Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221

OCT 1 5 2004

Dr. Steven D. Warren, General Manager
Washington TRU Solutions, LLC
P. O. Box 2078
Carlsbad, NM 88221

Re: Type B Accident Investigation Board Report

Dear Dr. Warren:

As the appointing official, I accepted the report, *Type B Accident Investigation Report of the August 25, 2004, Head Injury to Miner at the Waste Isolation Pilot Plant, Carlsbad, New Mexico*, on October 8, 2004. The Board, established on September 3, 2004, fulfilled it responsibilities with respect to its investigation.

The Board identified, pursuant to DOE Order 225.1A, *Accident Investigations*, conclusions and judgments of need for corrective action by WTS. These are described in the Executive Summary and in the Conclusions/Judgments of Need in Table 1. To address the judgments of need, WTS management must prepare and transmit its Corrective Action Plan (CAP) to me within thirty (30) days.

The points of contact for this report are Don Galbraith, 505-234-8365, and George Basbilvazo, 505-234-8013.

Sincerely,

R. Paul Detwiler
Acting Manager

Enclosure

CBFO:OOM:DG:KJB:04-0469:UFC:1000

cc: w/enclosure
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I. Triay, EM-3
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CBFO:OOM:DG:KJB:04-0469:UFC:1000

Final Report **October 2004**

Type B
Accident Investigation Board Report
On the August 25, 2004
Head Injury to Miner
Waste Isolation Pilot Plant
Carlsbad, New Mexico

Carlsbad Field Office

Type B
Accident Investigation Board Report
of the August 25, 2004
Head Injury to Miner
at the
Waste Isolation Pilot Plant
Carlsbad, New Mexico

October 2004

Carlsbad Field Office
U.S. Department of Energy

This report is a product of an Accident Investigation Board appointed by R. Paul Detwiler, Acting Manager, Carlsbad Field Office, Department of Energy.

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

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

This report neither determines nor implies liability.

On September 3, 2004, I established a Type B Accident Investigation Board to investigate the injury of a miner at the Waste Isolation Pilot Plant located in Carlsbad, New Mexico.

The Board's responsibilities have been completed with respect to this investigation. The analysis process; identification of direct, contributing and root causes; and development of judgments of need during the investigation were done in accordance with DOE Order 225.1A, *Accident Investigations*.

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

R. Paul Detwiler
Acting Manager
Carlsbad Field Office

Prologue

On August 25, 2004, an employee of Washington TRU Solution, LLC (WTS) sustained a head injury when he was struck by a C-clamp and rope attachment that broke loose from a piece of metal vent line that was being dragged. This occurred as part of the development and recovery of an existing drift for underground disposal of waste at the Waste Isolation Pilot Plant (WIPP).

The activities performed at WIPP involve mining and other operations that can present varied and significant hazards. It is imperative that the core functions of Integrated Safety Management (ISM) are implemented at all levels. The Type B Accident Investigation Board found that the WIPP program needs to fully perform work scope identification, stop work process, and feedback implementation. CBFO must assure, through the oversight of the management and operating contractor, that this is done and that performance is satisfactory.

Continuous improvement in the WIPP safety program and improved performance are our goals. My expectation is that all work supporting the WIPP's mission will be done only when it can be done safely.

R. Paul Detwiler
Acting Manager
Carlsbad Field Office

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Acronyms and Initialisms

CBFO	Carlsbad Field Office
CH	Contact Handled
DOE	Department of Energy
E1	Employee One
E2	Employee Two
E3	Employee Three
E5	Employee Five
E7	Employee Seven
E8	Employee Eight
E9	Employee Nine
E12	Employee Twelve
FR	Facility Representative
FY	Fiscal Year
HCA	Head of Contracting Authority
ISH	Industrial Safety and Hygiene
JHA	Job Hazard Analysis
LHD	Load Haul Dump
LTA	Less than adequate
M & O	Maintenance and Operations
MGC-1	Mining and Ground Control Manager 1
MGC-2	Mining and Ground Control Manager 2
MGC	Mining and Ground Control
MRT	Mine Rescue Team
MSHA	Mine Safety and Health Administration
NRC	Nuclear Regulatory Commission
OA	Office of Independent Oversight
SCBA	Self Contained Breathing Apparatus
SIMON	Standardized Work Instruction of Maintenance and Operations
WIPP	Waste Isolation Pilot Plant
WTS	Washington TRU Solutions, LLC

I. Executive Summary

A. Introduction

An injury accident was investigated in which a Washington TRU Solution, LLC (WTS) employee was struck by a C-clamp and rope attachment that broke loose while pulling a piece of metal vent line.

B. Accident Description

The accident occurred at approximately 8:45 am, on August 25, 2004, at the Waste Isolation Pilot Plant (WIPP) when an employee was struck when a C-clamp and rope attachment broke loose while pulling a piece of metal vent line.

The employee was transported to a medical center in Carlsbad, New Mexico and after initial examination was airlifted to a medical facility in Lubbock, Texas for treatment. He was kept overnight for tests and observations and released the next day.

C. Direct, Contributing, and Root Causes

The direct cause of the accident was the impact to the employee's head by a C-clamp pulled from a metal vent line by an attached rope.

The contributing causes of the accident were:

- Management could not assure that the MRT work scope was identified or properly integrated into the work package for safely removing vent lines and other debris.
- Hazard analysis was less than adequate.
- Review of work package was less than adequate.
- Without invoking stop work, work was allowed to continue without being adequately analyzed.
- Workers knowledge to move metal vent line was less than adequate.

The root causes of the accident were:

- Planning for moving the vent lines was less than adequate.
- Work proceeded without proper tools, equipment, methods, and conditions to conduct the work safely.

D. Conclusions and Judgments of Need

The Board identified several conclusions and 6 judgments of need. These are identified in Table ES-1.

Table ES-1: Conclusions and Judgments of Need

Conclusions	Judgments of Need
• Continuous accountability for conduct of the work was not provided at the work site. • Stop work actions failed to be implemented because no one was in charge at the work site to whom to go to express concerns. • Workers placed more emphasis on continuing the job than on safety concerns. • Several workers discussed stopping work, but no one took action.	• WTS needs to establish a program to provide a formal Person-In-Charge program, or the equivalent, to assure that safe work practices accomplish work package objectives.
• Work scope was not fully identified to assure the work package addressed all aspects of the work. • WTS has not met the training requirements in 30 CFR 49.8(b)(1). • Work scope did not integrate MRT training session and regular mine operations work. • Hazard analysis could not be complete without work scope being adequately defined. • Controls could not be developed to address hazards, which had not been identified. • Work package did not contain methods to safely conduct the work. • Work could not be conducted safely with inadequate scope, hazard analysis, or the development of controls. • Feedback provided by inspections and incidents has not resulted in an effective change in the hazard identification and mitigation process.	• WTS needs to strengthen its ISM program to fully identify work scope and hazards; plan, control, and conduct work safely; and effectively address improvement opportunities when developing work packages. • WTS needs to better communicate work scope involving multiple work groups to integrate safe work practices. • WTS needs to adhere to the training requirements contained in 30 CFR 49.8.

Conclusions	Judgments of Need
• WTS management has not effectively used feedback to provide complete hazard identification for work. • Management did not confirm that planning/integration of the work was completed following the August 11, 2004 meeting. • Coordination of MRT training session and regular mine operations work was less than adequate. • MPs 1.2 and 1.12 were not implemented during work performance.	• WTS management needs to focus attention on hazard identification and work performance at the activity level.
• Implementation of hazard recognition and accident prevention training was not utilized in the work.	• WTS needs to assess the effectiveness of hazard recognition and accident prevention training.

II. Introduction

A. Appointment

On August 25, 2004 at approximately 8:45 am a WTS employee working at the WIPP site was struck in the head by a 5.5 pound C-clamp propelled by a stretched rope. A 20' section of steel vent line was being moved with a Load Haul Dump (LHD), an underground mining vehicle (Figure 8), using the rope and C-clamp to pull the vent line. The worker was transported by ambulance to the Carlsbad Medical Center and subsequently air lifted to a Lubbock, Texas medical center. He was kept overnight for observation and tests and was released the following day.

On September 4, 2004, R. Paul Detwiler, Acting Manager of the Carlsbad Field Office (CBFO) appointed a Type B Accident Investigation Board to investigate the accident in accordance with DOE Order 255.1 A, "Accident Investigations."

B. Facility Description

The United States Department of Energy (DOE) was authorized by Public Law 96-164, "Department of Energy National Nuclear Security and Military Applications of Nuclear Energy Authorization Act of 1980," to provide a research and development facility for demonstrating the safe permanent disposal of transuranic (TRU) wastes from national defense activities and programs of the United States exempted from regulations by the U.S. Nuclear Regulatory Commission (NRC). The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico near Carlsbad, New Mexico, was constructed to determine the efficacy of an underground repository for disposal of TRU wastes. Disposal operations began in 1999 and are scheduled to continue for 35 years.

The site is operated by Washington TRU Solutions, LLC, and managed by the DOE CBFO. The facility is under the programmatic direction of the Department of Energy Office of Environmental Management.

Contact Handled (CH) wastes are disposed of in the 100-acre (.04 km^2) disposal area on a horizon located 2,150 ft (655m) beneath the surface in a deep-bedded salt formation. Waste is transferred from the surface to the disposal horizon through a waste shaft using a hoisting arrangement.

Vertical shafts, including the waste shaft, the salt handling shaft, the exhaust shaft, and the air intake shaft, extend from the surface to the underground horizon as shown in Figure 1. These shafts are lined from the shaft collar to the top of the salt formation, approximately 850' (259m) below the surface, and are unlined through the salt formation.

The WIPP underground consists of waste disposal area, construction area, north area, and the waste shaft station area.

The principal operations at the WIPP involve (1) the receipt and disposal of TRU waste, (2) and the mining of underground rooms in which the waste is disposed. In the underground, the waste containers are removed from the waste hoist conveyance, placed on the underground transporter, and moved to a disposal room. In the disposal room, the containers are removed from the transporter and placed in the waste stack.

The preparation of underground rooms at the WIPP is accomplished through conventional underground mining methods. Mining is performed using continous mining machines. The mined salt is loaded into haul trucks, transported to the salt conveyance, and removed from the underground by skipping it to the surface using the salt conveyance. At the surface, the mined salt is loaded onto dump trucks, transported to a salt disposal cell, and deposited in the cell. Operations underway at the time of the accident were part of the preparation to continue mining E-140 drift south to support development of underground disposal Panel 4.

C. Scope, Purpose and Methodology

The Board began its activities on September 8, 2004, and completed its investigation on September 25, 2004. The scope of the Board's investigation was to identify all relevant facts; analyze the facts to determine the direct, contributing, and root causes of the event; develop a conclusion; and determine Judgments of Need for action that, when implemented, should prevent recurrence of the incident. The investigation was performed in accordance with DOE Order 225.1A, *Accident Investigations*, using the following methodology:

- Facts relevant to the event were gathered through interviews, reviews of documents and other evidence, including photographs and visits to the event scene.

- Facts were analyzed to identify the causal factors using event and causal factors analysis, barrier analysis, change analysis, root cause analysis, regulatory compliance analysis, and ISM analysis.

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

Accident Investigation Terminology

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

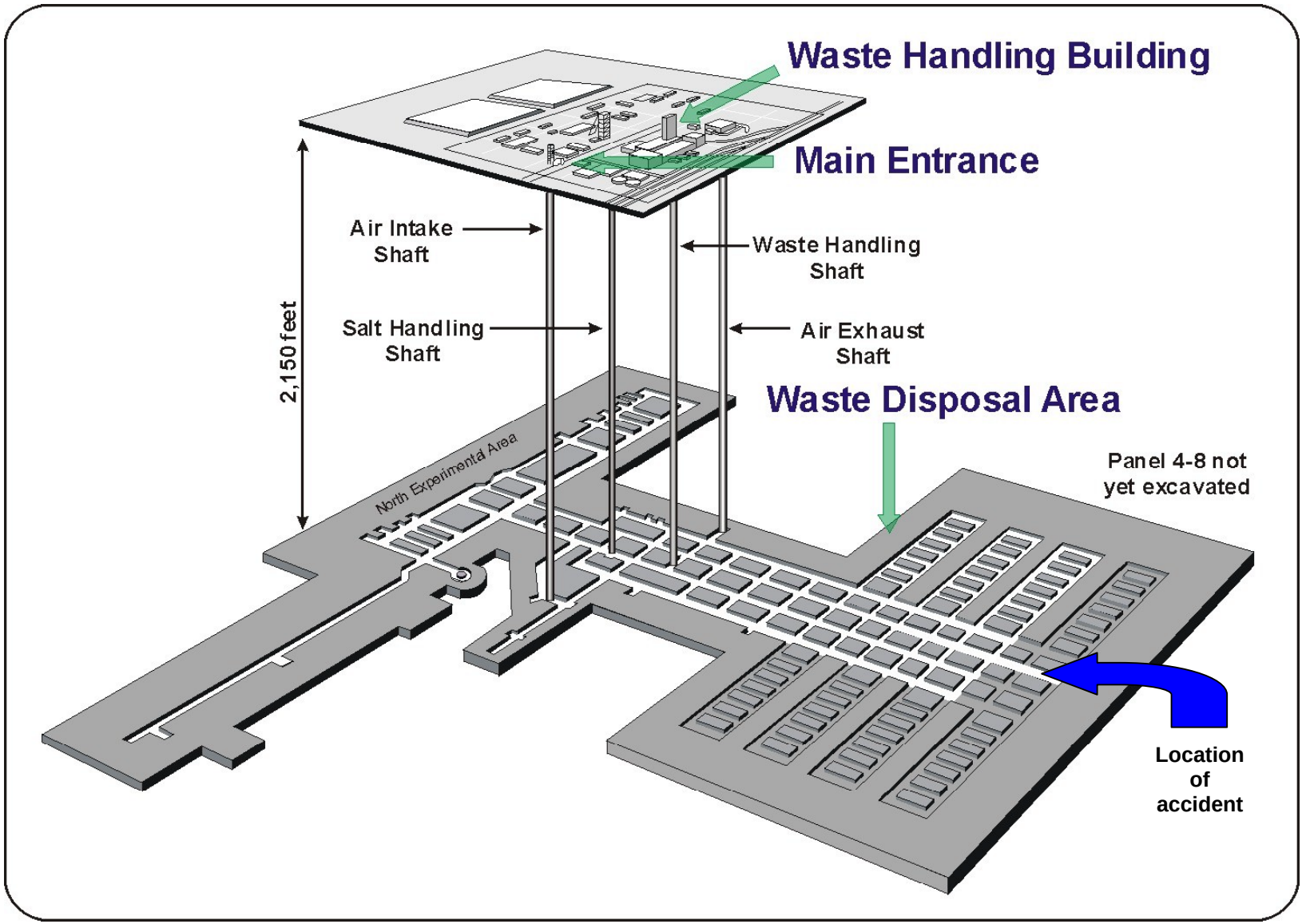

Figure 1: Location of the accident scene

- **Event and causal factors analysis** includes charting, which depicts the logical sequence of events and conditions (causal factors that allowed the even to occur), and the use of deductive reasoning to determine the events or conditions that contributed to the accident.
- **Barrier analysis** reviews the hazards, the targets (people or objects) of the hazards, and the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.
- **Change analysis** is a systematic approach that examines planned or unplanned changes in a system that causes the undesirable results to the accident.
- **Root cause analysis** is a technique that identifies the underlying deficiencies that, if corrected would prevent the same or similar accidents from occurring.
- **Judgments of Need** are managerial controls and safety measures necessary to prevent or minimize the probability or severity of recurrence of an accident.
- **Requirements verification analysis** is a forward/backward analysis process to ensure that all portions of the report are accurate and consistent from the flow of facts to analysis to conclusion and Judgments of Need.

III. Facts

A. Background

1. Similar Operations

The El Paso drift had been closed for over ten years when reentry under Work Order 0407479 was planned. Metal vent line was commonly used in the WIPP underground during that time about 10, or more, years ago. This is consistent with the fact that most employees interviewed had not seen or worked with metal vent line, and consequently were not familiar with moving it. Those who did report some experience with moving the metal vent line had done it by directly attaching the end of the vent line to the LHD bucket or pulling it with a strap around the vent line. None remembered removing it with a rope and C-clamp attached to the LHD bucket or elsewhere.

Note: A drift is a mined underground opening used for travel and transporting material.

2. ORPS

a. ALO-WTS-WIPP-2003-0001, "Near Miss to Personal Injury"

This report, documenting an injury of a WIPP underground maintenance employee, resulted in a safety meeting with the affected crew which 1) stressed that safety must come before production, and 2) that supervisors should implement the principles of safe job performance by adequately identifying hazards and appropriate mitigations. The WIPP Site's Lessons Learned Committee published

and distributed a lessons learned bulletin (LL03-39) describing this event and the steps necessary to preclude its recurrence.

b. ALO-WTS-WIPP-2003-0002, "Minor Personnel Injuries"

This report was a roll up of three incidents that occurred in April and May 2003. This occurrence report resulted in a stand down for all underground work during which management emphasized to workers the importance of attention to detail to maintain safe and effective operation of equipment. CBFO FR concurred with contractor analysis that fluctuations in number of accidents were due to statistically random variations.

3. Assessments

a. 2002 Office of Independent Oversight and Performance Assurance (OA) Inspection

In August 2002, OA performed an inspection of Environmental, Safety and Health management. OA identified that the work control process for some underground operations was not sufficiently documented to ensure that all hazards were adequately identified, analyzed and documented.

A corrective action plan was developed. Actions included the development of implementing procedures to institutionalize the documentation of hazard analysis for underground operations to ensure appropriate controls for all underground activities. This action was closed through revision of procedure WP10-WC3011, Maintenance Process.

b. WIPP Assessment of Job Hazard Analyses (JHA)

In June 2004, an assessment was done to evaluate the adequacy and usefulness of JHAs in identifying hazards and mitigating site hazards. It described the process for identifying hazards for work packages in the following manner:

> The cognizant engineer performs a walk down of the area, then writes the work order using Standardized Work Instruction of Maintenance and Operations (SIMON) software package. The writer then identifies the hazards of the work and the software provides mitigating actions. The SIMON system further requires the writer to review a standard list of hazards to ensure all hazards are identified. The Board reviewed this hazard list. It did not include potential energy as a possible hazard.

The assessment concluded that the process is adequate to ensure "work is maintained within the appropriate margins of safety." However, the revision of SIMON software, communication and employee training and qualification is important to ensure that effective JHAs are developed for work at WIPP.

The assessment identifies one example of a JHA, which was not specific enough to provide protection for the worker.

4. Contract Performance

The management and operating (M&O) contractor's contract contains provisions for performance based incentive fee. With approval from the Head of Contracting Authority (HCA), CBFO withheld $100,000 of the available fee from WTS for less than satisfactory safety performance, due to the number of injuries during the third quarter of Fiscal Year (FY) 2003. This was done with a provision that the withheld fee would be paid to WTS during the first quarter of FY 2004 if WTS sustained a favorable safety trend through the 4th quarter of FY 2003.

The number of recordable injuries decreased in the fourth quarter of FY 2004; however, CBFO management continued to have concerns on WTS safety performance, and there were several near misses. Therefore, CBFO, with concurrence by the HCA, only returned one half of the fee in December 2003. CBFO identified further improvement in WTS safety performance during the 1st quarter of FY 2005, and the remaining fee was returned in March 2004.

5. Training

To meet the requirements of DOE Order 5480.20A, "Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities," ongoing training is provided by training courses SAF 650, "Hazard Recognition and Accident Prevention" and MAS 123, "Industrial Safety."

Hazard Recognition and Accident Prevention training was provided for all WTS site employees during the third and fourth quarters of FY 2003. This was one of 8 actions in response to a CBFO letter, dated May 12, 2003, concerning the high incidence of recordable injuries in the 1st four months of CY 2003.

The mine rescue training records show that the last underground mine rescue training was conducted in February 2003. Mine Safety and Health Administration (MSHA) regulations (30 CFR Part 49.8) require this type of underground training sessions to be conducted each six months.

B. Accident Chronology

In July 2004, a request was made to allow the Mine Rescue Team (MRT) to participate in work scheduled to clean out the south end of E-140 ("El Paso") drift. This was part of the overall task to continue development of the E-140 south main drift. This would allow the MRT to satisfy an MSHA underground training requirement and to provide new MRT members an opportunity to practice and improve team performance and proficiency in actual underground conditions.

This request was initially not approved by the Washington TRU Solutions, LLC (WTS) Industrial Safety and Hygiene Manager, because of concerns about entry of the area by the MRT personnel prior to inspection for ground conditions and air quality by mine and ground control personnel.

On August 11th, a meeting was held involving the Repository Development Project Manager, Radiation Safety and Emergency Management Manager, Industrial Safety and Hygiene (ISH) Manager, Underground Operations Manager, MRT Coordinator, a representative of the Industrial, Safety and Health team, and some MRT members. The purpose of the meeting was to discuss incorporating a MRT training session into a work package. Compressed gas cylinders, located in the refuge chamber at the south end of E-140 drift, were to be retrieved as the main purpose of the training. CBFO was not fully informed of the meeting or of the planned underground training session.

As a result of the meeting, it was decided to allow the MRT to recover the compressed gas cylinders as part of the training session. Then, the mining process would continue. The following conditions were adopted:

- The work package prepared for this work would contain a safety briefing and hazard analysis.
- Mining and ground control personnel would enter the area to ensure ground conditions and air quality were safe.
- If ground control and air quality were satisfactory, then the MRT would be allowed to enter the area and recover the cylinders.
- If the conditions were not satisfactory, then the team would not be allowed to enter.

There was no discussion at the meeting of the MRT moving other excess debris in the area, including fiberglass and metal vent line. The August meeting did not result in requiring a written "exercise" plan for the proposed mine rescue training. A member of the mine engineering group was tasked to prepare a work package for the work that would include the opportunity for mine rescue personnel training.

On August 17th, an Action Request, "2004 El Paso Drift Re-Entry," was completed by the work planner in accordance with WP10-WC3011, Rev. 14, "Maintenance Process," dated October 21, 2003. Section 5 of the Action Request, which indicates the type of work, was not signed by the Zone Maintenance Manager.

The work planner then prepared Work Order 0407479, "2004 El Paso Drift Re-Entry," using the SIMON template. The scope of the work to be done by this work order included:

- removal of stock-piled muck
- establish ventilation
- determine roof beam conditions and remediate as necessary
- retrieve abandoned materials and equipment

The equipment list in the work order did not include a Kubota tractor, the nylon rope, board, and C-clamps used in the work.

WP10-WC3011 requires that the work order be written per WP10-2, "Maintenance Operations Instructions Manual," June 2, 2004. Page 3, Precautions, of WP10-2 requires a JHA "to alert procedure users to actions and conditions that…establish abnormal conditions." Three hazards were identified: rotating hazards, noise hazards and ground control hazards. There was no mention in the work order of hazards associated with movement of the metal vent line. This particular work had not been done in several years. When interviewed by the accident investigation board, miners said that they had moved fiberglass vent line, but had not moved metal vent line.

Step 8.2.6 of the work order is a hold point to determine if the drift is safe. Based on this determination, a decision to conduct the mine rescue exercise was to be made.

Step 8.2.7 states that "whether or not it is decided to conduct a mine rescue exercise within the newly obtained drift the remaining work will still be required to be completed by either the Mine Rescue Team or the regular mine operations personnel."

No drill plan was provided for the MRT training session or included in Work Package 0407479 as required by WP 12-ER3004 and WP 12ER-01.

Per Step 8.2.7.2 of the work order, the removal and disposal of abandoned materials and equipment was to be done "in accordance to approved WIPP procedures." No specific Safety Analysis Sheets (SAS) or applicable procedures were identified for removal of the materials including the metal vent line.

On August 23rd, members of the MRT and underground operations personnel performed a walk down of the work area. The area under the brow, the point where the mine ceiling steps down to the lower level (Figure 2), where abandoned materials and equipment were located was not entered during the walk down.

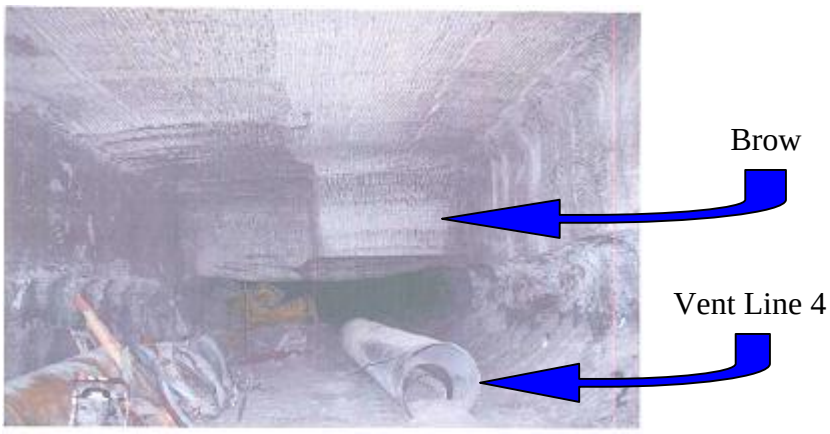

Figure 2: Looking South in Drift E-140

The work order review and approval was completed August 24, 2004. The review included craft and MRT personnel, Industrial Safety and Hygiene personnel, and the Mining and Ground Control (MGC) Managers. No additional hazards were identified or included as a result of the review.

On August 24th, a pre-job safety meeting was held prior to beginning operations under Work Order 0407479. It was attended by three mining operations personnel and was given by a MGC Manager. Items discussed were warning signage, communications, ventilation, personal protective equipment, ground conditions, stop work authority and vent line. The particular hazard identified for the vent line was heavy lifting and the mitigation was "use proper lifting practices, use mobile equipment when possible-more man power if needed." No additional hazards were identified according to the MGC Manager.

Following the pre-job safety briefing on August 24th, proper ventilation was assured and ground conditions checked in the low back (or mine ceiling) area at the south end of E-140 drift. The MGC Manager noted both metal and fiberglass vent line sections, but did not relay the information to MRT members and mine operations personnel conducting the work on August 25th. The MGC manager had no concerns at the time. Mine Operations personnel removed several sections of fiberglass vent line from under the brow and placed them along the East rib approximately 30' outside the brow. An area under the brow on the west side was mined out to improve ground conditions.

On August 25th, at approximately 5:30 am, workers arrived at the site. Members of both mine rescue teams, the "blue" team and the "silver" team, collected Self Contained Breathing Apparatuses (SCBA) and staged this equipment at the Waste

Handling Shaft collar prior to going underground. At 5:45 am, the Underground Operations Manager held the regularly scheduled pre-shift meeting. It was attended by underground managers, ISH representative, and representatives of the MRT. Underground work for the day was discussed. The moving of the vent line in the E-140 drift was not specifically discussed at this meeting. At about 6:00 am, miners and MRT members proceeded underground. The two MGC Managers went to the work area for a final walk down about 6:20 am.

At 7:00 am, the morning Plan of the Day meeting was held. Work Order 0407479 appeared on the work schedule for work on August 25th.

Also, at about 7:15 am, a pre-job briefing for MRT members began at the work site, conducted by an MRT member, ISH representative, and both MGC Managers. According to the report of the meeting, the issues discussed were: proper use of personal protective equipment, ground conditions, lifting hazards, stop work, communications and tripping hazards. No specific mention of how to move metal vent lines was documented.

After this meeting, the MGC Managers went to the South 1000 lunchroom underground to conduct a briefing for mining personnel. No record of this briefing was made; however, work assignments were made and hazards discussed, with no specific mention of how to move metal vent lines. After this briefing, the miners assigned to the E-140 drift work site went to the worksite.

Figure 3 depicts the work site where the accident occurred. It illustrates the various objects present at the site, and shows the number identifying each worker at the work site and their positions at the time of the accident.

After the pre-job brief at the work site concluded, the MRT began its training session. The “blue” team donned SCBAs and entered the drift area under the brow. They checked ground conditions and air quality and worked back to the area where the compressed gas cylinders were located. Finding the cylinders to be in good condition, the “blue” team removed the cylinders from under the brow area for subsequent disposition. They also removed a brattice bulkhead in the same area. Upon completion of these tasks, which took about 30 minutes, the “blue” team removed their SCBAs, but remained in the area of the drift.

The “silver” team donned SCBAs and entered to the area under the brow, where they took down and removed a section of line brattice, which took about 20 minutes. The “silver” team removed SCBAs and remained in the area. MRT members removed several sections of fiberglass vent line by hand. The fiberglass sections are equipped with handles and weigh about 140 pounds each. The sections were moved out from under the brow but were staged in the drift for later removal. MRT members were able to remove one section of metal vent line (weighing about 460 lbs.) by hand and placed it along the left wall, or rib, just outside the brow. This task was physically difficult for MRT members to do.

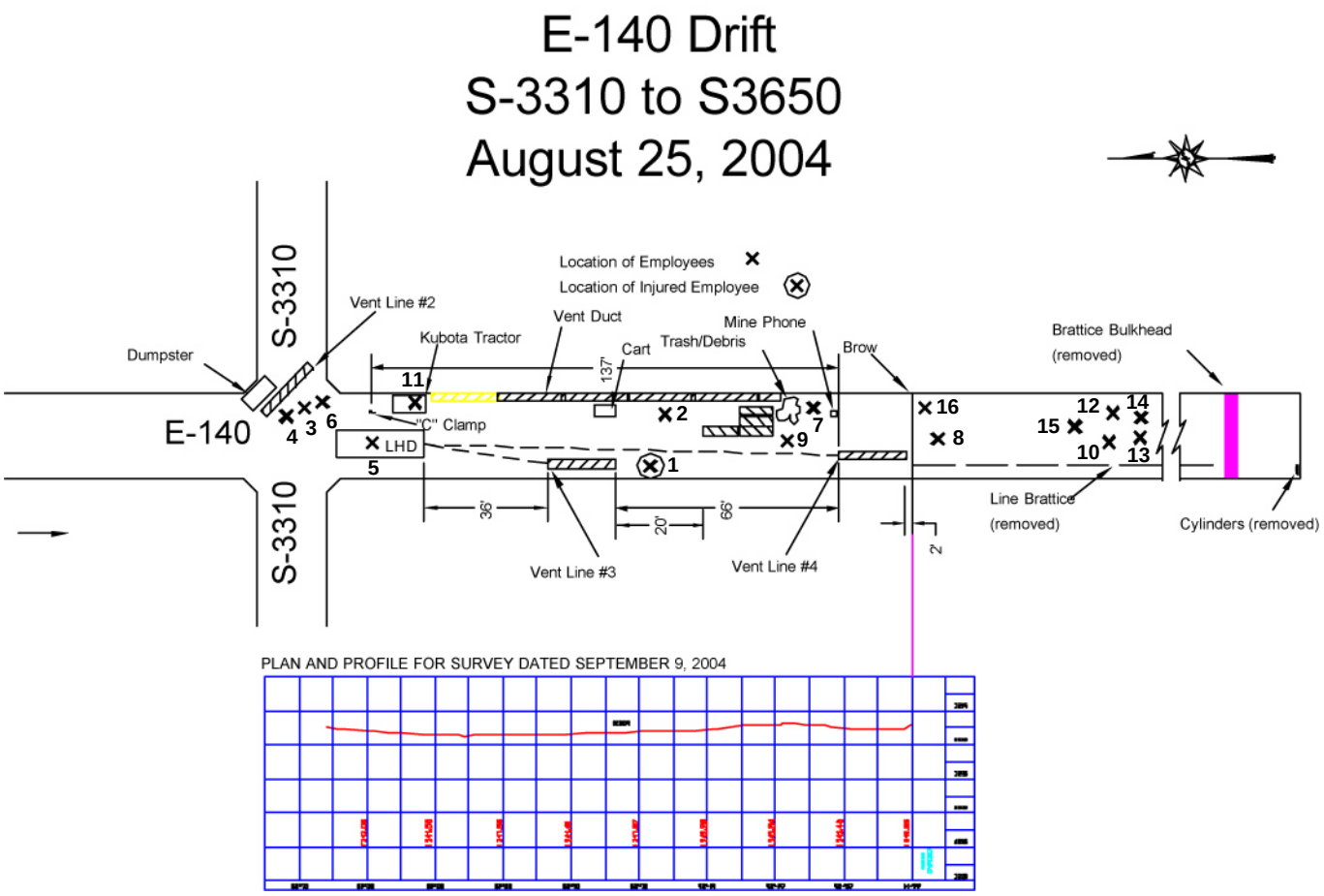

Figure 3: Schematic of Drift and Elevation Map

The work order does not make clear at what point the MRT training session was to have ended. MRT members interviewed felt the work was going well and they were ready to help complete the removal of the abandoned materials and equipment under the brow. The work order was worded such that MRT members could participate in the remaining work. Workers interviewed all agreed that for the work accomplished to this point, the MRT captains were in charge under the brow.

The miners arrived at the worksite between 7:45 and 8:00 am. MRT members had already removed the compressed gas cylinders and were in the process of removing the brattice. As MRT members removed brattice from under the brow, miners took it to a dumpster brought to the site. Workers interviewed generally agreed it was not clear who was in charge of the entire worksite after the arrival of the miners. They believed the MGC Manager was in charge of the work outside the brow and that the MRT captain was in charge in the area under the brow, even after the MRT members removed SCBAs and continued to work under the brow. When the MGC Manager was not present at the worksite, workers were unsure who was in charge outside the

brow. There was no process for identifying a person in charge when the MGC Manager is not at the worksite. Some workers interviewed believed employee 1 (E1) was in charge of the work outside the brow; others were unsure.

The first metal vent line (36" diameter x 20' long) was removed from the E-140 work site area south of S-3310 to S-3650 using the Kubota tractor (Figure 4) and its attached hitch mechanism. A nylon rope (1/2" diameter) was double wrapped around the circumference of the vent line using half-hitch (or timber hitch) knots.

Figure 4: Kubota Tractor

Pipe wrenches were used to guide the metal vent line as it slid. A board 1" X 8" x 6' long was placed under the vent line at the brow to aid in sliding. Because of difficulties in holding the wrenches in place, 8 C-clamps were ordered by MGC-1 to be used as handles to guide the vent line. The work package contained no procedure or instructional steps indicating how to secure, or move the vent line or how the nylon rope would be attached to the Kubota tractor's hitch. The work package equipment list did not include use of the Kubota tractor, nylon rope, board or C-clamps. The vent line being moved was metal rather than fiberglass. Mining operations in the past had not involved moving metal vent line by methods used for this work activity. There were 16 workers at E-140 work site area, which included a mix of mine operations personnel and MRT members. The MRT members working under the brow believed they were supporting mine operations personnel in removing vent line sections from the work site.

At approximately 8:15 am, MGC-1 directed E5, to bring a Load Haul Dump (LHD), Figure 8, for moving nested metal vent line sections. Employee 8 (E8) and MGC-1 discussed using C-clamps as handles rather than pipe wrenches, but this was not communicated to MRT members under the brow. When the ordered LHD had not arrived by 8:30 am, MGC-1 left the worksite to check on its status. It was unclear to workers not under the brow, who was in charge when MGC-1 left the worksite area.

Mine Operations employees in the worksite area recognized the Kubota tractor was inadequate to pull heavier metal vent line sections, because the tractor lost traction in

the loose salt and uneven haulage surface. Mine operations employees intended to use the LHD, which was included in the work package, in place of the Kubota tractor. Workers also realized the nylon rope being used had been severely abraded (Figure 5) by being wrapped around the vent line and dragged on the rough floor. Because the rope was abraded when moving the first vent line, a discussion was held among workers under the brow. Some concerns were expressed, but it was decided to attach rope using a C-clamp rather than the timber hitches as on the first vent line. Employees did not utilize stop work.

Figure 5: Rope used to pull Vent Line 1

The MRT members prepared Vent Line 2 (36" x 20' long) and pulled it from under the brow using the Kubota tractor. Vent Line 2 was connected to the Kubota tractor with ½ inch nylon rope that was tied at one end to the hitch of the tractor and tied at the other end to a C-clamp attached to the vent line. The C-clamp, (Figure 6) weighed approximately 5.5 pounds, was attached to Vent Line 2 though a hole punched in it about 5 or 6 inches from the end of the vent line. The C-clamp was used, because MRT members believed that using the nylon rope tied directly through the hole punched in Vent Line 2 could cause the rope to be cut by the sharp edges of the hole. Vent Line 2 was moved to and left at, the intersection of E-140 and S-3310. The C-clamp was removed by mine operations personnel.

WTS workers started moving Vent Line 3 (36" x 20' long) using the Kubota tractor to pull it. Workers used an axe to chop a hole approximately 8" from the end of Vent Line 3, through which a C-clamp was attached without being closed, like a hook (Figure 7). The rope used to pull the vent line with the tractor was tied to the C-clamp.

Vent Line 3 reached the brow, and the Kubota tractor being used to pull it lost traction and bogged down. It was decided that the tractor was unable to pull the vent line further. The LHD (Figure 8), operated by E5, which was much heavier and more

powerful than the Kubota tractor arrived at the work site to be used in place of the Kubota tractor for pulling the vent lines.

Figure 6: C-clamp on the floor of E-140 following the accident

Figure 7: C-clamp still attached to Vent Line 3

Figure 8: Example of an LHD

Workers removed the nylon rope from the Kubota tractor and secured it to the LHD. This was accomplished by tying an over hand knot along the length of the doubled rope. The resulting loop was placed though a hole situated in the LHD bucket, and an axe handle was used to prevent the loop from pulling back through the hole. One end of the rope was connected to a C-clamp attached to Vent Line 3 and the other end was connected to a C-clamp attached to Vent Line 4 (36" x 20' long). Vent Line 3 was situated 40' and Vent Line 4 was situated 100' from the LHD (see Figure 3).

Workers used an axe to chop a hole approximately ½" from the end of Vent Line 4 (Figure 9 shows where the C-clamp ripped out of the aforementioned hole), through which a C-clamp was attached, like a hook, then closed. Two other sections of smaller diameter metal vent line had been inserted into Vent Line 4 (Figure 10) to speed up removal of the vent line from under the brow. This nested arrangement of vent lines weighed approximately 890 lbs., making the nested arrangement almost twice as heavy as Vent Line 3. Although not aware that he was pulling two vent lines, E5 began pulling Vent Lines 3 and 4 with the LHD, and successfully moved the two vent lines for approximately 40'. At this point, Vent Line 4 began to dig into the floor (Figure 10) of the drift near the area of the brow where a slight incline existed. The LHD operator could not feel any resistance associated with pulling two vent lines or see where they were situated. E5 was depending upon the light signals given by Employee 9 (E9), the spotter for E5. The continuing pulling action resulted in the rope lengths being stretched. The work package authorizing this work contained no procedures for moving vent line or any detailed information regarding associated hazards.

During the pull, E1 was standing at the south end of Vent Line 3. E1 warned Employee 7 (E7) to move away from the rope used for pulling Vent Line 4. At about the same time, Vent Line 4 began to dig into the floor, and E9 saw the C-clamp begin to rip out of the end of Vent Line 4.

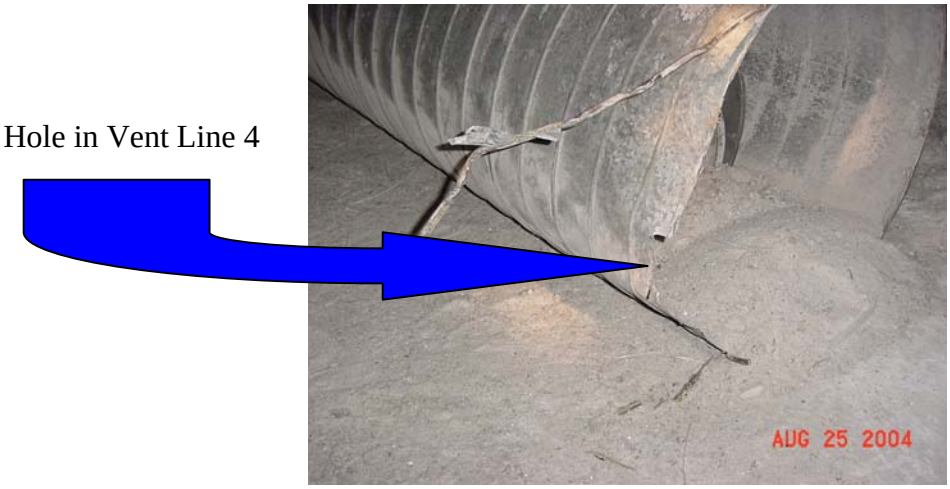

Figure 9: End of Vent Line 4

Figure 10: Inside Vent Line 4

E9 yelled for E5 to stop pulling. However, E5 was driving the LHD in reverse and was looking back at the time the C-clamp came loose. In addition, E5's attention was split between watching E9 and the path on which the LHD was moving. E5 was wearing hearing protection, as required, because the LHD operator environment is noisy. E5 did not hear the warning or immediately see any miner's lamp signal directing him to stop.

E1 turned his head southward in response to E9's warning. The C-clamp, still connected to the nylon rope, broke free from Vent Line 4 and shot forward in a northerly direction carrying the rope with it. The energy stored in the rope propelled the C-clamp, which weighed approximately 5.5 pounds, forward approximately 65'

where it struck E1 on the left side of the head and came to a rest about 85' beyond E1. The rope between the LHD and Vent Line 3 remained intact.

E5 turned back and saw E1 falling to the ground, and stopped the LHD at once. However, E5 realized he would need to move his equipment for the ambulance to get into the area. Unaware he was still connected to Vent Line 3, E5 began moving the LHD North away from the accident site. He was signaled to stop and did. He moved the LHD out of the area after the pull rope attached to it was removed from the bucket.

Although the hard hat (Figure 11) and safety glasses were broken by the impact of the clamp, E1 did not lose consciousness, but was knocked down. Several co-workers got to the injured worker almost immediately. E8 took the back of a leather work glove and placed it over a head wound which was bleeding. Employee 3 (E3), who is a licensed practical nurse, removed his tee shirt and wrapped it around the head of E1 to control bleeding. There were no first aid supplies cached in the area; however, Employee 2 (E2) retrieved gauze and other first aid supplies from his mine rescue gear and brought it to the scene.

Figure 11: E1's hard hat

E9 called the Central Monitoring Room (CMR) to report the medical emergency. A call was also made to summon the underground ambulance to the scene by Employee 12 (E12). Upon identifying that this was not a drill, the CMR announced suspension of underground waste handling operations per WP 12-ER4912, "Underground Medical Emergency Response." The waste hoist was also staged at the bottom of the shaft in preparation for transfer of E1 to the surface. Also during

this time, MGC-1, MGC-2, and the Underground Facility Services Manager arrived at the scene.

The underground ambulance arrived at the location about 8:53 am. E1 was placed on a backboard and his head was immobilized. E1 was stable and conscious at the time. He was not placed on the gurney because of problems with operating the gurney. E1 was placed in the ambulance directly on the backboard. Employees treating E1 said that medical supplies in the ambulance, such as the cervical collar, were dusty.

E1 was then transported in the ambulance to the Waste Shaft station where he was removed from the ambulance and carried on the backboard onto the conveyance about 9:05 am. Medical personnel on the surface, who were staged at the Waste Shaft collar to receive E1 for primary assessment and transfer, reported that there were problems in obtaining information about E1's vital signs and the nature of injuries.

Upon arrival at the surface, E1 was assessed by the Site Occupational Nurse, assisted by EMT and EST personnel. E1 was found to be alert, reasonably oriented, and asking for a cigarette repeatedly. E1 had no idea of what had hit him, how badly he was hurt or how long it had been since the accident. However, his overall mental state seemed within normal limits, as far as event recall before and after the accident. The nurse performed a brief secondary survey and found no other indication of injury other than his head. Trauma protocols were applied and E1 was loaded in the ambulance. The emergency dressing applied by responders underground, which was a tee shirt supplied by a coworker, was removed. The wound was a full thickness starburst laceration encompassing the entire left side of the head. The T-shaped wound (top of T) extended from the left temple to approximately 5cm from midline on the back of the head. The top of the T was full thickness, rolled into a flap towards the top of his head. The posterior section of the wound was flayed into 4 or 5 "fingers" of flapped flesh rolled towards the back of the head. Each "finger" was rolled either up or down as it deflected towards the back. Approximately 10-12 cm of skull was plainly visible (Figure 12 prior to medical treatment, Figure 13 post treatment). There appeared to be no indication of fractures; however, the skull was discolored near the front leading edge of the wound. Bleeding was moderate at that time. The nurse and EMT irrigated the wound with sterile normal saline, approximated the wound edges as well as possible and applied sterile dressings. His vital signs and level of consciousness were stable at this time.

The CBFO Facility Representative (FR) and the WTS Operations Manager were notified of the injury about 9:00 am in Carlsbad. The FR proceeded to the hospital and arrived shortly before the ambulance arrived. As a matter of WTS practice, MGC-1 arrived at the hospital at approximately 10:00 am.

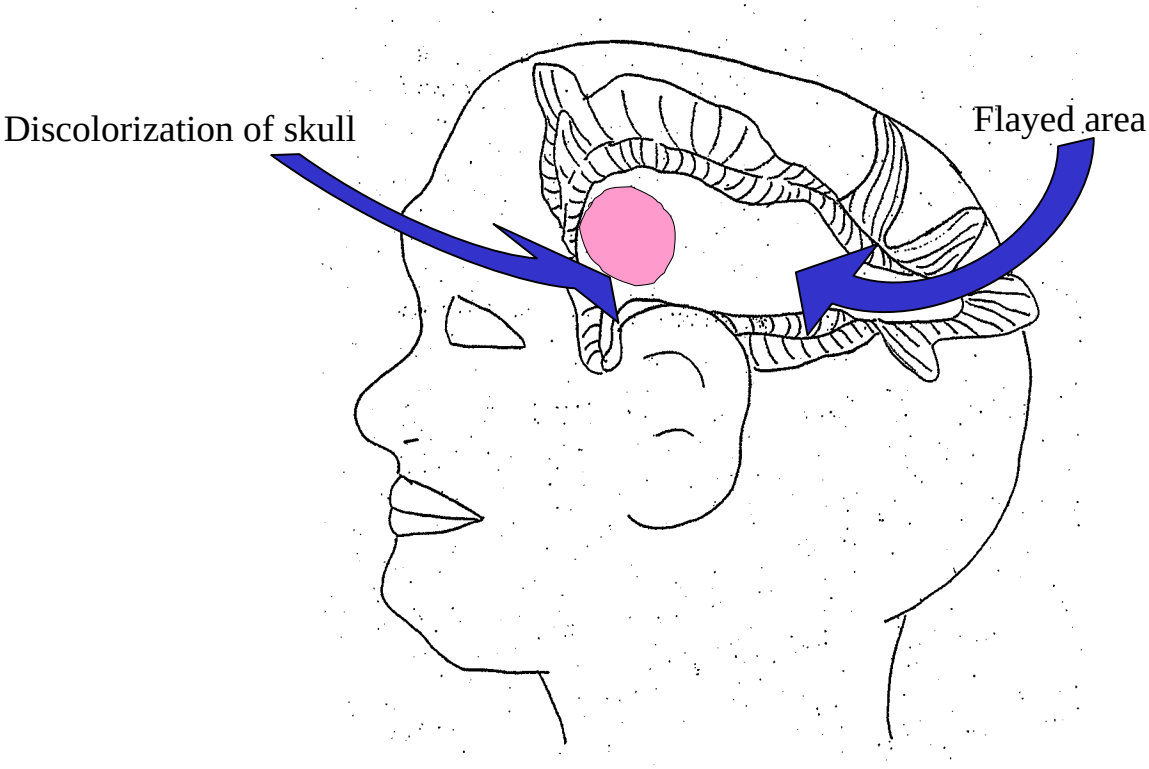

Figure 12: Wound Suffered by E1

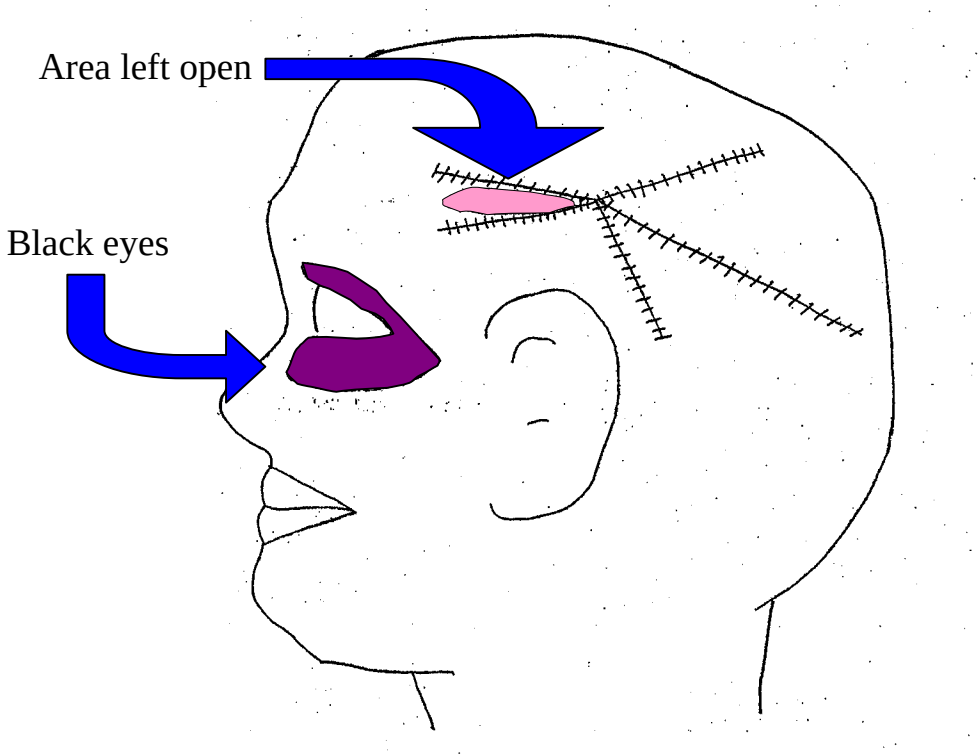

Figure 13: Closure of Wound

As the assessment and dressing of the injury proceeded, the ambulance departed for Carlsbad Medical Center-Emergency Room (ER) at 9:15 am. Vital signs were monitored during transport; near the end of the transport, E1's blood pressure began to rise significantly.

The ambulance arrived at the medical center at 10:10 am. There was confusion at the medical center about whether ER personnel had been notified that E1 was being transported to the ER. WTS personnel had made the notification but another, unrelated, patient with a similar injury arrived shortly before the arrival of E1.

After examination, including a CT scan, Medical Center personnel decided to transport E1 to a Lubbock, Texas medical facility by helicopter. E1 spent the night in the hospital and was released the following day.

After E1 was taken from the work site, all workers at the accident site were sent to the underground lunchroom at S2520. Subsequently, all underground personnel, with the exception of MGC-1 who had left the site to go to the hospital, were sent to the underground lunchroom at S1000 for a safety meeting to discuss the incident. After this meeting concluded, all employees involved in the incident came to the surface.

Post event trauma issues were addressed with those employees directly involved. At 9:25 am, the site secured from the underground medical emergency per WP 12-ER4912. At 9:29 all underground activities were suspended. At 10:20 normal activities in the underground resumed. Normal underground waste handling activities resumed at 10:21 am.

C. DOE Oversight

CBFO has developed the "CBFO Contractor Oversight Plan" to describe the process to conduct oversight of contractor activities to verify work is performed in a safe, secure and quality manner. The plan is a systematic process to monitor, assess, analyze, and document contractor performance, and is based on the principle that the contractor is primarily responsible for performing work and verifying compliance with contractual requirements. The plan utilizes four levels of evaluation: self-assessments and independent assessments by the contractor and informal and formal oversight by DOE personnel.

Annually, CBFO will evaluate the assessments completed by the contractor and use the results to determine the extent and level of assessments to be done the following year. Planned assessments by CBFO are documented in an Integrated Evaluation Plan and are dependent on planned DOE HQ inspections and planned contractor inspections.

Implementation of the plan addresses the program weaknesses identified in the report of the 2002 Inspection of Environmental, Safety and Health Management and Emergency Management by the OA. Some aspects of CBFO line management

oversight activities were not sufficiently rigorous and formalized to ensure that management inspections were communicated, understood and effectively implemented. The current CBFO oversight plan appears adequate to enable continued safety performance at a high level.

The September 2003 Integrated Safety Management System Annual Review Report, identified the following deficiency. CBFO did not provide clear and complete feedback to WTS on safety performance in the Performance Evaluation Report for the period of October 1, 2002 through March 31, 2003. The root cause of the deficiency was identified as ineffective communications between CBFO management and staff. This was corrected by assigning clear roles and responsibilities for providing performance feedback to the manager and contracting officer.

Also, the CBFO Manager met with WTS management to discuss the need for immediate improvement due to the severity of poor safety performance. In the third quarter of FY 03, CBFO withheld a portion of the performance incentive fee. Recent performance feedback actions by CBFO demonstrated improved communication among CBFO staff members and accurate safety performance feedback. This must continue in order for CBFO oversight to affect contractor performance.

The most recent CBFO staff reorganization established a Mine Operations Advisor position. Currently, the CBFO FR has been assigned collateral responsibility for overseeing underground mining activities, and CBFO oversight of the WIPP underground mining program is partitioned between the FR and the Mine Operations Advisor.

IV. Analysis

A. Accident Analysis

Following review of the accident scene and interviews with WTS personnel, the Board has identified that the accident occurred when a vent line (Vent Line 4) being dragged by an LHD dug into the floor of the E-140 drift. The C-clamp, which was used as a hook and weighed approximately 5.5 lbs., was used to attach a rope connected to a LHD to the vent line. The C-clamp pulled through approximately ½" of vent line and broke the vent line end ring which was tack welded around the end of the vent line. The C-clamp pulled free with sufficient energy and direction to deflect off the left side of E1's hard hat (approximately 52' away), breaking the hard hat, and landing just short of the E-140/S3310 intersection (total distance approximately 137').

The wounds suffered by E1 were sustained by the impact of the C-clamp, which fractured his hard hat, which cut E1s scalp and tore the scalp from his head. The indentation on the hard hat shows the direct point of impact. The discoloration of the skull indicates the indirect contact of the C-clamp on E1's skull through the hard hat.

B. Causal Factor Analysis

The board used several analytical techniques to determine the causal factors of the event. The Board used change and barrier analysis techniques to analyze the facts and identify the causes of the event. The causal factors related to weaknesses in implementation of the ISM Core Functions and collectively contributed to the event. JONs are presented in Table 1, in Section V.

1. Barrier Analysis

Barrier analysis is based on the premise that hazards are associated with all accidents/events. Barriers are developed into a system or work process to protect personnel and equipment from hazards. For an accident/event to occur, there must be a hazard that comes into contact with the target (worker) 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 means used to control, prevent, or impede the hazard from reaching the target, thereby reducing the severity of the resultant accident or adverse consequence. The results of the barrier analysis are used to support the development of the causal factors. The Board's analysis is presented in Appendix C.

2. Change Analysis

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

3. Events and Causal Factor 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/event. Causal factors are the events or conditions that produced or contributed to the occurrence of the accident/event and they consist of direct, contributing, and root causes.

The direct cause is the immediate events or conditions that caused the accident/event. The contributing causes are the events or conditions that,

collectively with the other causes, increased the likelihood of the event but which did not cause this event. Root causes are the events or conditions that, if corrected, would prevent recurrence of this and similar events.

The Board concluded that the direct cause of this accident was the employee was struck in the head by a clamp pulled from a metal vent line by a stretched rope.

The Board identified five contributing causes for this event. The contributing causes are:

- Management could not assure that the MRT work scope was identified or properly integrated into the work package for safely removing vent lines and other debris.
- Hazard analysis was less than adequate.
- Review of work package was less than adequate.
- Without involving stop work, work was allowed to continue without being adequately analyzed.
- Workers knowledge to move metal vent line was less than adequate.

A summary of the Board's causal factors analysis is presented in Appendix E. A chart depicting the Events and Causal Factors is provided in Appendix F.

4. Root Cause Analysis

Root cause analysis is a systematic process that uses the facts and results of the core analytic techniques to determine the most important reasons for the accident. The intent of the analysis is to address only those root causes that can be controlled within the system being investigated, excluding events or conclusions that cannot be reasonably anticipated or controlled, such as some natural disasters. Root cause analysis is primarily performed to resolve the question, "Why?"

As a result of this investigation, the Board determined there were two root causes. The root causes are:

- Planning for moving vent lines was less than adequate, and
- Work proceeded without proper tools, equipment, methods, and conditions needed to conduct work safely.

5. Requirements Verification Analysis

Requirements verification analysis is conducted after all the analytical techniques are completed and a draft of the report has been prepared. The analysis ensures that all portions of the report are accurate and consistent and verifies that the conclusions are consistent with the facts and judgments of need. The verifications analysis determines whether the flow from facts to analysis, conclusion, and judgments of need is logical. The conclusions and judgments of need are traced back to locate the facts to support the conclusions. The goal is to eliminate conclusions that are not based on facts. One approach is to compare the facts, analysis, conclusions, causes, and judgments of need on a wall chart, and then validate the continuity of facts through the analysis and conclusion to the judgments of need. This method also identifies any misplaced facts, insufficient analyses, and unsupported conclusions or judgments of need. This analysis tool was used by the Board; however, it is not included as part of the report.

C. Integrated Safety Management

The Board examined management systems as potential contributing and root causes of the event. The DOE Accident Investigation Program requires that accidents be evaluated in terms of ISM to foster continued improvements in safety and to prevent or minimize future accidents. The Core Functions and Guiding Principles of ISM are the primary focus for contractors in conducting work efficiently and in a manner that ensures the protection of workers, the public, and the environment. Properly implemented, ISM is a standards-based approach to safety, requiring rigor and formality in the identification, analysis, and control of hazards. Weakness in implementation of the ISM Core Functions is discussed below.

1. Define the Work

The identification of the scope for the work was discussed amongst WTS personnel starting about a month before the accident occurred. The discussions centered around the inclusion of a MRT training session into a planned mine operations activity to reopen the southern end of the E-140 drift in preparation for continuing the development of the WIPP underground. Inclusion of the MRT training session would have given the MRT members underground experience needed to meet the requirements in 30 CFR 49.8. However, the training session was not identified as a “drill” as defined in WP 12-ER3004, “WIPP Drills and Exercises.” Initial discussions on the inclusion of the MRT training session identified that the participation of the MRT may have provided the wrong public perception that MRTs using SCBAs must to go in first when an area is being reopened.

A meeting was held on August 11, 2004, to discuss the MRT training session. It was determined, at that time, that the training session could be included

along with the mine operation work. Due to the fact that it had been several years since individuals had been in that portion of the drift, a decision was made, during the meeting, that Mine Operations personnel would enter the area first to determine whether the area was safe to enter and to provide the MRT the opportunity to proceed with the training session. No discussions were held about when the training session was to be completed and no discussions were held on the moving of metal vent lines during the meeting. The Underground Mine Engineer responsible for developing the work package attended this meeting.

Based on this meeting the Underground Mine Engineer developed Work Order 0407479, "El Paso Drift Re-entry." Work Orders developed through the CHAMPS system are used to plan for and conduct work at the WIPP site. The scope in the Work Order did not mention the MRT training session. The Work Order identified that the work was to "accomplish the following:

- Remove the stockpiled muck south of the E-140 and S-3310 Drift Intersection.

- Establish ventilation for the E-140 Drift from S-3310 Drift to S-3650 Drift.

- Following re-entry procedures, investigate the condition of the roof beam between S-3310 Drift and S-3650 Drift.

- If roof beam conditions warrant, secure the beam by installing rock bolts into the beam.

- Retrieve abandoned materials and equipment."

Section 8.2.7 of the Work Order identifies that the work to retrieve the abandoned materials and equipment needed to be conducted "Whether or not it is decided to conduct a Mine Rescue Exercise". Either the MRT or "regular Mine Operations Personnel" could have conducted this work. The only other identification of the MRT training session occurred in Section 8.2.6. This is the hold point identified as being needed in the August 11th meeting. There is no discussion in the Work Order of the objectives of the MRT training session or when it would conclude. There was also no separate package giving specifics on the specific scope, objectives and completion criteria of work for the MRT training session. With no documentation for the MRT training session actions, confusion developed as to when the MRT training session ended and retrieval operations began.

2. Analyze the Hazards

As identified above, the area where the work was to be conducted had not been entered in several years. Initial entry into the area was made on August 23, 2004, to conduct a walk down of the area. There was no entry under the brow and the metal vent lines under the brow were not identified. Entry under the brow was made on August 24, 2004, and the miners were surprised to discover metal vent lines under the brow.

Metal vent lines have been replaced with fiberglass vent lines throughout the mine, and Mine Operations personnel have had experience with moving fiberglass vent lines exclusively over the last several years and were not accustomed to the differences and potential hazards in moving metal vent lines. Although the metal vent line discovery was a surprise and Mine Operations personnel were not accustomed to working with metal vent lines, the potential hazards were not analyzed.

WTS uses the "SIMON" software system to identify hazards when preparing a work package. Determination and identification of potential hazards is not conducted outside of the "SIMON" system. A review of the system identified that it is does not contain a set of hazards appropriate for the WIPP site and which were applicable to this work activity, such as metal vent lines, or potential energy sources like the stretched rope or compressed gas cylinders. In addition, the system is used as the single method to identify hazards.

3. Develop and Implement Controls

With the absence of a proper scope and hazard analysis, controls identified in Work Order 0407479 were incomplete, and potential training needs were not identified. The work order treated moving the metal vent line as skill of the craft type work, although metal vent lines had not been moved for several years and the properties and configuration of metal vent lines is significantly different than fiberglass vent lines. The work also did not identify the integration point between the MRT training session and the general mine operations activities.

Control of hazards was limited to the general hazards when operating in the WIPP underground: rotating/pinch point hazards, noise control, and ground control hazards. By treating the removal job as skill of the craft and not recognizing significant changes between moving metal and fiberglass vent lines, WTS did not develop and implement specific controls to mitigate potential hazards associated with the removal activities conducted on August 25, 2004.

4. Perform Work Safely

As identified previously in this section, the work was not appropriately scoped out, analyzed or controlled. Without knowledge of the potential hazards and proper method to move the metal vent line, MRT and regular Mine Operations personnel developed the process as they went.

Several individuals discussed concerns with the use of C-clamps as hooks. Although the WTS stop work policy (MP 1.2, "Work Suspension and Stop-Work Direction") is stressed by management and recognized by the employees, but the work was not stopped. Therefore, the work was not analyzed and it was not determined whether the informal methods being utilized were safe, or whether other methods needed to be developed, and other tools provided, to remove the metal vent lines.

5. Feedback and Improvement

The Board found that weaknesses in the identification of work hazards had occurred on several occasions.

The 2002 OA Inspection found that the work control processes for some underground operations was not sufficiently documented to ensure that all hazards are adequately identified and analyzed. The inspection team found in particular that hazards not identified in the underground shop area may have contributed to an accident there. Among several other corrective actions, the procedure for development of the work packages was revised to institutionalize the documentation of hazard analysis.

CBFO concerns with safety performance were documented in a memorandum to WTS dated May 13, 2003, identifying that 4 recordable injuries since January 1, 2003, was unacceptable and requesting that WTS take the necessary steps to resolve this situation. WTS responded back to CBFO on May 22, 2003, with a list of 8 corrective actions, including the conduct of special hazard recognition training. Hazard Recognition and Accident Prevention training was given to all underground workers.

In May 2004, an assessment of Job Hazard Analyses was done by the WTS. The assessment concluded that integration of job hazard analyses (JHA) into work procedures is important and that JHAs are not used to the extent they should be. The assessment contained one example of a JHA, which was not specific enough to provide adequate information.

In September 2003, CBFO recommended that the Chief Operations Officer (EM-3) as the HCA withhold $100,000 of the award fee for the 3rd quarter of FY 2003 from WTS due to inadequate safety performance. CBFO's recommendation also identified that WTS could recover the withheld amount

if they improved their safety trends. EM-3 approved this recommendation and the $100,000 was withheld. WTS took the necessary steps to satisfy CBFO concerns and the $100,000 was restored to WTS, with HCA concurrence, by the end of March 2004.

The failure to identify the hazards associated with the accident on August 25, 2004, either during preparation of the work package or during the work demonstrate that the feedback provided by inspections and incidents has not resulted in an effective change in the hazard identification process.

CBFO must continue to provide adequate staffing for oversight of mining and other underground activities. This will provide timely input to the contractor on safety issues and provide backup for safety performance evaluation. The CBFO Manager should evaluate the effects of the most recent reorganization after an appropriate time to determine if it has resulted in adequate oversight of day-to-day contractor underground work.

V. Conclusions and Judgments of Need

Based on the facts gathered and analysis conducted on the facts, the Board identified the following conclusions and judgments of need in Table 1. Judgments of need are managerial controls and safety measures necessary to prevent or minimize the probability or severity of recurrence of an accident.

Table 1: Conclusions and Judgments of Need

Conclusions	Judgments of Need
• Continuous accountability for conduct of the work was not provided at the work site. • Stop work actions failed to be implemented because no one was in charge at the work site to whom to go to express concerns. • Workers placed more emphasis on continuing the job than on safety concerns. • Several workers discussed stopping work, but no one took action.	• WTS needs to establish a program to provide a formal Person-In-Charge program, or equivalent, to assure that safe work practices accomplish work package objectives.
• Work scope was not fully identified to assure the work package addressed all aspects of the work. • WTS has not met the training requirements in 30 CFR 49.8(b)(1). • Work scope did not integrate MRT training session and regular mine operations work. • Hazard analysis could not be complete without work scope being adequately defined. • Controls could not be developed to address hazards, which had not been identified. • Work package did not contain methods to safely conduct the work. • Work could not be conducted safely with inadequate scope, hazard analysis, or the development of controls. • Feedback provided by inspections and incidents has not resulted in an effective change in the hazard identification and mitigation process.	• WTS needs to strengthen its ISM program to fully identify work scope and hazards; plan, control, and conduct work safely; and effectively address improvement opportunities when developing work packages. • WTS needs to better communicate work scope involving multiple work groups to integrate safe work practices. • WTS needs to adhere to the training requirements contained in 30 CFR 49.8.

Conclusions	Judgments of Need
• WTS management has not effectively used feedback to provide complete hazard identification for work. • Management did not confirm that planning/integration of the work was completed following the August 11, 2004 meeting. • Coordination of MRT training session and regular mine operations work was less than adequate. • MPs 1.2 and 1.12 were not implemented during work performance.	• WTS management needs to focus attention on hazard identification and work performance at the activity level.
• Implementation of hazard recognition and accident prevention training was not utilized in the work.	• WTS needs to assess the effectiveness of hazard recognition and accident prevention training.

VI. Board Signatures

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DOE Accident Investigation
Board Chairperson
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Appendix A – ORPS Report of the Accident

ALO--WTS-WIPP-2004-0011 UPDATE

Occurrence Report

After 2003 Redesign

Waste Isolation Pilot Plant

(Name of Facility)

Nuclear Waste Operations/Disposal

(Facility Function)

Carlsbad Field Office Washington TRU Solutions, LLC.

(Laboratory, Site, or Organization)

Name: PORTER, PHILIP V

Title: Facility Manager Designee **Telephone No.:** (505) 234-8442

(Facility Manager/Designee)

Name: PORTER, PHILIP V

Title: **Telephone No.:** (505) 234-8442

(Originator/Transmitter)

Name: **Date:**

(Authorized Classifier (AC))

1. Occurrence Report Number: ALO--WTS-WIPP-2004-0011

PERSONNEL INJURY WITH NEAR MISS TO MORE SERIOUS CONSEQUENCES

2. Report Type and Date: UPDATE

	Date	Time
Notification:	08/26/2004	14:12 (ETZ)
Initial Update:	09/01/2004	13:10 (ETZ)
Latest Update:	09/01/2004	13:10 (ETZ)
Final:		(ETZ)

3. Significance Category: 2

4. Division or Project: WIPP

5. Secretarial Office: EM - Environmental Management

6. System, Bldg., or Equipment: Balance of Plant

7. UCNI?: No

8. Plant Area: Underground

9. Date and Time Discovered: 08/25/2004 08:45 (MTZ)

10. Date and Time Categorized: 08/25/2004 09:30 (MTZ)

11. DOE HQ OC Notification:

Date	Time	Person Notified	Organization
NA	NA	NA	NA

12. Other Notifications:

Date	Time	Person Notified	Organization
08/25/2004	08:50 (MTZ)	MANAGEMENT CHAIN	WTS
08/25/2004	08:55 (MTZ)	FACILITY REP.	CBFO

13. Subject or Title of Occurrence:

PERSONNEL INJURY WITH NEAR MISS TO MORE SERIOUS CONSEQUENCES

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14. Reporting Criteria:

2A(6) - Any single occurrence resulting in a serious occupational injury. A serious occupational injury is an occupational injury that:

(a) Requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received;

(b) Results in a fracture of any bone (except simple fractures of fingers, toes, or nose, or a minor chipped tooth);

(c) Causes severe hemorrhages or severe damage to nerves, muscles, or tendons;

(d) Damages any internal organ; or

(e) Causes second- or third-degree burns, affecting more than five percent of the body surface.
10(1) - Any event resulting in the initiation of a Type A or B investigation as categorized by DOE O 225.1A, ACCIDENT INVESTIGATION.

Note: This reporting criterion may raise the significance category of an occurrence already reported under separate criteria. Multiple reporting criteria should be noted when appropriate.
10(3) - A near miss, where no barrier or only one barrier prevented an event from having a reportable consequence. One of the four significance categories should be assigned to the near miss, based on an evaluation of the potential risks and the corrective actions taken. (1 of 4 criteria - This is a SC 3 occurrence)

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15. Description of Occurrence:

At 0845 on August 25, 2004 a group of employees in the underground were moving old ventilation tubing from an old storage location. The tubing pieces are 36" diameter x 20 feet long, made of galvanized steel. The employees were using a bucket loader to pull the tubing into a clear area. They had tied the loader to the tubing using 1/2" nylon rope attached to the tubing with a large C-clamp. The rope was approximately 100 feet long. While pulling the tubing, it became stuck when it reached a depression in the floor. The rope stretched and ripped the C-clamp from the tubing. The C-clamp flew forward and struck an employee in the head.

The employee's hard hat and safety glasses were fractured, and he suffered a severe blunt trauma and laceration to the left side of his head.

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16. Is Subcontractor Involved? No

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17. Operating Conditions of Facility at Time of Occurrence:

N/A

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18. Activity Category:

03 - Normal Operations (other than Activities specifically listed in this Category)

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19. Immediate Actions Taken and Results:

1. Workers in the vicinity provided first response, attending to the fallen employee with first aid practices and direct pressure to minimize bleeding from a major scalp laceration.

2. Implemented the WIPP procedure for medical emergency.

3. Employee was brought up from the underground and transported by WIPP ambulance to Carlsbad Medical Center.

4. Work activities were stopped in the area and it was isolated and secured to preserve the scene.

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20. ISM:

2) Analyze the Hazards
3) Develop and Implement Hazard Controls
4) Perform Work Within Controls

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21. Cause Code(s):

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22. Description of Cause:

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23. Evaluation (by Facility Manager/Designee):

The employee was examined and treated at the Carlsbad Medical Center. The medical center doctors considered the head injury to be serious enough that the employee was evacuated by helicopter to Lubbock, Texas (about 180 road miles east of Carlsbad) where a better equipped medical facility is located.

Preliminary information from Lubbock doctors indicated that the employee would be kept for several days to monitor his status, and that a full recovery was expected. Subsequently, after medical examination and an over-night stay, the employee was released from the Lubbock hospital mid-morning on August 26.

This event, while serious, was a near-miss to even more serious consequences. Had the flying C-clamp struck the employee three inches lower, the energy from the blow would not have been dissipated by his protective equipment.

An investigation team was appointed and has begun its work.

UPDATE September 1, 2004: CBFO has informed WTS that DOE will initiate a Type B investigation in accordance with DOE O 225.1A. Accordingly, the Significance Category has been increased to SC-2 per Criteria 10(1). WTS will support the DOE as requested during their investigation. The accident scene remains isolated and controlled.

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24. Is Further Evaluation Required?: Yes

If YES - Before Further Operation? No

By whom? WTS and CBFO Management

By when?

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25. Corrective Actions

(* = Date added/revised since final report was approved.)

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26. Lessons Learned:

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27. Similar Occurrence Report Numbers:

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28. User-defined Field #1:

29. User-defined Field #2:

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30. HQ Keyword(s):

12H--EH Categories - Injuries Requiring Offsite Medical Treatment
13A--Management Concerns - HQ Significant (High-lighted for Management attention)
01N--Conduct of Operations - Inadequate Job Planning (Other)
08D--OSHA Reportable/Industrial Hygiene - Injury
08F--OSHA Reportable/Industrial Hygiene - Industrial Operations
08G--OSHA Reportable/Industrial Hygiene - Industrial Equipment
08K--OSHA Reportable/Industrial Hygiene - Near Miss (Other)

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31. DOE Facility Representative Input:

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32. DOE Program Manager Input:

Appendix B – Type B Investigation Board Appointment Memorandum

DOE F 1325.8

United States Government **Department of Energy**

memorandum

Carlsbad Field Office
Carlsbad, New Mexico 88221

DATE: SEP 3 2004

REPLY TO ATTN OF: CBFO:OOM:RPD:JGW:04-0457:UFC:3790

SUBJECT: Type B Accident Investigation – Underground Worker Injury

TO: Bill Tunnell, Safety and Occupational Health Manager, ES&H Division, Yucca Mountain Project, RW-51W

You are hereby appointed Chairperson of the Type B Investigation Board to investigate the subject accident that occurred at the Waste Isolation Pilot Plant in Carlsbad New Mexico on August 25, 2004. The board comprises the following members:

Nathan Morley, NNSA Service Center, Analyst/Member
Don Galbraith, Carlsbad Field Office, Accident Investigator/Member
Richard Farrell, Carlsbad Field Office, Member

The board will be assisted by advisors and consultants and by other support personnel as you deem necessary. If additional resources are required to assist you in completing this task, please let me know and they will be provided.

The accident investigation will be conducted consistent with DOE O 225.1A, *Accident Investigations*, and DOE G 225.1A-1, *Implementation Guide for Use with DOE Order 225.1A, Accident Investigations*. The scope will include the review of the information developed by the WIPP Contractor Washington TRU Solutions (WTS) on the accident prior to the notification that DOE would conduct a Type B investigation, causal factors, an independent site investigation, interviews, and analysis as necessary.

The board should provide me and the Deputy Manager, Lloyd Piper, with weekly informal reports on the status of the investigation, but shall not include any conclusions until an analysis of all the causal factors have been completed. Draft copies of the factual portion of the investigation report should be submitted to my office and WTS for factual review prior to report finalization.

The final investigation report should be provided to me on or before October 8, 2004. Any proposal to change this date should be justified and sent to this office. Discussions of the investigation and copies of the draft report should be controlled until I authorize release of the final report. A copy of the subject ORPS report is attached for your information. If you have any questions, please contact me or Lloyd Piper at 505-234-7303.

Thank you for agreeing to assist the Carlsbad Field Office and WTS in this important matter.

R. Paul Detwiler
Acting Manager

Attachment

cc w/attachment:
R. Hardwick, EH-2, *ED
R. Stark, EH-24, *ED
D. Huff, EH-24, *ED
P. Golan, EM-1, *ED
I. Triay, EM-3, *ED
P. Bubar, EM-3.1, *ED
F. Marcinowski, EM-10, *ED
J. Arthur, YMP, *ED
D. Chaney, NNSA, *ED
N. Morley, NNSA, *ED
A. McDougall, NNSA, *ED
G. Basabilvazo, CBFO, *ED
R. Farrell, CBFO, *ED
D. Galbraith, CBFO *ED
L. Piper, CBFO *ED
C. Wu, CBFO, *ED
S. Warren, WTS, *ED
CBFO M & RC

*ED denotes Electronic Distribution

CBFO:OOM:RPD:JGW:04-0457:UFC:3790

Appendix C – Barrier Analysis

Barrier Analysis

Hazard: Flying C-Clamp			Target: Miner
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier effect the accident?**
Complete identification of work scope	Scope underestimated task of moving vent line and workers familiarity as to working with it.	• Focus was not on moving metal vent line. • Vent line removal included under "debris removal." • Unusual work of moving metal vent line not in work order – see WP 10-WC3011. • The walk down of work area did not note different kinds of vent line – not added to work order or discussed in pre-job brief. • Line managers and workers did not recognize the differences in moving metal and fiberglass vent lines. • Tools to conduct the work brought to work site as needed. • Work done by MRT was not an "exercise" as defined by WP 12-ER3004, "WIPP Drills and Exercises."	• Management could not assure that the MRT work scope was identified or properly integrated into the work package for safely removing vent line and other debris. • Planning for moving vent line was less than adequate (LTA). • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Workers preparation to conduct the work LTA.

Barrier Analysis

Hazard: Flying C-Clamp			Target: Miner
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier effect the accident?**
Hazard Analysis	Hazard analysis did not identify and address all hazards.	• Analysis was not completely done. JSA did not identify abnormal conditions (e.g., metal vent line) required by WP 10-2. • Miners and MRT members were not used to working with metal vent lines. • Safety Analysis Sheets (SAS) did not include the vent line removal. • Work was not assessed to identify changes and hazards. • On site review should have noted the vent line to be moved. • Supervisors should have recognized this was a "new" task – most workers had only moved fiberglass vent line. • Analysis too dependent on automated checklist (SIMON). • 08/23/2004 walk down did not identify the metal vent lines.	• Tools used improperly. • Application of hazard recognition and accident prevention training provided LTA. • Hazards not identified and characterized as a part of the work order. • Not discussed in pre-job briefings.

Barrier Analysis

Hazard: Flying C-Clamp			Target: Miner
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier effect the accident?**
Work package	Work package was not complete.	• All tools for the job not in the work order (i.e., Kubota, rope, and C-clamps). • Did not adequately address job hazards. (e.g., JSA did not identify abnormal conditions (moving metal vent line) required by WP 10-2). • Method of removal of metal vent line and other items under the brow were not considered. • MRT management did not review work package. • Worker order review did not identify hazards in moving metal vent lines. • Not signed-off by MGC-1.	• Planning for moving vent line LTA. • Workers did not have the methods and tools to conduct the work safely. • Work package review LTA.
Training	Did not cover work being conducted.	• Unusual work of moving metal vent line. • No training provided on moving metal vent line. • Previous experience with fiberglass vent line with attached “D-ring” connecting points. • Considered “skill of the craft” type work.	• Workers knowledge to move metal vent line LTA. • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.

Barrier Analysis

Hazard: Flying C-Clamp			Target: Miner
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier effect the accident?**
Pre-job Briefings	Briefings were incomplete and were held separately between the MRT and miners on 08/25/2004	• Did not recognize the significance or discuss the discovery of metal vent lines identified in the 08/24/2004 walk down. • Did not address all hazards of work, due to lack of an adequate hazard analysis. • Separate briefings for the miners and the MRT on 08/25/2004 did not allow for a consistent understanding of the scope of the work between the MRT members and Mine Operations personnel.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.
Stop Work Implementation	Stop work was not implemented.	• Workers only discussed concerns among themselves. • Workers failed to act on concerns. • Thought the work process was “ok” to do it this way here.	• Without invoking stop work, work was allowed to continue without being adequately analyzed.
Supervision of the work	Amount of supervision varied during the job.	• Unclear to workers who was in charge of work - especially out from brow. • No procedure specifically designates a person in charge when MGC manager is not present. • No person in overall charge of job.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.

Barrier Analysis

Hazard: Flying C-Clamp			Target: Miner
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier effect the accident?**
Communication	Information not communicated effectively.	• Unclear which group was supporting the clean up portion of the work. • No knowledge of who was in charge of the work. • Discovery of metal vent lines identified in the 08/24/2004 walk down was not discussed. • LHD operator could not hear call to stop at the time of the accident. • Information on E1's condition not passed on between the CMR and medical personnel awaiting the E1's arrival at the surface.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • LHD continued pulling, increasing the stress on the vent line and rope stretch. • Emergency medical personnel on the surface were unaware of severity of the medical emergency.
Capacity of Kubota Tractor	Could not move due to resistance when vent lines dug in.	• Kubota was replaced with LHD. • More power overcame resistance of vent lines digging into floor.	• Increase in energy released when C-clamp broke free of the vent line. • Use of LHD increased chance of impact on personnel or equipment. • C-clamp had greater impact on E1.

Appendix D – Change Analysis

Change Analysis

Accident Situation	Prior, Ideal, or Accident Free Situation	Difference	Evaluation of Effect
Work scope not completely defined.	Work scope completely defined.	• No discussion on methods to remove vent lines. • No identification on when exercise was over. • No identification as to who was in charge. • Not all hazards identified. • No identification as to when the MRT activity was to conclude. • No identification of interfaces between MRT and mine operations activities. • Not identified who was in charge of the operation once the MRTs removed their SCBAs.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Work proceeded without proper tools, equipment, methods, and information needed to conduct the work safely. • No clear identification of who was in charge of the operation once the MRTs removed their SCBAs.
Hazard analysis did not address all hazards.	Hazard analysis completely addresses all hazards.	• "SIMON" does not include all hazards. • Not all hazards identified. • Not all hazards analyzed. • Incomplete discussion of work hazards. • Some hazards not discussed with workers. • Hazards in moving metal vent line not considered. • Workers did not think of moving vent line as work involving hazards they had not encountered previously.	• Hazard analysis too dependent on "SIMON." • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Hazards of moving metal vent line were unmitigated.
Work package did not identify all applicable hazards and processes.	Work package identifies all applicable hazards and processes.	• Not all hazards identified. • Not all hazards analyzed.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.

Change Analysis

Accident Situation	Prior, Ideal, or Accident Free Situation	Difference	Evaluation of Effect
MRT activity not defined as a drill or exercise.	MRT activity defined as a drill or exercise.	• MRT activity did not meet WTS criteria for conducting a drill or exercise. • Limited formality utilized in the developing and conducting the MRT activity.	• Management could not assure that the MRT work scope was identified or properly integrated into the work package for safely removing vent line and other debris.
No MRT plan was developed.	MRT plan developed.	• MRT objectives and scope, end of MRT activities, and exit of MRT from work site not established and planned. • Activity not identified as an exercise or drill.	• Management could not assure that the MRT work scope was identified or properly integrated into the work package for safely removing vent line and other debris.
No MSHA training as required by 30 CFR Part 49.8(b)(1) since 02/26/2003.	MSHA training to meet the requirements of 30 CFR Part 49.8(B)(1) available in 10/2003 and 03/2004.	• WTS did not take advantage of underground training opportunities to meet 30 CFR Part 49.8(b)(1) requirements. • MRTs did not meet the requirement to train underground each 6 months.	• Need to meet 30 CFR 49.8(b)(1) requirements led to MRT activities included in the vent line removal work package normally conducted by Mine Operations. • MRT activities included in the vent line removal work package normally conducted by Mine Operations. • Integration of MRT and Mine Operations activities was less than adequate (LTA).
CBFO not informed of MRT exercise.	CBFO informed of MRT exercise.	• CBFO unaware of the scope of the work to be conducted.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.
CBFO underground oversight of this contractor activity lacked focus.	Establish and assign a CBFO underground operations and engineering manager.	• Management attention on this activity was not provided.	• CBFO was unable to commit resources to assure that the contractor could safely perform this work package. • Work planning and work performance progressed without discussing other potentially hazardous conditions.

Change Analysis

Accident Situation	Prior, Ideal, or Accident Free Situation	Difference	Evaluation of Effect
Multiple work crews.	Single integrated work crew.	• No identification as to who was in charge of the combined work crew. • Separate pre-job briefings for MRTs and miners operations personnel. • No chance to discuss point where MRT activity was to be considered complete and when combined activities began. • Both MRT and mine operations personnel felt they were supporting the other after the MRT members removed their SCBAs.	• All workers did not receive the same information for the work. • Confusion between the MRTs and mine operations personnel on who was in charge of the debris removal operation.
Pre-job briefing did not discuss all hazards and safe work methods.	Pre-job briefings discuss all pertinent hazards and safe work methods.	• Briefing utilized incomplete hazard analysis results. • Work package did not address methods to mitigate applicable hazards for the work. • Results from 08/24/2004 walk down not effectively communicated to those providing the briefing.	• Incomplete recognition and discussion of work hazards to workers. • Workers did not recognize moving metal vent line involved hazards and methods they had not encountered previously.
No permanent locations to attach to the metal vent lines	Permanent locations to attach to metal vent lines.	• Location is not consistent between pieces of vent line. • Analysis not conducted to place the attaching points so that the vent line can be moved safely.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Hole in Vent Line 4 placed too close to the end of the vent line. • C-clamp broke loose from vent line.
Hole in Vent Line 4 located ½" from end of vent line.	Hole placed several inches from end of vent line.	• Hole in Vent Line 4 place ½" from end of vent line versus ~8" from end of Vent Line 3.	• Hole in Vent Line 4 placed too close to the end of the vent line. • C-clamp broke loose from vent line.

Change Analysis

Accident Situation	Prior, Ideal, or Accident Free Situation	Difference	Evaluation of Effect
No training identified as being necessary. Skill of the craft type work.	Training provides workers with the knowledge necessary to safely and correctly conduct the work.	• Proper technique for dragging metal vent line not provided to workers. • Connections to vent line not consistent. (e.g., hole for Vent Line 3 placed ~8" from end, hole for Vent Line 4 place ½" from end of vent line).	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Hole in Vent Line 4 placed too close to the end of the vent line. • C-clamp broke loose from vent line.
Supervisor not at the work site during entire operation.	Supervisor or person in charge at the work site during the entire operation.	• Overall supervisor not clearly identified. • MGC-1 not at the work site during crucial decision how to use C-clamp.	• Decision how to use C-clamp made without MGC-1 input.
Getting the work done	Getting the work done safely	• Work was not adequately analyzed. • Workers placed getting the work done over concerns for getting the work done safely.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.
Stop work not utilized.	Stop work utilized.	• Work continued even though some workers expressed and discussed their concerns on the process with each other.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.
Workers get tools during work.	All tools available for the work.	• Work not properly analyzed in keeping with hazard analysis and mitigations. • Proper tools not available due to work in keeping with hazard analysis and mitigations. • Tools used ad hoc.	• Tools used for work did not allow the work to be conducted safely.
Holes chopped in vent line.	Holes punched in vent line.	• Edges rough rather than smooth.	• Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.

Change Analysis

Accident Situation	Prior, Ideal, or Accident Free Situation	Difference	Evaluation of Effect
Metal vent lines removed by pulling with nylon rope.	Mining over the top and recovering debris out of the muck.	• Vent lines directly attached or pulled with slings to the LHD rather than rope. • Limited experience in pulling metal vent lines.	• Tensile stress in rope provided energy to detached C-clamp. • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely. • Needed to identify the process was different than normally used.
Rope stretches.	Method to attach vent line to LHD that does not stretch.	• Rope continues to be pulled when vent lines become stuck.	• Tensile stress in rope provided energy to detached C-clamp.
LHD could not get to vent line location.	LHD could get to vent line location.	• Vent line could not be secured directly to LHD. • Did not mine over the top. • Trash and other debris laying in the drift between the LHD and the brow.	• Needed to use an extended piece of rope to connect the LHD to the vent lines. • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.
C-clamps used to attach rope to vent lines.	No C-clamps used.	• No experience in pulling metal vent lines using C-clamps.	• C-clamp became projectile. • Work proceeded without proper tools, equipment, methods, and conditions needed to conduct the work safely.
C-clamps used to pull vent line	C-clamps to be used as handles.	• C-clamps not used for purpose intended by MGC-1.	• Decision how to use C-clamp made without MGC-1 input.
Vent line could not sustain stress of being pulled.	Vent line could sustain stress of being pulled.	• C-clamp did not remain attached to the vent line. • Hole in 4th vent line too close to end (½”).	• Location of hole allowed clamp to pull out of vent line. • C-clamp became projectile.
Smaller vent line nested inside larger vent line.	Vent line moved a piece at a time.	• Weight of material being pulled increases (~890 lb. versus ~460 lb.) • Developed more strain in rope to move Vent Line 4.	• Vent Line 4 was much heavier and required more force to be moved than others vent lines pulled on 08/25/2004.

Change Analysis

Accident Situation	Prior, Ideal, or Accident Free Situation	Difference	Evaluation of Effect
Moving 2 vent lines in different locations in the drift simultaneously.	Moving 1 vent line only.	• Vent lines need to be guided in order to prevent entanglements with the rope. • Employees in line with stretched ropes.	• E1 needed to keep Vent Line 3 off the rib. • E1 was in position to be hit by the C-clamp.
Worker in hazardous position.	Employees not in position to be hit if attachments come loose.	• Increased possibility of being struck by flying material.	• E1 was in position to be hit by the C-clamp. • E1 tells another employee to get away from the rope before LHD moves Vent Line 3 and 4. • E1 did not recognize hazard to himself. • E1 struck by clamp.

Appendix E – Causal Factors Analysis

Causal Factors Analysis

Direct Cause: The employee was struck in the head by a clamp pulled from a metal vent line by a stretched rope.

Root Cause 1 and Associated Contributing Causes	Discussion
RC-1: Planning for moving vent lines was less than adequate (LTA).	1. The hazards associated with moving the metal vent line were not identified during the work order preparation. 2. The hazards associated with moving the metal vent line were not identified during the walk down of the work area. 3. SIMON work package preparation software does not include all hazards. 4. There is not a specific SAS for moving metal vent line. 5. Specific steps for moving the metal vent line were not included in Work Order 0407479. 6. The planning meeting included all the mine rescue teams in the mining activity only discussed removal of compressed gas cylinders; but the work package allowed participation in other activities. 7. No drill plan, consistent with WP12-ER3004 and WP 12-ER-01 was written for the mine rescue activity so there was no definition when their activity was complete. 8. CBFO was not notified of the planning meeting which discussed including the mine rescue team activities in the mining activity; they were not notified of the planned mine rescue training. 9. The review of the work order did not correct the incomplete and inaccurate equipment list 10. The review of the work order did not identify that the hazard of moving the metal vent line was not included or mitigated.

Root Cause 1 and Associated Contributing Causes	Discussion
	11. The review of the work order did not identify that no drill for Mine Rescue Team activities was included although it was referenced in steps 8.26 and 8.27. 12. The work order did not include specific steps for movement of the metal vent line; it relied on skill of the craft although it was not a normal task.
CC-1: Management could not assure that the MRT work scope was identified or properly integrated into the work package for safely removing vent lines and other debris.	1. The integration of MRT and Mine Operations. 2. In July 2004, a request was made to allow the MRT to participate in work scheduled to clean out the end of E-140 drift. 3. That proposal would allow the MRT to satisfy an MSHA underground training requirement and provide MRT members an opportunity to practice and improve team performance in actual underground conditions. 4. The request was initially not approved by the WTS IS & H Manager, because of concerns about entering into a closed area by MRT personnel prior to inspection by MGC personnel to ensure safe ground conditions and air quality. 5. During an August 11 meeting WTS Managers (including the Underground Operations Manager, a representative of the IS & H team, and some MRT members decided to allow the MRT to recover compressed gas cylinders from the south end of E-140 Drift as part of a training drill. The mining process would continue south in E0140 drift. 6. CBFO was not informed of the meeting or of the planned training drill. 7. CBFO has removed a staff position from the Office of Disposal responsible for WIPP underground operations, which limited its capability to effectively over see underground work

Root Cause 1 and Associated Contributing Causes	Discussion
	on a continuing basis. 8. Moving other excess debris, including fiberglass and metal vent line was not discussed and associated hazards were not recommended to be included in the work package. 9. Preparation of a drill plan consistent with WP 12-ER3004 and WP 12ER-01 was not discussed in the meeting. Therefore with MRT conducted the training exercise to recover the compressed gas cylinders, it was unclear when the drill was to end. 10. A member of the WTS Mine Engineering group was tasked to prepare a work package for work that would include the opportunity for MRT personnel training.
CC-2: Hazard analysis LTA.	1. The walk down of the work area on August 23 did not include the area under the brow where the vent line was stored. 2. Pre-job brief prior to entry into the area under the brow on August 24 identified heavy lifting as a hazard with mitigation to use mobile equipment if possible, manpower otherwise, using proper lifting procedures. 3. From the record of the pre-job brief before work began on August 25, it is not clear if the lifting hazard identified at the August 25 pre-job brief was discussed. 4. The walk down of the work area did not identify the hazards associated with moving the metal vent lines out of the drift. 5. The writer of Work Order 0407479 was at the worksite walk down and during the work done on August 24, 2004. 6. Work orders are written using the SIMON work package software.

Root Cause 1 and Associated Contributing Causes	Discussion
	7. SIMON work package software contains a standard list of hazards, which must be reviewed as part of the work package preparation, but the list does not include potential energy. 8. There is not a Safety Analysis Sheet for moving metal vent lines. 9. WP 10-2 requires a Job Hazard Analysis to alert procedure users to actions or conditions that establish abnormal conditions. 10. The hazards associated with moving the metal vent lines were not discussed at the pre-job briefs on August 25, 2004. 11. Workers and Managers received Hazard Recognition and Accident Training. 12. The hazards associated with moving the metal vent lines were not included in Work Order 0407479. 13. Specific steps for vent line removal were not included Work Order 0407479. 14. Workers at the work site at the time of the accident had no experience in moving metal vent line at WIPP. 15. A previous OA assessment in 2002 and a self-assessment in 2004 identified weaknesses in hazard identification.
CC-3: Review of work package LTA	1. No drill plan was included in the work package for the MRT Training exercise. 2. Work order JSA did not identify abnormal conditions (metal vent line) required by WP10-2.

Root Cause 1 and Associated Contributing Causes	Discussion
	3. MRT management did not review the work package (040749) to satisfy their expectation that a drill plan was included in the package 4. Highest level of approval for the work package was MGC-2 5. MGC-1, who supervised the subject work, did not sign the work package. 6. The Kubota tractor, rope, board, and C-clamp were not included in the work order equipment list. 7. The work order allows “the remaining work” still required to be completed by either MRT personnel or underground mine operations personnel. 8. Although Work Package 0407479 identified “retrieve abandoned material and equipment” as work to be accomplished, underground operations management and personnel did not use the work package in the pre-job brief or discuss the potential hazards of moving vent line.

Causal Factors Analysis

Root Cause 2 and Associated Contributing Causes	Discussion
RC-2: Work proceeded without proper tools, equipment, methods, and conditions needed to conduct work safely.	1. Work planning performed did not include a thorough analysis of hazards. 2. The work package did not include effective coordination and communication between the MRT members and the mine operations personnel. 3. No MRT drill plan was included in the work package to adequately describe coordination and communication between the MRT members and Mine Operations personnel. 4. Workers raised and discussed concerns among themselves regarding the use of C-clamps. 5. Use of tools, equipment, and methods were unclear in the work package and not clearly communicated to workers. 6. Specific steps describing the method to move vent line were not included in the work package. 7. No combined pre-job briefing was conducted to discuss work activity control, coordination or communication between MRT members and Mine Operations personnel. 8. Work proceeded although workers had expressed concerns and discussed these among themselves. 9. Workers did not exercise stop-work authority responsibility required by MP 1.12 and MP 1.2
CC-4: Without invoking stop work, work was allowed to continue without being adequately analyzed.	1. WTS management policy, MP 1.2 Worker Protection Policy, describes its commitment to a safe environment through safe work practices. 2. The policy commits both management and employees to the goal of worker protection and safe work performance.

Root Cause 2 and Associated Contributing Causes	Discussion
	3. Safe work performance and worker protection MP 1.2 are based on: • Employee participation in processes to identify hazards for unique and routine work. • Work that is unsafe will be stopped. • Managers will ensure tools, equipment, and work sites are in a safe condition. • Employees will be trained and qualified for the work performed. 4. MP 1.12 states WTS work will be performed according to the ISM principles, approved work process and procedures which includes: • Identification and mitigation of hazards as part of the work planning process • Work suspension and stop-work direction as described in MP 1.2 5. Workers failed to recognize that conditions changed which had not adequately been analyzed or mitigated include: • A decision on how to use the C-clamps and not been analyzed or communicated; o Vent line 4 was much heavier than others moved with the Kubota tractor. o Using the LHD increased the chance of impact on personnel and equipment. o Increased energy which led to the C-clamp breaking free from vent line #4. o Increased stress on vent line #4 and rope stretched as LHD continued pulling. o Location of the holes punched ½" from the end of vent line #4.

Root Cause 2 and Associated Contributing Causes	Discussion
	o E1 positioned himself in the danger zone. MP 1.12 requires that personnel will identify unsafe conditions and actual potential imminent danger conditions and stop and/or refuse to work until the condition is corrected. MP 1.12 introduction statement reinforces that activities will be suspended or stopped if necessary, to comply with this policy. The policy describes responsibilities for work suspension initiated by individuals and WTS General Manager. Under the responsibilities section, any worker who has a concern for employee safety has the responsibility and authority to suspend the performance of that activity. The policy further describes that the employee who suspended the work present concerns to the person in charge of the activity. The responsible person will resolve the concerns of the employee or inform the cognizant manager. Management will resolve the concern before resuming operations or take actions to correct the condition using existing procedures or processes. • Work activities continued without invoking stop-work to suspend work when they had questions or concerns regarding how C-clamps were to be used was not understood or was not clearly communicated or analyzed. • Although workers had questions and concerns, none took the responsible action required to suspend the work activity as required by this policy. • There was confusion between the MRT and mine operations personnel of who the person in charge of the debris removal operation was.

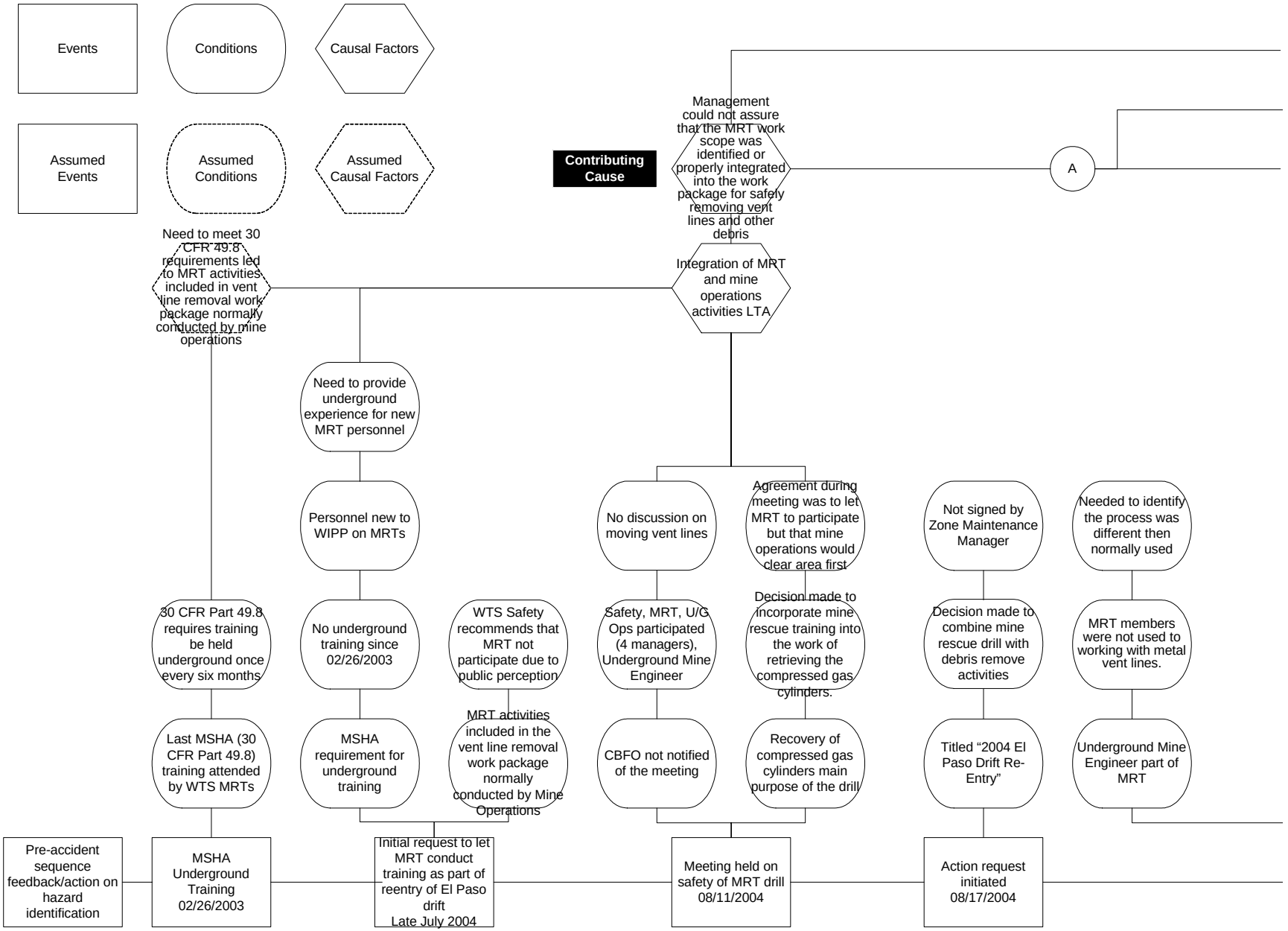
Root Cause 2 and Associated Contributing Causes	Discussion
	6. Workers failed to effectively apply hazard recognition and accident prevention training related to this activity as work progressed. • Hazard Recognition and Accident Prevention (SAF 560) training plan was developed and training courses were attended by supervisors and managers between March 2002 and September 2003. • In response to the CBFO Manager's letter dated May 12, 2002, WTS technical training Hazard Recognition and Accident Prevention was modified and presented to site personnel between September and early October 2003. The course lesson plan outline included the objective that students shall be able to recognize hazards in the work place and take corrective actions to prevent accidents. Enabling objectives included: • A description of the legal responsibilities of supervisors and managers pertaining to work place safety included a discussion of WTS Worker Protection Policy, MP 1.2 • A definition of the term hazard. • A discussion difference between normal versus off-normal situation in regard to workplace safety. • A discussion of the three basic elements of work place safety, which are knowledge, skill and attitude. • A description of a JHA or JSA, what it is used for and worker responsibilities pertaining to these. • A listing of good management in field activities

Root Cause 2 and Associated Contributing Causes	Discussion
CC-5: Worker knowledge to move metal vent line LTA.	1. Moving excess debris, including fiberglass and metal vent line was not discussed and associated hazards were not analyzed or recommended to be included in the work package. 2. Integration and implementation of a MRT plan was not prepared for incorporation into work package. This plan for MRT drill should have been consistent with WP 12-ER3004 and WP 12 ER-01 including work scope objectives, drill control, drill termination and feed back after the drill was completed. 3. MRT conducted training that included work performance to remove compressed gas cylinders. 4. The walk down of the work area on August 23rd, did not include the area under the brow where the sections of fiberglass and metal vent line were stored. 5. Assessment of conditions and amount of materials under the brow was not effectively communicated to workers by the work package or during pre-job briefings. 6. Work orders produced using SIMON software package did not adequately list the hazards encountered or change conditions that planners or workers should have recognized or analyzed for incorporation into the work package and pre-job briefings 7. WTS site workers received Hazard Recognition and Accident Prevention training in September and early October 2003. • The training objective stated that students should be able to recognize hazards in the work place and take corrective actions to prevent accidents. • The basic elements of work place safety including knowledge, skill and attitude were addressed

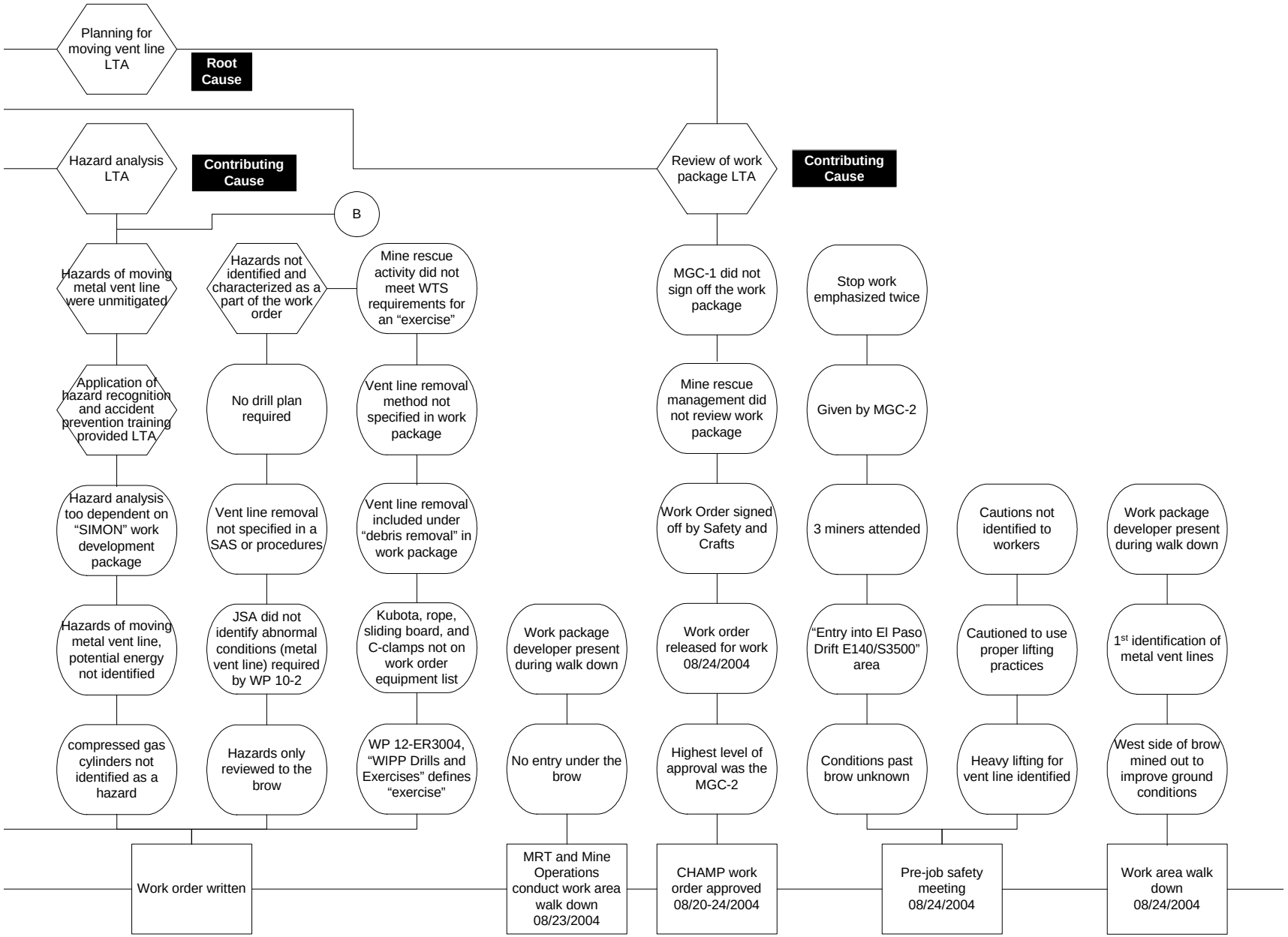
Root Cause 2 and Associated Contributing Causes	Discussion
	8. Underground workers also had hazard identification as part of their annual Mine Safety refresher training: SAF 502 as required by 30 CFR Part 48. 9. The hazards associated with moving the metal vent lines were not documented at the pre-job briefing for Mine Operations personnel. 10. Specific steps for moving metal vent lines were not included in Work Order 0407479. 11. Work package reviews were less than adequate. The work order JSA did not identify abnormal conditions (metal vent lines or heavier nested vent line) as required by WP 10-2. 12. MRT management did not review Work Package 0407479 to ensure that a MRT drill plan was needed or incorporated in work planning.

Appendix F – Events and Causal Factors Chart

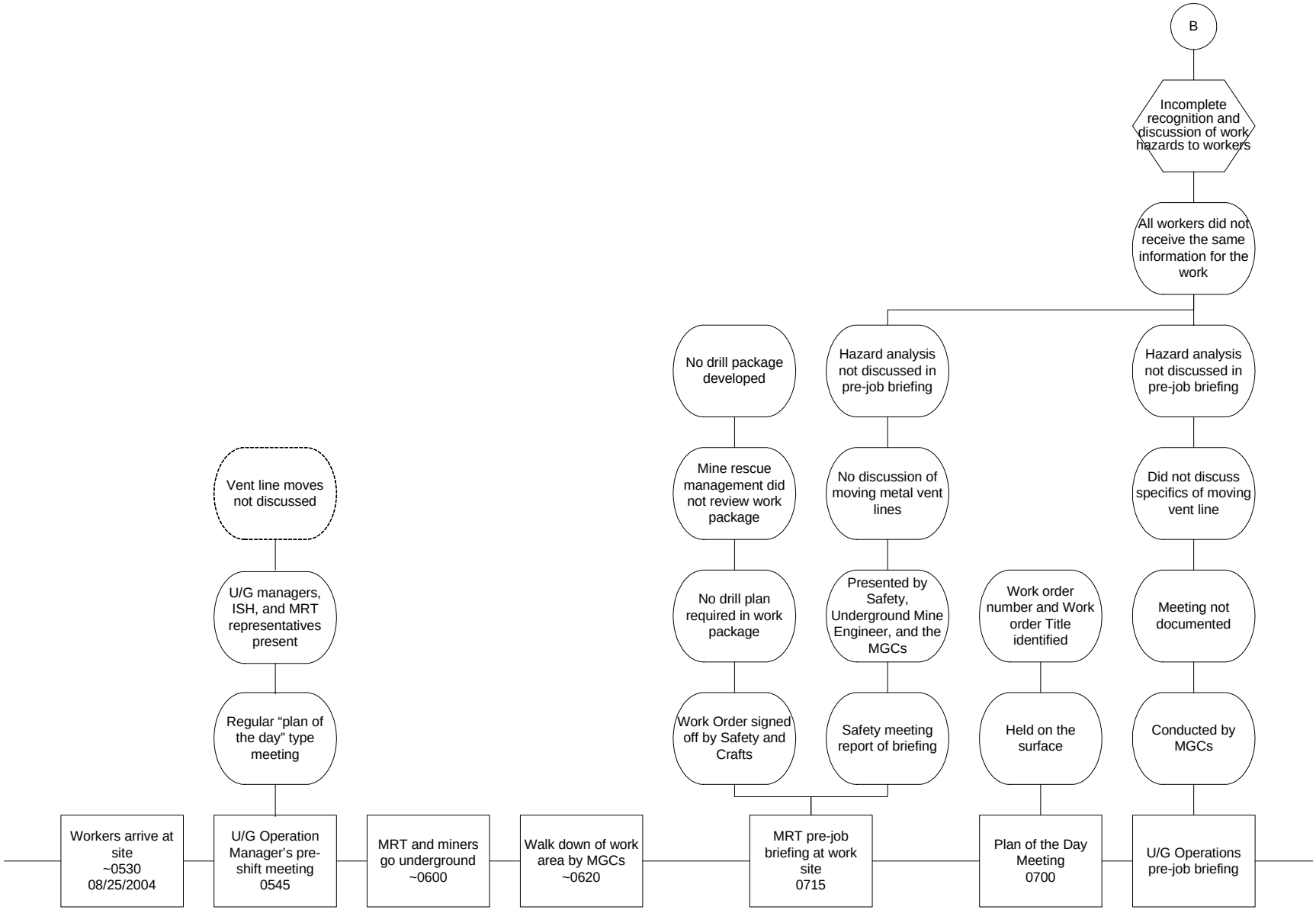
Events and Causal Factors Chart



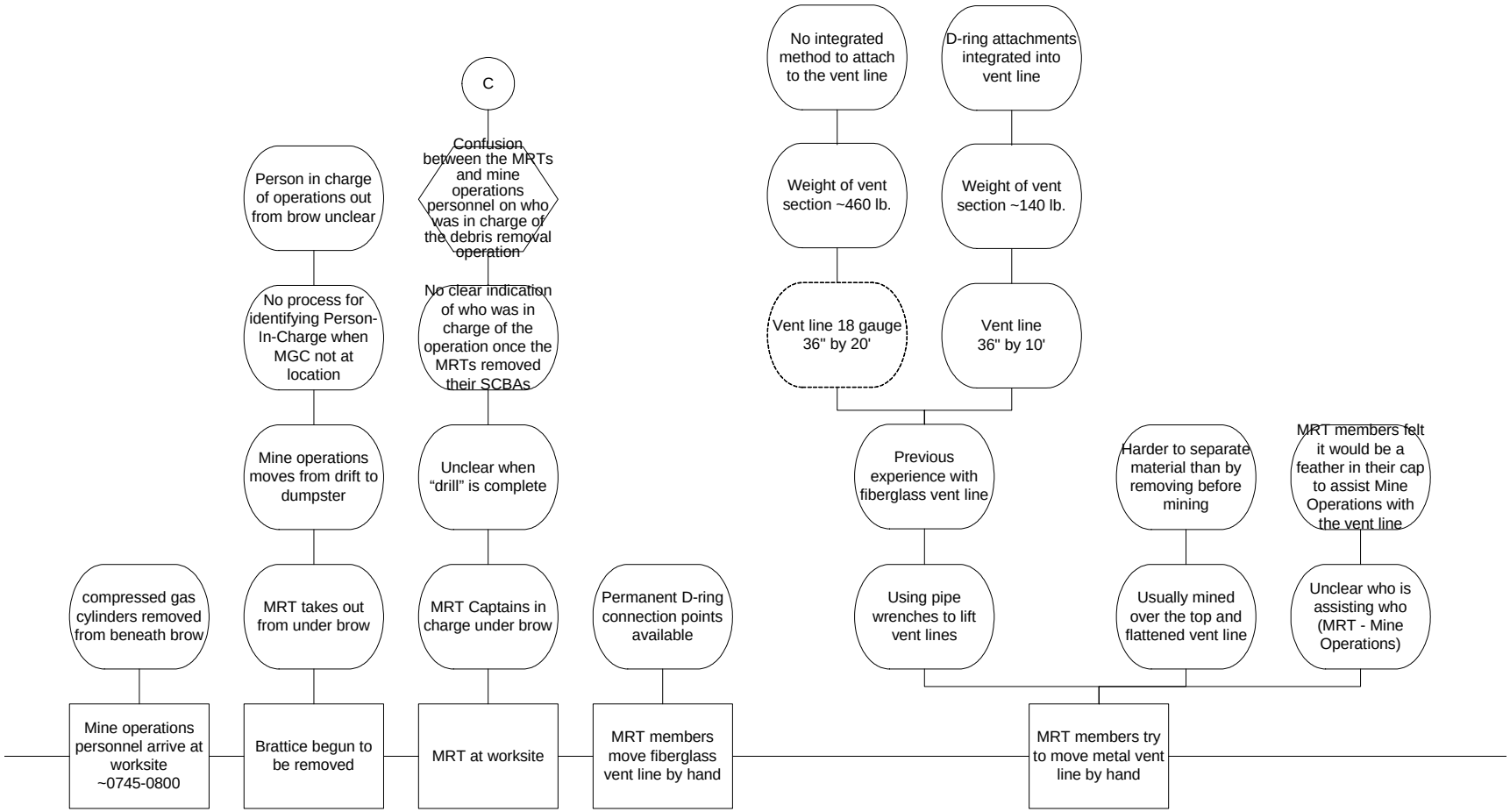
Events and Causal Factors Chart



Events and Causal Factors Chart

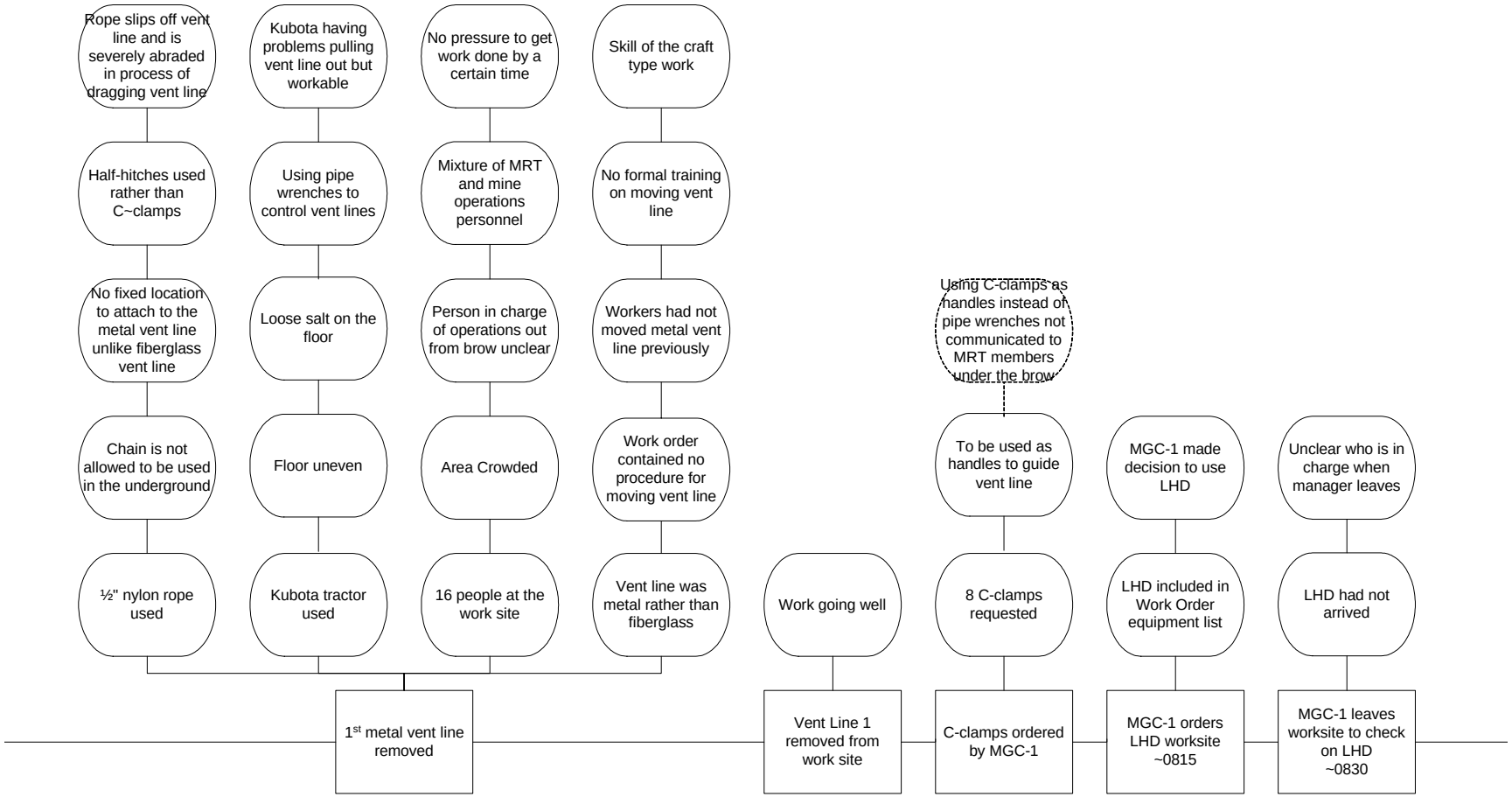


Events and Causal Factors Chart



Events and Causal Factors Chart

August 25, 2004
WIPP Type B Head Injury to Miner
Events and Causal Factors Chart



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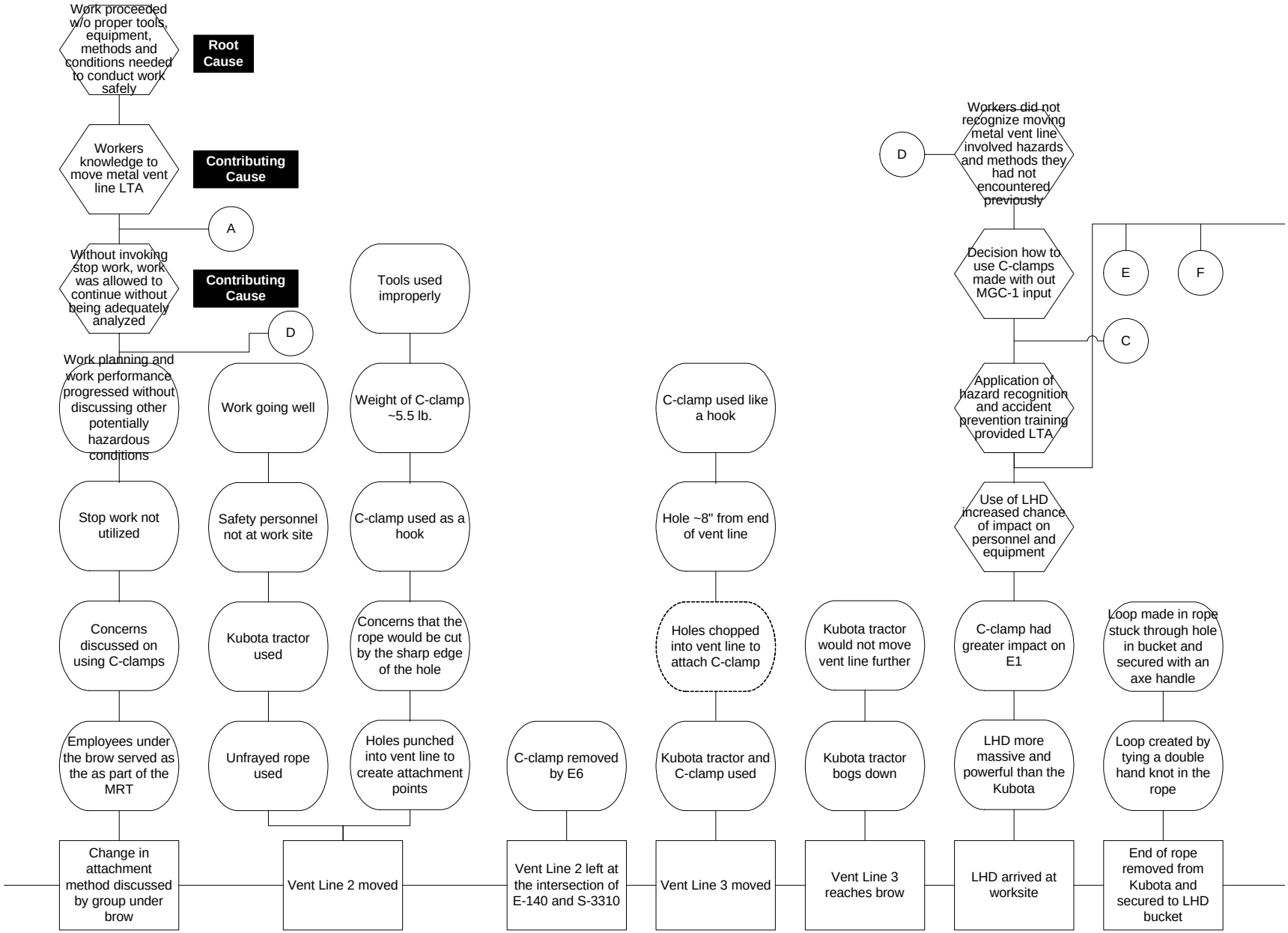

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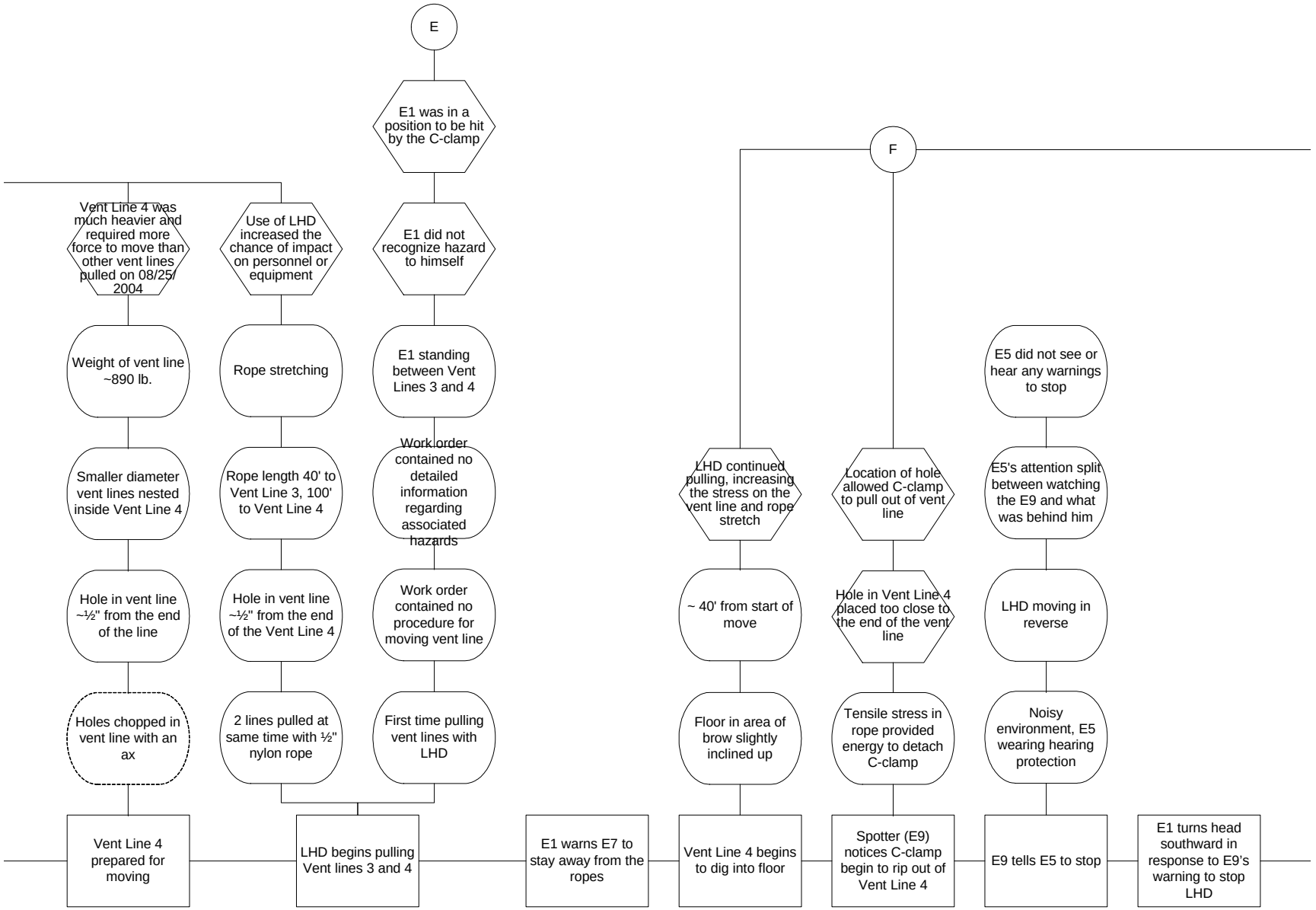

Events and Causal Factors Chart