U.S. Department of Energy
Portsmouth/Paducah Project Office

Type B Accident Investigation Report

THE JULY 12, 2007
FORKLIFT AND PEDESTRIAN ACCIDENT
AT
THE PADUCAH GASEOUS DIFFUSION PLANT

April 2008

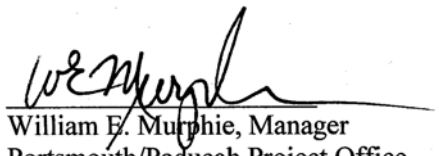
This report is an independent product of the Paducah Gaseous Diffusion Plant Accident Investigation Board appointed by William E. Murphie.

The Board was appointed to perform a U.S. Department of Energy Type B Accident Investigation of this accident and to prepare an investigation report in accordance with DOE O 225.1A, *Accident Investigations*.

The discussion of facts, as determined by the Board, including its conclusions, opinions and judgments do not express acceptance by other independent agencies as to their agreement of the Board's interpretation of their regulations, 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, subcontractors at any tier, lessee, or any other party. Certain attachments to this report are not available to the public because they contain personal information covered by the Privacy Act of 1974 (5 U.S.C. § 552a) and the Health Insurance Portability and Accountability Act of 1996 (P.L.104-191).

This report neither determines nor implies liability. DOE's issuance of this report is not intended to constitute official direction to any contractors or USEC.

On August 17, 2007, I established a Type B Accident Investigation Board to investigate the forklift accident that occurred at the Paducah Gaseous Diffusion Plant on July 12, 2007, that resulted in serious injury to a pedestrian. The Board's responsibilities have been completed with respect to this investigation. The analysis process, identification of causal factors, and development of judgments of need were performed during the investigation in accordance with DOE O 225.1A, *Accident Investigations*. I accept the findings of the Board and authorize the release of this report for general distribution.



William E. Murphie, Manager
Portsmouth/Paducah Project Office

4/14/08
Date

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ACRONYMS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AHA	activity hazard analysis
AHR	activity hazard review
ASME	American Society of Mechanical Engineers
ATR	Assessment Tracking Report
BJC	Bechtel Jacobs Company LLC
BPS	Business Prioritization System
CAR	corrective action report
CATS	Corrective Action Tracking System
CDL	Commercial Driver's License
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
D&D	decontamination and decommissioning
DEAR	U.S. Department of Energy Acquisition Regulations
DOE	U.S. Department of Energy
DOE-EM	U.S. Department of Energy Office of Environmental Management
DOE-HQ	U.S. Department of Energy-Headquarters
DOE-NE	U.S. Department of Energy Office of Nuclear Energy
DOE-OR	U.S. Department of Energy-Oak Ridge
DOL	U.S. Department of Labor
DUF_6	depleted uranium hexafluoride
DWPF	Defense Waste Processing Facility
EC	employee concern
E&CF	events and causal factors
EDS	Employee Driven Safety
EM	environmental management
EPAct 1992	Energy Policy Act of 1992
ERDA	U.S. Energy Research and Development Administration
ER/WM	environmental restoration/waste management
ES	Energy*Solutions*
ES&H	environmental, safety, and health
ETTP	East Tennessee Technical Park
FacRep	Facility Representative
FESS	Facility Evaluation Safety Swap
GDP	Gaseous Diffusion Plant
GET	General Employee Training
GOCO	government-owned contractor-operated
H&S	health and safety
HIRD	Harassment, Intimidation, Retaliation or Discrimination
ICATS	Issue and Corrective Action Tracking System
ISMS	Integrated Safety Management System
INEL	Idaho National Engineering Laboratory
JHA	job hazard analysis
JON	Judgments of Need
KRS	*Kentucky Revised Statutes*
LMES	Lockheed Martin Energy Systems
LMUS	Lockheed Martin Utility Services
LTA	less than adequate

M&I	management and integration
M&O	management and operating
MORT	management oversight and risk tree
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NFS	Nuclear Fuel Supply
NPDES	National Pollution Discharge Elimination System
NQA-1	ANSI/ASME NQA-1 Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
OER	operational experience review
OERP	Operational Experience Review Program
OR	Oak Ridge
ORO	DOE Oak Ridge Operations Office
ORPS	Occurrence Reporting and Processing System
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
OSHAct	Occupational Safety & Health Act
PACE	Paper, Allied-Industrial, Chemical and Energy Workers International Union
PAD	Paducah
PCB	polychlorinated biphenyls
PGDP	Paducah Gaseous Diffusion Plant
PIT	powered industrial trucks
PL	Public Law
PORTS	Portsmouth
PPPO	Portsmouth/Paducah Project Office
PR	problem report
PRS	Paducah Remediation Services, LLC
PRS QAPP	Quality Assurance Program Plan for the Paducah Environmental Remediation Project
PSS	Plant Shift Superintendent
QAP	Quality Assurance Plan
QAP-PGDP	Quality Assurance Program-Paducah Gaseous Diffusion Plant
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
ROA	Regulatory Oversight Agreement
S&H	safety and health
SCAQ	significant conditions adverse to quality
SST	Swift & Staley Team, Swift & Staley Mechanical Contractors, Inc.
STOP	Safety Team of Paducah
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
TVA	Tennessee Valley Authority
UDS	Uranium Disposition Services, LLC
USEC	United States Enrichment Corporation
VSAOH	Visitor's Site Access Orientation Handbook
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

On July 12, 2007, an employee at the Paducah Gaseous Diffusion Plant (PGDP) was walking alone during her scheduled lunch period. The weather was clear and sunny with little or no breeze. At the same time, another employee was driving a forklift between buildings moving two empty liquid nitrogen dewars to be refilled. Both the pedestrian and the forklift were traveling on streets owned by the U.S. Department of Energy (DOE) and operated and maintained by the site lessee, the United States Enrichment Corporation (USEC). The pedestrian was walking west in the road, near the left edge of the road, facing traffic, approaching an intersection. The forklift was traveling north in the road approaching the same intersection. Neither the driver nor the pedestrian recalls seeing the other. A collision occurred in the intersection that resulted in the forklift knocking the pedestrian down and running over the pedestrian's leg. The pedestrian suffered severe injury to the skin and soft muscle tissue of the right leg, which required extended hospitalization and extensive surgery to repair the damage. No eyewitnesses to the accident are known.

Within moments, bystanders arrived to provide assistance and reported the accident to the USEC on-duty Plant Shift Superintendent (PSS). Within minutes an ambulance crew arrived and provided emergency medical treatment to the pedestrian and the PSS responded to the accident scene. Prompt notifications were made to appropriate DOE, DOE contractor and USEC managers. The driver was an employee of USEC. The pedestrian was employed by a subcontractor to the DOE contractor for Site remediation.

On August 17, 2007, the Portsmouth/Paducah Project Office Manager appointed a DOE Type B Accident Investigation Board, in accordance with DOE Order 225.1A, that began an investigation on August 21, 2007. The Board concludes that the accident was the direct result of concurrent and independent situational awareness failures on the part of both the driver and the pedestrian, such that neither recognized the presence of the other.

The Board also concludes that there were a number of contributing causes that include significantly restricted visibility from the forklift, a substantial breakdown of the traffic safety management program, inconsistent rules regarding pedestrian right-of-way, deficiencies in the implementation of feedback and improvement programs, and failure to effectively implement USEC management systems to ensure the forklift driver was properly qualified and fit for duty to operate a forklift. Also contributing to the accident was a systematic process of separating elements of work within a federally-owned nuclear material production facility, the introduction of an accelerated environmental remediation mission combined with privatizing of the government corporation. The work was performed by numerous organizations regulated by different federal agencies, resulting in obscured lines of responsibility and authority, ineffective communication between parties, and inadequate safety management.

The Board identified two root causes: (1) DOE, USEC, and DOE contractors failed to clearly establish and appropriately implement roles, responsibilities, authorities, and accountabilities at all levels for line management's responsibility for safety. (2) USEC failed to assure that the driver was able to safely perform assigned duties (see Section 4.4.5). The Board concludes that management at all levels failed to take ownership for resolving identified safety concerns and failed to adequately evaluate 1) precedent events for applicability of controls, 2) existing conditions and control measures, 3) hazards associated with activities performed by site personnel, and 4) the consequences of their failures to resolve known safety concerns. The following are symptomatic manifestations of the breakdown noted above: expectations for safe performance at the Site by all tenants were not clearly defined, conveyed to the workers, and monitored for adequate implementation. In addition, DOE failed to perform appropriate monitoring of performance at the Site, and USEC management failed to effectively implement their management systems to review employee performance, evaluate conditions that could affect fitness for duty, and ensure that the driver was capable of safely performing assigned duties.

The Board determined the following Judgments of Need from its investigation of the accident to ensure safe operations and prevent similar events in the future.

Table ES-1. Judgments of Need

No.	Judgments of Need
1.	Need for a single, clearly defined site-wide policy for vehicle/traffic safety management. This must be communicated to and understood by all employees and visitors on government-owned property at PGDP. There is also a need to evaluate the adequacy and effectiveness of existing traffic control measures/devices and to implement changes determined to be needed to provide for adequate worker safety.
2.	Need for a DOE-HQ process to ensure the implementation of requirements contained in DOE O 225.1A to verify the completion of approved corrective actions and satisfaction of judgments of need, and to ensure that records pertaining to these responsibilities are maintained and available for future use. Based on the similarity of this accident to the 1991 fatality, DOE-HQ needs to re-evaluate the corrective actions taken in response to the 1991 JON for DOE-wide guidance regarding in-plant pedestrian/vehicle safety to determine whether they were appropriate and effective.
3.	Need for clearly defined expectations for performance of oversight of industrial safety. This must be a unified expectation representing all organizations involved with work at the Site and include: a) regulatory authorities and jurisdictional boundaries for industrial safety; b) performance standards and requirements for controlling industrial safety hazards; c) frequency of Site visits/inspections to monitor workplace conditions and evaluate compliance; and d) criteria and schedules for reporting of events and information pertaining to tracking/trending of performance related to industrial safety.
4.	Need for USEC to fully implement existing procedures for performing fitness for duty evaluations to ensure the safety of employees and co-located workers. USEC also should consider opportunities for improvement, which can include provisions for appropriate line management and support organization involvement in monitoring and evaluating fitness for duty indicators such as physical abilities, training and experience, medical concerns, performance trends, and aberrant behavior against defined criteria.
5.	Need to evaluate the suitability of existing industrial equipment and policies for equipment selection to provide for enhanced safety of personnel and equipment. This should include an evaluation of the effectiveness of existing processes for identifying and mitigating industrial safety hazards and implementing changes, as appropriate.
6.	Need to strengthen, formalize, and implement an integrated process at the site for identifying and resolving shared site issues, including those that involve industrial safety hazards. This should include defined authorities, a process to track actions, and a dispute resolution process to ensure prompt correction of safety-related issues, as well as an effective site-wide communication process for sharing lessons learned and other site information.

1. INTRODUCTION

1.1 BACKGROUND

On the morning of July 12, 2007, a subcontractor employee to the U.S. Department of Energy (DOE) remediation contractor at the Site, Paducah Remediation Services, LLC (PRS), discussed plans to go walking with two co-workers, as was their daily routine. The two co-workers were unable to go and the employee (pedestrian) decided to go walking alone. She was wearing a tan or beige and white checked top and blue denim pants. After changing into walking shoes, the pedestrian donned a pair of sunglasses and departed the office trailer at about 10:25 a.m. During interviews, the pedestrian's co-workers and her direct supervisor reported that they had spent time working with and communicating with the pedestrian and had ample opportunity to observe the pedestrian's physical appearance and demeanor at various times throughout the morning. They did not observe anything about the pedestrian that they considered to be unusual or different from her typically positive and cheerful disposition.

The pedestrian's regular walking route involved walking north on the sidewalk adjacent to 10th Street along the east side of building C-409, then turning west at the intersection of Tennessee Avenue, and following the sidewalk until it ended at the driveway area on the north side of C-409. The route then continued west on the left side (southern edge) of Tennessee Avenue (in the road) along the north side of C-409 driveway area since there is no sidewalk. After passing C-409, another system of sidewalks exists, which begins at the west end of the C-409 driveway, parallel to Tennessee Avenue for about 80 feet, then turns south for about 20 feet, and then turns west and crosses 8th Street about 30 feet south of the edge of Tennessee Avenue. The sidewalk on the west side of 8th Street continues west to a "T" and then goes north and south parallel to 8th Street. The section of sidewalk going north ends when it returns to Tennessee Avenue. Because of this circuitous route to cross 8th Street and then return to Tennessee Avenue on the sidewalk, the pedestrian elected to continue in the street, despite the existence of the sidewalk 30 feet away. (See Figure 1.1-1.) Thus, the route continued to the west along the southern edge of Tennessee Avenue, crossing the intersection with 8th Street, and then continued west along Tennessee Avenue.

As the pedestrian was walking west along Tennessee Avenue toward the intersection with 8th Street, two workers passed her in a van driving east on Tennessee Avenue. The passengers in the van recognized the pedestrian, and the driver went wide around her to give her plenty of room. They waved to each other as the van passed. There were no visual obstructions to block her view of 8th Street as she approached the intersection.

Also on the morning of July 12, 2007, a United States Enrichment Corporation (USEC) employee was assigned the routine task of replacing empty liquid nitrogen dewars with filled dewars at the C-335 facility. This involved moving the mostly empty dewars from the facility to the basket on the forklift, transporting the empty dewars in the basket to the C-600 building by forklift, unloading the empty dewars from the basket, and moving them to the filling area. Then the process was reversed to move, load, and transport the filled dewars back to C-335. Sometime before 9:00 a.m. that morning, the driver departed in the forklift to pick up the dewars at C-335. After loading the mostly empty dewars, she transported the load westward along Tennessee Avenue to C-600.

However, when the driver arrived at C-600, the facility operators were filling some dewars, but there were none filled to exchange. The driver then returned to the garage, located south of C-600 on 8th Street, to wait until the dewars were filled. She indicated that she waited for about 45 minutes. Two co-

workers reported that they had observed the driver sitting in the cab of the forklift outside the garage writing something for some time, estimated to have been about 20 to 25 minutes. At about 10:30 a.m., the driver departed the garage to return to C-600 and turned north on 8th Street toward the intersection of Tennessee Avenue. During interviews, the driver's co-workers and her supervisor who had seen and talked with the driver that morning indicated that they didn't observe anything they considered unusual or different about the driver's appearance and behavior and that she didn't seem to be distracted.

Shortly after 10:30 a.m. on the morning of July 12, 2007, the pedestrian was walking west along the south edge of Tennessee Avenue and the driver was driving the forklift carrying the mostly empty dewars north on 8th Street. A few moments later, the forklift collided with the pedestrian in the intersection of 8th Street and Tennessee Avenue, striking her on the left side and knocking her to the ground. The pedestrian recalls seeing a flash of orange and silver just prior to the impact to her left shoulder. During the collision, the forklift ran over or contacted the pedestrian's right leg, causing injury to the skin and soft muscle tissue.

The driver indicated she did not feel the impact of the collision and did not hear anything until she had crossed Tennessee Avenue and was turning into the driveway for C-600. The driver reported at the time of the accident she was riding in the forklift with the air-conditioning operating and with the windows open, allowing her to hear sounds from outside the forklift. She reported hearing some kind of a noise, looking back toward the intersection, noticing the pedestrian lying in the middle of the road, and assuming that the pedestrian had tripped while crossing the street. As soon as she saw the pedestrian, she stopped the forklift, set the load down, and ran over to the pedestrian, who said, "You ran over me; you hit me." There were no known eyewitnesses to the accident.

Within moments of the accident, several bystanders arrived to provide assistance. The two SST workers in the van who had just passed the pedestrian reached the stop sign at the corner of Tennessee Avenue and 10th Street; and the driver stopped and paused for a moment to glance in his rear view mirror. He reported that he saw something unusual in the street behind him and remarked that he thought the pedestrian "had just got run over." He then quickly turned the van around, drove back to where the pedestrian was lying near the middle of the intersection of Tennessee Avenue and 8th Street, and blocked the road to prevent vehicles from approaching the accident scene from the east. Several other bystanders saw or heard something unusual and responded to the scene. Several of those responding to the scene contacted the USEC on-duty Plant Shift Superintendent (PSS) via the plant radio system, reporting a "man down….with a knee injury." The PSS immediately directed the Fire Department be called and responded to the accident scene within a couple of minutes. Upon arrival, the PSS observed that medical attention was being provided. Within minutes, the ambulance crew transported the injured pedestrian to Site Medical Services for emergency medical treatment.

Personnel at the scene initiated notification to management and other personnel within USEC, Energy*Solutions*, PRS, and the DOE Paducah Site Office. Within about 10 minutes of the accident, senior managers within each company had received word of the accident and appropriate personnel, not already at the scene, were dispatched to obtain firsthand information. Following a brief evaluation of the event, DOE Paducah Site Office Team Lead initiated a "30-Minute Notification" call to DOE-Headquarters (HQ) Office of Environmental Management (EM) as required by EM-3 directives at about 11:15 a.m. This call was followed up by an e-mail to applicable DOE-HQ and other DOE personnel.

The pedestrian sustained injuries to her right leg and a contusion to her left temple area. The injured pedestrian was taken to a local hospital for treatment and then airlifted to Vanderbilt Hospital, Nashville, Tennessee, where she was initially treated by a specialist for her degloving injuries and released on July 13, 2007.

Due to the extent of the pedestrian's injuries, she was rehospitalized on July 29, 2007. She remained hospitalized in Nashville until August 24, 2007. Debridement and skin grafts were performed to replace the damaged tissue on her upper and lower right leg. The pedestrian has not returned to work.

On August 17, 2007, a Type B Accident Investigation was established by William E. Murphie, the DOE Portsmouth/Paducah Project Office (PPPO) Manager, to investigate the accident in accordance with DOE Order 225.1A, *Accident Investigations.* (See Appendix A.)

1.2 FACILITY DESCRIPTION

The Paducah Gaseous Diffusion Plant (PGDP), referred to hereafter as the Site, is located in Western Kentucky, approximately ten miles west of Paducah and four miles south of the Ohio River (see Figure 1.2-1). The Site is a uranium enrichment facility owned by DOE and operated under a DOE Lease Agreement by USEC, a private corporation, with much of its operations conducted under a Nuclear Regulatory Commission (NRC) Certificate. DOE, NRC, EPA and OSHA share regulatory authority of the site. The Site has been in operation since 1952 and enriches low enriched uranium for use in commercial reactors under a privatized arrangement between DOE and USEC.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup activities also are being conducted concurrently at several locations at the Site under the DOE's Environmental Management Program to address contamination that resulted from past waste-handling and disposal practices. Cleanup activities are carried out by DOE contractors and include decontamination and decommissioning (D&D), legacy waste materials management, storage/disposition of depleted uranium hexafluoride (DUF_6) cylinders, and environmental remediation.

There are currently three categories of facilities and areas at the Site: 1) those that are controlled exclusively by DOE; 2) those that are leased from DOE by USEC under a lease agreement and are controlled exclusively by USEC; and 3) those that are leased by USEC and jointly used by both DOE and USEC, referred to as "common areas." The accident occurred at an intersection of streets in a common area.

Management of the DOE/USEC lease is conducted by DOE's Nuclear Energy Program Office of Nuclear Fuel Supply (NFS) in Oak Ridge, Tennessee. The NFS staff in Oak Ridge is supplemented by NFS staff on-site in Paducah. DOE contractor activities at the Site are managed by the PPPO Site Office located at the plant. Since transitions, which occurred in 2005 and 2006, the DOE contractors at the Site are PRS for remediation work, Swift & Staley Mechanical Contractors, Inc. (Swift & Staley Team or SST) for infrastructure work, and Uranium Disposition Services, LLC (UDS) for storage/disposition of DUF_6 cylinders.

Staffing levels at the Site have changed over time due to the changing missions of the Site, with decreasing numbers of USEC employees and fluctuating numbers of DOE contractor employees. The result has been that Site programs have been adjusted, combined, and restructured with line management being assigned responsibility for safety. Health and safety staffs also have been affected by the reduction in work force number and realignment. The increasing numbers of DOE contractors and work locations have resulted in changing workforce mixes, particularly in the common areas of the Plant, leading to traffic and pedestrian congestion.

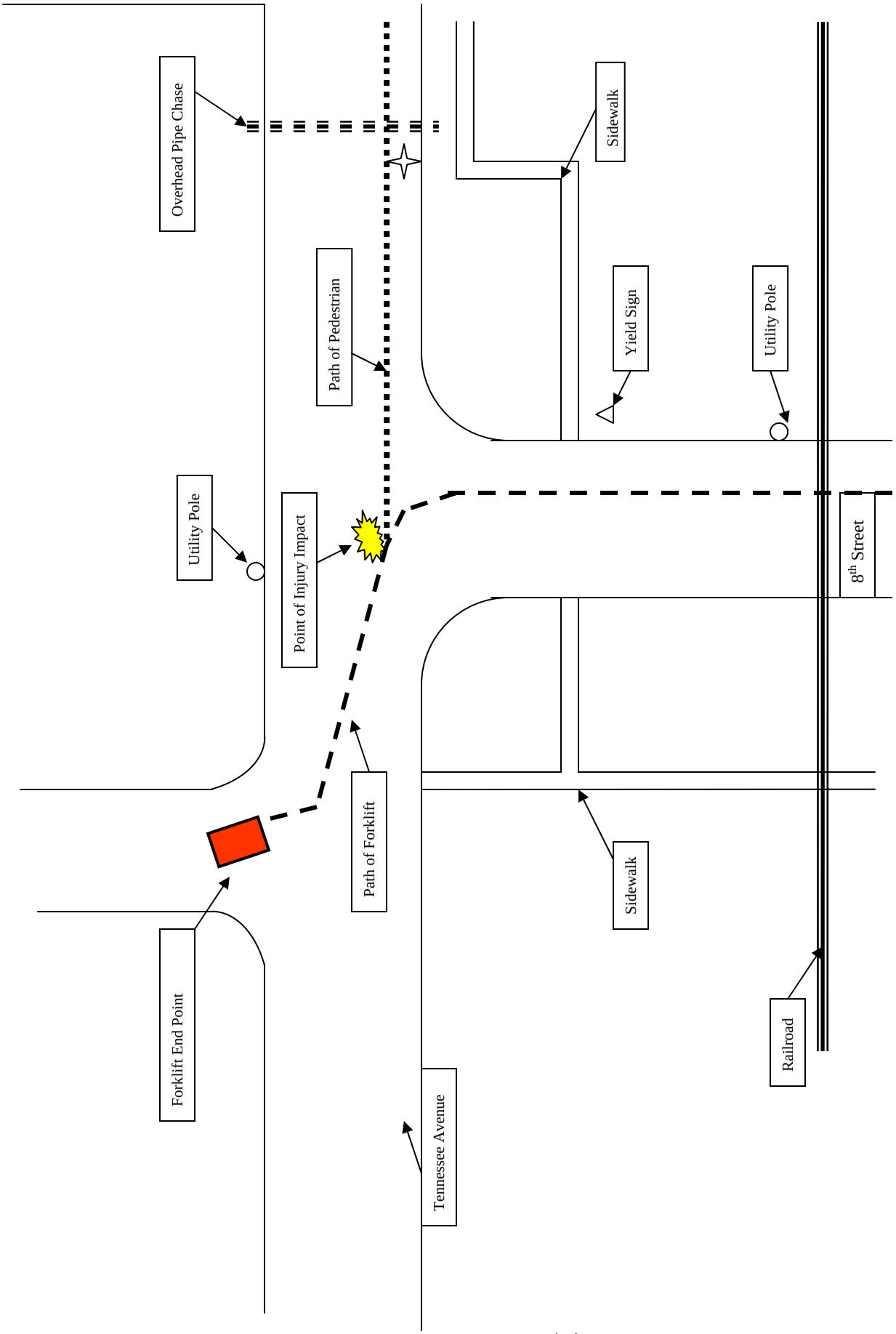

Figure 1.1-1. Diagram of Accident Scene

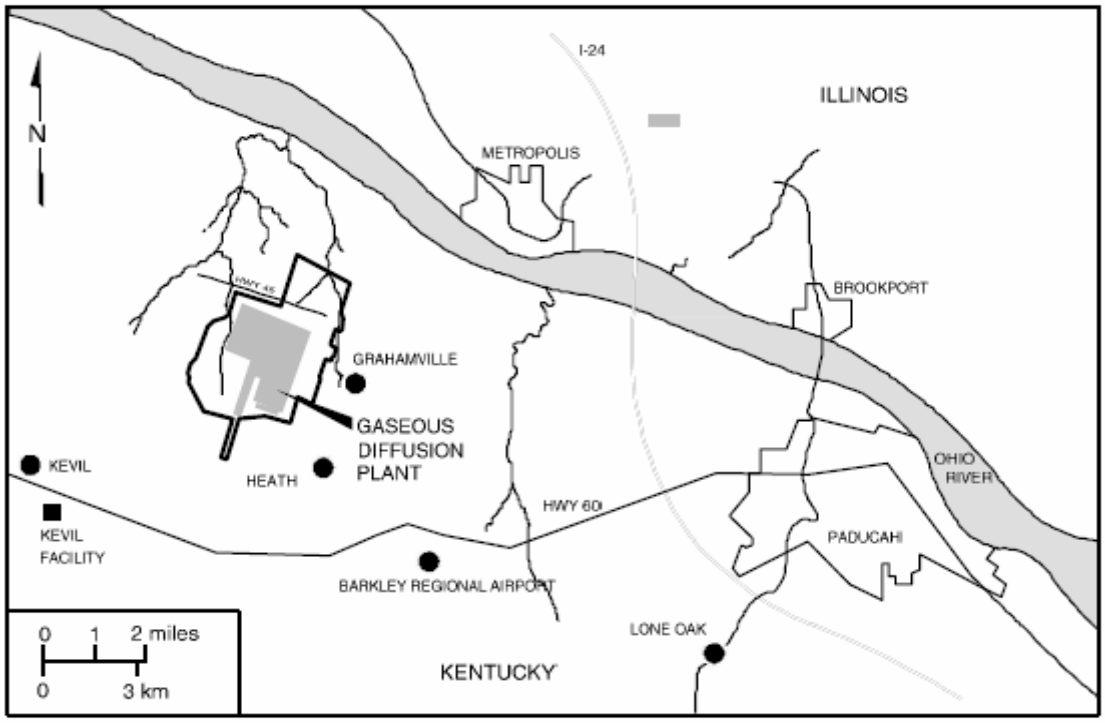

Figure 1.2-1. Location of the Paducah Site

1.3 SCOPE, PURPOSE, AND METHODOLOGY

The Board began its investigation on August 21, 2007; completed the investigation; and submitted its report to the Manager of PPPO on October 10, 2007.

The scope of the Board's investigation was defined in William E. Murphie's memorandum establishing an Accident Investigation Board, dated August 17, 2007. (See Appendix A.) The scope was defined to include review and analysis of the circumstances of the accident and to determine its causes. The Board was charged to specifically address the role of DOE, DOE contractors, USEC organizations and management systems, and the Lease Agreement between DOE and USEC, as they have contributed to conditions leading to the accident. The scope includes disciplines associated with traffic/pedestrian interactions and forklift operations and the applications of lessons learned from similar accidents within the Department.

The purposes of this investigation were to determine the causes of the accident and to assist DOE in understanding lessons learned to improve safety and reduce the potential for similar accidents at the Site and across the DOE Complex.

The Board conducted its investigation using the following methodology:

- Inspecting and photographing the accident scene and forklift.
- Reviewing public documents identifying roles and responsibilities for USEC, DOE, DOE contractors, the NRC, and the Occupational Safety and Health Administration (OSHA).

- Gathering facts through interviews and documents
  - More than 40 interviews were conducted with the parties involved in the accident and personnel with firsthand knowledge of the accident and/or applicable management systems and processes related to the accident. Most interviews were conducted in person, but some were conducted by telephone for those at remote sites and locations.
  - The Board established a hot-line number to permit Site personnel to contact the Board with any information related to the accident without having to make contact in person. One person responded by calling, and a phone interview was conducted with the individual who requested anonymity.
- Requesting and participating in reenacting the accident scenario
  - The reenactment consisted of three elements – the van that passed the pedestrian; two co-workers representing the pedestrian walking on Tennessee Avenue; and another forklift driver representing the driver, driving the same forklift configured the same as on the day of the accident.
  - The reenactment was captured both by video and still camera photos, all of which were reviewed by the Board.
- Reviewing the emergency and medical response.
- Analyzing facts and identifying causal factors through events and causal factors charting and analysis, barrier analysis, change analysis, and relative motion analysis to correlate and analyze facts and identify the accident's causes.
- Developing conclusions and judgments of need (JON) for corrective actions to prevent recurrence, based on analysis of the information gathered.
- Providing the factual portions of the draft report (sections 1 and 2) to USEC, DOE-PPPO, DOE-Oak Ridge (DOE-OR), PRS, SST, NRC, and OSHA. Due to the nature and extent of comments provided by USEC, the Board performed two additional factual accuracy reviews with USEC.
- Completing a review of the draft final report for classified or unclassified controlled nuclear information and Privacy Act/personal medical information.

1.4 REGULATORY AND POLITICAL CONTEXT ENVELOPING THE SITE

At first blush, this accident would appear to be a simple one where neither the pedestrian nor the driver was paying attention and the two collided, with serious results for the pedestrian. A possible contributing factor identified during the investigation was the presence of conflicting rules at the Site, about whether pedestrians or vehicles have the right-of-way at intersections. This conflict is exacerbated by the problem that the pedestrian, a DOE contractor, believed one set of rules gave her the right-of-way. The driver, an employee of USEC, was subject to a different set of rules that she believed gave her the right-of-way. Thus, the potential expectations of the parties became an important component of the analysis of this accident. Although DOE personnel and management of both the pedestrian and the driver were aware of the differing policies, apparently the conflict that existed between those specific rules was not recognized or appropriately communicated, and the process for resolving the problem was not invoked effectively.

In order to further investigate the bases for the rule conflict and the failure by the affected Site organizations to resolve the issue, the Board had to delve extensively into the regulatory and political landscape of the Site not just as it existed at the moment of the accident, but the development of the differing rules over time. The gaseous diffusion plants (GDPs) are unique in the DOE Complex, being the only operating facilities that have largely privatized businesses that operate pursuant to a DOE lease agreement. Other facilities, such as the Idaho National Laboratory's Advanced Mixed Waste Treatment

Plant, have operated under a model similar to a private sector business, but they remain under contracts to DOE.

At the Paducah site, USEC continues the long-standing industrial mission of uranium enrichment, carrying out activities in many facilities scattered across the 3,500 acre site. Production demands are based upon milestones established in an DOE/USEC agreement and upon USEC contractual commitments.

Across the same geographic area, all of which is a CERCLA National Priority Listed site, DOE contractors and subcontractors are carrying out various arrays of CERCLA cleanup activities that are driven by rigorous milestones established by a Federal Facility agreement. The contractors conduct remediation pursuant to DOE contracts, with various incentives. Some offices for the remediation contractor and subcontractors are located in trailers on the Site, in the middle of the busy comings and goings of the uranium enrichment activities. Vehicles operated by USEC for routine operations range from enormous uranium hexafluoride cylinder-haulers, cranes, forklifts, acid pigs, trucks of all sizes, busses, golf carts, and bicycles, to name just a few.

The result is a single site with two very different missions and workforce interfaces that are not always compatible. Different roles and responsibilities have arisen from a series of overlapping statutes, regulations, and agreements. The following historical overview is set out to convey the regulatory and political complexity that has developed over time and continued just prior to and at the time of the accident. The bottom line is that the responsibility for industrial safety is unclear at the locations on the Site considered “common areas,” particularly when the activities conducted in the common areas involve both DOE and USEC activities.

- The Atomic Energy Act (AEA) of 1946 transferred the Army’s responsibilities for the U.S. atomic energy program to a civilian agency.

- 1950 – the U.S. Government determines that it needs to double the capacity for domestic fissionable materials, and Atomic Energy Commission (AEC) decides to locate one GDP on a former military site outside Paducah, Kentucky (the Site).
- 1951–1952 – construction and operation of the Site begins.

- 1954 – the AEA of 1954 gave the AEC full governmental control over regulatory, developmental, and military aspects of all atomic materials and facilities, including uranium enrichment activities at the GDPs.

- 1955 to 1993 – the Site is fully operational, regulated by the AEC/ERDA/DOE from the Oak Ridge Office and operated by government contractors. The operations at the Site are conducted according to policies, standards, and procedures that are based on DOE orders and flow down through contractual agreements between the Management and Operating (M&O) contractors and DOE.

- 1974 – the Energy Reorganization Act of 1974 creates the NRC, for the predominant purpose of licensing and regulating commercial nuclear power reactors, commercial handling of nuclear materials, research on nuclear energy reliability, and nuclear event reporting.

- 1989 – DOE establishes the Paducah Site Office to provide local programmatic management and day-to-day oversight of the Site.

- June 1991 – DOE Type A Accident Investigation Report on forklift-pedestrian fatality at the Idaho National Engineering Laboratory (INEL) (with facts that are very similar to those of the present accident) recommends that DOE implement safety standards regarding pedestrian-forklift interactions.
- October 24, 1992 – the Energy Policy Act (EPAct 1992) is signed into law amending the AEA 1954 and establishing a wholly-owned government corporation, USEC, to operate the GDPs on the same DOE sites, but subject to NRC regulation for the DOE leased nuclear processes (rather than DOE), based upon an NRC certificate rather than a license (the vehicle for NRC regulation over a nuclear power plant). The EPAct 1992 makes USEC subject to OSHA regulation as if it were a private enterprise. The statute is silent on whether DOE orders and standards will also continue in effect. Under the EPAct 1992 only portions of the DOE sites would be available for use by USEC, pursuant to a lease agreement covering principally some facilities. The non-leased areas of the Site, including DOE activities performed in common areas, would continue under DOE jurisdiction.
- February 13, 1993 – DOE Transition Task Team publishes a white paper regarding the applicability of DOE orders to USEC once NRC grants it a certificate. The paper points out the confusion surrounding which standards will apply and says on page 2: "There will be areas where DOE managed activities will interface with USEC managed activities, primarily where DOE procures services from USEC such as security or operators in Environmental Restoration/Waste Management (ER/WM) areas. Compliance requirements will need to be defined for those areas to avoid confusion as to which Orders or regulations govern.
- July 1, 1993 – USEC begins operations at the Site, pursuant to a lease agreement (lease) between DOE and USEC. Under the lease, until the NRC develops standards for the protection of public safety, USEC will operate under DOE's regulatory oversight and control throughout the Site. DOE's implementation of this responsibility is set forth in Chapter 3 of the *Safety Basis and Framework for DOE Oversight of the Gaseous Diffusion Plants*. These are limited to nuclear safety and safeguards, and security requirements. The lease establishes limited access areas – "leased premises" that include real property; fixtures; easements; and rights-of-way, within which DOE has access; and other areas. "Common areas" are those areas of the Site that include roads, easements, power lines, railroad, utilities, parking lots, etc. DOE agrees to provide USEC with "quiet enjoyment" of the leased premises. Likewise, in Exhibit C to the lease, the Memorandum of Understanding (MOU) between USEC and DOE regarding environmental issues states that DOE will conduct its environmental restoration activities in a manner that does not significantly interfere with USEC's ongoing operations, nor will USEC conduct its operations in such a way as to interfere with DOE's environmental remediation activities. DOE agrees to pay USEC $35 million to completely satisfy all obligations and/or expenses for making the leased areas and facilities compliant with OSHA standards.
- December 20, 1993 – DOE and NRC complete the "Joint Statement of Understanding Between the Nuclear Regulatory Commission and the Department of Energy on Implementing the Energy Policy Act Provisions on the Regulation of Gaseous Diffusion Uranium Enrichment Plants," which provides for DOE regulation of the GDPs until NRC assumes regulatory oversight.
- August 11, 1994 – NRC and DOE complete "Agreement Establishing Guidance for NRC Inspection Activities at the Paducah and Portsmouth Gaseous Diffusion Plants between Department of Energy Regulatory Oversight Manager and Nuclear Regulatory Commission." The agreement emphasizes the fact that DOE retains regulatory oversight at the leased portions of the Site, but that NRC will begin to locate observers at the facility to obtain information and knowledge to help it develop or implement its standards.
- September 23, 1994 – NRC publishes its final standards, 10 *CFR* Part 76, regarding the certification of GDPs.

- December 21, 1994 – OSHA and DOE complete an interim MOU delineating the areas of responsibilities of both DOE and OSHA at the Site. OSHA agrees to enforce all applicable standards, rules, and requirements including the general duty clause for all industrial safety hazards due to either the plant's physical conditions or its operations and chemical and toxicological exposures; DOE will regulate radiation hazards to the general public and the environment; and DOE and OSHA jointly will regulate health hazards due to potential exposure to radiological materials. This MOU was implemented to define responsibilities during the interim period until NRC assumed this oversight responsibility.
- January 5, 1995 – DOE's Office of Environment, Safety & Health (ES&H) sends out a public announcement that the Agreement with OSHA on the GDPs could become a model for effective external regulation at DOE sites nationwide. The announcement states that, in reaching the MOU terms, both OSHA and DOE will work closely with labor organizations.
- September 1995 – USEC submits its completed application for certification to the NRC.
- January 24, 1996 – USEC and DOE complete "USEC and DOE Resolution of Shared Site Issues at Gaseous Diffusion Plants."
- January 25, 1996 – USEC sends a letter to Carl Paperiello with NRC regarding DOE regulating in nonleased areas and common areas in accordance with applicable DOE requirements.
- April 26, 1996 – USEC Privatization Act is signed. This statute provides for the establishment of a private corporation to succeed USEC, mandates that the private corporation shall be subject to and comply with the Occupational Safety and Health Act (OSHAct), and that it "shall be liable for any liabilities arising out of its operations after the privatization date."
- May 24, 1996 – DOE sends a letter to USEC proposing a revision to the USEC application to the NRC, which DOE says "is needed to clarify the fact that the DOE will be performing activities on the common portion of the leased properties at the GDPs under the requirements of DOE Orders and Rules." The letter points out that "The current USEC applications [to the NRC] for the GDPs do not address these areas." and proposes to add a footnote to Exhibit A of the Lease to clarify "that common areas are a part of the leased premises to avoid any future confusion." The DOE position is that common areas are part of the leased areas.
- July 26, 1996 – OSHA and NRC complete the "Memorandum of Understanding with Respect to the Gaseous Diffusion Plants," describing the roles and responsibilities of both NRC and OSHA regarding occupational safety and health hazards at the Site. In the preliminary discussion of the purpose of the MOU, the two agencies state that because it is not always practical to sharply identify boundaries between the nuclear safety regulated by NRC and the industrial safety regulated by OSHA, the two agencies are agreeing to coordinate their regulatory programs to assure worker safety and avoid regulatory gaps. The MOU states that in general, NRC will apply its standards to working conditions involving radiological hazards, OSHA will apply its standards to working conditions involving nonradiological hazards, and both agencies will apply their standards to conditions involving a combination of hazards.
- September 19, 1996 – NRC issues its proposed certification decision for USEC, based both on the USEC application and the DOE-prepared compliance plan.
- November 26, 1996 – NRC issues its "initial" Certificate of Compliance to USEC, as well as a "Compliance Plan Approval," which is based upon the Compliance Plan written by DOE.
- December 16, 1996 – DOE and USEC release the "Joint Policy Statement on USEC and DOE Directives and Management Expectations for Shared Site Issues." This document is a joint administrative policy statement that describes the need for formal procedures to identify and resolve shared site issues. At this time, USEC has one prime contractor – Lockheed Martin Utility Services (LMUS) and DOE has, as one of its prime contractors, Lockheed Martin Energy Systems (LMES).

The policy statement creates roles and responsibilities whereby LMUS and LMES would jointly identify "shared" issues and have coordinators that will communicate issues to other DOE contractors, rework maps to accurately reflect which areas of the Site are leased or nonleased, coordinate emergency management, communicate issues and incidents, coordinate media contacts, and plan work activities to avoid conflict. Noteworthy is Section 7.0 of the Policy which spells out 15 unresolved administrative control issues, including NRC liaison requirements and "Common Area Definition, Ownership and Interface Requirements."

- March 3, 1997 – Certificate of Compliance becomes effective and NRC assumes regulatory oversight of USEC's operations and leased areas at the GDPs for radiological operations.
- October 20, 1997 – NRC's Office of the Inspector General issues a report concluding, in part, that the Regulatory Oversight Agreement (ROA) between USEC and DOE did not appear to work well based on USEC's opinion that DOE was not effective in assuming an "NRC-type" regulatory role and also that issues relating to the determination of NRC and DOE regulatory boundaries needed to be addressed.
- October 27, 1997 – NRC and DOE complete a MOU, which describes NRC as having regulatory oversight over nuclear safety and safeguards, and security at the leased portion of the Site. The MOU is also specific in saying: "Nothing in this MOU is intended to restrict or expand the authority of DOE or otherwise alter the terms of the ROA [Regulatory Oversight Agreement, which was Exhibit D to the 1993 Lease Agreement] until by its terms it ceases to apply to facilities or activities for which NRC assumes regulatory oversight." The MOU also states: "NRC certification of the GDPs is in part conditioned upon USEC adherence to a Compliance Plan prepared and approved by DOE." Note: The Board did not evaluate USEC conformance to the requirements of the Compliance Plan.
- March 30, 1998 – USEC and DOE complete "USEC and DOE Resolution of Shared Site Issues at the Gaseous Diffusion Plants, Revision 1." This document specifically describes three types of areas: 1) DOE areas, which are generally nonleased and which are "exempt from NRC regulation;" 2) USEC leased areas where USEC activities are conducted subject to NRC regulation; and 3) "common areas" (e.g., site roads), which are used for USEC and DOE activities." Under this resolution, USEC agrees to assume "full responsibility" for safety of its activities by USEC personnel, contractors and subcontractors in both USEC areas and common areas. Likewise DOE agrees to self-regulate and be responsible for safety of DOE activities in DOE areas and common areas.
- July 28, 1998 – USEC is privatized through an initial offering of public stock and USEC becomes a wholly-owned subsidiary of USEC, Inc.
- December 1, 1998 – OSHA publishes its Final Rule on Powered Industrial Truck Operator Training, amending 29 *CFR* Parts 1910, 1915, 1917, 1918, and 1926 to substantially enhance the training requirements for operators using forklifts, including testing, retesting, and enforcement. This was based on an OSHA study of serious accidents involving forklifts, which concluded that because existing training standards for operators left employers "to their own devices to determine that scope of their training programs," more than 80 deaths per year resulted.
- August 1999 – DOE initiates an independent investigation of the Site in response to public concerns about issues such as ineffective communication of hazards to workers.
- October 1999 – DOE's Office of Oversight in the ES&H Office issues "Phase I, Independent Investigation of the Paducah Gaseous Diffusion Plant," which identifies problems with inconsistent application of safety and health procedures and DOE not effectively implementing all ES&H requirements or identifying all ES&H hazards.
- March 22, 2000 – OSHA testifies before House Subcommittee on Energy and Power regarding external regulation by OSHA of DOE sites and the results of three major pilot projects, one of which was a 1998 activity at the Oak Ridge National Laboratory and the East Tennessee Technology Park.

Conclusions included finding 75 violations at Oak Ridge during OSHA simulated inspections and the overall observation by OSHA that OSHA places greater weight on the seriousness of potential hazards than does DOE.

- October 2003 – creation of the DOE PPPO for CERCLA remediation activities under DOE's Office of Environmental Management (EM).
- February 11, 2004 – NRC issues its NRC Inspection Manual, Chapter 1007, "Interfacing Activities Between Regional Offices of NRC and OSHA." The manual points out that nuclear plants frequently have conditions that can result in occupational risks, but do not affect the safety of licensed radioactive materials, which can create a gap in worker protection by the NRC. The Manual creates responsibilities and authorities to help eliminate issues involving worker safety and health by designating an NRC Regional Office OSHA Liaison Officer to serve as the principle point of contact with the appropriate OSHA area or regional office.
- December 8, 2006 – DOE and USEC complete a lease agreement for the use of DOE's gas centrifuge enrichment plant (GCEP) in Piketon, OH, with initial term until June 2009. In that agreement, the term "common areas" is clarified and reads: "Common Areas shall mean those areas within the ….Leased Premises … in which the Department, its contractors, subcontractors, agents and representatives conduct activities in accordance with applicable department requirements."

Figure 1.4-1 is an attempt to portray in graphical format the interface agreements that exist between the regulators, DOE contractors, and USEC.

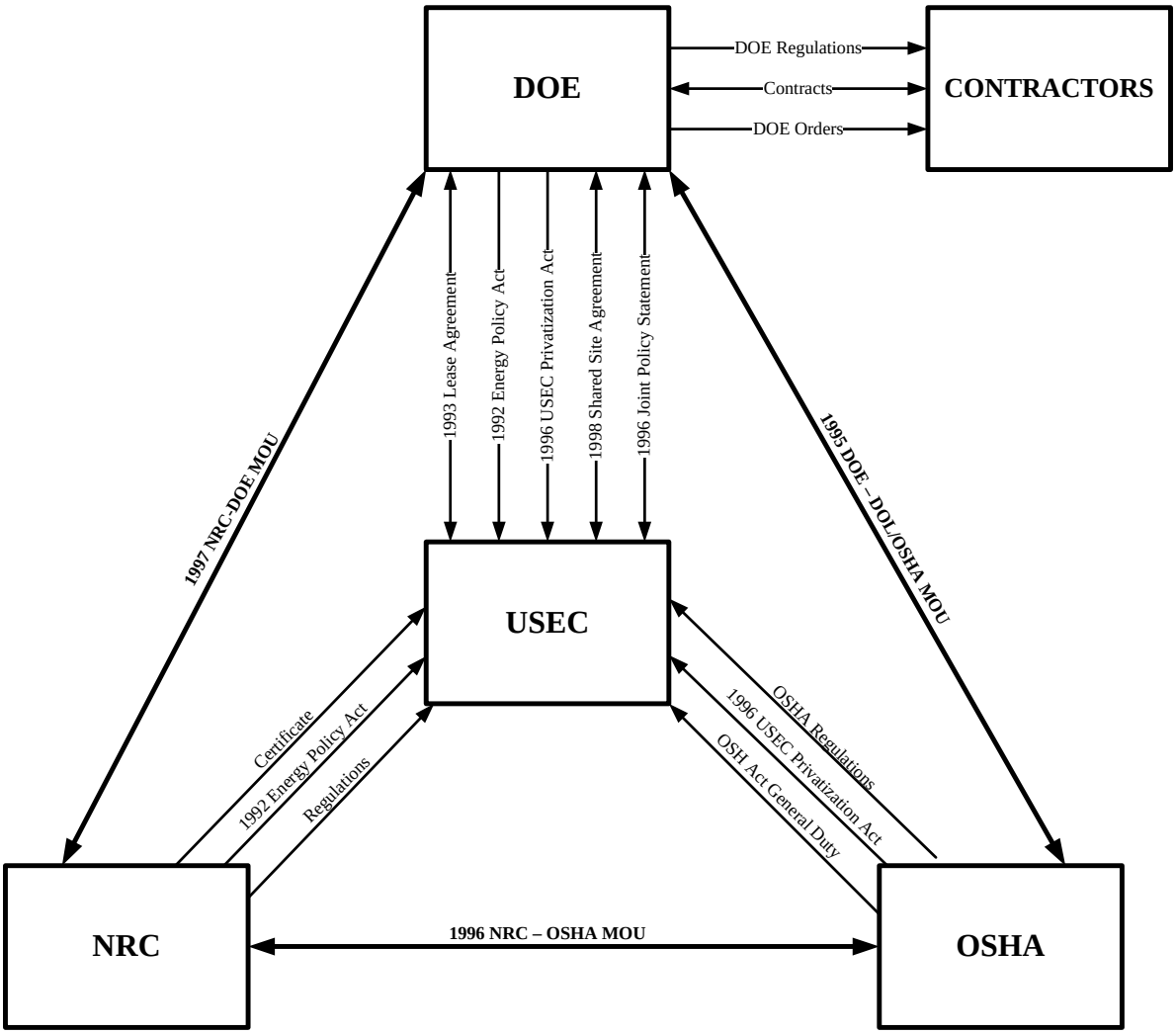

Figure 1.4 -1 Interface Agreements That Exist Between the Regulators, DOE Contractors, and USEC

2. FACTS RELATED TO THE ACCIDENT

2.1 ROLES AND RESPONSIBILITIES

Overview

On October 24, 1992, the EPAct of 1992 was signed by President George H. Bush creating a government corporation (USEC) to operate leased portions of the GDPs under the regulatory oversight of the NRC and OSHA. DOE was required to take actions to divest itself from plant operations, to transfer existing uranium enrichment contractual obligations, and relinquish oversight of the GDP facilities. USEC was leased site equipment and facilities required to produce enriched uranium with the remainder of the facilities remaining with DOE. A third class of facilities used by both USEC and DOE were designated as common areas leased to USEC. The corporation was to assume the operation of the uranium enrichment enterprise on July 1, 1993.

2.1.1 USEC Roles and Responsibilities

2.1.1.1 Duties Established by Statute

1. The EPAct 1992 amended the AEA of 1954 requiring USEC to comply with the OSHAct.
2. The USEC Privatization Act continued OSHA requirements and also made USEC liable for any liabilities arising out of its operations.
3. The OSHAct states that each employer shall furnish a place of employment that is free from recognized hazards and complies with OSH standards. The OSHAct also requires all employees to comply with applicable OSH standards.

2.1.1.2 Duties Established by Regulation

The NRC imposes requirements on licensees and certificates via published requirements in the *Code of Federal Regulations* (*CFR)*. USEC's certificate is based upon an application submitted to demonstrate compliance to the requirements of 10 *CFR* Part 76, "Certification of the Gaseous Diffusion Plants," which was promulgated by the NRC in September, 1994. Any additional *CFR* requirements deemed necessary by the NRC are invoked in 10 *CFR* Part 76.

2.1.1.3 Duties Established by Agreements

Agreements are in place between the DOE and USEC regarding safety at the Site. Paducah site-wide coordination and integration of safety programs and issue resolution is encouraged by:

- USEC and DOE Resolution of Shared Site Issues at the GDPs, Rev. 1, (dated March 31, 1998).
- The Joint Policy Statement on Shared Site Issues (dated December 1996 between DOE and USEC).

USEC Procedure CP2-PO-PO1033, Rev. 1, *PGDP Shared Site Interface*, (dated June 5, 2003, Change A, dated July 25, 2005), governs the performance of actions to implement the agreements listed in section 2.1.1.

2.1.2 DOE Roles and Responsibilities

2.1.2.1 Duties Established by Statute

1. The AEA of 1954 created the Executive Agency with the overall fundamental responsibilities for the safe possession, management, and control of radioactive materials. Although its name has changed over time and the statute has been amended countless times, DOE and it predecessors have all continued basic responsibility for safety at sites and facilities owned by DOE.
2. The Energy Reorganization Act of 1974 created NRC, but did not limit DOE's responsibilities for overall safe operation of its facilities within its jurisdiction.
3. The EPAct of 1992 created a government corporation for the purpose of managing and operating the Site; however, DOE retained ownership of the Site and facilities, and its overall substantive responsibility for safety under the AEA was not diminished. What was changed by this statute was the method by which DOE would achieve its statutory duty. Congress assigned implementation responsibilities to the NRC to create standards and procedures for certifying the nuclear safety of the leased portions of the Site based on DOE input.
4. The USEC Privatization Act provided a mechanism for privatizing the uranium enrichment operations and changed the government corporation to a private corporation.

2.1.2.2 Duties Established by Regulation

DOE's own regulations at 10 *CFR* Parts 830, 835, 850, and 851 established the standards and procedures for DOE and its contractors to achieve DOE's responsibility for safety.

The Site is a DOE-owned nuclear facility subject to 10 *CFR* Part 830 for quality assurance and nuclear safety. Although a portion of the Site is leased to USEC, which is excluded from 10 *CFR* Part 830 for its activities, the remainder is subject to the DOE regulations that govern the conduct of DOE contractors, their personnel, and others that perform work that could affect the safety of the Site. The Safety Basis for the Site should provide reasonable assurance that the Site, including the USEC-leased portion of the plant, can be safely operated in a manner that adequately protects workers, the public, and the environment.

2.1.2.3 Duties Established by Agreements, Orders etc.

1. The MOU between DOE and NRC (October 27, 1997) retained overall DOE responsibility for safety at the Site in nonleased spaces, with NRC agreeing to take on the role of actual oversight of the plant operations regarding nuclear safety, safeguards, and security for the leased portions of the plant. Regarding the NRC certification, the MOU is clear that it is conditioned, in part, by USEC adherence to the Compliance Plan prepared and approved by DOE. Communication between NRC and DOE also is required regarding matters of safety. The DOE agreed not to conduct inspections of nuclear safety, safeguards, and security in leased areas. However, each agency agreed that they would refer to the other agency concerns relating to nuclear safety, safeguards, and security observed in the other agency's area of responsibility during the performance of its normal oversight functions.

2. DOE MOU with OSHA, the MOU between the U.S. Department of Labor (DOL) and the DOE (dated January 19, 1995), established the joint working relationship, oversight, and jurisdiction associated with the Site with regard to safety and health matters.

There are four organizations/programs at the Site that independently attempt to consider and address the safety concerns from a site-wide standpoint.

- Shared Site Committee – This organization meets every two weeks, or as needed, and is composed of representatives from USEC, DOE, and DOE contractors. There is no formal charter or procedures for the committee, although a draft charter was prepared toward that end. USEC acts as the coordinator by informal agreement of the organizations that participate. The agenda and minutes of the meetings are maintained and distributed by USEC. Membership on the Shared Site Committee is not mandatory and additional persons are encouraged to attend to address specific topics as they arise. There is no set agenda and the information presented at the meetings may not always include all of the necessary information to fully discuss and resolve the item. However, this committee's primary intent is to provide a mechanism to ensure that activities and issues that have site-wide application or that could affect others are discussed, understood, and resolved to ensure compliance, proper coordination, and safety.
- Site Council – This organization meets monthly, or as needed, and is composed of senior-level managers from the DOE, USEC, PRS, SST, and UDS. This council is a high-level organization that considers issues that could not be resolved by the Shared Site Committee, matters affecting the Site's mission, funding, and coordinated overall efforts at the Site. There is no charter or procedure(s), and no minutes are issued.
- Safety Team of Paducah (STOP) – The STOP Committee meets monthly, or as needed, to discuss and address ES&H elements and issues associated with the Site. The STOP is established as a voluntary organization consisting of representatives from all organizations at the Site, including DOE, USEC, PRS, SST, UDS, the unions, and other groups or persons as necessary or interested. The STOP is defined in an SST procedure that was reviewed, agreed to, and adopted by all primary organizations at the Site. The STOP committee's primary intent is to provide an open and organized forum for information exchange and to promote awareness of information and ideas relative to safety in support of integrated safety management system (ISMS). The STOP committee has formed, from time to time, subcommittees to address specific issues, concerns, or programs. Minutes are kept and issued by the SST ES&H Manager, who currently serves as Chair at DOE's request.
- Facility Evaluation Safety Swap (FESS) – The FESS was developed by the ES&H Managers at the Site as a limited version of the Facility Evaluation Board at Savannah River Site. The FESS Charter was established and accepted for implementation by SST and PRS through a formal charter. UDS and USEC elected not to participate. The FESS meets as necessary with an expectation of quarterly. The membership to FESS is limited to the ES&H Managers from SST and PRS and others as deemed necessary to complete a defined task. The function of FESS is to identify programs, areas, and activities of interest or concern within the participating organizations and to perform brief, detailed evaluations. The results of these evaluations are shared with the evaluated organization to identify aspects of operation, conditions present, or safety implementation methods that are satisfactory or in need of improvement. The FESS evaluations and resultant reports are considered as a method of prevention, avoidance, and self-identification of improvements prior to the issues becoming more significant.

2.1.3 Contractor Roles and Responsibilities

2.1.3.1 Duties Established by Statute

There are no statutory requirements for DOE contractors.

2.1.3.2 Duties Established by Regulation

The DOE has numerous regulations, directives, orders, and guidance that specifically apply to the safe performance of activities and contractual requirements at the Site. For the purposes of this accident

investigation/report, applicability to, adherence to, and implementation of the DOE regulations at the Site is as follows:

1. 10 *CFR* 830 (See section 2.1.2.2.)

2. All DOE contractors and their subcontractors must comply with the provisions of 10 *CFR* 851 as of May 2007. PRS, SST, and UDS all have complied with the associated deadlines for compliance with this regulation and have a suitable Worker Health and Safety Plan in place. Compliance with the provisions of 10 *CFR* 851 automatically includes the applicable provisions for safe performance found in the OSHA regulations.

2.1.3.3 Duties Established by Agreements, Orders, etc.

DOE contractors are required by their contract with DOE to comply with laws and regulations applicable to worker safety, as noted above. Worker safety requirements are contained in each contractor's Worker Safety and Health Program Plan, which is approved by DOE in accordance with 10 *CFR* 851. There are no contractual requirements in place to direct DOE contractors to perform to meet DOE's requirements from the agreements listed in 2.1.1.3; however, there are clauses in the contract requiring cooperation between Site contractors.

The following documents exist to govern the performance of actions to implement the agreements listed in section 2.1.1:

- A STOP Committee was established and adopted for site-wide monthly discussions of safety issues and topics (SST Procedure 1.2.1, *STOP Committee*, dated October 25, 2006).
- Draft Charter for Shared Site Process Review Subcommittee, undated, SST Draft, work in progress.
- Bechtel Jacobs Company (BJC) Procedure PAD-4010, *Shared Site Issues – Paducah*, Rev. 1, dated June 28, 2004.

2.1.4 NRC Roles and Responsibilities

2.1.4.1 Duties Established by Statute

1. The Energy Reorganization Act of 1974 created the NRC, an independent regulatory commission for licensing possession and management of nuclear materials, as well as regulatory functions related to licensing.
2. The EPAct of 1992 requires NRC oversight of USEC activities under the DOE Lease Agreement using standards and procedures to certify the nuclear safety of the leased portions of the Site.
3. The USEC Privatization Act provided a mechanism for privatizing the uranium enrichment operations.

2.1.4.2 Duties Established by Regulation

10 *CFR* Part 76 describes NRC responsibilities for certification of the Site.

2.1.4.3 Duties Established by Agreements, Orders, etc.

1. MOU between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy on Cooperation Regarding the Gaseous Diffusion Plants (Docket No. 70-7001 and 70-7002, dated

October 30, 1997). This MOU supplements and replaces various other prior lease-related agreements between DOE and NRC and addresses the interfaces, exchange of information, interactions regarding safety, changes to safety, emergency response, and coordination between the two parties.

The 1997 MOU specified that DOE would notify the NRC on "matters of common interest." "Matters of common interest" is defined in the MOU as "modifications to GDP Site areas, railways, roadways, structures, systems, components, hazards, activities, tenant mix, population, etc. which, can impact safety, safeguards, or security risks (likelihood or consequence) under DOE or NRC jurisdiction…" The NRC agreed to notify DOE of substantial proposed changes in USEC operations potentially impacting safety, safeguards, and/or security on-site. The MOU established the NRC as the initial lead federal agency for on-site emergencies.

The NRC agreed not to conduct inspections of nuclear safety, safeguards, and security in nonleased areas. However, each agency agreed that they would refer to the other agency concerns relating to nuclear safety, safeguards, and security observed in the other agency's area of responsibility during the performance of their normal oversight functions.

2. The MOU between the NRC and the OSHA, dated July 26, 1996, established NRC responsibilities for referral of OSHA noncompliances.

The NRC has an inspection procedure (Manual Chapter 1007) titled "Interfacing Activities between Regional Offices of NRC and OSHA." This procedure is a result of MOUs between OSHA and the NRC dated October 21, 1988, and July 26, 1996. As a result, the NRC is required to address any OSHA concerns that it observes as part of its inspection activities. If the NRC observes OSHA concerns with DOE activities during the performance of its inspection activities, its procedure requires it to notify USEC, DOE, and OSHA. Similarly, if the NRC observes OSHA concerns with USEC operations, the NRC will notify USEC management. If either DOE or USEC management does not address the concern (a pattern of unresponsiveness), the NRC is procedurally required to notify OSHA.

The NRC maintains two full-time inspectors at the Site who monitor USEC's compliance to the NRC certification requirements and commitments. During the performance of their duties, the NRC inspectors will notify the PPPO Paducah Operations Oversight Group in accordance with the terms of the 1997 DOE/NRC MOU when observing concerns arising from DOE operations either impacting their regulatory jurisdiction or concerns about safety, health, or security. This notification is usually made informally to DOE's Facility Representatives (FacReps). Similarly, if DOE FacReps have concerns with USEC's safety and health performance, they informally notify the NRC Site inspectors.

2.1.5 OSHA Roles and Responsibilities

2.1.5.1 Duties Established by Statute

OSHA is responsible for administering the requirements established under the OSHAct and OSHA standards. Under the OSHAct, USEC, as an employer, has a general duty to furnish each employee with a place of employment that is free from recognized hazards that can cause death or serious physical harm and complies with all OSHA standards, rules, and regulations. OSHA standards contain requirements designed to protect employees against workplace hazards. OSHA is authorized, among other things, to conduct workplace health and safety inspections, including inspections in response to employee complaints, and to issue citations and conduct enforcement actions.

2.1.5.2 Duties Established by Regulation

29 *CFR* Part 1910 and 1926

OSHA applies its standards in inspection and enforcement of working conditions involving nonradiological hazards or combined hazards. OSHA does not conduct enforcement actions with regard to GDP working conditions that involve solely radiological hazards.

2.1.5.3 Duties Established by Agreements, Orders, etc.

1. Under the MOU between NRC and OSHA dated July 26, 1996, OSHA is responsible for administering the requirements established under the OSHAct. This includes the general duty clause and industrial hazards in the workplace.

2. The MOU between DOL and DOE dated January 19, 1995, establishes the joint working relationship, oversight, and jurisdiction associated with the Site with regard to safety and health matters. The 1995 MOU implements the provisions of the EPAct of 1992, which requires OSHA to regulate USEC-leased activities at the GDPs (i.e., the Site) and still remains effective.

3. The 1992 MOU is a general understanding between OSHA and DOE as to the responsibilities of each agency and defines DOE as the regulator of industrial safety for its facilities and operations at government-owned contractor-operated (GOCO) facilities. Per discussion with OSHA representatives, DOE retains oversight of nonleased areas at the Site as a GOCO facility via the 1992 MOU.

Specific criteria for safe work are found within the DOE orders and 10 *CFR* 851 for the DOE contractors and subcontractors at the Site. Both of those primary source documents reference and recognize the overarching requirements of the DOL's regulations found in 29 *CFR* 1910 and 1926. Therefore, the aspects, limits, requirements, and provisions of OSHA are, by reference and association, implemented at the Site by the DOE contractors. Oversight, compliance, and enforcement of those safe work provisions are typically performed by the DOE for its contractors. OSHA may come on-site in an advisory capacity to DOE, but has no enforcement authority over industrial safety in functions by DOE contractors. OSHA does have enforcement authority over USEC industrial safety for NRC regulated leased portions of the Site.

2.1.5.4 OSHA Historical Experience at the Site

OSHA involvement at the Site has not occurred on an established frequency. Four OSHA inspections occurred between October 1993 and February 1994 and one inspection was conducted in January – March 2000. The Board was unable to identify any OSHA inspections performed since March 2000. This accident did not meet OSHA oral reporting requirements of 29 *CFR* Part 1904. OSHA was not contacted by either party involved in this forklift/pedestrian incident. OSHA was invited to participate in the DOE Type B Investigation but declined, citing lack of jurisdiction and unavailability of personnel. OSHA does not intend to intervene, investigate, or issue any findings related to this accident.

2.1.6 Differing Interpretations

Due to disagreement within the Board and between USEC and the Board as to an accurate factual representation of some of these issues discussed in the above sections, additional discussions are deferred to section 3.

2.2 IMPLEMENTATION OF ROLES AND RESPONSIBILITIES

2.2.1 Safety Programs

2.2.1.1 Safety Programs Introduction

The three primary DOE contractors performing work at the Site are PRS, SST, and UDS. Of those, PRS and SST are most likely to perform work within the Controlled Area where this incident occurred. While this investigation deals primarily with PRS and SST, all three prime contractors are expected to implement corrective actions resulting from this investigation. Work also is conducted at the Site within this area by the private company, USEC. The USEC facilities, actions, and performance expectations are established under a lease agreement and subsequent associated documents between DOE and USEC. Each of the DOE contractors has specific facilities and missions for which each is responsible at the Site. All three DOE contractors and USEC, to some extent:

- Interact with each other on a frequent basis (formally and informally).
- Can perform work in the same areas or adjacent work areas.
- Abide by similar safety/nuclear requirements.
- Customize the method of implementing the requirements to meet their individual corporate structures, approaches, and interpretations.

Interactions, which occur at the Shared Site Committee, are documented through meeting minutes distributed via e-mailing by USEC to USEC, DOE and DOE contractor personnel. (Some of the meeting minutes were provided to the Board.)

Each organization performing work at the Site maintains additional contract- and regulatory-required plans, program descriptions, policies, and procedures that define the controls and mechanisms for ensuring safety to the worker, the public, environment, and facilities. Among these are the following:

- Health and Safety Plan
- Emergency Response Plan
- ISMS
- Environmental Management System
- Quality Assurance Plan
- Radiation Protection Program
- Procedures for work control
- Procedures for hazard identification, assessment, and control
- Procedures for employee concerns and resolution
- Procedures for self-assessment and corrective action resolution
- Procedures for industrial hygiene and safety
- Procedures for occupational health
- Methods for lessons learned dissemination

In comparison to other DOE facilities across the nation, the extent and implementation of the associated safeguards and oversight would be similar.

For USEC, the following procedures that address workplace hazards were provided to the Board:

- CP2-SH-IS1063, *Instructions for Safety and Health Work Permit*
- UE2-SH-IS1038, *Job Hazard Analysis Program*

- CP2-GP-GP1032, *Work Control Process*

For PRS, the following procedure that addresses workplace hazards was provided to the Board:

- PRS-ESH-2010, Rev. 0, *Hazard Assessment*, dated February 9, 2007

For SST, the following procedures address various elements of workplace hazards and were provided to the Board:

- SST Procedure 3.2.3, Rev.1, *Hazard Assessments*, dated June 18, 2007
- SST Procedure 3.1.3, Rev.1, *Suspension of Work (Safety-Related)*, dated August 9, 2007

2.2.1.2 Safety Performance of the Site

The following data represents the safety posture and performance as compared to the DOE, OSHA, and Standard Industrial statistics. General safety performance for the primary parties at the Site has consistently been better than the general industry standards. (See Table 2.2.1-1.)

2.2.1.3 Integrated Safety Management

USEC has programs and procedures added in place to integrate safety into its day-to-day activities to meet industry standards and to satisfy requirements for safe operation of a nuclear facility as established by the NRC and OSHA. USEC is not required to adhere to DOE orders or 10 *CFR* 851 for USEC worker safety and health protection.

USEC does not have a program specifically identified as ISMS. However, separate programs contain elements similar to the DOE ISMS. The first is associated with the reviews conducted under the safety and health work permit procedure (USEC Procedure CP2-SH-IS1063, Rev. 5, dated July 16, 2004). Closely associated with that procedure is USEC's work control procedure (USEC Procedure CP2-GP-GP1032, Rev. 14, dated February 15, 2006), which incorporates elements normally associated with hazard identification, mitigation, and establishment of safe work controls/practices. The third USEC program that provides elements similar to the DOE ISMS is USEC's job hazard analysis process, described in UE2-SH-IS1038, Rev. 1, dated March 21, 2001. The final piece is the Employee Driven Safety (EDS) Program. The EDS Program was a pilot program implemented in June 2007 only within the maintenance organization. The EDS Program participation is voluntary and provides USEC employees with a mechanism to self-identify improvement opportunities. EDS is no longer a pilot program, but remains solely within the maintenance organization.

Safety integration into the day-to-day activities for the DOE contractors located at the Site is accomplished through implemented programs. These are established independently by the DOE contractors through established criteria found in DOE orders and policies and 10 *CFR* 851. Therefore, minimal safety components, expectations, and the ultimate oversight for overall safety effectiveness and integration for the DOE contractors at the Site resides with DOE. The DOE office and contractors receive certification to document their compliance with DOE's ISMS requirements.

Table 2.2.1-1 PGDP Organization Safety Performance

CY 2006 and 2007 (through July 2007)					
PGDP Organization	**Lost Workday Case Rate**		**Goal**		**OSHA Industry Standard (as of 2005)**
	2006	**2007**	**2006**	**2007**	
PRS	0.60	0.86	0.48	0.48	2.0
SST	0.00	0.00	0.48	0.48	2.0
UDS	0.00	0.23	0.48	0.48	2.0
USEC	0.60	0.70	0.50	0.40*	1.4

* for days away cases

CY 2006 and 2007 (through July 2007)					
PGDP Organization	**Total Recordable Case Rate**		**Goal**		**OSHA Industry Standard (as of 2005)**
	2006	**2007**	**2006**	**2007**	
PRS	0.60	2.59	1.1	1.1	4.1
SST	0.00	0.00	1.1	1.1	4.7
UDS	0.46	0.92	1.1	1.1	4.1
USEC	1.36	1.67	2.0	1.80	2.5

2.2.2 Lessons Learned

2.2.2.1 USEC

For the DOE leased facilities, USEC is subject to the NRC requirement in 10 *CFR* Part 76, *Certification of Gaseous Diffusion Plants.* Subpart 76.93, "Quality Assurance," applies to NRC regulated activities and requires that USEC establish, maintain, and execute a quality assurance program satisfying each of the applicable requirements of American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1, *Quality Assurance Program Requirements for Nuclear Facilities (NQA-1),* on a graded approach that is commensurate with the importance to safety. USEC developed the *Quality Assurance Program-Paducah Gaseous Diffusion Plant* (QAP-PGDP) to address the requirements of this regulation.

The USEC Lessons Learned Program is implemented through USEC Procedure UE2-OP-RA1035, *Operational Experience Review Program* (OERP). The OERP summaries for 2005 to 2007 were provided. Board review of the items in the summaries included DOE Lessons Learned, DOE Suspect Counterfeit/Defective Items Notices, DOE Operating Experience Summaries, DOE Occurrence Reports, and DOE ES&H Bulletins among other NRC and industry sources. No specific issues with forklifts were identified in any of the summaries reviewed. This included the two Assessment Tracking Reports (ATRs) associated with findings from the forklift self-assessment conducted in November 2005, which were screened as not meeting the OERP criteria for sharing as lessons learned.

Communications of the OERP items that were deemed applicable to the USEC activities were disseminated either via e-mail for information only or through the USEC ATR system, which requires a formal evaluation. The initial dissemination was limited to those deemed directly affected or the primary organization with responsibility in the given area of the operational experience review (OER) item. Further dissemination was determined by the affected manager(s) as described in the OERP procedure.

Actions that may be taken when a lessons learned communication is determined to be applicable may include:

- Procedure revision
- Training revision
- Crew briefings
- Safety discussions

USEC provided a page from its 2004 OERP that indicated a bulletin entitled "Forklift Safety – Control the Load" was distributed within USEC (OERP 04-149). The OERP was sent as information only to functional organization managers at Portsmouth and the American Technology group.

2.2.2.2 PRS

PRS performs the remediation scope of work at the Site under contract number DE-AC30-06EW05001. PRS is subject to requirements of contract section I.129, 970.5223-1, "Integration of Environment, Safety, and Health into Work Planning and Execution (Dec. 2000)." This section requires the contractor to manage and perform work in accordance with a documented safety management system that describes, in part, how the contractor will provide feedback on adequacy of controls and continue to improve safety management. This is identified as a contract deliverable in section C.1.9.2, "Integrated Safety Management System."

The PRS Lessons Learned Program is identified in PRS-CDL-0061/R1, Integrated Safety Management System Description and Environmental Management System Description for the Paducah Environmental Remediation Project, section 4.8.2, "Lessons Learned." This section determines that lessons learned are identified and distributed as appropriate for the content of the lessons learned. The specifics of the lessons learned program are further defined in procedure BJC-PQ-1240, *Lessons Learned Program*, which was blue-sheeted during the contract transition in April 2006. This procedure assigns the general program management to the Quality Assurance Manager who interfaces with Lessons Learned Coordinators in the different organizations.

The procedure identifies that lessons learned can originate from the following sources:

- Occurrence reports
- Employee health and safety concerns
- Near miss incidents
- Post-job completion reviews
- Independent assessments
- Management assessments
- Internal operating experiences
- Readiness reviews
- Trend analysis activities
- Reviews of external operating experiences
- Issues identified per the Issues Management Program
- Generic implications review

The actions that can be taken when a lessons learned is determined to be applicable include the following:

- Incorporate in procedures or work instructions
- Incorporate in training

- Change design criteria
- Modify qualification requirements
- Modify subcontract specifications
- Issue lessons learned to communicate widely

Board members reviewed a set of data provided from the DOE Lessons Learned system, National Aeronautics and Space Administration (NASA), and from other sources. PRS also provided an Occurrence Reporting and Processing System (ORPS) summary of items with forklift in the report for Paducah from 2004 to present. The summary included eleven occurrences, including the forklift stand down and the forklift/pedestrian accident addressed by this investigation report. One of the ORPS reports also had a DOE Lessons Learned issued (B-2004-OR-BJCPAD-0601) for the incident (i.e., striking overhead lines with mobile equipment).

There was no evidence provided by PRS that a lessons learned was issued for the 2006 forklift suspension or any information from this event was communicated to USEC.

The primary form of communication of lessons learned is through an e-mail distribution and through crew briefings. Occasionally, a bulletin is prepared and distributed to staff to be discussed in tailgate or safety meetings.

2.2.2.3 SST

SST performs the infrastructure scope of work at the Site under contract number DE-AC24-05OH20178. SST is subject to requirements of contract section I.97, 952.223-71, "Integration of Environment, Safety, and Health into Work Planning and Execution (June 1997)." This section requires the contractor to manage and perform work in accordance with a documented safety management system that describes, in part, how the contractor will provide feedback on adequacy of controls and continue to improve safety management. This is identified as a contract deliverable in section C.2.V.K, "Environmental, Safety and Health (ES&H) Program," item 4, which requires SST to develop and execute an ISMS Description.

The SST Lessons Learned Program is discussed in SST.ESH-0002/R3, *Integrated Safety Management System Plan*. The discussion under core function 5, "Feedback/Improvement," indicates lessons learned will be used from external lessons learned and experiences. SST also uses formal assessment programs, performance indicators, post-job briefings, event critiques, and toolbox briefings as improvement mechanisms.

Copies of four lessons learned were supplied by SST as part of the training materials used for forklift operator training. These included lessons learned from the DOE Lessons Learned database regarding operator awareness of forklift equipment limitations, preplanning travel routes and use of spotters, securing attachments to forklift tines, and awareness of worker proximity during forklift operations.

2.2.2.4 DOE

The DOE Lessons Learned Program is defined in DOE-STD-7501-99, *The DOE Corporate Lessons Learned Program*. The DOE expectation contained in this standard is that each DOE element and each contractor tailor lessons learned activities based on the work and organizational complexity at each local level. The standard ties the lessons learned programs to the ISMS requirements contained in contracts. The effectiveness of the ISMS programs, including the Lessons Learned Program, is to be reviewed annually.

The PPPO identifies use of lessons learned in PPPO-M-413.1-1, Rev. 2, *Portsmouth/Paducah Project Office Management Plan*, section 10.3, and in PPPO-M-414.1A, Rev. 3, *Portsmouth/Paducah Project Office Quality Assurance Program Plan*. The PPPO Management Plan identifies that PPPO will implement a lessons learned program utilizing existing DOE database systems and PPPO site-specific information.

2.2.3 Corrective Actions/Issues Management

2.2.3.1 USEC

The USEC corrective actions and issues management requirements are outlined in the USEC QAP-PGDP. The Business Prioritization System (BPS) is managed by the Regulatory Affairs Manager and establishes measures that ensure significant conditions adverse to quality (SCAQ) are identified and corrected as soon as practical. Additionally, BPS requires causes be determined for SCAQ and actions taken to preclude recurrence.

The subjects of implementing procedures include: nuclear event reporting, Paducah self-assessment, corrective action process, trend analysis, and conduct of internal surveillances. The USEC program is implemented through their BPS, which allows input from any Site employee or subcontractor.

Inputs to BPS are initially the filing of an ATR, which is subsequently screened by a group of representatives from the Regulatory Affairs organization, where it is assigned a significance category and assigned to the appropriate organization(s). The level of rigor associated with the investigation of the ATR is dependent on the significance category assigned. The highest significance category, a SCAQ, requires a formal root cause determination. All assessment findings and concerns, including those from self-assessments, are formally entered into the BPS for corrective action tracking through the issuance of an ATR.

Two self-assessments were reviewed as part of the Board's investigation process. One was on powered industrial trucks (C41-SA-05-23) and one was a company-wide self-assessment of the corrective action process (C28-SA-05-04).

The powered industrial trucks (PIT) self-assessment conducted by the USEC maintenance organization in November 2005 had two findings and two recommendations. The two findings were entered into the BPS database through issuance of ATRs (ATRC-05-4574 and ATRC-05-4575). The first finding dealt with deficiencies in daily inspection and prompt reporting and correction of defects. This was considered a generic issue across the maintenance organization, and corrective actions were subsequently taken to reinforce procedural adherence and to modify the procedure to clearly flow down requirements of 29 *CFR* 1910.178 [specifically (q)(7)].

The second finding was related to unsafe operation or involvement in an accident or near misses. This finding indicated there were 14 ATRs during the previous two years involving accidents or unsafe operations. In a majority of the 14 cases, the response to the ATR did not document the required refresher training, and the refresher training being provided could not be determined from training records. A manager's response to the finding (ATRC-05-4575) provided on February 24, 2006, indicated that seven of nine of the specific ATRs reviewed did not constitute unsafe acts and, therefore, did not warrant retraining. Another manager's response to ATRC-05-4575 documented a crew briefing being conducted on safe operations of PITs.

The two recommendations also were entered into the BPS through issuance of ATRs (ATRC-05-4576 and ATRC-05-4578). The first recommendation was to clarify the need for refresher training (finding #2), to place it in only one procedure (previously in three); and to assign the responsibility for ensuring refresher training is conducted to a single entity. (Procedures had conflicting guidance on this responsibility.) The second recommendation was to clarify the requirements for chocking of wheels on cylinder hauling trailers.

The company-wide assessment of the corrective action process involved a self-assessment conducted by each organization in USEC at the Site. The individual self-assessments did not identify any findings, but identified several negative observations that were subsequently entered into BPS as ATRs. One self-assessment of note included observations that responses to raise awareness or administer discipline did not seem effective. This same self-assessment included a recommendation to implement engineering fixes to areas where there are repeat errors rather than to continually attempt to increase awareness.

Additionally, USEC provided a summary of forklift incidents from 2004 to present. The summary includes 14 incidents that were divided into five categories. The category with the most incidents (7) was mast/forklift position errors that involved striking stationary objects with a forklift or an attachment to the forklift. The second highest category involved DOE contractor incidents (4) affecting leased or common areas and systems. The other three incidents involved striking a light pole, a shift in load, and (the subject of this accident investigation) a forklift striking a pedestrian.

2.2.3.2 PRS

PRS performs environmental remediation at the Site under contract number DE-AC30-06EW05001. PRS is subject to requirements of section H.11, "Quality Assurance." This section requires the contractor to comply with the List A and B directives, which include both 10 *CFR* Part 830 Subpart A, "Quality Assurance Requirements," and DOE Order 414.1C, *Quality Assurance*.

The PRS corrective actions and issues management requirements are outlined in PRS-CDL-0058/R1, *Quality Assurance Program Plan for the Paducah Environmental Remediation Project (*PRS QAPP). The PRS QAPP identifies several implementing procedures for quality improvement and issues management. The following are the primary procedures implementing these programs:

- PRS-QAP-1210, *Issues Management Program*
- PRS-QAP-1220, *Occurrence Notification and Reporting*
- PRS-QAP-1230, *Causal Analysis*
- PRS-QAP-1460, *Event Investigations and Critiques*

PRS uses a database system called Issue and Corrective Action Tracking System (ICATS) to track issues. This system is managed by the Quality Assurance organization and has a tracking coordinator assigned to each organization who can input and maintain the issues database. Additionally, DOE reportable occurrences are reported and documented in the DOE ORPS in accordance with requirements of DOE O 231.1A, *Environment, Safety and Health Reporting*.

Three items were reviewed to evaluate the PRS self-assessment process. One item was the actions taken as part of the forklift operations suspension, one was an ISMS surveillance on forktrucks, and one was a quarterly recurring events analysis for the period of April 1, 2007, to June 30, 2007.

1. Forklift Operations Suspension

   An adverse trend in incidents involving forklifts was identified by PRS and a suspension of forklift operations was initiated on July 17, 2006 (EM—PPPO-PRS-PGDPENVRES-2006-0008). PRS had previously reported a near miss occurrence involving a forklift striking a parked truck (EM—PPPO-PRS-PGDPENVRES-2006-0007), which was one of the incidents included in the adverse trend that resulted in the suspension of forklift operations. As a result of the suspension, a full evaluation of the PRS forklift program implementing procedures, retraining, and performance evaluation of drivers was performed. A team of subject matter experts was assembled and the forklift operating procedures and training was evaluated and determined to be adequate and in full compliance with OSHA requirements. Individual training records were evaluated and performance of drivers was assessed.

   Forklift operations were resumed on a phased approach two days after the suspension was initiated. Forklift drivers involved in incidents received refresher training prior to being allowed to resume forklift operations. PRS This was incorporated into activity hazard analyses (AHAs) to work control documents. Additional actions of note included using flatbed trucks rather than forklifts for transporting large items across the Site and evaluating the need for incorporating traffic plans into work control documents for comprehensive cargo moving activities.

2. Forklift Surveillance

   PRS-2007-0038, *ISMS Functions 4 and 5 – Forktrucks*, was conducted March 27-30, 2007. This surveillance was conducted to verify the forklift program, based on PRS-ESH-2007, had been implemented and was being used by PRS field employees. The surveillance identified seven findings and one observation. The findings included the following:

   - PRS Field personnel were not aware of the issuance of the new procedure issued with an effective date of January 24, 2007.
   - The new procedure was not flowed down to subcontractors.
   - Receiving inspections were not being forwarded to Procurement, as required by the procedure.
   - The preventative maintenance system did not capture all the manufacturer recommended maintenance requirements.
   - Issuance of yellow cards for initially qualified forklift operators was not being done.
   - Issuance of green cards following a second evaluation of operator performance at least 30 days following the initial training was not being done.
   - The Front Line Supervisor was not updating the maintenance history file following completion of any maintenance activity.

   The observation involved inconsistent documentation of daily forklift inspections due to unclear guidance in the procedure. There were no documented deficiencies in the actual performance of the daily inspections, only in the forms being used to document the inspections.

3. Quarterly Trending Analysis

   The *Quarterly Trend Analysis Report for April 1, 2007 through June 30, 2007,* dated August 21, 2007, was reviewed. This review included inputs from occurrence reports and ICATS items looking back at trends for the past 12 months. The review indicated the overall number of initial event reports was decreased and the number of observations from management assessments

and walkthroughs has increased. Overall, the number of events that occurred dropped, which was a favorable trend. The report identified the following two opportunities for improvement:

- Stressing awareness of personnel to changed conditions to reduce human performance errors.
- Continuing to support reporting of safety and contamination events.

2.2.3.3 SST

SST performs the infrastructure activities at the Site under contract number DE-AC24-05OH20178. SST is subject to requirements of section H.11, "Quality Assurance." This section requires the contractor to comply with the requirements of NQA-1 unless otherwise specified in the contract. Section J, Attachment B(2), deliverable number 54 requires the *Quality Assurance Plan* be developed to implement the requirements of both 10 *CFR* 830 Subpart A, "Quality Assurance Requirements," and DOE O 414.1C, *Quality Assurance*.

The SST corrective actions and issues management requirements are outlined in SST.QA-0001/R2, *Quality Assurance Plan* (SST QAP). The SST QAP incorporates a single problem identification and corrective action control system based on DOE G 414.1-5, *Corrective Action Program Guide*. The following are the primary procedures implementing these programs:

- SST Procedure 5.4.1, *Issues Management Program*
- SST Procedure 5.4.2, *Corrective Action Program*

SST uses a database system called Corrective Action Tracking System (CATS) to track issues. This system is managed by the Quality Assurance organization. Corrective actions are assigned to a functional manager and are assigned significance category and reviewed for additional reportability (e.g., ORPS).

The SST Corrective Action Program includes the following elements:

- Problem identification/extent of problem determinations.
- Problem significance determination.
- Extent of problem/extent of condition evaluation
  - Effectiveness reviews of those corrective actions implemented to prevent recurrence.

Additionally, any condition determined to be a DOE reportable occurrence is reported and documented in ORPS in accordance with requirements of DOE O 231.1A, *Environment, Safety and Health Reporting*.

As the result of the PRS suspension of forklift operations on July 17, 2006, SST initiated a self-assessment entitled *Forklift and Heavy Equipment Use Assessment*, which was completed on July 27, 2006. The assessment included a review of controls, programs, procedures, AHA, training, oversight, and general use of forklifts and other heavy equipment. The results of the assessment concluded that the programs in place were thorough and training was sufficient; however, improvements were identified to further strengthen performance. Only opportunities for improvement were identified with no findings or programmatic weaknesses.

The Board reviewed SST quarterly performance analyses – one for the period of April 1, 2006, to March 30, 2007, and the second from July 1, 2006, to June 30, 2007. SST has had no reportable occurrences since the start of its contract, so the evaluation primarily includes nonreportable incidents or problems

from self-assessments. The performance analysis did highlight three incidents of note for the periods covered – one was a naturally occurring radioactive event and the others were instances of hazardous material spills.

2.2.3.4 DOE

The primary system used by PPPO for tracking corrective actions associated with safety issues is the ORPS database. The PPPO Paducah FacRep has authority for approval for all PRS, SST, and UDS occurrences at Paducah. The PPPO Paducah FacRep reviews and approves or rejects contractor significance category 2 or R reports in accordance with DOE O 231.1A, *Environment, Safety and Health Reporting*. Additionally, the PPPO Paducah FacRep reviews and comments on significance category 3 occurrences in accordance with the July 5, 2006, guidance from Dr. Ines R. Triay entitled *Occurrence Reporting Categorization and Review*.

A DOE Type B Accident Investigation of a drum explosion at Paducah in 1997 identified two JONs that applied to DOE: 1) "DOE needs to track and trend information from the occurrence reporting and lessons learned systems…" and 2) "DOE needs to develop a comprehensive assessment program for the Paducah Gaseous Diffusion Plant." The Board was unable to identify what corrective actions had been taken by DOE for the first JON, which was assigned to the Oak Ridge Operations (ORO) Quality Management Systems Team, Director of Technical Support Division for closure. The second JON was addressed by the Paducah Site Office by development of an implementation schedule, and implementation was deferred pending an assessment of the applicability of such assessments under the Management and Integration Contract and the qualification of a FacRep. The assessment schedule was implemented following the FacRep qualification in 2002.

An assessment of the Site by DOE-Office of ES&H was conducted in October 1999. The assessment concluded, in part, that: 1) Safety and Health procedures were not consistently applied and followed and, in some cases, hazards were not adequately addressed by those procedures and 2) DOE and BJC had not conducted effective oversight of ES&H or effectively implemented all DOE and regulatory requirements. The Board was unable to determine what corrective actions were taken to correct these findings at the time of this report.

2.2.4 Employee Concerns

2.2.4.1 USEC Program

USEC is subject to the NRC requirement in10 *CFR* Part 76, Subpart 76.7, "Employee Protection," that prohibits discrimination against employees for engaging in certain protected activities in NRC regulated leased portions of the Site. These activities include protection from retaliation for identifying safety concerns.

The USEC procedure for implementation of 10 *CFR* 76.7 is UE2-HR-EO1035, *Employee Concerns*, Rev. 4. The purpose of the procedure is to provide an alternate path for USEC employees and contractors to express concerns in a manner to ensure they are appropriately addressed and can still protect individual privacy. The intent of this system is to allow concerns, safety or other, to be addressed should the existing plant issues and corrective action management systems fail to produce an adequate response in the view of the complainant. The concerns can be classified as Nuclear Safety; Harassment, Intimidation, Retaliation or Discrimination; Wrongdoing; Chilling Effect; Industrial Safety; Security; Management Concerns; or Ethics Concerns. The program is administered by the Employee Concerns (EC) Manager who reports directly to the USEC General Manager.

The only information provided to the Board upon request for a summary of all employee concerns for the past three years was an e-mail from the EC Manager that there were 48 employee concerns received in the past two years, and none involved forklifts or traffic safety. USEC employees interviewed were aware of the program. Several USEC employees interviewed displayed and/or expressed discomfort about raising safety concerns, and some indicated having had safety concerns that they did not report.

2.2.4.2 PRS Program

PRS is subject to requirements of contract section I.108, 952.203-70, "Whistleblower Protection for Contractor Employees" (December 2000). This section requires PRS to comply with the provisions of 10 *CFR* Part 708, *DOE Contractor Employee Protection Program.*

The PRS procedure that implements 10 *CFR* Part 708 is PRS-HMR-1000, "Employee Concerns Program." The program has been established for PRS employees to use in communicating and resolving concerns in areas of ES&H, security, Equal Employment Opportunity/Affirmative Action, harassment, ethics, and other issues. The program is administered by the Human Resources Manager.

Any concern can be flagged if it is an immediate concern, a recurring concern, or a unique circumstance. Additionally, the forms provide guidance to immediately report any condition determined by the complainant to be an imminent danger directly to his/her supervisor or to the PSS.

Information regarding employee concerns for the past two years was provided and showed an implemented program and database. PRS employees interviewed were aware of the program and no concerns were expressed related to raising safety concerns.

2.2.4.3 SST Program

SST is subject to requirements of contract section I.90 952.223-71 952.203-70 "Whistleblower Protection for Contractor Employees" (December 2000). This section requires SST to comply with provision of 10 *CFR* Part 708, *DOE Contractor Employee Protection Program.*

There are two separate procedures for addressing employee concerns for SST. SST Procedure 3.1.5/R0, *Employee ES&H Concerns Procedure*, is for SST employees to use in communicating and resolving concerns in areas of ES&H, and SST document SST.HR.0006, *Employee Concerns Program*, is for security, Equal Employment Opportunity, Affirmative Action, ethics, harassment, and other issues.

The SST procedure for reporting ES&H concerns allows the worker to input directly into the system by completing a paper form and submitting it to the supervisor, placing it in a designated drop box, or sending it directly to the SST ES&H Manager. The ES&H Manager and staff are directly responsible for ensuring concern forms are readily available and concerns are logged and tracked to resolution.

A review of the SST employee ES&H concerns was submitted as part of this incident. One of the issues raised involved unsafe forklift operations by another DOE contractor on-site. SST employees interviewed were aware of the program, and no concerns were expressed related to raising safety issues.

2.2.5 Traffic Safety

2.2.5.1 Training

Each organization for the Site has general safety programs in place, which include Health and Safety Plans and implementing procedures relative to safety. Vehicle and pedestrian safety is addressed in

general terms by each organization. There is no site-wide agreement of concepts that are relevant to this accident specifically for the term "right-of-way" and pedestrian versus vehicle safe performance expectations. The site-wide General Employee Training (GET) programs and documents, including DOE and USEC, address the concepts of pedestrian and vehicle safety, use of crosswalks, and right-of-way. The training materials referenced in Table 2.2.5-1 have been in place for years and remain essentially unchanged through the shifts from various regulating agencies, through various DOE contractor changes, changes in regulatory emphasis and oversight, changes in Site mission, and through the changes in upper level management expectations within the various affected organizations.

The pedestrian stated that she received GET training and read the Visitor's Site Access Orientation Handbook (VSAOH).

All organizations on-site accept a valid driver's license to operate a vehicle on-site.

2.2.5.2 Traffic Safety Control Measures

Traffic control devices at the Site consist of signs and warning lights to indicate intersections that require vehicles to stop or yield. Signs also are present that indicate access controls, directional controls, speed limits, specific area hazards, and specific precautions to take. The vehicle traffic signs and warnings were adopted by USEC as found and prior to the lease and since then have been maintained by USEC. USEC has added new controls and improved existing controls in critical areas.

As noted in Figure 1.1-1, the primary vehicular traffic control device at the time of the accident was a yield sign located south on 8th Street prior to the pedestrian sidewalk and approximately 30 feet from the intersection. There is no marked pedestrian crosswalk at the intersection where the accident occurred. Since the accident, USEC has relocated the sign to a position near the intersection of Tennessee Avenue and 8th Street and has changed the sign to a stop sign.

Pedestrian controls for safe walking at the Site consists primarily of sidewalks, crosswalks, and occasional signs to indicate areas with specific hazard concerns or restrictions for access. Some intersections near the more congested locations of the Site have crosswalks marked to enable safer pedestrian use. Other intersections farther from the congested locations of the Site do not have marked crosswalks; some have established sidewalks either at the intersections or nearby.

The intersection involved in the accident does not have a marked crosswalk at the actual intersection where the pedestrian was walking. A pedestrian sidewalk terminates at each side of 8^{th} Street approximately 30 feet south of the intersection and also does not have a pedestrian crosswalk marked. As noted in section 1.1, these sidewalks are not convenient for use by pedestrians.

Two traffic violation citations (tickets) were issued by USEC Site Protective Force (Shift Commander) to the USEC forklift driver and the PRS pedestrian. The forklift driver was cited for "careless driving, resulting in accident" as defined in *Kentucky Revised Statutes* (*KRS*) 189.290. The pedestrian was cited for "failed to yield" as defined in *KRS* 189.570 (6) (a). No additional citations by Site protective forces or other state or federal agencies are known to have occurred.

The Shift Commander who issued the citation to the pedestrian indicated that USEC procedures require issuing a citation in the event of a traffic accident if assignment of blame can be determined by the security investigation. The Shift Commander stated that he had probably not previously issued a citation to a pedestrian. He was not aware of whether a citation had been issued to a pedestrian by others. The

Table 2.2.5-1 Training Summary Related to Traffic Safety

This table summarizes the site-wide training that was in place at the Site regarding pedestrian and vehicle safety over the past eight years

Training Document	Vehicle/Pedestrian Pertinent Content
General Employee Training (GET), May 14, 1999 (GET Reference Guide No. 308.01.02-RG, Rev. 0), required for USEC employees getting access to the Site.	The section on traffic safety in this document was minimal in content. There were no instructions relative to pedestrian safety or crosswalks. One paragraph is included which reads, "Exercise caution around cylinder handlers/haulers. These transports have ABSOLUTE right-of-way at all times. Due to the large size of these transports, the cylinder handler's visibility is limited, and the driver cannot quickly stop the machinery." No additional USEC-type supplemental instructions or training information was utilized at that time.
PGDP Visitors Orientation Handbook (308.01HP, Rev. 2, approved August 13, 1999). Note: BJC required its workers and visitors to take Training Module No. 23688 as well as Module No. 21221. Module 23688 was the PGDP Visitor's Orientation Handbook, which contained emergency instructions and traffic rules.	The section on vehicles states that "pedestrians have the right-of-way and must cross in designated crosswalks. Vehicles must stop and allow them to cross."
ETTP Park Workers Training for BJC workers at ORR, PORTS, and PGDP. Training Module 21221, approved February 24, 1999.	The general training had to be completed plus the PGDP Visitor's Orientation Handbook had to be read. The guidance provided to the workers stated: "Always allow pedestrians and heavy equipment (e.g., cylinder handlers) the right-of-way. When walking you should use crosswalks. Never block sidewalks, driveways, loading zones, or driving lanes. While driving be aware that workers driving heavy equipment may not be able to see you in a smaller vehicle, on a bike or on foot." Note: While this training was stand alone at ORR, additional training was necessary for BJC workers to access the other two sites. At PGDP, this additional training was to read the PGDP Visitor's Orientation Handbook. Guidance on right-of-way in the additional training required for access to PGDP was different than the guidance on right-of-way in the multi-site training module.

Training Document	Vehicle/Pedestrian Pertinent Content
DOE PGDP GET Site Specific Self-Study Guide, GP101SS, Rev. 4, dated 5/30/02.	Contains no discussion relative to traffic safety, pedestrians, or right-of-way. Note: This is only a study guide.
DOE Paducah General Employee Training (GET), (a.k.a. Paducah Worker Training) Version conveyed to in-coming new contractors May, 2005.	The General Employee Training (GET) for the PGDP discusses pedestrian right-of-way in two sections (for PGDP and PORTS): 1. Under "Site Driving Requirements," subsection "Drivers Must," it says: "Yield at all crossings for pedestrians." 2. Under "Traffic Safety," subsection "Right-of- Way," it says: "Always allow pedestrians and heavy equipment (e.g., cylinder haulers) the right-of-way. When walking, you should use crosswalks. Never block sidewalks, driveways, loading zones, or driving lanes. While driving, be aware that workers driving heavy equipment may not be able to see you in a smaller vehicle, on a bike, or on foot. Yield to cylinder haulers."
USEC Visitor's Site Access Orientation Handbook, no document number, effective date October 19, 2005.	States under "Vehicular Safety": "Pedestrians have the right-of-way in designated crosswalks."
USEC Visitor's Site Access Orientation Handbook, no document number, effective date June 2, 2006.	States under "Vehicular Safety": "Pedestrians have the right-of-way in designated crosswalks." Note: No change from previous version.
DOE current GET Training Program as effective on August 8, 2007.	The General Employee Training (GET)for the PGDP discusses pedestrian right-of-way in two sections: 1. Under "Site Driving Requirements", subsection "Drivers Must" it says: "Yield at all crossings for pedestrians." 2. Under "Traffic Safety", subsection "Right-of- Way," it says: "Always allow pedestrians and heavy equipment (e.g., cylinder haulers) the right-of-way. When walking, you should use crosswalks. Never block sidewalks, driveways, loading zones, or driving lanes. While driving, be aware that workers driving heavy equipment may not be able to see you in a smaller vehicle, on a bike, or on foot. Yield to cylinder haulers."

Training Document	Vehicle/Pedestrian Pertinent Content
USEC Health and Safety Information Bulletin, Memo # 07-01, dated August 9, 2007.	States in part: • "Vehicle operators approaching an oncoming cylinder hauler must stop and pull over to one side, slow forward progress to a bare minimum, or take an alternate route due to the large size of the cylinder and cylinder handler and the potential hazard represented by an accident." • "Pedestrians have the right-of-way in designated crosswalks. Designated crosswalks were established in 1991 and are located at various locations between C-300 and C-720 primarily on Ohio Avenue. Heavy equipment or vehicles over 1-ton should avoid this area if possible. Although pedestrians have the right-of-way in these limited areas, they should always enter the crosswalk with caution." • "Recreational walking on plant roads within the plant site was suspended on July 16, 2007. This prohibition is still in effect. Riding bicycles for exercise also is not allowed. Health and Safety personnel will work with the other contractors on-site to evaluate if safe areas can be established for recreational walking and cycling." • "We are all responsible for our own safety. Exercising caution and being aware of our surroundings when operating mobile equipment or when walking within the plant area are a must to ensure everyone's safety. Please ensure you follow the rules of the road."

Shift Commander stated that he has observed other pedestrians jaywalking. He was unaware of other citations for jaywalking. Citations are provided to the employee's supervisor and can be used for disciplinary action.

In July 2001, USEC issued Information Bulletin number 01-24 entitled, "Jogging on Plant Site." This information bulletin:

- States there is no specific policy or procedure that states "No Jogging" on plant site.
- There are inherent risks associated with running that could lead to an accident.
- Security Officers are required to jog/run to maintain fitness.
- Security Officers should be the only ones participating in jogging/running.
- Vehicle traffic has increased and creates additional risk to pedestrians.
- Staying physically fit is important, but USEC does not want employees to get hurt on the job.
- The C-720 truck alley is sometimes used for walking and is considered by USEC to be an acceptable risk.

2.2.6 Forklift Training and Qualification

2.2.6.1 DOE Requirements for Forklift Operations

At the time of the incident, DOE's primary standard for forklift operations was the *DOE Standard Hoisting and Rigging* (formerly, Hoisting and Rigging Manual), DOE-STD-1090-2004. The DOE standard closely parallels the OSHA standards for forklift operation, but provides more prescriptive details on implementation than contained within the OSHA requirements. The two chapters of the DOE standard specifically applicable to forklifts are Chapter 10, "Forklift Trucks," and Chapter 6, "Personnel Qualification and Training." Chapter 10 specifies operation, inspection, testing, and maintenance requirements for forklift trucks powered by internal-combustion engines or electric motors and implements the requirements of appropriate standards. Chapter 10, section 10.1.1, establishes the requirement that operators of forklift trucks shall be trained and qualified as described in Chapter 6, "Personnel Qualification and Training."

2.2.6.2 OSHA Forklift Regulations

Effective March 1999, OSHA released new regulations that required compliance by December 1, 1999, on PIT operator training.

Under OSHA regulations prior to December 1, 1999, OSHA did not prescribe detailed elements for power industrial truck training programs. This approach was viewed as contributing to more than 80 deaths each year due to industrial truck accidents.

OSHA concluded that allowing an untrained or poorly trained employee to use a PIT poses significant risks, both to the operator and to other workers in the vicinity of the truck. To protect employees from those risks, OSHA deemed it necessary to require that only properly trained employees operate these vehicles. Under the regulations promulgated in 1999, all industrial truck operators in all industries were included in OSHA Standard 29 *CFR* Part 1910.178.

2.2.6.3 USEC Training and Qualifications

29 *CFR* Part 1910.178 requires the training, evaluation, and certification of operators that drive mobile industrial equipment. USEC has developed training modules and a procedure to formalize the training and certification process and to establish requirements for candidates completing the certification process. In addition, the procedures define the roles and responsibilities of organizations and individuals in the certification process.

USEC management at the Site is responsible for the selection of candidates for initial certification. USEC managers must complete Form CP-20331, "Request for Addition/Deletion to Mobile Industrial Equipment Operator Program." Once selected, the candidate must undergo a medical exam in accordance with guidelines established in Appendix A of Procedure CP2-TR-QP1030, *Mobile Industrial Certification Equipment Operator Certification*. The medical evaluation of candidates must take into account the equipment and condition under which it is operated.

In addition to the successful completion of the medical exam for initial certification, the candidate, in order to maintain certification, also must pass assessments made during routine physical examinations, injury or illness examination, or return-to-work examinations to ensure fitness for operating forklifts.

Upon notification of medical certification, the Plant Training organization administers a training program for the initial certification process. The training program consists of classroom instruction followed by a practical demonstration evaluated by an instructor from the Training Division. The classroom instruction uses a training module for PITs developed by USEC subject matter experts and approved for use by their technical and training management. In order to receive the initial certification, the candidate must successfully demonstrate his understanding of the classroom instruction by passing a written examination and by a successful demonstration of a physical ability to safely operate a forklift. Procedure CP2-TR-QP1030 provides a guide for conducting practical training evaluations and a forklift evaluation checklist including criteria. Plant Training provides a remedial training program for those individuals who receive unsatisfactory scores on classroom training module examinations or practical evaluations.

Upon successful completion of training, Plant Training issues a Mobile Industrial Equipment Operators Certification card certifying that the operator has been trained and evaluated as required by 29 *CFR* 1910.178. The certification card for all individuals trained after 12-1-1999 includes the following information:

- Name of the Operator
- Date of the training
- Date of the evaluation
- Identity of the person(s) performing the training

Individual training records are maintained in a data tracking system maintained by Plant Training.

Each forklift operator must be recertified every 3 years. Plant Training provides notification of approaching certification expirations 60 days before the expiration date. Medical notifies the group manager, first line manager, and Training of Medical Qualification status. Recertification without any outstanding concerns does not require the completion of classroom training and may be completed by a USEC subject matter expert or by a manager who was previously certified to operate a forklift and currently supervises personnel who use forklifts or directly interacts with personnel who use the equipment. Recertification is accomplished by completing a practical demonstration, which is

documented by the evaluator using "Forklift Evaluation Checklist" CP-23023. When all the requirements are met, Plant Training recertifies the forklift operator for another 3 years.

There are conditions where a forklift operator can have his/her certification revoked or suspended by Plant Training. These conditions include the following:

- Failure to meet mental or physical requirements.
- Deletion from the program by use of CP-20331.
- Failure to complete or attend required training.
- Failure of a performance safety evaluation.
- Failure to perform to safe acceptable standards.
- If deemed necessary by the group manager in the event of revocation of state's driver's license and any event that requires refresher training or involvement in a forklift accident or near miss incident.

Refresher training is required if the operator has been observed to operate the vehicle in an unsafe manner; the operator has been involved in an accident or near miss incident; the operator has received an evaluation that reveals that the operator is not operating the mobile industrial equipment safely; the operator is assigned to a different type of forklift; or a condition in the workplace changes in a manner that could affect safe operation of the forklift. The requirements for refresher training are consistent with OSHA and DOE requirements. Following refresher training, recertification is completed by the normal recertification process.

At the time this report was published, the Board was able to verify only one recertification of the driver. On September 25, 2006, the driver was recertified to drive a roll-off truck following the September 21, 2006, Gradall incident discussed in section 2.6.6.1.

USEC discontinued Commercial Driver's License (CDL) certification in 2002 due to the fact that it is not required by DOT regulations within the Site and was only in effect for a small number of USEC workers.

2.2.7 Forklift Operator Medical Fitness

As discussed in section 2.2.6, a candidate selected to operate PIT must undergo a medical exam in accordance with guidelines established in Appendix A of Procedure CP2-TR-QP1030, *Mobile Industrial Certification Equipment Operator Certification*, to determine medical fitness for operating powered industrial equipment (note: includes physical as well as mental fitness). This includes:

- Vision
- Hearing
- Function of extremities
- Significant mental disorders, including signs of aberrant behavior and other conditions that could impair judgment

2.3 FORKLIFT FACTS

The forklift involved in this incident is a Linde Forklift Model H25 with a diesel engine. The forklift was purchased new and placed in service at the Site on March 28, 2005, following an acceptance and readiness inspection. A picture of the right side of the forklift is shown in Figure 2.3-1 on page 2-26.

The USEC front line manager indicated that Black Equipment provided basic training and orientation to USEC personnel for Linde forklift operation at the time of delivery. The Linde operating instructions, in addition to providing specifications, maintenance, and operating instructions, includes safety tips. Several safety tips pertinent to this investigation were extracted from the operating instructions and included below:

1. "The employer shall ensure that each powered industrial truck operator is competent to operate a powered industrial truck safely, as demonstrated, by the successful completion of the training and evaluation specified in" the OSHAct.
2. "Watch out for pedestrians. Always yield the right-of-way to pedestrians."
3. "If your vision is restricted, then operate the truck in reverse."

Figure 2.3-1. Forklift Involved in the Accident

2.3.1 Forklift Specifications and Control Features

The operator's seat for the forklift has seven adjustments: 1) horizontal adjustment, 2) backrest adjustment, 3) driver's weight adjustment, 4) lumbar support adjustment, 5) backrest extension adjustment, 6) seat angle of tilt, and 7) armrest adjustment. The seat does not swivel to facilitate operating the forklift in reverse. In addition, the steering column has two adjustments – a tilt adjustment and a height adjustment. Seat belts and a roll cage are provided to ensure operator safety in the event of tilt or turn over.

The Linde forklift is equipped with a 4-cylinder, 4-stroke diesel engine. The forklift travel control consists of a double pedal ergonomic arrangement, which has become common in the later models of

power industrial trucks, with one pedal to go forward and a separate pedal to go backward. The forklift data considered most pertinent to the incident under investigation is summarized below:

- Axis Load front without load ..... 3,706 pounds
- Axis Load rear without load ..... 3,512 pounds
- Maximum speed (load independent) ..... (~13 miles per hour)
- Ground clearance ..... 5.15 inches
- Mean noise level at the driver's ear ..... 76 + 4 decibels
- Sound level at driver's place while driving ..... 83 + 4 decibels
- Acoustic power level while driving ..... 98 + 2 decibels

Since the nitrogen dewars being transported by the forklift at the time of the incident were mostly empty, the forklift's axis load distribution would most likely resemble that of an empty forklift.

2.3.2 Forklift Visibility

The forklift involved in this incident possessed features with the potential to impair operator visibility. The roll cage of the forklift is supported by substantial posts on either side of the front windshield with the potential to create a blind spot. The wiper blade rests, when not in use, near the right side of the forklift windshield near the roll cage post adding to the width of the blind spot. It also has black plastic doors with plastic see through windows. The black plastic boundary around the window also increases the blind spot associated with the roll cage posts. A clipboard near the right post also can limit visibility.

Measurements were taken to determine the extent of the blind spots created by the roll cage and the black plastic doors. The width of the roll cage post was approximately 4 inches. The black, plastic boundary around the window next to the post was approximately 4.5 inches. Including the obstruction to view added by the windshield wiper, the total obstruction was estimated to be approximately 8 inches (see Figure 2.3-2). In this view, the driver's seat is almost entirely obscured.

Figure 2.3-2. Linde Forklift Depicting Field of View Impairment

The forklift mast when tilted backwards decreases the width of the window of visibility between the mast and the windshield support column, window frame, and windshield wiper. A photo of the right side of the forklift was taken to demonstrate the full extent of the blind spot created by the combination of the roll cage post, door, windshield, wiper, and clipboard. Related photos are shown in Figures 2.3-3 through 2.3-5. In Figure 2.3-3, there was an individual standing approximately 10 feet away who could not be seen by the driver.

Figure 2.3-3. Inside the Forklift Cab Showing Field of View Impairment From the Windshield Wiper, the Post, and Door Frame

Figure 2.3-4. Front View of Forklift Showing Mast Pillars and Roll Cage Post

Figure 2.3-5. View in the Direction of Travel, Obscured by the Dewars and Mast Pillars

2.4 PHYSICAL EVIDENCE FROM THE SCENE

Except for photographs taken at the scene, there was no physical evidence beside the pedestrian's clothes, which were provided by her husband. The Board examined the clothes and shoes the pedestrian was wearing at the time of the accident. The pedestrian was wearing a tan or beige and white checkered top, denim jeans, and walking shoes. The jeans had a small tear in the upper thigh area (about 3 inches in length) and rust marks on both the upper and lower sections of the back of the left leg. (See Figure 2.4-1.) There were also two tears or rips in the crotch area. (The Board did not observe any other noticeable marks on the jeans.) There was no damage or marks evident on the top. There were prominent black scuff marks on the toe and the interior side of the left shoe. Both shoes were tied in a double knot and did not have any noticeable wear or damage. (See Figure 2.4-2.)

2.5 PEDESTRIAN BACKGROUND

Because there were no eyewitnesses to the actual impact between the forklift and the pedestrian, the Board attempted to determine if there were any mental, perceptive, or physical conditions that could have affected/impaired the pedestrian's abilities to perceive the hazards in her environment. Information summarized below came from interviews of the driver and pedestrian, co-workers, supervisors, witnesses, Site Director of Medical Services, and reviews of professional publications. The pedestrian had no file and no recorded visits to the Site medical center, other than immediately after the accident. The Board requested but was unable to obtain medical records for the pedestrian.

Figure 2.4-1. Pedestrian's Pants Showing Rust Marks on Left Leg

Figure 2.4-2. Pedestrian's Shoes Showing Black Scuff Marks on Left Shoe

2.5.1 Employment History

The pedestrian is currently employed by Energy*Solutions*, a subcontractor to PRS. The pedestrian has been employed at the Site since March 2001. The pedestrian was reported as being reserved, quiet, and "laid back." Her daily schedule included a 6:30 a.m. morning meeting with supervisor and co-workers to

discuss safety matters, daily work assignments, other group issues, and a lunch break from 10:30 to 11 a.m.

On the day of the accident, her supervisor and co-workers reported that the pedestrian appeared to be normal, and there was nothing unusual or abnormal about her behavior throughout the morning when they met with and spoke with her during the course of their work.

2.5.2 Mental Stress Factors for the Pedestrian

Two interviews of the pedestrian, a separate interview with her husband, and interviews with her close co-workers and supervisor, did not yield any evidence of work deadlines, marital strife, co-worker strife, illnesses, or any other obvious issues that could have affected the pedestrian immediately preceding the accident.

The pedestrian immediately stated at the scene that the forklift ran over her and that she never saw the forklift. Immediate responders to the scene, including the medical emergency responders, noted that she was lucid, aware of her surroundings, and aware of what had happened to her. Regarding her overall state-of-mind just prior to the accident, the only information she was able to provide of unique nature was that three days previously she had just returned from a very pleasant week vacation with her husband and was still wishing she were on vacation. She also stated that as a part of her walk routine, she tries to "clear her mind" of stresses and concerns because it is her time to relax. Although she normally walks with at least one, and often two, close friends/co-workers, neither was available to walk that day so she was walking alone. This situation did not cause her any irritation, stress, or other unusual mental state. She was not facing any imminent work production deadlines. She does not carry a personal cell phone with her on-site, and her work cell phone was found still clipped to her belt at the accident scene. A review of her work cell phone and phone records showed no calls to her or from her at any time on the day of the accident, nor for any previous days until just prior to her vacation.

2.5.3 Physical Stress Factors for the Pedestrian

The pedestrian was 52 years old and 5 feet 1 inch tall at the time of the accident and routinely walked for exercise, both at work and on a treadmill at home. She reported no physical injuries to her feet, knees, or legs that could have somehow impaired her walking on that day. In fact, both as self-reported and as reported and demonstrated by her co-walkers, she walked at a fast pace finishing approximately 1.8 miles in roughly 30 minutes. She had undergone a hearing test and vision test within less than a month before the accident and both were normal, as reported by the pedestrian. She did not have corrected vision, except for prescription reading glasses, and no hearing aids. She reported no eye conditions or diseases that would have contributed to degeneration of her peripheral vision. There were no visual obstructions to block her view of 8th Street as she approached the intersection.

2.5.4 Prescription Medications Taken by the Pedestrian

The pedestrian reported taking two prescription medications, and no other medication, on the day of the accident. (See Appendix C for additional details.)

2.5.5 Apparent Safety Consciousness of the Pedestrian

The pedestrian said she was aware of the overall Site rules regarding pedestrians, which she understood to be that pedestrians have the right-of-way and which she said she had seen in the site-wide daily employee newsletter called *InsideP*. Co-workers described her as a very conscientious person. Her tennis shoes recovered from the accident scene were both still tied in a double knot and, other than obvious marks

from the accident, were in good used condition and showed no separated soles or other tripping hazards. When the accident occurred, she was wearing a pair of polarized Solar-brand sunglasses, the frames of which were recovered from the accident scene. Although the one lens was also at the accident scene and photographed, no one was able to find it for study by the Board. Using the Internet, the Board was able to get a picture of the same sunglasses with the lenses and determined that the wrap-around lenses provided protection from the sun without affecting her peripheral vision. During her second interview, she was asked if she had ever noticed that the glasses caused her any visual obstructions due to possible glare, reflections from light on the inside of the lenses, or other vision problems. She said she had never noticed anything, which is why she wore them regularly.

2.6 DRIVER BACKGROUND

As with the pedestrian, the Board attempted to determine if there were any mental, perceptive, or physical conditions that could have affected/impaired the driver's ability to perceive the hazards in her environment. Information summarized below came from three interviews with the driver and interviews with the pedestrian, several co-workers, witnesses at the scene, supervisors, Union representatives, the USEC Medical Services Director, and reviews of professional medical publications, as well as from documents USEC provided to the Board, which included training, personnel, medical records, and personal notes. The driver had an extensive Site medical file, the contents of which were obtained from the Director of the USEC Medical Services after obtaining her full release to discuss her conditions and medical files.

2.6.1 Employment History

The driver was employed by USEC and had been employed at the Site since June 1994. In February 1995, she worked as an escort for uncleared employees and visitors. In July 1995, she took a position as a Laborer, responsible for performing various work including mowing lawns and moving equipment. In May 1995, she took a position as a Lubricator, responsible for performing preventive maintenance on a wide variety of equipment, including plant equipment, vehicles, etc. Following a union strike, she returned to being a Laborer in June 2003. In July 2003, she bid on and accepted a position as a truck driver. In this position, she was responsible for driving a variety of mobile equipment and PITs, including busses, water trucks, trash dumpster trucks, tractors, dump trucks, forklifts, Roll-on/Roll-off trucks, etc.

The driver's daily schedule consisted of reporting to work at 6:00 a.m. and driving a bus to transport arriving employees to their various job locations around the Site. The garage group held a morning meeting at 7:00 a.m., with all employees that included a daily safety briefing, recent events of interest, safety statistics, work assignments for the day, and other matters of concern raised by employees. Her supervisor normally conducted this meeting with all members of the group present. The supervised employees in the group consisted of two truck drivers, four mechanics, and a lubricator. The employees were allowed a mid-morning break at about 8:30 a.m. and an afternoon break at about 1:30 p.m. Lunch break was scheduled from 11:00 to 11:30 a.m. Her workweek consisted of 9.1 hours per day, Monday through Friday, which included 1.1 hours of scheduled overtime each day.

The driver's supervisor and/or co-workers reported that she

- Was a hard worker, always looking for something to do.
- Frequently cleaned and straightened commonly used areas, such as the break room, to keep busy.
- Seemed to be a good driver.

- Was observed driving inappropriately.
- Would not allow anything to stand in the way of completing a job.
- Was an independent person who was sometimes resistant to offered assistance or suggestions/advice.
- Had a lot of health problems and often had a plastic bag of prescription medications with her at work.
- Took copious notes in a personal notebook and on other pieces of paper.
- Routinely took breaks, ate lunch with her boyfriend, and had frequent contact with him throughout the day.

A single co-worker stated that, in his opinion, she did not have the ability to comprehend the capability of the equipment she drives and was not capable of safely operating the equipment.

Several co-workers stated they had observed her taking medications while at work.

Her supervisor also reported that he tried to monitor her performance as a driver, that she seemed to be a careful driver, and that he had not observed any problems in her driving performance. He also reported that he split his time between observing the mechanics and the truck drivers and that he observed the mechanics more because they were in the shop. He noted that he doesn't get out to observe the drivers as much as he should.

2.6.2 Mental Stress Factors for the Driver

The driver reported that she had no personal or family problems prior to the accident. She reported no concerns or worries about family or personal matters that could have affected her behavior on the day of the accident.

Although the driver stated that she was under no stress on the morning prior to the accident, she indicated several regular conditions in the workplace that caused her stress, which were likely to have been present on the day of the accident. The Director of Medical Services stated the driver took three months of leave between October 1, 2006, and January 2, 2007, to have carpel tunnel surgery and treatment for "nerves." The Director of Medical Services stated that he assumed that "nerves" was of an emotional nature. This leave was shortly after she had been involved in three separate accident/incidents within a period of two weeks during September 2006.

Potential workplace stressors include the following:

- The driver indicated that she had a previous, unsuccessful sexual harassment claim, involving alleged physical contact and subsequent litigation involving another USEC employee in 2004. The driver stated that her work conditions were such that she had to see the alleged harasser routinely. The driver stated that she was very uncomfortable about the possibility of these interactions and that she has a habit of looking for his truck.
- A hostile relationship with a co-worker existed, originally arising from perceived rivalry between driver and co-worker over the driver's boyfriend, another USEC employee. This resulted in a tense and complicated work environment.
- Driver's ongoing and imminent divorce, which was described as very stressful both by the driver and by her co-workers.
- The driver saw her boyfriend at work on a regular basis, taking breaks and eating lunch with him.
- The driver reported experiencing pain and discomfort on the job while driving the forklift due to back surgery and a degenerative back condition, carpel tunnel surgery, and neck injury. Although the

driver specifically referred to her constant pain, she was taking pain-relieving medication, which according to the USEC Director of Medical Services was substantial. (See Appendix D for details.)

- As stated by the driver and co-workers, she had the habit of writing notes on a regular basis at work, not as part of her work duties, but instead as personal notes regarding work issues and other subjects.
- She indicated that on the day of the accident she was getting ready to celebrate her father's birthday and go to the lake for the weekend. Other co-workers reported that prior to the accident, at around 10:00 a.m. that morning, they observed the driver sitting in her forklift writing something for almost 20 to 25 minutes. In her first interview, the driver described her activities just prior to driving the forklift and the accident as working around the shop cleaning up. However, in her third interview, when informed that co-workers had seen her writing in the forklift, the driver stated she was probably preparing a grocery list for the weekend at the lake.
- The driver had just returned from a vacation for nearly two weeks, from June 29 to July 10, 2007, and had returned to work July 11. The driver reported that she had no problems or concerns related to the vacation period that may have affected her performance on the day of the accident.

2.6.3 Physical Stress Factors for the Driver

The driver was 48 years old and 5 feet 5 inches tall at the time of the accident. The driver wears corrective contact lenses, which she reported wearing at the time of the accident. The driver did not report, to the Board, having any hearing impairment. The driver has an extensive history of physical problems both musculoskeletal and neurological. In reviewing the driver's leave records and statements by co-workers, USEC management, and the Site Director of Medical Services, she has had numerous extended periods of leave due to these physical conditions.

The driver was operating the forklift on a roadway rather than inside a building and, therefore, would need to watch for vehicular traffic, including very large industrial trucks.

The driver was riding in a vehicle that had poor suspension, which she indicated caused her to "feel every rock she went over." Although the forklift has the capability to adjust the seat position in a variety of ways and the forklift is driven by others besides her, she indicated that she does not normally make any seat adjustments.

2.6.4 Prescription Medications Taken by the Driver

The driver listed that she was taking at least seven prescription medications at the time of the accident due to her significant health problems. Although she reported taking them only at home, co-workers stated they had seen her carrying a large plastic bag of medications at work and taking medications in the workplace.

She had been in an automobile accident from which she sustained injuries to her arms and neck and which resulted in surgeries in 1997 to correct problems experienced. She indicated she had a degenerative condition in her back that required corrective surgery. She also had surgery to correct leg problems in 2003.

The driver reported she swayed back and forth to help minimize back pain and to allow her to see around the load in front of the forklift windshield. The driver indicated that movements that flexed her back and torso, flexed her elbows and shoulders, or twisted her neck and back were painful and difficult. (See Appendix D for details.)

2.6.5 Apparent Safety Consciousness of the Driver

The driver reported wearing her safety glasses and her seatbelt at the time of the accident. The driver and her co-workers stated that she was very meticulous and that she cleaned the workplace to stay busy.

The driver stated that she stopped at the intersection of the accident, even though the traffic sign was a yield sign.

Statements by co-workers, supervisors, and USEC management noted that the driver had had a history of prior accidents while driving equipment at the Site. These included the three accidents in September 2006 and an accident on October 9, 1996, in which a mower she was driving tipped over in a ditch. She also had a personal car accident in the past and suffered a serious injury to her right elbow. The driver acknowledged that these prior accidents had occurred, but she downplayed their significance.

The driver stated that she never saw the pedestrian nor felt the forklift run over the pedestrian's leg.

2.6.6 Vehicle Incidents

Following her six-month leave for back surgery, she returned to work on July 5, 2006. She was then involved in three separate vehicular incidents in September 2006. The incidents, which did not involve forklifts, were 1) Roll-Off Truck/Gradall, 2) Mired Truck Event, and 3) Bus Uncontrolled Movement.

2.6.6.1 Roll-Off/Truck Gradall Incident

On September 21, 2006, during excavation activities at the west side of building C-600, the driver was positioning a roll-off container as close as possible to a Gradall to facilitate the loading of the container with dirt. During the backing process, the driver backed into the cab enclosure of the Gradall Excavator. The right rear corner of the truck struck and broke the front cab window of the Gradall Excavator. As a result of this incident, the driver was required to take refresher training in order to be recertified as a truck driver. Lessons learned were communicated between the truck drivers, and operators were asked to assist the drivers when backing.

2.6.6.2 Mired Truck Event

On September 26, 2006, the driver was driving a dump truck to a location west of C-405. When the driver arrived at the Site, the road was blocked by a vehicle driven by a PRS employee, and the driver decided to drive the truck off-road past the vehicle rather than request the vehicle be moved. In order to get around the vehicle, the driver drove through an area with a vegetative waterway ditch. The soil in the ditch area was softer and wetter than the soil in the surrounding area resulting in the truck becoming mired and stuck in the ditch.

Prior to this incident, trucks were allowed to be driven off the roadways into solid grassy areas to pick up roll-off containers or to be loaded. As a result of this event, an ATR (ATRC-06-3195) was written. The ATR was not written against the driver but was written as a generic problem because of the previous practice of trucks driving off Site roads onto solid grassy areas to pickup material.

2.6.6.3 Bus Uncontrolled Movement

A third event, the bus uncontrolled movement incident, occurred after September 26, 2006. The exact date of the incident is not known since no ATR was written on the occurrence by the parties privy to the incident.

One of the primary duties of the two truck drivers at the Site is to pick up USEC employees at bus stops inside the plant near the employee parking lots and carry the employees to their work locations inside the plant.

Following the completion of the morning bus route, the driver arrived in the parking area near the garage (C-750 building), stopped the bus, exited the bus, and started walking away from the bus. The driver indicated that she was in a hurry to go the restroom and failed to set the airbrakes. A co-worker driver noticed that the bus was rolling away and alerted the driver that the bus was moving as the driver was walking away from the bus. The driver turned around, returned, reboarded the bus, and pulled the brake to stop the bus. There were other vehicles in the parking lot waiting for repairs that the bus could have struck.

Following the event, co-worker 1 who witnessed the incident discussed the event with co-worker 2. Co-worker 2 indicated that co-worker 1 should report the event. Co-worker 1 indicated a reluctance to report the incident because of the strained relationship between co-worker 1 and the driver. Co-worker 2 made the decision that the incident was of sufficient significance that the matter should be discussed with the USEC Health and Safety Manager and did so. The USEC Health and Safety Manager indicated to co-worker 2 that it would be necessary for the Manager to talk with co-worker 1, and co-worker 2 relayed the request to co-worker 1. Per the USEC Health and Safety Manager, a meeting occurred between co-worker 1, co-worker 2, and the Manager. The Manager indicated that both workers declined to support movement of the issue forward and did not want the issue raised anonymously because of their identifiable involvement in the issue. As a result, no ATR was issued.

The Health and Safety Manager did share the concern with the Maintenance Manager without providing the co-workers' names, as requested. As a result, the maintenance organization manager increased his presence in the garage to ensure availability for expressing concerns.

The Board noted the driver was out on leave beginning the afternoon of September 29, 2006, and remained on leave for the remainder of the year.

2.7 EMERGENCY RESPONSE

2.7.1 Emergency Management

USEC provides emergency services for the entire Site. The USEC Emergency Plan was prepared pursuant to 10 *CFR* 76.91. While this plan was prepared for the leased property under the regulatory authority of the NRC, USEC provides these services for the entire Site under work authorization "25973 Paducah Fire, Emergency and PSS" with the DOE. This work authorization is defined in the Memorandum of Agreement between DOE and USEC for Services, Exhibit F of the Lease Agreement. The Emergency Plan also provides for off-site assistance, as necessary, which includes medical transport for treatment at either of two local area hospitals, Western Baptist Hospital and Lourdes Hospital.

2.7.2 Radio Communications

USEC emergency communications protocol states that the call for an emergency would normally include "Emergency Traffic, Emergency Traffic" prior to transmission. The incoming calls were to "A-1" (versus alpha phonetic "Alpha one") and indicated an employee with a knee injury: "…we got a man down at the intersection just south of C-600 … looks like a knee injury … need some assistance … quickly." The PSS responded to the call and called for the Medic 1 ambulance.

No reevaluation or adjustment of the severity of the accident was communicated from the accident scene to the PSS/Site control room.

2.7.3 Emergency Response

The PSS and Medic 1 were on the scene within approximately two minutes after the call. Additional calls were made to Health and Safety and to Security to summon their assistance. The Health and Safety representative arrived approximately 15 minutes after the accident and Security arrived 18 minutes after the accident.

The medical response by Medic 1 was prompt and provided stabilization of the injured PRS pedestrian prior to transport to the USEC Medical Services. The USEC Medical staff promptly identified the injuries as not life threatening and directed that the pedestrian be transported to a local hospital for further treatment.

2.7.4 Scene Preservation and Evidence Control

The PSS assumed the role of Incident Commander and told the maintenance supervisor not to move the forklift until Security had the opportunity to document the accident. Based on discussions with the H&S representative and the Security representative, there was little in the way of physical evidence to be preserved. The physical location of the injured pedestrian and other evidence were not conspicuously marked at the scene prior to her removal by medical personnel. A blood spot from the pedestrian was marked using readily available objects (i.e., keys and a radio) to mark the spot when photographs were taken. The photographs were the only evidence collected and retained. The scene was finally released following the H&S and Security gathering of information. Verbal statements were taken by the PSS. No written personnel statements were immediately collected from those on the scene following the accident.

2.8 INTERIM CONTROLS/COMPENSATORY MEASURES

The following controls/compensatory measures were those actions taken within a week following the accident.

2.8.1 USEC

- Initiated a formal accident investigation.
- The driver was tested for drugs and/or alcohol.
- The driver's certification was suspended.
- The driver was placed on administrative leave pending test results.
- Briefings were provided to Maintenance, Procurement (Materials Management), and Operations organizations who operate forklifts.
- A "Fast Track" message was sent to all USEC staff curtailing recreational walking in the controlled access area.
- A "Vehicle Safety Reminder" bulletin was placed in *InsideP* to remind people of USEC vehicle and pedestrian responsibilities.
- The yield sign was replaced by a stop sign at the same location. No changes were made to the sidewalk, crosswalk, or the configuration and use of forklift in this capacity.

2.8.2 PRS

- Discussed incident with the training instructor and trainees in forklift training class.
- Curtailed recreational walking via "Fast Track" message coordinated with USEC.
- Issued a PRS bulletin to curtail recreational walking.
- Performed pedestrian surveys during entry and exit times for locations where PRS employees walk to their work locations daily.
- Issued a PRS briefing bulletin to be provided at each plan-of-the-day meeting for all PRS employees and subcontractors.

2.8.3 SST

- Distributed copies of the USEC bulletin that prohibited recreational walking to all SST employees.
- Provided briefings about forklift and pedestrian hazards at plan-of-the-day and safety meetings.
- Provided brief updates concerning the investigation to managers.
- Developed an SST interim awareness statement on right-of-way and yielding for distribution to all SST employees.

2.8.4 DOE

DOE-HQ chartered a representative to review activities associated with the investigation, interim corrective action effectiveness, and proposed long-term corrective actions (week of July 23, 2007).

2.9 ACCIDENT INVESTIGATIONS AND CORRECTIVE ACTIONS

2.9.1 USEC Investigation

The USEC implementing procedure used for the accident investigation was CP2-SH-IS1033, *Accident Reporting and Investigation of Employee Injuries/Illnesses and Motor Vehicle/Mobile Equipment Accidents*, Rev. 6. The applicability section of the procedure indicates it applies only to accidents that are not reportable to the NRC or other outside agencies. The accident investigation was conducted and documented under the requirements of this procedure.

Senior management of USEC met in the General Manager's office shortly after being informed of the accident to determine a path forward for the investigation. These managers included the General Manager, Plant Manager, Security Manager, Health and Safety Manager, and the Maintenance Manager. It was decided at that time to assign the chairperson for this accident investigation from the USEC Health and Safety organization. The co-chairperson was the representative from the Safeguards and Security organization and other representatives were assigned from the PSS's office, the United Steelworkers Union local Safety & Health (S&H) representative, and from the Maintenance organization. Additionally, PRS and the PRS subcontractor were allowed to participate in the USEC accident investigation team meetings as ad hoc members.

A critique was held approximately two hours following the accident. The critique included those who were immediately on the scene rendering aid after the accident and those involved in pedestrian assistance and investigation of the accident. Personnel statements were taken during or following the critique. A representative from the PRS (S&H) organization was in attendance at the critique.

There was little physical evidence from the accident as the pedestrian had to be removed to ensure appropriate medical treatment was given in a timely manner. The accident scene was photographed by both the USEC Health and Safety organization and the Security organization. The forklift involved in the accident was secured by the PSS to allow photographs to be taken.

Biological sampling of the forklift driver for illegal substances was conducted less than two hours following the accident at 12:20 p.m. USEC performed breath alcohol content and urinalysis sampling as typically required of DOE contractors and consistent with the PRS policy and procedures. She signed a release for testing for substances of abuse, and the testing laboratory performed a "substance abuse panel" screen, which was negative. The Board was provided with the test results.

The USEC accident investigation included a reenactment of the accident on July 19, 2007, one week after the accident. The reenactment was performed using a different forklift driver and a slightly different (physically shorter) configuration of the nitrogen dewars. The size of the nitrogen dewars was noted and adjusted for the USEC reenactment by raising the forklift tines. Representatives from USEC, DOE, PRS, and the PRS subcontractor were present at the reenactment. Representatives from DOE were not invited, but happened to come by and observed the activity. Photographs were taken that represented the driver's visibility when carrying the nitrogen dewars in the forward traveling position.

2.9.1.1 Proposed Corrective Actions

The USEC accident investigation resulted in conclusions, contributing causes, and the root cause that the accident was caused by inattention to detail/surroundings by both the forklift driver and the pedestrian.

The USEC accident investigation included the following corrective actions and recommendations to address the contributing and root causes:

- Evaluate the intersection at 8th and Tennessee to determine the appropriateness of the yield sign versus a stop sign and replace if needed. (This was completed and a stop sign installed.)
- Discuss the traffic/pedestrian issues with the Shared Site Committee and work corrective actions through the committee. (Discussion was completed and committee actions are in progress.)
- A "Traffic" Team should be formed to determine if pedestrians should continue to have the right-of-way at any location throughout the plant including cross walks. (This is in progress, as part of the joint effort between USEC and the DOE contractors.)
- Recommendation for USEC to give the right-of-way to vehicles in lieu of pedestrians and communicate this to all plant employees. (Pending completion of items 2 and 3 above.)

2.9.2 PRS Evaluation

PRS performed an independent evaluation of the incident because USEC had the lead on the accident investigation. The evaluation was performed by four representatives from the PRS Safety and Health organization using DOE guidance for accident investigation, since no specific procedures existed governing the evaluation of such an event. The results were documented in *PRS Forklift Accident Evaluation*, dated July 25, 2007.

The PRS evaluation team consisted of the PRS Safety and Health Manager, the Radiological Safety Manager, a Safety and Health Specialist, and an ISMS/Emergency Management Specialist. Several of these representatives also had participated in the USEC accident investigation team. These representatives participated in the reenactment conducted on July 19, 2007.

The evaluation included a broader range of issues than were evaluated by the USEC investigation. Issues addressed by the PRS evaluation included Site agreements between DOE and USEC; drug and alcohol testing differences; responsibility for scene preservation and documentation; a follow-up pedestrian traffic survey for PRS and PRS subcontractor personnel routinely walking on the Site to designated work locations; a summary of differing guidance that exists on the Site for USEC and DOE contractor workers; and an evaluation of the USEC investigation process. The PRS evaluation report included recommendations that included USEC and all DOE contractors located at the Site. The recommendations exceeded PRS's scope of control and would require DOE to take actions to integrate the involvement of USEC and DOE contractors.

PRS documented these broadly based corrective actions in PRS-ESH-0208, Corrective Action Report (CAR) in Response to Accident Involving a PRS Employee and a USEC Forklift at Paducah Gaseous Diffusion Plant, Paducah, Kentucky. The CAR included sections on barrier analysis and root cause analysis, which came to a similar root cause as the USEC investigation report but was limited only to the driver inattention. However, the causal factors included the additional issues associated with multiple Site users, conflicting guidance, missions, and inattention to surroundings by both parties.

2.9.2.1 PRS Corrective Actions

The PRS CAR identified the following longer term comprehensive actions:

- Continue awareness of the workforce with use of bulletins and agenda topics at plan-of-the-day meetings, safety meetings, etc., until a Traffic Study can be completed and corrective measures identified and implemented.
- Conduct a Traffic Engineering Survey of the entire Site looking at pedestrian and vehicle traffic patterns and recommend additional traffic controls (see section 2.9.1.1).
- Review training materials, policies, and procedures to ensure consistency and recommended corrective actions are implemented and understood by the workforce.

2.9.3 DOE Investigation

DOE-HQ chartered an independent representative with extensive experience in Human Performance Improvement to review activities associated with the investigation, interim corrective action effectiveness, and proposed long-term corrective actions. Unfortunately, the representative did not have access to the USEC forklift driver during his visit due to the USEC legal representative not being available to attend an interview and, subsequently, chose not to talk with the pedestrian since that would only represent one perspective of the accident.

The DOE-HQ chartered representative was able to complete the following activities:

- Toured the scene of the accident.
- Observed traffic flow, traffic patterns, and vehicle interactions with pedestrians within the Site-controlled access area.
- Interviewed Safety personnel from USEC and PRS and its subcontractors who were involved in the accident investigation.
- Interviewed SST personnel who saw the pedestrian just before the event.
- Reviewed accident reports, witness statements, scene photos taken following the event and during the reenactment.
- Met with PRS management.

- Talked with FacRep.
- Interviewed a person who routinely walks with the pedestrian.

3. DISCUSSION AND ANALYSIS

3.1 ROLES, RESPONSIBILITIES, AND AUTHORITIES

3.1.1 USEC

DOE is the owner of the Site and USEC leases areas. In order for both USEC and DOE to function effectively on the same Site, both needed to utilize the common facilities and utilities identified in the 1994 lease agreement. The use of these facilities required the development of implementing agreements. This has resulted in the development of a hierarchy of flow-down documents developed with the intent that the lower tier document would implement the provisions of the upper. The hierarchy is provided below:

- AEA of 1954
- EPAct 1992 (Public Law 102-486)
- Lease Agreement between DOE and USEC commencing July 1, 1993
- USEC and DOE Resolution of Shared Site Issues at the GDPs
- Clarifying Letters – January 25, 1996, letter from USEC to NRC and DOE letter to USEC on May 24, 1996
- Joint Policy Statement on USEC and DOE Directive and Management Expectations for Shared Site Issues – USEC-100 R0 – dated December 16, 1996
- Implementing procedures: CP2-PO-PO1033, *PGDP Shared Site Interface*, applies to all USEC and USEC subcontractor employees, and PAD-4010, *Shared Site Issues – Paducah*, applies to all BJC and BJC subcontractor employees

As discussed in section 2.1, each entity at the Site has specific roles, responsibilities, and other obligations that might not be fully understood in a site-wide fashion.

USEC has a number of obligations to assure that the common areas of the Site are safe for DOE contractor employees. These obligations arise from 1) USEC's overall duty as a reasonable business; 2) the "general duty clause" of the OSHAct; 3) section VIII.C of the Memorandum of Agreement between DOE and USEC for environmental and waste management, wherein USEC agrees to conduct its operations in such a way as to not significantly interfere with DOE's environmental restoration activities; 4) the Lease Agreement's section 5.1(a), wherein USEC accepted $35 million from DOE in exchange for its achieving compliance with OHSA standards in effect on or after July 1, 1993; and 5) the DOE and USEC Shared Site Agreement that requires USEC to coordinate with DOE to resolve issues regarding safety of DOE contractor employees and to "ensure that [USEC] work activities that affect [DOE] are conducted in accordance with the appropriate procedures."

3.1.2 DOE Oversight

The Board noted there was a significant change in the DOE entities involved in operations at the Site. Specifically, the ORO initially provided both the USEC lease management and the clean-up activities at the Site. These two functions were conducted by two different departments at ORO, but both reported to the ORO Field Office Manager. In October 2003, EM created the PPPO and located the newly formed project office in Lexington, Kentucky. The PPPO was created to perform the clean-up activities while the lease management function remained with ORO. DOE-PPPO performs its environmental remediation responsibilities by coordinating day-to-day activities of DOE and its contractors with USEC and with the

NRC resident inspectors through its on-site employees at the Paducah Operations Oversight Group site office. ORO lease management includes transfer of real property and personality and administrative functions associated with terms and conditions of the lease. This resulted in a management change within DOE that remains separated all the way up to the Assistant Secretary level. The ORO lease management function reports to the Office of Nuclear Energy and the PPPO clean-up management function reports to the Office of Environmental Management. This separation has resulted in further complication of interfaces and interactions required to implement roles and responsibilities for DOE duties at the GDPs.

The Board concludes that this separation of DOE roles and responsibilities has further added to the complication in performing DOE responsibilities associated with activities at the GDPs. This included the coordination of activities between DOE and USEC, as well as the interactions between DOE and its sister Federal agencies, NRC and OSHA.

As stated in section 2.1.2.2, DOE personnel, contractors, and others performing work for DOE at the Site are subject to 10 *CFR* Part 830 for quality assurance and nuclear safety. This is true whether the work is being performed in areas leased by USEC or retained by DOE. This accident arose, in part, due to conflicting safety rules between DOE and USEC, as well as USEC's less-than-adequate compliance with their OSHA forklift training requirements and fitness-for-duty obligations. The fact that in the common areas both DOE and USEC workers have constant interface in an environment of conflicting rules, unclear enforcement authorities, and substandard compliance regarding safety indicates that the Safety Basis for the common areas at the Site is not adequate.

The DOE oversight process follows DOE requirements for any work by DOE contractors performed in any area of the Site. If the work impacts USEC, DOE must notify USEC of the potential impact per the Shared Site Agreement. The reverse is true for USEC activities in leased and common areas. DOE contractors doing work in USEC-leased space must perform within the requirements of USEC and its DOE contract, coordinating DOE activities in USEC-leased space to ensure that USEC's regulatory requirements are followed. Common areas at the Site, which are used by both DOE and USEC in the performance of their daily activities, are addressed in the lease with USEC. However, in accordance with the agreement titled "USEC and DOE Resolution of Shared Site Issues at the Gaseous Diffusion Plants…." signed by Joe Parks of DOE and George Rifakes of USEC, the DOE's contractors' activities in the common areas became subject to DOE requirements. The NRC codified its consent to this arrangement by accepting the agreement into the basis of the USEC certificate. With the NRC's acceptance of the agreement, DOE activities in common areas follow DOE requirements and any DOE activities in USEC-leased space follow DOE requirements and the rules and regulations established by NRC for radiological safety and by OSHA for industrial safety. Table 3.1.2-1 attempts to define performance standards and regulated agency responsibilities performing oversight of work in the common areas leased to USEC.

Based upon numerous comments received during the factual accuracy review, as well as differing opinions even within this Board, it is apparent that DOE's legal authority over different areas of the Site is not clearly and unambiguously expressed or understood. There is disagreement regarding DOE's overall responsibility for safety and health under the various statutes that pertain to DOE, as well as the 1993 Lease Agreement. For this reason, the following table is limited to regulations only and not other legal drivers.

Table 3.1.2-1 Regulatory Authorities and Oversight of Activities in PGDP Common Areas

	USEC Activities	**DOE/Contractor Activities**
Affecting USEC	Performance Standards: 29 *CFR* 1910, OSHA regulations for industrial/occupational safety work 10 *CFR* 76, NRC regulations for work involving NRC-regulated nuclear materials Oversight: NRC for work involving NRC-regulated nuclear materials OSHA for industrial/occupational safety work	Performance Standards: 10 *CFR* 830 10 *CFR* 835 10 *CFR* 851 29 *CFR* 1910, OSHA regulations 10 *CFR* 76, NRC regulations for work involving NRC-regulated nuclear materials DOE orders Oversight: DOE for all work NRC for work involving NRC-regulated nuclear materials OSHA for industrial/occupational safety work
Affecting DOE/Contractors	Performance Standards: 29 *CFR* 1910, OSHA regulations for industrial/occupational safety work 10 *CFR* 76, NRC regulations for work involving NRC-regulated nuclear materials Oversight: NRC for work involving NRC-regulated nuclear materials OSHA for industrial/occupational safety work DOE for safety of DOE contractor	Performance Standards: 10 *CFR* 830 10 *CFR* 835 10 *CFR* 851 29 *CFR* 1910, OSHA regulations, DOE orders Oversight: DOE for all work

There is disagreement between DOE and USEC for requirements for performing work in common areas that impact the other parties. Although DOE has oversight for its contractor safety in the common areas, confusion about authorities has resulted in disagreement about how activities are to proceed. This includes notification, coordination, and interface for work that affects the other party. For example, there is disagreement as to the applicability of 10 *CFR* 830, 10 *CFR* 835, 10 *CFR* 851, and DOE orders to USEC work affecting DOE/contractors in the common areas. The Joint Policy Statement of December 16, 1996, intends to define requirements for control of work activities, but it has not been updated to identify the current Site contractors.

3.1.3 Occupational Safety and Health Administration Oversight

During interviews, OSHA personnel indicated they were aware of a regulatory oversight role for the USEC operations required by the EPAct when USEC was a government corporation, but were not aware of the Privatization Act or the DOE/OSHA MOU signed on December 21, 1994. OSHA treats the Site plant as a large chemical plant that happens to have a radioactive component. USEC incidents that involve the radioactive components are usually deferred to NRC's oversight of the incident in accordance with an MOU between OSHA and the NRC, although OSHA reserves the right to perform a joint

inspection if determined to be warranted. OSHA personnel indicated that the last OSHA referral from the NRC was in the 2003 timeframe.

At times, OSHA concentrates its resources on specific targeted industries, such as the chemical industry. The targeting is not risk-specific. OSHA indicated that the only chemical industry in Kentucky subject to federal jurisdiction is the Site plant. Hazardous chemical facilities are included under OSHA's Special Emphasis Program as being an industry type that is particularly prone to serious injuries or deaths. USEC is required to comply with the OSHA standards. However, based on OSHA comments, the Site plant would not be a priority because of a need to better utilize its limited resources elsewhere. (Refer to Table 2.2.1-1.)

- OSHA does not schedule random inspections. OSHA regulatory response is triggered by either employee complaints or by serious incident reports. OSHA may inspect near misses, but does not have a structured program to collect near miss events. Near misses are usually identified by OSHA via inspection of reportable incidents, employee complaints, or so informal sources.
- The last industrial safety visit conducted by OSHA at the Site was conducted in January – March 2000.

3.1.4 NRC Oversight

USEC activities in USEC areas and common areas are regulated by the NRC and follow the NRC standards for radiological, safety, health, and security. The driver in this case was carrying nonradiological materials, but at the time of the accident there is no evidence that she was restricted from carrying radiological materials. To the contrary, she carried both radiological and nonradiological materials as a regular part of her job duties moving heavy equipment around the Site. Thus, NRC can have authority over the driver, in general, and her use of the forklift since her activity could just as easily have involved radioactive materials at the time of the accident. NRC expects USEC to operate according to its NRC Certificate, including compliance with OSHA standards, the Lease Agreement, and all accompanying documents to the Lease Agreement such as the MOU between DOE and USEC that includes an obligation for USEC to operate in the common areas in a manner that does not interfere with DOE's environmental restoration activities, the Resolution of Shared Site Issues document, and others.

The presence of the NRC inspectors at the Site creates a visible reminder to USEC that it must comply with their regulatory requirements for nuclear safety, safeguards, and security. USEC is a privately owned for-profit company with accountability to their shareholders. The NRC formal regulatory actions are a matter of public record, which encourages USEC to meet NRC regulatory requirements or potentially be exposed to adverse publicity. As a result of the NRC's rigorous inspection program and regulations that permit escalating penalties for violations of its standards, USEC has developed policies and programs to fully comply with the NRC's requirements.

The NRC has MOUs with DOE and OSHA requiring notification to appropriate agencies regarding concerns that the NRC may observe in the performance of its oversight. The Board has determined that NRC inspectors have identified OSHA concerns and safety concerns to DOE within the last few years in accordance with the terms of the MOUs. There were no concerns relevant to this accident.

3.1.5 Summary

The Site has evolved over time, including changes in its overall mission, financial changes, and changes in the workforce. All of these changes have resulted in a gradual shift from what was initially only an industrial facility to what is now an industrial facility sharing space with CERCLA cleanup activities

throughout the Site. This has resulted in two different, interacting workforces – the USEC workforce, most of whom have been at the Site for an extensive period of time and are presumably accustomed to working in a major industrial facility actively producing significant products, and the DOE contractor workforce focused on CERCLA activities, most of whom have been at the Site for a much shorter period of time and are not familiar with USEC operations and culture. Many of these contractor employees are likely to have worked at other CERCLA sites that are only undergoing environmental remediation. These two different workforces must interact routinely given the location of the DOE contractor offices in the middle of the Site footprint and work location at various points around the Site.

The Board recognized that both USEC and DOE have jobs to do across the Site, milestones to meet, and other goals and missions that do not always mesh, and sometimes conflict. In the common areas where both entities interface, it is essential for both entities to engage in formal communications, as soon as possible, to agree on those standards for activities that meet DOE's and USEC's obligations to protect their employees. A process of checks and balances must be created by agreement of both parties that ensures the standards agreed to are continuously being met. This includes flowdown to all employees by all organizations at the Site. In the Board's opinion, the ownership and responsibilities for the safe performance of work in common areas are not clearly defined and understood by all Site organizations.

The Board noted there were numerous documents created to support the requirements of the 1992 EPAct to transition the operation of the GDPs. These documents are outlined in sections 1.4 and 2.1. An area of concern to the Board was the changes in privatization of USEC and in the various Federal agencies (DOE, NRC, and OSHA) that have occurred over the past decade with no subsequent changes in the lease or in the MOUs between the Federal agencies. Examples include the change of USEC from a government corporation to a private entity with no subsequent revision to the lease agreement to better align the DOE/USEC relationship with contract requirements of the Department of Energy Acquisition Regulations (DEAR). The agreements established to manage resolution of shared site issues have not been updated to reflect the changes, which have occurred with increased numbers of organizations at the Site. Likewise, changes in the operating philosophies in the Federal agencies over the past decade did not result in subsequent changes in the MOUs that govern the interaction of the agencies in oversight of the GDPs. Additionally, the Board noted some of the requirements currently contained in the MOUs are not identified in implementing procedures for each of the Federal agencies, further obfuscating the implementation of the roles and responsibilities delineated in the MOUs. The Board concludes that the collection of documents that were established to define and coordinate the implementation of obligations, roles, and responsibilities between DOE, USEC, NRC, and OSHA, including the Lease Agreement, the Shared Site Agreement, the Joint Policy Statement, the MOUs and other policies and procedures, should be revisited and updated as appropriate to reflect changes in the relationships since their development and ensure implementation of each party's current missions and operating philosophies.

The only regular communication regarding activities and requirements for industrial safety pertaining to work performed with the potential to impact the other party (especially in common areas) has been through the Shared Site Working Group, which does not include OSHA. Neither DOE nor OSHA has taken the initiative to discuss regulatory interface issues on a regular basis. Even though DOE has established an MOU with the DOL and the NRC has a working relationship with some elements of the DOL, essentially no direct input or constructive involvement has occurred between the DOL and the Site.

In the Board's opinion, OSHA standards are applicable to the Site and should be complied with by all organizations. Since OSHA has demonstrated extremely limited on-site presence, the Board concludes that this may have contributed to some inadequate implementation of safety processes in industrial safety.

In the Board's opinion, the NRC oversight of USEC activities has been effective in ensuring nuclear safety, safeguards, and security. Opportunities for improvement exist with regard to determining industrial safety incident severity and OSHA involvement, as well as more thorough and timely recognition of adverse trends.

3.2 IMPLEMENTATION OF ROLES AND RESPONSIBILITIES

3.2.1 Safety Programs

3.2.1.1 Integrated Safety Management

As discussed in section 2.2.1, safety integration into the day-to-day activities for the various Site employees is accomplished through implemented programs. DOE and its contractors are required to implement the principles of ISMS in their work activities whether it occurs in nonleased, leased, or common areas. Previous pedestrian safety issues were discussed at the Shared Site meetings, including inadequate lighting for pedestrians and the need for a new crosswalk. Relative to this incident, DOE and its contractors were made aware of the USEC policy on the "vehicular and pedestrian right-of-way" on February 7, 2007, in a Shared Site meeting. Apparently, neither DOE nor its contractors recognized the significance of the conflict between USEC and DOE policies regarding traffic and pedestrian safety, and the problem was not resolved.

In the opinion of the Board, integration of industrial safety aspects between the DOE contractors and USEC is not clearly defined, delineated, or effectively implemented. The following weaknesses in effective site-wide integration of safety requirements and approaches were identified by the Board and are considered to have contributed to the accident:

- Meaningful and effective cross-talk and interactive communication within existing mechanisms regarding safety is lacking.
- Coordinated evaluation of safety concerns, along with mutually acceptable corrective actions, needs improvement.
- Sharing and distributing lessons learned as a preventive force for future safety problems is disjointed and ineffective.
- Thorough consideration, scheduling, and coordination of activities in adjacent work areas that could adversely affect others need improvement.

3.2.1.2 Hazard Identification and Mitigation

Starting with fundamental principles of acting responsibly to assure a safe environment for all Site personnel, USEC had the obligation to conduct nitrogen dewar movement in the common areas in a manner that was reasonable and complied with standards. Thus, USEC had an obligation to select a safe vehicle to transport the dewars on common roads, select a safe route for the transportation, use a safe process for the transportation of the dewars, and use a safe driver for the activity. Following the Board's reconstruction of the accident, an inspection of the loaded forklift, the obvious significant obstruction of vision when loaded with the dewars, and an in-depth review of the background of the driver, the conclusion is that most or all of these activities were carried out in an unsafe manner. Based upon an unexpected event during the Board's accident reconstruction, the obstructed vision problem was apparent when the taller stand-in driver operating the forklift ran over a bright orange traffic cone (placed by USEC Security to block regular traffic) in the middle of her route to reposition for the accident reconstruction.

The USEC process appeared to provide an adequate framework for hazard identification and mitigation of those hazards.

Workday schedules at the Site are established by the individual organizations, including the unions. Breaks and lunch periods occur throughout the day and are not consistent from organization to organization. Therefore, no set pattern is currently available for preferential vehicle traffic or pedestrian traffic use periods. This uncoordinated workday/break period schedule offers extended periods of high traffic interaction/conflict where incidents and injuries could be more likely to occur, and there is no evidence that an evaluation of the potential site-wide hazards associated with the recognized condition has been performed by any organization on-site. Although there is no specific indication that this directly or indirectly contributed to the accident, the possibility exists.

As discussed in section 2.2.1, the DOE contractors are required to develop and implement procedures and programs for hazard identification and mitigation. DOE contractors (i.e., PRS and SST) have work control procedures in place that address the overall development of tasks and include references to their specific procedures that address hazard identification and mitigation.

The DOE contractors' work control and hazard assessment procedures appear to provide an adequate framework for hazard identification and mitigation of those hazards. PRS implementation of the hazard identification and mitigation process can result in an activity hazard review (AHR) and an AHA. SST implementation of the hazard identification and mitigation process results in AHAs and specific mitigation and control elements defined in the work packages. Review of the associated SST AHAs indicates that walking or activities that could be construed as pedestrian in nature are addressed.

Relative to the accident, the specific hazards associated with walking at the Site do not appear to be adequately defined and addressed. Hazards associated with forklift use appear to be adequately addressed by PRS and SST. Overall hazard identification and mitigation processes by each party at the Site appear to be adequately defined. However, weaknesses in implementation are evident and consistent implementation across the Site to address site-wide hazards is not well integrated or accomplished.

3.2.1.3 Summary

In the opinion of the Board, hazardous conditions existed, resulting in this accident, that indicate the implementation and thorough use of guiding documents, procedures, and hazard analyses was less than effective. For instance:

- A thorough hazard assessment for general forklift operation was not conducted by USEC nor has this been conducted from a site-wide perspective (i.e., USEC and DOE contractors combined).
- The use of the forklift in a forward direction for hauling items that impair the forward field of view was not mitigated through either driving the forklift in the reverse direction or eliminating the obstruction.
- The visual impairments and related blind spots on forklift accident are significant and do not appear to have been sufficiently considered.
- The use of an alternate method of transporting the load, such as by truck, was not sufficiently considered as a hazard mitigation method.
- Neither USEC nor DOE initiated a hazard analysis of the impact of the differing policies on pedestrian/vehicular interfaces to assess the potential impact of the USEC/DOE policy differences on Site workers.

- The hazards associated with walking (both recreational and work-related) were known and identified, but not analyzed or mitigated.

The USEC process appeared to provide an adequate framework for hazard identification and mitigation of those hazards if thoroughly implemented. USEC indicated that a specific job hazard analysis (JHA) was not prepared to cover forklift hazards and safe operation. There was no JHA for either the job task being performed or the specific forklift involved in this accident, which could have provided mitigation for operational concerns identified by the Board.

3.2.2 Lessons Learned

3.2.2.1 USEC

As discussed in section 2.2.2, the USEC equivalent of the lessons learned is provided by its OERP. Based on the Board's review of USEC logs, USEC has routinely reviewed information, as required by its procedures. This tends to indicate a robust program is in place with a variety of different sources of information being reviewed.

The review of the lists indicated a majority of the items distributed for further evaluation were from ATRs or problem reports (PRs) from the Sites or from NRC Information Notices. Additionally, most of the DOE Lessons Learned and Defective Equipment Notices are distributed as information only. This appears consistent with the graded approach for the potential hazards presented.

One item worthy of note was OERP 07-001, *DOE Implementation Guide: DOE G440.1-8, 10 CFR* 851, *Worker Safety and Health Program.* The applicability criterion for providing this was "same or similar administrative controls." The OERP was issued as information only and the response action provided indicated it was forwarded as information only to the Health and Safety Managers at both GDPs and the Construction Manager at the American Centrifuge Plant being constructed at Portsmouth. The Board notes this is a positive action.

3.2.2.2 DOE

As discussed in section 2.2.2, the Board retrieved lessons learned from the DOE database, but the ability to retrieve specific meaningful information appears highly dependent on how the search criteria is entered. It appears a single set of meaningful keywords, such as those used for ORPS, would be appropriate.

The ability to find lessons learned on specific issues as part of the planning of work activities is easily demonstrated. However, the extent to which lessons learned are incorporated into program changes, procedure changes, training, and work control documents is left to the organization performing the review.

The Board identified the following document of note in regard to forklift operations:

1. *Type A Accident Investigation – June 1991*

On May 9, 1991, a fatality occurred at the Idaho Chemical Processing Plant which resulted from a pedestrian being struck by a forklift. The probable causes identified in the report were:

- Acceptance of vehicle/pedestrian risk evidenced by an inadequate management system for vehicle and pedestrian safety.

- Less than adequate management control over equipment selection.

Additionally, the following contributing causes were identified:

- Victim's inattention.
- Poor rearward visibility from the forklift due to the high lift mechanism.
- Victim walking on the right side of the road with traffic (versus facing traffic).
- The unsecured load, which required the driver to divide his attention between the direction of travel and the load.
- The gravel intrusion onto the paved roadway, which likely caused the victim to alter his walking direction toward the path of the forklift.

Four Judgments of Need were identified in the 1991 AI report:

- Study in-plant vehicle use and address the safety of pedestrians using the same passageways as vehicles.
- Give more management attention to selection of the most suitable vehicle or other equipment for material and load handling.
- Clarify and enforce the various DOE and DOE Idaho Operations sidewalk requirements.
- Provide DOE-wide guidance regarding in-plant pedestrian/vehicle safety.

Investigation and reporting of accidents is done by DOE for the express purpose of continuing to improve the safety and health of DOE employees and contractors and to prevent the recurrence of accidents. DOE directives require that the judgments of need that address systemic problems should be implemented to assist managers throughout the DOE complex in helping to prevent future occurrences, and assign responsibility to DOE-HQ to verify the completion of approved corrective actions and satisfaction of judgments of need.

The Board concludes that no one at the Site was aware of the existence of the 1991 accident investigation of a forklift collision with a pedestrian resulting in a fatality, until pointed out by the Board. Likewise, inquiries to DOE-HQ failed to identify that any corrective actions were taken DOE-wide as a result of the 1991 accident. As stated above, the fourth JON clearly expressed the need for DOE-wide guidance regarding in-plant pedestrian/vehicle safety. There is no evidence this was ever undertaken by DOE-HQ or that any corrective action was taken, either at the Site or at DOE-HQ. The apparent failure to take action to address the JON and the recent pedestrian/vehicle accident at Paducah identifies the need to better define requirements for pedestrian/vehicle safety.

3.2.2.3 DOE Contractors

As discussed in section 2.2.2, lessons learned have been generated from previous incidents. PRS has the ability to perform searches of specific topical areas, as needed. SST lessons learned have been generated from previous incidents and SST uses these lessons learned in making programmatic improvements. Additionally, SST maintains a log of lessons learned. However, the distribution and use of these lessons learned could not be determined.

A review of the DOE Lessons Learned database indicated that there were no lessons learned generated from the suspension of forklift activities initiated by PRS in July 2006. Additionally, the USEC OERP Coordinator and the USEC Health and Safety Manager indicated they had not heard anything about the suspension of forklift activities. From interviews, the Board determined the lessons learned coordinators

from some of the Site organizations did not know who their counterparts were. As such, it appears information about significant safety concerns with forklift operations was not adequately communicated with other entities working at the Site.

3.2.2.4 Summary

In the opinion of the Board, each organization at the Site has a lessons learned program that is clearly defined and appropriately implemented for its individual needs. Additionally, communication of lessons learned information between organizations has been performed in an informal manner with limited distribution that may not always target all the appropriate organizations. However, the Board determined there is not a clearly defined expectation of the types of issues that need to be communicated nor is there a designated contact list of the appropriate representatives of the Site organizations to ensure an adequate and timely sharing of lessons learned between all parties at the Site. The Board concluded that this is particularly necessary for issues that occur at the Site that have the potential to adversely affect the safety of other Site organizations.

3.2.3 Corrective Action/Issue Management

3.2.3.1 USEC

In general, use of the ATR process to enter issues into the USEC BPS is an effective tool for capturing issues, evaluating issues, and implementing corrective actions. However, during the performance of this investigation, the Board identified several potential weaknesses in the implementation of the corrective action process.

Section 2.6.6 identifies an incident with an unattended bus rolling after being parked by the driver. The discussion in that section indicates the issue was identified and concerns were raised, but the issue was never entered into the BPS for evaluation or tracking. The details of this event were identified only during interviews regarding the forklift driver in this accident and recreating a history of previous performance issues associated with the driver. Failure to capture this issue is a single example of an issue not being identified and entered into BPS, but could represent other potential unreported issues in other areas.

Section 2.2.3 identifies two USEC self-assessments that were reviewed, one specifically addressing PITs. The self-assessment appeared to be an appropriate review of requirements from three procedures implementing the PIT program at USEC. One of the findings (ATRC-05-4578B) identified 14 ATRs regarding forklift accidents or observations that documented unsafe driving. There were no corrective actions identified for this issue and the (USEC) Management Response section refuted the assessment finding for 7 of the ATRs. The ability for the manager to "overrule" the assessment findings with no independent validation appears to be a weakness in the USEC corrective action system.

Section 2.2.3 also addresses a self-assessment of the corrective actions process. This included a group of ten corrective action self-assessments from various departments in USEC. In general, each self-assessment was tailored to the scope of work for the individual group, and the sample size of the information reviewed was adjusted accordingly. Some departments included all the ATRs assigned to their department and others used only a sampling of the ATRs. In general, the self-assessments appeared appropriate in scope and content and ATRs were filed for negative observations and recommendations.

3.2.3.2 DOE Contractors

In general, the ICATS system used by PRS is an effective tool for identifying and tracking issues. Section 2.2.3 identifies three items that were evaluated as part of the PRS corrective action process. The corrective actions to evaluate and verify the effectiveness of the PRS forklift safety program appeared appropriate and identified some effective corrective actions that could be applicable to other parties working on the Site. Specifically, the use of transport methods other than forklifts for over-the-road transport and developing activity-specific traffic plans could help eliminate some hazards presented by forklift transportation methods. The PRS implementation of the activity-specific traffic safety plans was not reviewed as part of this investigation.

The PRS self-assessment on forklifts was obviously self-critical based on the number of findings that were identified, including the finding that PRS personnel were not aware of a revised procedure having been recently issued. While this speaks highly of the self-assessment, it indicates that implementation of the revised PRS forklift program was less than adequate. This is of particular concern since PRS had self-imposed suspension of forklift activities only six months earlier.

The fact that SST performed a self-assessment based on the PRS self-imposed suspension of forklift activities speaks positively to its corrective action program. While the self-assessment did not identify any significant deficiencies, corrective actions were identified to further improve the implementation of the SST forklift program.

3.2.3.3 Summary

In the opinion of the Board, each of the corrective action programs was acceptable for its individual use. However, information sharing between the different organizations needs to be improved.

The ATR system contained reports for two of the three incidents described in section 2.6.6. It is the Board's opinion that, had the second USEC ATR identified the driver's involvement and had the third incident been correctly entered as an ATR, the trend of three incidents within a two-week period may have been detected by USEC management and further follow-up of the driver's performance could have prevented the accident.

3.2.4 Employee Concerns

The information provided by USEC and PRS in this area was rather limited. Several of the USEC employees interviewed displayed and/or expressed discomfort about raising safety concerns either through issuing an ATR or through the formal Employee Concerns Program. This information was supported by the incident involving the rolling bus that was not reported as an ATR, but instead raised as an employee concern. Based on subsequent discussion with USEC management, the USEC employee's concerns regarding this incident were raised to their attention, yet remained unreported through an ATR into the BPS. The action taken by USEC management in this case appeared to be less than adequate. There were also a number of USEC employees who reported having had concerns related to the driver's fitness for duty, potential impairment, or similar issues that were not reported. Although the Board was not able to identify the specific reasons for not reporting, the fact that the USEC employees, although having concerns, did not report them is of concern to the Board.

Although the Board asked USEC to provide all Employee Concerns reports and resolutions for the past three years, USEC's only response was an e-mail message stating that USEC had no employee concerns regarding forklifts or vehicle accidents. Later, after the Board made inquiries, USEC indicated there were a total of 48 employee concerns received during the two-year period. The Board detected reservations by

several witnesses regarding what they could say about safety conditions including one witness who remarked, when USEC counsel left the interview to take a phone call, that he was worried that he had already said too much.

Because of the Board's concern, the Board searched the NRC website for NRC employee concerns at the Site. Notice of Violation EA-99-256, dated January 3, 2001, found a severity level III violation by USEC. Also found was Confirmatory Order EA-04-123, dated January 27, 2005, which resulted from the use of alternative methods for dispute resolution. The Board also found that for the time period between January 2007 and July 2007, the NRC had five allegations received for the Site fuel facility of which three were open and two were "substantiated."

A review of the SST Employees ES&H Concerns Log revealed there were a total of 19 concerns for 2006-2007. All employee concerns were closed. One of the concerns, SSTEC-2006-12, identified an incident regarding a forklift being operated by another DOE contractor driving at a dangerously high speed and coming in close proximity to SST workers. The resolution was to forward the concern via e-mail to the offending DOE contractor and issue an immediate site-wide bulletin addressing forklift driving dangers. The information provided by SST regarding this particular employee safety concern demonstrates the practice of sharing safety concerns across organizational lines to implement correction.

The Board believes that each organization must encourage the freedom to express concerns without fear of retaliation; must establish an environment of trust in order to receive necessary feedback to establish a safe working environment; and site-wide dissemination of issues and appropriate corrective actions should be enhanced. Although based on limited information, the Board is concerned that USEC may not have achieved an environment that is conducive to its employees freely reporting their safety concerns.

3.2.5 Traffic Safety

The location of the sign and the type of sign at the time of the accident, in the opinion of the Board, could have been a contributor to the accident. The distant location may have provided a potentially false indication to the driver entering the intersection that yielding 30 feet previously was sufficient to allow the vehicle to enter the intersection safely.

The Board's review of the site-wide training material indicates that the content and the directions to the Site employees, pedestrians, and vehicle operators is contradictory, confusing, and lacks overall integration of the various Site organizations' input and has, therefore, resulted in an ineffective and substandard programmatic guide for overall safe performance. Pedestrians will continue to walk throughout the Site to perform work. In the opinion of the Board, the inconsistent site-wide training and guidance should be revised to ensure pedestrian safety at all times regardless of location.

The Board believes that due to the lack of appropriate sidewalks in many areas of the Site and the very few designated crosswalks, USEC policy for vehicle and pedestrian interaction places pedestrians at risk of injury. The Board believes this matter should be given immediate attention to provide adequate protection to Site personnel.

The Board considers the inconsistent and nontypical manner of designating the pedestrian crosswalks as a potential contributor for injury to persons who walk throughout the Site. Walking in the inadequately identified areas, especially intersections and in roads without established sidewalks, for work-related activities where vehicles could be operated presents an unacceptable hazard to the pedestrian, which must be evaluated and managed.

3.2.6 Training and Qualification

The July 2001 USEC Information Bulletin entitled "Jogging on Plant Site," does not specifically identify a written policy or procedure addressing prohibition of walking or jogging. The bulletin's content does not specifically prohibit walking or jogging and even uses the word "should" to indicate that an absolute prohibition is not defined in the bulletin. The bulletin further identifies inherent hazards for the activity and an additional alternative location for those activities, but also indicates that some risks still remain that are "acceptable." Therefore, based on this bulletin, walking or jogging could still be an acceptable activity, but has identifiable risks yet no limitation on location. The Board believes that this bulletin should be cancelled and a new policy issued to address jogging and walking.

USEC indicated that the requirement for truck drivers to possess a CDL was eliminated in 2002. In the opinion of the Board, the elimination of the CDL requirement also eliminated certain medical, performance, training, and oversight benefits that, even though not required and enforceable by the Department of Transportation, can provide benefits, such as more experienced and better qualified drivers, and should be reconsidered.

The Board reviewed the training and qualifications requirements established by USEC for forklift/truck drivers and also reviewed the training and qualifications of the driver. The Board concludes that the various vehicle incidents during 2006 and 2007 attributed to the driver were not handled in accordance with USEC procedures. Operation recertification and retraining were not adequately performed or documented and did not include the rigor or consideration for serious adverse trends in the driver's ability to perform to expectations or standards.

3.2.7 Driver Fitness for Duty

Several USEC management-level witnesses stated there was no requirement for USEC to meet fitness for duty standards. Nonetheless, the OSHAct general duty clause requires USEC to maintain a safe work environment and comply with OSHA standards. USEC Procedure CP2-HR-LR1031, Rev. 2, *Fitness for Duty*, is in effect. The procedure's definition of "fitness for duty" is "being physically and mentally able to perform job duties in a competent and safe manner." The responsibility for assessing fitness for duty lies with the front line managers in accordance with their safety oversight duties. USEC management, with support from USEC Medical Services, is responsible for monitoring USEC employees to determine whether they are fit for duty. The Board determined that USEC management did not adequately evaluate the driver's fitness for duty.

The driver had numerous physical limitations that could have affected her ability to operate the forklift in a safe manner. Although there is no evidence that she intended to drive in a careless manner, her neck injuries made it extremely difficult for her to turn her neck and rotate her head in order to maintain side-to-side visibility; she had extensive back injuries that would have hampered her ability to turn her body to operate the forklift in reverse with a clear view, assuming this had been proposed as a mitigation measure. The seat in the forklift did not have any ability to swivel from side to side, so any turning or twisting movement while driving would have been dependant entirely on the movement of the driver. Since the loaded forklift had significant visual obstruction of the path ahead, movement of the driver by turning and twisting needed to be a requirement for operating the equipment. The Board had no evidence that USEC considered these limitations when apparently concluding that she was physically fit to operate the forklift in a safe manner.

The driver had the first phase of her USEC annual physical exam on June 27, 2007, two weeks prior to the accident. At that time, she provided a list of eight prescription medications that she took at least once

a day, one of which she took up to four times a day. The Board's review determined that six out of eight of these medications had warnings regarding affects on judgment, alertness, or other mental or physical functions that impact the ability to operate heavy equipment. Nonetheless, there is no evidence that USEC, prior to the accident, sought any outside opinion from any of her treating physicians that these listed medications, whether singly or in combination, could affect her ability to drive the loaded forklift safely. According to the statement of the USEC Director of Medical Services, a Physician's Assistant, although he was aware of the driver's medication regime just prior to the accident, he did not question it because the driver's medical file contained a release for her to return to work with no restrictions from her neurosurgeon, which he interpreted to mean that her medications would not impair her judgment.

The driver's medical file contains a letter from her orthopedic physician dated July 24, 2006, that she was able to return to work with no restrictions from a six-month absence for back surgery. There is no evidence that the neurosurgeon was aware of her medication regime when writing that letter, or whether it was even the same medication regime.

The driver reported to having additional physicians treating pain and other conditions and, as of the date of the accident, there is no evidence that USEC sought any opinions from these physicians regarding possible impairment based upon the influence of these drugs in combination after she reported them on June 26, 2007.

The driver reported to the Board that she did not take the drugs during the workday. However, statements from co-workers and from the driver in a later interview indicated she took the drugs during the workday. The USEC Director of Medical Services was not aware of the driver taking drugs during the work period; however, he was aware that the prescription schedule could make that possible. Based on the results of the drugs test, the Board was not able to differentiate, substantiate, or refute the presence or absence of possible prescription drugs for the driver on the day of the accident. The Board expressed concern that, given the medical record's listing of drugs taken and the driver's own statement that the drugs were routinely taken, the prescription medications should have been detected.

3.2.7.1 Summary

The Board concludes the responsibility assigned to the front line manager, with the support of the USEC Medical Services and the driver's co-workers, to determine fitness for duty was not properly performed. There was also inadequate USEC upper-level management involvement to support a determination of the driver's fitness for duty to safely perform her assigned tasks.

Since the operation of heavy equipment includes operation of the forklift and the standard medical reference for prescription medications included warnings about the majority of her drugs, the USEC Director of Medical Services should have questioned whether she was fit to operate a forklift.

The Board concludes that sufficient factors existed to reasonably question the fitness for duty of the driver. Specifically identified factors are as follows:

- The numerous physical limitations that could have affected the ability to operate the forklift in a safe manner.
- The potential for prescribed medications to diminish the driver's mental alertness while driving the forklift.

3.3 FORKLIFT ANALYSIS

3.3.1 Pedestrian Vision and Hearing

On the day of the incident, the weather in the area was warm and clear with no precipitation to affect the pedestrian's visibility. The pedestrian was traveling west along Tennessee Avenue at approximately 10:30 a.m. The direction of travel and the time of day placed the sun at the pedestrian's back and overhead. As such, the Board believes the pedestrian's vision was not impacted by the sun. The pedestrian was wearing sunglasses with a wrap around frame, which could have potentially impacted the pedestrian's ability to detect motion or objects approaching from the side. The Board's review of the photo of the same sunglasses determined it is unlikely the sunglasses affected the pedestrian's peripheral vision. (Refer to Figure 3.3.1-1.)

The intersection where the collision occurred is a T-shaped intersection surrounded by a grassy area with no obstructions from trees, bushes, or buildings and, at the time of the accident, the traffic flow was not excessive.

The pedestrian told the Board that she was not required to wear glasses except for reading purposes and that she had just had her hearing and vision tested; she reported no deficiencies. The noise level of the forklift should have allowed the pedestrian to hear it approaching. The Board concludes there were no objects that could have obscured the moving forklift as it approached the intersection, and the bright orange forklift and silver dewars in the yellow cage should have been clearly audible and visible to the pedestrian.

Figure 3.3.1-1. Picture of Sunglasses from the Internet

3.3.2 Driver Vision and Hearing

In interviews, the driver indicated that she looked to the right and left and did not see the pedestrian at anytime, and she did not even realize that the forklift had struck the pedestrian until hearing the cries of the pedestrian.

The Board believes that the driver's hearing was not a factor in the accident.

The Board conducted a reenactment of the incident to better understand the actual circumstances of the accident. The reenactment of the incident also was performed in reverse and recorded on video. The driver was present at the reenactment to provide input from her recollections of the forklift speed, path, and actions taken on the day of the incident. Two co-workers who walked regularly with the pedestrian walked the path taken by the pedestrian at the speed that the pedestrian would normally have walked. Utilizing the data, an approximate time and distance of the travel paths were established for the forklift and the pedestrian.

The last known reference point prior to the accident was the observation of the pedestrian by SST employees at a location near overhead piping approximately 20 seconds prior to the accident. The location of the forklift at approximately 20 seconds prior to the impact was estimated from the videos. The accident scene was revisited and measurements were taken. Measurements at the scene revealed that the distance covered by the pedestrian and forklift were approximately equal, which indicated they were both traveling at approximately the same speed. Since the two paths were perpendicular, the pedestrian would have been at an angle of approximately 45 degrees relative to the forklift direction of travel.

The forklift visibility issue discussion in section 2.3.2 indicates that the driver had a field of view impairment located at approximately 38 degrees from the driver's point of view. Further analysis by the Board revealed the blind spot from the forklift design created a field of view impairment which extended from approximately 31 degrees to 44 degrees to the right of the path of travel. Figure 3.3.2-1 represents obstructions to the driver's field of vision from the dewars, the forklift mask, and the post and door frame.

Since the driver and the pedestrian were both maintaining a constant direction of travel and the same relative speed, the Board concludes (if the driver did not physically move to look around the field of view impairment) that the driver could have looked to the right several times and not observed the pedestrian until seconds before the collision. A graphical representation of this possibility is shown below in Figure 3.3.2-2.

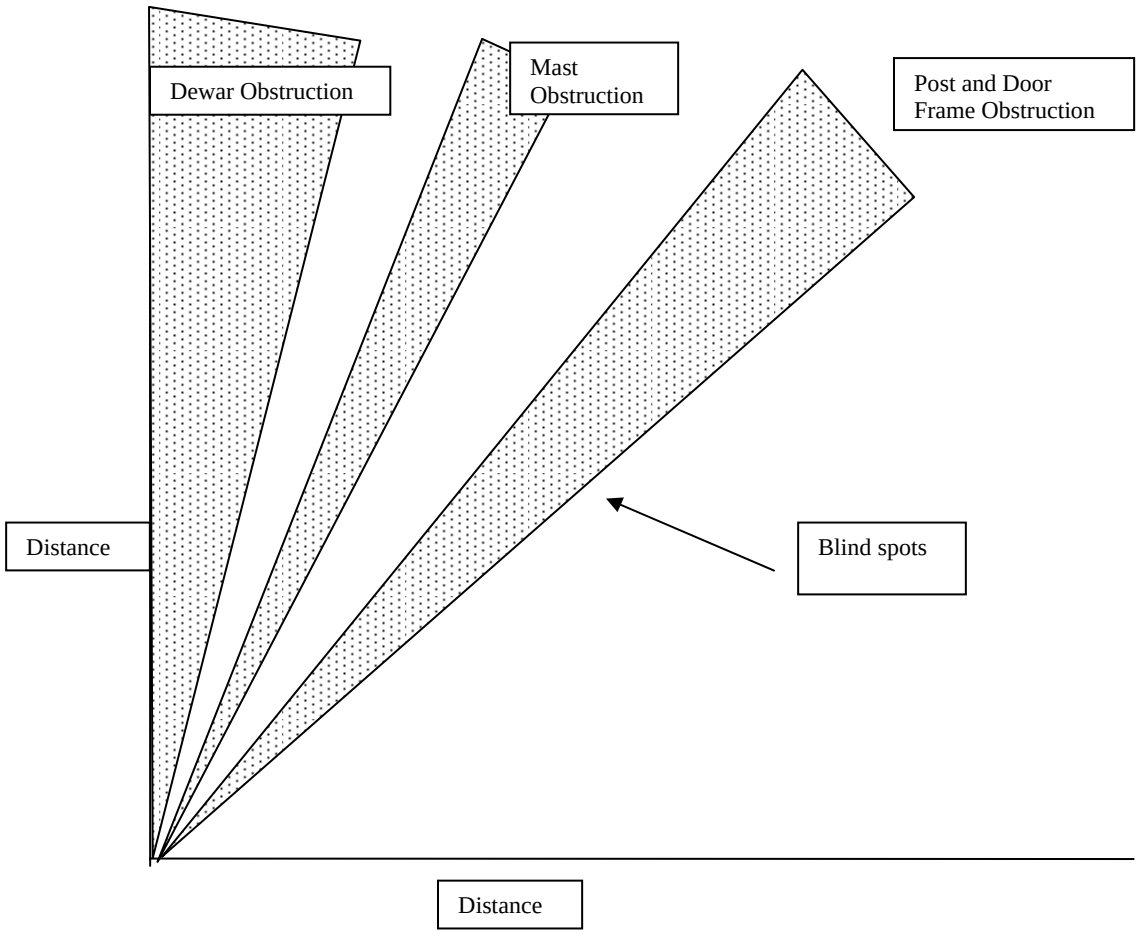

Figure 3.3.2-1. Driver's Field of View From Forklift Seat

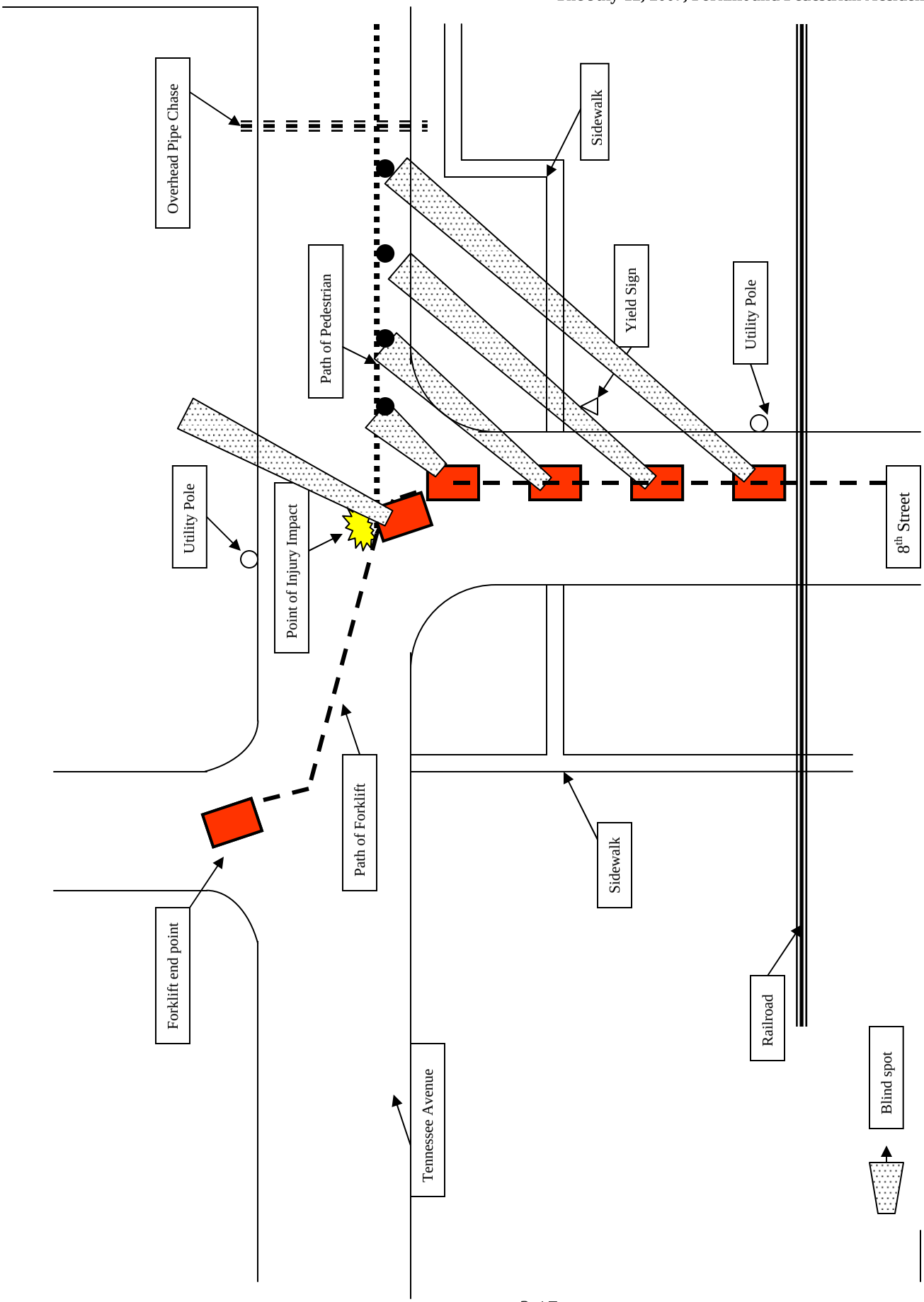

Figure 3.3.2-2. Pedestrian Masked by the Forklift Blind Spot

As indicated in section 2.3.2, the forklift was carrying nitrogen dewars on the day of the incident. The nitrogen dewars and their carrying cage restricted the driver's frontal visibility. The restriction was evident in the Board's reenactment of the accident when the forklift struck a small traffic cone near the center of the street.

Observations were made to determine the magnitude of the blind spot by having the individual move in approximately 1 foot increments. Based upon the observations and assuming no operator body movement, it is estimated that, at 23 feet, the blind spot has a width of 6 to 8 feet centered at an angle of approximately 45 + degrees relative to the forward direction of travel. Tests revealed that the effect of the blind spot can be considerably reduced by operator body movement to the left or right.

3.3.3 Forklift Audibility

An analysis of the data indicates that the change in the decibel levels of the forklift noise would be clearly noticeable to the pedestrian at about 6 feet for a soft site. For a hard site, the noticeable change would be at about 12 feet of the vehicle. In the opinion of the Board, the change in noise perception as the pedestrian and the forklift approached each other, as well as the magnitude of the noise, would indicate that the pedestrian should have been clearly aware of the presence of the forklift.

3.3.4 Forklift Operation

In order to verify the current condition of the forklift, the Board initiated an independent assessment of the forklift, which verified the sound mechanical condition of the forklift from an operational and safety perspective. The maintenance records and the Board's independent assessment provide no indication of any mechanical deficiencies that could be identified as a contributing factor.

The DOE requirements for forklift operation closely parallel those OSHA standards for forklift operation, but provide more prescriptive details on implementation than contained within the OSHA requirements. One of the primary differences between the OSHA standard and the DOE standard is in the area of pedestrian safety requirements. Section 10.5.1.2 (b) of DOE-STD-1090-2004 states that when traveling, the forklift operator should "yield the right-of-way to pedestrians and emergency vehicles. Whenever possible, establish eye contact with approaching pedestrians or vehicle drivers before continuing." The OSHA standard is silent on pedestrian right-of-way. Section 6.9 of the DOE standard for training of forklift operators provides operators with a checklist of factors with which they should be familiar. One of the checklist items is "pedestrian traffic in areas where the forklift will be operated." The OSHA standard has essentially the same language for workplace awareness. As discussed previously, the Board recognizes that there is a disagreement as to whether the DOE standard referenced in this section is applicable to USEC's operations.

The DOE standard in section 10.5.1.2 (f) on visibility impairment due to loads states that an operator should "face in the direction of travel, except if the load being carried obstructs forward view. In such cases, travel with the load trailing." The OSHA standard does not provide specific direction on resolving issues of frontal visibility. In a manner similar to workplace awareness of pedestrians, the OSHA standard for training program content includes visibility as a topic to be considered under the section "Truck-related topics" as item (F) "Visibility," which includes restrictions due to loading.

The USEC training requirements addressed operations in reverse when the frontal visibility is restricted by the load.

If a forklift was considered the most appropriate tool for moving the dewars within the common areas, there were other models of forklifts that could have been used for the task. Alternatively, other

conveyances (e.g., trucks or trailers) with greater visibility could have been used. Since USEC had just recently purchased the particular forklift and used it multiple times each day for moving the dewars and continues to use the forklift for the transportation of the same sized dewars on the same route in the same configuration making multiple trips on the common roads every day, the Board concludes that USEC has apparently accepted the risks posed to any vehicle or pedestrian within the path of the forklift.

Even if that model of forklift was the only one available for purchase, once it arrived and the dewars were loaded for the first time, the obvious visibility problem should have been identified, and USEC should have mitigated it with appropriate controls (e.g., assigning a spotter to accompany the forklift, assuring that the horn is used at appropriate locations where other vehicles or pedestrians are likely, operating the forklift in reverse to assure a clear view of the path ahead, or other mitigation measures).

In the opinion of the Board, the driver was not operating the forklift in a manner consistent with the guidance contained in the USEC PIT training program, and adequate hazard assessment was not conducted relative to the standards and the actual problems associated with operating the forklift in this manner.

3.4 ACCIDENT CONDITIONS

Awareness of surroundings and activities occurring in the surroundings can be influenced by many factors such as state of mind, physical condition, noise, visibility, weather, or undefined distractions. In many situations, sound situational awareness and due diligence can and will prevent many unwanted incidents from occurring.

The most common factor affecting awareness is weather conditions. At 10:30 a.m. on July 12, 2007, the weather in the area of the incident was warm and clear. The Board does not consider the weather to be a significant factor in decreasing the situational awareness of either the forklift driver or the pedestrian. Obscured vision from sunshine can decrease situational awareness. However, the time of the incident and the corresponding elevation of the sun, combined with the directions of travel of the two individuals involved in the accident, led the Board to conclude that no obscured vision due to sunshine impacted either person's situational awareness.

Visibility obstructions from trees and bushes or from buildings, signs, traffic, or other manmade obstructions often interfere with situational awareness. The southeast corner of the intersection of Tennessee Avenue and Eighth Street is totally free from visibility obstructions. The Board does not consider any external obstructions at the intersection to have contributed to the accident.

3.4.1 Pedestrian Situational Awareness

As indicated in section 2, the pedestrian frequently walked in the area of the incident around the same time during her lunch hour and, as such, was familiar with the area and its surroundings. Because of her familiarity with the area, the pedestrian may have been less attentive than necessary. However, prior to the incident, the pedestrian waved to co-workers in a passing van traveling in the opposite direction indicating that at about 20 seconds prior to accident she was aware of traffic on Tennessee Avenue. The pedestrian's situational awareness of the forklift may have been affected by the following factors:

1. Sensory perception of the presence, speed, and direction of the forklift

    - The relative position and direction of the forklift was essentially unchanging over time, which would have made it more difficult to detect and perceive it as a potential threat.

- There is evidence from the interviews that work activities were in progress and employees were standing and talking outside C-600, located to the pedestrian's right. Whatever was occurring could have distracted her attention from the presence of the forklift.

2. General Employee Training provided by her employer, Energy*Solutions*, which instilled a belief that pedestrians have the right-of-way on plant roads except for uranium hexafluoride cylinder haulers, and the instilled belief may have lessened her concerns about vehicles on plant roads.
3. Both the bystanders and driver said that immediately after the accident, the pedestrian was lucid, aware of her surroundings, and aware of what had happened to her, indicating to the Board that there was no evidence of a stroke, seizure, or other debilitating mental condition that could have impaired her judgment just prior to the accident.
4. Based upon review of the professional literature on both of her reported prescription medications, as well as statements by the pedestrian during interviews, the Board concludes there is no indication that regular doses of either could have impaired judgment, perception, or physical function.

Based on these considerations, the Board concludes that the pedestrian should have been able to detect the presence of the forklift and take appropriate avoidance action.

3.4.2 Driver Situational Awareness

The driver frequently traveled the plant roads in the area of the incident. One of the routine, daily scheduled tasks for the forklift driver was the transport of nitrogen dewars to and from the C-600 facility. The Board concludes the forklift driver's familiarity with the area may have decreased her situational awareness of potential danger.

The forklift driver's situational awareness of the pedestrian may have been affected by the following factors:

1. Sensory perception of the presence, pace, and direction of the pedestrian

- The field of view impairment is addressed in section 3.3.2.
- A yield sign was located some 30 feet from Tennessee Avenue. Based on the driver's statement that she stopped before entering the intersection, the Board does not believe this could have influenced the accident.
- The nature of the driver's handwritten notes was that many reflected a high degree of emotional involvement, including anger, frustration, jealousy, revenge, etc. It is possible, that if the driver was writing notes just prior to departing the garage area, as indicated during the interviews, this could have affected her situational awareness.
- The driver may have been looking for vehicles approaching the intersection from the east and west. This could have diverted her attention from the location of the pedestrian in the blind spot and prevented her from detecting the pedestrian as she emerged from the blind spot.
- The driver indicated that she often looked for the truck belonging to the alleged sexual harasser, which is normally parked to her left when approaching the intersection. Due to the great distance from the intersection to the C-724 parking area, the Board does not believe the truck could have been seen.
- The driver's prescription medications could have impaired her concentration on tasks or her judgment, alertness, or responsiveness.

- The driver's physical condition may have adversely affected her ability to turn her body or twist her neck in order to detect the presence of vehicles or other hazards. At a minimum, she stated that performing these motions caused her pain.

- Whatever activities may have been occurring at C-600 also may have served to distract the driver's attention.

2. Site vehicular policies and training provided by USEC, which instilled a belief that vehicles had the right-of-way on plant roads with the exception of uranium hexafluoride cylinder haulers and pedestrians in designated crosswalks (of which there were none in this area of the plant), may have lessened her awareness of pedestrians on plant roads.

The Board concludes that there were sufficient factors that could have impacted her ability to detect the presence of the pedestrian and take appropriate avoidance actions.

The driver indicated that she stopped at the intersection. While this may have occurred, the Board believes that if she had stopped as indicated, the brisk speed of the pedestrian should have been clearly evident to an alert and attentive driver.

3.4.3 Emergency Response

As discussed in section 2.7, the emergency response provided following the forklift accident was prompt and professional. However, a weakness in initiating the response likely resulted in a delay in getting Security involved in providing traffic control and performing its vehicle accident investigation. Specifically, improper radio use protocol likely contributed to a failure in identifying the urgency of the incident and clearly summoning the PSS to an emergency. Other radio communications between Medic 1, the PSS office, and the Site Medical Services were professional with demonstrated use of alpha phonetics and repeat backs.

While prompt attention was provided and individual actions were taken to control traffic to protect the injured pedestrian, the need for crowd control was highlighted by the emergency medical technicians when they arrived on the scene. Additionally, the Board concludes that control of the accident scene and the vehicle involved in the accident to ensure all potential physical evidence was gathered, prior to releasing the area and equipment for routine use, was deficient.

3.5 MITIGATION

3.5.1 Interim Controls

USEC, PRS, and SST took immediate actions, including replacing the yield sign at the intersection with a stop sign, stopping recreational walking, and sending out bulletins and follow-up reminders. In addition, USEC took disciplinary actions and suspended the driver's certification for driving PITs.

There is no evidence that a site-wide approach has been taken regarding retraining forklift drivers or evaluating the proper selection and use of vehicles for the particular task, overall vehicle blind spots, and/or visibility limitations. The Board concludes the interim controls or compensatory measures taken in response to the accident were less than adequate.

Although actions were taken to heighten awareness, USEC is continuing to transport the nitrogen dewars using the same forklift and in the same configuration. The problem with this was evident when the stand-

in driver ran over the traffic cone during the accident investigation. Additionally, walking still occurs in a business context on the Site and there is no resolution of the conflict as to when a pedestrian has the right-of-way with respect to a vehicle.

On September 17, 2007, information was provided by USEC that indicated an initiative to reevaluate all forklift activity to minimize transporting loads by forklift across plant roads was taken. A follow-up discussion with the USEC Plant Manager indicated he had directed all his functional managers to update their sections of the USEC Business Plan to incorporate this evaluation and any subsequent actions needed to implement changes. However, material and equipment movements using forklifts remains unchanged pending the completion of the reevaluation and implementation of any identified modification to the use of forklifts.

The DOE-HQ chartered individual concluded the short-term actions would enhance awareness in the near term, but there are a number of pedestrians that are routinely in the plant as part of work activities for which the recreational walking prohibition has no effect and the long-term corrective actions appeared to be appropriate. He also recognized the complexity and challenge presented by the relative roles and responsibilities of DOE, the DOE contractors, and USEC, especially as there are two sets of standards in force on the Site (DOE and NRC). The Board agrees with these conclusions.

3.5.2 Corrective Actions

Three separate efforts were initiated to understand deficiencies and develop corrective actions. The Board recognizes the three independent corrective action efforts are fruitful and timely. The corrective actions being taken are identified in section 2.9.

To date, no comprehensive, site-wide, and fully integrated resolution of the deficiencies and implementation of site-wide policies and corrective actions has occurred. The Board considers this to be a high priority needed to help prevent developing or implementing any conflicting, confusing, or contradictory mitigative actions and policies and to prevent additional accidents and injuries.

3.5.3 Site-wide Safety Integration and Cross-talk

There are four existing organizations and programs at the Site that independently exhibit beneficial attempts to consider the needs and safety concerns site-wide. These are as follows:

- Shared Site Committee
- Site Council
- STOP Committee
- FESS Committee

The Board determined that these committees do not all have clearly defined charters, defined responsibilities and authorities, and procedures in place to implement effective performance. Their historical performance reveals inadequate site-wide integration and inconsistent participation to provide maximum benefit to all Site workers. There also is an apparent disconnect within the DOE contracts pertaining to flow down of requirements to DOE contractors for implementing the Shared Site Agreement and the Joint Policy Statement.

The process for addressing shared site issues failed to adequately resolve issues such as pedestrian-vehicle interface on the Site. Concerns regarding the risks of the type that led to this accident have languished with no consolidated resolution by the organizations to address this type of concern. Considerations

regarding the cost of implementing simple changes (e.g., painting crosswalks, aligning procedures for vehicle-pedestrian right-of-way, and placing traffic signs at busy intersections) apparently have interfered with the immediate mitigation of some of the identified hazards, with the exception of USEC installing a stop sign at the particular intersection where the accident occurred.

The membership, agenda, the charter, the purpose, actions, and the outcome from these four site-wide organizations are not coordinated, funded, or formally established, and performance is not as effective as it could be. In many cases, the organizations are strictly voluntary and were established by the concerned ES&H Managers as an attempt to attain site-wide coordination, awareness, sharing of information and consolidated approaches to the Site's requirements.

The Board believes that improvements must be implemented for these four organizations with regard to the following:

- Improved charter, functional direction, and agenda.
- Required attendance.
- Improved level of input.
- Establishment of clear responsibilities, expectations, and authorities.
- Absolute direction to fully integrate and consider the needs of all Site organizations and their employees in the development and implementation of safety aspects for the Site.
- A process to resolve disputes to achieve timely resolution of safety-related issues.
- Appointment of DOE as the responsible party for managing the integrated effort of these committees.

3.6 LIKELY ACCIDENT SCENARIO

The pedestrian likely remained in the obstructed field of view caused by the forklift post and window until the forklift slowed at the intersection. The pedestrian passed through the driver's field of view undetected by the driver and, unaware of the forklift, was struck on the left side (pedestrian statement) in the shoulder area. This likely caused the pedestrian to fall to the roadway where the basket went over the back of the pedestrian's legs, which resulted in rust marks on pants. The forklift then continued the turn resulting in the rear wheel of the forklift traveling up the side of the pedestrian's right leg resulting in the damage to the soft tissue.

The Board came to no conclusion as to the direct cause for each party's failure to detect the other's presence. The most likely cause of the pedestrian's failure to detect the forklift was an unknown distraction. The driver reported she had taken her daily prescriptions on the morning of the accident. The most likely cause of the driver's failure to detect the presence of the pedestrian was a combination of 1) perceptive impairment from her prescription medication, 2) physical disabilities that limited her ability to position herself to maximize visibility, and 3) failure to adequately slow and look for vehicles or pedestrians approaching the intersection.

Both parties failed to adequately pay attention to their surroundings. Clearly, this accident could have been prevented by an increased situational awareness by either party.

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4. CAUSAL FACTOR ANALYSIS

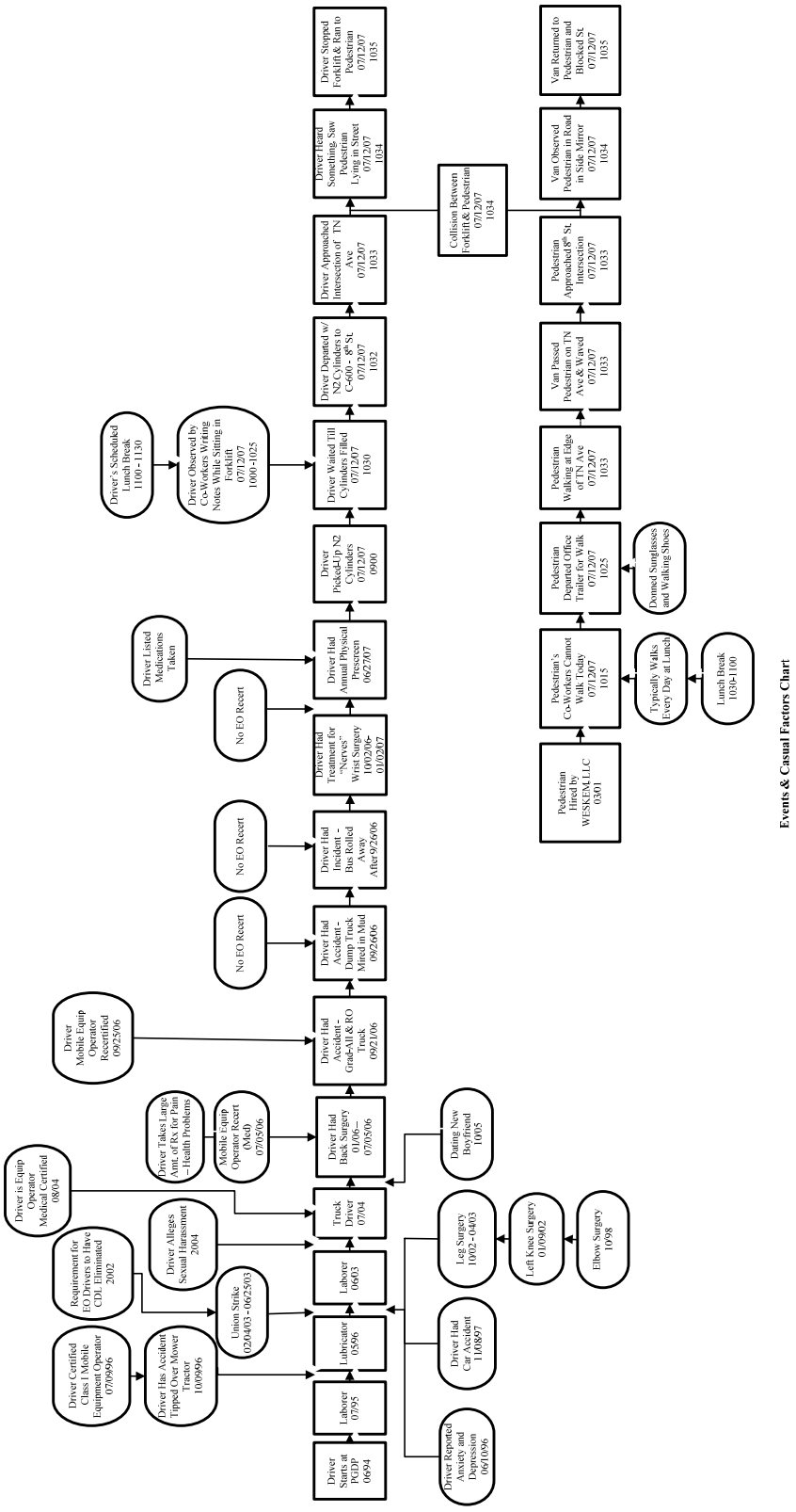
4.1 EVENTS AND CAUSAL FACTORS ANALYSIS

As the Board began gathering information about the accident and related management system performance, significant events were assembled to create a timeline of the accident scenario. Conditions that described or modified each event were linked to the respective event to create an Events and Causal Factors (E&CF) wall chart. This process continued as new information was identified resulting in more notes on the E&CF wall chart. Periodically during the first few days of the investigation, the Board reviewed the E&CF chart as a group to understand the progression of events and conditions and to identify topics or areas where more information was needed to fully understand the accident sequence. During these reviews, the Board identified several areas representing weaknesses or deficiencies that could have potentially contributed to the accident. As this analysis progressed, it became apparent that several recurring areas of potential deficiencies existed with respect to safety programs and areas of management performance.

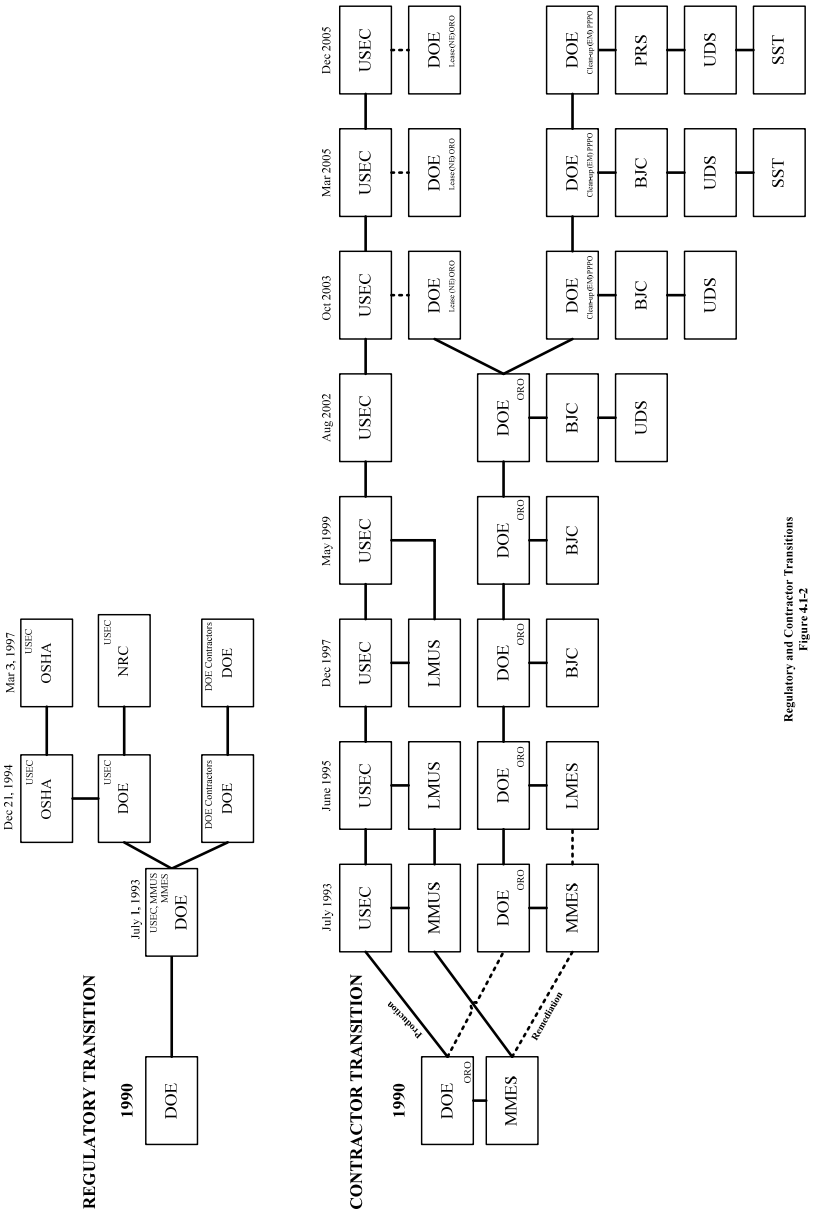
Areas of potential weakness or management deficiency that were identified by the Board were as follows:

- Fitness for duty for the forklift driver, both medical and performance.
- USEC management involvement in forklift driver's performance evaluation.
- Internal self-assessment of USEC safety management programs and performance.
- External oversight of USEC safety management programs and performance.
- USEC forklift training and qualification program, including certification and recertification.
- Traffic safety policies (i.e., definition, dissemination, and worker understanding).
- USEC Hazard identification and analysis for work controls.
- Differing missions evolving at the Site.
- Clearly defined and understood roles and responsibility for safety and oversight.
- Issues management and corrective actions.
- Sharing and implementation of lessons learned information.

Because the E&CF wall chart contained a huge amount of detailed information, the wall chart was eventually condensed to represent a fairly high level of information that would serve as a useful diagram to understand the events and conditions that contributed to the accident. This resulted in two separate diagrams, see Figures 4.1-1 and 4.1-2.



Events & Casual Factors Chart
Figure 4.1-1



Regulatory and Contractor Transitions
Figure 4.1-2

4.2 CHANGE ANALYSIS

A change analysis was conducted to identify and better understand the changes that have occurred at the Site over time that may have contributed to the accident. The analysis initially identified the series of Site management and regulatory oversight changes that occurred as a result of the EPAct 1992. Upon promulgation of the EPAct 1992, USEC was established as a government-owned corporation to continue uranium enrichment production activities. Subsequently, a Lease Agreement was signed between USEC and DOE on July 1, 1993, which defined conditions for facility maintenance and use of the existing facilities at the Site, and an MOU was signed between DOE and DOL, which established DOL/OSHA responsibility for regulatory oversight for all occupational and industrial safety at the Site. DOE retained primary responsibilities for nuclear and radiological safety at the Site until March of 1997, by which time the NRC had issued a certificate for uranium processing under NRC regulatory control. Upon signing an MOU between DOE and NRC, the NRC assumed regulatory authority for nuclear safety and radiological oversight for the USEC operations involving nuclear material based upon their certificate.

Other changes that occurred are as follows:

- DOE implements ISMS policy.
- Number of contractors performing work at the Site increases.
- Different lunch hour schedules evolve.
- USEC implements restrictions on jogging.
- Conflicting right-of-way guidance emerges.

This analysis resulted in the identification of some issues related to the changes that had occurred, as depicted in Table 4.2-1:

- Increased numbers of organizations at the Site and increased lines of communication.
- Increased numbers of regulators responsible for work at different Site areas.
- A plethora of interfaces (for organizations performing work and three regulatory agencies) led to agreements attempting to define authorities for controlling work.
- Increased guidance for pedestrian safety was conflicting and confusing.
- Divided responsibilities (stovepiping) within DOE.
- Shared Site Agreement not updated to be consistent with changed conditions.
- Site employees performing work while other employees were on lunch breaks.
- Reduced safety professional staffing levels.
- Less experienced drivers on-site.
- A part-time licensed physician to provide medical services.

The Board concludes that these issues could have contributed to confusion and a decrease in the safety of conditions at the Site.

Table 4.2-1 Change Analysis

Original Condition	Changed Condition	Effect of Change
No DOE site office on-site.	DOE established DOE Paducah site office. (1989)	DOE on-site presence provides day-to-day DOE programmatic management and oversight at PGDP.
A single consistent site-wide mission. Single M&O contractor under DOE regulatory authority.	Site remediation started. Two missions exist on-site – a production mission and an environmental remediation mission. (~1990)	Minimal impact. Funding split between DOE HQ programs (NE and EM).
A single contractor operated the PGDP site for DOE with 2 missions.	USEC created as a government corporation via EPAct of 1992. USEC assumes operation of production facilities. Two divisions of Martin Marietta perform two differing missions under DOE regulatory authority. (1993)	Different divisions of Martin Marietta and USEC require working in shared areas. More contractors results in an increased number of lines of communication in order to inform, plan, coordinate, and perform work. Different standards for controlling work evolve.
DOE regulatory oversight of all site entities. Consistent site policies on industrial safety.	OSHA regulatory oversight of USEC industrial safety. DOE regulatory oversight of USEC nuclear safety and security and DOE contractor. (1994)	Different regulators with different standards for industrial safety in leased areas. Different rules and standards for safety and health apply at different locations. Potential for misunderstanding roles and responsibilities, authorities, and accountabilities.
OSHA regulatory oversight of USEC industrial safety. DOE regulatory oversight of USEC nuclear safety and security and DOE contractor. Consistent site policies on nuclear safety.	NRC assumes regulatory oversight of USEC for nuclear safety and security activities. OSHA regulatory oversight of USEC industrial safety remains unchanged. DOE retains regulatory oversight of DOE contractors. (1997)	More diverse interface and increased lines of communication. Resolution of shared site issues develops to define roles and responsibilities for USEC certification. Also defines regulatory criteria (NRC/OSHA vs. DOE) applicable to site work activities and areas.
DOE contractor performs environmental remediation using an M&O contract.	DOE replaces contract with a management and integration (M&I) contract and a new contractor. (1997)	Increases the number of subcontractors on-site performing work activities for the DOE contractor resulting in more complicated work control for planning and coordination and increased need for enhanced communication.
DOE safety policy based on DOE industry standards. Expert based implementation. Work controls were situational and performance based.	DOE implemented enhanced safety management policy under the ISMS policy. (1998)	DOE requires its contractors to implement ISMS and achieve certification via a multi-faceted independent verification by DOE of the adequacy of the ISMS program's implementation. USEC, as a private corporation regulated by OSHA, is not required to implement ISMS. No equivalent upgrades or evaluations.
USEC operates as a government corporation.	USEC is privatized via the Privatization Act. (1998)	Privatization language confirms OSHA oversight of USEC, establishes the transfer of the lease, and establishes financial responsibilities pre-privatization liabilities.

Original Condition	Changed Condition	Effect of Change
Cylinder haulers have right-of-way for entirety of PGDP site.	DOE contractor training program is changed to accommodate multi-site nature of M&I contractor with PGDP site training. Cylinder haulers still have right-of-way for USEC activities except at crosswalks. DOE contractor's guidance is provided for pedestrian right-of-way.	Conflicting guidance between DOE general contractor and site-specific training modules on pedestrian/vehicle right-of-way. Informal transition from 'cylinder haulers have right-of-way' to 'all vehicles have right-of-way, and pedestrians only have right-of-way in designated crosswalks.'
USEC operates PGDP using an M&O contractor.	USEC self-performs operation of PGDP. (1999)	Eliminates contractor interface and establishes clear responsibilities with a single voice for all USEC activities.
A single site-wide contractor determines work schedules and lunch hours.	DOE contractor and USEC establish different work and lunch hour schedules. (~ 1998)	Site personnel performing work while others are at lunch/break.
DOE performs cleanup and cylinder management activities with a single M&I contract (BJC).	DOE awards an award fee contract for conversion facility design, construction, and conversion services (UDS). The M&I contractor (BJC) remains for cylinder management activities and cleanup activities. (2002)	Little change as conversion facility design activities are primarily off-site. Groundbreaking occurs in July 2004 and adds an additional DOE contractor presence resulting in more complicated work control for planning and coordination and increased need for enhanced communication.
DOE manages lease (NE) and contractor oversight activities (EM) at PGDP out of the Oak Ridge Office (ORO) with a site office located at PGDP.	DOE creates the PPPO for managing cleanup activities at Paducah. (EM) Lease management activities remain with ORO. (NE) (2003)	Results in divided DOE roles and responsibilities between PPPO and ORO for DOE activities at PGDP resulting in need for more coordination and increased need for enhanced communication.
DOE contractors include an M&I contractor performing cleanup and cylinder management activities (BJC) and an award fee for conversion facility construction and operation (UDS).	DOE awards a cost plus award fee contract for infrastructure work (SST) and transitions cylinder management to the existing award fee contract for conversion services (UDS). The M&I contractor (BJC) remains for cleanup activities. BJC procedures blue sheeted. (2005)	Additional DOE contractor presence results in more complicated work control for planning and coordination and increased need for enhanced communication. Conflicting guidance on pedestrian/vehicle right-of-way for site.
DOE contractors include a cost plus award fee contract for infrastructure work (SST), an M&I cleanup contract (BJC), and an award fee contract (UDS) for conversion services and cylinder management.	DOE awards a cost-plus incentive fee contract (PRS) for cleanup activities. DOE contractor for infrastructure work (SST) and for conversion services and cylinder management (UDS) remain unchanged. BJC procedures blue sheeted. (2005)	New DOE contractor presence results in more complicated work control for planning and coordination and increased need for enhanced communication. Conflicting guidance on pedestrian/vehicle right-of-way for site.

Original Condition	Changed Condition	Effect of Change
There is no official policy on jogging or recreational walking on-site roads and areas.	USEC issues a policy bulletin to prohibit jogging on the Site. (2007)	Jogging is discouraged, but recreational walking is not addressed. Although the intent is to discourage jogging it is ineffective, leading to an increase in the number of pedestrians and increase in the number of pedestrian interfaces.
Drivers are required to obtain CDL for PIT operation.	USEC eliminates requirements to obtain CDL for PIT operation. (2002)	Less qualified and experienced drivers.
Full-time licensed physician in charge of USEC Medical Services. Full-time physician assistant for support.	Full-time physician assistant in charge of USEC Medical Services. Part-time licensed physician for support.	Reduced training and qualification level and reduced availability to provide medical evaluation of employees reduces likelihood to question a physician's statement.
"Joint Policy Statement on … Shared Site Issues" is developed between DOE and USEC with one contractor providing contract services for both parties.	New contractors are hired to perform DOE cleanup activities and USEC is privatized. Joint Policy Statement is not flowed down into DOE contractors.	The "Joint Policy Statement on …Shared Site Issues" is not updated for unresolved items. Implementation of items addressed by the Joint Policy is reduced as deemed necessary by the involved parties. Becomes highly reliant on Shared Site Committee without a requisite improvement of formality of the interactions of the Committee.

4.3 BARRIER ANALYSIS

A barrier analysis was performed in an attempt to better understand the accident sequence. Apart from the failure of the final barriers for each individual in preventing a collision (situational awareness), deliberations amongst the members revealed the following issues that either appear to have failed or could have potentially failed. These are organized under the five elements of integrated safety management (ISMS):

- Define the scope of work
  - Differing or conflicting missions.
  - Clearly defined roles and responsibilities for safety, oversight, and performance of work.
  - Walking was not a defined task.
- Identify and analyze the hazards
  - Pedestrian safety/traffic safety programs.
  - Lessons learned program to incorporate lessons learned from recent events into current work controls.
  - Hazard identification and analysis for existing work processes.
- Develop and implement controls to mitigate hazards
  - Fitness for duty program to ensure workers are capable of safely performing work.
  - Training and qualification program for forklift operators.
  - Traffic controls (signs, crosswalks, and sidewalks).
- Perform work within controls
  - Experience, skill, and abilities of the forklift operator.
  - Integrated and effective communications between affected organizations.
- Feedback and Improvement
  - Internal self-assessments to evaluate and correct identified weaknesses or deficiencies.
  - Issues management and corrective action processes.
  - External oversight for compliance/conformance to requirements.
  - Employee concerns program for reporting and resolving safety issues.

The specific barriers that were evaluated to assess the effects on the accident are shown in Table 4.3- 1.

Table 4.3-1. Barrier Analysis

Barrier	Purpose	Analysis/Effect on Incident
Physical Barriers		
Traffic Control Devices	To control traffic and pedestrian flow to prevent injuries from collisions.	Traffic control devices (i.e., yield sign and marked crosswalks) were not located in the immediate vicinity of the intersection. This may have contributed to confusion by driver.
Forklift Roll Cage and Weather Enclosure	To prevent injury to forklift driver in the event of a rollover.	Forklift roll cage limited driver field of view affecting ability to see pedestrian approaching intersection and contributing to a collision (unintended consequence).

Barrier	Purpose	Analysis/Effect on Incident
Concrete Sidewalk near Intersection	To separate pedestrians from vehicle traffic.	Sidewalk locations not conducive to use by pedestrians crossing intersection, contributing to jaywalking and contributing to an increased probability of a collision.
Management Barriers		
Work Planning and Control/Activity Hazard Analysis	Identifies the scope of work and the hazards. Controls implemented to mitigate hazards.	1. Recreational walking not identified as a work activity on-site, which resulted in employee performing an unanalyzed activity. 2. Work-related walking not identified as a work activity on-site, which resulted in employee performing an unanalyzed activity.
Work Planning and Control/Activity Hazard Analysis	Identifies the scope of work and the hazards. Controls implemented to mitigate hazards.	No hazard analysis performed for transporting nitrogen dewars by forklift resulting in unidentified and uncontrolled hazards from unanalyzed activity.
Guidance on Pedestrian/Vehicle Traffic Interface	Determines "Rules of Road" for pedestrian/ vehicular right-of-way at the PGDP site.	Conflicting guidance resulted in misunderstanding of responsibilities. Both parties involved in the event may have assumed they had the "right-of-way" at the intersection.
Shared Site Communication	Identifies work and hazard impacts to co-located site tenants.	Ineffective identification, communication, and resolution of shared site issues and activities with impacts on overall safety (e.g., lessons learned, corrective actions) increased the potential for unintended interactions such as the collision.
Lessons Learned	Early detection and identification of safety issues and implementation of controls to prevent recurrence.	While each on-site entity appears to have an effective lessons learned program, there is ineffective cross sharing of lessons learned on-site (e.g., PRS forklift suspension) to prevent recurrence of incidents.
Type A Corrective Actions	Preclude recurrence of forklift fatality.	No evidence available to show what actions were taken. No evidence of DOE complex-wide pedestrian safety policy.
Management Barriers (continued)		
Fitness for Duty Verification	Ensures physical and mental capabilities of site personnel who handle hazardous material and machinery.	USEC Fitness for Duty Program appears to be adequate; however, implementation deficiencies failed to provide assurance that the driver was capable of performing assigned activities safely.
Self-Assessment Program	Ensures that management systems and processes are in accordance with regulatory requirements and commitments.	A USEC self-assessment of industrial safety has not been performed recently. USEC was unable to provide evidence that a self-assessment of the Fitness for Duty Program or Training and Qualification Programs for industrial equipment drivers had been performed.
Shared Site Committee Meetings	Identifies and resolves issues affecting multiple parties, including safety.	Shared site members do not have the necessary authority to resolve significant conflict or issues. Senior managers from all organizations are not always present at the shared site meetings and identified issues and conflicts may take some time to either be resolved or

Barrier	Purpose	Analysis/Effect on Incident
		carried to senior level management. Some issues pertaining to pedestrian safety were raised and discussed. Had the significant differences between the DOE contractor "GET" training and USEC policy been resolved, the "right-of-way" issue could have been corrected before the incident.
Site Council	Site Council meetings resolves management issues including safety concerns.	Site council is an informal group without defined roles, responsibilities, and authorities and no clear mission, and no minutes or other records are kept regarding the substance of the Council's meetings. There is no evidence that problem of conflicting traffic policy/ guidance was raised to the Site Council.
Forklift Operator Training	USEC forklift training procedure CP2-SH-IS204, *Use of Powered Industrial Trucks* requires the operator to "keep a clear view of the path of travel and observe for other traffic, personnel, and safe clearance."	The operator did not have a clear view of the path of travel, which could have contributed to the accident.
Effective Employee Concerns Programs	Employee awareness and involvement to raise and correct safety issues/ problems.	USEC employees who were aware of problems did not raise safety concerns, or the USEC management action on concerns raised was inadequate.
Forklift Operator Recertification	Ensures forklift drivers can drive safely.	Performance was not compliant with the requirements. Opportunities were missed to evaluate driver's performance and ensure competent operation.
Selection of Proper Equipment for Task	Selects right tool for the job to assure safety.	No hazard analysis performed to identify and mitigate hazards due to transporting nitrogen dewars.
Management Barriers (continued)		
External Oversight for Industrial Safety	Ensures that safety programs are properly implemented and effective.	An infrequent OSHA site presence to assess the Industrial Safety Program and implementation may have contributed to LTA implementation of controls pertaining to forklift safety.
External Oversight for Industrial Safety	Ensures that safety programs are properly implemented and effective.	Inconsistent or LTA DOE or NRC oversight to assure effective implementations of controls pertaining to forklift safety for DOE contractor employees and nuclear material transportation.
Issues Management and Corrective Action Process	Resolve issues through appropriate corrective actions to correct problems and prevent recurrence.	Some issues, which may have helped prevent the accident, were identified, discussed in various forums, but ultimate resolution was not fully achieved.
Human Barriers		
Recognition of the	To identify threats while	The pedestrian did not see or hear the approaching

Barrier	Purpose	Analysis/Effect on Incident
Approaching Forklift	walking.	forklift despite the fact that there was no visual obstruction to impede the field of vision. The pedestrian failed to take avoidance action.
Recognition of the Approaching Pedestrian	To avoid hitting pedestrians.	Driver failed to detect and avoid pedestrian.

The Board concludes that there were multiple failures of management systems and physical controls established to prevent the accident at all levels within all involved organizations. There also is evidence that most of the failures remain uncorrected, which could lead to a repeat event.

4.4 MANAGEMENT OVERSIGHT AND RISK TREE ROOT CAUSE ANALYSIS

The Board conducted a Root Cause Analysis using the Management Oversight and Risk Tree (MORT), which illustrates a series of interrelated questions about the system factors and management control system factors that guide the safe operation of an organization. MORT is a graphic checklist that provides a disciplined method for determining the systematic causes and contributing factors of accidents. For all elements discussed, LTA = less than adequate.

4.4.1 DOE, USEC and PRS Causal Factors

The following causal factors were determined to be common to all organizations, and likely contributed to the accident.

4.4.1.1 DOE, USEC and PRS Management Factors

1. [Policy] Up to Date LTA (MA1a1) [Policy LTA] – Although there were agreements in place for identification and resolution of site-wide issues, they were not up to date and did not address current organizations' roles and responsibilities.
2. [Policy] Written LTA (MA1a2) [Policy LTA] – Although there were governing agreements in place for identification and resolution of site-wide issues, they were not documented or flowed down into procedures for effective implementation.
3. [Policy] Consistent at All Organizational Levels LTA (MA1a7) [Policy LTA] – Although there were policies in place for vehicle and pedestrian interaction, they were inconsistent between the various Site organizations. Site management failed to appropriately integrate vehicle and pedestrian interaction safety policies across the Site.
4. Known Precedent LTA (MA3/MB2/SD1a1b2c4) [Knowledge LTA; Technical Information LTA; Technical Information System LTA; Risk Assessment System LTA] – Precedent event (1991 forklift/pedestrian fatality accident) was unknown within Site organizations. Corrective actions were not recognized, applied, or effective to prevent recurrence.
5. Internal Communication LTA (MA3/MB2/SD1a1b2c3) [Technical Information LTA; Technical Information System LTA; Risk Assessment System LTA] – Although recreational walking and jogging had been identified as a potentially hazardous situation, management within each Site organization failed to communicate the need to evaluate the hazards associated with recreational walking. No controls were implemented.
6. External Communication LTA (MA3/MB2/SD1a1b2c4) [Technical Information LTA; Technical Information System LTA; Risk Assessment System LTA] – Although recreational walking and

jogging had been identified as a potentially hazardous situation, Site management failed to communicate the need to evaluate the hazards associated with recreational walking with other Site organizations.

7. Inspection Plan LTA (MB2a2b10) [System Design and Development Plan LTA; Hazard Analysis Process LTA] – Although barriers existed (sidewalks) to separate the pedestrian from the forklift, they were not suitable for use; were not convenient; and were, therefore, not used. Similarly, inconsistent and unclear policies for pedestrian and vehicle interaction were known, and conditions of differing lunch periods were recognized. Although the technical information was available and understood, Site management failed to evaluate the hazards associated with walking in the roads.
8. Engineering Studies LTA (MB3a2b20c41) [System Design Plan LTA; Design and Development Plan LTA] – Site management failed to perform an evaluation of the configuration and adequacy of the existing traffic and pedestrian control devices.
9. Safety Goals and Risks Not Defined (MB3a1b1c10) [Definition of Goals and Tolerable Risks LTA; Concepts and Requirements LTA; Hazard Analysis Process LTA] – Although Site management permitted recreational walking to continue, there is no evidence that the significance of the hazards or consequences of accidents were considered.

4.4.1.2 DOE, USEC and PRS System Factors

1. Barriers Failed (SC2/SB1a2c1) [Between (Pedestrian and Forklift) Barriers LTA; Barriers and Controls LTA] – Site management understood the barriers and controls were LTA (e.g., the sidewalks that were available for use to protect the pedestrian from the vehicles were not appropriately located, were not suitable for use, were not convenient, etc.) resulting in the pedestrian deciding to walk in the road.
2. Barriers Not Provided (SC2/SB1a4c1) [Separate in Time and Space; Barriers LTA] – Although Site management was aware of conditions of differing lunch periods, no controls or measures were implemented to provide protection for the pedestrian while walking during her lunch period at the same time that the driver was performing work tasks.
3. Job Hazard Analysis Not Performed (SD5a5b3c9) [Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – Although recreational walking and jogging had been identified as a potential problem, Site management failed to perform an analysis of the hazards associated with recreational walking where vehicles were driving and failed to implement controls.

4.4.2 DOE Causal Factors

For the DOE organization, the Board determined the following additional causal factors were applicable and which likely contributed to the accident.

4.4.2.1 DOE Management Factors

1. [Policy] Written LTA (MA1a2) [Policy LTA] – Although there were governing agreements in place for identification and resolution of site-wide issues, they were not documented or flowed down into contracts for effective implementation.
2. [Policy] Congruence With Organizational Goals LTA (MA1a11) [Policy LTA] – Assignment of line management responsibilities and authorities within DOE were not clearly defined with respect to oversight of USEC performance to provide appropriate levels of safety and compliance with terms of the agreements between DOE and USEC. Alignment with organizational goals was LTA.

3. Execution LTA (MA3/SA2a1b2c3) [Prevention of Second Accident LTA; Amelioration LTA; Risk Assessment LTA] – Corrective actions from precedent event (1991 forklift/pedestrian fatality accident) were not effectively implemented to preclude a recurrence.

4.4.2.2 DOE System Factors

Management Concern, Vigor and Example LTA (SD5a5b3c14d17e24) [Employee Motivation LTA; Personnel Performance Discrepancy; Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – DOE involvement in and leadership of the process to manage resolution of site-wide safety issues affecting its contractors is LTA, such that issues that were identified were not adequately resolved.

4.4.3 USEC Causal Factors

For the driver and her management organization, the Board determined the following additional causal factors were applicable and likely contributed to the accident.

4.4.3.1 USEC Management Factors

1. Safety Goals and Risks Not Defined (MB3a1b1c10) [Definition of Goals and Tolerable Risks LTA; Concepts and Requirements LTA; Hazard Analysis Process LTA] – Notwithstanding the significant evidence to indicate inability to safely perform duties, USEC management allowed the driver to continue to drive vehicles. There was no evidence that consequences of errors were considered.
2. Did Not Predict Errors (MB3a2b8c31d6) [Human Factors Review LTA; System Design and Development Plan LTA; Hazard Analysis Process LTA] – The driver failed to identify the presence of the pedestrian.
3. Under Fitness for Duty (MB3a2b13c39d18) [Fitness for Duty LTA; Hazard Analysis Process LTA] – the following causal factors were identified:

    a. Abilities LTA (a1b1c1) [Physiological Factors LTA] – The driver experienced pain from physical movements, including twisting, turning, and bending her body, which severely limited her ability to perform driving duties in a safe manner.
    b. Drug Impairment (a1b2c3) [Psychological Factors LTA] – Heavy doses of prescription pain medications, with warnings concerning operating equipment, could have impaired the driver's judgment, attention, or response to hazards.
    c. Stress (a1b2c3) [Psychological Factors LTA] – The driver had a number of external stress factors, which may have significantly affected her ability to perform her duties safely.

4.4.3.2 USEC System Factors

1. Task Performance Errors (SB4a1b2c3) [Prevention of Second Accident LTA; Amelioration LTA] – USEC management failed to take appropriate actions following the driver's involvement in the series of accidents in September 2006.
2. Did Not Relate Accident to Prior Errors (SD5a1b1c2d4) [Detection Plan LTA; Did Not Detect or Correct Hazards; Supervision LTA] – USEC management did not correlate prior events in September 2006 with performance errors and take appropriate actions.
3. Job Hazard Analysis Not Performed (SD5a5b3c9) [Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – Although driving with restricted forward visibility was a known problem,

USEC management failed to perform an analysis of the hazards associated with transporting the nitrogen dewars in forward direction. Selection of vehicle for the task was LTA.

4. Deviant Performance (SD5a5b3c11d13) [Did Not Use Safety Analysis Recommended Controls; Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – USEC personnel failed to recognize the hazards associated with driving the forklift with restricted vision and failed to implement appropriate controls, as specified in the USEC training material.
5. Personnel Selection LTA (SD5a5b3c14d14) [Personnel Performance Discrepancy; Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – Evaluation of performance limitations (i.e., physical and mental) for the driver failed to detect problems that could lead to errors. This included the direct supervisor, others in line management, Safety and Health support organization, and the Director of Medical Services.
6. Fitness for Duty LTA (SD5a5b3c14d18) [Personnel Performance Discrepancy; Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – USEC evaluation of performance limitations for the driver (physical and mental) failed to detect problems that could lead to errors. This included the direct supervisor, others in line management, Safety and Health support organization and the Director of Medical Services.
7. Did Not Observe (SD5a5b3c14d16e22) [Consideration of Deviations LTA; Personnel Performance Discrepancy; Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – USEC failed to detect and correct problems, including performance errors, physical limitations, stressors, etc., that could lead to errors. This included the direct supervisor, others in line management, and Safety and Health support organization.

4.4.4 DOE Contractor Causal Factors

For the pedestrian and her management organization, the Board determined the following additional causal factors were applicable and likely contributed to the accident.

4.4.4.1 PRS Management Factors

Did Not Predict Errors (MB3a2b8c31d6) [Human Factors Review LTA; System Design and Development Plan LTA; Hazard Analysis Process LTA] – The pedestrian failed to identify the presence of the forklift threat.

4.4.4.2 PRS System Factors

1. Task Assignment LTA (SD5a5b4c8) [Task Performance Errors, Supervisor Performance Errors, Supervision LTA] – Recreational walking was not considered a task. Walking was not evaluated and applicable hazards identified for correction. No controls were established to provide specific safety measures for ensuring safety for pedestrians.
2. Deviant Performance (SD5a5b3c11d13) [Recommended Controls Not Used] – The sidewalks that were available for use to protect the pedestrian from the vehicles in the road were not suitably located and were not convenient; and were therefore not used, resulting in the pedestrian deciding to walk in the road.

4.4.5 Summary

As discussed in Section 3.6, the direct cause of the accident was the concurrent situational awareness failures on the part of the driver and pedestrian. The root causes are related to a variety of management system failures. All Site organizations played a role in the events leading up to the accident. (See Section

5.0 for additional discussion.) Contributory factors applicable to all organizations included failure to recognize and correct inconsistent policy for pedestrian/vehicle safety; failure to recognize and correct deficient traffic safety measures and controls; and failure to recognize and implement effective controls associated with an almost identical prior event.

Within DOE, roles and responsibilities within the different offices were not appropriately assigned, effectively defined, and appropriately implemented. Responsibilities were not documented to effectively implement agreements for site-wide resolution of deficiencies, and the agreements were out-of-date. Documentation of DOE corrective actions from the 1991 forklift/pedestrian fatality accident does not exist and corrective actions were not effective to preclude a recurrence. DOE involvement in and leadership of the process to manage resolution of site-wide safety issues affecting its contractors is LTA.

Within USEC, management failed to effectively implement processes to analyze hazards related to forklift operations; identify and take appropriate action to correct fitness for duty deficiencies; and failed to recognize and take appropriate action to respond to significant performance failures.

Within PRS, management failed to appropriately evaluate the hazards associated with walking on-site.

4.5 RELATIVE MOTION ANALYSIS

This accident occurred as the result of relative motion between two objects, which ended in a collision. From interviews with the pedestrian and the fact that common sense dictates that no one would willingly allow a heavy vehicle to run over him/her, it is a reasonable assumption that the pedestrian was completely unaware of the forklift until an instant prior to the collision.

From the interviews with the driver, her co-workers, and others, as well as information from the reenactment, it is obvious that the driver was approaching the intersection, did not see the pedestrian, and failed to yield as was required. It is likely also that the driver failed to stop as she claimed. An understanding of elementary human performance methods would indicate also that performing a task routinely gives a sense of familiarity and complacency, which fosters a less attentive mental attitude and establishes an error precursor for failing to perform actions in a manner consistent with safety. Thus, it is likely that the driver glanced up the street to determine if any cylinder haulers were visible and, seeing none, continued through the intersection failing to slow or yield as required.

These assumptions establish a situation in which two objects were in motion at a constant course and speed on intersecting lines of travel. It is an understood fact that two objects in the same plane moving at constant course and speed toward a collision point (both objects located at the same point at the same time) generate a constant relative bearing with respect to each other. That is to say, the relative direction from either object to the other object does not change. Thus, in simple terms, from the perspective of the pedestrian, the forklift remained in the same position in her field of view throughout the approach to collision and did not appear to be moving, only getting closer or larger in size. Likewise, from the perspective of the forklift driver, the pedestrian remained in the same relative position with respect to her field of view and was simply getting larger. (See Figure 3.3-2.)

As discussed previously, a relatively large blind spot (i.e., windshield pillar and window frame) exists from the driver's perspective at about 45 degrees relative to the straight ahead direction of the forklift's line of travel. It is entirely possible that the pedestrian was located in this area. In this case, it is highly likely that the pedestrian would have remained in the blind spot for the entire duration of their respective approaches to the intersection. Thus, the pedestrian would have been essentially invisible to the driver until the moment of impact, except for the extent to which the width of the pedestrian's profile extended

beyond the vertical edges of the blind spot at extremely close range. Based on this assumption, if neither object changed course or speed until the instant of impact, the impact would have occurred behind the blind spot or just in front of the right corner of the windshield.

It is understood that drivers often do not see approaching vehicles or other objects while driving simply because they are not "looking for them." It is well known that motorcycle riders are quite often not seen by automobile drivers because the drivers are looking for other automobiles or large vehicles, such as trucks, and not for motorcycles. For this reason, motorcycle safety courses emphasize to motorcycle riders that defensive riding requires the rider to consider himself invisible to motorists. With this concept in mind, if the forklift driver was looking for other vehicles and cylinder haulers as she approached the intersection, she may not have seen the pedestrian even if she had been located in an area outside of the blind spot. With the approaching turn to the left, the driver, after checking to see if there were any approaching vehicles on the right, probably directed her attention to the left to check for approaching vehicles or equipment in that direction.

The human mind tends to observe objects in relative motion and is much less likely to observe an object that is relatively motionless. The greater the relative motion, the greater the likelihood that the moving object will be noticed. If the pedestrian was located in an area that was free of visual obstruction, but was moving relatively slowly, it is reasonable to assume that the driver may not have observed or seen the pedestrian.

Assuming that the driver began to turn the forklift slightly to the left as she approached the intersection, just prior to the collision, the size of the blind spot still may have been large enough to cover the pedestrian. At some point, mere moments prior to the impact, the pedestrian would have begun to appear to the left side of the blind spot. It also is likely that during this turn to the left at the intersection, the driver's focus normally and reasonably would been directed to the left in the direction of the vehicle's intended course of travel, which would have again served to limit the driver's ability to detect the pedestrian. The most likely result of a collision from this scenario would be the pedestrian being knocked to the ground away from the forklift.

Again, study of human performance indicates that habits are extremely powerful influences and are essentially automatic in nature. That is to say, a person performs the same actions without thinking about it unless he/she actually concentrates on overriding the automatic action. It is human nature to slow at an intersection, and it is likely that the driver did slow at the intersection out of habit. Assuming that the driver slowed slightly at the approach to the intersection, the result would have been a change in relative motion between the pedestrian and the forklift, allowing the pedestrian to progress further to the left of the blind spot from the driver's perspective, placing the pedestrian more to the front of the forklift where the basket of dewars was located.

5. CONCLUSIONS AND JUDGMENTS OF NEED

The Board concludes that the accident was a near miss to a more serious injury. The pedestrian's injuries, although very serious, could have been significantly worse and could easily have been fatal. The direct cause of the accident was the concurrent situational awareness failures on the part of the driver and pedestrian.

The Board determined that the accident could have been prevented. Two root causes were identified: (1) Roles, responsibilities, authorities and accountabilities at all levels within DOE, USEC and the DOE contractors to implement a responsible and coordinated program to ensure the safety of personnel at the Site, were not clearly established and appropriately implemented. (2) Established USEC safety management systems and programs to review its employees' past performance, evaluate conditions that could affect fitness for duty, and ensure that the driver was capable of safely performing assigned duties were not effectively implemented. These concurrent root causes were compounded by multi-tenant utilization of common spaces, which produced working conditions that were ill-defined and confusing.

This rather broad determination of the root causes is based on numerous overlapping failures by DOE, USEC, and the DOE contractors. Table 5-1 lists the Board's conclusions that support each JON, which the Board believes are necessary to correct identified deficiencies related to the causal factors and to prevent recurrence of the accident. The specific failures that led the Board to this root cause determination are identified as conclusions in Table 5-1 and the detailed discussion is as noted in the Reference Sections portion of Table 5-1.

Applicability for the Board's conclusions is as follows:

- DOE means the Department of Energy, at all levels.
- USEC means the United States Enrichment Corporation, at all levels.
- OSHA means the Occupational Safety and Health Administration, at all levels.
- NRC means the Nuclear Regulatory Commission, at all levels.
- The term "Regulators" means DOE, OSHA, and NRC, as defined above.
- All means DOE, DOE contractors, and USEC, at all levels.

The Board recognizes that determination of corrective actions for the JONs will require a great deal of interaction between DOE, USEC, DOE contractors and Federal regulatory agencies. Therefore, the Board recommends assigning PPPO as the lead DOE organization responsible to ensure these interactions happen and appropriate corrective actions are established and implemented. Ownership of and responsibility for the JONs reside with PPPO except as noted below:

- DOE-HQ is responsible for JON 2
- USEC is responsible for JON 4.

Table 5-1 Conclusions and Judgments of Need for the Forklift Accident at the Paducah Gaseous Diffusion Plant

Conclusions		Judgments of Need	Reference Sections
1-1	There is no single consistent traffic policy that clearly defines traffic and pedestrian safety requirements and responsibilities, which results in inconsistent understanding by site personnel. (All)	1. Need for a single, clearly defined site-wide policy for vehicle/traffic safety management. This must be communicated to and understood by all employees and visitors on government-owned property at PGDP. There also is a need to evaluate the adequacy and effectiveness of existing traffic control measures/devices and to implement changes determined to be needed to provide for adequate worker safety.	3.1.1 3.2.1 3.2.5 3.5.1
1-2	Implementation of physical controls, including signs, sidewalks, and crosswalks, are not well implemented on-site. (All)		
1-3	Site traffic levels and patterns have changed significantly in recent years, and there have been no commensurate evaluations of the adequacy of traffic controls and measures, resulting in various unanalyzed hazards from traffic and pedestrian interactions. (All)		
2-1	No one at the Site was aware of the existence of the 1991 accident investigation of a forklift collision with a pedestrian resulting in a fatality, until pointed out by the Board (All)	2. Need for a DOE-HQ process to ensure the implementation of requirements contained in DOE O 225.1A to verify the completion of approved corrective actions and satisfaction of judgments of need, and to ensure that records pertaining to these responsibilities are maintained and available for future use. Based on the similarity of this accident to the 1991 fatality, DOE-HQ needs to re-evaluate the corrective actions taken in response to the 1991 JON for DOE-wide guidance regarding in-plant pedestrian/vehicle safety to determine whether they were appropriate and effective.	3.2.2.2
2-2	There is no evidence that the need for DOE-wide guidance regarding in-plant pedestrian/vehicle safety, as noted in the JON from the 1991 accident report was ever undertaken by DOE-HQ. (DOE-HQ)		
2-3	There was no evidence to show that any corrective action was taken, either at the Site or at DOE-HQ, to implement lessons learned from the 1991 forklift/pedestrian accident. (All)		
2-4	Corrective actions taken as a result of the 1991 accident investigation were not effective to prevent recurrence of a nearly identical accident. (All)		
3-1	Ownership and responsibilities for the safe performance of work in the common areas are not clearly defined and/or understood by all affected Site organizations. (All, Regulators)	3. Need for clearly defined expectations for performance of oversight of industrial safety. This must be a unified expectation representing all organizations involved with work at the Site and include: a) regulatory authorities and jurisdictional boundaries for industrial safety; b) performance standards and requirements for controlling industrial safety hazards; c) frequency of Site visits/inspections to monitor workplace conditions and evaluate compliance;	3.1.1 3.1.3 3.1.4
3-2	Each organization has different missions, responsibilities, goals, schedules, and other requirements that do not always mesh and sometimes conflict. (All)		
3-3	Responsibility and authority for industrial safety oversight of USEC is not clearly understood by OSHA and its on-site presence is essentially nonexistent, resulting in diminished accountability and influence. (DOE, OSHA)		

Conclusions		Judgments of Need	Reference Sections
3-4	Exchange of information between DOE, NRC, OSHA, and USEC regarding industrial safety hazards and controls is extremely limited and could reduce the effectiveness of each organization's oversight. (USEC, Regulators)	and d) criteria and schedules for reporting of events and information pertaining to tracking/trending of performance related to industrial safety.	
4-1	Some USEC employees had concerns or questions about the driver's performance and/or abilities and failed to act on them; when employees voiced concerns or questions about the driver's performance and/or abilities, USEC management action was less than adequate, which resulted in a failure to identify and correct lingering problems. (USEC)	4. Need for USEC to fully implement existing procedures for performing fitness for duty evaluations to ensure the safety of employees and co-located workers. USEC also should consider opportunities for improvement, which can include provisions for appropriate line management and support organization involvement in monitoring and evaluating fitness for duty indicators, such as physical abilities, training and experience, medical concerns, performance trends, and aberrant behavior, against defined criteria.	3.2.4 3.2.7 3.4.2
4-2	Sufficient negative indicators existed that should have caused USEC management to question the driver's ability to safely perform assigned duties, as evidenced by: • the number and frequency of accidents. • physical limitations and restrictions. • prescription medication in quantities and types of concern. (USEC)		
4-3	There appears to be a single point failure at the first line supervisor to ensure USEC employees are fit for duty. (USEC)		
4-4	USEC management failed to provide appropriate support to the front line manager to determine fitness for duty. (USEC)		
5-1	The configuration of the nitrogen dewars and basket on the forklift severely restricted visibility of the forklift driver in the direction of travel, and the design of the forklift resulted in a large blind spot at each side of the driver's field of view, which increased the likelihood of an accident. (USEC)	5. Need to evaluate the suitability of existing industrial equipment and policies for equipment selection to provide for enhanced safety of personnel and equipment. This should include an evaluation of the effectiveness of existing processes for identifying and mitigating industrial safety hazards and implementing changes, as appropriate.	3.2.1.2 3.2.3.3 3.3.1 3.5.1
5-2	There is no evidence that USEC performed an evaluation of hazards associated with selection of equipment to use for specific tasks or the use of the forklift in this configuration, which resulted in missed opportunities to identify hazards and implement appropriate controls that likely contributed to the accident. (USEC)		
5-3	Site organizations have demonstrated weaknesses in hazard identification, hazard mitigation, and deficiencies in correcting identified site-wide safety issues in a timely manner, which are indicative of weaknesses in effective safety management across the site. (All)		

Conclusions		Judgments of Need	Reference Sections
6-1	Roles, responsibilities, and integration for the Site Safety Team of Paducah (STOP) Committee, the Shared Site Committee, and the Site Council are not clearly defined and understood or effectively implemented. (All)	6. Need to strengthen, formalize, and implement an integrated process at the site for identifying and resolving shared site issues, including those that involve industrial safety hazards. This should include defined authorities, a process to track actions, and a dispute resolution process to ensure prompt correction of safety-related issues, as well as an effective site-wide communication process for sharing lessons learned and other site information.	3.1.1 3.1.2 3.2.2.2 3.2.3.3 3.5.2 3.5.3
6-2	Membership on the Shared Site Committee is not assigned, and responsibility for Shared Site Committee performance is not shared equally by all stakeholders, which results in inconsistent attendance and a lack of accountability for implementing corrective actions. (All)		
6-3	Sharing of lessons learned information between organizations at the site is not effective or integrated. (All)		
6-4	DOE has not flowed down specific requirements for shared site responsibilities and implementation of the Shared Site Agreement and the Joint Policy Statement into its contracts, which could lead to confusion over roles and responsibilities. (DOE)		
6-5	Portions of the lease and implementing agreements have not been updated since inception and previously unresolved issues remain unaddressed leading to confusion in responsibilities for safe performance of work activities. (DOE, USEC)		
6-6	The separation of DOE roles and responsibilities has complicated the performance of DOE management. (DOE)		

6. BOARD SIGNATURES

Brian Anderson — Date: 10/16/07

Denise Glore — Date: 10/16/07

James McVey — Date: 10/4/07

Randy DeVault — Date: 10/10/07

Greg Bazzell — Date: 10/04/07

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7. BOARD MEMBERS, ADVISORS, AND STAFF

The Board and those involved in the Accident Investigation are deeply saddened by the loss of Ms. Denise Glore, who passed away as this report is being issued. During the few months that we worked together, we came to admire and love her as a wonderful and talented person. We will always remember Denise for her: positive attitude, warm and friendly personality, brilliant smile and delightful sense of humor, extraordinary and diverse knowledge, spirit of cooperation and willingness to assist others, and her dedication and perseverance. We will all greatly miss our dear friend and colleague.

7.1 BRIAN ANDERSON

Mr. Anderson has worked in nuclear operations and safety for over 30 years. The last 20 years have been with the U.S. Department of Energy, Idaho Operations Office, where he is currently the Assistant Manager, Nuclear and Safety Performance. He has been involved in nuclear facility operations and oversight, nuclear safety, industrial safety, nuclear quality assurance, project management, reactor program direction, and radioactive waste remediation facility management. Before coming to the Department of Energy, he was a shift supervisor at a nuclear fuel reprocessing facility and Quality Assurance Manager for an architect/engineer contractor involved in the construction and startup of new DOE nuclear facilities. He graduated from the United States Naval Academy in 1977 with a degree in electrical engineering and spent seven years as a submarine officer in the Naval Nuclear Propulsion Program, where he was certified as a Nuclear Engineer Officer, and earned the designation "Qualified in Submarines." He has attended four accident investigation training courses sponsored by the DOE and served as a Board member on a DOE Type B Accident Investigation Board.

7.2 DENISE GLORE

Ms. Glore has over 30 years of experience in various occupations focused on investigation. She received her Master of Science degree in 1980 and her Juris Doctorate in 1985, both from the University of New Mexico. Her employment history ranges from detailed investigation and interpretation of satellite and high altitude aircraft images to counsel for a DOE Source Evaluation Board on a $4.5 billion procurement. She also has worked as a prosecutor, defended medical malpractice cases, and litigated constitutional law cases in federal court. In addition, as Adjunct Faculty, she has taught environmental law, natural resources law and policy, and nuclear materials law to hundreds of engineering graduate students at universities in New Mexico and Idaho.

7.3 JAMES MCVEY

Mr. McVey received a Bachelor of Science degree and a Master of Science degree in Radiation Biophysics in 1972 from the University of Florida. He has over 35 years experience in the nuclear and hazardous materials areas and is proficient in applied health physics and handling of hazardous materials or mixed waste, including unrestricted release criteria and methodologies for decontaminated items and decommissioned facilities. Mr. McVey successfully permitted the nation's first two mixed waste disposal facilities, including the complex permitting for RCRA (TSD), NESHAP, Air Pollution, NPDES, Radioactive Materials Licensing, and successfully obtained nationwide TSCA permits for PCB. He is proficient in OSHA, health and safety, and fire protection considerations associated with unique and often extremely hazardous circumstances and is proficient in interpreting the applicable rules and regulations. Mr. McVey has performed over 80 complex facility evaluations during 28 years of his career for Fortune 500 companies, private firms, and DOE. He has participated in seven occupational readiness reviews,

including DWPF, HB-Line, H Area Evaporators and Tritium Facility. He has performed ES&H evaluations at WIPP, INEL, West Valley, and Hanford. He has authored over 30 technical papers and is co-author of two hazardous materials handling books. Mr. McVey was the Lead ES&H Evaluator with the Facility Evaluation Board at the Savannah River Site for Environmental Protection, Fire Protection, Health and Safety, Packaging and Transportation, Facility Organization and Administration, Quality Assurance, and Emergency Preparedness. Mr. McVey is currently the ES&H Manager for infrastructure services at the Site.

7.4 RANDY DEVAULT

Mr. DeVault received a Bachelor of Science in Nuclear Engineering in 1969 from the University of Tennessee. He has over 35 years of experience in the nuclear industry, is proficient in uranium separation technology, reactor technology, nuclear safety, and uranium materials processing. Mr. DeVault was involved in the development of the design and implementation of the Gaseous Diffusion Plant Cascade Improvement and Upgrade Programs. He is proficient in core physics analysis, core thermal hydraulic analysis, health and safety, and regulatory and licensing processes. He is the recipient of the Tennessee Valley Authority's (TVA) Bronze Award for development of an innovative process for nuclear safety grade equipment qualification and served as TVA's representative on numerous Westinghouse Owner and utility subgroups. Mr. DeVault has served as Regulatory Oversight Manager during the transition of DOE's Gaseous Diffusion Plant from the public to private sector. He served on the three member panel that evaluated the privatization bids and selected the successful bidder for privatizing the GDPs. He has served as team lead on numerous inspections of the GDPs and centrifuge programs in the areas of management controls and oversight, nuclear safety, industrial safety, nuclear criticality, fire protection, authorization basis documentation and implementation, quality assurance and control, emergency preparedness, and hoisting and rigging.

7.5 GREG BAZZELL

Mr. Bazzell currently serves as a Facility Representative for the DOE Paducah Operations Oversight Group. He became a Facility Representative for the Paducah Site in 1998 and received his qualification certificate in 2002. Mr. Bazzell has been at the Paducah Site for 17 years performing nuclear safety oversight activities as a Site Safety Representative for the uranium enrichment activities at the Paducah Gaseous Diffusion Plant from 1993 to 1997. Prior to that, Mr. Bazzell served as the Paducah Site Office Operations Engineer and the Acting Operating and Management System Branch Chief for approximately four years. His work experience prior to DOE included approximately nine years as a Test Engineer and Process Performance Engineer with the Tennessee Valley Authority. He holds a Bachelor of Science in Chemical Engineering from the University of Kentucky.

7.6 ADMINISTRATIVE SUPPORT

The Board would like to especially recognize Linda O'Hara (SST) for her patience and diligent efforts through long hours to incorporate hundreds of wording changes and extensive markups as she prepared this investigation report for issue. "Thank you, Linda !!"

Linda O'Hara SST Administrative Support and Document Coordinator

The Board would like to recognize the following individuals for their support in requesting, organizing, and tracking document requests and information provided to the board, and for assistance with specific administrative duties during report preparation.

Doris Becker SST Technical Editor

Dina Brown	DOE	Administrative Support
Pilar Fondaw	PRC	Administrative Support
Betty Hart	SST	Administrative Support
Barbie Jessup	SST	Administrative Support

7.7 OTHER SUPPORT

The Board would like to recognize the following individuals for their support in arranging setup of the reenactment, having measurements taken, and photos taken.

Jeff Snook	DOE
Glenn Newtown	DOE

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Appendix A

Formal Correspondence for Appointment of Type B Accident Investigation

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DOE F 1325.8
(3/02)

United States Government **Department of Energy**
Portsmouth/Paducah Project Office

memorandum

DATE: AUG 17 2007

REPLY TO ATTN OF: PPPO:Murphie PPPO-02-556-07

SUBJECT: **ESTABLISHING AN ACCIDENT INVESTIGATION BOARD**

THROUGH: Dr. Inès Triay, Chief Operating Officer, EM-3/FORS

TO: James Rispoli, Assistant Secretary for Environmental Management, EM-1/FORS

I hereby establish a Type B Accident Investigation Board to investigate the accident that occurred at the Paducah Gaseous Diffusion Plant on July 12, 2007 between U.S. Department of Energy (DOE) contractor Paducah Remediation Services, LLC (PRS) and the United States Enrichment Corporation (USEC). I have deemed it appropriate to conduct a Type B accident investigation as authorized in the Other Effects accident investigation categorization algorithm of DOE O 225.1A, *ACCIDENT INVESTIGATIONS*, dated November 26, 1997.

I appoint Brian Anderson as the accident board chairperson. The board members will be determined as soon as possible. The board will be assisted by advisors and consultants and by other support personnel as determined by the chairperson.

The scope of the board's investigation will include, but is not limited to, identifying all relevant facts; analyzing the facts to determine the causes of the accident; developing conclusions; and determining the judgments of need that, when implemented, should prevent the recurrence of the accident. The investigation will be conducted in accordance with DOE O 225.1A and will specifically address the role of DOE, DOE Contractor and USEC organizations and management systems and the Lease Agreement between DOE and USEC as they have contributed to the accident. The scope will also include disciplines associated with traffic/pedestrian interactions and forklift operations and the applications of lessons learned from similar accidents within the department.

The board will provide my office with periodic reports on the status of the investigation but will not include any conclusions until an analysis of all the causal factors has been completed. Draft copies of the factual portion of the investigation report will be submitted to Portsmouth/Paducah Project Office, PRS, and USEC, and to Oak Ridge Operations as it relates to the Lease Agreement between DOE and USEC for a factual accuracy review prior to report finalization.

The report should be provided to me for acceptance within 30 calendar days from the date of this memorandum. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

William E. Murphie
Manager
Portsmouth/Paducah Project Office

cc:
B. Anderson, NE/ID
R. Blumenfeld, PPPO/LEX
G. Boyd, ORO
R. Boyd, PRS/Kevil
D. Chung, EM-60/FORRESTAL
L. Clark, ORO
D. Glore, NE/ID
A. Grose, NE/ID
R. Knerr, PPPO/PAD
D. Kozlowski, PPPO/PORTS
M. Moore, EM-3.2/FORS
S. Penrod, USEC
B. Provencher, NE/ID
E. Sellers, NE/ID
R. Taylor, OSHA/Frankfort
M. Thomas, NRC/C-100, PGDP
P. Worthington, HS-10/GERMANTOWN

08/27/2007 16:31 FAX 002

DOE F 1325.8
(3/02)

United States Government **Department of Energy**

Oak Ridge Office

memorandum

DATE: August 27, 2007

REPLY TO
ATTN OF: NS-50:Clark

SUBJECT: **OAK RIDGE OFFICE (ORO) PARTICIPATION IN TYPE B FORK LIFT ACCIDENT INVESTIGATION**

TO: Rachel Blumenfeld, Acting Deputy Manager, Paducah/Portsmouth Project Office

Per our discussion the following information is provided relative to the absence of conflict of interest as it pertains to ORO participation on the subject investigation.

As we discussed, Randy DeVault has no current responsibilities that include line oversight of the United States Enrichment Corporation (USEC) operations at the Paducah Gaseous Diffusion Plant (PGDP). Although Randy's current approved position description (provided previously) does indicate broad responsibility for implementation of safety oversight via the USEC/DOE Lease Regulatory Oversight Agreement and management of ES&H activities at the PGDP, this language predates Nuclear Regulatory Commission (NRC) regulation. These duties are no longer applicable, nor implemented by him at the PGDP since NRC assumed such responsibility effective March 1997.

It should be noted that the Regulatory Management Team organization under Randy's purview is responsible for the collection of data on the production capability and viability of the PGDP for the creation of a quarterly report for DOE/NE headquarters. However this collection of data and the preparation of the report is simply a statusing function and does not involve line oversight of the PGDP.

Randy is also responsible for authorizing arming and arrest authority for the PGDP guard force. The arming and arrest authority permits the guards to carry weapons, but does not include the oversight of the roles and responsibilities of the guard force for ensuring plant security. The oversight of USEC PGDP site security is the responsibility of NRC.

Therefore, there are no conflicts of interest which would prohibit Randy from serving on the Type B Investigation Team examining the July 12, 2007, fork lift accident at PGDP.

Robert J. Brown
Deputy Manager

cc's on page 2

G. Boyd, M-1
L.W. Clark, NS-50
D. Thress, CC-10
R. DeVault, NS-52
W.E. Murphie, PPPO
R. Knerr, PPPO

DOE F 1325.8
(3/02)

United States Government **Department of Energy**
Portsmouth/Paducah Project Office

memorandum

DATE: AUG 3 1 2007

REPLY TO ATTN OF: PPPO:Knerr PPPO-02-589-07

SUBJECT: **OAK RIDGE OFFICE PARTICIPATION IN TYPE B FORKLIFT ACCIDENT INVESTIGATION**

TO: Brian Anderson, Type B Investigation Board Chairperson

Reference: Memorandum from R. Brown to R. Blumenfeld, "Oak Ridge Office (ORO) Participation in Type B Fork Lift Accident Investigation," dated August 27th, 2007

The Portsmouth/Paducah Project Office (PPPO) has reviewed the Oak Ridge Office's (ORO) August 27th, 2007, Memorandum (Reference) regarding Mr. Randy DeVault's current responsibilities pertaining to United States Enrichment Corporation (USEC) operations at the Paducah Gaseous Diffusion Plant (PGDP). PPPO hereby accepts ORO's determination that Mr. DeVault has no current responsibilities that include line oversight of USEC operations at the PGDP or applicable responsibilities with respect to the implementation of safety oversight at the PGDP and that there are no conflicts of interest which would prohibit Mr. DeVault from serving on the Type B Investigation Team.

If you have any questions regarding this matter, please call Reinhard Knerr at (270) 441-6825.

Rachel H. Blumenfeld
Acting Deputy Manager
Portsmouth/Paducah Project Office

cc:
G. Boyd, M-1
R. Brown, M-2
L.W. Clark, NS-50
D. Chung, EM-60
R. Devault, NS-52
R. Knerr, PPPO/PAD
B. Murphie, PPPO/LEX
D. Thress, CC-10

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Appendix B

Glossary

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GLOSSARY

AEA 1954	The Atomic Energy Act of 1954.
blue-sheet	To adopt an existing procedure without change during contract transition.
Board	The Accident Investigation Board appointed August 17, 2007, to investigate the forklift/pedestrian accident that occurred at the Paducah Gaseous Diffusion Plant Site on July 12, 2007.
C-600	For the purpose of this investigation, the C-600 complex includes C-603, where the liquid nitrogen cylinders are filled.
common areas	Those areas of the Site that are used by both USEC and DOE, each party having access to perform its activities. The roads and the intersection where the accident took place are located in common areas. Although the Lease Agreement is silent as to whether common areas are "leased areas," subsequent letters were written by DOE and USEC to declare that the common areas are part of areas leased to USEC, and the Common Areas are subsequently included in the Lease map as part of the leased areas. See also "leased areas."
DOE Contractors	PRS, SST, and UDS at PGDP, including predecessors for the purpose of this report.
InsideP	USEC employee newsletter, normally issued on a daily basis.
Joint Policy Statement	The Joint Policy Statement on Shared Site Issues (dated December 1996) between DOE and USEC. This document was intended to implement aspects of the lease and to establish a mechanism to resolve specific issues related to shared site activities. See "Shared Site Agreement."
leased areas	The 1993 Lease Agreement between USEC and DOE formally provided for the lease of certain DOE-owned property, facilities, and equipment located at the PGDP Site by USEC in exchange for rent payments to DOE. These areas are defined in Exhibit A of the Lease Agreement and have been updated periodically by means of a lease map, approved by DOE and USEC.

nonleased areas	Areas of the PGDP Site which were retained by DOE under the 1993 Lease Agreement with USEC.
OSHAct	The Occupational Safety and Health Act, issued December 29, 1970, to assure safe and healthful working conditions for working men and women by authorizing enforcement of the standards developed under the Act.
Plant	The area of the site located within the controlled area (security perimeter) containing DOE-owned equipment, facilities, and property leased to USEC.
PGDP	The uranium enrichment facility located about 12 miles west of Paducah, Kentucky, owned by DOE and operated since about 1952. See "Site."
Shared Site Agreement	Shared Site Agreement Resolution of Shared Site Issues at the GDPs, Rev. 1, signed by DOE and USEC, March 31, 1998, and accepted by the NRC in the USEC certificate. This document was intended to implement aspects of the lease and to establish a mechanism to resolve specific issues related to shared site activities. See "Joint Policy Statement."
Site	For the purposes of this report, the Site is the DOE-owned property comprising approximately 3,500 acres upon which the PGDP uranium enrichment facility was built and has been operated since the 1950s. Both USEC and DOE conduct activities at various locations on the Site.
USEC	United States Enrichment Corporation, a wholly-owned subsidiary of USEC, Inc., that operates uranium enrichment facilities leased from DOE at Paducah, Kentucky, and other locations. For the purpose of this investigation, USEC refers only to the management of the Paducah, Kentucky, plant.

Appendix C

Background Information on Pedestrian

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Due to personal privacy information, this appendix intentionally has not been included. If you believe you have a need-to-know or reason to see this information, please contact Mr. Brian Anderson at 208-526-0086 or andersbs@id.doe.gov.

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Appendix D

Background Information on Driver

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Due to personal privacy information, this appendix intentionally has not been included. If you believe you have a need-to-know or reason to see this information, please contact Mr. Brian Anderson at 208-526-0086 or andersbs@id.doe.gov.

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