

Independent Review of the Fatality at the Strategic Petroleum Reserve Bryan Mound Site



September 2010

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

This report is an independent product of the Independent Review Board appointed by Glenn Podonsky, Chief Health, Safety and Security Officer, Office of Health, Safety and Security, U.S. Department of Energy (DOE).

In accordance with DOE Order 225.1A, *Accident Investigations*, the Board was appointed to perform an independent review of the fatality at the Strategic Petroleum Reserve Bryan Mound Site and prepare a report for the Chief Health, Safety and Security Officer in accordance with the direction provided in the July 20, 2010, appointment letter (see Appendix A).

The discussion of 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.

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Executive Summary

In accordance with U.S. Department of Energy (DOE) directives, and in consultation with the Office of the Assistant Secretary for Fossil Energy (FE), the DOE Chief Health, Safety and Security Officer established an Independent Review Board (IRB) to review a July 8, 2010, fatality incident involving a subcontractor employee at the Bryan Mound Site, Strategic Petroleum Reserve (SPR). The employee was performing work activities involving cleaning the tank floor in a large crude oil storage tank. Recognizing that the Occupational Safety and Health Administration (OSHA) is also investigating this incident and that DOE line management and site contractors are concurrently performing a joint incident analysis, the IRB was directed to perform an independent review of selected aspects of the broader safety management programs applicable to the safety elements that were in place at the time of the incident.

Within FE, the SPR Project Management Office (SPRPMO) is the DOE field element with responsibility for SPR. Under contract to DOE, DynMcDermott Petroleum Operations Company (DM) has been the SPR site managing and operating contractor since 1993. In 2003, construction management activities were split from the contract with DM, and DOE awarded a separate contract to ASRC Gulf States Constructors, LLC (AGSC) for these services. At the time of the incident, AGSC was managing the tank cleaning project. The deceased tank technician was an employee of ES&H LLC, which is a subcontractor to AGSC.

The IRB determined that many safety controls were in place for the tank cleaning activity at the Bryan Mound Site. The subcontractor effectively used daily safety briefings to communicate hazards and controls to workers. Lockout/tagout processes were effectively implemented and were sufficient to eliminate many of the hazards involved in tank cleaning operations. An appropriate work permitting process has been implemented to formally authorize a variety of hazardous operations. However, there were significant deficiencies in important aspects of safety controls for the work activity at the time of the incident: (1) actions to monitor and control heat stress for tank entrants were inadequate and were not performed in accordance with the requirements established in the tank cleaning contract; (2) the respiratory protection program and equipment used during the tank cleaning operations did not meet applicable requirements; (3) air quality monitoring and sampling for confined space (tank) entries may have been inadequate; and (4) some aspects of confined space safety controls were not effectively implemented.

During this incident, the affected worker was retrieved rapidly, the immediate medical actions were appropriate for the situation, the coordination with and actions of the fire department were rapid and effective, and emergency communications and notifications were adequate. Although a few shortcomings were identified, the process of preserving and photographing the incident scene, obtaining witness statements, and establishing access controls was timely and effective. However, the effectiveness of the effort resulted in large part from individual initiative and was not supported by effective incident investigation plans, procedures, and tools.

The IRB identified two aspects of safety management systems that were not fully effective and need to be improved to prevent recurrence of the identified deficiencies. First, in some cases, safety requirements were not met because the subcontractor did not effectively convey them to the tank cleaning crew. Breakdowns in translating applicable requirements to work instructions occurred at various points in the requirements management system. An underlying factor in these breakdowns is an apparently insufficient process for reviewing work instructions against the set of requirements to ensure that all relevant requirements are clearly communicated to the working level. Second, the fact that the deficiencies identified during the line management and IRB investigations had not been previously identified by line management indicates that assurance processes and oversight were not fully effective. A contributing factor is the lack of industrial hygiene expertise at the site.

At this stage, the cause of death has not been determined by the coroner, and it is premature to draw any conclusions about whether the identified work control deficiencies were contributing factors. However, the work control, emergency response, and other deficiencies identified in this report are significant and, in other circumstances, could contribute to an injury or exposure, delay an effective emergency response, or result in

gaps in investigating an event. Consequently, they warrant timely management attention and appropriate corrective actions in accordance with site issues management processes.

The IRB review indicated that the SPR incident analysis was performed with an adequate scope and appropriate methods by a team with appropriate operational and safety experience. Further, the areas of deficiency identified by the IRB and the SPR line management review are similar, and therefore the IRB investigation provides an independent perspective that supports the conclusions of the SPR incident analysis. Although the IRB and SPR reviews focused primarily on the fatality incident and the safety programs in place at the Bryan Mound Site, both teams identified deficiencies in program documents, sitewide safety processes, organization interfaces, cross-cutting management systems (e.g., procedure development), and safety oversight. Such deficiencies are not limited to the Bryan Mound Site but could impact other activities at SPR to varying degrees, particularly activities with similar characteristics (e.g., construction projects, work performed by subcontractors, work in confined spaces, work involving respiratory protection, or work where heat stress monitoring is warranted). The SPR incident analysis produced an appropriate set of recommendations that address the implementation deficiencies identified at the Bryan Mound Site and also appropriately address deficiencies in contractor safety and emergency management programs. However, additional evaluation, either by the Bryan Mound Tank #2 Tier 2 team or through follow-on efforts, is needed in some areas to ensure that specific concerns and the underlying causal factors are fully addressed and to ensure that all affected site organizations are sufficiently involved in corrective actions. In addition, while the broad recommendations in the SPR incident analysis are an appropriate step toward addressing the extent of condition, additional evaluation by SPR management is warranted to further determine the extent of condition. Sustained management attention will be needed to ensure that the information is used to develop and implement effective corrective actions.

The opportunities for improvement that were identified by the IRB and that warrant priority management attention and timely action are presented in Section 7 of this report. In developing opportunities for improvement, the IRB considered the preliminary findings and recommendations of the DOE line management incident analysis. Rather than duplicating the information provided by the SPR line management analysis, the IRB focused on determining what underlying factors (e.g., systemic weaknesses in procedures or maintenance/testing) need to be addressed by DOE and contractor management to provide assurance that similar deficiencies are unlikely to recur.

The IRB recommends that FE and the SPRPMO ensure that the results of this review and opportunities for improvement are evaluated and integrated into a comprehensive corrective action plan to improve safety at SPR, in accordance with the site issues management process. The corrective action plan should clearly identify actions that need to be completed before resuming tank cleaning operations. As additional information becomes available through the OSHA investigation and the autopsy report, FE and SPRPMO should evaluate the need to modify or expand the corrective action plan as warranted. The corrective action plan should establish clear organizational ownership for each action, a schedule and criteria for closing actions, and a process for independent validation that corrective actions as implemented are effective.

ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AED	Automated External Defibrillator
AGSC	ASRC Gulf States Constructors, LLC
ASRC	Arctic Slope Regional Corporation
AM	Air Monitor
AT	Attendant
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
CSS	Covenant Security Solutions
DOE	U.S. Department of Energy
DM	DynMcDermott Petroleum Operations Company
EMS	Emergency Medical Services
FE	DOE Office of Fossil Energy
HSS	DOE Office of Health, Safety and Security
IRB	Independent Review Board
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
SCBA	Self-Contained Breathing Apparatus
SP	Security Police
SPR	Strategic Petroleum Reserve
SPRPMO	Strategic Petroleum Reserve Project Management Office
ST	Safety Technician
TT	Tank Technician

Independent Review of the Fatality at the Strategic Petroleum Reserve Bryan Mound Site

1.0 INTRODUCTION

This report documents the results of an independent review of a fatality at the U.S. Department of Energy (DOE) Bryan Mound Site, which is one of the Strategic Petroleum Reserve (SPR) crude oil storage sites. The fatality occurred on July 8, 2010, when a tank technician (hereafter referred to as TT#1) who worked for a subcontractor to the site construction contractor died during work activities involving the cleaning of the tank floor in a large crude oil storage tank identified as BMT-2.

The review was performed by an Independent Review Board (IRB) chartered by the DOE Chief Health, Safety and Security Officer. The IRB was chaired by an experienced safety professional from the Office of Health, Safety and Security (HSS) and included experienced safety professionals and accident investigators as members and advisors. The Chief Health, Safety and Security Officer letter that established the IRB and a list of the team members and their roles are provided in Appendices A and B, respectively.

This IRB review is the third tier of the three-tier review approach outlined in Table 1. This approach was established by the responsible DOE Headquarters program office, the Office of Fossil Energy (FE), in coordination with the Chief Health, Safety and Security Officer and HSS.

At the time of this independent review, the cause of death was not known. The autopsy process is ongoing, and the report had not been released as of the end of August 2010. The extent to which the autopsy will shed light on medical causes and work-related conditions contributing to the death is not known. After reviewing the autopsy report, HSS and the IRB will determine whether an addendum to this report is warranted.

At the time of this report, the Occupational Safety and Health Administration (OSHA) had not provided DOE with documented results but had discussed preliminary investigation issues with the IRB. OSHA personnel indicated that their field investigation was not complete and that they have unanswered questions in several areas, including the adequacy of air hoses, lighting, and air sampling. Also, the DOE line management investigation team had issued a draft report on the incident that identified a number of deficient conditions in each of the three areas of review (i.e., documentation, equipment, and personnel), as well as a set of recommendations to address the deficiencies and improve safety management elements. The IRB's perspectives on the DOE line management investigation are included in Section 5.

Facility and Organization Overview

SPR is the government's largest stockpile of crude oil and uses large underground salt caverns along the coastline of the Gulf of Mexico to store federally-owned stocks of crude oil. Bryan Mound, located near Freeport, Texas, is one of the four SPR sites.

Within FE, the Office of Petroleum Reserves manages SPR and other programs that provide the United States with strategic and economic protection against disruptions in oil supplies. The SPR Project Management Office (SPRPMO) is the DOE field element with responsibility for SPR.

Under contract to DOE, DynMcDermott Petroleum Operations Company (DM) has been the SPR site managing and operating contractor since 1993. DM is responsible for operating and maintaining SPR

sites and related pipeline operations. Covenant Security Solutions (CSS), the site security contractor, performs work under a subcontract with DM.

The tank cleaning project is managed by ASRC Gulf States Constructors, LLC (AGSC), which has provided construction management services for SPR since 2003 under contract to DOE. AGSC is a member of the ASRC Construction Holding Company, which is a wholly-owned subsidiary of the Arctic Slope Regional Corporation (ASRC). AGSC has had a good safety performance record during its work at SPR. No recordable injuries were reported for work performed by AGSC and its subcontractors for the period January 1, 2004, through July 7, 2010.

TT#1 was an employee of ES&H LLC, which is a subcontractor to AGSC. ES&H LLC provides tank cleaning, remediation, asbestos abatement, and mold management services and was under contract to AGSC to perform tank cleaning operations at the Bryan Mound Site. As a vendor under contract to ES&H LLC, Oilind Safety provided respiratory protection equipment and safety technician support for tank entry.

Purpose and Scope of the Review by the Independent Review Board

The DOE Chief Health, Safety and Security Officer established this IRB with the objectives of confirming conclusions of the DOE line management investigation, evaluating the extent of condition, and identifying additional opportunities for improvement. This independent review is intended to provide DOE line management with additional information that can be useful in making decisions about the readiness of site restart operations and additional actions that might be needed to improve safety management at SPR.

The IRB independently evaluated selected aspects of SPR safety programs that were determined to be important with respect to three aspects of the July 8, 2010, incident at BMT-2: (1) the work controls that were in place to protect ES&H LLC workers performing tank cleaning operations at BMT-2, (2) the processes in place to respond to emergencies in tank cleaning operations, and (3) the effectiveness of the SPR line management second-tier review of the incident at BMT-2. Background on the incident is provided in Section 2, and the results of the IRB evaluation of the three areas listed above are presented in Sections 3, 4, and 5, respectively. The IRB's perspectives on SPR safety management systems are presented in Section 6. Section 7 presents the IRB's conclusions in accordance with the objectives of the review.

Documentation of the establishment of the Board and approval of the report are provided in appendices. As noted, Appendix A shows the letter from the DOE Chief Health, Safety and Security Officer that appointed the Board Chairman and authorized the establishment of the Board, and Appendix B identifies the Board members and the associated management team and support personnel. Appendix C presents the Board Member signatures and the letter from the Chief Health, Safety and Security Officer that accepted the report and authorized its release.

Table 1. Three-Tier Approach to the Review

FE, in coordination with the SPRPMO, the Chief Health, Safety and Security Officer, and other HSS personnel (including the HSS organizational element that manages the DOE accident investigation program), built on the OSHA investigation to implement a three-tier incident review approach. The intent of the three-tier approach is to ensure that DOE and site contractor management have comprehensive and timely information about the incident and the deficiencies in site safety programs that were manifest as a result of the incident so that any needed corrective actions can be developed and implemented.

Tier 1. In accordance with an agreement between OSHA and DOE, SPR is subject to OSHA regulation, including investigation of fatalities and incidents. OSHA inspectors arrived at the Bryan Mound Site on July 9, 2010, one day after the incident, and initiated an investigation of the fatality in accordance with their established protocols. The OSHA Assistant Director advised that the OSHA report was not expected to be published for at least six months, and possibly not for one year. Consistent with OSHA protocols, OSHA investigations focus on identifying instances of non-compliance with requirements and can result in the issuance of citations and fines. However, OSHA investigations do not establish the causal factors of an incident or identify corrective actions to prevent recurrences.

Tier 2. Recognizing the scope and timing of the OSHA investigation, FE directed that a second-tier incident analysis be performed by SPR line management organizations. The second-tier review team performed a safety review of the incident and relevant safety elements to identify contributing factors and lessons learned to immediately improve safety of site operations. The review will include an “Operational Readiness Review” that is intended to provide FE with information that supports line management decisions about resuming tank cleaning operations.

Tier 3. The HSS IRB is the third and final tier of the review approach. The IRB consists of HSS personnel and thus is independent of the line management chain. The third-tier IRB review is intended to complement but not duplicate the OSHA investigation and second-tier line management incident analysis by providing DOE management with perspectives on safety program elements and the effectiveness of the DOE line management incident analysis.

Coordination. Although performed separately and with complementary purposes, the second- and third-tier review activities were performed concurrently to provide timely information about deficiencies and needed corrective actions. Further, the IRB and SPR reviews were closely coordinated, and information developed by both teams was openly shared to ensure that line management has the benefit of multiple perspectives. In addition, throughout the reviews HSS and SPRPMO were in contact and sharing information with OSHA. OSHA and SPR also coordinated efforts to control and preserve physical evidence to allow OSHA or DOE to conduct testing of the respiratory system used by the TT#1 if such testing is determined to be warranted based on the autopsy report.

2.0 BACKGROUND

Summary of the Fatality Incident. On July 8, 2010, at approximately 1400, a tank technician (TT#1) collapsed while cleaning the tank floor in a large crude oil storage tank (i.e., the BMT-2 tank) and was subsequently pronounced dead at the local hospital.

At the time of the event, one other tank technician (TT#2) was working inside the tank and three other individuals who had been assigned specific safety responsibilities were at or near the tank manways: an attendant (AT#1), a safety technician monitoring air supplies (AM#1), and a safety technician who was checking air quality (ST#1).

Based on site reports, the IRB developed a detailed timeline of the sequence of events that occurred before, during, and after the fatality incident, and validated the timeline with SPRPMO. Table 2 summarizes the key events that occurred on July 8, 2010, at the time of the incident. Following the incident, site security personnel secured the scene. DM ordered a shutdown of work at BMT-2 until further notice. Site organizations began to collect evidence and witness statements. Following the incident, site personnel noted that the air line for the individual had become disconnected and that other disconnections had occurred on previous occasions, including once earlier that day.

Table 2. Summary of Key Incident Events

- During morning work activities, two tank technicians were conducting work inside the tank when an air supply line to one of the technicians became disconnected. He opened his five-minute air supply bottle, proceeded to the entry point, and connected to a different air supply line. This event was not reported until after the afternoon incident. The disconnected line remained in the tank but was not used after this time.
- Two tank technicians (TT#1 and TT#2) entered the tank for afternoon work activities.
- At approximately 1400, TT#2 approached TT#1 to inform him that the power washer would not be needed. As he approached, he saw TT#1 pulling on his air line. A few seconds later, TT#2 and an attendant (AT#1) heard an audible “pop,” indicating that TT#1’s air line had disconnected.
- TT#2 saw TT#1 take a few steps in one direction, shift direction, and fall forward without attempting to break the fall.
- TT#2 turned TT#1 onto his back, turned on TT#1’s five-minute bottle, and attempted to pull him to the entry point.
- AT#1 entered the tank without donning respiratory protection to assist TT#2.
- AT#1 and TT#2 removed TT#1 from the tank soon after the collapse.
- ST#1 and AT#1 initiated cardiopulmonary resuscitation (CPR).
- The Bryan Mound operations center was notified that a man was down at 1407.
- The local (Freeport, Texas) fire/emergency medical services (EMS) department was notified at 1408, and Emergency Response Team members were told to report to BMT-2 at about the same time.
- The Site Safety Specialist and a security police officer (SP#1) arrived at the scene, and SP#1 relieved the individuals performing CPR.
- An automated external defibrillator (AED) was applied. TT#1 was shocked three times.
- At 1416, the Freeport EMS arrived at the scene. TT#1 was placed on a backboard and prepared for transport.
- Freeport EMS was en route to Brazoria Memorial Hospital in Lake Jackson at 1424.
- Site personnel were subsequently notified by the hospital that TT#1 had been pronounced dead.

According to documents provided by ES&H LLC, TT#1 was in good health, certified to work at a hazardous waste site, and properly trained to work in a hazardous environment. In addition, TT#1 had recently passed the Department of Transportation commercial driver's physical exam, benzene worker medical screening, and Federal drug and alcohol screening as required for this contract. TT#1 had performed a respiratory fit test in 2009 for the same respirators used during the work activity; however, the fit test had expired in March 2010.

Background on the Work Activities. The tank is about 32 feet high by 222 feet in diameter, with a nominal capacity of 200,000 barrels. The tank has an internal roof designed to float, with internal supports that prevent the roof from lowering beyond approximately 8 feet when the tank is drained. It also has a fixed (conical) external roof supported by internal columns.

ES&H LLC began efforts to clean BMT-2 on June 2, 2010. Cleaning activities included removing sediment and sludge by pressure washing, applying a squeegee, and pumping residues to a fractionation tank for treatment. By the time of the event on July 8, 2010, approximately 80 percent of the BMT-2 tank cleaning work had been completed.

Before the events of July 8, 2010, another subcontractor performed a vapor freeing treatment to enable work inside the tank. The contract required the vapor freeing treatment to be performed in accordance with American Petroleum Institute specifications and was conducted to ensure that the atmosphere in the tank is not flammable or explosive.

The work in BMT-2 was performed with supplied air to protect workers against the possibility of inhaling hazardous materials (e.g., benzene in oil vapors) that could be stirred up by cleaning operations. Air monitoring indicated that oxygen concentrations inside the tank were at normal levels – that is, the air was not oxygen deficient per National Institute for Occupational Safety and Health (NIOSH) standards – and flammable organics were below detection levels. Subsequent analysis raises questions about the adequacy of this monitoring (see Section 3).

Safety Responsibilities at SPR. Because of the nature of the work, various organizations are responsible for developing and implementing safety controls and emergency management processes. As the site operations contractor, DM has overall responsibility for site safety programs, including such functions as developing and implementing the site safety program and issuing safe work permits and confined space permits (which involve analyzing the hazards and defining required controls for an activity). As the construction contractor, AGSC is responsible for developing processes and work instructions to ensure that AGSC personnel and subcontractors follow applicable regulations and site-specific safety requirements. AGSC is also responsible for ensuring that site safety requirements flow down to its contractors and subcontractors. As a subcontractor, ES&H LLC is responsible for ensuring that its workers and subcontractors/vendors (e.g., Oilind) understand and follow established controls. CSS has responsibilities for emergency response, such as facilitating access of offsite emergency response. Because there are multiple prime contractors at SPR, including DM, AGSC, and CSS, SPRPMO has responsibilities for ensuring that the various contractors' activities and safety programs are effectively coordinated.

3.0 EVALUATION OF WORK CONTROLS

The IRB Team reviewed hazards and controls associated with the cleaning of crude oil storage tank BMT-2 at the Bryan Mound Site, focusing on processes and procedures relevant to the incident.

To implement responsibilities for analyzing hazards and establishing controls, the site organizations have issued various documents that identify safety requirements and processes. Some of the key site documents that govern the subject tank cleaning work and are relevant to the incident included:

- The SPRPMO Organization and Function Manual, which designates functions, responsibilities, and authorities for site organizations
- The DM Accident Prevention Manual
- DM-issued safe work permits, which were issued for each phase of the tank cleaning effort (e.g., vapor freeing, cleaning)
- The contract between ES&H LLC and AGSC, which identifies specific safety requirements, such as requirements for monitoring heat stress and conducting weekly safety inspections.
- The ES&H LLC Corporate Policy and Procedures Manual
- The ES&H LLC Corporate Health and Safety Plan
- The ES&H LCC-issued confined space permit for the activity
- The ES&H LLC-developed a formal job safety analysis and a site-specific health and safety manual that was approved by AGSC.

Collectively, these documents reflect efforts to comply with regulations that apply to SPR, such as various OSHA regulations and NIOSH standards, and establish appropriate site-specific requirements. The requirements, hazards, and controls are intended to be communicated to workers through various work instructions, such as procedures and briefings. For example, Daily Tail Gate meetings are used to remind workers of potential hazards and controls identified in the AGSC-approved site-specific health and safety manual for the planned activities for each day. In addition, various personnel are assigned to monitor the implementation of safety requirements and to support operations personnel in developing and implementing controls. For example, a DM and AGSC safety representative each visited the site at least weekly, an AGSC project inspector visited several times each day, and ES&H LLC provided a full-time safety specialist to monitor health and safety hazards and controls.

The IRB review of the incident indicates that most hazards had been adequately analyzed, some of the controls were appropriate for the hazards, and some of the established processes were adequately implemented. The use of supplied air was an appropriate choice to protect workers against potential respiratory hazards. Some other personal protective equipment, such as protective eyewear and clothing, was also used appropriately. TT#1 had the appropriate medical certifications to perform work, and safety attendants were in place as required. Some examples of effective performance in implementing safety processes are as follows:

- **ES&H LLC effectively used the daily safety briefing to communicate hazards and controls to workers.** ES&H LLC conducted Daily Tail Gate safety talks each morning of work at the Bryan Mound Site, covering the upcoming work activities and the precautions that would be necessary. The briefings covered appropriate topics, such as heat stress and illumination.
- **Lockout/tagout was effectively implemented and sufficient to eliminate many hazards involved in tank cleaning operations.** The lockout/tagout established prior to tank entry was conservative. Motor-operated valves on oil inlets and outlets were electrically locked out, and spool pieces were

removed from the inlet and outlet pipes prior to tank entry. Mechanical mixers were also locked out electrically, air-gapped, and removed before tank entry.

- **A work permitting process has been established and implemented to formally authorize a variety of hazardous operations.** The safe work permit process, as outlined in the DM Accident Prevention Manual, provides an appropriate mechanism to formally authorize and control hazardous operations, such as hot work, excavation, and confined space entry. In accordance with this process, DM personnel, other contractors, and subcontractors must initiate and comply with specified controls as indicated on the safe work permit before performing work. The safe work permit also alerts operations personnel to all hazardous work being performed at the Bryan Mound Site, provides assurance that appropriate controls are in place to initiate work, and alerts operations personnel to restore operating systems after hazardous work activities are completed.

In several cases, however, safety controls were not adequately implemented for the tank cleaning activity. In most of these cases, appropriate requirements were defined in site- or activity-specific safety documents but were not fully and effectively implemented for the activity. As discussed in the following paragraphs, deficiencies were evident in aspects of several important programs, such as heat stress monitoring, respiratory protection, air sampling, and confined space controls.

Actions to monitor and control heat stress for tank entrants were inadequate and were not performed in accordance with the requirements established in the tank cleaning contract. Heat stress was recognized as a potential hazard because of the nature of the work, the required safety clothing (impermeable clothing), and the high ambient temperatures often experienced in the summer in the area. Some actions were taken to monitor tank and ambient temperatures, provide protection against heat stress (e.g., shade areas), and communicate hazards to workers (e.g., discussion at daily briefings). Workers were aware of heat stress hazards and attempted to monitor their own condition and the condition of their coworkers. However, these actions were informal and inconsistently applied, did not meet contractual requirements to follow American Conference of Governmental Industrial Hygienists (ACGIH) recommendations, and were insufficient for the conditions. Specific deficiencies included:

- Heat stress monitoring of individuals (e.g., heart rate, core body temperature) was not performed in accordance with ACGIH recommendations or contract requirements. TT#1 and other ES&H LLC technicians had occasionally experienced muscle cramps, which are a symptom of heat stress, during the work effort; none had reported cramps on the day of the incident (July 8).
- The measures ES&H LLC had established to protect workers against heat stress (using shade areas, rotating workers, using the buddy system, and providing water to maintain hydration) were not consistently implemented. No wet bulb/dry bulb measurements were made. Work/rest regimes were not routinely computed and implemented. Tank entry logs indicated that on some occasions the same individuals worked within the tank in both the morning and the afternoon. Shade covers were not in place the day of the incident. The buddy system was not fully effective because workers often were not close enough to one another to maintain visual contact, and according to entry logs, the buddy system was not used for all entries.
- ES&H LLC logs indicate that temperature measurements were not routinely made and/or recorded while workers were in the tank. The temperature was recorded as 95 degrees F on June 18, 19, and 21. Other measurements were reportedly made but were not recorded. Some crew members indicated that the temperature inside BMT-2 on July 8th seemed lower than it had been on previous days.

A lack of specific implementing procedures and gaps in safety program documents were possible contributing factors to the inadequate controls. The ACGIH threshold limit values for heat stress are referenced in the contract but are not addressed in project plans or work instructions. The ES&H LLC Site-Specific Safety Manual identifies heat stress as a potential hazard but does not specify applicable controls. Title 29 Code of Federal Regulations (CFR) 1910.146 requires that the permit space be tested or monitored as necessary to determine whether acceptable entry conditions are maintained during the course of entry operations. These requirements were not sufficiently translated to specific work instructions.

The respiratory protection program and equipment used during tank cleaning operations did not meet applicable requirements. The use of supplied air was an appropriate measure for protecting workers against tank hazards (e.g., benzene). However, several important aspects of the respiratory protection program were not implemented in accordance with applicable regulations and site-specific requirements:

- Air line hoses manufactured by Oilind have not been tested and approved by NIOSH as required by OSHA. NIOSH testing for hoses and couplings, Type C and CE supplied-air respirators, as conducted by the National Personal Protective Technology Laboratory, includes standard testing procedures for determining: strength of hoses and couplings, tightness of hoses and couplings, non-kinkability of hoses, and gasoline permeability of hoses and couplings.
- Individuals had experienced hose coupling failures (“pops”) three times during this job. The ES&H LLC Corporate Policy and Procedures Manual, dated June 18, 2007, Section 32, Respiratory Protection Program, requires that employees report any problems or defects in equipment or inadequate elements of the program. Contrary to this requirement, no such reports were made before the fatal incident.
- The ES&H LLC Corporate Policy and Procedures Manual requires each job site requiring the use of respiratory protective equipment to have a completed site-specific respiratory program. However, no documented program was in place for this project.
- The ES&H LLC Corporate Policy and Procedures Manual requires the Safety Manager to “maintain all respirator inspection and repair records, site specific respirator programs, as well as this program and completed Supplied Air Check Lists.” Such records were not available, and the ES&H LLC consultant was not aware that TT#1 had been using an ES&H LLC-issued respirator.
- Annual respirator fit testing had not been maintained for all workers. TT#1’s fit test for the applicable respirator (Scott AV2000) had lapsed in March 2010. (TT#1’s medical qualification was current.)
- Air line couplings used in the construction of the air lines supplied by Oilind matched those commonly used for air powered tools, contrary to OSHA requirements. Title 29 CFR 1910.134(i)(8) states that the employer “shall ensure that breathing air couplings are incompatible with outlets for nonrespirable worksite air or other gas systems.”

Site organizations have not taken advantage of several lessons learned that have been issued relative to respiratory protection. For example, a lesson learned was issued by DOE Richland Operations Office in 2000 pertaining to Breathing Air Hoses Disconnect, the content of which is directly applicable to SPR operations at BMT-2, and states: “Old worn quick disconnects on breathing air hoses come apart when bumped. Hoses should be replaced with new models when fittings become worn.”

Air quality monitoring and sampling for confined space tank entries may have been inadequate.

Routine measurements of potential airborne contaminants are required in accordance with the DM Accident Prevention Manual. Appropriate control levels were established for methane, hydrogen sulfide, and oxygen, and records of samples collected prior to each tank entry indicate that these criteria were met. Interviews indicate that air was monitored continuously while individuals were inside the tank, although the continuous monitoring results were not recorded. However, two aspects of air monitoring were not adequate:

- While continuous monitoring appears to have been conducted within the tank, the measurements may not have been representative of the atmosphere inside the tank. The samples were collected just inside the tank entry point, with airflow being drawn into the tank. Considering the large size of the tank and the relatively low expected turnover of the atmosphere (e.g., small manway openings), the samples at the entry point might not be representative of the workers' breathing zone deeper inside the tank.
- Although records indicated that airborne benzene levels were elevated during initial monitoring, OSHA-required worker exposure monitoring was not performed. Air monitoring logs indicated that benzene concentrations at open manways were 1299 ppm 51 minutes before initial tank entry on June 15 but dropped to zero 16 minutes before the entry. SPR personnel indicated that there were questions about the validity of some of these readings at the time they were made; ES&H LLC did not document the concerns about measurement errors or the actions that were taken to resolve them and did not inform the IRB that the measurements may be in error. The ventilation method used at that time did not have the capacity to reduce the concentration of benzene by that much across the volume of the tank, so it appears that the measurement and monitoring methods were either in error or not sufficient to provide accurate information on the levels deeper inside the tank. Because of the combination of deficient monitoring and inadequate respiratory protection, the systems in place at the time of the incident did not provide sufficient assurance that worker exposures to benzene were less than the OSHA 1 ppm time-weighted-average permissible exposure limit.

Some aspects of confined space safety controls were not effectively implemented. The tank was appropriately designated and controlled as a confined space, including development of a confined space permit. However, two deficient practices and conditions were identified:

- The method for communicating between tank entrants and the attendant was not sufficiently reliable for the working conditions present in the tank. Communications between tank entrants and the confined space attendant were limited to hand signals and a bull horn that was available to the attendant. The visibility of the attendant was reduced by bright sunlight outside the tank and relatively dim artificial lighting inside the tank. Artificial lighting was used in the area where cleaning work was ongoing but not in the area between the tank entry point and the work area. Based on worker interviews, the area where the fatality occurred was not well illuminated, and the attendant's ability to maintain visual contact with individuals in this location was limited.
- Individuals who were removing sludge inside the tank did not wear hard hats. The ES&H LLC Site-Specific Health and Safety Plan requires that hard hats be worn for sludge removal, and the personal protective equipment selection guide for the job safety analysis requires that hard hats be worn for the cleaning of BMT-2. However, these requirements were not clearly conveyed to ES&H LLC workers through work control documents. Head hazards were present on entering and exiting tank manways, and a hard hat could provide protection against striking one's head during a fall.

Overall, while many safety controls were in place, there were significant deficiencies in important aspects of safety controls for the work activity at the time of the incident. Some of the above deficiencies (e.g., hard hats, lighting, air monitoring) were likely not significant factors in the fatality incident, but the identified deficiencies could have resulted in risks to workers in other circumstances. The relevance of deficiencies in heat stress monitoring and respiratory protection to the incident will need to be examined when the autopsy information is available. In any case, the identified work control deficiencies will need to be evaluated and addressed to ensure safe operations inside tanks.

4.0 EVALUATION OF EMERGENCY MANAGEMENT

The IRB Team reviewed emergency response processes associated with the confined space entry to the BMT-2 crude oil storage tank at the Bryan Mound Site, including the efforts to evacuate TT#1 and provide medical treatment. The IRB team also reviewed the immediate actions to secure the scene and preserve evidence for subsequent reviews.

Emergency Actions. Most aspects of the SPR emergency response processes appropriately reflect applicable regulations and DOE requirements. SPR organizations have issued documents that identify requirements and processes for responding to an emergency condition, such as an employee who experiences a medical condition or injury. In addition, the DM Accident Prevention Manual defines certain emergency response requirements and practices, and the preliminary hazard review for the project specifies various requirements to facilitate the response to an emergency, such as positioning of safety response equipment, training provisions, and requirements for safety harnesses. SPR has infrastructure and processes for emergency response: an operations center and security dispatcher system that facilitates communication, processes for staffing the emergency response center, and processes for notifying emergency response teams and calling offsite fire departments and EMS organizations. There are also various requirements for training the personnel who could respond to emergencies, including general requirements (e.g., CPR training) and activity-specific requirements (e.g., physical training on evacuation prior to a confined space entry).

Most aspects of these processes were adequately implemented, and in general the emergency response following rescue was rapid and effective. The Bryan Mound security staff and emergency response team responded quickly and effectively to the BMT-2 incident. Responders were dispatched to the scene with AED and pulmonary assist devices, and CPR was maintained until the Freeport ambulance arrived. CSS took appropriate actions to ensure that the ambulance could enter and leave the site rapidly. All personnel involved in the rescue and emergency response had appropriate CPR training certificates.

However, the sequence of events following the incident shows that there were a number of deficiencies in implementing site requirements and that the onsite personnel were not fully prepared to respond to an incident of this nature. Specific deficiencies included:

- Individuals working inside the tank were not wearing retrieval harnesses as required by the DM Accident Prevention Manual. According to site personnel, workers did not wear retrieval harnesses because managers believed the harnesses would increase the overall risks to workers in the confined space. The decision to neglect this requirement is not well documented and may not have been justified, given the size of the tank and the spacing of obstructions within the tank.
- As noted previously, the obstructions and tank lighting deficiencies limited the ability of workers inside the tank and external attendants to maintain communications.
- Although some tabletop training and briefings had been conducted, the tank cleaning team had not trained and practiced a physical rescue (e.g., of a live person or dummy), contrary to site and regulatory requirements that training include removing a person or dummy from a simulated or actual confined space.
- Site contractor personnel were not sufficiently prepared for an emergency entry. For example, self-contained breathing apparatus (SCBA) was available at the BMT-2 work site but was not pre-

positioned and/or ready for use at the tank. Also, protective equipment, such as latex gloves and eye protection, was not pre-positioned and readily available to protect rescuers.

- The previously noted deficiencies in the air sampling strategy diminished the protection of emergency personnel during the emergency response. Based on available information, the onsite personnel believed that the atmosphere in the tank was safe (benzene levels below detection), but the sampling methods did not provide a reliable measure of air quality in the tank. During the response, personnel were understandably focused on assisting TT#1 as rapidly as possible; believing that the air quality was safe, personnel did not use SCBA during the emergency entry. As a result, one ES&H LLC employee entered the tank for a very short time without the required respiratory protection equipment, thus risking exposure to an uncharacterized atmosphere.

Actions to Preserve Scene and Evidence. With a few exceptions, the immediate efforts to preserve the scene and collect and preserve evidence from the incident were effective. Onsite personnel took prompt action to test the tank air. A SPRPMO member assigned to Bryan Mound issued clear verbal instructions to CSS to secure the incident scene. The CSS protective force member who was verbally assigned the responsibility for evidence collection was generally successful in preserving the incident scene, photographing the scene and equipment, and collecting and controlling equipment/items that may be useful as evidence for determining incident events or causes. CSS was timely and effective in establishing access controls. In some respects, CSS was appropriately prepared for preserving evidence by procuring some essential items (e.g., a digital camera and various sizes of tamper-indicating, plastic bags) to serve as an evidence collection kit. According to logs, physical evidence was secured, documented, and recorded on an evidence/property custody form promptly (within one half hour of the incident). SPR personnel also took prompt action to gather initial handwritten witness statements from the personnel working in the immediate area and CSS response personnel.

Although the immediate efforts to preserve the scene and collect evidence were generally adequate, some shortcomings were identified. The photographs taken by CSS at the scene were generally sufficient for purposes of the reviews, but their value would have been enhanced by better preparation and techniques (e.g., recording the time of day when the photos were taken, and sizing various objects by comparison with a measuring tape or recognizable articles, such as a dollar bill). Also, some shortcomings were evident in marking and storage of potential biohazard materials. For example, some items had biohazard markings but were apparently not doubled wrapped/bagged, and evidence inventory logs did not properly identify all potential biohazard materials.

Potentially critical equipment involved in this incident – specifically, 150 feet of the air hose and the Scott air pack used by TT#1 – was not collected for preservation and entered into evidence/property inventory until July 13. SPRPMO indicated that they initially decided to leave the equipment in place to enable FE and HSS to first view the incident scene before making a decision on the equipment disposition. In addition, site evidence collection activities were suspended during the four days of the onsite OSHA investigation. The decision not to immediately collect and preserve the equipment enabled other organizations to better view the original scene, but also left the equipment on the ground and exposed to the environment for five days, possibly resulting in deterioration of physical evidence.

Although the evidence collection and scene preservation efforts were mostly adequate, their success was largely the result of individual initiative and competence rather than effective safety management systems. As noted above, the scene and evidence preservation efforts were promptly initiated. Although the CSS member who was verbally assigned the responsibility for evidence collection was generally successful and his actions were commendable under the circumstances, he had limited training in control and photographing of incident scenes or collection, custody, and control of evidence, and did not have

procedures to follow. This individual did subsequently receive advice from the Brazoria County Sheriff's Office, which arrived on site at 1554.

Some gaps and errors in the Bryan Mound Site incident management requirements and processes were evident. The DM Accident Prevention Manual (updated May 2010) should have reflected the responsibility and capability for DM to provide a Site Readiness Team (defined in the Contractor Requirements Document attachment to DOE Order 225.1A, *Accident Investigation*). While the Manual addresses some aspects of managing and investigating incidents, it does not address organizational roles and responsibilities for such topical areas as incident scene management; evidence collection methodology; marking, controlling, and storing perishable evidence; and protocols for the transition from emergency response to post-incident activities. In addition, this document delegates responsibility for incident investigations involving subcontractor employees to subcontractor safety personnel without sufficient provisions for DM involvement (e.g., participation or review) and execution of their site safety responsibilities. The Manual also includes a number of references to outdated provisions of DOE directives (i.e., DOE Order 231.1, *Occurrence and Reporting Processing System*, and DOE Order 225.1A, *Accident Investigation*) and thus could result in misinformation about current requirements.

In addition, the *SPRPMO Organization and Function Manual*, SPRPMO M 111.1-1D, approved August 2008 (which designates functions, responsibilities, and authority) is not comprehensive. Organizational roles and responsibilities are not assigned or addressed with respect to developing policy, procedures, or processes for an integrated site emergency plan; managing an incident scene (evidence collection, custody, and control; initial witness statements); or transitioning from emergency response to post-incident activities.

Overall, for this incident, the retrieval was accomplished rapidly, the immediate medical actions (CPR and AED) were appropriate for the situation, the coordination with and actions of the fire department were rapid and effective, and emergency communications and notifications were adequate. The deficiencies in emergency response preparation did not significantly slow down the emergency response or result in significant risks to emergency workers (with the above-noted exception of the short-term exposure of one individual to air of unknown quality). However, in other circumstances, the identified deficiencies could have resulted in risks to emergency responders or delays in emergency response. In addition, although a few shortcomings were identified, the process of initial incident scene preservation, photography, obtaining witness statements, and establishing access controls was generally timely and effective. However, the effectiveness of the effort resulted in large part from individual initiative and was not supported by effective incident investigation plans, procedures, and tools.

5.0 EVALUATION OF INCIDENT ANALYSIS

The BMT-2 Tier 2 Incident Analysis Team conducted the second-tier incident analysis and data analysis while the IRB was on site. As part of its data collection efforts, the IRB attended several Tier 2 team daily briefings, reviewed documents compiled and lines of inquiry prepared by the Tier 2 team, and discussed specific issues and observations with Tier 2 team members. To ensure open communications, the IRB provided the Tier 2 Team Chair with an overview of issues and concerns related to the BMT-2 tank cleaning operations identified by the IRB Tier 3 team. As of the writing of this IRB report, the BMT Tier 2 team had issued a draft report (dated August 2, 2010) describing the incident analysis, identifying a number of deficient conditions, and listing a number of recommendations.

Based on the information to date, the IRB identified many effective aspects of the Tier 2 incident analysis effort. The Tier 2 team included personnel with appropriate experience in site operations and safety programs and included members from DOE (SPRPMO and the individual assigned to Bryan Mound), DM, and AGSC and an observer from FE Headquarters. Although there are some differences in the detailed results, the Tier 2 incident analysis identified deficiencies that are similar to those identified by the IRB, in part because of the open communication and sharing of results between the two teams. The Tier 2 incident analysis also appropriately identified a number of deficiencies in site safety management systems and safety programs and explored contributory factors associated with the flowdown of requirements, contract management, and contractor oversight. For example, the review appropriately identified a concern with the SPRPMO approach to oversight. Specifically, in designing its oversight activities, SPRPMO considered the fact that DM had implemented a voluntary protection program; however, their review highlighted the fact that the DM voluntary protection program does not encompass other prime contractors at the site, such as AGSC, or subcontractors to other prime contractors, such as ES&H LLC. The draft Tier 2 report provides specific recommendations for improving safety programs at the Bryan Mound Site, as well as recommendations that are sufficiently broad to address the concerns in SPR-wide programs and processes. In addition, based on the Tier 2 incident analysis, DM issued a sitewide lessons-learned document that communicated the problems with certification of respirator assemblies and directed appropriate actions at all SPR sites.

Although the draft Tier 2 report effectively identifies general areas that need to be addressed (which are similar to those identified by the Tier 3 team), the IRB review identified a number of issues that were discussed in the draft Tier 2 report but warrant additional evaluation, either by the Tier 2 team or through follow-on efforts. These include:

- The draft Tier 2 report appropriately recognizes that ES&H LLC “must develop, provide, and enforce an adequate heat stress program.” However, it does not sufficiently identify and address causal factors that contributed to AGSC’s failure to enforce, through the Health and Safety Plan process, the specific heat stress management requirements that are included in the contract. Further, the draft Tier 2 report does not discuss why such deficiencies were not identified during the frequent worksite inspections.
- The draft Tier 2 report appropriately recognizes the need for better air quality readings but does not specifically address the factors that contributed to inadequate personal exposure monitoring for benzene, as required by OSHA under 29 CFR 1910.1028, and the inadequate resolution of general perimeter monitoring that recorded benzene concentrations in excess of 1,000 ppm during the early stages of the tank cleaning effort.
- The draft Tier 2 report appropriately recognizes the problems with respiratory protection equipment, including air lines. However, it does not specifically address the concern that air line decoupling

problems were considered routine by workers, were not recorded, and did not result in ES&H LLC pausing work until the problem was fixed. An additional concern about the use of non-certified air lines that was not identified in the draft Tier 2 report is the potential for contaminants to permeate into the material and potentially contaminate the air flowing to workers. Because these air lines are in direct contact with crude oil and are typically left in the tank between work crew entries, the potential for worker exposure to benzene and other contaminants through the respiratory protection system cannot be precluded without conducting tests on the air line material.

- The draft Tier 2 report appropriately recommends retaining the services of an industrial hygienist to “develop program and work practices deemed acceptable.” Additional effort is needed to determine which SPR organization should address this recommendation and to ensure industrial hygienist involvement in safety-related activities, such as contract review, Health and Safety Plan approval, and oversight of work activities.
- The draft Tier 2 report appropriately identifies concerns and recommendations for improving ES&H LLC’s preparation and execution of emergency response plans and procedures. However, additional evaluation of this topic is needed to address integration and coordination of all emergency responders, including DM, CSS, and the Freeport fire department.
- Although the need for compliance with requirements is discussed, the draft Tier 2 report does not specifically address the process deficiencies that allowed a worker with expired credentials to perform work on BMT-2 tank cleaning.

Overall, the SPR line management second-tier incident analysis identified an appropriate set of recommendations for addressing deficiencies, both at the Bryan Mound Site and for SPR-wide safety programs. In addition, some of the Tier 2 team’s recommendations focus primarily on necessary ES&H LLC actions but do not fully address the need for coordination with other site organizations or the actions that other site organizations will have to undertake in order to fully address each concern and the underlying causal factors to ensure that they do not recur in other construction management subcontracts. SPR line management recognizes that a number of issues warrant additional evaluation and is currently conducting further analysis of the incident to ensure that specific concerns and the underlying causes are fully considered and addressed.

6.0 EVALUATION OF SAFETY MANAGEMENT SYSTEMS

After reviewing the safety program elements, the IRB evaluated commonalities between the identified deficiencies. Although the review of safety management systems was limited to activities related to the incident, the IRB identified two aspects of safety management systems that were not fully effective: requirements management and oversight of subcontractor work activities.

Requirements Management. Identification of safety standards and requirements is a guiding principle of DOE Policy 450.4, *Safety Management System Policy*. The policy states that before work is performed, the hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established. To ensure safety and compliance, workers must understand the applicable requirements and the expectation that requirements will be followed. As previously discussed, several important safety requirements applicable to the cleaning of BMT-2 were not met in such areas as heat stress monitoring, respiratory protection equipment, air monitoring, and confined space work.

In most cases, site program documents or contracts appropriately specify the requirements. However, the requirements were not met because ES&H LLC did not effectively convey them to the tank cleaning crew. Mechanisms were established to inform the tank cleaning crew of hazards and controls, but those mechanisms were not effectively implemented. In addition, although DM issued safe work permits and confined space permits to inform workers of hazards and applicable controls, the broad requirements in DM permits (e.g., “protective clothing” and “supplied breathing air”) were not translated by ES&H LLC into specific work instructions to ensure workers’ clear understanding of the controls and effective compliance with the applicable requirements. ES&H LLC also issued confined space permits and conducted Daily Tail Gate meetings, during which they reminded workers of the potential hazards and controls identified in a formal job safety analysis and a site-specific Health and Safety Plan approved by AGSC. However, these mechanisms were not effective in conveying the requirements to workers through work instructions or briefings.

Breakdowns in communicating requirements occurred at various points in the system. In some cases, institutional documents included a requirement but did not establish implementing mechanisms or identify applicable standards. In other cases, requirements were not addressed in activity-specific hazard assessments and thus were not translated into work controls. For example, the ES&H LLC Site-Specific Safety Manual, which was accepted by AGSC, identifies heat stress as a potential hazard but does not specify the applicable controls as required by the contract. In other cases, the requirements were adequately addressed in activity-specific documents but were not communicated to, or were not understood by, the workers. An underlying factor in these breakdowns is an apparently insufficient process for contractors to review work instructions against the requirements to ensure that all relevant requirements are clearly communicated to the working level.

Oversight of Subcontractor Work Activities. Oversight by DOE and contractor line management provided an opportunity to identify health and safety deficiencies in the work practices and controls established for the BMT-2 tank cleaning project. FE/SPRPMO and its contractors have established oversight programs pursuant to DOE Order 226.1A, *Implementation of DOE Oversight Policy*.

SPRMO, DM, and AGSC provided frequent oversight of ES&H LLC activities at the BMT-2 job site. SPRMO and DM safety representatives visited the site several times to assess controls and maintain awareness of ongoing activities. DM personnel visited the tank cleaning work site about once a week. AGSC representatives reviewed ES&H LLC activities at the BMT-2 job site several times daily and documented their observations in Daily Construction Management Reports. However, none of these efforts identified the deficiencies in work controls that were evident during this review. Readily discernible deficiencies, such as poor lighting impacting worker and attendant communications, non-

compliance with tank cleaning contract requirements for heat exposure management, and poor tank air quality monitoring practices were not identified or addressed.

ES&H LLC provided oversight as required by 29 CFR 1910.134 and Section J of its contract with DOE. Title 29 CFR 1910 requires ES&H LLC to conduct evaluations of the workplace as necessary to ensure that the provisions of their confined space program are effectively implemented, and their contract requires them to perform weekly safety inspections. Weekly safety and health inspections were performed but did not identify significant safety deficiencies. For example, “general housekeeping” was the only unsafe practice noted in records of such inspections for the four weeks preceding the fatality, and AGSC representatives participated in two of those inspections. ES&H LLC also provided a full-time safety representative to oversee the safety of tank cleaning activities and to monitor air quality inside the tank, but this oversight was not fully effective.

DM maintains a lessons-learned program to disseminate lessons learned pursuant to DOE Order 226.1A. However, this program was not effective in disseminating previously-reported DOE lessons regarding respirator air supply hoses and couplings, and these lessons were not considered in the planning of the BMT-2 tank cleaning project.

Overall, the fact that the deficiencies identified by the second- and third-tier reviews had not been previously identified by line management indicates that oversight has not been fully effective. A contributing factor is insufficient industrial hygiene expertise to support special projects, such as periodic tank cleaning activities. Most of the identified deficiencies are related to industrial hygiene, and neither line managers nor safety representatives have expertise in this area.

7.0 CONCLUSIONS AND OPPORTUNITIES FOR IMPROVEMENT

At this stage, the cause of death has not been determined by the coroner, and it is premature to draw any conclusions about whether the identified work control deficiencies were contributing factors. However, the work control, emergency response, and other deficiencies identified in this report are significant and, in other circumstances, could have contributed to an injury or exposure, delayed an effective emergency response, or resulted in gaps in the investigation of an event. Consequently, they warrant timely management attention and appropriate corrective actions in accordance with site issues management processes.

The IRB review indicates that the SPR incident review was performed with an adequate scope and appropriate methods by a team with appropriate operational and safety experience. Further, the areas of deficiency identified by the IRB and the SPR line management review are essentially the same, and therefore the IRB investigation provides an independent perspective that supports the conclusions of the SPR incident analysis.

Although the IRB and SPR reviews focused primarily on the fatality incident and the safety programs in place at the Bryan Mound Site, both teams identified deficiencies in program documents, sitewide safety processes, organization interfaces, cross-cutting management systems (e.g., procedure development), and safety oversight. Such deficiencies are not limited to the Bryan Mound Site but could impact other activities at SPR to varying degrees, particularly activities with similar characteristics (e.g., construction projects, work performed by subcontractors, work in confined spaces, work involving respiratory protection, or work where heat stress monitoring is warranted). The SPR incident investigation produced an appropriate set of recommendations that address the implementation deficiencies identified at the Bryan Mound Site and also appropriately address deficiencies in DM, AGSC, and ES&H LLC safety and emergency management programs. However, additional evaluation, either by the BMT-2 Tier 2 team or separate follow-on efforts, is needed in some areas to ensure that specific concerns and the underlying causal factors are fully addressed and that all affected site organizations are sufficiently involved in the corrective actions. In addition, while the broad recommendations resulting from the SPR incident analysis are an appropriate step toward addressing the extent of condition, additional evaluation by SPR management is warranted to further determine the extent of condition. Sustained management attention will be needed to ensure that the information is used to develop and implement effective corrective actions.

Additional opportunities for improvement are presented below. In developing opportunities for improvement, the IRB considered the preliminary findings and recommendations of the DOE line management second-tier incident analysis. Rather than duplicating the information provided by the second-tier review, the IRB focused on determining what underlying factors (e.g., systemic weaknesses in procedures or maintenance/testing) need to be addressed by FE, SPRPMO, and contractor management to provide assurance that similar deficiencies are unlikely to recur in the future.

The IRB recommends that DOE line management – FE and SPRPMO – ensure that the results of this review and opportunities for improvement are evaluated and integrated into a comprehensive corrective action plan to improve safety at SPR, in accordance with the site issues management process. The corrective action plan should clearly identify actions that needed to be completed before resuming tank cleaning operations. As additional information becomes available through the OSHA investigation and the autopsy report, FE and SPRPMO should evaluate the need to modify or expand the corrective action plan as warranted. The corrective action plan should establish clear organizational ownership for each action, a schedule and criteria for closing actions, and a process for independent validation that corrective actions as implemented are effective.

Opportunities for Improvement

- 1 **DM and AGSC, in coordination with SPRPMO and subcontractors, should perform comprehensive extent-of-condition reviews for the deficiencies identified in this IRB report and the SPR line management incident analysis to ensure that activities at SPR can be performed safely.** The reviews should consider using a systematic approach that places more priority on SPR activities with characteristics similar to the Bryan Mound Site tank cleaning activities (e.g., construction projects, work performed by subcontractors, work in confined spaces, work involving respiratory protection, or work where heat stress monitoring is warranted).
- 2 **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.** Specific actions to consider include:
 - Obtain the assistance of an industrial hygienist to establish the specific requirements to be followed for confined space entry, respiratory protection, and monitoring exposure to hazardous materials. Ensure that these requirements are clearly specified in the contract for tank cleaning.
 - Ensure that each applicable hazard and control is specifically identified in work control documents and that the crew members understand these hazards and controls. Use the work control documents as a guide for the Daily Tail Gate meetings to remind workers of the hazards they may encounter and the controls that must be followed. Question the workers to confirm their understanding.
- 3 **DM and AGSC, in coordination with SPRPMO, should evaluate the deficiencies in communicating requirements to workers, including an analysis of potential root causes and causal factors that contributed to breakdowns in adherence to requirements (e.g., poorly defined roles and responsibilities, safety culture, insufficient quality assurance, or insufficient consideration of human performance factors).**
- 4 **DM site emergency managers, in coordination with SPRPMO and other site contractors, should evaluate and enhance emergency response processes as they apply to the Bryan Mound Site and other potentially hazardous projects.** Specific actions to consider include:
 - Ensure that all site emergency responders have been adequately trained and have access to the protective equipment needed in a medical response.
 - Ensure that kits with sufficient protective equipment are available in the field at the project site.
 - Establish provisions for notifying security, the site emergency response team, and local fire rescue units to confirm their readiness and availability for confined space entries.
 - Ensure that security personnel are included in medical emergency response drills and that all patrol vehicles have airways, latex gloves, and safety glasses for use in emergency response. Ensure that such equipment is periodically inspected and maintained.
 - Request the local Freeport EMS's assistance in critiquing the Bryan Mound emergency responders' response to the recent incident, including the inventories of medical supplies. Request their assistance in addressing any resulting deficiencies.
- 5 **SPRPMO, DM, AGSC, and ES&H LCC should improve their oversight programs and oversight of tank cleaning activities.** Specific actions to consider include:
 - Strengthen oversight of industrial hygiene by adding an industrial hygienist or otherwise providing industrial hygiene expertise to oversee hazard analysis and controls associated with future tank cleaning activities, and establish an industrial hygiene program for SPR.

- Establish a process for assessing and prioritizing health and safety risks at SPR sites, and maintain a cadre of safety specialists that can be temporarily located at sites, commensurate with these risks.
- Ensure that the safety representative assigned to support tank cleaning activities has the requisite knowledge of applicable health and safety requirements to effectively monitor and control the safe execution of this work.
- Modify procedures and practices as necessary to ensure that DOE lessons learned are considered during the planning of work to be performed by construction subcontractors.
- Evaluate the identified deficiencies in oversight of tank cleaning activities, including an analysis of potential root causes and causal factors that contributed to the failure of the multiple oversight activities to identify deficient conditions and practices.

6 SPRPMO should enhance its accident/incident investigation capabilities and its program oversight and direction to contractors. Specific actions to consider include:

- Ensure that SPR develops a cadre of personnel who are trained in DOE accident/incident investigation and analysis techniques so that SPR can conduct its own accident/incident investigations when needed.
- Enhance the SPRPMO Organization and Function Manual and identify organizational and individual roles and responsibilities for incident scene management.
- Ensure that SPR contractors develop integrated site incident response procedures to address the contractor requirements document of DOE Order 225.1A for supporting Federal accident/incident investigations with a site readiness team.
- Perform assessments of SPR accident/incident investigation programs after corrective actions are complete and fully implemented.

7 HSS should evaluate options for further enhancing DOE-wide accident and event policies and practices and incorporating lessons learned from this incident. Specific actions to consider include:

- Review the memorandum of understanding between DOE and OSHA (dated 1992) and revise as appropriate to include provisions for a proactive Departmental investigative readiness initiative, especially during the early stages of evidence collection, preservation, and analysis (including protocols for independent laboratory testing).
- As part of the ongoing revision to DOE Order 225.1A, *Accident Investigations*, reevaluate DOE responsibilities, and revise as needed. Include a provision for evaluating the need to perform a DOE review to identify causal factors to prevent recurrence of a similar type of incident in cases when OSHA (or another Federal Accident Investigation Board that does not identify causal factors) has primary responsibility for investigating events.
- Develop and issue a DOE-wide lessons-learned document to communicate safety information that could be important and useful to other DOE sites, including emphasis on the requirements for use of certified respirator equipment.

APPENDIX A
APPOINTMENT LETTER



Department of Energy

Washington, DC 20585

July 20, 2010

MEMORANDUM FOR WILLIAM C. GIBSON, JR.,
PROJECT MANAGER
STRATEGIC PETROLEUM RESERVES

FROM: ~~GLENN S. PODONSKY~~
CHIEF HEALTH, SAFETY AND SECURITY OFFICER
OFFICE OF HEALTH, SAFETY AND SECURITY

SUBJECT: Independent Review of the July 8, 2010, Fatality at the Bryan
Mound Site, Strategic Petroleum Reserve, Freeport, TX

In accordance with Department of Energy (DOE) Order 225.1A, and consultation with the Assistant Secretary for Fossil Energy, we are establishing an Independent Review Board for the July 8, 2010, subcontractor fatality at the Bryan Mound Storage Site, Strategic Petroleum Reserve. I am appointing Mr. Lawrence Denicola, of my staff, to serve as the Board Chairperson. Mr. Denicola will be supported by other members of my staff, including Mr. Dennis Vernon who will serve as the Board coordinator.

The Board will analyze the information gathered by the Occupational Safety and Health Administration's investigation, and the Strategic Petroleum Reserve Project Management Office's comprehensive safety review of the incident to confirm conclusions, evaluate extent of condition, and identify opportunities for improvement. The Board's report will support the Department's learning organization objective by providing lessons learned to help prevent future accidents. In the context of the DOE Order 225.1A *Accident Investigations*, this approach represents a modified Type-A investigation.

We anticipate and encourage the Office of Fossil Energy, and/or your office, to designate a representative to observe the Board's activities and, as appropriate, provide assistance to the Board during their data collection activities. My staff sincerely appreciates the information initially collected and shared with us by Mr. Rick Shutt, Assistant Project Manager for Technical Assurance. The candid exchange of information during the evaluation process will continue to strengthen our organizational relationships and make DOE a safer workplace.



Printed with soy ink on recycled paper

The Chairperson will provide me with reports on the status and progress of this Review. The Board's final report should be provided to my office in approximately thirty calendar days on/about August 18, 2010. Should you have any questions, please contact me at (202) 287-6071.

cc: Daniel B. Poneman, DS
James J. Markowsky, FE-1
William A. Eckroade, HS-1
Lawrence J. Denicola, HS-64
William H. Roege, HS-30
Charles B. Lewis, III, HS-31
Mark J. Matarrese, FE-7
Thomas R. Staker, HS-64
Dennis Vernon, HS-31

APPENDIX B

INDEPENDENT REVIEW BOARD MANAGEMENT AND TEAM COMPOSITION

Management

Glenn S. Podonsky, Chief Health, Safety and Security Officer
William A. Eckroade, Deputy Chief, Office of Health, Safety and Security (HSS)
William H. Roege, Director, HSS, Office of Corporate Safety Analysis
John S. Boulden III, Director, HSS, Office of Independent Oversight
Charles B. Lewis III, Director, HSS, Office of Corporate Safety Programs
Thomas R. Staker, Director, HSS Office of Environment, Safety and Health Evaluations

Board Members

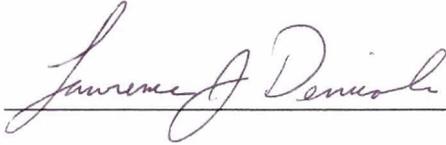
Lawrence Denicola, HSS, Board Chairperson
Bert Davis, HSS, Board Member
Marvin Mielke, HSS, Board Member

Independent Review Support

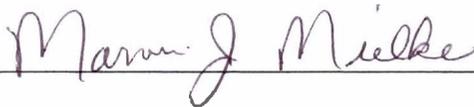
Al Gibson, Board Advisor
Joe Lischinsky, Board Advisor
Dennis Vernon, Board Advisor
Tom Davis, Board Advisor
Sue Keffer, Administrative Support

APPENDIX C

BOARD MEMBER SIGNATURES AND RELEASE LETTER



Lawrence J. Denicola
DOE Incident Review Board Chairperson
Office of Environment, Safety and Health Evaluations (HS-64)



Marvin J. Mielke
DOE Incident Review Board Member
Office of Environment, Safety and Health Evaluations (HS-64)



Bertrand E. Davis
DOE Incident Review Board Member
Office of Corporate Safety Programs (HS-31)



Department of Energy
Washington, DC 20585

September 27, 2010

Release Authorization

On July 20, 2010, an Independent Review Board was appointed to investigate the July 8, 2010, subcontractor fatality at the Bryan Mound Storage Site, Strategic Petroleum Reserve. The Board's responsibilities have been completed with respect to reviewing the Occupational Safety and Health Administration's investigation and the Strategic Petroleum Reserve Project Management's Office comprehensive safety review of the incident to confirm conclusions, evaluation of extent of conditions, and identification of opportunities for improvement.

The report of the Incident Review Board has been accepted and the authorization to release this report for general distribution has been granted.

A large, stylized handwritten signature in black ink, appearing to read "G. Podonsky".

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

