



**U. S. Department of Energy
Oak Ridge Operations Office**

Type B Accident Investigation

**Bechtel Jacobs
Company LLC
Subcontractor Employee
Injuries from a
November 15, 2000,
Fall Accident at the
Oak Ridge National
Laboratory**

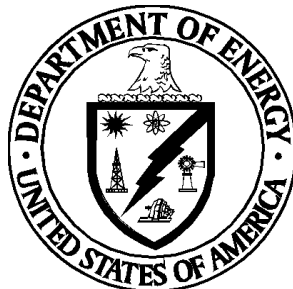
December 2000

This page intentionally left blank.

Type B
Accident Investigation

Bechtel Jacobs Company LLC
Subcontractor Employee
Injuries from a November 15, 2000,
Fall Accident at the
Oak Ridge National Laboratory

December 2000



Oak Ridge Operations Office
U. S. Department of Energy

INDEPENDENT REPORT



This report is an independent product of the Type B Investigation Board appointed by G. Leah Dever, Manager, Oak Ridge Operations Office, U.S. Department of Energy. The Board was appointed to perform a Type B investigation of this incident and to prepare an investigation report in accordance with DOE Order 225.1A, *Accident Investigations*.

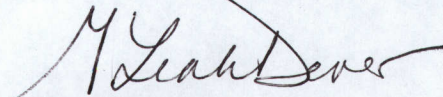
The discussion of the facts, as determined by the Board, and the views expressed in the report are not necessarily those of the U.S. Department of Energy and do not assume and are not intended to establish the existence of any legal causation, liability, or duty at law on the part of the U.S. Government, 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 November 21, 2000, I appointed a Type B Accident Investigation Board to investigate the November 15, 2000, fall of a subcontractor employee who required hospitalization. The employee worked for Decon and Recovery Services of Oak Ridge, Limited Liability Corporation (LLC), which is a lower-tier subcontractor of Bechtel Jacobs Company LLC. The employee was working on the Building 3505 Metal Recovery Facility Decommissioning and Demolition Project at the Oak Ridge National Laboratory. The responsibilities of the Board have been satisfied with respect to this investigation. The analysis, identification of contributing and root causes, and judgments of need resulting from the investigation were performed in accordance with DOE Order 225.1A, *Accident Investigations*.

I accept the report of the Board and authorize release of the report for general distribution.



G. Leah Dever
Manager
Oak Ridge Operations Office

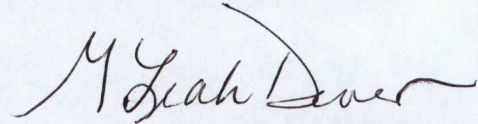
Date Accepted: 12/20/00

PROLOGUE

This Type B investigation is an important reminder that activities we carry out every day have important health and safety implications.

Many of the projects at Oak Ridge Operations Office involve multiple customers, programs, and contractors. The identification of hazards by each individual is of the utmost importance if we are going to ensure that work is being performed in a safe manner. This investigation points out the importance of communication and sharing of information between all levels in the contractor's and the Department of Energy's organizations, including understanding each others roles and responsibilities. In addition, the identification of potential hazards continues to be an area that needs improvement, and each person has to take responsibility for identifying the hazards associated with their daily work. If hazards are appropriately identified and controlled, occurrence of industrial accidents such as this one can be minimized.

I encourage all federal employees and contractors supporting the Oak Ridge Operations Office to read this report, think about the applicability to their work, recognize that there is no such thing as a routine health and safety activity, and work with us to implement Integrated Safety Management.



G. Leah Dever
Manager
Oak Ridge Operations Office

TABLE OF CONTENTS

Exhibits, Figures, and Tables	iii
Acronyms	iv
Executive Summary	v
1.0 Introduction	1
1.1 Background	1
1.2 Facility/Site Description	1
1.3 Scope, Purpose, and Methodology	1
2.0 Facts	5
2.1 Accident Description and Event Chronology	5
2.1.1 Accident Description	5
2.1.2 Event Chronology	10
2.1.3 Emergency Response	12
2.1.4 Medical Summary	13
2.2 Hazards, Controls, and Management Systems	13
2.2.1 Contracts and Agreements	13
2.2.1.1 General	13
2.2.1.2 BJC Subcontract with FIU, Exhibit G, ES&H Requirements	14
2.2.2 Safety and Health Oversight	16
2.2.2.1 ORO EM	16
2.2.2.2 BJC	16
2.2.2.3 FIU	17
2.2.3 Work Planning and Hazard Controls	18
2.2.3.1 Initial	18
2.2.3.2 Work Control Documents	19
2.2.3.3 SCN, 23900-SC-OR027F, Change Notice 001	20
2.2.3.4 Communications	21
2.2.4 Personnel Training and Qualifications, Exhibit G of the Subcontract with FIU	21
2.2.5 Lessons Learned	22

TABLE OF CONTENTS (continued)

3.0	Analysis and Conclusions	25
3.1	Contracts and Agreements	25
3.2	Safety Management	25
3.2.1	Job Hazards	25
3.2.2	Hazard Identification and Work Control Documents	28
3.2.2.1	Activity Hazard Analysis	28
3.2.2.2	Enhanced Work Plan	29
3.2.2.3	Asbestos Work Plan	29
3.2.2.4	Radiation Work Permit	30
3.2.3	UT-Battelle Ladder Safety Program	31
3.2.4	Safety Communications	32
3.2.5	Emergency Response/Medical	32
3.2.6	Lessons Learned	33
3.3	Safety and Health Oversight	33
3.4	Analysis Techniques	34
3.4.1	Integrated Safety Management Systems	34
3.4.2	Barrier Analysis	34
3.4.3	Change Analysis	35
3.4.4	Events and Causal Factors Analysis	35
4.0	Judgments of Need	43
5.0	Board Signatures	45
6.0	Board Members and Staff	47
Appendix A: Type B Investigation Board Appointment Memorandum		
Appendix B: Meteorological Data		
Appendix C: Ladder Inspection Record		

EXHIBITS, FIGURES AND TABLES

Exhibit 2-1.	Work Platform Before Pipe Removal	5
Exhibit 2-2.	Work Platform After Pipe Removal	5
Exhibit 2-3.	JLG Lift	5
Exhibit 2-4.	Asbestos Worker PPE for MRF D&D Project – Front View	6
Exhibit 2-5.	Asbestos Worker PPE for MRF D&D Project – Side View	6
Exhibit 2-6.	Asbestos Worker PPE for MRF D&D Project – Back View	6
Exhibit 2-7.	Protective Gloves Worn by Asbestos Workers	7
Exhibit 2-8.	Powered Air-Purifying Respirator	7
Exhibit 2-9.	View of Fixed Ladder with Obstructions	8
Exhibit 2-10.	Closeup View of Top of Ladder	8
Exhibit 2-11.	Location of Employee After Fall	9
Exhibit 3-1.	Construction Barrier	27
Figure 1-1.	Partial Map of ORNL (Building 3505 Circled)	2
Figure 1-2.	Site Layout with Steam Pipe and Platform Locations	3
Figure 2-1.	MRF D&D Project Organizational Structure	15
Figure 3-1.	Events and Causal Factors Chart	39
Figure B-1.	Meteorological Data on November 15, 2000, at 10 Meters ORNL Met Tower 2	B-1
Table ES-1.	Judgments of Need	vii
Table 2-1.	Event Chronology	10
Table 3-1.	Weaknesses in Implementation of the ISM Core Functions	36
Table 3-2.	Barrier Analysis	37
Table 3-3.	Change Analysis	37
Table 3-4.	Causal Factors	41
Table 4-1.	Judgments of Need	43

ACRONYMS

AEA	AEA Technology Engineering Services, Inc.
AHA	Activity Hazard Analysis
AW-1	Asbestos Worker #1
AWP	Asbestos Work Plan
BJC	Bechtel Jacobs Company LLC
Board	Type B Accident Investigation Board
Building 3505	Metal Recovery Facility (also called the MRF)
CFR	Code of Federal Regulations
D&D	Decommissioning and Demolition
DOE	U.S. Department of Energy
DRS	Decon and Recovery Services of Oak Ridge, LLC
EM	Environmental Management – Oak Ridge
ES&H	Environment, Safety, and Health
EWP	Enhanced Work Plan
FIU	Florida International University
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
LLC	Limited Liability Corporation
M&I	Management and Integration
MRF	Metal Recovery Facility (also called Building 3505)
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Office
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
RCT	Radiological Control Technician
RWP	Radiological Work Permit
SCN	Subcontract Change Notice
SESHR	Site Environment, Safety, and Health Representative
STR	Subcontract Technical Representative
SWP	Safe Work Permit
UT-Battelle	UT-Battelle, LLC

EXECUTIVE SUMMARY

On November 15, 2000, an accident occurred at the U. S. Department of Energy (DOE) Oak Ridge National Laboratory located in Oak Ridge, Tennessee. An employee of Decon and Recovery Services of Oak Ridge, LLC (DRS), working on an Oak Ridge Operations Office (ORO) Environmental Management decommissioning and demolition project received serious injuries from a fall (approximately 13 feet) from a fixed ladder. DRS is a subcontractor to AEA Technology Engineering Services, Inc., who had subcontracted with Florida International University (FIU) in a teaming arrangement contract with Bechtel Jacobs Company LLC (BJC). BJC is a management and integrating contractor to the DOE ORO Environmental Management Program.

The employee's personal protective equipment (PPE) consisted of work clothes, tyvek suit with booties and hood, steel-toed boots, disposable shoe scuffs with a traction bottom surface, full-face powered air-purifying respirator that included a power pack belt around the waist, full body harness, hard hat, and four pairs of gloves that included a cotton inner glove, two layers of latex gloves, and outer leather work gloves. As the employee descended from the platform, his right foot slipped off of the fourth rung of the ladder and he fell, sustaining injuries.

Two asbestos workers were performing abatement and removal of a steam line from a platform. This was a change in work scope because the pipe sections above the platform were not accessible from the JLG lift (extending boom-operated manlift) due to interference from the railing around the platform. When the workers realized that they could not accomplish the work from the JLG lift, they suspended work and checked with the DRS Foreman. The foreman consulted with the FIU Site Environment, Safety and Health Representative, who visually inspected the ladder and, after inspection, determined it to be safe to use even though he noted that there were a number of obstructions. This work could have been accomplished in a safer alternate fashion. The fixed ladder had previously (February 1997) been tagged as "rejected" by Lockheed Martin Energy Research Corporation (predecessor to UT-Battelle, LLC [UT-Battelle]) due to obstructions and rust/corrosion. It was not known if the tag deteriorated over the years or was removed. Moreover, the tag was not in place on the ladder at the time of the accident.

The Board reviewed the contractual structure for the Metal Recovery Facility Decommissioning and Demolition Project to evaluate how safety policies and standards are integrated throughout the planning and implementation phases. Interface agreements were in place between UT-Battelle, LLC, and BJC establishing a list of management and integration contractor facilities at the Oak Ridge National Laboratory. The interface agreements reviewed by the Board did not discuss changes in ownership/accountability due to temporary operations during decommissioning and demolition or remedial action activities. As a result, there was no clear responsibility or ownership of the defective ladder.

Since a formal hazard analysis was not performed when the work activity changed, the worker accessed a ladder with numerous Occupational Safety and Health Administration deficiencies

regarding obstructions. In combination with the ladder obstructions, the level of PPE that the worker was wearing may have contributed to the accident. The powered air-purifying respirator, body harness, and multiple layers of gloves possibly contributed to the fall due to decreased mobility and visibility. Inconsistencies in the work control process documents allowed the worker to be dressed in a level of PPE that exceeded the minimum requirements for the work being performed.

The Board concluded that this accident and the resulting injuries were preventable. This accident highlighted weaknesses in the five core functions of Integrated Safety Management (i.e., defining the work, analyzing the hazards, developing and implementing controls, performing work safely, and feedback and improvement).

The direct cause of the accident was that the worker's foot slipped off the ladder rung, resulting in his fall. The Board identified two root causes for the accident. These are:

- FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.
- UT-Battelle failed to take appropriate actions to prevent use of the defective ladder.

Judgments of Need are the managerial controls and safety measures determined by the Board to be necessary to prevent and/or minimize the probability or severity of a recurrence. They flow from the causal factors, which are derived from the facts and analysis. Judgments of Need are directed at providing guidance for managers during the development of corrective action plans. See Table ES-1 for a list of the Judgments of Need.

Table ES-1. Judgments of Need

No.	Judgments of Need	Related Causal Factor
JON 1	UT-Battelle and BJC need to ensure that the scope and responsibility for management of common use equipment, including fixed ladders, is clearly defined.	<p>UT-Battelle failed to take appropriate actions to prevent use of the defective ladder.</p> <p>UT-Battelle's and BJC's roles and responsibilities for fixed ladder safety were not clearly developed and implemented.</p>
JON 2	UT-Battelle and BJC need to ensure that all fixed ladders under their purview are safe for use or that appropriate measures are taken to ensure prospective users understand the hazards associated with their use.	<p>UT-Battelle failed to take appropriate actions to prevent use of the defective ladder.</p> <p>FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.</p>
JON 3	BJC needs to ensure that all activities to be performed are adequately reviewed to identify potential hazards.	<p>FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.</p>
JON 4	BJC needs to ensure that the work control process integrates all controls for performing work (i.e., EWP, AHA, etc.) in a manner that identifies specific controls for identified hazards and provides for re-evaluation should a change in work scope or methodology be encountered.	<p>FIU's management systems lacked change control provisions.</p> <p>FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.</p>
JON 5	BJC needs to ensure that work control documents appropriately define the work and do not contain conflicting requirements or inconsistencies.	<p>FIU failed to ensure that the AWP appropriately defined the work requirements and responsibilities.</p> <p>FIU's management system documents have inconsistencies and conflicting requirements and are not adequately integrated for effective work control.</p>

This page intentionally left blank.

1.0 Introduction

1.1 Background

On November 15, 2000, a subcontractor employee working on the Metal Recovery Facility (MRF) Decommissioning and Demolition (D&D) Project (Building 3505) at the Oak Ridge National Laboratory (ORNL) fell from a fixed ladder and sustained serious injuries which resulted in hospitalization. An initial investigation was begun by the contractor on November 16. On November 17, U.S. Department of Energy (DOE) Oak Ridge Operations Office (ORO) management categorized the accident as a Type B, and investigative activities began on November 20.

On November 21, 2000, Leah Dever, ORO Manager, formally appointed a Type B Accident Investigation Board (Board) to investigate the accident in accordance with DOE Order 225.1A, *Accident Investigations* (see Appendix A). This report documents the facts surrounding the accident and the conclusions of the Board.

1.2 Facility/Site Description

ORNL is a multiprogram science and technology laboratory established in 1943 to pioneer a method for producing and separating plutonium. Operational facilities at ORNL are managed by UT-Battelle, LLC (UT-Battelle). Inactive facilities in the ORO Environmental Management (EM) D&D Program are managed by Bechtel Jacobs Company LLC (BJC).

One such inactive facility is the MRF (Building 3505), which is a former small-scale, spent nuclear fuel reprocessing plant located in the Bethel Valley portion of ORNL (see Figure 1-

1). The facility includes Building 3505 and an adjacent canal. The MRF was originally built in 1951 and began operations in 1952. The facility was last operated in the early 1960s.

Building 3505 is a steel-siding structure set on a concrete slab. The facility includes concrete process cells, the canal, a dissolver pit, and support structures. The canal is a 6' x 35' x 14' deep concrete basin located adjacent to Building 3505. The canal has been emptied, cleaned, and filled with crushed stone. Figure 1-2 is a graphical depiction of the site layout of the project. The accident occurred on the fixed ladder at the work platform shown on the left side of Figure 1-2.

1.3 Scope, Purpose, and Methodology

The BJC investigation team began transition of information to the Board on November 20, 2000. The Board completed its investigation on December 20. 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 incident; develop conclusions; and determine Judgments of Need that, when implemented, should prevent recurrence of the accident. The investigation was performed in accordance with DOE Order 225.1A, *Accident Investigations*, using the following methodology:

- Facts relevant to the accident were gathered through interviews and review of documents and evidence.
- The accident scene was inspected, and photographs were taken of the scene and available items of evidence.
- Facts were analyzed to identify the causal

factors using events and causal factors analysis, barrier analysis, root cause analysis, and change analysis.

- Judgments of Need for corrective actions to prevent recurrence were developed and address the causal factors of the accident.

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 (are) the causal factor(s) that, if corrected, would prevent recurrence of the accident; and **contributing causal factors**, which are causal factors that collectively with the other causes increase the likelihood of an accident but which individually 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 or conditions that contributed to the accident.

Barrier analysis reviews 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.

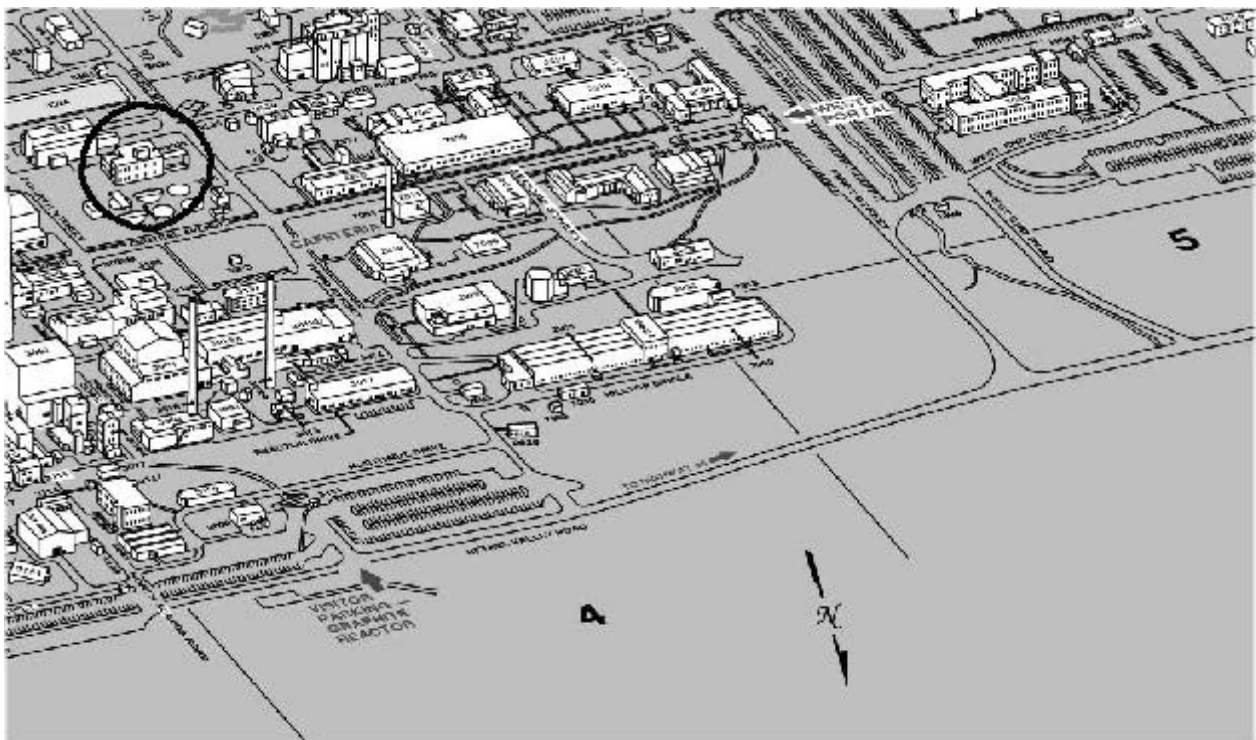


Figure 1-1. Partial Map of ORNL (Building 3505 Circled)

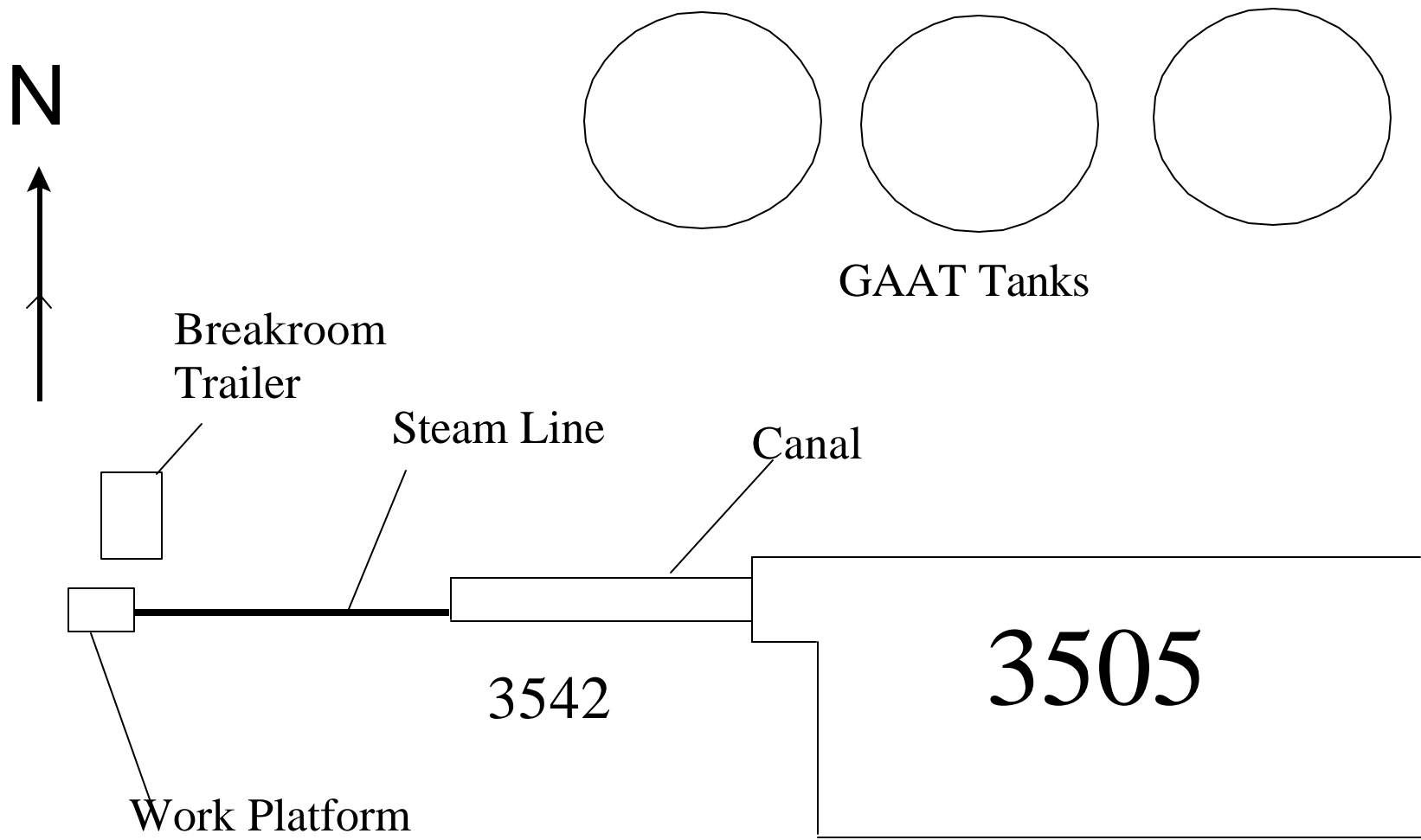


Figure 1-2. Site Layout with Steam Pipe and Platform Locations

2.0 Facts

2.1 Accident Description and Event Chronology

2.1.1 Accident Description

In September 2000, Florida International University (FIU) and its subcontractors (AEA Technology Engineering Services, Inc., [AEA] and Decon and Recovery Services of Oak Ridge, LLC [DRS]) began work on the MRF D&D Project under a subcontract with BJC (Subcontract 23900-SC-OR027F). On November 14, 2000, asbestos workers for DRS began the task of asbestos abatement and removal of steam lines and associated piping from the MRF canal to an elevated platform near the road west of the MRF. (See Exhibits 2-1 and 2-2 for before and after pictures of pipe removal.) The original plan, as defined in Enhanced Work Plans (EWPs) issued by FIU, was to perform all abatement and pipe cutting from a JLG lift, which is an extending boom- operated manlift. (See Exhibit 2-3, JLG Lift.) A forklift was in place east of the platform to support and lower cut steam lines. A plastic mesh construction barrier with metal supports was in place around the immediate work area. Asbestos flagging and signage were also in place around the work area. There were approximately 20 employees on site on any given day (e.g., 1 to 3 from BJC, 12 from DRS, 3 or 4 from FIU/AEA, and 3 to 4 Safety and Ecology Corporation [SEC] Radiological Control Technicians [RCTs]).

The asbestos workers, including the injured employee, were dressed out in the personal protective equipment (PPE) listed below.



Exhibit 2-1. Work Platform Before Pipe Removal



Exhibit 2-2. Work Platform After Pipe Removal



Exhibit 2-3. JLG Lift

(See Exhibits 2-4 through 2-8 for pictures of typical asbestos PPE for this project.)

- C Work clothes,
- C Tyvek suit with booties and hood,
- C Steel-toe boots,
- C Disposable shoe scuffs with a traction bottom surface,
- C Full-face powered air-purifying respirator (PAPR) that included a power pack belt around the waist (worn under the tyvek suit),
- C Full body harness,



Exhibit 2-4. Asbestos Worker PPE for the MRF D&D Project – Front View



Exhibit 2-5. Asbestos Worker PPE for the MRF D&D Project – Side View



Exhibit 2-6. Asbestos Worker PPE for the MRF D&D Project - Back View

- C Hard hat,
- C Four pairs of gloves that included a cotton inner glove, two layers of latex gloves, and outer leather work gloves.

The minimum PPE requirements for asbestos workers per Occupational Safety and Health Administration (OSHA) 29 Code of Federal regulations (CFR) 1926.1101 are (a) a half-



Exhibit 2-7. Protective Gloves Worn by Asbestos Workers

face, negative pressure respirator for concentrations not greater than 1.0 fibers per cubic centimeter (f/cc), (b) full body covering (i.e., tyvek suit with hood); (c) one layer of nitrile or latex gloves; and (d) over-booties or shoe scuffs.

As the work progressed, Asbestos Worker #1 (AW-1), the injured employee, and Asbestos Worker #2 (AW-2) realized that they could not complete the job from the JLG lift. The pipe sections above the steam valve access platform were not accessible from the JLG lift due to interference from the railing around the platform. Consequently, the asbestos workers suspended work and asked the DRS Foreman if they could access the platform via the fixed ladder. The DRS Foreman checked with the FIU Site Environment, Safety, and Health Representative (SESHR), who performed a visual inspection and determined that it was permissible to use the ladder. After SESH approval and since the ladder was not tagged out, AW-1 climbed the ladder to the platform on the afternoon of November 14, 2000, and resumed asbestos abatement.

As shown in Exhibit 2-9, a condensate drain line runs down the back of the rungs, with the distance behind the top rung to the line being 5 3/8 inches. The drain line angles into the back of the ladder, and at the bottom



Exhibit 2-8. Powered Air-Purifying Respirator

rung, the clearance distance was diminished to 1 1/8 inches. The clearance at the fourth rung was approximately 4 inches. Also, a steel angle created an obstruction (3 3/4 inches) behind one rung. Title 29 CFR 1910.27(c)(4) requires at least a minimum clearance of 7 inches in back of a fixed ladder. UT-Battelle tagged the ladder out as “rejected” due to obstructions, rust, and corrosion. However, at the time of the accident, no tag was in place on the ladder.

The FIU SESH stated to the Board that he evaluated the condition of the fixed ladder per 29 CFR 1926.1053, *Ladders*. He further stated that the only two problems he noted were the obstructions behind the rungs of the ladder and the obstruction created by the valve and line to the oxygen tank. (See Exhibit 2-9 for a view of the ladder showing the obstructions.) The SESH also stated that it should be noted that the OSHA requirements use the words “should not” rather than “shall not” in determining use of ladders.

The asbestos abatement and pipe-cutting work continued the next day, November 15, 2000. The temperature at 7:00 a.m. was 28°F with 96% relative humidity. Warming continued throughout the morning, and by early afternoon, the temperature was 47°F with 40% relative humidity. (See Appendix B, Meteorological Data). At approximately 1:10 p.m., AW-1 climbed to the platform via the



Exhibit 2-9. View of Fixed Ladder with Obstructions

humidity. (See Appendix B, Meteorological Data). At approximately 1:10 p.m., AW-1 climbed to the platform via the fixed ladder to complete the asbestos abatement and pipe cuts. AW-2 returned to the JLG lift, and the operator was ready at the forklift.

In addition to the two asbestos workers, five other employees were in the immediate vicinity of the platform. These were the AEA Site Superintendent, the DRS Foreman, a DRS Electrician, a DRS Operating Engineer at the forklift, and an SEC RCT. The AEA and DRS employees were flagging traffic while the JLG lift and forklift moved into position.

AW-1 and AW-2 worked as a team. AW-2 provided equipment from the JLG lift to AW-1 on the platform, and AW-1 performed asbestos abatement and pipe removal. After asbestos abatement and pipe removal were completed on the platform, AW-1 handed the asbestos bags and pipe segments to AW-2. AW-2 then repositioned the JLG lift and made

the final cut on the large steam line pipe segment. The pipe segment was lowered by the forklift operator, and AW-2 withdrew the JLG lift from its working position.

After work on the platform was completed, AW-1 began to descend from the platform via the fixed ladder. As AW-1 descended from the platform, his right foot slipped off of the fourth rung of the ladder. He then lost his grip with his right hand, causing him to swing around 180 degrees while still hanging on with his left hand from the platform support grab bar. (See Exhibit 2-10, Closeup View of Top of Ladder.) The injured employee and two eyewitnesses informed the Board that AW-1 tried to regain his footing, but he could not do so and fell approximately 13 feet. At some point during his fall, AW-1 was somehow turned so that he landed on the back side of his head. Two other eyewitnesses observed the fall but did not see what caused AW-1 to turn as he fell. (See Exhibit 2-11 for the general location of AW-1 after he fell.)



Exhibit 2-10. Closeup View of Top of Ladder

The accident scene was not properly preserved—namely, (a) AW-1's entire PPE was not collected and held for the Board's inspection, (b) the scene was not preserved (asbestos flagging and signage had been removed for emergency access), and (c)

access to the scene was not controlled. The PPE that was made available to the Board as evidence was AW-1's respirator, hard hat, and body harness.



Exhibit 2-11. Location of Employee After Fall

2.1.2 Event Chronology

Table 2-1 provides the events leading up to and following the accident.

Table 2-1. Event Chronology

Date/Time	Event
2/26/97	Fixed Ladder IE 70144 was tagged out as rejected by Lockheed Martin Energy Research Corporation (predecessor operating contractor at ORNL). See Appendix C, Ladder Inspection Record).
1998	The ORNL Safety Improvement Team received an employee concern that Fixed Ladder IE 70144 had deteriorated at the top anchor point.
7/6/98	ORNL issued ORNL-SH-P37, <i>ORNL Ladder Safety Program</i> .
8/20/98	Lockheed Martin Energy Research Corporation issued a memorandum that shifted responsibility for funding fixed ladder inspections and other equipment from overhead to the Facility Managers. Facility Managers became responsible for requesting and funding inspections.
11/25/98	The ORNL Safety Improvement Team repaired Fixed Ladder IE 70144 at the top anchor point and affixed a chain to the guardrail. (NOTE: Obstructions, corrosion, and rust were not addressed during this ladder repair.)
11/9/99	AW-1 received an annual medical examination.
4/25/00	BJC awarded the subcontract (23900-SC-OR027F) to FIU for the MRF D&D Project.
9/5/00	BJC accepted the FIU ES&H Plan and Comprehensive Work Plan for the MRF D&D Project.
9/5/00	The FIU Activity Hazard Analysis (AHA) became effective for the MRF D&D Project.
9/8/00	The FIU Deputy Project Manager approved AW-1's Training/Medical Surveillance Certification.
9/12/00	AW-1 signed the AHA for the MRF D&D Project.
9/14/00	The BJC Readiness Evaluation Board approved FIU's readiness to begin MRF D&D activities.
9/26/00	FIU issued EWP-00-003, <i>Asbestos and MMF Abatement</i> , Revision 0.
10/31/00	BJC completed a Management Assessment on work controls and the Integrated Safety Management System (ISMS) for BJC's ORNL projects.
11/2/00	BJC issued a Subcontract Change Notice (SCN) (23900-SC-OR027F, Change Notice 001) between BJC and FIU to extend the MRF D&D activities.

Table 2-1. Event Chronology (continued)

11/2/00	AW-1 received an annual medical examination.
11/13/00	The FIU Deputy Project Manager approved AW-1's updated Training/Medical Surveillance Certification.
11/14/00 Morning	AW-1 and AW-2 began asbestos abatement of the steam line from the stanchion hanger back to the platform.
11/14/00 Afternoon	AW-1 and AW-2 told the DRS Foreman that they could not reach the entire steam line from the JLG lift and asked to use the platform to finish the job.
11/14/00 Afternoon	The DRS Foreman checked with the SESHR on using the platform. The SESHR visually inspected the ladder and determined that it was permissible to use. NOTE: FIU did not revise the work control documents for use of the ladder and platform.
11/14/00 Afternoon	AW-1 climbed the fixed ladder to access the platform and continued asbestos abatement on the steam line.
11/15/00 6:30 a.m.	The AEA Site Superintendent held a Plan of the Day Meeting with the work crew.
11/15/00 7:45 a.m.	AW-1 signed in under Radiological Work Permit (RWP) BJC-ORNL-6731, Revision 1.
11/15/00 Morning	AW-1 abated the asbestos on the steam line. This included using the fixed ladder to reach the platform.
11/15/00 12:10 p.m.	AW-1 signed out under RWP BJC-ORNL-6731, Revision 1. Revision 1 of the RWP expired, and Revision 2 was issued.
11/15/00 12:30 p.m.	Pre-job briefing was provided on RWP BJC-ORNL-6731, Revision 2.
11/15/00 1:10 p.m.	AW-1 signed in under RWP BJC-ORNL-6731, Revision 2.
11/15/00	The JLG lift was moved to the north side of the platform, and the forklift was placed on the southeast side.
11/15/00 Between 1:10 -1:35 p.m.	AW-1 climbed the ladder to the platform. He abated a bleed-off line and made pipe and hanger cuts using a portaband saw. He handed the cut pipes and saw to AW-2 in the JLG lift.
11/15/00 Between 1:10 -1:35 p.m.	AW-2 moved the JLG lift to the stanchion to make the final cut on the steam line. The forklift lowered the cut pipe. AW-2 withdrew in the JLG lift.
11/15/00 ~1:35 p.m.	AW-1 began his descent from the platform via the fixed ladder with nothing in his hands.
11/15/00 ~ 1:35 p.m.	AW-1 fell approximately 13 feet from the ladder.

Table 2-1. Event Chronology (continued)

11/15/00 1:41 p.m.	The ORNL Fire Department received the 911 call from the DRS Electrician.
11/15/00 Between 1:35 - 1:41 p.m.	The DRS Foreman, who was the asbestos competent supervisor, removed all the asbestos signage and roping to provide easy access for the emergency response crew.
11/15/00 Between 1:35 - 1:41 p.m.	The DRS Foreman and the SEC RCT removed AW-1's respirator, body harness, and leather gloves. They began cutting his tyvek coverall in preparation for first aid treatment.
11/15/00 1:42 p.m.	Emergency medical personnel arrived at the scene and began treatment.
11/15/00 2:00 p.m.	AW-1 was signed out on the RWP by an unknown person.
11/15/00 2:10 p.m.	Life Star (helicopter) arrived at the designated on-site landing zone and was met by the ambulance transporting AW-1.
11/15/00 2:21 p.m.	Life Star left with AW-1 to go to the University of Tennessee Memorial Hospital.
11/17/00	The fixed ladder was re-tagged as "rejected" by UT-Battelle.
11/19/00	AW-1 was released from the hospital.
11/21/00	The ORO ORNL Site Office directed UT-Battelle to perform a self-assessment of its Fixed Ladder Safety Program.
11/28/00	AW-1 was returned to the hospital for placement of pins in both wrists. He was kept in the hospital overnight.
11/29/00	AW-1 was released from the hospital.

2.1.3 Emergency Response

The AEA Site Superintendent observed the employee fall from the ladder and immediately directed another project employee to call 911, which was completed expeditiously. The call was received at the ORNL Fire Department at 1:41 p.m., and emergency medical personnel were on the scene at 1:42 p.m. (The Fire Department is two blocks from the accident scene.) The UT-Battelle Ambulance Director and the Fire Department Shift Supervisor arrived at the accident scene first. The Ambulance Director initiated a Life Star

(helicopter) pickup, which is the normal practice for head injuries. The Shift Supervisor began initial care of the employee. An Emergency Medical Technician and two Paramedics arrived shortly after the Ambulance Director. The UT-Battelle Medical Director, another UT-Battelle doctor, and a nurse also went to the accident scene. The Medical Director supervised activities at the accident scene.

The employee was unconscious immediately after the fall. When the emergency medical personnel arrived, the employee's respiration

was approximately six breaths per minute, which is half the normal rate, and he was cyanotic. Cyanosis is a bluish discoloration of skin and mucous membranes due to excessive concentration of reduced hemoglobin in the blood. The paramedic attempted to improve respiration by using a bag-valve mask. After a short period, he tried to insert a breathing tube through the patient's mouth; however, AW-1's jaws were clenched. The paramedic inserted a breathing tube through AW-1's nose and administered oxygen. The employee regained consciousness before being transported to the University of Tennessee Memorial Hospital via Life Star. During routine questioning by emergency personnel, AW-1 stated that he was taking Dilantin for control of seizures.

2.1.4 Medical Summary

The employee sustained head trauma, compression fractures of the T-3 and T-8 vertebrae, a fractured right elbow, and a broken right wrist. He was admitted to the hospital on November 15 and discharged on November 19. During an appointment with an orthopedic doctor on November 28, it was determined that his left wrist was also broken. He was readmitted to the hospital on November 28 for surgical pinning of both wrists. He returned home on November 29.

2.2 Hazards, Controls, and Management Systems

2.2.1 Contracts and Agreements

2.2.1.1 General

BJC is the Management and Integration (M&I) contractor for ORO Environmental Management and Enrichment Facilities. As such, the scope of the work assigned to BJC includes collection, storage, and disposal of

waste; remediation of contaminated sites; and disposition of excess/surplus facilities transitioned to the ORO EM Program. UT-Battelle is the management and operating contractor for ORNL. UT-Battelle is responsible for performing research activities and providing technical support for ORNL (i.e., environmental monitoring, safety and health, sample analysis, and equipment calibration); providing site services, which consist of but are not limited to maintaining utilities, roads, and grounds; and maintaining the infrastructure.

At the time of the accident, several interface agreements were in place between BJC and UT-Battelle to delineate on-site responsibilities. BJC and UT-Battelle had documented and agreed to the list of M&I contractor facilities at ORNL. In addition, a letter from the BJC Vice President and General Manager, to the UT-Battelle Associate Director for Operations, Environment, Safety, and Health, dated February 7, 2000 (LTR-GM-00-0014), documented interface guidelines for contractor areas and facilities at ORNL. These agreements described the services to be provided by each prime contractor, but they did not identify responsibilities regarding common use structures, access areas, boundary areas, etc.

On November 30, 2000, the Board received an electronic mail message from UT-Battelle that stated, "UT-Battelle is the operating contractor for the active steam system at ORNL. Formal transfer of the ladder in question has not occurred between UT-Battelle and BJC. However, BJC had assumed operational control over the ladder and adjacent area as was necessary to perform their work." However, the interface agreements between UT-Battelle and BJC did not include a definition of the term

“operational control,” did not address temporary transfers, and did not document the interface boundaries for shared site systems to this level of detail. Updates to the current interface agreements are in progress.

Consistent with the intent of an M&I contract, BJC has subcontracted over 85% of the projects in support of the ORO EM mission. The D&D of the MRF at ORNL is one such project (see Figure 2-1, MRF D&D Project Organizational Structure). FIU was awarded the subcontract (23900-SC-OR027F) to D&D Building 3505 on April 25, 2000. In turn, FIU entered into a subcontract with AEA on July 20, 2000, to establish a teaming agreement for performing the work. Within this subcontract, roles and responsibilities of each entity include but are not limited to the following:

- FIU is responsible for providing the following:
 - Project management,
 - ES&H support and oversight,
 - PPE, and
 - Certification of medical surveillance and training.
- AEA is responsible for providing the following:
 - Decommissioning engineering services,
 - Site management services,
 - General labor services,
 - Asbestos abatement services, and Demolition services.

To fulfill its general labor services responsibility, AEA entered into a subcontract with DRS (AEA Purchase Order 6181) on August 1, 2000, to support asbestos abatement and associated demolition activities by providing skilled craft workers. AEA Purchase Order 6181 was updated on September 5, 2000, and October 25, 2000.

2.2.1.2 BJC Subcontract with FIU, Exhibit G, ES&H Requirements

Environment, Safety, & Health Plan – In accordance with Exhibit G, Part I, Section 1.6, of the BJC subcontract with FIU, an ES&H Plan was jointly prepared by FIU and AEA and submitted to BJC on August 30, 2000. This plan is intended to meet the requirements of BJC’s ISMS, the Environmental Management and Enrichment Facilities Work Smart Standards, the requirements of Title 29 CFR Part 1926.65, and the provisions of applicable regulatory and industry standards. It also specifies how ES&H requirements will flow down to employees and lower-tier subcontractors. All work by FIU and its subcontractors, AEA and DRS, is performed under the FIU ES&H Plan.

Work Control – Section 1.1.3 of the ES&H Plan, “Work Control and the Process for Involving Employees and Lower-Tier Subcontractors,” states that project work will be implemented and controlled using an Integrated Safety Management (ISM) EWP process. The EWP process involves workers, supervisors, and subject matter experts to implement the five core functions of ISM. Employees use the project’s general AHA as a guide to conducting activity-specific hazard assessments.

Activity Hazard Analysis – Exhibit G, Part II, Section 1.3, provides guidance for developing AHAs. The requirement is for development of an AHA at the activity/task level that provides a detailed, job-specific hazard assessment that addresses each step of the work process, the hazards involved, and the controls for those hazards. FIU is responsible for preparing the AHA, training and involving the subcontractor workforce, implementing the AHA, overseeing and

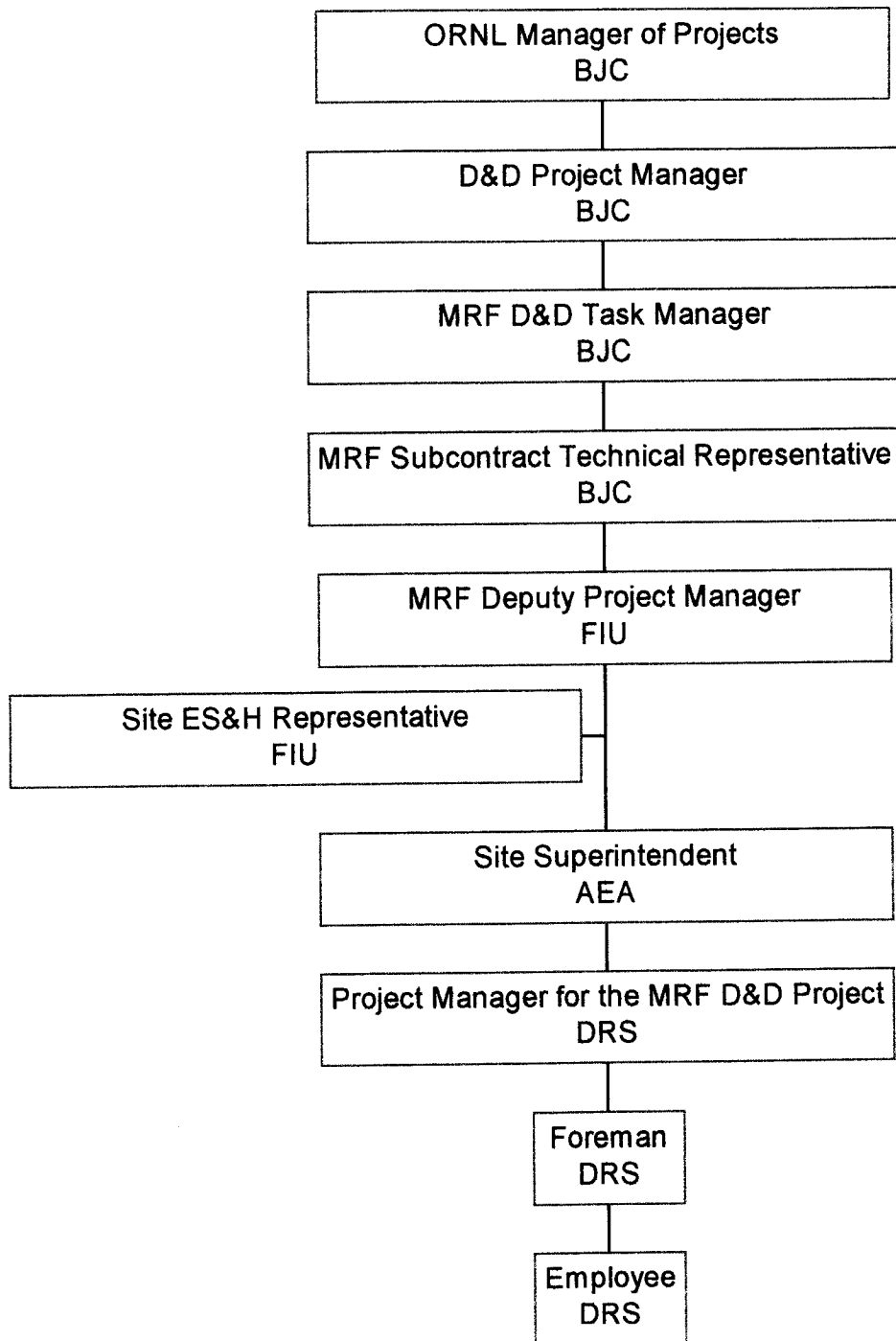


Figure 2-1. MRF D&D Project Organizational Structure

assessing implementation of the AHA in the field, and taking appropriate action(s) as needed.

Enhanced Work Plan – EWP's are developed from the project-based AHA. They are intended to provide a step-by-step flow of activities to complete the work and to identify the hazards and preventive measures. The EWP covering the scope in the SCN (23900-SC-OR027F, Change Notice 001) did not include a complete list of equipment to be used in executing the work (i.e., the forklift was not listed). Also, the EWP was not modified when the method of accomplishing the work changed.

2.2.2 Safety and Health Oversight

2.2.2.1 ORO EM

ORO EM's commitment to safe operations can be found in several organizational policies. One such example would be ORO EM's ISM policy dated June 8, 1999. These policies are further defined in organizational procedures that identify the roles and responsibilities of Team Leaders, Program Managers, and team members in fulfilling these commitments.

ORO EM Procedure EM-7.4, *Environmental Management Environment, Safety, and Health Oversight Program*, which was effective on September 20, 2000, outlines the responsibilities of ORO EM employees for conducting safety oversight of contractor activities. The procedure identifies the roles of ORO EM employees to include:

- Evaluating the adequacy, consistency, and effectiveness of contractors' performance.
- Implementing the core oversight program, which includes but is not limited to ISM,

industrial safety, occupational medicine/health surveillances, facility safety, etc.

ORO EM Procedure EM-4.1, *Assessments*, which was issued on November 11, 1999, provides the systematic process for conducting assessments of ORO EM's projects, programs, and management systems. The goal of ORO EM's assessments is to ensure that contractors' and internal ORO EM's activities are conducted in accordance with defined requirements and expectations.

Following are the key ORO EM positions and their responsibilities for overseeing the MRF D&D Project:

- The ORO EM Program Managers are responsible for the overall coordination of schedule and budget with their BJC counterparts. Program Managers are responsible for contractors' adherence to ISM principles and implementation. They are also responsible for conducting oversight activities as defined above.
- The ORO EM Facility Representative is responsible for the day-to-day conduct of operations to ensure safe operations in compliance with laws, regulations, and DOE guidance. Facility Representatives may interface directly with the contractor and any of the lower-tier subcontractors that are performing work on site. They also have responsibility for implementation of DOE oversight programs and procedures.

2.2.2.2 BJC

The BJC ISMS description (BJC-GM-1400) reflects the company's approach for integrating safety into all aspects of work planning and control. This document describes BJC's functions and responsibilities,

organizational framework for implementing its ISMS, worker empowerment, and flowdown of ES&H requirements to subcontractors. Key employees and their responsibilities as they relate to safety are as follows:

- BJC Managers of Projects are responsible and accountable for the execution of the M&I work scope. They have direct and immediate responsibility for the safe performance of the project activities under their direction, including field implementation of the ISMS. It was noted that BJC Policy 401 identifies the responsibilities of BJC Managers of Projects for planning, controlling, and monitoring the execution of site-specific or operations work assigned to BJC by DOE. Included in this policy is the responsibility of Managers of Projects to integrate ISM and quality assurance components into work planning, execution, and assessment. This responsibility has been delegated to the BJC D&D Project Manager.
- The BJC Safety Advocate is expected to be familiar with the specific requirements of the subcontractor's scope of work and with the workplace hazards. Safety Advocates are responsible for orienting and mentoring subcontractors to attain safety and environmental excellence through the appropriate level of safety controls. Safety Advocates assist subcontractors by providing guidance, fostering implementation of BJC's ES&H programs, reviewing subcontractor-generated reports and data, monitoring subcontractor trends, promoting continuous improvement, etc.

2.2.2.3 FIU

Section 1.2.2, "Project Organization and Structure," of FIU's ES&H Plan (issued

August 30, 2000) defines roles for ES&H personnel and delineates lines of ES&H authority. Following are the job titles identified in the ES&H Plan (with the exception of the Decommissioning Engineer), along with a brief description of each position's responsibilities. (Refer back to Figure 2-1, MRF D&D Project Organizational Structure.)

- Among the responsibilities of the Project Manager is the responsibility for overall coordination with the BJC Subcontract Technical Representative (STR). The Project Manager ensures that the project and the SESHHR obtain all the necessary resources to accomplish each task efficiently and safely. This position is filled by an FIU employee.
- The Site Manager is responsible for resource management, supervision of daily site activities, site safety and health, and coordination of the task personnel. The Site Manager leads daily meetings to transfer lessons learned, reiterate and reinforce the commitment to ISM and the Zero Accident Performance Policy, solicit worker feedback, and issue task assignments. In addition, the Site Manager is responsible for ensuring strict adherence to all ES&H and quality assurance and quality control procedures. This position is filled by an AEA employee.
- The SESHHR interfaces directly with the BJC Safety Advocate and is responsible for implementing, coordinating, and managing safety programs to ensure safe operation in full compliance with laws, regulations, and DOE guidance. The SESHHR is responsible for the development of AHAs for specific tasks, implementing the ES&H Plan, and conducting daily job site inspections to ensure compliance with

the Safety Program. The SESHR is an FIU employee and must be present on site anytime hands-on work is being performed.

- The AEA Decommissioning Engineer develops the high-level schedule of activities and ensures integration of those activities. As a facilitator for the work to be done, he prepares work packages for D&D activities. With the aid of technical staff and skilled labor, he prepares the EWPs and provides the pre-job briefings prior to implementation of an EWP.

2.2.3 Work Planning and Hazard Controls

2.2.3.1 Initial

The formal Notice to Proceed to commence site characterization activities at the MRF was issued on July 24, 2000, by the BJC STR. Specific restrictions on pulling samples for transportation and mobilizing hazardous materials were listed on the Notice to Proceed until a Transportation Plan was approved. A Readiness Evaluation meeting was held on September 7, 2000. It was agreed that FIU would not perform any additional field work (beyond site characterization) prior to receiving the formal Notice to Proceed from the Board Chairperson (BJC D&D Projects Manager). Included in the Readiness Evaluation was review of the work control documents listed below.

- Radiation Protection Plan – includes participation in a bioassay program
- Emergency Response Plan – provides a detailed description of routine requirements to ensure project integration with the Oak Ridge Reservation

Emergency Plan and its implementation of DOE Order 151.1

- Quality Assurance Project Plan – defines the requirements for nonconforming processes, services, items, etc.
- Asbestos Work Plan (AWP) – details the approach for implementing asbestos and man-made mineral fiber abatement activities associated with floor tiles and thermal systems insulation at the MRF
- ES&H Plan – serves as the site ES&H Plan for all levels of employees, including lower-tier subcontractor employees
- Safety authorization basis – covers decontamination, radiological surveying, sampling, maintenance, waste removal, and dismantlement activities

The BJC final Notice to Proceed was approved and transmitted to FIU on September 14, 2000, after all conditions were verified complete.

The work plan document that defines the types of jobs needed for project execution and appropriate roles and responsibilities is the Comprehensive Work Plan. The Comprehensive Work Plan incorporates the following:

- Anticipated site activities,
- Project objectives,
- Job site requirements,
- Management planning and control approach,
- Training and medical surveillance implementation,

- Definition of work tasks and methods of accomplishment, and
- Waste management and verification approach.

2.2.3.2 Work Control Documents

The specific work control documents that pertain to work being performed on the day of the accident (November 15, 2000) are the AHA, the EWP, the RWP, and the AWP.

Activity Hazard Analysis – The AHA was prepared and issued jointly by FIU and AEA on September 5, 2000. This document addresses the hazards associated with all general site operations and construction activities associated with D&D of the MRF. The AHA was developed with input from all organizational levels, including laborers. Twenty-eight general tasks/activities were identified in the AHA, with an analysis of all hazards that could be encountered during the work and the associated generic controls. All workers are required to review the AHA and sign it to indicate their understanding of the hazards and control measures to be utilized during performance of the tasks identified. Other than the BJC instruction guidelines contained in Appendix G-5 of the subcontract, FIU does not have a procedure that addresses the process for developing and processing the AHA. A general discussion of the AHA is provided in the ES&H Plan.

Enhanced Work Plan – The work control process intended to implement the five core functions of ISM is the EWP. Each job activity to be performed is covered by an EWP. The EWP identifies hazards and controls from the AHA for job activities, as well as any additional unique hazards. The scope of work allows for multiple but related job activities to be addressed on one EWP. The scope of work gives some bounding

conditions and helps determine what craft workers and subject matter experts are needed to help develop the detailed plan of the job and to work out each step. The individuals who participate in development of the EWP sign the “EWP Meeting Attendance” section of the EWP. Employees sign and date the “Pre-Job Brief Sheet” section of the EWP when they are briefed on the portion that directly affects their work activities. Details of what is contained in the briefing are maintained in the AEA Site Superintendent’s daily logbook.

After the step-by-step work flow in the EWP is the “Task Specific Activity Hazard Assessment” table. This table lists the work plan steps, hazards, and hazard controls. The hazards section uses numbers that refer back to the generic AHA for specific topics. For example, 14 refers to the fall protection section of the AHA and the generic controls listed for all types of fall protection control methods. There is no discussion as to what specific hazards will be encountered during these work steps or what specific controls will be necessary to control the hazards and protect employees. The ES&H Plan provides guidance on developing and processing EWPs, but it does not include guidance on addressing changes in the scope of work or changes in the methods by which the work is to be accomplished.

Site personnel indicated that two EWPs were in place that pertained to the work being performed when the accident occurred. There were differing opinions among FIU, AEA, and DRS personnel as to which EWP covered the activities associated with the work on the ladder/platform that was performed by AW-1. The EWPs are as follows:

- EWP-00-003, *Asbestos and MMF Abatement*, Revision 0, issued on September 6, 2000, identifies seven activities to be performed, one of which is

“abatement and removal of the steam line above the MRF canal (from the Dissolver Room west wall to above the GAAT project break/lunch trailer).” Steps 49 through 58 cover the steam line abatement and removal.

- EWP-00-006, *240/120 V Panel & Lighting Stripout & Utilities Decommissioning*, Revision 0, issued on October 2, 2000, identifies four activities to be performed, one of which is “decommissioning of remaining utilities (pipework and conduit throughout the building).” Steps 18 through 22 cover this activity.

Radiation Work Permit – RWP BJC-ORNL-6731 was issued as a general site RWP for all radiological work on the MRF D&D Project. Workers attend a pre-job briefing prior to working under an RWP. Inconsistencies as to whether employees should have signed in under RWP BJC-ORNL-6731, Revision 2, were evident during the interviews and review of the RWP sign-in sheets. For example, on the day of the accident (November 15), the injured worker (AW-1) signed in under the RWP for work in Building 3505, although the planned work would be performed on the ladder/platform outside and to the west of the building. Interviews with SEC’s radiological control staff indicated that AW-1 should not have signed in under the RWP to perform the asbestos abatement and removal of the steam line. The PPE requirements to which the worker was adhering were not for control of radiological hazards.

Asbestos Work Plan – The FIU AWP, issued on September 5, 2000, details the approach for implementing asbestos and man-made mineral fiber abatement activities associated with the floor tiles and thermal systems insulation in Building 3505. The approach was based on current site characterization, taking into

account the known hazards at the facility. Personnel responsibilities are delineated, as well as specific abatement training requirements. The AWP states, “All asbestos abatement shall be performed in accordance with DRS procedure MCP-HS-24, *Asbestos Abatement*.” The inclusion of the DRS procedure into the FIU AWP creates some confusion because the DRS procedure states, “The respiratory protection intended for use on each operation of the asbestos abatement project shall be identified on the respective safe work permit (SWP).” FIU uses the EWP process rather than an SWP system. The site RWP listed PPE requirements for use while working under the RWP; however, no MRF D&D Project document delineated the specific PPE requirements for the work that AW-1 was performing on the day of the accident. Other discrepancies exist between the DRS procedure and the actual site work process. It is not clear whether the DRS procedure was intended to cover the specific work on the MRF D&D Project or to be used in concert with FIU’s processes or plans.

2.2.3.3 SCN, 23900-SC-OR027F, Change Notice 0001

The work being performed on November 14 and 15 that involved asbestos abatement and removal of the steam line from the stanchion back to the platform was initiated under the SCN, which became effective November 2, 2000. The change described in the SCN is as follows:

“Abate asbestos and remove steam piping (~ 25’) from the southwest corner of the 3505 canal over to the elevated work platform. Remove plant air and condensate piping along this same run. Dispose of all waste generated. This additional piping was not included within the site boundary based upon prior site walkdown.”

One of the activities covered by EWP-00-003, issued September 6, 2000, is “abatement and removal of the steam line above the MRF canal (from the Dissolver Room west wall to above the GAAT project break/lunch trailer).” Interviews with the FIU Deputy Project Manager and the AEA Decommissioning Engineer indicated that the work delineated in the SCN was deemed to be more of the same work already being performed under EWP-00-003. They stated that since it did not change the scope covered by the EWP, a new or revised EWP was not required.

Previously, the asbestos on the steam line had been abated by two asbestos workers working from a JLG lift using the glovebagging method and then cutting/removing the pipe sections. All previous work on the steam line had been successfully accomplished using this method, along with a forklift operator to hold large overhead pieces of the steam line as they were cut and then remove them.

Work began under the SCN on November 14, 2000. As the two asbestos workers in the JLG lift reached the elevated platform, they realized they could not finish the work from the JLG lift on the portion of the steam line above the platform due to interference from the platform railing. The workers informed the Board that site policy prohibited the JLG lift from being used as a manlift to access another work platform by climbing over the platform railing. The workers determined that they would be able to complete the job if they could access the elevated platform via the fixed ladder. The workers halted work and discussed the change in methodology with the DRS Foreman, who found it acceptable but checked with the SESHR. The SESHR visually inspected the ladder and indicated that it was permissible to use. An in-depth hazard analysis of the change in methodology was not performed, and the EWP was not revised. The “Rejected” tag

placed on the ladder by UT-Battelle in 1997 was not in place.

2.2.3.4 Communications

A number of methods are used on the site to ensure daily communications. Beginning each day at 6:30 a.m., the Plan of the Day (POD) Meeting is held with all workers. The SESHR discusses a safety topic, and then the meeting is turned over to the AEA Site Superintendent and the DRS Foreman. The work activities for the day are discussed for each individual, and tasks are assigned. Opportunities to discuss problems or concerns are offered. In fact, employees interviewed by the Board indicated that the feedback is encouraged and well received anytime.

In addition to the POD Meetings, pre-job briefings are held to discuss specific tasks associated with the appropriate EWP and/or RWP. Employees sign and date the EWP after they are briefed on the portion that directly affects their work activities. Details of the briefings are maintained in the AEA Site Superintendent’s logbook.

At the end of each work day, the AEA Site Superintendent, DRS Foreman, AEA Decommissioning Engineer, SESHR, and available management personnel hold a Plan of Tomorrow Meeting. The next day’s activities are planned in this meeting (as well as a discussion as to whether any problems were encountered during the day), and the safety briefing for the next day is reviewed.

2.2.4 **Personnel Training and Qualifications, Exhibit G of the Subcontract with FIU**

Medical Surveillance – Part I, Section 3.6, of the FIU subcontract outlines the subcontractor’s responsibility to comply with applicable regulatory requirements for medical

surveillance. Part II, Section 7.1, provides general medical surveillance requirements and includes a requirement that all personnel for which the subcontractor is responsible must be current in their medical qualifications. Within this section is the subcontractor's responsibility to adhere to the medical monitoring requirements specified in 29 CFR 1910, Subpart Z, *Toxic and Hazardous Substances*, and 29 CFR 1926.

Part II, Section 7.2, outlines the expectations for the subcontractor personnel to participate in a medical surveillance program designed to meet the requirements of 29 CFR 1910.120 or 29 CFR 1926.65. The subcontractor is required to maintain a physician's statement for each employee that is based on a medical examination which, at a minimum, meets the criteria specified by the subcontractor's ES&H Plan and 29 CFR 1926.65(f).

Access Training – Part I, Section 3.7, addresses the minimum training requirements to allow access to DOE facilities, such as Security Controlled Areas, Radiological Controlled Areas, and other posted areas with radiological hazards. This section briefly describes the general training required for all workers and the requirement to obtain and display Site Access Cards.

Specific Training – Part II, Section 8.0, establishes the specific training requirements that apply to subcontractors. The following is a sample list of the types of training that are required when performing work at the MRF.

- Radiation Worker Training
- Hazardous Waste Operations Training
- Respirator Training and Fit Test
- Hazard Communication Program and Training
- Asbestos Abatement Training

Finally, the subcontractor is responsible for certifying that its personnel and any sub-tier subcontractor's personnel meet the training and medical requirements relevant to the work the employee will be performing at the project site. The subcontractors provided the required certifications, which indicated that all training requirements had been met by the DRS employees involved in the work activity covered by the SCN.

Records also indicated that a medical surveillance program was in place and no restrictions had been placed on the injured employee. AW-1 revealed information to the Board that had not been included in his annual physical examination record.

2.2.5 Lessons Learned

The BJC Lessons Learned Program is defined in BJC-PQ-1240, *Lessons Learned Program*. This program is referenced in the BJC ISMS description (BJC-GM-1400) and is based on DOE-STD-7501-95, *DOE Standard on Development of DOE Lessons Learned Programs*. This procedure defines the BJC program for identifying, disseminating, and utilizing positive and negative operating experiences (i.e., lessons learned) which may be applicable to other organizations.

Lessons learned information is disseminated to BJC project and functional organizations for review to determine applicability and for development of organizational responses, as required. The BJC project and functional organizations are responsible for further dissemination of these lessons learned within their organization and to subcontractors. Actions associated with implementation of lessons learned are identified and tracked through implementation to closure.

In addition to the formal processing of lessons learned as described above, the BJC Manager of ORNL Projects routinely addresses applicable lessons learned with affected parties through one of three methods or all three methods, depending on the subject of the lessons learned. Lessons learned are addressed at monthly BJC Team Meetings,

addressed at monthly Subcontractor Safety Meetings, and distributed by STRs to affected sub-contractors. ORNL Subcontractor Project Managers and their SESHRS attend the monthly Subcontractor Safety Meetings. In these meetings, BJC lessons are shared/addressed with subcontractors, and subcontractor lessons learned are shared with BJC and other subcontractors.

This page intentionally left blank.

3.0 Analysis and Conclusions

3.1 Contracts and Agreements

The Board reviewed the contractual structure for the MRF D&D Project to evaluate how safety policies and standards are integrated throughout the planning and implementation phases. The BJC contract with ORO contains Department of Energy Acquisition Regulation clause 970.5704-2, *Integration of Environment, Safety, and Health into Work Planning and Execution* (June 1997). BJC's subcontracts enforce the ISM requirements through Exhibit G, "Environment, Safety, and Health Requirements," which is applied to subcontractors and any lower-tier subcontractors.

The interface agreement between BJC and UT-Battelle, dated February 7, 2000 (LTR-GM-00-0014), established guidelines that included the following general description of the utility interfaces:

"In general, the utility interface point will be the five-foot line off the facility foundation, or the first isolation point (electrical disconnect, valve, etc.) to the facility inside, or in close proximity, to the five-foot line. The facility contractor/subcontractor will be responsible for maintenance of facility utility systems up to the interface point. Responsibilities for maintenance and operation of the laboratory-wide utility systems which pass through, or cross, other contractor/subcontractor areas/facilities will remain with the contractor/subcontractor responsible for operating the utility system."

During the Board's review, there were inconsistencies in statements by the two prime contractors regarding responsibility for the fixed ladder. Specifically, UT-Battelle indicated that its opinion was that BJC had "operational control" of the ladder, platform, and associated structures. However, the term "operational control" was not defined in the interface agreements between the two prime contractors.

3.2 Safety Management

3.2.1 Job Hazards

As AW-1 and AW-2 abated the steam line up to the platform, they realized they would not be able to accomplish all abatement from the JLG lift. The pipe sections above the steam valve access platform were not accessible from the JLG lift due to interference from the railing around the platform. Consequently, the asbestos workers suspended the work and asked the DRS Foreman if they could access the platform to complete the task. The DRS Foreman checked with the FIU SESHR, who then did an independent, visual inspection of the ladder and authorized its use.

In Board discussions with the FIU SESHR, he stated that his evaluation was based on:

- (1) Title 29 CFR 1926.1053, *Ladders*, requirements
- (2) Obstructions behind the rungs of the ladder, and the obstruction created by the valve and line to the oxygen tank (refer back to Exhibit 2-9 for a view of the ladder showing the obstructions)
- (3) OSHA requirements use the words "should not" rather than "shall not" in determining use of ladders

In the Board's determination, the OSHA standard applicable to the ladder and platform was 29 CFR 1910.27, *Fixed Ladders*. The Board also determined that use of the ladder was not the safest alternative for accessing the platform due to the ladder obstructions and the level of PPE worn by AW-1.

During a visit to the accident scene, the Board identified the existence of an impalement hazard from the plastic mesh construction barrier with metal supports that had been erected around the west end of the platform (see Exhibit 3-1, Construction Barrier). Had the employee not fallen to the north side of the ladder, he might well have been impaled on one of the metal supports to the south or the west of the ladder. The impalement hazard had not been identified, analyzed, nor abated.

Since a formal hazard analysis was not performed when the work methodology changed, AW-1 climbed the ladder to perform the work. An adequate hazard analysis should have noted the numerous obstructions, as well as the rust and corrosion on the ladder. Also, since the ladder had a tag identifying it as IE 70144, that should have prompted a telephone call to the ORNL ladder inspection group, which should have produced the most recent inspection record (this was also the only recorded inspection). This telephone call should have elicited the information that the ladder should have been tagged as "rejected" due to the obstructions and the excessive rust and corrosion identified in February 1997. Title 29 CFR 1910.27(b) requires that metal ladders be painted or otherwise treated to resist corrosion and rusting when the location demands it.

As a result of this review, deficiencies with 29 CFR 1910.27, *Fixed Ladders*, requirements were noted. One of most

serious deficiencies was the noncompliant clearance at the rungs from the back of the ladder. A condensate drain line runs down the back of the rungs, with the distance behind the top rung to the line being 5 3/8 inches. The drain line angles into the back of the ladder, and at the bottom rung, the clearance distance was diminished to 1 1/8 inches. The clearance at the fourth rung was approximately 4 inches. This could seriously impede a worker's climb or descent from the ladder. It was noted that the drain line runs down the right side of the ladder (refer back to Exhibits 2-9 and 2-10), and AW-1 was reported to have lost his footing with his right foot. It is possible that this obstruction helped cause the worker to lose his footing. A steel angle created an obstruction (3 3/4 inches) behind one rung. Title 29 CFR 1910.27(c)(4) requires at least a minimum clearance of 7 inches in back of a fixed ladder. Also, the overhead obstructions (steam line and other piping) at the top of the ladder and a protruding valve adjacent to the fifth rung created an unsafe condition.

In combination with the ladder obstructions, the level of PPE that AW-1 was wearing may have contributed to the accident. The PAPR, body harness, multiple layers of gloves, and shoe scuffs possibly contributed to the fall due to decreased mobility and visibility. The asbestos abatement activity for the SCN work involved the use of a full-face PAPR for glovebag operations in an outdoor setting. The use of a PAPR was a standard practice for the project, based, in part, on input from the asbestos workers. However, a half-face, negative pressure respirator would have been adequate to protect the worker from the expected inhalation hazard from the glovebag operation. This was substantiated by a review of historical personal (breathing zone) sampling results for this activity. The use of the PAPR while working from the JLG lift did



Exhibit 3-1. Construction Barrier

not create an additional hazard to the employee.

However, when the work changed and the employee accessed the platform via the ladder, the PAPR increased the risk to AW-1 due to limited visibility when considered in light of the numerous obstacles and general noncompliant condition of the ladder. It was possible that the PAPR obstructed AW-1's view and contributed to the accident. Use of a half-face, negative pressure respirator would not have obstructed the worker's view as much as the PAPR. Appropriate review and assessment of hazards associated with the change in working conditions might have identified this increased risk, and the

substitution of respirator type could have been made without compromising the respiratory protection requirements. This was especially relevant because asbestos was the only potential inhalation concern.

The Board determined that alternate methods of accessing the platform had not been considered. FIU, AEA, and DRS personnel stated to the Board during interviews that the JLG lift could not be used as a manlift for an employee to climb over the JLG lift's railing to access another work platform. This prohibition was also stated by the BJC Safety Advocate. It was their understanding this was

in accordance with OSHA regulations [i.e., 29 CFR 1910.67(c)(2)(iii) and (iv)].

However, on work involving the use of aerial lifts, the site AHA stated, "Personnel shall remain in the platform at all times and shall not use the platform to access another location without the written approval of the Safety & Health Department."

The specific OSHA regulations cited above read as follows:

- Title 29 CFR 1910.67(c)(2)(iii) states, "Belting off to an adjacent pole, structure, or equipment while working from an aerial lift shall not be permitted."
- Title 29 CFR 1910.67(c)(2)(iv) states, "Employees shall always stand firmly on the floor of the basket, and shall not sit or climb on the edge of the basket or use planks, ladders, or other devices for a work platform."

It was the Board's determination that the above-referenced OSHA standards do not prohibit the practice of using a JLG lift as a manlift to place an employee on a work platform, nor are there any other OSHA regulations that specifically address the practice. In discussions with the DOE Headquarters Construction Safety Program Manager, it was determined that use of a JLG lift to place an employee on a work platform is acceptable under OSHA as long as adequate precautions are taken to address fall protection and other possible hazards.

There was also a possibility that the overnight low temperatures (28°F) and the high relative humidity (96%) followed by daytime warming could have contributed to some moisture on the ladder. See the meteorological data in Appendix B. The Board could not determine

if this was a contributing factor of the accident.

3.2.2 Hazard Identification and Work Control Documents

The SCN (23900-SC-OR027F, Change Notice 0001) was effective on November 2, 2000, and it added approximately 25 feet of steam line abatement and removal to the base scope in the subcontract. The Board evaluated how this change was addressed by FIU to assess whether the changed conditions were adequately incorporated into the affected work control documents. The Board concluded that FIU did not have a formalized description of how the different work control documents (i.e., AHA, EWP, AWP, and RWP) are intended to work together or complement each other. This resulted in inconsistent work practices, PPE that was potentially more stringent than the work required, misunderstanding as to the acceptable process when changes in work methodology occur, confusion with interfacing DRS procedures with FIU documents, and incomplete hazard identification and control. These items are discussed in greater detail in the sections below.

3.2.2.1 Activity Hazard Analysis

The AHA was intended to address all tasks/activities, hazards, and associated controls that could be encountered during work on the MRF D&D Project. Employees received a briefing on the site AHA and signed it to indicate their understanding of the hazards. The following concerns were identified with the AHA:

- Under AHA hazard 24 for "asbestos abatement," it was noted there were no hazards/controls listed for the asbestos worker, while hazards/controls for other

employees who might enter an asbestos-regulated area were covered. During interviews, it was reported to the Board that the asbestos worker determined (skill of the craft) the specific controls necessary for the hazard involved.

- FIU did not have a formal process that addressed developing and applying the AHA (other than the BJC instruction guidelines contained in Appendix G-5 of the subcontract).

3.2.2.2 Enhanced Work Plan

Project work was implemented and controlled using an ISM EWP process. The EWP process involved workers, supervisors, and subject matter experts to implement the five core functions of ISM. Using the project's general AHA as a guide, the EWP team defined the scope of work, identified tasks and job steps, identified any new/unique hazards associated with each specific task, and documented those hazards in the EWP.

The Board concluded that:

- For the EWPs reviewed, the identification and control of hazards remained at the generic level listed in the AHA. Specifically, particular tasks/working conditions associated with asbestos abatement outside of Building 3505 were not addressed in sufficient detail by the original EWP used to identify and control the hazards.
- The EWP referenced HCET-2000-D063-004-26, *Asbestos Work Plan*, as an essential document for the work. However, neither the EWP nor the AWP identified the PPE requirements for the job, but rather they allowed employees to select the level of PPE to use. "Skill of the

craft" was necessary in accomplishing the work, but hazard identification and control should be at the management level (in conjunction with the workers).

- When the method of accomplishing the asbestos abatement changed, employees did not recognize the need to re-evaluate or modify the existing EWP. The implementing safety documents did not address how changes in the methodology for completing a particular task affect the work control documents (i.e., the EWP and AHA). There was no formal change control process in place to ensure that changes were evaluated and work control processes were updated. Failure to include the new steps in the EWP resulted in inadequate evaluation and control of the new hazards.

3.2.2.3 Asbestos Work Plan

The FIU/AEA AWP (HCET-2000-D063-004-26) was intended to provide direction for the protection of personnel engaged in asbestos abatement. The AWP provided the approach for implementing asbestos and man-made mineral fiber abatement activities associated with the floor tiles and thermal systems insulation in Building 3505. The AWP stated, "All asbestos abatement shall be performed in accordance with DRS procedure MCP-HS-24, *Asbestos Abatement*." The Board reviewed the AWP requirements for performing asbestos work and determined the following:

- The inclusion of the DRS procedure into the FIU AWP created confusion because the DRS procedure stated, "The respiratory protection intended for use on each operation of the asbestos abatement project shall be identified on the respective safe work permit (SWP)." FIU did not use a SWP system but rather the EWP. There

was also no documentation available to describe how FIU intended to handle the differences between the two processes.

- Delineated responsibilities in the DRS procedure did not align with FIU job title responsibilities. The procedure listed specific safety oversight responsibilities for the Health and Safety Manager. However, safety oversight on the MRF D&D Project was being performed by the FIU SESHHR.
- DRS initially stated that no DRS procedures were being used for the MRF D&D Project and all work was being done under FIU's processes or plans. However, DRS management personnel later indicated that the DRS procedure was applicable. It was not clear to the Board whether the DRS procedure was intended to cover the specific work on the MRF D&D Project or to be used in concert with FIU's processes or plans.
- The AWP did not adequately specify the PPE requirements for asbestos abatement work. The AWP required respiratory protective equipment (but did not specify the type), disposable coveralls (but did not specify with a hood), disposable gloves (but did not specify type or number of layers), work gloves, and safety shoes. The level of PPE exceeded the minimum required for asbestos abatement in a nonradiological area and may have contributed to the worker's fall.

The minimum PPE requirements for asbestos workers per OSHA 29 CFR 1926.1101 are (a) a half-face, negative pressure respirator for concentrations not greater than 1.0 f/cc, (b) full body covering (i.e., tyvek suit with hood); (c) one layer of nitrile or latex gloves; and (d) over-booties or shoe scuffs.

The Board concluded that requirements and work control processes for asbestos abatement were not consistently defined in the AWP, EWPs, and referenced DRS procedures.

3.2.2.4 Radiation Work Permit

RWP BJC-ORNL-6731 was issued as a general site RWP for all radiological work on the MRF D&D Project. Based on interviews with employees and a review of project documents, the Board observed the following problems with the use and application of the RWP:

- There was inconsistent understanding by employees on the proper use and application of the RWP for work on the MRF D&D Project. The asbestos workers and the foreman interviewed understood that the RWP applied to the exterior abatement and removal work. However, the RCTs interviewed indicated that the work the asbestos workers were performing on November 15 was not radiological work and did not fall under the RWP; therefore, the workers should not have signed in on the RWP log sheet. The majority of the work on the project was being done under the RWP, but most of that work was inside Building 3505. The sign-in sheet for the RWP on November 15 indicated that AW-1 and AW-2 were signed in for work inside Building 3505 rather than outside the building. Interviews with workers confirmed that they had a clear understanding of the need to sign in under the site's RWP for interior work. The inconsistencies arose when the work being performed was outside of Building 3505.
- The PPE worn by the asbestos workers was more than that specified in the RWP under which they had signed in. Signing in

under the RWP called for a level of PPE that would not be required for work outside a radiological area and was the basis for why AW-1 had on the inner cotton gloves and two latex pairs of gloves, as well as the outer shoe scuffs. The RWP was the sole document provided to the Board that required a full-face respirator (but not specifically the PAPR). Interviews with the DRS Foreman indicated that the PAPR was the respirator of choice for the workers, and that it was the only kind worn on site.

- The injured worker was improperly signed out on the RWP log sheet. The RWP sign-in sheet for November 15 contained a sign-out entry by AW-1's name, even though the employee could not have signed the log, since he was en route to the hospital via Life Star. Whoever signed out AW-1 failed to initial or otherwise indicate that a different person was performing the sign-out.

3.2.3 UT-Battelle Ladder Safety Program

The UT-Battelle Ladder Safety Program (ORNL-SH-P37, *ORNL Ladder Safety Program*) requires that fixed ladders be inspected every five years. The only recorded inspection of Fixed Ladder IE 70144 was dated February 6, 1997, and it is not due for re-inspection until February 2002. The Board determined the following:

- The February 6, 1997, inspection record stated that the ladder was tagged as "rejected" due to safety obstructions and excessive rust and corrosion. Title 29 CFR 1910.27(f) requires "all ladders be maintained in a safe condition. All ladders shall be inspected regularly, with the intervals between inspections being determined by use and exposure."

- Lockheed Martin Energy Research Corporation (predecessor to UT-Battelle) issued a memorandum on August 20, 1998, that shifted responsibility for funding fixed ladder inspections and other equipment from overhead to the Facility Managers. Facility Managers became responsible for requesting and funding inspections. Since Fixed Ladder IE 70144 was not due for reinspection until February 2002 (based on ORNL procedure), this change in inspection policy did not affect the accident.

- The ORNL Safety Improvement Team repaired Fixed Ladder IE 70144 at the top anchor point and affixed a chain to the guardrail on November 25, 1998. It was not known how workers made the repairs, if the "Rejected" tag was still on the ladder, or if the "Rejected" tag was subsequently removed. (NOTE: Obstructions, corrosion, and rust were not addressed during this ladder repair.)

- On November 15, 2000, the day of the accident, the "Rejected" tag was not in place on Fixed Ladder IE 70144. It could not be determined by the Board how this tag disappeared (removed by an unknown individual or deteriorated due to weather). A small plastic piece of material was still attached to one of the ladder rungs.

- On November 17, UT-Battelle re-tagged the ladder as "rejected."

On November 28, 2000, the ORO ORNL Site Office requested UT-Battelle to perform a self-assessment of its Fixed Ladder Program. As a result of this review, UT-Battelle has:

- (a) Re-inspected all 42 "rejected" fixed ladders (as listed in the Quality & Inspection database) under its control on

site and at the Y-12 National Security Complex.

- (b) Identified all fixed ladders associated with facilities under BJC's control on December 4, 2000.
- (c) Reviewed (by safety and health staff) all "rejected" fixed ladders to determine if they were unsafe or unsuitable for use and affixed permanent, metal "Danger - Defective Ladder - Do Not Use" tags as appropriate. Eleven of the 42 ladders were determined to be unsafe or unsuitable, including Fixed Ladder IE 70144.

3.2.4 Safety Communications

The Plan of the Day Meetings held each morning covered a safety topic and then a general discussion on work assignments. The level of work discussion reported during interviews was an identification of tasks by worker and the type of work to be done that day. Nothing specific as to method of accomplishment was reported as being discussed in this meeting, since it was intended that "skill of the craft" be adequate to ensure safe, quality work. This meeting was not formalized as to minutes, although employees signed in as having attended the safety topic discussion. No one interviewed indicated that any concerns were ever expressed regarding the asbestos abatement work in progress on November 14 and 15. All employees and management interviewed indicated that employees were encouraged to provide feedback and freely discuss issues or concerns anytime.

In addition to the Plan of the Day Meetings, pre-job briefings were held to discuss specific tasks associated with the appropriate EWP or RWP. The information discussed in these

briefings was documented in the AEA Site Superintendent's logbook. Employees signed and dated the EWP for the portion of the EWP that directly affected their work activities for that period. The last sign-in by AW-1 on any portion of EWP-00-003 (which governed the asbestos abatement work on November 15) was October 30, 2000, and AW-2's last sign-in was October 9, 2000.

At the end of each day, Plan of Tomorrow Meetings were held where work for the next day was planned. Interviews with the DRS Foreman revealed that in this meeting on the afternoon of November 14, no discussions were held regarding the change in methodology (i.e., the JLG lift versus use of the ladder and platform) that occurred that afternoon. This would have been the appropriate time to discuss the change in work that had occurred.

3.2.5 Emergency Response/Medical

Emergency response by the UT-Battelle Fire Department and Medical Department was excellent. The seriousness of the injuries sustained by the employee was quickly determined, and the University of Tennessee Memorial Hospital Life Star helicopter was immediately requested.

However, BJC failed to properly preserve the accident scene—namely, (a) AW-1's entire PPE was not collected and held for the Board's inspection, (b) the scene was not preserved (asbestos flagging and signage had been removed for emergency access), and (c) access to the scene was not controlled. The PPE that was made available to the Board as evidence was AW-1's respirator, hard hat, and body harness. If the tyvek suit had been preserved, it might have revealed how the employee turned during the fall.

The Board concluded that there was no indication that the employee's medical condition contributed to the accident.

3.2.6 Lessons Learned Program

For the MRF D&D Project, lessons learned packages were routinely distributed by electronic mail from the BJC STR to the FIU Project Manager for evaluation. In addition, the subcontractor has access to the BJC Lessons Learned website. Individual lessons learned that are judged by the STR and/or the Safety Advocate to be potentially applicable to the MRF D&D Project were addressed directly with the FIU staff to assure proper consideration. An example of the latter involved Lessons Learned A-2000-OR-BJCETTP-1005, *Power Tool Manufacturers Announce Recall of Various Power Tools*, dated October 24, 2000, which addressed a Consumer Product Safety Commission recall of power tools, including bandsaws. This lessons learned was reviewed with FIU to assure that the portable bandsaws being used on the MRF D&D Project were not among those being recalled. In response to this lessons learned, the subcontractor identified two portable bandsaws that were part of the recall notice and removed them from service. A lessons learned on inspecting respirators prior to use was recently discussed in one of the FIU morning safety meetings.

3.3 Safety and Health Oversight

ORO EM's ISM policy of June 8, 1999, establishes line management's responsibility for safe operations. ORO EM procedures outline line management's roles and responsibilities for conducting and documenting oversight activities.

A portion of these activities is provided through the ORO Facility Representative

Program. A sample of this support included review of an Occurrence Report initiated on the first day of activities on the MRF D&D Project that involved the Facility Representative's concerns with a JLG lift activity. Only two months had elapsed since project initiation, so no formal reviews had been conducted by ORO.

BJC-PQ-01, *Subcontractor Oversight*, establishes requirements and processes for planning and documenting oversight of subcontractor activities. Attachment B of the procedure identifies the frequency for each type of assessment and designates the expected participant(s) (i.e., Manager of Projects, Safety Advocate, etc.). To date the following have occurred:

- BJC's Management Assessment of FIU's work controls and ISMS, October 28-31, 2000. This review rated the program as outstanding.
- Weekly inspections of work areas under the subcontractor's control.

Based on the information reviewed during this investigation, the Board determined that BJC has complied with procedural requirements associated with Management Assessments; however, weekly inspections have not been consistently performed.

Exhibit G, Subsection 1.6.3, requires the SESH to conduct daily, documented ES&H inspections and weekly joint inspections with BJC's Safety Advocate. Based on the documents reviewed, the Board concluded the following:

- Weekly inspections were not consistently performed.

- Daily inspections were not documented in the SESHR's logbook.

3.4 Analysis Techniques

During the early phase of the investigation, the Board identified potential factors that could have contributed to or caused the injured worker to slip and fall off of the ladder. These potential contributing causes included the condition of the ladder, the appropriateness of the PPE, and the weather conditions on the day of the accident.

3.4.1 Integrated Safety Management System

Management systems were examined as potential contributing and root causes of the accident. The Board reviewed the roles of ORO, BJC, and FIU management in promoting and implementing ISM in this project. The Board also reviewed line management's role at the ORO Office of EM and included FIU's role in preparing for and approving the work activities of this project, readiness reviews, lessons learned, communication of hazards, and project oversight. In addition, the Board reviewed UT-Battelle's role at ORNL for oversight and implementation of its ISMS for ladder safety.

The ISMS provides a formal, organized process for planning, performing, assessing, and improving the safe conduct of work. Properly implemented, ISM is a systems-based approach to safety, requiring rigor and formality in the identification, analysis, and control of hazards. The system establishes a hierarchy of components to facilitate the orderly development and implementation of safety management throughout the DOE complex. The guiding principles and core functions of ISM are the primary focus for contractors in conducting work efficiently and

in a manner that ensures the protection of workers, the public, and the environment. The Accident Investigation Program requires that accidents be evaluated in terms of ISM to foster continued improvement in safety and to prevent more accidents.

BJC's ISMS program at ORO EM ORNL D&D projects has been contractually required since BJC became the M&I contractor for ORO's EM Program on April 1, 1998. BJC has an approved ISMS description and passed its combined Phase I and Phase II ISMS verification earlier this year. The overall process for implementation of the ISM Program at the MRF D&D Project appeared to be reasonably complete and well understood. However, the accident investigation highlighted weaknesses in work planning and controls. Table 3-1 summarizes the weaknesses identified in the application of the five core functions of ISM.

3.4.2 Barrier Analysis

Barrier analysis is based on the premise that hazards are associated with all accidents. Barriers are developed into a system or work process to protect personnel and equipment from hazards. For an accident to occur, there must be a hazard that comes into contact with a target because the barriers and controls were not in place, not used, or failed. A hazard is the potential for an unwanted energy flow to result in an accident or other adverse consequence. A target is a person or object that a hazard may damage, injure, or fatally harm. A barrier is any means used to control, prevent, or impede the hazard from reaching the target, thereby reducing the severity of the resulting accident or adverse consequence. The results of the barrier analysis are used to support the development of causal factors. Table 3-2 contains the barriers that failed to perform as intended.

3.4.3 Change Analysis

Change is anything that disturbs the “balance” of a system which is operating as planned. Change is often the source of deviations in system operations. Change can be planned, anticipated, and desired, or it can be unintentional and unwanted. Change analysis examines planned or unplanned changes that caused undesired results or outcomes related to the accident. This process analyzes the difference between what is normal (or “ideal”) and what actually occurred. The results of the change analysis are used to support development of causal factors. The change analysis is presented in Table 3-3.

3.4.4 Events and Causal Factors Analysis

A causal factors analysis was performed in accordance with the DOE Workbook, *Conducting Accident Investigations*, Revision 2. Events and causal factors analysis requires deductive reasoning to determine which events and/or conditions contributed to the accident. Causal factors are the events or conditions that produced or contributed to the occurrence of the accident and consist of direct, contributing, and root causes. A summary of the Board’s events and causal factors chart is presented in Figure 3-1. The direct, contributing, and root causes are presented in Table 3-4.

Table 3-1. Weaknesses in Implementation of the ISM Core Functions

<p>Weaknesses in the implementation of the five core functions of ISM include:</p>
<p><u>Core Function 1</u> Define the Work</p> <ul style="list-style-type: none"> • UT-Battelle and BJC did not ensure that the scope and responsibility for management of fixed ladder safety at the site were clearly and unambiguously defined. • The EWP did not define the “Basic Job Steps” to be performed in sufficient detail and did not address fixed ladder hazards. • When field activities deviated from expected conditions, FIU and DRS did not perform an adequate review of the change in methodology for the new work activities and properly incorporate them into project documentation and work planning sessions.
<p><u>Core Function 2</u> Analyze the Hazards</p> <ul style="list-style-type: none"> • UT-Battelle’s Ladder Safety Program was ineffective in assuring that defective ladders were controlled to prevent use (i.e., the “Rejected” tag was missing, resulting in use of a defective ladder). • FIU failed to ensure that an adequate management system was in place to ensure that specific hazards were addressed. The EWPs routinely referenced the generic AHA for hazard identification, but they did not adequately address task-specific hazards. • The hazards associated with use of the ladder and platform to abate and remove the exterior steam line were not identified. • The hazards associated with accessing the platform via the fixed ladder while wearing PPE were not adequately analyzed.
<p><u>Core Function 3</u> Develop and Implement Controls</p> <ul style="list-style-type: none"> • Roles and responsibilities for ownership and oversight of fixed ladder safety were not clearly developed and implemented between UT-Battelle and BJC. • Workers signed in under the RWP to perform asbestos abatement in a nonradiological area. • FIU’s decision not to revise the EWP resulted in the hazards associated with accessing the platform via the fixed ladder (including use of PPE) not being adequately analyzed. • The FIU work control process included identification of generic hazards from the AHA, but it did not clearly identify the specific hazard controls applicable to individual job steps in the EWP. • Requirements and work control processes for asbestos abatement were not consistently defined in the AWP, EWPs, and referenced DRS procedures.
<p><u>Core Function 4</u> Perform Work Safely</p> <ul style="list-style-type: none"> • When field activities deviated from expected conditions, FIU did not appropriately determine that use of the ladder represented a new hazard and accordingly incorporate it into project documentation. • The FIU and DRS standard practice of donning full PPE for MRF D&D work resulted in the asbestos worker wearing PPE exceeding the minimum requirements for the particular job being performed. The hazards associated with accessing the platform via the fixed ladder while wearing PPE were not adequately analyzed.
<p><u>Core Function 5</u> Feedback and Improvement</p> <ul style="list-style-type: none"> • There was at least one missed opportunity in the Plan of Tomorrow Meeting on November 14, 2000, for the change in work scope regarding the use of the ladder to be addressed. • Changing field conditions were not fed back into the hazard analysis phase to improve safety of operations.

Table 3-2. Barrier Analysis

Hazard: Falling from fixed ladder	Target: Worker	
What were the barriers?	Why did the barrier fail?	How did each barrier failure affect the accident?
UT-Battelle Ladder Safety Program	The controls used on the defective ladder were not sufficient to prevent use. The "Reject" tag was missing.	Allowed worker to use ladder.
Hazard Identification	<p>The authorization to perform work from the platform did not include an adequate evaluation of the ladder prior to use.</p> <p>The hazards associated with using the ladder while wearing PPE were not adequately evaluated.</p>	<p>Allowed defective ladder to be used.</p> <p>The PPE contributed to the reduction in mobility and visibility of the worker using the ladder.</p>
Work Control	The ES&H Plan did not adequately describe a process for ensuring that changes in scope and/or methodology (changed condition) were evaluated for additional hazards, reflected in work control documents, and addressed with the involved workers.	A change in the work scope did not result in adequate evaluation of the new hazards and development of appropriate controls.

Table 3-3. Change Analysis

Normal ("Ideal")	Actual	Analysis
The "Reject" tag hung in 1997 remains intact, warning workers not to use the ladder.	The "Reject" tag hung in 1997 was missing.	There was no warning concerning ladder use, and the defective ladder was used.
The foreman and SESHHR identify the ladder hazard and do not allow workers to use it.	The foreman and SESHHR did not identify the ladder hazard.	The defective ladder was used, and the worker was exposed to an unsafe condition.
The EWP is revised to accommodate the new methodology (i.e., using the ladder).	The EWP was not revised to include appropriate controls for the new hazard.	The new methodology (i.e., using the ladder) was not adequately evaluated. The new hazard was not identified, and the ladder was used.

This page intentionally left blank.

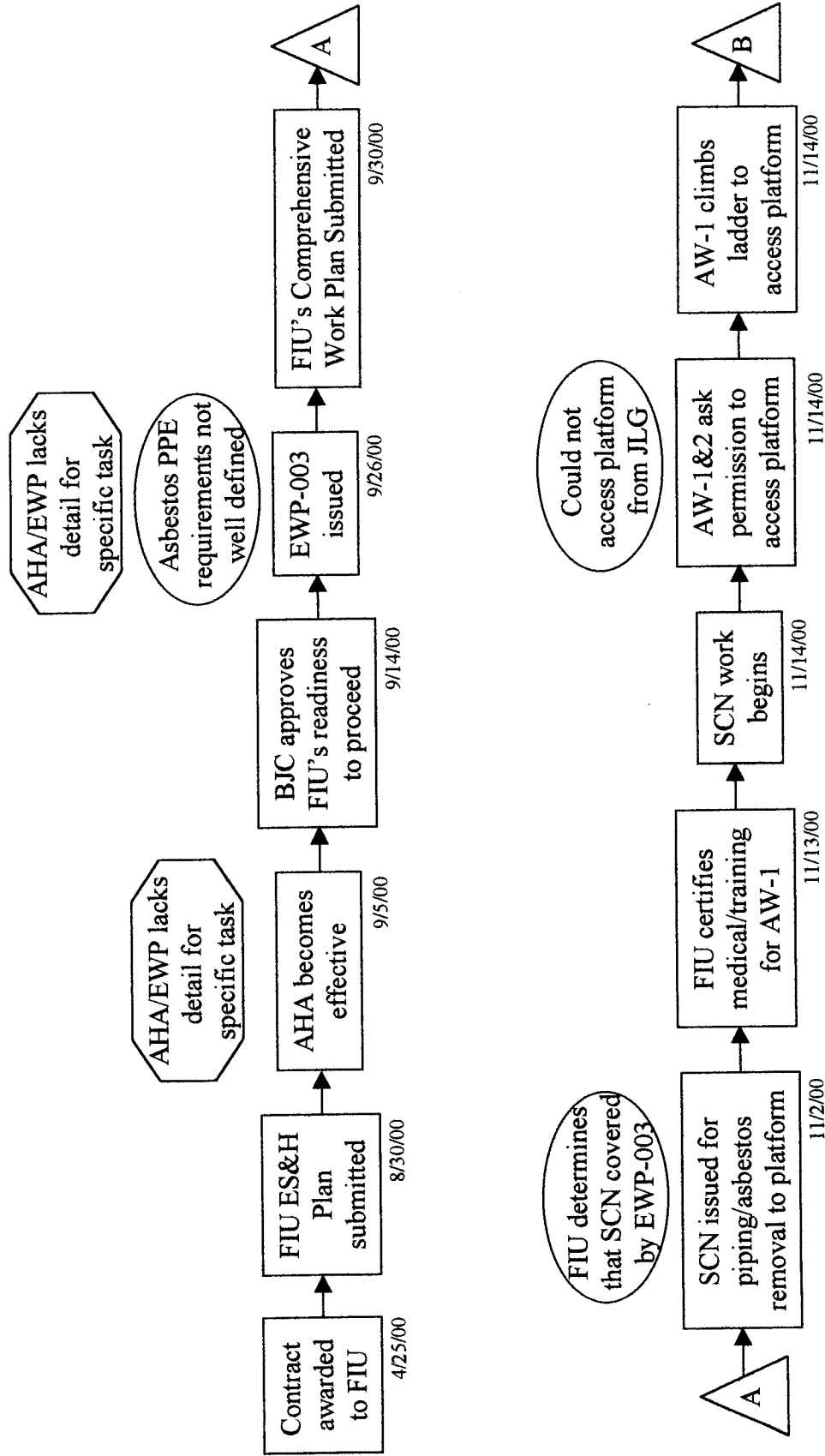
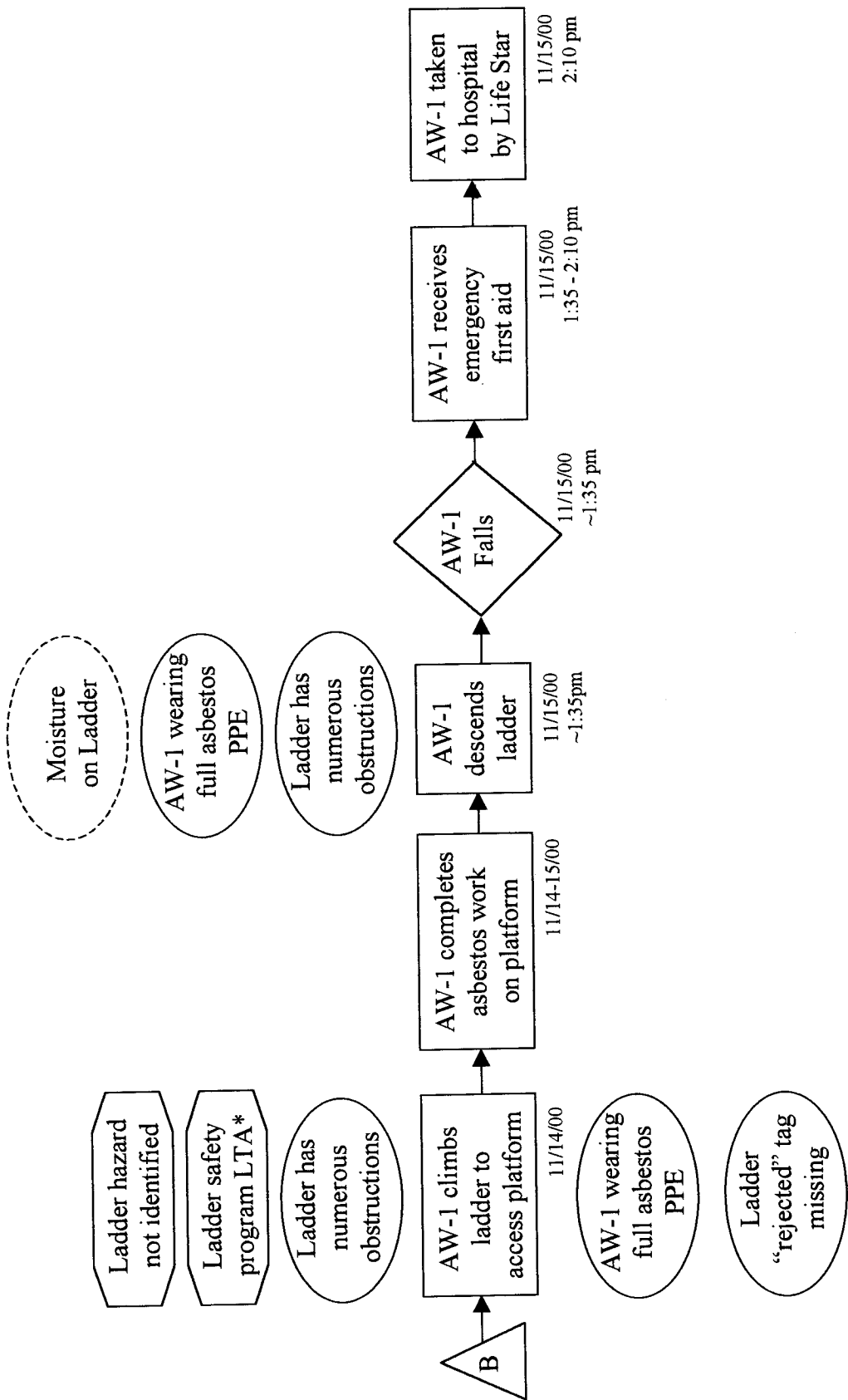


Figure 3-1. Events and Causal Factors Chart (sheet 1 of 2)



*LTA - Less than adequate

Figure 3-1. Events and Causal Factors Chart (sheet 2 of 2)

Table 3-4. Causal Factors

Direct Cause: The worker's foot slipped off the ladder rung, causing him to fall.	
Root Causes	Discussion
<p>FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.</p>	<p>When the asbestos workers determined that all work could not be completed from the JLG lift, they appropriately suspended work and raised the question of using the fixed ladder/platform to the job foreman, who then raised the question to the SESHR. The SESHR's determination that the ladder was safe to use was not appropriate.</p> <p>FIU's review of the ladder hazards introduced by the added scope of work associated with the SCN and the change in methodology for completing the work did not identify the hazards.</p> <p>Alternative methods for safely accomplishing the work were not considered.</p> <p>The FIU and DRS standard practice of donning full PPE for MRF D&D work resulted in the asbestos worker wearing PPE exceeding the minimum requirements for the particular job being performed. The hazards associated with accessing the platform via the fixed ladder while wearing PPE were not adequately analyzed.</p>
<p>UT-Battelle failed to take appropriate actions to prevent use of the defective ladder.</p>	<p>UT-Battelle did not assure that appropriate signage on the defective ladder was maintained, that repairs were completed, or that use was otherwise prevented.</p>
Contributing Causes	Discussion
<p>UT-Battelle's and BJC's roles and responsibilities for fixed ladder safety were not clearly developed and implemented.</p>	<p>UT-Battelle did not assure that appropriate signage on the defective ladder was maintained, that repairs were completed, or that use was otherwise prevented.</p>
<p>FIU's management systems lacked change control provisions.</p>	<p>A formal change control process was not incorporated into work planning documents.</p> <p>When field activities deviated from expected conditions, changes were not incorporated into project documentation.</p>
<p>FIU failed to ensure that the AWP appropriately defined the work requirements and responsibilities.</p>	<p>The FIU AWP adopted the DRS asbestos abatement procedure (MC-HS-24) but did not resolve conflicting job titles and work control terminology.</p> <p>It was not clear if the DRS procedures were intended to cover the specific work or to be used in concert with FIU's processes or plans.</p> <p>The AWP does not adequately specify PPE requirements for asbestos abatement work.</p>
<p>FIU's management system documents have inconsistencies and conflicting requirements and are not adequately integrated for effective work control.</p>	<p>Deficiencies were identified with the EWP and AWP processes and their integration with the DRS procedures.</p> <p>There was inconsistent understanding on the proper use and application of RWPs.</p> <p>Signing in under the RWP for nonradiological work created requirements for PPE beyond the minimum requirements for asbestos work.</p>

This page intentionally left blank.

4.0 Judgments of Need

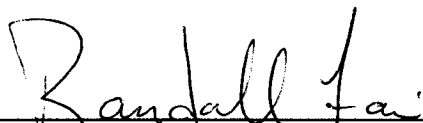
Judgments of need are the managerial controls and safety measures determined by the Board to be necessary to prevent and/or minimize the probability or severity of a recurrence. They flow from the causal factors, which are derived from the facts and analysis. Judgments of Need are directed as providing guidance for managers during the development of corrective actions.

Table 4-1. Judgments of Need

No.	Judgments of Need	Related Causal Factor
JON 1	UT-Battelle and BJC need to ensure that the scope and responsibility for management of common use equipment, including fixed ladders, is clearly defined.	<p>UT-Battelle failed to take appropriate actions to prevent use of the defective ladder.</p> <p>UT-Battelle's and BJC's roles and responsibilities for fixed ladder safety were not clearly developed and implemented.</p>
JON 2	UT-Battelle and BJC need to ensure that all fixed ladders under their purview are safe for use or that appropriate measures are taken to ensure prospective users understand the hazards associated with their use.	<p>UT-Battelle failed to take appropriate actions to prevent use of the defective ladder.</p> <p>FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.</p>
JON 3	BJC needs to ensure that all activities to be performed are adequately reviewed to identify potential hazards.	FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.
JON 4	BJC needs to ensure that the work control process integrates all controls for performing work (i.e., EWP, AHA, etc.) in a manner that identifies specific controls for identified hazards and provides for re-evaluation should a change in work scope or methodology be encountered.	<p>FIU's management systems lacked change control provisions.</p> <p>FIU failed to identify and analyze the hazards associated with the defective ladder and the level of PPE being worn while climbing the ladder.</p>
JON 5	BJC needs to ensure that work control documents appropriately define the work and do not contain conflicting requirements or inconsistencies.	<p>FIU failed to ensure that the AWP appropriately defined the work requirements and responsibilities.</p> <p>FIU's management system documents have inconsistencies and conflicting requirements and are not adequately integrated for effective work control.</p>

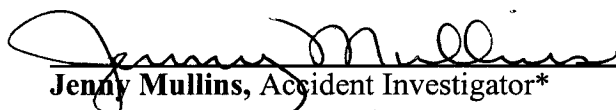
This page intentionally left blank.

5.0 BOARD SIGNATURES



Randall Fair, Chairperson*
DOE Accident Investigation Board
Acting Deputy Site Manager for Program Coordination
Oak Ridge Operations Office

Date: 12/20/00



Jenny Mullins, Accident Investigator*
DOE Accident Investigation Board
Technical Support Division
Oak Ridge Operations Office

Date: 12/20/00



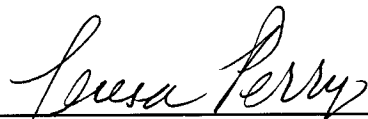
Katatra Day, Member*
DOE Accident Investigation Board
Technical Support Division
Oak Ridge Operations Office

Date: 12/20/00



Brian DeMonia, Member
DOE Accident Investigation Board
ORR Remediation Management Group
Oak Ridge Operations Office

Date: 12/20/00



Teresa Perry, Member*
DOE Accident Investigation Board
Assessment and Emergency Management Division
Oak Ridge Operations Office

Date: 12/20/00

* Trained Accident Investigator

This page intentionally left blank.

6.0 BOARD MEMBERS, ADVISORS, AND STAFF

Chairperson	Randall Fair, DOE ORO
Member	Katatra Day, DOE ORO
Member	Brian DeMonia, DOE ORO
Member	Jenny Mullins, DOE ORO
Member	Teresa Perry, DOE ORO
Technical Editor/Administrative Support	Karen Brown Informatics Corporation
DOE Advisors	Jeff Burgin, Contract Specialist Larry Jones, Industrial Hygienist Ray Miskelley, Legal
Observer	John Lyons, Bechtel Jacobs Company LLC Work Force Transition and Systems Integration, Manager

This page intentionally left blank.

**Appendix A: Type B Investigation Board Appointment
Memorandum**

This page intentionally left blank.

United States Government

Department of Energy

Oak Ridge Operations Office

memorandum

DATE: November 21, 2000

REPLY TO

ATTN OF: SE-32:Mullins

SUBJECT: **TYPE B INVESTIGATION - SUBCONTRACTOR EMPLOYEE FALL INJURIES -
BECHTEL JACOBS COMPANY, LLC, OAK RIDGE, TENNESSEE**

TO: Randall Fair, Acting Deputy Site Manager for Program Coordination, ORNL Site Office, LM-10

You are hereby appointed Chairman of the Investigation Board to investigate the November 15, 2000, fall injuries to an employee of Decon and Recovery Services (DRS), lower tier subcontractor to Bechtel Jacobs Company, LLC, at the Oak Ridge National Laboratory. I have determined that, based on preliminary findings, a Type B Accident Investigation as described in DOE Order 225.1A, "Accident Investigations," is warranted.

You are to perform a Type B investigation of this incident and to prepare an investigation report. The report shall conform to requirements detailed in DOE Order 225.1A and DOE G 225.1A-1, "Implementation Guide for Use with DOE 225.1A, Accident Investigations." The Board will be comprised of the following members:

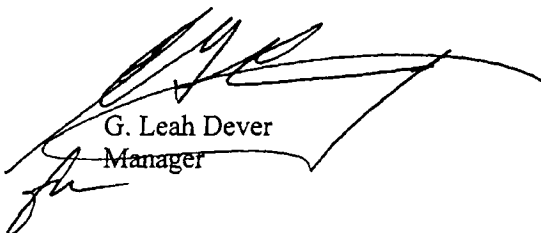
Jenny Mullins, Technical Support Division, Accident Investigator
Teresa Perry, Assessment and Emergency Management Division, Team Member
Katatra Day, Technical Support Division, Team Member
Brian DeMonia, ORR Remediation Management Group, Team Member

The scope of the Board's investigation is to include, but is not limited to, identifying all relevant facts; analyzing the facts to determine the direct, contributing, and root causes of the incident; developing conclusions; and determining judgments of need that, when implemented, should prevent the recurrence of the incident. The Board will focus on and specifically address the role of DOE and contractor organizations and Integrated Safety Management Systems, including oversight of subcontractors, as they may have contributed to the overall accident. The scope will also include an analysis of the application of lessons learned from similar accidents within the Department.

If additional resources are required to assist you in completing this task, please let me know and it will be provided. A representative from General Counsel will be appointed to serve as the Board's legal liaison. You and members of the Board are relieved of your other duties until this assignment is completed.

The Board will provide my office with weekly reports on the status of the investigation but will not include any findings or arrive at any premature conclusions until an analysis of all the causal factors have been completed. Draft copies of the factual portion of the investigation report will be submitted to my office and the contractor for factual accuracy review prior to the report finalization.

The final investigation report should be provided to me by December 22, 2000. Any delay to this date shall be justified and forwarded to this office. 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 Robert Poe at 576-0891.



G. Leah Dever
Manager

cc:

D. Michaels, EH-1, 7A-097, HQ/FORS
C. Huntoon, EM-1, 5A-014, HQ/FORS
R. Berube, EH-4, 7A-075, HQ/FORS
T. Rollo, EH-21, HQ/270CC
M. Johnson, SC-3, 7B-084, HQ/FORS
E. Cumesty, M-2, ORO
R. Folker, M-2, ORO
S. Wyatt, M-4, ORO
R. W. Poe, SE-30, ORO
H. Monroe, SE-32, ORO
J. Cravens, SE-34, ORO
R. Nelson, EM-90, ORO
J. O. Moore, EM-93, ORO
G. Malosh, LM-10, ORO
N. Carnes, CC-10, ORO
J. Fowler, CC-10, ORO

Appendix B: Meteorological Data

This page intentionally left blank.

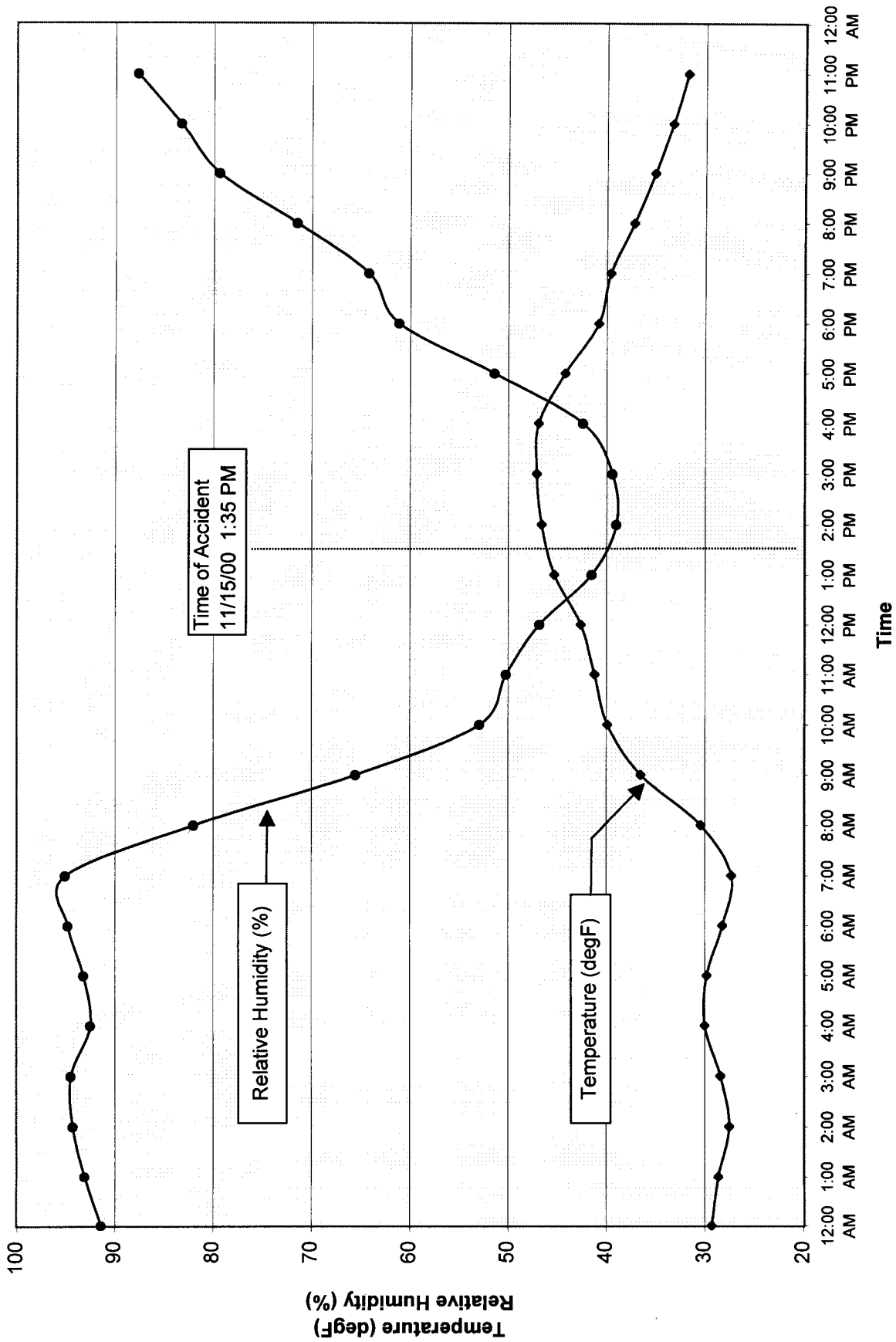


Figure B-1. Meteorological Data on 11/15/00 at 10 Meters - ORNL Met Tower 2

This page intentionally left blank.

Appendix C: Ladder Inspection Record

This page intentionally left blank.

INSPECTION ADD FORM
EITS DATABASE

IR NUMBER 13512 IE NUMBER 70144

SCHEDULE VISUAL/AUG

DATE OF NEXT SCHEDULE 08/01/2002 FREQUENCY 5 YRS

NEXT INTERNAL SCHEDULE / / FREQUENCY

DIVISION CTD CONTACT BRAD PATTON

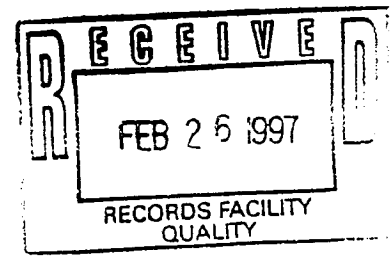
PROCEDURE TR1-DC-703 BUILDING 3542

LOCATION WEST SIDE OF BLDG - OUTSIDE

DESCRIPTION FIXED LADDERS

STATUS X DATE OF ADDITION 2/26/97

REQUESTED BY [Signature] [Stamp]
[Signature]
SSI SUPERVISOR



SUBMIT FORM TO THE QE&I DOCUMENT CENTER

1997

RECORD COPY
Margaret Whitehead

REJECTED

DATE

2/26/97

TAG NUMBER

10416

EQUIPMENT NUMBER

70144

EQUIPMENT TYPE

LADDER

REJECT REASON

Does Not Meet Specifications

EXCESSIVE CORROSION
OTHER INFORMATION (Purchase Order No., Drawing No., Requisition No., etc.)

INSPECTOR

Gene E. Stone

000

IGN-17434 (123 9 95)

RECORD COPY

Margaret Whitehead

This page intentionally left blank.