ACCIDENT INVESTIGATION COMMITTEE REPORT
ON THE LEG INJURY
AT THE
BNL NSLS-II CONSTRUCTION SITE
THAT OCCURRED ON
SEPTEMBER 30, 2009

DRAFT
December 4, 2009

BROOKHAVEN NATIONAL LABORATORY
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<th>Definition</th>
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<tbody>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>BLS</td>
<td>Bureau of Labor Statistics</td>
</tr>
<tr>
<td>BNL</td>
<td>Brookhaven National Laboratory</td>
</tr>
<tr>
<td>BSA</td>
<td>Brookhaven Science Associates</td>
</tr>
<tr>
<td>BHSO</td>
<td>U.S. Department of Energy Brookhaven Site Office</td>
</tr>
<tr>
<td>CAIRS</td>
<td>Computerized Accident, Incident Reporting System</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>DART</td>
<td>Days away, restricted, or transferred</td>
</tr>
<tr>
<td>DEAR</td>
<td>Department of Energy Acquisition Regulation</td>
</tr>
<tr>
<td>DOE</td>
<td>Department of Energy</td>
</tr>
<tr>
<td>E&amp;CFC</td>
<td>Events and Causal Factors Charting</td>
</tr>
<tr>
<td>EMT</td>
<td>Emergency Medical Technician</td>
</tr>
<tr>
<td>EMS</td>
<td>Emergency Management System</td>
</tr>
<tr>
<td>ES&amp;H</td>
<td>Environment, Safety, and Health</td>
</tr>
<tr>
<td>ESH&amp;Q</td>
<td>Environment, Safety, Health and Quality</td>
</tr>
<tr>
<td>ETA</td>
<td>Estimated time of arrival</td>
</tr>
<tr>
<td>HASP</td>
<td>Health and Safety Program</td>
</tr>
<tr>
<td>HFBR</td>
<td>High Flux Beam Reactor</td>
</tr>
<tr>
<td>ISM</td>
<td>Integrated Safety Management</td>
</tr>
<tr>
<td>ISMS</td>
<td>Integrated Safety Management System</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IO</td>
<td>Internal Audit and Oversight</td>
</tr>
<tr>
<td>JON</td>
<td>Judgment of Need</td>
</tr>
<tr>
<td>JRA</td>
<td>Job Risk Assessment</td>
</tr>
<tr>
<td>LIE</td>
<td>Long Island Expressway</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Name</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>NSLS</td>
<td>National Synchrotron Light Source</td>
</tr>
<tr>
<td>NSLS-II</td>
<td>National Synchrotron Light Source II</td>
</tr>
<tr>
<td>OHSAS</td>
<td>Occupational Health &amp; Safety Advisory Services</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PDHQ</td>
<td>Police Department Head Quarters</td>
</tr>
<tr>
<td>PHA</td>
<td>Phase Hazard Analysis</td>
</tr>
<tr>
<td>PTI</td>
<td>Project Technologies International, LLC</td>
</tr>
<tr>
<td>RTV</td>
<td>Rough Terrain Vehicle</td>
</tr>
<tr>
<td>SBMS</td>
<td>Standards-Based Management System</td>
</tr>
<tr>
<td>SHE</td>
<td>Safety, Health, and Environment</td>
</tr>
<tr>
<td>SHSD</td>
<td>Safety and Health Services Division</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

On September 30, 2009, at 0840 hours, a Laborer at the National Synchrotron Light Source II (NSLS-II) construction site at Brookhaven National Laboratory (BNL) was injured when a bundle of rebar struck his leg. He was directing the Operator of the rough-terrain forklift (Lull) to place bundles of rebar on cribbing in preparation for pickup by crane, when the rebar struck his right leg and fractured it. The rebar was immediately removed from his leg by the Operator using the Lull.

At 0845 hours, BNL’s Laboratory Protection Division’s emergency reporting number, extension 2222, received a call from Torcon’s Safety Manager advising of the injury and requesting an ambulance. In parallel, Torcon’s site EMT was alerted of the injury and proceeded from Torcon’s Project Trailer to the accident location. Upon her arrival, she immediately started providing medical care. At 0848 hours, the BNL Fire Captain arrived at the scene and assumed the role of Incident Commander.

Upon arrival of the BNL Ambulance at 0848 hours, BNL Fire Rescue personnel assumed responsibility for the injured worker and prepared him to be transported to Stony Brook University Medical Center (Hospital) via BNL Ambulance. The injured arrived at the Hospital Emergency Room at 0936 hours, and the BNL Ambulance returned to BNL at approximately 1030 hours.

On October 1, 2009, Dr. Steven Dierker, NSLS-II Project Director, charged an independent Accident Investigation Committee to: (1) investigate the leg injury incident; (2) review the adequacy of contractual safety requirements and the safety incentive program; and (3) review the implementation of the construction safety program.

On October 6, 2009, six days after the accident, the Laborer was released from the Hospital. He had undergone surgery to repair the fracture and rehabilitation to allow him to move with crutches. Five continuous calendar days in a hospital requires a Type B investigation per DOE O 225.1A, Accident Investigations. However, on October 7, 2009, Michael D. Holland, Manager, Office of Science Brookhaven Site Office (BHSO), received a Memorandum from Glenn S. Podonsky, Chief Health, Safety and Security Officer, Office of Health, Safety and Security, granting a request by BHSO to allow BSA’s Accident Investigation Committee to complete the investigation with DOE oversight.

The Accident Investigation Committee began its activities on October 1, 2009 and submitted the final report to the NSLS-II Project Director on December 4, 2009. The charge of the Committee was to: (1) investigate the leg injury incident; (2) review the adequacy of contractual safety requirements and the safety incentive program; and (3) review the implementation of the construction safety program.

The Accident Investigation Committee applied several analytical techniques to determine the causal factors of the event. They included Barrier Analysis (BA), Events and Causal Factors Charting (E&CFC), and TapRooT® (TR). Facts were also analyzed using the Core Functions and Guiding Principles of Integrated Safety Management (ISM). In addition, ES&H oversight was evaluated against contract requirements.

A Human Factors Scientist reviewed the accident description and these analyses to ensure Human Performance Improvement was incorporated in the results. The Accident Investigation Committee also analyzed the adequacy of the Contractor’s safety program implementation and flow down to subcontractors, as well as the adequacy of BSA’s NSLS-II oversight of the Contractor (as per its charter) using the above results. The Committee limited this analysis to those processes and systems viewed during the performance of the accident investigation, therefore this should not be interpreted as a full analysis.
The Accident Investigation Committee has concluded that this accident was preventable. There is one direct cause and two root causes to this event, which are summarized in the following table.

<table>
<thead>
<tr>
<th>DCE No.</th>
<th>Direct Cause of the Event</th>
<th>JON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Laborer struck by rebar</td>
<td>1, 2, 5 &amp; 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RCE No.</th>
<th>Root Cause of the Event</th>
<th>JON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Torcon and its subcontractors failed to ensure employees possessed the experience, knowledge, skills, and abilities that were necessary to discharge their responsibilities.</td>
<td>1, 5 &amp; 7</td>
</tr>
<tr>
<td>2</td>
<td>Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety.</td>
<td>2, 5 &amp; 7</td>
</tr>
</tbody>
</table>

The Accident Investigation Committee identified four causes that did not contribute to this event but contributed to weakening the NSLS-II ES&H Program at the construction site, which are summarized in the following table.

<table>
<thead>
<tr>
<th>CCW No.</th>
<th>Contributing Cause (Program Weakness)</th>
<th>JON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Torcon and its subcontractors failed to establish clear and unambiguous lines of authority and responsibility for ensuring ES&amp;H compliance was established and maintained at all organizational levels.</td>
<td>3, 5 &amp; 7</td>
</tr>
<tr>
<td>2</td>
<td>Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&amp;H Program and therefore contributed to its weakness.</td>
<td>4, 5 &amp; 7</td>
</tr>
<tr>
<td>3</td>
<td>Torcon and its subcontractors failed to implement an effective suspect/counterfeit program for rigging.</td>
<td>5, 6 &amp; 7</td>
</tr>
<tr>
<td>4</td>
<td>NSLS-II failed to ensure that the NSLS-II ES&amp;H Program was performing as designed.</td>
<td>5 &amp; 7</td>
</tr>
</tbody>
</table>
Judgments of Needs were developed to address each Cause and are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Judgment of Need</th>
<th>Cause Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure workers are qualified and possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities in compliance with (1) Contract Attachment A, Article 43, (2) ES&amp;H program and (3) ISM.</td>
<td>DCE-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCE-1</td>
</tr>
<tr>
<td>2</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure workers are aware of foreseeable hazards and protective measures for their safety. This includes, but is not limited to defining “major phases” of work to determine when hazard analyses are required, establishing the criteria for acceptance of hazard analyses, discussing hazards and their controls during pre-job briefings, and ensuring compliance with (1) Contract Attachment A, Article 43 (d)(1), Establishment of Safety Protocols, and (2) Torcon’s SHE Program Section 11, PHAs.</td>
<td>DCE-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCE-2</td>
</tr>
<tr>
<td>3</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to establish clear and unambiguous lines of authority and responsibility for the implementation the (1) Contract, (2) Torcon’s SHE Program, and (3) other ES&amp;H requirements.</td>
<td>CCW-1</td>
</tr>
</tbody>
</table>
| 4   | There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure all ES&H requirements of the Contract and Torcon’s SHE Program are being adequately implemented. This includes, but is not limited to, the following requirements:  
  - Contract, Attachment A  
    - Article 16, Suspect/Counterfeit Items  
    - Article 43 subsections  
      - (d)(1) Establishment of Safety Protocols  
      - (d)(2) Frequent and Regular Inspections of the Work Site  
      - (f) Immediate Notification to BSA’s Contractual Representative of Recordable Injuries  
      - (k) Subcontractor’s Compliance with ES&H                                                                                                                                                                                                                                                                                                                                  | CCW-2          |
<table>
<thead>
<tr>
<th>No.</th>
<th>Judgment of Need</th>
<th>Cause Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Requirements of the Contract</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torcon’s SHE Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 11, PHAs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 14, <em>Daily Inspections of Heavy Equipment</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 19, <em>Procedures for Injuries and Near Misses</em></td>
<td></td>
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<tr>
<td></td>
<td>o Section 23, <em>Job Site Inspections</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 38, <em>Rigging Procedures and Inspections</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• NFPA 10, <em>Standard for Portable Fire Extinguishers</em></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>There is a need for the NSLS-II project to provide adequate oversight to ensure</td>
<td>DCE-1</td>
</tr>
<tr>
<td></td>
<td>that BSA ES&amp;H Contract requirements and the NSLS-II ES&amp;H programs are being</td>
<td>RCE-1</td>
</tr>
<tr>
<td></td>
<td>fully implemented. This includes, but is not limited to:</td>
<td>RCE-2</td>
</tr>
<tr>
<td></td>
<td>• Compliance with Contract, Attachment A, Article 43 (g), *Written Notification</td>
<td>CCW-1</td>
</tr>
<tr>
<td></td>
<td>to Contractor of Non-compliances</td>
<td>CCW-2</td>
</tr>
<tr>
<td></td>
<td>• Compliance with BSA’s <em>Construction Safety</em> Subject Area</td>
<td>CCW-3</td>
</tr>
<tr>
<td></td>
<td>• Compliance with NSLS-II ES&amp;H Management Plan, paragraph 3.3.1.1, *Safety</td>
<td>CCW-4</td>
</tr>
<tr>
<td></td>
<td>Responsibilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Compliance with NSLS-II Project Procedure LT-ESH_P-00013, <em>Safety Inspections.</em></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the</td>
<td>CCW-3</td>
</tr>
<tr>
<td></td>
<td>NSLS-II construction site, to implement an effective suspect/counterfeit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>program for rigging. This includes, but is not limited to, revising Torcon’s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHE program to reflect inspection of rigging equipment for suspect/counterfeit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>items prior to use and ensuring there are no unknown suspect/counterfeit items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>currently in use on the NSLS-II construction site. There is a further need for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Torcon and all its subcontractors, at all levels, on the NSLS-II construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>site, to ensure that Contract, Attachment A, Article 16, is being met.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>There is a need for the NSLS-II project to establish and implement a well</td>
<td>DCE-1</td>
</tr>
<tr>
<td></td>
<td>structured assessment program to complement field inspections. The assessment</td>
<td>RCE-1</td>
</tr>
<tr>
<td></td>
<td>program should be designed to ensure all elements of the ES&amp;H program required</td>
<td>RCE-2</td>
</tr>
<tr>
<td></td>
<td>by the Contract and ES&amp;H Plans are functioning properly. The schedule should</td>
<td>CCW-1</td>
</tr>
<tr>
<td></td>
<td>be established to ensure elements that support or monitor life protection</td>
<td>CCW-2</td>
</tr>
<tr>
<td></td>
<td>programs (e.g., LOTO, confined spaces, excavation, electrical safety) are</td>
<td>CCW-3</td>
</tr>
<tr>
<td></td>
<td>given priority.</td>
<td>CCW-4</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

1.1 BACKGROUND

On September 30, 2009, at 0840 hours, a Laborer at the National Synchrotron Light Source II (NSLS-II) construction site at Brookhaven National Laboratory (BNL) was injured when a bundle of rebar struck his leg. He was directing the Operator of the rough-terrain forklift (Lull) to place bundles of rebar on cribbing in preparation for pickup by crane, when the rebar struck his right leg and fractured it. The rebar was immediately removed by the Operator using the Lull.

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Upon arrival of the BNL Ambulance at 0848 hours, BNL Fire Rescue personnel assumed responsibility for the injured worker and prepared him to be transported to Stony Brook University Medical Center (Hospital) via BNL Ambulance. The injured arrived at the Hospital Emergency Room at 0936 hours, and the BNL Ambulance returned to BNL at approximately 1030 hours.

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This report responds to that charge.

On October 6, 2009, six days after the accident, the Laborer was released from the Hospital. He had undergone surgery to repair the fracture and rehabilitation to allow him to move with crutches. Five continuous calendar days in a hospital requires a Type B investigation per DOE O 225.1A, Accident Investigations. However, on October 7, 2009, Michael D. Holland, Manager, Office of Science Brookhaven Site Office (BHSO), received a Memorandum from Glenn S. Podonsky, Chief Health, Safety and Security Officer, Office of Health, Safety and Security, granting a request by BHSO to allow BSA’s Accident Investigation Committee to complete the investigation with DOE oversight (see Appendix B).
1.2 FACILITY DESCRIPTION

NSLS-II will be a new state-of-the-art, medium-energy electron storage ring designed to deliver world-leading intensity and brightness, and will produce x-rays more than 10,000 times brighter than the current NSLS located at BNL.

The conventional facilities required for the NSLS-II will include a Ring Building of approximately 392,000 square feet. The Ring Building will serve as the centerpiece of the NSLS-II and will house offices for the visiting user community, laboratory space, the main accelerator ring, experimental beamlines, experimental floor area, and supporting facilities.

Figure 1. Conceptual view of the NSLS-II when completed.

The construction type for the Ring Building will be reinforced slab on grade with perimeter footing, structural steel frame with composite reinforced concrete slab on metal deck for the upper floors, and insulated metal panel exterior.

Although the building design will generally involve standard commercial design and construction techniques, there are some additional considerations due to the specific requirements of the accelerator, experimental beamlines, and types of research that will take place in laboratory spaces. Placement of the floor slab will involve an estimated 35,000 cubic yards of concrete, with special consideration given to minimization of differential settlement to assure alignment integrity of the installed accelerator and beamlines.
The NSLS-II Ring Building has been designed to minimize sources of vibration and transmission of vibration that would impact beam stability in the accelerator and experimental beamline areas and laboratory spaces. Construction started in April 2009, is currently in progress, and is scheduled for completion in April 2012.

1.3 PROJECT MANAGEMENT

Brookhaven National Laboratory is operated by Brookhaven Science Associates, LLC, (BSA) who is under contract to the United States of America’s Department of Energy. Figure 2 provides an organizational chart for the NSLS-II Construction Project.

![Figure 2. NSLS-II Construction Project Chart as of June 3, 2009.](image)
BSA has contracted the construction of the NSLS-II Ring Building to Torcon Incorporated (Torcon). The Operator of the Lull was employed by Macedos Construction, LLC (Macedos), who is under direct contract to Torcon. The Laborer, who was injured, was employed by Rebar Steel Corporation (Rebar Steel), who is under contract to Macedos. Figure 3 illustrates these contractual relationships.

**Figure 3.** BSA, Torcon, and subcontractor relationships with respect to this accident.
1.3.1 CONTRACTUAL RESPONSIBILITIES

Brookhaven Science Associates (BSA) manages the operations of Brookhaven National Laboratory (BNL) for the United States Department of Energy (DOE). Pertinent to the accident investigation are the environmental, safety, and health (ES&H) roles and responsibilities established by BSA and DOE under Contract DE-AC02-98CH10886. BSA implements these roles and responsibilities through its Standards-Based Management System (SBMS).

The NSLS-II team has taken these roles and responsibilities described in SBMS as they apply to their entire project and documented them in the Environmental, Safety, and Health Plan for the National Synchrotron Light Source-II; Doc #LT-ESH-002-CD-REV02 (NSLS-II ES&H Plan). To clearly communicate the construction ES&H requirements, the project team created the Environment, Safety, and Health Management Plan for the Construction of the NSLS-II Conventional Facilities, DOC #LT-ESH-0009-Rev1 (NSLS-II ES&H Management Plan). In addition, the project team created the National Synchrotron Light Source II Construction Environment, Safety and Health Plan for Conventional Construction of the Ring Building; Doc #LT-EHS-0006/rev1 (NSLS-II Construction HASP) specifically for the construction activities being conducted by Torcon.

BSA contracted Torcon (Contract 7700000004) to perform the construction of the conventional facilities for the NSLS-II Ring Building. Included in the Contract is the NSLS-II Construction HASP. Also included in the contract is Torcon’s responsibility to ensure these requirements are imposed on all of their contractors at all levels and tiers.

To demonstrate understanding of these requirements, Torcon was required to submit a health and safety plan that meets the requirements of the NSLS-II Construction HASP prior to the start of work. Torcon’s Project Safety, Health and Environmental Program was reviewed by NSLS-II, BSA, and DOE-BHSO safety and health professionals and approved on March 17, 2009. A notice to proceed was transmitted by BSA to Torcon on March 25, 2009. Figure 4 provides an illustration of the flowdown of pertinent ES&H requirements as it relates to this accident investigation.
Figure 4. BSA/NSLS-II, Torcon, and subcontractor key ES&H requirements and their flowdown with respect to this accident.
1.4 SCOPE, PURPOSE, AND METHODOLOGY

The Accident Investigation Committee began its activities on October 1, 2009 and submitted the final report to the NSLS-II Project Director on December 4, 2009. The charge of the Committee was to: (1) investigate the leg injury incident; (2) review the adequacy of contractual safety requirements and the safety incentive program; and (3) review the implementation of the construction safety program. The Committee identified relevant facts; analyzed the facts to determine the direct, contributing, and root causes of the incident; developed conclusions; and determined Judgments of Need that, when addressed, should prevent recurrence of a similar accident.

Charge (1) addresses the accident investigation. Charges (2) and (3) expand the scope of the investigation beyond DOE O 225.1A.

The accident investigation was performed consistent with DOE O 225.1A, Accident Investigations. The Laborer was in the Hospital for six days, which requires a DOE Type B investigation. However, on October 7, 2009, Michael D. Holland, Manager, Office of Science Brookhaven Site Office (BHSO), received a Memorandum from Glenn S. Podonsky, Chief Health, Safety and Security Officer, Office of Health, Safety and Security, granting a request by BHSO to allow BSA’s Accident Investigation Committee to complete the investigation with DOE oversight (see Appendix B). The investigation conducted by BSA meets the intent of the Order.

The following methodology was used:

- Facts relevant to the accident were gathered through reviews of photographs, measurements of the scene and equipment, obtaining interview statements, and a fact finding meeting held on the day of the accident. Following the first day of the accident additional and follow up interviews, measurements and photographs were performed, as well as the review of additional documents and logs.

- Facts relevant to the adequacy of the contractual safety requirements, the safety incentive program, and the implementation of the construction safety program, were gathered through interviews, the review of documents, and field observations.

- Facts were analyzed to identify causal factors using Event and Causal Factors Charting (E&CF), Barrier Analysis and TapRooT®. Facts were also analyzed using the Core Functions and Guiding Principles of Integrated Safety Management (ISM). In addition, ES&H oversight was evaluated against contract requirements.

- The emergency response was evaluated against procedures and effectiveness in performance.

- Judgments of Need (JONs) for corrective actions to prevent recurrence of the accident and to improve program weaknesses identified were developed.
1.4.1 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, which is the immediate event(s) or condition(s) that caused the accident; root cause(s), which is the causal factor that, if corrected, would prevent recurrence of the accident; and the contributing causal factors, which are the causal factors that collectively with the other causes increase the likelihood of an accident but which did not cause the accident. The causal factors related to weaknesses in the five Core Functions of Integrated Safety Management (ISM) are analyzed.

Event and causal factors analysis includes charting, which depicts the logical sequence of events and conditions (causal factors that allowed the event to occur), and the use of deductive reasoning to determine the events or conditions that contributed to the accident.

Barrier analysis reviews the hazards, the targets (people or objects) of the hazards, and the controls or barriers that Management Systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.

TapRoot® is a proven tool used to evaluate causal factors that resulted in equipment and human performance problems. The focus is on the system (the way that the work is performed), not the individual. TapRoot® defines causal factors as any problem associated with the incident that, if corrected, would have prevented the incident from occurring or would have significantly mitigated its consequences.
2.0 FACTS

2.1 ACCIDENT

2.1.1 DESCRIPTION OF THE ACCIDENT SITE

On September 30, 2009, the primary construction activities underway on the NSLS-II site were concrete, site work and utility installation. In the accident area, concrete work being conducted included placing forms and rebar for the vehicle tunnel east retaining wall footings, storage ring tunnel floor slab and storage ring tunnel walls. Site work in progress included grading of the north portion of the site to prepare the entrance drive and parking area near the Lobby, additional pouring of concrete to the east, and earthwork required to support installation of drainage utilities on the north and east sides of the site. Utility installations included extension of water mains to the future fire control room, installation of underground sanitary piping under the Ring Building, and installation of electrical grounding for the footings at the Ring Building column line. Figures 5 and 6 show the site on the day of the accident.

Figure 5. Aerial view of the NSLS-II construction site taken from the BNL HFBR Stack facing southeast, September 30, 2009, at 0800 hours.
2.1.2 DESCRIPTION OF THE ACCIDENT

The Accident Investigation Committee has reconstructed the accident as they believe it occurred using interview statements, response logs, reports, physical evidence, and fact finding minutes. Photographs were taken by project, BNL Safety & Health Services Division (SHSD) personnel, as well as members of the Accident Investigation Committee. Physical measurements were taken by SHSD and the Accident Investigation Committee. A survey of the accident site was conducted and documented in a scale drawing (see Appendix H). See Appendix D for an explanation of the footnotes and the reasons why the Accident Investigation Committee concluded the event occurred as described.

On September 30, 2009, a rough-terrain forklift (Lull) Operator employed by Macedos started work at approximately 0645 hours by performing his daily inspection and testing of the equipment. The Lull was in good working condition and the Operator had no problem with it. At 0700 hours, he began working with carpenters to move material.

A Laborer employed by Rebar Steel was directed by the Rebar Steel foreman that morning to prepare some rebar for hoisting by a crane into the form work area. At approximately 0815 hours, the Laborer asked the Operator to move some rebar from a laydown area to a staging area where it could be hoisted by crane. The Laborer, acting as a spotter, was directing the placement of the rebar load by directing the Lull.

The Operator and the Laborer moved 6 to 7 loads of rebar to another area before starting to work in the area where the accident occurred. The Laborer identified the rebar bundles to be moved by marking them with orange paint. The Operator and the Laborer indicated that they were not under any unusual pressure to get the job done.

* See Appendix D for all Footnotes
The Laborer arranged cribbing in the accident area to support the bundles of rebar. The Operator, directed by the Laborer, then moved two bundles of rebar into the area, one with a bend and one bundle of ½ inch rebar. The Operator, again directed by the Laborer, moved two bundles of 1 ¼ inch rebar into the area. Figure 7 shows the staging of the rebar.

Figure 7. Shows the accident site facing northeast. Note the placement of the cribbing, the two bundles laying on it, and the lack of area to move freely while directing the Lull.

At approximately 0835 hours, a second worker (Worker 2) saw the Operator and Laborer preparing to place a load of rebar onto the ground as he was walking behind a spoil pile to his work area.

The Laborer was standing in front of the first two bundles of rebar that were placed in the accident staging area, directing the Operator to position the load. The Operator was able to clearly see the Laborer giving hand signals, but the load obscured the Operator’s visibility of the Laborer’s feet and lower legs.

Figure 8 provides a sketch of how the Accident Investigation Committee believes the Operator’s view was obstructed. Although the Laborer is clearly visible, the location of his lower legs is obscured by the load and the location of the rebar behind his feet cannot be seen. The boom extension was 14 to 18 feet.
The Laborer’s lower legs and feet are hidden from view.

Two bundles of rebar, one struck the Laborer’s leg. This sketch shows the load just before the accident while it was being moved.

The Laborer was directing the Operator while the load was moving toward him, and signaling the Operator to place the load while walking backwards out of the way. The Laborer’s foot contacted the rebar behind him as he was backing up. He was able to get his left leg out of the way, but tripped over the rebar that was behind him and fell backward.

At approximately 0840 hours, the load was being placed by tilting the forks downward. The bundles were sliding off the forks and one of the bundles struck and laid on the Laborer’s leg while the other remained on the forks. The Operator saw the Laborer fall and heard screaming. In an effort to remove the bundle of rebar from the Laborer’s leg, the Operator speared the bundle and tilted the forks up, causing the center wire tie of the bundle to break. After the load was lifted, the Laborer rolled onto his stomach.

The Operator then exited the cab to see if the Laborer was alright. Worker 2 also heard screaming and ran over to see the Laborer on the ground face down and the rebar above him, part on the forks of the Lull and part off the forks, hanging several inches above the Laborer’s legs.

After Worker 2 arrived on the scene, the Operator moved the load back further by retracting the boom and by moving the vehicle backwards. He then dropped both bundles of rebar to the ground.
2.2 EMERGENCY RESPONSE

At 0845 hours, BNL’s Laboratory Protection Division received a phone call via BNL’s emergency reporting number, extension 2222, from Torcon’s Safety Manager advising of an injured worker with an “injury to leg perhaps serious” at the NSLS-II construction work site and the need for an ambulance. At 0846 hours, BNL Fire Rescue’s Car 1, Heavy Rescue Truck, and the Kubota RTV (equipped for patient transport from remote locations), were dispatched to the accident location given. BNL Security also responded to the call. The BNL Ambulance was at the BNL Motor Pool for routine servicing when the call was received. The Motor Pool was notified and the Ambulance was prepared and waiting for the responding crew, who picked up the Ambulance and proceeded to the scene.

In parallel, Torcon’s site Emergency Medical Technician (EMT) was alerted of the injury and proceeded from Torcon’s Project Trailer to the accident location. Upon her arrival, she immediately started providing emergency treatment.

A site worker was waiting at the entrance gate to guide the BNL responding vehicles onto the site to where the injured Laborer was located.

Upon arrival at the scene, the Fire Captain in Car 1 took control of the accident as the Incident Commander. The Incident Commander notified Suffolk County Police Department (SCPD) aviation in case a helicopter was needed to transport the injured worker.

The BNL EMT’s were at the scene within four minutes of the initial call. Upon arrival, they relieved Torcon’s EMT and took custody and control of the injured worker. The BNL Ambulance arrived shortly afterwards. The Injured was evaluated and then prepared for transport. At that time, the Incident Commander and the EMTs who were treating the patient determined that the estimated arrival time of the SCPD helicopter was too long and they would transport the injured worker to Stony Brook University Medical Center (Hospital) via the BNL Ambulance.

BNL Ambulance is New York State (NYS) Certified and operates as a basic life support (BLS) unit. Qualifications for a BLS provider include: training to the level of EMT, Defibrillation (EMT-D), and a current NYS Department of Health Certification as an EMT. The NYS Department of Health Bureau of Emergency Medical Services Policy Statement No 98-09, dated 09/01/98, establishes a policy for Advanced Life Support (ALS) intercepts. An Intercept is a staffed unit (person and equipment) that is picked up by the BLS unit while it is en route to the nearest appropriate hospital. If the Intercept is not at the designated point when the BLS unit arrives, the BLS continues on to the hospital without the Intercept, the BLS will not wait for the Intercept.

For this accident, the BNL Fire Rescue transport crew initiated the ALS protocol with Suffolk County via radio. Suffolk County dispatched a certified ALS provider to meet the BNL Ambulance on the service road of the Long Island Expressway on route to the Hospital. Pick-up of the ALS provider took less than 20 seconds, as stated by the Chief of Fire Rescue. The Ambulance then continued on to the Hospital. If the ALS provider had not been available, or had not been at the designated area when the Ambulance arrived, the Ambulance would not have stopped and would have continued to the Hospital without the ALS. Per the Chief of Fire Rescue, the actual care the ALS provided falls under the Health Insurance Portability and Accountability Act (HIPAA) and could not be disclosed to the Accident Investigation Committee without the injured worker’s permission, which the Committee was not given.
The Ambulance arrived at the Hospital Emergency Room at 0936 hours and the Injured was transferred to Hospital emergency room staff. After leaving the Hospital, the BNL Ambulance crew returned the ALS provider to his station and returned to BNL at approximately 1030 hours.

2.3 CHRONOLOGY

Table 1. Chronology of the Accident and Response

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 1, 2009</td>
<td>Laborer arrives at site and attends orientations.</td>
</tr>
<tr>
<td>Sept. 16, 2009</td>
<td>Operator arrives at site and attends orientations.</td>
</tr>
<tr>
<td>Sept. 30, 2009</td>
<td>The remainder of this event takes place on September 30, 2009</td>
</tr>
<tr>
<td>0645 hours</td>
<td>Operator starts work by performing his daily inspection and testing of equipment.</td>
</tr>
<tr>
<td>0700 hours</td>
<td>Operator begins to move material for carpenter.</td>
</tr>
<tr>
<td>0815 hours</td>
<td>Rebar Steel Foreman directs Laborer to prepare rebar for movement by crane into form area.</td>
</tr>
<tr>
<td>0815 hours</td>
<td>Laborer marks rebar bundles to be moved by spraying them with orange paint.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer asks Operator to move rebar with Lull.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer, acting as a spotter, directs placement of six to seven loads moved.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer places cribbing for rebar to be placed onto.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer directs placement of two bundles moved into the incident area.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer directs placement of two additional bundles (2,467 lbs. 23 pieces, 24’10” long).</td>
</tr>
<tr>
<td>0835 hours</td>
<td>As Worker 2 walks by, he sees Operator and Laborer working to lay down rebar.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Lull stopped.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Boom of the Lull extended to permit load to be placed.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer stands in front of two bundles of rebar, in front of the Lull.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Operator signals Operator to place load.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Operator tilts forks to place load while Laborer steps backwards to move out of the way.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Load slides off the forks of the Lull while the back of Laborer’s foot contacts rebar behind him.</td>
</tr>
<tr>
<td>0835 hours</td>
<td>Laborer trips over rebar.</td>
</tr>
<tr>
<td>0840 hours</td>
<td>Rebar strikes lower right leg of the Laborer.</td>
</tr>
<tr>
<td>0840 hours</td>
<td>Laborer’s right lower leg is fractured.</td>
</tr>
<tr>
<td>0840 hours</td>
<td>Operator, in response to screams, picks up rebar bundle with the Lull.</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>(if it was possible to determine)</td>
<td>Laborer rolls onto stomach.</td>
</tr>
<tr>
<td></td>
<td>Operator exits Lull to see if the Laborer is alright.</td>
</tr>
<tr>
<td>0845 hours</td>
<td>Worker 2, hearing scream, arrives at scene.</td>
</tr>
<tr>
<td></td>
<td>Operator enters Lull to further retract boom and backs up Lull 6 to 9 feet.</td>
</tr>
<tr>
<td>0845 hours</td>
<td>BNL Emergency number x 2222 called for Ambulance.</td>
</tr>
<tr>
<td>0845 hours</td>
<td>BNL Fire Rescue responds.</td>
</tr>
<tr>
<td>0845 hours</td>
<td>Local (Pembrooke) EMT arrives at scene.</td>
</tr>
<tr>
<td>0848 hours</td>
<td>Fire Rescue and Security arrive at scene.</td>
</tr>
<tr>
<td>0848 hours</td>
<td>BNL Ambulance arrives.</td>
</tr>
<tr>
<td>0901 hours</td>
<td>Ambulance leaves accident site with injured Laborer.</td>
</tr>
<tr>
<td>0915 hours</td>
<td>Ambulance picks up Advanced Life Support (ALS) provider en route to Hospital.</td>
</tr>
<tr>
<td></td>
<td>BNL Security secures accident site.</td>
</tr>
<tr>
<td>Approx. 0915 hours</td>
<td>Operator leaves BNL.</td>
</tr>
<tr>
<td>0936 hours</td>
<td>Ambulance arrives at Hospital.</td>
</tr>
<tr>
<td>0944 hours</td>
<td>Event declared reportable to DOE.</td>
</tr>
<tr>
<td>0946 hours</td>
<td>Operator returns to BNL for the day.</td>
</tr>
<tr>
<td>Approx. 1030 hours</td>
<td>BNL Ambulance returns to BNL.</td>
</tr>
<tr>
<td>Approx. 1200 hours</td>
<td>Operator leaves BNL.</td>
</tr>
</tbody>
</table>

2.4 ENVIRONMENTAL CONDITIONS

The recorded temperature for September 30, 2009 at 0900 hours was approximately 55 degrees Fahrenheit, with a wind speed of approximately seven miles per hour from the northwest. There was no recorded precipitation for the day (see Appendix I).

The incident area possessed a one percent grade towards the northeast. The soil was composed of sand and clay, was moist and compacted. No water accumulation was observed in the incident area on the day of the accident.
2.5 OPERATOR TRAINING AND QUALIFICATIONS

The Operator of the Lull was a Journeyman in the International Union of Operating Engineers, Local 138 (Farmingdale, NY), and had over thirty-five years of experience as an Operator of cranes and powered industrial trucks. A summary of his training and qualifications is as follows:

- New York State Crane Operator – Class A; Expiration August 31, 2012;
- New York City Department of Buildings Hoist Machine Operator – Class A; Expiration February 28, 2012;
- International Union of Operating Engineers OSHA 10-Hour Construction Safety & Health Training; dated 5/21/2008;

A review of the training curriculum provided by Local 138 contains the following as it applies to this incident:

- Operator must read and understand the Operator’s Manual for each truck they operate, including warning decals.
- Instructions for operating around other personnel, including the use of a spotter. In addition, if you use a spotter and you can’t see him or a clear path of travel does not exist, don’t move the truck.
- From the practical driving test, the following skills are assessed:
  - Were the loads handled without bumping?
  - Were the loads centered on the forks?
  - Were the loads kept low to the ground?
  - Ability to judge proper clearance all-around when turning.

In addition, the Operator attended BSA’s Contractor Vendor Orientation (CVO) and Torcon’s Project Safety Orientation classes, which are not skill based.

2.6 LABORER TRAINING AND QUALIFICATIONS

The Laborer was a member of Laborers’ Local 66, International Union of Operating Engineers, as a Journeyman since September 2009. He was employed by Rebar Steel for the NSLS-II project since September 2, 2009. Rebar Steel provided the following experience and qualifications for the Laborer (see Appendix L):

Yardman

- Moved and disbursed reinforcing steel to different locations.
- Construction, dismantling and knockdown of shanties on both hi-rises and infrastructures.
- Mechanic for small engines.
- Operated forklift - Lifting of materials in the shop yard.
- Operate and maintain diesel powered stud welding machine.
The Union Hall stated that the Laborer was not with them long enough to start any of their training.

The Laborer attended BSA’s Contractor Vendor Orientation (CVO) and Torcon’s Project Safety Orientation classes, which are not skill-based.

Discussions held by a member of the Accident Investigation Committee and the Long Island Business Agent for Local 66 revealed an employer can request by letter that the Union accept a person the employer wants to sponsor as a full Journeyman. The employer advises the Union that the candidate has all the necessary training to be a Journeyman (approximately 4,000 hours of experience). The employer may have to document time worked for the person by providing “pay stubs” for the previous 4 years worked. A Journeyman is capable of independent work. The Business Agent indicated that Rebar Steel made such a request for the Laborer, which was granted by the Union.

2.7 FORKLIFT SPECIFICATIONS

The power fork lift that was used to move the rebar was a JLG Industries Lull Telehandler Model 1044-C54, serial number 0160033803, manufactured in 2008, with 1391 hours on its meter. The rated capacity of this vehicle at 24 inches load center is 10,000 pounds. Its maximum reach is 45 feet with a capacity of 1,500 pounds. Following the accident, the equipment was inspected by BNL’s Hoisting & Rigging Inspector and then by an authorized representative of the manufacturer, both found the equipment and its forks to meet all requirements for the applications.

The boom length after the accident was approximately 13 feet. The load capacity for this boom length is 6,000 pounds. At 18 feet, the capacity limit for the Lull is 5,000 pounds. A load of 2,467 pounds for one bundle, or a load of 4,934 pounds for two bundles, was well within this rated capacity.
3.0 ANALYSIS

The Accident Investigation Committee applied several analytical techniques to determine the causal factors of the event. They included Barrier Analysis (BA), Events and Causal Factors Charting (E&CFC), TapRooT (TR) and were analyzed using the Guiding Principles and Core Functions of (ISM). Causal factors from each technique were grouped under one common causal statement with supporting information following. Each cause is keyed to Tables 3 and 4 in Section 4.0 (see p. 62), which summarize the event causes, provide the analytical technique that was used to establish the cause, and identify the associated Judgment of Need.

In addition, a Human Factors Scientist reviewed the accident description and these analyses to ensure Human Performance Improvement was incorporated in the results. The Accident Investigation Committee also analyzed the adequacy of Torcon’s safety plan implementation and flow down to subcontractors, as well as the adequacy of BSA’s oversight of Torcon (as per its charter) using the above results. The Committee limited this analysis to those processes and systems that were reviewed during the performance of the accident investigation. Therefore this report should not be interpreted as a full analysis of the entire Management System.

There are two specific areas that warrant further discussion due to their significance in how the Accident Investigation Committee determined the events leading to the accident occurred: the use of a spotter and hand signals, and the Laborer’s statement about getting stuck in the mud. These two topics are discussed in detail in Section 3.1. A summary of the interview statements submitted by the Laborer, Operator, and Worker 2, arranged chronologically, is provided as Appendix C.

3.1 ANALYSIS OF CONFLICTING STATEMENTS

3.1.1 SPOTTER AND HAND SIGNALS

This section is an analysis of the events immediately preceding the accident. In this event, the operator of the Lull, a rough terrain forklift, was being guided or directed by a “spotter” or signal person. A spotter or signal person is used in material handling industries whenever an equipment operator’s visibility for the placement of a load may be impaired or obscured. Neither OSHA standards nor ANSI standards address requirements for spotters and only provide the following with respect to visibility for operating a forklift near personnel:

- Do not drive a truck up to anyone standing in front of an object.
- If the load being carried obstructs forward view, travel with the load trailing.

In this case, neither requirement was applicable to the accident.

However, both the manufacturer’s Lull Operator & Safety Manual (1) and the Association of Equipment Manufacturer’s Rough Terrain Forklift Safety Manual (2) retrieved from the cab of the incident forklift provided the following regarding use of a spotter:
1) **Lull Operator & Safety Manual**

- **Before Operating the Machine**
  - Plan your work
    - Before you operate, know how and where you will travel, turn and pickup, lift and place loads.
    - If you will be placing loads at high elevations, *remember your depth perception is decreased because of distance. Use a signal person near the point where the load is to be landed.* [emphasis added]
  - Know the Rules
    - Make sure you understand all hand, flag, whistle, siren, or bell signals.

2) **Association of Equipment Manufacturers Rough Terrain Forklift Safety Manual**

- **Know the Rules of Operation**
  - Make sure you know and understand:
    - Hand, flag, whistle, siren or bell signals.
- **Plan Your Work**
  - Know the weights of all loads you may be expected to transport before attempting to lift them. Avoid loads of loose material if possible. Check that loads are properly banded or strapped together.
  - If you will be placing loads in landing areas where visibility is a problem, use a signal person near the point where the load is to be landed.
- **Operate Safely**
  - Transporting the Load
    - Carrying the load as low as possible and fully retracted will:
      - Allow for better visibility over the load.
      - Watch clearances carefully when handling loads that are long, tall or wide. Load end-swing can be deceiving and could cause injury to personnel or damage to objects nearby.
  - Lifting and Placing the Load
    - Now that the load has been transported to the location where it is to be placed, remember:
      - *While lifting or lowering always make sure the path of the forks or load is clear of obstacles.*
The very reason a spotter is used in material handling evolutions is to assist the equipment operator in situations where visibility may be impaired. Visibility could be impaired by elevation and/or distance, other objects, or the load itself. Other reasons for a spotter could be precision, in that the location requires placement within inches or fractions thereof, which is not possible to accomplish from the operator’s position. In this accident, the Laborer was serving as the spotter and directing the Operator of the forklift to place loads in a position where they could be later hoisted with a crane. This required placement within reach by the crane, and proximity to the other bundles to be hoisted. The incident bundles also were very long - over 24 feet – so clearance was an issue along the path of travel.

Through analysis of this accident, the Accident Investigation Committee determined that only the Laborer was responsible for placing the load where it was because he was performing the duties of the spotter or signal person. It is incontrovertible that the Laborer was performing this function because it appears in the statements of both the Operator and the Laborer. Figure 8 (page 24) shows that the load would partially obscure the Operator’s visibility forward of the load on the forks, and particularly the placement of the load. Therefore, the Operator had to rely upon the Laborer’s signals to place the load in the desired location. Figure 8 also clearly shows that the Laborer was visible to the Operator, and the Operator could see the hand signals being given by the Laborer. In fact, the Operator, in both of his statements indicated he was following the signals of the Laborer, and in one statement said he had no problems with visibility (Operator Statement #2). Therefore, there is no evidence that the Operator was moving the load without being able to see the Laborer. The Operator also stated in both statements that the Laborer was standing approximately 5 feet in front of the forks (Operator Statement #1) or 5 feet from where the load was to be dropped (Operator Statement #2). At least this was his perception of the location of the Laborer. His perception that the Laborer was 5 feet away from the forks or the intended placement of the load indicates that the Operator believed the Laborer was a safe distance away from the travel path of the load. Therefore the Operator did not knowingly begin placement of the load with the Laborer in the intended or perceived path of the load.

There is some disparity between the Operator’s statements regarding the actions of the Laborer and the Laborer’s statement regarding his actions. In both statements, the Operator indicated the Laborer was standing on bundles of rebar just prior to being struck by the load, and in the first statement he indicated the Laborer backed up to move out of the way of the rebar. This correlates with the Laborer’s statement that he was in the process of “backing up out of the way.” As discussed in footnote 8 to the Accident Description, Section 2.1.2 (pages 22 and 88), the Accident Investigation Committee believes that the Laborer gave a “down” or “tilt down” signal to the Operator in anticipation that he would be out of the way of the load in a couple of steps while he was walking backward. Again, the Laborer, performing the duties of a spotter or signal person, is in the best location to determine where he would be with respect to the load, because the Operator’s visibility is partially obscured. The Laborer’s proximity to the load is consistent with good and accepted safe practice as the Lull Operator’s Manual states to “Use a signal person near the point where the load is to be landed.” It would not be reasonable for the Operator to question the Laborer’s hand signal to place the load if 1) he has a spotter or signal person directing his actions, and 2) the Operator perceived the Laborer was 5 feet from the path of the load. There is no other evidence to the contrary. This is where the Accident Investigation Committee attributes causation to the Laborer because he gave a “down” or “tilt down” signal to the Operator in anticipation that he would be out of the way of the load in a couple of steps while he was walking backward. Therefore, based upon the evidence available, the Accident Investigation Committee can only conclude that the Laborer imprudently gave a “down” or “tilt down” signal to the Operator while he was in the way or path of the load, with the Operator lacking the visual clarity necessary to determine that the Laborer was not a safe distance away – which is why he was using a spotter or signal person. It is possible, and in fact likely, that the Laborer would have been out of the path of the load but for the rebar that he tripped over. Since the Laborer had
placed that rebar at that location within minutes of the accident, the Accident Investigation Committee found the work area organization a contributing cause to the accident, one that is also attributable to the Laborer, primarily due to his lack of training and qualification.

Also discussed in footnote 8 to the Accident Description, Section 2.1.2, the Accident Investigation Committee believes that the Laborer gave a “down” or “tilt down” signal to the Operator, and that inconsistent use of hand signals at the construction site is not a possible contributing cause to this accident. The Accident Investigation Committee reached these conclusions considering several facts or the lack thereof. The Operator has several operating engineer licenses and training certificates, as well as many years of construction site experience. The Laborer, however, has mostly yard experience and non-material handling construction experience, and no licenses or operating engineer training, as evidenced by the letter of “experience” provided by Rebar Steel Corporation. The Laborer’s statement regarding the Operator’s previous unexpected response to hand signals is not evidenced by other means. The Laborer did not tell anyone else of these experiences, and construction site management has no record or recollection of this issue. The Operator states he had previously worked with the Laborer and others before the day of the accident and had no trouble understanding the Laborer’s signals. The Operator indicated there are several hand signal methods used on site and he had no problem with any of them.

As a crane operator as well as a forklift operator, the Operator would have had training and experience with different signals. The Accident Investigation Committee also evaluated the crane and forklift hand signals and does not believe that a crane stop signal could be misinterpreted as a tilt hand signal. Members of the Accident Investigation Committee have seen the crane stop signal used on the construction site with equipment other than cranes with no indication of misunderstanding between operators and spotters.

3.1.2 MUD

The Laborer stated that, immediately prior to the accident, his foot became stuck in mud as he was backing up.

The members of the Accident Investigation Committee that responded to the accident site within an hour of the accident did not find mud at the accident site. Figure 9 shows there were no footprints (indents in mud) at all in the area, even from emergency responders. The precipitation report for the month of September shows that there were 1.39 inches of precipitation on September 27, 2009 and 0.12 inches of precipitation on September 28, 2009 (see Appendix I). The area of the accident has been significantly excavated and reshaped, and the normal soil for the entire Long Island area as well as the site is Class C, or sandy soil. In addition, there were 0.74 inches of precipitation on October 3, 2009, and the Accident Investigation Committee on that day did not find any evidence of viscous mud that would trap an individual’s footwear.

The rebar was slightly elevated and narrow in diameter, and its contact with the Laborer’s footwear might feel like the foot was stuck, but lateral motion would still be possible, which is consistent with the Laborer’s statement that he was able to get his left foot out of the way. (See also Figures 11 and 16.) For these reasons the Accident Investigation Committee concludes that the Laborer tripped over the rebar and his foot was not stuck in mud.
Figure 9. Photo taken on September 30, 2009, at approximately 0940 hours. The oval shows the approximate area where the Laborer was standing at the time of the accident. Note that the area is clear of mud and there are no signs of footprints even after emergency response efforts.

3.2 BARRIER ANALYSIS

Barrier Analysis is based on the premise that hazards are associated with all tasks. Barriers are any management or physical means used to control, prevent, or impede the hazard from reaching the target (person or object that a hazard may damage). For an accident or event to occur, there must be a hazard that comes into contact with a target because the barriers or controls were not in place, not used, or failed. The results of the Barrier Analysis are used to support the development of causal factors. Appendix E contains the analysis of the physical and administrative barriers that could have had an impact on this accident and how they performed.

3.3 TAPROOT ANALYSIS

TapRooT® System is a systematic tool used to determine causal factors contributing to equipment and human performance problems. The focus is on the system (the way that the work is performed), not the individual. An analyst, with a small team (for this event, the Accident Investigation Committee) objectively looks at the facts, identifies the problem, and goes through a systematic process to find causes. Software is utilized that documents and assists in the causal analysis process. In this accident investigation, causal factors were identified using E&CFC. TapRooT was then used to analyze each causal factor to determine contributing and root causes. The results of the TapRooT Analysis are provided as Appendix F.
3.4 EVENT AND CAUSAL FACTORS ANALYSIS

The E&CFC process produces a cause and effects diagram that describes the time sequence of events and the surrounding conditions leading to an event. The purpose of the E&CFC is to identify causal factors. “A Causal Factor is any problem associated with an event that, if corrected, would have prevented the event from occurring or would have significantly mitigated its consequences” (Taproot, by M. Paradies and L. Unger, 2000). For this accident, the E&CFC created by the Accident Investigation Committee begins with work commencement on the day of the accident and ends shortly after the BNL Ambulance returned to the Laboratory. See Appendix G for the Events and Causal Factors Chart.

3.5 PROJECT OVERSIGHT

The Accident Investigation Committee was tasked to evaluate the ES&H systems and processes in place leading up to the incident to determine if Torcon and NSLS-II oversight was adequate to identify deviations or weaknesses in implementation of the ES&H Program and correct them in a proactive manner.

This was accomplished by evaluating the requirements in Attachment A of the Contract, which is entitled Brookhaven Science Associates, LLC General Terms and Conditions for NSLS-II Conventional Construction at Brookhaven National Laboratory, as they pertain to this accident investigation.

Two specific Articles in Attachment A provided key requirements for evaluating the performance of the NSLS-II ES&H program implementation. The first was Article 43, Compliance with 10 CFR 851 and Brookhaven Science Associates’ Worker Safety and Health Program by Integration of Environmental, Safety, and Health into Work Planning and Execution. The second was Article 16, Suspect/Counterfeit Items. Although Attachment A contains other Articles that involve ES&H, Articles 16 and 43 are most pertinent to understanding the root and contributing causes to this accident and/or weaknesses to the ES&H Program. Figure 4 provides an illustration of the flowdown of these ES&H requirements.

The following sections are organized to provide a review of the pertinent requirement, followed by an analysis of its implementation and the results of that review.

3.5.1 ANALYSIS OF CONTRACT ATTACHMENT A, ARTICLE 43

Review of Requirement

Article 43, Compliance with 10 CFR 851 and Brookhaven Science Associates' Worker Safety and Health Program by Integration of Environmental, Safety, and Health into Work Planning and Execution, requires the contractor to comply with 10 CFR 851 and BSA's (the Laboratory's) Worker Safety and Health Program by integrating environmental, safety, and health into work planning and execution. It requires Torcon and all of its subcontractors at all levels to comply with all federal, state, and local environmental, safety, and health laws and regulations applicable to work at the NSLS-II site. The general contractor and all of its subcontractors at all levels are also required to comply with 10 CFR 851 (DOE Worker Safety and Health Program), the Laboratory's Worker Safety and Health Program, and
DEAR 970.5223-1, entitled *Integration of Environmental, Safety and Health into Work Planning and Execution*, dated December 2000.

Specifically, Article 43 (b) states that the contractor shall perform work safely, in a manner that ensures adequate protection for employees, the public, and the environment, and will be held accountable for the safe performance of work. It further states that the contractor is to exercise a "degree of care" commensurate with the work and the associated hazards and ensure that management of ES&H functions and activities becomes an integral and visible part of the work planning and execution processes. The contractor is to submit a Construction ES&H Plan before work commencement that conforms to the NSLS-II Construction ES&H Plan (i.e., the NSLS-II Construction HASP). The Plan must ensure the following during the performance of work:

1. Personnel possess the experience, knowledge, skills and abilities that are necessary to discharge their responsibilities, and will retain records respecting such competency and qualifications, making them available upon request.
2. Prior to work performance, the associated hazards will be evaluated and a set of ES&H standards and requirements will be established and implemented to provide assurance that employees, the public, and the environment are protected from adverse consequences.
3. Line management is responsible for the protection of employees, the public, and the environment. Line management includes those contractor and subcontractor employees managing or supervising employees performing work.
4. Clear and unambiguous lines of authority and responsibility for ensuring ES&H compliance will be established and maintained at all organizational levels.

**Analysis of Requirement**

Torcon was required to submit an ES&H plan that meets the requirements of the NSLS-II Construction HASP prior to the start of work. Torcon submitted their *Project Safety, Health, and Environmental Program* (Torcon’s SHE Program) to satisfy this requirement. It was reviewed by NSLS-II, BSA, and DOE-BHSHO safety and health professionals and approved on March 17, 2009. A notice to proceed was transmitted by BSA to Torcon on March 25, 2009.

Highlights of Torcon’s SHE Program include:

- A written Project-Specific Safety Plan that includes a statement from the subcontractor regarding the scope of work on the NSLS-II project, and Phase Hazard Analyses for all major tasks involved in the scope of work for the project, and the name(s) of the responsible supervisor(s) for safety issues.
- A copy of the subcontractor's Corporate Safety Program.
- A letter from all Torcon’s subcontractors, on the subcontractor’s company letterhead, including the following statements:
  - That all of their workers have received all required safety training for their jobs.
  - Name of subcontractor’s representative to the Labor/Management Safety Committee for the project.
  - Name of subcontractor’s competent supervisor(s) for safety issues on the NSLS-II site. This supervisor must possess the OSHA 30-Hour Course. The subcontractor is also required to provide the name and telephone number of the subcontractor’s Safety Director or chief safety officer.
• Documentation that the subcontractor’s competent supervisor for safety issues on the site has completed the OSHA 30-Hour Course in Construction Safety.
• After the subcontractor submits the Project-Specific Safety Plan with PHA’s to the Torcon Safety Manager, a pre-construction meeting is held. At this meeting, safety requirements for the subcontractor’s scope of work are discussed and guidance provided for any changes needed in the PHA’s. Any questions regarding safety or administrative aspects of the job are clarified.
• Every worker and supervisor on the project is required to attend the BNL Contractor Vendor Orientation (CVO) and the Torcon Project Safety orientation on his/her first day on the project. No one is permitted on the project site before completing both orientations, except for approved and escorted visitors.

The Accident Investigation Committee also reviewed Macedos’ (Torcon’s subcontractor) site specific construction safety plan. Highlights of the plan include:

• Macedos’ commitment to provide adequate training to employees, and employees’ responsibility to ask a qualified person for assistance if the employee is in doubt about how to do a job or task safely.
• Senior management’s responsibility to support and monitor the safety, health, and risk management process.
• All employees must comply with safety, health, and risk management requirements.
• Identification of personnel having the authority for implementing the provisions of the safety plan.
• The responsibility of all supervisors for implementing and maintaining the safety plan in their work areas and for answering worker questions about the safety plan.
• Major safety hazards/risks and exposures must be assessed and documented in the PHA’s.
• Daily inspections are required.
• Macedos’ system for ensuring that all workers comply with the rules and maintain a safe work environment includes:
  o Informing workers of the provisions of the safety plan.
  o Evaluating the safety performance of all workers.
  o Recognizing employees who perform safe and healthful practices.
  o Providing training to workers whose safety performance is deficient.
  o Disciplining workers for failure to comply with the safety and healthful practices.

Result of Analysis

The Accident Investigation Committee determined that Torcon and its subcontractors failed to implement the contractual requirement to ensure personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities. Based on the work experience provided by Rebar Steel for the Laborer and the layout of the staging area, the Accident Investigation Committee determined, supervision failed to ensure the Laborer was qualified to perform the work safely. The Accident Investigation Committee has determined the following root cause to this accident:

Root Cause Statement (RCE-1): Torcon and its subcontractors failed to ensure employees possessed the experience, knowledge, skills, and abilities that were necessary to discharge their responsibilities.

• Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely.
The Accident Investigation Committee further determined that Torcon failed to meet the contractual requirement for "clear and unambiguous lines of authority and responsibility for ensuring ES&H compliance will be established and maintained at all organizational levels" for the following reasons:

- Torcon was not able to produce an organizational chart or documented roles and responsibilities that were in effect at the time of the accident.
- Interviews conducted by members of the Accident Investigation Committee with subcontractor supervisors revealed that supervisors believe investigations and toolbox training to be the responsibility of the safety staff and not theirs, though responsibility is clearly stated in the Torcon SHE Program.
- Interviews conducted by the Accident Investigation Committee with Torcon and its subcontractors did not identify the individual responsible for requesting drug and alcohol screening after an accident. After this accident the Operator was not requested to undergo screening until after he had left the site, over 3 hours after the accident.
- Torcon was not able to provide documented roles and responsibilities for their Safety Manager.

As a result of this analysis, the Accident Investigation Committee has determined the following is a contributing cause to weaknesses in the implementation of the ES&H Program:

**Contributing Cause Statement (CCW-1):** Torcon and its subcontractors failed to establish clear and unambiguous lines of authority and responsibility for ensuring ES&H compliance was established and maintained at all organizational levels.

- Torcon and its subcontractors did not indicate a clear responsibility for requesting drug and alcohol screening after an accident or injury. The Operator was not requested to submit to a drug and alcohol screening following the accident until 3 hours had passed and he had left the site.
- Torcon’s supervisors and its subcontractor’s supervisors had abdicated safety responsibilities to safety staff. Supervisors believed investigations and toolbox training to be the responsibility of the safety staff and not theirs, even though Torcon’s SHE Program clearly states that the supervisors are responsible for conducting toolboxes and participating in injury investigations.
- Torcon was not able to provide a document defining roles and responsibilities for their Safety Manager.

**Review of Requirement**

Attachment A, Article 43 (c) states the contractor, must perform and manage work in accordance with BSA’s DOE-approved Integrated Safety Management (ISM) Program and demonstrate through documentation and work practices that its performance of work under the contract: 1) fulfills the scope of work as outlined in the contract; 2) identifies and analyzes specific, task-level hazards associated with the work; 3) develops and implements hazard controls related to the hazards; 4) allows the performance of work within the controls; and 5) provides feedback on the adequacy of hazard controls and continues improvement in safety management as detailed in their ES&H Plan.

Section 4 of Torcon’s SHE Program provides their commitment to integrate safety into every phase of the project, from concept through completion of construction. Torcon states they will achieve this by using the ISM System set forth in BNL’s Construction Safety Plan, National Synchrotron Light Source II.
Torcon’s SHE Program describes the five core functions of ISM. It also puts into place the requirements and processes to ensure contractors and their subcontractors have received all the required safety training for their jobs to perform work on the NSLS-II site, but does not provide criteria for said training.

Attachment A, Article 43 (d)(1) requires the contractor to demonstrate safety protocols applicable to the scope of work that are well-established and consistent with the requirements of the Laboratory’s ISM program, prior to the initiation of work. Prior to commencement of work on any major separately definable activity, Torcon must (1) submit a Phase Hazard Analysis (PHA) of the affected work, (2) ensure workers are aware of foreseeable hazards and protective measures described within the PHA, and (3) require that the workers acknowledge being informed of the hazards and protective measures associated with the work activity.

NSLS-II Construction HASP, Section 7.1, Job-Specific Work Requirements, states that PHAs shall be developed for each major phase of the Project to be performed on site, but does not define “major”. The PHA shall identify the task and the steps necessary to complete the task, the hazards associated with each step of the task, and the means to protect the workers performing the task from those hazards. It goes on to say that supervisors and employees are responsible for developing the PHA of their work activities. The supervisor is also responsible for ensuring that hazard analyses are developed and reviewed by the employee before work begins. Torcon is required to submit all PHAs to the NSLS-II ES&H Manager, or designee, for review and approval. The completed and approved PHA shall be reviewed with all personnel involved in the task.

Torcon’s Project Orientation and General Safety & Health Rules pamphlet is reviewed with each employee during their orientation on the first day on the site. This pamphlet includes discussions on General Safety Rules, Ten Top Tips for Safety, Phase Hazard Analysis, Personal Protective Equipment, and much more. Each employee signs an acknowledgment that states “I have reviewed Torcon’s Project Orientation and General Safety Rules for the Brookhaven National Laboratory NSLS-II Project. I agree that a safe jobsite makes good sense for everyone and will act accordingly. I agree to report any accident in which I am involved to the superintendent/foreman of my employing subcontractor immediately after the incident. I also agree to report any unsafe condition or “near miss” potential injuries which are a result of unsafe conditions or circumstances. I will be responsible for strict observance of Department of Energy, OHSA and Torcon Rules & Regulations.”

Torcon’s SHE Program, Section 11, Pre-Planning of All Construction Work (PHA’s), requires that each of their subcontractors break the scope of their work down into major jobs to be performed by their workers and write a PHA for each job. Once the PHAs have been reviewed and approved by Torcon and NSLS-II ES&H, the PHA must be reviewed by the foremen with their workers in the field. Each worker is required to sign off on the PHA form indicating that he has reviewed the requirements and will abide by them during the work. If job conditions change during the work, requiring deviation from the original PHA, the Torcon Superintendent or Safety Manager requires an addendum to the PHA or a new PHA be completed, reviewed, and signed before work can continue.
Analysis of Requirement

The Accident Investigation Committee determined that the Torcon’s Project Orientation and General Safety & Health Rules provides an adequate safety orientation for the project. In addition, Torcon was able to provide signed acknowledgements of review and agreement with the pamphlet for the Laborer and Operator.

The Accident Investigation Committee requested a PHA for the work performed by the Laborer and Operator on the day of the injury and was provided with a Macedos’ PHA entitled “All Footings, revised 6/29/09.” This PHA included a job step entitled “Materials pick up w/forklift” and identified one potential hazard, “Dropping/Misplacement Pinchpoints”. The “Preventive or Protective Measures to Be Used” column of the PHA identified the following: 1) flagman direction/horn warning, 2) cordoned off area with caution tape, and 3) spotter will work with forklift. This was the only PHA provided by Torcon that analyzed hazards associated with forklifts. The copy reviewed was not signed by Torcon. There was no place for NSLS-II ES&H to sign the form. However, NSLS-II ES&H indicated that they review all PHAs they receive and usually there are several iterations before they are accepted. The Field Supervisor (employed by Macedos) signed the PHA on July 15, 2009. Nine workers signed the PHA (undated). However, neither the Laborer nor the Operator had signed it.

Results of Analysis

The Committee also determined that the PHA lacked specificity in that it was less-than-adequate to identify hazards associated with moving rebar and is a root cause of the accident.

Root Cause Statement (RCE-2): Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety.

- Hazard analyses are required for major phases of the project. However, major phases were not defined.
- Hazard analyses failed to identify hazards and lacked detail for the movement and placement of rebar. The hazard analysis for materials pick up with a forklift only addressed “dropping/misplacement pinch points” as a hazard and provided the following controls: “flagman direction/horn warning”, “cordoned off area with caution tape”, and “spotter will work with forklift”.

The Accident Investigation Committee determined that Torcon and its subcontractors failed to fully implement Article 43 (d)(1) of the Contract by not making workers aware and acknowledge hazards and associated measures for their safety and is therefore a contributing cause to weaknesses in the implementation of the ES&H Program.

Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Implementation of Section 11 of Torcon’s SHE Program failed to identify and correct (1) the inadequate hazard analysis for material handling (the movement or directing the movement of materials is a major portion of Rebar Steel’s activities) and (2) the lack of review of PHA’s by new workers.
- Supervision failed to ensure the Laborer and Operator had reviewed and signed the PHA for the work they were performing in accordance with Torcon’s SHE Program, Section 11.
Review of Requirement

Attachment A, Article 43 (d)(2) requires the contractor to employ a designated ES&H representative with no collateral duties on the worksite. The ES&H representative is to be knowledgeable of the project’s hazards and has authority to act on behalf of the contractor. The ES&H representative must have appropriate training and qualification to perform this function. This person must, as a minimum, have completed the 30-hour OSHA Construction Safety Course and be a Certified Safety Professional, Certified Industrial Hygienist, or have equivalent documented education and experience in construction safety. This section requires the designated ES&H representative to make frequent and regular inspections of the worksite to identify and correct any instances of noncompliance with the project safety and health requirements.

Analysis of Requirement

Torcon has assigned a full time Safety Manager to the project. A review of the Safety Manager’s resume indicated that he possesses a Masters Degree in Safety Management, completed the 40-hour OSHA Construction Safety Course, and has the necessary experience in compliance with Article 43 (d) (2). Though the Accident Investigation Committee did not identify any collateral duties for the Safety Manager, we were unable to obtain his roles and responsibilities to fully evaluate his duties.

The Accident Investigation Committee reviewed Torcon’s Project Safety Evaluation records documenting Torcon’s daily safety inspections. Some Project Safety Evaluation forms were completed, while others were not, and some work periods were missing altogether. Objective evidence was not available to indicate whether these inspections had actually taken place daily as required by Article 43 (d)(2).

Results of Analysis

The Accident Investigation Committee therefore determined that Torcon failed to ensure Section 23 of Torcon’s SHE Program was being adequately implemented and therefore did not fully meet the requirements of Article 43 (d)(2) and is therefore a contributing cause to weaknesses in the implementation of the ES&H Program.

Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Torcon’s Project Safety Evaluation forms were not completed correctly and some work periods were missing altogether. Objective evidence was not available to indicate whether these inspections had actually taken place daily as required by the contract.

Review of Requirement

Attachment A, Article 43 (d)(3) requires workers be instructed to report any hazard not previously identified or evaluated to the Project Superintendent or the Contractor’s Safety Manager. If immediate corrective action is not possible or the hazard falls outside the project’s scope, the contractor must immediately notify affected workers, post appropriate warning signs, implement needed interim control measures, and notify the NSLS-II ES&H Manager of the action(s) taken. The contractor or its designated ES&H representative must stop work in the affected area until appropriate protective measures are established. The contractor’s ES&H representative is required to document the condition and the corrective action in their inspection report.
Analysis of Requirement

Torcon’s Project Orientation and General Safety & Health Rules pamphlet, General Safety Rules, 2, states that employees are to report all unsafe practices or conditions to their Foreman and/or Torcon immediately. In addition, this pamphlet provides a section that discusses PHAs and employees’ responsibility to review and sign them. Each employee signs a copy of this pamphlet acknowledging receipt; signed copies of this pamphlet were provided for the Laborer and Operator.

Results of Analysis

The Accident Investigation Committee has determined that this is in compliance with Attachment A, Article 43 (d)(3).

Review of Requirement

Attachment A, Article 43 (f) requires the contractor to immediately notify the Laboratory's Contractual Representative of any OSHA-recordable injuries/illnesses and any “off-normal occurrences” or government owned property damage that the Contractor has determined to have occurred during the project. As defined in this section, an “off-normal occurrence” is any unplanned or unexpected event, including near misses, or the discovery of a deficiency in a procedure, plan, or system that has real or potentially undesirable consequences to personnel, equipment, facilities, the environment, and/or programs. This section also requires the contractor to ensure compliance with 10 CFR 851.26, Recordkeeping and Reporting.

Torcon’s SHE Program, Section 19, Procedures for Injuries, Near Misses, and Fires, states that all injuries and near misses, and other incidents, such as fires or vehicle accidents, must be reported to Torcon immediately. The first priority will be to ensure that any needed first aid or medical treatment is administered and the scene is secured. Torcon will report the incident to the NSLS-II Construction Safety Engineer.

The Accident Investigation Committee performed a comparison of the NSLS-II site EMT Incident Reports and Torcon’s investigations. This revealed that there were several more incidents than investigations. The list of missing reports was provided to Torcon who stated that they were unaware of the injuries and did not investigate them. They also stated that they believed the injuries to be minor or not work related.

Results of Analysis

The Accident Investigation Committee determined that Torcon’s response to this accident met their contractual and ES&H program responsibility.

The Accident Investigation Committee determined Torcon’s failed to ensure all injuries were being reported in accordance with their Program SHE and therefore did not fully comply with Attachment A, Article 43 (f) and is therefore a contributing cause to weaknesses in the implementation of the ES&H Program.

Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Torcon failed to ensure all injuries were being reported in accordance with Torcon’s SHE Program, Section 19, Procedures for Injuries, Near Misses and Fires, and the requirements of Contract Attachment A, Article 43 (f) were not met.
**Review of Requirement**

Attachment A, Article 43 (k) requires the contractor to be responsible for its subcontractors’ compliance with the ES&H requirements of this contract. The contractor is required to include NSLS-II site ES&H requirements in all agreements with its subcontractors.

Torcon’s SHE Program, Section 23, *Job Site Inspections*, requires documented daily safety inspections to be performed and documented by Torcon and the subcontractors. Section 23 further states that these inspections are to be carried out to ensure compliance with all safety procedures and PHAs. Torcon’s safety inspections are performed by the Safety Manager, Superintendents, Project Manager and Project Executive. Each active subcontractor company is also required to perform a daily safety inspection of their work areas, done by a supervisor, using the form provided in Article 9 of the Program. This form must be completed each day that the subcontractor is active on the site. The completed form is to be submitted to the Torcon Safety Manager on a weekly basis. Any deficiencies found in the safety inspections are to be corrected, with the date of correction noted on the form. The Torcon Safety Manager is required to review these forms daily to identify trends or problem areas so they can be addressed by training or other action.

**Analysis of Requirement**

A review of the records provided to the Accident Investigation Committee indicated that daily safety inspections were not being completed daily by all subcontractors and they were not being filled out correctly in most cases. For example, the records provide a code for indicating whether the inspection results were acceptable or correction is needed. Numerous records were marked in a manner that was incomprehensible and made the feedback unusable. Other records had comments that appeared to need corrective actions, but there was no indication that action was taken. Objective evidence was not available to indicate whether these inspections were actually taking place daily.

**Results of Analysis**

Torcon’s SHE Program is an ES&H contractual requirement (reference Contract Attachment A, Article 43 (d)), the Accident Investigation Committee determined that Torcon failed to ensure Section 23 of Torcon’s SHE Program was being implemented and did not meet the requirements of Article 43(k) to ensure subcontractors’ compliance with ES&H requirements of the contract. Therefore this is a contributing cause to weaknesses in the implementation of the ES&H Program.

**Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.**

- Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.
3.5.2 ANALYSIS OF CONTRACT ATTACHMENT A, ARTICLE 16

Review of Requirement

Attachment A, Article 16 describes the prohibition of counterfeit or suspect items on the BNL site and the actions the Laboratory will implement when these items are found. As defined in this article, suspect items are "items for which there is an indication by visual inspection, testing, or other information that it may not conform to established government or industry-accepted specifications or national consensus standards". Counterfeit or suspect items include lifting materials, such as slings, hooks, cables, and shackles. Furthermore, this article directs the contractor to the Suspect/Counterfeit Items Subject Area within the Laboratory's Standards-Based Management System.

Analysis of Requirement

Suspect shackles and wire clips (no manufacturer's name or stamp) were found on the NSLS-II site several times over several days by members of the Accident Investigation Committee conducting site observations. The suspect shackles and wire clips were impounded and reported to the NSLS-II ES&H Manager.

A review of Torcon’s SHE Program, Section 38 Rigging Procedures and Inspections, and its associated Daily Rigging Inspection form, did not indicate a requirement or discussion of the need to inspect for suspect/counterfeit items prior to rigging.

Results of Analysis

The Accident Investigation Committee determined that Torcon and its subcontractors failed to implement the requirement of Article 16 to prevent the use of suspect/counterfeit items during rigging operations and is therefore a contributing cause to weaknesses in the implementation of the ES&H Program.

Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Torcon failed to detect and correct the use of suspect/counterfeit items used during rigging operations.

Contributing Cause Statement (CCW-3): Torcon and its subcontractors failed to implement an effective suspect/counterfeit program for rigging.

- Suspect shackles and wire clips (no manufacturer's name or stamp) were found several times over several days by members of the Accident Investigation Committee.
- Torcon’s SHE Program, Section 38, Rigging Procedures and Inspections, and its associated Daily Rigging Inspection form outlined in Article 38, did not address inspection for suspect/counterfeit items prior to rigging.
3.5.3 ANALYSIS OF BSA AND NSLS-II OVERSIGHT

Review of Requirement

The organizational structure and responsibilities for the NSLS-II team is documented in their Environmental, Safety, and Health Plan for the National Synchrotron Light Source-II; Doc #LT-ES&H-002-CD-REV02 (NSLS-II ES&H Plan) and is further defined for this phase of construction in the Environment, Safety, and Health Management Plan for the Construction of NSLS-II Conventional Facilities; DOC LT-ESH-009-Rev1 (NSLS-II ES&H Management Plan). The NSLS-II ES&H Management Plan identifies the requirements for ES&H Project oversight. It states that the Environmental, Safety, and Health Manager (ES&HM) is responsible for implementing the BNL ISM program for the NSLS-II Project to ensure that environmental, safety, and health issues are addressed in the design, construction, and ultimate operations of NSLS-II. In this capacity, the ES&HM’s responsibilities include:

- Utilizing appropriate BNL ES&H subject matter experts (SMEs) to prepare hazard analyses, review design documents, and oversee construction activity to ensure compliance with ES&H standards.
- Oversee implementation of the construction safety program to ensure compliance with BNL and OSHA regulations, and monitor progress toward “Best in Class” performance.
- Be responsible for internal oversight and evaluations of the implementation of the NSLS-II construction safety program. The evaluations shall address consistency with defined expectations (i.e., conformance to internal procedures) and shall identify hazards not effectively addressed by the program.
- Support the implementation of a construction ES&H program consistent with BNL expectations by (1) identifying expectations and (2) developing the construction ES&H Management Plan for implementing those expectations.
- Communicate concerns and offer constructive guidance directly to other NSLS-II Project personnel.

Analysis of Requirement

Both NSLS-II and Torcon’s insurance carriers have performed field observations of this construction site and have provided feedback to improve operations on the site. It appears these recommendations have been implemented.

BSA’s Internal Audit and Oversight Office has conducted two assessments on elements of the NSLS-II ES&H program to date: Report IO 09-97 Phase 1, dated August 26, 2009, and IO 09-97 Phase 2 (in draft, the assessment was completed on August 25, 2009). The scope of Phase 1 included a document review of the NSLS-II and Torcon Safety documents. There were no findings or areas for improvements identified. The Phase 2 scope included training provided to all Project personnel. There were no findings, but three areas for improvement were identified. The scope of the assessment of Phase 3 will consist of field observations of work in progress.

BSA’s Safety & Health Services (SHSD) Construction Safety Engineer performs NSLS-II site observations on an average of twice a week. These observations are conducted jointly with NSLS-II
personnel, Torcon personnel, and subcontractor personnel. When findings are developed, they are documented by NSLS-II Personnel.

NSLS-II conducted one assessment to date, lead by BNL’s Training Coordinator for NSLS-II. The report is entitled Assessment of Brookhaven National Laboratory, National Synchrotron Light Source II Project Training Requirement, dated September 2, 2009, and was scoped to assess project training requirements. One minor non-compliance and one opportunity for improvement were noted. NSLS-II has scheduled four assessments for calendar year 2010. They will cover safety inspections, equipment inspections, phase hazard analyses, and permits.

NSLS-II Construction Safety Inspectors are conducting daily safety inspections in accordance with paragraph 3.3.1.1 of the NSLS-II ES&H Management Plan, NSLS-II Project Procedure LT-ESH_P-00013, Safety Inspections, and BSA’s Construction Safety Subject Area. Construction Safety Inspection (CSI) reports are being generated. However, not all findings are being documented on the CSI; some are being verbally transmitted to Torcon, while others are being communicated via e-mail. In addition, the BSA Contractual Representative was not notified of the findings and thus did not issue a Notice of Non-Compliance to Torcon as required by Attachment A, Article 43 (g) of the Contract. As a result, CSI’s generated by the NSLS-II staff were not properly processed or completed as required by BSA’s Construction Safety Subject Area and the Contract.

Results of Analysis

Considering the number of elements in the NSLS-II ES&H Program and the scheduled completion of this contract in April 2012, the Accident Investigation Committee determined that the current assessment schedule is inadequate to review all program elements in a timely manner to proactively identify and correct deviations.

The Accident Investigation Committee has also determined that NSLS-II failed to ensure full implementation of the NSLS-II ES&H Program by not identifying Torcon’s deviations from NSLS-II ES&H Program requirements as explained in section 3.5.1. Though this failure is not a cause for this accident it does weaken the ES&H Program and can lead to missed opportunities to proactively identify and correct minor problems before they become severe.

Contributing Cause Statement (CCW-4): NSLS-II failed to ensure that the NSLS-II ES&H Program was performing as designed.

- NSLS-II Construction Safety Inspectors did not document all findings, and reports were not properly processed or completed as required in BSA’s Construction Safety Subject Area and the Contract.
- NSLS-II’s oversight of Torcon’s implementation of Section 7.1 of the NSLS-II Construction HASP and Section 11 of Torcon’s SHE Program did not identify and correct shortcomings in PHA implementation, such as the lack of specificity, not adequately identifying hazards, and new workers not reviewing and signing PHA’s.
- NSLS-II’s oversight did not reveal that daily and frequent inspections by Torcon and its subcontractors were not being performed.
- NSLS-II’s oversight did not identify and correct the use of suspect shackles and wire clips (no manufacturer’s name or stamp) found several times over several days on the site.
- The NSLS-II assessment schedule was inadequate to review all program elements in a timely manner to proactively identify and correct deviations.
3.6 INTEGRATED SAFETY MANAGEMENT

The Accident Investigation Committee examined Management Systems as potential contributing and root causes of the event and the overall NSLS-II ES&H program in terms of Integrated Safety Management (ISM). At BNL, the ISM Program Description describes BNL’s approach to integrating Environment, Safety, Health, and Quality (ESH&Q) requirements into the processes for planning and conducting work at the Laboratory. It also describes BNL's programs for accomplishing work safely and provides a road map of the systems and processes that make up the BNL Integrated Safety Management System (ISMS). The ISMS Program is accomplished by employing an integrated set of non-overlapping Management Systems that embody the requirements defined in the DOE ISMS Manual. These systems collectively form the Standards-Based Management System (SBMS) Management Systems, BNL's highest level of operating and business processes that define how work is conducted at the Laboratory. These Management Systems are defined via Management System Descriptions that identify each system's processes, standards of performance, external requirements, and the set of Laboratory procedures and guidelines (Subject Areas and other Laboratory-wide procedures) to carry-out the elements of each system. Management Systems, Program Descriptions, and Subject Areas operate in an integrated fashion by providing programs and procedures that implement the Plan, Do, Check, Act framework.

The Core Functions and Guiding Principles of ISM are the primary focus for BNL and its 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 controls of hazards. The five Core Functions of ISM are defining the work, analyzing the hazards, developing and implementing controls, performing work safely, and feedback and improvement. How failure of these core functions apply to the accident is discussed in detail in the following sections. Using ISM's Core Functions and Guiding Principles, each phase of the work related to the accident was analyzed. In addition, ISM's Core Functions and Guiding Principles were also used to examine the ES&H program and evaluate its performance.

Attachment A, Article 43 (c) of the BSA/Torcon Contract requires Torcon to perform and manage work in accordance with BSA's DOE-approved Integrated Safety Management (ISM) Program and to demonstrate through documentation and work practices that its performance of work under the contract: (1) fulfills the scope of work as outlined in the contract; (2) identifies and analyzes specific, task-level hazards associated with the work; (3) develops and implements hazard controls related to the hazards; (4) allows the performance of work within the controls; and (5) provides feedback on the adequacy of hazard controls and continuous improvement in safety management as detailed in their ES&H Plan.

Section 4 of Torcon's SHE Program provides their commitment to integrate safety into every phase of the project, from concept through completion of construction. They plan to achieve this by using the ISM System set forth in the NSLS-II Construction HASP.

The following sections are organized using the five Core Functions (CF) and seven Guiding Principles (GP), followed by a brief description of the function and/or principle, and the Accident Investigation Committee's analysis of Torcon’s and its subcontractor's performance.

While each section below lists only the supporting statements that belong to this particular CF or GP, Table 2 summarizes all the connections between the causes identified and the ISM Core Functions and Guiding Principles.
The five Core Functions, as defined by DOE P 450.4, Safety Management System Policy, are the following:

Core Function 1: *Define the scope of work*: Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

Core Function 2: *Identify and analyze hazards associated with the work*: Hazards associated with the work are identified, analyzed, and categorized.

Core Function 3: *Develop and implement hazard controls*: Applicable standards and requirements are identified and agreed-upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.

Core Function 4: *Perform work within controls*: Readiness is confirmed and work is performed safely.

Core Function 5: *Provide feedback on adequacy of controls and continue to improve safety management*: Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

The seven Guiding Principles, as defined by DOE Manual 450.4-1, Integrated Safety Management System Manual, are as follows:

Guiding Principle 1: *Line manager clearly responsible for ES&H*: Line management is directly responsible for the protection of the public, the workers, and the environment.

Guiding Principle 2: *Clear ES&H roles and responsibilities*: Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the Department and its contractors.

Guiding Principle 3: *Competence commensurate with responsibilities*: Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.

Guiding Principle 4: *Balanced priorities*: Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.

Guiding Principle 5: *Identify ES&H standards and requirements*: Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences.
Guiding Principle 6: *Hazard controls tailored to work:* Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.

Guiding Principle 7: *Operations authorization:* The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed-upon.

3.6.1 GUIDING PRINCIPLES

The following three Guiding Principles of ISM cover all five core functions. They are followed by the Accident Investigation Committee's analysis of their implementation at the NSLS-II construction site.

**GP 1:** *Line management is directly responsible for the protection of the public, the workers, and the environment.*

Torcon's SHE Program clearly identifies line management is directly responsible for the protection of the public, the workers and environment.

During the course of the investigation, the Accident Investigation Committee observed many good practices that demonstrated NSLS-II, Torcon, and its subcontractors were proactively protecting the public, workers and the environment, and these are noted in Section 5.3.1 of this report. However, it is indisputable that this accident occurred and is therefore an example of failure to fully implementation of GP 1. Table 2 identifies the causes impacted by GP 1.

**GP 2:** *Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the organization and its contractors.*

Interviews conducted by members of the Accident Investigation Committee with subcontractor supervisors revealed that supervisors believe investigations and toolbox training to be the responsibility of the safety staff and not theirs. Additional interviews conducted by the Accident Investigation Committee with Torcon and its subcontractors found that the individual responsible for requesting the Operator submit to a drug and alcohol screening following this accident was not clearly defined. The Operator was not requested to submit to a drug and alcohol screening following the accident until 3 hours had passed and he had left the site.

Torcon was not able to produce an organization chart that was in effect at the time of the accident; only copies of their organization chart that were included with their bid-proposal and copies dated after the accident were provided. In addition, a description of the roles and responsibilities for the Torcon Safety Manager was requested and could not be provided.

The Accident Investigation Committee also determined that the lack of clear roles and responsibilities is a contributing cause to weaknesses in the implementation of the ES&H Program.
**Contributing Cause Statement (CCW-1):** Torcon and its subcontractors failed to establish clear and unambiguous lines of authority and responsibility for ensuring ES&H compliance was established and maintained at all organizational levels.

Torcon and its subcontractors did not indicate a clear responsibility for requesting drug and alcohol screening after an accident or injury. The Operator was not requested to submit to a drug and alcohol screening following the accident until 3 hours had passed and he had left the site.

Torcon’s supervisors and its subcontractor’s supervisors had abdicated safety responsibilities to safety staff. Supervisors believed investigations and toolbox training to be the responsibility of the safety staff and not theirs, even though Torcon’s SHE Program clearly states that the supervisors are responsible for conducting toolboxes and participating in injury investigations.

Torcon was not able to provide a document defining roles and responsibilities for their Safety Manager.

**GP 3:** Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.

The Accident Investigation Committee determined that the Laborer’s experience and skills were not adequately assessed or validated to ensure they were adequate to perform the work he was assigned. In directing the staging of the rebar at the accident location, the Laborer did not allow himself adequate space to move about the area. This resulted in him tripping over the rebar. Torcon and its subcontractors failed to ensure the Laborer possessed the experience, knowledge, skills and abilities necessary to discharge his responsibilities and therefore implementation of GP 3 was not met; this is a Root Cause of this event.

**Root Cause Statement (RCE-1):** Torcon and its subcontractors failed to ensure employees possessed the experience, knowledge, skills, and abilities that were necessary to discharge their responsibilities.

Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely.

**GP 7:** The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed-upon.

This GP does not apply until operations are authorized at NSLS-II and therefore does not apply to this investigation.
3.6.2 DEFINE WORK

CF 1: Laboratory missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

GP 4: Resources shall be effectively allocated to address safety, programmatic and operations considerations.

To clearly communicate the construction ES&H requirements, the NSLS-II project team created the NSLS-II Construction HASP, which is included in the contract signed with Torcon. Also included in this contract is Torcon’s responsibility to ensure these requirements are imposed on all of its subcontractors at all levels and tiers.

Torcon was required to submit a health and safety plan that meets the requirements of the NSLS-II Construction HASP prior to the start of work. Torcon’s Project Safety, Health and Environmental Program (Torcon’s SHE Program) was reviewed by NSLS-II, BSA, and DOE-BHSO safety and health professionals and approved on March 17, 2009. A notice to proceed was transmitted by BSA to Torcon on March 25, 2009.

The Accident Investigation Committee determined that CF 1 and GP 4 were clearly defined by BSA and NSLS-II and communicated to Torcon, and that Torcon clearly communicated these to their subcontractors.

3.6.3 ANALYZE THE HAZARDS

CF 2: Hazards associated with work are identified, analyzed, and categorized.

GP 5: Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers and the environment are protected from adverse consequences.

As previously stated in section 3.5.1 of this report, the Accident Investigation Committee determined PHA’s did not adequately identify the hazards for material handling of rebar due to the lack of specificity

Root Cause Statement (RCE-2): Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety.

- Hazard analyses are required for major phases of the project. However, major phases were not defined.
- Hazard analyses failed to identify hazards and lacked detail for the movement and placement of rebar. The hazard analysis for materials pick up with a forklift only addressed “dropping/misplacement pinch points” as a hazard and provided the following controls: “flagman direction/horn warning”, “cordoned off area with caution tape”, and “spotter will work with forklift”.

Draft 51 December 4, 2009
• Torcon and its subcontractors failed to establish that personnel were ready to perform work by ensuring they were aware and prepared to protect themselves from hazards associated with their work. The Laborer created a staging area for the rebar which was unacceptable.

• Pre-job briefings failed to address the hazards associated with the work being performed. Briefings were primarily concentrated on what work needed to be performed and did not address the associated hazards.

### 3.6.4 DEVELOP AND IMPLEMENT CONTROLS

**CF 3:** Applicable standards and requirements are identified and agreed-upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.

**GP 5:** Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers and the environment are protected from adverse consequences.

As previously stated in section 3.5.1, the PHA for the work performed by the Laborer and Operator on the day of the injury was requested, and the Accident Investigation Committee was provided with a Macedos PHA entitled *All Footings*, revised 6/29/09. This PHA did not include the signatures of the Laborer and the Operator, as required by Torcon’s SHE Program.

Pre-job briefings witnessed by members of the Accident Investigation Committee during the course of the investigation did not include a discussion of the hazards of the work to be performed. These briefings primarily concentrated on what work needed to be performed and not how to perform the work or identify the associated hazards. There was no evidence that the Laborer and Operator took part in a pre-job brief that identified specific job hazards. In addition, these observations are supported by Macedos’ Safety Manager, who stated that PHAs are used during pre-job reviews conducted by Supervisors with their workers to identify and mitigate/reduce hazards. This is usually not repeated for routine, ongoing tasks, such as moving rebar.

Communication between equipment operators and laborers was observed to be effective throughout the site, and there was no sign of miscommunication. However, members of the Accident Investigation Committee observed the following: no evidence of uniform use of standard hand signals on site, even within the same craft of workers; and no discussion or coordination of hand signals between work crew members. This included crew members from different employers who work together on the same job task. Although the Accident Investigation Committee determined that hand signals did not contribute to this accident, the coordination of hand signals poses a potential error trap. Reliable and consistent hand signal communication is critical to safe operations. The equipment manufacturer provides hand signals to be used and these should be incorporated into operations. Therefore, the Accident Investigation Committee determined that this control was not adequately implemented.

Torcon’s SHE Program, Section 19, *Procedures for Injuries, Near Misses, and Fires*, states that anyone involved in a near miss or injury situation may be required to be tested for substance-abuse at the discretion of Torcon or the NSLS-II Project Management. Section 6, *Drug-Free Workplace Policy*, states the same. In addition, Torcon’s *Project Orientation and General Safety & Health Rules*, not dated, state under the *Principles of the Program, 2 No alcohol or drugs*, that post-incident or injury drug and alcohol
testing are performed. Section 10 of Torcon’s Project Safety Orientation Outline, Revision 6: September 2009, also includes the same requirement. As stated in the Accident Description section of this report (see Section 2.1, page 21), the Operator left the site for approximately 30 minutes and then returned for 1.5 hours before leaving for the day at approximately 1200 hours. The Operator had indicated that he was not asked to submit to an alcohol or drug test before he left the site for the day. Torcon’s Project Manager stated that it was after the Operator had left that they realized they wanted to administer a drug test. Macedos then attempted to reach the Operator but were not able to speak to him until later that day. The Operator did return the following day as requested by Torcon to undergo the drug test. The results of the test were negative. Further conversations with Torcon’s Safety Manager revealed that drug and alcohol testing had not been performed as a result of any injury or incident on the NSLS-II site. The Accident Investigation Committee concluded that Torcon failed to fully implement their alcohol and drug testing requirements.

The Accident Investigation Committee determined CF 3 and GP 5 was not adequately implemented. Failure to include hazards as part of pre-job briefings is a root cause of this event. Supervision’s failure to review PHAs with workers, use uniform hand signals, and fully implement their alcohol and drug testing requirements is a contributing cause to weaknesses in the implementation of the ES&H Program.

**Root Cause Statement (RCE-2):** Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety.

- Pre-job briefings failed to address the hazards associated with the work being performed. Briefings were primarily concentrated on what work needed to be performed and did not address the associated hazards.

**Contributing Cause Statement (CCW-2):** Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Supervision failed to ensure the Laborer and Operator had reviewed and signed the PHA for the work they were performing in accordance with Torcon’s SHE Program, Section 11.

- Torcon failed to ensure all injuries were being reported in accordance with Torcon’s SHE Program, Section 19, Procedures for Injuries, Near Misses and Fires, and the requirements of Contract Attachment A, Article 43 (f) were not met.

- Hand signal usage was not uniform and relied upon the skill-of-the-workers.

- Torcon failed to fully implement their alcohol and drug testing requirements.
3.6.5 PERFORM WORK SAFELY

CF 4: Readiness is confirmed and work is performed safely

GP 6: Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.

As previously stated in Section 3.6.4., the Laborer failed to verify his readiness to perform the work safely. The Laborer, standing where he did, had not left himself an escape route. As a result, the Laborer put himself in close proximity to the load, which set the scene for the accident.

The Accident Investigation Committee determined that the following are examples of failure by Torcon and its subcontractors to implement administrative controls and confirm readiness to work and are therefore contributing causes to weaknesses in the implementation of the ES&H Program:

- The maintenance log in the Lull, which was boldly marked in red “DO NOT REMOVE FROM VEHICLE!!!” was different from the one provided by Macedos’ Risk and Compliance Director. The copy provided contained more information than the one in the vehicle and should therefore have been in the Lull.

- The fire extinguisher located in the Lull did not have an inspection tag as required by NFPA 10. However, its gauge indicated full.

- Inspection records identified for use in Torcon’s SHE Program Section 14, Initial and Daily Inspections of Heavy Equipment, is different from what is actually being used. Although the Accident Investigation Committee considers these two forms as nearly equivalent, it is another example of less than full implementation of administrative controls.

- Torcon Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.

Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- The maintenance log in the Lull was different from the one provided by Macedos.

- The fire extinguisher located in the Lull did not have an inspection tag as required by NFPA 10.

- Inspection records identified for use in Torcon’s SHE Program Section 14, Initial and Daily Inspections of Heavy Equipment, were different from what was actually being used. Although the Accident Investigation Committee considers these two forms as nearly equivalent, it is another example of failure to implement administrative controls.

- Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.
3.6.6 FEEDBACK AND IMPROVEMENT

CF 5: Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and if necessary, regulatory enforcement actions occur.

The NSLS-II ES&H Monthly Meeting is conducted by NSLS-II ES&H staff and is attended by BSA ES&H staff, DOE-BHSO, as well as Torcon to discuss ES&H-related tasks, issues, and solutions.

Torcon’s Labor/Management Safety Committee is described in Torcon’s SHE Program, Section 15, Labor/Management Safety Committee. The Safety Committee meets weekly and is attended by a field supervisor or shop steward. The purpose of the Safety Committee is to create two-way communication on safety issues between Torcon and its subcontractors, including inspection findings, near misses or injuries, suggestions for improvement of safety on the job, and any BNL safety concerns.

Torcon’s SHE Program, Section 19, Procedures for Injuries, Near Misses, and Fires, states that injury and incident investigation will be conducted by Torcon’s Safety Manager, the NSLS-II Construction Safety Engineer, and the subcontractor supervisor to identify causes, contributing factors and lessons learned from the incident. Torcon’s SHE Program, Section 16, Weekly Tool Box Safety Meetings, states that each week, at the Labor/Management Safety Committee meeting, Torcon’s Safety Manager distributes the topic of the weekly Tool Box Safety Meeting. Each Torcon supervisor is to hold a brief meeting with his workers. The subcontractor supervisor is free to use a different safety topic for the meeting if desired, in order to keep the topics relevant to the work. Documentation of this meeting, including worker signatures, is to be submitted to the Torcon Safety Manager by the end of each week.

Torcon had no assessment schedule for the project and relies on job site inspections and walkthroughs, including those with their insurance carrier. Though this process has a value in ensuring that work activities are being adequately performed in the field, the lack of a systematic approach to assessing the health of the implementation of a safety program, or any other program or process, lessens the effectiveness of that program by not providing feedback to ensure all program expectations are being met.

As previously stated, Torcon’s Job Site Daily Inspection Records, required per Torcon’s SHE Program, Section 23, Job Site Inspections, were not being completed daily and not completed correctly in most cases.

There are many good practices occurring across the site that focus on field operations, as is stated above, and the result is a site that is in good condition, as described in section 5.3.1 and demonstrates that feedback and improvement is partially working. However, though there are many feedback loops that exist and are being executed, the lack of feedback on the performance of the Project’s ES&H programs has lead the Accident Investigation Committee to determine that the implementation of CF 5 is less-than-adequate and is a contributing cause to weaknesses in the implementation of the ES&H Program.
**Contributing Cause Statement (CCW-2):** Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Torcon had no assessment schedule for the project and relied on job site inspections and walkthroughs, including those with their insurance carrier.
- Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.

**Contributing Cause Statement (CCW-4):** NSLS-II failed to ensure that the NSLS-II ES&H Program was performing as designed.

- NSLS-II Construction Safety Inspectors did not document all findings, and reports were not properly processed or completed as required in BSA’s *Construction Safety* Subject Area and the Contract.
- The NSLS-II assessment schedule was inadequate to review all program elements in a timely manner to proactively identify and correct deviations.
Table 2. Summary of Causes Identified and the Corresponding ISM Core Functions and Guiding Principles.

<table>
<thead>
<tr>
<th>Cause</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Root Cause Statement (RCE-1):</strong> Torcon and its subcontractors failed to ensure employees possessed the experience, knowledge, skills, and abilities that were necessary to discharge their responsibilities.</td>
<td>GP-1 / GP-3</td>
</tr>
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<td>• Torcon and its subcontractors failed to ensure their personnel were qualified for the work they were assigned.</td>
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<tr>
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<td></td>
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<td><strong>Root Cause Statement (RCE-2):</strong> Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety.</td>
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<td>• Hazard analyses are required for major phases of the project. However, major phases were not defined.</td>
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</tr>
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<td>• Torcon and its subcontractors failed to establish that personnel were ready to perform work by ensuring they were aware and prepared to protect themselves from hazards associated with their work. The Laborer created a staging area for the rebar which was unacceptable.</td>
<td>CF-2 / GP-5</td>
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<tr>
<td>• Pre-job briefings failed to address the hazards associated with the work being performed. Briefings were primarily concentrated on what work needed to be performed and did not address the associated hazards.</td>
<td>CF-3 / GP-5</td>
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### Contributing Cause Statement (CCW-1): Torcon and its subcontractors failed to establish clear and unambiguous lines of authority and responsibility for ensuring ES&H compliance was established and maintained at all organizational levels.

- Torcon and its subcontractors did not indicate a clear responsibility for requesting drug and alcohol screening after an accident or injury. The Operator was not requested to submit to a drug and alcohol screening following the accident until 3 hours had passed and he had left the site.

- Torcon’s supervisors and its subcontractor’s supervisors had abdicated safety responsibilities to safety staff. Supervisors believed investigations and toolbox training to be the responsibility of the safety staff and not theirs, even though Torcon’s SHE Program clearly states that the supervisors are responsible for conducting toolboxes and participating in injury investigations.

- Torcon was not able to provide a document defining roles and responsibilities for their Safety Manager.

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<td>Torcon was not able to provide a document defining roles and responsibilities for their Safety Manager.</td>
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### Contributing Cause Statement (CCW-2): Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness.

- Implementation of Section 11 of Torcon’s SHE Program failed to identify and correct (1) the inadequate hazard analysis for material handling (the movement or directing the movement of materials is a major portion of Rebar Steel’s activities) and (2) the lack of review of PHA’s by new workers.

- Supervision failed to ensure the Laborer and Operator had reviewed and signed the PHA for the work they were performing in accordance with Torcon’s SHE Program, Section 11.

- Torcon failed to ensure all injuries were being reported in accordance with Torcon’s SHE Program, Section 19, Procedures for Injuries, Near Misses and Fires, and the requirements of Contract Attachment A, Article 43 (f) were not met.

- Hand signal usage was not uniform and relied upon the skill-of-the-workers.

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<tr>
<td>Hand signal usage was not uniform and relied upon the skill-of-the-workers.</td>
<td>CF-3 / GP-5</td>
</tr>
</tbody>
</table>
### Cause

- Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.

- The fire extinguisher located in the Lull did not have an inspection tag as required by NFPA 10.

- The maintenance log in the Lull was different from the one provided by Macedos.

- Inspection records identified for use in Torcon’s SHE Program Section 14, *Initial and Daily Inspections of Heavy Equipment*, were different from what was actually being used. Although the Accident Investigation Committee considers these two forms as nearly equivalent, it is another example of failure to implement administrative controls.

- Torcon had no assessment schedule for the project and relied on job site inspections and walkthroughs, including those with their insurance carrier.

### Affected Core Function (CF) / Guiding Principle (GP)

<table>
<thead>
<tr>
<th>Cause</th>
<th>CF-4 / CF-5 / GP-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.</td>
<td></td>
</tr>
<tr>
<td>The fire extinguisher located in the Lull did not have an inspection tag as required by NFPA 10.</td>
<td>CF-4 / GP-6</td>
</tr>
<tr>
<td>The maintenance log in the Lull was different from the one provided by Macedos.</td>
<td>CF-4 / GP-6</td>
</tr>
<tr>
<td>Inspection records identified for use in Torcon’s SHE Program Section 14, <em>Initial and Daily Inspections of Heavy Equipment</em>, were different from what was actually being used. Although the Accident Investigation Committee considers these two forms as nearly equivalent, it is another example of failure to implement administrative controls.</td>
<td>CF-4 / GP-6</td>
</tr>
<tr>
<td>Torcon had no assessment schedule for the project and relied on job site inspections and walkthroughs, including those with their insurance carrier.</td>
<td>CF-5</td>
</tr>
</tbody>
</table>

### Contributing Cause Statement (CCW-4): NSLS-II failed to ensure that the NSLS-II ES&H Program was performing as designed.

- NSLS-II Construction Safety Inspectors did not document all findings, and reports were not properly processed or completed as required in BSA’s *Construction Safety* Subject Area and the Contract. | CF-5 |

- The NSLS-II assessment schedule was inadequate to review all program elements in a timely manner to proactively identify and correct deviations. | CF-5 |
3.7 ANALYSIS OF EMERGENCY RESPONSE

Notifications to BNL emergency responders and the NSLS-II Project were made in accordance with NSLS-II Project procedure LT-ESH-P-00012, *Reporting Events*.

When the ambulance crew returned to the Firehouse, the Fire Captains conducted a critique of the NSLS-II emergency response. The results are as follows:

- Fire Rescue personnel, including the EMT, responded directly to the accident site and arrived within 4 minutes of notification.
- Fire Rescue personnel needed to go to the Motor Pool to pick up the ambulance because it was being serviced. The Motor Pool was notified and had the ambulance out and ready by the time Fire Rescue arrived.
- The Suffolk County Police Medevac was placed on standby because of the report of a serious injury, but released when it was determined by Fire Rescue that there wouldn’t be a delay in transporting the patient.
- When Fire Rescue personnel arrived at the NSLS-II site, personnel from Torcon directed them directly to the accident scene; they were highly visible and accurate.
- The Torcon EMT was already on scene and had initiated patient care.
- The scene was secure and there was ample room for responding apparatus.
- Fire Rescue personnel stabilized the patient and prepared him for transportation to the hospital.
- A notification was sent to the hospital apprising them of the incoming patient and his condition. They had a team ready that met the ambulance when it arrived.
- A request for an ALS intercept was made and provided to the patient without delay in transportation.
- The entire operation was conducted very smoothly, quickly, efficiently, and safely.

As indicated above, the ambulance was at the Motor Pool for maintenance. If it had not been available to respond to the accident, Suffolk County Police Medevac or mutual aid could have been utilized to transport the injured to the hospital.

Feedback received from the hospital indicated that the emergency response team did an excellent job in stabilizing the fracture and keeping it clean.

Torcon’s and BSA’s Fire Rescue response time to the accident site and the subsequent transport of the injured worker to the Hospital was acceptable.

The Accident Investigation Committee has determined that the emergency response for this event was acceptable.
4.0 CONCLUSIONS AND JUDGMENTS OF NEED

The Accident Investigation Committee has concluded that this accident was preventable.

The Laborer, standing where he did, had not left himself an escape route. It is less important whether the Laborer signaled correctly, whether the Operator misinterpreted the Laborer’s intentions, or whether it was rebar or mud that impeded the Laborer’s movement. In this regard, the Accident Investigation Committee determined that there was no need to think that any of the people involved were being less than truthful in recounting the events. Memory, especially in the wake of a traumatic event, is “reconstructive,” that is, people try their best to make sense of an impossible series of occurrences. The significant point is that the margin for error was reduced by the Laborer standing in the trajectory of the rebar. Therefore any coincidental mishap would be more likely to result in an injury. It seems reasonable to assume that, as the load was being moved toward him and being positioned over the place where it was to be placed, the Laborer’s attention was entirely on what was in front of him, not on what was at his feet or immediately behind him, and that his focus remained so even as he began to move away from where the load would be placed.

There are two root causes to this event. The first is that Torcon and its subcontractors failed to ensure employees were qualified and possessed the experience, knowledge, skills and abilities that were necessary to discharge his responsibilities. The Laborer was assigned work by his supervisor who failed to ensure the Laborer was qualified to perform it. In addition, pre-job briefings did not adequately address the hazards associated with the work being performed. Briefings primarily concentrated on what work needs to be performed, not on the associated hazards.

The second root cause was that Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety. Hazard analyses are required for major phases of the project. However, major phases were not defined. Hazard analyses failed to identify hazards and lacked detail for the movement and placement of rebar. The hazard analysis for materials pick up with a forklift only addressed “dropping/misplacement pinch points” as a hazard and provided the following controls: “flagman direction/horn warning”, “cordoned off area with caution tape”, and “spotter will work with forklift”. In addition, pre-job briefings did not adequately address the hazards associated with the work being performed. Briefings primarily concentrated on what work needs to be performed, not on the associated hazards.

Four causes were identified that did not contribute to this event but contributed to weaknesses in the NSLS-II ES&H Program at the construction site. NSLS-II has the potential to achieve best in class if their ES&H Program is fully implemented. The first contributing cause to program weakness was due to poorly defined lines of authority and responsibilities for ensuring ES&H compliance. No one was assigned by Torcon or its subcontractors to determine if drug and alcohol screening needed to be performed after an accident. Line supervisors were not aware of their responsibility to conduct injury investigations and toolbox training, but believed these were the responsibility of the safety staff in contradiction to the Torcon SHE Program. The second contributing cause to program weakness was due to poor oversight by Torcon to ensure their ES&H program was being properly implemented. Examples include not detecting and correcting that (1) new workers were reviewing and signing PHA’s, (2) that not all injuries were being investigated, and (3) that daily job site inspections were not being correctly performed if performed at all.
The third contributing cause to program weakness was due to a lack of effective suspect/counterfeit program for rigging. Suspect shackles and wire clips were found on the NSLS-II construction site several times over several days by members of the Accident Investigation Committee. In addition, the daily rigging inspection forms provided by Torcon failed to address the inspection of suspect/counterfeit items.

The fourth and final contributing cause to program weakness was due to the lack of oversight by the NSLS-II project to ensure their ES&H program was being properly implemented. This included not detecting and correcting that: (1) NSLS-II Construction Safety Inspectors were documenting all findings, (2) PHAs were adequate for the work being performed and were being reviewed by new workers, and (3) daily inspections by Torcon and their subcontractors were not being performed.

4.1 DIRECT, ROOT, AND CONTRIBUTING CAUSES

Based upon the results of the analytical methods described above, the Accident Investigation Committee has identified one direct cause to the event (DCE) and two Root Causes to the event (RCE). In addition, the Accident Investigation Committee, as part of its charter, has identified four causes that contributed to weakening the BSA, NSLS-II, and Torcon ES&H Programs (CCW).

For each cause, the analytical method that is its source is identified, using the following codes: Barrier Analysis (BA), Event & Causal Charting (E&CFC), ISM Analysis (ISM), and TapRooT (TR). In addition, a reference to the requirements that the cause applies to is also provided.

Table 3. Event causes, summaries, sources, and associated JONs.

<table>
<thead>
<tr>
<th>DCE No.</th>
<th>Direct Cause of the Event</th>
<th>Summary and Source</th>
<th>JON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Laborer struck by rebar</td>
<td>Rebar strikes the Laborer’s lower right leg and fractures it. (E&amp;CFC)</td>
<td>1, 2, 5 &amp; 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RCE No.</th>
<th>Root Cause of the Event</th>
<th>Summary and Source</th>
<th>JON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Torcon and its subcontractors failed to ensure employees possessed the experience, knowledge, skills, and abilities that were necessary to discharge their responsibilities.</td>
<td>• Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely. (BA, TR, OS, ISM, E&amp;C))</td>
<td>1, 5 &amp; 7</td>
</tr>
</tbody>
</table>

(Reference: Contract Attachment A, Article 43 (b))
<table>
<thead>
<tr>
<th>RCE No.</th>
<th>Root Cause of the Event</th>
<th>Summary and Source</th>
<th>JON</th>
</tr>
</thead>
</table>
| 2       | Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety. | • Hazard analyses are required for major phases of the project. However, major phases were not defined. (OS, ISM)  
• Hazard analyses failed to identify hazards and lacked detail for the movement and placement of rebar. The hazard analysis for materials pick up with a forklift only addressed “dropping/misplacement pinch points” as a hazard and provided the following controls: “flagman direction/horn warning”, “cordoned off area with caution tape”, and “spotter will work with forklift”. (BA, OS, ISM)  
• Torcon and its subcontractors failed to establish that personnel were ready to perform work by ensuring they were aware and prepared to protect themselves from hazards associated with their work. The Laborer created a staging area for the rebar which was unacceptable. (ISM, TR)  
• Pre-job briefings failed to address the hazards associated with the work being performed. Briefings were primarily concentrated on what work needed to be performed and did not address the associated hazards. (BA, ISM, E&CF) | 2, 5 & 7 |

(References: Contract Attachment A, Article 43 (d)(1), and Torcon’s SHE Program Section 11)
Table 4. Contributing causes to program weaknesses, summaries, sources, and associated JONs.

<table>
<thead>
<tr>
<th>CCW No.</th>
<th>Contributing Cause (Program Weakness)</th>
<th>Summary and Source</th>
<th>JON</th>
</tr>
</thead>
</table>
| 1       | Torcon and its subcontractors failed to establish clear and unambiguous lines of authority and responsibility for ensuring ES&H compliance was established and maintained at all organizational levels. | • Torcon and its subcontractors did not indicate a clear responsibility for requesting drug and alcohol screening after an accident or injury. The Operator was not requested to submit to a drug and alcohol screening following the accident until 3 hours had passed and he had left the site. (BA, OS, ISM)  
  • Torcon’s supervisors and its subcontractor’s supervisors had abdicated safety responsibilities to safety staff. Supervisors believed investigations and toolbox training to be the responsibility of the safety staff and not theirs, even though Torcon’s SHE Program clearly states that the supervisors are responsible for conducting toolboxes and participating in injury investigations. (BA, OS, ISM)  
  • Torcon was not able to provide a document defining roles and responsibilities for their Safety Manager. (OS, ISM)  
  
(Reference: Contract Attachment A, Article 43 (b)) | 3, 5 & 7 |
| 2       | Torcon and its subcontractors failed to ensure implementation of the NSLS-II ES&H Program and therefore contributed to its weakness. | • Implementation of Section 11 of Torcon’s SHE Program failed to identify and correct (1) the inadequate hazard analysis for material handling (the movement or directing the movement of materials is a major portion of Rebar Steel’s activities) and (2) the lack of review of PHA’s by new workers. (BA, ISM, OS)  
  • Supervision failed to ensure the Laborer and Operator had reviewed and signed the PHA for the work they were performing in accordance with Torcon’s SHE Program, Section 11. (OS, ISM)  
  • Torcon failed to ensure all injuries were being reported in accordance with Torcon’s SHE Program, Section 19, Procedures for Injuries, Near Misses and Fires, and the requirements of Contract Attachment A, Article 43 (f) were not met. (BA, OS, ISM)  
  • Torcon’s Job Site Daily Inspection Records were not | 4, 5 & 7 |
<table>
<thead>
<tr>
<th>CCW No.</th>
<th>Contributing Cause (Program Weakness)</th>
<th>Summary and Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases. (BA, OS, ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torcon’s Project Safety Evaluation forms were not completed correctly and some work periods were missing altogether. Objective evidence was not available to indicate whether these inspections had actually taken place daily as required by the contract. (OS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torcon failed to detect and correct the use of suspect/counterfeit items used during rigging operations. (OS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hand signal usage was not uniform and relied upon the skill-of-the-workers. (ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torcon failed to fully implement its alcohol and drug testing requirements. (ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The maintenance log in the Lull was different from the one provided by Macedos. (BA, ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The fire extinguisher located in the Lull did not have an inspection tag as required by NFPA 10. (BA, ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Inspection records identified for use in Torcon’s SHE Program Section 14, Initial and Daily Inspections of Heavy Equipment, were different from what was actually being used. Although the Accident Investigation Committee considers these two forms as nearly equivalent, it is another example of failure to implement administrative controls. (BA, ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torcon had no assessment schedule for the project and relied on job site inspections and walkthroughs, including those with their insurance carrier. (ISM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Toolbox meetings topics were not always germane to the work hazards being encountered in the field. The continuing training program was inadequate. The</td>
<td></td>
</tr>
<tr>
<td>CCW No.</td>
<td>Contributing Cause (Program Weakness)</td>
<td>Summary and Source</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------</td>
<td>--------------------</td>
</tr>
</tbody>
</table>
| 3      | Torcon and its subcontractors failed to implement an effective suspect/counterfeit program for rigging. | - Suspect shackles and wire clips (no manufacturer's name or stamp) were found several times over several days by members of the Accident Investigation Committee. (OS)  
- Torcon's SHE Program, Section 38, *Rigging Procedures and Inspections*, and its associated Daily Rigging Inspection form outlined in Article 38, did not address inspection for suspect/counterfeit items prior to rigging. (OS)  
(References: Contract Attachment A, Article 16 and Torcon's SHE Program Section 38) | 5, 6 & 7 |
<table>
<thead>
<tr>
<th>CCW No.</th>
<th>Contributing Cause (Program Weakness)</th>
<th>Summary and Source</th>
<th>JON</th>
</tr>
</thead>
</table>
| 4       | NSLS-II failed to ensure that the NSLS-II ES&H Program was performing as designed. | • NSLS-II Construction Safety Inspectors did not document all findings, and reports were not properly processed or completed as required in BSA’s *Construction Safety* Subject Area and the Contract. (BA, OS, ISM)  
• NSLS-II’s oversight of Torcon’s implementation of Section 7.1 of the NSLS-II Construction HASP and Section 11 of Torcon’s SHE Program did not identify and correct shortcomings in PHA implementation, such as the lack of specificity, not adequately identifying hazards, and new workers not reviewing and signing PHA’s. (OS)  
• NSLS-II’s oversight did not reveal that daily and frequent inspections by Torcon and its subcontractors were not being performed. (OS)  
• NSLS-II’s oversight did not identify and correct the use of suspect shackles and wire clips (no manufacturer’s name or stamp) found several times over several days on the site. (OS)  
• The NSLS-II assessment schedule was inadequate to review all program elements in a timely manner to proactively identify and correct deviations. (OS, ISM)  
(References: Contract Attachment A, Article 43 (g), BSA’s *Construction Safety* Subject Area, NSLS-II ES&H Management Plan paragraph 3.3.1.1, and NSLS-II Project Procedure LT-ESH_P-00013, *Safety Inspections*) | 5 & 7 |
4.2 JUDGMENTS OF NEED

Judgments of Need are managerial controls and safety measures believed necessary to prevent or minimize the probability of recurrence. They flow from the causal factors and are directed at guiding managers in developing corrective actions. The Judgments of Need and associated Cause Codes are shown in Table 5.

Table 5. Judgments of Need.

<table>
<thead>
<tr>
<th>No.</th>
<th>Judgment of Need</th>
<th>Cause Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure workers are qualified and possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities in compliance with (1) Contract Attachment A, Article 43, (2) ES&amp;H program and (3) ISM.</td>
<td>DCE-1, RCE-1</td>
</tr>
<tr>
<td>2</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure workers are aware of foreseeable hazards and protective measures for their safety. This includes, but is not limited to defining “major phases” of work to determine when hazard analyses are required, establishing the criteria for acceptance of hazard analyses, discussing hazards and their controls during pre-job briefings, and ensuring compliance with (1) Contract Attachment A, Article 43 (d)(1), Establishment of Safety Protocols, and (2) Torcon’s SHE Program Section 11, PHAs.</td>
<td>DCE-1, RCE-2</td>
</tr>
<tr>
<td>3</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to establish clear and unambiguous lines of authority and responsibility for the implementation the (1) Contract, (2) Torcon’s SHE Program, and (3) other ES&amp;H requirements.</td>
<td>CCW-1</td>
</tr>
</tbody>
</table>
| 4   | There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure all ES&amp;H requirements of the Contract and Torcon’s SHE Program are being adequately implemented. This includes, but is not limited to, the following requirements:  
  - Contract, Attachment A  
    - Article 16, Suspect/Counterfeit Items  
    - Article 43 subsections  
      - (d)(1) Establishment of Safety Protocols | CCW-2       |
<table>
<thead>
<tr>
<th>No.</th>
<th>Judgment of Need</th>
<th>Cause Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• (d)(2) Frequent and Regular Inspections of the Work Site</td>
<td></td>
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<tr>
<td></td>
<td>• (f) Immediate Notification to BSA’s Contractual Representative of Recordable Injuries</td>
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<tr>
<td></td>
<td>• (k) Subcontractor’s Compliance with ES&amp;H Requirements of the Contract</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torcon’s SHE Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 11, PHAs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 14, Daily Inspections of Heavy Equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 19, Procedures for Injuries and Near Misses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 23, Job Site Inspections</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Section 38, Rigging Procedures and Inspections</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• NFPA 10, Standard for Portable Fire Extinguishers</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>There is a need for the NSLS-II project to provide adequate oversight to ensure that BSA ES&amp;H Contract requirements and the NSLS-II ES&amp;H programs are being fully implemented. This includes, but is not limited to:</td>
<td>DCE-1</td>
</tr>
<tr>
<td></td>
<td>• Compliance with Contract, Attachment A, Article 43 (g), Written Notification to Contractor of Non-compliances</td>
<td>RCE-1</td>
</tr>
<tr>
<td></td>
<td>• Compliance with BSA’s Construction Safety Subject Area</td>
<td>RCE-2</td>
</tr>
<tr>
<td></td>
<td>• Compliance with NSLS-II ES&amp;H Management Plan, paragraph 3.3.1.1, Safety Responsibilities</td>
<td>CCW-1</td>
</tr>
<tr>
<td></td>
<td>• Compliance with NSLS-II Project Procedure LT-ESH_P-00013, Safety Inspections.</td>
<td>CCW-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CCW-3</td>
</tr>
<tr>
<td>6</td>
<td>There is a need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to implement an effective suspect/counterfeit program for rigging. This includes, but is not limited to, revising Torcon’s SHE program to reflect inspection of rigging equipment for suspect/counterfeit items prior to use and ensuring there are no unknown suspect/counterfeit items currently in use on the NSLS-II construction site. There is a further need for Torcon and all its subcontractors, at all levels, on the NSLS-II construction site, to ensure that Contract, Attachment A, Article 16, is being met.</td>
<td>CCW-3</td>
</tr>
<tr>
<td>No.</td>
<td>Judgment of Need</td>
<td>Cause Codes</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>7</td>
<td>There is a need for the NSLS-II project to establish and implement a well structured assessment program to complement field inspections. The assessment program should be designed to ensure all elements of the ES&amp;H program required by the Contract and ES&amp;H Plans are functioning properly. The schedule should be established to ensure elements that support or monitor life protection programs (e.g., LOTO, confined spaces, excavation, electrical safety) are given priority.</td>
<td>DCE-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCE-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCE-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CCW-1</td>
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<td>CCW-2</td>
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<td></td>
<td></td>
<td>CCW-3</td>
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<td></td>
<td></td>
<td>CCW-4</td>
</tr>
</tbody>
</table>
5.0 OTHER ANALYSES REQUIRED BY TEAM CHARTER

5.1 IMMEDIATE RESPONSE TO THE ACCIDENT

This section reviews the response actions taken by NSLS-II and Torcon immediately following the accident. The emergency response to the accident is analyzed in section 3.7.

At 0845 hours, in accordance with NSLS-II Project Procedure LT-ESH-P-00012 Reporting Events, Torcon’s Safety Manager called BNL’s emergency number advising of an injury and requesting an ambulance. In parallel, Torcon’s site EMT was alerted of the injury and proceeded from Torcon’s Project Trailer to the accident location. Upon her arrival, she immediately started providing medical care.

When Fire Rescue arrived at NSLS-II, Torcon employees directed Fire Rescue personnel directly to the accident scene where they assumed responsibility for the emergency. Fire Rescue commented that Torcon personnel were highly visible and accurate in their directions.

After the injured was placed in the ambulance, Laboratory Protection personnel took control of the scene and secured it. Safety and Health Services personnel started to gather information, i.e., take pictures, measurements and statements.

NSLS-II and Torcon personnel took the following actions the day of the accident:

- NSLS-II held a fact finding meeting with Torcon, Macedos Rebar Steel, and S&HSD. The Laborer was at the hospital and did not attend, the Operator had left for the day prior to the fact finding meeting. However, he returned the following day and S&HSD personnel obtained his statement.
- A standdown was held the day of the accident to inform all workers of the event.
- All rebar mechanical material handling activities were suspended and were not allowed to re-start without the approval of the NSLS-II Project Director.

NSLS-II and Torcon Personnel took the following actions the first several days following the accident:

- Torcon developed toolbox training on material handling and hazards associated with rebar.
- NSLS-II and Torcon started holding daily ES&H meetings to discuss activities planned for the day as well as safety issues and responses by Torcon.
- Torcon’s Corporate Safety Manager increased his weekly presence at the NSLS-II site.
- Torcon started working with the subcontractor (Macedos, employer of the injured) on training topics.
- BSA and Torcon started developing PHA’s for off-loading and moving rebar on site.
- Torcon developed and started implementing a preliminary version of their corrective action plan prior to the completion of this report.
5.1.1 DISCUSSION/RECOMMENDATIONS

The procedures established in BSA’s Contractor Vendor Orientation and Torcon’s site orientation were followed and notifications were made swiftly.

Within minutes of the injured being removed from the incident site, the scene was promptly secured by BNL Laboratory Protection and data collection was started, including statements from those in the area, photographs, measurements, and a fact finding meeting. These data provided the baseline for this investigation.

Sr. Project Management’s walk down of the site and calling for a stand down to inform workers of the event and the implementation of immediate corrective actions, even before the investigation was completed, demonstrated their concern for the safety of all workers on site.

The Accident Investigation Committee determined that NSLS-II and Torcon’s response to this event was acceptable.

5.2 SAFETY INCENTIVE PROGRAM

Though the Safety Incentive Program did not have any impact on this accident, it is part of the Accident Investigation Team’s Charter to review the adequacy of contractual safety requirements and the safety incentive program.

BSA has designed a safety incentive to motivate Torcon to strive for continuous improvement and perform at a best-in-class level. This is reflected in Article 44, Safety Incentive, of the Contract. The safety incentive is based on three factors:

1. Accident/Injury Rates (Days Away, Restricted, Transferred (DART) Rate and Lost Work Day (LWD) case rates;
2. Serious violations of OSHA requirements;
3. Responsiveness to less serious OSHA violations.

The DOE construction average for DART and LWD case rates are used to determine the award. The DART rate will be based on the rates for the most recent full year as presented in the DOE Computerized Accident, Incident Reporting System (CAIRS) database.

The value of the safety incentive for the term of the Contract is set at two million Dollars. This earned incentive is to be paid by BSA to Torcon for superior safety performance over and above the contract price and is to be awarded as follows:

- Up to five hundred thousand Dollars to be awarded annually 3 times, on the anniversary date of BSA’s Notice to Proceed, over the length of the contract;
- A final incentive of up to five hundred thousand Dollars when the contract is completed.

Work related illness and injuries are defined in 29CFR 1904, Final rule, the OSHA record keeping guidelines for Occupational Injuries and Illnesses, effective January 1, 2002.
The basis for the award is as follows:

- The first award will be made on the basis of DART and LWD case rates at the end of the first year following BSA’s Notice to Proceed. An additional award will be made each succeeding year for a maximum of three annual awards. Annual awards are not cumulative.
- No award will be made if the DART rate or LWD rate for the combined Contractor and subcontractor (working on site) rate is greater than the construction average from DOE’s CAIRS.
- Fifty percent of the maximum award will be granted if the DART rate and LWD rate for the combined Contractor and subcontractors at the site is less than or equal to the DOE construction annual average from CAIRS for the DART rate and three year rolling average for the LWD rate.
- Additional award is earned based on the percentage difference below the DOE average LWD rate only, reaching 100% at 50% of the DOE average LWD rate.

There will be a five thousand Dollar reduction of the earned annual award for each significant instance of OSHA violations, including but not limited to:

- Any worker not properly using appropriate fall protection systems.
- Entry into a confined space without a required confined space permit or violation of permit requirements.
- Failure to use, when required, the Lock-out Tag-out procedures, as approved in Torcon’s Safety Plan.
- Any work on or near energized parts without a required Energized Electrical Work Permit or violation of permit requirements.
- Failure to report a recordable work related injury or illness to NSLS-II ES&H.
- Any fire caused by insufficient or inadequate fire protection measures.
- Excavation without required Dig/Penetration permit or violation of the requirements of a Dig Penetration permit.
- Failure to protect all excavation from cave-ins by adequate protection systems designed in accordance with 29CFR 1926.652.

In addition, there will be a five thousand Dollar reduction of the earned annual award for lack of responsiveness to less significant issues called to the attention of Torcon, including but not limited to:

- Repeated violations of any worker not wearing personal protective equipment, as required in Torcons’ safety plan.
- Repeated housekeeping issues at the job site,
- Repeated use of defective hand tools, power tools, extension cords, etc.
- Smoking in violation of the no-smoking policy,
- Repeated traffic violations issued on the BNL site.

There will be no annual award regardless of rates if there is a fatality, loss of limb, or an injury to the head resulting in permanent disability, at the work site.

Determination of incentive award reductions will be made by the NSLS-II ES&H Manager.

The final award will be made on the basis of cumulative injury rates over the time period of the conventional construction.
There will be no award if the average DART Rate or LWD rate for Torcon including all subcontractors working at the site over the duration of the project is greater than CAIRS construction average for DART and LWD rates for the same period.

Fifty percent of the final award will be granted if the DART Rate and LWD rate for Torcon and all subcontractors working at the site over the duration of the project is less than or equal to DOE construction average for DART and LWD rates for the same time period.

Torcon’s SHE Program, Section 26, Safety Incentive Programs for the Project, Revision 3, dated June 9, 2009, outlines the potential distribution of any earned incentive as follows: 50% to the Union tradesmen, apportioned to the workers based on their man hours worked during the incentive period; 20% to the subcontractor company; and 5% to Torcon’s field supervision. The remaining 25% will be distributed to Torcon. Any workers or subcontractor companies receiving a violation during the incentive period will be disqualified from receiving the safety incentive payment.

Torcon has also implemented short-term incentives or rewards programs for outstanding safety leadership or compliance. Torcon’s Labor/Management Safety Committee provides input into what programs are to be offered. Torcon uses these programs to reward workers and supervisors for showing the extra diligence and professionalism it takes to achieve high levels of safety.

Torcon’s Project Orientation and General Safety & Health Rules pamphlet that is reviewed with all new employees does not mention the safety incentive program. However, Torcon’s Project Safety Orientating Outline includes a flyer called “Safety Pays”. This document briefly describes the safety incentive agreement with BSA and informs the workers that it is conceivable that a 100% incentive award earned with no workers being disqualified, could result in an average award of six thousand Dollars per tradesman, with some awards being much higher for tradesmen that are on the Project for the full three year duration. It further states that, even if you are no longer on the job, Torcon will pay any earned bonus Dollars directly to you, not your employer.

Field workers were interviewed on their knowledge of the Safety Incentive Program. Many workers were aware of Torcon’s $50 gift card incentive, which is separate from the safety incentive program in the Contract. However, this too was not mentioned in Torcon’s Project Orientation, pamphlet, or SHE Program. Workers interviewed were not aware of the NSLS-II Safety Incentive Program.

The NSLS-II construction workforce is partly made up of transient local Union trade workers, who, at the end of their particular phase of the work, will move on to other projects. The Accident Investigation Committee determined that the transient nature of the workers creates a situation where long-term buy-in is difficult to achieve. Short-term incentives can produce the desired results, if properly applied, promoted, and effectively delivered to the worker.
5.2.1 DISCUSSION/RECOMMENDATIONS

The Safety Incentive Program had no impact on this accident.

It is extremely difficult for the Accident Investigation Committee to determine if the Safety Incentive Program, as stated in the Contract, has had an influence in improving safety considering the injuries that have occurred on the NSLS-II site to date. The Safety Incentive Program, as stated in the Contract, only indicates what awards will be paid out by BSA to Torcon. It is up to Torcon to determine how best to distribute the award to achieve the desired outcome. The Program is results oriented with only punitive actions for behavior, i.e. the loss of award monies as stated above.

Torcon has indicated in their SHE Program how the award will be disbursed to workers. However, workers’ awareness of this program is low. Torcon has an incentive program of their own, used on this and other sites they manage, that rewards workers on the spot when observed working safely. It can be stated that the BSA Safety Incentive encourages this program on site. It is recommended that more emphasis be placed on informing workers of the safety incentive program, from the time when they start working on site and continuing throughout the project. Information concerning safety incentives could be added to Torcon’s Project Orientation and General Safety & Health Rules pamphlet, orientation outline, and as a toolbox topic.

There were many discussions with the NSLS-II Safety team with respect to slow and sometimes non-responsiveness from safety individuals working for Torcon. This was also witnessed by the Accident Investigation Committee. The Contract states that lack of responsiveness to less significant issues brought to Torcon’s attention will result in a five thousand Dollar reduction in the annual award per event. Torcon should be reminded of this and BSA should consider raising this amount for repeat occurrences and providing immediate feedback of any award reduction that will be taken.

The use of gift cards, state lottery tickets, or theater tickets may allow the monetary incentive to effectively reach the field worker who will be on site for a short time. These incentives could be given to all employees on site during a particular week, or other short period of time, where no accident occurs.
5.3 REVIEW OF CONSTRUCTION SAFETY PROGRAM IMPLEMENTATION

5.3.1 FIELD OBSERVATIONS

During the course of this investigation, Accident Investigation Committee members who are professional construction safety inspectors, conducted site observations and interviewed workers. While conducting approximately 500 observations over seven days they did not observe any human performance safety deficiencies. In addition to the other findings identified previously in this report they made the following determination with respect to the implementation of the NSLS-II Construction Safety Program on the construction site:

- there was a high degree of PPE compliance;
- housekeeping was good;
- environmental controls were effective;
- all hardhats carried the BNL emergency number;
- discussions with field workers indicated a positive attitude towards participating in efforts to make the site safe;
- material staging and storage areas were well organized;
- construction equipment appeared to be in good operating condition;
- paths of travel for equipment were well established;
- scaffolding was erected properly;
- excavation practices were adequate.

5.3.2 ADEQUACY OF TORCON’S SAFETY PLAN IMPLEMENTATION AND FLOWDOWN TO SUBCONTRACTORS

The Accident Investigation Team has determined that Torcon has adequately flowed down the requirements of its safety plan to subcontractors. However, Torcon failed to implement their SHE Program plan. The causes identified in Table 4 under Contributing Causes (Program Weakness) provide the basis for this determination.

5.3.3 ADEQUACY OF BNL OVERSIGHT OF TORCON’S SAFETY PROGRAM

The Accident Investigation Team has determined that NSLS-II’s oversight failed to identify and correct all weaknesses in Torcon’s SHE Program plan. The causes identified in Table 4 under Contributing Causes (Program Weakness) provide the basis for this determination.
5.3.4 RECOMMENDATIONS TO IMPROVE OVERALL CONSTRUCTION SITE SAFETY

The ES&H requirements established by the NSLS-II Project, the Contract, and Torcon, provide a program that has the potential to produce a best-in-class performance.

Each element of this program plays an important and integral part in achieving the desired results and can be compared to a cable used for structural support. Each program element is like a strand within the cable. Taken together, each strand contributes to a cable’s functional design. The impact of a broken or weakened strand may not be evident at the beginning of cable use. However, as factors such as time, wind, sun, and structural load, start to impact the cable, the importance of each wire becomes more evident. As a result, detailed inspections and tests of the cable are conducted, using both visual means to evaluate the surface layers, and other means to ensure the internal layers are to specification. These inspections and tests are periodically repeated through the lift of the cable to ensure it maintains its integrity. Failure of the cable can cause significant results.

Likewise, when an ES&H program is designed, each element plays a part in the overall desired performance of that program. When one of those elements is not fully implemented as designed, or not implemented at all, the program fails to perform as intended. Impact to the program may not be immediately noticed, if noticed at all. However, as time goes on and events occur, these weaknesses may materialize in significant ways that cannot always be predicted.

To prevent this from occurring, structured audits are required. Field inspections play an important part in ensuring the surface results, i.e., behavioral performance, is as expected, but they fall short in identifying internal elemental performance that is not as easily identified. This is why the Accident Investigation Committee recommends a well structured assessment program to complement the field inspections. The assessment program should be designed to ensure all elements of the ES&H program required by the Contract and ES&H Plans are functioning properly. The schedule should be established to ensure elements that support or monitor life protection programs (e.g., LOTO, confined spaces, excavation, electrical safety) are given priority. Finally, adequate resources must be provided to support the schedule.
5.4 NON-ACCIDENT INVESTIGATION JUDGMENT OF NEED - HIPAA

The Accident Investigation Committee identified an additional need concerning the Health Insurance Portability and Accountability Act (HIPAA).

HIPAA was enacted by the U.S. Congress in 1996. Title II of HIPAA, known as the Administrative Simplification (AS) provisions, defines numerous offenses relating to health care and sets civil and criminal penalties for them. It also creates several programs to control fraud and abuse within the health care system.

On several occasions, the Accident Investigation Committee came in contact with BSA employees who stated they could not talk to the Committee about the incident due to HIPAA requirements and their fear of violating them. The Committee asked questions regarding the type of fracture, its location, and general medical care provided. At one point, members of the Committee were informed by a BSA employee that we could not ask the injured any questions about his injury due to HIPAA. Although this point was clarified by BNL’s legal department (yes, the Injured can talk about his injury), and HIPAA did not prevent us from completing our investigation, it did identify a need for BSA to develop and provide training on HIPAA as it applies to injuries and investigations on site. This would aid future investigations by providing clear instructions to all involved and ensure the HIPAA requirements are properly executed across the site.
APPENDIX A  ACCIDENT INVESTIGATION COMMITTEE CHARTER

October 1, 2009

To: Ray Costa
From: S. Dierker, Associate Laboratory Director for Light Sources
Subject: Independent Construction Safety Investigation of contractor injury at the NSLS-II Ring Building construction site on 9/30/2009

On September, 30, 2009, a contractor working at the NSLS-II construction site sustained a serious injury. I request that you chair a committee to investigate this incident. The committee membership will include:

- R. Costa – Facilities & Operations (Chair)
- T. Conrad – Safety & Health Services Division
- S. Kane – Safety & Health Services Division
- E. Sierra – Quality Management Office
- D. Fuller – ORNL
- C. Seniuk, DOE BHSO, will also participate in the committee’s work as an observer.

You are hereby authorized to take any and all reasonable actions necessary to conduct and complete this investigation in a timely manner. Please provide a draft report to me by October 23, 2009 and a final report by November 13, 2009.

In addition, please keep me apprised of corrective actions that need immediate attention, development of findings, and resources required to provide a quality report in the time specified.

In addition to the personnel, equipment, and procedures directly related to the incident scene, the scope of the report shall include evaluation of all systems and processes leading up to the incident as well as actions taken in response to the incident to mitigate its consequences.

Specifically the investigation should address:

1. Investigation of the leg injury incident
   a. Adequacy of the BNL and Torcon response
   b. Development of causal factors analysis and corrective recommendations
   c. Any added investigation, if warranted
2. Review of adequacy of contractual safety requirements and safety incentive program
   a. Does the contract with Torcon have appropriate requirements?
   b. Is the safety incentive program appropriately structured and designed to promote worker safety?
3. Review of implementation of the construction safety program
a. Adequacy of Torcon safety plan implementation and flow down to subcontractors
b. Adequacy of BNL oversight of Torcon safety program
c. Recommendations to improve overall construction site safety

The investigation should be conducted following the BNL Subject Area on Investigation of Incidents, Accidents, Injuries, and other DOE guidelines for accident investigation.

Cc:

S. Aronson
L. Bates
M. Bebon
A. Byon
T. Conrad
F. Crescenzo
M. Fallier
D. Fuller
D. Gibbs
S. Hoey
S. Kane
E. Nowak
C. Parnell
C. Semtk
E. Sierra
October 7, 2009

MEMORANDUM FOR MICHAEL D. HOLLAND
MANAGER
OFFICE OF SCIENCE
BROOKHAVEN SITE OFFICE

FROM: GLENN S. PODOLSKY
CHIEF, HEALTH, SAFETY AND SECURITY OFFICER,
OFFICE OF HEALTH, SAFETY AND SECURITY

SUBJECT: Waiver of Type B Accident Investigation Categorization

The Office of Health, Safety and Security (HSS) has reviewed your October 6, 2009, memorandum requesting a waiver from the Department of Energy (DOE) Order (O) 225.1A, Accident Investigations, required to conduct a Type B accident investigation. Your request to allow Brookhaven Science Associates team to complete their investigation with the oversight of the referenced independent DOE team, in line with the Office of Science reform is acknowledged.

We concur with your path forward and hereby approve your request for a waiver.

If you have any questions on this matter, please feel free to contact me or your staff may contact Charles Lewis, Director, Office of Corporate Safety Programs at (301) 903-8008.

cc: William Eckroade, HS-1
    William Roege, HS-30
    George Malosh, SC-3
    Marc Jones, SC-31
APPENDIX C  SUMMARY OF INTERVIEW STATEMENTS

The following is a compilation of the statements obtained about the accident from the Laborer, Operator, and Worker 2, arranged in chronological order. Similar statements are combined for brevity. Dissimilar statements are both included and appropriately annotated. The Accident Investigation Committee’s reconstruction of the accident is provided in Section 2.1.2, Description of the Accident, page 25.

On September 30, 2009, the Lull Operator employed by Macedos started work at approximately 0700 hours by working with carpenters to move material. At approximately 0815 hours, the Laborer, employed by Rebar Steel, asked the Operator to move some rebar, as directed by the Rebar Steel foreman that morning. The Laborer was directing the placement of the rebar load.

The Operator and Laborer were moving bundles of rebar from the laydown area to an area where they could be hoisted with the crane. The Operator stated that he and the Laborer moved 6 to 7 loads of rebar before moving to the area where the incident occurred. The Laborer marked the rebar bundles to be moved by spraying them with orange paint.

The Operator had previously worked with this Laborer and others before this day. The Laborer stated that on several previous occasions (not on the day of the accident) the Operator misread the Laborer's hand signals and operated the Lull in a manner not expected by the Laborer. The Operator indicated there are several hand signal methods used on site and he had no problem with any of them. The Operator did not have any problem understanding the Laborer's signals. The Laborer had never complained to the Operator about not following his signals.

The Operator indicated to the Accident Investigation Committee that the Lull was in good working condition and he had no problem with it. The Operator also indicated to the Accident Investigation Committee that there was no unusual pressure placed upon him to get the job done.

The Operator stated that the incident occurred with the first rebar bundle moved to the incident area, but the Laborer stated that it was the third bundle moved to the incident area. Both Operator and Laborer stated they were moving one bundle at a time. The responsible supervisor and Worker 2 indicated to the investigation team that there were two bundles being moved.

At approximately 0835 hours, Worker 2 saw the Operator and Laborer placing a load of rebar onto the ground between two other loads of rebar already on the ground.

The Operator stated that the Laborer was standing on several bundles of rebar approximately 5 feet in front of the forks of the Lull. The Operator stated that he was being guided by the Laborer who signaled the Operator to land the load. The Operator stated that the Lull was stopped prior to the load being placed. The Operator stated the Laborer directed him to drive over a bundle of rebar that was located at the incident area. The Operator stated that he had no problems with visibility; he was able to clearly see the Laborer at all times. The Laborer stated that he was facing the Lull and had indicated, using hand signals, for the Operator to stop movement, but the Operator stated that the Laborer had indicated for him to lay down the load while the Laborer was standing on a stack of rebar approximately 5 feet from where the load was to be dropped. Worker 2 stated that he saw the Laborer turn away as if he was going to get out of the way so the load could be placed, but also later stated to the investigation team that he did not see the incident.
The Operator stated that the Laborer, facing the Lull, backed up to move out of the way of the rebar, at the same time the Operator was in the process of placing the load. The Operator stated that the boom of the Lull was extended to permit the load to be placed in the area indicated by the Laborer. The Laborer stated that he was in the process of backing up out of the way when his right foot got stuck in the mud. As he was trying to move his foot, the Operator continued to move and lower the bundle of rebar. The Laborer was able to get his left foot out of the way, but the bundle of rebar rolled off the forks of the Lull and struck his right leg, resulting in the injury. The Laborer was facing the Operator when the load was placed.

Per the Operator, as the load started to slide off the forks, the Laborer slipped off the bundles of rebar he was standing on into a sitting position and the load came down on his right lower leg. The Laborer stated that the bundle of rebar was not completely off of the Lull forks, some of the rebar was still supported by the forks. The Operator, responding to the Laborer’s screams, removed the rebar from his leg. The Operator stated that he did not remember if he speared or cradled the load off the Laborer’s leg. The Laborer rolled onto his stomach after the load was lifted.

The Operator stated that he then exited the Lull and went to the injured. Worker 2 heard screaming and ran over to see the Laborer on the ground face down and the rebar above him, half on the forks of the Lull and the other half off the forks hanging several inches above Laborer’s legs. Worker 2 stated he did not see the incident occur; he was located behind a spoil pile at the time of the incident. When he arrived, the Operator was out of the Lull near the Laborer. At this time, the Operator saw the rebar on the forks and believed them not to be at a safe distance from the Laborer and moved the rebar back further by retracting the boom and by moving the vehicle backwards. After Worker 2 arrived at the scene, the Operator moved the load back further and dropped it to the ground. The Operator stated that he thought the bundle of rebar was still on the forks of the Lull when he moved the Lull back, but the first responding investigators did not find any rebar on the forks.

The Laborer stated to Worker 2 while awaiting medical assistance that his foot got stuck in mud as he went to get out of the way of the load, and the rebar hit him.
APPENDIX D  FOOTNOTES

The statements of the people involved in the accident and some witnesses conflict with each other or with physical evidence. The following is the analysis of the statements and evidence that explains the conclusion of the Accident Investigation Committee for the sequence of events.

1 – After the incident the Lull was inspected by both the BNL Hoisting & Rigging Inspector and an equipment technician, and both found the Lull was sound and operating correctly.

2 - The Laborer arranged cribbing in the accident area, including moving a 2 x 4 inch piece of wood approximately 10 feet north to the incident location. There was an impression in the ground in the shape of a 2 x 4 inch piece of wood between the forks of the Lull, where it was located after the accident (Figure 10).

![Figure 10. Tire marks and impression in the ground visible in the center, above the bundle of rebar.](image)

3 - The Accident Investigation Committee believes the Operator and the Laborer moved two bundles of rebar, one with a bend and another bundle of ½ inch rebar before the incident bundles were moved. There was one statement by the Laborer that the incident bundle was the third bundle to be moved, and this fits with the placement of two different bundles already in the staging area. There is a bundle of rebar with a bend and a bundle of ½ inch rebar set on cribbing in the staging area (Figures 11 and 12). These would have come from different areas when they were unloaded, as was found in the piles of rebar around the area (Figure 13).
Figure 11. Staging area (accident location).

Figure 12. Staging area (accident location), including the Lull.
4 - There are two bundles of 1 ¼ inch rebar south of the other two bundles in the staging area. They are both marked with orange paint, and nearest to the forks of the Lull as it was found after the accident. The Laborer and Worker 2 both state that the rebar was partly on the forks of the Lull after it struck the Laborer. Two bundles would have that same appearance. The combined weight of the two bundles, 4,934 pounds, would still be within the capacity of the Lull at 18 feet of boom extension.

5 - The Laborer was found lying over and between two piles of rebar. The Laborer was reportedly 6 feet 2 inches tall (74 inches), and the distance between the rebar pile on which the laborer’s head was located post-accident, and the bundles of rebar in the staging area measured 59 inches. The two bundles of rebar in the staging area measured 24 inches wide. The Laborer also stated that his foot was stuck in mud. He could only make this statement if he knew he was standing on ground as opposed to standing on rebar immediately before the accident, as stated by the Operator.

6 - This conclusion is based upon Figures 8 and 14. One may easily see that an elevated load would block the view of the Laborer’s lower body while standing in the location in front of the staged rebar.

7 - The boom of the Lull was found at approximately 13 feet after the accident (see Figures 12 and 15). The Operator stated that he moved the load by retracting the boom and backing the vehicle. The capacity limit for the Lull is 5,000 pounds at approximately 18 feet. A load of 2,467 pounds for one bundle, or a load of 4,934 pounds for two bundles, was well within this rated capacity.
Figure 14. Operator’s view.

Figure 15. Load chart for Lull.

8 - This conclusion is drawn from the Operator’s and Laborer’s statements that the Laborer was facing the Lull at the time of the accident, and the Operator’s and Laborer’s statements that the Laborer was in the process of backing up at the time of the accident. During the second interview with Worker 2 he
stated that he did not see the accident occur. His observations were before the accident occurred and afterwards. Worker 2 stated he was behind the spoil pile at the time the Laborer was screaming. The spoil pile is the large mound of dirt visible in Figure 16. The crane is visible behind the spoil pile.

Finally, the Accident Investigation Committee believes that the Laborer gave a “down” or “tilt down” signal to the Operator in anticipation that he would be out of the way of the load in a couple of steps. The Laborer, however, tripped or was otherwise stopped in his retreat by the rebar behind him. The Accident Investigation Committee reached this conclusion considering several facts or the lack thereof. The Operator has several operating engineer licenses and training certificates, as well as many years of construction site experience. The Laborer, however, has mostly yard experience and non-material handling construction experience, and no licenses or operating engineer training, as evidenced by the letter of “experience” provided by Rebar Steel Corporation. The Laborer’s statement regarding the Operator’s previous unexpected response to hand signals is not evidenced by other means. The Laborer did not tell anyone else of these experiences, and construction site management has no record or recollection of this issue. The Operator states he had previously worked with the Laborer and others before the day of the accident and had no trouble understanding the Laborer’s signals. The Operator indicated there are several hand signal methods used on site and he had no problem with any of them. As a crane operator as well as a forklift operator, the Operator would have had training and experience with different signals. The Accident Investigation Committee also evaluated the crane and forklift hand signals and does not believe that a crane stop signal could be misinterpreted as a tilt hand signal. Members of the Accident Investigation Committee have seen the crane stop signal used on the construction site.

![Figure 16. The spoil pile is visible at the back of the photo.](image)

9 - The Laborer states his foot became stuck in mud as he was backing. The members of the Accident Investigation Committee that responded to the accident site within an hour of the accident did not find mud at the accident site (see Figure 9). The precipitation report for the month of September shows that there were 1.39 inches of precipitation on September 27, 2009 and 0.12 inches of precipitation on September 28, 2009 (see Appendix I). The area of the accident has been significantly excavated and reshaped, and the normal soil for the entire Long Island area as well as the site is Class C or sandy soil. In addition, there was 0.74 inches of precipitation on October 3, 2009, and the Accident Investigation
BNL NSLS-II Accident Investigation

Committee did not find any evidence of viscous mud that would trap an individual’s footwear. The rebar was slightly elevated and narrow in diameter, and its contact with the Laborer’s footwear might feel like the foot was stuck, but lateral motion would still be possible, hence the statement by the Laborer that he was able to get his left foot out of the way. (See also Figures 11 and 16.)

10 - This is evidenced by the broken cribbing at the accident site (see Figure 17), the position of the forks post-accident, the fact that the Operator could not immediately stop the load when he saw the Laborer slip, and the Operator’s statement that the load was sliding off the forks.

Figure 17. Broken cribbing.

11 - The Accident Investigation Committee came to this conclusion in order to explain the statement by the Laborer that the rebar was partly on the forks of the Lull after it struck him. This the Laborer would have seen before the Operator lifted the rebar from his leg. The Laborer also rolled onto his stomach after the rebar was lifted off his leg, therefore he might not have seen the rebar partially on the forks and partially off the forks when it was suspended above him, as the Operator and Worker 2 had seen.

12 - See Figures 10, 18, and 19. The bundles are identical, and the remnants of the wire tie are visible in the photographs.

13 - This is the statement by Worker 2, and is consistent with the statement by the Operator.

14 – The photographs show the Lull in a location after the accident that is away from the accident site. (The photographs show neither the load nor the Lull in a location that would contact the Laborer, who was located north of the Lull at the location of the staged rebar bundles.) Fresh tire marks are found in the soil leading from the incident rebar bundles to the Lull in its as-found location (see Figure 10).
Figure 18. Broken center wire tie visible in bundle on the right-hand side.

Figure 19. Broken center wire tie visible in bundle in front of photograph.
APPENDIX E  BARRIER ANALYSIS OF THE ACCIDENT (PHYSICAL AND ADMINISTRATIVE)

Each barrier failure is keyed to Tables 3 and 4 in Section 4.0 (see p. 62), which summarize the event causes, provide the analytical technique that was used to establish the cause, and identify the associated Judgment of Need.

The codes used are as follows: Direct Cause (DC), Root Cause (RC) and Contributing Cause to Program Weakness (CCW). Numbers following the codes indicate the specific causal factor.

**Part 1: Physical**

<table>
<thead>
<tr>
<th>Hazard: Mechanical Impact</th>
<th>Target: Laborer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What were the barriers?</td>
<td>How did the barrier perform?</td>
</tr>
<tr>
<td>Tools &amp; Equipment</td>
<td>Functioned as designed</td>
</tr>
<tr>
<td>Design/operation of Lull</td>
<td>Functioned</td>
</tr>
<tr>
<td>Maintenance of Lull</td>
<td>Functioned</td>
</tr>
<tr>
<td>Environment</td>
<td></td>
</tr>
<tr>
<td>Appropriate soil (type &amp; condition)</td>
<td>Functioned</td>
</tr>
<tr>
<td>Appropriate grade</td>
<td>Functioned</td>
</tr>
<tr>
<td>Appropriate weather conditions</td>
<td>Functioned</td>
</tr>
<tr>
<td>Good housekeeping</td>
<td>Functioned</td>
</tr>
<tr>
<td>Area staging</td>
<td>Failed</td>
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</tbody>
</table>
### Hazard: Mechanical Impact

<table>
<thead>
<tr>
<th>What were the barriers?</th>
<th>How did the barrier perform?</th>
<th>Why did the barrier fail?</th>
<th>How did the barrier affect the accident?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker - Laborer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-job brief / Job planning</td>
<td>Failed</td>
<td>Briefings were primarily concentrated on what work needed to be performed and did not address the associated hazards.</td>
<td>Missed opportunity to identify and address hazards (RCE-2)</td>
</tr>
<tr>
<td>Qualifications</td>
<td>Failed</td>
<td>Torcon and its subcontractors failed to ensure their personnel were qualified for the work they were assigned.</td>
<td>Enabled creation of hazardous condition (RCE-1)</td>
</tr>
<tr>
<td>Skills (ability to do job as intended)</td>
<td>Failed</td>
<td>Torcon and its subcontractors failed to ensure their personnel were qualified for the work they were assigned.</td>
<td>The Laborer put himself in close proximity to the load, which resulted in the accident. (RCE-1)</td>
</tr>
<tr>
<td>PPE</td>
<td>Functioned</td>
<td>Did not fail</td>
<td>Had no effect on accident</td>
</tr>
<tr>
<td>Communication (e.g., hand signals, language skills)†</td>
<td>Functioned</td>
<td>Did not fail</td>
<td>Had no effect on accident</td>
</tr>
</tbody>
</table>

† See discussion on the use of hand signals in section 3.1.1.
### Hazard: Mechanical Impact

<table>
<thead>
<tr>
<th>What were the barriers?</th>
<th>How did the barrier perform?</th>
<th>Why did the barrier fail?</th>
<th>How did the barrier affect the accident?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Worker - Operator</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-job brief</td>
<td>Failed</td>
<td>Briefings were primarily concentrated on what work needed to be performed and did not address the associated hazards.</td>
<td>Missed opportunity to identify and address hazards (RCE-2)</td>
</tr>
<tr>
<td>Qualifications</td>
<td>Functioned</td>
<td>Did not fail</td>
<td>Had no effect on accident</td>
</tr>
<tr>
<td>Skills (ability to do job as intended)</td>
<td>Functioned</td>
<td>Did not fail</td>
<td>Had no effect on accident</td>
</tr>
<tr>
<td>PPE</td>
<td>Functioned</td>
<td>Did not fail</td>
<td>Had no effect on accident</td>
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<tr>
<td>Communication (e.g., hand signals, language skills)</td>
<td>Functioned</td>
<td>Did not fail</td>
<td>Had no effect on accident</td>
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</table>
### Part 2: Administrative

<table>
<thead>
<tr>
<th>Hazard: Mechanical Impact</th>
<th>Target: Laborer</th>
<th>How did the barrier affect the accident?</th>
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<tr>
<td><strong>What were the barriers?</strong></td>
<td><strong>How did the barrier perform?</strong></td>
<td><strong>Why did the barrier fail?</strong></td>
</tr>
<tr>
<td>Proof of Maintenance: Maintenance Log of Lull</td>
<td>Failed</td>
<td>The maintenance log in the Lull was different from the one provided by Macedos.</td>
</tr>
<tr>
<td>Proof of Inspection: Fire extinguisher inspection label (I.A.W. NFPA 10)</td>
<td>Failed</td>
<td>The fire extinguisher located in the Lull did not have an inspection tag as required by NFPA 10.</td>
</tr>
<tr>
<td>Torcon Safety Program: Subcontractor Project-Specific Safety Plan</td>
<td>Failed</td>
<td>Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.</td>
</tr>
<tr>
<td>Torcon Safety Program: PHA</td>
<td>Failed</td>
<td>Implementation of Section 11 of Torcon’s SHE Program failed to identify and correct (1) the inadequate hazard analysis for material handling (the movement or directing the movement of materials is a major portion of Rebar Steel’s activities) and (2) the lack of review of PHA’s by new workers.</td>
</tr>
<tr>
<td>Torcon Safety Program: Hazard Analyses</td>
<td>Failed</td>
<td>Hazard analyses failed to identify hazards and lacked detail for the movement and placement of rebar. The hazard analysis for materials pick up with a forklift only addressed “dropping/misplacement pinch points” as a hazard and provided the following controls: “flagman direction/horn warning”, “cordoned off area with caution tape”, and “spotter will work with forklift”.</td>
</tr>
<tr>
<td>Torcon Safety Program: Heavy Equipment Inspection Records</td>
<td>Failed</td>
<td>Inspection records identified for use in Torcon’s SHE Program Section 14, <em>Initial and Daily Inspections of Heavy Equipment</em>, were different from what was actually being used.</td>
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<tr>
<td>Torcon Safety Program: Injury/Incident Investigations</td>
<td>Failed</td>
<td>Torcon’s failed to ensure all injuries were being reported in accordance with Torcon’s SHE Program, Section 19, <em>Procedures for Injuries, Near Misses and Fires</em></td>
</tr>
<tr>
<td>Hazard: Mechanical Impact</td>
<td>Target: Laborer</td>
<td></td>
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<tr>
<td>--------------------------</td>
<td>----------------</td>
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</tr>
<tr>
<td>What were the barriers?</td>
<td>How did the barrier perform?</td>
<td>Why did the barrier fail?</td>
</tr>
<tr>
<td>Torcon Safety Program: Post Drug and Alcohol Screening</td>
<td>Failed</td>
<td>Torcon and its subcontractors did not indicate a clear responsibility for requesting drug and alcohol screening after an accident or injury. The Operator was not requested to submit for a drug and alcohol screening following the accident until 3 hours had passed and he had left the site.</td>
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<tr>
<td>Torcon Safety Program: Injury/Incident Investigations</td>
<td>Failed</td>
<td>Supervisors not participating in investigations and believe the investigations are the responsibility of the safety staff and not theirs, even though Torcon’s SHE Program clearly states that the supervisors are responsible for participating in injury investigations.</td>
</tr>
<tr>
<td>Torcon Safety Program: Training</td>
<td>Failed</td>
<td>Supervisors believe toolbox training to the responsibility of the safety staff and not theirs, even though Torcon’s SHE Program clearly states that the supervisors are responsible for conducting toolboxes.</td>
</tr>
<tr>
<td>Hazard: Mechanical Impact</td>
<td>Target: Laborer</td>
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<tr>
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<td>----------------</td>
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</tr>
<tr>
<td><strong>What were the barriers?</strong></td>
<td><strong>How did the barrier perform?</strong></td>
<td><strong>Why did the barrier fail?</strong></td>
</tr>
<tr>
<td>Torcon Safety Program: Daily Job Site Inspections</td>
<td>Failed</td>
<td>Torcon’s Job Site Daily Inspection Records were not being completed daily by all subcontractors as required in Section 23 of Torcon’s SHE Program. In addition, those records were being improperly completed in most cases.</td>
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<tr>
<td>Training on unintentional contact with mobile equipment and personnel</td>
<td>Functioned</td>
<td>Did not fail</td>
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<tr>
<td>NSLS-II ES&amp;H Management Plan: Construction Safety Inspections</td>
<td>Failed</td>
<td>NSLS-II Construction Safety Inspectors did not document all findings, and reports were not properly processed or completed as required in BSA’s Construction Safety Subject Area, the Contract.</td>
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<tr>
<td>Fitness for duty (as required by contract) capability to do task (pre-arrival drug screening)</td>
<td>Functioned</td>
<td>Did not fail</td>
</tr>
<tr>
<td>General, across site: high visibility garments</td>
<td>Functioned</td>
<td>Did not fail</td>
</tr>
<tr>
<td>Laborer supervision</td>
<td>Failed</td>
<td>Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely.</td>
</tr>
</tbody>
</table>
APPENDIX F  TAPROOT® ANALYSIS

Two Causal Factors were identified from the TapRoot® Analysis:

- Laborer in close proximity to load, and
- Rebar Layout (staging) Less Than Adequate.

TapRooT defines Causal Factors as any problem associated with the incident that, if corrected, would have prevented the incident from occurring or would have significantly mitigated its consequences.

Each TapRooT cause that was identified for the Causal Factor analyzed is keyed to the causal table found in section 4.0. The codes used are as follows: Direct Cause (DC), Root Cause (RC), and Contributing Cause to Program Weakness (CCW). Numbers following the codes indicate the specific causal factor found in Tables 3 and 4. This Appendix contains the Root Cause Trees that resulted from the analysis.

TAPROOT RESULT SUMMARY

Causal Factor: Laborer in close proximity to load

Training

Understanding Needs Improvement (NI)

Instruction NI - Torcon and its subcontractors failed to ensure their personnel were qualified for the work they were assigned. (RCE-1)

Testing NI - Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely. The Laborer had a skill and knowledge deficiency that should have been caught by verification and corrected before allowing him to perform this work. Lack of verification failed to ensure mastery of required skills, knowledge, and abilities to necessary perform the work. (RCE-1)

Continuing Training NI - Toolbox meetings topics were not always germane to the work hazards being encountered in the field. The continuing training program was inadequate. The toolbox training provided was not specific to tasks being performed. (CCW-2)

Management System

Oversight/Employee Relations

Audits & Evaluations (A&E) lack depth - Torcon and its subcontractors failed to ensure their personnel were qualified for the work they were assigned. (RCE-1)
Human Engineering

Work Environment

Housekeeping NI - Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely. The Laborer prepared an inadequate rebar staging area, which resulted in a trip and fall hazard. (RCE-1)

Work Direction

Selection of Worker

Not Qualified Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely. The Laborer prepared an inadequate rebar staging area, which resulted in a trip and fall hazard. (RCE-1)

Causal Factor: Rebar Layout (staging) Less Than Adequate

Training

Understanding NI

Continuing training NI - Toolbox meetings topics were not always germane to the work hazards being encountered in the field. The continuing training program was inadequate. The toolbox training provided was not specific to tasks being performed. (CCW-2)

Management System

Oversight/Employee Relations

Audits & Evaluations (A&E) lack depth - Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely. (RCE-1)

Work Direction

Selection of Worker

Not Qualified - Torcon, Macedos, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely. The Laborer prepared an inadequate rebar staging area, which resulted in a trip and fall hazard. (RCE-1)
TapRoot®
Root Cause Tree®
Incident: SC–BHSO-BNL-BNL-2009-0019, Construction Worker Suffers Broken Leg
Causal Factor: CF - Laborer in close proximity to load

START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

NATURAL Dis Hàng/ SUBSTAGE

START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

NATURAL Dis Hàng/ SUBSTAGE

START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

NATURAL Dis Hàng/ SUBSTAGE

START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

NATURAL Dis Hàng/ SUBSTAGE

START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

NATURAL Dis Hàng/ SUBSTAGE

START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

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START HERE with each causal factor/issue and select or eliminate each category to find root causes.

HUMAN PERFORMANCE DIFFICULTY

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HUMAN PERFORMANCE DIFFICULTY

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HUMAN PERFORMANCE DIFFICULTY

TOLERABLE FAILURE

DESIGN

EQUIPMENT / PARTS DEFECTIVE

PREVENTIVE / PREDICTIVE MAINTENANCE

ORDER (SECURITY)

NATURAL Dis Hàng/ SUBSTAGE

START HERE with each causal factor/issue and select or eliminate each category to find root causes.
BNL NSLS-II Accident Investigation

TapRooT® Root Cause Tree®

Incident: SC-BHSC-BNL-2009-0019, Construction Worker Suffers Broken Leg
Causal Factor: CF - Rebar Layout Less Than Adequate

TapRooT® Root Cause Tree® Basic Cause Categories

Procedures

- Not Listed: Not Followed
  - no procedure
  - procedure not available or inconvenient for use
  - procedure difficult to use
  - procedure use not required but should be

- Wrong
  - typo
  - sequence wrong
  - facts wrong
  - situation not covered
  - wrong revision used
  - second checker needed

- Followed Incorrectly
  - format confusing
  - > 1 action per step
  - excess references
  - multi unit
  - list

- Understanding
  - task not analyzed
  - task not to train
  - no learning objective
  - missed training

- No Training
  - task not reviewed
  - incorrect objective
  - lesson plan

- No Inspection
  - inspection not required
  - no hold point

- QC NI
  - inspection not performed
  - foreign material
  - equipment

Communications

- No Comm. or Not Timely
  - comm. system failure
  - site communication

- Turnover NI
  - no standard turnover process
  - turnover process not used

- Misunderstood Virtual Comm.
  - standard terminology not used
  - standard terminology NI
  - expect 2 back not used
  - long message
  - noisy environment

Management System

- Standards, Policies, or Action Controls
  - no SPAC
  - not strict enough
  - confusing or incomplete

- Safety/Compliance
  - comm. of SPAC NI
  - newly changed
  - enforcement NI
  - no way to implement
  - accountability NI

- Direct Action
  - corrective action NI
  - corrective action not yet implemented

Human Engineering

- Work Environment
  - housekeeping NI
  - tool
  - toolset
  - lights NI
  - noisy
  - obstruction
  - cramped quarters
  - equipment guard
  - high radiation / contamination

- Complex System
  - knowledge-based decision required
  - increasing too many bars

- Non-Fault Tolerant System
  - errors not detectable
  - errors not recoverable

Selection of Worker

- Safety
  - not qualified
  - work experience
  - no job training

- Selection of Worker
  - walk-in NI
  - scheduling NI
  - look out for cut NI
  - fall protection NI

Supervision/Teamwork

- not supervised
  - crew teamwork NI

NI = NEEDS IMPROVEMENT
May also substitute LTA (Less Than Adequate) or PFO (Potential Improvement Opportunity)
APPENDIX G  EVENTS AND CAUSAL FACTORS ANALYSIS

START

Laborer arrives at site and attends orientations. September 1, 2009

- Passed pre-employment drug & alcohol testing
- BSA Contractor Vendor Orientation
- Training/qualifications
- Torcon Project Safety Orientation

Operator arrives at site and attends orientations. September 16, 2009

- Passed pre-employment drug & alcohol testing
- BSA Contractor Vendor Orientation
- Training/qualifications
- Torcon Project Safety Orientation

Unions journeyman for several days

Laborer has limited construction experience

Only training record provided was OSHA 10 hour

Torcon, Macedo, and Rebar Steel supervision failed to ensure the laborer was qualified to perform the assigned work safely. (RCE-1)

35+ years of experience

Union card to operate Lull

Training current; has a card showing 32 hours of training; includes manual and a practical test on forklift operation

Also possesses static and sky crane operator licenses

Key Symbols

- Accident
- Transfer
- Event
- Condition
- Condition Causal Factor
- Event Causal Factor

CCE – Contributing Cause to the Event
RC – Root Cause
DC – Direct Cause

All events take place on September 30, 2009, except as noted.
Operator starts work by performing his daily inspection and setting of equipment 0645 hours

Lull in good working order

Pre-job briefings did not adequately address the hazards associated with the work being performed. Briefings are primarily concentrated on what work needs to be performed, not the associated hazards.

Operator and Laborer worked together numerous times

Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety (RCE-2)

Laborer marks rebar bundles to be moved by spraying them with orange paint

Laborer asks Operator to move rebar with Lull 0815 hours

Laborer, acting as a spotter, directs placements of aisle to seven loads moved

Operator begins to move material for carpenter 0700 hours

Rebar Steel Foreman directs Laborer to prepare rebar for movement by crane into form area

No pre-job discussion of hazards

Inadequate PHA for moving & staging rebar

Operator and Laborer worked together numerous times

Laborer wearing high-visibility clothing (according to witness)

No pre-job discussion of hazards

Torcon and its subcontractors failed to ensure workers were aware of foreseeable hazards and protective measures needed for their safety (RCE-2)
Laborer places cribbing for rebar to be placed onto

Laborer directs placement of two bundles moved into incident area

Laborer directs placement of two additional bundles (2,457 lbs, 23 pieces, 24'10" long)

As Worker 2 walks by, he sees Operator and Laborer working to lay down rebar 0835 hours

Lull stopped

Boom of the Lull extended to permit load to be placed

Laborer stands in front of two bundles of rebar, in front of the forks of the Lull

Inadequate placement of rebar created the tripping hazard

Two bundles at the same time

As directed by Laborer

Operator can clearly see Laborer’s hand signals

Operator has clear view of Laborer, but not of his lower legs, which are obstructed by the rebar bundles being carried on the Lull

Trench, Vacade, and Rebar Steel supervision failed to ensure the Laborer was qualified to perform the assigned work safely (RCE-1)
BNL NSLS-II Accident Investigation

Laborer directs load while walking backwards → Laborer signals Operator to place load → Operator tilts forks to place load → Load slides off the forks of the Lull → Laborer tries to move backward to move out of the way → Laborer steps backwards to move out of the way → Back of Laborer's foot contacts rebar behind him → Laborer in close proximity to load → Layout less than adequate → Contractor, Macelos, and Rebar Steel supervision failed to ensure the laborer was qualified to perform the assigned work safely (RCE-1) → Operator sees Laborer fall → Laborer trips over rebar → Page 5
Rebar strikes lower right leg between knee and ankle (DC-1) 

Laborer’s right lower leg is fractured 0840 hours  

Operator, in response to screams, picks up rebar bundle with the Lull  

Laborer rolls onto stomach  

Operator exits Lull to see if the Laborer is alright  

Worker 2, hearing scream, arrives at scene  

Worker 2 sees rebar above Laborer’s leg on Lull  

Worker 2 indicates to Operator that load is too close to Laborer  

Forks of Lull spear bundle and raise it
Ambulance leaves accident site with injured Laborer 0901 hours.

Ambulance picks up Advanced Life Support (ALS) Provider an route to Hospital 0915 hours.

ALS provider is waiting when Ambulance arrives at County Road 83 and the North Service Road of the Long Island Expressway.

Insignificant impact on arrival time at hospital.

BNL Security secures accident site.

Operator leaves BNL 0915 hours.

First missed opportunity to perform drug & alcohol screening.

Ambulance arrives at Hospital 0936 hours.

Drug/alcohol test not performed at hospital.
## APPENDIX I  BNL METEOROLOGICAL SUMMARIES FOR SEPTEMBER AND OCTOBER 2009

**BROOKHAVEN NATIONAL LABORATORY METEOROLOGICAL SUMMARY**

**MONTH SUMMARY FOR SEPTEMBER, 2009**

Run: 2009,10,01,14,24,45

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Mean Daily minimum temp = 52.1, Extreme minimum temp = 38.66 degF
Mean Daily maximum temp = 72.4, Extreme maximum temp = 83.30 degF
Month mean temp = 62.5 degF
Monthly maximum wind speed (90 m) = 42.7 mph
Monthly total precipitation = 3.18 inches
Month total Heat DDs (F) = 111.3 (F)
Month total Cool DDs (F) = 29.0 F
Month mean insolation = -999.0 W/m^2

$\text{NOTE}$$ After a calibration on the 85 meter temperature sensor a -2.2 degree offset was added to the Campbell program and the new program was installed at 1420 on 09/23/09.

Definition: Heat degree day = MxMnAv - 65 (degF). Cool deg day = 65 - MxMnAv (degF). If deg day < 0, set deg day to 0.0. 65 degF = 18.3 degC
Ref: "The Urban Climate" by Helmut E. Landsberg

Temperature min/max based on 1-min averages
Wind gust based on 1-min extreme data
### BROOKHAVEN NATIONAL LABORATORY METEOROLOGICAL SUMMARY

**MONTH SUMMARY FOR OCTOBER, 2009**

**Run: 2009,10,22,13,56,55**

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</table>
Mean Daily minimum temp = 42.5,  Extreme minimum temp = 30.20 degF
Mean Daily maximum temp = 61.4,  Extreme maximum temp = 75.56 degF
Month mean temp = 52.1 degF
Monthly maximum wind speed (90 m) = 51.7 mph
Monthly total precipitation = 2.99 inches
Month total Heat DDs (F) = 276.2 (F)
Month total Cool DDs (F) = 2.3 F
Month mean insolation = 42.7 W/m^2

Definition: Heat degree day = MxMnAv - 65 (degF).  Cool deg day = 65 - MxMnAv (degF).  If deg day < 0, set deg day to 0.0.  65 degF = 18.3 degC
Ref: "The Urban Climate" by Helmut E. Landsberg

Temperature min/max based on 1-min averages
Wind gust based on 1-min extreme data
Missing data = $missing, signifies > $
## APPENDIX J  DESCRIPTION OF RADIO TRANSMISSIONS

Radio Transmissions at BNL on September 30, 2009 that concern the NSLS-II Accident

(Note: there is approx. a two-minute difference in the time logged by the system and the actual time.)

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<th>Time logged</th>
<th>Description of Call</th>
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<td>8:45:21</td>
<td>Leg injury, possible serious injury at NSLS-II</td>
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<tr>
<td>8:46:17</td>
<td>Rescue 4 on route to NSLS-II; fire captain contacted fire rescue to request Motor Pool expedite Ambulance and get it back to fire rescue as soon as possible</td>
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<tr>
<td>8:47:09</td>
<td>Fire Captain speaking...[cannot understand]</td>
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<td>8:47:21</td>
<td>Captain‡ is at the entrance to NSLS-II</td>
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<td>8:47:59</td>
<td>Captain is looking for confirmation of exact location; fire rescue confirmed it's on the west side by Princeton</td>
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<td>8:48:31</td>
<td>Captain said he is on scene at 8:46.</td>
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<td>8:48:43</td>
<td>Ambulance on route and Rescue 4 on scene [general area]</td>
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<tr>
<td>8:49:03</td>
<td>Captain contacted Rescue 4; specific directions</td>
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<td>8:49:33</td>
<td>Captain called Fire Rescue; standby</td>
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<td>8:49:51</td>
<td>Captain transmits what kind of injury the patient has: male with compound fracture to right leg; fire rescue repeats &quot;all units be advised compound fracture...&quot;; tells fire dispatcher that he needs aviation; fire dispatcher asks if captain wants him to handle it or if he will; Captain replies that he will handle it [contact Fire Rescue and Suffolk for helicopter]</td>
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<tr>
<td>8:51:21</td>
<td>Captain calling police headquarters [PDHQ]</td>
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<td>8:51:31</td>
<td>Captain calling police headquarters [PDHQ]</td>
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<td>8:51:42</td>
<td>Captain calling police headquarters [PDHQ]</td>
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<td>8:52:08</td>
<td>PDHQ responds</td>
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<td>8:52:36</td>
<td>Fire Rescue to Captain: asks if he wanted an engine to stand by at the landing zone; Captain says yes and to notify police that this will leave the base unmanned; Captain says that he will call Fire Rescue [Emergency Services, Suffolk County, Yaphank] to get an ETA of the bird.</td>
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<td>8:53:17</td>
<td>Fire House calls Captain to say that he has two firefighters in quarters, would he like him to stay on radio [indicating that base is not unmanned]; staying on radio</td>
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<td>8:53:55</td>
<td>PDHQ calls Captain</td>
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<td>8:54:12</td>
<td>PDHQ requests confirmation that Captain is calling for helicopter so he does not have to</td>
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‡ “Captain” in this document refers to Fire Captain.
8:54:36 Captain asks PDHQ that an ORPS Coordinator respond to the scene
8:54:53 Confirmed 8:53; Engine 2 going to PDHQ [for helicopter landing]
8:56:29 Engine 2 on scene [at the landing zone]
8:58:46 Police asks Fire if they got the page; says standby
9:00:32 Police says “go ahead Fire” (phone rings)
9:00:51 OK Fire, thanks
9:01:01 Ambulance [Unit 16] signaled to Stony Brook [this means they are on route to Stony Brook University Medical Center (Stony Brook)]
9:01:21 Fire calling Ambulance [no response]
9:01:35 Fire Rescue asks Captain if they are transporting patient via ground; Captain replies “yes”.
9:02:52 Fire to Engine 2
9:03:09 Fire to Engine 2
9:03:18 Engine 2 responds he read [the transmission] direct and he is returning to quarters
9:04:43 Captain: ES 2 and Rescue ok to return to quarters; Ambulance signal 18 [this means “on route”] to Stony Brook; Captain will wait on scene for the ORPS categorizer; Fire says OK; 34 later [phone call]
9:06:11 Rescue is returning to quarters
9:09:07 Captain informs Ambulance that it was 2,400 pounds of steel [that caused the injury]
9:14:08 Fire calling Ambulance asking for crew [names]
9:14:25 Ambulance provides names
9:14:48 [More about crew]
9:15:25 Ambulance picked up a first responder [from Farmingville Fire House]
9:27:55 [not related to this investigation]
9:28:32 [not related to this investigation]
9:36:21 Confirmed 9:34: Ambulance arrived at Stony Brook
9:52:11 Captain tells Fire Rescue that he is leaving the scene
10:04:43 Ambulance calling BNL Fire Rescue; leaving Hospital, on route back to BNL; needs to drop off first responder where he was picked up
10:29:32 At exit 68 of LIE; should be there in a couple of minutes; have somebody with a broom stand by to clean the Ambulance because it needs to get back to the Motor Pool right away
10:43:31 Dropping off Ambulance at Motor Pool
APPENDIX K    DESCRIPTION OF CALL TO BNL EMERGENCY REPORTING NUMBER

Date
September 30, 2009

Time logged
8:44:13

Description of Call
The Safety Manager for Torcon reports an injury that needs an ambulance; injury to leg, perhaps seriously, of one of our workers. He also reports the location: Vehicle tunnel, NSLS-II, west side of project; Princeton Avenue; at entrance in gate, take road to the left. Responder replies: We're on our way.
October 9, 2009

Brookhaven National Labs NSLS II
Attn: Investigation Committee

Re: [Redacted]
SSN: [Redacted]
Date of Employment: 9/2/09

To Whom It May Concern:

[Redacted] has been employed by Rebar Steel Corporation for the Brookhaven National Labs NSLS II project since September 2, 2009. Mr. [Redacted] experience prior to working for Rebar Steel is as follows:

- **Yardman**
  - Moved and disbursed reinforcing steel to different locations.
  - Construction, dismantling and knockdown of shanties on both hi-rises and infrastructures.
  - Mechanic for small engines.
  - Operated forklift – Lifting of materials in the shop yard.
  - Operate and maintain diesel powered stud welding machine.
  - Shoots metal shear studs into Q decking of superstructures.
  - Taught hand signals by job super.
  - OSHA 10 hour Certificate
  - Weekly Tool Box Talk

It is our understanding that Mr. [Redacted] also worked with his father since the age of fourteen at a beverage center operating a hi-low. In addition Mr. [Redacted] has attended college for a period of time. Thank you.

Very truly yours,

Teresa Smith,
President
APPENDIX M  REFERENCE DOCUMENTS

- Investigation Team Charge Memo
- Memo, G.S. Podonsky to M. Holland, October 7, 2009, Waiver of Type B Accident Investigation

Section 1: Contracts and Procedures

BNL/NSLS-II

- Final Hazard Analysis Report for NSLS-II
- NSLS-II ES&H Procedures
- BNL/Torcon Contract
- Final Report – Assessment of BNL NSLS-II Project Training Requirement
- NSLS-II ESH Monthly Meeting Minutes
- Environment, Safety, and Health Plan for the NSLS-II
- NSLS-II Construction Environment, Safety and Health Plan for Conventional Construction of the Ring Building (LT-ESH-0006/rev 1, April 2009)

Torcon

- Torcon Safety Violation Log
- Torcon Labor/Management Safety Committee Meeting Minutes (meetings #20, 9/10/09; #21, 9/17/09; #22, 9/24/09)
- Torcon Organization Chart for the NSLS-II Ring Building Construction
- Torcon Master Badge List (Names in red indicate those who have been disciplined or discharged for cause)
- Torcon NSLS-II Project Safety Orientation, Rev. 6, September, 2009 (Section 10 describes pre-employment drug testing)
- Torcon Project Orientation and General Safety and Health Rules (page 6 describes drug testing for cause). Each employee must sign an acknowledgement following training.
- BSA’s Torcon Assessment Schedule
- Resume of Tom Moon, Torcon Site Safety Manager
- Torcon Safety Incentive Program
- Torcon Corporate Policy, Drug-free Workplace Policy; Excerpt from Torcon Project SH & E Program regarding Drug-free Workplace Policy; and Procedures regarding Drug Collection
- Torcon Project Safety, Health and Environment Program (Original, Rev. 2 and Rev. 3)

Macedos

- Various Tool-Box training sessions conducted by Macedos
- Macedos Construction Lull Service Records
BNL NSLS-II Accident Investigation

- Lull Technical Brochure and Specification Sheet
- Daily Inspection Service Log for Lull

Other

- NY State Dept. of Health, Bureau of Emergency Medical Services, Policy Statement (Advanced Life Support) and F&O SOP Emergency Medical Services (EMS) Program, FR-EMS-3.00, Rev. 5, effective 12/12/07

Section 2: Reports prior to the Accident

- Internal Audit and Oversight Report, IO 09-07 Phase I, NSLS-II Construction Safety Program Review, Phase 1, 8/26/09
- Various e-mails between Torcon and BNL involving safety observations
- Various Phase Hazard Analyses
  - Rebar Steel – installing rebar and wire welded mesh
  - Macedos – Crane Operations
  - Macedos – DOCA Formwork using lifting clamps
  - Macedos – Installing Monuments
  - Macedos – Ring Tunnel Footings
  - Macedos – Project: All Footings
  - G.E. Modular – Install. of Project Office Trailers
  - Voller Ex. & Const. – Silt Fence Installation
  - Voller/Advanced Env. Services – Removal of Underground Transite Pipe (pre-existing)
  - Rebar Steel – Fabrication of Rebar
  - GLS Elec. – cad Welding Footings
  - Macedos – Heat Exposure
  - Macedos – Formwork Mockups
  - Macedos – “Other Contractor” Exposure
  - Macedos – Crane Operations: Vehicle Tunnel Formwork
  - Macedos – Pre Mobilization/New Hires
- Reports of Accidental Injury or Occupational Disease
  - 9/30/09: Lather, Rebar Steel, right leg (Torcon, Rebar Steel, and Pembroke reports)
  - 9/28/09: Carpenter, Macedos, right calf muscle (Torcon report only)
  - 9/21/09: Laborer, Macedos, left ankle (Pembrooke report only)
  - 9/2/09: Lather, Rebar Steel, left elbow (Torcon and Pembroke reports)
  - 8/13/09: Manager, Torcon, right calf muscle (Pembrooke report only)
  - 8/13/09: Concrete, Macedos, left arm (Pembrooke report only)
  - 8/10/09: Laborer, Voller, nosebleed (Pembrooke report only)
  - 8/7/09: Inspector, BNL, left and right knee (Pembrooke report only)
  - 8/5/09: Lather, Pratt Brothers, left forearm (Torcon and Pembroke reports)
  - 7/27/09: Eng., Voller, right elbow (Pembrooke report only)
  - 7/16/09: Electrician, Hinck Electric, chipped tooth (Torcon and Pembroke reports)
  - 4/16/09: Trailer Installer, Modular Dimensions, right heel (Torcon report only)
- E-mail dated 4/16/09 from M. Fallier to various re: heel injury
- E-mail dated 4/22/09 from M. Fallier to various re: Torcon Safety Concerns
- Notice to proceed with Ring Building construction – 3/25/09
- Series of e-mails regarding Work Observations at NSLS-II site on 4/20 & 4/21/09
BNL NSLS-II Accident Investigation

- Report from PTI to Leon Baukh, dated 9/9/09, BNL NSLS-II Ring Building General Loss Control Service Visit on 9/3/09
- Daily Inspection Reports, conducted by BNL, January – August 2009
- Liberty Mutual Report, dated, 9/2/09, of visit to NSLS-II Construction Site on 8/19/09
- Liberty Mutual Report, dated, 9/29/09, of visit to NSLS-II Construction Site on 9/10/09
- Allied North America, site visit conducted July 24, 2009
- Torcon Daily Jobsite Safety Inspections
- Project Safety Evaluations

Section 3: The Accident

- BNL weather summaries for September 30, 2009
- Fact finding meeting notes taken by NSLS-II Construction Safety Inspectors – September 30, 2009
- BNL Fire/Rescue Report
- Torcon (Pembrooke) Incident Report
- Torcon Report of Accidental Injury, preliminary
- Statement of Laborer (injured party)
- Letter from Rebar Steel dated 10/9/09 – Experience of Laborer
- Laborer Training History
- Results of Drug Test for Laborer and Operator
- Witness statement by Operator, including training records and list of persons in attendance during his statement
- Forklift Training Program and Certification for Operator
- Witness statement by Laborer2, Macedos Construction
- Witness Statement by Laborer3, Macedos Construction
- Witness statement by Pembroke EMT
- Witness statement by BNL Fire/Rescue Captial
- Statement by BNL EMT Response Team
- Response from BNL Fire/Rescue – Statement of Medical Response Personnel
- Photo Log
- Photographs of scene – post accident
- Photographs taken from the HFBR stack at 8:30, 8:45, and 9:00 A.M.
- Photographs taken 10/5/09 at scene of accident
- Topographical survey – Lull and rebar site (site of accident of 9/30/09), dated 10/7/09
- Rebar Steel Accident Report

Section 4: Post-Accident Data

- Torcon Safety Stand-down memo (including attendance sheet)
- Letter dated 10/2/09 – Torcon Measures in Response to 9/30/09 Accident
- Torcon Safety Stand-down meeting, 10/2/09
- Corrective Action and Restart Plan dated 10/7/09
- Minutes of Morning Safety Meeting, 10/9/09
- Hand Signals Tool Box, 10/14/09
- Phase Hazard Analyses for rebar handling with a forklift and for unloading rebar from trucks (including attendance sheet)
- Signed PHAs (2) for movement of rebar, Rev. 7, 10/7/09
- Photos of rebar demonstration using approved PHAs
• Authorization to restart mechanical rebar operations
• Two lift plans: (1) DOCA Formwork using crane; (2) installation of steel columns at vehicle and utility tunnels
• Interview with Macedos Construction on 10/7/09
• Interview with Torcon Construction on 10/8/09
• Interview with Rebar Steel Supervision on 10/13/09
• Safety Observations, LSII Project, Accident Investigation Committee Member, 10/12/09
• Field Observations Summary, Accident Investigation Committee Member, 10/15/09
• Memo dated 10/15/09, requesting additional information, and answers provided
• Torcon, Inc. Safety Status Report #1, 10/16/09
• Internal Audit and Oversight Report, 10 09-07 Phase 2, NSLS-II Construction Safety Program Review, Phase 2, 10/21/09 Draft
• Copy of Worker Safety and Health Management System Description, SBMS, printed 10/21/09
## APPENDIX N  ACCIDENT INVESTIGATION COMMITTEE MEMBERS

<table>
<thead>
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<th><strong>Member</strong></th>
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