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Department of Energy
Richland Operations Office
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FEB 16 1995

Mr. Douglas R. Sherwood
Hanford Project Manager
U. S. Environmental Protection Agency
712 Swift, Suite 5
Richland, Washington 99352

Mr. Roger F. Stanley
Tri-Party Agreement Implemention
State of Washington
Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

Dear Messrs. Sherwood and Stanley:

100 AND 200 AREA PUMP AND TREAT SYSTEMS SHUTDOWN

The letter dated January 12, 1995, identified the U.S. Environmental Protection Agency (EPA) and State of Washington Department of Ecology (Ecology) concerns regarding delays with pump and treat operations at the 200-BP-5, 200-UP-1, 200-ZP-1, and 100-HR-3 Operable Units. It is true that the systems have experienced delays due to winterization and to incorporate lessons learned from the incident at 100-HR-3. However, the 200 Area pump and treat systems restarted operations at all 4 sites in mid-January. Although the delays have impacted some of the schedules, the U.S. Department of Energy (DOE), Richland Operations Office, (RL) is continuing to look for ways to meet all of the commitments identified in the treatability test plans. 39862

200-BP-5 has experienced the greatest schedule impacts. However, a mini-column study is being initiated at both systems. The data from the studies will be used to obtain the breakthrough data needed to prepare the Treatability Test Report. The well extraction rates from the two BP-5 units make them infeasible locations for long term operations. Cost effectiveness considerations lead RL not to expect to operate either system after the test is completed in May 1995.

The treatability test at 200-UP-1 was completed on November 18, 1994. The Treatability Test Report was submitted to the EPA and Ecology Unit Managers for review on January 11, 1995. Although the system was shut down to complete winterization activities, operations were restarted on January 17, 1995.

The Treatability Test Report for 200-ZP-1 is scheduled to by submitted to EPA and Ecology by May 19, 1995. The system restarted on January 16, 1995, after the winterization activities had been completed. To date, the system has not obtained breakthrough of the filter media. Bechtel Hanford, Inc. is modifying the treatment system to incorporate sampling probes which will assess CCl_4 breakthrough and enable the treatability testing to be completed in time to support the Treatability Test Report.

A copy of the 100-HR-3 Type C Accident Investigation is attached for your information. Operations are expected to restart by Mid-February 1995, and the Treatability Test Report should be completed by September 29, 1995.

It is inappropriate to consider new milestones until the tests are completed and the results evaluated. All activities are being carefully weighed to determine whether they should be continued in the out years. RL will keep EPA and Ecology fully apprised of the FY 1996 planning and any impacts to on-going activities.

Sincerely,

Linda K. McClain, Assistant Manager
for Environmental Restoration

PRD:DMW

Attachment

cc w/attach:
P. Beaver, EPA
D. Einan, EPA
D. Faulk, EPA
D. Goswami, Ecology
W. Soper, Ecology

cc w/o attach:
G. Eidam, BHI
M. Hughes, BHI
S. Liedle, BHI
J. Zoghbi, BHI

TYPE C INVESTIGATION
100-HR-3 PUMP AND TREAT OPERATION
ACCIDENT WITH INJURY
DECEMBER 6, 1994

ISSUED
JANUARY 11, 1995

ACCIDENT INVESTIGATION TEAM

B. J. Hobbs, Chairman
ERC QS&H, Program
Date: 1-11-95

G. J. Carr
ERC QS&H, Radiological Control Program
Date: 1-11-95

S. R. Coleman
ERC QS&H, Project Support
Date: 1-11-95

A. A. Freitag
ERC Design Engineering
Date: Jan 11, 1995

D. R. Kibbe
WHC, OMPI
MORT Certified Accident Investigator
Date: 1-11-95

T. S. Quinn
ERC QS&H, Program
MORT Certified Accident Investigator
Date: 1-11-95

R. G. Shuck
ERC, Field Support
Date: 1-11-95

B. G. Tuttle
ERC QS&H, Project Support
Date: 1-11-95

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1.0 SCOPE OF INVESTIGATION

This investigation was initiated as a result of an accident that occurred on December 6, 1994 at the 100-HR-3 Pump and Treat Facility in the 100D Area. Two Westinghouse Hanford Company (WHC) Hanford Atomic Metal Trades Council (HAMTC) pipefitters were injured. On December 12, 1994, the Environmental Restoration Contractor (ERC) Vice President and Operations Manager issued a letter (Attachment 1) naming the following investigation team (Team) to conduct a Type C accident investigation:

B. J. Hobbs, Chairman, ERC QSH, Programs
G. J. Carr, ERC QSH, Radiological Control Program
S. R. Coleman, ERC QSH, Project Support
A. A. Freitag, ERC Design Engineering
D. R. Kibbe, WHC Operations and Maintenance Program Improvement
T. S. Quinn, ERC QSH, Programs
R. G. Shuck, ERC Field Support
B. G. Tuttle, ERC QSH, Project Support

The investigation was conducted in accordance with DOE Order 5484.1. The Team inspected the accident site and reviewed work activities and events leading to the accident. Written statements from employees were reviewed, and interviews were conducted with employees who were directly involved or could provide pertinent information. In addition, management systems, project team interfaces, operating procedures, and system design were considered.

2.0 SUMMARY

At approximately 1:00 pm on December 6, 1994, two WHC HAMTC pipefitters on work order to the ERC were injured at the 100-HR-3 Pump and Treat Facility in the 100D Area. The accident occurred when a pipe coupling retaining spline was removed and the pipe elbow joint separated under pressure with a discharge of compressed air and ice from both open ends. Pipefitter #1 was struck on the right thigh with the pipe and/or ice and in the face with compressed air and ice. Pipefitter #2 was struck on the face and body with compressed air and ice. Both pipefitters were transported to the 200 East First Aid Station by the ERC Field Coordinator. At the direction of the 200 East First Aid Station physician, Pipefitter #1 was taken to Kadlec Medical Center and diagnosed as having a large contusion to the right thigh and abrasions to left wrist. An eye examination was also given. The employee was treated and released with restricted duty for three days. Pipefitter #2 was treated at the Aid Station for lacerations to the face and released back to work.

The pipe involved in the accident was a 3-inch-diameter Yelomine PVC through which treated groundwater was pumped to injection wells approximately 1,400 feet from the Pump and Treat effluent skid. The day before the accident, after it was discovered that the line had frozen, the

effluent water booster pump was used to try and establish flow. When this failed, compressed air was used in an unsuccessful attempt to blow the ice blockage out. Operators of the system testified that following those unsuccessful attempts, the effluent pipe was depressurized by venting valves at both ends of the pipe and then physically disconnecting fittings (Camlocks) on the flexible hoses at both ends of the effluent pipe. The operators also testified that on the day of the accident, the compressor was staged at the effluent skid ready for use, but was never connected to the system.

From the evidence at the accident site, interviews, and review of the operations's logbooks, there was still not sufficient hard evidence for the Team to be able to determine how or why the system was pressurized at the time of the accident. The following theories were the most plausible:

1. Compressed air was trapped between ice plugs in the effluent pipe. Under this scenario, the ice blockage prevented the pressure from releasing when valves were vented and the flexible hoses were disconnected at the ends of the effluent pipe. This theory was most consistent with the testimony from the facility's operators.

2. The compressor was connected to the system and the system pressurized on the day of the accident. The possibility was not ruled out because there was an available source of compressed air, access to the compressed air connection was not controlled, lock and tag procedures were not implemented to secure the system, there was no record of a zero energy checks, and there was no record to confirm valve alignment at the time of the accident. This theory was unsubstantiated and was in direct conflict with testimony from the facility's operators.

The Management Oversight and Risk Tree - Accident Investigation (MORT-AI) method of analysis was used to analyze the facts and establish causes of the accident. From that analysis the Root Cause, Direct Cause, and Contributing Causes for the accident were determined. The Root Cause was defined as the cause that, if corrected, would prevent recurrence of this and similar accidents. The Direct cause was the cause that directly resulted in the accident. Contributing Cause were causes that contributed to the accident but, by themselves, would not have caused the accident. The following are the results of the MORT-AI analysis:

1. Root Cause: Management Systems. Policy not adequately defined, disseminated, or enforced. Management failed to correct deficiencies in operating procedures, employee training, work practices, and design and operation of the system/facility.

2. Direct Cause: Failure to depressurize the 3-inch Yelomine PVC pipe before disassembly.

3. Contributing Causes: Deficiencies in Conduct of Operations played a major role. The following were found to be "less than adequate:"

- Shift Routines and Operating Practices
- Lockouts and Tagouts
- Independent Verification
- Log Keeping
- Operations Turnover
- Operation Procedures
- Safety Plans and Hazard Analysis
- Winterization of System.

3.0 FACTS

3.1 BACKGROUND

The 100-HR-3 Pump and Treat is a test facility located in the 100D Area north of the D Reactor Building. The facility consists of an ion exchange unit, extraction and injection wells, tanks, and associated piping. The facility is designed to remove hexavalent chromium from the groundwater. Phase 1 testing of the unit started August 26, 1994.

3.2 PRE-EXISTING CONDITIONS

3.2.1 Tri-Party Agreement (TPA) Milestone

Milestone M-15-06 required start of Phase 1 testing at the 100-HR-3 Pump and Treat Facility by August 31, 1994.

3.2.2 Test Plan

The Introduction to the Test Plan (DOE/RL-94-54, Rev. 0, *Pilot-Scale Treatability Test Plan for the 100-HR-3 Operable Unit*) states "In Phase I, groundwater will be extracted from a three-well network (D5-14, D5-15, and D5-16), treated in an ion exchange (IX) unit, and reinjected into one or more upgradient wells (D5-17, D5-18, D5-19). The Pump and Treat system will operate nominally 8-hours/day, 5-days/week. This test will demonstrate the effectiveness of IX in treating effluent in the field as compared with laboratory test results. Phase I operations and winterization of the treatment system are scheduled for completion prior to November 15, 1994." The requirement for winterization was also addressed in Section 31, "Phase 1 Test Objectives." That Section states, "upgrade system for 24-hour and winter operations."

3.2.3 Design

WHC initiated the design of the overall system in May 1994, to meet the August 31, 1994 TPA Milestone for system operation. To meet the milestone, certain aspects of the engineering design, such as complete winterization, were postponed. The final mechanical design package contained several signed hand sketches with no evidence of drawing reviews and checking being performed. There were also no final approved "as-builts".

3.2.4 Operational Readiness

Before startup of Phase 1 testing, a readiness review was conducted in accordance with WHC-CM-7-7, EII 1.13, "Environmental Readiness Review". The readiness review was approved and authorization for startup was documented by the Project Manager in an ERC Interoffice Memorandum, CCN 002582, dated August 26, 1994.

3.2.5 Procedures

An approved procedure (BHI-00050) for the 100-HR-3 Pump and Treat Facility was prepared by the project team and published August 26, 1994. These procedures were in the process of revision as of December 2, 1994. The revised procedure was issued as a draft document (BHI-OP-00021) after December 6, 1994.

3.2.6 Site-Specific Safety Plan

A Site-Specific Health and Safety Plan was developed for the 100-HR-3 Pump and Treat Facility in accordance with OSHA 29 CFR 1910.120. The Plan was written by ERC Safety and Health, approved by project management, and issued August 4, 1994. The Plan assesses the hazards of chromium and radionuclides, as well as heat stress, cold stress, walking/working surfaces, heavy equipment operation, electrical safety, sanitation, emergency equipment, and noise.

3.2.7 Organization

The 100-HR-3 Pump and Treat Project organization that existed before the ERC reorganization of November 21, 1994 was described in an approved organization chart. At least one organizational change had been made by promoting one of the operators to Field Coordinator, effective December 2, 1994.

3.2.8 Operations

Phase I operations started at the 100-HR-3 Facility August 26, 1994. Phase I operations were based on manual operation 5 days/week, and were intended for a "shake down" of equipment, to determine breakthrough characteristics of the column resin, and demonstrate general effectiveness of groundwater treatment. Phase II operations started November 15, 1994 and were intended to achieve a production operation mode.

3.2.9 Oversight Surveillance

Surveillance No. BHI-QAS-94-032 was conducted by the ERC Quality Assurance Group, November 14, 1994. The following observations were made with no response or follow-up required:

1. "field procedures need to be updated. Phase I of the Treatability study was intended to refine the operating procedures. These refinements need to be incorporated into the current procedures prior to Phase II."

2. Sample and Analysis plan changes.

3. "deviations from approved sampling procedures need to be documented in the field log book. If deviations are substantial, the deviations need to be communicated to the Project Manager."

A second surveillance (BHI-QAS-036) was conducted at the 100-HR-3 Facility by Quality Assurance on November 28, 1994. This surveillance was performed to ensure cold weather protection was implemented at the facility. No findings are specifically indicated, but the detail portion of the surveillance states: "----However, most common water lines, valves, fittings, etc. are exposed to winter conditions, which can cause frozen or broken lines due to cold and windy climate. Project engineering has indicated that as long as all systems are operating they expect no freezing problems. Unfortunately, this Pump and Treat is not designed or manned to operate 24 hours a day and 7 days a week. This concern should be confronted prior to possible equipment damage and/or down time to the treatability facility." The surveyor indicated the observed condition to be satisfactory, with no follow-up required.

A management oversight evaluation was conducted at the 100-HR-3 Facility by the ERC President, October 23, 1994. The report of this evaluation (Letter File No. 8960/8900/100) identified five issues of concern, including: "Above ground small diameter piping was not adequately marked nor freeze protected." The report concluded that, "These observations combined with other recent incidents (plate decontamination, roof fires, etc.) raise questions about whether we are proceeding on automatic using existing procedures and design standards or are we adequately raising questions about the appropriateness and currentness of procedures and

our readiness to operate. In my opinion, the Ground Water Pump and Treat Operations were not ready for operation due to the above mentioned items." The report was sent to the ERC Vice President and Manager of Operations October 28, 1994, with no requirement for a response.

3.2.10 Previous Events

At 10:30 am, November 4, 1994, an overflow of the effluent tanks occurred during operation of the 100-HR-3 Facility. Water spilled to the containment area was pumped back to the effluent tanks with an air-operated diaphragm pump to recover from the incident. The Area Field Coordinator inspected the facility on November 4, 1994. He shut down the operation and required the following actions before re-start: review of the operating procedures; retraining of the operators; verification of completion of the above actions before restart.

On November 2, the ERC Safety Representative had approved the use of compressed air to blow water out of plastic lines with these provisions: (a) all non-essential personnel are to remain a safe distance away from the piping; (b) air pressure is not to exceed pressure ratings of the piping. The weekly project report for November 4, 1994 documented employee concerns related to the use of compressed air: (a) the use of high-pressure air in rigid plastic lines may not be an acceptable practice; (b) pressurization of the line could cause a failure at a coupling, which could cause whipping of the end of the line sufficient to cause damage to equipment and/or injury to personnel.

On the morning of November 22, 1994, the effluent pump system was found to be frozen in several areas; WHC HAMTC pipefitters were utilized to defrost the system. Portions of the 3-inch Yelomine PVC effluent piping were also suspected of being frozen. The operating crew restored flow by using the effluent booster pump to force warmer water into the line.

3.3 EVENTS

3.3.1 Effluent Pipe Frozen

At approximately 2:00 p.m. on December 5, 1994 facility operators discovered that flow could not be established in the 3-inch Yelomine PVC effluent pipe.

3.3.2 Pipefitter Support Requested

Work Package 2J-9400099 was prepared and issued on December 5, 1994. The package provided for craft support to 100-HR-3 Pump and Treat Facility. The craft personnel were to report to the Field Coordinator and take verbal direction for the work to be done.

3.3.3 Pipefitters Start Work

At approximately 10:40 a.m. on December 6, 1994 two WHC HAMTC pipefitters, at the direction of the Field Coordinator, commenced disassembly of an elbow in the 3-inch Yelomine PVC effluent pipe.

3.3.4 Effluent Pipe Under Pressure

At approximately 1:00 p.m. on December 6, 1994, the 3-inch Yelomine PVC effluent pipe was discovered pressurized when two WHC HAMTC pipefitters removed a retaining spline from a coupling. Facility operators and the Field Coordinator testified that they had taken steps deemed appropriate to depressurize the pipe.

3.3.5 Effluent Pipe Separated Under Pressure

At approximately 1:00 p.m. on December 6, 1994, a joint in the 3-inch Yelomine PVC effluent pipe separated under pressure. Compressed air and ice were ejected from the pipe with sufficient force to injure two employees.

3.3.6 Pipefitters Injured

Pipefitter #1 was struck on the right thigh with the pipe and/or ice and in the face with compressed air and ice. Pipefitter #2 was struck on the face and body with compressed air and ice.

3.3.7 Emergency Number Called

The Field Coordinator made several attempts to contact emergency dispatch by dialing 811 on his cellular phone but was unable to establish connection with emergency dispatch (cellular emergency service on 811 had been terminated without notification to ERC management).

3.3.8 Post Accident

1. Immediately after the accident, the Field Coordinator checked the pipefitters to determine the extent of their injuries. Both pipefitters were able to stand, were conscious, and were coherent.

2. The Field Coordinator informed the pipefitters that emergency dispatch notification was

not successful. The Field Coordinator transported the pipefitters to the 200 East First Aid Station. At the direction of the First Aid Station physician, pipefitter #1 was taken to Kadlec Medical Center. The pipefitter was diagnosed has having a large contusion to the right thigh and abrasions to left wrist; an eye examination was also given. Following examination and treatment, the employee was treated and released with restricted duty for three days. Pipefitter #2 was treated at the 200 East First Aid Station for lacerations to the face and released back to work.

3. The WHC Pipefitter Supervisor and Area Field Coordinator were notified by phone. The Field Coordinator notified project management from the 200 East First Aid Station and requested that appropriate event notifications be made.

4. At approximately 1:10 p.m., the former Field Coordinator came to the facility and assumed control. He notified the ERC Safety Representative and left a message on voice mail for the Project Manager.

5. At approximately 1:37 p.m., the ERC Safety Representative and another safety person arrived at the site. The Safety Representative took Polaroid photographs of the accident scene and instructed facility personnel to mark and barricade the area to preserve the facts at the scene. The Area Field Coordinator directed the operators at the site to secure and shut down operations.

4.0 ANALYSIS OF EVENTS

A causal factors analysis was used to identify the principal events of the accident and their probable causes. A Event and Causal Factors Chart (Attachment 2) was developed starting with the establishment of the Tri-Party Agreement (TPA) Milestone for the start-up of the 100-HR-3 Pump and Treat Facility and ending with transportation of the pipefitters to the 200 East First Aid Station.

During this investigation a number of changes were identified in project design, management systems, and operations during the principal events. Following were the changes identified as needing evaluation:

- Design: heat tracing and insulation changed to insulation and operational controls; 24-hour operation changed to 8-hour; design drawings changed (no "as-builts").

- Project Management: WHC to ERC; Project Assistant Manager designated; ERC reorganization; change in Field Coordinators at facility.

- Procedures: blowdown methods and procedures for effluent line changed.

- Operations: Yelomine PVC effluent piping system installed by ICF Kaiser Hanford Company (ICF KH) pipefitters, maintenance by WHC HAMTC pipefitters.

The result of the Management Oversight and Risk Tree (MORT) analysis indicated these MORT categories as less than adequate: Management Systems, Implementation, Hazard Analysis, Design and Development Plan, Supervision, Barriers and Controls, Facility Operability, and Management Technical Information Systems. The following were less than adequate at the project level and contributed to the above categories: change controls, independent audits and appraisals, accident/incident system, personnel training and qualification, procedures, pre-task briefing, communications, and lock and tag.

A barrier analysis was also conducted to organize the facts and identify failed barriers.

1. The procedures for blowdown of the effluent pipe were not adequate barriers to prevent freezing.

2. Procedures and training were not adequate barriers to prevent pressurization of the line

3. Supervision, communication, and training were not adequate barriers to prevent the fitters from starting work without knowledge of the system status.

4. Lock and Tag and zero energy check were not adequate (as conducted) to prevent the accidental release of stored energy in the pipe when the spline was removed from the coupling.

4.1 TPA MILESTONE

The TPA Milestone applicable to this investigation is the start-up date for Phase I Operation (August 31, 1994). This Milestone affected the design for the 100-HR-3 Pump and Treat Facility, however the adequacy or impact of the Milestone was not analyzed by the Team.

4.2 TEST PLAN

The Test Plan required the development of procedures and a design for the 100-HR-3 Pump and Treat Facility, however the adequacy of the Test Plan itself was not analyzed by the Team.

4.3 OPERATIONAL READINESS

BHI Interoffice Memorandum CCN 002582, dated August 26, 1994, "Start-up of 100-HR-3 Pump and Treat Facility", reviewed the level of readiness verification and determined it to be within the scope of WHC-CM-7-7, EII 1.13, "Environmental Readiness Review". A readiness review checklist and a Conduct of Operations matrix was completed, and authorization was given for start-up of Phase I operation. No information was discovered that indicated a readiness review for Phase II operations was ever conducted.

The Team identified several separate instances where deficiencies in the continued "readiness" to operate the facility after startup were observed. From the evidence available, the Team concluded that management response to deficiencies identified in the following was less than adequate:

- On October 28, 1994, the President of Bechtel Hanford, Inc. (BHI) wrote a memo identifying four areas that "relate to our 'readiness' to operate the facility." He further states "In my opinion, the ground water Pump and Treat Operations were not ready for operation due to the above mentioned Items." One of the four areas addressed was "above ground small diameter piping was not adequately marked nor freeze protected."

- On November 4, 1994, the BHI Area Field Coordinator wrote a memo explaining actions he assigned "for completion prior to start-up of the facility." These actions were to review and revise, if necessary, the operating procedures and retrain the operators to the procedure revisions. As a result, (a) the operating procedures were revised but were not approved; (b) there was apparent unresolved disagreement within the project team over restart of operations. The Field Coordinator and facility operators made an entry in the logbook on November 7, 1994 that states that the BHI Treatability Test Manager (Deputy Project Manager) directed the Field Coordinator to reinstate operation of the facility. The same logbook entry states the Test Manager was informed, "the failure to comply with the DOE Order, 'Conduct of Operations', had not been resolved." The Test Manager felt the Conduct of Operations issues had been resolved. Per a written statement on 1-6-95 by the Test Manager, "The BHI Treatability Test Manager provided direction to utilize two other certified operators to continue operations while the third certified operator could provide retraining to the operators of concern. Therefore, it was the BHI Test Manager's view that the 'Conduct of Operations' were still being met if it was run as directed."

- BHI ER Project Surveillance Report number BHI-QAS-94-032 dated 11/28/94 states, "Field procedures need to be updated." The procedures addressed were sampling procedures.

- BHI ER Project Surveillance Report number BHI-QAS-036 dated 11/14/94

documents that there is inadequate "Cold Weather Protection" at the 100-HR-3 Pump and Treat Facility. It further states "This concern should be confronted prior to possible equipment damage and/or down time to the treatability facility." No physical cold weather protection was in place at the time the accident occurred.

4.4 FACILITY DESIGN

The design of the overall system was initiated by WHC in May 1994. It was recognized and concurred by Management from design initiation to completion that certain aspects of the engineering design, such as complete winterization, would be addressed after the August 31, 1994 TPA Milestone. After the ERC transition, the original design team remained essentially intact from WHC to the ERC and carried pre-transition decisions through to the ERC. There is no indication that the ERC Management reviewed these decisions.

The Team reviewed the final mechanical design package provided and found that no formal design documents existed. Most of the drawings in the package are signed hand sketches with no evidence that drawing reviews and checks were performed. Final approved as-builts were not included. Several deficiencies noted by the Team include ball valves used as throttling valves, no pressure indication at the effluent booster pump discharge; and inadequate vents and drains at the equipment skids. For example, there was no drain valve in the line upstream of globe valve VE-8. This valve has upper and lower chambers where water may be trapped in the lower chamber and upstream piping. To avoid freeze-up, an upstream drain is required to allow for complete draining.

With the current design, the sequence and method of blowing down the injection lines is critical to maximize the water removal from the 3-inch Yelomine PVC effluent line. The blowdown sequence used on the Friday before the accident did not prevent freezing and ice blockage in the effluent pipe.

4.5 EFFLUENT PIPE FROZEN

4.5.1 Supervision

Conduct of Operations states, "The Shift Supervisor shall maintain authority and responsibility for all facility operations, which shall be transferred only through formal turnover to a qualified relief." The turnover of Field Coordinators on December 5, 1994 was less than adequate. At the start of work on December 5,1994, it was not clear to the incoming Field Coordinator or to the facility's operators who was in charge. The incoming Field Coordinator had not received the letter confirming appointment to the position. Confirmation of the appointment came after work was in progress during a telephone conversation with the former Field Coordinator.

4.5.2 Design

Project management allowed delay of the winterization design until after implementation of the August 31, 1994 TPA Milestone. The winterization design was initiated in September 1994 and included heat tracing and insulating all exposed piping. The design was completed by the end of October 1994 but because of budgetary concerns was not issued. A reevaluation was conducted in early November to determine the components susceptible to freezing conditions, outline operating procedures to protect components, and determine costs for insulating exposed piping. The recommendations from the reevaluation were summarized in a November 9, 1994 memo and in another memo dated November 21, 1994 as follows:

- Heat trace filter skid piping for influent and effluent storage tanks and all exposed metal piping in the system.
- Insulate all exposed plastic piping with 1-inch fiberglass.
- Rely on operational measures.
- Ensure continuous water flow through extraction piping.
- Drain water from all pipes before weekends or during extremely low temperatures.

The above recommendations were not completely implemented.

The sequence and method used to blow down the effluent pipes were not adequate. Water remained in the 3-inch Yelomine PVC pipe such that a complete ice block had occurred at the time of the accident. The procedure used on the effluent pipe on the Friday preceding the accident was an unapproved interim procedure taken directly from the extraction system. The sequence and method had not been analyzed to determine if it would be successful.

The system design did not include provisions for complete water drainage. Examples of system low points and traps include the piping between the effluent filter outlets and globe valve VE-8 where the valve traps water upstream because of the upper and lower chamber configuration of a globe valve; check valve CVE-1 located in a vertical pipe; and the Yelomine piping running through deep swales on the ground.

4.5.3 Operations

On Friday, December 2, 1994, to prevent freezing of the effluent piping system over the weekend, air was injected at the 199-D5-18 and 199-D5-19 well heads with the intent to blow

water in the piping back into the effluent tanks. This process had been used in the past, and the operating procedure was being revised to incorporate this as the approved method. However, based on oral statements from the operators, there was disagreement on this day that blowdown had been conducted properly. There was a difference of opinion as to which well should have been blown down first and whether water in the 2-inch line to D5-19 should be blown back into the well.

On the following Monday, December 5, 1994, the system operators tried to establish effluent flow from the effluent skid to the wells. Parts of the system on the skid were found to be frozen and were thawed using a heat gun to melt ice. An attempt was then made to pump water through the system. The system was aligned, and the effluent booster pump was turned on. The operators thought water was being introduced in the effluent piping; however, the operator at the well head did not observe flow, and the pump was shut down. At this time, it was assumed that the effluent piping was frozen. After the attempt to pump water, the operators tried to open a flow path through the system by using compressed air to blow the ice blockage toward the wells. An air compressor was hooked to the piping at the effluent skid, and the valves were aligned to blow through the effluent piping to the wells; the air compressor was operated for approximately five minutes. Operators testified that when the effluent piping could not be cleared, the compressor was disconnected and the system was depressurized.

On November 22, the system had experienced a similar freezing problem, and pipefitters were brought in to assist in thawing the effluent skid. On this occasion, effluent flow was reestablished by operating the effluent booster pump.

4.5.4 Procedures

Operation and blowdown of the effluent system was not addressed in the approved operating procedure. A section of the operating procedure (BHI-00050, August 25, 1994) that addressed blowing water from the extraction wells back to the piping skid was used to blow down the effluent piping from the injection wells to the effluent pipe skid. Although this procedure was approved for use with the extraction well piping, it was not approved for use with effluent piping. It referenced valve identification numbers of the extraction system that were different from those of the effluent system.

There were no existing procedures for performing thawing activities even though freezing of the skid had been experienced previously. A recovery plan did not exist for returning a system from an abnormal configuration to operability. The inadequacy of procedures had been discovered several weeks earlier after an incident in which the extraction tank level system malfunctioned. At the time of the accident, revisions to the operating procedures were in process.

4.5.5 Management Systems

Based upon oral testimony from the Facility Operators and project management, confusion existed among the project personnel regarding their role and responsibilities when the ERC took over the contract. Project management failed to effectively communicate this information. For example, the organizational chart that was current from July to November did not delineate the relationship between the Field Coordinator and Engineering when a problem occurred in the field(was it an operational or a design problem?). Also, site services such as Safety and Quality Assurance reported to the Project Manager. It was not clear if these services directly supported the Field Coordinator. Events that occurred at the time of the accident suggest that organizational changes that have occurred since the November reorganization have also been poorly communicated to the field staff.

Document control by Project Management also appeared to be less than adequate. The Team encountered difficulty in establishing facts during this investigation resulting from the lack of formality in communications. A number of important Project issues were discussed by "Don't Say It--Write It" (DSI) memos and electronic mail that had no document control (no document numbers). In addition, these documents were not included in the Project Files. Problems with formal document control were also noted with design drawings and design changes

Project Management did not effectively support the operations of the Facility. For example, management failed to adequately resolve concerns of the facility's operators regarding restart of the Facility on November 7, which were documented in the site log and included employee concerns about the safety of using compressed air to blow water out of the effluent PVC piping.

There was no evidence that Project Management or the senior management of the ERC Team adequately addressed operational problems clearly identified by oversight evaluations conducted at the 100-HR-3 Pump and Treat Facility before the accident. Readiness of the Facility to operate was questioned by the ERC President with specific findings concerning adequacy of procedures and winterization. These findings were repeated in subsequent oversight surveillances, with no documented corrective actions. (A draft revised procedure was issued after the accident.)

The Management Oversight Risk Tree analysis indicates that ERC and Project Management Systems were less than adequate. In the opinion of the Team this was the root cause of the accident.

4.6 EFFLUENT PIPE UNDER PRESSURE

4.6.1 Energy Control

The plant operators and the Field Coordinator gave oral testimony that after the effluent pump was run and a compressor was used to pressurize the effluent system, the system was then depressurized. The following summarizes that testimony:

- At approximately 2:00 p.m. on December 5, 1994, the day before the accident, the effluent booster pump was run in an unsuccessful attempt to establish flow in the effluent piping to well 199-D5-18. After the pump was shut down, the valves at the well and the effluent skid were configured to vent off pressure in the system. The pipe system was then physically disconnected at both ends by removing the flexible hose connections (Camlock fittings).

- At approximately 2:10 pm on December 5, 1994, operators attempted to remove ice obstruction in the effluent pipe to well 199-D5-18 with compressed air. Compressed air was injected into the system at the effluent skid. After several minutes the operators concluded the ice obstruction could not be removed by this method. The air line was disconnected from the effluent skid, and the valves were opened on the effluent skid and at the well to vent off pressure in the system. The piping systems were physically disconnected at both the effluent skid and well head by removing Camlock fittings.

- Operator testimonies on December 6, 1994, the day of the accident, state that no pressure was introduced into the effluent piping. Valves at the effluent skid and at wells 199-D5-18 and 199-D5-19 were opened to vent the system to atmosphere. An air compressor was started and staged at the effluent skid, but was never connected to the system.

How or why the system remained pressurized or became repressurized could not be determined. There are two theories: (a) the pressure was trapped between two ice plugs. This scenario would explain the presence of pressure and why the attempts to depressurize the system were not successful; (b) the pressure was introduced when the air compressor was started on Tuesday, December 6, 1994, before the pipefitters took the effluent pipe elbow coupling apart. It was considered as a possibility because there was an available source of compressed air, access to the compressed air connection was not controlled, and lock and tag had not been implemented to isolate the system. Also, there was no record documenting the zero energy check or documenting the configuration of the system's valves during or after depressurization. This theory was unsubstantiated and in direct conflict with testimony from the facility's operators.

4.6.2 Procedures

Because the approved operating procedure, BHI-00050, did not address blowdown of the effluent

system, the operators depended on their knowledge of the system to configure valves for the different system operating modes, including depressurization. During blowdown and depressurization of the system, two operators located approximately 1,400 feet apart used cellular telephones to communicate the needed directions and information for changes to system valve configuration. There was no independent verification of valve positions or records kept of valve alignment, making it impossible to verify the position of the valve at the time of the accident.

The project had adopted WHC-CM-4-3, Standard G-1, "Energy Control Program". The procedure and logbook were kept at the facility. There were no entries in the logbook on December 6, 1994. The operating procedure, BHI-00050, did not address energy control.

4.6.3 Health and Safety Plan

The Site-Specific Health and Safety Plan did not address the use of compressed air for system blowdown, nor did it contain requirements for energy control.

4.6.4 Supervision

Supervision did not enforce compliance with energy control (lock and tag) procedures. Work to draft operating procedures was allowed. A hazards analysis was not conducted for the use of compressed air for blowdown of the system or for removing ice blockage from the system. The health and safety plan had not been revised to address the use of compressed air.

On December 6, 1994 there was a new Field Coordinator in charge of operations. The person had been appointed to the position on December 5, 1994. In addition to the appointment of a new facility Field Coordinator, there had been a number of recent changes in supervision and management for the project. Following an ERC reorganization on November 21,1994, new persons had been appointed as Area Field Coordinator and Project Manager. The Deputy Project Manager position had been eliminated.

4.7 PIPEFITTER SUPPORT REQUESTED

Shifting from a construction phase into an operational phase required the use of WHC HAMTC employees to perform the work. The plant forces work review process assigned the construction phase of the project to construction forces and the operational support to operations. Once the need for pipefitter support was identified, the Field Coordinator requested a work request be prepared.

Work request 2J-9400099 was issued through the appropriate work control process to "provide

craft support as required to the 100-HR-3 Pump and Treat Facility and to take verbal direction from the Field Coordinator for work to be accomplished."

4.8 PIPEFITTERS START WORK

WHC HAMTC pipefitters were directed to disassemble the effluent pipe at a 90 degree elbow. The Yelomine PVC pipe had a style of coupling that the pipefitters were not familiar with. ICF KH craft had installed the piping. The WHC pipefitters decided they needed additional tools to disassemble the coupling. They returned to 100N for tools and during that time discussed the pipe with ICF KH fitters. They were shown the manufacturer's literature on the pipe before disassembling the coupling.

The following was established from the written statements of the pipefitters and oral statements from the facility operators and facility Field Coordinator.

4.8.1 Energy Control

The pipefitters did not walk the pipe system or assess for themselves the requirement for lock and tag nor did they perform a zero energy check.

4.8.2 Training

The pipefitters started work on the Yelomine PVC pipe without training on the coupler removal procedure or other recommendations by the manufacturer.

4.8.3 Supervision

The Field Coordinator directed the pipefitters to do the work; an adequate safety briefing on the details of the job or the preparation of the jobsite before the work began was not provided. The pipefitters commented they were not sure who to take direction from at the time they reported to the jobsite.

NOTE: The following events did not require analysis:

- EFFLUENT PIPE SEPARATED UNDER PRESSURE
- PIPEFITTERS INJURED
- EMERGENCY NUMBER CALLED
- POST ACCIDENT

5.0 CONCLUSION

5.1 PROBABLE CAUSES

The Management Oversight and Risk Tree-Accident Investigation method of analysis was used to analyze the facts and establish the following.

5.1.1 Root Cause

Management Problem: Policy not adequately defined, disseminated, or enforced.

Management failed to correct deficiencies in operating procedures, employee training, work practices, design, and operation of the system/facility.

5.1.2 Direct Cause

The direct cause was failure to depressurize the 3-inch Yelomine PVC effluent pipe before disassembly.

5.1.3 Contributing Causes

Conduct of Operations played a major role in allowing this incident to occur. The following describe the areas that were "Less Than Adequate":

- Shift Routines and Operating Practices: Roles and responsibilities were not clearly understood by on-site personnel. This was supported by interviews with WHC HAMTC pipefitters working at the facility that indicated they did not know who was in charge or who to take direction from.

- Lockouts and Tagouts: The available energy sources was not locked out. There was no lock and tag implemented during thaw and repair activities.

- Independent Verification: There was no independent verification that the valve line-up at the time of the accident assured that the system was depressurized.

- Log Keeping: The operating log did not keep an accurate account of the system status, activities being performed to thaw the system, or the personnel requested to assist in thawing activities.

- Operations Turnover: The Field Coordinator position was transferred on Monday

before this event. This was not conveyed to the "new" field coordinator or the field operators until mid morning on Monday. The transfer was confirmed through a telephone call with the former Field Coordinator. This was after the former Field Coordinator had directed the operator at the facility through telephone conversations throughout the morning.

- Operation Procedures: Blowdown of the piping between the effluent skid and the injections wells was not addressed in the approved operating procedure. There was not an approved "as-built" Piping and Instrumentation Diagram.

Other factors that contributed to the accident were:

- Safety planning and hazard analyses were less than adequate. The Site-Specific Health and Safety Plan did not address the use of compressed air for blowdown of systems or energy control (lock and tag). Hazards analyses were not conducted for blowdown or thawing of frozen systems.

- Winterization of systems was less than adequate. Insulation and/or heat trace was not provided prior to freezing conditions; water removal from a system with compressed air was inadequate; there was no provision for draining low points in the system.

5.2 JUDGEMENT OF NEEDS

1. DOE Order 5480.19, "Conduct of Operations," needs to be followed in the performance of all operations and maintenance activities.

2. All field personnel should be trained and/or qualified in their position and that process should be documented.

3. Lines of authority and responsibility should be clearly established and a current organization chart posted in the field. It should be conveyed to all personnel visiting the facility that the Field Coordinator is always the final authority for any activity conducted on or at the facility. Direction should be communicated to the craft personnel directly by the Field Coordinator or approved designated alternate.

4. Operating procedures should:

    - be approved and reflect current system conditions.

    - contain directions on how to respond to abnormal conditions.

- be revised to identify how and when lock and tag is required for control of pressurized systems as well as electrical systems.

- be developed to define the facility's log keeping requirements. Each facility should keep a deficiency log documenting the deficiency and the person responsible for correcting the deficiency. Any authorization to continue operations until the deficiency is corrected should be contained in the operating log.

5. Start-up or restart procedures should be walked down by peer operators from another facility.

6. The Site-Specific Health and Safety Plan should be revised to address the current status and operational phases of the facility. This should include hazards analysis for all potential hazards identified.

7. A pre-job safety meeting should be held and documented in the operations control log if any abnormal system condition is involved and before any craft work is performed at the facility.

8. The system design should address environmental conditions such as extreme weather temperatures.

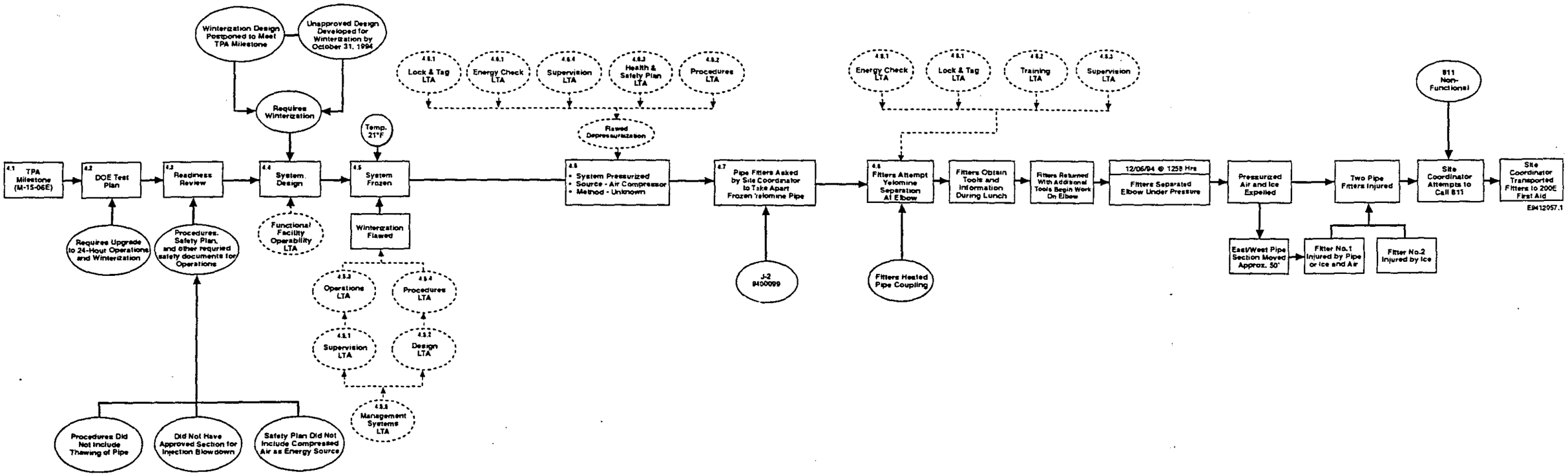
9. Engineering should re-evaluate use of compressed air for blowdown of piping systems. The use of compressed air in frozen or plugged systems should be included in the evaluation.

10. A change control system should be established for design, procedures, and safety concerns. All correspondence concerning matters such as surveillances, corrective actions, and operational issues should use document control numbers to ensure that they become part of the Project File.

11. Oversight findings should be tracked to ensure completion of required actions.

12. Facilities should have a system status board.

Event and Causal Factors Chart



ATTACHMENT 1 9519351291 | 006655

Bechtel Hanford, Inc.
Interoffice Memorandum

Written Response Required? Yes ■ No □
Date Due: 12/28/94

To Distribution

File 5600

Subject **Job 22192**
TYPE "C" ACCIDENT INVESTIGATION TEAM APPOINTMENT

Date December 12, 1994

From J. F. Nemec

Of Vice-President Operations

Copies BHI Doc. Control (H4-79)
E. S. Keen (H4-79)

At Hanford Ext. 5-4646

An incident occurred December 6, 1994 in 100-D Area at the HR-3 Pump & Treat site. Two individuals were slightly injured with minor damage to equipment. However, the potential existed for far more serious consequences. As a result, by copy of this memo, I am appointing you to serve on a team to conduct an investigation of this event. The investigation is to be conducted in accordance with direction provided in DOE Order 5484.1, "Environmental Protection, Safety and Health Protection Information Reporting." The report should fully explain the technical elements of the causal sequences associated with this event and describe the management systems that should have, or could have, prevented the occurrence. The investigation should include, but not be limited to, an evaluation of the issues identified in Attachment 1. The investigation team members are:

Bob Hobbs, ERC Quality, Safety and Health, Chairman
Bruce Tuttle, ERC Quality, Safety and Health
Sheldon Coleman, ERC Quality, Safety and Health
George Carr, ERC Quality, Safety and Health
Tim Quinn, ERC Quality, Safety and Health
Steve Foelber, Design Engineering
Homer Sherman, Field Support
WHC Representative - TBA

This team will immediately begin the investigation and recognize this activity as their top priority. An interim oral report is to be provided to me by December 19, 1994. A formal report is to be submitted to me by December 28, 1994. Please notify me if there are any obstacles to conducting or completing this assignment.

If you have any questions, please call Jim Tarpinian on 375-4667.

J. F. Nemec

JFN:shh

Attachment: Investigation Issues

Attachment 1

INVESTIGATION ISSUES

- What process was used to review and approve the continued operations of the system without winter protection?
- What process was used to review the design of the system?
- Assess the start-up readiness review process.
- What actions were taken in response to E. S. Keen's memo of October 28, 1994 regarding observations made during his tour of the site?
- Were funding constraints a contributing factor?
- Were the roles and responsibilities of all participants clearly defined and understood?
- Was the requirement to achieve operation of the system by a specified date (TPA Milestone) a contributing factor?
- Are standard design/review/operational approaches being consistently applied for similar activities? Specifically, were there different processes at HR-3 vs. the 200 Area Pump and Treat treatability tests?

GENERAL QUESTIONS TO BE ANSWERED FOR THE ASSESSMENT

For each project and/or major work activity in progress, please be prepared to answer the following questions:

1) What phase of the project do you believe you are currently in? (engineering/design, startup, operations, closeout)

2) Based on the phase you are in, is it clear and understood who is in charge and/or who has authorization to perform various tasks?

3) Where is the specific scope of the project defined?

4) Are there multiple tasks going on in parallel for some operations? (This especially applies to the field operations.) Is the specific requirements of each of the multiple tasks defined, i.e., by a work package, design package, etc.; is the definition adequate; is it understood?

5) When the task is complete and affects configuration, how are the drawings changed?

6) Are there procedures that govern the work or specific task?

7) How was the contents of the procedures developed and passed on to the personnel performing the work? Have the procedures been verified in the field?

8) Are there work logs or data entries being recorded? If yes, is it defined how this information should be kept? Is it being maintained according to the definitions/procedures? Do you use a project status board for keeping track of operational deficiencies, inoperable equipment, etc.?

9) Is there a Safety and Health Plan in place; is it specific to the job or generic for the entire project?

10) How are people qualified or trained for the job? What defines the qualifications and training required? How does the person in charge satisfy himself/herself that the person performing the work comprehended the training?

11) Are there pre-job briefings held; how often; what is covered? Are morning "tailgate" meetings held? Are modifications to systems discussed?

12) Does every member of the work team have a sense of management expectations with regard to Conduct of Operations?

13) Do the supervisors know what procedural compliance means? Are they practicing it? Does the team know how to get a procedure changed, a work package changed, etc.?

14) Are there radiological surveys being conducted? If yes, are they using current radiological procedures, standard practices. etc.?

15) Has management visited the work site? If yes, did they debrief the person in charge?

16) Do you have a system/procedure in place to address off-normals, occurrences, etc.? Do you routinely hold emergency drills?

17) Do you have active energy sources on your job? If so, what are they, i.e., electrical, steam, etc. Do you maintain a lock and tag log? Do you have a lock and tag procedure? Who is your lock and tag authority?

18) Where are controlled drawings maintained? Where are the field copies of these maintained? Do they reflect the most current condition of the project/operation?

19) Do you have craft personnel working on the job? If yes, how are they provided direction to perform work?

20) What do you believe you and your work team need to do your job better, i.e., faster, safety, more efficient?

NOTE:

THESE QUESTIONS SHOULD BE ANSWERED BASED ON WHAT YOU ALREADY ARE DOING!! DON'T GO OUT AND CREATE SOMETHING NEW OR CHANGE SOMETHING JUST FOR THIS ASSESSMENT!!

JOB NO. 22192

ERC TEAM SAFETY/HEALTH MEETING REPORT

I certify that the attached safety meeting information was read and explained to the personnel in attendance indicated by their signatures below:

SUPERVISOR (PRINT AND SIGN)	GROUP	DATE

WHERE MEETING WAS HELD	TIME MEETING WAS HELD

NAMES AND EMPLOYEES OF PERSONNEL ABSENT

TOPICS DISCUSSED

Corrective action taken by _____ for above listed safety questions, concerns, and/or recommendations on

_____.
Date

EMPLOYEE NO.	EMPLOYEE'S NAME	EMPLOYEE NO.	EMPLOYEE NAME

ROUTE THIS REPORT IN THE FOLLOWING ORDER

1. SUPERVISOR TO COMPLETE 2. RETURN TO AREA SAFETY MANAGER