were “qualified operators.” Since GC1 had not completed required OJT, he

would not have been a “qualified operator” for using a mower. In addition, there could be several JHAs that would be part of the SWP; however, the current SWP process does not provide a mechanism to list all of the applicable JHAs and link the JHAs to specific work activities prior to confirming readiness to work.

The Grass Cutters did not know about the JHA requirement to be a “qualified operator.” This indicates that the JHA(s) were not routinely discussed with the Grass Cutters. If the JHA box is checked on the SWP, APM Section 30.5.3 requires that the JHAs be reviewed with the employees.

Since the SMT knew that GC1 had done weedeating previously at the SPR-BM site as a DM employee, the SMT listed GC1 on the Tank Farm SWP even though he had not completed OJT for weedeating. This resulted in GC1 being listed on the SWP for work in the Tank Farm (SWP number 345692) without having been qualified for performing any of the work assigned. Although this would not be in conflict with requirements in APM Section 30.5.5, *All Personnel Performing Work*, and DM management expectations, this may conflict with how the Grass Cutters expected the SWP to be implemented. The Board determined that this lack of rigor with respect to reviewing the written SWP prior to performing work may have contributed to the Grass Cutters not recognizing that GC1 was not listed on the Cavern 5 SWP (SWP number 345686) on the day of the accident.

Although SWPs were routinely inspected, the ES&H/TS Manager and the SSS stated these inspections were used to confirm field conditions were in conformance with gas concentration limits and workers were using appropriate Personal Protective Equipment (PPE). In addition, they stated that these inspections would not confirm that workers were aware of and following controls identified in the JHA.

The Board concluded that the DM SWP process did not adequately integrate the hazards and controls of the applicable JHAs.

The Board concluded that the DM SWP process did not have an adequate mechanism for authorizing work.

2.6.2.2. Job Hazard Analysis

Section 2.19, *Job Hazard Analysis*, of the DM APM provides a description of the JHA process. Section 2.19.2, *Purpose*, of the APM states that the JHA “*is an effective management tool for identifying potentially hazardous conditions and unsafe acts in the workplace and eliminating/mitigating them.*” Section 2.19.3, *JHA Functions*, further indicates that a JHA “*identifies actual and potential physical and health hazards in the work environment, and helps determine how they will be managed, mitigated and controlled.*”

A JHA had been prepared for Large and Small Tractor Mowing (JHA BM-M-042) to address the job steps, potential hazards, recommended engineering, and administrative or PPE controls associated with the mowing activity performed by the Grass Cutters. This JHA had been prepared by the SMT and was reviewed by SPR-BM Site Safety and Maintenance and approved by the SPR-BM DM Site Director on January 4, 2007.

Records indicate that this version of the JHA was the most recent JHA in place at the time of the accident. This JHA is accompanied by a PPE selection guide indicating the required PPE to be used when performing large and small tractor mowing. JHA BM-M-042 does not include an identification of heat stress as a potential hazard although according to the SSS the heat index was 101 degrees F at the time of the accident. Interviews with the DM safety staff at the SPR-BM site indicated that heat stress is not identified in any other site-wide JHA. One of the controls for heat stress as discussed in Section 3.6.1, *Routine Controls*, of the APM (Section 3, *Thermal Stress Management Program*) was that a buddy system shall be in effect while the possibility of heat injury exists. According to interviews, GC2, GC3, and GC4 indicated a buddy system was in effect on the day of the accident although the JHA did not indicate such. According to Section 3.6.2, *Additional Controls*, of the APM the buddy system requires “line of sight.”

The JHA for Large and Small Tractor Mowing identifies the “inspection of area to be mowed” as a job step, as well as performing an equipment inspection. Based on follow-up interviews with GC3 and GC4, an inspection of the area mowed by GC1 was not performed on the day of the accident. GC3 and GC4 indicated that they typically do not perform such inspections prior to mowing since they are familiar with site conditions. The Board performed a walkdown of the accident site on September 21, 2011, and observed a number of physical hazards in or near the GC1 mowing location, such as an elevated unmarked concrete obstruction, a protruding electrical conduit that was painted red, and elevated horizontal pipes with bends and turns that were not identified in the JHA. In addition, the JHA does not include a number of the potential mowing hazards identified in the John Deere Operator’s Manual for Mower 1, nor is there a reference to this manual in the JHA. There is no evidence that the manual was used in preparation of the JHA. Under recommended controls, this JHA includes “seat belts” and the requirement for a “qualified operator,” neither of which was met by GC1 on the day of the accident.

Interviews with the SMT and GC2, GC3, and GC4 indicated that the JHA is reviewed during initial new employee training when the JHA is revised. According to the SMT, when a new employee begins work the entire grass cutting crew will review the JHA. Section 2.19.5.6, *Review of JHA*, of the APM indicates that JHAs shall be reviewed and updated periodically but the APM provides no minimum frequency for when workers are to review a JHA (e.g., annually). Based on interviews, on the day of the accident, this JHA was not reviewed by the Grass Cutters, and the most recent review of this JHA occurred approximately in March 2010 when the last new hire joined the group. APM Section 30.5.3, requires that as part of the SWP process, the JHA must be reviewed with the employees. APM Section 30.5.5 also requires that all personnel performing work must review, understand and comply with the JHA associated with the task. The SMT also indicated that when the JHA is revised the entire grass cutting crew participates. The SMT does review job hazards with the Grass Cutters each morning, although there is not a formal review of the JHA. The APM does not provide guidance on how the JHA should be used for daily work briefings.

DM Operations had also developed a two hour training course for JHA (Course ESSH1000) which is required of all SPR-BM site employees including subcontractors as indicated by the DM Training Coordinator during her interview. The DM Training Coordinator indicated that such training is required for the Grass Cutters. Although GC2, GC3 and GC4 could not recall having such training, training records indicate that GC3 received such training in 2007 and 2010, and GC2 received training in 2007. There is no evidence that GC4 had ever received the JHA training. At the time of the accident, GC1 had not been informed of nor read the JHA for Large and Small Tractor Mowing (BM-M-042), nor had GC1 received the required JHA training.

Analysis

In general, the Board determined that the JHA procedure as documented in the APM and associated JHA training were adequate with the exception that there is insufficient guidance in both the APM and in the JHA training on how the JHA is to be integrated into daily work activities.

Specifically, the JHA for Large and Small Tractor Mowing adequately identifies the basic sequential job steps associated with this work activity. However, the JHA for Large and Small Tractor Mowing does not specifically address the hazards associated with this accident, namely mowing in the vicinity of elevated piping and around other obstacles, nor does the JHA include the recommended control to mitigate such a hazard (e.g., maintain an appropriate distance from the piping). The JHA does not address the heat stress hazard and control (buddy system) that was applicable on the day of the accident. The JHA does not include a number of hazards that are described in the John Deere Operator's Manual, nor does the JHA reference the John Deere Operator's Manual for additional hazards and controls. For mowing activities this JHA requires a "qualified operator", and GC1 was not a qualified operator. The JHA also requires an "inspection of the area to be mowed" which based on interviews was not performed on the day of the accident. Based on interviews, this JHA is typically reviewed by the Grass Cutters upon initial training, but not subsequent to their initial training. GC2, GC3 and GC4 indicated their most recent review of this JHA was approximately March 2010, during the orientation of the most recent new hire. Based on interviews, there is no indication that pertinent information from the JHA was included in the worker briefing that was conducted on the morning of the accident or in any other recent worker briefing.

The Board concluded that the DM Job Hazard Analysis (JHA) process for large and small tractor mowing lacked an inclusion of applicable hazards from equipment manufacturer operator's manuals and other identified applicable hazards and controls (e.g., heat stress).

The Board concluded that the DM JHA process lacked specific requirements for periodic worker review, mechanisms for integration into the work control process (e.g., morning meeting), and that the controls specified in some JHAs were not followed by workers (e.g., use of qualified operators).

2.6.2.3. Morning Meeting

Section 30.5.3 in the DM APM requires that applicable SWP(s) and JHAs be reviewed with employees prior to performing work. Typically this review would occur at a morning meeting (i.e., pre-job briefing or tailgating meeting) prior to the commencement of work activities for the day. However, there is no formal requirement in the APM to conduct such a meeting nor is there guidance in the APM on the type of information (at a minimum) that should be discussed during the morning meeting. In practice there is a morning meeting held by the SMT and Grass Cutters that one of the Grass Cutters referred to as a tailgate meeting.

Interviews with the Grass Cutters confirmed that on the day of the accident, the SMT, having obtained the applicable SWPs from DM Operations, provided them to the Grass Cutters for the work areas that day. These SWPs were then discussed along with general safety requirements including heat stress concerns and to watch out for each other. During this meeting, the SMT indicated that GC1 would only be doing weedeating that day. Based on interviews, the JHAs were not used at this briefing. Although listed on the JHA, the Grass Cutters stated that “qualified operator” and “inspection of the area to be mowed” were not discussed.

Analysis

Although safety concerns were discussed by the SMT including heat stress, without having the JHAs available and used for the briefing, the JHA requirements for a “qualified operator” and “inspection of the area to be mowed” were not discussed on the day of the accident. This does not meet the intent of APM Section 30.5.3 to review the JHA with the employees assigned to perform the tasks covered by the SWP.

The Board concluded that DM lacks a policy and guidance for the conduct of pre-job briefings.

2.6.3. Training

The employee training plan for Grass Cutters at the SPR-BM site is defined and administered by the DM Training Coordinator. Since the Grass Cutters are DM-subcontracted employees, the contract between DM and the subcontractor (Contract No. 460000536, dated June 15, 2010) identifies five training requirements to be given to employees “when they arrive at the site and prior to beginning work”, such as hazardous communications training and training on PPE. As a supplement to the training specified in the contract, the DM Training Coordinator developed a list of minimum training courses (i.e., 13 training courses) required for these workers, some of which duplicate those training requirements in their contract. In addition to the formal training courses outlined in the contract and by the DM Training Coordinator, Grass Cutters must also complete OJT for each category of equipment they will be assigned to use (e.g., mowers, weed eaters, pressure washers).

The process for OJT is described in DM Procedure AAA8008.05 entitled *On-the-Job Training*. OJT training requirements for the Grass Cutters are determined by their supervisor, the SMT, who is a DM employee. OJT is documented on an “On-The-Job Training Activity Report”,

which lists the major points of OJT, the type of OJT (e.g., refresher vs. new hire), and required reading, and provides a space for trainer and employee comments as well as signatures of the employee, trainer and supervisor. Based on interviews with the SMT, during OJT employees are given step-by-step instructions to familiarize themselves with the task, related equipment, and any known or suspected hazards related to the operation. This instruction may be repeated over a period of time until the employee feels comfortable with the process, procedures, or equipment. The employee is then observed over a reasonable period of time by supervision to ensure the employee possesses the necessary skills, confidence, and related competencies to perform the job accurately and safely. The OJT record is signed by the employee and retained by the supervisor. Although the Board was provided with OJT training records for the Grass Cutters, the DM Training Coordinator indicated that she does not receive completed OJT training records.

At the time of the accident, GC1 had completed the new hire training video, but had not completed any of the formal/classroom training or OJT required of his position. The DM Training Coordinator also confirmed to the Board that on the day of the accident, the SMT had indicated at the morning meeting that GC1's work activities would be restricted to weedeating (i.e., no mowing activities), since the SMT had prior knowledge of GC1's weedeating experience. However, GC1 had not completed the Weedeating OJT.

According to the DM Training Coordinator, there have been no formal or informal assessments of the training program for the Grass Cutters at the SPR-BM site. The DM Training Coordinator could not produce any records of training audits conducted by either the SPR-BM site or the PMO. The DM Training Coordinator indicated that in general 90% of the workforce is current with respect to their training requirements.

Analysis

The Board determined that the formal/classroom training requirements established for the Grass Cutters are sufficient for their assigned work activities. Furthermore, grounds maintenance workers who are assigned additional duties, such as a member of the ERT, are provided additional training. Interviews with the DM Training Coordinator also indicated that improvements in the current training program were in process, such as improvements in training documentation for support equipment, and improved lesson plans and visual aids for respiratory protection.

Of concern to the Board, however, are elements of the OJT process. For example, the completed OJT records for the Grass Cutters lack specificity as to the topics of instruction (i.e., no lesson plan), and the content of any practical factors (field exercises) which the worker was required to perform, if any. Similarly, although the OJT indicates "required reading data," there is no specificity as to what was required to be read and whether such reading included any chapters of the John Deere Operator's Manual. The OJT for mowing is entitled, "Large and Small Tractor Mowing" but is not equipment-specific (i.e., Mower 1). If the OJT record for a small push mower was completed, it permitted the worker to also be qualified to operate a much larger powered mower, such as the John Deere 1435 mower. Although the OJT record has provisions to indicate whether the OJT provided is "refresher" or "new hire," a review of completed training records by the Board for both categories indicates no difference in OJT content or requirements. The OJT record lists the training duration for Large and Small Tractor Mowing as one hour,

which does not appear adequate by the Board, and based on interviews with the SMT is actually much longer.

In addition, the Board has found no evidence of any DM requirements for the individual who conducts OJT such as documented proficiency on the equipment for which instruction is being provided, or having completed a “train-the-trainer” type course.

Additional discussions on training are provided in Section 2.12, *Human Performance Improvement (HPI)*.

The Board concluded that the OJT program for Grass Cutters was not equipment-specific. For example, completing training/qualification on one lawn mower qualified an individual on all lawn mowers (large or small).

The Board concluded that the OJT program for Grass Cutters lacked sufficient documentation with respect to content (e.g., elements of the equipment operator’s manuals, equipment postings and warnings), and does not distinguish between new hire and refresher training.

The Board concluded that the training and qualification documentation did not provide sufficient guidance to personnel conducting OJT.

The Board concluded that GC1 was not qualified to operate Mower 1 since GC1 had not completed the required training for his position nor the OJT required to operate the mower.

2.6.4. Stop Work

The DM APM does not include a section that is dedicated to stop work. However, the APM does include a bolded statement within Section 2.16, *Occupational Safety and Health Concerns*, stating that “any SPR employee has the authority and the responsibility to stop work in an imminent danger situation.” The APM further states that “an employee will not be discriminated against nor will action be taken against him or her as a result of his/her filing an occupational safety and health concern or stopping work.” Stop work authority is also conveyed to workers at the SPR-BM site through training provided by the SSS during new employee orientation, and in the “Active Force of Protection” video provided to new employees and visitors. SPR-BM site workers are also required to sign a “safety commitment letter” prior to commencement of work which re-iterates their stop work authority. This safety commitment letter has also been incorporated into a poster which is displayed in Building 244. In reviewing the DM documents and training with respect to stop work, the Board did not identify any graded approach to the DM stop work policy that could be implemented for unsafe actions or conditions that may not appear

to present an imminent danger, such as “pausing work” or “time outs.” Based on document reviews, the current stop work policy is limited to only “imminent danger” situations. DOE Order 422.1, *Conduct of Operations*, requires that management policies establish the expectations that operators use written procedures for operations, will perform those procedures as written, and will stop work and notify management when procedures cannot be executed as written.

Through interviews, on the day of the accident, the Board identified at least six occasions when GC1 was either warned, advised, instructed or cautioned not to use Mower 1. However, when GC1 mounted the mower directly prior to the accident to “familiarize” himself with the mower operation there was no work stoppage invoked even though GC1 had not met the “qualified operator” requirements of the JHA or the DM OJT requirements to perform such OJT. Interviews with DM management and safety staff at the SPR-BM site indicated that a stop work is rarely invoked at the SPR-BM site and if invoked, it is typically initiated by a safety professional, as in the case of a work stoppage being invoked six weeks prior to the accident at Cavern 106 by a safety supervisor over a fall protection issue.

Analysis

The DM APM does not provide a sufficient description of the DM stop work policy, guidance, or implementation direction such that workers and supervisors are aware of when and how the policy is to be implemented. Similarly, unlike the JHA or SWP process, workers are not trained on the stop work policy in sufficient depth that they are enabled to implement their stop work authority consistent with DM management expectations. In addition, evidence reviewed by the Board indicates that the current stop work policy is limited to only “imminent danger” situations, although even in “imminent danger” cases, there is no clear description of the actions that would constitute an “imminent danger” situation in either the APM or in new hire training videos. Contrary to the requirements of DOE O 422.1, the DM APM does not provide management expectations or guidance for stopping work for “unsafe conditions” or “failure to follow safety requirements” as described in the APM or JHAs, except in cases where an “imminent danger” is evident. Based on the limited DM documentation on stop work, it is not clear to the Board if DM management expectations for unsafe work or work that is being performed contrary to requirements in the APM would constitute the need for work stoppage, although such expectations are clearly within the framework of DOE’s integrated safety management policy. Additional discussions on stop work are provided in the HPI Section of this report (Section 2.12).

The Board concluded that the DM stop work policy does not incorporate the requirements of DOE Order 422.1, *Conduct of Operations*, resulting in a policy that is limited to “imminent danger” and lacking sufficient instruction and training to ensure workers are knowledgeable of the policy.

The Board concluded that a stop work process/authority was not utilized by the workers at the job site to prevent GC1 from operating Mower 1.

2.6.5. Description of the Mowing Equipment

At the time of the accident GC1 was riding a John Deere Model 1435 Front Mower Series II (Figure 2-10). The mower was designed with a number of operator controls that may have been pertinent to this accident. In addition, the Operator's Manual for this mower provides a number of safety instructions pertinent to the accident that are examined in the following sections as well as the maintenance program for this mower.



Figure 2-10: Mower 1, John Deere 1435 Front Mower Series II Involved in the Accident

2.6.5.1. Equipment Description

The John Deere Model 1435 Front Mower Series II has a number of safety features and/or controls that are pertinent to this accident including the braking system, seat restraint system, ROPS, PTO, steering system and accelerator system (forward and reverse pedals). This mower is also placarded with a number of machine safety (warning) labels. The warning label on the front of the mower (Figure 2-11) states that operator training is required, to know all controls, and to read the Operator's Manual. The warning labels on the ROPS are provided in both English and Spanish. On September 28, 2011, the Board observed that the warning labels for Mower 1 were in place in accordance with the Operator's Manual; however the DM equipment tag (BMEQ-315) was missing from the left side of the mower deck.



Figure 2-11: Warning Label found on the Front of Mower 1

When GC2 and subsequently the SMT arrived at the accident scene, directly following the impact of the mower with the piping, the condition of Mower 1 was as follows: the mower engine was on, the PTO was disengaged, the mower throttle was in the mid-range position between high and low, and half of the PTO shield under the mower was missing. According to the Operator's Manual, the PTO will disengage under any of the following conditions: high engine coolant temperature, low engine oil pressure, high hydraulic oil temperature, and depressing the master brake pedal. Additional information on the condition of the mower controls at the time of the accident is provided in Section 2.6.1, *Physical Evidence*.

2.6.5.2. Equipment Operational Readiness

Prior to operating powered mowers, a daily operational check is performed by the mower operator and is documented on a "Daily Checklist – Powered Mowers." Daily checklists were prepared for Mower 1 on the day of the accident and the preceding day by GC4 who had indicated on the checklist that the only "unsat" item was associated with the tire and wheels. In the remarks section of the checklist GC4 further indicated "tire loose on deck." The daily checklist for Mower 1 on the day of the accident indicated the engine hours to date as 1248 hours. According to interviews, on the day of the accident the defective front tire on the mower deck was replaced in the field by GC3 and GC4 at approximately 1100 hours and shortly before the accident. Interviews with GC2 and GC4 who had used Mower 1 on previous days indicated

there was no prior knowledge of any operating deficiencies for this mower other than the front tire on the mower deck. For the months of August and September, 2011, only four Daily Checklists are documented for Mower 1, although Mower 1 was in service for a longer period of time.

The DM Daily Checklist for this mower requires the person performing the check to conduct five tasks: visually inspect the body condition, safety shields, tires, and wheels; and to check fuel oil and hydraulic fluid levels. The items listed on the DM Daily Checklist differ from those items listed by John Deere in their “Daily Operating Checklist” which is included in the John Deere Operator’s Manual. Missing from the DM Checklist, but included in the John Deere Daily Operating Checklist, are the following:

- Test safety systems,
- Check tire pressure,
- Remove debris from machine and attachment,
- Clean air intake screen,
- Check area below machine for leaks,
- Check air restriction indicator,
- Remove debris from radiator, oil cooler and alternator, and
- Check brakes and forward and reverse pedals.

The Safety Section of the Operator’s Manual for Mower 1 also identified a number of safety requirements to be performed prior to and during operation of the mower. Interviews with the SMT indicated that during OJT for Grass Cutters using mowers, sections of the Operator’s Manual are reviewed with the workers, although there is no indication on the OJT record that the manual was reviewed or which specific sections of the manual may have been reviewed with workers during OJT. Excerpts from the Safety Section of the John Deere Operator’s Manual that are relevant to Mower 1 are as follows:

- Operate the machine in an open, unobstructed area under the direction of an experienced operator,
- Inspect the area where the equipment is to be used and remove all objects such as rocks, toys, and wire which can be thrown into the machine,
- Use care when approaching blind corners, shrubs, trees or other objects that may obscure vision, and
- Low-hanging branches and similar obstacles can injure the operator or interfere with mowing operation. Before mowing identify potential obstacles such as low-hanging branches and trim or remove those obstacles.

Analysis

The Board determined that daily checks for Mower 1 have not been consistently documented on the DM Daily Checklist. The Board also determined that the DM “Daily Checklist-Powered Mowers” is deficient in not including a number of items that are listed in the Operator’s Manual for a “Daily Operating Checklist”, and does not include a number of daily checklist items such as checking the brakes, forward and reverse pedals, and checking the safety systems. An inclusion of these items on the DM checklist may have resulted in Mower 1 being tagged as “out-of-service” on the day of the accident since the turning brakes were clearly defective and/or out of tolerance prior to the accident (see Section 2.6.1).

In addition, although the DM checklist includes a visual inspection of safety shields, the inspection on the day of the accident did not identify the missing PTO shield which had been missing for some time prior to the accident as discussed in Section 2.6.1. The checklist on the day of the accident incorrectly indicated the safety shields as “sat”. Although the missing PTO shield is unlikely to have contributed to the accident, the missing PTO shield may have resulted in Mower 1 being tagged out for maintenance on the day of the accident. Furthermore, since the content of the OJT typically provided for this type of mower does not indicate which sections of the Operator’s Manual are reviewed with workers (if any), there is no documented evidence that the precautions identified in the Safety Section of the Operator’s Manual were reviewed with any of the Grass Cutters. Precautions, similar to those indicated in the previous section, would have been relevant to the conditions at the time of the accident, as observed by the Board.

The Board concluded that important information identified in the Mower 1 equipment Operator’s Manual had not been included in pre-operational checklists for this equipment, and that the daily equipment checks were not consistently performed and/or documented.

2.6.5.3. Equipment Maintenance Program

The SPR-BM site has implemented an equipment maintenance program as described in the DM SPR Plant Maintenance System Manual (ASI4330.16). The manual describes the maintenance work order process.

Routine maintenance for Mower 1 consisted of monthly and semi-annual inspections. The tasks involved in the performance of routine monthly maintenance are documented on an SPR Maintenance Requirement Card for “Riding Mowers” (MEI/MRC Number 655/691). This maintenance requirement card identified the tools, materials and test equipment required to perform the inspection as well as the requirements/procedure for performing the inspection. The monthly inspection typically consists of inspecting the mower engine, inspecting the chassis, performing a road test and cleaning up any spills, leaks or excess grease as indicated on the SPR Maintenance Requirement Card. A review of the maintenance records for Mower 1 indicates that monthly inspections had been performed by the DM Maintenance organization during the period directly prior to the accident with the most recent inspection having been performed on August 8, 2011. A review of the monthly maintenance inspection records also indicates that the

time to perform a monthly inspection ranges from 0.5 hours (typical) to 2.0 hours (max). During the 6 months prior to the accident, the only maintenance deficiency identified on the monthly maintenance inspection work orders for Mower 1 was a hole in the radiator that was identified on August 10, 2011.

The tasks involved in the semi-annual inspection are documented on a separate SPR Maintenance Requirement Card for “Riding Mowers” (MEI/MRC Number 655/692). This maintenance requirement card also identifies the tools, materials and test equipment required to perform the inspection as well as the requirements/procedure for performing the inspection. The semi-annual inspection typically consists of similar inspection tasks as required during the monthly inspection, namely; inspecting the mower engine, inspecting the chassis, performing a road test and cleaning up any spills, leaks or excess grease as indicated on the SPR Maintenance Requirement Card. A review of the maintenance records for Mower 1 does not differentiate which of the monthly mower inspections may have been the semi-annual inspection.

The Operator’s Manual for Mower 1 indicates a number of maintenance items that are required at various service intervals (e.g., after first 10, 50 ...3,000 hours). On the day of the accident, according to the hour meter for Mower 1, 1248 hours had been expended. A number of the maintenance items indicated in the Operator’s Manual for servicing at various time intervals are not included in either the monthly or semi-annual SPR Maintenance Requirement Cards for this type of mower, and there are no records to indicate that maintenance was performed on Mower 1 in accordance with the Manual. The DM maintenance requirement card for both the monthly and semi-annual inspections are for “riding mowers,” but the manufacturer and model of the mowers are not indicated on the cards.

Analysis

The Board determined that the DM requirements for periodic maintenance performed on Mower 1 were inconsistent with the requirements for periodic maintenance as specified in the Operator’s Manual for this type of equipment. Of concern to the Board is that: (1) the Operator’s Manual includes a number of maintenance activities that are not included in the SPR-BM site Maintenance Requirement Cards and there is no evidence that these additional maintenance items are being performed; (2) the frequency of maintenance for this type of mower is performed on a semi-annual and annual basis in lieu of being based on equipment “run hours” as specified in the Operator’s Manual; and (3) the SPR Maintenance Cards have not been tailored specifically for this type of mower. Also based on the Board’s analysis of evidence at the accident scene (See Section 2.6, *Examination of Evidence*), several pre-existing equipment maintenance deficiencies were identified with Mower 1 (i.e., left turning brake that was not functioning, PTO shield partially missing, brakes out of adjustment) that should have been identified and addressed by the SPR-BM site maintenance program. It is unclear to the Board if these maintenance deficiencies contributed to the accident. These maintenance deficiencies are also identified in a report provided to the Board by an independent expert/consulting engineer on agricultural and grounds maintenance equipment.

The Board concluded that important information identified in the Mower 1 equipment Operator's Manual had not been included in the maintenance programs for this equipment, and that there were several pre-existing equipment deficiencies for Mower 1.

2.6.6. Fitness for Duty

Fitness for duty requirements for Grass Cutters are outlined in the contract between DM and the subcontractor providing these services, and consist of: a written recommendation from a physician or licensed health provider regarding the employee's ability to use respiratory protection device(s) and any limitations on respirator use; and proof of an audiometric baseline test within the previous 15 working days. The contract also includes a section regarding the DM drug testing program, which states that "pre-entry testing" for initial substance abuse/ chemical screening is "required of all personnel prior to entering an SPR site for performing physical work." According to the contract, pre-entry tests include urine samples and may include breath tests and/or blood samples. The contract states that "the pre-entry test must be conducted within the five days prior to entering a SPR site."

On the evening of September 12, 2011, the SMT indicated that he had received a phone call from the subcontractor's representative for the SPR-BM site indicating that the results of GC1's physical were satisfactory and that GC1 was ready to perform work.

On the day of the accident, the SMT and the other Grass Cutters indicated that GC1 appeared to be in good spirits, alert and anxious to begin work. According to interviews with supervisors and co-workers, there was no indication of any health concerns with GC1 throughout the morning and leading up to his mower accident later that morning. Following the accident, two prescription medications were found in GC1's lunchbox. The SMT indicated in an interview that he was not aware of these medications being present in GC1's lunchbox. The Board also has no knowledge of the use of these medications.

Analysis

Although the Board has no knowledge of the exact medical tests and results provided to GC1 as part of his pre-employment physical, the Board assumes that the fitness for duty medical tests performed were consistent with the requirements of the contract as previously indicated. Based on the available evidence, the Board has no knowledge as to whether GC1 had any acute or chronic medical conditions. However, based on the successful completion of a pre-employment physical on the day before the accident, the Board has no reason to believe that GC1 was not fit for duty. This assumption was further validated by observations of GC1 by both the SMT and GC1's co-workers during the hours preceding the accident.

The Board concluded, based on evidence presented to the Board through interviews, that GC1 was fit for duty on the morning of the accident.

2.7. Feedback and Improvement

2.7.1. Previous Corrective Actions

On September 29, 2011, the Board, with the assistance of the DM Training Coordinator, performed a review of closed SPR Assessment Tracking System corrective actions at the SPR-BM site during the period of 2000 to the present. Corrective actions were sorted by organization with a focus on maintenance, facilities and grounds, and safety. In the maintenance category, 40 closed corrective actions were identified during this period, four of which were associated with equipment vehicle inspections or pre-operational checks (2007 – 2011). Although none of these inspections were associated specifically with grounds maintenance equipment, three of the four corrective actions were related to not completing the equipment daily or pre-operational checklists or not completing the checklists correctly. A review of the “Daily Checklists for Powered Mowers” for Mower 1 (BMEQ-315) identified only three completed checklists for the month of September 2011 and one completed checklist for August 2011, although maintenance records indicated that Mower 1 was in service during this two-month period for more than four days.

During the period of 2000 to the present, 33 closed corrective actions in the SPR Assessment Tracking System were identified for facilities and grounds activities at the SPR-BM site, none of which were associated with grounds and maintenance activities.

During the period of 2000 to the present, 40 closed corrective actions in the SPR Assessment Tracking System were identified with the safety organization, four of which were associated with the DM SWP process. In 2002, one of the corrective actions indicated that of 59 SWPs reviewed, none had the required initials to indicate that the supervisor had reviewed the JHA with the employees.

The Board also reviewed the September 2010 *Independent Review of the Fatality at the Strategic Petroleum Reserve Bryan Mound Site* prepared by HSS. This independent review was associated with a July 8, 2010, fatality at the SPR-BM site involving the death of a subcontracted employee while performing work activities involving the cleaning of a tank floor in a large crude oil storage tank. The DOE Independent Review Board for the oil storage tank accident identified seven opportunities for improvement as a result of the accident, three of which are similar to the conclusions and JONs reached by the Board during this accident investigation, namely:

- “AGSC and ES&H LLC should ensure that members of the tank cleaning crew understand applicable health and safety requirements and the need for strict compliance,”
- “SPRPMO, DM, AGSC and ES&H LLC should improve their oversight programs and oversight of tank cleaning activities,” and
- “SPRPMO should enhance its accident/investigation capabilities and its program oversight and direction to contractors.”

Analysis

A review of the previously completed corrective actions at the SPR-BM site for CY2000 to the present did not reveal any specific deficiencies associated with mowing equipment or the grass cutting subcontractor. However, previous deficiencies with the use and/or completion of the Daily Equipment Checklists and the SWP (particularly the failure to routinely review hazards associated with the SWP) indicate a long-standing concern in these areas that were also evident in this accident. In addition, the DOE Independent Review Board evaluating the July 8, 2010, fatality at the SPR-BM site identified a need for improvement in areas of understanding and adherence to safety requirements, oversight programs, and accident investigation deficiencies that are pertinent to this accident investigation.

The Board concluded, based on a review of completed corrective actions at the Strategic Petroleum Reserve Bryan Mound (SPR-BM) site, and a worker fatality at this site a year ago, that long-standing problems have existed at the SPR-BM site with respect to daily equipment pre-operational checks, integrating hazards into SWPs, and not understanding or strictly complying with health and safety requirements.

2.7.2. Lessons Learned

Each year, nearly 80,000 Americans require hospital treatment from injuries caused by lawn mowers, according to a study conducted by researchers at the Johns Hopkins Bloomberg School of Public Health. The researchers also concluded that the number of injuries from lawn mowers is increasing, with the majority of injuries occurring in children under age 15 and adults age 60 and older. The study, published in the April 2006 online edition of the *Annals of Emergency Medicine*, is the first to examine the extent and mechanisms of lawn mower injuries nationwide.

Department of Energy Order 210.2A, *Corporate Operating Experience Program*, requires DOE and contractor organizations to routinely screen and assess internal and external operating experience to identify significant issues and lessons learned that may be of safety significance or have a bearing on the success of DOE missions, and to make them available to the DOE Complex. Corporately, DOE publishes and provides internet access to Operating Experience Summaries, and Lessons Learned reports submitted by DOE sites and contractors. Other sources of DOE operating experience, to include reporting of injuries (through the Computerized Accident/Incident Reporting System, CAIRS) and events that could adversely affect worker safety and impact DOE missions (through the Occurrence Reporting and Processing System, ORPS) are available to promote organizational learning and continuous improvement in DOE operations.

A review of DOE injury and illness incident reports from the DOE CAIRS from 2001 to present identified 32 occurrences of injuries associated with loading, handling, or operating riding lawn mowers at DOE sites. Eight of these occurrences resulted in injuries received while operating “zero turn” and similar types of riding mowers. These eight occurrences resulted from operation of mowers on sloping and wet terrain, collision with marked and unmarked obstructions and objects, and lack of sufficient training; and resulted in body muscle strains, pinches, fractures,

lacerations, and severe chest trauma. One of these occurrences, in 2006, resulted in the compression of an employee between the mower seat and an elevated steam line, a situation similar to that found in this accident investigation.

A review of occurrence reports from the DOE ORPS from 2001 to present identified 14 occurrences involving the operation of riding mowers. These occurrences involved mowing over obstructed electrical outlets and cords, inadequate worker respiratory protection while operating equipment, grass fires caused by mower blades striking rocks and igniting grass, roll-over incidents, and mower roll bars striking building components.

A review of DOE Lessons Learned reports identified several lessons learned associated with the operation of riding mowers. These include the operation of three-wheeled riding mowers and their susceptibility to sudden, uncontrolled violent motion due to the sensitivity of their controls; and operating issues associated with the pedal configuration on certain riding mowers.

In 2007, as part of its Corporate Operating Experience Program, DOE issued Operating Experience Summary 2007-7, *Near Miss – Roll Bar on Riding Mower Knocks down Window Air Conditioner*. The Summary presented good practices for riding mower operation and highlighted the importance of ISM core functions of analyzing the hazards and performing work within controls. The Summary identified the following specific lessons learned associated with the occurrences discussed that are directly applicable to the SPR-BM site mower accident: (1) inexperienced operators mowing in an unfamiliar area; (2) inadequate training due to course content not addressing the operation of the particular mower the operator was using; and (3) the need for mowing supervisors to carefully evaluate the potential hazards associated with this fairly common work activity. The Summary also concluded that, *“These events underscore the need to ensure that mowing equipment operators are trained on the equipment, are familiar with the area, its terrain, and potential hazards; and are focused on the task at hand.”*

Analysis

A review of readily-available operating experience on the operation of riding mowers in the DOE complex over the past ten years identified numerous instances where the operation of riding mowers adversely impacted worker safety and DOE operations, resulting in injuries to workers and impacts to the environment. There were many lessons learned and opportunities for continuous improvement communicated through the available sources of riding mower operating experience applicable to grass cutting work control processes at the SPR-BM site. The occurrence in 2006 that resulted in the compression of an employee between the mower seat and an elevated steam line, and the Operating Experience Summary Issue 2007-7, were highly relevant to the nature of the hazards associated with grass cutting operations at the time of this accident.

The Board concluded that, to the Board’s knowledge, DOE and DM organizations at the SPR-BM site did not effectively review and utilize information available through DOE’s operating experience programs and reporting systems, resulting in a missed opportunity to continuously learn and improve their grass cutting operations – and other operations at the SPR-BM site.

2.8. Supervision

The SPR-BM site Grass Cutters were directly supervised by the SMT. Interviews with both the Grass Cutters and the SMT confirmed that, except for time keeping functions handled by another on-site Ashton, Inc., employee working in a different organization, day-to-day direction comes from the SMT who functions as the Subcontract Manager's Technical Representative for the work performed by these subcontractors. This includes assigning areas to be worked and ensuring safety and training requirements are met. The SMT also provides the OJT related to work done by the Grass Cutters and for refresher OJT.

Although the SMT establishes the schedule and designates the site areas for mowing based on the Bryan Mound Vegetation Plan, the Grass Cutters determine among themselves individual work assignments (i.e., who will be weedeating vs. mowing) without direct input from the SMT. On a daily basis, many of the grass cutting work activities are self-assigned and are agreed upon by the Grass Cutters without direct involvement of the SMT.

The SMT has no involvement in the performance of the daily check of the mower equipment and is not required to review and/or approve the checklists. On a typical day, the Grass Cutters obtain the SWP(s) during the morning briefing, check their equipment, and then travel to and begin work at the area(s) assigned by the SMT. The Grass Cutters stated that throughout the day the SMT checks on their progress, ensures they have adequate water and Gatorade, and reiterates working safely. However, both the SMT and the Grass Cutters stated that the SMT was not directly supervising on a continuous basis.

On the day of the accident, without the SMT present, GC1 participated in the discussion among the Grass Cutters on individual work assignments. At this time, when asked if he would be cutting grass, GC1 indicated he would be weedeating. Following the morning meeting, the SMT kept GC1 in the Maintenance Shop area so that GC1 could begin his training under supervision from the SMT.

When called for the ERT drill, the SMT directed the Grass Cutters to return to the Maintenance Shop so that GC1 could stay with them through the break and then return with them to the field. At this time, the SMT left for the ERT drill. Following the drill, the SMT returned to the Maintenance Shop and did not go to Cavern 5 until called by GC2 at 1132 hours.

Another responsibility of supervision, along with security, is to ensure that the DM escort policy is followed for new employees. On the morning of the accident, the SMT had assumed escort responsibilities for GC1, a new hire. When the ERT drill was announced, the SMT transferred these responsibilities to GC2, GC3, and GC4. Later that morning when GC3 and GC4 left GC1 with Mower 1, GC3 and GC4 assumed that GC2 had escort responsibilities for GC1 although GC2 was at a considerable distance from GC1 and was not directly informed by either GC3 or GC4 that they were leaving GC1 unattended. Chapter 3, page 15 of DM Manual ASI5600.1, *Security Operations Manual*, states that the escort must retain "visual and vocal control of the visitor at all times," and that the visitor "is restricted to the immediate area of the escort and the visitor may not under any circumstance separate from the escort." The line of sight between GC1 on Mower 1 and GC2 was obscured by infrastructure and piping as shown in Figure 2-12 and Figure 2-13.



Figure 2-12: Mower 1, Located to the Southwest of the Area Mowed by GC2 - Infrastructure and Piping Blocks Line of Sight

Analysis

Although the Grass Cutters are employed by a DM subcontractor, day-to-day supervision and work tasking is provided by a DM supervisor, and in this case, the SMT. Individual task assignments, with respect to equipment use, were typically determined among the Grass Cutters without input from the SMT. This relationship is well understood and accepted by both the Grass Cutters and the SMT. The SMT also provides the OJT for the Grass Cutters.

On the day of the accident, the SMT was not able to complete the required OJT for GC1 due to the ERT drill interruption. On the day of the accident, although the SMT provided clear direction to the other Grass Cutters that GC1 was not to use the mowers, assignment of equipment use was typically performed among the Grass Cutters themselves. This accepted practice of self-assignment of equipment, when combined with the Grass Cutters' prior knowledge of GC1's prior mowing experience and general site knowledge, may have resulted in a lack of rigor among the Grass Cutters in following the supervisor's guidance that GC1 was not to be mowing.

Furthermore, on the day of the accident, the DM escort policy was not enforced as required. Based on a review of the accident scene, and the number of physical obstacles observed and noise associated with the mowing operation, the Board concluded that at the time of the accident GC1 was not in the immediate area of the escort (GC2), nor was GC2 in continual visual or vocal control of GC1. Furthermore, it is not clear to the Board if GC2 was aware that he was the escort for GC1 at the time of the accident or aware of the escort responsibilities.

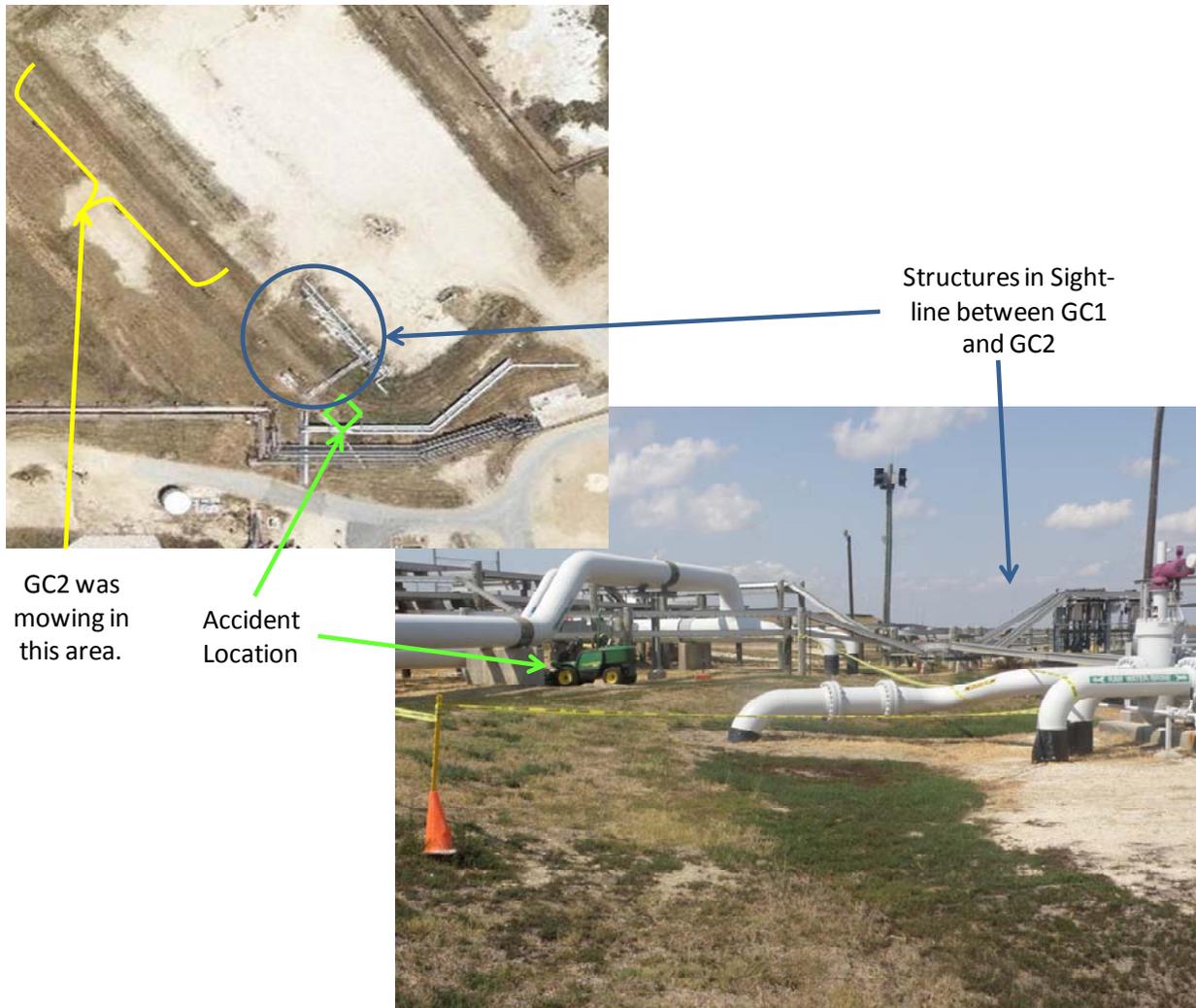


Figure 2-13: Line of Sight interrupted by SPR-BM Site Piping and Infrastructure

The Board concluded that the Grass Cutters did not follow the instruction of the DM Site Maintenance Technician (SMT).

The Board concluded that, on the day of the accident, the DM escort policy was not implemented as required by DM Manual ASI5600, *Security Operations Manual*.

2.9. Safety Organization

There are two segments of the DM safety organization that are applicable to the typical activities of the Grass Cutters. At the DM Corporate level (i.e., DM NOLA Office), the ES&H Manager is responsible for both ES&H support and safety oversight of all work activities at the SPR-BM site including the grass cutting work. DM Corporate ES&H is also responsible for the development and maintenance of the DM APM.

At the SPR-BM site the Manager of Site ES&H/TS is responsible for daily safety oversight of work activities at the SPR-BM site including the grass cutting activities. The ES&H/TS Manager is assisted in this function by a SSS who has been in this position since March 2011. The ES&H/TS Manager reports directly to the DM Site Director and has no reporting responsibility to the DM Corporate ES&H Manager. Roles and responsibilities of the safety positions are identified in the respective sections of the DM APM and in position descriptions for these positions.

Specifically with respect to the Grass Cutters, the SPR-BM site ES&H organization (i.e., SSS and/or ES&H/TS) provides the following roles:

- Provides worker safety training (e.g., JHA and SWP training, OSHA training),
- Reviews and approves SWP for items listed on the SWP requiring a safety review or approval,
- Reviews and approves the JHAs,
- Performs routine site inspections and safety walkdowns of the SPR-BM site,
- Conducts periodic safety committee meetings (e.g., monthly safety meeting). However, the SSS does not typically attend morning briefings and has not attended any morning briefings of the SPR-BM site Grass Cutters during the past six months,
- Reviews formal DM site training and lesson plans, but has no involvement in the preparation, review or performance of OJT, and
- Provides work observations as part of the “Behave Safe Program.”

The SPR-BM site safety organization performs routine inspection of work sites. Site inspections, according to interviews, focus on site conditions (e.g., safety signage) and conditions (oil spillage). Work activities are “spot checked.” During site inspections, PPE is checked as well as permits, but the SSS indicated that compliance with the requirements of a JHA is not reviewed during work site inspections. On the day of the accident, the SSS interviewed GC2 following the accident, and helped in securing the accident scene. The SSS indicated that the Heat Index was 101 degrees F at the time of the accident.

Analysis

Based on interviews with workers and supervisors, the Board determined that workers and supervisors were not implementing some requirements of the DM APM, or in some cases the manual is unclear and has resulted in inconsistent implementation of safety requirements. The failure to follow specific requirements in the JHA for Large and Small Tractor Mowing (e.g., use of a qualified operator and inspection of the area to be mowed) are examples of not following requirements (Section 2.6.2.2). The confusion and conflicting opinion that both workers and supervisors indicated when completing the SWP (Section 2.6.2.1), and failure to exercise stop work authority (Section 2.6.4) are examples of unclear requirements in the APM.

The Board concluded that DM employees were not implementing some requirements of the DM APM, or in some cases the manual was unclear and resulted in inconsistent implementation of safety requirements.

2.10. Integrated Safety Management System Implementation

DM is required to implement Integrated Safety Management (ISM) as identified in DOE Policy 450.4A, *Integrated Safety Management*, and further defined in DOE Order 450.2, *Integrated Safety Management*. DM is required to implement Process Safety Management (PSM) under 29 CFR 1910.119, *Process Safety Management of Hazardous Chemicals (PSM)*. ISM and PSM are closely related and DM must implement the requirements of both because they are a DOE site under OSHA regulation.

Section 38, *Integrated Safety Management*, of the DM APM defines the application of ISM at all DM sites. Section 38 addresses the ISM Guiding Principles and Core Functions as described in the DOE Policy and Order. Section 38 also identifies the DM organizational responsibilities for implementing the Guiding Principles and Core Functions.

Section 39, *Process Safety Management*, of the APM defines the application of Process Safety Management (PSM) at all DM sites. Section 39 describes at a high level how the requirements in each of the sections of the PSM rule are implemented and also documents the organizational responsibilities for implementing the requirements.

As described in other areas of this report, there are specific sections of the APM that implement various aspects of ISM and PSM such as the JHA process, SWP process, and Stop Work. There are no site-specific documents that describe the implementation of ISM or PSM at the SPR-BM site.

2.10.1. Define the Scope of Work

Section 30, *Safe Work Permits*, of the APM defines the DM-wide process for developing an SWP. The SWP is where the scope of work is documented. There were three SWPs in place on the day of the accident. In addition to an SWP for general work areas around the site, there were two SWPs that had been authorized by DM Operations for work to be performed by the Grass

Cutters. These SWPs were for work in the Tank Farm and at Cavern 5. The description of work in both SWPs was “*Perform Grass cutting, weed-eating, and the applic of herb.*”

2.10.2. Identify and Analyze Hazards Associated with the Work

Section 2.19, *Line Control Safety Program*, of the DM APM provides a description of the JHA process and describes the process to identify and analyze hazards. A JHA had been prepared for Large and Small Tractor Mowing (JHA BM-M-042) by the SMT, reviewed by site Safety and Maintenance, and was approved by the DM Bryan Mound Site Director on January 4, 2007. The JHA does not include an identification of heat stress as a potential hazard, although according to the SSS the heat index was 101 degrees F on the day of the accident. The Board observed a number of physical hazards in or near the GC1 mowing location, such as an unmarked, elevated concrete obstruction, a protruding electrical conduit painted red, and elevated horizontal pipes with bends and turns that were not identified in the JHA. The JHA does not include a number of the potential mowing hazards identified in the Operator’s Manual for Mower 1, nor is there a reference to the manual in the JHA.

2.10.3. Develop and Implement Hazard Controls

The JHA did identify job steps, potential hazards, and recommended engineering, administrative or PPE controls associated with the mowing activity performed by the Grass Cutters. The Grass Cutters could not recall reading or reviewing this JHA since the arrival of the last new hire to the crew in March 2010. The DM procedure on JHAs (APM Section 2.19) does not provide guidance on the frequency for reviewing JHAs. Based on interviews, there is no indication that pertinent information from the JHA was included in the worker briefing that was conducted on the morning of the accident or in any other recent worker briefing.

The Grass Cutters were not reminded of all of the requirements of the mowing JHA and did not implement all of the controls. Failure to integrate the requirements of the JHA into routine work activities and morning briefings resulted in the Grass Cutters not being consciously aware of the hazards and controls associated with mowing.

2.10.4. Perform Work within Controls

One of the controls identified in the JHA is to perform an inspection of the area to be mowed. However, the area mowed by GC1 was not inspected on the day of the accident. GC3 and GC4 indicated that they typically do not perform such inspections prior to mowing since they are familiar with site conditions. Under recommended controls, the JHA included “seat belts” and the requirement for a “qualified operator,” neither of which were met by GC1 on the day of the accident. Additionally, stop work and supervisory direction are controls that cover all safety-related activities in the site. There are several reasons why the Grass Cutters may not have exercised stop work authority, but all of the Grass Cutters knew that the SMT directed GC1 not to cut grass or use the mower. The SPR-BM site also has an escort policy. Although GC1 was required to be under escort on the day of the accident, the visual and audible controls defined in the policy were not followed.

2.10.5. Provide Feedback on Adequacy of Controls and Continue to Improve Safety Management

There have not been any specific deficiencies identified associated with mowing equipment or the grounds and maintenance subcontractor at the SPR-BM site since 2000. However, previous deficiencies with the use and/or completion of the Daily Equipment Checklists and the SWP (particularly the failure to routinely review hazards associated with the SWP) and deficiencies noted by the DOE Independent Review Board evaluating the July 8, 2010, fatality at the SPR-BM site indicate prior concerns in areas directly related to the accident. Additionally, as noted in Section 2.7, there have been numerous examples of relevant operating experience across the DOE Complex that, to the Board's knowledge, have not been shared or integrated into SPR-BM site work control or equipment operations. One example in particular was highly relevant to the nature of the hazards associated with grass cutting operations at the SPR-BM site at the time of the accident.

Given the severity of the accident in July 2010, the long-standing concerns in areas related to work planning and control processes that contributed to this accident, and to the Board's knowledge, lack of integration of complex-wide lessons learned, the SPR-BM site has not effectively implemented a feedback and improvement program that has fostered continuous improvement in operations.

2.11. Emergency Response

On September 13, 2011, sometime between 1120 and 1125 hours, GC1 struck three large elevated pipes while operating Mower 1. Sometime between 1125 and 1130 hours, a second person, GC2, who was mowing in the same general area noticed GC1 on Mower 1 facing south in the southwest corner of the Cavern 5 area. GC2 continued mowing, but soon after first noticing GC1 on Mower 1, observed the scene from a different angle that allowed him to see that GC1 had not moved and that he was leaned over to the right side of the mower. GC2 stopped his mower and hurried to assist GC1.

At 1132 hours, GC2 called the SMT by cellular phone to report the situation. The safety orientation video required to be viewed by all employees and visitors states, "All accidents, injuries, near misses, close calls, or environmental disturbances, - no matter how minor - shall be reported. This includes personal injury, property damage, environmental damage and vehicle accidents. Report all occupational injuries and illnesses to your DM supervisor who will notify the control room." The DM APM, Section 31.4, *Reporting and Recording Occupational Injuries/Illnesses and Near Misses, Procedures*, states, "At the operating sites, all occupational injuries/illnesses are reported immediately to the control room operator, regardless of severity."

The SMT hurried out of the Maintenance Shop and drove a vehicle to Cavern 5 where he located GC2 at the scene of the accident. The SMT is a qualified ERT member, and immediately after arriving at the scene of the accident he checked GC1 for vital signs. The SMT determined GC1 did not have a pulse and was nonresponsive, and that there were no obvious external injuries or marks. The SMT immediately radioed the CRO to request ERT and ambulance assistance.

The SMT and GC2 placed Mower 1 in reverse and moved the mower away from pipes and removed GC1 from Mower 1 and laid him on the ground so CPR could be administered. The SMT began CPR and within a short period of time additional ERT members began to arrive at the scene to assist with CPR and other emergency response actions. The ERT continued to perform CPR for about 43 minutes until GC1 was transferred to an ambulance. At about 1136 hours the CRO called 911.

At about 1137 hours, the CRO notified WSI-BM that an ambulance would be arriving onsite. WSI-BM had monitored the Operations radio channel and had heard the initial call for emergency assistance. WSI-BM initiated their own procedures for responding to the scene and for preparing for arrival of offsite emergency vehicles. At 1140 hours, the site fire truck arrived at the scene of the accident with emergency equipment. At 1145 hours, the ERT placed an AED on GC1. The AED analyzed the situation ten separate times between 1145 and 1209 hours, and did not detect the conditions required to advise a shock, and no shocks were administered.

At 1148 hours, the CRO called the Freeport Fire and EMS Dispatch to obtain an estimated time of arrival for the ambulance. Freeport Fire and EMS Dispatch advised the CRO that Freeport EMS were on calls and that they had dispatched Surfside EMS and off duty EMSs from both Clute and Freeport who would be responding in private vehicles. At 1157 hours, a county unit and a Freeport EMS person arrived at the accident scene, and at 1203 hours, a Clute EMS person arrived at the accident scene. At 1210 hours, EMS personnel placed GC1 on backboard in preparation for transfer to an ambulance. At 1215 hours, a Surfside ambulance arrived on scene, at 1217 GC1 was placed in the ambulance, and at 1220 hours, and the ambulance departed the SPR-BM site for Brazosport Memorial Hospital. At about 1235 hours, WSI-BM set up containment of the accident scene area and at about 1325 hours, they photographed the accident scene and collected the AED for evidence. At about 1500 hours, the Brazoria County Sheriff's Department contacted the DM Site Protection and Physical Security Specialist that the time of death for GC1 was 1220 hours.

Analysis

During this accident the call for emergency medical services was delayed at least four minutes because of a DM policy. The DM policy is that emergencies are reported to the DM supervisor who will then inform the CRO rather than the person who identifies the emergency directly calling 911. GC2 discovered the accident and called the SMT. The SMT responded from the Maintenance Shop to the accident scene at Cavern 5 to assess the situation before contacting the CRO. The CRO log indicates four minutes (1132 to 1136 hours) elapsed between notification to the CRO by the SMT and the call to 911.

Emergency medical response was also delayed because there were no units immediately available to dispatch because they were responding to other calls. The total time between notification of the accident to the SMT and arrival of the first offsite emergency medical responder was 25 minutes.

Initial actions by GC2 and the SMT were appropriate, and response actions by the ERT were well organized and performed. The number of ERT members trained to perform CPR allowed

the ERTs to provide continuous CPR from arrival of the first ERT responder (the SMT) until GC1 was transferred to an ambulance.

Actions by WSI-BM were well organized and coordinated. WSI-BM promptly initiated access control to the accident scene and made preparations to escort offsite medical responders to the accident scene.

The Board concluded that ERT response was timely and appropriate, and the ability of the ERT to continue cardiopulmonary resuscitation (CPR) for the period it did was commendable.

The Board concluded that the DM policy that employees contact their supervisor instead of directly calling 911 in emergency medical situations unnecessarily delays medical response.

2.12. 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), describes the HPI tools available for use at DOE sites. There is no specific requirement for DM to implement a *Human Performance Improvement Program* and the Board was not looking 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 2-14) 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 previously presented in this report.

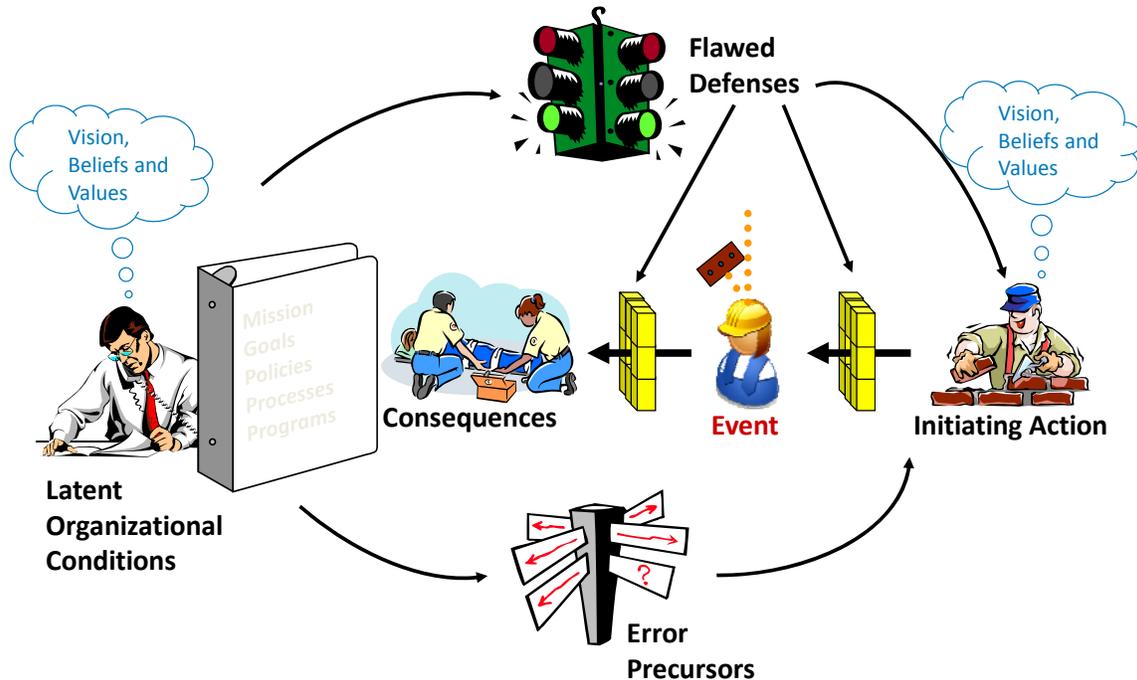


Figure 2-14: Anatomy of an Event Model

2.12.1. 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 2-15).

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 2-15: Human Performance Attributes

2.12.1.1. Error Precursor Analysis

The Board conducted an Error Precursor Analysis based on the information obtained from documents and interviews as documented throughout this report. The results of this analysis are presented in Appendix D, Table D-1. The analysis resulted in the identification of 16 different error precursors on the day of the accident. Four of the identified error precursors existed more than one time that day. The following is a discussion of some of the more predominant error precursors.

Task Demands

There were several examples of a *Lack of or Unclear Standards*. As described in the SWP section (Section 2.6.2.1) there were ambiguity and misunderstanding regarding the application of the SWP and who could perform work. There were no clear expectations regarding responsibilities of other operators to ensure that GC1 did not use the mower. Additionally, there was no clear standard or application of a standard related to the use of the JHA in pre-job briefs and the application of escort/buddy system responsibilities. Lacking the establishment and reinforcement of clear standards and expectations, front line workers will establish their own standards of behavior based on their visions, beliefs, and values.

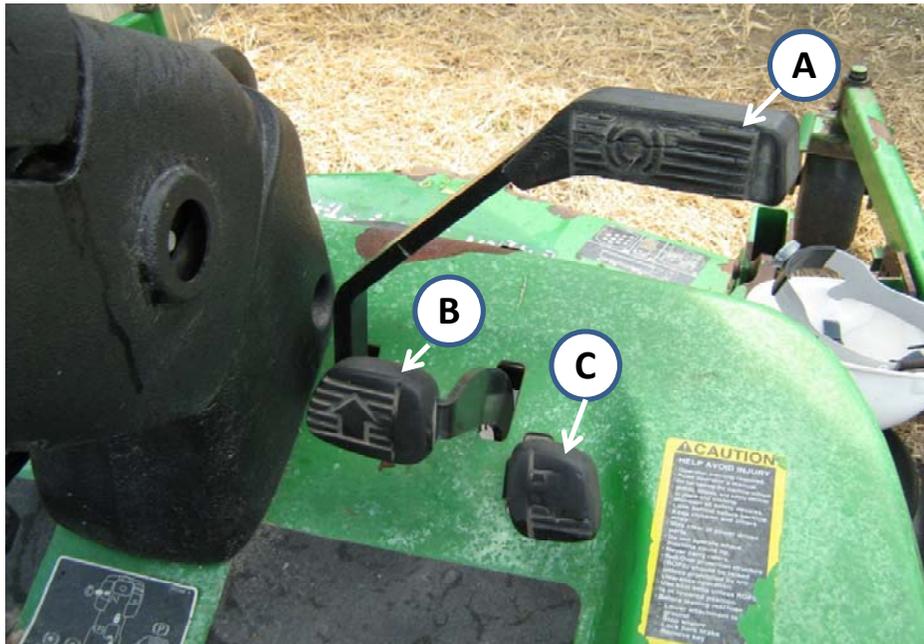
Work Environment

There were two *Distractions/Interruptions* error precursors that occurred during key points in the timeline of the accident. Most predominant was the ERT drill. Because the SMT was involved in the drill, he could no longer escort GC1 and he asked the other Grass Cutters to take GC1 with them to the worksite. Compounding that distraction/interruption was the fact that GC3 was directed to escort an outside vendor on the site and GC4 went to the front gate with GC3 to pick up his lunch. Although they tried to convince GC1 to accompany them to the gate, he refused and stayed with the mower. These changes contributed to the fact that GC1 was left alone with the mower.

There were examples of *Excessive Group Cohesiveness/Peer Pressure* error precursors that may have impacted the decision making processes that led to the accident. All four of the Grass Cutters knew each other and GC1 had worked for DM in the past. It was stated by one of the Grass Cutters that GC1 was someone they would go to for advice when they were younger. Additionally, GC2, GC3, and GC4 had all worked together for several years and "group think" may have occurred causing a reluctance to share contradictory information about a problem in order to maintain harmony of the work group; and this overrides a realistic appraisal of alternatives. This is a natural human tendency when individuals work together closely for a long period of time. This may have impacted the decision that GC3 and GC4 ultimately made to leave GC1 alone with the mower. Additionally, because GC1 had previously worked at the site and was generally more experienced than the other personnel, he may have felt peer pressure to be a meaningful part of the team and immediately demonstrate the ability to do work. This may have been the motivation for him to operate the mower and help out the other Grass Cutters.

Individual Capabilities

The most predominant error precursors related to this accident had to do with the training/experience of GC1 in the operation of Mower 1. *Unfamiliarity with Task/First Time, Lack of Knowledge (faulty mental model), New Technique not used Before and Lack of Proficiency/Inexperience* were all error precursors that existed prior to the accident. Mower 1 involved in the accident is a complex piece of equipment with multiple controls. Interviews with personnel at the site and from the independent expert/consulting engineer on agricultural and grounds maintenance equipment all indicated that it takes time to learn how to operate the equipment controls and get comfortable with the mower. The use of these controls to regulate the speed, direction and braking of the mower is not intuitively obvious to an inexperienced operator. For example there are three foot pedals on the right hand side of the mower (Figure 2-16). One extended pedal above the other two is the master brake and also disengages the PTO. There are two pedals below that. The larger of the two lower pedals to the left (similar in location to a brake pedal on a car) is the hydrostatic pedal that allows the machine to go forward. The more the pedal is depressed the faster the mower goes forward. The smaller of the two pedals on the right side is the hydrostatic control pedal that controls the unit going in reverse. The more that pedal is depressed the faster the unit goes in reverse. The mower is designed so that the maximum reverse speed is less than the maximum forward speed. This complexity of operation makes it even more important to ensure that only competent personnel (qualified operators) are allowed to operate the equipment.



- A – Master Brake Pedal**
- B – Forward Pedal**
- C – Reverse Pedal**

Figure 2-16: Configuration of Right Pedals on Mower 1

Human Nature

There were two different examples of *Inaccurate Risk Perception* error precursors on the part of personnel involved in the accident. 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. There was an inaccurate risk perception on the part of GC1 with regard to operating the mower before being trained and disregarding the direction provided by the SMT to not operate the mower. Although GC3 and GC4 attempted to talk GC1 into going to the gate with them rather than staying with the mower, there was an inaccurate risk perception on their part that led to their decision to leave GC1 at Cavern 5 with the mower. If GC1, GC3 or GC4 had an accurate risk perception with regard to the hazard or the consequences associated with G1 operating the mower, GC1 would not have operated it.

The Board concluded that there were numerous error precursors in existence on the day of the accident, and identifying and addressing these error precursors may have prevented the accident.

2.12.2. Flawed Defenses

Defenses, also referred to as controls or barriers, are in place to prevent an event from occurring, mitigate the consequences of an event should one occur, and/or warn. Defenses comprise any human, technical, or organizational features that protect the facility, personnel, and/or the environment against hazards. In addition to human error, other hazards include radiation, industrial safety hazards, hazardous chemicals, and various forms of energy, such as electricity and rotating equipment. Controls take the form of containments, physical interlocks, power sources, annunciators, personal protective equipment procedure use, caution tags, training and self-checking, among others. To be effective, defenses must be diverse (various types) and redundant (backups). This section analyzes defenses from an HPI perspective and supplements the barrier analysis as part of the overall analysis conducted by the Board.

2.12.2.1. Flawed Defense Analysis

Questioning Attitude

Individuals demonstrate a questioning attitude by challenging assumptions, investigating anomalies, and considering potential adverse consequences of planned actions. All employees must be watchful for conditions or activities that can have an undesirable effect on safety, and they do not proceed if faced with uncertainty. A reluctance to fear the worst is aggravated by human nature, since humans tend to accentuate the positive. A healthy questioning attitude must overcome the temptation to rationalize away “gut feelings” of something not right. A team approach where everyone is looking, questioning, and challenging every aspect of the work is required to increase the chances of identifying the job site hazards to ensure protection of the workers.

On the day of the accident, there was evidence that the workers displayed some indications of a questioning attitude, but it was clear that this was not an established and/or reinforced practice of the Grass Cutters. This is particularly true of the behaviors exhibited by the Grass Cutters at Cavern 5. Based on the “gut feel” that GC3 and GC4 experienced, they tried to talk GC1 out of staying with the mower and tried to convince him that he should go with them. However, eventually they left him there.

Questioning Attitude must be part of an effective Stop Work process and “pause” or “time out” as described below. Questioning Attitude is not something that you just “expect” people to do. It must be defined, clearly established and communicated on a routine basis, and constantly reinforced. Leaders must value employee involvement, encourage individual questioning attitude, and instill trust to encourage raising issues without fear of retribution.

Stop Work

In many organizations, workers are reluctant to formally stop work unless they are completely confident that it is justified and necessary. Formally stopping work is usually associated with the threat of imminent danger or other visible safety issues. Typically, workers believe that they need to be able to justify the consequences associated with the actions they are exercising their stop work authority for. In other words, they need to answer the “so what?” question or there may be consequences to them for stopping the work.

Formal stop work authority is necessary and must remain in place. However, some organizations will also implement a lower threshold HPI tool that allows workers to “pause,” take a “time out,” or “stop when unsure.” Workers tend to be more comfortable using this tool because there is no formal notification requirement associated with it. This tool can be used any time a worker is unsure or uncomfortable with a given situation, whether it is related to safety or not.

As described in Section 2.6.4, Stop Work Authority is defined at the policy level for DM facilities and the SPR-BM site. The Stop Work Authority is for activities that have significant safety implications. However there is no lower-level process for workers to pause or take a time out when things don’t seem right – even if there is no apparent significant safety implication. The other workers (GC3 and GC4) who were at Cavern 5 the day of the accident had obvious concerns about leaving GC1 alone; however, they did not exercise Stop Work Authority. This may be because they were not aware of Stop Work Authority, they may have felt that the actions that day did not meet that threshold, or they may have not been comfortable doing it.

Training

For individuals to perform their assigned duties in a safe, effective, and efficient manner, they must be competent. Training is another essential HPI tool. GC1 was not a trained and qualified operator on Mower 1. The SMT recognized this and that is why he did not assign GC1 to operate that mower and made it clear on more than one occasion that GC1 was not to operate the mower.

Pre-Job Brief

As discussed in Section 2.6.2.3, the SPR-BM site does not have a formal process for conducting pre-job briefs or task previews. The lack of this process leaves it completely up to supervisor discretion to determine the what, when and how of these discussions. This was clearly a flawed defense.

The pre-job brief process is a very important HPI tool. In addition to covering the hazards and activities that are identified in the JHA, work package or procedure, it helps to focus the workers on those unique and/or specific issues that may be different on any particular job on any given day. For example, on the day of the accident GC1 was a new employee but he had significant previous experience on the SPR-BM site. Pre-job or pre-activity briefs can be very beneficial on those jobs or activities that are perceived as being “routine” – such as the work tasks associated with the accident that occurred at the SPR-BM site. In most cases, supervisors and workers tend to pay very close attention and are very focused on jobs or activities that are complex, high-hazard, or being done for the first time. Rarely do events occur when performing these activities.

In most cases, events occur when workers and management are complacent or easily distracted performing “routine” activities.

Many organizations use a graded approach to pre-job briefings or pre-job reviews based on risk, complexity, and frequency of the task. This is industry-accepted guidance for pre-job briefs and it should be considered by DM. This practice recognizes that although a detailed and formal pre-job brief process is not necessary for some low risk, high frequency activities, some sort of review should always be conducted to keep workers “mindful” when they are performing activities.

Pre-job or pre-activity briefs should be an interactive discussion and should focus the workers on those items that are of particular importance such as significant hazards, changing conditions, and “critical steps” in the process. Training for supervisors is helpful in ensuring that they understand expectations for pre-job briefs. Managers need to make a conscious effort to observe pre-job or pre-activity briefs and provide coaching and reinforcement.

The Board concluded that DM would benefit from the application of HPI tools and techniques to help manage and defend against human error.

2.12.3. Visions, Beliefs, and Values

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. While that is important, most fatalities in DOE occur during “routine” operations such as grass cutting, loading equipment, operating forklifts or backhoes, and performing “routine” electrical work. The challenge for leadership is to establish and reinforce the safety culture expectations continuously so that workers are mindful and careful during all operations.

There are several examples concerning the accident where personnel “did not do” what was written down in a manual or what management expected them to do. For example they did not exercise stop work authority, follow requirements in the JHA, review the JHA requirements with the SWP, or follow the escort policy requirements. While it may be easy to point a finger at individuals for not following rules, leadership needs to first ensure that they are confident that these examples of not doing what was written down or what they believe should have been done are isolated cases. There were a number of individuals involved, and a number of times choices were made or actions taken that contributed to the accident. For whatever reasons, the Grass Cutters did not know to take the correct actions, did not feel comfortable taking the correct actions, or did not know how to take the correct actions. Therefore, the Board determined that clear performance expectations were not always in existence, communicated, and/or reinforced to the workers.

The Board concluded that clear performance expectations were not always communicated and/or reinforced to the workers.

3.0 Conclusions and Judgments of Need

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 which must be developed by line management. The Board’s conclusions and JONs are listed below in Table 3-1.

The two root causes of this accident were that GC1 failed to follow SMT’s direction to stay off Mower 1, and that the SPR-BM site Stop Work policy and its implementation did not address less than imminent danger situations.

The contributing causes were:

1. Less than Adequate Work Control Process (JHA, SWP, pre-job briefing, work assignments),
2. GC1’s lack of competency in operating Mower 1,
3. GC1 was a new employee with previous experience at the SPR-BM site,
4. Unavailability of the supervisor due to other duties, and
5. GC1 was left alone with Mower 1 when GC3 and GC4 left the worksite.

A total of 31 JONs were identified by the Board for these causes, 25 assigned to DM, five assigned to SPR-HQ, and one assigned jointly to SPR-HQ and DM.

Table 3-1: Conclusions and Judgments of Need

Conclusion	Judgment of Need
<p>Work Planning and Control:</p> <p>The Board concluded that the DM Job Hazard Analysis (JHA) process for large and small tractor mowing lacked an inclusion of applicable hazards from equipment manufacturer operator’s manuals and other identified applicable hazards and controls (e.g., heat stress).</p> <p>The Board concluded that the DM JHA process lacked specific requirements for periodic worker review, mechanisms for integration into the work control process (e.g., morning meeting), and that the controls specified in some JHAs were not followed by workers (e.g., use of qualified</p>	<p>DM needs to ensure that hazards listed in equipment manufacturer operator’s manuals and other relevant references are included in the JHAs.</p> <p>DM needs to revise the JHA procedure of the Accident Prevention Manual (APM) to include a requirement for workers to periodically review JHAs to ensure an understanding of the hazards and controls.</p> <p>DM needs to revise the SWP process to specifically include a review of the JHAs for the work to be performed and to confirm adequate controls are in place.</p>

Conclusion	Judgment of Need
<p>operators).</p> <p>The Board concluded that the DM Safe Work Permit (SWP) process did not adequately integrate the hazards and controls of the applicable JHAs.</p> <p>The Board concluded that the DM SWP did not have an adequate mechanism for authorizing work.</p> <p>The Board concluded that DM lacked a policy and guidance for the conduct of pre-job briefings.</p>	<p>DM needs to revise the SWP process to require the initiator to verify that assigned workers are qualified to perform the work, and that DM Operations has confirmed readiness before authorizing work to commence.</p> <p>DM needs to develop a pre-job briefing process that establishes a minimum set of requirements to be addressed at each pre-job briefing commensurate with the hazards and complexities of the work.</p> <p>The Office of Petroleum Reserves, FE-40 (SPR-HQ) needs to evaluate DM's effectiveness in implementing improvements in JHA, SWP, and pre-job briefing processes.</p>
<p>Training:</p> <p>The Board concluded that the on-the-job training (OJT) program for Grass Cutters (GC) was not equipment-specific. For example, completing training/qualification on one lawn mower qualifies an individual on all lawn mowers (large or small).</p> <p>The Board concluded that the OJT program for Grass Cutters lacked sufficient documentation with respect to content (e.g., elements of the equipment operator's manuals, equipment postings and warnings), and did not distinguish between new hire and refresher training.</p> <p>The Board concluded that the training and qualification documentation did not provide sufficient guidance to personnel conducting OJT.</p> <p>The Board concluded that Grass Cutter #1 (GC1) was not qualified to operate the John Deere 1435 Front Mower (Mower 1) since GC1 had not completed the required training for his position nor the OJT required to operate the mower.</p>	<p>DM needs to revise its OJT and qualification program so that the OJT is specific to equipment and processes that are significantly unique.</p> <p>DM needs to provide sufficient guidance in the OJT materials to ensure that consistent, task-specific training is conducted and documented.</p> <p>The DM OJT program needs to ensure relevant work documents such as equipment operator's manuals, JHAs, and equipment warnings are addressed and documented in the OJT record.</p> <p>DM needs to ensure the necessary OJT and other required training are properly completed and documented before assigning an employee to perform a particular task.</p> <p>SPR-HQ needs to evaluate DM's effectiveness in implementing training improvements for OJT, and DM's process for verifying that training is complete before employees are assigned tasks.</p>

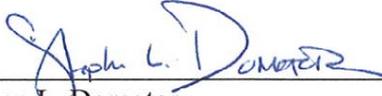
Conclusion	Judgment of Need
<p>Stop Work Authority:</p> <p>The Board concluded that the DM stop work policy does not incorporate the requirements of DOE Order 422.1, <i>Conduct of Operations</i>, resulting in a policy that is limited to “imminent danger” and lacking sufficient instruction and training to ensure workers are knowledgeable of the policy.</p> <p>The Board concluded that a stop work process/authority was not utilized by the workers at the job site to prevent GC1 from operating Mower 1.</p>	<p>DM needs to augment its current stop work policy by incorporating a graded approach to stop work that encourages workers to initiate a “stop when unsure,” “pause” or “timeout” process.</p> <p>DM needs to develop and implement stop work training that includes situations and scenarios that will help workers identify when to stop work at lower thresholds.</p> <p>DM needs to identify mechanisms (e.g., monthly safety meetings, pre-job briefings) to routinely communicate and reinforce the expectations for stop work at lower thresholds.</p> <p>SPR-HQ needs to evaluate DM’s effectiveness in implementing a graded approach for stop work including training and mechanisms to reinforce expectations for stop work.</p>
<p>Equipment Inspection and Maintenance:</p> <p>The Board concluded that important information identified in the Mower 1 equipment Operator’s Manual had not been included in pre-operational checklists for this equipment, and that the daily equipment checks were not consistently performed and/or documented.</p> <p>The Board concluded that important information identified in the Mower 1 equipment Operator’s Manual had not been included in the maintenance programs for this equipment, and that there were several pre-existing equipment deficiencies for Mower 1.</p>	<p>DM needs to revise daily equipment operating checklists to ensure consistency with the equipment operator’s manual for such equipment.</p> <p>DM needs to ensure that daily equipment checks are performed and documented.</p> <p>DM needs to revise the DM equipment maintenance program to ensure that DM equipment is maintained consistent with the requirements in equipment manufacturer operator’s manuals.</p>

Conclusion	Judgment of Need
<p>Accident Scene Preservation:</p> <p>The Board concluded that the accident scene was not adequately preserved, since DM management and staff were allowed access to Mower 1 following the accident.</p>	<p>DM needs to review its accident investigation process and ensure that there are adequate requirements and guidance to prevent the disturbance of an accident scene. The requirements and guidance need to be clearly communicated.</p> <p>DM needs to establish a more stringent control process at the scene of an event to ensure that no evidence is disturbed, and if evidence is disturbed, it is promptly documented and reported.</p>
<p>Human Performance Improvement (HPI):</p> <p>The Board concluded that there were numerous error precursors in existence on the day of the accident, and identifying and addressing these error precursors may have prevented the accident.</p> <p>The Board concluded that DM would benefit from the application of HPI tools and techniques to help manage and defend against human error.</p> <p>The Board concluded that clear performance expectations were not always communicated and/or reinforced to the workers.</p>	<p>DM needs to implement HPI principles that address the application of HPI tools and techniques to help manage and defend against human error.</p> <p>DM needs to include the identification and subsequent addressing of error precursors as part of the SWP and pre-job brief process.</p> <p>DM needs to ensure that performance and safety-related expectations are clearly defined, communicated, and understood by all workers and routinely reinforced by leadership.</p>

Conclusion	Judgment of Need
<p>Lessons Learned/ Feedback and Improvement:</p> <p>The Board concluded, based on a review of completed corrective actions at the Strategic Petroleum Reserve Bryan Mound (SPR-BM) site, and a worker fatality at this site a year ago, that long-standing problems have existed at the SPR-BM site with respect to daily equipment pre-operational checks, integrating hazards into SWPs, and not understanding or strictly complying with health and safety requirements.</p> <p>The Board concluded that, to the Board’s knowledge, DOE and DM organizations at the SPR-BM site did not effectively review and utilize information available through DOE’s operating experience programs and reporting systems, resulting in a missed opportunity to continuously learn and improve their grass cutting operations – and other operations at the SPR-BM site.</p>	<p>SPR-HQ and DM need to ensure that DOE operating experience programs and reporting systems are used to continuously improve operations.</p> <p>SPR-HQ needs to provide oversight of the resolution of corrective actions related to this accident and the corrective actions associated with the prior 2010 fatality at the SPR-BM site to ensure effective implementation and to prevent recurrence.</p>
<p>Fitness for Duty:</p> <p>The Board concluded, based on evidence presented to the Board through interviews, that GC1 was fit for duty on the morning of the accident.</p>	<p>No action required.</p>
<p>Emergency Response:</p> <p>The Board concluded that ERT response was timely and appropriate, and the ability of the ERT to continue cardiopulmonary resuscitation (CPR) for the period it did was commendable.</p> <p>The Board concluded that the DM policy that employees contact their supervisor instead of directly calling 911 in emergency medical situations unnecessarily delays medical response.</p>	<p>DM needs to revise its policy for requiring supervisor permission to make a 911 call when it is obvious that medical assistance is required.</p>

Conclusion	Judgment of Need
<p>Supervision:</p> <p>The Board concluded that the Grass Cutters did not follow the instruction of the DM Site Maintenance Technician (SMT).</p> <p>The Board concluded that, on the day of the accident, the DM escort policy was not implemented as required by DM Manual ASI5600, <i>Security Operations Manual</i>.</p>	<p>DM needs to reaffirm the roles and responsibilities of supervisors, and emphasize that supervisory direction is to be followed whether or not the supervisor is present.</p> <p>DM needs to provide additional guidance to supervisors and workers with respect to implementation of the DM escort policy.</p>
<p>Safety Organization:</p> <p>The Board concluded that DM employees were not implementing some requirements of the DM APM, or in some cases the manual was unclear and resulted in inconsistent implementation of safety requirements.</p>	<p>DM needs to revise the JHA and SWP sections of the APM to address the Board's concerns as expressed in Sections 2.6.2.1 and 2.6.2.2 of this report.</p> <p>DM needs to implement a clear policy stressing the importance of following procedures including work permits and the safety and health requirements of the DM APM.</p> <p>SPR-HQ needs to evaluate DM's effectiveness in ensuring management and workers are complying with DM safety and health requirements as written in the DM APM, JHA, and SWP.</p>

4.0 Board Signatures



Stephen L. Domotor
DOE Accident Investigation Board Chairperson
U.S. Department of Energy
Office of Health, Safety and Security, HS-24



Victor I. Crawford
DOE Accident Investigator and Board Member
U.S. Department of Energy
Office of Health, Safety and Security, HS-45



Rick Du Bose
DOE Accident Investigator and Board Member
U.S. Department of Energy
Office of Fossil Energy, FE-7

5.0 Board Members, Advisors and Consultants

Board Members

Chairperson	Stephen L. Domotor, Chair, HS-24
Member	Victor I. Crawford, Investigator/Board Member, HS-45
Member	Rick Du Bose, Investigator/Board Member, FE-7

Advisor/Team Coordinator

Consultant/Advisor	Jim Lockridge, Unwin Company
Consultant	Mike Schoener, MAS Consultants
Accident Analyst/Coordinator/ Consultant Advisor	Robert C. Seal, MAS Consultants

Administrative Coordinator

Consultant	Susan M. Keffer, Project Enhancement Corporation
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**Appendix A: Appointment of an Accident
Investigation Board**



Department of Energy

Washington, DC 20585

September 19, 2011

MEMORANDUM FOR STEPHEN L. DOMOTOR
BOARD CHAIRPERSON
OFFICE OF ANALYSIS

FROM: GLENN S. PODONSKY
APPOINTING OFFICIAL
CHIEF HEALTH, SAFETY, AND SECURITY OFFICER

SUBJECT: Accident Investigation into Fatality at the Strategic Petroleum Reserve Bryan
Mound Site, September 13, 2011

In coordination with the Office of Fossil Energy (FE) and in accordance with the requirements of Department of Energy (DOE) Order 225.1B, *Accident Investigations*, I am establishing an Accident Investigation Board (AIB) to investigate the fatality of a worker at the Strategic Petroleum Reserve Bryan Mound Site that occurred on September 13, 2011. I have determined the event meets the criteria of: *"Any injury or chemical or biological exposure that results in or is likely to result in, the fatality of an employee or member of the public."* for the conduct of an accident investigation delineated in Appendix A, DOE Order 225.1B.

You are appointed as the Board Chairperson. The Board will be composed of the following members:

- Victor Crawford, Board Member, Office of Safety and Emergency Management Evaluations (HS-45)
- Rick DuBose, Board Member, Office of Environment, Security and Safety (FE-7)
- Robert Seal – Accident Analyst/Coordinator/Consultant Advisor
- James Lockridge – Consultant Advisor
- Susan Keffer - Administrative Support

All members of the AIB, by this letter, and in accordance with the requirements of DOE Order 225.1B, are released from their normal regular duty assignment to serve on the AIB, during the period the AIB is convened.

The scope of the Board'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. Also, the scope of the investigation is to include DOE's programs and oversight activities.

The Board 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, FE, the Strategic Petroleum Reserve, and the affected contractor for factual accuracy review prior to finalization. The final report should be provided to me no later than 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.

cc: Charles D. McConnell, FE-1
William Gibson, SPR



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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.

Table B-1: Barrier Analysis

Hazard: Contacting Elevated Pipe		Target: Grass Cutter 1 (GC1)		
What were the barriers?	How did each barrier perform?	Why did the barrier fail?	How did the barrier affect the accident?	Context: ISM Guiding Principles (GP)
Supervision	Ineffective	Supervisor was called away for unannounced drill.	GC1 was not directly supervised at the time of the accident.	GP#4: Perform work within controls.
Morning Meeting	Ineffective	GC1 willfully failed to follow direction to stay off mowers.	GC1 used Mower 1.	GP#1: Define scope of work. GP#2: Identify Hazards. GP#3: Develop and implement hazard controls.
Safe Work Permit (SWP)	Failed	SWP did not include review of JHA and was not used to assign authorized workers.	Hazards were not identified and mitigated, and GC1 was not prevented from accessing worksite.	GP#3: Develop and implement hazard controls. GP#4: Perform work within controls.

Hazard: Contacting Elevated Pipe		Target: Grass Cutter 1 (GC1)		
What were the barriers?	How did each barrier perform?	Why did the barrier fail?	How did the barrier affect the accident?	Context: ISM Guiding Principles (GP)
Job Hazard Analysis (JHA)	Not used	Review of JHA was not included in morning meeting.	Hazards included in JHA were not identified and mitigated.	GP#1: Define scope of work. GP#2: Identify Hazards. GP#3: Develop and implement hazard controls.
On-The-Job Training (OJT)	Not used	OJT was planned but not completed.	GC1 did not know how to operate the mower.	GP#4: Perform work within controls.
Preventive Maintenance	Failed	Some safety related maintenance items from the equipment Operator's Manual were not included in preventive maintenance documents.	If proper preventive maintenance inspections would have been performed Mower 1 may not have been in service at the time of the accident.	GP#4: Perform work within controls.
Daily Maintenance Checklist	Inadequate	Checklist did not include key components of the Operator's Manual.	Brakes and forward and reverse pedals were not checked.	GP#4: Perform work within controls.
Escort Requirements	Ineffective, although it was for security purposes rather than safety.	Requirement for visual and verbal control was not followed.	GC1 was not under the direct observation and control of anyone at the time of the accident.	GP#4: Perform work within controls.

Hazard: Contacting Elevated Pipe		Target: Grass Cutter 1 (GC1)		
What were the barriers?	How did each barrier perform?	Why did the barrier fail?	How did the barrier affect the accident?	Context: ISM Guiding Principles (GP)
Buddy System	Ineffective	GC2 did not know he was Buddy System partner for GC1.	Unknown since Buddy System is mainly for heat stress.	GP#4: Perform work within controls.
Stop Work Policy	Failed	Workers did not recognize a stop work situation.	GC1 was not prevented from using equipment.	GP#4: Perform work within controls.
Equipment Safety Features (steering, brakes, controls)	Unknown	Some safety equipment was not properly tested and maintained.	Unknown because exact accident sequence was not determined.	GP#4: Perform work within controls.
Warning Postings on Mower 1	Failed	GC1 did not use seatbelt.	Unknown because exact accident sequence was not determined.	GP#4: Perform work within controls.

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

Change	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
C1	Before the job was completed GC3 was called away to perform escort duties and GC4 decided to go with him.	GC3 and GC4 would be at the worksite with GC1 to provide guidance and prevent unsafe actions.	GC1 did not have a co-worker to seek guidance from.	Unknown.
C2	Wheel on Mower 1 mowing deck needed to be replaced.	Mower 1 would be operational and would not require maintenance.	GC4 would have started using Mower 1 at Cavern 5 and it would not have been available to GC1.	Unknown, but it is likely that GC1 would have remained in the vehicle away from Mower 1.
C3	GC1 was mowing in an area that contained many obstacles (pipes, electrical boxes, above grade concrete structures).	GC1 would have inspected the area to be mowed and would remain a safe distance from obstacles.	GC1 did not know where obstacles and hazards were located along the mowing path.	Unknown, but it is likely that GC1 would not have chosen the mowing path that he did if he had been aware of the obstacles and hazards.
C4	GC1 was a new employee who had previous experience at the SPR-BM site but had been onsite less than 24 hours.	GC1 would have completed all new employee indoctrination and would have had current knowledge of DM policies.	GC1 would have been trained on current DM work control and work authorization policies.	Unknown, but it is likely that GC1 would have a better understanding of the SMT’s authority.

Change	Accident Situation	Prior, Ideal or Accident-Free Situation	Difference	Evaluation of Effect
C5	Because of an ERT drill the SMT was not able to remain with GC1.	The SMT would be available to continue working with GC1 to complete indoctrination and training.	GC1 would have remained in the office area and would not have been at the worksite where grass cutting activities were taking place.	The accident would not have occurred because GC1 would have remained in the office area.
C6	GC1 did not follow the SMT's clear direction to not use a mower.	GC1 would have followed the SMT's direction and would not use a mower.	GC1 would not have used Mower 1.	The accident would not have occurred.
C7	GC1 had not completed OJT and was not qualified to operate Mower 1.	GC1 would have completed OJT before using Mower 1.	GC1 would have been proficient with the controls and safety features of Mower 1.	Unknown, but highly likely that the accident would not have occurred.
C8	SWP did not include GC1 as a craftsman assigned to perform grass cutting in Cavern 5.	SWP would include GC1 as a craftsman assigned to perform grass cutting in Cavern 5.	SWP would be used as tool to authorize specific workers for a job.	Unknown, but assigning GC1 to Cavern 5 would have required a more deliberate action.
C9	Co-workers did not stop or suspend work, and allowed work to be performed outside established work control boundaries.	Co-workers would recognize that the use of Mower 1 by GC1, even for indoctrination purposes, was not allowed.	Instead of strongly advising GC1 to stay away from the mower, co-workers would have taken the steps necessary to prevent it.	The accident would not have occurred.

Appendix D: Error Precursor Analysis

Table D-1: Error Precursors¹

P1-TASK DEMANDS			P3-INDIVIDUAL CAPABILITIES		
x	A	Time Pressure (In a hurry)	x	A	Unfamiliarity with Task/First time
	B	High Workload (Memory Requirements)	x	B	Lack of Knowledge (faulty mental model)
	C	Simultaneous, Multiple Tasks	x	C	New Technique not used before
	D	Repetitive Actions/Monotony		D	Imprecise Communications
	E	Irreversible Acts	x	E	Lack of Proficiency/Inexperience
x	F	Interpretation Requirements		F	Indistinct Problem-solving Skills
x	G	Unclear goals, Roles, or Responsibilities		G	“Unsafe” Attitudes for critical task
xxx	H	Lack of or Unclear Standards		H	Illness/Fatigue (general health)
	I	Confusing Procedure/Vague Guidance		I	Unawareness of Critical Parameters
	J	Excessive Communication Requirements		J	Inappropriate Values
	K	Delays; Idle Time		K	Major Life Event: medical, financial, emotional
	L	Complexity/High Information Flow		L	Poor Manual Dexterity
	M	Excessive Time on Task		M	Low Self-esteem; Moody
	N	Long-term Monitoring		N	Questionable Ethics (bends the rules)
				O	Sense of Control/Learned Helplessness

¹ Table D-1: “x” indicates that this error precursor has occurred; multiple “x”s indicates multiple occurrences. See Table D-2 for an explanation of conditions present for each error precursor.

P2 – Work Environment			P4 – Human Nature		
xx	A	Distractions/Interruptions		A	Stress (limits attention}
x	B	Changes/Departure from Routine		B	Habit patterns
	C	Confusing Displays/Controls		C	Assumptions (inaccurate mental picture)
x	D	Work-arounds/Out-of-Service Instrumentation		D	Complacency/overconfidence
	E	Hidden System Response		E	Mindset
	F	Unexpected Equipment Conditions	xx	F	Inaccurate Risk Perception
	G	Lack of Alternative Indication		G	Mental Shortcuts (biases)
	H	Personality Conflicts		H	Limited Short-term Memory
	I	Backshift or recent shift change		I	Pollyanna effect
xx	J	Excessive Group Cohesiveness/Peer Pressure		J	Limited Perspective (bounded rationality)
	K	Production Overemphasis		K	Avoidance of Mental Strain
	L	Adverse Physical Climate (habitability)		L	First day back from vacation/Days off
	M	No Accounting of Performance		M	Sugar Cycle (after a meal)
	N	Poor Equipment Layout; Poor Access		N	Fatigue (Sleep deprivation, circadian rhythms)
	O	Fear of Consequences of Error		O	Tunnel Vision (lack of big picture)
	P	Mistrust among work groups	x	P	“Something is not right” (gut feeling)
	Q	Meaningless Rules		Q	Pattern-Matching Bias
	R	Unavailable Parts or Tools	x	R	Social Deference (excessive courtesy)
	S	Acceptability of “Cook Booking” Practices		S	Easily Bored

P2 – Work Environment			P4 – Human Nature		
	T	“Rule Book” Culture		T	Close-in-Time Cause – effect correlation
	U	Equipment Sensitivity (inadvertent actions)		U	Difficulty seeing own errors
	V	Lack of Clear Strategic Vision or Goals		V	Frequency and Similarity Biases
	W	Identical or Adjacent Displays/Controls		W	Availability Bias
	X	Out-of-Service Warning Systems	x	X	Imprecise Physical Actions
	Y	Nuisance Alarms		Y	Limited Attention Span
	Z	Lack of Place Keeping		Z	Spatial Disorientation
				AA	Physical Reflex
				BB	Anxiety (involving uncertainty)

Table D-2: Conditions

Precursor Code	Condition
P1-A	GC3 and GC4 were in a hurry to leave the Cavern 5 area, to go to the gate to pick up lunch and escort an external vendor.
P1-F	There was a misunderstanding of the application of the SWP and Grass Cutters could not perform a job/task if their name was not on the SWP.
P1-G	There was no clear understanding or accountability among the operators if it was their responsibility to ensure that GC1 did not use the mower.
P1-H	<p>1) Ambiguity and misunderstanding regarding the application of the SWP and who could perform work.</p> <p>2) Misunderstanding and/or clear expectations regarding responsibilities of other Grass Cutters to ensure that GC1 did not use the mower.</p> <p>3) No clear standard or application of standard related to the use of the JHA and the application of escort/buddy system responsibilities.</p>
P2-A	<p>1) There was an ERT drill and that is why the SMT sent GC1 out to the field with the other Grass Cutters - otherwise GC1 would have stayed in the shop.</p> <p>2) GC3 and GC4 had to leave Cavern 5 to escort a vendor and pick up lunch.</p>
P2-B	GC1 was a new Grass Cutter assigned to the team.
P2-D	The SMT informally qualified GC1 for weedeating based on previous experience working at the site. This allowed GC1 to be on the SWP and working with GC2, GC3 and GC4.
P2-J	<p>1) All four of the Grass Cutters knew each other and GC1 had worked for DM in the past. It was stated by one of the other Grass Cutters that GC1 was someone they would go to for advice when they were younger. The other three Grass Cutters have all worked together for several years and "group think" occurred causing a reluctance to share contradictory information about a problem in order to maintain harmony of the work group.</p> <p>2) Because GC1 had previously worked at the site and was generally more experienced than the other Grass Cutters, GC1 may have felt peer pressure to be a meaningful part of the team and do work.</p>

Precursor Code	Condition
P3-A	This is the first time GC1 operated Mower 1 and it takes time and training to become accustomed to using it.
P3-B	GC1 had not been trained on Mower 1.
P3-C	This is the first time GC1 operated Mower 1 and it takes time and training to become accustomed to using it.
P3-E	This is the first time GC1 operated this piece of equipment and it takes time and training to become accustomed to using it.
P4-F	<p>1) GC1 had an inaccurate risk perception regarding the hazard of operating Mower 1 for the first time around obstructions.</p> <p>2) GC3 and GC4 had an inaccurate risk perception with regard to leaving GC1 alone with Mower 1.</p>
P4-P	GC3 and GC4 recognized that GC1 should not stay alone and not use the mower (gut feel) and tried a couple of times to get him to go with them and not use the mower but they eventually relinquished.
P4-R	GC1 was older than GC3 and GC4 and had previously been a site employee. One of them acknowledged that in the past they had gone to him for advice and assistance in the work environment. GC1's age and experience may have led them to not sufficiently challenge his decision to use Mower 1.
P4-X	Although it is not known why, GC1 took imprecise physical actions that caused Mower 1 to impact the pipe. This type of mower is somewhat complex to operate and imprecise operation of the controls can create a hazard.

Appendix E: Events 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 Chart.

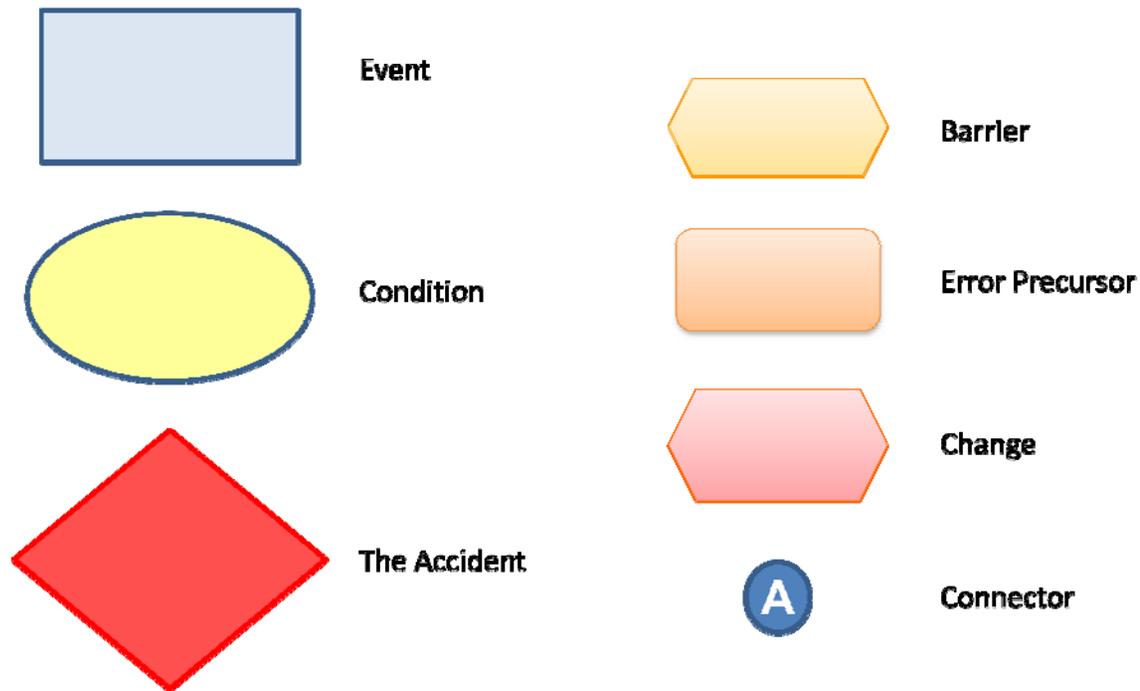


Figure E-1: Events and Causal Factors Chart

