DOE/ORO-2183

Type B Accident Investigation Board Report

Subcontractor Radioactive Release During the May 14, 2004, Transportation Activities Bechtel Jacobs Company LLC Oak Ridge, Tennessee

June 2004

U.S. Department of Energy Oak Ridge Operations Office

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INDEPENDENT REPORT

This report is an independent product of the Type B Accident Investigation Board (Board) appointed by Gerald G. Boyd, Manager, Oak Ridge Operations Office, U.S. Department of Energy. The Board was appointed to perform a Type B investigation of the event and prepare an investigation report in accordance with DOE O 225.1A, *Accident Investigations,* and DOE G 225.1 A-1*, Implementation Guide for Use with DOE 225.1A, Accident Investigations*.

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

This report neither determines nor implies liability.

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RELEASE AUTHORIZATION

On May 21, 2004, I appointed a Type B Accident Investigation Board to investigate the release of radioactively contaminated liquid during transportation of Tank T-12, which occurred on May 14, 2004. The responsibilities of the Accident Investigation Board have been satisfied with respect to this investigation. The analysis and the identification of the contributing and root causes and the Judgments of Need resulting from this investigation were performed in accordance with DOE O 225.1A, *Accident Investigations*.

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

Gerald G. Boyd
Manager
Oak Ridge Operations Office

Date Accepted: 8/17/04

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

APPENDICES:

TABLES & FIGURES

List of Tables

List of Figures

ACRONYMS

AHA	Activity Hazard Analysis
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
BJC	Bechtel Jacobs Company LLC
Board	Type B Accident Investigation Board
CA	Radiological Control Area
CC	Contributing Cause
cm	Centimeters
Ci	Curies
CFR	Code of Federal Regulations
CAQ	Condition Adverse to Quality
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DOT	Department of Transportation
DFS	DURATEK Federal Services
dpm	Disintegrations Per Minute
EM	Environmental Management
EMWMF	Environmental Management Waste Management Facility
e-mail	Electronic Mail
EPA	Environmental Protection Agency
ES&H	Environment, Safety, and Health
ETTP	East Tennessee Technology Park
Hwy-95	Tennessee State Highway 95
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
JON	Judgment of Need
LLLW	Low-Level Liquid Waste
LSA	Low Specific Activity
MV	Melton Valley
NHF	New Hydrofracture Facility
NNSA	National Nuclear Security Administration
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Office
OROC	Oak Ridge Operations Center
ORPS	Occurrence Reporting and Processing System
ORR	Oak Ridge Reservation
PBI	Performance-Based Incentive

ACRONYMS (Continued)

PHP	Project Health Physicist
POD	Plan of the Day
PSS	Park Shift Superintendent
QA	Quality Assurance
RC	Root Cause
RADCON	Radiological Control
RAP	Radiological Assistance Program
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
SCO	Surface-Contaminated Object
SEC	Safety and Ecology Corporation
State	State of Tennessee
STR	Subcontractor Technical Representative
TDEC	Tennessee Department of Environment and Conservation
TEMA	Tennessee Emergency Management Agency
TSCA	Toxic Substances Control Act
UCL-95	Upper Confidence Level 95%
WAC	Waste Acceptance Criteria
WAC Attainment Plan	*Attainment Plan for Risk/Toxicity-Based WAC at the ORR, Oak Ridge, Tennessee, DOE-2001*
WI	Work Instruction
Y-12	Y-12 National Security Complex

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EXECUTIVE SUMMARY

The Incident

On Friday, May 14, 2004, at approximately 11:30 a.m., a dump truck transporting mixing tank T-12 (Tank T-12) from the New Hydrofracture Facility (NHF) Decontamination and Decommissioning (D&D) Project arrived at the Environmental Management Waste Management Facility (EMWMF). Upon arrival, an incoming radiological survey was performed. While the results of the radiological survey were being processed, the dump truck proceeded to the weigh station and the disposal cell. Radiological Control (RADCON) personnel confirmed the presence of contamination on the dump truck and stopped the dump truck prior to its entrance into the cell area. Surveys were initiated to determine the extent of the contamination.

As a result of these initial surveys, the investigation into radiological contamination was extended to the entire truck route. Radioactive contamination was found on the Melton Valley Access Road, Bethel Valley Road, Bear Creek Road, and portions of Tennessee State Highway 95. The maximum contamination levels found on the roads outside of the EMWMF was 370,000 dpm/100 cm^2 on site and 85,000 dpm/100 cm^2 off site. By the afternoon of May 16, 2004, all roads along the truck route (including a portion of Tennessee State Highway 95) had been surveyed, marked for remediation, and closed to the public until remediation could be completed. Remediation, at a cost of greater than $1 million dollars, was completed on all roads along the dump truck's route, and all roads were reopened by May 19, 2004. There were no confirmed exposures or uptakes to individuals and all vehicles surveyed that had traversed the contaminated portions of the road were clean.

After evaluating the conditions associated with this event and considering previous events, the U.S. Department of Energy (DOE) Oak Ridge Operations Office (ORO) Manager requested that a Type B Accident Investigation be conducted in accordance with DOE O 225.1A, *Accident Investigations*. The Accident Investigation Board (Board) convened on May 24, 2004, and began the investigation of this incident that involved a radioactive release, in order to determine the root causes and Judgments of Need (JONs) that are necessary for prevention of recurrence.

Background

On April 16, 2001, Bechtel Jacobs Company LLC (BJC), as prime contractor to ORO, entered into a fixed-price subcontract *(*Subcontract 23900-BA-FS-FS072F-18*)* with Safety and Ecology Corporation (SEC) D&D to decontaminate, decommission, and disposition all structures affiliated with the NHF. The D&D process of the NHF began in 2003. It was the responsibility of Hubbard Trucking, a lower subtier subcontractor to SEC D&D to provide the dump truck that would transport Tank T-12 (located at the NHF) to the EMWMF.

Conclusion

The direct cause of the incident as determined by the Board was that Tank T-12 was shipped in packaging (a dump truck) that allowed the release of radioactively contaminated liquid.

The Board reviewed the work controls associated with the NHF D&D Project's transportation, notification, and emergency response to the incident. The results of these reviews were factored into the five core functions of Integrated Safety Management (ISM). JONs were developed that considered what actions were necessary to prevent recurrence of this incident and similar incidents. The Board concluded that:

- SEC D&D's work control process was not adequate to properly prepare Tank T-12 for safe transportation.
- SEC D&D did not accurately characterize Tank T-12 for transportation.
- Neither BJC's nor the ORO Environmental Management (EM) organization's oversight was adequate to ensure that SEC D&D's work control processes were adequate or that Tank T-12 was properly characterized for transportation.
- Neither SEC D&D's Quality Assurance (QA) process nor BJC's or SEC's corporate lessons learned program was adequately utilized.

The Board determined that there were two root causes of this incident, which are as follows:

- SEC D&D had an inadequate work control process.
- SEC D&D performed inadequate characterization of Tank T-12 for transportation.

The Board also identified five contributing causes, which are detailed in Table 3-1. Based on the root causes and contributing causes, the Board identified the JONs listed in Table ES-1 below:

Table ES-1. Judgments of Need

JON #	Judgments of Need	Contributing and Root Causes/ISM Function
Conduct of Work		
JON 1	SEC D&D needs to improve its work control processes to ensure that: 1. Work Instructions (WIs) are written with adequate detail to ensure workers properly perform the tasks. Hold points that require specific knowledge or verification are included in WIs. Reliance on "skill of the craft" should be used only where appropriate, based on the risks of the task and the qualifications of the workers.	RC-1: SEC D&D had inadequate work control. RC-2: SEC D&D performed inadequate characterization of Tank T-12 for transportation. Applicable ISM Functions: Define the Work Scope, Analyze the Hazards

Table ES-1. Judgments of Need (Continued)

JON #	Judgments of Need	Contributing and Root Causes/ISM Function
Conduct of Work (continued)		
JON 1 (continued)	2. Requirements from higher-tier plans (e.g., the *Attainment Plan for Risk/Toxicity-Based WAC at the ORR, Oak Ridge, Tennessee, DOE-2001*, and the *Waste Management Plan*) are included in the WIs. 3. Supervisory oversight ensures WIs are implemented as written.	
JON 2	SEC D&D needs to accurately characterize items being transported and ensure characterization is re-evaluated when a change in condition indicates that the original characterization could be incorrect.	RC-1: SEC D&D had inadequate work control. RC-2: SEC D&D performed inadequate characterization of Tank T-12 for transportation. Direct Cause: Tank T-12 was shipped in packaging (a dump truck) that allowed the release of radioactively contaminated liquid. Applicable ISM Functions: Analyze the Hazards, Develop and Implement Hazard Controls
JON 3	**JON 3a:** SEC D&D needs to improve the process for recognizing and communicating Conditions Adverse to Quality (CAQs) and to formalize corrective actions for CAQs. **JON 3b:** BJC and SEC D&D need to improve their change control process to ensure work plan changes affecting environment, safety, health, and QA are identified, appropriately analyzed, and communicated.	RC-1: SEC D&D had inadequate work control. CC-1: SEC D&D's implementation of its QA Plan was inadequate. CC-2: BJC's oversight was inadequate. Applicable ISM Function: Perform Work within Controls

Table ES-1. Judgments of Need (Continued)

JON #	Judgments of Need	Contributing and Root Causes/ISM Function
Management Oversight		
JON 4	BJC needs to improve its day-to-day oversight of subcontractors to ensure work is performed in compliance with ISM.	CC-2: BJC's oversight was inadequate. Applicable ISM Function: Provide Feedback and Continuous Improvement
JON 5	BJC and SEC D&D need to strengthen their lessons learned programs in the area of application of lessons learned.	CC-4: BJC and SEC D&D failed to use lessons learned in a proactive manner to prevent reoccurrence of similar incidents. Applicable ISM Function: Provide Feedback and Continuous Improvement
JON 6	ORO and its prime contractors on the Oak Ridge Reservation (ORR) need to modify emergency plans or other procedures to ensure a central command and control system is established for those events that are not classified as emergencies but affect the ORR.	CC-5: No centralized point exists for collection of information and direction of response activities. Applicable ISM Function: Provide Feedback and Continuous Improvement
DOE Oversight		
JON 7	ORO EM needs to ensure that oversight responsibilities and expectations are clearly defined and that transportation activities receive the appropriate priority.	CC-3: DOE's oversight was inadequate. Applicable ISM Function: Provide Feedback and Continuous Improvement

1.0 INTRODUCTION

1.1 Background

On Friday, May 14, 2004, a shipment of radioactive waste from the New Hydrofracture Facility (NHF) Decontamination and Decommissioning (D&D) Project to the Environmental Management Waste Management Facility (EMWMF) leaked radioactive contamination onto the Melton Valley (MV) Access Road, Bethel Valley Road, Bear Creek Road, and portions of Tennessee State Highway 95 (Hwy-95). The waste shipment consisted solely of a mixing tank (Tank T-12) that had been grouted and then packaged at the NHF. Contaminated portions from all of these roads were removed and disposed of at the EMWMF, and the roads were repaved or patched as necessary at a cost of over $1 million dollars.

On Tuesday, May 18, 2004, U.S. Department of Energy (DOE) Oak Ridge Operations Office (ORO) management determined that a Type B Accident Investigation should be conducted in accordance with DOE O 225.1A, *Accident Investigations*, based on the cost for cleanup which occurred as a result of the release of radioactive material on site and off site. On May 21, 2004, Gerald Boyd, ORO Manager, formally appointed the Type B Accident Investigation Board (Board). See Appendix A for the Board's appointment memorandum. This report documents the facts of the incident and the conclusions of the Board.

1.2 Facility Description

The NHF was constructed in 1980 to dispose of liquid and hazardous radioactive waste by mixing it with cement-based grout and additives and injecting the mixture under high pressure into deep geologic formations. During the period of operation from 1982 to 1984, a total of 2.9 million gallons of grout containing the following radionuclides were injected into the deep geologic formations:

- 644,000 Curies (Ci) of Strontium-90
- 83,800 Ci of Cesium-137
- 7,500 Ci of Curium-244
- 2,100 Ci of Transuranics
- 13,300 Ci of other nuclides

The facility was shut down in 1984 due to performance problems and changes in the laws that regulate deep well injections.

The NHF consisted of several "hot" cells constructed with 2.5-foot-thick reinforced concrete. These cells included a mixing cell, well cell, and pump cell. There was also a waste pit. Ancillary spaces were constructed of cinderblock or metal siding over steel frames. See Appendix G for photographs of the facility. This investigation focused on the mixing tank, Tank T-12, which was located in the mixing cell, along with a mixing hopper (T-11). The facility was going through D&D, which began in early 2003. At the time of this incident, most of the ancillary spaces had been demolished, and two access openings had been bored into the concrete walls of the mixing cell. The mixing cell contained Mixing Hopper T-11,

with a 90-gallon capacity, and the 600-gallon Tank T-12 that mixed grout and waste prior to underground injection. Tank T-12 was made of stainless steel, was approximately 4.5 feet in diameter, and was 5.5 feet high with a semispherical bottom (see Figure 1-1). It stood on legs that added another 6 inches to its height and had a mixer that protruded several feet above the top. It had multiple nozzles and a port with an observation window on the top. The tank weighed 3,500 pounds empty (without the mixer), and the total live load was estimated at 10,650 pounds. The waste pit contained Tank T-13, which was a below grade tank. The *SEC D&D Work Plan* called for Tank T-13 to be grouted and left in place. All solid waste from the D&D of the NHF would be sent to the EMWMF for disposal and all liquid would be treated through the Low-Level Liquid Waste (LLLW) System.

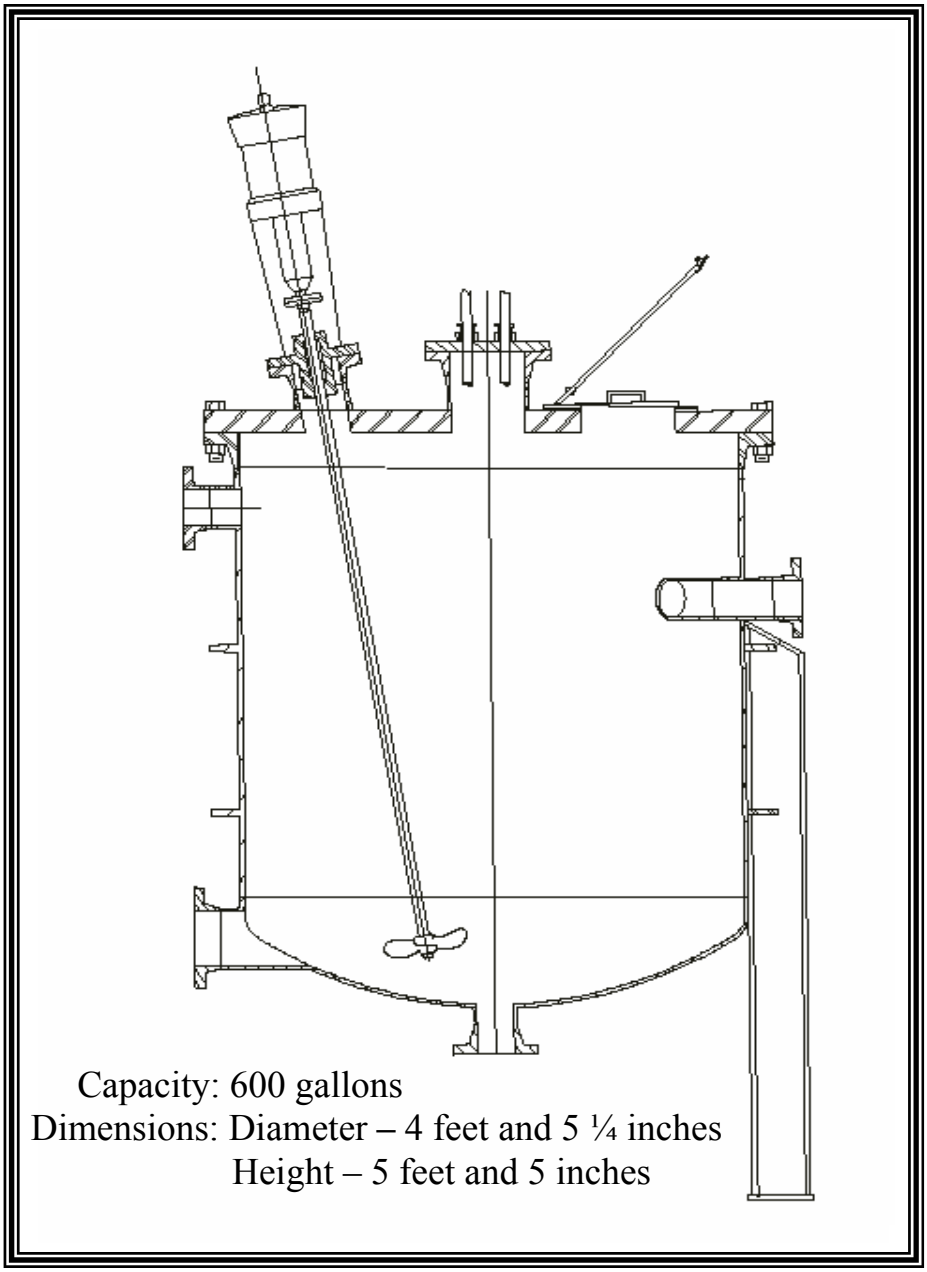

Figure 1-1. Drawing of Tank T-12

The EMWMF is a disposal facility for comprehensive management of waste generated from environmental waste activities on the Oak Ridge Reservation (ORR). The EMWMF is located in East Bear Creek Valley, just off the Bear Creek Road. The wastes disposed at the EMWMF include low-level radioactive substances, Resource Conservation and Recovery Act of 1976 (RCRA) hazardous substances, Toxic Substances Control Act of 1976 (TSCA)-regulated constituents, asbestos-containing materials, and combinations of these contaminants. The Environmental Protection Agency (EPA) and the State of Tennessee (State) approved this facility for the acceptance of waste that meets the Waste Acceptance Criteria (WAC) set forth in the *Attainment Plan for Risk/Toxicity-Based WAC at the ORR, Oak Ridge, Tennessee, DOE-2001*, which is hereinafter referred to as the WAC Attainment Plan.

1.3 Contractual Relationships

The Bechtel Jacobs Company LLC (BJC) is the ORO prime contractor for executing the *Environmental Management Accelerated Closure* plan through a cost-plus-incentive contract. This contract includes DOE' s standard clauses, which are the *Integration of Environment, Safety, and Health into Work Planning and Execution* (hereinafter referred to as the Integrated Safety Management [ISM] clause), *Laws, Regulations, and DOE Directives*, and other Environment, Safety, and Health (ES&H) requirements imposed by DOE. DOE is responsible for providing necessary funding and oversight of BJC's preparation, integration, and implementation of programs and projects. BJC has awarded numerous subcontracts to fulfill various functions and activities in performance of their contractual responsibilities. The ISM clause is included as part of the BJC requirements that are flowed down to subcontractors. Subcontractors involved in the transportation incident are identified below, with a brief description of their roles and responsibilities.

- Safety and Ecology Corporation (SEC) RADCON Alliance is a subcontractor to BJC and provides health physics support to various projects and activities across the ORR. They provide Radiological Control (RADCON) support such as writing Radiation Work Permits, supplying Radiological Control Technicians (RCTs), and performing surveys. SEC RADCON Alliance provides RADCON support personnel for both D&D activities at the NHF and the operations at the EMWMF.

- SEC D&D is a subcontractor to BJC and is responsible for the decontamination, decommissioning, and disposition of the NHF. SEC D&D is responsible for compliance with all Federal and state regulations and the specific ES&H requirements in their contract that relate to their scope of work.

- SEC provides various subject matter experts, such as the SEC Waste/Transportation Coordinator and the Project Health Physicists (PHPs) who are from their corporate staff and support SEC RADCON Alliance and SEC D&D in accomplishing the scope of work contained in their subcontracts with BJC.

- DURATEK Federal Services (DFS) is a subcontractor to BJC and is responsible for day-to-day operations of the EMWMF. DFS RADCON technicians perform vehicle decontamination and release surveys prior to the vehicle leaving the Radiological Control Area (CA) of the disposal cell.

- Hubbard Trucking is a subcontractor of SEC D&D and was the carrier for this shipment. Hubbard Trucking is responsible for compliance with all Federal and state regulations that apply to a carrier of hazardous material.

1.4 Scope, Purpose, and Methodology

The Board began its activities on May 24, 2004, and completed its investigation on June 16, 2004. The scope of the Board's investigation was to identify all relevant facts; analyze the facts to determine the direct, contributing, and root causes of the event; develop conclusions; and determine Judgments of Need that, when implemented, should prevent recurrence of the incident. The investigation was performed in accordance with DOE Order 225.1A, *Accident Investigations*, using the following methodology:

- Facts relevant to the event were gathered through interviews, reviews of documents and other evidence, including photographs and visits to the event scenes.
- Facts were analyzed to identify the causal factors using event and causal factors analysis, barrier analysis, change analysis, root cause analysis, regulatory compliance analysis, and ISM analysis.
- Judgments of Need for corrective actions to prevent recurrence were developed to address the causal factors of the event.

Accident Investigation Terminology

- A **causal factor** is an event or condition in the accident sequence that contributes to the unwanted result. There are three types of causal factors: **direct cause(s)**, which is the immediate event(s) or condition(s) that caused the accident; **root cause(s)**, which is the causal factor that, if corrected, would prevent recurrence of the accident; and the **contributing causal factors**, which are the causal factors that collectively with the other causes increase the likelihood of an accident but which did not cause the accident. The causal factors related to weaknesses in the five core functions of **ISM** are analyzed.
- **Event 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 the hazards, the targets (people or objects) of the hazards, and the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.
- **Change analysis** is a systematic approach that examines planned or unplanned changes in a system that caused the undesirable results related to the accident.
- **Root cause analysis** is a technique that identifies the underlying deficiencies that, if corrected, would prevent the same or similar accidents from occurring.
- **Judgments of Need** are managerial controls and safety measures necessary to prevent or minimize the probability or severity of a recurrence of an accident.
- **Requirements verification analysis** is a forward/backward analysis process to ensure that all portions of the report are accurate and consistent from the flow of facts to analysis to conclusions and Judgments of Need.

2.0 FACTS

2.1 Incident Description

On Friday, May 14, 2004, at approximately 11:30 a.m., a dump truck transporting Tank T-12 from the NHF D&D Project arrived at the EMWMF. Upon arrival, an incoming radiological survey was performed. While results of the radiological survey were being processed, the dump truck proceeded to the weigh station and then to the disposal cell where SEC RADCON personnel confirmed the presence of contamination on the truck. Surveys to determine the extent of contamination were initiated.

As a result of these initial surveys, the investigation into radiological contamination was extended to the entire truck route (see Figure 2-1). At approximately 1:00 p.m., the truck was moved to a controlled area within the EMWMF where any liquid leakage could be contained. Contamination of the road along the truck route at the Oak Ridge National Laboratory (ORNL) was confirmed by 1:20 p.m.

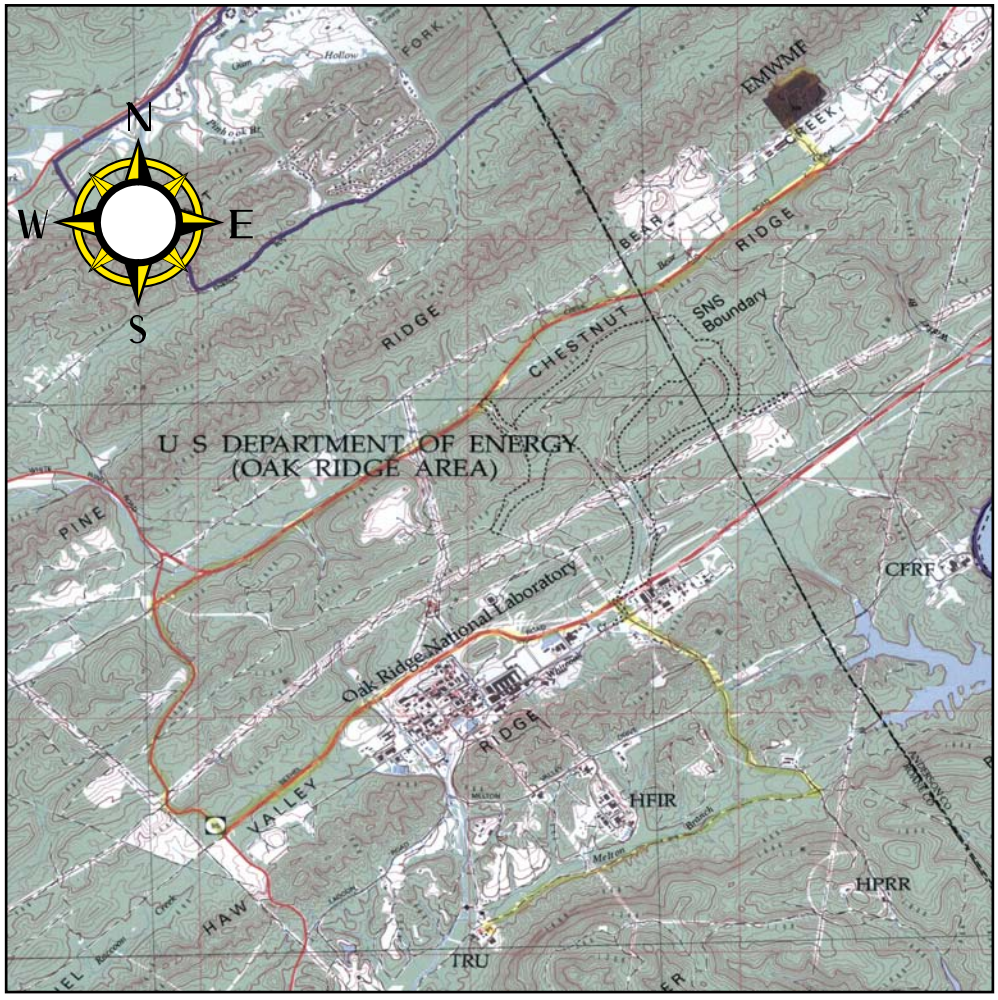

Figure 2-1. Map with Shipment Route for Tank T-12 Highlighted in Yellow

Due to As Low As Reasonably Achievable (ALARA) concerns and the threat of rain, the BJC Subcontractor Technical Representative (STR) for the EMWMF directed the off-loading of Tank T-12 and its burial at 3:30 p.m. Portions of Hwy-95 were closed at 4:15 p.m., and on-site roads were closed later that evening.

By the afternoon of May 16, 2004, all roads along the truck route had been surveyed, marked for remediation, and closed to the public until remediation could be completed. Remediation and resurveys were completed on all roads along the dump truck's route, which resulted in the roads being reopened by May 19, 2004. There were no confirmed exposures or uptakes to individuals, and all vehicles that had traversed the contaminated portions of the roads were surveyed and determined to be clean.

2.2 Chronology of Events

Table 2-1 provides background information and the events leading up to and immediately following the incident on May 14, 2004. The month in which the event occurred is listed when the exact date could not be determined.

Table 2-1. Event Chronology

Date	Event
2/28/1996	RCRA closure of the NHF was completed.
4/16/2001	BJC entered a fixed-price contract with SEC D&D.
2/2003	The NHF characterization was completed.
3/19/2003	The Tennessee Department of Environment and Conservation (TDEC) approved the WAC and the *Waste Management Plan* for the NHF.
5/06/2003	The EPA approved the *Waste Management Plan* and WAC for the NHF.
9/30/2003	The completion date for the NHF Performance-Based Incentive (PBI) was missed.
3/2004	The mixing cell and equipment were spray-washed, and a fixative was applied to the surfaces.
3/16/2004	The SEC D&D Site Manager's daily log documented the discovery of 12 to18 inches of liquid in Tank T-12, and he notified the BJC STR in writing. This amount of liquid (12 to 18 inches) equates to greater than 120 gallons of liquid.
3/29/2004	A revised Work Instruction (WI) for the NHF (WI-16) was issued by SEC D&D instructing solidification of the liquid, and it was approved by BJC.
4/14/2004	Preparation work for Tank T-12 for removal from the cell included the following: • 270 to 450 pounds of Portland cement were added to Tank T-12 to solidify the liquid • A plywood plug was put over a flange on Tank T-12 where sludge was observed • RADCON personnel stopped work in the mixing cell when liquid appeared to spray from a process water line when the line was tapped and foamed

Table 2-1. Event Chronology (Continued)

Date	Event
4/16/2004	Physical separation of the piping of Tank T-12 was completed, and it was grouted to fill the void space.
4/19/2004	Two variance requests were submitted to the EMWMF WAC Attainment Team. These variances were related to size limits and dose rates
4/20/2004	Tank T-12 was moved to the T-13 Annex for interim storage, where the following occurred: • The BJC STR observed liquid dripping from one penetration on Tank T-12 that had been sealed with plywood and informed SEC RADCON. The BJC STR noted this in a progress report. • Tank T-12 was lifted from the mixing cell and wrapped in plastic. • Tank T-12 was then placed in the T-13 Annex building for interim storage. • A hole was cut in the roof of the T-13 Annex to accommodate the mixer motor on Tank T-12. The mixer motor and the hole in the roof were covered by plastic and a tarp to protect Tank T-12 from rainwater.
5/05/2004	SEC D&D attached several steel plates to Tank T-12 for shielding purposes to reduce external dose rates in order to meet the WAC Attainment Plan.
5/10/2004	The EMWMF WAC Attainment Team approved the variance requests.
5/12/2004	Following are details of the initial attempt to ship Tank T-12: • Two sheets of plastic were laid in the dump truck bed for transporting Tank T-12. • Tank T-12 was rigged at the T-13 Annex and lifted off the ground. • Approximately 2.5 gallons of liquid was found in the plastic wrap and was drained into a bucket. • Tank T-12 was transferred to the dump truck. • Several drops of liquid were noticed falling to the ground. • Surveys indicated contamination levels of 60,000 dpm/100 cm^2 on the ground and 75,000 dpm/100cm^2 on the truck's tailgate. • A "diaper" was placed on the dump truck tailgate to collect the liquid. • The dump truck was moved to a permanent CA to prevent unnecessary blockage of the roadways. • An "Initial Event Report" form was completed.
5/13/2004	Resolution activities for the liquid discovered on May 12, 2004, included the following: • An inspection prior to the Plan of the Day (POD) meeting found that between 1 and 2 quarts of liquid had collected in the diaper. • The truck bed was tilted for 1 to 4 hours to check for additional liquid, and no additional liquid was observed in the diaper.

Table 2-1. Event Chronology (Continued)

Date	Event
5/14/2004	Specifics on the shipment of Tank T-12 to the EMWMF included the following: • The truck tarp was removed, and the truck bed was inspected. No liquid was observed. • The truck tailgate was adjusted to eliminate a gap between the tailgate and the seal. • Radsorb (in the amount of 1 quart) was added to the plastic wrapping around the tank, and the diaper was removed. • Radiation and contamination surveys were performed and found to be within Department of Transportation (DOT) regulations. • The dump truck left the NHF at approximately 11:00 a.m. and arrived at the EMWMF at 11:30 a.m. • An arrival survey detected contamination on the truck. • The EMWMF incoming road was shut down at 11:45 a.m., and surveys detected contamination at various sites within the EMWMF. • Several notifications occurred by 12:15 p.m. within BJC to ORO (EMWMF Facility Representative, NHF Facility Representative, and MV Project Director). • The EMWMF notified the East Tennessee Technology Park (ETTP) Park Shift Superintendent (PSS) at 12:18 p.m. • Contamination was detected on MV Access Road at 1:20 p.m. • The *Golan Report* was transmitted at 1:56 p.m. to BJC and DOE personnel indicating that the contamination was limited to the EMWMF. • It was noted that from 1 quart to 5 gallons of liquid came from the raised truck bed into the cell just before Tank T-12 slid from the truck bed into the cell at approximately 3:30 p.m. • The Tennessee Emergency Management Agency (TEMA) closed portions of Hwy-95 for the purpose of initiating radiological surveys at 4:15 p.m. • The Radiological Assistance Program (RAP) Team Leader and the RAP Team arrived on the scene at Hwy-95 at 5:45 p.m. and began supporting the TDEC surveys. • The ETTP PSS sent a fact sheet via electronic mail (e-mail) to the Oak Ridge Operations Center (OROC) and TEMA at 5:46 p.m., which indicated that some contamination had been found on the MV Access Road. (Note: This fact sheet indicated that it had been written at 3:35 p.m.) • Bear Creek Road between ORO Check Point 20 and Hwy-95 was closed at 6:22 p.m. • The DOT National Response Center was notified at 10:43 p.m.

Table 2-1. Event Chronology (Continued)

Date	Event
5/15/2004	The survey of Hwy-95 was completed at 3:30 a.m. The RAP Team left the scene at 3:56 a.m. The radiological surveys were completed on Bethel Valley Road at 5:15 a.m.
5/16/2004	Surveys were completed on Bear Creek Road in the afternoon. Hwy-95 and Bethel Valley Road were reopened after remediation and repairs were completed.
5/17/2004	Remediation and repairs continued.
5/18/2004	Bear Creek Road was reopened after remediation and repairs were completed.
5/19/2004	The MV Access Road was reopened.

2.3 Description of Events

2.3.1 NHF Disposal Operations Prior to D&D

The NHF was designed to support deep well injection of grouted sludge contaminated with radioactive material and potential RCRA characteristic hazardous waste. Sludge and grout were stored, pumped, and mixed in the mixing cell inside of the NHF. Mixtures were pumped into impermeable shale layers (700 to 1,000 feet below the surface) and allowed to harden. During operations, Tank T-11 was used for the initial mixing of waste and grout. After the initial mixing, the slurry flowed to Tank T-12 in order to complete a more thorough mix prior to the injection. In January 1984, the facility's last operational run was completed, at which time the facility was flushed with water (a critical step in maintaining operability) in preparation for the next run. However, the facility operations were permanently shut down in 1984, and the facility was closed in accordance with the approved RCRA Closure Plan in 1996.

During the NHF's operations, the liquid processed was considered to be RCRA characteristic waste for metals and pH, but no RCRA-listed waste was ever processed at the NHF. Therefore, closure activities focused on verifying that the equipment did not meet the definition of a RCRA characteristic waste. Sample results of what residues remained inside the tanks indicated levels less than the RCRA limits for characteristic waste. This information, combined with the cleansing practice employed during operation, was accepted by TDEC as an adequate way of declaring a clean closure as defined by RCRA. Even though Tank T-11 and Tank T-12 were empty at the time of closure, the facility remained highly contaminated with radioactive material.

2.3.2 NHF D&D Operations

On April 16, 2001, BJC (as prime contractor to DOE) entered into a fixed-price subcontract (Subcontract 23900-BA-FS-FS072F-18) with SEC D&D to decontaminate, decommission, and disposition all structures affiliated with the NHF. Included in the scope of this contract was the development of the required Comprehensive Environmental Response, Compensation, and Liability Act documents, the WAC Attainment Plan, and the *Waste Management Plan*. Together these documents outlined the sampling and analytical protocol

for meeting the WAC for the EMWMF. These documents contained a commitment to the regulators to treat residual liquid and formed the basis for the waste disposition strategy during the course of D&D activities. In addition, these documents identified data quality objectives for characterization to ensure compliance with DOT requirements.

The facility characterization began in December 2002 and ended in February 2003. Sampling activities consisted of swipe and radiation surveys of the facilities and equipment. In addition, core samples of the concrete walls were analyzed. This information formed the basis for the preparation of the waste profile that would be submitted to the WAC Attainment Team and used to determine the shipping requirements. A PBI was developed as part of DOE's prime contract with BJC to place a financial incentive on completion of this project. The PBI indicated that if completion occurred on or before September 30, 2003, BJC would earn the entire fee available for this task. During the course of the year, the facility underwent significant changes due to ongoing D&D activities in an attempt to complete the project. Ultimately, the milestone was missed, no fee was awarded for this task, and the remaining work scope was carried over to 2004.

Several reportable incidents occurred early on in the project. Due to these incidents, BJC and SEC D&D revamped the work package processes for the project. This entailed receipt of a more extensive package for review, a more extensive review of the package received, and more reviews of the work package by various subject matter experts, including RADCON and ALARA personnel. SEC D&D, BJC, and DOE personnel stated that the revised work package process had improved work control and that the number of incidents had decreased.

SEC D&D follows the BJC work control process depicted in BJC-FS-1001, *Work Control Requirements*, for development of work plans and WIs. SEC D&D prepared a WI package for Phase III that included an action description for each work step and identified the required stop or hold points. The WI identified the requirements for attending the POD meetings, how to modify the WI during executions of work (redlining), and when to modify the Activity Hazard Analysis (AHA). SEC D&D would submit these WIs and any modifications to the BJC NHF STR for approval. The BJC subject matter experts selected by the BJC NHF STR were responsible for reviewing the instructions for Phase III of the project. The BJC NHF STR would give final approval for work to proceed after appropriate disposition of the comments. BJC then refers to the package as the Work Plan.

Phase III of the project, which included D&D of the mixing cell, began in October 2003. As the D&D progressed, two access openings were cut in the cell structures. This added to the water intrusion problems, which were common.

During preparatory work on March 16, 2004, the SEC D&D Site Manager's daily log indicated the discovery of 12 to 18 inches of liquid in Tank T-12. This level was determined by visual observation through an inspection port on top of Tank T-12. The Board found no record of an attempt to measure the level of liquid in Tank T-12, and sampling of the liquid did not occur. A meeting was held that included the BJC STR, the SEC D&D Site Manager, and the SEC D&D Project Manager to decide on a course of action that would address the liquid. Three options were discussed. Two of the options (draining and pumping) were to remove the liquid. The third option involved solidifying the liquid. The third option was

selected, and the *SEC D&D Work Plan* was then revised (Revision 5) to provide direction for solidification of the liquid. BJC approved this revision on March 29, 2004.

On April 14, 2004, workers added between 3 and 5 bags of Portland cement weighing 90 pounds each. A piece of conduit with a 4-inch electrical box attached was used to mix the contents. Following the addition of the Portland cement, work continued on isolating Tank T-12 from piping, sealing the pipes with expandable foam, and capping the ends with herculite. However, one opening was capped with a piece of plywood. It was reported at a later time that the liquid had been successfully solidified and Tank T-12 was ready to be grouted.

Figure 2-2. Lifting a Tank from the T-13 Annex

On April 16, 2004, in order to comply with the EMWMF WAC, Tank T-12 was grouted to fill the void space. On April 19, 2004, two variance requests were submitted due to a concern for Tank T-12's overall size and dose rates. The following day, the tank was lifted from the mixing cell, wrapped in plastic, and placed in the T-13 Annex for interim storage. See Figure 2-2 for a photograph of this lifting process. The BJC STR's progress report notes that during the lift, there was liquid leaking from the opening that had been capped with a piece of plywood and a notification was made to SEC RADCON. The Board found no evidence to indicate this condition was evaluated further.

The Tank T-12 mixer extended beyond the top of the roof (see Figure 2-3), which made it necessary for a hole to be cut in the roof of the T-13 Annex in order to allow for storage of Tank T-12. Additional plastic and a tarp were placed over Tank T-12 to protect it from rainwater. While in storage, a total of two to three inches of rain was measured at a nearby ORNL meteorological station. The variance requests were approved on May 10, 2004.

Figure 2-3. Mixer for Tank T-12 Extends Beyond the Roof of the T-13 Annex

On May 12, 2004, a dump truck was provided by Hubbard Trucking (a lower-tier subcontractor to SEC D&D) and was prepared for the transportation of Tank T-12 to the EMWMF. The *SEC D&D Work Plan* called for Tank T-12 to be

placed in a Type A or Strong Tight container and then placed in the dump truck. The dump truck had a hydraulic tailgate with a gasket seal. During interviews, several personnel stated that this tailgate/gasket seal design would prevent the leakage of liquid. The Board found no evidence of this design.

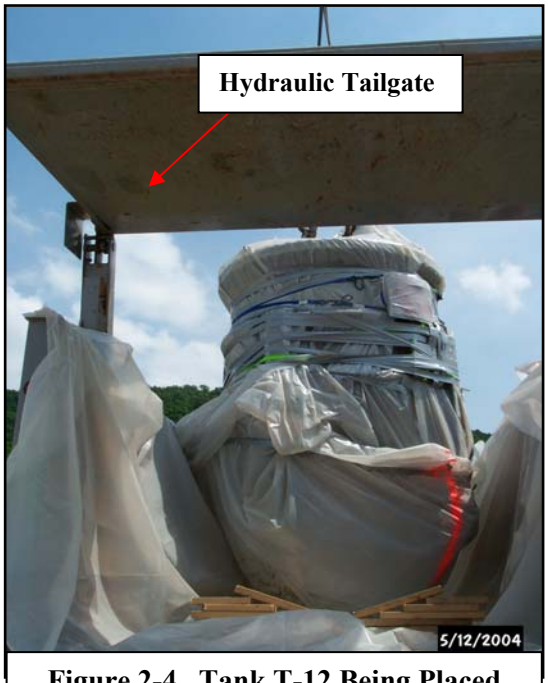

Figure 2-4. Tank T-12 Being Placed into a Truck Bed Lined with Plastic

Two sheets of plastic were placed in the bed of the dump truck (see Figure 2-4). As Tank T-12 was lifted off the ground for the purpose of loading, workers noticed liquid within the plastic wrap that was located at the base. The plastic was punctured to allow for the drainage of approximately 2.5 gallons of liquid (assumed by some personnel to be rainwater) into a bucket. While attempting to transfer Tank T-12 to the dump truck from the T-13 Annex, several drops of liquid fell to the ground. In addition, moisture was noted on the tailgate of the dump truck.

Ground surveys revealed contamination of 60,000 dpm/100 cm^2, while smears of the tailgate indicated 75,000 dpm/100cm^2. (Note: contamination surveys referred to in this report were both beta/gamma and alpha surveys). However, no alpha contamination was ever detected; therefore, all readings are beta/gamma results. Due to these findings, the dump truck was moved to a permanent CA and an "Initial Event Report" form was completed. As a precautionary measure, a "diaper" was affixed to the tailgate of the truck to collect any additional liquid (see Figure 2-5).

Figure 2-5. Liquid Collected in the Diaper

On the morning of May 13, 2004, the diaper had accumulated 1 to 2 quarts of liquid. At the POD meeting, a path forward for the shipment was discussed. One course of action discussed in the POD meeting was to tilt the truck bed. A static test for liquid was performed prior to Tank T-12 being shipped. BJC and SEC D&D tilted the truck bed for 1 to 4 hours in an effort to collect any additional liquid. (See Figure 2-6 on the following page.) No additional liquid was noted in the diaper. On the morning of May 14, 2004, the unobstructed portion of the truck bed was inspected by an SEC D&D employee, and no liquid was noted.

However, a gap was observed between the tailgate and the seal. The Hubbard Trucking mechanic adjusted the tailgate to ensure that it

was sealed properly. One quart of Radsorb was added to the plastic wrap around Tank T-12 as a contingency in case of accumulation of any additional liquid, and the diaper was removed.

Figure 2-6. Tilting the Truck Bed to Collect Any Additional Liquid

A shipping survey performed by SEC RADCON determined that both contamination levels and radiation levels were within DOT regulations. The SEC Transportation/Waste Management Specialist reviewed and signed the shipping papers that authorized release of the dump truck. The dump truck left the NHF with Tank T-12 at 11:00 a.m.

The dump truck arrived at the EMWMF at approximately 11:30 a.m. and underwent the standard radiological survey by an SEC RCT. The RCT had to leave the dump truck to analyze the smears because the background was too high to read the smears beside the dump truck. The dump truck driver stated that when the SEC RCT left the dump truck, he thought he was cleared to proceed. Therefore, before the smears could be analyzed, the dump truck proceeded to the weigh scales. As the dump truck left the weigh scales, the SEC RCT determined that the dump truck was contaminated and immediately informed the RADCON supervisor, who called for the dump truck to be stopped to mitigate the spread of contamination. The dump truck was stopped on North Perimeter Road prior to entering the fenced area of the disposal cell.

The SEC RCT surveyed the area near the survey station. At 11:45 a.m., contamination was confirmed at the survey station (89,460 dpm/100cm^2) and the weigh scales (200,000 dpm/100cm^2). The incoming road to the EMWMF was closed, and the contamination surveys were expanded. A Stop Work Order was issued for all incoming shipments

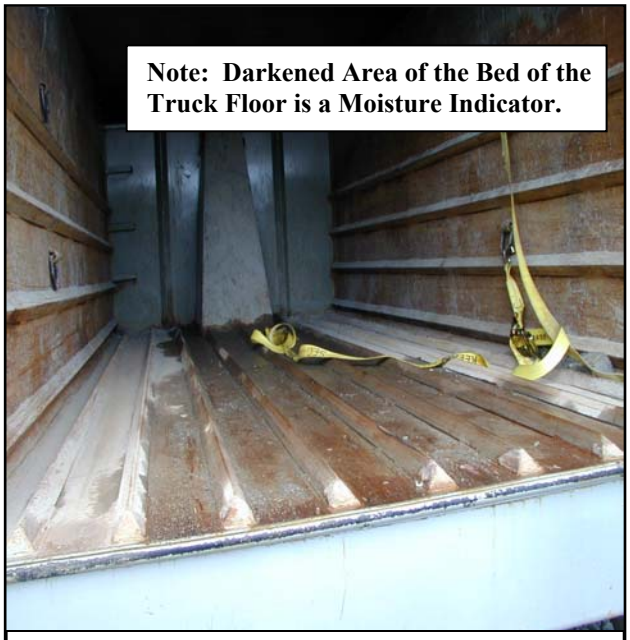

Figure 2-7. Moisture Indicated in the Back of the Truck Bed After Disposal

Concerned that rain could spread the contamination, the BJC EMWMF STR directed the positioning of the dump truck that contained Tank T-12 within the CA of the disposal cell where any runoff could be collected in the cell's water containment system. Due to the dose rates (ALARA) associated with Tank T-12 and the possibility of rain, the BJC EMWMF STR directed the disposal of Tank T-12 at approximately 3:30 p.m. It was noted that between 1 quart and 5 gallons of liquid exited the bed of the truck prior to Tank T-12 sliding into the cell (see Figure 2-7).

To comply with the EMWMF's operating procedures, Tank T-12 was covered soon afterwards with approximately 3 feet of cover material. Once emptied, DFS decontaminated and surveyed the exterior of the truck and initially determined that it was clean while at the cell area. A verification survey conducted by SEC RADCON at the entry survey station found contamination. The dump truck was then returned to the CA.

2.3.3 Shipment Classification Per DOT

Based on the information available, the SEC D&D Waste/Transportation Coordinator determined that Tank T-12 met the Low Specific Activity (LSA) definition of the DOT regulations better than that of a Surface-Contaminated Object (SCO). He based his decisions for shipping the tank on meeting LSA-II criteria. The LSA determination was based on the assumption that concentrations in the waste profile identified as the Upper Confidence Level 95% (UCL-95) were distributed within the estimated weight of the tank at 1,000 pounds and in approximately 50% of the mass of the grout (i.e., approximately 5,000 pounds of clean material).

The concentration was approximately 100 times lower than the concentration allowed as LSA-II. The total activity calculated was approximately 50% of the A_2 value for the mixture of isotopes in the tank, allowing the use of excepted packaging under Title 49 Code of Federal Regulations (CFR), Part 173.410. The SEC D&D Waste/Transportation Coordinator determined that the dump truck as a package met these packaging requirements. This LSA calculation was documented on a spreadsheet and sent to the BJC Transportation Advocate for review.

The BJC Transportation Advocate asked the BJC PHP to review the LSA calculation. The BJC PHP raised a concern that use of the UCL-95 concentrations would not be conservative for Tank T-12. In response to this concern, the SEC D&D Waste/Transportation Coordinator did additional calculations. He estimated the total activity associated with Tank T-12 by using an average dose rate of 200 millirem/hour and multiplying by a conversion factor to obtain the surface activity (1.6 E5 dpm/cm^2). This result was then multiplied by the surface area of the tank in order to calculate the total activity. This method calculated a total activity that was approximately $2x10^{-3}$ times the A_2 value for the mixture and less than the LSA calculations. The SEC D&D Waste/Transportation Coordinator used this information to confirm his LSA calculation and stated that he had responded to the concern raised by the BJC Transportation Advocate in writing on May 13, 2004. After review by the BJC Transportation Advocate and peer review by another BJC Transportation Advocate, the SEC D&D Waste/Transportation Coordinator signed the shipping papers. All of these determinations and those for packaging, hazard communication, and controls were based on the belief that the material associated with Tank T-12 was solid.

The SEC D&D Waste/Transportation Coordinator stated that he was unaware that liquid had been found in the tank or that cement had been added and that his calculations and packaging determinations would have been different if he had known liquid was in the tank. It had been his understanding at the time of grouting that it was only added to fill the void space in order to meet the WAC. He also had believed that the liquid issues occurring the day before the shipment were due strictly to rainwater trapped within the plastic wrapping and that this was mitigated prior to shipment.

Note: The SEC D&D Waste/Transportation Coordinator successfully completed the advanced ORO Transportation Course on March 1, 2002.

2.3.4 Notifications

On May 14, 2004, at approximately 12:15 p.m., the EMWMF STR made initial notifications regarding contamination concerns for the Tank T-12 shipment to the ETTP PSS, the BJC Manager of Projects for the MV Closure Project, the BJC STR at NHF, the BJC PHP, and the BJC Transportation Advocate. The BJC Manager of Projects asked the BJC Field Services Area Manager to coordinate the response to the event because he was scheduled to leave town. The MV Field Services Area Manager, the MV PHP, the MV Transportation Advocate, and the STR for NHF responded to the EMWMF STR. The ORO Environmental Management (EM) Project Director for the MV Closure Project, the ORO EM Facility Representative for the NHF D&D Project, and the ORO EM Facility Representative for the EMWMF were all notified. The ORO EM Project Director for the MV Closure Project and the ORO EM Technical Support and Assessment Division Director visited the EMWMF at 1:00 p.m. and were briefed on the incident by BJC personnel.

The BJC Field Services Area Manager collected information for the *Golan Report* and sent the report to the ETTP PSS. The *Golan Report* is a report that is required by the DOE Headquarters Office of EM. This requirement was made in a memorandum dated March 4, 2003, and in an additional one dated February 23, 2004. Its intent is to provide timely advance notification to increase awareness of events and situations that warrant attention by DOE. Even though surveys had not been completed to confirm or deny that areas outside of the EMWMF were clean, the initial *Golan Report* indicated that the areas outside of the EMWMF were clean. The ETTP PSS transmitted the report via e-mail to BJC and DOE personnel at 1:56 pm. However, BJC-GM-536, *Event Notification/Communication to DOE*, excludes the OROC from the notification list for the report. At 2:02 p.m., the ETTP PSS was notified that contamination had been found on the MV Access Road. This contamination had been detected at 1:20 p.m. At 2:18 p.m., the ETTP PSS made verbal notification to TEMA and reported no off-site contamination. The OROC received an update by phone from the ETTP PSS at 2:32 p.m. and a follow-up fax of the *Golan Report* at 2:39 p.m. The State called the ETTP PSS in order to obtain additional information about the event at 3:10 p.m. The OROC initiated a series of interactions with the State starting at 3:20 p.m.

The State notified the OROC of its intent to monitor Hwy-95 at 3:25 p.m., and the OROC mobilized a RAP response to assist the State. The State also notified the OROC that they would be closing the affected portion of Hwy-95 for the monitoring. The State notified the ETTP PSS, the National Nuclear Security Administration (NNSA) Plant Shift Superintendent for the Y-12 National Security Complex (Y-12), and the OROC that Hwy-95 was closed at approximately 4:15 p.m. The OROC notified the Y-12 Plant Shift Superintendent and the ORNL Laboratory Shift Superintendent of the closure. At 10:43 p.m., the National Response Center was notified of the incident through a conference call with BJC and Hubbard Trucking, the lower-tier transportation subcontractor to SEC D&D.

2.3.5 Response

Upon discovering that the contamination on the dump truck exceeded DOT limits, the SEC RADCON RCT Supervisor had DFS stop the dump truck prior to entering the CA. RADCON personnel from SEC and DFS started surveys inside the EMWMF and its access road off of Bear Creek Road. Several spots of contamination were found, including a spot near the scales that read approximately 200,000 dpm/100 cm^2. DFS personnel under the direction of SEC RADCON decontaminated the areas within the EMWMF.

Both SEC and DFS RADCON personnel surveyed the personnel and vehicles that had traversed the areas prior to them being identified as contaminated. More detailed surveys during decontamination of the scales found levels of approximately 1 x 10^6 dpm/100 cm^2. Surveys completed where the truck had sat for 1 to 2 hours on the North Perimeter Road found 3.2 x 10^6 dpm/100 cm^2.

Meanwhile, the BJC PHP requested SEC RADCON to begin surveys on Bear Creek Road, the MV Access Road, and Bethel Valley Road. Contamination outside of the EMWMF was first detected at 1:20 p.m. on the MV Access Road. BJC's support to the State for surveying Hwy-95 took priority over the surveying of on-site roads. However, surveys of the on-site roads continued throughout the weekend.

The State closed Hwy-95 between Bethel Valley Road and Bear Creek Road at approximately 4:15 p.m. on May 14, 2004. Bear Creek Road was secured between Check Point 20 and Hwy-95 at 6:22 p.m. The Board could not determine the exact time when Bethel Valley Road and the MV Access Road were closed, but it was sometime during the evening of May 14, 2004.

Figure 2-8. RAP Team Conducting Surveys on Hwy-95

The RAP Team arrived on scene at Hwy-95 at approximately 5:45 pm that evening. The RAP Team (augmented by resources from BJC, ORNL, and Y-12) completed surveying Hwy-95 at approximately 3:30 a.m. on May 15, 2004, and left the scene shortly afterwards (see Figure 2-8). The surveys found a maximum of 370,000 dpm/100 cm^2 on the on-site roads and a maximum of 85,000 dpm/100 cm^2 on Hwy-95. See Appendix F for a map with an overview of the spill.

2.3.6 Remediation Efforts

Remediation of the contaminated material was successfully completed for the route that was taken by the dump truck responsible for the transportation of Tank T-12. The dump truck left the NHF and proceeded east on the MV Haul Road, north on the MV Access Road, west on Bethel Valley Road, north on Hwy-95, then east on Bear Creek Road to the EMWMF. Contaminated portions of the roads were remediated to levels in compliance with 10 CFR 835, *Occupational Radiation Protection*, and with DOE Order 5400.5, *Radiation Protection*

of the Public and the Environment. The contaminated areas north of the MV Haul Road were graded into the posted contaminated areas.

The DOE Rule and Order (10 CFR 835 and DOE O 5400.5) are flowed down to the subcontractors and their subtier subcontractors through the contracts. Compliance with 10 CFR 835 and DOE O 5400.5 was confirmed by scanning the asphalt road areas with alpha detectors and beta/gamma floor monitors, while the gravel/dirt roads were scanned with alpha detectors and hand-held beta/gamma detectors for contamination. The beta/gamma detector face of the floor monitors was approximately ½ inch above the road and pushed forward at a rate of one-half the detector face per second. The hand-held beta/gamma detectors were maintained ¼ to ½ inch from the surface and moved forward at a rate of 2 inches per second. Both the floor monitors and hand-held instruments were used to make one-minute static counts to determine the activity at areas with elevated readings. Smears were taken at all areas of elevated count rates. The calibration dates were current for all equipment used for this survey of the truck route. Calibration data for all surveys, including efficiencies and detection levels, was documented. Alpha detectors were held approximately ¼ inch from the surface of elevated activity to determine if any alpha-emitting contaminates were along this route, since the route is used to transport other radioactive materials to the EMWMF. Alpha measurements remained at ambient levels. Strontium-90 was the isotope of primary concern from this contamination event, and the floor monitors and hand-held beta/gamma detectors were appropriate for this type of survey.

All contaminated and uncontaminated asphalt generated from this event was disposed of at the EMWMF based on the existing profile for the NHF, except for the contaminated gravel located north of the MV Haul Road. Gravel from some of the access roads was graded off and also sent to the EMWMF for disposal. All parts of the truck route that were remediated have been resurveyed to verify that the remediation of the roads and Hwy-95 contaminated during this event met the free-release requirements under 10 CFR 835 and DOE O 5400.5.

2.3.7 DOE Oversight

Day-to-day oversight of ES&H at the NHF is primarily the responsibility of the ORO EM Project Manager and the ORO EM Facility Representative for the NHF. They are supported in this oversight by ORO subject matter experts. In addition to the NHF, the Facility Representative is responsible for providing oversight of several other facilities, both nuclear and non-nuclear within MV. Likewise, the ORO EM Project Manager is responsible for several other MV Closure Projects. They both have conflicting priorities that affect their level of oversight.

During interviews, the NHF Facility Representative stated that he is not a transportation officer. His training in transportation is limited to the general technical qualifications that any Facility Representative must meet, and he does not have transportation responsibilities (i.e., he does not inspect shipments or documentation pertaining to shipments). The NHF Facility Representative has successfully passed the qualification requirements for the Technical Qualification Program for Facility Representatives. The ORO EM Technical Support and Assessment Division Director stated that his expectations of Facility Representatives are that they would be familiar with the day-to-day operations at the

facilities and that transportation should be evaluated as a part of their routine oversight of operations.

The NHF Facility Representative was notified by the BJC NHF STR of the liquid found in the wrapping on May 12, 2004, and visited the site at the end of the day. Other than this visit, the NHF Facility Representative was not on site at the NHF from May 12–14, 2004, but he was in his office reviewing documentation for an upcoming project. He talked with the BJC NHF STR on the morning of May 13, 2004, but he was never told of the decision to go forward with the shipment. The ORO EM Project Manager did not visit the site during this timeframe due to her involvement with another project. The ORO EM Project Manager also missed the weekly status meeting held by BJC for several weeks due to a conflicting training requirement. The ORO EM Project Manager kept in contact with the BJC Project Manager to be briefed on the status of the project during this time.

The NHF Facility Representative and the ORO EM Project Manager, as well as other DOE interviewees, expressed a concern that the new contract between ORO and BJC (*Accelerated Closure Contract*) hinders their ability to perform effective oversight of BJC. Section H of the contract contains the special contract requirements. Specific sections cited were subsections (a) and (b) of Clause H-2, "DOE Contract Administration and Oversight." Subsection (a) states ". . . DOE has a focused approach for providing oversight of Contractor work. This approach shall provide effective DOE oversight of project work, yet it must not present the Contractor with burdensome or 'non-value added' work related distractions." Subsection (b) states that ". . . the DOE oversight will be conducted in a tailored and proactive manner with minimal interference with project progress." The Facility Representative stated that had he been on site at the time of the shipment and had he felt that conditions were not favorable for the shipment, all he had to do was say so and work would have been stopped. However, he also indicated that under this contract one has to be careful about the approach used for stopping work due to the consequences associated with schedule delays.

3.0 ANALYSIS

The Board used several analytical techniques to determine the causal factors of the incident. Events and causal factors were charted using the ISM core functions. The Board used change and barrier analysis techniques to analyze the facts and identify the causes of the incident. The causal factors related to weaknesses in implementation of the ISM core functions collectively contributed to the event. The Judgments of Need are presented in Table 4-1.

3.1 Barrier Analysis

The barrier analysis is based on the premise that hazards are associated with all incidents. Barriers are developed into a system or work process to protect personnel and equipment from hazards. For an incident to occur there must be a hazard that comes into contact with a target (worker) because the barriers or controls were not in place, not used, or failed. A target is a person or object that a hazard may damage, injure, or fatally harm. A barrier is a means used to control, prevent, or impede the hazard from reaching the target thereby reducing the severity of the resultant accident or adverse consequence. The results of the barrier analysis are used to support the development of the causal factors. The barrier analysis determined that a lack of formality of operations was an important cause of the event. See Appendix B for the results of the barrier analysis. Actions were taken with incomplete information and without fully understanding the risks and consequences, leading ultimately to the failure of barriers. Examples include the following:

- Failure to implement the requirements in the *Waste Management Plan* and the WAC Attainment Plan resulted in inadequate characterization of Tank T-12 and attempts to solidify the liquid in Tank T-12 rather than treating it on site at the LLLW System.

- Liquid remained in Tank T-12 due to the failure to provide adequate WIs for the solidification process.

- Due to failure in following the WIs, plywood was applied to an opening in Tank T-12 (allowing an avenue for liquid to be released).

- The Quality Assurance (QA) Plan was not fully implemented, resulting in inadequate communication of changed conditions.

3.2 Change Analysis

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 event. This process analyzes the difference between what is normal (or "ideal") and what actually occurred. The results of the change analysis are used to support the development of causal factors. See Appendix C for the results of the change analysis. The change analysis determined that the lack of implementation and/or deviations from approved plans, instructions, and processes (along with inadequate information about the liquid) contributed to the incident. Examples include the following:

- The attempt to solidify the liquid in the tank was a deviation from the *Waste Management Plan*, which would have treated the liquid in Tank T-12 through the use of the LLLW System.

- The failure to implement the Quality Improvement Process resulted in the risks not being adequately evaluated in relation to ALARA and the *Waste Management Plan*.

- Inadequate information concerning the amount and characteristics of the liquid affected the solidification process.

3.3 DOT Compliance Analysis

DOE contractors and their subtier contractors are directly regulated by the DOT for off-site transportation. The packaging, offering for transport, and transporting of hazardous materials, including radioactive material, is regulated by DOT in 49 CFR 100-185, *Transportation*. For wholly intrastate transport of hazardous materials, these shipments are subject to the State laws under Tennessee Code, Annotated, Title 65, *State of Tennessee Motor Vehicle Laws*, and Title 1220, *Tennessee Motor Carrier Safety Regulations*.

BJC's procedures stipulate compliance with Federal and state transportation regulations, and these requirements are required of their subcontractors by contract. The regulations governing the transportation of hazardous materials are based on the accomplishment of specific actions to ensure that materials are transported in a safe manner. Failure to perform any of these actions can result in unsafe shipments. The specific actions are as follows:

1) **Identify the material,** including all constituents, their amounts, and their physical form. It is also necessary to identify all applicable regulations for the shipment (e.g., the EPA for hazardous wastes and polychlorinated biphenyls and the Nuclear Regulatory Commission for fissile radioactive materials). Failure to properly identify all constituents can result in improper classification in Step 2.

2) **Classify the material** in accordance with DOT's classification system (e.g., Class 7 for radioactive material). For radioactive materials, further determinations need to be made to determine the radioactive material shipping category (e.g., limited quantity, fissile, LSA, or SCO). This classification and categorization process establishes the required containment, communication, and controls.

3) **Contain the material** as prescribed by DOT in 49 CFR Part 173, *General Requirements for Shipments and Packaging*. Packaging is based on the material classification in Step 2. For radioactive materials, there are four categories of packaging: excepted packaging, industrial packaging, Type A packaging, and Type B packaging.

4) **Communicate the hazard** via markings, labels, and placards required by DOT and any other applicable agencies.

5) **Control the shipment** in transit by, for example, restricting public access to the surface of a package or imposing exclusive use provisions.

Identification, classification, and containment of the material were not adequately implemented for the Tank T-12 shipment. The shipping papers and BJC transportation checklist for the shipment of Tank T-12 on May 14, 2004, indicated that it met the DOT Class 7 definition, contained a Type A quantity of activity, met the defining criteria for LSA material, and was an exclusive use shipment. As such, the authorized packaging for this shipment included Type A packaging. Alternatively, as an exclusive use/LSA shipment, excepted packaging meeting the requirements in 49 CFR 173.410 may be used. The NHF D&D Project chose to ship the material as a bulk shipment in a closed dump truck. In this configuration, the truck serves as the packaging. For large, solid objects with no loose material, this configuration meets the 49 CFR 173.410 requirements for excepted packaging.

The SEC Waste/Transportation Coordinator inappropriately used the LSA-II category to characterize the tank. Since the tank had both fixed and removable contamination on both internal and external surfaces, the tank needed to be evaluated for meeting the SCO criteria. Once grout was introduced into the tank, the internal removable contamination and whatever liquid in the tank was not bound in the cement would have mixed with the grout and, therefore, should have been evaluated against the LSA criteria. Under the regulations, materials meeting both LSA and SCO criteria may be shipped together under the proper shipping name, *Radioactive Material, LSA, n.o.s.*, as the packaging requirements for both are identical.

The shipping papers indicated 4,111 Mega-Becquerel of activity, which is slightly over 50% of the A_2 value for the mixture of isotopes in the tank. The SEC Waste/Transportation Coordinator calculated this number using an LSA spreadsheet. The concentration numbers on the spreadsheet were taken from the waste profile and represent the UCL-95 of the mean concentration levels for the entire waste lot from the NHF. To be conservative, the SEC Waste/Transportation Coordinator multiplied these concentrations by 6,648 pounds, which represented his estimation of the weight of the tank 1,000 pounds plus half the grout. The tank and mixer actually weighed approximately 3,650 pounds; therefore, this calculation was not as conservative as he thought.

Use of the waste profile UCL-95 concentrations was also not conservative for calculating the activity of the shipment. These numbers in the waste profile are not meant to bound any individual shipment, and the radionuclide concentrations in the tank were undoubtedly much higher than the mean. Thus, given that the activity of the shipment was near the A_2 value, this was not an appropriate method for calculating the total activity of the shipment. The UCL-95 numbers from the waste profile were also used to calculate compliance with the LSA volumetric concentration limits for solids. While this is inappropriate for the reasons stated above, the UCL-95 numbers are less than 1% of the limit; therefore, the Board concludes that it is unlikely the shipment exceeded these limits. It is also unlikely that any liquid in the tank exceeded the LSA limits for liquid.

Even though he had classified the system as LSA-II, the SEC Waste/Transportation Coordinator also calculated surface contamination levels to determine compliance with SCO-II levels and provide a second check on the total activity. He did this because of a

concern by the BJC PHP that using the UCL-95 numbers was not conservative. A conversion factor of 1 millirem/hour equals 80,000 dpm/cm^2 for Strontium-90 was used to convert what he described as an average radiation reading on the tank to surface contamination levels. This was an inappropriate use of the conversion factor because the dose rate used in the conversion factor is a beta/gamma dose rate and the measurement was a gamma-only dose rate. It was also inappropriate because the regulations allow averaging over 300 cm^2, but not over an area as large as the tank. Using the highest dose rate on the tank prior to shielding could have provided a more conservative estimate. This would not have corrected the error of using an improper conversion factor. Also, no consideration was given to the transuranics and other high-toxicity alpha emitters and whether those surface contamination limits had been exceeded. Based on swipe surveys taken, the Board is confident the exterior surfaces met the SCO-II limits. But, given that no interior surface characterization data could be found, the Board cannot make any statement regarding the interior surface contamination levels.

The SEC Waste/Transportation Coordinator then took the surface contamination level he had calculated and multiplied that by the surface area of the tank (internal and external) to get the total activity. The calculation treated the internal surface contamination as being the same level as the external surfaces. He made this choice because no characterization data was available for the internal surfaces of Tank T-12. This assumption is highly questionable. This calculation of total activity was less than that obtained in the LSA calculation, which he felt validated the LSA calculation. The misuse of the conversion factor caused this calculation to be inaccurate.

The characterization process used by the NHF D&D Project is problematic and indicates an inadequate understanding of the correct application of the LSA and SCO sections of the regulations. However, in this case, it appears likely that Tank T-12 could meet both the SCO and LSA limits even with the liquid. As such, it could be offered under the LSA proper shipping name. However, it is questionable if the total activity was less than the A_2 value and thus the excepted packaging was allowable.

The balance of the shipping decisions for the tank (including packaging, communication, and controls) were appropriate for the material as characterized. The material characterization, packaging choice, and some of the shipping documentation entries were all inappropriate for liquid present with the shipment. Due to the fact that there was contaminated liquid in the shipment and that some of this liquid was released from the transport vehicle during transportation, the following section of the regulations was not met:

"There must be no loose Class 7 (radioactive) material in the conveyance; however, when the conveyance is the packaging there must be no leakage of Class 7 (radioactive) material from the conveyance." 49 CFR 173.427(a)(6)(ii)

3.4 Previous Events/Lessons Learned

Acting on previous events that provide valuable lessons learned information could have prevented this incident. Lessons learned, as defined by BJC, is a program for identifying, sharing, and utilizing both positive and negative experiences that may be of benefit or applicable to other organizations in the performance of their work. Since the accident

occurred on May 14, 2004, operating experiences documented by BJC through occurrence reports and lessons learned over the last year (May 17, 2003, through May 7, 2004) were evaluated by the Board for potential lead indicators that BJC might have used to prevent this accident.

BJC's policy on its Integrated Safety Management System (ISMS) states that the ISM program and safety culture provide environmental protection, worker safety, public health protection, feedback and improvement, pollution prevention, waste minimization, and QA programs. While these programs are tailored to meet the needs of specific projects and activities, one important central element to all of the programs is always feedback and improvement.

Several internal reporting and tracking systems exist for BJC. However, this investigation only looked at lessons learned that were issued by BJC and reports from the Occurrence Reporting and Processing System (ORPS) as a source for identifying operating experiences that could be utilized as a tool in the feedback and improvement process. The ORPS and Lessons Learned Programs are higher-tier management systems that provide BJC with assessment and improvement information on the status of their programs. In the year prior to the incident on May 14, 2004, BJC issued approximately 93 occurrence reports and approximately 321 lessons learned.

Forty-six occurrence reports and lessons learned generated by BJC during the last year were selected for having a relevancy to the work activity at the NHF as a source for potential lead indicators. A summary list of these items can be found in Appendix E. It contains descriptions provided by BJC in their weekly summaries. Reports that were addressed as lessons learned are flagged with the designation of "LL" in parentheses after the report number in column 4. Several occurrences that were initially issued before 2003 were later addressed as a lessons learned opportunity in 2003 as part of their program for evaluating events. These occurrences/lessons learned were divided into trending categories based on key words found in the summary descriptions. This trending categorization is listed in column 6 of Appendix E. While this categorization is subjective, the following occurrence reports/ lessons learned with these categories, as key topics in the reports are relevant to the transportation incident on May 14, 2004:

- Contamination
- Characterization
- Transportation (DOT)

During the last year, eight occurrences for the NHF (Building 7860) were issued by BJC that can be collectively grouped as five contaminations, one management concern, and two accidents (field truck breakaway and a cut into an energized conduct). The number of occurrences for the NHF D&D Project is of concern, as well as the fact that no discernible preventive actions from lessons learned or occurrence reports issued by BJC appeared to have been applied to this project in a formal manner. There are two important "what ifs" of interest in this evaluation. The first "what if" is associated with possible corrective actions for characterization issues that should also be considered a missed opportunity. It appears that

characterization is a routine problem with D&D projects. Therefore, BJC should have taken additional steps to correct this long-term problem.

It is apparent from the information associated with this event that solidification decisions were made with limited knowledge of the amount of liquid, chemical composition, and radiological content. The two options for either draining or pumping the liquid for treatment at the LLLW System would have been properly evaluated with this knowledge. It is hard to understand why the solidification option was chosen unless one believes that this was considered the best option in light of the lack of knowledge regarding the content of the liquid. The second "what if" is based on other contamination events associated with rainwater. If actions had been taken by BJC to erect a tent around Tank T-12 or to remove the mixer in order to prevent the possibility of rainwater collection in the plastic wrap, this would have prevented some spread of contamination. The mindset regarding the belief that all the liquid collected in the plastic wrap was rainwater could have been prevented if this had been done. Based on these considerations, additional efforts and/or oversight by BJC should have been directed to contamination control and the characterization process that would have ensured compliance with DOT regulations.

3.5 Integrated Safety Management

The DOE Accident Investigation Program (DOE O 225.1A, *Accident Investigations*) requires that this incident be evaluated in terms of ISM to prevent the recurrence of similar incidents. The core function and guiding principles 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. Properly implemented, the ISM approach to safety requires rigor and formality in the identification, analysis, and control of hazards. The Board examined physical and management systems as potential causes of the incident.

BJC is responsible and accountable for effectively integrating ES&H into all work planning and execution for the safe accomplishment of all work under the current closure contract. These contract requirements are formally flowed down through the BJC closure contract to all of its subcontractors. The BJC contract (DE-AC05-98OR22700) incorporates ISM requirements in the following clause, which states in part:

"The Contractor is fully accountable for an integrated safety management program that accomplishes all work in a manner that meets technical quality objectives and is protective of workers, the public, and the environment. Along with its subcontractors, the Contractor must comply with all applicable laws, regulations, and DOE directives as required by other provisions of this contract. While the Contractor must oversee and is accountable for all ES&H under the contract, implementation of ES&H practices is generally conducted through the individual subcontractors who perform the majority of the work tasks."

BJC has developed a detailed ISMS description document, *Integrated Safety Management System Description* (BJC-GM-1400, Revision 5, dated April 2003) that describes how employees and subcontractors implement ISM. This program, as described in the referenced document, was not adequately implemented in this incident. The core functions of ISM are described and evaluated in the following paragraphs.

3.5.1 Define the Work

Missions are translated into work, expectations are set, tasks are prioritized, and resources are allocated.

Effective work execution begins with the preparation of a defined scope of work that translates the mission and requirements into terms that those who are to accomplish the work can clearly understand. The definition of the work scope must provide sufficient detail to support the hazard analysis and development and implementation of controls at the task level. To fulfill its responsibilities, line management must define the work to be performed and be accountable for the safe implementation of the task. The scope of work was defined in the regulator-approved documents and the subcontract, which were then flowed down to the *SEC D&D Work Plan* (1335-16-PP9, Revision 5). This plan was broken up into individual WIs for each portion of the D&D work to be performed at the NHF.

SEC D&D relied on the WI as a primary tool for work control. Several problems with the WI associated with solidification and shipment are addressed in the following paragraphs. Step 13 of the WI deals with the solidification of liquid and the removal of Tank T-12. Step 13 states, *"Prior to isolating and removing Tanks T-11 and T-12, solidify existing residual liquid in Tank T-12 using Bentonite pellets or similar material that qualifies as non-compressible material per the EMWMF WAC."* Twelve to 18 inches of liquid were discovered in Tank T-12. This equates to greater than 120 gallons of liquid. One hundred gallons of liquid would have required over 1,000 pounds of cement for solidification. The WI did not provide adequate information on how much material would be required to solidify the liquid in Tank T-12 at the time of this project. The WI did not provide information on how to verify that the solidifying process was successful. Step 13 did not have a required stop or hold point for final verification of no liquid. Step 13 also covers grouting and the covering of openings on Tank T-12. This step in the WI did not provide information on how to verify the grout had hardened, and also did not specify a required stop or hold point.

Step 14 of the WI deals with the transportation of Tank T-12. Step 14 states, *"Place tanks in DOT Type A or Strong Tight containers, fill remaining void spaces with sand or other incompressible material to meet EMWMF WAC requirements, and place in the back of a dump truck or on a flatbed for shipment to EMWMF."* Step 13 has stipulated actions to be taken concerning residual liquid in Tank T-12. At the time of this project, Step 14 failed to mention what should be done if liquid continued to be an issue with Tank T-12. Step 14 does not have a required stop or hold point for any deviations from Step 13.

Part of the scope of work for the disposition of Tank T-12 was meeting the objectives of the WAC. The WAC specifies that one key decision developed from the characterization data involving Tank T-12 is compliance with transportation regulations. The data was not sufficient in that it failed to characterize the interior of Tank T-12. The data provided in the WAC Attainment Plan does not address residual liquid in Tank T-12.

BJC and SEC D&D reviewed and signed the *Waste Management Plan*, the WAC Attainment Plan, and the *SEC D&D Work Plan* (which contains the WI). Both BJC and SEC D&D had an opportunity to comment on the lack of characterization data for Tank T-12. BJC and SEC

D&D failed to raise the issue of liquid remaining in Tank T-12 and did not address the fact that characterization was not performed on the liquid.

3.5.2 Analyze the Hazards

Hazards associated with the work are identified, analyzed, and categorized.

The objective of the hazard analysis is to develop an understanding of the task-specific hazards that may affect the worker, the public, and the environment. Each level of the hazard analysis is the foundation for a more detailed analysis. Hazard identification and analysis must occur at each phase of the work to be performed. Below are several instances where hazards were not properly identified and analyzed prior to this incident. Tank T-12 was never properly characterized to fully develop an understanding of the hazards. Neither the physical contents nor the total activity was properly identified. Characterization of the tank was insufficient to identify the proper packaging for shipment.

Workers added cement without full knowledge of the quantity and characteristics (pH, etc.) of the liquid inside Tank T-12. Thus, there was no assurance that this method of eliminating the residual liquid would be successful. Also, without analytical information, worker radiation exposure could not be adequately assessed as required by the ALARA program for all options of eliminating the residual liquid.

During the movement of Tank T-12, liquid was noticed leaking from Tank T-12. Later, liquid was collecting and leaking from the plastic wrapping around Tank T-12, and contamination was detected from this liquid. Despite these clear indications of a potential problem, the hazard the liquid might present was never completely analyzed. The original AHA for the project does not mention liquid possibly being present in Tank T-12. Rather than evaluate this change in condition by performing an AHA or declaring a Condition Adverse to Quality (CAQ) concerning the liquid associated with Tank T-12, project personnel involved with this activity assumed any leakage was rainwater and proceeded with the work as planned.

Tank T-12 was grouted in place with a flowable grout mixture that typically produces bleed water. The potential for the bleed water to be a source of liquid during shipment was not analyzed, and the *SEC D&D Work Plan* did not contain controls to ensure that no liquid existed after grouting. Project controls failed to take adequate measures to prevent rainwater intrusion into Tank T-12's wrappings. Due to the failure of BJC and SEC D&D to recognize the continual presence of liquid in Tank T-12 and their failure to formally investigate the source of the liquid, a dump truck that was normally used to transport solids was used to transport an item that contained liquid.

3.5.3 Develop and Implement Controls

Identify standards, requirements, and identify controls to prevent hazards. In addition, establish safety controls and implement them.

The objective of developing and implementing controls is to identify and provide the full range of controls (i.e., engineering, administrative, and regulatory) consistent with the level and nature of the hazards to be encountered during task performance. The development and

implementation of work controls assumes that the contractor has adequately identified the hazards associated with the defined scope of work. Several instances where proper controls were not developed or implemented prior to this incident are discussed below.

In an effort to handle the liquid discovered in Tank T-12, the WI was rewritten to state *"solidify existing residual liquid in Tank T-12 using Bentonite pellets or similar material that qualifies as non-compressible material per the EMWMF WAC."* The WI did not provide sufficient details, nor was supervisory oversight sufficient to ensure that enough cement was used to properly solidify the liquid. The *SEC D&D Work Plan* did not give any direction on how to verify solidification of the cement. The plan also covered the method to be used for shipping Tank T-12 from the NHF to the EMWMF. Tank T-12 was supposed to be placed in a *"DOT Type A or Strong Tight containers, fill remaining void spaces with sand or other incompressible material to meet EMWMF WAC requirements, and place in the back of a dump truck or on a flatbed for shipment to EMWMF*." This control was not implemented, as Tank T-12 was placed directly into the dump truck without being placed in a DOT Type A or Strong Tight container. SEC D&D was responsible for writing the revised Work Plan, which was then reviewed and approved by BJC.

From interviews with SEC and BJC management and workers, the impression was that all of the liquid associated with the shipment of Tank T-12 was due to rainwater. BJC and SEC D&D made the assumption that the liquid was rainwater and not an issue affecting the shipment of Tank T-12 each time the workers pointed out the liquid. Consequently, the wrong package was selected to ship Tank T-12 to the EMWMF.

BJC did not adequately oversee its subcontractor to ensure the work was performed in accordance with the applicable requirements. SEC failed to implement the controls established in the *SEC D&D Work Plan*, the WAC Attainment Plan, the *Waste Management Plan*, and DOT regulations. BJC personnel were involved in the decisions made to deviate from all of these work control documents.

3.5.4 Perform Work Safely

Readiness is confirmed and work is performed safely.

Controls must be identified and implemented before starting work on any task. Many controls were noted and identified but not adequately implemented. SEC D&D did not adequately implement the CAQ Program and its QA Plan. A formal approach to identifying CAQs would have added rigor to the decision process and would have provided a concise, documented approach. On two occasions, the contractor deviated from the approved plans or WIs. The decision to solidify the liquid in Tank T-12 deviated from the regulator-approved *Waste Management Plan*, and the hazards were not properly analyzed. In addition, an opening in Tank T-12 was sealed with plywood, while the WI called for capping with "*herculite or similar material*." The decision to use plywood was initially made by a laborer and later concurred with by SEC D&D.

Decisions made during informal meetings resulted in deviations from the Work Plans and the WIs. The SEC Waste/Transportation Management Specialist was not included in all of the informal meetings, and he stated during interviews that information from the informal

meetings would have affected the selection of the dump truck to transport Tank T-12 to the EMWMF. The scope of work was not adequately defined, and materials were not properly characterized. Task-specific hazards were not identified or analyzed. Consequently, adequate work controls could not be established.

3.5.5 Feedback and Improvement

Feedback information on the adequacy of controls is gathered, and opportunities for improvement of the definition and planning of work are identified and implemented.

The BJC process for feedback and improvement consists of evaluation of BJC and subcontractor performance to assure conformance to specified requirements and effective implementation. BJC had many sources of feedback to ensure conformance to requirements and to ensure that those requirements were properly implemented. Examples for these sources of feedback include the STR's oversight of the subcontractor and assessments from the Safety Advocate, subject matter experts, and Quality Engineers. In addition, management assessments and independent assessments are conducted to provide ongoing formal feedback. The issues that are identified are documented, root cause analyses are performed, and corrective actions are developed and tracked. The BJC document that directs these activities is BJC-GM-1400, *Integrated Safety Management System Description*. The BJC procedures that cover these activities are BJC-PQ-1420, *Management Assessment*; BJC-PQ-1450, *Performance Monitoring*; BJC-PQ-1401, *Independent Assessment*; and BJC-PQ-1240, *Lessons Learned Program*. BJC issued a final report for an assessment of the MV Completion Project dated April 7, 2004. This assessment included SEC D&D's transportation activities for the NHF. The conclusion in the area of transportation was that *". . . BJC and subcontractor transportation performance was acceptable and within regulatory and procedural requirements."* In addition, a technical assessment of the BJC ES&H Program was performed by ORO in May 2004. One of the areas assessed was transportation. There were no findings associated with this area of the review.

The Board found that BJC is not being proactive about lessons learned and applying those lessons to tasks. From a summary list of occurrences from May 17, 2003, until May 7, 2004, there were several incidents that fall into the categories of contamination, transportation, and characterization. If BJC had been proactive in the application of lessons learned, special attention would have been given to the possibility of a contamination incident, a transportation incident, and an incident due to the lack of adequate characterization. This is further expanded on in Section 3.4 of this report.

The causal factors that led up to the loss of containment of radioactive material on and off DOE's property indicate that BJC and SEC D&D failed to adequately implement all portions of the ISM Wheel (Define the Scope of Work, Analyze the Hazards, Develop and Implement Controls, Perform the Work Safely, and Provide Feedback and Continuous Improvement) to make changes which would have led to halting the improper shipment of Tank T-12 or ensuring that all liquid had been removed from the tank.

3.6 Events and Causal Factors Analysis

The direct cause is the immediate events or conditions that caused the accident/incident. The contributing causes are the events or conditions that, collectively with the other causes, increased the likelihood of the incident but which did not cause this incident. Root causes are the events or conditions that, if corrected, would prevent recurrence of this and similar incidents. *The direct cause of the incident as determined by the Board was that Tank T-12 was shipped in packaging (a dump truck) that allowed the release of radioactively contaminated liquid.* A discussion of all the noted contributing causes and root causes is contained in Table 3-1. A chart of the events and causal factors is included in Appendix D.

Table 3-1. Causal Factors

Direct Cause: Tank T-12 was shipped in packaging (a dump truck) that allowed the release of radioactively contaminated liquid.	
Root Causes	**Discussion**
RC-1. SEC D&D had an inadequate work control process	1. WIs often relied on skill of the craft. Examples: Workers normally followed the directions of their supervisors without the benefit of any written instructions. When the lines to Tank T-12 were isolated, only skill of the craft was used to ensure these openings were adequately sealed/closed. The tilting of the truck bed to see if any liquid existed in the packaging (the dump truck, the wrapping, and/or Tank T-12) was not an established acceptance criterion. 2. The solidification option was not covered under the *Waste Management Plan*. The plan stated that all liquid would be sent to the LLLW System for treatment and disposal. 3. There was a lack of flowdown of the *Waste Management Plan* into the Work Plan. The defined option per the *Waste Management Plan* was removal of residual liquid; however, this option was not followed. 4. No measurement of the liquid levels in the tank was performed, and decisions on solidification were based on visual observations of levels that varied from 10 to 18 inches (at least 100 gallons difference). 5. No measurement of the pH of the liquid was performed. This information is necessary to ensure the proper solidification with cement; that is, the need for neutralization of liquid is required to ensure solidification is complete.
RC-2. SEC D&D performed inadequate characterization of Tank T-12 for transportation	1. Although concerns about liquid leaking from the wrapped tank existed, no consideration was given to re-characterizing the shipment for DOT as including liquid versus the original classification of Tank T-12 as a solid. 2. The person responsible for signing the shipping papers was not aware of the initial liquid in Tank T-12 and the efforts at solidification. 3. Personnel believed the dump truck was designed to hold liquid; therefore, any leakage from the tank would not be released outside the dump truck. This information was obtained from several interviews with BJC and SEC D&D personnel.

Table 3-1. Causal Factors (Continued)

Contributing Causes	Discussion
CC-1. SEC D&D's implementation of the QA Plan was inadequate	1. CAQs were not formally declared; therefore, the corrective actions taken were not adequately evaluated. 2. Personnel believed that field-found conditions did not require a formal evaluation. Since this was a D&D project, SEC D&D personnel interviewed stated that they usually do not know the condition of equipment in a facility until they go into the building. Therefore, they did not consider the as-found conditions to be a change in the baseline.
CC-2. BJC oversight was inadequate	1. BJC did not adequately communicate the changes in conditions associated with NHF to the appropriate subject matter experts. 2. BJC had oversight of this transportation activity and allowed a noncompliant shipment. 3. BJC personnel were involved in the decisions to deviate from the work control documents.
CC-3. DOE oversight was inadequate	1. The NHF Facility Representative and Program Manager assigned to this project were only aware of issues or concerns that were presented to them. This was due to limited availability on site due to multiple/conflicting priorities. 2. The NHF Facility Representative stated that he had no transportation responsibilities and that he did not inspect shipments or documentation pertaining to shipments. ORO EM management stated that transportation oversight was an expectation of ORO EM Facility Representatives as part of their routine operations. 3. ORO personnel have the perception that the current BJC contract hinders their ability to perform effective oversight.
CC-4. BJC and SEC D&D failed to use lessons learned in a proactive manner to prevent recurrence of similar incidents	Problems with characterization of other tanks, containers, and facilities within the ORR should have alerted management to this potential problem at the NHF. This information, if used in a proactive manner, should have required sampling of the contents of the Tank T-12 for accurate characterization. The spread of contamination by rainwater was noted in several occurrence reports, which are part of the BJC Lessons Learned Program. The Board found no evidence that this information was used at the NHF to prevent similar problems. Project controls failed to prevent rainwater intrusion into Tank T-12's wrappings. If the controls had been implemented, this would have prevented the mindset that any liquid collected in the wrappings on Tank T-12 was rainwater versus leakage from the tank itself.

Table 3-1. Causal Factors (Continued)

Contributing Causes (Continued)	Discussion
CC-5. No centralized point exists for collection of information and direction of response activities	1. Due to lack of a central clearing point for the survey information, vehicles traveled over the contaminated roadways after it was known that these roads were contaminated. 2. The initial road survey information was incorrect, which led to delays in making the decision to close the affected roads.

4.0 CONCLUSIONS AND JUDGMENTS OF NEED

Conclusions are a synopsis of the facts and analysis that the Board considers significant. The Judgments of Need shown in Table 4-1 on the following page include the managerial controls and safety measures determined by the Board to be necessary to prevent or minimize the probability or severity of a recurrence. These Judgments of Need are linked directly to the causal factors, which are derived from the facts and analyses and form the basis for corrective action plans, which are the responsibility of line management.

The Board concluded that:

- SEC D&D's work control process was not adequate to properly prepare Tank T-12 for safe transportation.

- SEC D&D's did not accurately characterize Tank T-12 for transportation.

- Neither BJC's nor ORO EM's oversight was adequate to ensure that SEC D&D's work control processes were adequate or that Tank T-12 was properly characterized for transportation.

- Neither SEC D&D's QA process nor BJC's and SEC D&D's lessons learned programs were adequately utilized.

The Judgments of Need focus on management systems and, if implemented, will accomplish the following:

- Improve SEC D&D's work control processes

- Ensure shipments are properly characterized in accordance with DOT regulations

- Improve BJC's and DOE's oversight

- Improve application of BJC's and SEC D&D's lesson learned programs.

Table 4-1. Judgments of Need

JON #	Judgments of Need	Contributing and Root Causes/ISM Function
Conduct of Work		
JON 1	SEC D&D needs to improve its work control processes to ensure that: 1. WIs are written with adequate detail to ensure workers properly perform the tasks. Hold points that require specific knowledge or verification are included in WIs. Reliance on skill of the craft should be used only where appropriate, based on the risks of the task and the qualifications of the workers. 2. Requirements from higher-tier plans (e.g., the WAC Attainment Plan and the *Waste Management Plan*) are included in WIs. 3. Supervisory oversight ensures WIs are implemented as written.	RC-1: SEC D&D had inadequate work control. RC-2: SEC D&D performed inadequate characterization of Tank T-12 for transportation. Applicable ISM Functions: Define the Work Scope, Analyze the Hazards
JON 2	SEC D&D needs to accurately characterize items being transported and ensure characterization is re-evaluated when a change in condition indicates that the original characterization could be incorrect.	RC-1: SEC D&D had inadequate work control. RC-2: SEC D&D performed inadequate characterization of Tank T-12 for transportation. Direct Cause: Tank T-12 was shipped in packaging (a dump truck) that allowed the release of radioactively contaminated liquid. Applicable ISM Functions: Analyze the Hazards, Develop and Implement Hazard Controls

Table 4-1. Judgments of Need (Continued)

JON #	Judgments of Need	Contributing and Root Causes/ISM Function
Conduct of Work (continued)		
JON 3	**JON 3a:** SEC D&D needs to improve the process for recognizing and communicating CAQs and to formalize corrective actions for CAQs. **JON 3b:** BJC and SEC D&D need to improve their change control process to ensure work plan changes affecting environment, safety, health, and QA are identified, appropriately analyzed, and communicated.	RC-1: SEC D&D had inadequate work control. CC-1: SEC D&D's implementation of its QA Plan was inadequate. CC-2: BJC's oversight was inadequate. Applicable ISM Function: Perform Work within Controls
Management Oversight		
JON 4	BJC needs to improve its day-to-day oversight of subcontractors to ensure work is performed in compliance with ISM.	CC-2: BJC's oversight was inadequate. Applicable ISM Function: Provide Feedback and Continuous Improvement
JON 5	BJC and SEC D&D need to strengthen their lessons learned programs in the area of application of lessons learned.	CC-4: BJC and SEC D&D failed to use lessons learned in a proactive manner to prevent reoccurrence of similar incidents. Applicable ISM Function: Provide Feedback and Continuous Improvement
JON 6	ORO and its prime contractors on the ORR need to modify emergency plans or other procedures to ensure a central command and control system is established for those events that are not classified as emergencies but affect the ORR.	CC-5: No centralized point exists for collection of information and direction of response activities. Applicable ISM Function: Provide Feedback and Continuous Improvement

Table 4-1. Judgments of Need (Continued)

JON #	Judgments of Need	Contributing and Root Causes/ISM Function
DOE Oversight		
JON 7	ORO EM needs to ensure that oversight responsibilities and expectations are clearly defined and that transportation activities receive the appropriate priority.	CC-3: DOE's oversight was inadequate. Applicable ISM Function: Provide Feedback and Continuous Improvement

5.0 BOARD SIGNATURES

Ralph Kopenhaver
DOE Accident Investigation Board Chairman
Senior Safety Advisor
NNSA, Livermore Site Office
U.S. Department of Energy

Telicia Mims
DOE Accident Investigator
Physical Scientist ES&H and EM
Oak Ridge Operations
U.S. Department of Energy

Mitch Hicks
DOE Accident Investigation Board Member
DOE Health Physicist
Environmental Management, Paducah
Oak Ridge Operations
U.S. Department of Energy

Dave McGinty
DOE Accident Investigation Board Member
System Engineer
NNSA, Y-12 Office
U.S. Department of Energy

Brian DeMonia
DOE Accident Investigation Board Member
Program Manager
Environmental Management, Oak Ridge Operations
U.S. Department of Energy

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6.0 BOARD MEMBERS, ADVISORS, AND STAFF

Chairperson	Ralph Kopenhaver, NNSA, Livermore Site Office
Trained Accident Investigator	Telicia Mims, DOE ORO
Member	Mitch Hicks, DOE ORO
Member	Dave McGinty, NNSA, Y-12 Site Office
Member	Brian DeMonia, DOE ORO
Transportation Safety Advisor	Dana Willaford, DOE ORO
Legal Advisor	Rob James, DOE ORO
Contractor Point of Contact	Daryl Mills, BJC
Contractor Point of Contact	Greg Boris, BJC
Technical Coordinator/Editor	Adrienne Diffin, Visionary Solutions, LLC
Technical Editor	Karen Brown, Parallax, Inc.
Administrative Support	Melisa Hart, Critique, Inc.

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Appendix A – Appointment Letter

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DOE F 1325.8
(3/02)

United States Government

Department of Energy
Oak Ridge Operations Office

Memorandum

DATE: May 21, 2004

REPLY TO ATTN OF: SE-32:Mullins

SUBJECT: **TYPE B INVESTIGATION - SUBCONTRACTOR RADIOACTIVE RELEASE DURING TRANSPORTATION ACTIVITIES - BECHTEL JACOBS COMPANY LLC, OAK RIDGE, TENNESSEE**

TO: Ralph R. Kopenhaver, Senior Safety Advisor, Livermore Site Office, LS

You are hereby appointed Chairperson of the Investigation Board to investigate the subject incident that occurred on May 14, 2004. 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 the Department of Energy (DOE) Order 225.1A, *Accident Investigations*, 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:

Telicia Mims, Assessment & Emergency Management Division, SE-32, Accident Investigator
David McGinty, Y-12 Site Office, Y12-50, Member
Brian DeMonia, Environmental Management, EM-92, Member
Mitch Hicks, Environmental Management, EM-92, Member

Rob James, Office of Chief Counsel, will serve as the legal liaison for the Board. 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. 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 June 28, 2004. Any delay in 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. A copy of the Oak Ridge Accident Investigation Guidelines is attached for your use. If you have any questions, please contact me or Robert W. Poe at 576-0891.

Gerald G. Boyd
Manager

Attachment:
ORO AI Guidelines

cc w/o attachment:
Jesse H. Roberson, EM-1, HQ/FORS
Paul M. Golan, EM-3, HQ/FORS
Patrice M. Bubar, EM-20, HQ/FORS
Milton D. Johnson, SC-3, HQ/FORS
Raymond J. Hardwick, EH-2, HQ/FORS
Robert A. Crowley, EH-2, HQ/FORS
Robert J. Brown, M-3, ORO
Stephen H. McCracken, EM-90, ORO
Donna M. Perez, EM-911, ORO
Steven L. Wyatt, M-4, ORO
Robert W. Poe, SE-30, ORO
Randall C. Smyth, EM-90, ORO
Jennifer Fowler, CC-10, ORO

Appendix B – Barrier Analysis

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Table B-1. Barrier Analysis

Barrier	Purpose	Analysis/Effect on Incident
Physical Barriers		
Strong Tight Container	Containment of waste during transportation	Characterization of Tank T-12 was inadequate for transportation, allowing for the selection of an improper container. The container chosen was designed to transport waste in a solid form. Using the dump truck as the Strong Tight container allowed for the liquid in Tank T-12 to be released.
Characterization of Liquid	Fully analyze the hazards to ensure proper treatment and disposal	• The pump/drain options were not fully evaluated. • The solidification process was not fully evaluated. • Decisions were made without the proper characterization data. This resulted in an attempt to solidify the liquid rather than removal.
Management Barriers		
Plans: - Work Instructions - Work Practices - Skill of the Craft	Provide adequate instruction according to skill of the craft to accomplish the work	The WIs were not adequately flowed down from higher-tier plans (i.e., the *Waste Management Plan* and the WAC Attainment Plan). The WIs did not contain enough detail on the acceptance criteria for solidification of cement or grout. Deviations from the WIs also occurred (i.e., placement of a plywood cap, use of Radsorb, and container selection). • The Work Plans were not implemented as written (i.e., the data quality objective was not met and CAQs were not considered). • Oversight of work practices, especially those considered to be skill of the craft, was less than adequate. As a result, the work was not performed to expectations.

Table B-1. Barrier Analysis (Continued)

Barrier	Purpose	Analysis/Effect on Incident
Management Barriers (Continued)		
Oversight (NHF)	Ensure performance with ISM requirements	SEC D&D: • The QA Program was not fully implemented, which resulted in poor communications and allowed a lack of formality of operations. • Management did not ensure that the WIs were effectively implemented. BJC: • Oversight of transportation was not effective. • Project information about the liquid was not shared with appropriate BJC subject matter experts. • Oversight of the SEC D&D WIs was inadequate. • BJC approved WIs that did not comply with upper-tier documents. DOE: • The NHF Facility Representative had conflicting priorities, which affected the level of oversight. • The NHF Facility Representative stated that he had no transportation responsibilities and that he did not inspect shipments or documentation pertaining to shipments. Management stated that oversight of transportation activities is a part of the routine oversight of operations for the NHF Facility Representative. • ORO personnel have the perception that the current BJC contract hinders their ability to perform effective oversight. Lack of adequate oversight was a missed opportunity to improve SEC D&D's ISM performance.

Table B-1. Barrier Analysis (Continued)

Barrier	Purpose	Analysis/Effect on Incident
Management Barriers (Continued)		
Lessons Learned	Learn from previous experiences	BJC and their subcontractors were not proactive in using lessons learned during planning of the NHF D&D Project work. Several leading indicators were missed. Therefore, some errors of the past were repeated.
Communication	Effective dissemination of information	Pertinent information was not passed on to the individuals making the decisions for the management of Tank T-12's transportation. The liquid was not properly solidified. Therefore, an improper shipping container was selected for the transport of Tank T-12.

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Appendix C – Change Analysis

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Table C-1. Change Analysis

Normal "Ideal"	Actual Condition	Analysis
Measurements of the liquid inside Tank T-12	Visual methods were used to estimate the level of the liquid in Tank T-12.	The lack of an actual measurement of the liquid in Tank T-12 affected the amount of Portland cement that should have been added to ensure stabilization of the liquid. Since estimates varied from 10 to 18 inches as to the amount of liquid observed, an accurate calculation to determine the amount of Portland cement that should have been added to stabilize the liquid did not occur. Also, no formal verification was performed to ensure that the liquid was stabilized. The lack of formal verification to ensure that the stabilization attempt was successful allowed liquid to remain in the tank.
Characterization of the liquid in Tank T-12	No characterization was performed on the liquid found in Tank T-12.	Assumptions about the characteristics of the liquid within Tank T-12 eliminated the option to drain its contents to Tank T-13. Tank T-13 had already been characterized and was in the closure approval process with the State. The chosen option, addition of Portland cement for stabilization, was affected by the pH of the liquid. The lack of characterization of the liquid in Tank T-12 resulted in choosing an option that may not have been effective in stabilizing the liquid.

Table C-1. Change Analysis (Continued)

Normal "Ideal"	Actual Condition	Analysis
The Quality Improvement Process and an evaluation against the ALARA plan would be implemented	A CAQ was not generated to address the deviation from the *Waste Management Plan* that had been approved by TDEC and EPA, nor was an evaluation against the ALARA plan performed.	The generation of a CAQ would have ensured that the NHF D&D Project fully ascertained the risks and uncertainties associated with the liquid in Tank T-12. Also, an evaluation of the treatment options for the liquid against the ALARA plan could have potentially shown that the use of the Portland cement to stabilize the liquid (versus draining or pumping the tank) would have incurred longer stay times. The effective implementation of the Quality Improvement Process and an evaluation against the ALARA Plan for all of the tasks being performed in connection with stabilizing the liquid in the tank would have ensured that the project fully ascertained the situation.
No liquid would be leaking from the wrapped tank	Liquid leaked from the wrapped tank.	There was one instance noted of Tank T-12 leaking from a flange that had been sealed with plywood while the tank was being lifted and wrapped for interim storage in the T-13 Annex. Several instances of liquid leaking from the wrapped Tank T-12 were observed during additional movements of the tank. An analysis of the source of the liquid did not occur. It was assumed that the leakage from the wrapping was rainwater. Therefore, the potential for the existence of liquid in Tank T-12 was discounted.

Table C-1. Change Analysis (Continued)

Normal "Ideal"	Actual Condition	Analysis
No liquid would be leaking from the wrapped tank (Continued)	Liquid leaked from the wrapped tank.	A static test was performed to test for leaks prior to Tank T-12 being shipped. However, this was not an adequate evaluation of Tank T-12 in transport, which is dynamic, nor is it a DOE-accepted testing methodology for liquid. Results of the static testing led the project team to believe that there was no additional liquid. This led to Tank T-12 being shipped in an inappropriate package.
Plans and instructions would be implemented as written	The treatment chosen for the liquid was a deviation from the *Waste Management Plan.*	The *Waste Management Plan* was a commitment to TDEC and EPA to treat all liquid encountered during the NHF D&D Project at the LLLW System. Following the *Waste Management Plan* would have eliminated the liquid remaining in Tank T-12.
Proper packaging used to transport Tank T-12	A dump truck was the package used to transport Tank T-12.	A dump truck was the package used for the transportation of Tank T-12, which was depicted to be a solid per DOT regulations. Even though leaks were observed while preparing Tank T-12 for transport, no thought was given to the fact that the dump truck was not an approved package for the transport of an item that contained liquid.
Closure of roads in a timely manner	The closure of roads was not timely.	Initial misinformation received about the roads outside of the EMWMF reported that they were not contaminated. Two hours lapsed before the contamination of the roads outside of the EMWMF was reported. This allowed for the contaminated areas to be traversed by employees and the public.

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Appendix D – Events and Causal Factors Chart

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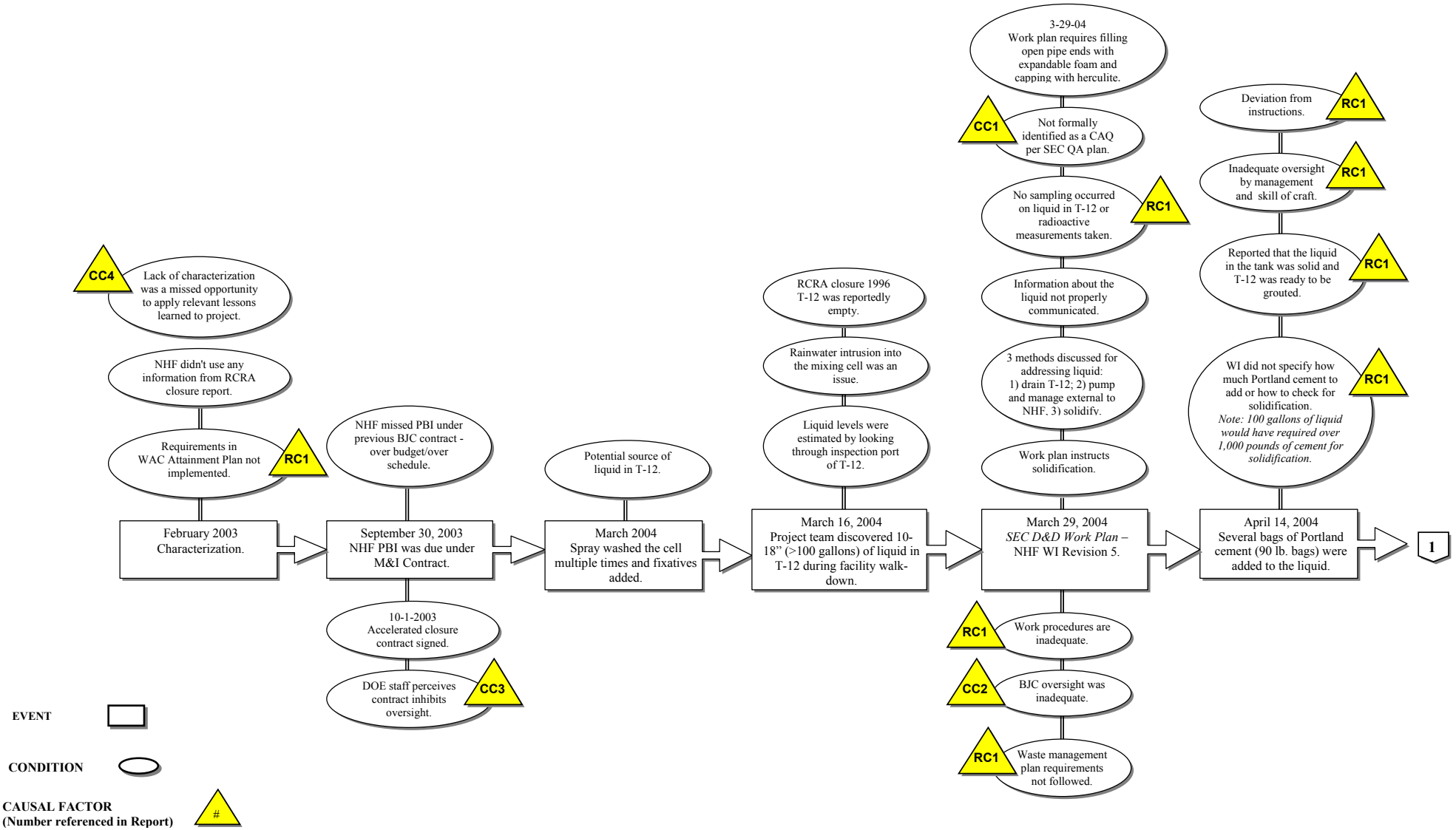
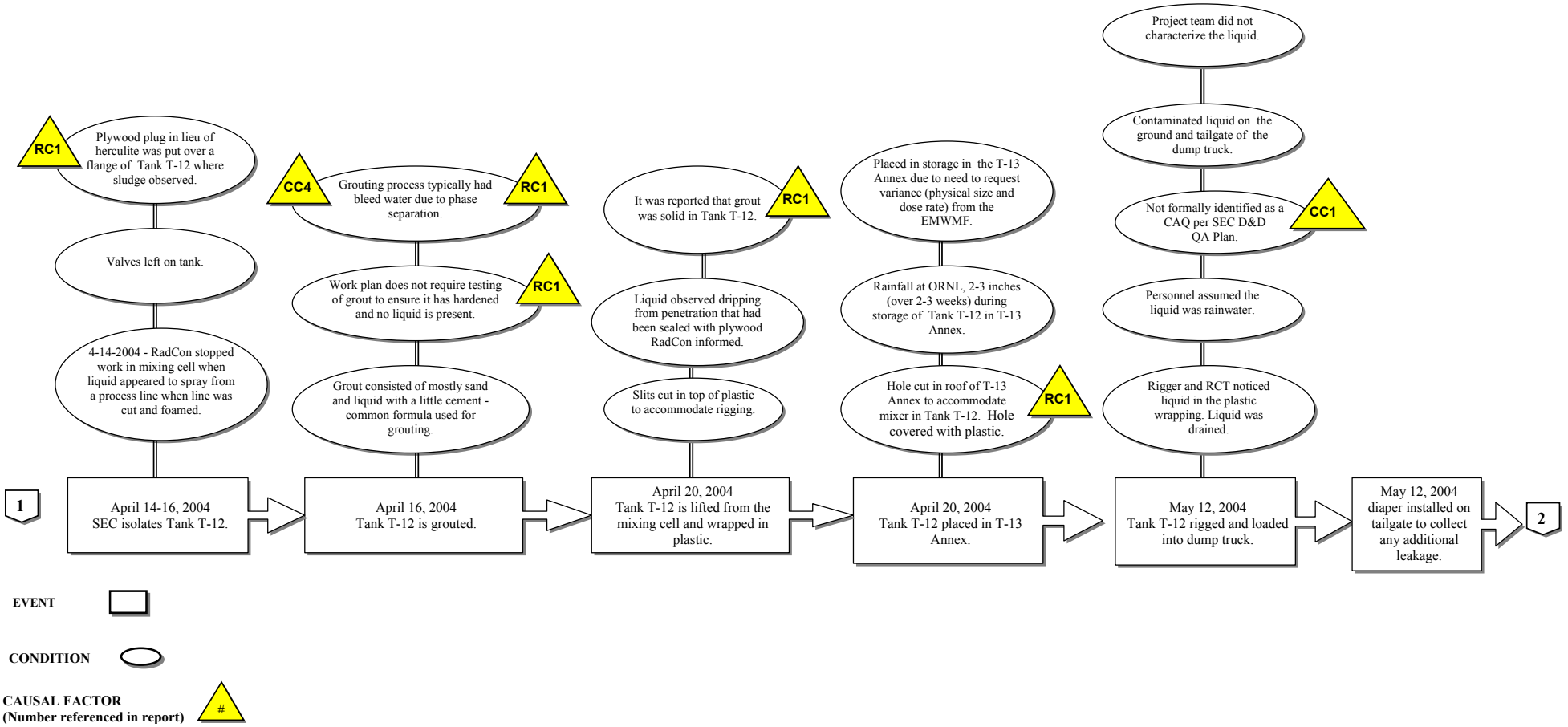
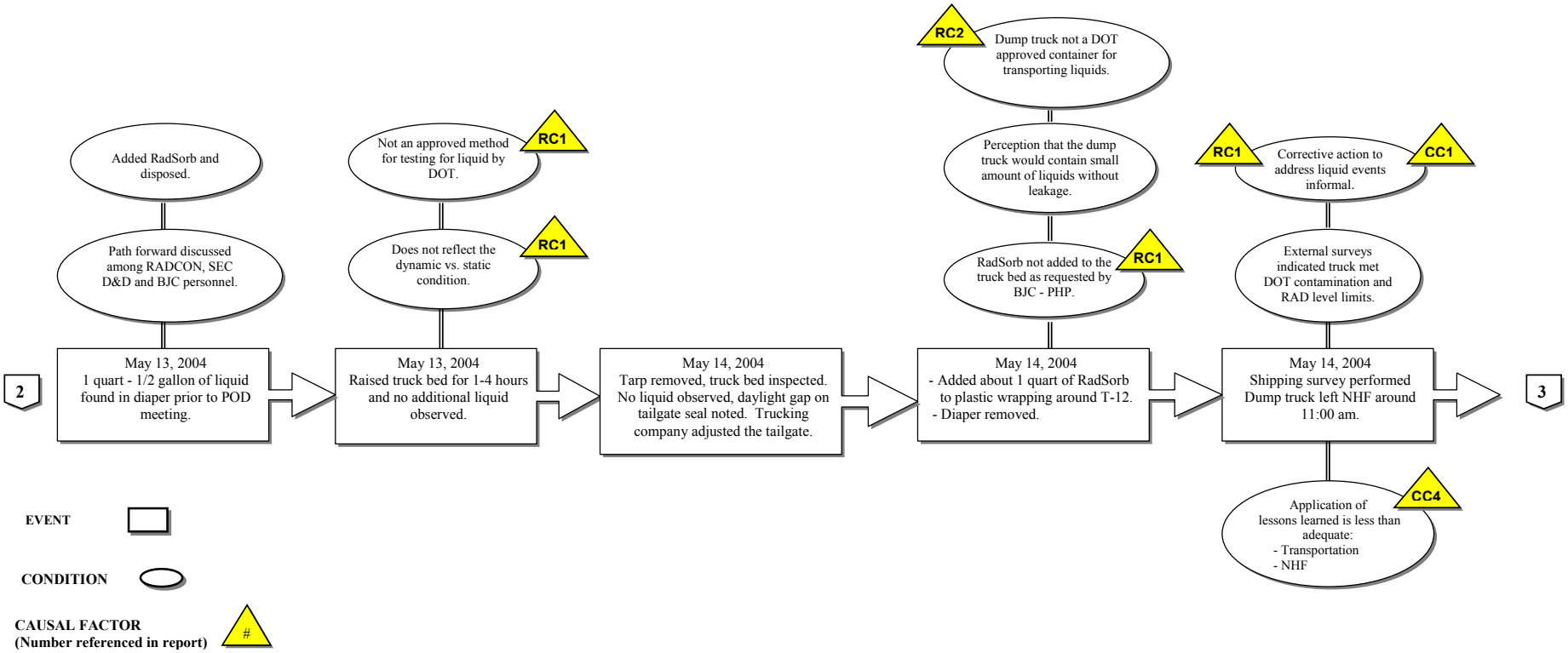
Event and Causal Factors Chart
Subcontractor Radioactive Release During Transportation Activities



Event and Causal Factors Chart
Subcontractor Radioactive Release During Transportation Activities

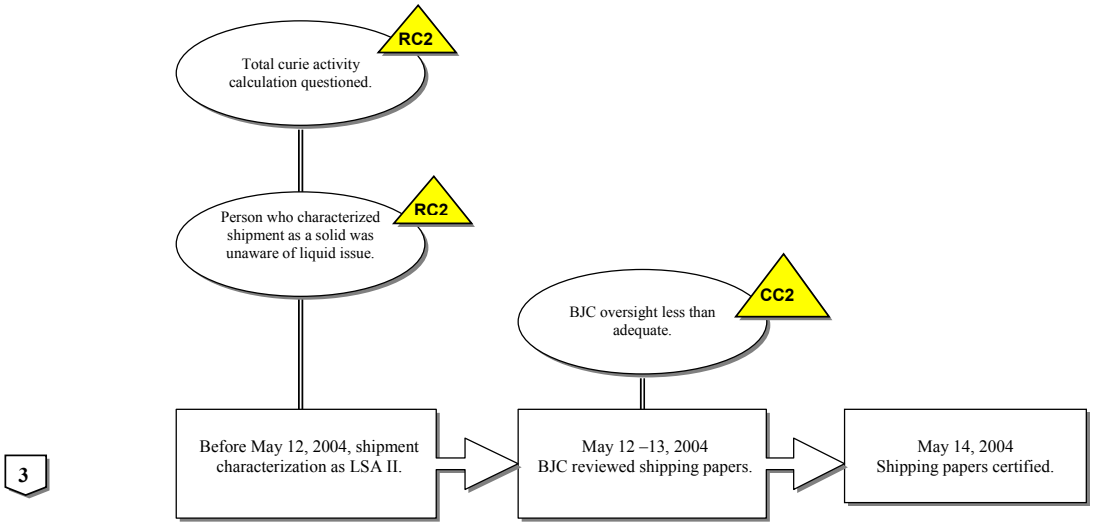


Event and Causal Factors Chart
Subcontractor Radioactive Release During Transportation Activities



Event and Causal Factors Chart
Subcontractor Radioactive Release During Transportation Activities

Events Pertaining to Transportation



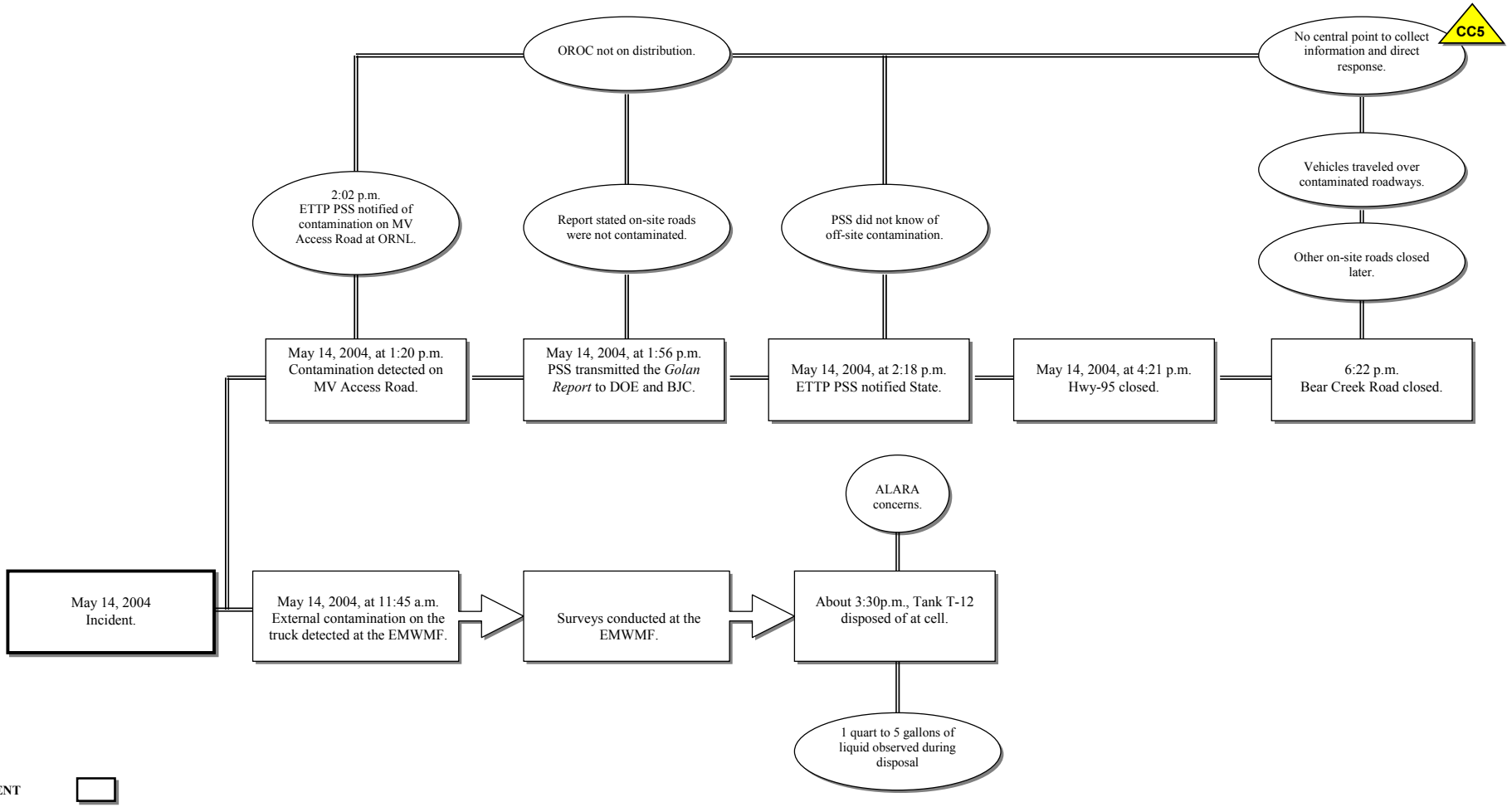
EVENT

CONDITION

CAUSAL FACTOR
(Number referenced in report) #

Event and Causal Factors Chart
Subcontractor Radioactive Release During Transportation Activities

Events Pertaining to Notification and Response



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Appendix E – Lessons Learned

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Table 3.4.1: Summary Listing of Occurrences/Lessons-Learned

#	Facility	Report Date	Report Number	Title/Description	Trend Category
1	Environmental Restoration	3/11/04	BJC-X10ENVRES-2004-0003	Skin Contamination at New Hydrofracture Facility (NHF)	Contamination
2	Environmental Restoration	3/09/04	BJC-X10ENVRES-2003-0019 (LL)	Radiological Contamination Discovered on Transport Trailer	Contamination Note: Levels below DOT but above DOE requirements
3	Environmental Restoration	3/05/04	BJC-PGDPENVRES-2004-0003	Potential Inadequate Safety Basis (PISB) for the C-410 Tank Farm	Categorization of Empty Tanks
4	Environmental Restoration	01/12/04	BJC-X10ENVRES-2004-0001	Personnel Contamination at Bldg. 7860	Contamination
5	Environmental Restoration	12/31/03	BJC-X10ENVRES-2003-0020	Personnel Contamination at New Hydrofracture Facility, Bldg.7860	Contamination
6	Waste Management & Remedial Action	12/19/03	BJC-X10WSTEMRA-2003-0013	Follow-Up RCRA NOV from TDEC	Permit Violations NOV
7	Waste Management	12/19/03	BJC-Y12WASTE-2003-0012	RCRA NOV from TDEC	Permit Violations NOV
8	Waste Management	12/08/03	BJC-Y12WASTE-2003-0003 (LL)	Discovery of Spilled Mixed Low-Level Waste Material in Railroad Boxcar	Contamination Transportation (DOT)
9	Waste Management	12/08/03	BJC-Y12WASTE-2003-0005 (LL)	Discovery of Spilled Mixed Low-Level Waste Material in Railroad Boxcar	Contamination Transportation (DOT)
10	Waste Management	12/08/03	BJC-Y12WASTE-2003-0008 (LL)	A Strong-Tight (ST-5) Waste Container Dropped from a Fork Truck	OSHA
11	Environmental Restoration	12/01/03	BJC-X10ENVRES-2003-0006 (LL)	Management Concern at NHF Building 7860	Spill Containerization
12	Environmental Restoration	12/01/03	BJC-X10ENVRES-2003-0008 (LL)	Release of Contaminated Water at Old Hydrofracture Facility Injection Well	Spill
13	Environmental Restoration	11/21/03	BJC-X10ENVRES-2003-0019	Radiological Contamination Discovered on Transport Trailer	Contamination Note: Levels below DOT but above DOE requirements
14	Environmental Restoration	11/11/03	BJC-PGDPENVRES-2003-0019	Potential Inadequate Safety Analysis Related to Trap Mix Discovery Issue	Characterization
15	Environmental Restoration	11/14/03	BJC-PORTENVRES-2003-0017 (LL)	*Actual Testing Plus Knowledgeable SMEs Important to Characterization (title not available—description provided by reviewer)*	Characterization

Table 3.4.1: Summary Listing of Occurrences/Lessons-Learned (Continued)

16	Environmental Restoration	11/14/03	BJC-X10ENVRES-2003-0004 (LL)	Legacy Contamination Found at HFIR Tank	Contamination
17	Environmental Restoration	09/24/03	BJC-X10ENVRES-2003-0014	Personal Clothing Contamination During New Hydrofracture Facility (NHF) D&D Work	Contamination
18	Environmental Restoration	09/26/03	BJC-X10ENVRES-2003-0015	Personnel Contamination at New Hydrofracture Facility	Contamination
19	Environmental Restoration	09/05/03	BJC-X10ENVRES-2003-0012	Fuel Truck Accident at New Hydrofracture Facility	Transportation
20	Environmental Restoration	08/19/03	BJC-X10ENVRES-2003-0010	SWSA 6 Remedial Action Stored Waste Inventory	Characterization
21	Waste Management & Remedial Action	08/19/2003	BJC-X10WSTEMRA-2003-0010	Notice of Violation (NOV) Improper Blocking/Bracing of Waste Containers	Permit Violations NOV Blocking & Bracing
22	Waste Management	08/14/03	BJC-K25WASTMAN-2003-0007	Notice of Violation (NOV) Improper Blocking/Bracing of Waste Containers	Permit Violations NOV Blocking & Bracing
23	Environmental Restoration	08/05/03	BJC-PORTENVRES-2003-0011 (LL)	Dropped Shear Head	Accident Stop Work Authority
24	Environmental Restoration	08/01/03	BJC-PGDENVRES-2003-0009 (LL)	Un-reviewed Safety Question (USQ) Due to Radiological Material Inventory	Characterization
25	Waste Management & Remedial Action	07/28/03	BJC-X10WSTEMRA-2002-0007 (LL)	Fixed Contamination Discovered on Flatbed Trailer Outside of A Controlled Area	Contamination Requirements
26	Waste Management	07/23/03	BJC-Y12WASTE-2003-0009	Trailer with Fixed Contamination Discovered on Arrival at Nevada Test Site (NTS)	Contamination 10 CFR 835
27	Waste Management	07/25/03	BJC-Y12WASTE-2003-0010	Contamination of Operators During Sludge Transfer	Contamination
28	Waste Management	07/22/03	BJC-K25WASTMAN-2002-0004 (LL)	Storage of Waste Outside Authorization Basis of the Facility	Characterization
29	Environmental Restoration	07/22/03	BJC-X10ENVRES-2001-0033 (LL)	Inadequate Safety Assessment – Storage Casks Located Outside Building	Safety Basis Containers/casks
30	Environmental Restoration	07/22/03	BJC-X10ENVRES-2002-0011 (LL)	Determination of Category III Material Quantities in Old Hydrofracture (OHF) Waste Container Staging Area	Safety Basis As-Found-Condition
31	Waste Management	07/22/03	BJC-Y12WASTE-1999-0006 (LL)	Discovery of Condition Revealing Inadequacy in Approved Authorization Basis	Hazard Categorization
32	Environmental Restoration	07/17/03	BJC-X10ENVRES-2003-0009	Boot Contamination During Subsurface Survey at Building 7860	Contamination

Table 3.4.1: Summary Listing of Occurrences/Lessons-Learned (Continued)

33	Waste Mgt	07/17/03	BJC-K25WASTMAN-2003-0006 (LL)	Spread of Contamination Due to Accumulated Contaminated Rainwater	Contamination Rainwater
34	Environmental Restoration	07/15/03	BJC-X10ENVRES-2003-0002 (LL)	Cut Into Energized Conduit at Building 7860	Independent Verification Accident
35	Environmental Restoration	07/15/03	BJC-X10ENVRES-2003-0003 (LL)	Legacy Contamination Encountered During Excavation	Contamination Work-controlling documents
36	Environmental Restoration	07/01/03	BJC-X10ENVRES-2003-0008	Release of Contaminated Water at Old Hydrofracture Facility Injection Well	Contamination
37	Waste Mgt	06/30/03	BJC-Y12WASTE-2003-0002 (LL)	Gaseous Material Release at Land Disposal Facility	Waste Characterization Emergency Planning
38	General Op. & Landlord Activities	06/24/03	BJC-K25GENLAN-2003-0006 (LL)	Violation of Department of Transportation (DOT) Hazardous Material Regulations	Transportation (DOT)
39	Waste Management	06/27/03	BJC-K25WASTMAN-2002-0009 (LL)	Discovery of Removable Radioactive Surface Contamination of TSCA Incinerator Tanker Truck	Contamination
40	Waste Mgt & Remedial Action	06/18/03	BJC-X10WSTEMRA-2003-0005	Notice of Violation Resulting from TDEC Resource Conservation and Recovery Act (RCRA) Inspection At ORNL	NOV Permit Violation Characterization Waste Analysis Plan
41	Environmental Restoration	06/11/03	BJC-PGDPENVRES-2003-0009	Potential USQ Due to Radiological Material Inventory	Characterization
42	Environmental Restoration	06/06/03	BJC-X10ENVRES-2003-0006	Management Concern at NHF Building 7860	Spill
43	Waste Management	05/30/03	BJC-K25WASTMAN-2003-0006	Spread of Contamination Due to Accumulated Contaminated Rainwater	Contamination Rainwater
44	Waste Mgt & Remedial Action	05/19/03	BJC-X10WSTEMA-2003-0003	Potential USQ Concerning Liquids and Pressurized Aerosol Cans in Legacy Waste Containers at ORNL	Characterization
45	Environmental Restoration	05/20/03	BJC-PORTENVRES-2003-0004 (LL)	G-17 Valve Falls Off of Flatbed Truck	Unsecured Loads Transportation (DOT)
46	General Op. & Landlord Activities	05/15/03	BJC-K25GENLAN-2003-0002 (LL)	Improper Shipping Papers for Disposition of PCB Light Ballasts	Transportation (DOT) Characterization

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Appendix F – Tank T-12 Spill Overview Map

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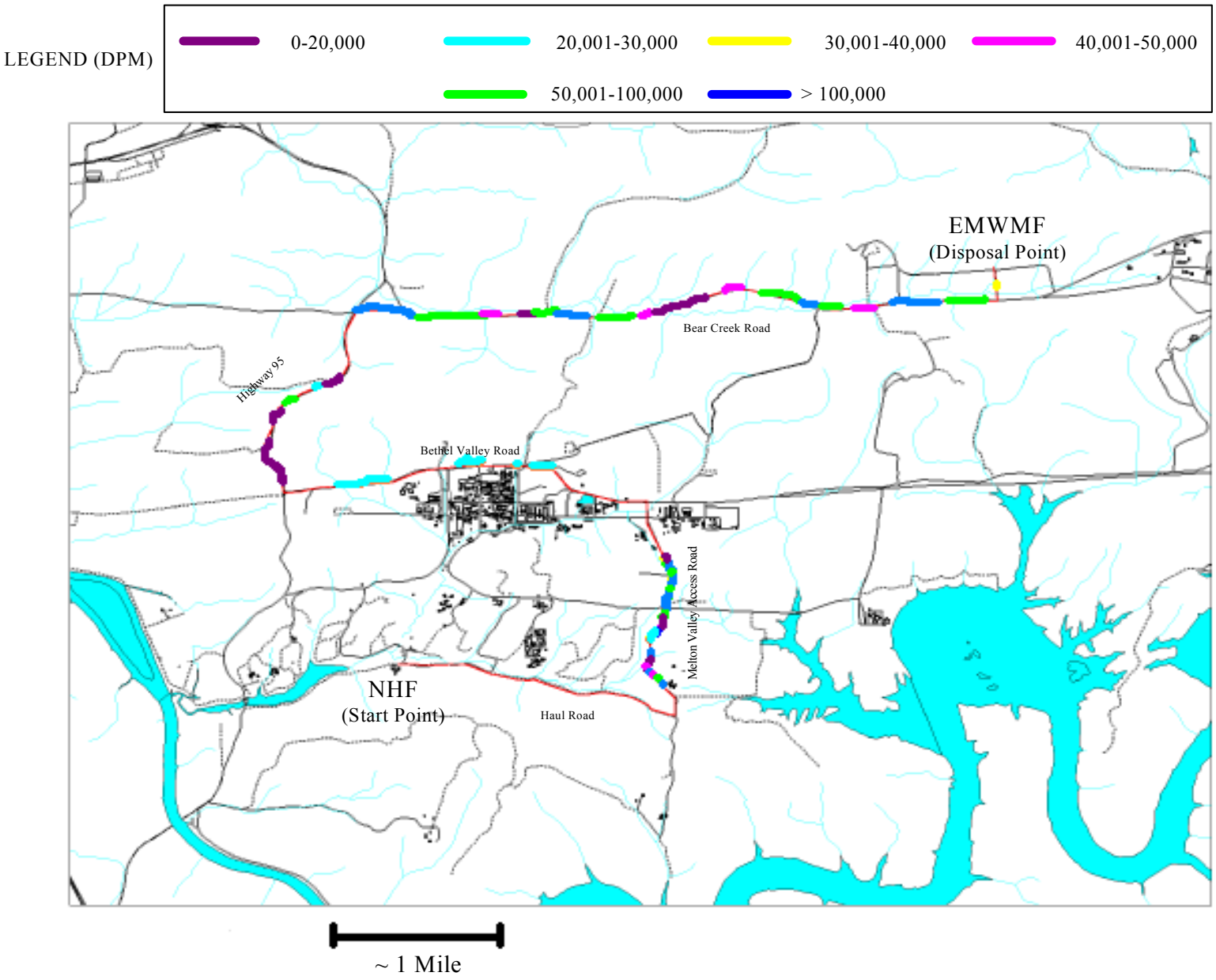
BJC Radiological Survey Map
T-12 Spill Overview



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Appendix G – New Hydrofracture Facility

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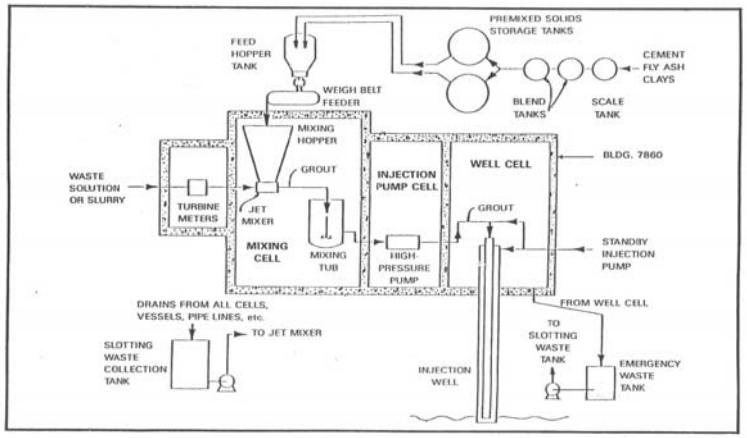
PRE-DEMOLITION



Containment Structure

Pump Room B

MARCH 13, 2004

17

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