

U.S. Department of Energy
Richland Operations Office

July 2009

DOE/RL-2009-83

Type B Accident Investigation Report

**Washington Closure Hanford, LLC
Employee Fall Injury on July 1, 2009,
at the 336 Building, Hanford Site,
Washington**

Approved for Public Release;
Further Dissemination Unlimited

Type B Accident Investigation Report

Washington Closure Hanford, LLC Employee Fall Injury on July 1, 2009, at the 336 Building, Hanford Site, Washington

Date Published
July 2009

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management



U.S. DEPARTMENT OF
ENERGY

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Office

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Release Approval 07/31/2009
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Acceptance Statement:

On July 2, 2009, I established a Type B Accident Investigation Board to investigate the Type B employee fall injury at the 336 Building, Hanford Site, Washington, that resulted in significant injuries to the employee. The Board's responsibilities have been completed with respect to this investigation. The analysis process, identification of causal factors, and development of judgments of need were performed during the investigation in accordance with DOE O 225.1A, *Accident Investigations*. I accept the findings of the Board and authorize the release of this report for general distribution.



David A. Brockman
Manager, Richland Operations Office
U.S. Department of Energy

7/30/09
Date

Disclaimer:

This report is an independent product of the Type B Accident Investigation Board appointed by David A. Brockman, Manager of the Richland Operations Office, U.S. Department of Energy. The Board was appointed to perform a Type B investigation of this accident and to prepare an investigation report in accordance with DOE O 225.1A, *Accident Investigations*.

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

This report neither determines nor implies liability.

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Acronyms and Abbreviations

Board	Type B Accident Investigation Board
CAMS	Corrective Action Management System
CF	Core Function
CONOPS	Conduct of Operations
D4	Deactivation, Decontamination, Decommissioning, and Demolition
DOE	U.S. Department of Energy
EMT	emergency medical technicians
e-stop	emergency stop
FFTF	Fast Flux Test Facility
FHI	Fluor Hanford, Inc.
FPOC	Facility Point-of-Contact
FPP	fall protection procedure
FR	Facility Representative
ft.	foot/feet
GP	Guiding Principle
HAMTC	Hanford Atomic Metal Trades Council
hazmat	hazardous material
HFD	Hanford Fire Department
IEP	Integrated Evaluation Plan
IH	Industrial Hygiene
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
IWCP	Integrated Work Control Program
JHA	job hazard analysis
JON	judgment of need
LLNL	Lawrence Livermore National Laboratory
MORT	Management Oversight and Risk Tree
OA	Operational Awareness
ONC	Occurrence Notification Center
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PNL	Pacific Northwest Laboratory (pre-1996)
PNNL	Pacific Northwest National Laboratory
POC	Patrol Operations Center
POD	plan-of-the-day
POS	personal observer statements
POW	plan-of-the-week
pre-ev	pre-evolution
PSR	Project Safety Representative
R2A2	roles, responsibilities, authorities, and accountabilities
RCOC	River Corridor Closure Contract
RL	Richland Operations Office
RM	Responsible Manager
S&M	surveillance and maintenance
SME	subject matter expert

SPOC Single Point-of-Contact
URS URS Corporation
WCH Washington Closure Hanford, LLC
WPF Work Process Form

Executive Summary

The Accident

During D4 project demolition preparation work on the morning of July 1, 2009, in Hanford's 300 Area, a millwright fell 50 feet from a catwalk and was severely injured. The millwright was part of a Washington Closure Hanford, LLC (WCH) team of craft personnel preparing a bridge crane for removal from the 336 Building. While completing final tasks on the crane, the millwright was walking toward the west end of the catwalk and stepped through an open hatch. The millwright struck a midpoint platform 25 feet below the catwalk and then fell another 25 feet to the concrete floor. The millwright survived the fall, but cracked two vertebrae in his back, broke bones in both legs, and damaged his left knee. There were no head or other internal injuries.

As part of the 336 Building demolition planning efforts, it was considered the safest method to demolish the 65-ft. high building included pulling the building bridge crane out prior to shearing the building structural beams. Once the crane was removed, high reach equipment would be used to demolish the building. The initial scope of work to prepare the crane for removal was to access the crane catwalk, remove the crane rail stops, disengage the travel wheels to allow free-wheeling, and cut the crane's lifting cable so it could be used to pull the crane out. Work began on June 30 and involved three riggers. During the day the riggers identified additional tasks necessary to prepare the crane for removal and discussed these changes with the Work Supervisor. These changes included the need for millwright support to accomplish free-wheeling of the crane's travel wheels. The next day, July 1, two riggers and two millwrights ascended the ladder to the catwalk and began working. The millwrights soon identified the need to remove the gear boxes associated with the travel wheels in order to accomplish their work scope. During this time, one of the riggers descended from the catwalk to replace the ground support rigger who had left to obtain some needed materials. The catwalk hatch cover was closed behind him by one of his co-workers. After the remaining three workers believed they were almost finished with the job, Millwright 2 began descending the ladder. The hatch was left open, with the thought that Millwright 1 would follow behind him. During this time, the ground support rigger had returned and called up to direct one additional task that required two people to accomplish: secure the crane trolley to the bridge with chains and tensioners. The remaining crew members on the catwalk, a rigger and a millwright, concluded the safest method to apply the chains would be to bring the crane closer to them by pushing the crane wheels from both ends of the crane bridge. As Millwright 1 walked toward the west end of the catwalk, he did not notice the open hatch, stepped into it and fell 50 feet.

After the millwright fell to the ground, his co-workers responded by calling 373-3800—Hanford Patrol Operations Center (POC)—and then rendering assistance by keeping him calm and still. Emergency personnel from the Hanford Fire Department (HFD) arrived at the scene in six minutes and 19 seconds. The millwright remained conscious throughout the event. HFD emergency medical technicians (EMTs) evaluated his injuries, stabilized him, and transported him to Kadlec Medical Center in Richland, Washington. After two weeks in the hospital, the millwright was released to continue recovery over the next several months.

After the accident WCH management secured the scene, made appropriate notifications, suspended all elevated work, and held a fact finding meeting. The U.S. Department of Energy (DOE) Richland Operations Office (RL) decided to perform a Type B accident investigation that afternoon and the

Accident Investigation Board (Board) was appointed by the RL Manager on July 2, 2009. The Board convened on Monday, July 6, 2009. URS Corporation (URS), a parent company to WCH, also initiated an independent corporate investigation on July 6. The URS investigation team and their efforts did not conflict with the Board's investigation.

Facility Description

The High Bay Testing Facility (336 Building) was built in 1969 and housed experimental equipment for the study of sodium properties in support of the Fast Flux Test Facility (FFTF) development. The building is 50 ft. x 50 ft. by 65 ft. high with a 50-ft. deep pit. The total square footage of the building is 6,438.

The building was transferred to Pacific Northwest Laboratory (PNL) in 1986 where use as a high bay mechanical testing facility continued. The building is not radiologically contaminated and no radioactive materials were ever used in the building. The surplus 336 Building was transitioned to WCH for eventual deactivation, decontamination, decommissioning, and demolition (D4) in August 2008.

Analysis and Results

Concerning the 300 Area D4 project, the Board concludes the following:

- The recognized shortage of work supervisors and PSR resources, the pace of work, and the inadequacies of work planning have been normalized by contractor management and the 300 Area work force.
- Implementation of the contractor's work control process was not adequate to sufficiently identify the work scope, hazards, and associated controls to safely perform the bridge crane removal from 336 Building.
- The contractor's supervisory and safety oversight methods and resources were inadequate to support safe execution of the 336 Building bridge crane removal activities.
- The fall protection procedure and its implementation does not fully comply with Occupational Safety and Health Administration (OSHA) standards and did not provide adequate protection to the workers.

These were the root causes of the accident. In addition the Board identified three causal factors that contributed to the accident and response.

WCH management recognized that critical personnel resources were either lacking or strained in the 300 Area. Although WCH re-prioritized some work toward perceived lower risk facilities, this action alone was not adequate to balance work priorities and rigors of work planning, control, and oversight for work execution to ensure the safety of the work force.

The integrated work control procedure was not consistently or adequately applied. Work scope, hazards, and related controls were not adequately defined. For example, the two walk downs conducted during the 336 Building work package and job hazard analysis (JHA) planning phase were conducted at the floor level only, preventing a thorough examination of the work area leading to inadequate work scope and hazard recognition. Coordination and communication affecting work

planning and execution was less than adequate. Work scope changes were not adequately managed to assess additional hazards and controls. Had key work scope changes been recognized, a formal change to the work package would have been required providing an opportunity to analyze any new hazards, evaluate the existing controls, and if necessary generate additional controls. Perceived schedule pressure was a significant contributor in failing to adequately plan the work.

Multiple assignments to supervisors and project safety representatives (PSRs) resulted in diminished oversight and were not sufficient to ensure adequate hazard controls were identified and implemented for the work being performed. The work supervisor initially assigned to the 336 Building demolition preparation had multiple existing assignments and was not familiar with the work plan, which resulted in the 300 Area D4 Superintendent assuming the duties of the direct work supervisor for this activity. Key supervisory and safety personnel did not execute their roles and responsibilities consistent with their authority and accountability.

The fall protection procedure content was not adequate to clearly convey the applicable regulatory requirements to the work force. The fall protection training failed to provide adequate information and instill an acceptable understanding of hazards and requirements. Staff failed to comply with WCH's fall protection procedure and the structural engineering recommendations for anchorage locations. Had the applicable OSHA requirements been followed, the injured millwright would have been tied off when the hatch was open or an engineering control would have been in place between him and the opening.

It is very fortunate that the worker survived this fall. The Board personally extends its best wishes to him for a full recovery from his injuries. This accident was clearly preventable.

WCH and the injured millwright's co-workers have extended extraordinary care for him. The millwright has 26 years of experience at Hanford and is well respected by his peers and management, not only for his skills and abilities, but also for his high regard toward performing work safely.

The following table contains the Board's conclusions and the resulting judgments of need (JONs).

Table ES-1. Conclusions and Judgments of Need

Conclusions	Judgments of Need
<p>The injured millwright fell through the open catwalk hatch due to multiple distractions and interruptions while workers were performing an unplanned and unanalyzed task.</p> <ul style="list-style-type: none"> • Multiple distractions, including collection of containers for gear box oil, retrieval of cable/chain for securing trolley, and the perception that work was complete when the guardrail was being cut, caused workers to leave the catwalk and violate the “team up, team down” hatch control concept, resulting in the hatch being left open. • None of the workers stopped/paused work when activities went beyond the defined scope. • Millwright 2 assumed that Millwright 1 was following right behind him when he descended the ladder, and did not request others to close the hatch. • Millwright 1’s mindset after the discussion with Rigger 3 about moving the crane caused Millwright 1 to focus on proceeding to the end of the catwalk to initiate the task of moving the crane. • Millwright 1 assumed he had an adequate walkway. 	<p>JON 1 - WCH needs to develop a strategy to change the culture associated with stop work/pause work from a perceived personal risk to an actual reward-based system.</p> <p>JON 2 - WCH needs to develop a pre-ev standard that encourages more interactive discussion of the work scope, hazards, and controls as documented in the Integrated Work Control Program (IWCP) task instructions and the JHA.</p> <p>JON 3 - WCH needs to utilize enhanced communication techniques, such as “repeat backs,” for critical or hazardous tasks.</p>
<p>The recognized shortage of work supervisor and PSR resources, the pace of work, and the inadequacies of work planning have been normalized by contractor management and the 300 Area work force.</p>	<p>JON 4 - WCH needs to balance its work schedule commensurate with its trained and qualified work force, and continually assess the work force’s capabilities and limitations, and employ them accordingly to perform work safely.</p> <p>JON 5 - WCH needs to perform an independent causal analysis on root causes 1 and 2, and contributing cause 1 to identify extent of causes and other latent organizational weaknesses, and supplement the JONs responses with additional corrective actions as necessary.</p> <p>JON 6 - WCH needs to re-evaluate the roles, responsibilities, authorities, and accountabilities (R2A2s) and hold personnel accountable for those who plan, concur on, and approve work packages and JHAs; and those who supervise or provide oversight of planned work.</p>
<p>Implementation of the contractor’s work control process was not adequate to sufficiently identify the work scope, hazards, and associated controls to safely perform the bridge crane removal from 336 Building.</p> <ul style="list-style-type: none"> • The integrated work control procedure was not consistently applied throughout the D4 project. • Work scope, hazards, and related controls were not adequately defined. • Coordination and communication affecting work planning and execution was less than adequate. • Work scope changes were not adequately managed to assess additional hazards and controls. • Perceived schedule pressure was a significant contributor in failing to adequately plan the work. 	<p>JON 7 - WCH needs to ensure that the full scope of work within each Type 1 and Type 2 work package is comprehensively evaluated and planned, including full and complete walk downs to identify potential hazards as part of the JHA process prior to the release of work.</p> <p>JON 8 - WCH needs to utilize an independent review of completed IWCPs/JHAs prior to work release for all D4 projects until a level of assurance is achieved that the work planning and control process is being executed as designed by management.</p> <p>JON 9 - WCH needs to clearly delineate the boundaries for skill-of-the-craft work versus detailed planned work, such that hazards are adequately analyzed and controlled.</p> <p>JON 10 - WCH needs to instill a workforce culture that understands and takes appropriate action when the actual work being performed begins to extend beyond the planned and analyzed work scope.</p> <p>JON 11 - WCH needs to ensure that all work conducted within the River Corridor Closure Contract (RCCC), including work release, will be performed under a single PAS-2-1.1 IWCP.</p>

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Conclusions	Judgments of Need
<p>The contractor's supervisory and safety oversight methods and resources were inadequate to support safe execution of the 336 Building bridge crane removal activities.</p> <ul style="list-style-type: none"> Normalized risk of scheduled work with known understaffing of key resources. Multiple assignments did not allow sufficient resources to be consistently available to provide oversight for the level of work being performed. Key supervisory and safety personnel did not execute their roles and responsibilities consistent with their authority and accountability. Perceived schedule pressure was a significant contributor in failing to adequately plan the work. 	<p>JON 12 - WCH needs to develop a staffing strategy (recruitment, qualification, assignment, retention) in order to ensure adequate availability of competent planning, supervisory, and safety personnel to support safe execution of work.</p> <p>JON 13 - WCH needs to balance its work schedule commensurate with its trained and qualified work supervisors and PSRs, and continually assess their capabilities and limitations in order to perform work safely.</p> <p>JON 14 - WCH needs to establish an expectation that all D4 work involving critical or hazardous tasks require effective barriers and the continuous presence of either a work supervisor or PSR to ensure work is performed safely.</p>
<p>The fall protection procedure and its implementation do not fully comply with applicable OSHA standards and did not provide adequate protection to the workers.</p> <ul style="list-style-type: none"> The fall protection procedure content is not adequate to clearly convey the applicable regulatory requirements to the work force. The fall protection training failed to provide adequate hands-on demonstration, performance testing, and understanding of the hazards and requirements. Staff failed to comply with WCH's fall protection procedure and the structural engineering analysis recommendations. 	<p>JON 15 - WCH needs to re-evaluate its fall protection program in its entirety, preferably utilizing external SMEs with regard to OSHA requirements. Minimum changes should include fixed ladders, training, and the definitions of qualified and competent persons.</p> <p>JON 16 - WCH needs to ensure that workers who are involved in activities that require the use of fall protection are trained, and that workers, supervisors, and PSRs are held accountable for fall protection procedure compliance.</p>
<p>The contractor's event management procedures for incident response, investigation, and event notifications were not implemented consistent with their requirements.</p> <ul style="list-style-type: none"> WCH did not categorize the event within the time limits required by the DOE Occurrence Reporting and Processing System (ORPS) manual. WCH did not follow procedure SEM-3-2.2, Attachment 3, convening a fact finding meeting, instead of a critique, which was clearly required based on the nature of the accident. Written Fact Finding Report lacked sufficient and accurate detail for the nature and seriousness of the event. The fact finding's causal analysis section reflected only a short list of potential contributing conditions. 	<p>JON 17 - WCH needs to re-evaluate its process for conservatively categorizing, reporting, and investigating events consistent with contractual requirements and the severity of the event.</p>
<p>The incident response by the Hanford POC created an unnecessary delay in initial deployment of emergency medical personnel.</p> <ul style="list-style-type: none"> Critical response time was lost by POC in obtaining irrelevant information prior to contacting HFD (~2:05-minute). HFD dispatch was delayed due to POC gathering information that was not needed to make the dispatch. (~1:00 minute). 	<p>JON 18 - FHI needs to re-evaluate its POC intake and dispatch procedure and training to eliminate unnecessary delay in emergency response.</p>
<p>The contractor's previous self-assessments and corrective actions on the integrated work control procedure and fall protection procedure were not effective in correcting underlying weaknesses.</p> <ul style="list-style-type: none"> NTS-RL-WCH-D4-2007-001, Worker Stepped Through Roof at B3706 corrective actions. ISMS Phase I and II corrective actions and related assessments (2007-2008). DOE-RL Operational Awareness (OA) reports on fall protection and work control. Evidence of the WCH lessons learned program improving fall protection or work planning/control was not identified. No corrective actions were identified with regard to WCH Safety programs as a result of the 2006 K-25 Type B investigation. 	<p>JON 19 - WCH needs to complete a comprehensive evaluation of their self-assessment, lessons learned, and corrective action management programs to understand inherent deficiencies or latent organizational weaknesses and improve the effectiveness of these feedback and improvement processes.</p> <p>JON 20 - WCH needs to complete an effectiveness review of the corrective actions taken in response to the JONs in this report and the causal analysis performed by WCH for root causes 1, 2, and contributing cause 1 described in JON 5 -.</p>

1.0 Introduction

1.1. Background

At approximately 9:30 a.m. on July 1, 2009, a WCH millwright (Millwright 1) working on an elevated catwalk in the 336 Building fell 50 feet through an open hatch to the floor below. The millwright was working as part of a team that was preparing a bridge crane to be removed from the building as the first step of demolition. As work on the catwalk neared completion, part of the team descended through the access hatch and down the ladder to the floor. The hatch was left open with the expectation that the remaining workers were preparing to descend. It was then brought to the workers' attention that an additional task remained undone and the two workers still on the catwalk stayed to complete the task. As these two workers were performing this additional task, each began to walk to opposite ends of the catwalk. Millwright 1 fell through the open hatch 50 feet to the concrete floor below, striking a guardrail on the midpoint platform during his descent.

The HFD responded to the scene in six minutes and 19 seconds. The emergency medical responders conducted an initial assessment at the scene, and transferred the individual to Kadlec Medical Center in Richland, Washington, via ambulance. It was determined the employee suffered two cracked vertebrae in his back, a broken femur and fibula in his right leg, and a broken tibia and damaged knee in his left leg. There were no internal or head injuries received.

On July 1, 2009, the DOE-RL Manager made the decision to conduct a Type B accident investigation of the incident, and informed WCH management. On July 2, 2009, the RL Manager formally appointed a Type B Accident Investigation Board (Board) to investigate the event in accordance with DOE Order 225.1A, *Accident Investigations* (see Appendix A). This report documents the facts and causes of the accident, conclusions, and JONs.

The organizations involved in this event were WCH, Fluor Hanford, Inc., (FHI) and DOE-RL. A brief description of each organization is provided below.

Washington Closure Hanford, LLC

WCH was selected by DOE-RL in March 2005 to manage the RCCC. WCH employs approximately 1,270 people, including subcontractors, in its mission to clean up and close the Columbia River corridor portion of the Hanford Site, which is an area of roughly 210 square miles. The WCH work scope includes safely demolishing hundreds of excess facilities, cleaning up waste sites and burial grounds, and placing deactivated plutonium production reactors in safe storage. The project is scheduled to be completed in 2015 and with an estimated cost of \$2.2 billion. By that time, WCH will have decontaminated and removed 486 facilities, closed or remediated 370 waste sites, cocooned four reactors, and disposed of about four million tons of contaminated materials.

Fluor Hanford, Inc.

A prime contractor to DOE-RL at Hanford since September 1996, FHI employs approximately 1,700 employees who provide site services by maintaining the site's infrastructure, operating the

Waste Sampling and Characterization Facility, providing fire protection (Hanford Fire Department) and security (Hanford Patrol), and operating the Volpentest HAMMER Training and Education Center. It is expected that Mission Support Alliance, LLC will complete their transition and assume operational responsibilities to include the FHI work scope on August 24, 2009.

U.S. Department of Energy Richland Operations Office

Located north of the city of Richland, in the southeastern part of Washington State, the 586-square-mile Hanford Site is managed by DOE-RL.

Hanford was established during World War II to produce plutonium for an atomic bomb. Peak nuclear materials production was reached in the 1960s, when eight reactors were in operation. Altogether, Hanford supplied plutonium for the United States nuclear weapons defense for more than four decades. All weapons material production was halted in the late 1980s, and Hanford is now engaged in the world's largest environmental cleanup project.

With a workforce of approximately 11,000 and an annual budget of approximately \$2 billion dollars, Hanford is vigorously pursuing three cleanup outcomes: restoring the Columbia River corridor, transitioning the central part of the Hanford Site for waste treatment and long-term storage, and putting DOE's assets to work solving regional and global energy, security, and environmental challenges.

1.2. Facility Description

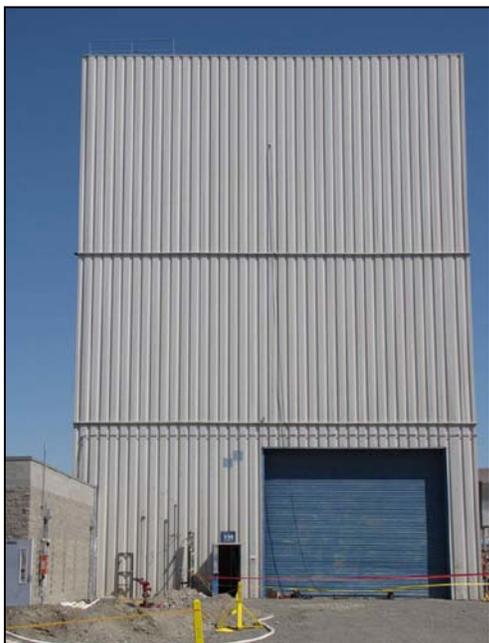


Figure 1-1. Exterior view of 336 Building

The High Bay Testing Facility (336 Building) was built in 1969 as a high bay addition to the 335 Building. It was originally constructed to house experimental equipment for the study of sodium properties. It was known as the Core Segment Development Facility and supported FFTF developmental studies. The building is 50 ft. x 50 ft. by 65 ft. high with a 50 ft. deep pit. The total square footage of the building is 6,438.

The sodium test loops installed in 336 Building were deactivated in 1977 and removed in 1983-84. The building was transferred to PNL in 1986 where use as a high bay mechanical test building was continued. The building was used by PNL for basic research related to multiphase flow phenomena and to experimentally address issues related to Hanford such as waste retrieval, transport, and disposal using non-radioactive simulates. Facility equipment/systems include numerous tanks (about 10) with capacities up to 12,000 gallons, a slurry test loop, and a small laboratory built in the early 1990s to support the high bay testing.

The building is not radiologically contaminated and no radioactive materials were ever used in the building. The surplus 336 Building was transitioned from Pacific Northwest National Laboratory (PNNL) to WCH for eventual D4 in August 2008.

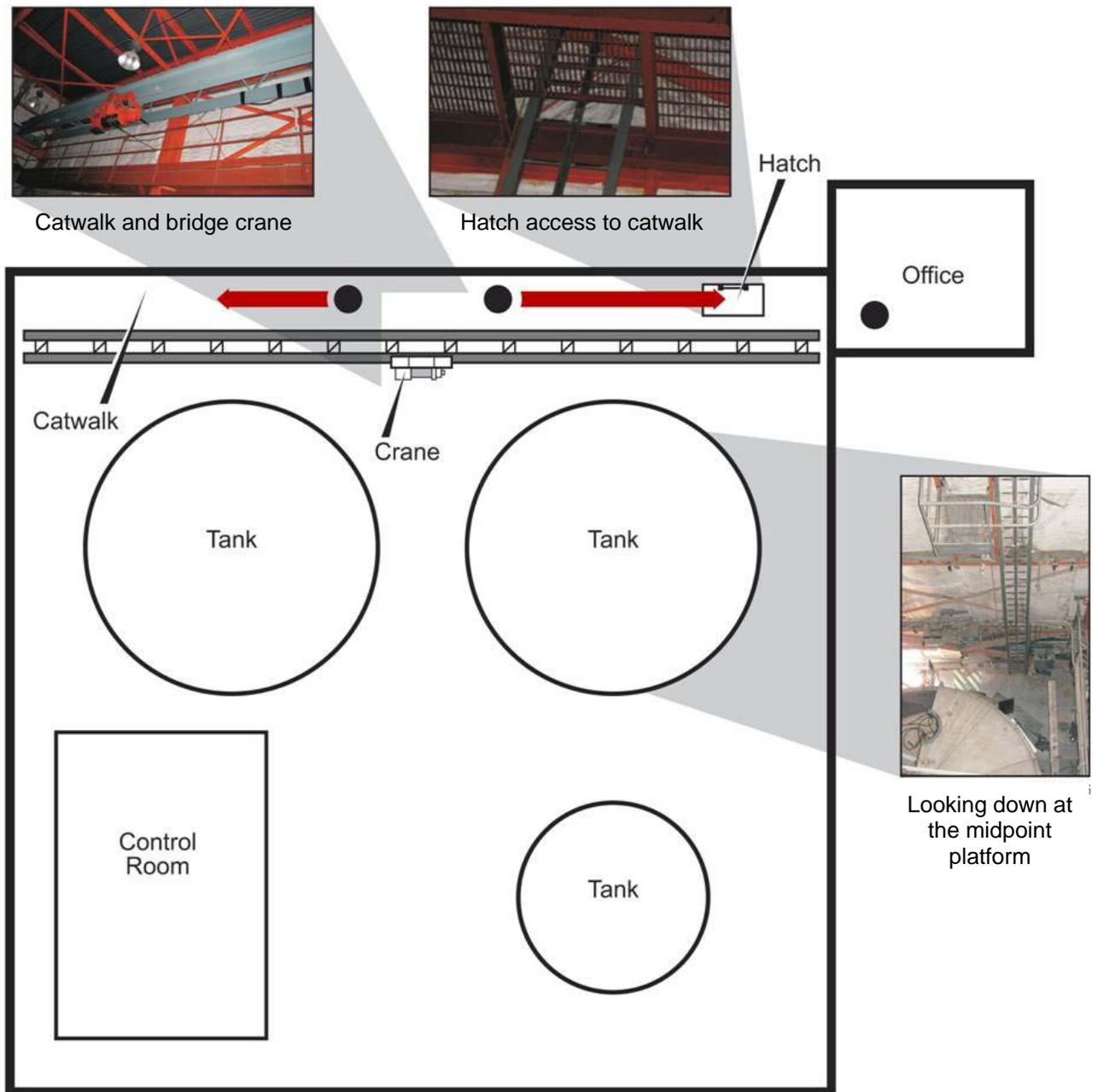


Figure 1-2. Diagram of the interior of 336 Building

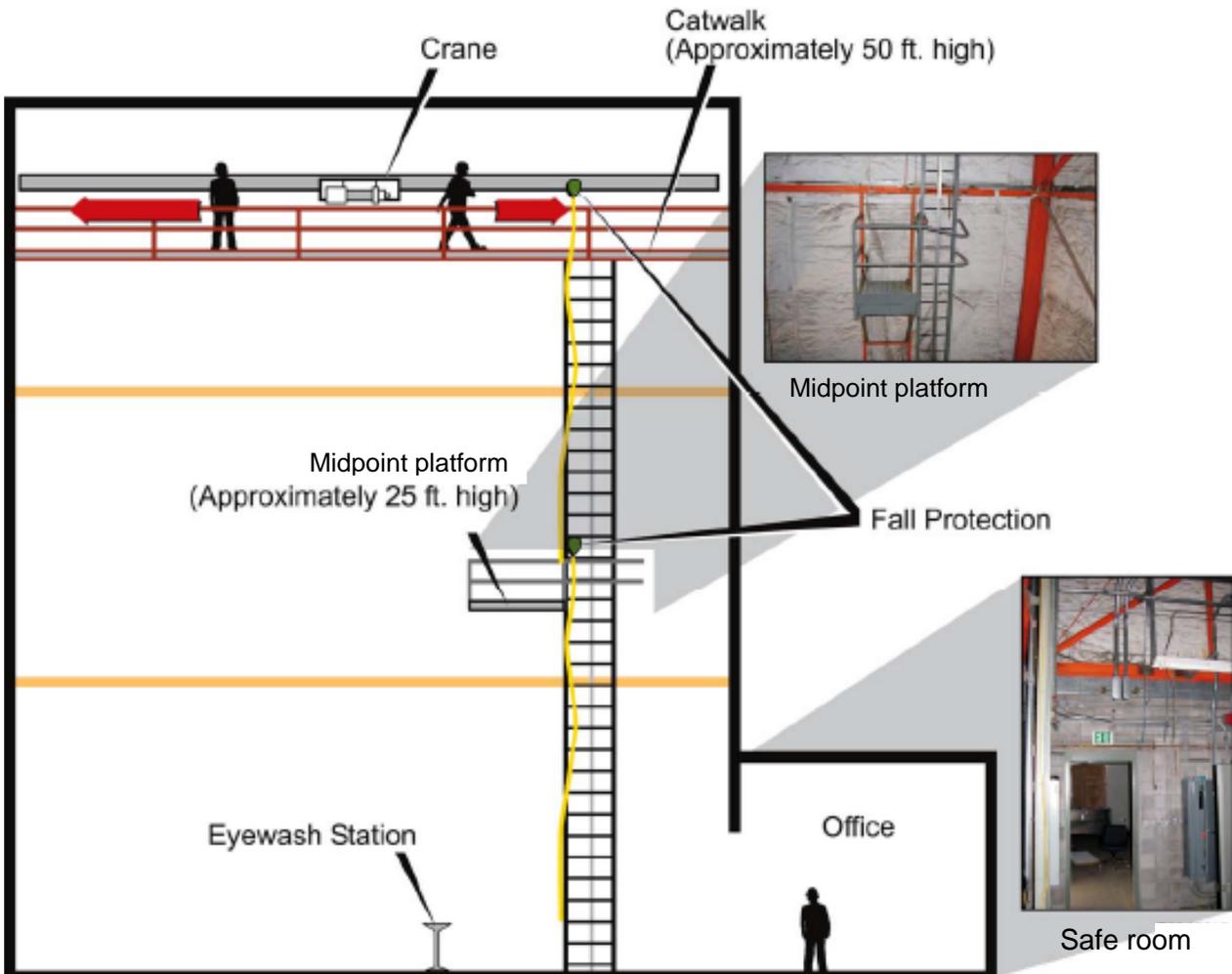


Figure 1-3. Diagram of ladder and catwalk

1.3. Scope, Conduct, and Methodology

The DOE Type B Accident Investigation Board began its activities on July 6, 2009, and completed its investigation on July 30, 2009. The scope of the Board's investigation was to identify all relevant facts; analyze the facts to determine the direct, contributing, and root causes of the accident; develop conclusions; and determine JONs that, when implemented, should prevent or mitigate recurrence of a similar accident. See Figure 1-4 for an explanation of accident investigation terminology. The investigation was performed in accordance with DOE Order 225.1A, *Accident Investigations*, using the following methodology:

- Facts relevant to the accident were gathered through interviews, document reviews, and examination of the physical evidence.

- The accident scene was inspected, and photographs and physical measurements were taken.
- The facts were analyzed to identify the causal factors using event and causal factors analysis, barrier analysis, change analysis, and human performance improvement analysis. Most of the Management Oversight and Risk Tree (MORT) analysis methodology was then used to validate the thoroughness of the other analyses.
- JONs for corrective actions to prevent or mitigate recurrence were developed to address the causal factors of the accident.

During the course of the investigation, the Board reviewed over 120 sets of documents; conducted 30 interviews; performed four onsite scene investigations that included visual examinations of work areas, photographs, and physical measurements; and committed over 1,750 hours to the investigation.

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 causes**, which is the immediate event(s) or condition(s) that caused the accident; **root causes**, which are those causal factors that, if corrected, would prevent or mitigate recurrence of a similar accident; and the **contributing causal factors**, which are the causal factors that collectively with the other causes impact the likelihood or severity of an accident but which did not cause the accident.

Event and causal factors analysis includes charting, which depicts the logical sequence of events and conditions (causal factors that allowed the accident 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 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.

Human performance improvement analysis addresses human error related to individual behavior, management and leadership practices, and organizational processes and values.

MORT analysis is a comprehensive, content-laden root cause analysis tool directed at identifying problems in the control of a work/process and deficiencies in the protective barriers associated with it. These problems are then analyzed for their origins in planning, design, policy, etc.

Figure 1-4. Accident Investigation Terminology

2.0 The Accident

2.1. Background

In August of 2008 the 336 Building was transferred from PNNL to WCH for subsequent D4. The facility underwent a period of surveillance and maintenance (S&M) until mid-May of 2009, when “cold and dark” (isolation of utilities and supporting infrastructure) conditions were achieved. The building was subsequently turned over to the 300 Area D4 project for D4.

In early June 2009 an IWCP work package, including a JHA, was initiated to demolish both the 335 and 336 Buildings. The first JHA meeting and facility walk down were performed on June 15. At that time, the plan was to demolish 336 Building, with the bridge crane left in place, using externally located high reach heavy equipment. However, it was discussed at the JHA meeting that the high reach equipment could not handle the weight of the crane. A decision was then made to remove the crane from the building prior to its demolition. For unrelated reasons, the 335 Building demolition was separated from the IWCP and planned and accomplished as a separate activity.

A second JHA meeting and facility walk down was conducted on June 25 to review the additional hazards associated with crane removal. This JHA was attended by Riggers 1, 2, and 3. The safety representative (336 PSR) present at the JHA noted the ladder that would be used to access the bridge crane catwalk and began development of a fall protection checklist and methodology to address this hazard.

Neither of the two JHA walk downs accessed the bridge crane catwalk itself, but instead were conducted from the ground level.



Figure 2-1. Ladder and center rail for engineered ladder safety device attachment

The 50-ft. high bridge crane catwalk is accessed by a vertical steel ladder with a midpoint platform 25 feet from the floor. The ladder also contains an engineered center safety fall protection rail. On June 29, WCH safety and engineering staff performed an evaluation of the ladder structural integrity. WCH safety staff briefly attempted to locate the engineered ladder safety devices that would fit the pre-existing center safety restraint rail, but were unsuccessful. Lacking these safety restraint devices, WCH safety staff decided to utilize two 50-ft. retractable fall restraint devices for climbing the ladder. They discussed areas suitable for fall protection anchors with the structural engineer and the building's horizontal structural beams were determined to be acceptable.

The first retractable would be set at an elevation to allow the climber to access the midpoint platform; the second retractable would be set at an elevation to allow the climber to access the catwalk. A fall protection checklist was completed by the 336 PSR on June 30.

The personal protective equipment required to access 336 Building catwalk included the following:

- Safety shoes
- Hard hat with head lamp
- Safety glasses with side shields
- Leather gloves
- Fall restraint harness
- High visibility vest

Headlamps were provided for use on the hard hats due to the poor lighting conditions on the catwalk. Lighting in the work area was provided by two open personnel entry doors and a temporary light string and halogen lamp stand all located at ground level.

2.2. Accident Description

On June 30 a pre-evolution (pre-ev) meeting was held for performing section 5.1.2 of task 1 for work package IWCP 300 09 05 11 001 between the times of 7:00 and 9:00 a.m. Task 1 (section 5.1) was to set up the work area for demolition. The intent of section 5.1.2 was to:

- Prepare the 336 bridge crane for removal and included accessing the 336 Building bridge crane catwalk to remove the rail stops.
- Disengage the travel wheels for free-wheeling.
- Support the bridge crane hook/block and field cut the lifting cable from one end with the intent of using this cable to pull the crane out of the building.
- Cut a hole in the exterior south wall for the crane cable.
- Run the bridge crane cable through the hole to the ground level outside the building.



Figure 2-2. Board member ascending the ladder using retractable lanyard

The pre-ev meeting was led by the 336 Work Supervisor/300 Area D4 Superintendent and attended by the three riggers and two PSRs, though the 324/327 PSR left early to support other work. During this pre-ev meeting, the 336 Work Supervisor/300 Area D4 Superintendent discussed the tasks associated with section 5.1.2 and his intention for the workers to use a “team up, team down” approach for controlling the hatch hazard on the catwalk. The “team up, team down” approach meant that all workers were to ascend to the catwalk (one at a time) and shut the hatch. All workers were to remain on the

catwalk until work was complete, then the hatch was opened and all workers to descend (one at a time).

At the 336 Building work site, the decision was made by the 336 PSR, and concurred on by the 336 Work Supervisor/300 Area D4 Superintendent, to allow the first rigger to free climb up the ladder without fall protection. At approximately 10:00 a.m. while the 336 Work Supervisor/300 Area D4 Superintendent and the two PSRs observed, Rigger 2 climbed the ladder without fall protection to the midpoint platform and used his lanyard to tie himself off to the guardrail. A bucket and rope were already in place and were used by the rigger to haul up the 50-ft. retractable lanyard and anchorage strap. He attached the retractable device and strap to a ladder support and then proceeded to free climb to the catwalk. Once on the catwalk, he closed the hatch behind him. Again, using the available bucket and rope, the rigger hauled up the second 50-ft. retractable device and anchorage strap, and secured it to a piece of diagonal bracing on the building structure. A second rigger climbed the ladder, utilizing the two retractable devices, and joined the first rigger on the catwalk. The two riggers inspected the catwalk area and crane, and evaluated the necessary steps to complete the job and determined what tools were needed to perform the work. They both descended the ladder using the retractable devices prior to their 11:00 a.m. lunch break.



Figure 2-3. Crane and trolley shown above the catwalk

After lunch, Rigger 2 and Rigger 3 accessed the catwalk, using the installed retractable devices. Rigger 1 stayed at ground level to provide support. The workers completed their efforts for the day by approximately 2:30 p.m. The day's work included cutting the bridge crane cable, drilling/punching a hole through the building's south exterior wall, threading the cable through the wall, securing the crane trolley from moving on the bridge using tube clamps, and cutting off one of the crane

rail emergency stops. This work was accomplished without the direct observation of the 336 Work Supervisor/300 Area D4 Superintendent or the PSRs. Both riggers then descended the ladder, again using the retractable devices. A post-job discussion with the 336 Work Supervisor/300 Area D4 Superintendent was held that afternoon. During this discussion it was decided that a portion of the catwalk guardrail would need to be cut away to allow the trolley/hoist to clear the guardrail during removal from the building and that millwright support would be needed to disengage the brakes on the crane wheels.

On July 1 a pre-ev meeting was held between 7:00 and 7:30 a.m. for performing the remaining work to prepare the crane for removal. The meeting was led by the 336 Work Supervisor/300 Area D4 Superintendent and was attended by the three riggers along with two millwrights. No

PSRs were present at this meeting. The scope of work for the day was discussed and covered releasing the brakes, unbolting the bridge rail stops (leaving one bolt in place on each side), cutting off the remaining bridge rail emergency stop, and cutting the catwalk guardrail to address the interference for the trolley/hoist removal. The 336 Work Supervisor/300 Area D4 Superintendent emphasized that cutting of the guardrail was to be the last activity performed before exiting the catwalk. The 336 Work Supervisor/300 Area D4 Superintendent again discussed his intention for the workers to use the “team up, team down” approach for controlling the hatch. Following the pre-ev the 336 Work Supervisor/300 Area D4 Superintendent discussed with Rigger 1 alone the need to secure the trolley to the bridge due to the concern that during crane removal a side pull would be placed on the crane cable, which could dislodge the trolley from the bridge. None of the other workers were aware of this discussion or need to perform this task.

The five workers and the 336 Work Supervisor/300 Area D4 Superintendent went to the 336 Building job site to begin the work activity that commenced at 8:00 a.m. Two of the riggers accessed the catwalk followed by the two millwrights. Rigger 1 stayed at ground level to provide support. The 336 Work Supervisor/300 Area D4 Superintendent watched the crew go up and then left to monitor other 300 Area work sites. No PSRs supported the 336 Building work on this day. While the riggers began working on removing the remaining emergency crane stop and partially unbolting the end rail stops, the millwrights examined the crane and determined that they needed to remove the two bridge crane gear boxes to disengage the crane wheels. The 336 Work Supervisor/300 Area D4 Superintendent checked in on the work and agreed with the recommended gear box removal at approximately 8:30 a.m. and then left again. The riggers completed the crane rail stop work scope at approximately 8:45 a.m.

Shortly following this work evolution, the rigger providing ground support (Rigger 1) notified the workers on the catwalk that he needed to leave the building to obtain some materials to support the work. As a result, Rigger 2 descended the ladder to provide ground support. The hatch was closed behind him by one of his co-workers on the catwalk when he reached the ground. Rigger 2 then sent up empty water bottles to be used to collect gear box oil. The remaining rigger (Rigger 3) and the millwrights drained the oil and removed the gear boxes, placing them on the catwalk grating.



Figure 2-4. Cut guardrail

At this point the three workers on the catwalk (Rigger 3, Millwright 1, and Millwright 2) and the one worker present on the ground (Rigger 2) believed all of the work was complete except for cutting the guardrail, intended to be the last activity. A rope was tied to the guardrail to prevent it from falling after being cut. At approximately 9:17 a.m. Millwright 2 exited the catwalk through the hatch. He expected Millwright 1 to follow him down and the hatch remained open. While Millwright 2 was descending the ladder, Rigger 3 remained on the catwalk and began cutting the catwalk guardrail, using a cordless band saw.

Rigger 1, who had left the building earlier to obtain materials to secure the trolley, returned at this time with chains and tensioners. At approximately the same time of his return with the chains, the 336 Work Supervisor/300 Area D4 Superintendent returned to the work site and agreed that chaining the trolley would work well and then left again to check on other 300 Area work sites. Rigger 1 then called up to Rigger 3, who was on the catwalk, to tell him that the trolley needed to be secured to the crane bridge. Rigger 3 stopped cutting the guardrail at this time. Millwright 1, who was still on the catwalk, offered to help Rigger 3 secure the trolley, and together they pulled the chain up to the catwalk using the installed bucket and rope. Neither Rigger 1 nor Millwright 2 conveyed to the workers on the catwalk that the hatch had not been closed.



Figure 2-5. Catwalk view of trolley

Up on the catwalk, Rigger 3 and Millwright 1 began a discussion about securing the trolley and recognized that this task would be easier and safer to accomplish if the crane was rolled closer to them. They decided to move the crane from each end by turning the crane wheels. Rigger 3 proceeded to the set of crane wheels on the east end of the building. Millwright 1 walked towards the set of crane wheels on the west end of the building, heading directly toward the open hatch.

At approximately 9:33 a.m. Millwright 1 fell through the open hatch. During his fall he struck the guardrail on the midpoint platform and then fell the remaining distance to the concrete floor, a total height of about 50 feet.



Figure 2-6. Facing west on the catwalk with the hatch open



Figure 2-7. Bent guardrail on the midpoint platform where Millwright 1 hit during fall

2.3. Accident Response

Two workers (Millwright 2 and Rigger 2) at ground level heard Millwright 1 fall and responded to his location. They called out to a teamster (Teamster 1) working outside the building to phone for an ambulance.

At approximately 9:34 a.m. the teamster contacted the Hanford POC to obtain an ambulance. The POC took about two minutes to gather data from the teamster (return call number, caller's name, distance the individual fell, etc.) before patching the call through to the HFD dispatcher. The HFD received the call and dispatched units from the 300 and 400 Area fire stations to the scene a minute later at about 9:37 a.m.

During this time frame, two radio "shout outs" from workers alerted another supervisor in the area (Planned 336 Work Supervisor) who proceeded to the scene while calling the 336 Work Supervisor/300 Area D4 Superintendent by cell phone. Within a very short time, the 336 Work Supervisor/300 Area D4 Superintendent responded to the scene and took charge. A second teamster (Teamster 2) who had been working in the area of 336 Building stayed with the injured millwright to keep him calm and stable. The 336 Work Supervisor/300 Area D4 Superintendent cleared the area around 336 Building by directing the removal of an aerial lift to clear an access way for the ambulance. At some point in time, the 336 Work Supervisor/300 Area D4 Superintendent asked Millwright 1 if he wanted his wife to be called to alert her of the accident. Millwright 1 said, "Yes," and gave the 336 Work Supervisor/300 Area D4 Superintendent her cell phone number. The 336 Work Supervisor/300 Area D4 Superintendent subsequently called Millwright 1's wife.

The HFD ambulance from the 300 Area arrived at the scene at approximately 9:40 a.m. The arriving EMTs performed an initial assessment of the millwright and found him conscious and responsive. The EMTs placed a cervical collar around the injured millwright neck, secured him to a backboard, moved him outside the building, and placed him on a gurney and into the ambulance. The ambulance left the 336 Building at approximately 9:52 a.m. and arrived at Kadlec Medical Center in Richland at 10:09 a.m.

The 336 Work Supervisor/300 Area D4 Superintendent immediately secured 336 Building and placed the facility on limited access to preserve the scene. Several telephone notifications were made of the incident around 9:50 a.m.: the 300 Area Facility Point of Contact (FPOC) contacted the WCH Single Point of Contact (SPOC); the RL Facility Representative (FR) Team Lead was notified by the WCH D4 Director. At this point in time, all that was known and communicated about the incident during these calls was that an individual had fallen, had injured his knee, and was taken to the hospital in an ambulance. There were no details communicated during these notifications regarding the fall distance or the seriousness of the millwright's injuries.

At 10:07 a.m. the WCH Event Classifier notified the Hanford Occurrence Notification Center (ONC) of the incident. Due to the lack of information on the seriousness of injuries, the ONC determined that this was not an "Abnormal Event" requiring immediate reporting.

At 10:30 a.m. the WCH D4 Director requested that a fact finding meeting be conducted. A 100N Area Planner was assigned to chair the fact finding at the 3760 Building.

At 11:30 a.m. a Hanford Atomic Metal Trades Council (HAMTC) representative at Kadlec Medical Center with the injured millwright contacted the D4 Closure Director and informed him that Millwright 1 had a broken leg. With knowledge of this information, WCH decided that the incident was required to be reported as a serious "Personal Injury" event.

At 12:00 p.m. the fact finding meeting began and lasted an hour and a half. All involved personnel were in attendance, with the exception of the injured millwright and the HFD. Also at this time, WCH decided to initiate a corporate accident investigation scheduled to begin on July 6.

At 1:30 p.m. the event was categorized as 2A(6) SC-3 (a single occurrence resulting in a serious occupational injury such as a fracture of any bone) by the Event Classifier in consultation with the D4 Closure Director. The ONC was notified of this categorization at 3:36 p.m.

At 4:30 p.m. the Deputy RCCC PM was informed by the DOE-RL Assistant Manager for River Corridor that DOE intended to initiate a Type B accident investigation.

At 4:50 p.m. the event was re-categorized by the Event Classifier as 10(1) SC-2 as a result of DOE's decision to conduct the Type B investigation. The ONC was notified of this change at 5:48 p.m.

2.4. Medical Summary

Injuries sustained by Millwright 1 as a consequence of the July 1 fall included:

- Closed fracture to left femur.
- Closed fracture to left tibia.
- Closed fracture to right fibula.
- Multiple tears to the medial and lateral ligaments and tendons of left knee.
- Compression fractures to L-1 and L-4 spinal vertebrae (no repair required).
- Multiple torso and extremity contusions.

Millwright 1 was fitted for a back brace, which he will be required to wear to immobilize his spine for 10 or more weeks. He underwent surgery to repair the fractures in the left femur and right fibula and to partially reconstruct his left knee. He was released from the hospital on July 15. He will require at least one more surgery on his left knee to finish its reconstruction.

2.5. Event Chronology

The table below provides the events leading up to and immediately following the accident on July 1, 2009.

Table 2-1. Event Chronology

Date/Time	Event
Feb. 2007	WCH revised IWCP procedure in response to DOE ISMS Phase I verification review.
Aug. 2007	WCH revised IWCP procedure in response to improvement opportunities and assessments.
Nov. 2007	DOE ISMS Phase II verification.
Sept. 2008	WCH and DOE-RL completed closure verification and effectiveness reviews related to concerns and opportunities for improvement from the Phase II ISMS review.
Aug. 2008	336 Building transferred from PNNL to WCH.
Fall 2008	WCH had Klaus Engineering review demolition of 336 Building. Klaus recommended using cutting torches, but WCH dismissed this approach as unsafe.
10-06-08	Beryllium survey report for 335 and 336 Buildings completed.
10-31-08	Industrial Hygiene Work Plan for all 300 Area D4 projects completed.
11-18-08	Radcon survey record approved for both 335 and 336 Buildings (survey performed June 2008).
12-1-08	Asbestos sampling report completed for 335 and 336 Buildings.
12-9-08	336 excavation plan was developed. Most signatures were obtained in Jan. 2009; the 300 Area Project Engineer and RM 2 (Risk Ranker) approved June 18, 2009.
Early 2009	CDI consultants discussed 336 Building explosive demolition approach with RM 2 (Risk Ranker), which was determined to be too risky. RM 2 (Risk Ranker) decided to go with high reach equipment approach.
April 2009	The 336 PSR started working at Hanford. Another PSR was temporarily assigned to the 300 Area (his assignment later became permanent as the 324/327 PSR).
May 2009	The 336 PSR began working in 300 Area.
-05-01-09 Friday	A 300 Area engineer researched the Komatsu high reach equipment by computer and determined it to be unsuitable to support crane removal (weight of crane).
05-11-09 Monday	335/336 Building WPF generated by the 336 Work Control Planner. The 300 Area Project Engineer signed the form. The Planner initiated the IWCP. RM 2 (Risk Ranker) performed risk ranking as "low" and designated the work to be performed per a Type 1 work package.
05-14-09 Thursday	The "cold and dark" walk down and checklist were completed and signed.
05-19-09 Tuesday	The 335/336 hazardous material removal work package was approved by the 336 Work Control Planner and the Work Supervisor for that activity.
05-20-09 Wednesday	335/336 hazardous material removal work package walk down and pre-ev were led by the Work Supervisor for that activity.
05-27-09 Wednesday	The 335 Building was removed from scope of work package. The WPF and risk rank determination worksheet were revised to exclude 335 Building by RM 1 (IWCP/JHA), who initialed and dated the revisions.
06-01-09 through 06-08-09	336 hazmat cleanout supervised by the 336 HazMat Removal Supervisor and the Planned 336 Work Supervisor. The Planned 336 Work Supervisor decided to not remove oils from crane gear boxes, as he determined it was too dangerous to access the catwalk.
06-04-09 Thursday	The Planner initiated the JHA for 336 demolition.
06-09-09 Tuesday	The Komatsu (high reach equipment) arrived on site. Vendor provided training to WCH teamsters beginning the week of June 16. Two days of training were provided for WCH operators.
06-15-09 Monday	First JHA meeting and walk down for 336 demolition. After the JHA meeting, the 336 Work Control Planner and crane operator did a walk down of 336 from the floor level only. A decision was made to pull the crane out through the side of building and was subsequently agreed to by RM 2 (Risk Ranker).

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WCH Employee Fall Injury on July 1, 2009

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Date/Time	Event
06-16-09 Tuesday	<p>RL FR who attended the JHA talked to the 336 Work Supervisor/300 Area D4 Superintendent about the poor quality of the JHA. RL FR recommended to the 336 Work Supervisor/300 Area D4 Superintendent to re-do IWCP and JHA.</p> <p>RL FR talked to WCH management about JHA quality.</p>
06-18-09 Thursday	335/336 hazardous waste material IWCP package closed.
06-19-09 Friday	The 300 Area RL FR began two-week leave through July 7.
06-22-09 Monday	IWCP 300 09 05 11 001 redrafted by the 336 Work Control Planner. Work package had four primary tasks: 1) set up for demo, 2) demo and load out of building, 3) prepare building slabs for post-demo, and 4) demobilize.
06-23-09 Tuesday	Signatures for work package approval initiated, including signature by the 336 PSR.
06-24-09 Wednesday	335 Building demolished.
06-25-09 Thursday 3:00 PM	<p>Second JHA meeting and walk down was conducted.</p> <p>The 336 PSR identified ladder issues.</p> <p>All three riggers were involved in second JHA meeting.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent understood need to change work package due to crane removal and asked the 336 Work Control Planner to make the changes. The 336 Work Supervisor/300 Area D4 Superintendent signed the JHA, but instructed the 336 Work Control Planner to make changes to address crane removal.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent decided at the JHA that he would supervise task 1 (crane removal prep) and the Planned 336 Work Supervisor would supervise the remainder of the IWCP tasks 2-4.</p> <p>The Planned 336 Work Supervisor was unaware of the 336 Work Supervisor/300 Area D4 Superintendent's decision to directly supervise the removal of the 336 Building crane.</p>
06-26-09 Friday	<p>Hanford Friday off.</p> <p>The 336 PSR performed a computer search on the existing engineered ladder safety device and looked around the 336 Building, but was unable to locate it.</p>
06-27-09 Saturday	The 336 PSR email to the 300 Area Project Engineer and the Structural Engineer requested a 336 ladder engineering evaluation. Ladder issues were identified during June 25 JHA review.
06-29-09 Monday AM	<p>The D4 Closure Director returned to Tri-Cities from travel.</p> <p>RM 2 (Risk Ranker) on vacation the week of June 29.</p> <p>Rigger 2 and Rigger 3 returned to 300 Area from various 100N jobs.</p> <p>The 324/327 PSR returned from 2½-week vacation.</p> <p>The 336 Work Control Planner made work package changes requested by the 336 Work Supervisor/300 Area D4 Superintendent.</p> <p>The Planned 336 Work Supervisor was originally assigned as the 336 Work Supervisor. He was given the work package by the 336 Work Control Planner and signed it after a cursory review.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent then volunteered to be the actual 336 Work Supervisor as he had been involved in the planning, considered the work higher risk, and the Planned 336 Work Supervisor was overloaded.</p>
06-29-09 Monday ~1:00 PM	<p>The Structural Engineer, 336 PSR, and the 324/327 PSR evaluated ladder integrity from the 336 Building white tower and from the floor level. The Structural Engineer briefed the 300 Area Project Engineer on results after walk down (followed by Tuesday's 10:57 AM email). The Structural Engineer, 336 PSR, and the 324/327 PSR discussed areas suitable for fall protection anchors. Horizontal structural I-beams were determined to be acceptable.</p> <p>In an attempt to locate the existing engineered ladder safety devices (Sellstrom/RT 2000 Climb-Rite), the 324/327 PSR called the telephone number posted near the 336 Building crane access ladder. He was told the listed employee was no longer in that PNNL group (PNNL employee still works at PNNL). The 324/327 PSR knew of the WCH S&M group that handles facility transitions, but it did not cross</p>

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WCH Employee Fall Injury on July 1, 2009

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Date/Time	Event
	<p>his mind to contact them about the Climb-Rite. No other action was taken to locate the device at PNNL.</p> <p>The 336 PSR could not find the manufacturer's name on the ladder climbing system center rail.</p> <p>Both PSRs discussed ladder and fall protection issues and alternatives. The 336 PSR and the 324/327 PSR decided to use two 50-ft. MSA Dynalock retractables as they were available in the 324/327 PSR's office. The 324/327 PSR would have preferred a single 100-ft. retractable, but they did not have any available. The 336 PSR made the final decision.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent loads craft resources for following day's work based on approved IWCPs and also pending IWCPs near approval at midday POD.</p>
<p>06-30-09 Tuesday 5:50 AM</p>	<p>POD meeting held. RM 1 (IWCP/JHA) was at POD.</p> <p>POD/POW work release for 336 Building was not signed by FPOC.</p>
<p>06-30-09 Tuesday Early AM</p>	<p>Beryllium work permit issued by IH for 336 Building, becoming effective July 1.</p> <p>The 336 PSR developed fall protection plan/checklist.</p>
<p>06-30-09 Tuesday Early AM</p>	<p>The 336 Work Control Planner brought IWCP to RM 1 (IWCP/JHA) for signature. RM 1 (IWCP/JHA) reviewed the task instructions, the IWCP content, and the JHA. He asked the 336 Work Control Planner to add more detail to the IWCP relative to cable size and attachments for crane pull. IWCP/JHA approved ~11:00 AM.</p>
<p>06-30-09 Tuesday 7:00 – 9:00 AM</p>	<p>Pre-ev meeting on task 5.1.2 led by the 336 Work Supervisor/300 Area D4 Superintendent. Pre-ev was conducted with three riggers and the 336 PSR in attendance. The 324/327 PSR did not sign in, but attended the beginning of the pre-ev, and then received a call and had to leave about 8:45 AM.</p> <p>The 336 PSR and the 336 Work Supervisor/300 Area D4 Superintendent believed they had the approved IWCP at the pre-ev.</p> <p>The 336 PSR knew the Structural Engineer had verbally approved the ladder.</p> <p>There was a discussion of the harness and initial two-hook ascend approach. The decision to allow "first man up" to free climb was agreed to by the 336 PSR and the 336 Work Supervisor/300 Area D4 Superintendent.</p> <p>General steps of 5.1.2 were discussed at the pre-ev. The three riggers each had a slightly different perspective on what was discussed.</p> <p>Pre-ev discussed ladder climbing and slaying tied off when setting retractable devices. Crane bus bar power strip support removal was also discussed.</p>
<p>06-30-09 Tuesday 9:00 – 10:00 AM</p>	<p>Work crew gathered tools and materials.</p>
<p>06-30-09 Tuesday 10:00 AM</p>	<p>Work team met at 336 Building with gear. Rigger 2 was the first man up and hung retractables. Rigger 2 climbed without fall protection, which was approved by the 336 PSR and the 336 Work Supervisor/300 Area D4 Superintendent.</p> <p>Rigger 2 free climbed to midpoint platform, used a 6-ft. lanyard to secure himself to guardrail and installed first retractable on the ladder support. He then climbed to the catwalk, through the hatch that was already open. Once he reached the catwalk, he closed the hatch and installed the upper retractable at anchor points identified by the "engineer" (referring to the 336 PSR).</p> <p>Rigger 2 stayed tied off when setting the midpoint retractable.</p> <p>The 336 PSR stayed in the building until the retractables were installed. Then the 336 PSR left to go to another meeting.</p> <p>Rigger 1 was the second man up. Rigger 2 stood back six feet from hole when Rigger 1 came through hatch. Rigger 2 and Rigger 1 both walked the catwalk.</p> <p>While on the catwalk, Rigger 1 identified that portions of the top guardrail needed to be removed, crane rail stops needed to be cut, and the end bridge stop needed one bolt left installed. They did not identify the need for gear box removal. Rigger 1 and 2 came down for lunch around 11:00.</p>
<p>06-30-09 Tuesday 10:57 AM</p>	<p>The Structural Engineer sent the 336 PSR an email saying that ladder evaluation was complete and attached a structural analysis that identified suitable anchorage areas. The 336 PSR did not review the attachment.</p>
<p>06-30-09 Tuesday</p>	<p>IWCP and JHA approved and signed by RM 1 (IWCP/JHA). Approximately 15 minutes after RM's approval, the 336 Work Control Planner gave IWCP to the 336 Work Supervisor/300 Area D4 Superintendent, as the 336 Work Control Planner knew that he wanted to work it right</p>

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Date/Time	Event
~11:00 AM	<p>away.</p> <p>Rigger 1 and 2 came down for lunch after a visual examination of the work site. At this point they made the decision to leave one bolt in each of the rail end stops.</p>
06-30-09 Tuesday 11:30 AM	<p>After lunch Rigger 1 was the "ground guy" and did not go up on the catwalk on Tuesday afternoon. Rigger 2 ascended to the catwalk and drilled holes in the south exterior wall with a cordless drill and punched the holes with a screwdriver. He cut the wire rope, ran wire rope outside through the hole, and cut pendant. Using the Sawzall® (which used several blades), he cut the west e-stop and left it on the catwalk. He then lowered his tools and descended down the ladder. All these tasks were discussed at the pre-ev.</p> <p>Tube-block clamps were applied to the trolley to prevent lateral movement.</p>
06-30-09 Tuesday 1:00 PM	<p>Midday POD preparation meeting; the 336 Building work completed was not discussed with FPOC.</p>
06-30-09 Tuesday 2:30 PM	<p>Riggers completed job for the day and descended the ladder.</p>
06-30-09 Tuesday 3:15 PM	<p>Post-job discussion between Rigger 1, Rigger 2, and the 336 Work Supervisor/300 Area D4 Superintendent about work performed that day and work to be performed next day. Rigger 3 also followed up with the 336 Work Supervisor/300 Area D4 Superintendent on the same topic.</p> <ul style="list-style-type: none"> • Crane brakes. • The need for millwrights the next day. • Guardrail needed to be cut and removed to eliminate interferences between the guardrail and the crane trolley.
07-01-09 Wednesday 5:50 AM	<p>Supervisor POD.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent attended POD and noted that he needed millwrights to release brakes on 336 crane. Millwrights 1 and 2 were assigned to his team.</p> <p>336 POD work release still not signed off by FPOC; 336 prior work completed or planned for the day was not clearly discussed with FPOC.</p>
07-01-09 Wednesday AM	<p>The 336 PSR was given WCH fall protection training by the 324/327 PSR.</p>
07-01-09 Wednesday 6:15 AM	<p>The 336 Work Supervisor/300 Area D4 Superintendent asked the Planned 336 Work Supervisor if he wanted to supervise 336 work. The Planned 336 Work Supervisor said he was still too busy to take on additional load. The 336 Work Supervisor/300 Area D4 Superintendent said he would directly supervise 336 work again.</p>
07-01-09 Wednesday 7:00 – 7:30 AM	<p>336 Building pre-ev was led by the 336 Work Supervisor/300 Area D4 Superintendent and attended by all three riggers and two millwrights. No PSR attended pre-ev.</p> <p>The following points were discussed in the pre-ev:</p> <ul style="list-style-type: none"> • Brake release • Unbolt bridge rail stop leaving one bolt on each side • Reinforced "team up, team down" approach • Complete e-stop removal • Cutting guardrail 3-4 feet to provide trolley clearance by last man out • The 336 Work Supervisor/300 Area D4 Superintendent directed the rigger that was cutting the guardrail to tie off on railing one rail back beyond cut guardrails. The 336 Work Supervisor/300 Area D4 Superintendent thought 6-ft. lanyards would be used to tie off on top guardrail one rail back. <p>The following was not covered in the pre-ev:</p> <ul style="list-style-type: none"> • Gear box removal • Gear box oil removal • Securing the trolley <p>The 336 Work Supervisor/300 Area D4 Superintendent emphasized keeping focus due to the upcoming four-day holiday weekend and the heat. The crane was going to be pulled out the following Monday. Once the trolley was secured and guardrails cut, they would be done for the day. The 336 Work Supervisor/300 Area D4 Superintendent expected work would be done by lunch, and knew millwrights were due out at 100N at 1:00.</p>
07-01-09 Wednesday	<p>Millwright 2 changed into his scrubs.</p>

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WCH Employee Fall Injury on July 1, 2009

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Date/Time	Event
7:30 – 8:00 AM	The 336 Work Supervisor/300 Area D4 Superintendent and Rigger 1 discussed securing the trolley, suggesting that cables be used. No one else was present during this discussion. Millwrights 1 and 2 picked up their harnesses from the 324/327 PSR.
07-01-09 Wednesday 8:00 AM	Work team arrived at 336 Building. The 336 Work Supervisor/300 Area D4 Superintendent watched as two riggers and then two millwrights went up the ladder. All four hooked and unhooked retractables, and the last person up closed the hatch on catwalk. The 336 Work Supervisor/300 Area D4 Superintendent left 336 Building to monitor other jobs as the 300 Area D4 Superintendent.
07-01-09 Wednesday ~8:30 AM	The 336 Work Supervisor/300 Area D4 Superintendent returned to check on the work and was informed by the millwrights of the need to remove the gear boxes and was okay with that.
07-01-09 Wednesday ~8:45 AM	The riggers completed the crane rail stop removal.
07-01-09 Wednesday ~8:50 AM	Rigger 1 realized he needed to go find cables to secure the trolley and told Rigger 2 he was leaving. Rigger 2 came down to take Rigger 1's place as the ground guy. Rigger 2 recalled someone closing the hatch behind him. Rigger 2 went to the safe room. Rigger 1 left.
07-01-09 Wednesday ~8:52 AM	Rigger 2 placed empty water bottles in the tool bucket to be used to collect the gear box oil and they were raised to the catwalk. He then began work outside of the 336 Building tying cables together.
07-01-09 Wednesday ~9:00 AM	Rigger 1 took the truck to get materials to be used to secure the trolley. He went to the Conex box by 384 Building and found a chain. He determined that using a chain would be easier and acquired two chains and tensioners.
07-01-09 Wednesday ~9:10 AM	The millwrights drained the oil from gear boxes, removed the gear boxes, and lowered them to the catwalk. The water bottles containing the drained oil were lowered in buckets to the floor.
07-01-09 Wednesday ~9:17 AM	A rope was tied to the guardrail to keep it from falling while Rigger 3 cut it in two places. Millwright 2 proceeded down the ladder and left the hatch open thinking that Millwright 1 was going to immediately follow.
07-01-09 Wednesday ~9:18 AM	Rigger 1 returned with chains and tensioners. The 336 Work Supervisor/300 Area D4 Superintendent visited and talked with Rigger 1 who suggested using chains to secure the trolley as they would be easier to work with. The 336 Work Supervisor/300 Area D4 Superintendent okayed the chain idea, then left. Rigger 1 yelled up to Rigger 3 and informed him that they needed to secure the trolley with the chains. Rigger 1 offered to go up to assist with chaining the trolley, but Millwright 1 suggested he stay up and help Rigger 3 with the task.
07-01-09 Wednesday ~9:23 AM	Rigger 1 put the chains in the bucket and sent the chains up. Rigger 1 and Millwright 2 went to safe room.
07-01-09 Wednesday ~9:27 AM	Rigger 3 and Millwright 1 discussed the new scope and methods to secure the trolley with the chains and decided to try and move the bridge 1½ to 2 feet closer to them to facilitate chaining it.
07-01-09 Wednesday ~9:33 AM	Millwright 1 and Rigger 3 each turned and started walking toward the crane wheels to reposition the crane. Rigger 3 walked east on the catwalk, Millwright 1 walked west on the catwalk toward the open hatch. Millwright 1 fell through the open hatch, hit the guardrail on the midpoint platform, and then fell to the floor. Rigger 3 heard Millwright 1 scream and looked. He saw Millwright 1 hit the midpoint platform through the grate. Millwright 1 was screaming on the floor. From the safe room, Rigger 1 heard Millwright 1 fall. Millwright 2 heard something heavy falling and thought it was the chain, but it was Millwright 1. Millwright 2 and Rigger 2 were first responders to Millwright 1. Millwright 2 went outside and asked Teamster 1 to call 911. Rigger 2 also told Teamster 1 to call 911 and went

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WCH Employee Fall Injury on July 1, 2009

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Date/Time	Event
	back inside to assist Millwright 1. Millwright 2, Rigger 2, and Teamster 2 remained with Millwright 1.
07-01-09 Wednesday 9:33:58 AM	Teamster 1 called 373-3800 (Hanford POC) from his cell phone for medical assistance. This phone number is the Hanford cell phone emergency number equivalent to 911.
07-01-09 Wednesday 9:35 AM	<p>Rigger 3 descended the ladder and closed the hatch behind him.</p> <p>The Planned 336 Work Supervisor heard radio a shout-out from Teamster 1 for the 336 Work Supervisor/300 Area D4 Superintendent, but did not hear the 336 Work Supervisor/300 Area D4 Superintendent respond. The Planned 336 Work Supervisor got a second radio shout-out and replied to Teamster 1. The Planned 336 Work Supervisor called 373-3800 (Hanford POC) from his cell phone. The Planned 336 Work Supervisor was told that Teamster 1 was on another line with the POC. The Planned 336 Work Supervisor called the 300 Area FPOC to report the incident as the FPOC also acts as the Building Emergency Director. The Planned 336 Work Supervisor responded to 336 in approximately 30 seconds. The Planned 336 Work Supervisor contacted the 336 Work Supervisor/300 Area D4 Superintendent by cell phone.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent received call from the Planned 336 Work Supervisor about Millwright 1's fall.</p>
07-01-09 Wednesday 9:36 AM	<p>The 336 Work Supervisor/300 Area D4 Superintendent arrived at the scene and took control. The 336 Work Supervisor/300 Area D4 Superintendent asked Millwright 1 about making a call to his wife. The 336 Work Supervisor/300 Area D4 Superintendent was able to get wife's cell phone number from Millwright 1.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent asked that the aerial lift be moved away from building to make room for the ambulance. Rigger 2 moved the aerial.</p>
07-01-09 Wednesday 9:36:03 AM	POC contacted the 200 Area HFD dispatcher.
07-01-09 Wednesday 9:37:19 AM	HFD called 300 and 400 Area stations to respond.
07-01-09 Wednesday 9:38 AM	<p>HFD en route to scene.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent contacted the 300 Area Deputy Project Manager.</p>
07-01-09 Wednesday 9:40 AM	<p>Engine 93 and ambulance arrived on scene from 300 Area HFD and attended to Millwright 1.</p> <p>The 300 Area Deputy Project Manager contacted the D4 Closure Director and D4 Closure Deputy Director.</p>
07-01-09 Wednesday 9:41 AM	POC called ONC.
07-01-09 Wednesday 9:45 AM	Once the EMTs arrived, Millwright 2, Rigger 1, Rigger 2, and Rigger 3 were segregated by the 336 Work Supervisor/300 Area D4 Superintendent. The 336 Work Supervisor/300 Area D4 Superintendent asked the four workers to go back to his trailer and write statements. 336 was secured by the 336 Work Supervisor/300 Area D4 Superintendent and placed in limited access status.
07-01-09 Wednesday 9:50 AM	The 300 Area FPOC contacted the WCH SPOC. The RL FR Team Lead was notified by the WCH D4 Director. The SPOC notified the WCH Event Classifier. At this point all that was known was that there was a fall involving a knee injury and an ambulance run to the hospital; no details were available on fall height or extent of Millwright 1's injuries.
07-01-09 Wednesday 9:52 AM	EMTs departed 336 Building with injured millwright.
07-01-09 Wednesday 10:07 AM	WCH SPOC notified ONC and a determination was made by ONC that this was not an "Abnormal Event" due to lack of information on seriousness of injury.
07-01-09 Wednesday 10:09 AM	EMTs arrived at Kadlec Medical Center.
07-01-09 Wednesday 10:20 AM	The RL Assistant Manager for Safety and Environment, Operations Oversight Division Director, and FR Team Lead arrived on scene.

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Date/Time	Event
07-01-09 Wednesday 10:30 AM	The D4 Closure Director initiated request for fact finding. The D4 Closure Deputy Director requested a 100N Planner to chair fact finding at 3760 Building.
07-01-09 Wednesday 11:30 AM	WCH determined Event Discovery time based upon a telephone call from a HAMTC representative at the hospital that Millwright 1 had a broken bone.
07-01-09 Wednesday 12:00 PM	WCH fact finding meeting convened at 3760 Building. WCH initiated a corporate (URS-led) Accident Investigation Team. All WCH work was suspended.
07-01-09 Wednesday 1:30 PM	Event categorized as 2A(6) SC-3 by the Event Classifier in consultation with the D4 Closure Director based on broken bone.
07-01-09 Wednesday 2:00 PM	The Event Classifier began to initiate a WCH Accident Investigation Team per SEM 3-2.2.
07-01-09 Wednesday 3:36 PM	The Event Classifier made initial notification to ONC of 2A(6) SC-3 categorization.
07-01-09 Wednesday 4:30 PM	The Deputy RCCC PM was notified by RL Assistant Manager for River Corridor that DOE planned to conduct a Type B accident investigation. WCH suspended internal Accident Investigation Team planning.
07-01-09 Wednesday 4:50 PM	Event recategorized by the Event Classifier as 10(1) SC-2 based on telephone call from RL.
07-01-09 Wednesday 5:15 PM	RL FR Team Lead was notified of SC-2 change.
07-01-09 Wednesday 5:48 PM	ONC notification of WCH recategorization to SC-2 was made by the Event Classifier.
07-02-09 Thursday	WCH day off. RL appointed Type B Accident Investigation Board. The 336 Work Supervisor/300 Area D4 Superintendent came in and typed his event statement. The Fact Finding Chair met with the 336 Work Supervisor/300 Area D4 Superintendent and other managers and updated Fact Finding Report based on the 336 Work Supervisor/300 Area D4 Superintendent's typed statement. The Fact Finding Chair and the 336 Work Supervisor/300 Area D4 Superintendent briefed WCH senior management on draft Fact Finding Report.
07-03-09 Friday	Federal holiday. WCH sent information packet of event to other Hanford contractors.
07-04-09 Saturday	Independence Day holiday.
07-06-09 Monday 9:00 AM	DOE Type B Accident Investigation Board convenes. WCH completes Issue Form. Fact Finding Report completed and signed by the Fact Finding Chair, D4 Closure Director, and D4 Closure Deputy Director.

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Date/Time	Event
07-06-09 Monday 9:30 AM	The DOE Type B Accident Investigation Board met with RL Manager to discuss expectations and logistics.
07-06-09 Monday 2:00 PM	WCH management provided a briefing to the DOE Type B Accident Investigation Board and the URS-led Accident Investigation Team.
07-06-09 Monday 3:00 – 5:00 PM	The DOE Type B Accident Investigation Board received an initial tour of 336 Building.
07-06-09 Monday 4:40 PM	WCH (Event Classifier) submitted ORPS report, EM-RL-WCH-DND-2009-005.
07-15-09 Wednesday	Millwright 1 was released from the hospital.

3.0 Facts and Analysis

3.1. Work Planning and Controls

May 11 – June 30

On May 11 a work process form (WPF) was initiated by the 336 Work Control Planner with the work request description as follows, "Perform above grade demolition of buildings 335 and 336." The "work scope" did not include the 336 Building bridge crane removal preparations. RM 2 (Risk Ranker), based on the work request and his understanding of the work scope, performed a risk ranking determination. This determination resulted in a risk ranking of "low." A risk ranking of low requires preparation, scheduling, and performance of work per normal work control processes. A higher risk ranking of medium or high invokes additional rigor such as a "What If" analysis and, when determined appropriate by the responsible manager (RM), a senior management review team or workability review. The RM knew that a Komatsu PC800-8 Hi-Reach would be utilized and assumed the demolition of the building was similar to other 300 Area building demolition activities. D4 had performed a building demolition in 107N involving crane removal; however, this did not involve manual preparation of the crane prior to removal. RM 2 (Risk Ranker) completed and approved the WPF, forwarding the WPF and risk ranking determination worksheet to the 336 Work Control Planner, starting the process of work package development.

One of the 300 Area project engineers had identified in May that the high reach equipment was not appropriate for 336 Building bridge crane removal, but did not communicate his findings to the Planner or PSRs.

On May 27 during the development of the work package IWCP 300 09 05 11 001, a decision was made to remove 335 Building from the work scope. This decision was based on expediting demolition of 335 Building, because demolition of the 336 Building required a trench be excavated invoking the need for an excavation permit. As a result of separating the two activities, 335 Building demolition was accomplished ahead of the start of 336 Building demolition activities. RM 1 (IWCP/JHA) revised both the WPF and the risk ranking determination worksheet by simply lining through 335 Building and initialing the change. RM 1 (IWCP/JHA) did not revise the original risk ranking since the scope, as he understood it, had not changed except for removal of the 335 Building.

On June 15 the first of two JHA sessions was conducted. The JHA session consisted of a walk down (floor level) followed by a tabletop discussion. The scope of work included the use of the Komatsu with shears to demolish the upper portion of the high bay structure and a standard excavator with shears for the remainder of the building. At the JHA session a crane operator raised a number of concerns regarding the Komatsu, including the potential for tipping if it was used to remove the bridge crane during demolition. The 336 Work Control Planner did not provide draft task instructions and did not utilize an overhead projector to cover the draft work instructions, which are the customary practices and expectations of the IWCP procedure. He did, however, use a draft version of the JHA during the tabletop discussion.

Due to concerns raised at the June 15 JHA session, the task instructions and JHA were revised. An additional activity was added to IWCP task 1 (set up work area for demolition) to manually prepare the 336 Building bridge crane for removal. In addition, task 2 (demolition and load-out

of building) was revised to provide more details regarding removal of the crane from the building using a piece of heavy equipment other than the Komatsu.

On June 25 the second of two JHA sessions was conducted. The 336 Work Control Planner covered both the revised JHA and IWCP task instructions. A tabletop discussion and a work site walk down were conducted; however, as before, the work site walk down was conducted at the floor level. During the walk down it was noted that a catwalk would have to be accessed to accomplish the majority of the work involved with preparing the bridge crane for removal. The decision to not access the catwalk during this planning phase would be a significant contributor in the events leading up to the fall. The only elevated work hazard in the JHA at this time involved the hazard associated with using an aerial lift. Attendance at this second JHA did not include a bridge crane subject matter expert (SME) or a millwright (someone familiar with the details of the crane from experience with the maintenance/repair of bridge cranes). A catwalk-level walk down, along with the utilization of bridge crane SMEs and/or millwrights, would have provided an opportunity to: 1) identify the details of bridge crane removal preparations, 2) formally identify and capture hazards and hazard controls associated with the bridge crane removal preparations, 3) formally identify and capture the hazards and controls associated with conducting work from the catwalk, and 4) formally identify and capture the hazards and controls relating to the catwalk hatch, including the hatch weight and methods for opening/closing the hatch. Additionally, a walk down of the catwalk might also have recognized the lighting deficiency as a hazard and prompted development of additional controls. The Board accessed the catwalk during its investigation, and using a light meter noted that lighting was poor and significantly less than the OSHA minimum lighting requirements.

During his interview, the 336 Work Control Planner indicated that he did not think the catwalk opening included a hatch and that he thought the opening was controlled by chain guards. If the catwalk had been accessed during the planning phase, this misconception could have been avoided.

June 30 – July 1

On the morning of June 30, the 336 Work Supervisor/300 Area D4 Superintendent attended the plan-of-the-day (POD) meeting, but he did not discuss his intent to begin work at 336 with the FPOC. He then conducted a pre-ev briefing covering the activities associated with the bridge crane removal preparations. In addition he discussed the installation of the retractable lanyards and the utilization of the retractable lanyards when ascending and descending the ladder. There was no discussion of the specifics regarding the fall protection method to be used by Rigger 2 when climbing the ladder during installation of the retractable lanyards.

A discussion regarding the climbing technique to be used was held at the work site between the 336 Work Supervisor/300 Area D4 Superintendent, 336 PSR, and Rigger 2. At this discussion the decision was made that the “first man up” (Rigger 2) would free climb while installing the retractable lanyards. The 336 Work Supervisor/300 Area D4 Superintendent, 336 PSR, and a second PSR (324/327 PSR) observed the free climb, and though the second PSR felt uneasy regarding the decision to free climb, he did not stop the free climb.

At approximately 10:00 a.m. on June 30, the activities associated with the preparation of the 336 Building bridge crane removal began. The first activity accomplished was the installation of the retractable lanyards by the “first man up” (Rigger 2). Subsequent to the retractable lanyard installation, Rigger 2 was joined on the catwalk by a second rigger (Rigger 1). After both riggers

were on the catwalk, the hatch was shut as observed by the 336 Work Supervisor/300 Area D4 Superintendent. The riggers conducted a walk down of the work area and descended to the floor level for lunch.

During the pre-lunch work area walk down, the riggers identified the following:

- A section of the catwalk guardrail needed to be cut to eliminate interference with the trolley removal (new scope).
- There were actually two crane bridge rail stops on each side as opposed to the single set initially assumed. One rail stop (emergency or e-stop) would require cutting and the other rail stop would require unbolting. The riggers recommended leaving one bolt per rail stop to prevent accidental movement of the bridge crane during initial building demolition activities (new scope).

This initial work activity was initiated prior to the IWCP/JHA being approved by RM 1 (IWCP/JHA), who signed the documents at approximately 11:00 a.m. In addition, the IWCP was not released for work per the 300 Area D4 procedure D4-110-1.7, *Work Release and Minimum Staffing*, which requires the FPOC (also called the release coordinator) to release the work.

After lunch two riggers (Riggers 2 and 3) ascended to the catwalk and performed the following activities:

- Cutting the bridge crane wire rope.
- Cutting a hole in the south exterior wall and running the cut wire rope through the hole.
- Installing tube-block clamps to prevent lateral trolley motion (new scope).
- Completing the cutting of the west bridge rail e-stop.

Neither the 336 Work Supervisor/300 Area D4 Superintendent nor any PSR observed the afternoon work activities. Upon the completion of the first day's work, the riggers met with the 336 Work Supervisor/300 Area D4 Superintendent and discussed the need to disengage the crane brakes, the need for millwrights to accomplish brake disengagement, and the need to cut catwalk guardrails. The 336 Work Supervisor/300 Area D4 Superintendent made an incomplete entry in the work status log capturing only the retractable lanyard installation and the cutting of the e-stop. He also failed to recognize the significance of the newly identified work scope and the required change to the IWCP task instructions and JHA revision.

The next day, July 1, the 336 Work Supervisor/300 Area D4 Superintendent failed to inform the FPOC of the prior day's work at 336 or have the FPOC release the IWCP work package at the 5:50 a.m. POD meeting. The 336 Work Supervisor/300 Area D4 Superintendent then conducted a pre-ev briefing at approximately 7:00 a.m., discussing the work to be accomplished that day, which included releasing the bridge crane brakes, cutting the remaining e-stop, unbolting the other two crane rail stops (leaving one bolt installed), and then cutting the catwalk guardrail as the last step. The 336 Work Supervisor/300 Area D4 Superintendent also discussed the "team up, team down" hatch control concept. In attendance for the first time were the two millwrights (Millwright 1 and Millwright 2). Neither millwright had been involved with this activity prior to July 1. No PSRs were at the pre-ev.

The “team up, team down” concept was developed informally by the 336 Work Supervisor/300 Area D4 Superintendent as a method to safely control the catwalk hatch/opening. The concept was simply that all workers would ascend to the catwalk (one at a time) and subsequently secure the hatch; after all work was complete the hatch would be opened and all workers (one at a time) would descend to the floor level.

After the pre-ev briefing, personnel proceeded to the work site to perform the activities discussed. After the pre-ev was completed, the 336 Work Supervisor/300 Area D4 Superintendent discussed with Rigger 1 alone the need to secure the trolley to the bridge in order to prevent the trolley from potentially falling off of the bridge when a side-pull is placed on it during final crane removal step. The 336 Work Supervisor/300 Area D4 Superintendent suggested using a cable to accomplish this task. This, too, was new work scope with associated hazards that had not been analyzed or incorporated into the IWCP/JHA.

That morning two of the three riggers (Rigger 3 and Rigger 2) and the two millwrights (Millwright 1 and Millwright 2) ascended to the catwalk, shutting the hatch, and began performance of their assigned tasks. The 336 Work Supervisor/300 Area D4 Superintendent, after verifying that the hatch had been shut, left the 336 Building to go check on other 300 Area work sites. No PSRs were present. While performing the task of releasing the crane brakes, the millwrights identified that they would have to remove the gear boxes.

The 336 Work Supervisor/300 Area D4 Superintendent, during the first of two visits, concurred with the decision to remove the gear boxes, failing again to recognize the gear box removal was new work scope. To facilitate gear box removal, one of the riggers (Rigger 2) descended the ladder and sent up empty water bottles to be used for collecting the used gear box oil. After removal of the gear boxes and crane rail stops, the only known remaining task to the workers on the catwalk was to cut the guardrail. Guardrail cutting began and in anticipation of completing the work, one millwright (Millwright 2) descended the ladder leaving the hatch open.

During these final tasks Rigger 1 had left to obtain a cable to secure the trolley. During his search he found chains and tensioners, which he concluded would work better and be easier to use than the recommended cable. The 336 Work Supervisor/300 Area D4 Superintendent concurred with his decision during a brief second visit to the work site and immediately left to oversee other work. At the time of Millwright 2’s descent, Rigger 1 yelled up to Rigger 3 informing him of the need to secure the trolley to the bridge. At this time, two of the three guardrail cuts were already made and the hatch remained open.

The millwright remaining on the catwalk (Millwright 1) elected to support the rigger remaining on the catwalk (Rigger 3) in securing the trolley. The rigger on the ground (Rigger 1), with assistance from Millwright 1 and Rigger 3, delivered the chains to the catwalk. Rigger 3 and Millwright 1 discussed potential methods for securing the trolley. During the discussion Millwright 1 thought it would be a good idea to move the trolley closer to the guardrail, minimizing the need to reach approximately two feet over the already cut railing. (The Board subsequently determined that the trolley could only have been moved approximately 3½ inches before the bridge would hit the building structure). The plan they developed was for Rigger 3 and Millwright 1 to go to opposite ends of the catwalk for the purpose of moving the bridge crane (new work scope). While positioning himself to the west end of the catwalk, Millwright 1 fell through the open hatch. The unplanned activities to secure the trolley and move the crane closer to the catwalk interrupted Rigger 3 and Millwright 1 from completing the work sequence

they had been performing (cutting the guardrail) and has been identified by the Board as the direct cause of the accident.

Additional Observations

There were a number of additional observations by the Board indicative of a lack of rigor in work planning and control as follows:

There were two planning pre-requisites that were not completed prior to performance of work. Section 3.0 of the IWCP work package task instructions contained a pre-requisite that read as follows, "Ensure the following attachments are complete. Work supervisor document completion in the associated A-Pack [additional attachments]." The attachments were: 1) hazardous material (hazmat) removal checklist, and 2) "ready for demolition" approvals. Although neither was completed prior to start of work, the Board determined that these incomplete pre-requisites had no direct bearing on the event. However, the new scope of work regarding the bridge crane wheel gear box removal involved the removal of hazardous waste in the form of gear box oil. This waste was not removed previously during the performance of the hazardous material removal for buildings 335 and 336, which was completed prior to June 18, 2009. Interviews with the Planned 336 Work Supervisor indicated a conscious decision was made not to access the bridge crane due to the elevated work hazards and what he determined at the time to be inadequate lighting. The fact that the bridge crane contained hazardous material (gear box oil) was not documented in the hazardous material removal work package status log and was not accounted for by the 336 Work Control Planner during planning efforts for 336 Building demolition. This resulted in the workers developing a non-compliant work-around for containing the gear box oil in empty drinking water bottles.

The catwalk was never formally analyzed by the Structural Engineer prior to access by the work crew. Fortunately, in this case the catwalk was in good condition. Through interviews with the Structural Engineer, he did indicate that he performed a cursory look at the catwalk during his analysis of the fixed ladder and notes that it appeared to be in good shape.

Conflicts exist between PAS-2-1.1, *Integrated Work Control*, and D4-110-1.7, *Work Release and Minimum Staffing*, regarding the release of work. Per D4-110-1.7, the actual daily release of a work package occurs when the release coordinator (FPOC) has signed the work release block of the POD schedule. Per PAS-2-1.1, work is released daily by the work supervisor by signing the pre-ev form indicating that all prerequisites have been met and that the work team is ready to perform the work in accordance with the approved work package.

On June 30 a pre-ev was conducted and signed by the 336 Work Supervisor/300 Area D4 Superintendent; however, the 336 Work Supervisor/300 Area D4 Superintendent did not take the completed pre-ev form and obtain formal work release from the FPOC. In addition, the RM had not yet approved the IWCP work package when work was initiated on June 30. Again on July 1 a pre-ev was conducted and signed by the 336 Work Supervisor/300 Area D4 Superintendent; however, the FPOC did not sign the work released block of the POD schedule. Based on an interview with the FPOC, he does not sign the work released column for a given work item until the work supervisor completes the pre-ev and brings the signed pre-ev briefing checklist to him for his initials. At this point the FPOC signs the work released column releasing the approved work package. The FPOC does not recall having seen an RM-approved work package relating to bridge crane removal preparations or the pre-ev briefing checklist, or that

the 336 Work Supervisor/300 Area D4 Superintendent had discussed that work activities at 336 had already commenced.

When the scope of work changed, adding manual bridge crane removal preparations and the removal of the crane by a different piece of heavy equipment other than the Komatsu, none of the three 300 Area RMs re-evaluated the risk ranking. Though not required by the IWCP procedure, had this been done, the risk would have most likely changed from low to medium. This would have officially invoked the use of the "What If" analysis/scenario. With that said, the 336 Work Control Planner did utilize a "What If" scenario despite a low risk ranking. However, the only "What If" scenario captured in the JHA concerned a chemical spill. At the first JHA session, the 300 Area RL FR noted the limited use of the "What If" scenario and recommended additional scenarios be developed prior to approval of the JHA. No other "What If" scenarios were developed by the 336 Work Control Planner after rejection of the 300 Area RL FR recommendation by the 336 Work Supervisor/300 Area D4 Superintendent and 336 HazMat Removal Supervisor. The 300 Area RL FR, who recommended additional "What If" scenarios, was on vacation at the time of the second JHA and the RM approval of the IWCP work package and JHA.

A review of the pre-ev briefing checklist attendance sheet indicates that not all of the attendees signed the attendance sheet at the July 1 pre-ev. The IWCP procedure requires the following regarding signing the attendance sheet, "Workers present shall sign the attached pre-ev roster for each brief."

The 336 Work Supervisor/300 Area D4 Superintendent did not provide pre-ev attendees with a written copy of the task instructions or show them written tasks to follow along during the pre-ev. The workers involved with the activities of June 30 and July 1 did not review the task instructions prior to performing work. Had this been done, it would have provided the workers with a better understanding of the details of the task instructions and an opportunity to determine when work scope changes occurred that were outside of what was planned and evaluated. There were many opportunities for this to occur during the course of the two days. Recognizing these work scope changes would have driven a change to the work package, resulting in planner involvement, the formal analysis of the hazards associated with the work scope, and the addition of necessary hazard controls.

The Board determined that the work crew and 300 Area management team did not recognize the crane removal manual preparations as a first-of-a-kind activity, but instead relied on their prior experience in both demolishing and removing overhead cranes using heavy equipment and the 107N approach; giving them an inaccurate understanding of the task that needed to be performed.

The IWCP procedure requires concurrence signatures from the personnel involved with development of the JHA and work package. The concurrence signatures should indicate that appropriate hazards and controls had been identified. After the first JHA session and prior to the second JHA session, the 336 Work Control Planner routed the JHA and IWCP work package cover sheet for concurrence. The 336 PSR signed both the JHA and work package concurrence sheets on June 23, two days prior to the second JHA on June 25. The 336 Work Control Planner explained to the Board that he did discuss changes with the PSR prior to the RM approval. In addition, the Planned Work Supervisor signing the work package cover sheet had no involvement with the planning/JHAs. He conducted only a cursory review prior to

signing. It is the Board's perception that this premature signing of the work package and JHA was due to the fact that the Planner was under significant pressure to deliver on approved work packages and JHAs.

The Board noted two instances of personnel not involved in any of the planning for the crane removal preparations concurring to or approving the work package and/or JHA. The Planned Work Supervisor who eventually signed the work package cover sheet had no involvement with any of the planning activities. He indicated that he performed a cursory review of the package prior to signing. The RM who approved the final work package and JHA had no involvement in the planning, yet approved both on June 30. The RM did conduct a review of the work package prior to signing, which resulted in a minor change, but this took place approximately within a three-hour time frame with little time to conduct a thorough review.

Interviews indicated that communication between personnel at the 336 Building floor level and catwalk level was informal, such as Rigger 1 yelling up to Rigger 3 regarding the need to secure the trolley. The Board felt a more formal or structured form of communication would be warranted when performing critical or hazardous tasks.

Conclusions

The Board concludes:

- The implementation of the IWCP procedure for the 336 Building demolition work package and JHA development was less than adequate. The IWCP drives either a tabletop, walk down (preferred method), or both as part of the JHA process. In this case the RM selected both. Only floor level walk downs of the job site were conducted. The floor level walk downs failed to recognize or formally capture the hazards associated with the task of manually preparing a bridge crane for removal or working from the catwalk. In addition, the 336 Work Control Planner did not utilize any bridge crane SMEs or millwright support in the development of the work instructions or JHA for this change in scope. The end result was a JHA that did not adequately capture the hazards and controls associated with the task or work on the catwalk, and a set of work instructions that did not provide sufficient details for the manual preparation of the bridge crane for removal.
- The implementation of the IWCP for the field execution of the 336 bridge crane removal preparations was less than adequate. Lack of detail for the bulleted items listed for the 336 bridge crane removal preparation tasks and the heavy reliance on the skill of the craft to fill in the details resulted in the work supervisor and the work crew failing to recognize new work or a change in existing work scope. Failure to recognize new work or changes in existing work scope prevented the full utilization of the IWCP change process to formally analyze the changes from the aspect of revised or new hazards and identification of their associated controls. In particular the new scope involving the securing of the trolley to the bridge crane cross rail was not well planned or communicated to the workers, and introduced significant new hazards.

3.2. Supervision and Oversight of Work

During the Board's review, numerous issues associated with WCH's supervisory and safety oversight methods and adequacy of resources were identified. Of concern to the Board is that the oversight methods employed and the shortage of available resources precluded the safe execution of the 336 Building bridge crane removal activity.

WCH has normalized the risks of performing scheduled work with a recognized understaffing of experienced key resources within 300 Area D4 projects. WCH currently has only two PSRs covering the entire 300 Area scope of work, and for the two weeks prior to the accident, only one PSR was available. The PSRs have responsibilities for performing other activities such as training and JHA support that preclude them from performing consistent oversight of day-to-day field work activities. Due to other activities in progress, the assigned PSR was unable to attend the July 1 pre-ev meeting and did not observe any 336 Building work activities on that day. For a portion of that morning, this PSR was receiving WCH fall protection training from another PSR.

After the June 25 JHA meeting, the originally assigned Work Supervisor for this task expressed that he was already overloaded covering other work activities and expressed concern in serving as the first-line work supervisor for the 336 Building crane removal preparation tasks under the IWCP. Since the 300 Area D4 Superintendent was involved in planning efforts for the building demolition and in order to avoid delay, the Superintendent took responsibility for the first-line work supervision while also maintaining overall responsibility for other 300 Area work conduct and planning activities, as well as performing his superintendent responsibilities. These other responsibilities precluded the 300 Area D4 Superintendent from performing continuous oversight of the higher risk activity in 336 Building involving the elevated catwalk. More troubling, though, is that the 300 Area D4 Superintendent believed that it was acceptable to leave five craft workers to conduct hazardous work without a supervisor or PSR present despite his perception of its risk.

In the 300 Area, WCH D4 projects have three RMs with general responsibilities for the 324 Building, subcontracted work, and the remainder of the 300 Area facilities. These RMs serve as the final approval authority for IWCPs and associated JHAs and are responsible for the safe conduct of work. The Board identified that they are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope under each IWCP. In the case of the demolition IWCP/JHA for the 336 Building, the assigned RM who was the most familiar with the planning efforts was not available at the time the Planner was collecting approval signatures. Rather than waiting, the Planner had another available RM (who principally oversees subcontracted work) review and approve the documents. While in this case the RM who signed the IWCP/JHA requested some minor changes to the task instructions, this practice may lead to omissions in the IWCP/JHA and/or unclear roles and responsibilities.

Perceived schedule pressure was noted by the Board as a significant issue that contributed to the accident. The Work Supervisor/300 Area D4 Superintendent was anxious to complete task 1 and turn over demolition to a crew of new D4 workers. This was evidenced by premature approvals of the IWCP/JHA by the PSR, several IWCP pre-requisites not being completed prior to initiation of the work, numerous work steps being verbally added to the scope of work without changing the IWCP/JHA as required, and PSRs not allowing adequate time to locate the pre-existing engineered ladder safety devices. Work was initiated, including the free climb up the

ladder, even before the written structural engineering analysis was provided to the PSR and before the IWCP/JHA was approved and released by the RM and FPOC. Since the PSR did not review the engineering analysis prior to work, the retractable lanyards were hung in unanalyzed locations. The 300 Area D4 Superintendent stated in an interview that he pushes his planners, work supervisors, and PSRs hard.

Despite everyone's broad knowledge of stop work authority/policy, Board interviews with staff indicated that workers are hesitant to exercise a "work pause" due to perceived pressures related to accomplishing the project mission. While there may not be a fear of direct retaliation, there is a culture of concern that individuals will be ostracized or seen as non-team players for raising issues which may slow work progress. The Board does not believe that employees would hesitate to use "stop work" when faced with an imminent personnel safety hazard or that overt retaliation has or would occur. Instead the Board is concerned that workers are knowingly taking on unplanned tasks under the guise of "skill of the craft" without adequate hazard identification and controls planned. In most of these cases the work is performed without incident; however, in the case of this accident, workers' and a PSR's inhibition to speak up and identify scope creep was a direct contributor.

Of additional concern to the Board is that key supervisory and safety personnel did not execute their roles and responsibilities consistent with their authorities and accountabilities. Both the PSRs and 300 Area D4 Superintendent allowed an individual to inappropriately free climb a 50-ft ladder, and inappropriately tie off on the midpoint guardrail. The Superintendent provided inappropriate tie-off points for riggers on the catwalk guardrail without a PSR being present. Training records for the work crew were not adequately evaluated prior to work performance, which would have identified a millwright as not having the necessary ladder training to perform the work.

There was an overall lack of understanding or adherence to requirements on the part of planners, work supervisors, PSRs, and craft workers as to what requires a work package change in accordance with PAS-2-1.1 with regard to introduction of new scope and hazards. In addition, the 300 Area Project Engineer was not directly involved in any work planning activities related to the 336 Building as outlined in the WCH Integrated Safety Management System (ISMS) description. Further exacerbating this was the Work Supervisor/300 Area D4 Superintendent's perception that the scope of work was adequately defined in the IWCP task instruction section 5.1.2, allowing at his discretion to add work with a package change if he felt the added work was "skill of the craft."

The lack of detailed pre-ev meetings was a further issue of concern to the Board. The pre-ev meeting associated with this activity failed to communicate the complete work scope for desired tasks, and was conducted with an unapproved IWCP. The Board's interviews with the six principal workers for the 336 task identified clear discrepancies among the understanding of what was discussed regarding scope of work, sequence of tasks, equipment expectations, and use of safety equipment. The "team up, team down" hatch control concept was either not well communicated or not well understood by the work crew, as was evidenced by workers individually exiting the catwalk on July 1. The Work Supervisor and PSRs assumed that the "team up, team down" concept was adequate for fall protection. Further, the direction to "secure the trolley," was imprecise and was only discussed between the 336 Work Supervisor/300 Area D4 Superintendent and Rigger 1. This is a key deficiency with regard to the WCH work planning and execution culture, in that WCH senior management relies on the work supervisor's

pre-ev to inform the workers actually performing the work scope of the hazards, controls, and specific tasks outlined in the IWCP. In many cases the pre-ev is the first and only involvement any particular worker has in understanding the intended work steps. Since most workers do not actually review the written IWCP task instructions, a less than adequate pre-ev, and a general cultural reliance on skill of the craft to perform work is an error precursor carrying considerable risk.

In spite of the recognized high turnover of planners, supervisors, PSRs, and D4 workers, the pace of work driven by D4 management appears to be unchanged even though the work activities have been refocused to perceived lower risk facilities. The high turnover creates several undesired conditions. First, experienced workers with institutional knowledge are lost. Second, new staff needs to be recruited and trained, usually by the remaining staff. This training needs to transition new workers in both the WCH and Hanford "way of doing business," which differs from both commercial work sites and many other DOE sites. These additional training duties further burden the existing staff resources, diverting their attention away from their core functions, and act as an additional precursor to exacerbate turnover of experienced WCH staff. It is the Board's position that there has become an over reliance on "skill of the craft" for WCH 300 Area D4 work activities. This over reliance on the craft has established a willingness to accept higher risk in order to accomplish work without adequate planning, hazard identification, and control. This was evidenced by one of the work supervisors who said, "That's the way D4 work is done."

3.3. Fall Protection, Ladder Safety, and Illumination

The WCH Safety and Health Program does not adequately implement the 10 CFR 851, *Worker Safety and Health Program* requirements for fall protection, fixed ladder safety, walking working surfaces, and illumination per OSHA 29 CFR 1910 and 1926. In addition, deficiencies were found in WCH Fall Protection Procedure (FPP) SH-1-3.5, and procedures had not been developed and/or implemented by WCH for fixed ladders and illumination of work in "cold and dark" buildings. Furthermore, WCH management did not ensure that the fall protection procedures in effect at the time of the accident were followed.

Procedures

WCH's FPP discusses the use of primary fall protection systems (guardrails, covers for floor openings, and closure apparatus for ladder openings or other points of access) and secondary fall protection systems (safety harnesses/lanyard systems). The written discussion in Sections 6.2 and 6.3, in general, meets standard requirements. However, additional clarification on the appropriate use of unconventional fall protection (warning lines, safety monitoring systems, and controlled access zones) is needed in order to fully comply with OSHA standards. Several other sections of the procedure do not meet OSHA requirements and are discussed below:

Section 6.4.1 - Lifeline Placement/Installation

This section allows horizontal lifelines to be installed and maintained under the direction of the field supervisor and competent person. This is contrary to 29 CFR 1926.502(d)(8) that requires a qualified person (i.e., an engineer or equivalent) to design, install, and supervise their use.

Section 6.5 - Temporary Work Platforms/Walkways

This section allows the PSR the option to provide a fall protection system for temporary work platforms or walkways in lieu of meeting applicable OSHA standards. In the case of this accident, the “team up, team down” concept was the system that was determined by the Work Supervisor (without objection by the PSRs) to be acceptable, which is not in compliance with 29 CFR 1926, Subpart M.

Section 6.7 - Permanent Structures/Stairs/Caged Ladders

Paragraph 2 of this section does not require the use of fall protection if an employee is six or more feet from a fall exposure. This policy conflicts with OSHA standards. The OSHA fall protection standard and written interpretation letters do not have provisions for a “safe distance” from a fall hazard. In addition, this section does not include OSHA requirements for fall protection for fixed ladders. The applicable OSHA standards for fixed ladders are found in 29 CFR 1910.27, 29 CFR 1926.1053 and 1060.

Section 6.11 - Additional Controls

This section discusses the use of controlled access zones, warning lines, safety monitoring systems and fall protection plans. However, the section does not limit the use of these controls in accordance with the OSHA standard set forth in 29 CFR 1926.501(b)(10), 502(h) and 502(k), an OSHA-written interpretation letter dated 5/12/2000, and the preamble for the fall protection standard in Volume 59 of the Federal Register. OSHA limits the use of these unconventional fall protection methods to three types of work: leading edge work during roof installation, residential construction, and precast concrete erection. With the possible exception of roofing work, WCH does not do work that would allow the use of unconventional fall protection.

Attachment 1 - Fall Protection Checklist

This checklist was considered by WCH to be the fall protection plan and was included in the IWCP for the 336 Building demolition. However, the use of a fall protection plan, as defined by 29 CFR 1926.502(k) is only allowed when unconventional fall protection is used for roofing work and thus was not appropriate to be used for 336 Building demolition work. Additionally, the content of WCH’s one-page checklist is not acceptable. The checklist did not document the reasons why conventional fall protection systems (guardrail systems, personal fall arrest systems or safety net systems) were infeasible or why their use would create a greater hazard as required by 29 CFR 1926.502(k)(5).

The requirements of 29 CFR 1926.502(k)(6) were also not addressed. This standard requires a written discussion of other measures that will be taken to reduce or eliminate the fall hazard for workers that cannot safely use conventional fall protection. Additional information must be included in the plan if controlled access zones and safety monitoring systems are used.

As suggested in WCH FPP SH-1-3.5, Section 6.11(2), 29 CFR 1926, Subpart M, Appendix E should be used as a guide in developing a fall protection plan. This should have ensured the plan would meet the rigor required by the OSHA standard as to when a fall protection plan is permissible.

Training

The WCH workers involved in this accident have had fall protection training; however, the training program is not adequate. The free climb of the 50-ft. ladder, disregard of structural

engineer recommendations for anchorage installation areas, the concept of “team up, team down” for hatch control, the lack of protection when cutting the guardrail, management’s expectation of workers standing six feet back from the hatch opening, and the instruction to tie off to the guardrail, collectively indicate a lack of understanding of OSHA fall protection requirements by WCH’s riggers, millwrights, work supervisors, and PSRs.

WCH provides in-house training for fall protection (course 105500) for workers who are potentially exposed to falls from height hazards and use secondary fall protection equipment. The training program includes the use of FPP SH-1-3.4, a fall protection PowerPoint presentation, hands-on demonstration of the equipment, and a self-graded quiz. The training includes the use of controlled access zones, safety monitors, and fall protection plans as acceptable fall protection methods for most of WCH’s work. However, as stated above, the OSHA standard and written interpretation letters only allow the use of personal fall arrest/restraint systems, guardrails, or safety nets as acceptable means of fall protection for demolition work.

WCH does not have a program or provide training on the use of fixed ladders. With the exception of one millwright, the workers accessing the catwalk had been trained on the use of portable ladders. Portable ladder training is combined with scaffold training in WCH’s ladder/scaffold training. However, this does not address the hazards and required protection when climbing fixed ladders.

After the Board requested information on fixed ladder training, WCH responded in an email and committed to adding the fixed ladder requirements in 29 CFR 1926.1053(a)(19) to their portable ladder and fall protection procedures. Periodic training is not provided or required by WCH management. However, retraining is required by both the OSHA ladder and fall protection standards when it becomes evident that workers have not retained the requisite understanding of the procedures to be followed as identified in 29 CFR 1926.1060(b).

Compliance

WCH management and safety representatives did not follow or implement their internal FPP SH-1-3.5, and/or implement the fall protection and ladder safety requirements in 29 CFR 1910 and 1926. In addition, workers did not fully implement the verbal fall protection direction (notwithstanding its regulatory inadequacy) that was given by management. The following is a summary of these non-compliances:

- The first man up free climbed a 50-ft. ladder to install anchorage and hang retractable lanyards. WCH does not have procedures for fixed ladders that exceed 24 feet in length. The purpose of



Figure 3-1. Ladder center rail for ladder safety device attachment

hanging the retractable lanyards was to provide fall protection while climbing a 50-ft. ladder that was not caged, and used to access and egress an overhead catwalk.

The ladder had an engineered ladder safety system; however, the PSRs only made a cursory attempt to locate the device. Contributing to the failure to obtain the safety device was determined to be an unfamiliarity of the Planner and PSRs regarding WCH's facility transition process. The Board was able to locate and obtain the engineered ladder safety device (Sellstrom/RT 2000 Climb-Rite) in less than an hour. Not using this device exacerbated control of the catwalk hatch since the retractable lanyards that were used rubbed on the hatch when it was in a closed position.

The 336 Work Supervisor/300 Area D4 Superintendent and 336 PSR were involved in the decision to allow the free climb based on the "fitness and experience" of the rigger. The 324/327 PSR stated that he was "uncomfortable" with the free climb decision, but did not overtly object to it. Contributing to this decision was Rigger 2's ascertain that free climbing was safer than using the double-hook method to climb the ladder. The OSHA ladder standard, 29 CFR 1926.1051(b) and 29 CFR 1926.1053(a)(18), do not allow free climbs and require the use of fall protection systems, cages, or ladder safety devices when the length of the ladder exceeds 24 feet.



Figure 3-2. Sellstrom/RT 2000 Climb-Rite

- Prior to the installation of the retractable fall protection for the ladder, the building structural horizontal beams were identified by the structural engineer as adequate anchorage areas. However, the recommendations of the structural engineer were not followed and the anchors were installed on flat iron used to support the fixed ladder and structural cross bracing for the building.

The OSHA fall protection standards, 29 CFR 1926.502(d)(15), (d)(15)(i) and



Figure 3-3. Lower anchorage at midpoint platform

(d)(15)(ii) require certification from a qualified person (such as a structural engineer) if the employer is not certain that the selected anchorage point is capable of supporting 5,000 pounds and independent of any anchorage being used to support or suspend platforms. After the accident the structural engineer evaluated the installed anchorage points that were used and determined they were adequate.

- Softeners were not used to protect the anchorage devices (beam straps) from the sharp and abrasives edges of the flat iron and cross bracing. WCH's FPP, SH -1-3.5, Section 6.4.1(2) requires the use of softeners for lifelines, but does not discuss anchorage attachments. MSA, the manufacturer of the anchorage connector straps, recommends avoiding sharp edges and abrasive surfaces.

- During the installation of the retractable fall protection for the ladder, the rigger used a 6-ft. lanyard and tied off to the midpoint platform guardrail. In addition, the 336 Work Supervisor/300 Area D4 Superintendent directed the last worker on the catwalk to cut the guardrail and be tied off one section back from the cut. When the scope of work changed to include chaining the bridge crane, neither the rigger nor the millwright had lanyards, so they opted to stand back from the cut rail. The OSHA fall protection standard 29 CFR 1926.502(d)(23) does not allow personal fall arrest systems to be attached to guardrails.



Figure 3-4. Retractable lanyard and hook

- Workers were exposed to a 50-ft. fall hazard whenever the hatch was open. The 336 Work Supervisor/300 Area D4 Superintendent and PSRs relied on the “team up, team down” hatch control concept to provide fall protection for workers on the catwalk. The workers were instructed to use the retractable fall protection and climb the ladder one at a time. Workers on the catwalk were instructed to stand back from the hatch opening until all workers were up and the hatch was closed. The process was to be reversed and all workers would exit the catwalk upon completion of all assigned tasks.

During the job, Rigger 2 completed his assigned task and exited the catwalk. The hatch was closed by another worker when he reached the midpoint platform since the closed hatch partially interfered with the lanyard when ascending and descending the ladder. This action broke the work supervisor’s “team up, team down” concept. When Millwright 2 exited the catwalk and was climbing down the ladder, the remaining two were redirected to complete another assignment and the open hatch was forgotten.

The first and last three workers accessing and exiting the catwalk were exposed to a 50-ft. fall hazard and were not protected with a fall arrest/restraint system, guardrail, or

safety net. Standing back from the edge of a fall hazard is not adequate protection as evidenced by the injured millwright stepping through the open hatch and falling 50 feet.

The OSHA fall protection standard 29 CFR 1926.501(b)(4)(i) requires that workers be protected from falling through holes by personal fall arrest systems, covers, or guardrail systems erected around such holes. WCH FPP SH -1-3.5, Section 6.11.1 conflicts with the OSHA standard and allows the use of controlled access zones, safety monitoring systems, and fall protection plans in lieu of conventional fall protection systems.

- Two workers were exposed to a 50-ft. fall hazard when the catwalk guardrails were compromised when cut in two locations. The 336 Work Supervisor/300 Area D4 Superintendent had directed that the guardrails be cut last. The two remaining workers on the catwalk did not tie off. The OSHA fall protection standard 29 CFR 1926.501(b)(1) requires a guardrail system, safety net, or personal fall arrest system when employees are exposed to a fall hazard greater than six feet.
- Workers climbing the 50-ft. ladder were exposed to a 25-ft. fall at the ladder opening on the midpoint platform. At this platform workers unhooked from the lower retractable lanyard and hooked into the upper lanyard before continuing the climb to the catwalk above. Workers were exposed to a fall hazard when not attached to the lanyard. The chain for the ladder access opening was too short and could not span the opening at the midpoint platform. Neither the WCH FPP nor the OSHA standards were followed. WCH FPP SH -1-3.5, Section 6.2(1) and the OSHA fall protection standard at 29 CFR 1910.23(a)(2) require workers be protected at ladder openings by a closure apparatus, swinging gate, or offset so a person cannot walk directly into the opening.

During the course of this investigation, worker, PSR, and management interviews, as well as a review of other accidents and near misses at DOE sites indicated there are considerable misunderstandings of the OSHA fall protection regulations. Several times there was mention of a “six-foot policy” as acceptable fall protection when workers stood six or more feet back from a “leading edge.” The confusion may have come from two 1998 letters written by DOE’s Office of Health, Safety, and Security, D98-01-009 and D98-05-009, which state, “...six feet may be considered the distance from an unprotected edge that is a reasonable threshold separating ‘safe’ from ‘unsafe’ zones with respect to fall hazards on platforms and low sloped roofs.”

The OSHA preamble for the fall protection standard (59 Federal Register 40683, August 9, 1994) and an OSHA interpretation letter dated May 12, 2000, state, “OSHA determined in the rulemaking that there is no safe distance from an unprotected side or edge of a walking/working surface that would render protection unnecessary.” OSHA only allows the use of a fall protection plan and alternative means of fall protection (warning lines combined with effective work rules) in three situations: leading edge work in roofing, residential construction, and precast concrete erecting.

In February 2006 DOE published 10 CFR Part 851, *Worker Safety and Health Program* in the Federal Register. This regulation generally adopted the OSHA standards for most areas of occupational safety. The Board believes the letters written in 1998 by the DOE Office of Health, Safety, and Security may be the source of widespread contractor confusion with respect to the “six-foot policy.”

Illumination

Illumination on the catwalk was not adequate for the work performed and did not meet the minimum OSHA standard 29 CFR 1926.56(a) of five foot candles. The Board took light meter readings with a calibrated Sper Scientific and measured 0.14 foot candles. The light meter reading was taken under similar conditions as the day of the accident and included the use of a headlamp. Workers had mixed perspectives on the adequacy of the lighting. However, the Board determined that the inadequate lighting may have been a contributing factor to the accident.

3.4. Emergency Response

Response by workers in the accident area was commendable. Various workers stayed with Millwright 1 to keep him from getting up and to keep him calm until HFD arrived. Notifications were made quickly to have a nearby teamster contact the Hanford POC to obtain an ambulance. The teamster remained calm throughout the call. Supervision and other workers acted quickly to clear the area of obstructions and equipment to allow ambulance access.

The teamster call to the POC occurred at 9:33:58. The POC took over two minutes to gather data from the caller before contacting the HFD dispatcher. After learning the location of the incident (336 Building), the POC requests the caller's call back number and then repeats back the number; requests the caller's name and spelling and then verifies the spelling; asks the caller to describe the extent of the individual's injuries to which the caller responds; and finally asks the caller for the distance that the individual fell, requiring the caller to get this distance from personnel in the 336 Building. The POC then contacts the HFD dispatcher at 09:36:03. HFD dispatches emergency response vehicles from the 300 Area and 400 Area fire stations approximately a minute later. The HFD engine and ambulance from the 300 Area arrive at the scene at 9:40:17. Vehicles responding from the 400 Area fire station were cancelled en route. The arriving 300 Area HFD EMTs performed an initial assessment of Millwright 1 and found him conscious and responsive. The EMTs placed a cervical collar around Millwright 1's neck, secured him to a backboard, moved him outside the building, and placed him on a gurney and into the ambulance. The ambulance left 336 Building at 9:52:17 and arrived at Kadlec Medical Center at 10:09:06.

The Board is concerned with the excessive time taken by the POC to gather irrelevant data prior to contacting the HFD. Critical time was lost in dispatching HFD to the scene by these actions.

3.5. Post-Event Management Response

Shortly after Millwright 1 was removed from the 336 Building by HFD medical personnel, the 336 Work Supervisor/300 Area D4 Superintendent secured the 336 Building and placed the facility on limited access to preserve the event scene.

Several telephone notifications were made around 9:50 a.m.: the 300 Area FPOC contacted WCH's SPOC; the RL FR Team Lead was notified by the WCH D4 Director. At this point in time, all that was known and communicated about the incident during these calls was that an individual had fallen, had injured his knee, and was taken to the hospital in an ambulance. There were no details available to be communicated during these calls regarding the fall distance or the seriousness of Millwright 1's injuries.

At 10:07 a.m. the WCH SPOC notified the Hanford ONC of the incident. Due to the lack of information on the seriousness of injuries, the ONC determined that this was not an “Abnormal Event” requiring immediate reporting.

At 10:30 a.m. the WCH D4 Director requested that a fact finding meeting be conducted. A 100N Area Planner was assigned to chair the fact finding at the 3760 Building.

At 11:30 a.m. a HAMTC representative who had gone to Kadlec Medical Center to be with Millwright 1 contacted the D4 Closure Director and the 300 Area Deputy Project Manager and informed them that Millwright 1 had a broken bone. The discovery of this information now requires this accident to be reported as an “Abnormal Event.” WCH also determined that this was the Event Discovery time based on the confirmed broken bone.

At 12:00 p.m. the fact finding meeting began at the 3760 Building and lasted until 1:30 p.m. All directly involved WCH personnel were in attendance (except Millwright 1), including the SPOC and the Event Classifier; however, no one from HFD attended. The SPOC and the Event Classifier are responsible for the Event Management Program and failed to recognize that a critique should have been conducted instead of a fact finding meeting.

The Board is concerned with WCH’s failure to recognize the need for conducting a critique instead of a fact finding meeting. While it is understandable that when the D4 Closure Director initiated the fact finding meeting, the extent of Millwright 1’s injuries were still unclear; however, a 50-ft. fall is by its nature a very significant event, regardless of actual extent of injury. At a minimum, it would be conservatively considered a near miss to a fatality or serious injury at the time of the actual event at 9:33 a.m. Further, by the time the fact finding was convened at 12:00 p.m., WCH senior management was aware of Millwright 1’s serious condition, including multiple broken bones. At least four criteria in SEM-3-2.2, Attachment 3, requiring a critique were met:

- Single personal injury that results in short-term hospitalization.
- Project stand-down for an actual event.
- Near miss events.
- Events that may be of interest to the media or other outside agencies.

At 1:30 p.m. the event was categorized as 2A(6) SC-3 by the Event Classifier in consultation with the D4 Closure Director. However, the ONC was not notified of this categorization until 3:36 p.m.

At 4:30 p.m. the Deputy RCCC PM is informed by the DOE-RL Assistant Manager for River Corridor that DOE intends to initiate a Type B investigation.

At 4:50 p.m. the event is re-categorized by the Event Classifier as 10(1) SC-2 as a result of DOE’s decision to conduct a Type B investigation. The ONC does not get notified of this re-categorization until 5:48 p.m.

Due to the weekend schedule, the ORPS Notification Report does not get uploaded until 4:40 p.m. on July 6, 2009. The Issue Form and Fact Finding Report were also issued on July 6, 2009.

Interviews with the Event Classifier, who is also the manager responsible for the event management procedure, indicated that the information provided in the Fact Finding Report issued on July 6 met the intent and expected outcome of a critique. However, SEM-3-2.2, *Event Management*, defines a critique as, "...a midpoint investigation (typically consisting of a mid/large group meeting with involved personnel or several impacted organization) that seeks to understand the precursors leading to the event including an evaluation of compensatory actions taken, potential causes and extent of condition." The Fact Finding Report fell far short of this description. Other than providing a brief timeline of events for the day of the incident, no analysis or evaluation was conducted to understand precursors leading to the event or potential causes and extent of condition. Contrary to SEM-3-2.3, the Event Classifier indicated that fact findings and critiques do not generally document work planning activities leading up to events. Rather, work planning timelines and documents are reviewed in those few cases where a root cause analysis team is convened to investigate more "significant" events. While the fact finding may have been inadequate, WCH did quickly recognize and initiate the formation of a corporate (URS-led) accident investigation, and was preparing to initiate a WCH internal Accident Investigation Team (including a causal analysis) at the time that DOE-RL notified WCH of its intent to conduct a Type B accident investigation.

Several of the personal observer statements (POSs) did not follow the format identified in SEM-3-2.2. This procedure deviation is understandable given the shock of the accident to Millwright 1's co-workers and the immediacy of the requested statements. However, the statement of the 300 Area D4 Superintendent (Work Supervisor) was typed on the following day and did not follow the POS format. The typing of this POS was conducted concurrent with the Fact Finding Chair's drafting and management review of the Fact Finding Report on the morning of July 2. Minor deviations in both the fact finding and/or critique report formats (Attachments 6 and 8, respectively) were noted, including failure to identify the Issue Form number (apparently completed on July 6, 2009). The fact finding also failed to list the SPOC as an attendee.

3.6. Assessment and Continuous Improvement/Lessons Learned

The Board reviewed contractor assessments, management operational awareness walk-throughs, Conduct of Operations (CONOPS) assessments, and lessons learned reports submitted by WCH as evidence of its mechanisms to detect and prevent quality and safety deficiencies.

In response to issues raised in the DOE ISMS Phase I verification review conducted in April 2006, WCH prepared and issued the IWCP procedure for implementation company-wide in February 2007. A significant revision to the IWCP procedure was implemented in August of 2007 in response to self-identified improvement opportunities. During 2007, a significant number (27) of management and independent assessments were performed to confirm adequacy of implementation of the revised IWCP procedure and to ensure readiness for the DOE ISMS Phase II verification review. Included in these assessments was a thorough independent assessment conducted in August 2007 that reviewed the content of over 100 IWCP packages and their implementation in the field. Many issues related to JHA content and flow down of controls into the work instructions were identified in the assessment and adequately resolved to support readiness declaration for the DOE Phase II verification review.

The DOE Phase II verification review was completed in November 2007 and identified that the IWCP procedure was adequate as implemented for planning and authorization of work.

However, the Phase II report identified two concerns and six opportunities for improvement related to IWCP process implementation. Corrective actions associated with these issues were completed and independently verified as effective by both WCH and DOE-RL by the end of September 2008. Self-assessments associated with these corrective actions and to support the continued maturation of IWCP procedure implementation resulted in 45 WCH self-assessments related to IWCP during 2008.

The Board's evaluation of 75 IWCP-related self-assessments conducted during 2007 (27) and 2008 (48) indicated that they were reasonably thorough and self-critical. The Board reviewed 17 self-assessments conducted through June of 2009. Of the 2009 self-assessments evaluated, none identified any significant issues relating to IWCP and therefore did not result in program or process improvements. The breadth and depth of 2007-2008 self-assessments is not evident in more recent assessments evaluated. Based upon the deficiencies identified in this Type B accident investigation relative to implementing the IWCP procedure, the Board concludes that WCH has not been effective in ensuring that IWCP, as one of their key ISMS implementing procedures, is rigorously implemented to ensure the safety of the work force. The recurrence of IWCP implementation issues and the failure of WCH to proactively self-identify these issues are considered contributing causes in this investigation.

The Board reviewed Operating Experience documents issued by WCH's Operating Experience Coordinator to appropriate WCH employees. This included documents prepared by WCH and those gathered from non-WCH sources for 2008 and 2009. Of 271 documents reviewed, the Board determined that nine related to either work control or fall protection. The Board asked WCH if any deficiencies or corrective actions were generated, and the response was that no deficiencies in WCH programs or practices were documented as a result of these nine documents.

The Board reviewed three CONOPS management assessments performed in September 2008, December 2008, and April 2009. The December 2008 and April 2009 assessments were "roll-up-type" assessments reviewing the output of previously performed CONOPS-related assessments. The September 2008 CONOPS assessment was to determine the level of implementation of CONOPS principles across WCH. Although the assessments appeared to be detailed and thorough, they failed to identify deficiencies in execution of IWCP, FPP, and related processes.

The Board also reviewed 25 WCH lessons learned generated in 2008 and 2009. Of those items, only two related to work control (June 2008 and June 2009) and one related to the Corrective Action Management System (CAMS) (April 2008). The two related to work control did not result in any changes to the WCH IWCP procedure or process. The one pertaining to CAMS did not result in a change to the CAMS program or process, but did result in an action to ensure that all deficiencies generated in an assessment report be documented and if deemed to be not easily fixed, or that they represent a high risk, should be entered in the CAMS via an Issue Form.

The Board also asked WCH if any actions were taken in response to the Type B investigations addressing the 2006 fall injuries at either Oak Ridge or LLNL with regard to the WCH Safety programs. WCH's response was that no corrective actions were identified.

In addition the Board reviewed the results of ten management operational awareness walk-throughs and four safety/health inspections conducted between June 2007 and June 2009. The walk-throughs covered a variety of project phases from pre-construction activities, work planning, to execution of work related to integrated work control and elevated work. Activities include, but are not limited to, pre-ev briefings, plan of the day meetings, general site conditions, and safety. Each walk-through checklist includes a comment section, a section to identify additional actions, and a section to address additional training. Of the 14 documents reviewed, several issues and recommended actions were identified. None of those issues or actions resulted in a change to either the IWCP or fall protection program.

3.7. Integrated Safety Management Analysis

WCH's execution of its ISMS was examined for potential direct, root, and contributing causes of the accident. The Board compared the WCH written program and implementation in the field as applied to the 336 Building fall accident. In the Board's view, the WCH ISMS should provide:

- A formal, organized process for planning, performing, assessing, and improving the safe conduct of work.
- A properly implemented system that integrates safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment.
- Appropriate levels of rigor and formality in the identification, analysis, and control of hazards commensurate with the work to be performed.

The DOE Accident Investigation Program requires that accidents be evaluated in terms of Integrated Safety Management (ISM) to foster continued improvement in safety and to prevent future accidents. The Board determined that the 336 Building accident was, in part, the result of a failure of WCH to implement several of the established ISMS Core Functions (CFs) and Guiding Principles (GPs).

The WCH Integrated Environment, Safety, and Health Management System description was reviewed by the Board and compared against the conditions and actions occurring before, during, and after the accident. The description's format lays out the CFs as CF-A through CF-G, imposing two additional functions beyond that described in DOE 450.4-1; the GPs as GP-1 through GP-11, imposing four additional principles beyond DOE's minimum requirements.

Many of the identified issues intertwine among CFs and GPs and are shown as having application in replicate areas of the ISM structure. Examples of individual issues affecting direct, root, and contributing causes are shown as statements from Appendix F under each CF and GP.

The CFs and GPs of the WCH ISMS determined by the Board to have failed are as follows:

Core Functions

CF-A – Establish Environment, Safety, and Health Policy. Work planning and execution of the 336 Building demolition preparation did not display an adequate application of an "injury free"

workplace. The injured worker, in the Board's opinion, was set up to fail by the system designed to protect him. The worker was placed in a position that was "outside" what was planned and "scope creep" subsequently led to the fall. For example, a safety culture allowing such actions as the free climb and the out-of-scope tasks to secure the trolley to the bridge crane, cut the guardrails on the catwalk, and reposition the crane failed to line up with the implementation of WCH Safety Policy PM-ESHQ-3, which states, "WCH is committed to developing and maintaining a culture based on an 'injury free workplace' philosophy, under which all accidents are preventable and occupational injuries and illnesses are not acceptable...controls are integrated into each work task to prevent events that could result in adverse safety and radiological consequences."

The Board determined that a deficiency in CF-A implementation, in part, contributed to root causes 1A and 1B. Individual example issue statements from Appendix F identified by the Board as affecting policy as defined by CF-A are:

- "This is the way D4 is done."
- Overall project and workforce have a high tolerance to risk.
- Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control.
- FR recommendations for additional "What ifs" were rejected.
- Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
- PSRs were not present at July 1 pre-ev.
- PSRs were not present on the job site on July 1.
- PSRs and Supervisor allowed free climb.
- No one stopped work when out of IWCP/JHA scope.
- The 336 Work Supervisor/300 Area D4 Superintendent and WCH management assume that craft workers do not need to be supervised or overseen by PSRs during the performance of hazardous tasks.
- Free climb by Rigger 2 was perceived as safer than using fall protection.

CF-B – Define Scope of Work. Certain facility-level work tasks performed by the 336 Building demolition preparation crew and leading to the accident were undefined. The process to prioritize work scope defined in the WCH ISMS description was advertised to have "...a systematic system for the defining and flow down of work scope and activities throughout all organizational levels."

The Board determined that a deficiency in CF-B implementation, in part, contributed to root causes 1A and 1B. Individual example issue statements from Appendix F identified by the Board as affecting scope of work as defined by CF-B are:

- Risk ranking not modified for scope changes.
- First JHA (June 15) did not include detailed work steps.
- Final IWCP steps lacked sufficient detail.
- Incomplete job walk down (did not access the catwalk) resulted in a less than adequate scope definition.
- Millwrights/crane SMEs not included in second JHA (June 25) and not all attendees signed final JHA.

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- 300 Area Project Engineer not involved in JHAs or walk downs, but signed JHA and IWCP.
 - No structural evaluation of catwalk.
 - JHA did not capture hazard associated with hatch and catwalk.
 - Less than adequate fall protection plan/requirements.
 - Lighting was assumed to be adequate to perform work tasks, yet actual light (0.14 foot candles) is non-compliant with OSHA regulations.
 - Planner had inadequate information to develop the detailed work scope necessary to perform the work safely. As a result of a failure to utilize appropriate SMEs and in particular to access the catwalk, the Planner lacked the understanding of the work and hazards involved in removing the bridge crane.
 - Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control.
 - Trolley location relative to the guardrail, actions necessary to allow the crane to free-wheel (gear boxes and oil), and extra crane bridge stops were all unexpected conditions that were identified after work began.
 - The need to secure the trolley to the crane bridge.
 - FR recommendations for additional “What ifs” were rejected.

CF-C – Analyze Hazards. The “primary mechanisms that any operations or activities performed during the execution of the RCCC do not endanger the worker, public, or environment” failed to identify and analyze the hazards presented by the above out-of-scope tasks. The tools outlined in the description to analyze known hazards and evaluate for potential unknowns were not effectively utilized for the 336 demolition preparation job.

The Board determined that a deficiency in CF-C implementation, in part, contributed to root cause 1A and root cause 2. Individual example issue statements from Appendix F identified by the Board as affecting hazards analysis as defined by CF-C are:

- Less than adequate compliance with IWCP procedure.
- Misinterpretation of what would require a work package change with regard to new scope, and specifically skill of the craft activities and related hazards and controls.
- Incomplete job walk down (did not access the catwalk) resulted in a less than adequate scope definition.
- Millwrights / crane SMEs not included in second JHA (June 25) and not all attendees signed final JHA.
- No structural evaluation of catwalk.
- JHA did not capture hazard associated with hatch and catwalk.
- Less than adequate fall protection plan /requirements.
- Planner had inadequate information to develop the detailed work scope necessary to perform the work safely. As a result of a failure to utilize appropriate SMEs and in particular to access the catwalk, the Planner lacked the understanding of the work and hazards involved in removing the bridge crane.
- Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control.
- FR recommendations for “What ifs” were rejected.
- Risk ranking not modified for scope change.

- Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.
- Perceived schedule pressure was a significant contributor in failing to adequately plan the work.

CF-D – Develop/Implement Controls. Programs, procedures, and processes such as portions of SH-1, *Safety and Health*, and PAS-2-1.1, *Integrated Work Control Program*, were not followed and therefore certain controls to protect the worker were omitted. The examples of the free climb by the first man up and “team up, team down” approach were undeveloped and non-compliant to safety standards, and therefore could not be effectively implemented as fall protection controls.

The Board determined that a deficiency in CF-D implementation, in part, contributed to root cause 1A, 1B, and root cause 2. Individual example issue statements from Appendix F identified by the Board as affecting development and implementation of controls as defined by CF-D are:

- Less than adequate compliance with IWCP procedure.
- IWCP not released by FPOC prior to performance of work.
- JHA did not capture hazard associated with hatch and catwalk.
- Less than adequate fall protection plan/requirements.
- Lighting was assumed to be adequate to perform work tasks, yet actual light (0.14 foot candles) is non-compliant with OSHA regulations.
- Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control.
- Risk ranking not modified for scope change.
- Engineering analysis not reviewed by PSRs prior to free climb; analysis provided anchorage areas for retractable lanyards.
- No one stopped work when out of IWCP/JHA scope.
- Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.
- “Team up, team down” hatch control concept was either not well communicated or not well understood by the work crew.
- PSRs did not adequately execute their safety oversight responsibilities in protecting the workers on the ladder and the catwalk.
- Work Supervisor and PSR did not provide continuous oversight of perceived higher risk work.
- Work Supervisor briefing pre-ev with an unapproved work package, which is inconsistent with IWCP requirements.
- Perceived schedule pressure was a significant contributor in failing to adequately plan the work.

CF-E – Perform Work. Readiness to perform 336 Building demolition preparation was not verified. The obvious deficiencies in planning, hazards identification, and analysis are well developed as less than adequate in other CFs and GPs. The focus in evaluating CF-E’s implementation is actual performance of work in the field and the “observational approach for newly identified hazards.” The workers and supervisor failed to recognize or accept the risk of

changing conditions requiring implementation of the observational approach during the work at 336 Building.

The Board determined that a deficiency in CF-E implementation, in part, contributed primarily to the Direct Cause. Individual example issue statements from Appendix F identified by the Board as affecting work performance as defined by CF-E are:

- Multiple distractions, including collection of containers for gear box oil, retrieval of cable/chain for securing trolley, and the perception that work was complete when the guardrail was being cut, caused workers to leave the catwalk and violate the “team up, team down” hatch concept, resulting in the hatch being left open.
- None of the workers stopped/paused work when activities went beyond defined scope.
- Millwright 2 assumed that Millwright 1 was following right behind him when he descended the ladder and did not request others to close the hatch behind him because he assumed Millwright 1 was right behind him.
- Millwright 1’s mindset after the discussion with Rigger 3 about moving the crane caused Millwright 1 to focus on proceeding to the end of the catwalk to initiate the task of moving the crane.
- Millwright 1 assumed he had an adequate walkway.

CF-F – Feedback/Improvement. POD meetings, pre-ev briefings, walk downs, JHA meetings, and the contractor’s self-assessment program were among the mechanisms advertised in the description as providing the necessary feedback to foster continuous improvement. The above mechanisms were less than adequate in understanding and controlling the hazards presented by accessing and working on the catwalk which ultimately led to the worker fall and injury.

The Board determined that a deficiency in CF-F implementation, in part, was primarily attributed to contributing cause 3. The general issue statement from Appendix F identified by the Board as affecting feedback and improvement as defined by CF-E is:

- The contractor’s previous self-assessments and corrective actions on the integrated work control procedure and fall protection procedure were not effective in identifying and correcting underlying weaknesses.
- Effectiveness of NTS-RL-WCH-D4-2007-001, Worker Stepped Through Roof at B3706.
- ISMS Phase I and II corrective actions and related assessments (2007-2008).
- DOE-RL OA reports on fall protection and work control.
- Evidence of the WCH lessons learned program improving fall protection or work planning/control was not identified.
- No corrective actions were identified with regard to WCH Safety programs as a result of the 2006 K-25 Type B investigation or the lessons learned from the LLNL Type B investigation.

CF-G – Management Review. This CF is covered below in GP-11, Senior Management Involvement. For the purposes of this evaluation, CF-G and GP-11 were considered equivalent.

Guiding Principles

GP-1 - Line Management Responsibility for Safety and Environmental Requirements. Line management's responsibility for safety, in this case, was abdicated. Management from project director to first-line supervisor displayed less than adequate responsibility for work execution.

Individual issue statements from Appendix F root causes evaluated by the Board as applicable to GP-1 are as follows:

- "This is the way D4 is done."
- Risk ranking not modified for scope change.
- Work began before the IWCP was approved and released by FPOC.
- Over reliance on skill of the craft to be accomplished without the adequate work planning, hazard identification, and control.
- RM who signed IWCP not involved in any of the planning.
- 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope.
- The 336 HazMat Removal Supervisor and the Planned 336 Work Supervisor failed to document in the Hazardous Waste Removal Closure Package or communicate to the 336 Work Control Planner that oil was left in the crane gear box upon completion of hazardous waste removal project scope.
- Several pre-requisites were not completed prior to work performance.
- Recognized high turnover of planners, supervisors, PSRs, and D4 workers.
- Only two PSRs covering the entire 300 Area; for the two weeks prior to event only one PSR was available to cover 300 Area.
- Originally assigned Work Supervisor expressed that he was already overloaded and declined to perform first-line supervision of the 336 job.
- 300 Area D4 Superintendent was providing oversight of multiple work sites and performing first-line supervision of the 336 job.
- The risk associated with the high pace of work appears to be unchanged notwithstanding: 1) the recognized understaffing of supervisors, safety, and planners; 2) spreading the current experienced and new supervisory and safety personnel too thin; and 3) additional supervisory and training needed for the replacement of those workers.
- Supervisor identified inappropriate tie-off points for riggers on catwalk guardrails.
- PSRs were not present at July 1 pre-ev.
- PSRs did not observe any of the work on July 1.
- Work Supervisor and PSR did not provide continuous oversight of perceived higher risk work.
- Work Supervisors covering multiple jobs of varying complexities.
- PSRs and Supervisor allowed free climb.
- 300 Area D4 Superintendent thought that the scope of work in the IWCP for task 5.1.2 was adequately defined as written, and therefore had the discretion to add what he considered to be skill of the craft work scope within that task.
- Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.
- The 336 Work Supervisor/300 Area D4 Superintendent and WCH management assume that craft workers do not need to be continuously supervised or overseen by Safety during the performance of hazardous tasks.

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- Work Supervisor briefing pre-ev with an unapproved work package, which is inconsistent with IWCP requirements.
 - Work Supervisor was anxious to complete task 1 and turn over demolition to new D4 workers.
 - 300 Area D4 Superintendent pushes his planners, work supervisors, and safety representatives hard.
 - The 336 Work Supervisor/300 Area D4 Superintendent considered the “team up, team down” concept to be adequate to control the hatch hazard.

GP-2 – Clear Roles and Responsibilities. Roles and responsibilities for the 336 demolition preparation appeared to be blurred in some cases and as lines of authority indistinct. The RM, 300 Area D4 Superintendent, 300 Area Project Engineer, Planner, and PSRs failed to execute their roles and responsibilities, and authorized tasks that should not have been under their purview.

Individual issue statements from Appendix F root causes evaluated by the Board as applicable to GP-2 are as follows:

- PRS and Supervisor allowed free climb.
- Rigger 2 was allowed to tie off to the midpoint platform (PSR and Supervisor authorized).
- Training records for the work crew were not adequately evaluated prior to work performance.
- No one stopped work when out of IWCP/JHA scope.
- Misinterpretation of what would require a work package change with regard to new scope, and specifically skill of the craft activities and related hazards and controls.
- 300 Area D4 Superintendent thought that the scope of work in the IWCP for task 5.1.2 was adequately defined as written, and therefore had the discretion to add what he considered to be skill of the craft work scope within that task.
- Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
- Over reliance on skill of the craft to accomplish the work in lieu of work planning and control.
- Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.
- 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope.
- Pre-ev failed to communicate complete work scope for desired tasks. The Board’s interviews with the six principle workers for the 336 task identified clear discrepancies among the understanding of what was discussed regarding scope of work and sequence of tasks, equipment expectations, and use of safety equipment.
- “Team up, team down” hatch control concept was either not well communicated or not well understood by the work crew.
- “Secure the trolley” was an imprecise work direction and was only discussed between the Work Supervisor and the Lead Rigger.
- The 336 Work Supervisor/300 Area D4 Superintendent and WCH management assume that craft workers do not need to be continuously supervised or overseen by PSR during the performance of hazardous tasks.

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- It was assumed that the “team up, team down” concept was adequate for fall protection.
 - Confidence of Rigger 2 to perform free climb without appropriate fall protection.
 - PSRs did not adequately execute their safety oversight responsibilities in protecting the workers on the ladder and the catwalk.
 - Free climb by Rigger 2 was perceived as safer than using fall protection.
 - Work Supervisor and PSR did not provide continuous oversight of perceived higher risk work.
 - Work Supervisor briefing pre-ev with an unapproved work package, which is inconsistent with IWCP requirements.

GP-3 – Competence Commensurate with Responsibilities. WCH’s described process for ensuring roles and responsibilities, mechanisms to impart relevant information, and proper management and supervision are evaluated under GP-2, CF-F, and GP-1, respectively.

GP-4 – Balanced Priorities. This GP is considered largely planning, prioritization, and budget driven on a macro level as shown in the description. Change control, as defined here, is a budget process for funding new unplanned work scope. However, the overarching root cause statement is applicable here;

- The recognized shortage of work supervisor and PSR resources, the pace of work, and the inadequacies of work planning have been normalized by contractor management and the 300 Area work force.

GP-5 – Identification of Safety and Environmental Standards and Requirements. The identification of safety standards and requirements for 336 Building fall protection, illumination, and waste collection were hindered by a lack of upfront planning and research. The “agreed upon” set of safety standards and requirements were therefore faulty for adequately ensuring fall protection, adequate lighting, and hazardous waste disposal. Regulatory standards and requirements are well established for these areas and should have been identified and instituted by the personnel assigned to the 336 work.

Work planning and control requirements were not followed for the release and execution of the work package. Contractor and DOE requirements for “stop work,” occurrence reporting and event investigation, and notifications were not adequately executed.

Individual issue statements from Appendix F, as attributing to the correct identification and application of standards and requirements are shown below. The statements ascribed to causes evaluated by the Board as applicable to GP-5 are as follows:

- Several pre-requisites were not completed prior to work performance.
- Less than adequate fall protection plan/requirements.
- Lighting was assumed to be adequate to perform work tasks, yet actual light (0.14 foot candles) is non-compliant with OSHA regulations.
- Water bottles were used for oil collection in lieu of proper waste containers.
- Planners and PSRs were unfamiliar with WCH’s facility transition process and organization in order to access information regarding the availability of the engineered ladder safety devices; transition team not utilized to obtain appropriate engineered ladder devices.

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- IWCP not released by FPOC prior to performance of work.
 - Supervisor identified inappropriate tie-off points for riggers on catwalk guardrails.
 - PSRs and Supervisor allowed free climb.
 - No one stopped work when out of IWCP/JHA scope.
 - Supervisor was not a “qualified” person to identify tie-off points.
 - Standing back from the open hatch was perceived as adequate fall protection.
 - Lower anchor point for retractable lanyard was not hung in an approved location.
 - Millwright 2’s training records do not indicate that he had ladder safety training.
 - Misinterpretation of fall protection requirements regarding free climbing, anchorage locations, lanyard use, open hatch, and team up/team down concept.
 - Rigger 3 assumed it was okay to cut the guardrail while not being tied off.
 - Safety assumed that the “six-foot policy” was adequate protection from the open hatch.
 - WCH did not categorize the event within time limits required by the DOE ORPS manual.
 - WCH did not follow procedure SEM-3-2.2, Attachment 3, convening a fact finding meeting, instead of a critique, which was clearly required based on the nature of the accident.

GP-6 – Hazard Controls Tailored to the Work Being Performed. The ideal hazard control for fall protection would have been to use the engineered system available from the previous 336 Building tenant, PNNL. The controls espoused at the pre-ev briefings, “team up, team down” and “first man up” were insufficient (and contrary to requirements) to prevent and mitigate fall hazards during the initial climb and subsequent work on the catwalk. In addition, since the walk down was less than adequate, controls for the unknown work, which was eventually performed, could not be tailored.

Individual issue statements from Appendix F, identified as failed to correctly apply or missed opportunities to tailor controls to the work being performed, are shown below. The statements ascribed to causes evaluated by the Board as applicable to GP-6 are as follows:

- Planner had inadequate information to develop the detailed work scope necessary to perform the work safely. As a result of a failure to utilize appropriate SMEs and in particular to access the catwalk, the Planner lacked the understanding of the work and hazards involved in removing the bridge crane.
- Failure to locate the engineered ladder safety device resulted in the decision to initially free climb and utilize retractable lanyards, which further exacerbated the risks associated with the operation of the hatch.
- JHA did not capture hazard associated with hatch and catwalk.
- Less than adequate fall protection plan/requirements.
- Lighting was assumed to be adequate to perform work tasks, yet actual light (0.14 foot candles) is non-compliant with OSHA regulations.
- Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control.
- Risk ranking not modified for scope change.
- Engineering analysis not reviewed by PSRs prior to free climb; analysis provided anchorage areas for retractable lanyards.
- Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.

- Misinterpretation of fall protection requirements regarding free climbing, anchorage locations, lanyard use, open hatch, and team up/team down concept.
- Misinterpretation of what would require a work package change with regard to new scope, and specifically skill of the craft activities and related hazards and controls.
- Incomplete job walk down (did not access the catwalk) resulted in a less than adequate scope definition.

GP-7 – Operations Authorization. Defined at the activity level, work authorization should reflect readiness to perform planned tasks and ensure the authorization envelope is not breached. Evidences that work was edging closer to being outside the envelope began with the attitude of D4 management, typified by the phrase, “This is how D4 work is done.”

The work package had not been released by the established work control process and therefore not authorized before work at 336 Building began. In addition to being inadequate for the proposed work, the work package had not been approved by the RM before activities began on June 30, 2009. In accordance with 300 Area specific requirements, the plan-of-the-week (POW)/POD document for June 30 and July 1 showed that the 336 demolition preparations had not been appropriately released by the FPOC. In addition, the 300 Area D4 Superintendent failed to disclose to the FPOC on at least two occasions that 336 Building work had already been conducted. Moreover, 336 Work Supervisor/300 Area D4 Superintendent field decisions made and instructions given to workers were outside the authorization envelope.

Individual issue statements from Appendix F, identified as failing to ensure readiness or missing opportunities to institute proper work authorization are shown below. The statements ascribed to causes evaluated by the Board as applicable to GP-7 are as follows:

- “This is the way D4 work is done.”
- IWCP not released by FPOC prior to performance of work.
- Several pre-requisites were not completed prior to work performance.
- Overall project and workforce have a high tolerance to risk.
- 300 Area Project Engineer not involved in JHAs or walk downs, but signed JHA and IWCP.
- RM who signed IWCP not involved in any of the planning. 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope.
- Recognized high turnover of planners, supervisors, PSRs, and D4 workers.
- 300 Area D4 Superintendent was providing oversight of multiple work sites and performing first-line supervision of the 336 job.
- Work Supervisor and PSR did not provide continuous oversight of perceived higher risk work.
- PSRs and Supervisor allowed free climb.
- 300 Area D4 Superintendent thought that the scope of work in the IWCP for task 5.1.2 was adequately defined as written, and therefore had the discretion to add what he considered skill of the craft work scope within that task.
- Work Supervisor was anxious to complete task 1 and turn over demolition to new D4 workers.
- Supervisor identified inappropriate tie-off points for riggers on the catwalk guardrails.

GP-8 – Worker Involvement. 336 Building demolition preparation job walk downs and JHA did not have the requisite involvement of appropriate craft and SMEs to adequately understand the scope of work, hazards involved, and hazard controls. The second JHA included the riggers, but not the millwrights or other SMEs. Planning and preparations for the work did not include accessing the catwalk where adequate hazard and work controls could have been identified.

Individual issue statements from Appendix F, identified as failing to ensure worker involvement are shown below. The statements ascribed to causes evaluated by the Board as applicable to GP-8 are as follows:

- Workers did not review work instructions – but relied on pre-ev communication and direction.
- Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
- Incomplete job walk down (did not access the catwalk) resulted in a less than adequate scope definition.
- Millwrights/crane SMEs not included in second JHA (June 25) and not all attendees signed final JHA.
- 300 Area Project Engineer not involved in JHAs and walk downs, but signed JHA and IWCP.
- Planner had inadequate information to develop the detailed work scope necessary to perform the work safely. As a result of a failure to utilize appropriate SMEs and in particular to access the catwalk, the Planner lacked the understanding of the work and hazards involved in removing the bridge crane.
- One of the 300 Area project engineers had identified in May 2009 that the high reach approach was not appropriate for 336 Building bridge crane removal but did not communicate his findings to the work planners or PSRs.
- PSRs were not present at July 1 pre-ev.
- PSRs did not observe any of the work on July 1.
- Pre-ev failed to communicate complete work scope for desired tasks. The Board's interviews with the six principle workers for the 336 task identified clear discrepancies among the understanding of what was discussed regarding scope of work and sequence of tasks, equipment expectations, and use of safety equipment.

GP-10 – Continuous Improvement. The Board reviewed contractor assessment and lessons learned reports submitted by WCH as evidence of their mechanism to detect and prevent quality problems.

Individual issue statements were not used to describe failure of implementation for GP-10. The Board submits the statement and sub-bullets for contributing cause 3 as evidence that adherence to GP-10 was deficient.

The contractor's previous self-assessments and corrective actions on the integrated work control procedure were not effective in correcting underlying weaknesses.

- NTS-RL-WCH-D4-2007-001, Worker Stepped Through Roof at B3706.
- ISMS Phase I and II corrective actions and related assessments (2007-2008).
- DOE-RL OA reports on fall protection and work control.

- Evidence of the WCH lessons learned program improving fall protection or work planning/control was not identified.
- No corrective actions were identified by the WCH Safety programs as a result of review of the 2006 K-25 Type B investigation or the lessons learned from the LLNL Type B investigation.

GP-11 – Senior Management Involvement. The 300 Area D4 project utilizes three RMs to control work planning and execution. By design the RMs' roles and authority are interchangeable. The RM identified in the work package as approving the 336 demolition preparation work was not involved in its inception or planning and execution phases. This RM's primary responsibility for 300 Area D4 was management of subcontracted work; he was only involved with the 336 demolition preparation because the IWCP process required an RM's signature. The RM involved in the initial 336 work planning was unavailable when the work package came up for final approval and signature. In accordance with the responsibilities outlined in Sections 5.1, *Work Assessment Phase*, and 5.3, *Work Package Development Phase*, these belong to the RM. The only involvement by the signatory RM was a review of the work package on the morning of June 30, the day 336 work began.

Senior WCH management at the project and functional director level did not have active participation in the 336 demolition preparation job walk down. Senior management did not ensure effectiveness of the Safety and Health Program (SH-1) as it applied to the 336 Building worker accident and injury.

Individual issue statements from Appendix F, identified as failing to demonstrate senior management involvement are shown below. The statements ascribed to causes evaluated by the Board as applicable to GP-11 are as follows:

- The recognized shortage of work supervisor and PSR resources, the pace of work, and the inadequacies of work planning have been accepted and normalized by contractor management and the 300 Area work force.
- "This is the way D4 work is done."
- RM who signed IWCP not involved in any of the planning. 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope.

Conclusion

The foregoing discussion by the Board illustrates the failure of ISM implementation in preventing this accident. Multiple errors and omissions were evident in planning and execution decisions. The Board has determined the 300 Area D4 project ISM implementation was not effective for the safe conduct of the 336 Building crane removal activities.

3.8. Summary of Causal Factor Analyses

After development of the event timeline through interviews, document reviews, and accident site observation, the Board utilized multiple causal methods to identify causal factors. These methods included a hazard-barrier-target analysis, three change analyses, events and causal factors analysis, and a human performance/error precursor analysis. A MORT analysis was then utilized as a "safety net" to validate the thoroughness of the other analyses. The causal

factors were then organized and binned into higher level causal statements, identifying the direct, root, and contributing causes of the accident.

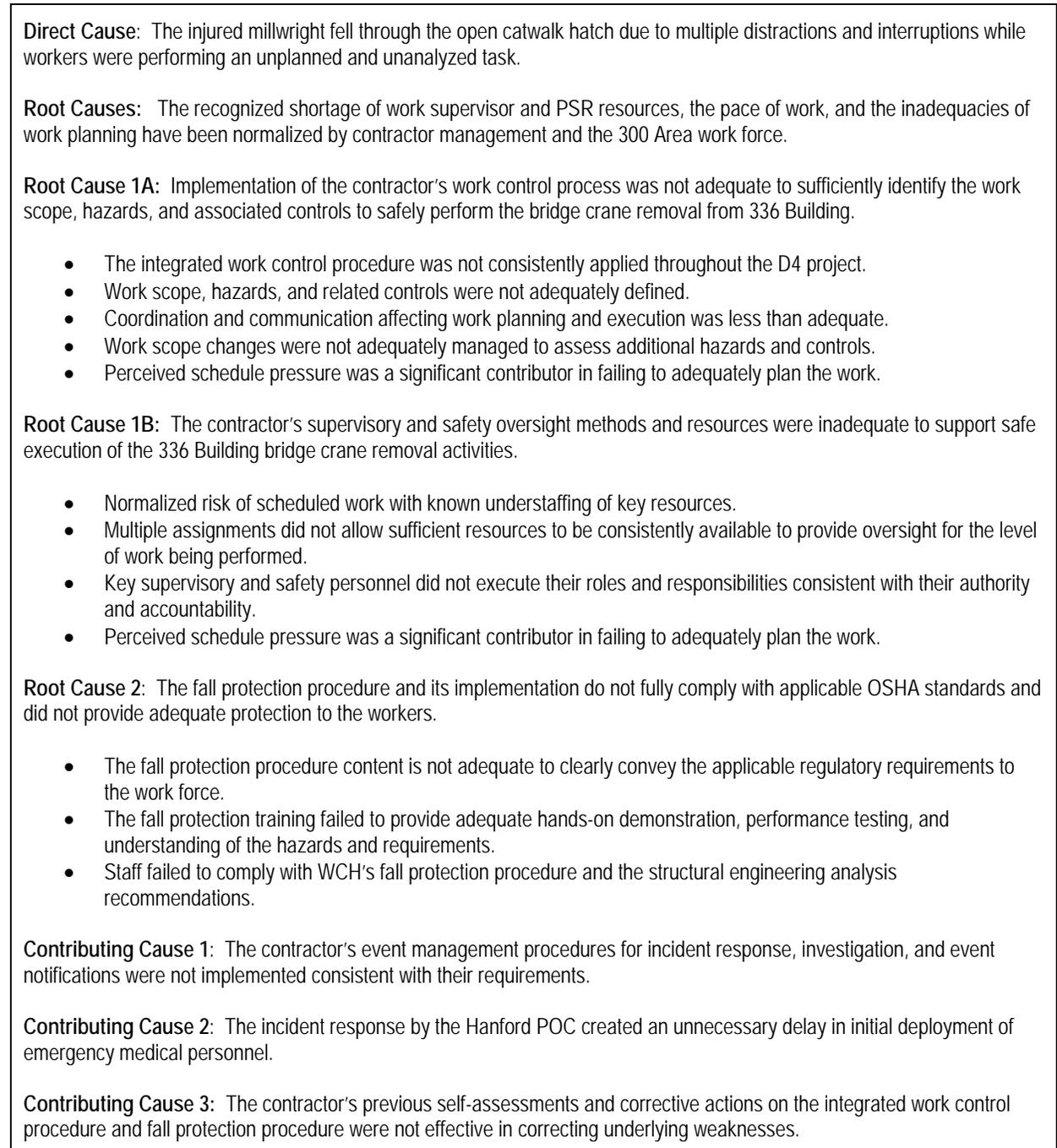


Figure 3-5. Summary of Causal Analysis

One of the most troubling revelations of the Board's investigation is that most of the employees interviewed through several organizational levels identified the elements of root cause 1 as the "one thing" they would change to prevent recurrence of this accident. Several expressed

concerns about the inadequacy of work planning due to the pace of work, which is exacerbated by understaffing and turnover of key positions. Employees also indicated that changing work scope and conditions were often either unrecognized or accepted as the way D4 is done by both management and crafts. Management employees also acknowledged that the workers should have been continuously supervised or overseen by a PSR, but resources were too limited. WCH staff are aware of these problems, yet have accepted and normalized these deficiencies (latent organizational weakness), partly due to the nature of the work, and partly because it is outside their sphere of control.

3.9. Barrier Analysis

Barrier analysis (hazard-barrier-target) is based on the premise that hazards are associated with all tasks. For an accident to occur there must be a hazard that comes into contact with a target because the barriers or controls were not in place, not used, or failed. A hazard is the potential for unwanted energy flow to result in an accident or other adverse consequence. A target is a person or object that a hazard may damage, injure, or fatally harm. A barrier is any advertised means (physical or administrative controls) used to control, prevent, or impede the hazard from reaching the target, thereby reducing the probability or severity of the resultant accident or the adverse consequence. The results of the barrier analysis are used to support the development of causal factors. Appendix B contains the barrier analysis.

3.10. Change Analysis

Change is anything that disturbs the “balance” of a system that is operating as planned. Change is often the source of deviations in system operations. Change can be planned, anticipated, and desired, or it can be unintentional and unwanted. Change analysis examines the planned or unplanned changes that caused the undesired results or outcomes related to the accident. This process analyzes the difference between what was planned and what actually occurred. The results of three change analyses were used to support the development of the causal factors. Appendix C contains the change analyses.

3.11. Events and Causal Factors Analysis

An events and causal factors analysis was performed in accordance with the DOE workbook, *Conducting Accident Investigations*. The events and causal factors analysis requires deductive reasoning to determine which events and/or conditions contributed to the accident. Causal factors are the events or conditions that produced or contributed to the occurrence of the accident, and they consist of direct, root, and contributing causes.

The direct cause is the immediate events or conditions that caused the accident. The contributing causes are the events or conditions that, collectively with the other causes, affect the probability or consequence of the accident, but do not cause the accident. Root causes are the events or conditions that, if corrected, would prevent recurrence of this and similar accidents. Appendix D contains the events and causal factors analysis.

3.12. Human Performance Improvement Analysis

Analysis of events in many different types of industry has shown that between 60 and 90% of major accidents have some type of human error as a contributing cause. Of these human

errors, only about 30% are due to the active mistake or error of an individual and the remaining 70% are due to weaknesses that exist in the organization that supports or directs the work. Including an approach in this accident investigation to identify the precursor conditions that contributed to human error and the potential organizational weaknesses helped the Board to identify not only any systemic problems, but also to point out where human fallibility may have contributed. Equally important is the opportunity to identify and anticipate the likelihood of human error in the future and to strengthen barriers to those failures. Appendix E contains the human performance improvement analysis.

3.13. Department of Energy Richland Operations Office Oversight

DOE-RL has developed and implemented an integrated program to evaluate contractor performance. The associated processes and procedures are contained within the RL Integrated Management System under the heading of "Contractor Integrated Performance Evaluation." The oversight and planning crosscutting process is the central element in the Richland Requirements, Performance, and Risk-Based Contractor Oversight System. It supports implementation of DOE Manual 411.1-1, *Safety Management Functions, Responsibilities and Authorities* and DOE Order 226.1, *Implementation of Department of Energy Oversight Policy*.

RL personnel plan and conduct contractor surveillances, assessments, audits, and OA activities; and then develop the Integrated Evaluation Plan (IEP), which is used to capture the planned oversight activities on a quarterly basis. OA activities can be either IEP-planned or impromptu task-specific oversight activities.

In CY08 RL staff conducted twelve IEP scheduled work control and planning oversight activities. Included in CY08 was a formal work planning surveillance. During CY09 RL staff conducted eight planned oversight activities related to work control and fall protection and elevated work. A review of the OA database provided the following results for RL oversight of WCH: There were 165 OA entries in CY08 on the subject of fall protection and scaffolding; 30 issues were identified. In CY08 there were 108 OA entries associated with work planning and control; 8 issues identified. To date in CY09 there have been 55 fall protection and scaffolding-related OA entries with 6 issues identified; and 58 work planning and control entries with 6 issues identified.

There are currently four qualified FRs and one FR-in-training assigned to provide oversight of WCH projects and facilities. The 300 Area RL FR attended the June 15 JHA for the above-grade demolition of 336 Building and generated an OA entry for that JHA session. One observation was issued regarding the "What If" analysis, citing that the "What If" scenario was inadequate for the work activity. The only "What If" scenario developed related to a chemical spill. The 300 Area RL FR was concerned that other scenarios, such as a "What If" associated with the use of the Komatsu in the proximity of energized overhead electrical lines should be developed. The 300 Area RL FR discussed the "What If" issues with the 300 Area Project Engineer and the 336 Work Control Planner. The 336 Work Control Planner agreed to develop other more pertinent scenarios with the 300 Area Project Engineer committing to discuss the issues with the planners. The final approved JHA did not include any additional "What If" scenarios. The 300 Area RL FR was on vacation between the June 15 JHA and the accident, and as a result was not available to attend the June 25 JHA.

Another RL FR qualified to perform oversight of WCH monitored 300 Area D4 activities and provided oversight of 327 Building activities on June 25, resulting in the identification of one

finding related to ladder use and three observations. This FR also communicated the second 336 Building JHA meeting to the FR Team Lead and the FR-in-training as an oversight opportunity. Unfortunately, the FR was involved with the planning for an upcoming ISMS Phase I assessment of a different contractor and was unable to attend the June 25 JHA.

4.0 Conclusions and Judgments of Need

Concerning the 300 Area D4 project, the Board concludes the following:

- The recognized shortage of work supervisors and PSR resources, the pace of work, and the inadequacies of work planning have been accepted and normalized by contractor management and the 300 Area work force.
- Implementation of the contractor's work control process was not adequate to sufficiently identify the work scope, hazards, and associated controls to safely perform the bridge crane removal from 336 Building.
- The contractor's supervisory and safety oversight methods and resources were inadequate to support safe execution of the 336 Building bridge crane removal activities.
- The fall protection procedure and its implementation do not fully comply with OSHA standards and did not provide adequate protection to the workers.

These were the root causes of the accident. In addition the Board identified three causal factors that contributed to the accident.

While WCH management recognized that critical personnel resources were either lacking or strained in the 300 Area, adequate measures were not taken to balance work priorities and the rigors of work planning, control, and oversight for work execution to ensure the safety of the work force.

The integrated work control procedure was not consistently applied throughout the D4 project. Work scope, hazards, and related controls were not adequately defined. For example, the two walk downs conducted during the 336 Building work package and JHA planning phase were conducted at the floor level only, preventing a thorough examination of the work area leading to inadequate work scope and hazard recognition. Coordination and communication affecting work planning and execution was less than adequate. Work scope changes were not adequately managed to assess additional hazards and controls. Had key work scope changes been recognized, a formal change to the work package would have been required providing an opportunity to analyze any new hazards, evaluate the existing controls, and if necessary generate additional controls. Perceived schedule pressure was a significant contributor in failing to adequately plan the work.

Regarding the contractor's supervisory and safety oversight methods and use of resources, 300 Area D4 management accepted the risk of scheduled work with known understaffing of key resources such as work supervisors, planners, and PSRs. Multiple assignments did not allow sufficient resources to be consistently available to provide oversight for the level and hazards of work being performed. The work supervisor initially assigned to the 336 Building demolition preparation had multiple existing assignments and was not familiar with the work plan, which resulted in the 300 Area D4 Superintendent assuming the duties of the direct work supervisor for this activity. Key supervisory and safety personnel did not execute their roles and responsibilities consistent with their authority and accountability.

From the perspective of fall protection, the fall protection procedure content was not adequate to clearly convey the applicable regulatory requirements to the work force. The fall protection training failed to

provide adequate information and instill an acceptable understanding of the hazards and requirements. Staff failed to comply with WCH's fall protection procedure and the structural engineering recommendations. Had the applicable OSHA requirements been followed, the injured millwright would have been tied off when the hatch was open or an engineering control would have been in place between him and the opening.

It is very fortunate that the worker survived this fall. The Board personally extends its best wishes to him for a full recovery from his injuries. This accident was clearly preventable.

WCH and the injured millwright's co-workers have extended extraordinary care for him. The millwright had 26 years of experience at Hanford and is well respected by his peers and management, not only for his skills and abilities, but also for his high regard toward performing work safely.

The following table contains the Board's conclusions and the resulting JONs.

Table 4-1. Conclusions and Judgments of Need

Conclusions	Judgments of Need
<p>The injured millwright fell through the open catwalk hatch due to multiple distractions and interruptions while workers were performing an unplanned and unanalyzed task.</p> <ul style="list-style-type: none"> • Multiple distractions, including collection of containers for gear box oil, retrieval of cable/chain for securing trolley, and the perception that work was complete when the guardrail was being cut, caused workers to leave the catwalk and violate the "team up, team down" hatch control concept, resulting in the hatch being left open. • None of the workers stopped/paused work when activities went beyond the defined scope. • Millwright 2 assumed that Millwright 1 was following right behind him when he descended the ladder, and did not request others to close the hatch. • Millwright 1's mindset after the discussion with Rigger 3 about moving the crane caused Millwright 1 to focus on proceeding to the end of the catwalk to initiate the task of moving the crane. • Millwright 1 assumed he had an adequate walkway. 	<p>JON 1 - WCH needs to develop a strategy to change the culture associated with stop work/pause work from a perceived personal risk to an actual reward-based system.</p> <p>JON 2 - WCH needs to develop a pre-ev standard that encourages more interactive discussion of the work scope, hazards, and controls as documented in the Integrated Work Control Program (IWCP) task instructions and the JHA.</p> <p>JON 3 - WCH needs to utilize enhanced communication techniques, such as "repeat backs," for critical or hazardous tasks.</p>
<p>The recognized shortage of work supervisor and PSR resources, the pace of work, and the inadequacies of work planning have been accepted and normalized by contractor management and the 300 Area work force.</p>	<p>JON 4 - WCH needs to balance its work schedule commensurate with its trained and qualified work force, and continually assess the work force's capabilities and limitations, and employ them accordingly to perform work safely.</p> <p>JON 5 - WCH needs to perform an independent causal analysis on root causes 1 and 2, and contributing cause 1 to identify extent of causes and other latent organizational weaknesses, and supplement the JONs responses with additional corrective actions as necessary.</p> <p>JON 6 - WCH needs to re-evaluate the roles, responsibilities, authorities, and accountabilities (R2A2s) and hold personnel accountable for those who plan, concur on, and approve work packages and JHAs; and those who supervise or provide oversight of planned work.</p>
<p>Implementation of the contractor's work control process was not adequate to sufficiently identify the work scope, hazards, and associated controls to safely perform the bridge crane removal from 336 Building.</p> <ul style="list-style-type: none"> • The integrated work control procedure was not consistently applied 	<p>JON 7 - WCH needs to ensure that the full scope of work within each Type 1 and Type 2 work package is comprehensively evaluated and planned, including full and complete walk downs to identify potential hazards as part of</p>

Conclusions	Judgments of Need
<p>throughout the D4 project.</p> <ul style="list-style-type: none"> • Work scope, hazards, and related controls were not adequately defined. • Coordination and communication affecting work planning and execution was less than adequate. • Work scope changes were not adequately managed to assess additional hazards and controls. • Schedule was a controlling priority. 	<p>the JHA process prior to the release of work.</p> <p>JON 8 - WCH needs to utilize an independent review of completed IWCPs/JHAs prior to work release until a level of assurance is achieved that the work planning and control process is being executed as designed by management.</p> <p>JON 9 - WCH needs to clearly delineate the boundaries for skill-of-the-craft work versus detailed planned work, such that hazards are adequately analyzed and controlled.</p> <p>JON 10 - WCH needs to instill a workforce culture that understands and takes appropriate action when the actual work being performed begins to extend beyond the planned and analyzed work scope.</p> <p>JON 11 - WCH needs to ensure that all work conducted within the River Corridor Closure Contract (RCCC), including work release, will be performed under a single PAS-2-1.1 IWCP.</p>
<p>The contractor's supervisory and safety oversight methods and resources were inadequate to support safe execution of the 336 Building bridge crane removal activities.</p> <ul style="list-style-type: none"> • Accepted risk of scheduled work with known understaffing of key resources. • Multiple assignments did not allow sufficient resources to be consistently available to provide oversight for the level of work being performed. • Key supervisory and safety personnel did not execute their roles and responsibilities consistent with their authority and accountability. • Schedule was a controlling priority. 	<p>JON 12 - WCH needs to develop a staffing strategy (recruitment, qualification, assignment, retention) in order to ensure adequate availability of competent planning, supervisory, and safety personnel to support safe execution of work.</p> <p>JON 13 - WCH needs to balance its work schedule commensurate with its trained and qualified work supervisors and PSRs, and continually assess their capabilities and limitations in order to perform work safely.</p> <p>JON 14 - WCH needs to establish an expectation that all work involving critical or hazardous tasks require effective barriers and the continuous presence of either a work supervisor or PSR to ensure work is performed safely.</p>
<p>The fall protection procedure and its implementation do not fully comply with applicable OSHA standards and did not provide adequate protection to the workers.</p> <ul style="list-style-type: none"> • The fall protection procedure content is not adequate to clearly convey the applicable regulatory requirements to the work force. • The fall protection training failed to provide adequate hands-on demonstration, performance testing, and understanding of the hazards and requirements. • Staff failed to comply with WCH's fall protection procedure and the structural engineering analysis recommendations. 	<p>JON 15 - WCH needs to re-evaluate its fall protection program in its entirety, preferably utilizing external SMEs with regard to OSHA requirements. Minimum changes should include fixed ladders, training, and the definitions of qualified and competent persons.</p> <p>JON 16 - WCH needs to ensure that workers who are involved in activities that require the use of fall protection are trained, and that workers, supervisors, and PSRs are held accountable for fall protection procedure compliance.</p>
<p>The contractor's event management procedures for incident response, investigation, and event notifications were not implemented consistent with their requirements.</p> <ul style="list-style-type: none"> • WCH did not categorize the event within the time limits required by the DOE Occurrence Reporting and Processing System (ORPS) manual. • WCH did not follow procedure SEM-3-2.2, Attachment 3, convening a fact finding meeting, instead of a critique, which was clearly required based on the nature of the accident. • Written Fact Finding Report lacked sufficient and accurate detail for the nature and seriousness of the event. The Fact finding's causal analysis section reflected only a short list of potential contributing conditions. 	<p>JON 17 - WCH needs to re-evaluate its process for conservatively categorizing, reporting, and investigating events consistent with contractual requirements and the severity of the event.</p>
<p>The incident response by the Hanford Patrol Operations Center (POC) created an unnecessary delay in initial deployment of emergency medical personnel.</p>	<p>JON 18 - FHI needs to re-evaluate its POC intake and dispatch procedure</p>

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Conclusions	Judgments of Need
<ul style="list-style-type: none"> • Critical response time was lost by POC in obtaining irrelevant information prior to contacting HFD (~2:05-minute). • HFD dispatch was delayed due to POC gathering information that was not needed to make the dispatch (~1:00 minute). 	<p>and training to eliminate unnecessary delay in emergency response.</p>
<p>The contractor's previous self-assessments and corrective actions on the integrated work control procedure and fall protection procedure were not effective in correcting underlying weaknesses.</p> <ul style="list-style-type: none"> • NTS-RL-WCH-D4-2007-001, Worker Stepped Through Roof at B3706 corrective actions. • ISMS Phase I and II corrective actions and related assessments (2007-2008). • DOE-RL Operational Awareness (OA) reports on fall protection and work control. • Evidence of the WCH lessons learned program improving fall protection or work planning/control was not identified. • No corrective actions were identified by the WCH Safety programs as a result of review of the 2006 K-25 Type B investigation. 	<p>JON 19 - WCH needs to complete a comprehensive evaluation of their self-assessment, lessons learned, and corrective action management programs to understand inherent deficiencies or latent organizational weaknesses and improve the effectiveness of these feedback and improvement processes.</p> <p>JON 20 - WCH needs to complete an effectiveness review of the corrective actions taken in response to the JONs in this report and the causal analysis performed by WCH for root causes 1, 2, and contributing cause 1 described in JON 5 -.</p>

5.0 Board Signatures



Rob G. Hastings
DOE Accident Investigation Board Chairperson
U.S. Department of Energy, Richland Operations Office
Deputy Assistant Manager for Safety and Environment

Date: 7/30/09



Dennis C. Humphreys
DOE Accident Investigation Board Member
U.S. Department of Energy, Richland Operations Office
Facility Representative

Date: 7/30/09



Thomas H. Davies
DOE Accident Investigation Board Member
U.S. Department of Energy, Pacific Northwest Site Office
Facility Representative

Date: 7/30/09



Clark H. Gunion
DOE Accident Investigation Board Member
U.S. Department of Energy, Richland Operations Office
Facility Representative

Date: 7/30/09

6.0 Board Members, Advisors, Consultants, and Staff

Board Chair Trained Accident Investigator	Rob G. Hastings Deputy Assistant Manager for Safety and Environment DOE-RL
Member Trained Accident Investigator	Dennis C. Humphreys Facility Representative DOE-RL
Member	Thomas H. Davies Facility Representative DOE-Pacific Northwest Site Office
Member	Clark H. Gunion Facility Representative DOE-RL
Advisor	Joy Flack Safety and Engineering Division DOE-RL
Advisor	William (Craig) Rife Occupational Safety and Health Specialist DOE-Oak Ridge Office
Consultant	Steven D. Cooke Assistant General Counsel Pacific Northwest National Laboratory
Consultant	Karla J. Smith Technical Operations and Assurance Office Pacific Northwest National Laboratory
Technical Editor and Administrative Support	Linda P. Minaker Senior Technical Editor Project Assistance Corporation

Appendix A: Board Letter of Appointment

RL-F-1325.6 (02/98)

United States Government

Department of Energy

memorandum

Richland Operations Office

DATE: JUL 2 2009
REPLY TO
ATTN OF: OOD:RMG/09-OOD-0074

SUBJECT: APPOINTMENT OF TYPE B ACCIDENT INVESTIGATION BOARD TO
INVESTIGATE THE FALL RELATED WORKER INJURY AT THE 336 BUILDING

TO: R. G. Hastings, Deputy Assistant Manager
for Safety and Environment

I hereby establish a Type B Accident Investigation Board to investigate the fall related worker injury accident which occurred at the 336 Building on July 1, 2009. I have determined it meets the requirements established for a Type B accident investigation in DOE O 225.1A, Accident Investigations, dated September 29, 1997.

I am appointing you as the accident board chairperson. The board members will be Dennis Humphreys, Tom Davies, and Clark Gunion, Joy Flack will also serve as an expert advisor to the board, consultants and by other support personnel as determined by the chairperson. The scope of the board's investigation will include but is not limited to identifying all relevant facts; analyzing the facts to determine the causes of the accident; developing conclusions; and determining the judgments of need that, when implemented, should prevent the recurrence of the accident. The investigation will be conducted in accordance with DOE O 225.1A and will specifically address the role of DOE and contractor organizations and management systems as they may have contributed to the accident. The scope will also include the application of lessons learned from similar accidents within the Department.

The board will provide my office with periodic reports on the status of the investigation but will not include any conclusions until an analysis of all the causal factors has been completed. Draft copies of the factual portion of the investigation report will be submitted to RL and Washington Closure Hanford (WCH) for a factual accuracy review prior to report finalization. The report should be provided to me for acceptance within 30 calendar days from the date of this memorandum. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

R. G. Hastings
09-OOD-0074

-2-

JUL 2 2009

If you have any questions, please contact me on (509) 376-7395.


David A. Brockman
Manager

cc: D. Y. Chung, EM-2
R. J. Corey, RL
T. H. Davies, PNSO
R. A. Dodd, WCH
J. R. Franco, RL
M. S. French, RL
R. Goldsmith, EM-62
R. M. Gordon, RL
R. M. Irwin, RL
J. M. Owendoff, EM-3
D. Pegram, HS-31
C. G. Spencer, WCH
M. J. Weis, PNSO

Appendix B: Barrier Analysis

Table B-1. Hazard-Barrier-Target Analysis

Hazard	Advertised Barriers Physical/Admin	SPSR	DNP	DNU	Failed	DNF	Target	Comment
Falls <ul style="list-style-type: none"> • Ladders/midpoint platform • Catwalk • Open hatch • Cut guardrail 	Fall protection procedure	4			✓		Workers at 336 Building	SH-1, Safety and Health Procedure is not fully compliant with OSHA. Allows FPP to mistakenly be used in lieu of OSHA standards. Workers and management did not follow SH-1 as written (e.g., free climb is not authorized).
	Gloves	2				✓		
	Fall protection training	5			✓			Tie off to guardrail on midpoint platform, workers did not have fixed ladder training, the 336 Work Supervisor/300 Area D4 Superintendent and 336 PSR approved free climb, and the 336 Work Supervisor/300 Area D4 Superintendent instructed rigger to tie off to guardrail.
	Ladder engineering review	4		✓				Identified adequate anchorage "areas." Actual anchorage "points" left to the discretion of PSRs.
	Fall protection checklist	4			✓			Less than adequate detail of multiple controls.
	Pre-ev meeting (T & W)	5			✓			Less than adequate discussion of work, hazards, and controls.
	Fall protection equipment:							
	• First man up double hook method	6		✓				Work Supervisor and PSR approved deviation from FPP and allowed free climb.
	• Harnesses	2					✓	
	• Lanyards, 6-foot	2		✓				Lanyards not used when hatch open.
	• Retractable lanyards (yo-yos)	2					✓	
	• Engineered ladder safety system	1		✓				Less than adequate search for existing safety device, which would have allowed for easier use of ladder hatch opening/closing and preclude opportunity for free climb, and 100% tie-off failures.
	Ladders (rungs/skid material)	2					✓	
	Catwalk guardrails	1					✓	
Anchorage locations	2		✓			✓	Less than adequate placement, but were not challenged.	

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Hazard	Advertised Barriers Physical/Admin	SPSR	DNP	DNU	Failed	DNF	Target	Comment
	100% tie off (hook/unhook method)	4		✓		✓	Workers at 336 Building	Procedure was not followed in all cases at midpoint platform.
	Work performance sequence (last task was to cut guardrail)	5			✓			Guardrails were cut prior to completion of other tasks.
	Closed hatch	1			✓			Hatch left open.
	"Team up, team down"	5			✓			Workers did not follow as work tasks overtook verbal direction from Work Supervisor.
	Lanyard tie-off on guardrail during guardrail cut	2		✓				No lanyards used or present on catwalk.
	Safety representative	4			✓			Approved fall plans and free climb.
	Supervisor	4			✓			Approved free climb and allowed work scope additions w/o full understanding of hazards and controls necessary.
	JHA/walk downs	4			✓			Less than adequate scope/hazards/controls. Work began before JHA approved. Work scope beyond JHA hazards and controls. Multiple walk downs did not include accessing the catwalk to assess hazards and determine work scope.
	IWCP	4			✓			Less than adequate scope/hazards/control. Work began before IWCP was approved and released. Work scope beyond IWCP steps. Workers do not review or see the written work steps.
	Stop work authority	4		✓				Neither the workers nor the safety reps invoked stop work authority even though one of the PSRs was "uncomfortable" during the free climb. Based on interviews, workers appear to have both a high risk tolerance and a reluctance to "pause" work.
Visibility	Open man doors	2				✓		Limited light.
	Floor lights	2				✓		Less than adequate on catwalk; "dark work" accepted in D4 environments.
	Reflective vests	2				✓		
	Headlamps	2				✓		
Ergonomics								
• Lifting (gear boxes)		5				✓		Two-man lift, zip line backup
• Contact Hazard	Hard hat	2				✓		
Pinch Points/Crushing	Gloves	2				✓		
	Skill of the craft	5				✓		
	Safety shoes	2				✓	▼	

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Hazard	Advertised Barriers Physical/Admin	SPSR	DNP	DNU	Failed	DNF	Target	Comment
Working Surfaces • Catwalk • Floor	Substantial footwear	2				✓	Workers at 336 Building	
	Housekeeping	5				✓		
Cutting/Sharp Surfaces	Gloves	2				✓		
	Safety glasses	2				✓		
	Training	5				✓		
	Job skills	5				✓		
Heat	Morning work	4				✓		
	Water bottles	2				✓		Inappropriately used for removing gear box oil
Falling Objects	Tied off railing for cut	2				✓		
	Hard hats	2				✓		
	Safe room	4				✓		
	Access control door	4				✓		
	Tool bucket on rope	2				✓		
	Toe board on catwalk	2				✓		
	Steel toes	2				✓		
Airborne Debris	Safety glasses	2				✓	↓	

Key:
 SPSR = safety precedence sequence rating
 DNP = did not provide
 DNU = did not use
 DNF = did not fail

Appendix C: Change Analyses

Table C-1. Change Analysis: Work Planning and Control

Planned Work	Actual Work	Impact
Issue WPF.	Issued WPF.	No direct impact. The original WPF scope did not include crane removal.
RM to determine risk ranking, work package type, and approve WPF.	RM determines risk ranking, work package type, and approves WPF.	No direct impact. The original risk ranking was low. Risk ranking based on high reach excavator work, but not crane removal. No requirement to re-rank as work scope is detailed.
Planner begin work package development	Planner begins work package development	No direct impact. The package was still not based on any crane removal. Planner was not aware that a 300 Area engineer had determined that high reach excavator was not suitable for facilities with overhead cranes.
Planner to assemble relevant personnel and conduct JHA. JHA to include table top discussion and walk down of work site.	Planner assembles relevant personnel and conducts JHA (first of two JHAs) – table top discussion and walk down completed – results in additional scope to remove bridge crane. Scope change based crane operator recommendations due to high reach excavator limitations. JHA includes one “What If” scenario concerning a chemical spill.	Significant impact. Crane removal introduced new hazards not previously evaluated, including work on the catwalk. The walk down for the first JHA was at floor level only. One month of planning time lost based on lack of knowledge of 300 Area engineer’s determination. FR recommended additional “What If” scenarios due to increase in scope.
Planner to revise work instructions and JHA to accommodate scope change; crane removal.	Planner revises work instructions and JHA to accommodate scope change. New section 5.1.2 adds the following: <ul style="list-style-type: none"> • Access overhead catwalk to remove bridge crane truck stops • Access bridge crane to disengage crane’s travel wheels for free wheeling • Support bridge crane hook/block, then access bridge crane and field cut lifting cable from one end • Access building exterior panel siding on south side and cut hole • Run bridge crane cable through hole in panel siding Planner modifies JHA to reflect scope change. JHA does not capture catwalk hatch/opening as hazard to control. No additional “What If” scenarios.	Significant impact. Had the JHA captured the catwalk access hatch as a hazard requiring formal controls, it may have invoked adequate controls to prevent a fall. Planner assumed the hatch had a safety chain around it. An additional “What If” scenario relating to fall from catwalk or fall through catwalk access might have resulted in formal access controls.
Planner to assemble relevant personnel to conduct second JHA for crane removal revisions. Should include both table top discussion and job site walk down.	Planner held second JHA. Conducted table top discussion and job site walk down (floor level only). No millwrights or crane SMEs in attendance.	Significant impact. Floor level walk down, lack of millwrights or crane SMEs prevents adequate evaluation of hazards associated with new scope of work. Again catwalk access not recognized as formal hazard in JHA.

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

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Planned Work	Actual Work	Impact
Planner to complete work package development, obtain concurrence signatures from various supervisors, crafts, safety, and SMEs	Planner routes package w/JHA and obtains concurrence signatures on work package.	Potential impact. PSR signs both JHA and work package cover sheet two days prior to second JHA. Planner stated that he did provide the revised JHA to the PSR.
Planner to submit JHA for concurrence signatures to all attendees.	Planner submits JHA for concurrence signatures for all attendees.	Potential impact. PSR signs both JHA and work package cover sheet two days prior to second JHA. Planner stated that he did provide the revised JHA to the PSR. Initial work supervisor that signed the work package cover sheet did not review the package and was not involved in any of the JHA sessions.
Planner to submit work package and JHA to RM for approval. Should be RM that was involved with the planning/JHA process.	Planner submitted work package and JHA to RM for approval. RM that signed not involved with any of the planning/JHA sessions. Different RM than one that did initial risk ranking.	Potential impact. The RM reviews the completed JHA and work package to ensure that the work package is suitable for the scope, current references are incorporated, and that all hazard controls from the JHA have been incorporated into the task instructions (Type I and II work packages), or that the craft work package JHA is suitable to protect the workers. An RM with little or no involvement does have the background to adequately accomplish the above. RM 1 (IWCP/JHA) approved work package at 11:00 a.m. on June 30.
Initial work supervisor to conduct tasks 1-4.	Initial work supervisor too overloaded with other tasks. 300 Area D4 Superintendent decides to personally supervise 5.1.2 work scope due to elevated work surface hazards and prior involvement in planning.	Significant impact. 300 Area D4 Superintendent adds direct supervisory 336 Building work scope to other superintendent duties. Permits craft crew to work recognized hazardous tasks without any continuous supervision or safety oversight.
FPOC release work package at the POD for each day of work.	FPOC did not release work package on either day work performed.	No direct impact. 300 Area D4 Superintendent does not disclose to FPOC on Tuesday afternoon or Wednesday morning that 336 work had commenced. Indicates problem with implementation of work release requirements.
Conduct pre-ev with approved work package.	Pre-ev conducted by the 336 Work Supervisor/300 Area D4 Superintendent on first day of work without an approved work package. Pre-ev conducted by the 336 Work Supervisor/300 Area D4 Superintendent on second day of work with an approved work package.	No direct impact. Indicates problem with implementation of work release requirements.
Perform work per section 5.1.2 of the work package.	Performed work per section 5.1.2 of work package, but added additional scope without processing change to work package. Additional scope added: <ul style="list-style-type: none"> • Applied tube-block clamps to laterally secure trolley • Cut catwalk guardrail • Secure trolley with cable or chain (work not completed) • Move trolley to support securing of trolley (work not completed) 	Significant impact. New work scope to move trolley to support securing trolley results in fall when workers proceed to opposite ends of catwalk with hatch open. Work scope changes require revision to work package; requiring re-evaluation of existing JHA to determine if JHA is still adequate or if additional hazards have been introduced. If new hazards are introduced, additional controls should be put in place.

Table C-2. Change Analysis: Work Execution
Task 1, Step 5.1.2, June 30 - July 1, 2009

Planned Work	Actual Work	Impact/Consequence	
		Change	Impact
Access overhead catwalk to remove bridge crane rail stops.	Accessed overhead catwalk, identified two sets of stops on each rail, removed two e-stops, and partially unbolted hard stops.	E-stops identified in the field as new scope and the decision was made in the field to partially unbolt the hard stops rather than remove them.	Missed opportunity to "pause" and re-plan.
Access bridge crane to disengage crane's travel wheels for free-wheeling.	Accessed bridge crane, identified need to remove gear boxes. Drained oil and removed gear boxes.	Removal of gear boxes and oil draining were new scope. Two millwrights were required and added to the work crew on second day.	Increased scope w/o revising work package resulted in a lack of hazard identification and controls. No prior millwrights involved in work planning. Improper waste management protocol.
Support bridge crane hook/block, then access bridge crane and field cut, lifting cable (1/2-inch diameter) from one end. This 1/2-inch cable will be used to pull crane out of building.	Performed as planned.	None.	None.
Access building exterior panel siding on south side and cut hole.	Performed as planned.	None.	None.
Run bridge crane cable through hole in panel siding.	Performed as planned.	None.	None.
	Applied tube-block clamps to laterally secure trolley.	New scope.	Increased scope w/o revising work package resulted in a lack of hazard identification and controls.
	Cut guardrail without fall protection.	New scope. Two of three cuts completed.	Non-compliant fall protection. Weakened guardrail. Railing is cut out of directed sequence (prior to chaining the trolley).
	Prepared to secure trolley to bridge using a cable.	New scope. Rigger 1 leaves building to obtain chain because the idea to use the cable was not feasible. Rigger 2 comes down from catwalk to take ground position. Millwright 2 believes work is complete and starts down. Hatch remains open in anticipation of remaining workers descent. Workers forgot to secure the trolley prior to initiating guardrail cutting. Rigger 1 reminds Rigger 3 to chain the trolley. Millwright 1 remains on the catwalk to support the chaining of the trolley. Millwright 1 and Rigger 3 discuss moving the crane to aid in using the chain and prevent Rigger 3 from leaning over the partially cut guardrail to reach the trolley.	When Rigger 2 comes down, he breaks the "team up, team down" concept. Hatch is left open after Millwright 2 descends. The chaining interruption distracts the work crew and stops Millwright 1 from descending. Crane move discussion between Rigger 3 and Millwright 1 refocuses their attention on a new, unplanned, and unanalyzed task.
	Rigger 3 and Millwright 1 each move to opposite ends of the catwalk in order to move the crane to improve access for securing the trolley with the chain.	New scope.	Millwright 1 falls 50 feet through open hatch.

Table C-3. Change Analysis: Fall Protection Code Compliance

Planned Work	Actual Work	Impact
100% tie-off while ascending and descending ladder.	First man up free climbed.	Actual work failed to comply with 29 CFR 1926.1051(b), which states, "Employers shall provide and install all stairways and ladder fall protection systems required by this subpart and shall comply with all other pertinent requirements of this subpart before employees begin the work that necessitates the installation and use of stairways, ladders, and their respective fall protection systems," and 29 CFR 1926.1053(a)(19), which states, "Where the total length of a climb equals or exceeds 24 feet (7.3 m), fixed ladders shall be equipped with one of the following: (ii) Self-retracting lifelines and rest platforms at intervals not to exceed 150 feet (45.7 m)..."
100% tie-off while ascending and descending ladder.	Workers unlocked from one lanyard before hooking to the other lanyard at the midpoint platform	Actual work failed to comply with 29 CFR 1926.501(b)(1), which states, "Each employee on a walking/working surface (horizontal and vertical surface) with an unprotected side or edge which is 6 feet (1.8 m) or more above a lower level shall be protected from falling by the use of guardrail system, safety net system, or personal fall arrest system."
Hatch open during ascent/descent; workers on the catwalk would stand back away from the edge of the opening (all up, all down concept).	Same.	Planned and actual work failed to comply with 29 CFR 1926.501(b)(1), which states, "Each employee on a walking/working surface (horizontal and vertical surface) with an unprotected side or edge which is 6 feet (1.8 m) or more above a lower level shall be protected from falling by the use of guardrail system, safety net system, or personal fall arrest system."
Hatch cover closed when workers have accessed the catwalk.	Performed as planned.	Catwalk is compliant when hatch cover is closed.
Supervisor verbal instructions: one worker remain on the catwalk; tie off to guardrail one stanchion over, make three cuts to remove top rail of guardrail and exit down ladder.	Two guardrail cuts were made while two workers were on catwalk and not tied off.	Planned and actual work failed to comply with 29 CFR 1926.502(d)(23), which states, "Personal fall arrest systems shall not be attached to guardrail systems, nor shall they be attached to hoists except as specified in other subparts of this part."
Structural engineer recommended that retractable lifelines be installed on horizontal C-channels. Specific anchorage locations were not documented by the engineer.	Midpoint anchorage location was placed around ladder support and upper anchorage location was placed around cross brace (angle iron).	Midpoint and upper anchorage locations were not consistent with structural engineering recommendation. However, post-accident engineering analysis determined that the anchorage locations met applicable standards.
Anchorage straps were not addressed in the FPP.	Retractable lifeline anchorage synthetic straps were not properly protected from sharp/abrasive edges.	Protection of straps should have been addressed in the FPP. Actual strap installation did not include softeners to protect the straps from sharp and abrasive edges of the angle brace for the upper lanyard and the flat steel of the ladder brace for the lower lanyard. The use of softeners is recommended by the manufacturer and required by WCH fall protection procedure no. SH-1-3.5, 6.4.1.2.
All workers are properly trained for the assigned duties.	Millwright 2 did not have ladder training (portable or fixed). Millwright 1 and riggers did not have fixed ladder training.	Actual work did not comply with 29 CFR 1926.1060(a), which states, "The employer shall provide a training program for each employee using ladders and stairways, as necessary. The program shall enable each employee to recognize hazards related to ladders and stairways, and shall train each employee in the procedures to be followed to minimize these hazards."

Planned Work	Actual Work	Impact
<p>Compliant fall protection training (content, delivery, and effectiveness).</p>	<p>Fall protection training was not effective.</p>	<p>The fall protection training program is ineffective, as evidenced by the first man up securing his fall protection lanyard to the guardrail on the midpoint platform, the lack of fall protection usage during the free climb, lack of fall protection usage by another employee during the catwalk guardrail cutting, and the lack of fall protection used/required when the catwalk ladder access cover was raised. Workers were also unaware of some of the limitations (retractable has limited horizontal protection) of the MSA retracting lanyard they were using. 29 CFR 1926.503 (a)(2) (ii) and (iii) states, "(ii) The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used. (iii) The use and operation of guardrail systems, personal fall arrest systems, safety net systems, warning line systems, safety monitoring systems, control access zones, and other protection to be used."</p> <p>In addition, the ineffective training program was evidenced by management and safety representatives not requiring the use of adequate fall protection and workers' lack of recognition of the following fall hazards:</p> <ul style="list-style-type: none"> • The top guardrail was cut in two locations and workers continued to perform work on the catwalk. Fall protection was not required by management; the expectation was to perform the cuts as the last task before exiting the catwalk to minimize time exposed to a fall hazard. • The first workers accessing the catwalk were expected to stand back from the edge of the hole in the walkway until all workers had come up or gone down. The use of fall protection was not required by management. • Rigger tasked with setting up the fall protection system was allowed to free climb a 50-ft. fixed ladder without fall protection. The ladder did not have a cage. <p>WCH had not ensured workers were adequately trained and retraining had not been provided as required by 29 CFR 1926.21(b)(2), which states, "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury," and 29 CFR 1926.503(c)(3), which states, "Inadequacies in an affected employee's knowledge or use of fall protection systems or equipment indicate that the employee has not retained the requisite understanding or skill."</p>
<p>Illumination of the catwalk work area was not adequate, so head lamps, open man doors, and portable floor lighting were provided.</p>	<p>Illumination of the catwalk work area remained inadequate for the work tasks performed.</p>	<p>29 CFR 1926.56(a) states, "Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lighted to not less than the minimum illumination intensities listed in table D-3 while any work is in progress." Table D-3 requires five foot candles for general construction area lighting. Illumination of the catwalk work area was measured by the Board using the planned illumination techniques and resulted in a reading of 0.14 foot candles for the work area.</p>

Appendix D: Events and Causal Factors Analysis

Table D-1. Events and Causal Factors Analysis

Date/Time	Event	Comments/Conditions	Causal Factors
Feb. 2007	WCH revised IWCP procedure in response to DOE ISMS Phase I verification review.	WCH conducted 27 IWCP-related assessments in 2007, 48 in 2008, and 17 year-to-date in 2009.	CC3
Aug. 2007	WCH revised IWCP procedure in response to improvement opportunities and assessments.		
Nov. 2007	DOE ISMS Phase II verification.		
Sept. 2008	WCH and DOE-RL completed closure verification and effectiveness reviews related to concerns and opportunities for improvement from the Phase II ISMS review.		
Aug. 2008	336 Building transferred from PNNL to WCH.	PNNL left hatch on catwalk open and retained ladder climbing safety devices with its millwrights.	
Fall 2008	WCH had Klaus Engineering review demolition of 336 Building. Klaus recommended using cutting torches, but WCH dismissed this approach as unsafe.		
10-06-08	Beryllium survey report for 335 and 336 Buildings completed.		
10-31-08	Industrial Hygiene Work Plan for all 300 Area D4 projects completed.		
11-18-08	Radcon survey record approved for both 335 and 336 Buildings (survey performed June 2008).		
12-1-08	Asbestos sampling report completed for 335 and 336 Buildings.		
12-9-08	336 excavation plan was developed. Most signatures were obtained in Jan. 2009; the 300 Area Project Engineer and RM 2 (Risk Ranker) approved June 18, 2009.		
Early 2009	CDI consultants discussed 336 Building explosive demolition approach with RM 2 (Risk Ranker), which was determined to be too risky. RM 2 (Risk Ranker) decided to go with high reach equipment approach.		
April 2009	The 336 PSR started working at Hanford. Another PSR was temporarily assigned to the 300 Area (his assignment later became permanent as the 324/327 PSR).		
May 2009	The 336 PSR began working in 300 Area.		
-05-01-09 Friday	A 300 Area engineer researched the Komatsu high reach equipment by computer and determined it to be unsuitable to support crane removal (weight of crane).	The engineer determined that the high reach equipment was not appropriate due to inadequate lateral pulling forces. The equipment is good for shearing only, but cannot handle heavy weights. These results were not communicated to D4 management or planners.	RC1a
05-11-09 Monday	335/336 Building WPF generated by the 336 Work Control Planner. The 300 Area Project Engineer signed the form. The Planner initiated the IWCP. RM 2 (Risk Ranker) performed risk ranking as "low" and designated the work to be performed per a Type 1 work package.	Typical D4 packages are Type 2 and generic. Type 2 uses an applicable attachment with building-specific instructions and is considered step-by-step. The 336 Building IWCP was a Type 1 package because of the use of the high reach equipment. At this time, IWCP was based on high reach demolition. The 336 Work Control Planner was told by RM 2 (Risk Ranker) that the work package was based on using high reach equipment and that the high reach equipment would arrive in early June. The 336 Work Control Planner was told to complete IWCP by then. IWCP practice was to cut and paste existing packages, and use workers' input to update work package.	RC1a

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Date/Time	Event	Comments/Conditions	Causal Factors
		<p>RM 2 (Risk Ranker) performed risk ranking based on building knowledge and initial high reach plan. Typically the area supervisor and PSR do risk ranking walk downs. In 336, it was the 336 Work Supervisor/300 Area D4 Superintendent and RM 2 (Risk Ranker). RM 2 (Risk Ranker) decided it was a Type 1 package based on high bay configuration. RM 2 (Risk Ranker) said he did not participate in the JHA walk downs.</p> <p>Risk ranking identified:</p> <ul style="list-style-type: none"> • Team experience – high • Risk of injury – low • More than one supervisor – no • Complexity – medium • Demolition – low • Elevated surfaces – no • Ranking score – 27 (less than 35 equals low risk) 	
05-14-09 Thursday	The "cold and dark" walk down and checklist were completed and signed.		
05-19-09 Tuesday	The 335/336 hazardous material removal work package was approved by the 336 Work Control Planner and the Work Supervisor for that activity.	<p>Risk ranking for the hazardous material removal identified:</p> <ul style="list-style-type: none"> • Elevated surfaces – yes • Hazardous material removal ("removal of hazardous chemicals to include solvents, lubricants, paints, lead, mercury, oils, glycol) – low risk task 1.2.3 • Precautions and limitations – 336 hazmat material walk down checklist • Oils/greases – yes • Fall protection work – yes • "Need engineering evaluation for high bay [mezzanine] and grating" 	RC1a
05-20-09 Wednesday	335/336 hazardous material removal work package walk down and pre-ev were led by the Work Supervisor for that activity.		
05-27-09 Wednesday	The 335 Building was removed from scope of work package. The WPF and risk rank determination worksheet were revised to exclude 335 Building by RM 1 (IWCP/JHA), who initialed and dated the revisions.	<p>Buildings 335 and 336 were separated as different jobs in order to get things done easier on 335 as a Type 2. One delay in getting the 336 work package completed was the need for a trench to create a dust control moat. Trenching requires an excavation permit, so RM 1 (IWCP/JHA) made the decision to delete 335 from this scope.</p> <p>RM 1 (IWCP/JHA) did not revise the risk rank determination since the only modification was to delete 335 Building and that did not affect the scope of work as he understood it.</p> <p>The D4 Closure Director said that risk ranking was based on the fact that there was no elevated work and that the JHA never got revised to reflect the post-June 25 change to address removal of the crane and associated elevated work. The D4 Closure Director noted that the process does not require it, but it should have happened.</p>	RC1a
06-01-09 through 06-08-09	336 hazmat cleanout supervised by the 336 HazMat Removal Supervisor and the Planned 336 Work Supervisor. The Planned 336 Work Supervisor decided to not remove oils from crane gear boxes, as he determined it was too dangerous to access the catwalk.	<p>During the hazardous waste removal, the Planned 336 Work Supervisor had the rollup door open to add additional light.</p> <p>The Planned 336 Work Supervisor knew there would be oil in gear boxes from past experience.</p> <p>The Planned 336 Work Supervisor felt it was unsafe to access catwalk and remove bridge rail gear box oils (removal risk was too high for small amount of oil). He believed the two PSRs were aware that oil was left behind. There was no entry in the hazardous waste work package to identify that the gear box oil remained.</p>	RC1a
06-04-09 Thursday	The Planner initiated the JHA for 336 demolition.		

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WCH Employee Fall Injury on July 1, 2009

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Date/Time	Event	Comments/Conditions	Causal Factors
06-09-09 Tuesday	The Komatsu (high reach equipment) arrived on site. Vendor provided training to WCH teamsters beginning the week of June 16. Two days of training were provided for WCH operators.		
06-15-09 Monday	<p>First JHA meeting and walk down for 336 demolition.</p> <p>After the JHA meeting, the 336 Work Control Planner and crane operator did a walk down of 336 from the floor level only. A decision was made to pull the crane out through the side of building and was subsequently agreed to by RM 2 (Risk Ranker).</p>	<p>The first JHA meeting was led by the 336 Work Control Planner and attended by the 300 Area RL FR, planner-in-training, one crane operator, plus others, including the 336 PSR. The 336 Work Control Planner brought the JHA forms. A walk down (floor level only) of the work site preceded the JHA tabletop discussion. A draft of the JHA was covered at the JHA meeting and was based on high reach approach hazards. The crane operator did not like the high reach approach with regard to the 336 Building bridge crane, and the FR agreed.</p> <p>The crane operator suggested not using high reach shears on 336 Building due to weight of the bridge crane. The recommendation was to remove the bridge. The crane would need to be pulled out first using heavy equipment other than the high reach excavator.</p> <p>The 336 PSR went to first JHA and walk down to look at catwalk access and fall protection. He recalled all craft being concerned about lifting out the bridge crane.</p> <p>The 300 Area Project Engineer does not typically attend JHAs or walk downs, but is a required signatory.</p> <p>The 300 Area RL FR was concerned that the Planner did not bring copies of the draft task instructions. She believed the PSR did not contribute at the meeting and characterized the meeting as "weird and the planner was abrupt." The FR provided a safety perspective along with the planner-in-training (a former PSR). Crane operator raised safety issues on high reach approach. FR raised issue regarding nearby power lines and inside pit. No engineering reps were at meeting. New D4 workers were observing the meeting, which lasted approximately one hour. The 300 Area RL FR observed arguments between the crane operator and the Planner, for example: There were arguments about the driving path for heavy equipment. The 336 Work Control Planner said, "We drive heavy equipment all the time, it's no big deal." FR was concerned that the only "What If" scenario considered was for chemical spills, and argued that other "What If" scenarios to consider included toppling heavy equipment and power line contact. The 336 Work Supervisor/300 Area D4 Superintendent was not in attendance. FR recommended at JHA that attendees do an additional walk down.</p> <p>The 336 Work Control Planner runs the JHA meetings and sends out invitations to perspective attendees; attendance is not always 100%.</p> <p>The 336 Work Control Planner discussed additional "What If" scenarios with the 336 HazMat Removal Supervisor and the 336 Work Supervisor/300 Area D4 Superintendent, and the decision was that no further "What Ifs" were necessary.</p>	RC1a
06-16-09 Tuesday	<p>RL FR who attended the JHA talked to the 336 Work Supervisor/300 Area D4 Superintendent about the poor quality of the JHA. RL FR recommended to the 336 Work Supervisor/300 Area D4 Superintendent to re-do IWCP and JHA.</p> <p>RL FR talked to WCH management about JHA quality.</p>	<p>The 336 Work Supervisor/300 Area D4 Superintendent was disappointed with FR's negative view of the JHA meeting because he wanted to start the job the next day.</p> <p>FR was going on vacation the next two weeks.</p>	RC1a RC1b
06-18-09 Thursday	335/336 hazardous waste material IWCP package closed.	Gear box oil task removal was not documented as not being performed. The Planned 336 Work Supervisor also indicated that some mercury lamps still remained in the facility.	RC1a
06-19-09 Friday	The 300 Area RL FR began two-week leave through July 7.	Two FRs were assigned to provide backup for the 300 Area.	

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Date/Time	Event	Comments/Conditions	Causal Factors
06-22-09 Monday	IWCP 300 09 05 11 001 redrafted by the 336 Work Control Planner. Work package had four primary tasks: 1) set up for demo, 2) demo and load out of building, 3) prepare building slabs for post-demo, and 4) demobilize.		
06-23-09 Tuesday	Signatures for work package approval initiated, including signature by the 336 PSR.	<p>The following concurrence signatures were initiated prior to work package and JHA completion: Planned 336 Work Supervisor, 300 Area Environmental Protection Lead, 336 PSR, Radiological Engineer, Project Industrial Hygienist, Fire Protection Engineer, 336 Work Control Planner, 300 Area Project Engineer (Engineering, USQ, and FHC), and RM 1 (IWCP/JHA).</p> <p>The 336 Work Control Planner's practice is to discuss changes in IWCP/JHA with key people for review as revisions are made; he does not get updated signatures. The IWCP procedure allows for this, but the expectation is that concurrence signatures are not obtained until the package and JHA are complete. The provision to allow discussion of revisions is intended for changes made after concurrence signatures have been made and prior to the work package and JHA approval by the RM.</p>	RC1a RC1b CC3
06-24-09 Wednesday	335 Building demolished.		
06-25-09 Thursday 3:00 PM	<p>Second JHA meeting and walk down was conducted.</p> <p>The 336 PSR identified ladder issues.</p> <p>All three riggers were involved in second JHA meeting.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent understood need to change work package due to crane removal and asked the 336 Work Control Planner to make the changes. The 336 Work Supervisor/300 Area D4 Superintendent signed the JHA, but instructed the 336 Work Control Planner to make changes to address crane removal.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent decided at the JHA that he would supervise task 1 (crane removal prep) and the Planned 336 Work Supervisor would supervise the remainder of the IWCP tasks 2-4.</p> <p>The Planned 336 Work Supervisor was unaware of the 336 Work Supervisor/300 Area D4 Superintendent's decision to directly supervise the removal of the 336 Building crane.</p>	<p>The second JHA was the result of the change in scope involving the manual preparation of the bridge crane for removal.</p> <p>This JHA meeting involved the riggers; there were no millwrights or bridge crane SMEs in attendance. The JHA added steps 5.1.2 into task 1. The 336 Work Control Planner walked down the work site from the floor with the riggers and the 336 Work Supervisor/300 Area D4 Superintendent. The 336 Work Control Planner did not recognize that there was a cover for the hatch on the catwalk; he assumed an open hole with chained access controls. The hatch had been left open by PNNL at time of August 2008 turnover. All other walk down attendees reported to have seen the catwalk hatch open. The JHA meeting did not formally capture the hatch hazards for control.</p> <p>PSRs participate in JHA and IWCP development; however, there is a low percentage of walk downs on JHA and IWCP by teams.</p> <p>About two-thirds of craft staff who do the work attend JHAs; however, the percentage is less for D4 workers and RCTs. This practice is different in the 300 Area from 100N, where JHAs are better organized and attended.</p> <p>JHA signatures obtained between 6-23 and 6-30. The 336 PSR signed on 6-23. JHA modification for the June 25 session included the new task 1 activity of bridge crane removal preparations and identified the hazard associated with the 336 high bay fixed ladder. The only elevated work hazard pertained to the use of an aerial lift. There was no mention of the elevated catwalk hazard.</p>	RC1a RC2 CC3
06-26-09 Friday	<p>Hanford Friday off.</p> <p>The 336 PSR performed a computer search on the existing engineered ladder safety device and looked around the 336 Building, but was unable to locate it.</p>	The 336 PSR did not utilize WCH S&M transition team to assist in locating appropriate PNNL contact for equipment.	RC1a
06-27-09 Saturday	The 336 PSR email to the 300 Area Project Engineer and the Structural Engineer requested a 336 ladder engineering evaluation. Ladder issues were identified during June 25 JHA review.	WCH does not have a fixed ladder procedure, rather they use OSHA 1926 and 1910 code standards. No fixed ladder training.	RC2
06-29-09 Monday AM	<p>The D4 Closure Director returned to Tri-Cities from travel.</p> <p>RM 2 (Risk Ranker) on vacation the week of June 29.</p>	<p>The D4 Closure Director's Deputy had been acting in his absence.</p> <p>The 324/327 PSR had no involvement in planning 336 IWCP. His principal assignments are 324 and 327 Buildings. However, prior to</p>	RC1a RC1b CC3

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Date/Time	Event	Comments/Conditions	Causal Factors
	<p>Rigger 2 and Rigger 3 returned to 300 Area from various 100N jobs.</p> <p>The 324/327 PSR returned from 2½-week vacation.</p> <p>The 336 Work Control Planner made work package changes requested by the 336 Work Supervisor/300 Area D4 Superintendent.</p> <p>The Planned 336 Work Supervisor was originally assigned as the 336 Work Supervisor. He was given the work package by the 336 Work Control Planner and signed it after a cursory review.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent then volunteered to be the actual 336 Work Supervisor as he had been involved in the planning, considered the work higher risk, and the Planned 336 Work Supervisor was overloaded.</p>	<p>vacation, the 324/327 PSR identified the 336 pit as a non-permit confined space.</p>	
<p>06-29-09 Monday ~1:00 PM</p>	<p>The Structural Engineer, 336 PSR, and the 324/327 PSR evaluated ladder integrity from the 336 Building white tower and from the floor level. The Structural Engineer briefed the 300 Area Project Engineer on results after walk down (followed by Tuesday's 10:57 AM email). The Structural Engineer, 336 PSR, and the 324/327 PSR discussed areas suitable for fall protection anchors. Horizontal structural I-beams were determined to be acceptable.</p> <p>In an attempt to locate the existing engineered ladder safety devices (Sellstrom/RT 2000 Climb-Rite), the 324/327 PSR called the telephone number posted near the 336 Building crane access ladder. He was told the listed employee was no longer in that PNNL group (PNNL employee still works at PNNL). The 324/327 PSR knew of the WCH S&M group that handles facility transitions, but it did not cross his mind to contact them about the Climb-Rite. No other action was taken to locate the device at PNNL.</p> <p>The 336 PSR could not find the manufacturer's name on the ladder climbing system center rail.</p> <p>Both PSRs discussed ladder and fall protection issues and alternatives. The 336 PSR and the 324/327 PSR decided to use two 50-ft. MSA Dynalock retractables as they were available in the 324/327 PSR's office. The 324/327 PSR would have preferred a single 100-ft. retractable, but they did not have any available. The 336 PSR made the final decision.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent loads craft resources for following day's work based on approved IWCPs and also pending IWCPs near approval at midday POD.</p>	<p>The Structural Engineer for WCH is an experienced subcontractor. He used a flashlight from white platform looking for rust, loose bolts, and corrosion. He found the ladder was in good shape, construction was adequate and okay to use. He was not asked to evaluate the catwalk and guardrails, but briefly looked at them from white platform and thought they looked okay. He did not evaluate hatch as it was not part of the ladder. He identified potential "tie off areas" at the midpoint platform and catwalk. "Tie off points" and methods were the decision of the PSR.</p> <p>The Board obtained Climb Rite safety device in less than one hour after contacting PNNL.</p> <p>According to the 324/327 PSR, any of the structural steel channels (including diagonals) were okay to use based on an understanding from the Structural Engineer.</p> <p>The 336 PSR had noticed the open hatch on the June 25 JHA walk down and was concerned about ladder protection.</p> <p>The 336 PSR stated that riggers have their own harnesses, but can get lanyards from PSRs. Lanyards are six feet long. Retractable are not checked out by individuals, but are assigned to the job.</p> <p>The 324/327 PSR was not focused on the hatch; he had only done a cursory review of the catwalk from the ground. He would have preferred that all workers near the hatch to be tied off while the hatch was open, but never discussed this with the 336 PSR. The 324/327 PSR discussed only the ladder with the 336 PSR.</p> <p>The 324/327 PSR says the FPP was a checklist and holdover from Bechtel Hanford, Inc. Per procedure and OSHA, an FPP is not required, but the 336 PSR had done one for the IWCP. The 324/327 PSR thought it was overkill, but okay.</p> <p>The 324/327 PSR believed a written FPP was unnecessary at this point since the guardrail cut had not been identified as a task. He did not consider the initial free climb in fall protection planning because he was unaware that they would be doing that.</p>	<p>RC1a RC1b RC2 CC3</p>
<p>06-30-09 Tuesday 5:50 AM</p>	<p>POD meeting held. RM 1 (IWCP/JHA) was at POD.</p> <p>POD/POW work release for 336 Building was not signed by FPOC.</p>	<p>RM 1 (IWCP/JHA) was not involved in any 336 IWCP planning and does not recall the FPP. His normal assignment is managing subcontract projects.</p> <p>POD work release sheet did not identify the work package number, contained no initials for work package release, and identified the Planned 336 Work Supervisor. Pre-ev is supposed to be conducted prior to formal work release approval, along with approved IWCP and JHA.</p>	

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06-30-09 Tuesday Early AM	Beryllium work permit issued by IH for 336 Building, becoming effective July 1. The 336 PSR developed fall protection plan/checklist.	The FPP did not address any cover hatch controls or identify specific tie-off points for placing the retractable lanyards.	RC1a RC2
06-30-09 Tuesday Early AM	The 336 Work Control Planner brought IWCP to RM 1 (IWCP/JHA) for signature. RM 1 (IWCP/JHA) reviewed the task instructions, the IWCP content, and the JHA. He asked the 336 Work Control Planner to add more detail to the IWCP relative to cable size and attachments for crane pull. IWCP/JHA approved ~11:00 AM.	An RM is required to approve IWCP/JHA before pre-ev. RM 1 (IWCP/JHA) signed the package after work had been initiated though he had no involvement in the planning of the manual preparation of the bridge crane for removal. The RM who was familiar with this activity was on vacation and RM1 (IWCP/JHA) was one of two RMs available. The practice of allowing any RM to review and approve work packages and JHAs is allowed by the IWCP procedure.	RC1a RC1b
06-30-09 Tuesday 7:00 – 9:00 AM	<p>Pre-ev meeting on task 5.1.2 led by the 336 Work Supervisor/300 Area D4 Superintendent. Pre-ev was conducted with three riggers and the 336 PSR in attendance. The 324/327 PSR did not sign in, but attended the beginning of the pre-ev, and then received a call and had to leave about 8:45 AM.</p> <p>The 336 PSR and the 336 Work Supervisor/300 Area D4 Superintendent believed they had the approved IWCP at the pre-ev.</p> <p>The 336 PSR knew the Structural Engineer had verbally approved the ladder.</p> <p>There was a discussion of the harness and initial two-hook ascend approach. The decision to allow "first man up" to free climb was agreed to by the 336 PSR and the 336 Work Supervisor/300 Area D4 Superintendent.</p> <p>General steps of 5.1.2 were discussed at the pre-ev. The three riggers each had a slightly different perspective on what was discussed.</p> <p>Pre-ev discussed ladder climbing and staying tied off when setting retractable devices. Crane bus bar power strip support removal was also discussed.</p>	<p>Interviews with the pre-ev attendees indicated that they observed the 336 Work Supervisor/300 Area D4 Superintendent using a hard copy bound in a three-ring binder during the conduct of the pre-ev.</p> <p>There was no discussion of free climbing at the pre-ev. The 336 PSR said the guardrail cut was not discussed at Tuesday's pre-ev. The 324/327 PSR did not know the guardrail was going to be cut and does not think the 336 PSR knew that either on Tuesday morning.</p> <p>The PSR is deemed a "qualified person" for establishing tie-off requirements by the WCH procedure. The 336 PSR is a "qualified person" for FPP as a result of his job title as a PSR per WCH procedure. By inference, those who are not PSRs are not "qualified" to sign off an FPP.</p> <p>Rigger 2 was chosen as "first man up" based on his previous experience climbing windmills. Windmills use the same carabineer harness system as PNNL had in 336. "First man up" rule is really for building scaffolding, but Rigger 2 thought it was also a WCH rule in general. Rigger 2 is familiar with double hook carabineer tie off, "first man up" method, but does not like it. He believes it is less safe than free climbing because you have to take your hands off on climb during carabineer gate manipulations.</p> <p>The 324/327 PSR is a "competent person" for training on fall protection.</p> <p>The 336 PSR provided brand new lanyards to the riggers from the ones the riggers found in the 324/327 PSR's office. In general, only riggers carry around their own lanyards.</p>	RC1a RC1b RC2
06-30-09 Tuesday 9:00 – 10:00 AM	Work crew gathered tools and materials.		
06-30-09 Tuesday 10:00 AM	<p>Work team met at 336 Building with gear. Rigger 2 was the first man up and hung retractables. Rigger 2 climbed without fall protection, which was approved by the 336 PSR and the 336 Work Supervisor/300 Area D4 Superintendent.</p> <p>Rigger 2 free climbed to midpoint platform, used a 6-ft. lanyard to secure himself to guardrail and installed first retractable on the ladder support. He then climbed to the catwalk, through the hatch that was already open. Once he reached the catwalk, he closed the hatch and installed the upper retractable at anchor points identified by the "engineer" (referring to the 336 PSR).</p> <p>Rigger 2 stayed tied off when setting the midpoint retractable.</p> <p>The 336 PSR stayed in the building until the retractables were installed. Then the 336 PSR left to go to another meeting.</p> <p>Rigger 1 was the second man up. Rigger 2 stood back six feet from</p>	<p>Rigger 3 was the ground support and did not go up ladder on Tuesday morning. His first time up was Tuesday afternoon.</p> <p>Heat was not a factor on Tuesday morning.</p> <p>Prior to the climb, the 336 PSR did not disclose to the 324/327 PSR that Rigger 2 would be free climbing.</p> <p>The 324/327 PSR watched "uncomfortably," but did not raise his concern about the free climb.</p> <p>Rigger 3 stated that the double-hook climb is uncomfortable. Free climbing is normal on the "outside." It would have been easier to use the PNNL equipment.</p> <p>Rigger 2 was the only one to use 6-ft. lanyard at any time. He used it at the midpoint platform on free climb. During Rigger 2's free climb, anchors and retractables were bucketed up to him. Rigger 2</p>	RC1a RC1b RC2

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	<p>hole when Rigger 1 came through hatch. Rigger 2 and Rigger 1 both walked the catwalk.</p> <p>While on the catwalk, Rigger 1 identified that portions of the top guardrail needed to be removed, crane rail stops needed to be cut, and the end bridge stop needed one bolt left installed. They did not identify the need for gear box removal. Rigger 1 and 2 came down for lunch around 11:00.</p>	<p>assessed catwalk safety on first climb.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent thought the midpoint platform had a safety chain, which it did, but it wasn't long enough to attach to anything.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent saw lanyards with the riggers' harnesses at 336.</p> <p>The RM had not approved either the IWCP or the JHA when this work started.</p>	
<p>06-30-09 Tuesday 10:57 AM</p>	<p>The Structural Engineer sent the 336 PSR an email saying that ladder evaluation was complete and attached a structural analysis that identified suitable anchorage areas. The 336 PSR did not review the attachment.</p>	<p>This evaluation did not include an assessment of the catwalk. Neither PSR reviewed the detailed engineering evaluation. Anchor tie-off points were determined based on discussion from previous day.</p>	<p>RC1a RC1b RC2</p>
<p>06-30-09 Tuesday ~11:00 AM</p>	<p>IWCP and JHA approved and signed by RM 1 (IWCP/JHA). Approximately 15 minutes after RM's approval, the 336 Work Control Planner gave IWCP to the 336 Work Supervisor/300 Area D4 Superintendent, as the 336 Work Control Planner knew that he wanted to work it right away.</p> <p>Rigger 1 and 2 came down for lunch after a visual examination of the work site. At this point they made the decision to leave one bolt in each of the rail end stops.</p>	<p>At the time of IWCP approval, scope did not include gear box oil removal, gear box removal, cutting the guardrail, releasing the bridge brakes, addition of two crane stops, fall protection requirements on catwalk, chaining the trolley, leaving two bolts on bridge rail stops, cutting the crane pendant, clamping each side of trolley, and moving the crane. Based on interviews, the Work Supervisor and work crew did not recognize the above as new scope that needed a work package change. The Work Supervisor assumed that the work package was written in such a manner as to allow him the leeway to treat this type of new work as "skill of the craft," thereby not requiring any formal revisions.</p> <p>The IWCP contained a FPP in the form of a checklist. The checklist did not identify anchor or tie-off points; that was the responsibility of the PSRs. The checklist did not include a discussion of the "team up, team down" approach, hatch, safe distance from open hole, catwalk tie-offs, or guardrail cutting fall protection controls.</p> <p>The D4 Closure Director believed the IWCP was detailed, but the JHA could have been better. It was too focused on the ladder and not on the hatch. He knew the "team up, team down" concept was being used to control the hatch opening hazards. In hindsight, he thinks they should have tied off on the catwalk.</p> <p>According to the D4 Closure Director, supervisors are responsible for running work packages; workers typically do not review work packages, but rely on pre-ev to convey work and hazard. Supervisors have multiple jobs; WCH relies on supervisors to inform workers at pre-evs, and are not expected to be at each work site all the time.</p> <p>It is a common practice for RMs to approve IWCP/JHA, even though several planning pre-requisites are still incomplete. It is the work supervisor's task to complete the pre-requisites before work begins. However, even in this case the work was started with not all of the pre-requisites being met. Specifically, a hazardous material checklist and a sheet containing "ready for demolition" approvals from environmental, waste operations, radiological, industrial hygiene, and the RM.</p> <p>The 336 Work Control Planner stated that the guardrail cutting and drum securing were beyond JHA and IWCP, but that guardrail cutting was the only significant issue that should have been re-planned for hazard evaluation and controls.</p>	<p>RC1a RC1b RC2</p>
<p>06-30-09 Tuesday 11:30 AM</p>	<p>After lunch Rigger 1 was the "ground guy" and did not go up on the catwalk on Tuesday afternoon. Rigger 2 ascended to the catwalk and drilled holes in the south exterior wall with a cordless drill and punched the holes with a screwdriver. He cut the wire rope, ran wire rope outside through the hole, and cut pendant. Using the Sawzall®</p>	<p>Rigger 2 believed the lighting was adequate for the work.</p> <p>Rigger 3 saw the whole job as "access crane, get set up, and determine how to cut wire rope and stops." Rigger 3 knew that the millwrights would be required for removing gear boxes the next day.</p>	

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	<p>(which used several blades), he cut the west e-stop and left it on the catwalk. He then lowered his tools and descended down the ladder. All these tasks were discussed at the pre-ev.</p> <p>Tube-block clamps were applied to the trolley to prevent lateral movement.</p>	<p>However, Rigger 3 loosened some gear box bolts that afternoon.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent specified the order as right stop (west stop) first, then the left (east stop).</p> <p>The 336 PSR did not observe Tuesday afternoon's work.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent said cable was cut on Tuesday by 1:00 PM. Riggers inspected stops, brakes, cut cable, cut pendent, and ran cable through hole.</p>	
<p>06-30-09 Tuesday 1:00 PM</p>	<p>Midday POD preparation meeting: the 336 Building work completed was not discussed with FPOC.</p>	<p>The 336 Work Supervisor/300 Area D4 Superintendent did not disclose to the FPOC that work had begun on the 336 crane removal.</p>	<p>RC1a</p>
<p>06-30-09 Tuesday 2:30 PM</p>	<p>Riggers completed job for the day and descended the ladder.</p>		
<p>06-30-09 Tuesday 3:15 PM</p>	<p>Post-job discussion between Rigger 1, Rigger 2, and the 336 Work Supervisor/300 Area D4 Superintendent about work performed that day and work to be performed next day. Rigger 3 also followed up with the 336 Work Supervisor/300 Area D4 Superintendent on the same topic.</p> <ul style="list-style-type: none"> • Crane brakes. • The need for millwrights the next day. • Guardrail needed to be cut and removed to eliminate interferences between the guardrail and the crane trolley. 	<p>The need for guardrail cutting was first identified by the riggers at this post-job discussion.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent completed the work status log, but did not account for the fact that they had completed the crane cable cutting, cutting the hole in the wall, pulling the cable through the hole, the application of the tube clamps, or the guardrail clearance issues.</p>	<p>RC1a</p>
<p>07-01-09 Wednesday 5:50 AM</p>	<p>Supervisor POD.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent attended POD and noted that he needed millwrights to release brakes on 336 crane. Millwrights 1 and 2 were assigned to his team.</p> <p>336 POD work release still not signed off by FPOC; 336 prior work completed or planned for the day was not clearly discussed with FPOC.</p>	<p>The D4 Closure Director returned to work from travel.</p>	<p>RC1a</p>
<p>07-01-09 Wednesday AM</p>	<p>The 336 PSR was given WCH fall protection training by the 324/327 PSR.</p>	<p>The training had some hands-on and video, and never expires (no re-training required).</p>	<p>RC2</p>
<p>07-01-09 Wednesday 6:15 AM</p>	<p>The 336 Work Supervisor/300 Area D4 Superintendent asked the Planned 336 Work Supervisor if he wanted to supervise 336 work. The Planned 336 Work Supervisor said he was still too busy to take on additional load. The 336 Work Supervisor/300 Area D4 Superintendent said he would directly supervise 336 work again.</p>		<p>Rc1b</p>
<p>07-01-09 Wednesday 7:00 – 7:30 AM</p>	<p>336 Building pre-ev was led by the 336 Work Supervisor/300 Area D4 Superintendent and attended by all three riggers and two millwrights. No PSR attended pre-ev.</p> <p>The following points were discussed in the pre-ev:</p> <ul style="list-style-type: none"> • Brake release • Unbolt bridge rail stop leaving one bolt on each side • Reinforced "team up, team down" approach • Complete e-stop removal • Cutting guardrail 3-4 feet to provide trolley clearance by last man out • The 336 Work Supervisor/300 Area D4 Superintendent directed the rigger that was cutting the guardrail to tie off on railing one rail back beyond cut guardrails. The 336 Work Supervisor/300 Area D4 Superintendent thought 6-ft. lanyards would be used to tie off on top guardrail one rail back. 	<p>The 336 Work Supervisor/300 Area D4 Superintendent was using a hard copy IWCP binder with final approved work package.</p> <p>This pre-ev was the first time the two millwrights were involved with the task of preparing the bridge crane for removal.</p> <p>Millwright 2 said the pre-ev by the 336 Work Supervisor/300 Area D4 Superintendent was good. The 336 Work Supervisor/300 Area D4 Superintendent mentioned that they needed to get in before the heat got bad. Millwright 2 needed to disengage brakes and pull them off after the riggers went up. Millwright 2 had no role in JHA; the pre-ev was his first involvement in the job. The normal practice is to read only the job-specific tasks in the JHA. Millwright 2 claimed guardrail cutting was not covered in pre-ev.</p> <p>Riggers and millwrights stated they did not remember additional fall protection discussion in pre-ev regarding catwalk (i.e., no discussion of lanyards).</p>	<p>RC1a RC1b RC2</p>

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	<p>The following was not covered in the pre-ev:</p> <ul style="list-style-type: none"> • Gear box removal • Gear box oil removal • Securing the trolley <p>The 336 Work Supervisor/300 Area D4 Superintendent emphasized keeping focus due to the upcoming four-day holiday weekend and the heat. The crane was going to be pulled out the following Monday. Once the trolley was secured and guardrails cut, they would be done for the day. The 336 Work Supervisor/300 Area D4 Superintendent expected work would be done by lunch, and knew millwrights were due out at 100N at 1:00.</p>	<p>Guardrail cutting was supposed to be the last thing done. The riggers had no lanyards with them; the lanyards were in the truck. Again, no discussion of lanyards at pre-ev.</p> <p>Rigger 2 was concerned that the work started without all the necessary equipment present (i.e., cable and clamps).</p> <p>Millwright 1 recalled that fall protection was supposed to be used for climbing the ladder and guardrail cutting was supposed to be the last thing. He does not recall the discussion of chaining trolley. The basic scope for the millwrights was the wheel brake removal. Millwright 1 recalled being told that no fall protection was required on catwalk. His understanding was that the guardrails were to be tied off and cut, and then last man down.</p> <p>Rigger 3 had no recollection of fall protection being talked about in pre-ev and had no extra lanyards to use when he cut the guardrail. With regard to fall protection while cutting the guardrail, he knew that he needed to stay away from the cut. Sequence for the guardrail cut was "away from the hazard and skill of the craft and no lanyard was needed." Rigger 3 believed there was no need for lanyards on the catwalk.</p> <p>With regard to the ladder, Rigger 3 estimated top retractable anchor was 10 feet above the catwalk and that this was safe. Rigger 3 had received one-time training on fall protection, and had been an iron worker for 16 years. He wears fall protection about once a month.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent thought riggers checked out lanyards on the day before, but riggers sometimes have their own.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent stated that the 336 Work Control Planner, 336 PSR, and the entire work crew knew the hatch was there. This type of hatch is common at Hanford. Most hatches in the 300 Area have safety chains or cages. "Hole watches" have also been widely used at Hanford when there is no chain.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent identified tie-off points using the guardrail; however, according to the 324/327 PSR, only PSRs can identify fall protection anchor points per WCH procedures.</p> <p>Millwrights did not know about the need to remove gear boxes until they were up on the catwalk that day.</p> <p>Each craft has its own lead; riggers team was led by Rigger 1 and millwright team was led by Millwright 1.</p> <p>According to the 336 Work Supervisor/300 Area D4 Superintendent, his "team up, team down" approach meant that all workers would ascend the ladder one after the other, close the hatch, all would stay up until all work was completed, and then all descend the ladder one after the other. In other words, the 336 Work Supervisor/300 Area D4 Superintendent expected all four to be on catwalk when the guardrails were cut, and all four would descend together at end of guardrail cut.</p>	
<p>07-01-09 Wednesday 7:30 – 8:00 AM</p>	<p>Millwright 2 changed into his scrubs.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent and Rigger 1 discussed securing the trolley, suggesting that cables be used. No one else was present during this discussion.</p> <p>Millwrights 1 and 2 picked up their harnesses from the 324/327 PSR.</p>	<p>Rigger 1 thought the crane would have to be pulled closer to the catwalk to secure the trolley, but did not discuss with anyone; considered it skill of the craft.</p> <p>Rigger 1 recognized that securing the trolley was an addition to the work scope, but did not consider it a significant enough change to require revision of the work package.</p>	<p>RC1a DC</p>

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07-01-09 Wednesday 8:00 AM	<p>Work team arrived at 336 Building.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent watched as two riggers and then two millwrights went up the ladder. All four hooked and unhooked retractables, and the last person up closed the hatch on catwalk.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent left 336 Building to monitor other jobs as the 300 Area D4 Superintendent.</p>	<p>Work package was not released by the FPOC for work.</p> <p>Millwright 2 believed there was a "rule that two people have to stay up on catwalk."</p> <p>Rigger 3 was chosen to cut the guardrail as he was the most experienced rigger.</p> <p>No PSRs were there to provide oversight; however, the 324/327 PSR came to the door once, but did not enter due to overhead work. The 336 Work Supervisor/300 Area D4 Superintendent and both PSRs had a high degree of confidence in this work crew due to the crew's level of experience, and as a result did not think continuous coverage was warranted.</p> <p>Rigger 3 had only his harness, no lanyard. He was comfortable making the top guardrail cut without fall protection as the midrail was above his knees and still intact. Rigger 3 was not tied off when he made the two cuts through the guardrail.</p> <p>Riggers and millwrights planned to work opposite ends of the catwalk and eventually switch sides.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent noted that it is not unusual to have craft working without a supervisor present.</p> <p>Millwright 1 says that D4 gets a lot of "dark work" and that it would be nice to have better lighting.</p>	RC1b RC2
07-01-09 Wednesday ~8:30 AM	<p>The 336 Work Supervisor/300 Area D4 Superintendent returned to check on the work and was informed by the millwrights of the need to remove the gear boxes and was okay with that.</p>	<p>Millwright and rigger suggested that because gear boxes were at eye level, no fall arrest protection was needed.</p> <p>The gear box unit was estimated to weigh 45-50 pounds.</p>	RC1a RC2
07-01-09 Wednesday ~8:45 AM	<p>The riggers completed the crane rail stop removal.</p>		
07-01-09 Wednesday ~8:50 AM	<p>Rigger 1 realized he needed to go find cables to secure the trolley and told Rigger 2 he was leaving.</p> <p>Rigger 2 came down to take Rigger 1's place as the ground guy. Rigger 2 recalled someone closing the hatch behind him. Rigger 2 went to the safe room. Rigger 1 left.</p>	<p>Rigger 1 was not aware that Rigger 2 was coming down.</p> <p>This represented the first violation of the "team up, team down" concept.</p>	DC RC2
07-01-09 Wednesday ~8:52 AM	<p>Rigger 2 placed empty water bottles in the tool bucket to be used to collect the gear box oil and they were raised to the catwalk. He then began work outside of the 336 Building tying cables together.</p>		RC1a
07-01-09 Wednesday ~9:00 AM	<p>Rigger 1 took the truck to get materials to be used to secure the trolley. He went to the Conex box by 384 Building and found a chain. He determined that using a chain would be easier and acquired two chains and tensioners.</p>	<p>Teamster Conex box near 384 Building has chains, binders, straps, and related supplies. Craft noted that finding tools and materials is often difficult because "everything keeps moving."</p>	
07-01-09 Wednesday ~9:10 AM	<p>The millwrights drained the oil from gear boxes, removed the gear boxes, and lowered them to the catwalk. The water bottles containing the drained oil were lowered in buckets to the floor.</p>	<p>Approximately seven water bottles were used to collect the oil from the gear boxes. Scene preservation did not include drained oil in water bottles. One oil bottle remains at scene; location and fate of other oil bottles unknown.</p>	DC
07-01-09 Wednesday ~9:17 AM	<p>A rope was tied to the guardrail to keep it from falling while Rigger 3 cut it in two places.</p> <p>Millwright 2 proceeded down the ladder and left the hatch open thinking that Millwright 1 was going to immediately follow.</p>	<p>The 336 Work Supervisor/300 Area D4 Superintendent expected all four to be on catwalk when guardrail was cut per "team up, team down" concept.</p> <p>When Millwright 2 reached the floor, he noted that no one was descending the ladder.</p>	DC R2

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07-01-09 Wednesday ~9:18 AM	<p>Rigger 1 returned with chains and tensioners.</p> <p>The 336 Work Supervisor/300 Area D4 Superintendent visited and talked with Rigger 1 who suggested using chains to secure the trolley as they would be easier to work with. The 336 Work Supervisor/300 Area D4 Superintendent okayed the chain idea, then left.</p> <p>Rigger 1 yelled up to Rigger 3 and informed him that they needed to secure the trolley with the chains.</p> <p>Rigger 1 offered to go up to assist with chaining the trolley, but Millwright 1 suggested he stay up and help Rigger 3 with the task.</p>	<p>Rigger 2 was outside and heard Rigger 1 yell to Rigger 3 to chain the trolley.</p> <p>Millwright 1 never hooked up to the retractable or started down the ladder. The hatch had been left open when guardrail cutting (last task) had been initiated and team was supposed to descend. Distraction of securing the trolley interrupted sequence and left Rigger 3 and Millwright 1 exposed to open hatch. None of the personnel reminded Millwright 1 or Rigger 3 that the hatch was still open.</p>	<p>RC1a RC1b DC RC2</p>
07-01-09 Wednesday ~9:23 AM	<p>Rigger 1 put the chains in the bucket and sent the chains up. Rigger 1 and Millwright 2 went to safe room.</p>		
07-01-09 Wednesday ~9:27 AM	<p>Rigger 3 and Millwright 1 discussed the new scope and methods to secure the trolley with the chains and decided to try and move the bridge 1½ to 2 feet closer to them to facilitate chaining it.</p>	<p>Millwright 1 was the one who suggested rolling the crane closer to chain the drum trolley. He knew the rail was cut at this point and was concerned that Rigger 3 would have to lean over rail. The crane reach was about two feet. The Board subsequently determined that the trolley could only have been moved approximately 3½ inches before the bridge would have hit the building structure.</p>	<p>DC RC1a RC1b</p>
07-01-09 Wednesday ~9:33 AM	<p>Millwright 1 and Rigger 3 each turned and started walking toward the crane wheels to reposition the crane. Rigger 3 walked east on the catwalk, Millwright 1 walked west on the catwalk toward the open hatch. Millwright 1 fell through the open hatch, hit the guardrail on the midpoint platform, and then fell to the floor.</p> <p>Rigger 3 heard Millwright 1 scream and looked. He saw Millwright 1 hit the midpoint platform through the grate. Millwright 1 was screaming on the floor.</p> <p>From the safe room, Rigger 1 heard Millwright 1 fall.</p> <p>Millwright 2 heard something heavy falling and thought it was the chain, but it was Millwright 1. Millwright 2 and Rigger 2 were first responders to Millwright 1. Millwright 2 went outside and asked Teamster 1 to call 911. Rigger 2 also told Teamster 1 to call 911 and went back inside to assist Millwright 1. Millwright 2, Rigger 2, and Teamster 2 remained with Millwright 1.</p>	<p>Millwright 1 was distracted. He was looking at crane wheels at end of catwalk. He had his headlamp on, but did not see that the hatch was open.</p> <p>Rigger 3 last saw Millwright 1 about 12 feet from hatch at the trolley.</p> <p>After the fall, a worker recalled Millwright 1 asking who left the hatch open.</p>	<p>DC R2 RC1b</p>
07-01-09 Wednesday 9:33:58 AM	<p>Teamster 1 called 373-3800 (Hanford POC) from his cell phone for medical assistance. This phone number is the Hanford cell phone emergency number equivalent to 911.</p>	<p>POC gathered too much unnecessary information before calling HFD to dispatch emergency vehicles.</p> <p>It is unclear whether planning for job required or provided for communication (radios) to be on site while performing work in case of emergency.</p>	<p>CC2</p>
07-01-09 Wednesday 9:35 AM	<p>Rigger 3 descended the ladder and closed the hatch behind him.</p> <p>The Planned 336 Work Supervisor heard radio a shout-out from Teamster 1 for the 336 Work Supervisor/300 Area D4 Superintendent, but did not hear the 336 Work Supervisor/300 Area D4 Superintendent respond. The Planned 336 Work Supervisor got a second radio shout-out and replied to Teamster 1. The Planned 336 Work Supervisor called 373-3800 (Hanford POC) from his cell phone. The Planned 336 Work Supervisor was told that Teamster 1 was on another line with the POC. The Planned 336 Work Supervisor called the 300 Area FPOC to report the incident as the FPOC also acts as the Building Emergency Director. The Planned 336 Work Supervisor responded to 336 in approximately 30 seconds. The Planned 336 Work Supervisor contacted the 336 Work Supervisor/300 Area D4 Superintendent by cell phone.</p>	<p>Rigger 3 did not remember coming down, but said he "must have hooked up and must have closed hatch" on the way down.</p> <p>The Planned 336 Work Supervisor was not sure if the 336 Work Supervisor/300 Area D4 Superintendent had his radio; he noted that 300 Area radio coverage is spotty.</p>	<p>RC2b CC2</p>

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Date/Time	Event	Comments/Conditions	Causal Factors
	The 336 Work Supervisor/300 Area D4 Superintendent received call from the Planned 336 Work Supervisor about Millwright 1's fall.		
07-01-09 Wednesday 9:36 AM	The 336 Work Supervisor/300 Area D4 Superintendent arrived at the scene and took control. The 336 Work Supervisor/300 Area D4 Superintendent asked Millwright 1 about making a call to his wife. The 336 Work Supervisor/300 Area D4 Superintendent was able to get wife's cell phone number from Millwright 1. The 336 Work Supervisor/300 Area D4 Superintendent asked that the aerial lift be moved away from building to make room for the ambulance. Rigger 2 moved the aerial.		
07-01-09 Wednesday 9:36:03 AM	POC contacted the 200 Area HFD dispatcher.	It was over two minutes from Teamster 1 call about fall and injury before POC contacted HFD.	CC2
07-01-09 Wednesday 9:37:19 AM	HFD called 300 and 400 Area stations to respond.	HFD responded from stations 3 and 4 with a fire truck and ambulance from both stations. Station 3 units arrived and station 4 units were cancelled en route.	
07-01-09 Wednesday 9:38 AM	HFD en route to scene. The 336 Work Supervisor/300 Area D4 Superintendent contacted the 300 Area Deputy Project Manager.		
07-01-09 Wednesday 9:40 AM	Engine 93 and ambulance arrived on scene from 300 Area HFD and attended to Millwright 1. The 300 Area Deputy Project Manager contacted the D4 Closure Director and D4 Closure Deputy Director.	Millwright 1's harness was unbuckled when HFD arrived. EMTs quickly become aware of Millwright 1's injured left knee and recognized potential severity of back injury. EMTs applied neck brace and backboard, and transported to Kadlec via ambulance. It was six minutes and 19 seconds from the initial emergency call to POC and when HFD arrived at 336.	
07-01-09 Wednesday 9:41 AM	POC called ONC.	Millwright 1 believed the emergency response was slow from the time of the call to the arrival of the ambulance. Millwright 1's wife was called by the 336 Work Supervisor/300 Area D4 Superintendent; the information given was minimal in nature that Millwright 1 had a broken leg and that she needed to come to the hospital. A Radiological Control Technician overheard this conversation and called Millwright 1's wife about the seriousness of the injury and told her that someone else should drive her to the hospital. Millwright 1's wife received multiple phone calls from workers as she went to Kadlec.	CC2
07-01-09 Wednesday 9:45 AM	Once the EMTs arrived, Millwright 2, Rigger 1, Rigger 2, and Rigger 3 were segregated by the 336 Work Supervisor/300 Area D4 Superintendent. The 336 Work Supervisor/300 Area D4 Superintendent asked the four workers to go back to his trailer and write statements. 336 was secured by the 336 Work Supervisor/300 Area D4 Superintendent and placed in limited access status.		
07-01-09 Wednesday 9:50 AM	The 300 Area FPOC contacted the WCH SPOC. The RL FR Team Lead was notified by the WCH D4 Director. The SPOC notified the WCH Event Classifier. At this point all that was known was that there was a fall involving a knee injury and an ambulance run to the hospital; no details were available on fall height or extent of Millwright 1's injuries.		
07-01-09 Wednesday 9:52 AM	EMTs departed 336 Building with injured millwright.	The 336 PSR followed the ambulance to Kadlec Medical Center and stayed with Millwright 1's family.	
07-01-09 Wednesday 10:07 AM	WCH SPOC notified ONC and a determination was made by ONC that this was not an "Abnormal Event" due to lack of information on seriousness of injury.		

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Date/Time	Event	Comments/Conditions	Causal Factors
07-01-09 Wednesday 10:09 AM	EMTs arrived at Kadlec Medical Center.		
07-01-09 Wednesday 10:20 AM	The RL Assistant Manager for Safety and Environment, Operations Oversight Division Director, and FR Team Lead arrived on scene.		
07-01-09 Wednesday 10:30 AM	The D4 Closure Director initiated request for fact finding. The D4 Closure Deputy Director requested a 100N Planner to chair fact finding at 3760 Building.	The regular 300 Area Fact Finding Chair was unavailable. The 100N Area Fact Finding Chair is a trained and experienced fact finding chair and has been at Hanford 33 years. The D4 Closure Director knew it was a 50-ft. fall and a serious injury. He should have initiated a critique rather than a fact finding based on SEM 3-2.2.	CC1
07-01-09 Wednesday 11:30 AM	WCH determined Event Discovery time based upon a telephone call from a HAMTC representative at the hospital that Millwright 1 had a broken bone.	A HAMTC representative present at the hospital notified the D4 Closure Director and the 300 Area Deputy Project Manager, and confirmed that Millwright 1 had sustained broken bones.	
07-01-09 Wednesday 12:00 PM	WCH fact finding meeting convened at 3760 Building. WCH initiated a corporate (URS-led) Accident Investigation Team. All WCH work was suspended.	Fact finding completed at approximately 1:30 PM. The SPOC and the Event Classifier were present and each took notes for the Fact Finding Chair. The SPOC was the author of the SEM 3-2.2 and was also the instructor for the fact finding and critique training. Both the Event Classifier and SPOC should have recognized the need for conducting a critique instead of a fact finding based on the procedure. At this point most WCH management was aware that Millwright 1 had fallen 50 feet and broken one or more bones. Fact finding should have been transitioned into a more detailed critique, as they already had made the decision to initiate both a corporate (URS) and WCH Accident Investigation Team.	CC1
07-01-09 Wednesday 1:30 PM	Event categorized as 2A(6) SC-3 by the Event Classifier in consultation with the D4 Closure Director based on broken bone.		
07-01-09 Wednesday 2:00 PM	The Event Classifier began to initiate a WCH Accident Investigation Team per SEM 3-2.2.	The WCH Accident Investigation Team is planned to become the causal analysis team following issuance of the Type B and URS-led corporate reports.	
07-01-09 Wednesday 3:36 PM	The Event Classifier made initial notification to ONC of 2A(6) SC-3 categorization.		
07-01-09 Wednesday 4:30 PM	The Deputy RCCC PM was notified by RL Assistant Manager for River Corridor that DOE planned to conduct a Type B accident investigation. WCH suspended internal Accident Investigation Team planning.		
07-01-09 Wednesday 4:50 PM	Event recategorized by the Event Classifier as 10(1) SC-2 based on telephone call from RL.		
07-01-09 Wednesday 5:15 PM	RL FR Team Lead was notified of SC-2 change.		
07-01-09 Wednesday 5:48 PM	ONC notification of WCH recategorization to SC-2 was made by the Event Classifier.		
07-02-09 Thursday	WCH day off. RL appointed Type B Accident Investigation Board. The 336 Work Supervisor/300 Area D4 Superintendent came in and typed his event statement.		

TYPE B ACCIDENT INVESTIGATION
WCH Employee Fall Injury on July 1, 2009

DOE/RL-2009-83

Date/Time	Event	Comments/Conditions	Causal Factors
	<p>The Fact Finding Chair met with the 336 Work Supervisor/300 Area D4 Superintendent and other managers and updated Fact Finding Report based on the 336 Work Supervisor/300 Area D4 Superintendent's typed statement.</p> <p>The Fact Finding Chair and the 336 Work Supervisor/300 Area D4 Superintendent briefed WCH senior management on draft Fact Finding Report.</p>		
07-03-09 Friday	Federal holiday. WCH sent information packet of event to other Hanford contractors.		
07-04-09 Saturday	Independence Day holiday.		
07-06-09 Monday 9:00 AM	<p>DOE Type B Accident Investigation Board convenes.</p> <p>WCH completes Issue Form.</p> <p>Fact Finding Report completed and signed by the Fact Finding Chair, D4 Closure Director, and D4 Closure Deputy Director.</p>	<p>The Event Classifier indicated fact finding meeting was conducted to the same level of detail as a critique meeting. Generally, in each case the work planning timeline is not well defined; that level of detail is usually left for the causal analysis.</p> <p>The Fact Finding Report's section on causal factors was not intended to reflect a causal analysis; it was merely to identify potential contributing conditions to the event.</p>	CC1
07-06-09 Monday 9:30 AM	The DOE Type B Accident Investigation Board met with RL Manager to discuss expectations and logistics.		
07-06-09 Monday 2:00 PM	WCH management provided a briefing to the DOE Type B Accident Investigation Board and the URS-led Accident Investigation Team.		
07-06-09 Monday 3:00 – 5:00 PM	The DOE Type B Accident Investigation Board received an initial tour of 336 Building.		
07-06-09 Monday 4:40 PM	WCH (Event Classifier) submitted ORPS report, EM-RL-WCH-DND-2009-005.		
07-15-09 Wednesday	Millwright 1 was released from the hospital.		

<p>Key: DC = direct cause RC = root cause CC = contributing cause</p>

Appendix E: Human Performance Improvement Analysis

Table E-1. Human Performance Improvement – Error Precursors Summary

Task Demands		Individual Capabilities	
✓	Time pressure (in a hurry)	✓	Unfamiliarity with task/first time
✓	High workload (memory requirements)	✓	Lack of knowledge (mental model)
✓	Simultaneous, multiple tasks		New technique not used before
	Repetitive actions, monotonous	✓	Imprecise communication habits
	Irrecoverable acts		Lack of proficiency/inexperience
✓	Interpretation requirement		Indistinct problem-solving skills
✓	Unclear goals, roles, and responsibilities	✓	"Hazardous" attitude for critical task
✓	Lack of or unclear standards		Illness/fatigue
Work Environment		Human Nature	
✓	Distractions/interruptions		Stress (limits attention)
✓	Changes/departure from routine	✓	Habit patterns
	Confusing displays or controls	✓	Assumptions (inaccurate mental picture)
✓	Work-arounds/out-of-service instruments	✓	Complacency/overconfident
	Hidden system response	✓	Mindset ("tuned" to see)
✓	Unexpected equipment conditions	✓	Inaccurate risk perception (Pollyanna)
	Lack of alternative indication		Mental shortcuts (biases)
	Personality conflicts		Limited short-term memory

Table E-2. Human Performance Improvement – Task Demands

Task Demands	
✓	<p>Time pressure (in a hurry)</p> <ul style="list-style-type: none"> • 336 Work Supervisor was anxious to complete crane removal task and turn over to new D4 workers. • 300 Area D4 Superintendent pushes his planners and work supervisors hard. • Planner was under significant pressure to complete the approved IWCP and JHA. • Work began before the IWCP was approved and released by FPOC. • 300 Area D4 projects are schedule driven and tied directly to contract fee. • PSRs did not allow adequate time to locate the pre-existing engineered ladder safety devices in the possession of PNNL.
✓	<p>High workload (memory requirements)</p> <ul style="list-style-type: none"> • Recognized high turnover of planners, supervisors, safety reps, and D4 workers. • Only two PSRs covering entire 300 Area; for the two weeks prior to event only one PSR was available to cover 300 Area. • Originally assigned Work Supervisor expressed that he was already overloaded and declined to perform first-line supervision of the 336 job. • 300 Area D4 Superintendent was providing oversight of multiple work sites and performing first-line supervision of the 336 job.
✓	<p>Simultaneous, multiple tasks</p> <ul style="list-style-type: none"> • Safety reps covering multiple work sites and other duties (e.g., training, JHA support). • 300 Area D4 Superintendent was providing oversight of multiple work sites and performing first-line supervision of the 336 job. • Work supervisors covering multiple jobs of varying complexities.
✓	<p>Interpretation requirement</p> <ul style="list-style-type: none"> • Misinterpretation of fall protection requirements regarding free climbing, anchorage locations, lanyard use, open hatch, and "team up, team down" concept. • Misinterpretation of what would require a work package change with regard to new scope, and specifically skill of the craft activities and related hazards and controls. • 300 Area D4 Superintendent thought that the scope of work in the IWCP for task 5.1.2 was adequately defined as written, and therefore had the discretion to add what he considered to be skill of the craft work scope within that task.
✓	<p>Unclear goals, roles, and responsibilities</p> <ul style="list-style-type: none"> • Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
✓	<p>Lack of or unclear standards</p> <ul style="list-style-type: none"> • "This is the way D4 is done." • Work release is not consistent between the IWCP procedure and the 300 Area D4 work release procedure. • Over reliance on skill of the craft to accomplish the work in lieu of work planning and control. • Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.

Table E-3. Human Performance Improvement – Individual Capabilities

Individual Capabilities	
✓	<p>Unfamiliarity with task/first time</p> <ul style="list-style-type: none"> • First time that this type of crane removal has been attempted by this work crew and 300 Area management team; however, their prior experience in both demolishing buildings and removing overhead cranes gave them an inaccurate understanding of the tasks that needed to be performed.
✓	<p>Lack of knowledge (mental model)</p> <ul style="list-style-type: none"> • 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope. • Planner had inadequate information to develop the detailed work scope necessary to perform the work safely. As a result of a failure to utilize appropriate SMEs and in particular to access the catwalk, the Planner lacked the understanding of the work and hazards involved in removing the bridge crane. • Planners and PSRs were unfamiliar with WCH's facility transition process and organization in order to access information regarding the availability of the engineered ladder safety devices at PNNL.
✓	<p>Imprecise communication habits</p> <ul style="list-style-type: none"> • Pre-ev failed to communicate complete work scope for desired tasks. The Board's interviews with the six principal workers for the 336 task identified clear discrepancies among the understanding of what was discussed regarding scope of work and sequence of tasks, equipment expectations, and use of safety equipment. • "Team up, team down" hatch control concept was either not well communicated or not well understood by the work crew. • "Secure the trolley" was an imprecise work direction and was only discussed between the Work Supervisor and the lead rigger. • Use of workers yelling from the floor up to 50-ft. catwalk concerning work tasks, tool needs, and personnel movements.
✓	<p>"Hazardous" attitude for critical task</p> <ul style="list-style-type: none"> • Overall project and work force have a high tolerance to risk. • Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control. • Despite broad knowledge of stop work authority/policy, workers are hesitant to exercise a "work pause" due to cultural and organizational pressures related to accomplishing the project mission. Workers perceive that pausing work will result in negative consequences – including being stigmatized as a non-team player. • The recognized shortage of work supervisors and safety rep resources, the pace of work, and the inadequacies of work planning have been normalized by management and the 300 Area work force. • The 336 Work Supervisor/300 Area D4 Superintendent and WCH management assume that craft workers do not need to be continuously supervised or overseen by PSRs during the performance of hazardous tasks. • Rigger 3 assumed it was okay to cut the guardrail while not being tied off. • PSRs and Work Supervisor approval of free climb, and Rigger 2's preference for this type of ascent.

Table E-4. Human Performance Improvement – Work Environment

Work Environment	
✓	<p>Distractions/interruptions</p> <ul style="list-style-type: none"> Multiple distractions, including collection of containers for gear box oil, retrieval of cable/chain for securing trolley, and the perception that work was complete when the guardrail was being cut, caused workers to leave the catwalk and violate the "team up, team down" hatch concept, resulting in the hatch being left open. The unplanned activities to secure the trolley and move the crane closer to the catwalk interrupted Rigger 3 and Millwright 1 from completing the work sequence that they had been performing (cutting the guardrail last). Additional work scope to secure the trolley required the workers to devise a method to safely attach the chain to the trolley. The meeting between the rigger and millwright concluded with the decision to move the crane closer to the catwalk. This distraction caused Millwright 1 to focus on the crane wheels as he walked toward the open hatch on his way to the end of the catwalk to move the crane.
✓	<p>Changes/departure from routine</p> <ul style="list-style-type: none"> Prior 300 Area demolitions of facilities with overhead cranes were done without prepping cranes for removal using heavy equipment from the outside. No prior pre-demolition crane removal projects were performed using manual hands-on methods to disassemble the crane drive system.
✓	<p>Work-arounds/out-of-service instruments</p> <ul style="list-style-type: none"> Failure to locate the pre-existing engineered ladder safety device resulted in the decision to initially free climb and utilize retractable lanyards, which further exacerbated the risks associated with the operation of the hatch. Water bottles were used for gear box oil collection in lieu of proper waste containers.
✓	<p>Unexpected equipment conditions</p> <ul style="list-style-type: none"> Trolley location relative to the guardrail, actions necessary to allow the crane to free wheel (gear boxes and oil), and extra crane bridge stops were all unexpected conditions that were identified after work began. The need to secure the trolley to the crane bridge. Retractable lanyards interfered with the ability to close the hatch. No guard chain around the hatch. The chain located at the ladder entryway to the midpoint platform was too short to perform its intended function.

Table E-5. Human Performance Improvement – Human Nature

Human Nature	
✓	<p>Habit patterns</p> <ul style="list-style-type: none"> • Over reliance on skill of the craft to accomplish the work in lieu of work planning and control. • Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.
✓	<p>Assumptions (inaccurate mental picture)</p> <ul style="list-style-type: none"> • Planner assumed that hatch had a safety chain. • Lighting was adequate to perform work tasks. • Millwright 2 assumed that Millwright 1 was following right behind him when he descended the ladder. • Millwright 1 assumed he had an adequate walkway. • The 336 Work Supervisor/300 Area D4 Superintendent and WCH management assume that craft workers do not need to be continuously supervised or overseen by PSRs during the performance of hazardous tasks. • Rigger 3 assumed it was okay to cut the guardrail while not being tied off. • It was assumed that the “team up, team down” concept was adequate for fall protection. • PSRs assumed that the six-foot policy was adequate protection from the open hatch.
✓	<p>Complacency/overconfident</p> <ul style="list-style-type: none"> • Over reliance on skill of the craft to accomplish the work in lieu of work planning and control. • Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA. • The walk down was not rigorous enough to identify the full scope of the work and associated hazards. • “That’s the way D4 work is done.” • Confidence of Rigger 2 to perform free climb without appropriate fall protection.
✓	<p>Mindset (“tuned” to see)</p> <ul style="list-style-type: none"> • Millwright 1’s mindset after the discussion with Rigger 3 about moving the crane caused Millwright 1 to focus on proceeding to the end of the catwalk to initiate the task to move the crane. • The 336 Work Supervisor/300 Area D4 Superintendent’s mindset was to get the crane removal task done in order to utilize new D4 workers.
✓	<p>Inaccurate risk perception (Pollyanna)</p> <ul style="list-style-type: none"> • PSRs did not adequately execute their safety oversight responsibilities in protecting the workers on the ladder and the catwalk. • Free climb by Rigger 2 was perceived as safer than using fall protection. • Rigger 3 cutting the guardrail without fall protection was perceived as safe. • Standing back from the open hatch was perceived as adequate fall protection. • The 336 Work Supervisor/300 Area D4 Superintendent accepted that a work team did not need continuous supervision or oversight during the execution of higher risk work even though he believed that this work was higher risk due to the elevated catwalk. • The 336 Work Supervisor/300 Area D4 Superintendent considered the “team up, team down” concept to be adequate to control the hatch hazard. • Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control. • The risk associated with the high pace of work appears to be unchanged notwithstanding: 1) the recognized understaffing of supervisors, safety, and planners; 2) spreading the current experienced and new supervisory and safety personnel too thin; and 3) additional supervision and training needed for the replacement of those workers.

Appendix F: Detailed Summary of Causal Factors

Table F-1. Detailed Summary of Causal Factors

Direct Cause: The injured millwright fell through the open catwalk hatch due to multiple distractions and interruptions while workers were performing an unplanned and unanalyzed task.

- Multiple distractions, including collection of containers for gear box oil, retrieval of cable/chain for securing trolley, and the perception that work was complete when the guardrail was being cut, caused workers to leave the catwalk and violate the “team up, team down” hatch concept, resulting in the hatch being left open.
 - The unplanned activities to secure the trolley and move the crane closer to the catwalk interrupted Rigger 3 and Millwright 1 from completing the work sequence that they had been performing (cutting the guardrail last).
 - The trolley’s location relative to the guardrail, actions necessary to allow the crane to free wheel (gear boxes and oil), and extra crane bridge stops were all unexpected conditions that were identified after work began.
 - Workers failed to follow supervisory instructions for accessing and exiting the catwalk (“team up, team down” and then close hatch) when Rigger 2 descended to retrieve water bottles to use for gear oil removal.
- None of the workers stopped/paused work when activities went beyond defined scope.
- Millwright 2 assumed that Millwright 1 was following right behind him when he descended the ladder, and did not request others to close the hatch.
 - Workers (Millwright 2/Rigger 1) did not communicate to Millwright 1/Rigger 3 that the hatch was left open.
- Millwright 1’s mindset after the discussion with Rigger 3 about moving the crane caused Millwright 1 to focus on proceeding to the end of the catwalk to initiate the task of moving the crane.
 - The meeting between Rigger 3 and Millwright 1 to discuss the additional work scope and devise a method to safely attach the change to secure the trolley concluded with the decision to move the crane closer to the catwalk. This distraction caused Millwright 1 to mentally focus on the crane wheels as he walked toward the open hatch on his way to the end of the catwalk to move the crane. The headlamps may have also visually focused Millwright 1’s attention on the end of the catwalk.
- Millwright 1 assumed he had an adequate walkway.
 - No guard chain or other physical barriers around the hatch.
 - Millwright 1 fell through open hatch.

Root Causes: The recognized shortage of work supervisor and PSR resources, the pace of work, and the inadequacies of work planning have been normalized by contractor management and the 300 Area work force

Root Cause 1A: Implementation of the contractor’s work control process was not adequate to sufficiently identify the work scope, hazards, and associated controls to safely perform the bridge crane removal from 336 Building.

- The integrated work control procedure was not consistently applied throughout the D4 project.
 - Less than adequate compliance with IWCP procedure.
 - IWCP not released by FPOC prior to performance of work.
 - Several pre-requisites were not completed prior to work performance.
 - Workers did not review work instructions, but relied on pre-ev communication and direction.
 - Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
 - “This is the way D4 is done.”
 - Overall project and workforce have a high tolerance to risk.
 - Misinterpretation of what would require a work package change with regard to new scope, and specifically skill of the craft activities and related hazards and controls.
- Work scope, hazards, and related controls were not adequately defined.
 - Risk ranking w/o detailed work scope.
 - First JHA (June 15) did not include detailed work steps.
 - Final IWCP steps lacked sufficient detail.

- Incomplete job walk down (did not access the catwalk) resulted in a less than adequate scope definition.
- Millwrights/crane SMEs not included in June 25 JHA and not all attendees signed final JHA.
- 300 Area Project Engineer not involved in JHAs or walk downs, but signed JHA and IWCP.
- No structural evaluation of catwalk.
- JHA did not capture hazard associated with hatch and catwalk.
- Less than adequate fall protection plan/requirements.
- Lighting was assumed to be adequate to perform work tasks, yet actual light (0.14 foot candles) is non-compliant with OSHA regulations.
- Use of the retractable lanyards inhibited ease of the use of the hatch.
- Supplemental lighting provided at ground level did not provide adequate lighting on catwalk.
- Weight of hatch and the methods for opening were not adequately evaluated.
- Work began before the IWCP was approved and released by FPOC.
- Planner had inadequate information to develop the detailed work scope necessary to perform the work safely. As a result of a failure to utilize appropriate SMEs and in particular to access the catwalk, the Planner lacked the understanding of the work and hazards involved in removing the bridge crane.
- Use of "yelling" from floor up to 50-ft. catwalk on work tasks, tool needs, and personnel movements.
- Over reliance on skill of the craft allows higher risk work to accomplish the work without adequate work planning, hazard identification, and control.
- Failure to locate the engineered ladder safety device resulted in the decision to initially free climb and utilize retractable lanyards, which further exacerbated the risks associated with the operation of the hatch.
- Water bottles were used for oil collection in lieu of proper waste containers.
- Trolley location relative to the guardrail, actions necessary to allow the crane to free wheel (gear boxes and oil), and extra crane bridge stops were all unexpected conditions that were identified after work began.
- The need to secure the trolley to the crane bridge.
- No guard chain or other physical barriers around the hatch.
- The chain located at the ladder entryway to the midpoint platform was too short to perform its intended function.
- Planner assumed that hatch had a safety chain.
- The walk downs were not rigorous enough to identify the full scope of the work and associated hazards.
- Over reliance on skill of the craft allowed higher risk work to be accomplished without adequate work planning, hazard identification, and control.
- FR recommendations for additional "What ifs" were rejected.
- Coordination and communication affecting work planning and execution was less than adequate.
 - RM who signed IWCP not involved in any of the planning. 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope.
 - Planners and PSRs were unfamiliar with WCH's facility transition process and organization in order to access information regarding the availability of the engineered ladder safety devices; transition team not utilized to obtain appropriate engineered ladder devices.
 - Use of workers yelling from floor up to 50-ft. catwalk concerning work tasks, tool needs, and personnel movements.
 - Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
 - One of the 300 Area project engineers had identified in May 2009 that high reach approach was not appropriate for 336 Building bridge crane removal but did not communicate his findings to the work planners or PSRs.
 - The 336 HazMat Removal Supervisor and the Planned 336 Work Supervisor failed to document in the Hazard Waste Material Removal Closure Package or communicate to the 336 Work Control Planner that oil was left in the crane gear box upon completion of hazard waste removal project scope.
- Work scope changes were not adequately managed to assess additional hazards and controls.
 - Risk ranking not modified for scope changes.
 - Over reliance on skill of the craft to accomplish the work in lieu of work planning and control.
 - First time that this type of crane removal has been attempted by this work crew and 300 Area management team; however, their prior experience in both demolishing buildings and removing overhead cranes gave them an inaccurate understanding of the task that needed to be performed.
 - Prior 300 Area demolitions of facilities with overhead cranes were done without prepping cranes for removal using heavy equipment from the outside. No prior pre-demolition crane removal projects were performed using manual hands-on methods to disassemble the crane drive system.
 - Work steps were verbally added to scope of work w/o changing IWCP or JHA.
- Perceived schedule pressure was a significant contributor in failing to adequately plan the work.
 - Planner/PSR IWCP approvals prior to completion (second JHA on June 25).
 - PSRs did not allow adequate time to locate the pre-existing engineered ladder safety devices.

- Work began before the IWCP was approved and released by FPOC.
- Pre-requisites were not completed prior to work performance.
- The 336 Work Supervisor/300 Area D4 Superintendent needed to put new D4 worker crew on assignments in lower risk buildings.

Root Cause 1B: The contractor's supervisory and safety oversight methods and resources were inadequate to support safe execution of the 336 Building bridge crane removal activities.

- Normalized risk of scheduled work with known understaffing of key resources.
 - Recognized high turnover of planners, supervisors, safety reps, and D4 workers.
 - Only two PSRs covering entire 300 Area; for the two weeks prior to event only one PSR was available to cover 300 Area.
 - Originally assigned Work Supervisor expressed that he was already overloaded and declined to perform first-line supervision of the 336 job.
 - 300 Area D4 Superintendent was providing oversight of multiple work sites and performing first-line supervision of the 336 job.
 - PSRs covering multiple work sites and other duties (e.g., training, JHA support).
 - Overall project and workforce have a high tolerance to risk.
 - The risk associated with the high pace of work appears to be unchanged notwithstanding: 1) the recognized understaffing of supervisors, safety, and planners; 2) spreading the current experienced and new supervisory and safety personnel too thin; and 3) additional supervision and training needed for the replacement of those workers.
- Multiple assignments did not allow sufficient resources to be consistently available to provide oversight for the level of work being performed.
 - Engineering analysis not reviewed by PSRs prior to free climb; analysis provided anchorage areas for retractable lanyards.
 - Decision for 300 Area D4 Superintendent to directly supervise the 336 work.
 - Work Supervisor identified inappropriate tie-off points for riggers on catwalk railing cuts.
 - PSRs were not present at July 1 pre-ev.
 - PSRs did not observe any of the work on July 1.
 - Work Supervisor and PSR did not provide continuous oversight of perceived higher risk work.
 - The 336 PSR was trained on WCH fall protection on the morning of July 1.
 - Work supervisors covering multiple jobs of varying complexities.
- Key supervisory and safety personnel did not execute their roles and responsibilities consistent with their authority and accountability.
 - PSRs and Supervisor allowed free climb.
 - Rigger 2 was allowed to tie off to the midpoint platform (PSR and Supervisor authorized).
 - Training records for work crew were not adequately evaluated prior to work performance.
 - No one stopped work when out of IWCP/JHA scope.
 - Misinterpretation of what would require a work package change with regard to new scope, and specifically skill of the craft activities and related hazards and controls.
 - 300 Area D4 Superintendent thought that the scope of work in the IWCP for task 5.1.2 was adequately defined as written, and therefore had the discretion to add what he considered to be skill of the craft work scope within that task.
 - Individuals signed off the IWCP and JHA without adequate review and understanding of work scope, hazards, and controls.
 - Over reliance on skill of the craft to accomplish the work in lieu of work planning and control.
 - Over reliance on informal pre-evs by work supervisors to adequately convey the detailed work scope, hazards, and controls as identified in the IWCP and JHA.
 - 300 Area RMs are used interchangeably to approve IWCPs despite lack of knowledge of the specific work scope.
 - Pre-ev failed to communicate complete work scope for desired tasks. The Board's interviews with the six principle workers for the 336 task identified clear discrepancies among the understanding of what was discussed regarding scope of work and sequence of tasks, equipment expectations, and use of safety equipment.
 - "Team up, team down" hatch control concept was either not well communicated or not well understood by the work crew.
 - "Secure the trolley" was an imprecise work direction and was only discussed between the Work Supervisor and Rigger 1.
 - Over reliance on skill of the craft allows higher risk work to accomplish the work without adequate work planning, hazard identification, and control.
 - The 336 Work Supervisor/300 Area D4 Superintendent and WCH management assume that craft workers do not need to be continuously supervised or overseen by Safety during the performance of hazardous tasks.
 - It was assumed that the "team up, team down" concept was adequate for fall protection.
 - Confidence of Rigger 2 to perform free climb without appropriate fall protection.
 - PSRs did not adequately execute their safety oversight responsibilities in protecting the workers on the ladder and the catwalk.
 - Free climb by Rigger 2 was perceived as safer than using fall protection.
 - Work Supervisor briefing pre-ev with an unapproved work package, which is inconsistent with IWCP requirements.

- Perceived schedule pressure was a significant contributor in failing to adequately plan the work.
 - Work steps were verbally added to scope of work w/o changing IWCP.
 - Several pre-requisites were not completed prior to work performance.
 - Work Supervisor was anxious to complete task 1 and turn over demolition to new D4 workers.
 - 300 Area D4 Superintendent pushes his planners, work supervisors, and safety representatives hard.
 - Planner was under significant pressure to complete an approved IWCP and JHA.
 - 300 Area D4 project is schedule driven.
 - PSRs did not allow adequate time to locate the pre-existing engineered ladder safety devices.
 - "This is the way D4 is done."
 - Despite broad knowledge of stop work authority/policy, workers are hesitant to exercise a "work pause" due to cultural and organizational pressures related to accomplishing the project mission. Workers perceive that pausing work will result in negative consequences – including being stigmatized as a non-team player.
 - Work began before the IWCP was approved and released by FPOC.

Root Cause 2: The fall protection procedure and its implementation do not fully comply with applicable OSHA standards and did not provide adequate protection to the workers.

- The fall protection procedure content is not adequate to clearly convey the applicable regulatory requirements to the work force.
 - Less than adequate fall protection plan/requirements.
 - Engineering analysis not reviewed by PSR prior to free climb; analysis provided anchorage areas for retractable lanyards.
 - Supervisor was not a "qualified" person to identify tie-off points.
 - Failure to locate the engineered ladder safety device resulted in the decision to initially free climb and utilize retractable lanyards, which further exacerbated the risks associated with the operation of the hatch.
 - Confidence of Rigger 2 to perform free climb without appropriate fall protection.
 - Free climb by Rigger 2 was perceived as safer than using fall protection.
 - Standing back from the open hatch was perceived as adequate fall protection.
- The fall protection training failed to provide adequate hands-on demonstration, performance testing, and understanding of the hazards and requirements.
 - PSRs and Supervisor allowed free climb.
 - Lower anchor point for retractable lanyard was not hung in an approved location.
 - Supervisor identified inappropriate tie-off points for riggers on catwalk guardrails.
 - Rigger 2 was allowed to tie off to the midpoint platform (PSR and Supervisor authorized).
 - Workers failed to follow supervisory instructions for accessing and exiting the catwalk ("team up, team down" and then close hatch).
 - "Team up, team down" concept is not in compliance with OSHA (cannot leave workers exposed to open hatch w/o fall protection).
 - The 336 Work Supervisor/300 Area D4 Superintendent considered the "team up, team down" concept to be adequate to control the hatch hazard.
 - Use of the retractable lanyards inhibited ease of the use of the hatch.
 - Unhook and re-hook methods used at midpoint left workers unprotected – no functional chain at midpoint ladder entry.
 - The 336 PSR was trained on WCH fall protection on the morning of July 1.
 - Misinterpretation of fall protection requirements regarding free climbing, anchorage locations, lanyard use, open hatch, and "team up, team down" concept.
 - Rigger 3 assumed it was okay to cut the guardrail while not being tied off.
 - Upon ascent of the ladder, workers failed to recognize that the lack of a safety chain left workers on the catwalk exposed to an open hatch hazard and that additional controls should have been put in place.
 - The chain located at the ladder entryway to the midpoint platform was too short to perform its intended function.
 - Safety assumed that the "six-foot policy" was adequate protection from the open hatch.
 - None of the workers had fixed ladder training; WCH does not have a fixed ladder training program.
- Staff failed to comply with WCH's fall protection procedure and the structural engineering analysis recommendations.
 - Failed to use softeners on synthetic lines.
 - Did not comply with structural engineering midpoint and upper anchorage area recommendations.

Contributing Cause 1: The contractor's emergency management procedures for incident response, investigation, and event notifications were not implemented consistent with their requirements.

- WCH did not categorize the event within the time limits required by the DOE ORPS manual; Event Discovery should have been time of fall.

- WCH did not follow procedure SEM-3-2.2, Attachment 3, convening a fact finding meeting, instead of a critique, which was clearly required based on the nature of the accident.
- Written Fact Finding Report lacked sufficient and accurate detail for the nature and seriousness of the event.
 - Fact finding “causal analysis” reflected only a short list of potential contributing conditions.

Contributing Cause 2: The incident response by the Hanford POC created an unnecessary delay in initial deployment of emergency medical personnel.

- Critical response time lost by POC in obtaining irrelevant information prior to contacting HFD (~2:05-minute delay).
- HFD dispatch was delayed due to POC gathering information that was not needed to make the dispatch (~1:00 minute).

Contributing Cause 3: The contractor's previous self-assessments and corrective actions on the integrated work control procedure and fall protection procedure were not effective in correcting underlying weaknesses.

- NTS-RL-WCH-D4-2007-001, Worker Stepped Through Roof at B3706.
 - Roof Safety Monitor (3/2007), 100% Oversight into FPP.
 - Work Pause for Safety Refocus (5/2007): questioning attitude, communicate, and never walk past a hazardous condition without taking action.
- ISMS Phase I and II corrective actions and related assessments (2007-2008).
- DOE-RL OA reports on fall protection and work control.
 - CY08, 165 OA and 30 issues (findings and observations).
 - CY09, 55 OAs and 6 issues.
 - CY08, 108 OAs and 8 issues.
 - CY09, 58 OAs and 6 issues.
- Evidence of the WCH lessons learned program improving fall protection or work planning/control was not identified.
 - Of nine identified as applicable, no deficiencies in WCH programs or practices were documented.
- No corrective actions were identified with regard to WCH Safety programs as a result of the 2006 K-25 Type B investigation or the lessons learned from the LLNL Type B investigation.