

memorandum

DATE: August 16, 2004

REPLY TO
ATTN OF: NA-30

SUBJECT: **FORWARDING OF AN ACCIDENT INVESTIGATION REPORT ON A PERSONNEL
INJURY AT BETTIS ATOMIC POWER LABORATORY - PITTSBURGH,
PENNSYLVANIA**

TO: EH-2, R. M. Stark

Naval Reactors conducted a formal Type B accident investigation of a personnel injury that occurred on February 17, 2004 at the Bettis Atomic Power Laboratory in Pittsburgh, Pennsylvania. The injury occurred when an employee tripped on uneven asphalt pavement and fell in an area of the employee parking lot designated as a pedestrian walkway. The resulting injuries are believed to have aggravated pre-existing medical conditions. Medical complications ensued that resulted in the need for an extended hospital stay for intensive medical treatment and physical rehabilitation.

An accident investigation report was prepared using the guidelines of DOE Order 225.1A *Accident Investigations*. This memorandum forwards for your information and use the accident investigation report and associated Lessons Learned Document. If there are any questions concerning this report, please contact G. E. Jensen of my staff at (202) 264-6111 or myself at (202) 264-6183.


J. M. McKenzie
Naval Reactors

Copy to:
NA-3.6

Lessons Learned Statement:

Prime contractors need to provide a safe work environment for the entire facility site, including parking lots and outdoor pedestrian walkways. Particular attention needs to be given to areas that must be traversed by individuals with physical handicaps. The contractor must proactively maintain its facilities to ensure a safe work environment for its employees. Even minor deficiencies can contribute to significant injury to employees.

Discussion:

The accident occurred at approximately 8:30 a.m., on Tuesday, February 17, 2004, when an employee of the prime contractor, Bechtel Bettis, Inc., was reporting to work. The employee tripped on uneven asphalt pavement in an area of the employee parking lot that was designated as a pedestrian walkway, about 95 feet from the primary pedestrian entrance to the facility. The employee fell on both palms and knees, receiving superficial injuries. Due probably to frost heave, the asphalt pavement where the employee fell had been raised approximately ½-inch along a crack that traversed the width of the walkway. The employee was provided prompt first-aid treatment and returned to work within an hour of the accident. It was later determined that the employee's minor knee injury had aggravated pre-existing medical conditions. Medical complications ensued resulting in the need for an extended hospital stay for intensive medical treatment and physical rehabilitation.

Analysis:

The asphalt pavement in the parking lot area outside the primary pedestrian entrance, including the designated pedestrian walkway where the accident occurred, had last been maintained in 1996. The pavement had since degraded in several locations including the area where the accident occurred. Since this walkway also serves as the primary access route into the facility for individuals who park in designated handicapped and MEDICAL parking spaces, the walkway falls within the scope of the Uniform Federal Accessibility Standards (UFAS). These standards specify the levelness requirements for new construction or alterations to "accessible routes".

On March 10, 2004, a consulting engineering services firm was subcontracted by the prime contractor to evaluate pavement conditions near the primary pedestrian walkway to the facility entrance and adjacent parking areas to determine the cause of the pavement degradation. The engineering firm issued a report on March 17, 2004 which identified several other locations where the pavement had comparable vertical displacements and the need for regular maintenance of the asphalt pavement.

The Accident Investigation Board reviewed the prime contractor safety inspection program and determined that the prime contractor had been aware of a number of pedestrian safety issues through these inspections. However, eight of the 13 deficiencies related to pedestrian safety were still not resolved even though two of the eight were long-standing (17 months old). During the week of March 15, 2004, the Accident Investigation Board inspected the parking lot areas and identified an additional 23 safety-related deficiencies or concerns that were brought to the attention of prime contractor management.

The Accident Investigation Board determined that prime contractor managers responsible for maintenance of the parking lot were not familiar with levelness requirements for ground surfaces along accessible routes. In addition, the managers had an incorrect understanding of how to maintain the parking lot. The Accident Investigation Board also determined that prime contractor management had not established specific maintenance requirements for accessible routes. The degraded walking surfaces in the accessible routes had been accepted as normal based on experience of degraded conditions of paved pedestrian, road, and parking lot areas in the surrounding community. Government oversight personnel also did not enforce the proper the proper maintenance standard.

Recommended Actions:

1. The prime contractor should formally train cognizant personnel on applicable construction and maintenance standards and incorporate their use into daily operations and surveillance programs.
2. The prime contractor should review their pavement maintenance programs to ensure they meet industry and safety standards.
3. The prime contractor should use consistent standards of worker safety for the entire site including parking areas.
4. Appropriate technical representatives in the local Department of Energy field office should become trained in applicable requirements to provide sufficient oversight to the prime contractor.

Priority Descriptor: Blue/Information

Functional Category(s) (DOE): Maintenance – Roads & Grounds

Functional Category(s) (User-Defined): Accident Investigation

ISM Core Function: Analyze Hazard; Develop/Implement Controls

Hazards: Personal Injury – Slips and Tripping

Originator: DOE – Pittsburgh Naval Reactors Office

Contact: E. D. Shollenberger (412) 476-7290

Name of Authorized Derivative Classifier: E. D. Shollenberger

Name of Reviewing Official: E. D. Shollenberger

Keywords: Uniform Federal Accessibility Standards

References: DOE Order 225.1A, Uniform Federal Accessibility Standards

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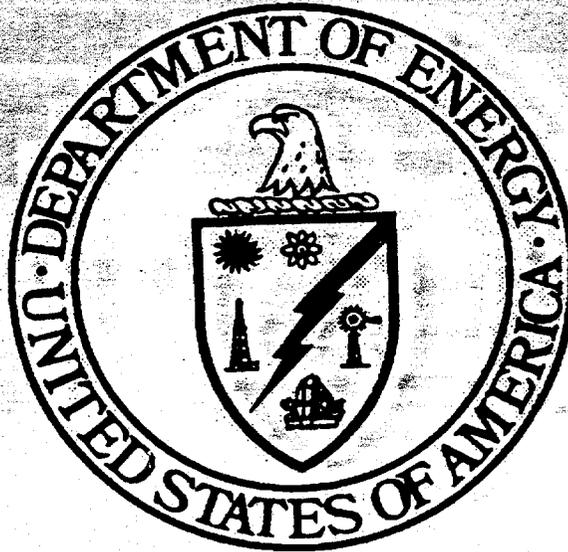
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Type B Accident Investigation Board Report

**Personal Injury Accident at the
Bettis Atomic Power Laboratory
February 17, 2004**



May 2004

Pittsburgh Naval Reactors Office
U.S. Department of Energy
West Mifflin, Pennsylvania

Disclaimer

This report is an independent product of the Type B Accident Investigation Board appointed by H. A. Cardinali, Manager, Pittsburgh Naval Reactors Office.

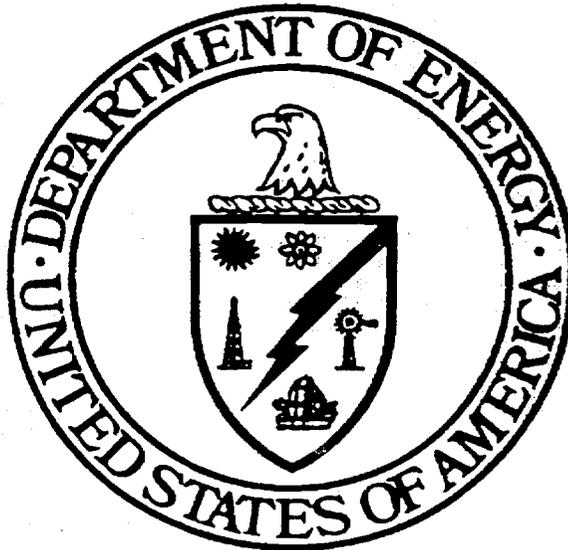
The Investigation Board was appointed to perform a Type B investigation of this accident and to prepare an investigation report in accordance with Department of Energy (DOE) Order 225.1A, Accident Investigations.

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

This report neither determines nor implies liability.

Type B Accident Investigation Board Report

**Personal Injury Accident at the
Bettis Atomic Power Laboratory
February 17, 2004**



May 2004

Pittsburgh Naval Reactors Office
U.S. Department of Energy
West Mifflin, Pennsylvania

Official's Acceptance Statement

On March 9, 2004, I established a Type B Accident Investigation Board to investigate a trip and fall accident at the Bettis Atomic Power Laboratory that resulted in an extended hospitalization. The Investigation Board's responsibilities have been completed with respect to this investigation. The analysis; identification of direct, root, and contributing root causes; and judgment of need reached during the investigation were performed in accordance with U.S. Department of Energy Order 225.1A, Accident Investigations. I accept the findings of the Investigation Board and authorize the release of this report for general distribution.



H. A. Cardinali, Manager
Pittsburgh Naval Reactors Office

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Executive Summary

Introduction:

On February 17, 2004, a Bechtel Bettis, Inc. (BBI) employee tripped and fell on uneven pavement while walking in a designated pedestrian walkway in the parking lot at the Bettis Atomic Power Laboratory in West Mifflin, Pennsylvania. The accident resulted in a first-aid case with minor injuries and escalated to an Occupational Safety and Health Administration (OSHA) recordable incident due to complications related to the injury and pre-existing medical conditions. The complications led to the employee being hospitalized for more than five days and caused the accident to meet the criteria for a U.S. Department of Energy (DOE) Type B Accident Investigation per DOE Order 225.1A, Accident Investigations.

The Accident Investigation Board (Investigation Board) inspected and photographed the accident site, reviewed events surrounding the accident, and conducted extensive interviews and document reviews. In conducting the investigation, the Investigation Board used various analysis techniques, including events and causal factors charting and analysis, barrier analysis, change analysis, and root cause analysis to determine the causal factors that contributed to the accident, including any management system deficiencies. The Investigation Board also examined the policies, standards, and requirements that were relevant to the accident as well as management and safety systems that could have contributed to or prevented the accident.

Accident Description:

The accident occurred at approximately 8:30 a.m. on Tuesday, February 17, 2004, when a BBI employee was reporting to work. The employee was walking from the Bettis parking lot, where the employee's car was parked, to the Gate 2 entrance. The employee tripped on uneven pavement in a designated pedestrian walkway approximately 95 feet from the Gate 2 entrance. The employee fell on both of her palms and knees. The pavement where the employee fell was raised approximately 1/2-inch along a crack that traversed the width of the walkway. The employee was provided first-aid treatment for a minor injury to her left hand and pain in her right knee. The employee returned to work within an hour of the accident. It was subsequently determined that most likely the employee's minor knee injury had aggravated pre-existing medical conditions, resulting in the need for additional medical treatment of the employee, including hospitalization. The employee was admitted to the hospital on February 24, 2004. On April 20, 2004, the employee was discharged from the hospital.

Direct and Root Causes:

The direct cause of the accident was the employee tripping and falling on uneven pavement in a designated walkway.

The root causes (fundamental causes that, if corrected, would prevent recurrence of this and similar occurrences) to the accident were:

- BBI management failed to provide a safe walking surface for employees who are required to traverse the parking lot.
- BBI management failed to ensure that areas of the parking lot used by employees with medical problems or disabilities are maintained in accordance with Uniform Federal Accessibility Standards (UFAS) for accessible design.
- BBI management failed to maintain the parking lot in accordance with current industry standards for pavement maintenance and did not deal aggressively with recurring safety deficiencies in the Bettis parking lot.

Prologue – Interpretation of Significance

An employee tripped and fell on uneven pavement while walking to work in a designated walkway. The recurring uneven pavement conditions near Gate 2 were not reacted to as safety hazards in the workplace environment and did not receive the safety priority for correction that hazards inside the site security perimeter routinely receive. The designated walkway is used daily by most Laboratory employees including those who park their cars in handicapped spaces and the spaces specially designated for individuals with medical restrictions. The walkway was not maintained in a manner to ensure that the walking surfaces met minimum federal safety standards for the handicapped and those with medical restrictions who are routinely expected to use the walkway.

The Investigation Board recognizes that the UFAS are standards for new Federal and federally-funded facilities for the accessibility of physically handicapped persons and were not written to apply retroactively to already existing parking lots. The Investigation Board also recognizes that the UFAS does not imply nor require immediate repairs of accessible routes (pedestrian walkways) each and every time a weather-related irregularity appears on the walkway surface. However, the Investigation Board considers that the prime contractor should have a reasonable maintenance program in place to keep these key walkways in good order. The unsafe walking conditions found in the area where the accident occurred have persisted in the areas where approximately 90 percent of the Laboratory's employees, including those with disabilities and medical restrictions, must walk to enter the Laboratory. The BBI walkway maintenance program and the BBI safety oversight programs did not deal effectively with this situation and therefore fell below the standard of reasonableness. In

addition, the DOE Pittsburgh Naval Reactors Office (PNR) contractor oversight program did not ensure that BBI management was maintaining key walking surfaces to the safety criteria of the UFAS.

1.0 Introduction

1.1 Background

On February 17, 2004 at approximately 8:30 a.m., a BBI employee transiting a Bettis designated walkway toward Gate 2 from the parking lot, tripped on uneven pavement and fell (see Figure 1). The employee received first aid treatment immediately after the accident. The employee was hospitalized a week later on February 24, 2004 for treatment of complications from pre-existing medical conditions that most likely were impacted from the fall. On April 20, 2004, the employee was discharged from the hospital.

Due to the extended hospitalization, the accident was deemed to be a serious injury requiring an in-depth investigation. On March 9, 2004, H. A. Cardinali, Manager, PNR, appointed a Type B Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1A, Accident Investigations (see Appendix A).

1.2 Facility Description

Bettis is a science and engineering facility responsible for designing, developing, and maintaining nuclear propulsion plants that are used by the U.S. Navy in submarines and surface ships. Bettis is owned by the DOE and operated under DOE contract by BBI. The Government field office, PNR, oversees operations at Bettis. PNR is part of the Division of Naval Reactors in Washington, D.C. There are approximately 2,000 contractor employees and 80 Government employees stationed at Bettis.

Bettis is situated on an approximate 207-acre tract of land in the Borough of West Mifflin, a suburb of Pittsburgh, Pennsylvania. The developed section consists of 20 acres of buildings with an adjoining 17 acres of irregularly shaped parking areas. The parking areas are paved with asphalt. A combination of curbing, guide rails, jersey barriers, signs, and painted pavement are used to designate vehicle roadways, pedestrian walkways, and various assigned parking areas (i.e., reserved parking, handicapped parking, medical parking, visitor parking).

The developed portion of the site is contained within a fenced-in area. In order to enter the developed area of the site, employees are required to park their cars in the parking lot and proceed on foot to one of the four security gates that control access into the developed section (i.e., protected area). The majority of Bettis employees, estimated at 90 percent of the workforce, park their cars east or south of the developed area and enter and exit the site through Gate 2.

1.3 Scope, Conduct, and Methodology

The Investigation Board commenced its investigation on March 15, 2004, and completed the investigation and submitted its findings to the Manager, PNR on May 12, 2004.

The scope of the Investigation Board's investigation was to review and analyze the circumstances to determine the cause of the accident. The Investigation Board also evaluated events subsequent to the accident including follow-up care received by the injured employee through the Bettis Medical Department. During the investigation, the Investigation Board inspected and photographed the accident site, reviewed events surrounding the accident, conducted interviews, documented reviews, and performed analyses to determine causes.

The purposes of this investigation were to determine the nature, extent, and causation of the accident and any programmatic impact, and to assist in the improvement of policies and practices with emphasis on safety management systems.

The Investigation Board conducted its investigation, focusing on management systems at all levels, using the following methodology:

- Facts relevant to the accident were gathered.
- Relevant management systems and factors that could have contributed to the accident were evaluated in accordance with DOE Order 225.1A, Accident Investigations, and the DOE Workbook, Conducting Accident Investigations dated May 1, 1999, as guidance.
- Events and causal factors charting and analysis, along with barrier analysis and change analysis, were used to provide supportive correlation and identification of the causes of the accident.

2.0 Facts and Analysis

2.1 Accident Description and Chronology

2.1.1 Background and Accident Description

Events Leading up to the Accident

Pavement maintenance to the parking lot area outside Gate 2, including the walkway where the accident occurred, was last performed in 1996. The maintenance consisted of paving a 1.5-inch overlay on top of the existing asphalt. The designated pedestrian Bettis walkway where the accident occurred leads directly to Gate 2 from the parking lot. This is one of two walkways leading directly to Gate 2, which is the main ingress and egress point to the protected area of the Bettis site. This walkway also serves as the access route to Gate 2 for individuals who park in the handicapped and MEDICAL parking spaces. At Bettis, a number of spaces relatively near Gate 2 are designated as MEDICAL spaces so that employees who have medical problems or disabilities can walk a shorter than typical distance to enter the Bettis site protected area (see Figure 2). MEDICAL parking spaces are assigned to employees as determined by the Bettis Medical Department based on an evaluation of an employee's medical limitations. This would include individuals who have handicapped placards or license plates issued by the Commonwealth of Pennsylvania and some who do not. The walkway is an accessible route as defined by UFAS that connects aisles for parking spaces that are reserved for individuals with disabilities.

Events During the Day of the Accident

The accident occurred at approximately 8:30 a.m. on Tuesday, February 17, 2004, at the Bettis Atomic Power Laboratory. While approaching Gate 2 on a designated walkway from the parking lot, at approximately 95 feet from the gate, a part-time BBI employee tripped on uneven pavement and fell to the ground landing on both hands and knees. The walkway was dry. The temperature was 23°F and the sky was clear.

A BBI Security Police Officer who was on duty at Gate 2 at the time observed the fallen employee and immediately went to the scene to assist the employee and summoned in-house BBI medical responders. A Bettis nurse and two volunteer Emergency Medical Technicians arrived within a few minutes and provided medical treatment at the scene. The on-site ambulance had also responded to the accident. The site of the accident was approximately 145 feet from the Medical Department. The medical responders placed the injured person on a gurney and pushed the gurney directly to the Medical Department.

While at the Medical Department, the nurse continued to attend to the employee. The nurse cleaned (with soap and water) an abrasion on the employee's left

palm, applied triple antibiotic cream, and applied a bandage. The nurse applied ice to the employee's right knee and gave the employee over-the-counter pain medication. The injured employee was then promptly examined by a BBI physician. The examination included a visual and hands-on examination of the injuries. The physician informed the Investigation Board that the employee sustained an abrasion to the left palm, and the employee was complaining of some pain to the right knee. The physician agreed with the treatment given by the nurse and released the employee back to work without any restrictions. The physician told the Investigation Board that employees are always instructed to return to the Medical Department should any symptoms return or not get better as a result of a workplace accident. The employee told the Investigation Board that she was instructed to contact the Bettis physician and use Bettis-appointed doctors if her medical condition worsened.

After the examination, the employee returned to work at approximately 9:10 a.m. and worked the remainder of the day with no further complications from the accident. The employee did return to the Medical Department in the afternoon for redressing of the bandage to her left hand.

The BBI Plant Maintenance Manager informed the Investigation Board that he inspected the accident scene on Tuesday, February 17, 2004, shortly after the accident had occurred. The Manager noted that the uneven pavement in the walkway where the employee fell had a vertical displacement of approximately ½-inch and attributed this condition to frost heave. The Manager deemed the pedestrian walkway to be in an acceptable condition for continued unrestricted pedestrian access and that no action was warranted to repair the uneven pavement.

Events After the Date of the Accident

The employee was not scheduled to work the following day, Wednesday, February 18, 2004. The employee worked a full day on Thursday, February 19, 2004, displaying no medical complications from the accident. The employee was not scheduled to work on Friday, February 20, 2004.

On Sunday, February 22, 2004, the employee was suffering flu-like symptoms. The employee believed that she had contacted influenza since her spouse had similar symptoms during the weekend. The employee did not relate her flu-like symptoms to medical complications resulting from her accident at work. During the evening of February 22, 2004, the employee telephoned her supervisor's voice mail to report off work for the following workday. Coincidentally, the supervisor was at work on Sunday evening and spoke directly with the employee. The supervisor stated that she was reporting off sick the following Monday because of flu-like symptoms. She also mentioned that her right knee was sore and indicated that she may be contacting Bettis Medical for followup care about the knee. The supervisor agreed that was a good idea.

The supervisor had no contact with the injured employee on Monday, February 23, 2004. The injured employee did not contact Bettis Medical on February 23, 2004.

When the supervisor arrived at work on Tuesday, February 24, 2004, the supervisor received a voice mail from the employee reporting off work a second day with flu-like symptoms and a sore knee. In the voice mail message, the employee stated that she had not yet contacted Bettis Medical but intended to do so.

The employee telephoned the Bettis Medical Department sometime after 7:30 a.m. on Tuesday morning, February 24, 2004, and talked to the Bettis Medical doctor first and then the Bettis nurse. The nurse stated that the employee complained of medical complications related to her injury and that she could not get out of bed. The Bettis Medical Department has community medical specialists available to provide followup medical care, as needed. When the Bettis doctor learned of the employee's medical complications, the doctor requested the nurse to make a followup appointment for the employee with an orthopedist. The nurse waited until approximately 9:15 a.m. (when the orthopedist's office was open for business) to make an appointment for the employee. When the employee learned that there were no appointments available that day and had to wait until the following day, February 25, 2004, to see the orthopedist, the employee asked if there was any way she could be seen sooner, such as at a hospital emergency room. The nurse consulted the Bettis doctor about the request for a hospital emergency room visit and the Bettis doctor agreed. The Bettis Medical Department facsimiled a written authorization to Jeannette District Memorial Hospital in Jeanette, Pennsylvania, the nearest hospital to the employee's home, and the employee went to the hospital emergency room later on February 24, 2004. Following examination by the emergency room physician, the employee was admitted to Jeannette Hospital. A Jeannette Hospital physician subsequently informed Bettis Medical that the employee had been admitted because she had developed serious medical complications most likely as a result of the fall and pre-existing medical conditions and needed hospital treatment. An attending physician at Jeanette Hospital informed the employee that she was not suffering from the flu, but from complications as a result of her medical history.

On February 25, 2004, the employee was transferred to a regional acute care hospital (UPMC Presbyterian University Hospital in Pittsburgh, Pennsylvania) for more advanced treatment. The employee received medical treatment at UPMC Presbyterian University Hospital due to her medical complications. After the medical complications subsided, the employee was transferred to UPMC Montefiore Hospital, which is connected to Presbyterian University Hospital, for physical therapy and occupational therapy. On April 20, 2004, the employee was discharged from UPMC Montefiore Hospital.

BBI Safety Engineering first inspected the accident site a week after the accident when the accident had become OSHA recordable. Safety Engineering observed a vertical displacement of approximately ¼-inch at the site where the accident occurred and their assessment was that no further action was needed and considered that there was no safety issue. BBI management did not critique the event. Section II of Bettis Management Guide 505 (Unplanned Event Reporting System) defines an occupational injury requiring hospitalization as an unplanned event requiring investigation.

During the course of the investigation, the Investigation Board took additional measurements of the pavement at the accident site and observed at least a ½-inch displacement. The Investigation Board observed that the walkway outside Gate 2 where the accident occurred had extensive cracks and evidence of heaving in addition to the crack where the employee tripped (see Figures 3, 4, and 5). Pedestrian traffic at the accident site was not restricted. After Bettis was notified of the Type B accident investigation, the area involved was not cordoned off and entry denied to all personnel except those directly involved in mitigating the event and/or placing the scene in a stable condition.

On March 10, 2004, Bettis issued a task order to Michael Baker Corporation, a consulting engineering services firm, to evaluate the Gate 2 entrance and adjacent parking areas to determine the cause of the breakup, cracking, and changes in elevation of the paved surfaces during the current winter. The evaluation was to include recommendations for both corrective actions to restore the area and also to prevent future occurrences of similar conditions. On Monday, March 15, 2004, during a tour of the pedestrian walkway areas outside Gate 2, the Investigation Board found a Michael Baker Corporation consultant along with the BBI cognizant engineer for paving reviewing the pedestrian walkway for cracks and uneven pavement. The consultant briefed the Investigation Board on the task to review and provide recommendations on improving the pavement near the Gate 2 area. The Investigation Board requested a copy of the Michael Baker report to use as an additional reference for this report. While at the Gate 2 area, the Investigation Board found that the BBI cognizant engineer and the consultant knew the general area where the accident occurred, but did not know the specific location.

On March 17, 2004, Michael Baker Corporation issued a report of their findings and recommendations. Bettis is in the process of evaluating the report recommendations. The following are observations from the report:

- Most of the cracks observed were in line with underground utilities, edge of pavement overlays, and pavement seams. The report noted that various published materials and the Americans with Disabilities Act suggest that a tripping hazard is created by a ¼-inch abrupt vertical displacement. Michael Baker noted that many of the cracks observed at the site were found to have

more than ¼-inch vertical displacement. Many of the areas of distressed pavement had vertical displacements on the order of ½-inch.

- Pennsylvania Department of Transportation suggests that roadway pavements have maintenance at 5-year intervals and overlays at 20-year intervals. Generally, a horizontal crack of ¼-inch or more requires placement of emulsified asphalt to seal the crack or an overlay.

The report made several recommendations and conclusions:

- Action should be taken to seal or overlay existing cracks that measure more than ¼-inch vertically to reduce tripping hazards.
- Cracks measuring more than ¼-inch horizontally should be sealed adequately to reduce the introduction of water to the pavement sub-base.
- A more definitive pedestrian walkway with barriers could be designated and maintained to keep the walkway free of tripping hazards.

The Investigation Board found that BBI is in the process of a major redesign of the Bettis parking lot that will significantly change the vehicular traffic pattern. The redesign has been in the planning stages for a few years. Actual renovation work is expected to start later this year.

2.1.2 Chronology of Events

Appendix B summarizes the chronology of significant events.

2.2 Physical Hazards, Controls, and Related Factors

This section of the report states the facts related to the accident and the analysis of those facts. It focuses on the events connected to the accident; the factors that allowed those events to occur; and the results of the various analytical techniques used to determine the direct, contributing, and root causes of, and contributing factors to, the accident, including the role of management and safety system deficiencies.

2.2.1 Personnel Performance

Facts relating to personnel performance with regard to the accident are:

- The employee knew that there were uneven areas in the designated walkway that could have been avoided and believes that she should have been more careful when walking.
- The cognizant engineer for pavement maintenance and the Manager, Facilities Construction are responsible for identifying paving maintenance

needs and scheduling repairs, as necessary. There have been no repairs to the accident area since 1996 despite heaving and degraded conditions that have persisted.

- The cognizant engineer for pavement maintenance started in this position with limited knowledge of asphalt pavement maintenance. The cognizant engineer attended an off-site training program on concrete pavement. However, additional training for asphalt pavement was requested by the cognizant engineer but not approved by Bettis management due to cost and location.

2.2.2 Management Systems

2.2.2.1 Policies and Procedures

Facts relating to policies and procedures with regard to the accident are:

- Pavement maintenance to the area outside Gate 2 was last performed in 1996 with a 1 ½-inch overlay. This area includes the walkway where the accident occurred and is a high pedestrian traffic area. As reported in the evaluation report of pavement in the Gate 2 area by an independent consulting engineer, Pennsylvania Department of Transportation suggests that pavement should be repaired on a 5-year cycle.
- The last two updates to the 5-year maintenance paving program excluded paving maintenance to major Laboratory parking areas in anticipation of proposed modifications to the areas as part of security upgrades. The renovation is a multi-year program that has been in the planning stages for a few years. The work is expected to start later this year.
- The UFAS (which mirrors the requirements contained in the Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities) contains the following criteria for working surfaces to accommodate physically handicapped individuals:
 - **Accessible Route:** is a continuous unobstructed path connecting all accessible elements and spaces in a building or facility. Exterior accessible routes may include parking access aisles, curb ramps, walks, ramps, and lifts.
 - **Changes in Level:** are changes in level up to ¼-inch may be vertical and without edge treatment. Changes in level between ¼-inch and ½-inch shall be beveled with a slope no greater than 1:2.

- **Walk:** is an exterior pathway with a prepared surface intended for pedestrian use, including general pedestrian areas such as plazas and courts.
- In the UFAS Appendix, Section A4.5 Ground and Floor Surfaces, it states in part – Ambulant and semi-ambulant people who have difficulty maintaining balance and those with restricted gaits are particularly sensitive to slipping and tripping hazards. For such people, a stable and regular surface is necessary for safe walking.
- OSHA standards do not include any provisions directly applicable to maintaining outdoor pedestrian walkways free of tripping hazards. However, under the OSHA General Duties clause, Section 5 (a) Each employer – (1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.

2.2.2.2 Physical Barriers

Facts relating to the physical condition of the scene at the time of the accident are:

- A vertical displacement at least ½-inch in a pedestrian walkway existed without edge treatment. The walkway is a UFAS accessible route since it connects parking access aisles for parking spaces that are reserved for individuals with medical disabilities. The UFAS states that changes in level for ground surfaces in accessible routes between ¼-inch and ½-inch shall be beveled with a slope no greater than 1:2.
- BBI did not limit access where a potential safety hazard existed.

2.2.2.3 Supervision, Management, and Oversight

Facts relating to supervision, management, and oversight at the time of the accident are:

- BBI has limited in-house capability to perform maintenance to asphalt parking lots and walkways. In-house maintenance is restricted to minor repairs that are identified on a case-basis. BBI annually subcontracts paving maintenance (i.e., pothole repair and resurfacing of large sections of parking lot). The subcontracted work is performed in accordance with a technical specification that BBI develops.

- BBI had documented 13 deficiencies related to pedestrian safety with 8 deficiencies that are still not resolved, and two of which were long-standing (17 months old). In addition, BBI placed the 2003 paving maintenance contract late in the calendar year (October 2003). The 2002 paving maintenance contract was similarly delayed late in the respective year. As a result, work had to be postponed because it could not be completed before the asphalt plants closed for the winter. During the week of March 15, 2004, the Investigation Board inspected the parking lot areas and identified 23 safety-related deficiencies or concerns that were brought to the attention of BBI management.
- BBI cognizant management were not familiar with levelness requirements for ground surfaces along accessible routes as defined by UFAS.
- BBI cognizant management did not consider sealing cracks with emulsified asphalt to be an effective maintenance method. An independent consulting engineer evaluated the Gate 2 area after the accident and recommended sealing of horizontal cracks as common industry practice to reduce the risk of moisture introduction to the pavement sub-base.
- BBI cognizant management did not have specific maintenance requirements for accessible routes. Management accepted the degraded conditions of the accessible routes as normal based on experience of degraded conditions of paved pedestrian, road, and parking lot areas in the surrounding community.
- As per the Bettis Safety Engineering Manual, Safety Engineering conducts periodic surveillances of the Laboratory and issues an annual inspection schedule. However, BBI Safety Engineering did not have a routine inspection program for the parking lot. In the past, Safety Engineering had performed limited focus reviews such as a lighting survey dated May 24, 2002.
- Safety inspections are the line manager's tool for surveying and evaluating areas for potential safety hazards. As per the Bettis Safety Engineering Manual, line management are to perform quarterly inspections in laboratory and shop type areas. The Safety Engineering Manual does not address performing inspections of the parking lot areas and walkways.

2.3 Barrier Analysis Summary

Barrier analysis is a method of determining safety system elements that failed. A barrier analysis was performed on this accident and included physical and management

barriers. Appendix C provides the details of the barrier analysis. The barrier failures are summarized in Table 2-1.

Table 2-1: Barrier Analysis Summary

Hazard		Uneven Surface in Walkway
Barrier Failures	Physical	Failure to limit access where a safety hazard existed.
		Failure to repair pavement with a vertical displacement greater than ¼-inch.
	Management	Inadequate maintenance methods for paved pedestrian walkways.
		Inadequate pavement maintenance planning.
		Failure to maintain parking lot in accordance with UFAS for accessible design.
		Inadequate training of the cognizant engineer for asphalt paving.
		Failure to ensure that a safe working environment was maintained in the parking lot areas.

2.4 Change Analysis Summary

Change analysis examines planned or unplanned changes that contribute to undesired outcomes. A change analysis was performed to identify deviations from an ideal condition or requirements that may have contributed to the accident and to determine where processes or protocols need to be revised to correct deficiencies. Appendix D provides the details of the analysis. The table below summarizes the deviations that contributed to the accident and subsequent results.

Table 2-2: Change Analysis Summary

Deviation from Ideal Condition or Requirements	Result of Deviation
Accessible routes did not have a level ground surface in accordance with UFAS for accessible design.	Surfaces of accessible routes are not adequately maintained and pose physical safety hazards.
Safety Engineering and line management do not have effective inspection programs for evaluating potential parking lot safety hazards.	Parking lot areas do not receive sufficient management attention, and physical hazards are not routinely evaluated by appropriate personnel.
The engineer responsible for paving contracts does not have sufficient knowledge of industry standards to maintain pavement in a safe condition and was not provided special training.	Additional training in the latest industry standards for pavement maintenance may have enabled the engineer to recognize and mitigate unsafe conditions accordingly.
Degraded or inadequate facility conditions that result in first-aid injuries are not routinely investigated by Safety Engineering, and lessons learned from these events are not commonly disseminated to Bettis employees.	First aid cases are often not analyzed and trended, potentially allowing physical hazards resulting from degraded or inadequate conditions to persist.

2.5 Probable Causal Factors

Appendix E depicts the logical sequence of the events and causal factors with regard to the accident. It indicates, in a time-sequenced flow, factors that allowed the accident to occur leading up to the employee's hospitalization.

Direct Cause

- The direct cause of the accident was the tripping on uneven pavement and falling.

Root Causes

There were root causes (fundamental causes) that, if corrected, would prevent recurrence of this and similar occurrences.

- BBI management failed to provide a safe walking surface for employees who are required to traverse the parking lot.
- BBI management failed to ensure that areas of the parking lot used by employees with medical problems or disabilities are maintained in accordance with UFAS for accessible design.
- BBI management failed to maintain the parking lot in accordance with current industry standards for pavement maintenance and did not deal aggressively with recurring safety deficiencies in the Bettis parking lot.

Contributing Causes

There were contributing causes to the accident that, if corrected, would not by themselves have prevented the accident but are important enough to be recognized as needing corrective action.

- Failure by BBI management and Bettis self-assessments to recognize safety shortcomings in the parking lot, such as the vertical displacements in the walkway, as tripping hazards requiring immediate corrective action.
- BBI construction activity lacked an adequate pavement maintenance plan.
- BBI management had limited knowledge of UFAS for accessible design.
- The cognizant engineer had limited knowledge and training for pavement maintenance.
- The employee knew there were uneven places in the designated walkway which could have been avoided but did not use sufficient caution when walking.
- PNR has limited knowledge of UFAS guidelines and did not provide sufficient oversight to BBI management to ensure conformity with UFAS guidelines and mitigation of physical hazards in the parking lot.

3.0 Conclusions and Judgment of Need

This section of the report identifies the conclusions and judgment of need determined by the Investigation Board using the accident analysis methods described in Section 2.0. The Investigation Board considered significant facts and the analytical methods in developing conclusions.

Judgment of need are managerial controls and safety measures believed necessary to mitigate the probability or severity of a recurrence. They flow from the conclusions and causal factors. Table 3-1 identifies the conclusions and the corresponding judgment of need identified by the Investigation Board.

Table 3-1 Conclusion and Judgment of Need

Conclusion	Judgment of Need
BBI failed to maintain parking lot in accordance with UFAS for accessible design.	BBI needs to formally train cognizant personnel on specific UFAS and incorporate their use into daily operations.
BBI failed to incorporate common industry practices for maintaining parking lots.	BBI needs to review their pavement maintenance programs to ensure they meet industry and safety standards.
BBI did not adequately consider the parking lot as part of the work environment.	BBI should use consistent standards of worker safety for the entire site, including parking areas.
PNR did not provide adequate oversight to BBI management to ensure conformity with UFAS and mitigation of physical hazards in the parking lot.	PNR should become familiar with applicable UFAS to provide sufficient oversight to BBI management.

4.0 Other Investigation Board Observations

The Investigation Board identified weaknesses in communications among the Bettis Medical Department, the employee's supervisor, and the employee. The Investigation Board considers that these issues should be addressed to ensure that close, immediate attention is given to any medical complications that may arise from future work-related injuries.

- The Bettis physician reviewed the employee's previous medical history but did not specifically discuss with the employee that she was at risk for other medical complications because of pre-existing medical conditions. The physician did inform the employee to immediately notify the Medical Department if her condition worsened.
- The Bettis Medical Department did not comply with section III.B.1 of Bettis Management Guide 503 regarding informing the employee that the services provided were not intended to replace the medical care of the employee's private physician.
- The employee was not informed on the day of the accident on how to contact Bettis doctors during off-hours.
- The Bettis Medical Department did not provide written patient discharge instructions. The Bettis Medical Department did give oral instructions for the employee to contact the Bettis Medical Department immediately if her condition worsened.
- The Bettis Medical Department did not have a specific procedure to followup on potential medical complications for this employee as a result of this accident.
- The employee's supervisor did not comply with Section III.A. of Bettis Management Guide 503 regarding the need to promptly direct the employee to the Bettis Medical Department when the employee informed him that the injury persisted.
- The supervisor did not report the employee's absences from work due to her flu-like symptoms and knee injury to the Bettis Medical Department and the Bettis Safety Department.
- The employee did not recognize her flu-like symptoms as an indication of a medical complication from the injury.
- The employee did not follow through in notifying the Bettis Medical Department on Monday, February 23, 2004, that her work-related injury persisted after indicating to her supervisor that she may notify Medical.

5.0 Investigation Board Signatures

S. R. Burinski

S. R. Burinski
Investigation Board Chairperson
DOE Trained Accident Investigator
U.S. Department of Energy
Pittsburgh Naval Reactors Office

Date: 5/13/04

M. C. Roper

M. C. Roper
Investigation Board Member
DOE Trained Accident Investigator
U.S. Department of Energy
Pittsburgh Naval Reactors Office

Date: 5-13-04

C. M. Labee

C. M. Labee
Investigation Board Member
U.S. Department of Energy
Pittsburgh Naval Reactors Office

Date: 5/13/04

E. Q. Drobotij

E. Q. Drobotij, P.E.
Investigation Board Member
U. S. Department of Energy
Schenectady Naval Reactors Office

Date: 5-13-04

D. M. Ackerman

D. M. Ackerman
Investigation Board Member
U.S. Department of Energy
Pittsburgh Naval Reactors Office
Idaho Branch Office

Date: 5-13-04

6.0 Investigation Board Advisors

E. D. Shollenberger
Director, Environment, Safety and Health
Pittsburgh Naval Reactors Office

S. D. Trepeta, MD, MRO
Medical Director
Knolls Atomic Power Laboratory

J. S. Carey, Jr.
Chief Counsel
Pittsburgh Naval Reactors Office

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Appendix A – Appointment of Investigation Board



Department of Energy
Pittsburgh Naval Reactors Office
P.O. Box 109
West Mifflin, Pennsylvania 15122-0109

March 9, 2004

MEMORANDUM FOR Those Listed Below

SUBJECT: APPOINTMENT OF INVESTIGATION BOARD

I hereby establish a Type B Accident Investigation Board to investigate the personal injury accident which occurred at the Bettis Atomic Power Laboratory site on February 17, 2004 involving a Bettis employee who tripped and fell on raised asphalt pavement. I consider it meets the requirements established for a Type B accident investigation in accordance with Department of Energy (DOE) Order 225.1, Accident Investigations, as implemented by Naval Reactors Bulletin 225.1-95, Revision 1, dated April 15, 1998.

I appoint S. R. Burinski as the Accident Board Chairperson. The Board members will be C. M. Labee (PNR), M. C. Roper (PNR), E. Q. Drobotij (SNR), and D. M. Ackerman (IBO). The Board will be assisted by advisors, consultants, and other support personnel as determined by the Chairperson.

The scope of the Board's investigation will include, but is not limited to, identifying all relevant facts; analyzing the facts to determine the direct, contributing, and root causes of the accident; developing conclusions; and determining the actions that, when implemented, should prevent the recurrence of a similar accident. The investigation will be conducted in accordance with DOE Order 225.1 and will specifically address the role of DOE and contractor organizations and management systems as they may have contributed to the accident.

The Board will provide my office with periodic reports on the status of the investigation but will not include any conclusions until an analysis of all the causal factors has been completed. Draft copies of the factual portion of the investigation report should be provided to Bettis site officials for a factual accuracy review prior to report finalization.

Appendix A – Appointment of Investigation Board

Those Listed Below

2

March 9, 2004

The report should be provided to me for acceptance within 30 days from the date of this memorandum. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

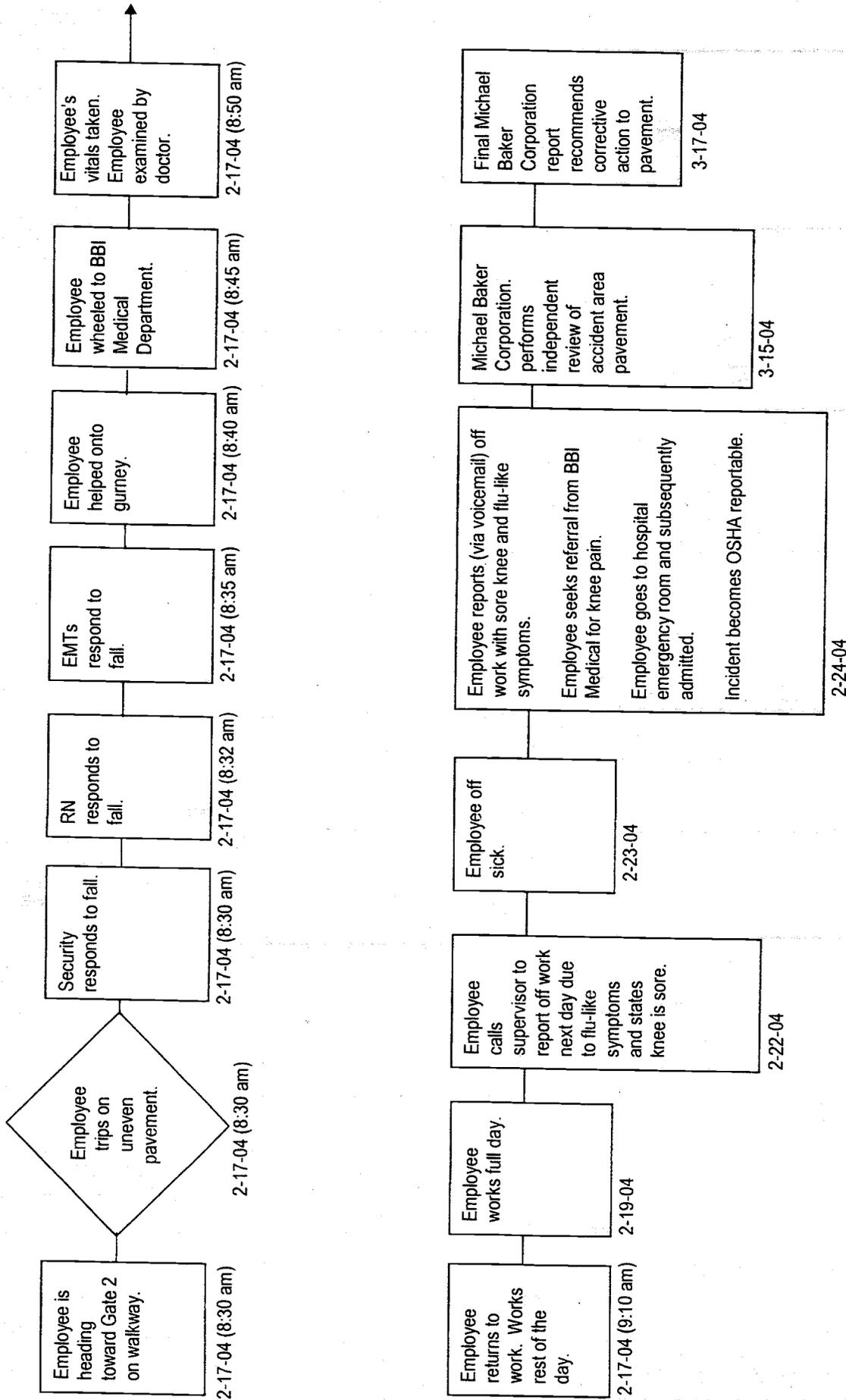


H. A. Cardinali
Manager

Addressees:

J. M. McKenzie, NR
P. E. Salm, SNR
S. L. Dunn, IBO
J. F. Koury, PNR

Appendix B – Chronology of Events



Appendix C – Barrier Analysis

<u>HAZARD</u>	<u>DIRECT BARRIER FAILURE</u>	<u>FACTORS CONTRIBUTING TO</u>	<u>ROOT CAUSE</u>	<u>POTENTIAL LOSS EVENT</u>	<u>EVALUATION</u>
Uneven Surface in Walkway	Failure to erect safety barricades to isolate an area where a safety hazard exists.	Hazard not recognized as tripping hazard.	Lack of knowledge of UFAS for accessible design.	Serious injury.	BBI management failed to recognize a tripping hazard.
	Failure to repair vertical displacement greater than one quarter of an inch (1/4").	Requirements for accessible routes not defined. Heavement and cracking of pavement tolerated.	Lack of knowledge of UFAS for accessible design. Degraded condition of parking lot normalized, assumed acceptable based on conditions of roadways and parking lots in community.	Serious injury. Premature pavement degradation.	BBI management failed to maintain accessible route in accordance with UFAS. BBI management failed to maintain accessible route in accordance with UFAS. BBI management accepted the degraded condition of the parking lot as normal, based on conditions of pavement in the suburban Pittsburgh area.
	Inadequate pavement maintenance planning.	Failure to address industry guidelines to keep walkways free of tripping hazards. Late contract placements. Deferral of repaving work in anticipation of parking lot renovations.	Low prioritization of mitigating physical hazards for pedestrians in accessible routes. Pavement maintenance is a low priority.	Serious injury. Premature pavement degradation.	BBI management failed to recognize a tripping hazard. BBI management failed to maintain accessible route in accordance with UFAS. BBI and PNR oversight personnel have limited knowledge of UFAS. BBI management focused on the weather and behavioral hazards associated with pedestrian traffic without recognizing the need to address physical hazards.

Appendix C – Barrier Analysis

<u>HAZARD</u>	<u>DIRECT BARRIER FAILURE</u>	<u>FACTORS CONTRIBUTING TO</u>	<u>ROOT CAUSE</u>	<u>POTENTIAL LOSS EVENT</u>	<u>EVALUATION</u>
	Failure to maintain parking lots in accordance with UFAS for accessible design.	General lack of knowledge by BBI personnel on specific UFAS.	General lack of knowledge by BBI on specific UFAS.	Serious injury. Premature pavement degradation.	BBI management displays a general lack of knowledge on specific UFAS for accessible design.
	Inadequate maintenance methods of paved pedestrian walkways.	Outside training resources not utilized. Not using alternate maintenance methods such as sealing cracks.	BBI management did not ensure that staff were competent to perform their responsibilities.	Serious injury. Premature pavement degradation.	BBI management failed to keep up with industry guidelines on pavement maintenance.
	Inadequate training of cognizant engineer for asphalt pavement maintenance.	Mechanical engineer with refueling background fulfilling civil engineering duties requested additional training, but was denied.	Cognizant engineer required additional guidelines for asphalt pavement maintenance.	Premature pavement degradation.	BBI management failed to adequately train the cognizant engineer on current industry guidelines for asphalt pavement maintenance.
	Failure to ensure that safe working environment is maintained for the parking lot.	No critique of event performed. No hazard analysis documented. No formalized or documented plan. Accident investigation procedure not followed by BBI management.	Parking lot not generally recognized as part of working environment. Degraded condition of parking normalized, assumed acceptable based on condition of roadways in community.	Serious injury. Premature pavement degradation.	BBI management focused on the weather and behavioral hazards associated with pedestrian traffic without recognizing the need to address physical hazards. BBI management did not give attention to the physical hazards in the parking lot because the parking lot is not generally treated as a work environment.

Appendix D – Change Analysis

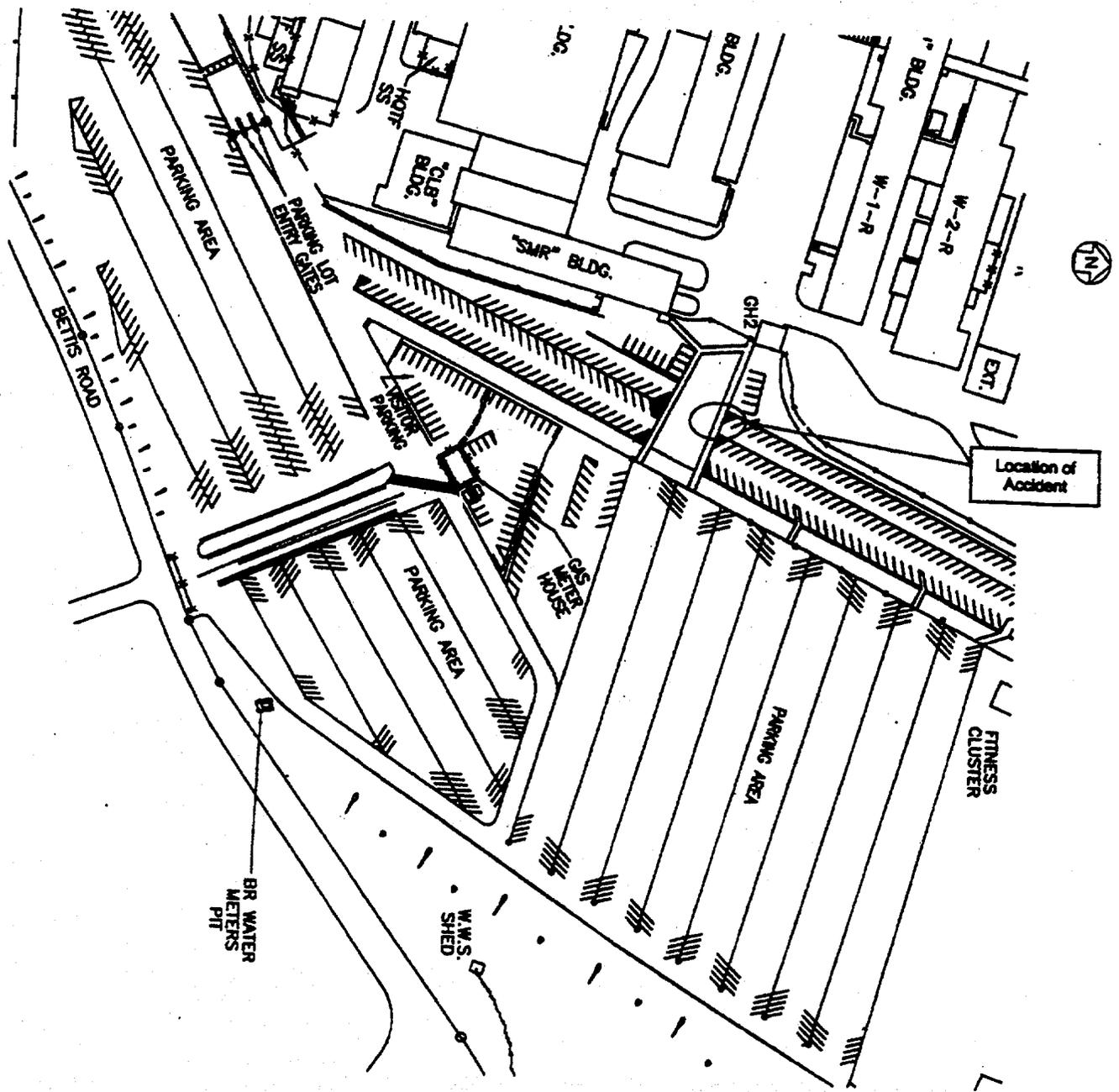
Change Analysis			
Prior or Ideal Condition	Present Condition	Difference (Change)	Analysis
Accessible routes have a level surface.	Cracked and uneven pavement.	Standard guidelines for maintenance of pavement and accessible routes were not incorporated into subcontracted work.	Surfaces of accessible routes are not maintained adequately and pose physical safety hazards.
Detailed, periodic safety inspections of parking lot areas by line management and Safety Engineering.	Sporadic spot checks of the parking lot by individuals while in the process of doing something else.	Safety Engineering and line management did not recognize the need to perform safety inspections of the parking lot areas and thorough inspections were not performed.	Physical hazards in the parking lot are not evaluated by Safety Engineering and line management.
Work-related employee injuries that would include first-aid injuries are investigated shortly after the accident and lessons learned disseminated to BBI employees.	No immediate investigation was conducted by Safety Engineering.	Acceptance of slips, trips, and falls in the parking lot as weather-related or employee complacency.	Physical hazards in the parking lot persist.
Accessible routes maintained in accordance with UFAS.	BBI management not aware of UFAS and fails to be in accordance with criteria.	Accessible routes are not closely reviewed for physical hazards and not given appropriate maintenance attention.	Tripping hazards are not identified and persist in accessible routes.
PNR provides oversight of BBI management to ensure conformity with UFAS and mitigation of physical hazards in the parking lot.	PNR did not provide sufficient oversight of BBI management.	Additional scrutiny of conformity and safety posture did not exist.	PNR did not provide feedback to BBI management to ensure requirements and maintenance given higher priority.
Cognizant engineer for pavement maintenance has an adequate background and training in industry standards for asphalt pavement maintenance.	Cognizant engineer does not have sufficient knowledge of industry standards to maintain asphalt pavement in a safe condition.	BBI management failed to provide additional training previously requested and considers asphalt pavement maintenance a low priority.	Additional training in the latest pavement maintenance may recognize and emphasize unsafe asphalt pavement conditions.
The parking lot is considered a working environment and a hazard analysis is performed.	The parking lot is not treated as a work environment, and a hazard analysis is not performed.	Appropriate attention to physical hazards is not given.	BBI management attention to parking lot conditions may have reduced parking lot hazards.

Appendix F - Glossary

Accessible Route	A continuous unobstructed path connecting all accessible elements and spaces in a building or facility. Exterior accessible routes may include parking access aisles, curb ramps, walks, ramps, and lifts.
ADA	Americans with Disabilities Act of 1990
DOE	U.S. Department of Energy
Heave	The horizontal displacement by the faulting of a substrate such as pavement.
NR	Naval Reactors (Washington, DC)
PNR	Pittsburgh Naval Reactors Office
UFAS	Uniform Federal Accessibility Standards
Vertical Displacement	Vertical changes in level.
Walkway	An exterior pathway with a prepared surface intended for pedestrian use.

FIGURE 1

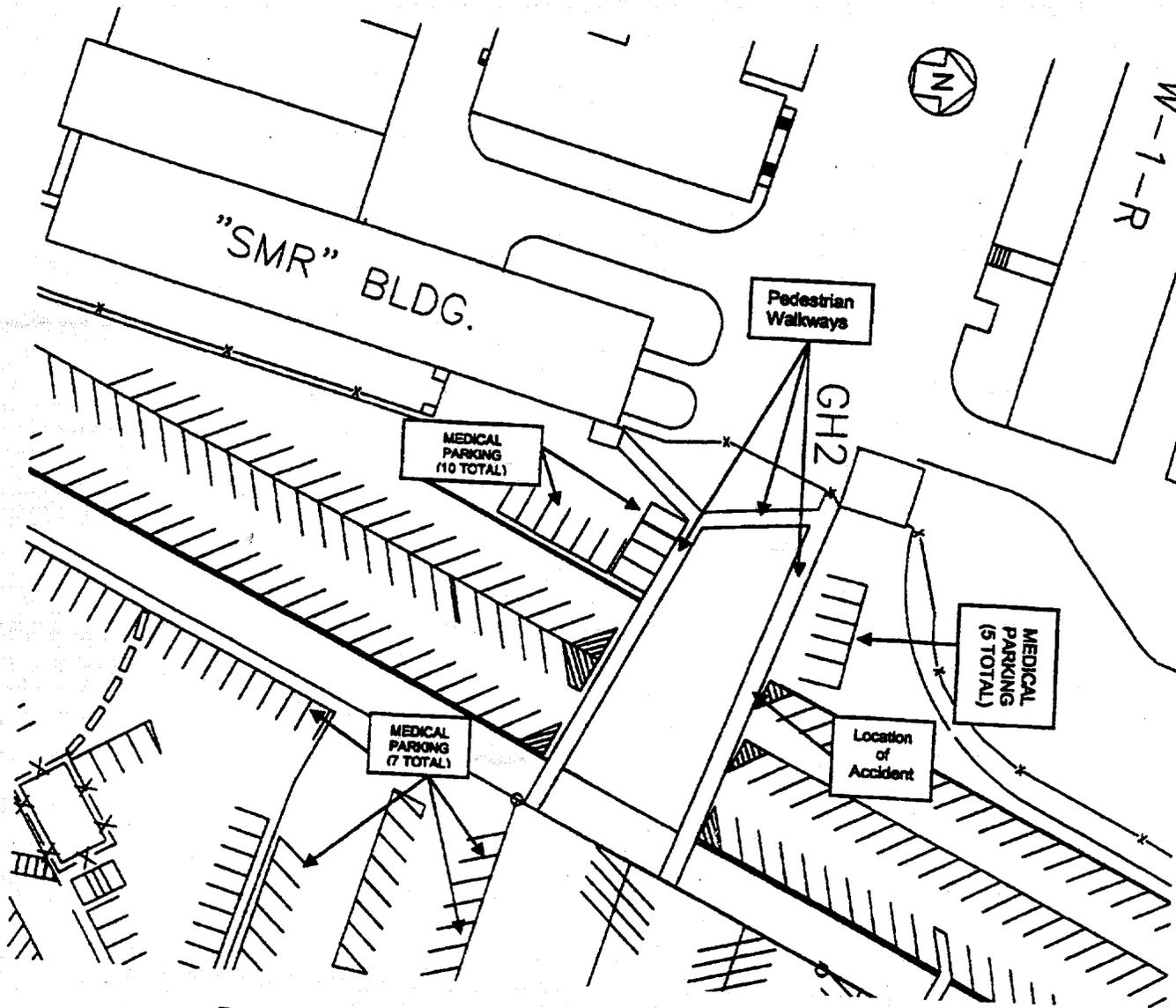
BETTIS SITE



Partial Bettis Site Map.

FIGURE 2

BETTIS SITE



Pedestrian Walkways and Parking Areas Near Gate 2.

FIGURE 3



Figure 3 - Photograph taken March 9, 2004 showing pedestrian walkway approaching Gate 2 looking west.

FIGURE 4



Figure 4 – Photograph taken March 9, 2004 showing area of uneven pavement in crosswalk where employee tripped and fell near Gate 2.

FIGURE 5



Figure 5 – Photograph taken March 11, 2004 showing area of heaved pavement highlighting area of vertical displacement > 1/4-inch.