Heavy Flavor Tracker (HFT) Upgrade to the STAR Detector at Brookhaven National Laboratory

MIE-01VB

Preliminary Hazard Analysis

Lead Program Office:
Office of Nuclear Physics
Office of Science
Brookhaven Site Office
U.S. Department of Energy

October 5, 2009

Submitted by:

D. Beavis, HFT Safety Coordinator
Brookhaven National Laboratory

10/21/09
Date

F. Videbaek, HFT Project Manager
Brookhaven National Laboratory

10/21/09
Date

Concurred by:

P. Sullivan, ES&H Team
DOE Brookhaven Site Office

10/22/09
Date

Approved by:

N. Narain, HFT Federal Project Director
DOE Brookhaven Site Office

10/22/09
Date

Revision History

Revision No.	Description / Pages Affected	Effective Date
Rev 0	Draft document for CD-1	October 2009

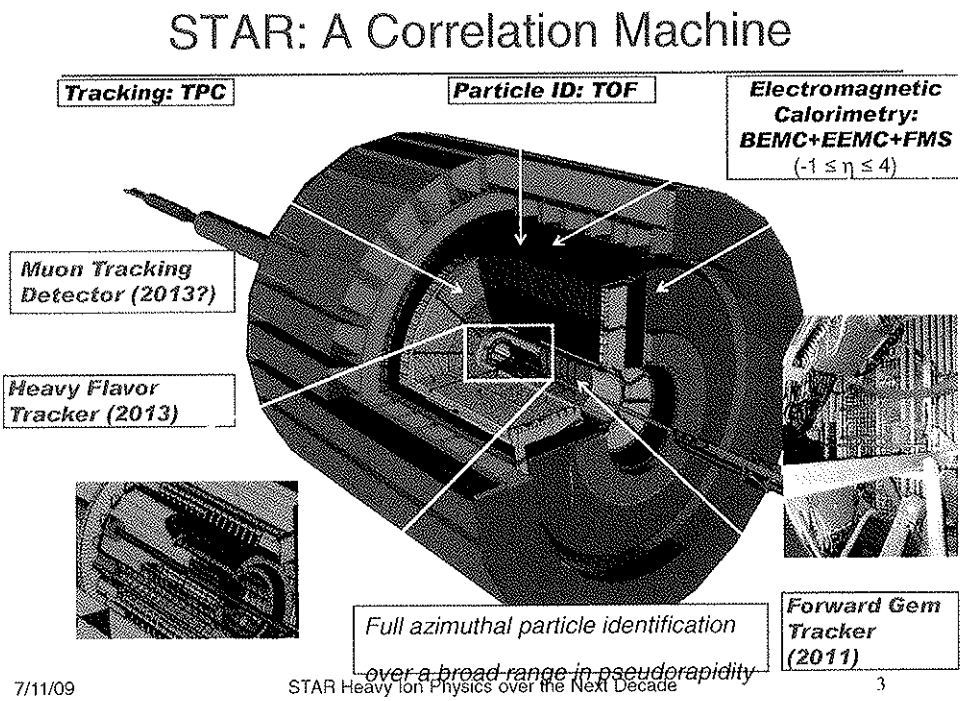
Table of Contents

1 Introduction

The STAR detector is one of two operating experiments at Brookhaven National Laboratory's (BNL) Relativistic Heavy Ion Collider (RHIC). STAR has an extensive and successful research program studying the behavior of quark-gluon matter under conditions that occurred in the early universe before it expanded and cooled into the hadronic phase that now exists. The experiment has made extensive measurements for Au-Au, Cu-Cu and d-Au collisions up to energies of 100 GeV per nucleon. The nearly complete coverage of the STAR detector systems make it ideally suited for global characterization of events and studying event-by-event measures such as flow. STAR also has an extensive research program to understand the fundamental source of the proton spin by using the available polarized proton beams up to a beam energy of 250 GeV. Several unexpected and exciting results have come from both research programs. The accelerator is continuously being upgraded to provide the experiments with new research opportunities. The experiments require concurrent upgrades to be able to pursue these new opportunities.

More details of the STAR Detector and the research programs can be found at:
http://www.star.bnl.gov/

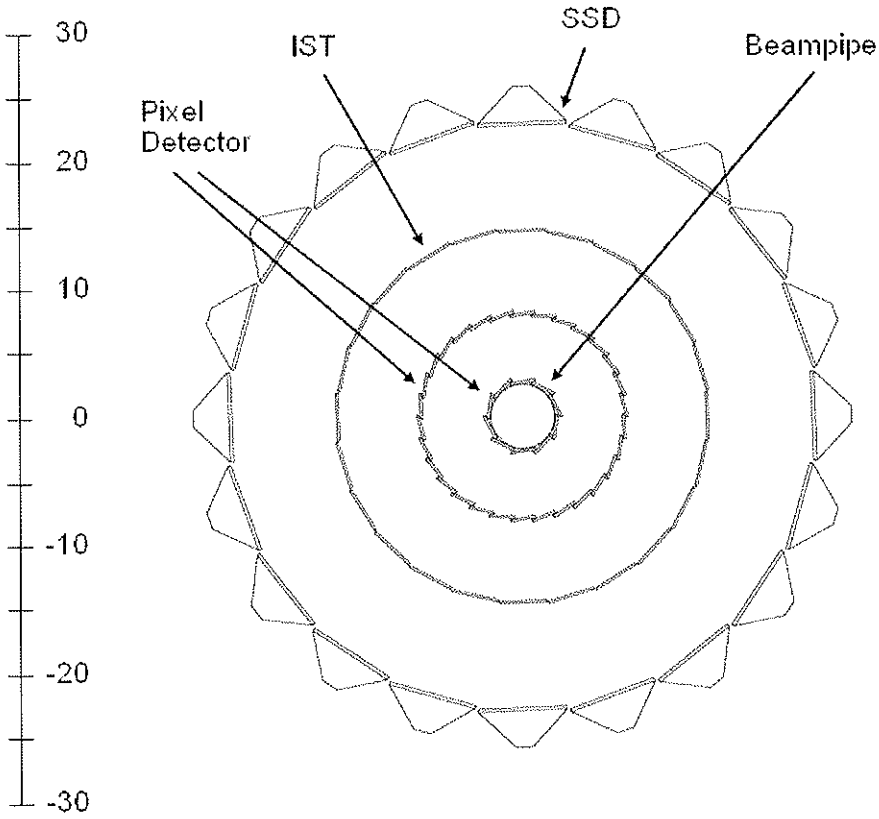
STAR detector systems with some future upgrades are shown below in a talk by J. Dunlap at the STAR analysis meeting in July 2009.



The research program for ion collisions at RHIC is moving from the "discovery phase" into a systematic study of the properties of strongly interacting quark-gluon matter created in the early stages of the ion-ion collisions. Systematic studies and the measurements of rare processes

require the RHIC machine to have higher luminosity and the experiments to handle the associated higher collision rates. The HFT upgrade will explore several topics but its primary goal is the study of D^0 production through topological reconstruction of the decays via $D^0 \rightarrow K^- Pi^+$. The short lifetime of the heavy charmed mesons are of the order of 50 microns so that vertex resolution of order $20*10^{-6}$ meters (20 microns) is required to resolve the decay vertex from backgrounds. The present STAR detectors have a decay vertex resolution on the order of 1000 microns. To achieve the desired resolution requires that a system be constructed with thin materials close to the beam collision point, the innermost detectors must be close to the beam pipe and have very good special resolution, and the detectors must be able to handle the interaction rate and high density hit environment near the beam pipe.

A proposed system of detectors that meets the stringent requirements is show below. The vertical scale is in cm. The basic system is a series of detectors including two layers of pixel detectors, one layer silicon strips (IST), and a final layer of a silicon drift detector (SSD) which exists but is having its readout upgraded. These detectors are buried inside the main STAR detector system as depicted below.



Personnel safety and protecting the environment are high priorities for the HFT Project. This Preliminary Hazard Analysis Document (PHAD) is intended to identify those aspects of the Project that present potential hazards to project personnel, the environment, existing pieces of the experiment, or the public at large. By determining the categories and analyses used for those hazards, the document will show how each of them can be mitigated. All of the hazards that will be encountered are presently encountered in the operating experiments at RHIC and specifically

at STAR. The hazards associated with existing detectors or facilities are not in the scope of this document except to how the HFT integrates with such systems. The PHAD addresses the hazards associated with the prototyping, assembly, installation, testing, and operation of the HFT upgrade to STAR.

The HFT Project has substantial experience safely designing, installing, and operating experiments and detector systems at BNL. Much of this experience has been at the STAR experiment itself. This experience provides for a basis that will aid the completion of this project with an excellent safety record.

The scope of this PHAD covers all HFT equipment and work that is to be conducted at the STAR Detector at BNL. It does not cover work or equipment used at participating universities and laboratories. The safety and hazards analysis for those activities is covered by the safety organization for the institution where the work is conducted. Most of the principal institutions have substantial project experience and safety organizations. The HFT Project Office is available to help participating institutions with hazards that they are not familiar analyzing.

2 Approach

Safety and environmental issues need to be identified and addressed early to provide for adequate planning and implementation of mitigation measures. Early identification and planning facilitate safe operation and reduce the open safety issues during the project. Proper Integrated Safety Management (ISM) implementation ensures that planning, design, and physical work are performed with proper attention to potential hazards, regardless of the type of activity being performed. In effect, the ISM functions to optimize task planning and performance to enable those closest to the task - those who perform the task, those who manage or supervise the task, and those who will be affected by the results of the task – to plan and assume responsibility for it.

The HFT Project has a Safety Coordinator to manage safety within the project and improve ISM. The safety coordinator will keep the STAR management apprised of issues related to HFT but has the full authority of the Project and STAR Collaboration to handle safety for the HFT Project. Each HFT Level II subsystem will have the subsystem manager or another person designated as the subsystem safety contact. These contacts will work with the safety coordinator to ensure that the detectors are designed to meet the required standards. The safety coordinator along with the subsystem safety contact will prepare and present materials to the appropriate C-AD (or BNL) safety review committees for review. Both system designs and work practices will be reviewed.

The HFT upgrade for STAR will use the BNL Standards Based Management System (SBMS) to identify and control hazards for all equipment and work at BNL for the HFT. The Physics Department and the C-AD have review processes that comply with the BNL SBMS. The project will prepare designs and work procedures and have them reviewed by the appropriate laboratory or department review committees. Testing of equipment in Physics Department will go through the Experimental Safety Review (ESR) process (see http://www.phy.bnl.gov/~safety/ESRs/). The equipment and work practices used at STAR will be reviewed by the C-AD Experimental Safety Review Committee (ESRC). The reviews of the ESRC are covered in C-AD Operations

procedures manual (OPM) chapter 9 section 2. In addition, it has become customary for experiments to use the C-AD OPM 13.6.1.a "Design Review Questionnaire" and the Accelerator Safety Section Review Committee's (ASSRC) hazard identification tool, which is linked via the Design Review Questionnaire.

The following links are provided so that the reader can access these web sites and examine the review processes:

SBMS→https://sbms.bnl.gov/

Physics Department ESR→http://www.phy.bnl.gov/~safety/ESRs/

C-AD OPM 9.2.1→http://www.c-ad.bnl.gov/ESSHQ/SND/OPM/Ch09/09-02-01.PDF

C-AD OPM 13.6.1.a→http://www.c-ad.bnl.gov/ESSHQ/SND/OPM/opm_chapter_13.htm

C-AD Haztool→http://www.c-ad.bnl.gov/ESSHQ/SND/C-AHazardTool/screen.html

3 Hazard Analysis

3.1 Initial Hazard Analysis

The SBMS includes tools for hazard analysis and work control practices. A hazard analysis questionnaire has been developed for the BNL Collider-Accelerator Department (C-AD) to identify safety issues early in the design. In addition the C-AD has a hazard analysis tool for additional analysis of potential hazards. The Hazard Analysis Tool will be used to document hazards in work activities and equipment design. The Level 2 managers or their designees will use the Hazard Analysis Tools to provide the Safety Coordinator with the information necessary to review all equipment and activities.

The C-AD hazard assessment tool was distributed to each U.S. detector subsystem manager for completion. This tool is a version of the BNL SBMS hazard assessment tool, which was modified by the BNL Collider-Accelerator Department. The hazard assessment tool has 15 main questions that cover various categories. When a user answers yes to the question a list of sub-questions appear that the user must answer. Each sub-question has a predetermined hazard rating which is assigned. The tool provides a list of notes and standards for the users to examine to avoid or mitigate the hazard. The results of the hazard assessment tool for each subsystem are given in the appendices I to IV.

Examination of the initials answers demonstrates that the hazards are low. The only higher hazard is in system integration and is related to the beryllium beam pipe. The beam pipe is not part of the project but Project personnel will be assembling the beam pipe into the HFT detectors. Personnel will also be working in close proximity to the beam pipe. To mitigate the Beryllium hazard the pipe is coated with a protective coating similar or identical to the existing RHIC beam pipes. The Be section cannot be touched on the inside. It is expected that when reviewed that the work around the beam pipe will not be rated as a class 3 hazard.

All jobs performed at BNL require work planning. The HFT integration subsystem manager will work with the STAR Work Control Coordinator for the planning of all work at the STAR IR. The appropriate L2/L3 manager will communicate the work needs of the subsystem to the HFT integration manager and the STAR Work Control Coordinator. The work orders will be written and contain the following information:

- A description of the potentially hazardous activity
- Scope of the task
- List of Personnel
- Special Equipment required
- Description of safety concerns
- List of PPE for identified portions of the task
- List of work procedures used.
- Special permits (LOTO, working hot, critical lift, etc.)
- A sign-off by the Work Control Coordinator
- A sign-off by the safety coordinator as necessary

Once the work is authorized to proceed, the work order will be reviewed with the employee prior to performance of the associated activities. If the hazard of the work is sufficiently high then BNL work permits may be required. This will be determined during the review progress of the work planning.

3.2 Periodic Activity Hazard Review

As required by Integrated Safety Management (ISM), the ongoing design, assembly, installation and operation of HFT at STAR will be reviewed on a regular basis to identify any necessary changes or additions to the identified job hazards and the associated mitigation procedures. The C-AD conducts quarterly tier 1 reviews of the experimental area. Members of STAR participate in these reviews and take corrective actions as determined by the review team. The ESRC conducts yearly reviews and walkthroughs of the RHIC experiments with representatives from STAR and generates a corrective action list.

4 Identification of Hazards

The Project will work with the appropriate C-AD committees to review and mitigate hazards. The initial responses to the hazard analysis tool have been sent to the C-AD Safety Section Head, the Chair of the C-AD Experimental Safety Review Committee, and the C-AD Associate Chair for ESSHQ. A brief description of the hazards for HFT is given below by category.

4.1 *Electrical*

The C-AD department will review all changes to the AC power distribution required for the HFT. These changes will be done by BNL electricians and follow the National Electric Code (NEC)(NFPA70 and 70E). Low power DC systems will be installed by the experiment and also

follow the NEC where appropriate. The ESRC will review the DC power supplies, fusing, and cabling to mitigate the chance of shock or fire. The experimenter will only work with live voltages consistent with worker planned work for physicists. Any work with DC voltages above 50 V will be reviewed with the C-AD safety section and the ESRC. The solid state detectors typically use voltages less 100V to bias the detector.

Electronics for the detectors will be located on the south platform whenever possible. The standard STAR racks systems including smoke detectors, water cooling, AC breakers, and power interlocks will be used whenever possible. Some of the electrical systems distribute power to locations where there is a possibility for P10 to leak from the Time Projection Chamber (TPC). If electrical systems are within this zone they are required to be interlocked by the flammable gas detector system. Although the US Department of Transportation (DOT) does not classify P10 as a flammable gas the RHIC Experimental Safety Review Committee (ESRC) treats it as one. The gas from the TPC could leak into the region of the HFT detectors and electronics and therefore the power to the electronics and detectors will be interlocked to the flammable gas detectors as required by the C-AD (ESRC).

Electrical devices are required to be rated by a Nationally Recognized Testing Laboratory (NRTL) when available. Electrical devices that are not available as NRTL will be evaluated by BNL Electrical Equipment Inspectors (EEI) for NRTL equivalency.

4.2 *Mechanical*

There are few mechanical hazards related to the detectors. The movement mechanism of the pixel insertion device will be reviewed by the ESRC for pinch hazards. The tooling to assemble the HFT and install the HFT into STAR will be reviewed for mechanical hazards.

An air blower system will be used to provide cooling for the pixel detector. Air will be drawn from the IR and filtered (HEPA) to remove dust. It will then be blown over the pixel detector to remove heat and then discharged into the IR air space. The temperature increase of less than 10^{o} C is expected. The noise generated by the blower system is approximately 65dB. The SSD will use an air blower system with an expected noise level on the order of 80 dB. The noise levels will be reviewed by the C-AD Safety Section and appropriate actions taken to reduce levels to acceptable OSHA compliant levels. The system will be reviewed for any mechanical hazards.

The HFT detectors are very light weight. The assembly process will be examined for possible pinch hazards that may exist in the final assembly process. It is premature to examine these now.

Mechanical hazards that exist for moving the STAR magnet assembly for access into the magnet volume already exist and are not new to the HFT project. The processes will be examined for mechanical hazards when the HFT design is more complete.

4.3 *Chemical*

There are few chemicals used for HFT. A list of materials, epoxies, and solvents will be gathered and given to the ESRC for review. MSDS will be obtained for the materials and made available

to both the review committees and the workers. All chemicals used onsite will be entered into the BNL Chemical Management System (CMS). Epoxy for bonding parts is expected to be used in the construction. Some solvents will be used for cleaning.

4.4 *Lasers*

Lasers will be used on boards as part of the fiber optics communication. These are Class 3 lasers that drive the optical fibers. These are typical for modern communications systems and will be reviewed by the ESRC. Similar systems are already in use at STAR.

4.5 *Gases*

There are no compressed or special gasses used by HFT.

4.6 *Cryogenics*

The HFT has no plans to use cryogenic fluids.

4.7 *Waste/releases*

Assembly and installation of HFT may generate a small quantity of waste from the use of epoxy and cleaning solvents. These wastes will be disposed of following the appropriate procedures used at BNL. Empty containers will be disposed of properly.

4.8 *Radioactivity*

The detector subsystems are expected to use weak (unaccountable) sealed radioactive sources for testing the detectors. The sources will be registered with the department where they are used and will be under the supervision of the STAR source custodian. Existing sources will be used when possible. The experiment will not remove the sources from BNL.

Components of the HFT are not expected to become activated by the beam or secondary particles. The STAR IR is not an activation area. However, as this will represent the first time detectors are placed this close to the beam the initial removal of components will be activation checked. The C-AD Liaison Physicist will work in conjunction with the C-AD Safety Section and the C-AD Radiation Control Division Representative to develop a plan for the careful activation checking of items close to the RHIC beam before removal from the IR. The experimental IRs at RHIC will not be reclassified as activation areas. If activation near the beam pipe becomes an issue then a small area around the beam pipe will be placed under administrative control and appropriately posted.

4.9 *Work Practices*

The principle hazard introduced by HFT is the work. This hazard is reduced to acceptable levels by the work planning program as detailed in the BNL SBMS. The work control coordinator plays a pivotal role in a successful work program. Much of the work will be worker planned work. This is low hazard work that is considered in the "skill of the craft" of the worker. The worker is expected to recognize hazards related to his craft and work safety. He is expected to understand the limitations of what is classified as low hazardous work for his craft and seek additional hazard analysis when it is above the allowed level. Most hazardous work will be conducted by reviewed work procedures and work permits.

The initial assembly is planned to be conducted in the existing small assembly area on the IR assembly floor. This area will provide the workers with a clean, comfortable, and easy to work area. Some work will need to be conducted on the STAR detector such as the cable routing from the racks to the detector locations. Some of this work is conducted at elevated working heights. Man-lifts and scaffolds will be used to aid in this work. Only trained personnel will be allowed to operate the man-lifts. Fall protection will be used following the SBMS subject area. A small amount of work may be conducted inside the STAR east pole tip. This area is classified as a Class IIa confined space

Training will be an important part of hazard mitigation. It is expected that the HFT effort at the STAR IR will not require any additional training for the average user or worker in the area. Specific tasks for the assembly, construction, and installation of HFT many require the worker to have additional training. These tasks will be identified and added to the JTA of the worker.

Appendix I

The completed hazard analysis tool for the pixel subsystem (WBS 1.2)

Collider-Accelerator Hazard Identification Tool

BNL

Collider-Accelerator Department

Operation Title: HFT-PIXEL
Point Of Contact:H. Wieman
Hazard Rating: 2

NOTE 1: If you have Adobe Acrobat PDF Explorer Bar installed on your browser, then you can print this page to a pdf file, which can be sent via email to others.

OR

NOTE 2: Select the whole output with 'ctl A', save to the clipboard with 'ctl C', and paste to Microsoft Word or other text file with 'ctl V'. Mail the file to others as needed such as the Chair of the ASSRC [currently JW Glenn: jglenn@bnl.gov].

Explanation of Rating::

A Hazard Rating of 0 indicates an operation with minimal risk
A Hazard Rating of 1 indicates an operation with low initial risk
A Hazard Rating of 2 indicates an operation with moderate initial risk
A Hazard Rating of 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk. Please ensure that you adequately address the magnitude of the hazard (i.e., quantity, duration, frequency, physical state) in your analysis.

The following questions were answered YES and are considered a hazard rating of 3:

The following questions were answered YES and are considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
7g. Does work require fall protection equipment (harness, lanyard)?
8c. Is it required for personnel to enter any Class 2A or 2B Confined Spaces?
11b. Will operation require work outside normal working hours?

The following questions were answered YES and are considered a hazard rating of 1:

3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?
3a. Does this operation involve handling of radioactive materials or sources?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7e. Will you be purchasing any ladders or scaffolds?
7f. Will this operation require any elevated work?
10. Does this operation involve: the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the use of equipment or apparatus not commercially available?
11. Will this operation require trained operators or close surveillance?
11c. Will this operation require the 2-person rule?

Notes:

- (3) Work with radioactive materials and source may require an RWP. Contact the FSS Representative.
- (3a) If your operation uses radioactive sources, inventories are required. Include isotope and quantity.
- (3f, 4d) Provide a list of all material being stored at Collider-Accelerator, and intended location.
- (6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training.
- (6d) Devices that are not commercially available must be certified by the Chief Electrical Engineer
- (7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. If you would like to add your equipment to the facilities annual request for these services, notify Plant Engineering Maintenance Management.
- (7b) Forklifts, powered trucks, platform lift trucks, and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact your FSS Representative for more information.
- (7c, 7d) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer
- (7g) Personnel wearing fall protection equipment must be trained.
- (8c, 8d) Entrance into Class 2 Confined Spaces requires planning and training. Contact the ES&H Coordinator.
- (10) Please list the equipment that you are using outside of design specifications or manufacturer recommendations and/or locally built equipment in your analysis along with associated controls. Certification by the Chief Electrical and/or Chief Mechanical Engineer may be required.
- (11a) If your operation will be left unattended and it poses a hazard to individuals who may enter the area for whatever reason then you must ensure that the area is posted with the name of the contact and phone number along with associated hazards when unattended. This information and instructions for a safe shutdown should be included in the analysis for your operation.
- (11c) In your analysis delineate any tasks that require a two-person rule as a control.
- (11f) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required.

BNL Requirements and References:

Department Of Energy
OSHA Code of Federal Regulations
National Fire Protection Agency
American National Standards Institute
Institute of Electrical and Electronics Engineers, Inc.
American Conference of Governmental Industrial Hygienists
C-A OPM 9.2.1 Procedure for Reviewing Environmental, Health and Safety Aspects of and Experiment
C-A OPM 9.3.1 Procedure for Reviewing Conventional Safety Aspects of a C-A Accelerator System
DOE Order 420.2
BNL Radiological Control Manual
Radiation Protection Training and Qualifications subject area
Radiological Work Permits subject area
Radiological Dose Limits and Administrative Control Levels subject area
Entry and Egress Requirements for Radiological Areas subject area
Radiological Posting Requirements subject area (in development).
Radiological Protection Training and Qualification subject area
Release of Materials from Controlled Radiological Areas subject area (in development)
ALARA Program subject area
Issuing and Use of Personnel Monitoring Devices subject area (in development)
Radiological Stop Work Policy
Release of Materials from Areas Controlled for Radiological Purposes subject area
ALARA Program Subject Area

Labelling Documentation and Handling of Radioactive Material subject area
29 CFR 1910 Subpart S - Electrical Safety (29 CFR 1910.301-308)
ANSI National Electrical Safety Code (ANSI-C2)
NFPA National Electrical Safety Code (NFPA-70 and 70E)
ESH Standard 1.5.2 Design Criteria for Electrical Equipment
ESH Standard 1.5.1 Lockout/Tagout Requirements
ESH Standard 1.5.0 Electrical Safety
C-A OPM 9.3.4 Review and Approval of Electrical Equipment Built In-House (in development)
DOE Order 5480.4 Environmental Protection, Safety, and Health Protection Standards
C-A OPM 8.25 Material Handling and Lifting Safely; Equipment and Procedures
29 CFR 1910.178 Powered Industrial Trucks.
ESH Standard 1.6.0 Material Handling.
29 CFR 1910.66 Appendix C, Personal Fall Arrest System
ACGIH Threshold Limit Values and Biological Exposure Indices
Confined Space Subject Area
C-A OPM 8.14 Confined Spaces
C-A OPM 9.2.3 Procedure for Chief Engineers to Certify the Conformance of Devices

Appendix II

The completed hazard analysis tool for the IST subsystem (WBS 1.3)

Collider-Accelerator Hazard Identification To

BNL

Collider-Accelerator Department

Operation Title: HFT-IST
Point Of Contact: Gerrit J. van Nieuwenhuizen
Hazard Rating: 2

NOTE 1: If you have Adobe Acrobat PDF Explorer Bar installed on your browser, then you can print this page to a pdf file, which can be sent via email to others.

OR

NOTE 2: Select the whole output with 'ctl A', save to the clipboard with 'ctl C', and paste to Microsoft Word or other text file with 'ctl V'. Mail the file to others as needed such as the Chair of the ASSRC [currently JW Glenn: jglenn@bnl.gov].

Explanation of Rating::

A Hazard Rating of 0 indicates an operation with minimal risk
A Hazard Rating of 1 indicates an operation with low initial risk
A Hazard Rating of 2 indicates an operation with moderate initial risk
A Hazard Rating of 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk. Please ensure that you adequately address the magnitude of the hazard (i.e., quantity, duration, frequency, physical state) in your analysis.

The following questions were answered YES and are considered a hazard rating of 3:

The following questions were answered YES and are considered a hazard rating of 2:

1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?
3d. Will any radioactive material/waste be transported as a result of this operation?
5. Does this operation involve the use of lasers?
6a. Is there any exposed electrical components where there is the potential for personnel to be exposed to voltages greater than 50V (Range A)?
6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
11b. Will operation require work outside normal working hours?
11e. Will this operation require an emergency procedure due to unusual or complicated shutdown instructions?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?
3a. Does this operation involve handling of radioactive materials or sources?
5c. Does the operation involve Class I, II or IIIa lasers?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7f. Will this operation require any elevated work?
10. Does this operation involve: the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the use of equipment or apparatus not commercially available?
11. Will this operation require trained operators or close surveillance?

Notes:

- (1) Consult the Working with Chemicals SBMS Subject Area
- (1d) For all flammable gases and liquids, a safe volume must not be exceeded. The safe volume is calculated by dividing the volume of the gaseous state of the flammable/combustible material by the total volume of the room and ensuring this number does not exceed ten percent of the lower flammability limit for the material.
- (3) Work with radioactive materials and source may require an RWP. Contact the FSS Representative.
- (3a) If your operation uses radioactive sources, inventories are required. Include isotope and quantity.
- (3d) The transportation of radioactive materials is strictly controlled at Brookhaven National Laboratory. Contact your FSS Representative for more information.
- (5c) ANSI Z136.1 requires that Class II and IIIa lasers have a protective housing and that they be labeled according to their Class. Also, obtain an evaluation from your FSS representative prior to viewing Class 2 or 3a beams through any kind of collecting optics such as microscopes and telescopes which may concentrate the beam energy and increase the hazard.
- (6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training.
- (6d) Devices that are not commercially available must be certified by the Chief Electrical Engineer
- (7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. If you would like to add your equipment to the facilities annual request for these services, notify Plant Engineering Maintenance Management.
- (7b) Forklifts, powered trucks, platform lift trucks, and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact your FSS Representative for more information.
- (7c, 7d) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer
- (10) Please list the equipment that you are using outside of design specifications or manufacturer recommendations and/or locally built equipment in your analysis along with associated controls. Certification by the Chief Electrical and/or Chief Mechanical Engineer may be required.
- (11e) An emergency procedure must be developed in accordance with C-A OPM 3.0.
- (11f) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required.

BNL Requirements and References:

Department Of Energy
OSHA Code of Federal Regulations
National Fire Protection Agency
American National Standards Institute
Institute of Electrical and Electronics Engineers, Inc.
American Conference of Governmental Industrial Hygienists
C-A OPM 9.2.1 Procedure for Reviewing Environmental, Health and Safety Aspects of and Experiment
C-A OPM 9.3.1 Procedure for Reviewing Conventional Safety Aspects of a C-A Accelerator System
29 CFR 1910 Subpart Z - Toxic & Hazardous Substances
29 CFR 1910. 1200 Hazard Communication
29 CFR 1910.1450 Occupational Exposures to Hazardous Chemical In Laboratories
Working with Chemicals subject area
29 CFR 1910.106 Flammable and Combustible Liquids
C-A OPM 9.2.7 Design of Experimental Flammable Gas Systems
DOE Order 420.2
BNL Radiological Control Manual
Radiation Protection Training and Qualifications subject area
Radiological Work Permits subject area
Radiological Dose Limits and Administrative Control Levels subject area
Entry and Egress Requirements for Radiological Areas subject area
Radiological Posting Requirements subject area (in development).
Radiological Protection Training and Qualification subject area
Release of Materials from Controlled Radiological Areas subject area (in development)
ALARA Program subject area
Issuing and Use of Personnel Monitoring Devices subject area (in development)
Radiological Stop Work Policy
Release of Materials from Areas Controlled for Radiological Purposes subject area
ALARA Program Subject Area
Labelling Documentation and Handling of Radioactive Material subject area
49 CFR Transportation
Transportaion of Radioactive Materials Onsite Subject Area (in development)
ANSI Z136.1 Safe Use of LasersLaser Safety subject area
29 CFR 1910 Subpart S - Electrical Safety (29 CFR 1910.301-308)
ANSI National Electrical Safety Code (ANSI-C2)
NFPA National Electrical Safety Code (NFPA-70 and 70E)
ESH Standard 1.5.2 Design Criteria for Electrical Equipment
ESH Standard 1.5.1 Lockout/Tagout Requirements
ESH Standard 1.5.0 Electrical Safety
C-A OPM 9.3.4 Review and Approval of Electrical Equipment Built In-House (in development)
DOE Order 5480.4 Environmental Protection, Safety, and Health Protection Standards
29 CFR 1910.178 Powered Industrial Trucks.
ESH Standard 1.6.0 Material Handling.
29 CFR 1910.66 Appendix C, Personal Fall Arrest System
C-A OPM 9.2.3 Procedure for Chief Engineers to Certify the Conformance of Devices

Appendix III

The completed hazard analysis tool for the SSD subsystem (WBS 1.4)

Collider-Accelerator Hazard Identification Tool

BNL

Collider-Accelerator Department

Operation Title: HFT - SSD subsystem
Point Of Contact:Howard Matis
Hazard Rating: 2

NOTE 1: If you have Adobe Acrobat PDF Explorer Bar installed on your browser, then you can print this page to a pdf file, which can be sent via email to others.

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NOTE 2: Select the whole output with 'ctl A', save to the clipboard with 'ctl C', and paste to Microsoft Word or other text file with 'ctl V'. Mail the file to others as needed such as the Chair of the ASSRC [currently JW Glenn: jglenn@bnl.gov].

Explanation of Rating::

A Hazard Rating of 0 indicates an operation with minimal risk
A Hazard Rating of 1 indicates an operation with low initial risk
A Hazard Rating of 2 indicates an operation with moderate initial risk
A Hazard Rating of 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk. Please ensure that you adequately address the magnitude of the hazard (i.e., quantity, duration, frequency, physical state) in your analysis.

The following questions were answered YES and are considered a hazard rating of 3:

The following questions were answered YES and are considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
11b. Will operation require work outside normal working hours?

The following questions were answered YES and are considered a hazard rating of 1:

7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7f. Will this operation require any elevated work?
10. Does this operation involve: the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the

use of equipment or apparatus not commercially available?
11. Will this operation require trained operators or close surveillance?

Notes:

- (6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training.
- (6d) Devices that are not commercially available must be certified by the Chief Electrical Engineer
- (7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. If you would like to add your equipment to the facilities annual request for these services, notify Plant Engineering Maintenance Management.
- (7b) Forklifts, powered trucks, platform lift trucks, and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact your FSS Representative for more information.
- (10) Please list the equipment that you are using outside of design specifications or manufacturer recommendations and/or locally built equipment in your analysis along with associated controls. Certification by the Chief Electrical and/or Chief Mechanical Engineer may be required.
- (11a) If your operation will be left unattended and it poses a hazard to individuals who may enter the area for whatever reason then you must ensure that the area is posted with the name of the contact and phone number along with associated hazards when unattended. This information and instructions for a safe shutdown should be included in the analysis for your operation.
- (11f) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required.

The following facility systems act as controls for your operation:

Be sure that these controls are mentioned in your analysis, along with instructions to personnel to verify that the controls are functional prior to beginning work.

- Electric Power (includes Grounding and UPS)
- Ventilation Supply/Exhaust

BNL Requirements and References:

Department Of Energy
OSHA Code of Federal Regulations
National Fire Protection Agency
American National Standards Institute
Institute of Electrical and Electronics Engineers, Inc.
American Conference of Governmental Industrial Hygienists
C-A OPM 9.2.1 Procedure for Reviewing Environmental, Health and Safety Aspects of and Experiment
C-A OPM 9.3.1 Procedure for Reviewing Conventional Safety Aspects of a C-A Accelerator System
29 CFR 1910 Subpart S - Electrical Safety (29 CFR 1910.301-308)
ANSI National Electrical Safety Code (ANSI-C2)
NFPA National Electrical Safety Code (NFPA-70 and 70E)
ESH Standard 1.5.2 Design Criteria for Electrical Equipment
ESH Standard 1.5.1 Lockout/Tagout Requirements
ESH Standard 1.5.0 Electrical Safety
29 CFR 1910 and 29 CFR 1926
C-A OPM 9.3.4 Review and Approval of Electrical Equipment Built In-House (in development)
DOE Order 5480.4 Environmental Protection, Safety, and Health Protection Standards
29 CFR 1910.178 Powered Industrial Trucks.
ESH Standard 1.6.0 Material Handling.
29 CFR 1910.66 Appendix C, Personal Fall Arrest System
C-A OPM 9.2.3 Procedure for Chief Engineers to Certify the Conformance of Devices

Appendix IV

The completed hazard tool for the integration subsystem (WBS 1.5)

Collider-Accelerator Hazard Identification Tool

BNL

Collider-Accelerator Department

Operation Title: HFT-Integration
Point Of Contact: Dana Beavis
Hazard Rating: 3

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Explanation of Rating::

A Hazard Rating of 0 indicates an operation with minimal risk
A Hazard Rating of 1 indicates an operation with low initial risk
A Hazard Rating of 2 indicates an operation with moderate initial risk
A Hazard Rating of 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a high initial risk. Please ensure that you adequately address the magnitude of the hazard (i.e., quantity, duration, frequency, physical state) in your analysis.

The following questions were answered YES and are considered a hazard rating of 3:

1f. Will this operation involve the use of beryllium - other than Be articles?

The following questions were answered YES and are considered a hazard rating of 2:

1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?
1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?
6a. Is there any exposed electrical components where there is the potential for personnel to be exposed to voltages greater than 50V (Range A)?
6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
7g. Does work require fall protection equipment (harness, lanyard)?
8c. Is it required for personnel to enter any Class 2A or 2B Confined Spaces?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13c. Is any personal protective equipment used in this operation?
13d. Are HEPA filters in place/used?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7e. Will you be purchasing any ladders or scaffolds?
7f. Will this operation require any elevated work?

Notes:

- (1) Consult the Working with Chemicals SBMS Subject Area
- (1d) For all flammable gases and liquids, a safe volume must not be exceeded. The safe volume is calculated by dividing the volume of the gaseous state of the flammable/combustible material by the total volume of the room and ensuring this number does not exceed ten percent of the lower flammability limit for the material.
- (1e) Work with caustic/corrosive chemicals must be done in an area with an eye wash and shower.
- (1f) All Be articles must be inventoried and any operations must be evaluated by your ES&H Coordinator - complete the Be Use Review Form and forward it to the Be SME for an evaluation.
- (6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training.
- (6d) Devices that are not commercially available must be certified by the Chief Electrical Engineer
- (7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. If you would like to add your equipment to the facilities annual request for these services, notify Plant Engineering Maintenance Management.
- (7b) Forklifts, powered trucks, platform lift trucks, and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact your FSS Representative for more information.
- (7c, 7d) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer
- (7g) Personnel wearing fall protection equipment must be trained.
- (8c, 8d) Entrance into Class 2 Confined Spaces requires planning and training. Contact the ES&H Coordinator.
- (13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact your FSS representative for guidance.
- (13c(1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact your FSS Representative for further guidance and list the required type of gloves in the analysis for your operation.
- (13d) HEPA filters must be tested annually to ensure collection efficiency. Your FSS representative can aid in ensuring your equipment is included in the annual inspection.

BNL Requirements and References:

Department Of Energy
OSHA Code of Federal Regulations
National Fire Protection Agency
American National Standards Institute
Institute of Electrical and Electronics Engineers, Inc.
American Conference of Governmental Industrial Hygienists
C-A OPM 9.2.1 Procedure for Reviewing Environmental, Health and Safety Aspects of and Experiment
C-A OPM 9.3.1 Procedure for Reviewing Conventional Safety Aspects of a C-A Accelerator System
29 CFR 1910 Subpart Z - Toxic & Hazardous Substances
29 CFR 1910. 1200 Hazard Communication
29 CFR 1910.1450 Occupational Exposures to Hazardous Chemical in Laboratories
Working with Chemicals subject area
29 CFR 1910.106 Flammable and Combustible Liquids
C-A OPM 9.2.7 Design of Experimental Flammable Gas Systems
Beryllium Subject Area
29 CFR 1910 Subpart S - Electrical Safety (29 CFR 1910.301-308)
ANSI National Electrical Safety Code (ANSI-C2)
NFPA National Electrical Safety Code (NFPA-70 and 70E)
ESH Standard 1.5.2 Design Criteria for Electrical Equipment
ESH Standard 1.5.1 Lockout/Tagout Requirements
ESH Standard 1.5.0 Electrical Safety
29 CFR 1910 and 29 CFR 1926
C-A OPM 9.3.4 Review and Approval of Electrical Equipment Built In-House (in development)
DOE Order 5480.4 Environmental Protection, Safety, and Health Protection Standards
C-A OPM 8.25 Material Handling and Lifting Safely; Equipment and Procedures
29 CFR 1910.178 Powered Industrial Trucks.
ESH Standard 1.6.0 Material Handling.
29 CFR 1910.66 Appendix C, Personal Fall Arrest System
Confined Space Subject Area
C-A OPM 8.14 Confined Spaces
ESH Standard 1.16.0 Personal Protective Equipment