

Type B Accident Investigation Board Report

**Grounds Worker Injury At The
Pacific Northwest National Laboratory
October 8, 2004**



November, 2004

Pacific Northwest Site Office
U. S. Department of Energy
Richland, Washington

Disclaimer

This report is an independent product of the Type B Accident Investigation Board appointed by Paul W. Kruger, Manager, Pacific Northwest Site Office (PNSO), U.S. Department of Energy.

The Board was appointed to perform a Type B investigation of this accident and to prepare an investigation report in accordance with DOE Order 225.1A, *Accident Investigation* and DOE G 225.1-A, *Implementation Guide for Use with DOE 225.1A, Accident Investigations*.

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

This report neither determines nor implies liability.

Release Authorization

On October 15, 2004, I established a Type B Accident Investigation Board to investigate the October 8, 2004, grounds worker injury at the Pacific Northwest National Laboratory (PNNL) that resulted in a broken leg of a PNNL grounds worker. 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.



Paul W. Kruger
Manager, Pacific Northwest Site Office

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Executive Summary

The Accident

On October 8, 2004, at approximately 11:00 AM, a Grounds Worker at the Pacific Northwest National Laboratory (PNNL) fell from a Toro Workman 3200 Utility Vehicle and fractured his right leg above the ankle. The accident occurred on the west side of the west cooling pond on the Richland Research Complex.

On October 15, 2004, the Manager of the Department of Energy's Office of Science Pacific Northwest Site Office appointed a Type B Accident Investigation Board to analyze causal factors, identify root causes, and determine Judgments of Need related to the accident to preclude similar accidents in the future. The Board arrived onsite and began the investigation on October 18, 2004.

Background

PNNL is a multi-program national laboratory located in Richland, Washington and operates under the programmatic direction of the DOE Office of Science. PNNL is operated for DOE by the Battelle Memorial Institute. The PNNL mission supports the Office of Science to advance basic research, solving complex problems in energy, national security, the environment, and life sciences by advancing the understanding of physics, chemistry, biology, and computation. PNNL employs 3800 and has an annual budget in excess of \$600 million. The PNNL site is an array of facilities differing in age, condition, and ownership. The real property breakout in each major category is as follows: 910,000 sq. ft. DOE-owned, 500,000 sq. ft. Battelle-owned, and 600,000 sq. ft. leased. Included with this real property holding is nominally 221 acres of landscaped area, 82 acres of paved surfaces (i.e., roads, sidewalks, and parking), and 120 acres of un-maintained land.

Conclusions

The Board concludes that this accident was preventable. The direct cause of this accident was the lack of a seat belt and hip restraint to prevent the passenger from falling from the utility vehicle. The utility vehicle was placed in service without the safety equipment being in place. The Grounds Work Team Leader believed that the vehicle was safe for use since it was a newer version of vehicles already in use by the Grounds Work Team. The Grounds Work Team Leader and Grounds Workers had not reviewed the Operator's Manual of the vehicles to identify the missing safety equipment. The root cause of the incident was that Facilities & Operations (F&O) did not effectively implement its hazards analysis process. The responsibilities described in the Administrative procedure ADM-082 *General Expectation and Operational Guide for PNNL Grounds Maintenance Activities*, have not adequately addressed the hazards associated with the utility vehicle use and design feature to mitigate personnel injury. Additionally, the process used to accept the utility vehicle from the supplier and the method used to place it in service did not identify missing safety equipment. The removal of the cab doors after the identification of a potential carbon monoxide (CO) exposure problem as well as the continuing warm weather, and the release of the vehicle for use by the Grounds Workers Team Leader allowed the Grounds Worker to fall from the vehicle. The conclusions and judgments of need are summarized in Table ES-1.

The Board identified one root cause for this event. *F&O failed to ensure effective implementation of its hazard analysis process.*

Table ES.1. Conclusions and Judgments of Need

Conclusions	Judgment of Needs
The Grounds Worker fell from the utility vehicle because the seat belts and hip restraints were not present.	F&O needs to conduct a comprehensive hazard analysis of the work performed by its grounds personnel to ensure that hazards are identified and mitigating controls are documented .
Existing hazard analysis does not adequately address the hazards of the utility vehicle.	F&O needs to ensure that personnel who develop, review and approve the hazard analyses are knowledgeable of the SBMS process for identifying and mitigating workplace hazards .
The Grounds Supervisor was not aware of requirements to instruct Grounds Workers on familiarization with manufacturer's Operator's Manual.	F&O needs to ensure that grounds personnel are trained in the recognition of hazards and implementation of controls.
The existing utility vehicles were not provided with optional seat belts to increase the safe operation of this equipment.	F&O needs to ensure that personnel who conduct self-assessments are knowledgeable of the SBMS process for identifying and mitigating workplace hazards .
The operators of the utility vehicle were not aware of the changes to safety equipment nor did they heed the safety decals requiring seat belt use.	F&O needs to ensure that workers are knowledgeable of the hazards in their work environment.
F&O management had not verified that the Grounds Supervisor was aware of all pertinent requirements and responsibilities.	F&O needs to develop and implement a process to ensure that line managers are knowledgeable of their ES&H roles and responsibilities as documented in SBMS and other applicable laboratory documents .
Self-assessments conducted in F&O did not identify optional safety equipment for grounds vehicles.	PNNL's Office of Audit and Oversight needs to conduct a sampling of organizations to determine if similar deficiencies in documented hazard analyses and personnel's knowledge of workplace hazards exist .
Grounds Supervisor and ESH personnel conducted various tests on the utility vehicle involved in the accident without consideration of preventing another accident .	The PNNL accident readiness measures need to ensure that subsequent Laboratory investigation efforts do not create additional unsafe situations .
PNNL policies and procedures do not address how to respond to accidents which would require DOE Boards. Information on mitigating the consequences, collection and preservation of the accident scene and evidence and other information is not identified .	PNSO needs to ensure that the requirements of the Contractors Requirements Document of DOE O 225.1A, <i>Accident Investigations</i> , are incorporated into the PNNL SBMS.

1.0 Introduction

1.1 Background

On October 8, 2004, at approximately 11:00 AM, Grounds Worker A of the Pacific Northwest National Laboratory (PNNL) was injured when he slipped from a Toro Workman 3200 Utility Vehicle while the vehicle was making a left turn. Grounds Worker A was a passenger in the utility vehicle. The right foot of Grounds Worker A made firm contact on the concrete walkway and the torsional movement caused a fracture of his right leg above the ankle. Grounds Worker A fell and came to rest on the lawn adjacent to the concrete walkway on which the vehicle was traveling. Bystanders were participating in a United Way fundraiser located approximately 60 yards southwest of the injured Grounds Worker A witnessed the fall and proceeded to provide assistance. The driver asked the bystanders to call for emergency assistance using the PNNL 2400 emergency call number. The Richland Fire Department (RFD) responded to the PNNL Operations Center's call for an ambulance. Grounds Worker A was taken to the Kadlec Medical Center where he was hospitalized. The injury to his leg was serious enough to require surgery which was performed on October 15, 2004. Grounds Worker A was released from the hospital on October 16, 2004.

On October 13, 2004, Paul Kruger, Manager of the U S Department of Energy, Office of Science, Pacific Northwest Site Office (PNSO) informed the management of PNNL that a Type B Investigation Board would be initiated to investigate this accident. On October 15, 2004, the Type B Accident Investigation Board was formally appointed (Appendix 1). This report documents the facts of the accident and the analyses and conclusions of the Board.

1.2 Facility Description



Figure 1. Battelle's Richland Research Complex

Pacific Northwest National Laboratory (PNNL), operated by Battelle Memorial Institute (BMI) for the U. S. Department of Energy (DOE), is a multi-program national laboratory. PNNL is one of the Department of Energy's Office of Science national laboratories. The PNNL mission supports the Office of Science to advance basic research, solving

complex problems in energy, national security, the environment and life sciences by advancing the understanding of physics, chemistry, biology and computation. PNNL employs 3800 and has an annual budget in excess of \$600 million. The Laboratory has been managed by Battelle since the lab's inception in 1965. The PNNL site is an array of facilities differing in age, condition, and ownership. The real property breakout in each major category is as follows: 910,000 sq. ft. DOE-owned, 500,000 sq. ft. Battelle-owned, and 600,000 sq. ft. leased. Included with this real property holding is nominally 221 acres of landscaped area, 82 acres of paved surfaces (i.e. roads, sidewalks, and parking), and 120 acres of un-maintained land.

The accident occurred near the northwest corner of the ponds located in the center of the Battelle's Richland Research Complex (RRC) (Figure 1). These ponds are an architectural design feature of the RRC and function as an integral part of the cooling system serving as the condenser water system for the facility chillers. The pond containment varies in depth but is nominally 36 inches deep from the top of the sidewalk, with an operating water depth of 24 inches.

1.3 Scope, Conduct, and Methodology

The Board began its activities on October 18, 2004, and submitted the final report to the DOE-PNSO Manager on November 19, 2004. The scope of the Board's investigation was to identify all relevant facts; analyze the facts to determine the direct, contributing, and root causes of the accident; develop conclusions; and determine the actions that, when implemented, should prevent the recurrence of a similar accident.

The investigation was performed in accordance with DOE O 225.1A, *Accident Investigations*, using the following methodology:

- Facts relevant to the accident were gathered through interviews and reviews of documents and evidence.
- The event scene and equipment involved were inspected, and photographs taken of them.
- Facts were analyzed to identify the causal factors using event and causal factors analysis, barrier analysis, root cause analysis, change analysis, and Integrated Safety Management (ISM) analysis.
- Judgments of Need (JONs) for corrective actions to prevent recurrence were developed to address the causal factors of the event.

Accident Investigation Terminology

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

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

Barrier analysis reviews the hazards, the targets (people or objects) of the hazards, and

the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.

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

Root Cause Analysis is a technique that identifies the underlying deficiencies that, if corrected, would prevent the same or similar accidents from occurring.

Judgments of Need are managerial controls and safety measures necessary to prevent or minimize the probability or severity of a recurrence of an accident.

Requirements Verification Analysis is a forward/backward analysis process to ensure that all portions of the report are accurate and consistent in the flow of facts to analysis to conclusions to the Judgments of Need.

2.0 Facts

2.1 Accident Description and Chronology

2.1.1 Accident Description

October 8, 2004, at approximately 11:00 AM, a PNNL Grounds, Relocation and Receiving Work Team (Grounds) employee (Grounds Worker A) was working with another Grounds employee (Grounds Worker B) checking irrigation sprinkler heads around the Auditorium building on the north side of the Research Operations Building. After they completed this task they drove north between the two cooling ponds and then west along the north side of the west cooling pond. At the same time other PNNL employees were making preparations for a United Way fundraising event at a picnic area east of the Engineering Development Laboratory (EDL) and Physical Science Building (Figure 2).

The two Grounds employees were using a newly-purchased gasoline-engine driven Toro Workman 3200 Utility Vehicle that had been delivered on September 23, 2004, to PNNL. The PNNL Grounds had used this type of small utility vehicle in the past and decided to purchase two more of the same model when funding became available in late Fiscal Year (FY) 2004. This vehicle was purchased with the options of a Toro-manufactured cab (not an after-market cab), a heater, and a tachometer. The standard equipment on the vehicle included a rollover protection system (ROPS), seat belts, and hip restraints. The seat belts and hip restraints were not present on the Toro Workman that Grounds Workers A and B were using at the time of the accident. The new Toro Workman 3200 Utility Vehicle had been redesigned to allow for an adjustable bucket seat rather than the fixed two piece seat. The redesigned utility vehicle also had increased leg room to allow easier entry and exit from the driver and passenger seats. The new Toro Workman 3200 Utility Vehicles no longer have shoulder restraints as part of the ROPS.

In addition to the missing safety equipment (seat belts and hip restraints), the two glass, latching side doors had been removed from the vehicle in part due to the warm weather and in part due to a concern about carbon monoxide (CO) buildup in the cab if the vehicle was idling still for lengthy periods of time.

Shortly after 11:00 AM, with Grounds Worker B driving, the two Grounds Workers traveled in the Toro Workman 3200 on a sidewalk around the west cooling pond east of the Engineering Development Laboratory. The sidewalk was wider than the width of the Toro Workman and was commonly used for travel with these small utility vehicles to avoid marring the grass.

The two Grounds workers drove north from the Auditorium, then west along the sidewalk as it followed the pond, then turned to the south when they reached the west side of the pond (Figure 2). As the vehicle rounded the corner to turn south, Grounds Worker A began to slide down the passenger seat and fall out of the vehicle. When Grounds Worker A realized he was falling from the vehicle he attempted to position himself for the pending fall by planting his right foot on the concrete sidewalk. The right foot of Grounds Worker A made firm contact on the concrete walkway and torsional movement caused a fracture of his right leg above the ankle. Grounds Worker A fell and came to rest on the lawn adjacent to the concrete walkway on which the vehicle was driving.

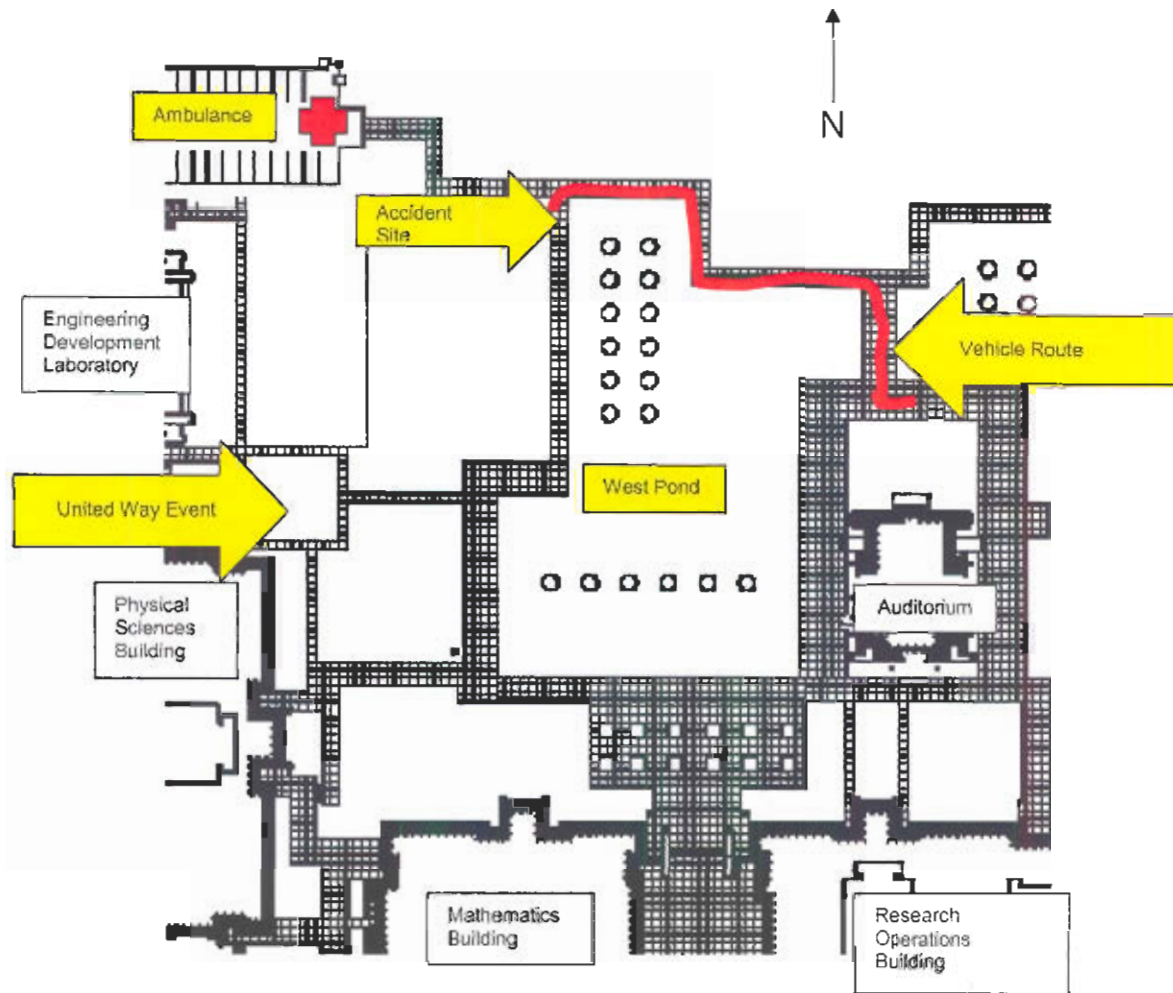


Figure 2. Accident scene

Grounds Worker B (driver) immediately stopped the utility vehicle and observed Grounds Worker A laying face up on the lawn. One of the participants in the United Way event witnessed Grounds Worker A fall from the utility vehicle and ran toward the accident site. Grounds Worker B motioned for her to phone for emergency medical assistance (See Emergency Response below).

Post-Accident Actions

The Building Manager for this area and the PNNL Vehicle Safety Representative secured the accident scene (Figure 3) and began preliminary investigation. The event was classified under the DOE Occurrence Reporting system as a 2A(6)(b), "any single occurrence resulting in a serious occupational injury. A serious occupational injury is an occupational injury that results in a fracture of any bone." The PNNL Maintenance and Fabrication Services Manager issued a verbal order to stop the use of all Grounds utility vehicles. PNNL held a critique of the event on October 11, 2004. The PNSO Manager appointed an Accident Investigation Board on October 15, 2004.



Figure 3. Photo of Toro Workman 3200 at accident scene

2.1.1.1 Description of Events Preceding Accident

On the morning of October 8, 2004, Grounds Worker A wanted to investigate irrigation sprinkler heads by the Auditorium. He drove the next available utility vehicle in the Grounds Equipment Storage Facility, the new Workman 3200 Utility Vehicle, to the planting area on the north side of the Auditorium. Grounds Worker B was a passenger in the utility vehicle and would also check the irrigation sprinkler heads. The grounds workers operate under ADM-082 "*General Expectation and Operational Guide for PNNL Grounds Maintenance Activities*" which sets the expectations that they are responsible for their assigned zones. The examination of sprinkler heads was a portion of this expectation.

Grounds Worker A had driven the new Workman 3200 utility vehicle two or three times since it was placed in service. He had driven the existing Toro Workman vehicles many times over several years.

After inspecting the irrigation sprinkler heads, Grounds Worker A wanted to go to the Benefits Office in the nearby PNNL Research Operations Building to inquire about the next scheduled flu immunization shots. With Ground Worker B now driving the Toro Workman, Grounds Workers A and B traveled on the wide sidewalk surrounding the edges of the cooling pond in a northerly direction between the cooling ponds on the north side of the Auditorium. They followed the sidewalk around the cooling pond, first turning west, and then turning south. About 11:00 AM, as the vehicle was making the left turn to head south, Grounds Worker A felt himself falling out of the cab, and the injury to his leg resulted.

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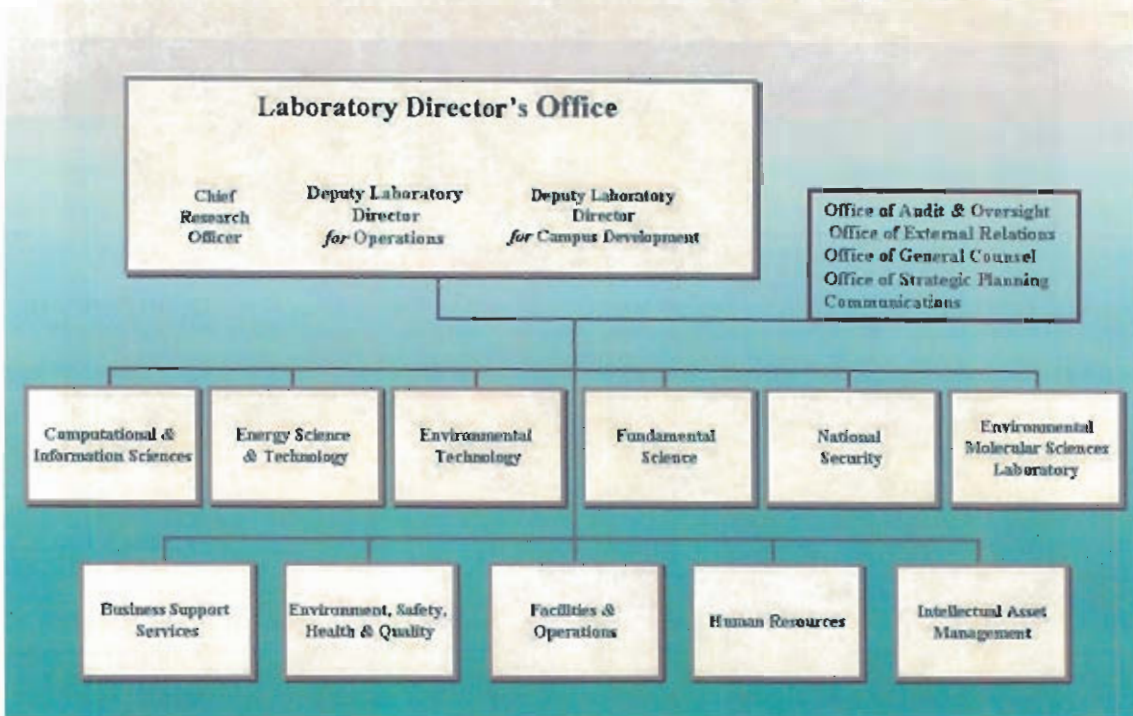


Figure 4. PNNL organization chart

2.1.1.2 Organizational Structure

Roles, Responsibilities, Accountabilities, and Authorities

The Pacific Northwest National Laboratory Director's Office comprises the Laboratory Director, and three senior management positions, one of which is the Deputy Director for Operations. This is indicated in Figure 4, PNNL Organization Chart. The Facilities and Operations (F&O) Director, reports to the Laboratory Director, and is responsible for the F&O Directorate. As outlined in the Facility Management System in the SBMS, the F&O Directorate is responsible for the following in operating PNNL:

- Life cycle asset management of facility and land assets
- Serves as the Management Representative and makes final determinations for actions associated with applicable major emergencies and/or events (except those directed by the Laboratory Director)
- Appoints the investigation board for the investigation of applicable events
- Approves all news releases related to applicable events.

There are three organizations in the F&O Directorate, one of which is the Facility Operations Division. According to the Facility Management System under SBMS, the responsibilities of this division are

- Implementation of an effective and efficient facility operations and maintenance program

- Operate and maintain Laboratory facilities in accordance with applicable federal, state and local requirements and BMI policies
- Implementation of a maintenance management program
- Customer service
- Implementation of an effective self-assessment program
- Providing technical and management support to Building Emergency Response Organization
- Approval of the safety envelope, authorization basis, and Facility Use Agreements, and changes thereto
- Approval of building and facility operations support services annual work plans
- Transfer of facilities to the Facility Transition and Legacy project manager
- Execution of forced moves.

Within the Facility Operations Division are four organizations, including Maintenance and Fabrication Services. An Administrative Procedure, ADM-44, "*Roles and Responsibilities for the Management and Operations of the Facility Operations Division*," further defines what each organization does. The Maintenance and Fabrication Services Service Manager's responsibilities are broadly

Establishes and maintains an organization to provide maintenance and fabrication services to facility management and R&D occupants

and

Develops and administers a workforce management program for skilled craft labor – maintains an integrated resource plan to meet current and future workloads.

Within the Maintenance and Fabrication Services organization are four work centers, but the Grounds, Relocation and Receiving Work Team, for the entire Laboratory, is under the South Work Center. The six-person Grounds Work Team is under the Grounds Work Team Leader. The responsibilities of the Grounds Work Team are described in the Administrative procedure ADM-082, "*General Expectation and Operational Guide for PNNL Grounds Maintenance Activities*." This is a detailed document that includes expectations for the quality of work, establishment of responsibilities, general information, hazard assessment and mitigation information, qualification requirements for operating equipment, extensive information on general safety best practices, and information on the safe operation of some equipment deemed to be especially hazardous.

Relationship to SBMS Management Systems

The PNNL Standards Based Management System (SBMS) concept establishes general and specific descriptions of how to perform work at PNNL. There are 20 major "management systems descriptions" and numerous program and subject area requirements descriptions. Links are provided as appropriate between all of these to try to guide the user to the specific information needed to perform work.

The SBMS does not specifically define how all organizations will operate, although it does establish broad roles, responsibilities, authorities, and accountabilities (R2A2s). Specific organization-level R2A2s are often contained in administrative procedures within those organizations.

The majority of the work performed by the Grounds Work Team is physical labor. The requirements that define how to safely perform that work are established for the Grounds Work team, primarily in its Administrative Procedure ADM-082, and the SBMS in general. The SBMS and other organizational documents state that the responsibility for safe operation lies with line management. SBMS also states that environment, safety, and health expertise is available to answer questions concerning operational safety.

2.1.1.3 PNNL Standards Based Management System

2.1.1.3.1 System Description

PNNL uses an online information system available to Laboratory employees to manage activities at the site. The information system is the SBMS. The Director of Environment, Safety, Health & Quality is responsible for the maintenance and upkeep of the SBMS. The SBMS comprises three major functions: Requirements Management, Information Development and Integration, and Operations and Administration. The SBMS establishes the overall information hierarchy for Laboratory policies and procedures. The information hierarchy is tiered off of the management system descriptions. The management system descriptions identify how the Laboratory operates. Each management system description explains how the processes and services of that particular management system relate to the Laboratory's Customer Service Model, the process used to deliver the services, the services delivered, and the key roles and responsibilities of Laboratory staff in implementing the management system. Within the SBMS, the Laboratory Policies and Standards establish the operating philosophy and intent for PNNL and its staff as well as define performance expectations. The policies and standards can either be stand alone or have SBMS subject areas developed for their implementation. SBMS subject areas are Laboratory-wide procedures and guidelines. Internal operating procedures are prepared for an operation when it is not sufficiently covered by a subject area.

2.1.1.3.2 Applicable Management Systems, Subject Areas, and Work Procedures

The procurement and subsequent operation of the Toro Workman 3200 Utility Vehicle involved in this accident was covered by the following SBMS management systems and subject areas and internal operating procedures:

- Facilities & Operations Administrative Procedure ADM-082 (Rev. 1), dated 5/14/02, "General Expectation and Operational Guide for PNNL Grounds Maintenance Activities." The following notes apply to the operation of the utility vehicles:

This F&O Procedure identifies the expectations, safety practices and safety precautions for grounds keeping operations. Note 3 in Section 3.1 "General definitions and expectations for grounds work" indicates that the Grounds Manager will determine the qualifications of grounds staff

members: "Whenever a new piece of grounds equipment is received all grounds staff will be trained on its operation and safety features."

There is no discussion of the hazards of using utility vehicles in Section 4, "Hazard Assessment and Mitigation."

Section 6.0 "Precautions and Limitations," requires that "grounds staff must be trained in the operation of all grounds equipment before use of any grounds equipment."

Item 21 in subsection 7.1, "General Safety Best Practices," indicates that Toro Workman carts may be driven between RCHN (Richland North, the main Battelle-owned campus) and the 300 Area (approximately one mile north of RCHN) if the carts have an orange triangle and flashing yellow beacon. It also identifies the preferred routes which should be used to minimize exposure to traffic.

The supervisor did not train the Grounds Workers in the operation of the new Toro Workman 3200 Utility Vehicle prior to its being placed in service. The new Toro Workman 3200 Utility Vehicle was not provided with an orange triangle or flashing yellow beacon prior to being placed in service. It could not be determined if the utility vehicle had been used to drive between RCHN and the 300 Area.

ADM-082 does not provide information to operators or passengers of the utility vehicles concerning rollover hazards and the mitigating actions.

- SBMS Management Systems and Subject Areas

The Acquisition Management System and procedures were used for the procurement and acceptance of the utility vehicles. This management system outlines requirements for identifying the prescriptive and regulatory process by which goods and services must be purchased:

- Direction to Laboratory staff on the procedures and guidelines by which goods and services must be requested
- Direction and support to technical staff on how to request contracting assistance to obtain goods and services
- Contract obligation information for project management
- Property management information pertaining to the receipt of goods and services.

The Purchasing Goods and Services subject area was used to procure the utility vehicles. This subject area provides the procedures and guidance for purchasing goods and services. This subject area pertains to purchases that are made with a purchase requisition and result in a contract. Section 1, "Planning Purchases," identifies a seven-step procedure to guide a staff member to plan a purchase and initiate a purchase request. Links are provided to the electronic Acquisition System which is used complete the purchase requisition. The second step in Planning Purchases procedure identifies areas in which special considerations are included (e.g., quality assurance stipulations; environmental, safety & health requirements; nuclear safety rules; and onsite

work practices and procedures). The procurement of the Toro Workman 3200 Utility Vehicles did not trigger any of the additional requirements.

Section 3, "Administering the Contract," of the *Purchasing Goods and Services* subject area identifies a five-step procedure. Step 3 of this procedure references the *Inspecting and Accepting Received Items* subject area. Section 1, "Inspections and Acceptance by Staff of Items Received," of the *Inspecting and Accepting Received Items* subject area is a five-step procedure to be used by "the staff member who has been given responsibility for receiving the item." This procedure is focused on suspect and counterfeit items, as well as equipment that will be used in nuclear facilities. A receiving storekeeper checked the utility vehicles to affirm that optional equipment had been installed (tachometer, heater, cab & doors, full bed with sides on one, and vertical lift on the other). No inspection items were specified in the purchase order. This receiving storekeeper was unaware that hip restraints and seat belts were standard equipment and did not identify if they were or were not installed.

Section 3, "Receiving and Delivery Services (6th Street)," of the *Shipping, Receiving, and Transportation Logistics* subject area is a three step procedure. The third step of this procedure requires staff to "examine the shipping container and contents for signs of handling damage or purchase discrepancies in accordance with the *Purchase Goods and Services* subject area." This is linked to Section 3, "Administering the Contract," of the *Purchase Goods and Services* subject area. This procedure includes a step to return material as well as a guideline for reviewing invoices. There was no evidence of damage to the vehicles when inspected

The Worker Safety and Health Management System includes the subject area *Operating Vehicles for Business Purposes*. The overview in Section 4, "Operating Utility Vehicles," states "operate utility vehicles on public streets and highways only when escorted by a vehicle with flashing lights." The full section details a three step procedure. The first step indicates that the operator's supervisor confirms that the operator reviews the manufacturer's instructions specific to the utility vehicle. The second step identifies the requirements for escorting a "utility vehicle (e.g. fork lift, riding lawn mower, gasoline or electric cart, small unlicensed utility truck) on public streets or highways" with a vehicle that has flashing lights. The final step requires that utility vehicles designed to operate at less than 25 mph be equipped with a flashing yellow light. The supervisor, supervisor's manager, and the Grounds Workers were unaware of the SBMS requirement that the supervisor is responsible to confirm that the operator reviews the manufacturer's instructions specific to the utility vehicle. The supervisor did not allow the utility vehicle with the vertical lift bed to be put in service until a procedure could be developed for safe operation of this equipment. (The lift bed utility vehicle was still out of service at the time of the investigation.)

A May 2001 SBMS revision added the requirement for the supervisor to verify that the operator of the utility vehicle has reviewed the manufacturer's instructions; ADM-082 does not include this requirement.

2.1.2.3 DOE Voluntary Protection Program (VPP)

The purpose of DOE-VPP is to recognize and promote excellence in contractor occupational health and safety programs. Similar in purpose to the Occupational Safety and Health Administration VPP, the DOE VPP is intended to provide all of the necessary elements to achieve excellent worker safety and health through management leadership, employee involvement, worksite analysis, hazard prevention and control, and safety and health training. DOE-VPP recognizes sites at which safety and health programs go beyond DOE and OSHA standards to protect workers more effectively.

In June 2001 the DOE awarded PNNL with STAR status within the DOE VPP. This program is aimed at truly outstanding protectors of employee safety and health. PNNL has conducted evaluations of its safety and health program each fiscal year since being awarded STAR status. These evaluations have not identified any issues specific to the facts surrounding this accident. The most recent evaluation was conducted in January 2004. Recertification by DOE of the PNNL safety and health program took place in August 2004.

2.1.2.4 Grounds, Relocation & Receiving Safety Meetings

Since April 13, 2004, the Grounds Work Team Leader has held a weekly safety meeting with all of the staff members he supervises. In July one of the topics was "Vehicle Safety re-cap", however there are no details of the discussion.

2.1.2.5 Procurement of Vehicles

In August 2004, PNNL's Facilities and Operations Directorate decided, to procure additional small utility vehicles for their Grounds Work Team with funding that had become available. The Grounds Work Team already had four Workman 3200 Utility Vehicles, manufactured by the Toro Company, which had provided good service. The existing utility vehicles had been used for hundreds of hours. When this opportunity arrived to procure more small utility vehicles, the Grounds Work Team decided to procure two more of the same Toro Workman 3200 series. One was to be a 2-wheel drive vehicle with a flatbed, and the other was to have a small vertical-lift platform mounted behind the cab to enable the workers to reach tree limbs. Options to be included on both vehicles were enclosed cabs, tachometer and heaters. The manufacturer had made several improvements to the Workman 3200 Utility Vehicles since the purchase of the previous units. Some of those improvements included an adjustable bucket seat and increase leg room in the cab as well as increased cab access. Seat belts were now standard equipment, and the rollover protection system no longer included a shoulder restraint. Previous vintage (from introduction in 1993) Toro Workman 3200 Utility Vehicles did not include seat belts as standard equipment or as part of the roll over protection system, but they were available as optional equipment.

On August 18, 2004, after preparation of the procurement request, a PNNL Contract Specialist attempted to obtain bids from local Toro equipment suppliers. The local Toro equipment supplier told the PNNL Contract Specialist that Toro

only authorized its regional distributor for this area to sell the Workman 3200 Utility Vehicles. The Contract Specialist then negotiated the purchase with the regional distributor, as a sole source procurement, based on evidence provided indicating that a fair price was being proffered. The Contract Specialist signed a contract, for PNNL, on August 24, 2004, for the purchase of these two Toro Workman 3200 vehicles. (See Appendix B, Specification sheet.)

The cab and heater for the Workman 3200 vehicles are not installed at the factory by Toro, but rather at the regional distributor. The cab and heater are manufactured by Toro and installed by the distributor using an installation manual provided by Toro. This cab was much more substantial than some other after-market cabs that might have plastic and canvas for the sides. This cab consisted of a sturdy square-tube steel frame to which solid tempered glass doors with handle-operated locking mechanisms were attached. The cab installation procedure required the replacement of the front main suspension spring with a stronger spring. This procedure required the seats and seat-mounting hardware be removed for access. The instructions also required that the heater be installed prior to the cab installation. The installation instructions state that the cab reduces the vehicle load-carrying capacity by 420 pounds. The instructions specify that after installation of the spring and heater, the equipment removed be re-installed in the reverse order. Figure 5 compares existing and new versions of the Workman 3200. There is evidence that at sometime the bolt securing the seat belt was installed, as shown in Figure 6. The manufacturer's service representative informed the Accident Board Chairperson that seat belts and hip restraints are installed at the factory. PNNL staff who operate and maintain the vehicle stated that they did not remove the seat belts and hip restraints.

2.1.2.6 Delivery of Vehicles

On September 23, 2004, the two Toro Workman 3200 Utility Vehicles were delivered to the Battelle Receiving and Shipping Warehouse (BRSW) at PNNL by the regional distributor. The BRSW was very busy at that time. In order to expedite the processing of freight through the BRSW, Storekeeper 1 gave instructions to the regional distributor delivery driver where to offload and park the two vehicles.

2.1.2.6 Acceptance of Vehicles

After the Toro Workman vehicles had been offloaded, Storekeeper 1 verified that they were configured as specified in the PNNL Purchase Order. Storekeeper 1 verified that each vehicle had a cab, tachometer, and heater. One vehicle had a flatbed and the other had a vertical lift. He also checked that they appeared to be in an undamaged condition, in accordance with Section 3 of the *Shipping, Receiving, and Transportation Logistics* subject area procedure under SBMS and Section 4, "Shipping and Receiving Material Directly from the Field," in the internal Logistics Desk Procedure. The regional distributor's driver presented the delivery paperwork to Storekeeper 1, who then signed it without reviewing it. Storekeeper 1 did not notice whether or not the seat belts and hip restraints were present in the vehicles.

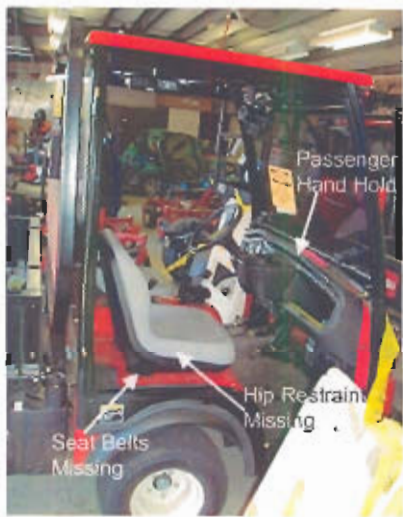


Figure 5. Top: existing Toro Workman 3200; bottom: new Toro 3200 (left) and detail of hand hold (right)

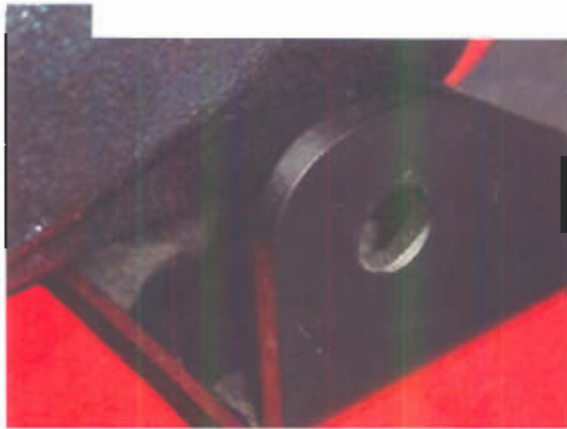


Figure 6. Seat belt attachment bracket (note missing paint in hole and circular scratch marks)

The regional distributor's delivery driver then gave Storekeeper 1 the Operators' Manuals and two videotapes on the operation of the Toro Workman vehicles, and left. Storekeeper 1 gave the manuals, delivery documentation, and videotapes to Storekeeper 2 at the BRSW. Storekeeper 2 verified that each vehicle had a cab, tachometer, and heater, and that one vehicle had a flatbed and the other had a vertical lift as specified in the PNNL Purchase Order. Storekeeper 2 informed the Grounds Work Team Leader that his Workman vehicles had arrived. The operator training videotapes provided at delivery were for a previous model of the Toro Workman 3000 series utility vehicles (Form No. 93-110-SV). In the supplied operator training, the manufacture states that watching the video is not a substitute for reviewing the Operator's Manual. Additionally, the video describes seat belts as an optional feature and identified hip and shoulder restraints as a standard feature. Prior to the accident, the PNNL management and staff of the Grounds Work Team did not view the delivered videos or review the Operator's Manual.

2.1.2.8 Receipt Inspection

PNNL details its receipt inspection process in the SBMS in *Shipping, Receiving, and Transportation Logistics* subject area, Section 3, "Inspections and Acceptance by Staff of Items Received." There is also an internal Logistics desk procedure "Policy and Procedures for Logistics" (December, 2003) in the Work team, of which Section 4, "Shipping and Receiving Material Directly from the Field," describes general receipt inspection protocols. Although the Storekeepers working at the BRSW verify that the items received are what were called for on the purchase order and appear to be undamaged, SBMS states that it is the responsibility of the end user to verify that the item received is what was ordered and is in full functioning condition. The end user must also examine the item for suspect or counterfeit items according to the SBMS subject area, and, if found, call for assistance. Additionally, if an item falls within one of the categories listed in this SBMS subject area, assistance in receiving and accounting for that item from another PNNL organization may be necessary. Payment for the item is not initiated by the PNNL procurement organization until the end user has determined that the item received meets all applicable requirements and documents this according to the established procedures in PNNL's procurement system.

2.1.2.9 Acceptance of Vehicles into Service

On September 23, 2004, a PNNL Vehicle Subject Matter Expert and a PNNL Industrial Hygienist raised concerns that elevated levels of CO in the cabs of vehicles may occur when the engine is idling for extended periods of time. This was based on previous experience with these types of vehicles operated by another DOE Contractor at the Hanford 200 Area. Testing was conducted at the BRSW, to ascertain if this was a problem. The results of the testing identified an elevated level of CO (44 ppm) in the vehicle cab after 5 minutes of stationary idling. A decision was made to remove the doors of the vehicles for the time being as a preventive measure. In the warm summer months, the doors would have been removed as a matter of comfort for the occupants of these vehicles. Additional testing and evaluation was planned before use with the doors installed.

Also on that day, the Grounds Work Team Leader went to the BRSW, collected the documentation for the new Toro Workman vehicles, and drove one of the Toro Workman vehicles to the Grounds Equipment Storage Facility. He returned and drove the second one to the Grounds Equipment Storage Facility. The Grounds Work Team Leader did not perform extensive checks on the vehicles at the BRSW prior to driving them. He knew the vehicles had been driven off of the trailer on which they arrived and had reasonable assurance that the vehicles were in drivable condition.

After driving the Toro Workman with the vertical lift platform to the Grounds Equipment Storage Facility, the Grounds Work Team Leader decided that it was a potentially hazardous piece of equipment that would require some specific procedures and training. He parked it in the Grounds Equipment Storage Facility and did not place it in service. The new Toro Workman 3200 with the flatbed, being very similar to the ones already in use, was not thought to present any unusual or new hazards and was put in service the next day, September 24, 2004. The Grounds Work Team Leader did not notice that the hip restraints or seat belts were missing. He did not notice the safety and instruction decal located above the windshield on the driver's side which stated "FOR YOUR SAFETY, ALWAYS USE SAFETY BELTS" (Figure 7). He also did not review the Operator's Manual prior to or after operating the vehicles.



Figure 7. Safety Instruction decal above windshield on driver side of cab

Shortly after receiving the two Toro Workman vehicles, the Grounds Work Team Leader was satisfied that the two vehicles were in satisfactory condition and notified the procurement organization that payment could be made. This payment had not occurred at the time of the accident. The Grounds Work Team Leader did not perform a review of the Toro Workman vehicles to assure that all standard equipment was installed on the vehicles.

From the time of the acceptance of the Toro Workman 3200 Utility Vehicle involved in this accident, the Grounds Work Team Leader and three other Grounds Workers drove this vehicle. None of the drivers noticed the seat belt safety and instruction decal located above the windshield or the absence of the hip restraints. This vehicle was accepted with approximately 3 hrs. of use on the dashboard runtime clock, and had approximately 11 hrs of use at the time of the accident.

2.1.3 Chronology of Events

Dates	Time (if determinable)	Events
August 17, 2004		Initial procurement request is made for the purchase of two new Toro Workman 3200 Utility Vehicles with after factory add-ons. One vehicle is to be provided with a flatbed, and the other with a vertical lift.
August 24, 2004		A PNNL purchase order is issued for two new Toro Workman 3200 Utility Vehicles with after-factory add-ons.
September 23, 2004		The two new Workman 3200 Utility Vehicles are delivered to the BRSW.
September 23, 2004		Both new Toro Workman 3200 Utility Vehicles are driven to the Grounds Equipment Storage Facility.
September 24, 2004		The new Toro Workman 3200 Utility Vehicle with flatbed is put into service, the doors are removed as a temporary means of abating a potential carbon monoxide hazard. The new Toro Workman 3200 Utility Vehicle with the vertical lift is held out of service due to concerns related to lack of safety procedures and training.
September 24 - October 8, 2004		The new Toro Workman 3200 Utility Vehicle with flatbed is used sporadically by the Grounds staff. (8 hrs. of use by PNNL personnel).
October 8, 2004	0730	Grounds Worker A and Grounds Worker B start work for the day.
October 8, 2004	0800 - 0830	Grounds Worker A drives the new Toro Workman 3200 Utility Vehicle with flatbed out of the Grounds Equipment Storage Facility. Grounds Worker B is the passenger.
October 8, 2004	1100	A United Way fund raiser is set up adjacent to the Physical Sciences Building, approximately 60 yards southwest of the cooling ponds.
October 8, 2004	Approximately 1100	Grounds Worker A drives the new Toro Workman 3200 Utility Vehicle with flatbed on the concrete walkway to the planting area on the north side of the Auditorium. Grounds Worker B is the passenger.
October 8, 2004	Approximately 1100	Grounds Worker B drives the new Toro Workman 3200 Utility Vehicle with flatbed north on the concrete walkway between cooling ponds from the north side of the Auditorium, and turns left (west) at northeast corner of the west cooling pond. Grounds Worker A is the passenger.
October 8, 2004	Approximately 1100	Grounds Worker B drives the new Toro Workman 3200 Utility Vehicle with flatbed west along the concrete walkway on the north side of the cooling ponds and turns left (south) at northwest corner of the west cooling pond. Grounds Worker A is the passenger.
October 8, 2004	Approximately 1100	While turning, Grounds Worker A slides down the passenger seat and starts to fall out of the new Toro Workman 3200 Utility Vehicle with flatbed.

October 8, 2004	Approximately 1100	The right foot of Grounds Worker A makes firm contact on concrete walkway and torsional movement causes a fracture of right leg above the ankle. Grounds Worker A falls and comes to rest on the lawn adjacent to the concrete walkway.
October 8, 2004	Approximately 1100	Grounds Worker B stops the new Toro Workman 3200 Utility Vehicle with flatbed on the concrete walkway, exits the vehicle, and attends to Grounds Worker A. Employees participating in the United Way fund raiser witness fall and run to aid injured employee.
October 8, 2004	1109	The "2400" Operations Center receives two calls requesting medical assistance for injured Grounds Worker A.
October 8, 2004	1110	The "2400" Operations Center makes call to the RFD to request medical assistance.
October 8, 2004	1111 - 1130	The "2400" Operations Center makes pre-arranged notification calls to PNNL and PNSO staff regarding injury.
October 8, 2004	1121	The RFD ambulance arrives at PNNL.
October 8, 2004	1141	The RFD ambulance leaves PNNL and transports Grounds Worker A to Kadlec Medical Center.
October 8, 2004		PNNL preserves accident scene and takes witness statements.
October 8, 2004	1152	The RFD ambulance arrives at Kadlec Medical Center.
October 8, 2004		Grounds Worker A is admitted to Kadlec Medical Center.
October 8, 2004	1230	The PNNL Maintenance and Fabrication Services Manager issues verbal order to stop the use of all Grounds utility vehicles.
October 8, 2004	1430	The PNNL Motor Vehicle Subject Matter Expert and Work Team Leader for Grounds, Relocation and Receiving Work Team attempt to determine if speed was factor in the accident.
October 10, 2004	1532	The PNNL Maintenance and Fabrication Services Manager issues formal "Timely Order LEM2005-1, Utility Vehicle Operation," which stops use of all motorized off-road Grounds vehicles.
October 11, 2004	1228	Facility Operations Division Director rescinds Timely Order LEM2005-1, and issues "Work Control Standing Order 2004-2, Utility Vehicle Operations," for all Division utility vehicles.
October 11, 2004	1300	PNNL conducts critique of accident.
October 12, 2004		PNNL maps out accident scene
October 13, 2004		The PNSO Site Manager determines need to convene a Type B Accident Investigation Board, and makes notification to SC Headquarters.
October 14, 2004		Grounds Worker A has surgery to repair right leg fracture.
October 14, 2004		EH-2 concurred with the PNSO determination to convene a Type B Accident Investigation.
October 15, 2004		The PNSO Site Manager appoints Accident Investigation Chairperson and Board.

October 16, 2004		Grounds Worker A is discharged from Kadlec Medical Center.
October 18, 2004		Type B Accident Investigation is initiated by Accident Investigation Board.

2.2 Environmental Conditions

On October 8, 2004, at 11:00 AM, the Hanford Meteorological Station located at PNNL recorded a partly cloudy sky, a temperature of 63°F, and wind from the northeast at 3 mph.

The surface of the walkway on which the Toro Utility Vehicle was traveling is concrete. The walkway was dry, level, and in good repair. The walkway is of sufficient width to afford ample room for the vehicle to maneuver normally. There are no objects that could obstruct the vision of the driver, or obstacles that could interfere with operation of the vehicle. The walkway was free of pedestrians and other vehicles at the time of the accident.

2.3 Operator Training and Qualifications

Training for PNNL staff is managed through the *Training and Qualifications Management System*. The SBMS subject area that identifies the procedure used at PNNL for staff training is *Training and Qualification for Staff*.

The Laboratory uses its Job Evaluation and Training System (JETS) to develop a training plan for each employee. This system allows managers to revise the JETS to include requirements which are applicable to their operations. Managers are required to evaluate the training plans for staff members on an annual basis.

Both Grounds Worker A and B have JETS training plans and their training was current. Both Grounds Workers who were involved in the accident and their Work Team Leader had participated in Motor Vehicle Safety Awareness as well as Off-Road Vehicle Safety training. The Grounds Workers are required to have current Washington State Commercial Drivers License (CDL). The Grounds Workers who were involved in this accident had current CDLs.

The SBMS subject area *Operating Vehicles for Business Purposes*, Section 4, *Operating Utility Vehicles* and F&O Administrative Procedure ADM-082, *General Expectations and Operational Guide for PNNL Grounds Maintenance Activities*, Section 6.0, *Precautions and Limitations*, require operators to be trained prior to use of equipment. The Grounds Workers who were involved in this accident did not review the Operator's Manual which was provided with the Toro Workman 3200 Utility Vehicle. A video safety training tape was provided with the Operator's Manuals for the new utility vehicles. The Grounds Workers and Work Team Leader did not view the video tape prior to the accident. The video tape provided with the new utility vehicles was copyrighted 1993 and showed the older version of the Toro Workman 3200 Utility Vehicle. The video identifies seat belts as being optional equipment, for the older model vehicles. The Toro Operator's Manual section titled "While Operating" states "Operator and passenger should use seat belts and remain seated whenever the vehicle is in motion." The section titled "*Operating Characteristics*" also states "Driver and passenger should always use the seat belts." The section titled "*Passengers*" states "Whenever you have a passenger riding in the vehicle make sure he or she is wearing the seat belt and holding on securely. Drive slower and turn less sharply because your passenger does not know what you are going to do next and may not be prepared for turning, stopping, accelerating, and bumps. You and your passenger should remain seated at all time, keeping arms and legs inside the

vehicle. The operator should keep both hands on steering wheel, whenever possible and passenger should use hand holds provided." The section titled "*Tipovers*" states that "The Toro Workman is equipped with a roll bar, hip restraints, seat belts and hand hold." The manufacturer's technical representative contacted the Board chairperson on October 25, 2004, to inform him that a new version of the video training tape was now available. He indicated that the information provided at time of delivery should have included a customer response card which could be used to obtain the new version of the video training tape. This card had not been located during reviews of the provided documentation

2.4 DOE Oversight

The PNSO has developed a formal Performance Assurance Procedure which defines the PNSO roles and responsibilities, methods, and tools for conducting contractor oversight. The contractor self-assessment program provides a cornerstone for performance assurance. DOE line oversight and contractor self-assessments together assure that field elements and contractors are adequately implementing the appropriate contractual requirements.

PNSO uses two Facility Representatives to provide day-to-day oversight of PNNL work activities. These two positions transferred to PNSO from the Richland Operations Office (RL) in July 2003. In the performance of their duties as Facility Representatives, they are currently following the RL Facility Representative Program. The RL Facility Representative Program is modeled after DOE-STD-1063-2000, *Facility Representatives*, and fully implements the provisions in the standard. PNSO is currently preparing a procedure for performing Facility Representative oversight of PNNL.

The PNSO Facility Representative responsible for overseeing the Grounds, Relocation and Receiving Work Team had not yet performed any in-depth assessment of this organization. He is currently assigned responsibility for overseeing several PNNL facilities and organizations. These range from craft-based work through nuclear facilities. The PNSO Facility Representative has implemented a risk-based approach for determining the focus of his work activities. This has directed the majority of his time towards the nuclear facilities located in the 300 Area. He has regularly monitored the self-assessments prepared by these organizations to maintain an awareness of their safety performance. Because he has responsibility for overseeing Grounds, Relocation and Receiving Work Team, this has included regularly reviewing their self-assessments. Because these self-assessments have indicated there are no pressing safety concerns, coupled with periodic incidental observation of their work activities being performed safely, oversight of this organization has been a lesser priority.

2.5 PNNL Oversight

PNNL's Integrated Planning and Assessment management system drives the development of organizational self-assessment. The Facility Operations Division FY 04 *Self-Assessment Plan* – Quarter 3 revision, dated May 7, 2004, notes the merger of Craft Resources Department and Facility Operations into one division. This revision addresses the major program changes and established the self-assessment priorities for the remainder of the fiscal year. F&O self-assessments are performed in accordance with ADM-028 *Performing Self-Assessments* and ADM-029 *Trend Analysis*. On March 1, 2004, a self-assessment was performed of the Occupational Safety Practices at the Grounds Equipment Storage Facility. The self-assessment focused on housekeeping, tool storage, "other potential safety discrepancies", and chemical inventory. It was

conducted by Grounds Work Team Leader, and others. There were no findings. The self assessment received a green rating (generally meets or exceeds performance expectations, may have deficiencies). None of the previous self-assessments of Grounds dating back to FY- 2002 were directed toward the operation of the existing Toro Workman 3200 Utility Vehicles in use at PNNL. A self-assessment of ADM-082 was not performed.

2.6 Emergency Response

Immediately after the accident occurred, Grounds Worker B ran across the lawn toward the United Way fundraiser event that was occurring by the Physical Sciences Building, making hand signals for someone to call the PNNL emergency number, 2400, to request an ambulance. Other people at or near the United Way fundraiser who saw the accident or its immediate aftermath started walking toward the accident to assist. Two persons in the vicinity of the accident called the 2400 emergency number in rapid succession to report the accident and summon an ambulance.

The calls to the 375-2400 emergency number are received and recorded in the PNNL Operations Center. The Operations Center receives both emergency and non-emergency calls on the 375-2400 number. When an emergency call is received, the Control Room Technicians (CRTs) in the Operations Center call the local 911 emergency call center, which is the Southeast Communications Center (SE-COMM) in this case. If an individual at PNNL uses a PNNL telephone to call the local 911 directly, the number of the telephone from which the call is being made is displayed and audibly announced to the CRT's in the Operations Center. The CRTs attempt to reach the person making the call from the number displayed in an effort to understand the reason for the call, as well as to take appropriate measures.

After the emergency call has been made to the PNNL Operations Center, and notification has been made to the SE-COMM Communications center of the emergency situation, when possible, one of the CRT's then travels to a point near the emergency scene to further direct the emergency responders to the exact site of the emergency. In the case of this accident, CRT-1 walked out onto Battelle Boulevard and waved her arms to direct the RFD ambulance into the building parking lot and to the nearest point of access.

The first call reporting the accident to 2400 was received in the PNNL Operations Center at 11:09 AM; the second was received shortly thereafter. The Operations Center called SE-COMM at 11:10 AM., and an ambulance from RFD was dispatched at 11:12 AM.

At 11:12 AM, an Advanced Life Support ambulance from the RFD was dispatched from Station 73, located at 1900 Jadwin, approximately four miles to the south of PNNL. The ambulance responded at 11:13 AM, and was on the scene at 11:21 AM. There were three Emergency Medical Technician-Paramedics on the Station 73 ambulance that particular day, although one or two is a normal complement.

The ambulance was dispatched to 902 Battelle Boulevard, where CRT 1 from the PNNL Operations Center flagged it down and directed it to the closest point of access to the emergency, the parking lot on the north side of the Engineering Development Laboratory.

The RFD Paramedics stabilized the injured victim, left the scene at 11:41 AM, and arrived at the Kadlec Medical Center, 888 Swift Boulevard, at 11:52 AM.

The routine procedure for the Operations Center staff after requesting emergency assistance is that one CRT remains and operates the Center while the other travels to the emergency scene and directs incoming emergency equipment. According to persons interviewed, this mode of operation has been effective.

The fire alarm systems in the PNNL facilities have radio transmitters called Radio Alarm System cards that send alarms directly to SE-COMM when the alarm systems are actuated. This was not a factor in this accident.

2.7 Investigative Readiness

The Contractor Requirements Document (CRD) of DOE Order 225.1A, *Accident Investigations*, mandates that contractors will support Type A and B accident investigations, establish and maintain readiness to respond to accidents, mitigate the consequences, assist in collecting and preserving evidence, and assist with the conduct of the investigation by providing office space and equipment, meeting regularly to discuss issues surrounding the accident, and providing general administrative assistance. Although the PNNL contract does not include this CRD, actions taken by PNNL were consistent with these requirements.

PNNL immediately secured the scene of the accident, and began investigating the event. A critique of the accident was conducted on October 11, 2004. The need for conducting this critique is established by the SBMS Subject Area, *Critiques*. This led to PNNL gathering technical information and related Laboratory documents, performing an engineering study to determine if speed and turning radius were a factor, taking witness statements, interviewing support staff, coworkers and line managers, and taking photographs. When on October 15, 2004 the PNSO Manager declared the need for a Type B Accident Investigation, the PNNL investigative and analysis activities were halted. All information compiled by PNNL during the investigation, critique and analysis activities were subsequently shared with the Accident Investigation Board. PNNL continued to be supportive of the needs of the Accident Investigation Board. This support included appointment of a PNNL staff member to serve as the Laboratory liaison to the Accident Investigation Board to assure that informational needs were being met, and allowance to the Hanford Atomic Metal Trades Council (HAMTC) Safety Representative to witness and participate in the on-site portion of the accident investigation in the interest of the various union bargaining units at the Laboratory.

In attempting to determine whether the operating speed of the vehicle might have been a factor in this accident, a reenactment was performed by the PNNL Motor Vehicle Subject Matter Expert and Grounds Work Team Leader. Both individuals drove in the utility vehicle involved in the accident and mimicked the route and movements reported to have been performed by the two Ground Workers involved. These reenactments were conducted in a controlled manner, but the utility vehicle was driven without installing the missing hip restraints or seat belts. The two individuals involved were fully aware of actions taken by the driver involved in the accident and were able to physically anticipate and brace themselves during all maneuvers. Although these additional actions were taken, there was still some potential for exposure to the hazards similar to those that resulted in this accident.

The DOE contract with PNNL at the time of the accident did not include the CRD for DOE O 225.1A. Consistency with the expectations of the CRD for the need to mitigate the consequences of the event to prevent recurrence or bringing the accident scene to safe-state, collecting and preserving evidence, preserving the accident scene to the

extent that it is under the control of the contractor, and documenting the accident scene through photography and other means could not be found in SBMS.

3.0 Analysis

3.1 Barrier Analysis

Barrier analysis is based on the premise that hazards are associated with all tasks. A barrier is any management or physical means used to control, prevent, or impede the hazard from reaching the target (i.e., persons or objects that a hazard may damage, injure, or harm). The results of the barrier analysis are integrated into the events and causal factors chart to support the development of causal factors. Appendix C contains the Board's Barrier Analysis of physical and management barriers that did not perform as intended and thereby contributed to the accident.

3.2 Change Analysis

Change analysis examines planned or unplanned changes that caused undesirable results related to the accident. This process analyzes the difference between what is normal, or expected, and what actually occurred before the accident. The results of the change analysis conducted by the Board are integrated into the events and causal factors chart to support the development of causal factors. Appendix D contains the Board's Change Analysis and reinforces the Barrier Analysis.

3.3 Events and Causal Factors Analysis

The Events and Causal Factors Analysis (Appendix E) is a systematic process that uses deductive reasoning to determine Causal Factors of an accident. Causal Factors are the significant events and conditions that produced or contributed to the Direct Cause, the Contributing Causes and the Root Cause(s) of the accident. The Board created an Events and Causal Factors Chart (Appendix F) to assist in determining the causal factors of this accident.

3.3.1 Direct Cause

The direct cause is the immediate event or condition that caused the accident or event. The Board concluded that the direct cause of the accident was that the utility vehicle did not have manufacturer specified active (seat belts) and passive (hip restraint) passenger safety equipment.

3.3.2 Contributing Causes

Contributing Causes are the events or conditions that, collectively with the other causes, increased the likelihood of the event but which did not cause this event. The eight Contributing Causes and associated facts identified for this accident and are detailed in Appendix E.

3.3.2 Root Cause

Root causes are the events or conditions that, if corrected, will prevent recurrence of this and similar events. The Board concluded that the single Root Cause of this accident was that F&O failed to ensure effective implementation of its hazard analysis process.

3.4 Integrated Safety Management

The Integrated Safety Management System Description for PNNL is provided as SBMS Program Description, Integrated Environment, Safety and Health Program Description. It notes that it will be maintained as a living document to reflect the current status of the

operating contract, system improvements, and/or changed conditions and requirements. It further requires that it be reviewed annually and updated as necessary. The version of this document currently in SBMS has an "Effective Date" of September 2003. This version does not reflect the organizational changes involving F&O that occurred in April 2004. However in terms of operational practice, this document remains consistent.

3.4.1 Define the Work

Daily work assignments to be performed by Grounds Workers are typically not assigned by the Work Team Leader for the Grounds, Relocation and Receiving Work Team. Instead each Grounds Worker is assigned a geographic zone for which they are responsible for maintaining. The work to be performed by the Grounds Workers is defined by F&O Administrative Procedure ADM-082, *General Expectation and Operational Guide for PNNL Grounds Maintenance Activities*. As is stated in ADM-082, the purpose of the document is to convey to staff assigned to supervise and/or to perform ground management their workplace expectations, general safety practices, and the necessary safety precautions required to operate specific pieces of equipment. Use of utility vehicles and any other equipment available through the Grounds Equipment Storage Facility is expected for meeting the responsibility for maintaining the grounds in an assigned geographic zone. All of the Grounds Workers have been with the Grounds, Relocation and Receiving Work Team (and predecessor organizations) for the past several years and are experienced with the work and how it is to be performed.

3.4.2 Analyze the Hazards

ADM-082 includes a section titled "Hazard Assessment and Mitigation Summary." This includes a listing of 14 different work hazards. It does not represent a comprehensive list of those hazards likely to be encountered by the Grounds Workers. Missing from the listing is mention of hazards linked to the safe operating requirements for off-road vehicles, e.g., vehicle roll-over. The only mention of the type of utility vehicles involved with this accident is found listed as a "General Safety Best Practice." This mention is focused on the preferred route these vehicles should travel when moving between the RCHN and 300 Area, and that they need to yield to pedestrian traffic and on-road vehicles.

The Accident Investigation Board concluded that hazard analysis and implementation of mitigating controls in ADM-082 is less than adequate.

3.4.3 Develop and Implement Controls

The ADM-082 section titled "Hazard Assessment and Mitigation Summary" includes a listing of controls for mitigating the 14 different work hazards noted. This summary is not a comprehensive listing of hazards; as it also lacks an associated listing of controls, e.g., use of seatbelts and provision of a roll-over protection systems. The utility vehicles involved in this accident are only mentioned in the "General Safety Best Practices" section as needing slow moving vehicle placard and flashing yellow light, if they travel between RCHN and the 300 Area.

The Accident Investigation Board concluded that hazard analysis and implementation of mitigating controls in ADM-082 are less than adequate.

In April 2004, an organizational change merged the Craft Resources Division (which included the Grounds Workers) and the Facility Operations Department into F&O. At that same time the Grounds Worker Team Leader was appointed to his current

position. A training course was held for all new F&O supervisors, which included the Grounds Worker Team Leader. In the training materials provided, "What Managers in the Facility Operations Division Need to Know About Their Jobs..." it is noted that as PNNL managers, SBMS is their primary source of requirements. It further states that each supervisor is expected to become familiar with SBMS subject areas and the additional organization- or activity-specific instructions that apply to their position, operations, and facilities. Up to the time of the accident, F&O line management had not confirmed whether the Grounds Workers Team Leader had gained needed familiarity with those SBMS subject areas and the additional organization- or activity-specific instructions.

The Accident Investigation Board concluded that management did not verify that the Grounds Workers Team Leader had knowledge of applicable SBMS requirements and other organizational- and activity-specific instructions.

ADM-082 requires that Grounds Workers be properly trained in the operation of all grounds equipment before use. Employee training needs are identified through the Job Evaluation and Training System (JETS) and Integrated Operations System. PNNL had provided an "Off-Road Vehicle Safety" (Course 693) training course. The two Grounds Workers involved in this accident completed this course during January 1997. The Grounds, Relocation and Receiving Work Team Leader also completed this course during August 1994, and September and November 1997. Through interviews with the Board, the users of the utility vehicles stated that they had received on-the-job training in the operation of the Grounds utility vehicles, while under the direction of their supervisor. No documented occurrence of this training exists since it was performed ad hoc. These utility vehicles have operated for hundreds of hours of use since 1993 without any reported accidents.

ADM-082 also requires that each Grounds Worker review the safe operating instructions and hazards associated with each piece of equipment during a scheduled safety meeting and during their annual performance review. This is consistent with the requirement of SBMS Subject Area, *Operating Vehicles for Business Purposes – Operating Utility Vehicles*, that the supervisor confirms that operators review the manufacturer's operating instructions specific to the utility vehicle in question. This was last accomplished prior to the April 2004 F&O reorganization. The Grounds Workers interviewed acknowledged in the past having reviewed the manufacturer's operating instructions for the older models of utility vehicles. However, no supporting documentation to confirm when this was accomplished could be located.

Finally, ADM-082 requires that when a new piece of equipment is received, all grounds employees will be trained on its operation and safety features. The Grounds Workers Team Leader had decided that the newly purchased utility vehicles, even though they were of different vintage and physically different in design from the previously purchased utility vehicles, were not new equipment since they were of the same make and model. Because of this erroneous decision, it was assumed that there was no need to have the Grounds Workers review the manufacturer's operating instructions provided with these new vehicles.

The Accident Investigation Board concluded that the Grounds Workers Team Leader did not know the SBMS requirements.

3.4.5 Perform Work Safely

As is required under "Staff" responsibilities in the SBMS Management System Description, Roles, Responsibilities, Accountabilities, and Authorities (R2A2), all PNNL employees are to follow PNNL safety requirements, stop unsafe work, and to report unsafe conditions to management. Working safely is also described as a general expectation of ADM-082. ADM-082 notes that Grounds Workers have a responsibility to "catch problems" in their assigned geographic zone before serious injury to staff or property damage can occur.

Both the 1993 and 2000 revisions of American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI) B56.8, Safety Standard for Personnel and Burden Carriers, require the provision of handholds and hip restraints for the driver and each passenger. These features are to assist in preventing occupants from falling or being thrown by momentum out of the vehicle. The four older utility vehicles in use by the Grounds Workers were found to be in compliance with ASME/ANSI B56.8. In addition, each of the older utility vehicles was provided with a shoulder restraint bar to provide additional stability to the driver and passenger. ASME/ANSI B56.8 does not require seat belts. The manufacturer of the four older utility vehicles offered seat belts as optional equipment; however, the reason why seat belts were not purchased for the four older utility vehicles could not be determined during the investigation. This design is not the same on the newly purchased utility vehicles. The manufacturer is not providing a shoulder restraint. The new utility vehicles are fitted by the manufacturer with a hip restraint, but now seat belts are installed as standard equipment.

Interviews with the Grounds Workers and Grounds Worker Team Leader indicate that because the four older utility vehicles were not provided with seat belts, they did not recognize that the seat belts were missing. The manufacturer's instruction for the new utility vehicles makes repeated reference to the provision of seat belts and the need for using this safety feature. The need to wear seat belts in the new utility vehicles is further reinforced through labels located on the window frame in front of the driver, and on both posts of the vehicle's roll-over protection system. The Grounds Workers also stated that since these newly purchased utility vehicles were purchased from a well known and reputable company, they assumed that the vehicles were safe for immediate use.

As a result of concerns related to the build up of CO within the cab of the new utility vehicles, the Grounds Workers Team Leader made the decision to remove the doors of the new utility vehicle purchased with the flatbed. This decision was made as an interim corrective action until more in-depth analysis of the potential for CO overexposure could be determined. The manufacturer's operating instructions makes a specific note of avoiding long periods of engine idling. Follow-up with the manufacturer on the CO issue was planned back on September 24, 2004, but had not been accomplished prior to the accident on October 8, 2004. As such it was not known whether the note for avoiding prolonged idling was due to CO accumulating in the cab, and if the conditions under which the sampling was performed may have been easily prevented by adherence to this instruction. Furthermore, it was not determined if the temporary removal of the doors may have been an appropriate mitigating measure. Though the doors are not intended to function as a passenger restraint system, removal of the doors joined with the widened access opening to the occupant compartment, and the missing seat belts and hip restraints may have created a more unsafe situation.

The Accident Investigation Board concluded that operations authorization was made without adequate inspection of the utility vehicle and review of the manufacturer's operating instructions.

The Grounds Workers Team Leader did recognize the need for an operational procedure to ensure the safe use of the utility vehicle purchased with the vertical lift. Because of this need, this newly purchased utility vehicle was placed out of service until that needed procedure was finalized. This decision was favorable overall for the Grounds Workers because this newly purchased utility vehicle was also missing seat belts and hip restraints.

The Accident Investigation Board concluded that hazard recognition by Grounds personnel is less than adequate.

3.4.6 Feedback and Improvement

Employees are highly encouraged to report safety concerns to their immediate supervision. Within the Grounds, Relocation and Receiving Work Team, employees expressed no reservations in doing so if needed. These employees reported there being open communication and trust with their supervisor. In addition, several avenues exist for permitting employees to communicate safety concerns beyond their immediate supervisor. These include union representatives, the VPP Steering Committee, and PNNL and DOE Employee Concerns Programs.

The SBMS Subject Area, Planning and Assessments, has required development of organizational self-assessment plans. Driven by the F&O Self-Assessment Plan, monthly self-assessments are performed. An occupational safety practices self-assessment in the Ground Equipment Storage Facility was performed February 16-20, 2004. Those performing the self-assessment included the Grounds Workers Team Leader, a representative from Field Waste Management Services, and a representative from the F&O Work Planning Center. This assessment involved a general workspace inspection that included housekeeping, tool storage, "other potential safety discrepancies," and a 100% chemical inventory. This was done for the intended purpose of concluding the overall safety condition in the Ground Equipment Storage Facility. None of the results identified any issues or concerns related to the Grounds off-road vehicles. The resulting scorecard provided a rating of "green." This is defined as there being performance in the assessment category that generally meets or exceeds requirements and performance expectations, but that there may be deficiencies.

Immediately following the accident, the F&O Manager for Maintenance and Fabrication Services issued a verbal order to stop use of all Grounds off-road vehicles. This was issued formally the following day, and subsequently rescinded by the F&O Director to include all F&O off-road vehicles. The intended purpose of these actions was to prevent recurrence of this accident, but to also ensure that staff using such equipment were properly training and knowledgeable of its use, and also to ensure that all required safety features were provided. Through these follow-up actions PNNL discovered that other grounds off-road vehicles (such as mowing equipment) were also missing required seat belts.

The Accident Investigation Board concluded that the F&O self-assessment plan is less than adequate.

The PNSO Facility Representative responsible for overseeing the Grounds, Relocation and Receiving Work Team had not yet performed any in-depth assessment of this organization. He is currently assigned responsibility for overseeing several PNNL facilities and organizations. These range from craft-based work through nuclear facilities. The PNSO Facility Representative has implemented a risk-based approach for determining the focus of his work activities. This has directed the majority of his time towards the nuclear facilities located in the 300 Area. He has regularly monitored the self-assessments prepared by these organizations to maintain an awareness of their safety performance. Because he has responsibility for overseeing Grounds, Relocation and Receiving Work Team, this has included regularly reviewing their self-assessments. Because these self-assessments have indicated there are no pressing safety concerns, coupled with periodic incidental observation of their work activities being performed safely, oversight of this organization has been a lesser priority.

The Office of Independent Oversight and Performance Assurance (OA-50) performed an inspection of environment, safety and health at PNNL in November and December 2003. This inspection did not include the Grounds, Relocation and Work Receiving Work Team and the use of off-road vehicles.

During interviews, F&O management reported that previous injuries or property damage related to the use of the Grounds utility vehicles was not known to have occurred. This was confirmed through a review of the DOE Computerized Accident/Incident Reporting System (CAIRS) for all PNNL incidents reported to CAIRS since 1990.

Review of the PNNL Lessons Learned and Best Practices website found no previous incidents involving utility vehicles. There was a single vehicle related occurrence prior to this accident, but it was for an accident involving the on-road use of a PNNL pickup truck. Immediately following this accident, PNNL prepared a lessons learned. The lessons learned report stresses the importance of being knowledgeable of the SBMS requirements, and the need to ensure the presence of required safety features. Information surrounding this accident was shared during this investigation with other organizations located at the Richland Reservation through union representatives. Because of this, other circumstances of utility vehicles missing required safety features have been identified.

4.0 Conclusions and Judgments of Need

Judgments of Need are managerial controls and safety measures believed necessary to prevent or minimize the probability of recurrence. They flow from the casual factors and are directed at guiding managers in developing corrective actions. The Executive Summary identifies the Board's Judgments of Need. The conclusions and Judgments of Need are provided in the Table 4-1.

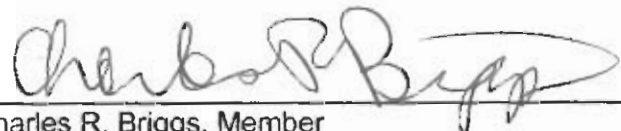
Table 4.1. Conclusions and Judgments of Need

Conclusions	Judgment of Needs
The Grounds Worker fell from the utility vehicle because the seat belts and hip restraints were not present.	F&O needs to conduct a comprehensive hazard analysis of the work performed by its grounds personnel to ensure that hazards are identified and mitigating controls are documented.
Existing hazard analysis does not adequately address the hazards of the utility vehicle.	F&O needs to ensure that personnel who develop, review and approve the hazard analyses are knowledgeable of the SBMS process for identifying and mitigating workplace hazards.
The Grounds Supervisor was not aware of requirements to instruct Grounds Workers on familiarization with manufacturer's Operator's Manual.	F&O needs to ensure that grounds personnel are trained in the recognition of hazards and implementation of controls.
The existing utility vehicles were not provided with optional seat belts to increase the safe operation of this equipment.	F&O needs to ensure that personnel who conduct self-assessments are knowledgeable of the SBMS process for identifying and mitigating workplace hazards.
The operators of the utility vehicle were not aware of the changes to safety equipment nor did they heed the safety decals requiring seat belt use.	F&O needs to ensure that workers are knowledgeable of the hazards in their work environment.
F&O management had not verified that the Grounds Supervisor was aware of all pertinent requirements and responsibilities.	F&O needs to develop and implement a process to ensure that line managers are knowledgeable of their ES&H roles and responsibilities as documented in SBMS and other applicable laboratory documents.
Self-assessments conducted in F&O did not identify optional safety equipment for grounds vehicles.	PNNL's Office of Audit and Oversight needs to conduct a sampling of organizations to determine if similar deficiencies in documented hazard analyses and personnel's knowledge of workplace hazards exist.
Grounds Supervisor and ESH personnel conducted various tests on the utility vehicle involved in the accident without consideration of preventing another accident.	The PNNL accident readiness measures need to ensure that subsequent Laboratory investigation efforts do not create additional unsafe situations.
PNNL policies and procedures do not address how to respond to accidents which would require DOE Boards. Information on mitigating the consequences, collection and preservation of the accident scene and evidence and other information is not identified.	PNSO needs to ensure that the requirements of the Contractors Requirements Document of DOE O 225.1A, <i>Accident Investigations</i> , are incorporated into the PNNL SBMS.

5.0 Board Signatures


Date 11/22/04
Justin T. Zamirovski, Chairperson*
DOE Accident Investigation Board
U. S. Department of Energy
Chicago Office


Date 11-22-2004
Matthew B. Cole, Member
DOE Accident Investigation Board
U. S. Department of Energy
Office of Science


Date 11/22/2004
Charles R. Briggs, Member
DOE Accident Investigation Board
U. S. Department of Energy
Pacific Northwest Site Office

*DOE Trained Investigator

6.0 Board Members and Advisors

Chairperson	Justin T. Zamirowski, DOE-CH, STS
Member	Matthew B. Cole, DOE-SC, SC-83
Member	Charles R. Briggs, DOE-PNSO
Analyst	Karl Moro, DOE-CH, STS
Advisor	Joseph Drago, DOE-CH, STS
Advisor	Roger Christensen, DOE-PNSO
Advisor	Vern Madson, PNNL VPP Co-Chair
Legal Advisor	Terri Slack, DOE-ORO, OCC
Laboratory Liaison	Larry Maples, PNNL-F&O
Technical Writer	Robert E. Allen, PNNL-STI

Appendix A

Board Appointment Memorandum

Appendix A Board Appointment Memorandum

RL-702 (02/01)

United States Government

Department of Energy
Pacific Northwest Site Office

memorandum

DATE: OCT 15 2004
REPLY TO: OD:CRB 05-OD-0015
ATTN OF:
SUBJECT: APPOINTMENT OF INVESTIGATION BOARD
TO: J. T. Zamirovski
Safety and Technical Services
Chicago Office

I hereby establish a Type B Accident Investigation Board to investigate the personal injury accident which occurred at the Pacific Northwest Laboratory (PNNL) site on October 8, 2004, involving a PNNL yard maintenance worker who fell out of a utility cart and broke his leg. The worker was a passenger and slid out of the vehicle in a turn, with his right foot contacting the ground and causing a twisting break in his leg above the ankle (RL-PNNL-PNNLBOPER-2004-0015). The injured worker has been in the hospital more than 5 days. I have determined it meets the requirements established for a limited Type B accident investigation in DOE O 225.1 A, Accident Investigation, dated September 27, 1997.

You are hereby appointed Accident Board Chairperson. The Board members will be Matt Cole, SC-83, Karl Mora from your office, and Roger Briggs from my office. The Board will be assisted by advisors, consultants, and other support personnel as determined by you.

The scope of the Board's investigation will include, but is not limited to, identifying all relevant facts; analyzing the facts to determine the direct, contributing, and root causes of the accident; developing conclusions; and determining the actions that, when implemented, should prevent the recurrence of a similar accident. The investigation will be conducted in accordance with DOE O 225.1 and will specifically address the role of DOE and Contractor organizations and management systems as they may have contributed to the accident.

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 should be provided to PNSSO officials and PNNL for a factual accuracy review prior to report finalization.

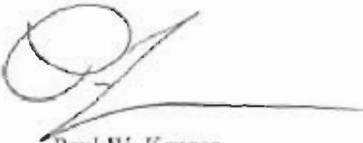
J. T. Zamirowski
05-OD-0005

-2-

OCT 15 2004

The report should be provided to me for acceptance by November 19, 2004. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

If you have any questions, please contact me, or you may also contact Roger Christensen of my staff, on (509) 372-4900.



Paul W. Kruger
Manager

cc: C. R. Briggs, PNSO
M. B. Cole, SC-83
G. L. Dever, SC-80
R. J. Hardwick, EH-2
M. D. Johnson, SC-3
K. G. Moro, CH
A. A. Patrinos, SC-70

Appendix B

Toro Workman 3200 Specifications

Appendix B Toro Workman 3200 Specifications



Workman 3000 and 4000 Series Specifications*

	WORKMAN 3200, 2WD, MODEL 07360 WORKMAN 3200, 2WD, W/BE3, MODEL 07361 WORKMAN 4200, 4WD, MODEL 07365 LIQUID-COOLED GAS	WORKMAN 3300-D, 2WD, MODEL 07362 WORKMAN 4300-D, 4WD, MODEL 07364 LIQUID-COOLED DIESEL	WORKMAN 3100, 2WD, MODEL 07363 AIR-COOLED GAS
ENGINE	B&S Daihatsu® 950G, 3-cylinder, 4-cycle, liquid-cooled, overhead camshaft, counterbalanced gasoline engine. 31 hp (23.3 kW); governed to a maximum speed of 3600 rpm by an internal mechanical centrifugal governor. 57.9 cu. in. (950 cc) displacement. Rear engine location, direct coupled to a transaxle. 12 volt electric starter and fuel pump. Full pressure lubrication with spin-on oil filter. Exhaust emissions meet C.A.R.B. for specialty vehicle engines and EPA regulations.	B&S Daihatsu® 950D, 3-cylinder, 4-cycle, liquid-cooled, counterbalanced diesel engine. 26.5 hp (19.9 kW); governed to a maximum speed of 3600 rpm by an internal mechanical centrifugal governor. 57.9 cu. in. (950 cc) displacement. Rear engine location, direct coupled to a transaxle. 12 volt electric starter. Full pressure lubrication with spin-on oil filter. 12 volt electric fuel pump with replaceable filter. Replaceable fuel filter/water separator with 3 micron filtration. Exhaust emissions meet C.A.R.B. for specialty vehicle engines and EPA regulations.	Kohler® Model CH23, 2-cylinder, 4-cycle, air-cooled, counterbalanced gasoline engine. 23 hp (17.3 kW); governed to a maximum speed of 3600 rpm by an internal mechanical centrifugal governor. 41.1 cu. in. (674 cc) displacement. Rear engine location, direct coupled to a transaxle. 12 volt electric starter. Full pressure lubrication with spin-on oil filter. Exhaust emissions meet C.A.R.B. for specialty vehicle engines and EPA regulations.
CLUTCH	6.7" (17 cm) clutch and pressure plate.	6.7" (17 cm) clutch and pressure plate.	6.7" (17 cm) clutch and pressure plate.
INSTRUMENT PANEL	Fuel, coolant temperature and hour meter gauges. Warning light cluster includes engine low oil pressure. Tachometer optional.	Fuel, coolant temperature and hour meter gauges. glow plug switch. Warning light cluster includes engine low oil pressure and glow plug light. Tachometer optional.	Fuel and hour meter gauges. Low oil pressure indicator light. Tachometer optional.
BATTERY	12 volt, 690 cold cranking amps at 0°F (-18°C).		12 volt, 525 cold cranking amps at 0°F (-18°C).
BED HEIGHT	30" (76 cm)	30" (76 cm)	30" (76 cm)
WHEELS AND TIRES	Front: 20 x 10-10, 4-ply rating, turf tread. Rear: 24 x 12-12, 8-ply rating, turf tread.		
AIR CLEANER	Remote mounted, heavy-duty 2-stage air cleaner with evacuator valve.		Kohler large capacity dual element air cleaner (filter with foam pre-cleaner).
RADIATOR	Mid-mounted with removable screen, lower clean-out access.		Not applicable.
VEHICLE WEIGHT	Model 07360: 1,565 lbs. (710 kg) Model 07361: 1,895 lbs. (859 kg) Model 07365: 1,993 lbs. (904 kg)	Model 07362: 1,020 lbs. (475 kg) Model 07364: 2,029 lbs. (920 kg)	Model 07363: 1,795 lbs. (814 kg)
RATED CAPACITY & MGWW	2,000 lbs. (1,134 kg) total. Includes 200 lb. (91 kg) operator, 200 lb. (91 kg) passenger and loaded attachment. 2WD Maximum Gross Vehicle Weight (MGWW): 4,000 lbs. (1,814 kg). 4WD Maximum Gross Vehicle Weight (MGWW): 4,200 lbs. (1,905 kg).		2,725 lbs. (1,236 kg) total. Includes 200 lb. (91 kg) operator, 200 lb. (91 kg) passenger and loaded attachment. Max Gross Vehicle Weight (MGWW): 4,000 lbs. (1,814 kg).
SOUND LEVEL	83 dB(A) at operator's ear, 3600 rpm. (Bed and sides installed).	88 dB(A) at operator's ear, 3600 rpm. (Bed and sides installed).	83 dB(A) at operator's ear, 3600 rpm. (Bed and sides installed).

SPECIFICATIONS COMMON TO WORKMAN 3000 & 4000 SERIES VEHICLES	
TRANSMISSION/ DRIVE TRAIN	Rear transaxle configuration, twin axle drive, 3-speed synchromesh (forward speeds only), H-shift pattern with high-low range providing 8 forward speeds, 2 reverse. Manual engage rear differential lock. 4WD: Automatic On Demand. Standard 3 rd high gear lockout.
SUSPENSION	Front: Independent A-Frame™ control arm, dual progressive coil springs, and dual shock absorbers with anti-sway bar. Rear: DeDion® axle (weight carrying axle is independent of transaxle), leaf springs, and dual shock absorbers.
FRAME	Welded, high-strength steel channels and tubes.
STEERING	Hydraulic power steering, 3-position tilt steering wheel, 13.5" (35 cm) diameter steering wheel, 4 turns lock-to-lock, 17.5 to 1 ratio, 7.0" (2WD), 5.0" (4WD).
2-POST ROPS	2-Post Roll Over Protective Structure.
BRAKES	4-wheel hydraulic, dual safety circuit, self-adjusting drum, 8" (20 cm) diameter front, 8" (20 cm) diameter rear. Hand actuated parking brake actuates rear brake shoes.

* Specifications and design subject to change without notice.



Workman 3000 and 4000 Series Specifications * (continued)

SPECIFICATIONS COMMON TO WORKMAN 3000 & 4000 SERIES VEHICLES													
FUEL CAPACITY	7 gallon (26 liter)												
LIGHTS	Two halogen headlights and single taillight with switch, rear stop lamp.												
HORN	Standard, button on dash.												
SEATS	Bucket seats with hip restraints. Seat belts standard.												
SEAT BELTS	Standard.												
CONTROLS	Throttle, brake and clutch pedals. Gear shifter, differential lock, parking brake, high-low range shifter, hydraulic lift lever, ignition switch, light switch and horn button. (Glow switch on diesel vehicle only; choke on air cooled vehicle only).												
3RD HIGH LOCKOUT	Interlock switch; engine won't run in third gear high range. Includes key switch.												
INTERLOCK	Clutch pedal must be depressed to start. PTO, electric clutch and generator must be disengaged (if installed) to start.												
SAFETY SUPPORT	7-gauge steel channel stores behind seat and fits over extended lift cylinder to prevent accidental lowering of bed.												
GROUND SPEED	<p style="text-align: center;">Standard Tires, Gear 1/2/3</p> Forward Speeds: High Range - 7.6/11.5/19.5 mph (12.2/18.5/31.2 km/h) Low Range - 2.94/5.7/7 mph (4.7/9.2/11.2 km/h) Reverse Speeds: High Range - 7.1 mph (11.6 km/h) Low Range - 2.8 mph (4.5 km/h)												
GROUND CLEARANCE	7" (18 cm) with no load.												
DIMENSIONS	<table border="1"> <thead> <tr> <th>Overall Length</th> <th>Overall Width</th> <th>Overall Height (top of ROPS)</th> <th>Clearance Circle</th> <th>Wheelbase</th> <th>Wheel Track¹</th> </tr> </thead> <tbody> <tr> <td>126" (325 cm) w/o bed 130" (330 cm) 136" (345 cm)</td> <td>65" (165 cm)</td> <td>75.8" (192.5 cm)</td> <td>32" (81 cm), Inside 19" (493 cm), Outside 100" (254 cm), Inside¹ 300" (720 cm), Outside¹</td> <td>70" (178 cm)</td> <td>46.5" (118 cm)—front 50.5" (128 cm)—rear</td> </tr> </tbody> </table> <p>¹With full bed. ²With 2/3 bed. Measured from wheel centerline. ³4WD dimensions only.</p>	Overall Length	Overall Width	Overall Height (top of ROPS)	Clearance Circle	Wheelbase	Wheel Track ¹	126" (325 cm) w/o bed 130" (330 cm) 136" (345 cm)	65" (165 cm)	75.8" (192.5 cm)	32" (81 cm), Inside 19" (493 cm), Outside 100" (254 cm), Inside ¹ 300" (720 cm), Outside ¹	70" (178 cm)	46.5" (118 cm)—front 50.5" (128 cm)—rear
Overall Length	Overall Width	Overall Height (top of ROPS)	Clearance Circle	Wheelbase	Wheel Track ¹								
126" (325 cm) w/o bed 130" (330 cm) 136" (345 cm)	65" (165 cm)	75.8" (192.5 cm)	32" (81 cm), Inside 19" (493 cm), Outside 100" (254 cm), Inside ¹ 300" (720 cm), Outside ¹	70" (178 cm)	46.5" (118 cm)—front 50.5" (128 cm)—rear								
REAR TOW HITCH	Bolt on formed steel hitch. Fastens to DeDion axle. Accommodates ballers up to 1,500 lbs. (680 kg) gross vehicle weight. Maximum tongue weight of 200 lbs. (91 kg).												
CERTIFICATIONS	Certified to meet the SAE J2258. Engine meets all applicable emissions standards per the manufacturer. Certified to meet the CE Machinery Directive.												
WARRANTY	Two-year limited warranty. See Operators Manual for further details.												

WORKMAN VEHICLE ACCESSORIES	
2/3 BED	Welded Steel diamond plate bed. Dimensions: 46.1" x 54.7" (122 x 139 cm). Weight: 161 lbs. (73 kg).
1/3 BED	Welded Steel diamond plate bed. Removable access panel for belt driven attachments. Dimensions: 21.5" x 54.7" (55 x 139 cm). Weight: 55 lbs. (25 kg).
FULL FLATBED FOLD DOWN SIDE KIT	Hinged side panels and tailgate can be folded down independently. Fits Full Flatbed Model 97301. 64.5" x 54.7" x 11" (164 x 139 x 28 cm) outside; 62.5" x 50.7" x 11" (159 x 129 x 28 cm) inside. 20 cu. ft. (.570 m ³) capacity. Weight: 109 lbs. (49 kg).
2/3 FLATBED SIDE KIT	Short bed side panels. Includes tailgate-welded pivot. 46.1" x 54.7" x 11" (122 x 139 x 28 cm) outside; 46.1" x 50.7" x 11" (117 x 129 x 28 cm) inside. 15 cu. ft. (.421 m ³) capacity. Weight: 72 lbs. (33 kg). Optional tailgate release. P/N 92-1220.
1/3 FLATBED STAKE SIDE KIT	Formed 14 gauge steel stake sides. 19.5" x 53.7" x 15" (49.5 x 136.4 x 38.1 cm) inside. Weight: 39 lbs. (18 kg).
REMOTE HYDRAULICS KIT HIGH-FLOW HYDRAULICS KIT	Standard: 4.25 gpm (16.1 liters) at 2,000 psi, up, down and float valve. Optional: 8 gpm (30.3 liters) at 2,000 psi. 4 gallon (15.1 liter) reservoir, electrically actuated valve.
200 GALLON SPRAYER	200 gallon (757 liter) low-profile polyethylene tank, Diaphragm pump, Detachable control box. Three section, 15.5' (5.6 m) open boom system.
110 ST SKID SPRAYER	Available with engine-driven centrifugal pump (86 psi, 120 gpm), engine-driven diaphragm pump (550 psi, 9.5 gpm) or PTO-driven centrifugal pump (95 psi, 76 gpm). High density, impact resistant polystyrene tank. Ratchet valve.
VICON SPREADER	14.1 cu. ft. (.398 m ³), 750 lbs. (340.5 kg) capacity. Durable polyester hopper. Spread width is 3-46" (1-14 m). Requires high flow hydraulic lift to operator.
TOPDRESSER 1800	Textured seamless conveyor belt, 60" (152 cm) spread width, 18 cu. ft. (.504 m ³), 1450 lbs. (641 kg) capacity, 5' (1.5 m) wide hopper. Hydraulic powered drive system. Workman bed lift cylinders raise topdresser. Spring load metering gate.
TOPDRESSER 2500	25 cu. ft. (.7 m ³) capacity. Textured belt, Oscillating axles and all wheel drive. Hydraulics use a charge pump and a closed loop system. Connects to heavy-duty draw bar or hitch. 4 large flotation tires. Electric on/off switch located in operator area. Electrically actuated hydraulic brakes.

¹ Specifications and design subject to change without notice.



Workman 3000 and 4000 Series Specifications* (continued)

SPECIFICATIONS COMMON TO WORKMAN 3000 & 4000 SERIES VEHICLES													
FUEL CAPACITY	7 gallon (26 liter)												
LIGHTS	Twin halogen headlights and single taillight with switch, rear stop lamp.												
HORN	Standard, button on dash.												
SEATS	Bucket seats with hip restraints. Seat belts standard.												
SEAT BELTS	Standard.												
CONTROLS	Throttle, brake and clutch pedals. Gear shifter, differential lock, parking brake, high-low range shifter, hydraulic lift lever, ignition switch, light switch and horn button. (Glow switch on diesel vehicle only; choke on air cooled vehicle only).												
3RD HIGH LOCKOUT INTERLOCK	Interlock switch, engine won't run in third gear high range. Includes key switch.												
SAFETY SUPPORT	Clutch pedal must be depressed to start. PTO, electric clutch and generator must be disengaged (if installed) to start.												
	7-gauge steel channel stones behind seat and fits over extended lift cylinder to prevent accidental lowering of bed.												
GROUND SPEED	Standard Tires, Gear 1/2/3 Forward Speeds: High Range - 7.6/11.5/19.8 mph (12.2/18.5/31.9 km/h) Low Range - 2.9/4.5/7.1 mph (4.7/7.2/12.5 km/h) Reverse Speeds: High Range - 7.1 mph (11.6 km/h) Low Range - 2.8 mph (4.5 km/h)												
GROUND CLEARANCE	7" (18 cm) with no load.												
DIMENSIONS	<table border="1"> <thead> <tr> <th>Overall Length</th> <th>Overall Width</th> <th>Overall Height (top of ROPS)</th> <th>Clearance Circle</th> <th>Wheelbase</th> <th>Wheel track¹</th> </tr> </thead> <tbody> <tr> <td>128" (325 cm) w/o bed 130" (330 cm) 136" (345 cm)²</td> <td>65" (165 cm)</td> <td>75.8" (192.5 cm)</td> <td>32" (81 cm), Inside 194" (493 cm), Outside 100" (254 cm), Inside³ 300" (726 cm), Outside³</td> <td>70" (178 cm)</td> <td>46.5" (118 cm)—front 50.5" (128 cm)—rear</td> </tr> </tbody> </table> <p>¹With full bed. ²With 2/3 bed. ³Measured from wheel centerline. ⁴WVD dimensions only.</p>	Overall Length	Overall Width	Overall Height (top of ROPS)	Clearance Circle	Wheelbase	Wheel track ¹	128" (325 cm) w/o bed 130" (330 cm) 136" (345 cm) ²	65" (165 cm)	75.8" (192.5 cm)	32" (81 cm), Inside 194" (493 cm), Outside 100" (254 cm), Inside ³ 300" (726 cm), Outside ³	70" (178 cm)	46.5" (118 cm)—front 50.5" (128 cm)—rear
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REAR TOW HITCH	Bolt on formed steel hitch. Fastens to DeDion axle. Accommodates trailers up to 1,500 lbs. (680 kg) gross vehicle weight. Maximum tongue weight of 200 lbs. (91 kg).												
CERTIFICATIONS	Certified to meet the SAE J2258. Engine meets all applicable emissions standards per the manufacturer. Certified to meet the CE Machinery Directive.												
WARRANTY	Two year limited warranty. See Operator's Manual for further details.												

WORKMAN VEHICLE ACCESSORIES	
2/3 BED	Welded Steel diamond plate bed. Dimensions: 46.1" x 54.7" (122 x 139 cm). Weight: 161 lbs. (73 kg).
1/3 BED	Welded Steel diamond plate bed. Removable access panel for belt driven attachments. Dimensions: 21.5" x 54.7" (55 x 139 cm). Weight: 55 lbs. (25 kg).
FULL FLATBED FOLD DOWN SIDE KIT	Hinged Side panels and tailgate can be folded down independently. Fits Full Flatbed, Model 07301. 64.5" x 54.7" x 11" (164 x 139 x 28 cm) outside. 62.5" x 50.7" x 11" (159 x 129 x 28 cm) inside. 20 cu. ft. (570 m ³) capacity. Weight: 109 lbs. (49 kg).
2/3 FLATBED SIDE KIT	Short bed side panels, includes tailgate w/ fixed pivot. 46.1" x 54.7" x 11" (122 x 139 x 28 cm) outside. 46.1" x 50.7" x 11" (117 x 129 x 28 cm) inside. 15 cu. ft. (421 m ³) capacity. Weight: 72 lbs. (33 kg). Optional tailgate release, P/N 02-1220.
1/3 FLATBED STAKE SIDE KIT	Formed 14 gauge steel stake sides. 19.5" x 53.7" x 15" (49.5 x 136.4 x 38.1 cm) inside. Weight: 39 lbs. (18 kg).
REMOTE HYDRAULICS KIT	Standard. 4.25 gpm (16.3 liters) at 2,000 psi, up, down and float valve.
HIGH-FLOW HYDRAULICS KIT	Optional. 6 gpm (30.3 liters) at 2,000 psi. 4 gallon (15.1 liter) reservoir, electrically actuated valve.
200 GALLON SPRAYER	200 gallon (757 liter) low-profile polyethylene tank. Diaphragm pump. Detachable control box. Three section, 18.5' (5.6 m) open boom system.
110 ST SKID SPRAYER	Available with engine-driven centrifugal pump (95 psi, 120 gpm), engine-driven diaphragm pump (550 psi, 9.5 gpm) or PTO-driven centrifugal pump (95 psi, 76 gpm). High density, impact resistant polyethylene tank. Ratchet valve.
VICON SPREADER	14.1 cu. ft. (396 m ³), 750 lbs. (340.5 kg) capacity. Durable polyester hopper. Spread width is 3-46' (1-14 m). Requires high flow hydraulic kit to operator.
TOPDRESSER 1800	Textured seamless conveyor belt. 60" (152 cm) spread width, 16 cu. ft. (504 m ³), 1450 lbs (541 kg) capacity. 5' (1.5 m) wide hopper. Hydraulic powered drive system. Workman bed lift cylinders raise topdresser. Spring load metering gate.
TOPDRESSER 2500	25 cu. ft. (7 m ³) capacity. Textured belt. Oscillating axles and all wheel drive. Hydraulics use a charge pump and a closed loop system. Connects to heavy-duty draw bar or hitch. 4 large flotation tires. Electric on/off switch located in operator area. Electrically activated hydraulic brakes.

* Specifications and design subject to change without notice.

Appendix C
Barrier Analysis

Appendix C Barrier Analysis

What Were the Barriers?	How Did Each Barrier Perform?	Why Did The Barrier Fail?	How Did The Barrier Affect The Incident?
<p>Acquisition SBMS subject area Purchasing Goods and Services used to purchase Toro Workman 3200 Utility Vehicle. The SBMS subject area prompts involvement of ES&H subject matter expertise to provide assistance in the recognition of hazards and the development of controls.</p>	<p>The requestor did not seek ES&H subject matter expertise.</p>	<p>The SBMS Subject Area places emphasis on suspect and counterfeit items. ES&H involvement for ensuring the identification of hazards and establishment of effective controls is limited by the core knowledge and experience of the requestor.</p>	<p>The requestor missed an opportunity to review safety features and identify seat belts and hip restraints which were absent.</p>
<p>Receipt Inspection SBMS subject area Operating Vehicles for Business Purposes requires the operator's supervisor confirms that the operator reviews the manufacturer's instructions specific to the utility vehicle.</p>	<p>The supervisor did not review the manufacturer's instructions with operators.</p>	<p>The supervisor was unaware of the requirement.</p>	<p>The operators and supervisor were not aware that the new utility vehicles were missing hip restraints and seat belts, as would have been indicated from reviewing the operator's manuals.</p>
<p>Certificate of Delivery identified "Review Safety Features"</p>	<p>Safety Features were not reviewed with Storekeeper or supervisor.</p>	<p>Storekeeper assumed that he was signing typical shipping/receipt acknowledgement papers. Storekeeper did not read the document prior to signing. Supervisor did not inquire of distributor when the follow-up visit was to be made.</p>	<p>Opportunity to review safety features and identify that seat belts and hip restraints were absent was missed.</p>
<p>Requestor's confirms receipt of equipment per manufacturer's specifications.</p>	<p>Requestor (Supervisor) did not perform inspection of vehicle and verify that the equipment met the manufacturer's specifications. Requestor did not read any of the manufacturer's supplied documentation or view the instructional video.</p>	<p>The requestor just didn't do it because he assumed that the vehicles were the same as the existing vehicles.</p>	<p>Opportunity to review safety features and identify seat belts and hip restraints were absent was missed.</p>
<p>OPERATION Operators of vehicle are responsible for daily checkout of the vehicle.</p>	<p>Operators did not recognize the differences between this vehicle and</p>	<p>Workers just did not recognize the hazard due to a lack of hazard</p>	<p>An opportunity to identify missing safety features was missed.</p>

What Were the Barriers?	How Did Each Barrier Perform?	Why Did The Barrier Fail?	How Did The Barrier Affect The Incident?
<p>earlier Toro Workman 3200 models, nor did they question the obvious lack of restraining mechanisms to keep the occupants inside this ROPS-protected vehicle.</p>	<p>recognition capability.</p>		
<p>Training Facilities & Operations Administrative Procedure ADM-082 (Rev. 1) dated 5/14/02 "General Expectation and Operational Guide for PNNL Grounds Maintenance Activities" requires that staff will be trained on the safety features of the new equipment A video tape training film was provided with the new vehicles</p>	<p>The Groundskeepers were not trained on the safety features of the new Toro Workman 3200 Utility Vehicles.</p>	<p>The new utility vehicle was assumed to be the same as the existing vehicles. The drivers and passengers were not aware of the missing seat belts and hip restraints.</p>	<p>The new utility vehicle was used without safety belts and hip restraints, allowing the passenger to fall from vehicle.</p>
<p>The supervisor holds weekly safety meetings with the Grounds Workers.</p>	<p>The video tape was not viewed and the video tape provided was for an older model of the utility vehicle.</p>	<p>The supervisor and Groundskeepers believed that the equipment was the same as previously in use.</p>	<p>The supervisor and Groundskeepers were not aware of the changes to the safety equipment for the new utility vehicles.</p>
<p>Engineered Features</p>	<p>The safety features of the new utility vehicles were not discussed at the weekly safety meeting.</p>	<p>The new utility vehicle was assumed to be the same as the existing vehicles.</p>	<p>Opportunity to review safety features and identify seat belts and hip restraints were absent was missed.</p>
<p>The Toro Workman 3200 Utility Vehicles are provided with hip restraints and seat belts.</p>	<p>The seat belts and hip restraints were missing from the vehicle.</p>	<p>The inspection of the new vehicles failed to identify that safety equipment was missing.</p>	<p>Passenger was able to fall from vehicle.</p>
<p>Doors were provided on the new Toro 3200 Utility Vehicles.</p>	<p>The doors were removed from the Toro Workman 3200 Utility Vehicle with a flat bed</p>	<p>The regional distributor did not deliver equipment with seat belts and hip restraints. Due to concerns about carbon monoxide exposure to the occupants in the cab of the new utility vehicle with the flat bed, the cab doors were removed. The cab doors would likely have been removed since this was common practice during the warmer months.</p>	<p>Although the doors are not provided for safety reasons, the doors could have prevented the passenger from falling.</p>
<p>Safety decals are provided on the new vehicle indicating required seat belts use.</p>	<p>The operators failed to read the safety decals and question the lack of seat belts.</p>	<p>The operators were not aware of the changes and failed to observe safety decals.</p>	<p>Operators did not question the disparity between the safety decals and the missing seat belts and</p>

What Were the Barriers?	How Did Each Barrier Perform?	Why Did The Barrier Fail?	How Did The Barrier Affect The Incident?
<p>Administrative Controls</p> <p>ADM-082 includes hazard analysis of grounds work activities and includes established controls</p> <p>PNNL's Voluntary Protection Program is intended to move the safety performance beyond minimum OSHA compliance.</p>	<p>ADM-082 does not address hazard analysis for utility vehicle use.</p> <p>VPP did not identify an opportunity to enhance safety in operating the existing vehicles by installing seat belts</p>	<p>ADM-082 does not include a comprehensive hazard analysis and associated controls for Roll Over.</p> <p>Supervisor and crew did not have an elevated awareness of hazards and their mitigation in operating utility vehicles.</p>	<p>operated the vehicle.</p> <p>People did not know what engineered and administrative controls are necessary to provide personnel protection. Personnel assumed that the delivered vehicle was safe.</p> <p>VPP missed the opportunity to provide additional protection to personnel operating existing utility vehicles by installing optional seat belts. Installation and use of seat belts in existing vehicles would have raised worker safety awareness with operators of the new vehicles.</p>

Appendix D
Change Analysis

Appendix D Change Analysis

Factors	Accident Situation	Prior, Ideal or Accident Free Situation	Difference	Evaluation of Effect
<p>WHAT: Conditions, occurrences, activities, equipment</p>	<p>New Toro Workman 3200 does not have seat belts installed on driver and passenger seats.</p>	<ul style="list-style-type: none"> • Seat belts installed by the manufacturer as standard equipment prior to delivery to customer when ordered without cab. • When ordered with cab, per Toro procedure, seat belts removed to install cab, then reinstalled prior to delivery to customer. 	<p>Absence of safety equipment.</p>	<ul style="list-style-type: none"> • Seat belts are one part of the restraining system to keep passenger inside vehicle. • If the passenger had been wearing a seat belt, he would not have fallen from the moving vehicle. • Seat belts not required per ASME/ANSI B56.8 (hip restraints and passenger hand holds are required.)
	<p>New Toro Workman 3200 has different safety equipment than existing models.</p>	<ul style="list-style-type: none"> • The four existing Toro Workman 3200 vehicles did not have seat belts on the driver and passenger seats. (Older models not directly involved in accident.) • Drivers and passengers of the new vehicle inquire if seat belts are available on existing vehicles. • In conducting inspections of vehicles, safety professionals inquire whether seat belts are available for the existing vehicles. 	<p>Absence of safety equipment.</p>	<ul style="list-style-type: none"> • Supervisor, drivers and operators are not aware that seat belts are standard equipment in new model and assumed that since the existing model did not have seat belts, the new vehicle did not have seat belts either. • Supervisor and operators not aware that seat belts were available from the manufacturer for existing vehicles. • Seat belts were always offered as optional equipment on old models. • No previous injuries related to absence of seat belts in old vehicles. • Self-assessments do not identify need for optional safety feature.
	<p>New Toro Workman 3200 does not have hip restraints installed on left side of driver's seat and right side of passenger seat.</p>	<p>Hip restraints installed on left side of driver's seat, and right side of passenger's seat.</p>	<p>Absence of safety equipment</p>	<ul style="list-style-type: none"> • Hip restraining system would help to keep passenger inside vehicle on left turn. • Hip restraint system is required per ASME/ANSI B56.8 • Drivers and passengers of the new vehicle did not notice that hip restraints are missing.
	<p>New Toro Workman 3200 has passenger hand hold located on dash in front of passenger.</p>	<p>Existing Toro Workman 3200 vehicles do not have passenger hand hold on dash in front of passenger.</p>	<p>New Toro Workman 3200 has a new location for the passenger hand hold in</p>	<ul style="list-style-type: none"> • Injured passenger did not use passenger hand hold in dash to prevent falling from the vehicle. Use of passenger hand hold in dash alone may have been

Factors	Accident Situation	Prior, Ideal or Accident Free Situation	Difference	Evaluation of Effect
<p>WHAT: Conditions, occurrences, activities, equipment</p>	<p>New Toro Workman 3200 does not have passenger hand hold on left hand side of passenger seat.</p>	<p>Existing Toro Workman 3200 does have passenger hand hold on left hand side of passenger seat.</p>	<p>Passenger may have been familiar and used the hand hold on the left side of seat.</p>	<p>sufficient to keep passenger from falling from vehicle.</p> <ul style="list-style-type: none"> As passenger was falling from the vehicle, he may have reached for the passenger hand hold on the left side of his seat. If that restraining component had been present, he may have remained inside the vehicle. Supervisor, drivers and passengers of the new vehicle did not notice the absence of passenger hand hold on left side of seat.
<p>WHERE: Physical location, Environment, conditions</p>	<p>New Toro Workman 3200 does not have either a shoulder restraint on left hand side of the driver's seat, or right hand side of passenger's seat.</p>	<p>Existing Toro Workman 3200 vehicles have shoulder restraints on both the driver's and passenger's side.</p>	<ul style="list-style-type: none"> The new Toro Workman 3200 design does not have shoulder restraints. 	<ul style="list-style-type: none"> Shoulder restraint not required per ASME/ANSI B56.8. If the new Toro Workman 3200 had a shoulder restraint but no hip restraint, passenger may have still fallen from vehicle. Supervisor, drivers and passengers of the new vehicle did not notice the absence of shoulder restraints.
<p>WHO: Staff involved, training, qualification, supervision</p>	<p>Pavement is dry, level, and in good repair. Weather is clear. No visible obstructions.</p> <ul style="list-style-type: none"> The new vehicles have safety labels indicating both graphically and with words that seat belt must be worn. This detail is directly above the driver's viewing area. The new vehicles have seat belt usage graphic decals on the left and right sides of the Roll Over Protection System (ROPS) bars. 	<p>Pavement is dry, level, and in good repair. Weather is clear. No visible obstructions.</p> <ul style="list-style-type: none"> Existing Toro Workman 3200 Utility Vehicles do not have safety labels regarding seat belt usage since seat belts were not required. Driver is expected to be aware and knowledgeable of safety details on the vehicle he is operating. 	<p>None</p>	<p>Weather was not a factor.</p>
<p>WHO: Staff involved, training, qualification, supervision</p>	<p>Supervisor and operators had not reviewed manufacturer's operating manual and safety video. Distributor provided video for older model vehicles (1993).</p>	<p>SBMS requires the supervisor to confirm that operators have reviewed the operator's manual prior to use. Supervisor and operators review and understand manufacturer's operating manual safety features, as described in Operator's Manual</p>	<p>Safety decals on the existing vehicles have different safety information from those on the new vehicles.</p>	<p>Had the drivers (supervisors and staff) who had operated the vehicle for approximately 8 hours of use over a period of 2 weeks read the safety decals above the driver's field of view or on the ROPS, the vehicle may have been taken out of service before the injury occurred.</p> <ul style="list-style-type: none"> Failure to provide training was a missed opportunity to learn about the safety features. Supervisor, drivers and passengers did not know that seat belts were standard equipment on the new Toro Workman 3200. Supervisor, driver and passengers

Factors	Accident Situation	Prior, Ideal or Accident Free Situation	Difference	Evaluation of Effect
<p>WHO: Staff involved, training, qualification, supervision</p>	<ul style="list-style-type: none"> Requestor assumed that same model number utility vehicle would also meet site safety requirements. Purchase did not trigger ESH review. Requestor did not review specification sheets which state that seat belts and hip restraints are standard equipment. Requestor orders utility vehicle with vertical lift without evaluating need to develop site operating procedure. 	<ul style="list-style-type: none"> and Certificate of Delivery. Manufacturer provides up to date video of utility vehicle. Supervisor and operators view safety video for delivered model. 	<ul style="list-style-type: none"> Ordering equipment without adequate ESH review creates the potential for buying and using equipment that is not compliant with site safety requirements. 	<p>have reviewed operators' manual of existing model but did not identify that the hip restraints similar to those in the existing vehicles were missing in the new vehicles.</p> <ul style="list-style-type: none"> Video for new model describes seat belts and hip restraints, and passenger hand hold in the dash. If personnel had read the manuals or viewed the video (either the old or current), staff would have likely noticed the absence of safety equipment on the delivered vehicles.
<p>HOW: Control chain, Hazard analysis, monitoring</p>	<ul style="list-style-type: none"> Supervisor assumed that since the vehicle was driven off the delivery truck, it was safe to operate. Supervisor did not conduct acceptance inspection (safety equipment, fluid levels, and tire pressure) prior to authorization for use. 	<p>Requestor and/or requesting organization reviews equipment and determines whether equipment meets site safety requirements. Requestor may ask for assistance from ESH or others.</p>	<p>Acceptance inspection not performed.</p>	<ul style="list-style-type: none"> Requestor cannot rely on manufacturer's model number and assume that the same equipment is expected to exist. Upon delivery of utility vehicle with vertical lift, supervisor recognizes that operators need a procedure prior to use. Supervisor tags vehicle out of service. Since this utility vehicle also did not have seat belts and hip restraints, if personnel had operated this vehicle there was the potential that another passenger may have been injured. <p>An unsafe vehicle, which did not meet the manufacturer's safety specifications, was authorized for use.</p>
	<p>Doors on the cab are removed because of buildup of carbon monoxide.</p>	<p>The doors on the cab are installed.</p>	<p>The doors are designed for heat and noise control for the occupants. Vehicle can be safely operated without doors when standard safety restraining system of seat belts and hip restraints are installed.</p>	<p>Although the cab doors are not designed for restraining personnel inside the cab, the doors could have prevented the passenger from falling.</p>

Appendix E

Events and Causal Analysis

Appendix E Events and Causal Analysis

E&CF Analysis, Root Cause & JONS

Events and Causal Factors Analysis:

Root Cause	Discussion	Related JONS
F&O failed to ensure effective implementation of its hazard analysis process.	<ul style="list-style-type: none"> Hazard analysis in ADM-082 is not adequate to inform employees and supervisors of the hazards and controls associated with use of utility vehicles. Employees at multiple levels failed to recognize the hazards of utility vehicles. Assessments failed to identify hazards of utility vehicles. 	1, 2, 3, 4, 5, 7

CC No.	Contributing Causes	Discussion	Related JONS
CC-1	Hazard analysis and implementation of mitigating controls in ADM-082 is LTA	<ul style="list-style-type: none"> ADM-082, General Expectation and Operational Guide for PNNL Grounds Maintenance Activities, did not address the hazards associated with utility vehicle use, such as roll over, and design features (Roll Over Protection System (ROPS)) to mitigate personnel from falling from the vehicle. ADM-082 did not meet the SBMS requirements for hazards analysis of work activities. The preparer and owner of the hazard analysis, safety reviewers and management did not identify the workplace hazard of operating a utility vehicle was not addressed in ADM-082. Hazard analysis does not specify that hip restraints and passenger hand holds which are safety features required by ASME/ANSI B56.8. 	1, 2, 3, 4, 5
CC-2	Operations authorization without adequate inspection of the vehicle and review of Operator's Manual.	<ul style="list-style-type: none"> The Grounds Supervisor makes erroneous assumption that since the utility vehicles are the same make and model as the existing vehicles on site, that he did not need to read the Operator's Manual. Grounds supervisor did not ensure that grounds personnel were trained on the operation of the newer model utility vehicle before use as required in ADM-082 which requires this training for new vehicles. Grounds supervisor did not conduct an adequate inspection of the new utility vehicles prior to authorizing their use by his grounds personnel to ensure that safety features were installed. Grounds supervisor did not ensure that the slow 	3, 5

CC No.	Contributing Causes	Discussion	Related JONs
		<p>moving vehicle placard and flashing yellow beacon was installed per ADM-082 prior to authorizing the new vehicles use.</p> <ul style="list-style-type: none"> • Grounds supervisor did not read the Operator's Manual as required by the manufacturer prior to authorizing the vehicle's use. This is also required by SBMS and ASME/ANSI B56.8. • Grounds supervisor did not view the manufacturer's safety video as recommended by the manufacturer. • Grounds supervisor did not review the Certificate of Delivery documents which makes reference to reading the Operator's Manual and manufacturer's standard safety features. 	
CC-3	Supervisor did not know SBMS responsibilities	<ul style="list-style-type: none"> • F&O management conducted new supervisor orientation and communicated expectation that managers are responsible for familiarity of roles, responsibilities, and other requirements specified in SBMS and department instructions. However, new supervisor did not read the applicable SBMS chapters. • SBMS prompts the requestor to seek ESH support in planning purchases. The supervisor did not know this requirement was in SBMS. • Since these utility vehicles were the same as those vehicles currently in use on site, the grounds supervisor did not see the need for ESH review. However, the utility vehicle with vertical lift was a new type of equipment for the grounds organization and the need for a procedure to operate the vehicle was not identified by the supervisor until the vehicle arrived on site. • Supervisor does not know standard safety equipment of the new vehicles prior to requesting purchase order. SBMS requires supervisor to understand the hazards and controls as part of the planning process. 	3, 5, 6
CC-4	Management did not verify supervisor knowledge of SBMS responsibilities	<ul style="list-style-type: none"> • F&O management conducted new supervisor orientation and communicated expectation that managers are responsible for familiarity of roles, responsibilities, and other requirements specified in SBMS and department instructions. The new supervisor did not read the applicable SBMS chapters. Management did not verify that the new supervisor had read and understood his responsibilities as listed in the SBMS. 	1
CC-5	Hazard recognition by personnel LTA	<ul style="list-style-type: none"> • Grounds supervisor and workers did not know the hazards and associated with use of utility vehicles. • Grounds supervisor and workers did not notice the seat belt required decal above the driver's field of view. • Grounds supervisor and workers did not notice 	1, 2, 3, 5

CC No.	Contributing Causes	Discussion	Related JONs
		<p>the seat belt required decal on the Roll Over Protection System (ROPS) structure at the rear of the cab.</p> <ul style="list-style-type: none"> • Grounds supervisor and workers did not notice the missing hip restraints on the left side of the driver's seat and right side of the passenger's seat. • Grounds supervisor and workers did not notice the missing passenger hold on the left side of the passenger's seat and inquire why the design has changed from the design in the existing utility vehicles. • Grounds personnel had operated the new utility vehicle for approximately 8 hours of use. • Grounds worker personnel operating the vehicle at the time of the injury had driven and ridden in the new vehicles 2 or 3 times. • Industrial hygiene and vehicle safety subject matter experts did not read the Operator's Manual or consult with the manufacturer when a potential carbon monoxide problem with the new utility vehicles was discovered. • Grounds personnel's daily checks prior to using the new utility vehicles did not identify the seat belt warning decals or missing hip restraints. 	
CC-6	Receipt inspection process was LTA	<ul style="list-style-type: none"> • Storekeeper assumed that he was signing typical delivery paperwork for receipt of the new utility vehicles. He did not read the shipping receipt paperwork to realize that he was acknowledging his awareness of the safety features of the new utility vehicles. • Storekeeper acknowledged unknowingly through signature an awareness of the safety features, but did not perform the receipt inspection of the safety features. • Grounds supervisor did not read and challenge the receipt inspection paperwork. • Storekeeper did not realize that dates and signatures of the salesperson did not match the delivery date on the Certificate of Delivery paperwork. • Grounds supervisor assumed that vehicle delivered from manufacturer and distributor was safe. 	1
CC-7	Self-assessment program LTA	<ul style="list-style-type: none"> • Annual VPP self-assessments did not identify an opportunity to provide for additional protection to personnel operating existing vehicles by installing optional seat belts. Installation and use of seat belts in existing vehicles would have raised worker safety awareness with operators of the new vehicles. • F&O self-assessments did not identify that ADM- 	2, 3, 5, 7

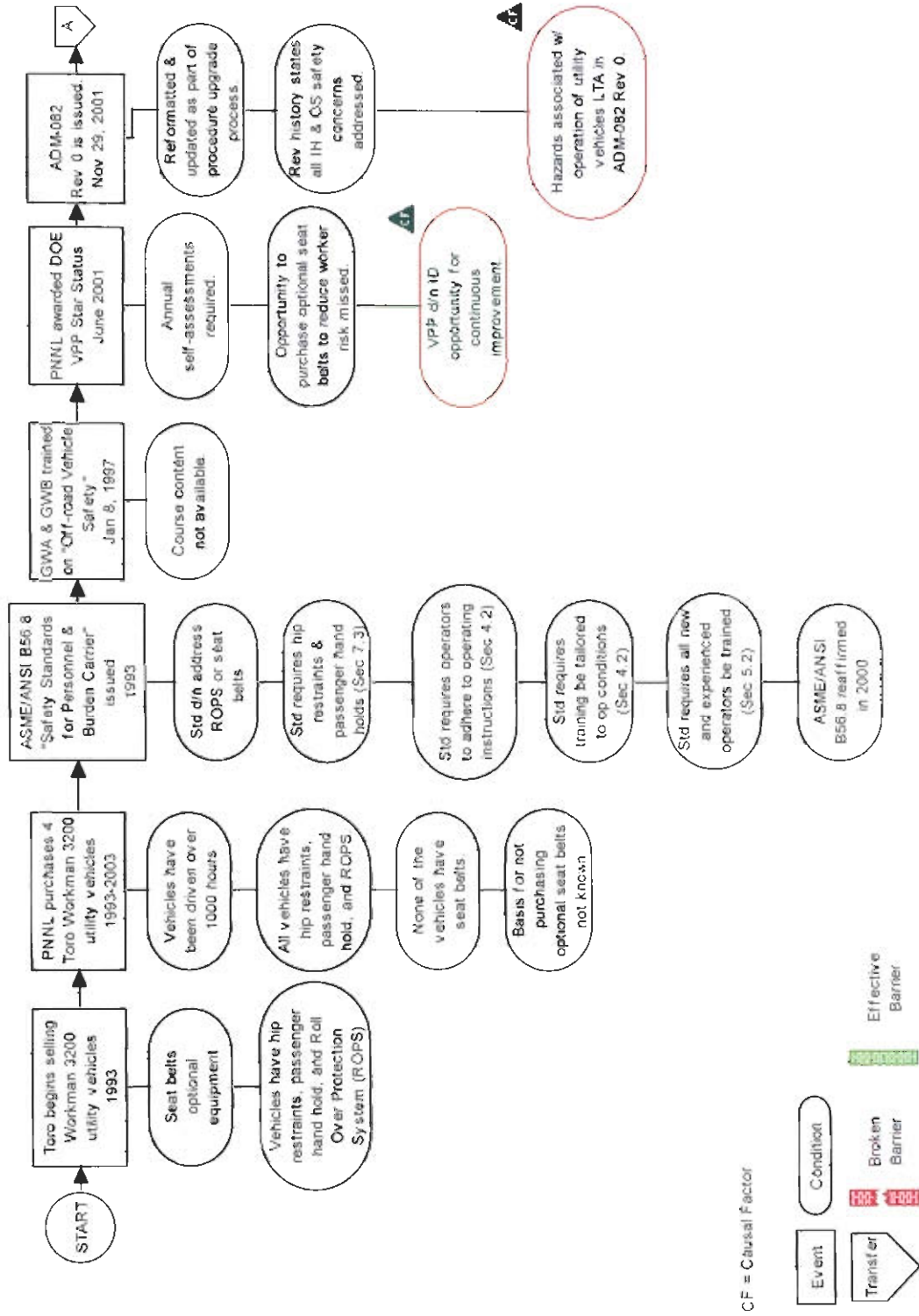
CC No.	Contributing Causes	Discussion	Related JONs
		<p>082 hazard analysis failed to address utility vehicle use.</p> <ul style="list-style-type: none"> • F&O self-assessment for occupational safety failed to identify that optional seat belts in the existing utility vehicles would have provided additional personnel protection. • F&O self-assessments failed to identify that personnel did not have an adequate understanding of the hazards associated with utility vehicle use. 	
CC-8	Initial Laboratory investigation efforts were performed unsafely.	<ul style="list-style-type: none"> • Grounds supervisor and ESH personnel conduct a recreation of the injury using the vehicle which was involved in the accident. Neither person reads the seat belt required warning decals. Neither person was aware that vehicle did not have hip restraints are required by ASME/ANSI B56.8. Although the recreation was stated to be performed in a controlled manner, the potential for another injury was present. • Grounds supervisor and ESH personnel did not read the Operator's Manual before performing the recreation scenario to verify that the manufacturer's safety equipment was installed. • PNNL did not have adequate controls in place to assess the risk to personnel who were investigating the scene of the injury. DOE 225.1A, Accident Investigations, requires the contractor to prevent further injuries following an incident. 	8, 9

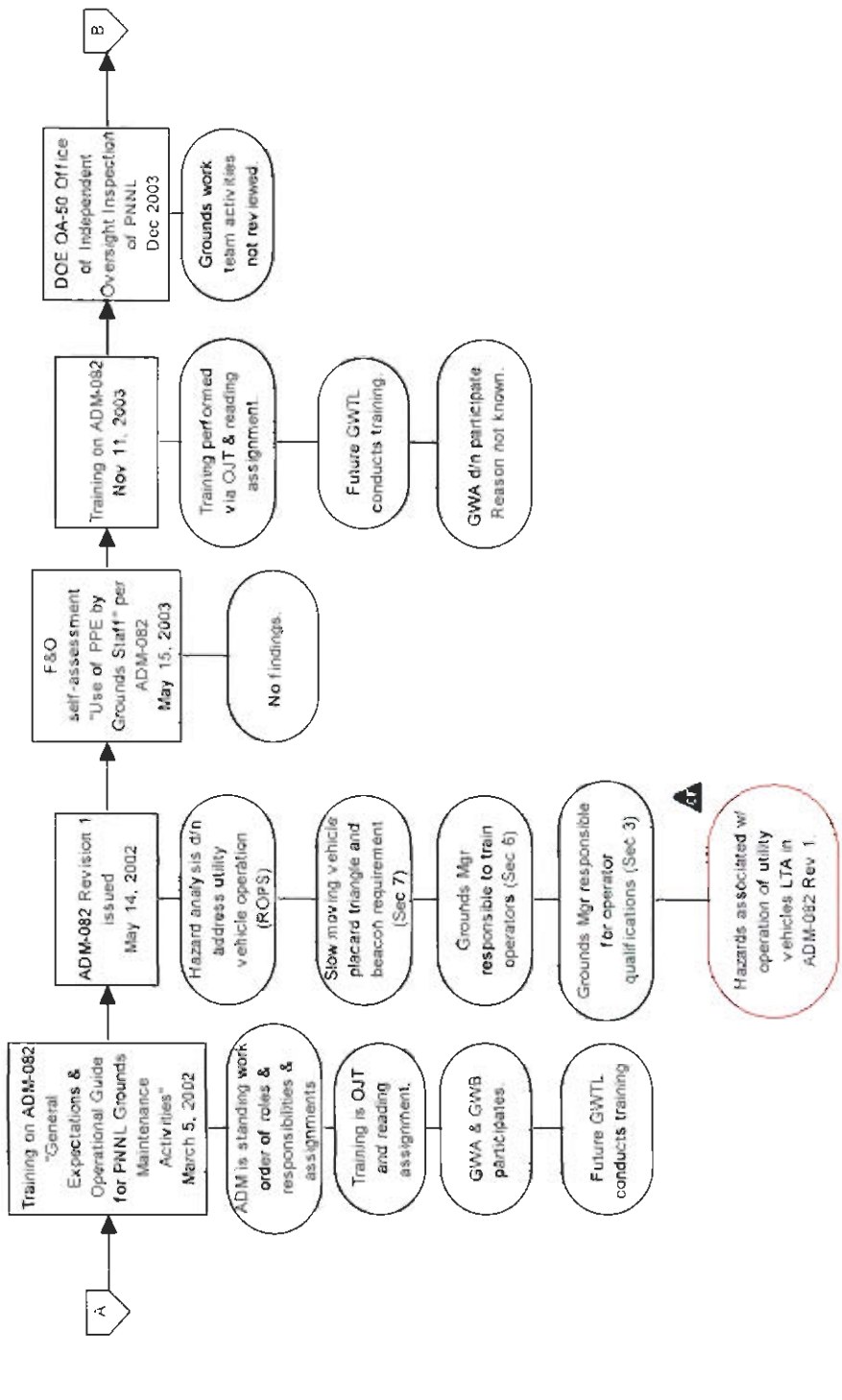
JON	Judgment of Needs	RC & CC
JON 1	F&O needs to conduct a comprehensive hazard analysis of the work performed by its grounds personnel to ensure that hazards are identified and mitigating controls are documented.	RC, 1, 4, 5, 6
JON 2	F&O needs to ensure that personnel who develop, review and approve the hazard analyses are knowledgeable of the SBMS process for identifying and mitigating workplace hazards.	RC, 1, 5, 7,
JON 3	F&O needs to ensure that grounds personnel are trained in the recognition of hazards and implementation of controls.	RC, 1, 2, 3, 5, 7
JON 4	F&O needs to ensure that personnel who conduct self-assessments are knowledgeable of the SBMS process for identifying and mitigating workplace hazards.	RC, 1
JON 5	F&O needs to ensure that workers are knowledgeable of the hazards in their work environment.	RC, 1, 2, 3, 5, 7
JON 6	F&O needs to develop and implement a process to ensure that line managers are knowledgeable of their ES&H roles and responsibilities as documented in SBMS and other applicable laboratory documents.	3
JON 7	PNNL's Office of Audit and Oversight needs to conduct a sampling of organizations to determine if similar deficiencies in documented hazard analyses and personnel's knowledge of workplace hazards exist.	RC, 7
JON 8	The PNNL accident readiness measures need to ensure that subsequent Laboratory investigation efforts do not create additional unsafe situations.	8
JON 9	PNSO needs to ensure that the requirements of the Contractors Requirements Document of DOE O 225.1A, <i>Accident Investigations</i> , are incorporated into the PNNL SBMS.	8

Appendix F

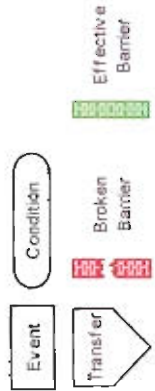
Events and Causal Factors Chart

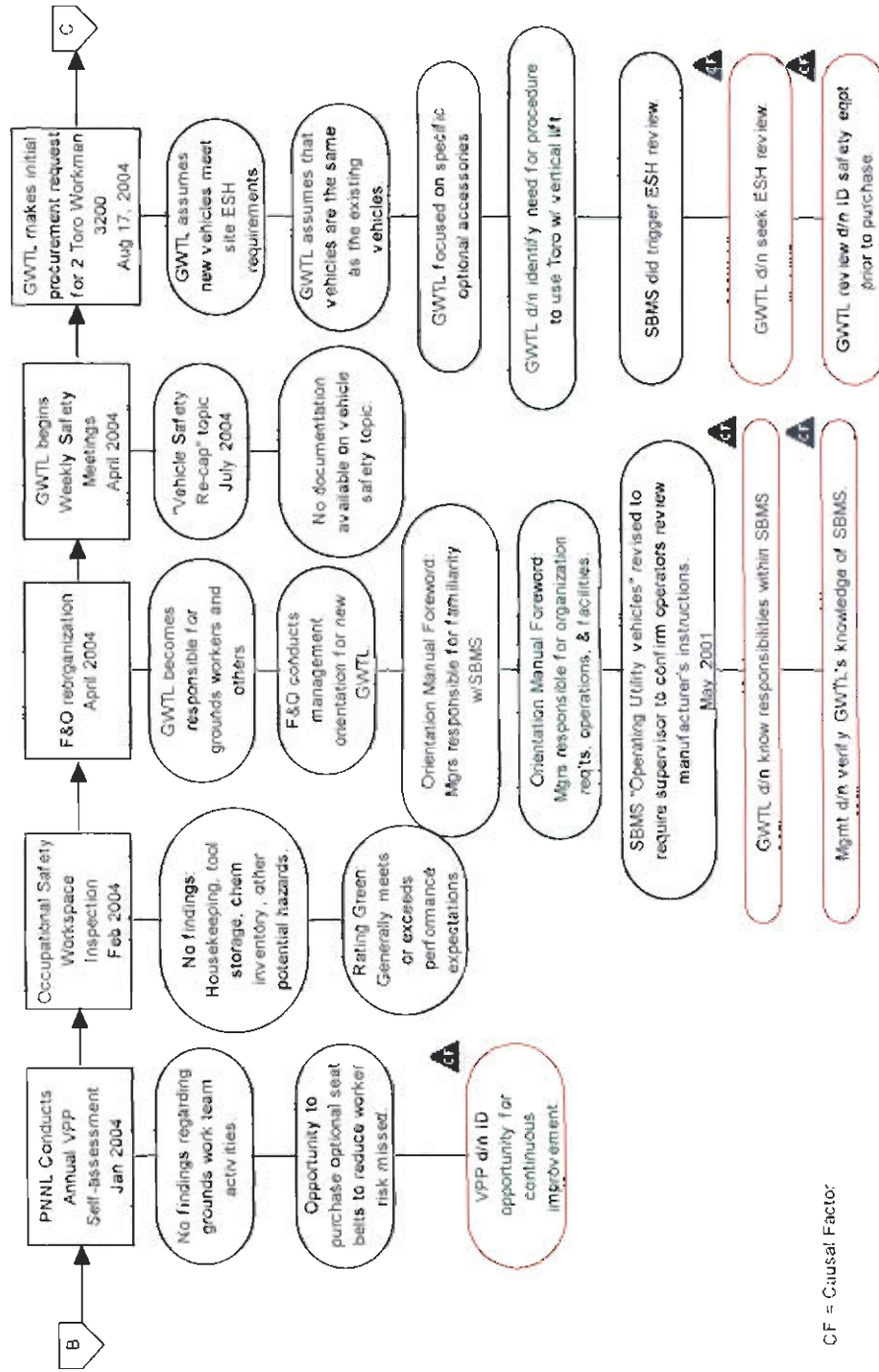
Appendix F: Events & Causal Factors Chart



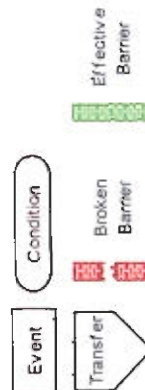


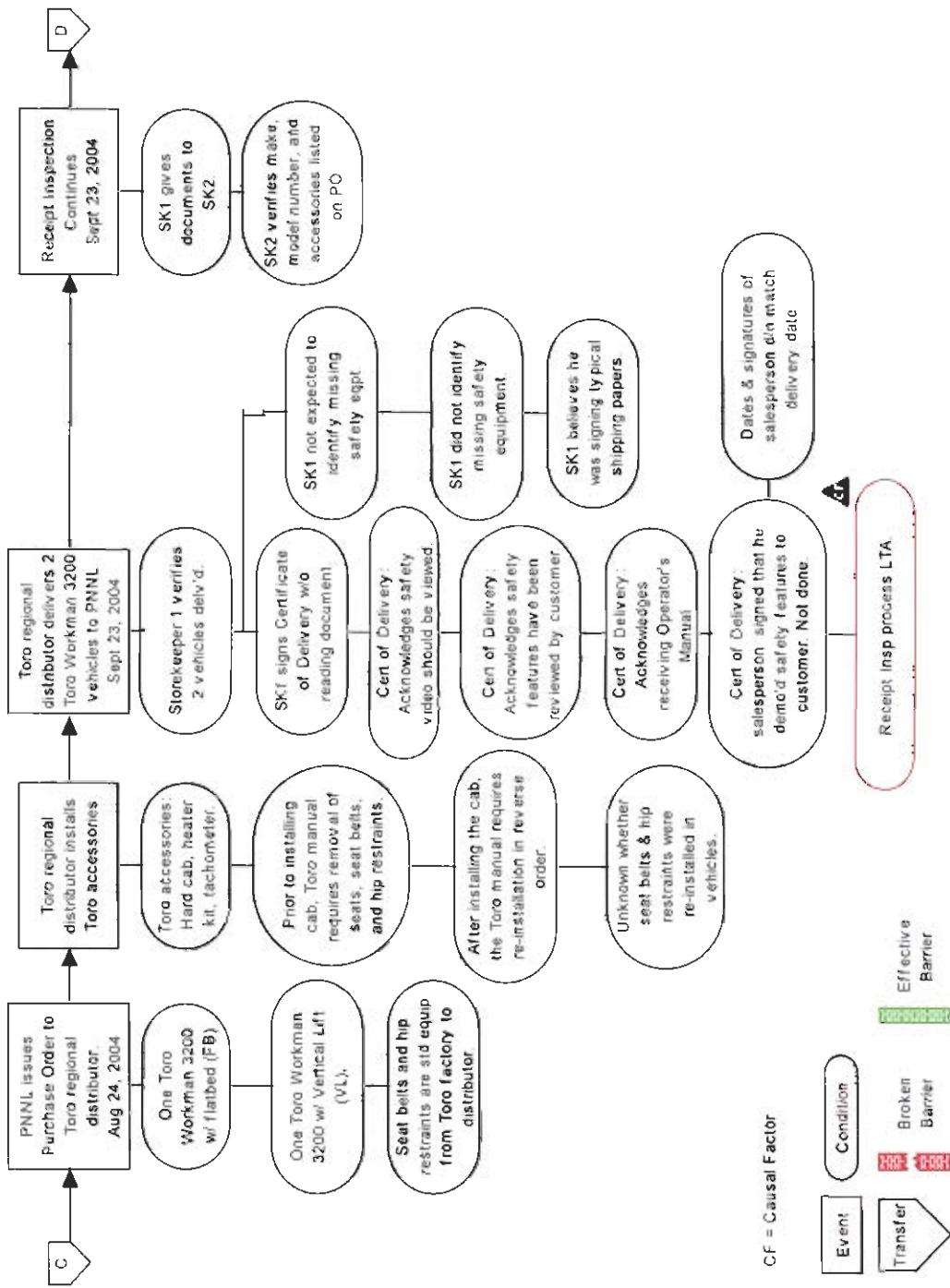
CF = Causal Factor

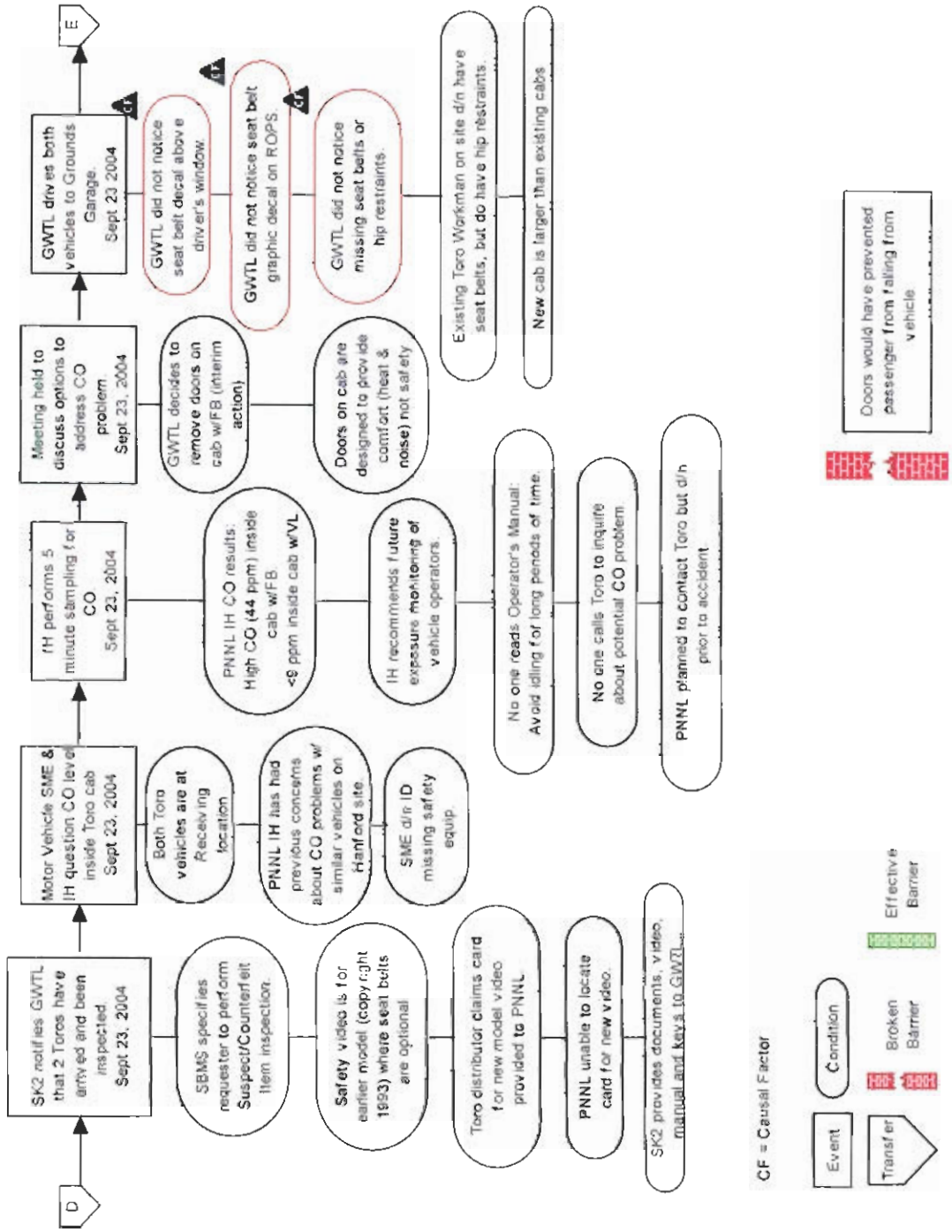




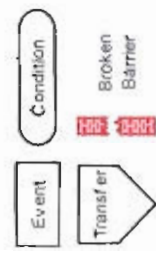
CF = Causal Factor

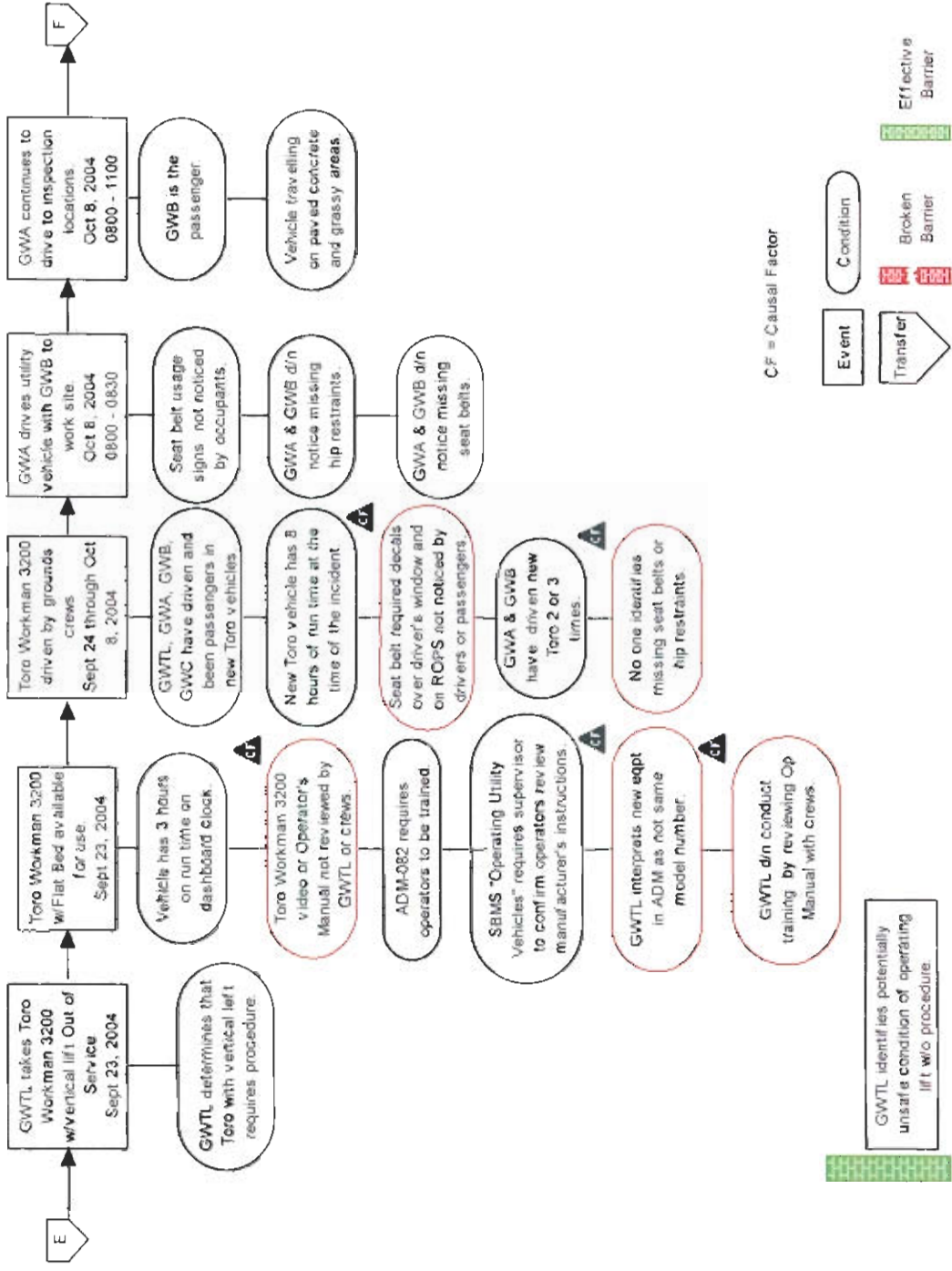


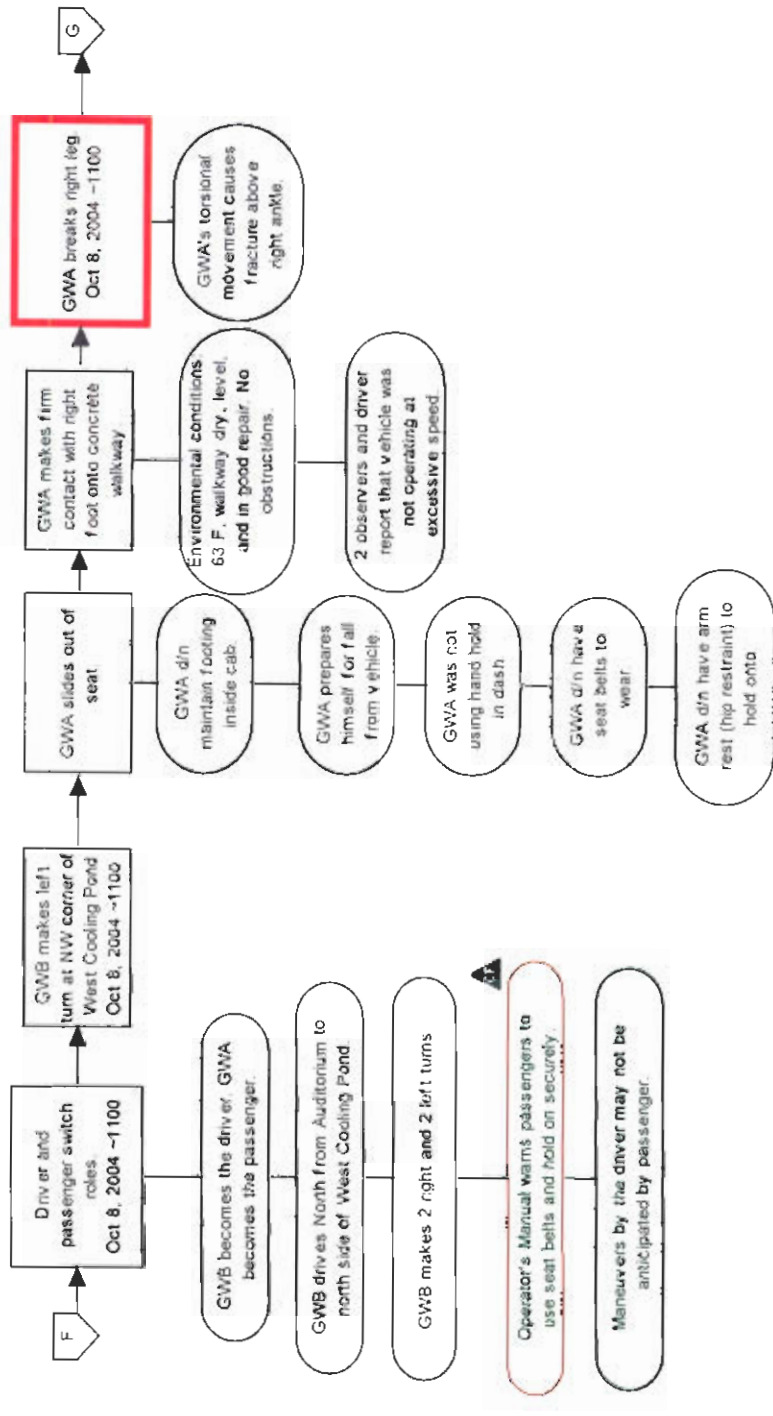




CF = Causal Factor

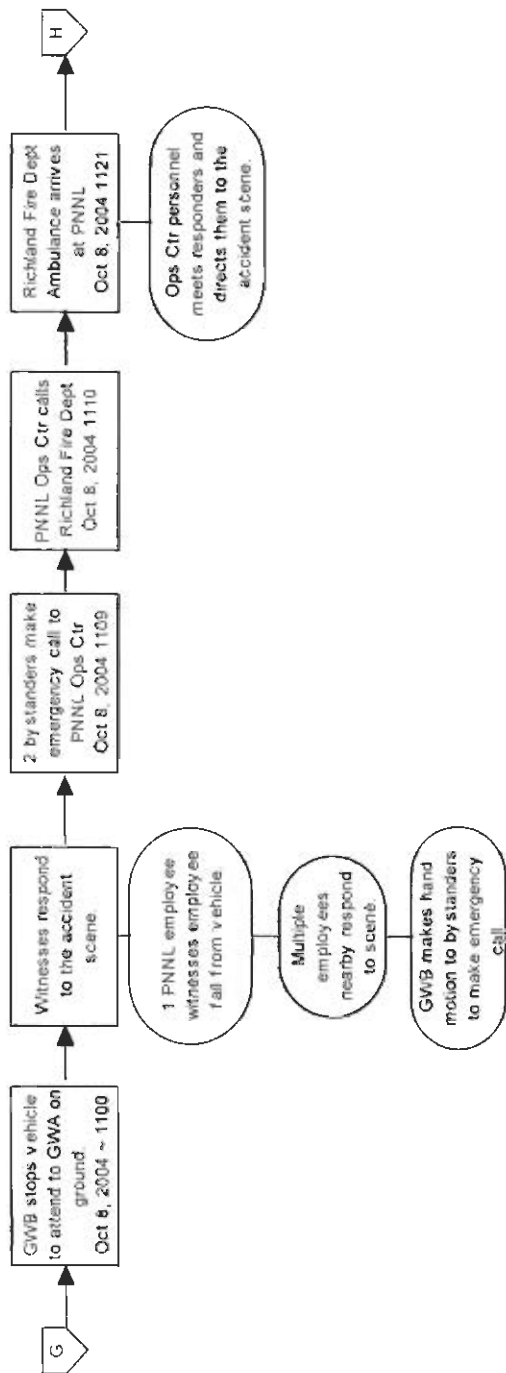




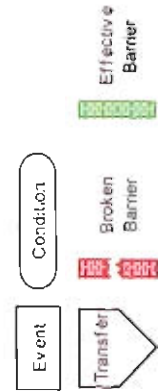


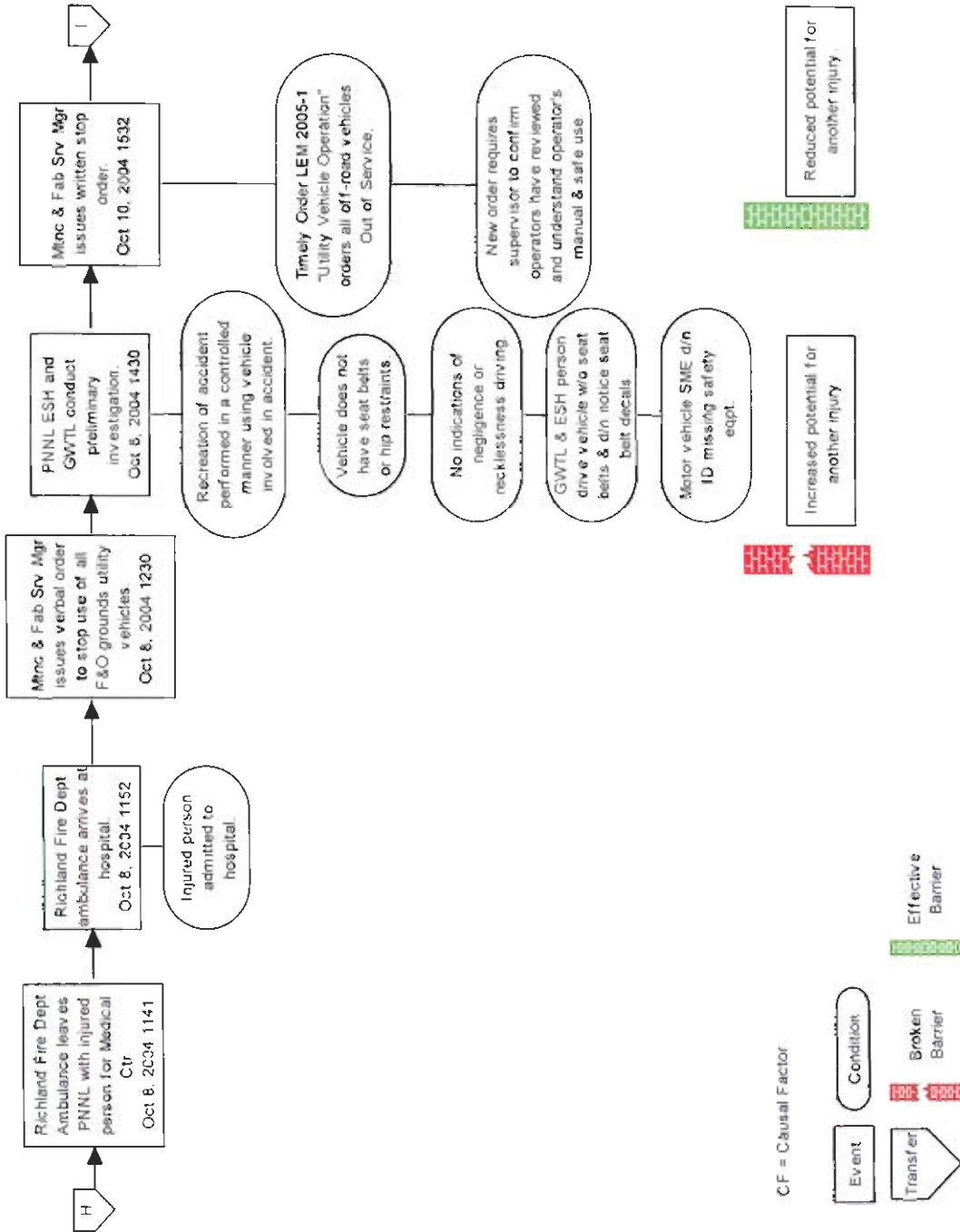
CF - Causal Factor

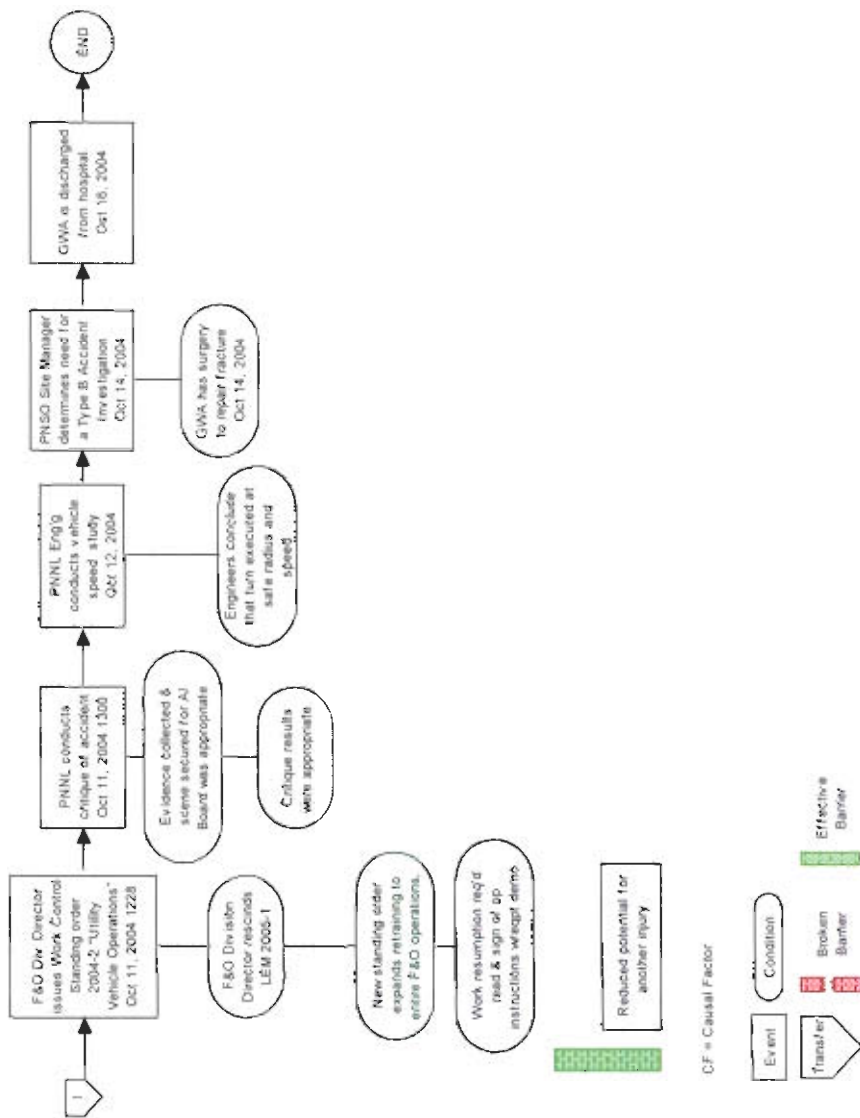




CF = Causal Factor







Appendix G

Glossary

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ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BMI	Battelle Memorial Institute
BRSW	Battelle Receiving and Shipping Warehouse
CAIRS	Computerized Accident/Incident Reporting System
CDL	Commercial Drivers License
CO	Carbon Monoxide
CRT	Control Room Technician
DOE	U.S. Department of Energy
E&CF	Events and Causal Factors
EDL	Engineering Development Laboratory
ES&H	Environment, Safety, and Health
F&O	Facilities & Operations
FY	Fiscal Year
Grounds	Grounds, Relocation and Receiving Work Team
HAMTC	Hanford Atomic Metal Trades Council
ISM	Integrated Safety Management
JETS	Job Evaluation and Training System
JONs	Judgments of Need
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
ppm	parts per million
R2A2s	roles, responsibilities, authorities, and accountabilities
RCHN	Richland North, the main Battelle-owned campus
RFD	Richland Fire Department
RL	Richland Operations Office
ROPS	Roll Over Protection System
RRC	Richland Research Center
SBMS	Standards Based Management System
SE-COMM	Southeast Communications Center
VPP	Voluntary Protection Program

