**Chapter 4**

Experiment Specific Equipment for the SBS GMn/GEN Experiments

**4.1 General Equipment Overview**

We need a reasonably short accurate description here.

**4.1.1 Hazards**

Jlab identified hazards can be found at <https://www.jlab.org/ehs/ehsmanual/2410T1.htm>

Hazards and mitigation requirements for the SBS Experiment are listed below. Identification, Evaluation, Documentation, Training, Security and Signage is required as applicable for all Identified Hazards. Specific mitigations will be addressed in the applicable sub-section containing the Hazard.

Confined space <https://www.jlab.org/ehs/ehsmanual/manual/6160.html>

Electrical / High Voltage <https://www.jlab.org/ehs/ehsmanual/manual/6200.html>

Elevated work <https://www.jlab.org/ehs/ehsmanual/manual/6131.html>

<https://www.jlab.org/ehs/ehsmanual/manual/6132.html>

Fire <https://www.jlab.org/ehs/ehsmanual/manual/6900.html>

Gasses <https://www.jlab.org/ehs/ehsmanual/manual/6150.html>

Hazardous waste <https://www.jlab.org/ehs/ehsmanual/manual/6610.html>

Hot work <https://www.jlab.org/ehs/ehsmanual/manual/6122.html>

Lead <https://www.jlab.org/ehs/ehsmanual/manual/6680.html>

Material Handling <https://www.jlab.org/ehs/ehsmanual/manual/6140.html>

Magnetic fields <https://www.jlab.org/ehs/ehsmanual/manual/6420.html>

ODH <https://www.jlab.org/ehs/ehsmanual/manual/6540.html>

Portable hand tools <https://www.jlab.org/ehs/ehsmanual/manual/6120.html>

Pressure vessels / Vacuum <https://www.jlab.org/ehs/ehsmanual/manual/6151.html>

Radiation <https://www.jlab.org/ehs/ehsmanual/manual/6310.html>

Sharp edges/pinch points <https://www.jlab.org/ehs/ehsmanual/manual/6140.html>

Slips, trips and falls <https://www.jlab.org/ehs/ehsmanual/manual/6131.html>

Stored energy <https://www.jlab.org/ehs/ehsmanual/manual/6110.html>

**4.1.2 Responsible Personnel**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first,last) | Dept. | Call | e-mail | Comment |
| *Hall A Technicians* | | | | |
| Tech-on-Call  Jessie Butler | Hall-A  Hall-A | W.B.  5544 | [jbutler@jlab.org](mailto:jbutler@jlab.org) | Vacuum  Vacuum |
| *Hall A Physicists* | | | | |
| Cryotarg-on-Call  Jian-Ping Chen Greg Smith Silviu Covrig | Hall-A  Hall-A Hall-C Hall-C | W.B.  7413  5405  6410 | [jpchen@jlab.org](mailto:jpchen@jlab.org) [smithg@jlab.org](mailto:smithg@jlab.org) [covrig@jlab.org](mailto:covrig@jlab.org) | Cryotarget  Cryotarget Cryotarget Cryotarget |
| *JLab Cryo-Target Group* | | | | |
| Dave Meekins  Christopher Keith | Physics  Physics | 5434  5878 | [meekins@jlab.org](mailto:meekins@jlab.org)  [ckeith@jlab.org](mailto:ckeith@jlab.org) |  |
| *Central Helium Liquefier (CHL) Experts* | | | | |
| Cryo-on-Call  CHL-group | via-MCC  Cryo | 7048  7405 |  | ESR  ESR |

“W.B.” stands for the white board in Counting House.

(Physics liaisons, experiment spokespersons and Hall Leader I suppose?)

**4.2 Target**

For description see section 3.5

**4.2.1 Hazards**

See section 3.5.1

**4.2.2 Mitigations**

See section 3.5.2

**4.2.3 Responsible Personnel**

See section 3.5.3

**4.2.4 Chamber rotation**

*This should give the degrees of rotation and note that this is a configuration change that has been used in the past to accommodate large acceptance experiments.*

**4.2.5 Special exit windows**

*This should give the angles and sizes of the windows*

*We will need pressure system paperwork on the windows to verify if it is has the J/cm2 to be a pressure system and the window may have to have pressure testing.*

**4.3 Beam line**

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| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
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The beamline in the Hall provides the interface between the CEBAF accelerator and the experimental hall. All work on the beamline must be coordinated with both physics division and accelerator division; in order to ensure safe and reliable transport of the electron beam to the dump.

For general beam line Hazards, Mitigations and responsible people please refer to section 3.3.

**4.3.1 Entrance Beam Line**

The entrance Beam Line for GMn/GEN-RP is Standard equipment, please refer to standard equipment for the Beam Line section 3.3

**4.3.2 Exit Beam Line Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

**4.3.3 Removable configuration specific upstream sections**

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| --- | --- | --- | --- | --- |
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| Jessie Butler | Hall A | 5544 | [jbutler@jlab.org](mailto:jbutler@jlab.org) | *Contact* |

Removable beam lines have several different configurations and are configured to accommodate corrector magnets that are in turn positioned to compensate for the SBS magnet settings. These beam line sections are shielded and are supported by the support tower described in section 4.3.8

**Hazards & Mitigations**

* **Pressure vessels /vacuum windows**

Due to the size of the exit beam line it must be considered a pressure system. It also has a sizable exit window in the Dump Tunnel that has previously been evaluated by a Design Authority (DA) and has been in use for several years.

* **Radiation**

Having been in use for several years/ decades the exit beam line is irradiated. It must be modified for the SBS series of experiments. These modifications include cutting and welding. It is understood by the Hall A work coordinator that the Radiation Control Group (RCG) must be involved in the planning of this work. After beam has been run through the Beam Line RCG clearance is required prior to any work on or around the beam line.

* **Elevated work / fall protection**

Modification of the exit beam pipe as well as the changing of the upstream shielded sections will require elevated work in some form. This could be on ladders, Man lifts or cloud hook. Proper training, PPE and permits/OSP will be required prior to anyone participating in this work.

* **Hot work**

The modification of the exit beam pipe will require welding and will require a Hot Work Permit.

* **Lead**

The removable sections of beam pipe are shielded with lead. The lead is painted and ready for installation but must be in compliance with the ES&H manual Chapter 6680 and will require evaluation by Industrial Hygiene.

* **Lifting / moving heavy objects**

The removable sections of beam pipe are very heavy (Duh). To facilitate safe and efficient removal and installation engineered lift points have been incorporated into their design. Proper material Handling and lifting techniques will be used. Lifting training as well as crane or forklift training must be current as required. Proper use of planning permits and documentation will be required.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

**4.3.7 Corrector magnets Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Tech on call  Jessie Butler  Jack Segal | Hall A  Hall A  DSG | W.B.  5544  7242 | [jbutler@jlab.org](mailto:jbutler@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

“W.B.” stands for the white board in the counting house.

There are two remotely controlled corrector magnets available for the SBS experiments to compensate for beam steerage from the SBS magnet. They are independently adjustable by powering the coils from their own power supplies. Control will be accomplished through a standard EPICS GUI and will be controlled by MCC?

***Need corrections and more details if necessary.***

**Hazards & Mitigations**

* **Electrical/ electronics**

These are conventional magnets that have individual power supplies. Power supplies will be located in shield huts and will contain 480 VAC, LCW and control electronics. Power at the magnets will be ???? Volts and ???? Amps. The magnets will be labeled and guarded as per the ES&H Manual Chapter 6200. An OSP will be required for these power supplies and operation of the magnets

* **Elevated work / fall protection**

Elevated work will be required for Magnet installation, testing, alignment and any maintenance that may be required. Elevation may be from ladder, scaffold or man lift, will require appropriate training and may require an elevated work permit or OSP depending on the nature of the work.

* **Fire**

The fire load on the magnets themselves is very small and will not require additional fire protection. Magnet power supplies have the potential to produce fire. The Hut that houses the magnet power supplies must be evaluated by the Fire Marshal for the necessity of a fire suppression system.

* **Lifting / moving heavy objects**

The corrector magnets are very heavy (Duh again). To facilitate safe and efficient removal and installation engineered lift points have been incorporated into their design. Proper material Handling and lifting techniques will be used. Lifting training as well as crane or forklift training must be current as required. Proper use of planning permits and documentation will be required.

* **Magnetic fields**

The corrector magnets will be capable of producing fringe magnetic fields. Since they are to be mounted in multiple positions along the beam line they will have a sign on both sides of the magnet stating the maximum field and the minimum keep out zone greater than 5 gauss. They will also be equipped with a “Magnet On” indicator that can be seen from all angles from a distance of at least twice the keep out zone

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use.

* **Radiation**

On initial installation Radiation will not be a problem for the magnet (Duh) but surrounding equipment may have residual activation and requires compliance with the standard RCG post run survey. After beam has been run through the magnets RCG clearance is required prior to any work on or around the corrector magnets

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls

* **Stored energy**

Magnet power supplies have the capability to store multiple sources of energy. It is important to follow the OSP and to use LTT.

**4.3.8 Support tower**

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| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Jessie Butler | Hall A | 5544 | [jbutler@jlab.org](mailto:jbutler@jlab.org) | *Contact* |

The Beam line support Tower was designed to support and accommodate all of the configurations of the SBS series of Experiments. Equipment to be supported include standard beam lines, shielded beam lines and corrector magnets.

**Hazards & Mitigations**

* **Elevated work / fall protection**

Much of the work installing the Bean Line support tower will require elevated work. Elevation may be from ladder, scaffold or man lift, will require appropriate training and may require an elevated work permit or OSP depending on the nature of the work.

* **Lifting / moving heavy objects**

To facilitate safe and efficient removal and installation of the support Tower, engineered lift points have been incorporated into the design of the Tower components as well as mechanisms for its adjustment and alignment. Proper material Handling and lifting techniques will be used. Lifting training as well as crane or forklift training must be current as required. Proper use of planning permits and documentation will be required

* **Magnetic fields**
* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* Slips, trips and falls

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

**4.3.9 Vacuum system**

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| --- | --- | --- | --- | --- |
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“W.B.” stands for the white board in the counting house.

The exit beam line will use the standard Hall A vacuum system with the location changed to fit the new beam line configuration.

**Hazards & Mitigations**

* **Confined space**

Inspection of the Beam line dump window will require proper training and a confined space permit.

* **Elevated work / fall protection**

Much of the work installing the Bean Line will require elevated work. Elevation may be from ladder, scaffold or man lift, will require appropriate training and may require an elevated work permit or OSP depending on the nature of the work.

* **Hazardous waste**

Vacuum pump oil is the only hazardous waste for this system

* **Lifting / moving heavy objects**

The only portion of the beam line vacuum system that is of any concern are the vacuum pumps themselves. Proper material Handling and lifting techniques will be used. Lifting training as well as crane or forklift training must be current as required. Proper use of planning, permits and documentation will be required.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use.

* **Pressure vessels /vacuum windows**

Due to the size of the exit beam line it must be considered a pressure system. It also has a sizable exit window in the Dump Tunnel that has previously been evaluated by a Design Authority (DA) and has been in use for several years.

* **Radiation**
* Having been in use for several years/ decades the exit beam line is irradiated. After beam has been run through the Beam Line RCG clearance is required prior to any work on or around the beam line.
* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* **Stored energy**

Vacuum is a source of stored energy. The beam pipe must be blead up to atmosphere or valved off prior to disconnecting any component connected to the system.

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| Name (first, last) | Dept. | Call | e-mail | Comment |
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**4.4 SBS Spectrometer**

**Hazards & Mitigations**

* **Confined space**

There are some areas in the SBS spectrometer that are able to accommodate a person. Some of these areas may have to be accessed for assembly. When this is necessary, confined space training and a confined space permit will be required. At all other times these areas will be closed off with a permanent cover that must be removed with tools and the cover will be labeled as per the requirement detailed in the ES&H Manual, Chapter 6160

* **Electrical/ electronics**

The SBS magnet is a conventional magnet and have a power supply capable of producing ???? Volts and 2200 Amps. The power supply will be located in a shield hut and will contain 480 VAC, LCW and control electronics. The magnets will be labeled and guarded as per the ES&H manual chapter 6200. An OSP will be required for these power supplies and operation of the magnets. An OSP will be required for these power supplies and operation of the magnets

magnet controls- since the magnet will be capable of steering the beam will MCC control it?

detector electronics and High Voltage

* **Elevated work / fall protection**

Much of the assembly and work on the SBS Spectrometer will require elevation of more than four feet from the floor. Platforms with guard rails will be provided where possible. Where they are not possible elevation may be from ladder, scaffold or man lift, will require appropriate training and may require an elevated work permit or OSP depending on the nature of the work.

* **Fire protection**

Magnet power supplies have the potential to produce fire

Fire risk for the magnet, detectors and the electronics hut will need to be evaluated! We have not needed it before and it will be difficult to provide but we need to look at it.

* **Gasses**

All the electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Hot work**

It is likely that hot work in the form of grinding cutting or welding will be required on the SBS Spectrometer. Before any such work may take place, proper training and a Hot Work Permit or OSP will be required.

* **Lead**

Lead in the form of collimators and shielding will be required on the SBS Spectrometer. All lead work must be in compliance with the ES&H manual Chapter 6680 and will require evaluation by Industrial Hygiene.

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly.

Proper use of planning, permits and documentation will be required

* **Magnetic fields**

The SBS magnet will be capable of producing a magnetic field strong enough to pull the iron out of your blood as well as strong fringe fields. It will have a sign on both sides of the magnet stating the maximum field of 1.71 T-m and the minimum keep out zone of ???? for 5 gauss?. It will also be equipped with a “Magnet On” indicator that can be seen from all angles from a distance of at least twice the keep out zone

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use.

* **Pressure vessels /vacuum windows**

Given that the gas delivered to the detectors of the SBS Spectrometer is less than 15 psi and is not flammable or explosive it represents no hazard.

Is the LCW system considered a pressure system? LCW manifolds and supply lines

* **Radiation**

On initial installation Radiation will not be a problem for the for the SBS Spectrometer but surrounding equipment may have residual activation and requires compliance with the standard RCG post run survey. After beam has been run through the beam line RCG clearance is required prior to any work on or around the SBS Spectrometer.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* **Stored energy**

Power supply, hydraulics, position actuators

**4.4.3 SBS Magnet System Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM but can be part of the spectrometer OSP**

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| --- | --- | --- | --- | --- |
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“W.B.” stands for the white board in the counting house.

Need description

Up to 1.71 T-m ‘kick’ to separate protons from neutrons.

Field uniformity not important – Not used as spectrometer

(map must be reasonably well understood)

**Hazards & Mitigations**

* Electrical/ electronics
* The SBS magnet is a conventional magnet and have a power supply capable of producing ???? Volts and ???? Amps. The power supply will be located in a shield hut and will contain 480 VAC, LCW and control electronics. The magnets will be labeled and guarded as per the ES&H manual chapter ??? An OSP will be required for these power supplies and operation of the magnets. An OSP will be required for these power supplies and operation of the magnets

detector electronics and High Voltage

* Elevated work / fall protection
* Much of the assembly and work on the SBS Magnet will require elevation of more than four feet from the floor. Platforms with guard rails will be provided where possible. Where they are not possible elevation may be from ladder, scaffold or man lift, will require appropriate training and may require an elevated work permit or OSP depending on the nature of the work.
* Fire

Magnet power supplies have the potential to produce fire

Fire risk for the magnet, and its power supply will need to be evaluated! VESDA in shield hut?

* Lead

Does SBS have a collimator/ sieve and is it lead?

* Lifting / moving heavy objects

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning permits and documentation will be required

* Magnetic fields

The SBS magnet produces a central field of 1.72 T at ??? A. As the magnet has a return yoke and a front field clamp, the external field is much smaller than the central field. Although the magnetic field is primarily confined to the magnet gap, fringe fields are strong enough to accelerate unsecured metal objects in the vicinity of the magnet. In addition these fields may present a particularly large hazard to individuals using a pacemaker. An additional hazard arises due to the close proximity of the magnet to the target area where an unsecured metal object could destroy the scattering chamber.

It will have a sign on both sides of the magnet stating the maximum field of 1.72 T and the minimum keep out zone of ???? for 5 gauss. It will also be equipped with a “Magnet On” indicator that can be seen from all angles from a distance of at least twice the keep out zone. The 5 gauss field line will be painted on the floor and labeled as a keep out zone for when the magnet is on.

* Portable hand tools

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use.

* Pressure vessels /vacuum windows

LCW manifolds and supply lines operate at a pressure greater than 15 psi and must be evaluated by a design authority and documented as a pressure system.

* Radiation

During installation there should be no problem with Radiation but after the SBS magnet has been in the Hall with Beam on there is a possibility that parts of it could become activated. As per the standing RWP the SBS Magnet components should be considered activated until cleared by the RCG.

* Sharp edges/pinch points

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* Slips, trips and falls

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* Stored energy

Magnet power supplies have the capability to store multiple sources of energy. It is important to follow the OSP and to use LTT. The Power supply and the magnet have stored energy in the form of water pressure and the magnet collimator/ sieve in the up position is stored energy.

**4.4.4 Carriage and motion system** **Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

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| Name (first, last) | Dept. | Call | e-mail | Comment |
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“W.B.” stands for the white board in the counting house.

The SBS carriage serves as a counter-balance support for the SBS magnet, the main detector packages for multiple experiments, mounts for secondary detector packages as well as providing access to the rear of the magnet assembly and the detectors.

Motion for the XXX Ton carriage is provided by four Hillman rollers and multiple electrically powered linear actuators the can be mounted at various positions on the carriage and to the floor plated the carriage rests on

Hazards & Mitigations

* Electrical/ electronics

Has it been decided if the carriage will have a power distribution center?

Simple electric controls for the positioning actuators?

* Hot work

Hot is likely to be required in the SBS carriage in the form of grinding and welding. . Before any such work may take place, proper training and a Hot Work Permit or OSP will be required.

* Lifting / moving heavy objects

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the operation of the SBS Spectrometer positioning system. Proper relevant and current training will be required for anyone participating in the installation or operation of this equipment. Proper use of planning, permits and documentation will be required

* Portable hand tools

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* Radiation

During installation there should be no problem with Radiation but after the carriage has been in the Hall with Beam on there is a possibility that parts of it could become activated. As per the standing RWP the Carriage components should be considered activated until cleared by the RCG.

* Sharp edges/pinch points

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* Slips, trips and falls

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* Pressure system and stored energy

It is understood the hydraulic section of the motion system will be constructed using off the shelf appropriately rated components. However, if there is a need to deviate from this it is also understood that this will require documentation and signoff of a Design Authority to pressure system requirements.

It is understood that the possibility of stored energy exists in both the hydrolica system and the linier actuator system and this hazard will be required to be evaluated by the SME in the system OSP.

**4.4.5 GMn Detector Package Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

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| Name (first, last) | Dept. | Call | e-mail | Comment |
| Bogdan Wojtsekhowski  Jack Segal  Kondo Gnanvo  Evaristo Cisbani  Nilanga Liyanage | Hall A  SSG  U Va.  INFN  U Va. | 7191  7242  321-604-8026  434-466-4670 | [bogdanw@jlab.org](mailto:bogdanw@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org)  [kg6cq@virginia.edu](mailto:kg6cq@virginia.edu)  [evaristo.cisbani@iss.infn.it](mailto:evaristo.cisbani@iss.infn.it)  [nilanga@virginia.edu](mailto:nilanga@virginia.edu) | *Contact* |

“W.B.” stands for the white board in the counting house.

The Gas Electron Multiplier (GEM) tracker for GMn experiment consists of four GEM detector layers before the GRINCH detector and one GEM detector layer after GRINCH. Each of the first four layers has an active area of 150 cm 40 cm and consists of three SBS front tracker GEM modules. The GEM layer after GRINCH has an active area of 200 cm 60 cm and consists of four SBS back tracker GEM modules.

Needs to get incorporated below

Hazards to personnel include the high voltage applied to the GEM chambers, and the low voltages supplied at high currents to power the readout electronics.

Hazards to equipment (GEM detectors) include:

* Exceeding the recommended high voltage values applied to the detectors.
* Exceeding the gas flow rates/input pressures to the detectors leading to the rupture of the detectors.
* Exceeding the recommended voltage values applied to readout electronics.

4.4.2 Mitigations

* Hazards to personnel are mitigated by turning off HV and LV before doing any work on the detectors.

Hazards associated with high voltage, both to personnel and detectors, is also mitigated by the use of HV voltage modules with a maximum current limit of 1 mA. Furthermore, a more strict pre-set current limit of 0.8 mA is programmed into all channels. Any current exceeding this limit causes the HV channel to trip off and remain off.

Hazards associate with exceeding the recommended voltage values will be mitigated by locking the controls with password protections with only the authorized trained personnel having access to change the setting. Any change to the established settings will have to be authorized by the responsible personnel for the detector.

Hazards to the detectors associate with excessive gas flow rates and input pressures will be mitigated by the use of input relief bubblers in the input gas line of each detector module.

**Hazards & Mitigations**

* **Electrical/ electronics**

All GEM modules will be powered by Wiener-Iseg 6 kV power supplies housed in a Wiener-Iseg mainframe crate. The GEM signals will be readout using an APV-25 chip based Multi-Purpose Digitizer (MPD) system, where the APV-25 front-end cards on GEM detectors are connected using HDMI cables to a the MPD units housed in VME crates inside a shielding enclosure behind Bigbite spectrometer. The low voltage power for the readout system is provided by KEPCO 15 V, 15 A power supplies. HV and LV power supplies will be controlled using Labview interfaces running on a computer located in the hall A counting room

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

Fire risk for the **GMn Detector Package** will need to be evaluated!

* **Gasses**

A pre-mixed non-flammable gas mixture of 70% Ar and 30 % CO2 will be continuously supplied to the GEM detectors from a gas line coming into the hall from the Hall A gas shed. The total gas flow rate into the detectors will be approximately 160 liters per hour.

The electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A. All gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Lead**

Lead shielding will be used to protect the detectors from radiation from the beam line. The will be painted and must be in compliance with the ES&H manual Chapter 6680 and will require evaluation by Industrial Hygiene.

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Magnetic fields**

The 5 gauss field line will be painted on the floor and labeled as a keep out zone for when the magnet is on.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Pressure vessels /vacuum windows**

It should be noted that the beam pipe is a pressure vessel and that there is a possibility of close proximity.

* **Radiation**

During installation there should be no problem with Radiation but after the carriage has been in the Hall with Beam on there is a possibility that parts of it could become activated. As per the standing RWP the Carriage components should be considered activated until cleared by the RCG.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* **Stored energy**

Magnet power supplies have the capability to store multiple sources of energy. It is important to follow the OSP and to use LTT.

**4.4.6 GEN-RP Detector Package Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Brad “want coffee” Sawatzky  Jack Segal | Hall A  SSG | 5947  7242 | [brads@jlab.org](mailto:brads@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

PR Polarimeters require

* 3 main frames with supports and alignment
* 1 'inline' weldment with 8 GEM planes
* GEM fixtures are able to be rolled out using a detachable rail assembly for maintenance
* 2 'proton recoil' assemblies, each with a plastic scintillator plane + GEM planes
* GEM fixtures are able to be rolled out using a detachable rail assembly for maintenance
* 1 Active analyzer scintillator array

**Hazards & Mitigations**

* **Electrical/ electronics**

The high voltage to the 128 PMTs will be provided through standard HV cables and utilizes SHV connectors. Those cables and connectors are rated at 5,000 volts and 4 amps. We will use power supplies whose maximum output is significantly below these ratings and plan to run at voltages below 2300 volts and less than 3 mA per channel. The plastic PMT housing prevents accidental contact with the HV distribution resistor chain.

The signals are less than 5 volts and will be output on BNC coax connectors. The SHV connectors are designed to prevent any accidental connections between SHV and BNC connectors

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire protection**

Fire risk for the **GMn Detector Package** will need to be evaluated!

* **Gasses**

All the electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Lead**

Lead shielding will be used to protect the detectors from radiation from the beam line. The will be painted and must be in compliance with the ES&H manual Chapter 6680 and will require evaluation by Industrial Hygiene.

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Magnetic fields**

The possible presence of high magnetic fields will be indicated by standard Jefferson Lab signs and by a flashing beacon. The area surrounding the magnet will be roped off whenever it is possible that the magnet will be energized. The ropes will be at a distance from the magnet such that the fringe fields are less than 500 *µ*T (5 G) at the maximum allowed current of 800 A. This should be roughly one meter, but should be checked as soon as possible once the magnet has been energized. Personnel with ferromagnetic implants and those wearing electronic medical devices are not allowed inside the roped off area. Due to the large magnet gap size, personnel working inside the roped-off area should be aware of the possible presence of a magnetic fringe field, as well as a high field in the magnet gap.

The magnet produces a central field of 0.92 T at 518 A. As the magnet has a return yoke and a front field clamp, the external field is much smaller than the central field. Although the magnetic field is primarily confined to the magnet gap, fringe fields are strong enough to accelerate unsecured metal objects in the vicinity of the magnet. In addition these fields may present a particularly large hazard to individuals using a pacemaker. An additional hazard arises due to the close proximity of the magnet to the target area where an unsecured metal object could destroy the scattering chamber.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Pressure vessels /vacuum windows**

It should be noted that the beam pipe is a pressure vessel and that there is a possibility of close proximity.

* **Radiation**

During installation there should be no problem with Radiation but after the carriage has been in the Hall with Beam on there is a possibility that parts of it could become activated. As per the standing RWP the Carriage components should be considered activated until cleared by the RCG.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

**4.4.7 Hadron Calorimeter (HCAL-J) Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Bogdan Wojtsekhowski  Jack Segal | Hall A  SSG | 7191  7242 | [bogdanw@jlab.org](mailto:bogdanw@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

The Hall A Hadron Calorimeter, HCAL-J, will be mounted at the back of the

SBS detector package and used to detect protons, neutron, pions, and kaons. It will be constructed from 288 individual detector modules assembled into an array 12 modules wide by 24 modules high (180 cm wide x 360 cm high). The total weight of the HCAL-J detector will be approximately 40 tons, but the modules will be mounted into 4 sub-assemblies so that the individual sub-assemblies can be positioned with a 20-ton capacity crane.

The individual modules are each constructed from two rows of alternating iron energy absorbers and scintillators and a single wavelength shifter that runs the length of the modules between the two rows. The wavelength shifter directs light to a 2 inch diameter PMT mounted on the back of the module. The completed HCAL-J array will have 288 modules, thus 288 PMT signals. The array will be instrumented using existing XP2262H and XP2282/B PMTs. The PMT housing, module can lid, and one row of iron absorbers/scintillators have been removed so that the wavelength shifter and the associated light guide is visible. A row of alternating iron absorbers/scintillators can be seen looking through the wavelength shifter.

HCAL-J will also include an LED/ fiber optic pulser system to facilitate signal checkout and stability monitoring.

**Hazards & Mitigations**

* **Electrical/ electronics**

The high voltage to the 288 PMTs will be provided through standard HV cables and utilizes SHV connectors. They are rated at 5,000 volts and 4 amps. We will use power supplies whose maximum output is significantly below these ratings and plan to run at voltages below 2300 volts and less than 15 mA per channel. The plastic PMT housing prevents accidental contact with the HV distribution resistor chain.

The signals are less than 5 volts and will be output on BNC coax connectors. The SHV connectors are designed to prevent any accidental connections between SHV and BNC connectors.

The pulser system will use blue LEDS distributed via fiber optics. This avoids the safety issues associated with systems which use a UV-laser system to excite scintillators.

The PMT HV should be kept below 2300 volts unless a higher voltage authorized by an HCAL expert. Under no circumstances should it exceed 2500 volts.

The PMTs are susceptible to degradation when exposed to the raised helium concentration levels in Hall A over extended periods of time. The sub- assembles should be removed from the Hall when possible. When located in the hall, dry nitrogen should be applied to the distribution manifold located on each sub-assembly. This manifold will distribute the dry nitrogen to spigots located on the back of each PMT housing. Rubber O-rings, shown in Fig. 3, create a seal between the PMT housing and the cylindrical output end of HCAL-J module’s light guide so that only the PMT housing is used to establish the dry-nitrogen overpressure. A procedure for verifying the presence a functioning nitrogen flow will be checked on a regular basis when the HCAL-J sub-assemblies are in the hall.

I stole this so it needs to be edited/evaluated

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

Fire risk for the **GMn Detector Package** will need to be evaluated!

* **Gasses**

All the electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Lead**

Is there lead in this?

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Radiation**

During installation there should be no problem with Radiation but after the carriage has been in the Hall with Beam on there is a possibility that parts of it could become activated. As per the standing RWP the Carriage components should be considered activated until cleared by the RCG.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

**4.4.8 Coordinate Detector Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

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| Name (first, last) | Dept. | Call | e-mail | Comment |
| Bogdan Wojtsekhowski  Jack Segal | Hall A  SSG | 7191  7242 | [bogdanw@jlab.org](mailto:bogdanw@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

The Coordinate Detector (CDet) is a scintillator hodoscope which is to be used as part of the Super BigBite Spectrometer (SBS) in the nucleon form factor experiments. CDet will provide complementary particle tracking in- formation by measuring the vertical coordinate and can be used as either an electron or proton detector.

The CDet consists of an array of 2352 scintillator paddles, with each individual paddle measuring 0.5 cm x 4.0 cm x 51 cm. Each group of 14 of these scintillator paddles are arranged into a single bar; there are 28 of these bars arranged into a single module, with 14 bars on the left and 14 bars on the right side of each module. There are 6 modules in total in the full detector array

The scintillation light from each paddle is read out via a wavelength-shifting optical fiber inserted through the middle of the paddle and connected at one end to a multi-anode photomultiplier tube (ma PMT). The bar and fiber bundle are shown in figure [1.](#bookmark1) There is one ma PMT used to read out each scintillator bar (14 paddles) and so each module has a total of 28 ma PMTs. The signals from each ma PMT are output to an amplifier-discriminator card based on the NINO chip (referred to as NINO cards). The NINO cards for all 14 ma PMTs on one side of a module are mounted on the module itself, beside the ma PMTs. A short (∼ 15cm) coaxial cable connects eight of the output channels from the ma PMT to the NINO card with each ma PMT requiring two such connections. The NINO cards provide both an analog and digital output signals; an amplified charge signal for pulse height measurement and LVDS logic signals for timing measurements

I stole this so it needs to be edited/evaluated

**Hazards & Mitigations**

* **Electrical/ electronics**

The ma PMTs will be operated at voltages of -700 to -800 V. The high voltage for the whole detector is supplied by two CAEN power supplies. Each side of the detector modules (14 ma PMTs) will have a single high voltage distribution box attached to it. A single, multi-wire cable will be run from the power supply crates, to the distribution box on the module. The power supply cables on each ma PMT will then connect into the other side of the distribution box. Both sets of power cables have connectors which have recessed pins, ensuring that they cannot be touched by hand. Each wire line in the cable from the power supply crate to the distribution box is connected to a single, individual channel in the power supply which can be remotely controlled via a computer connected to the crate. The software to control each HV channel in the CAEN crates allows for a maximum voltage on each channel to be set and a maximum current draw limit to be set as well. If a current over the set limit is drawn, the power supply will shut down.

I stole this so it needs to be edited/evaluated

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

Fire risk for the **GMn Detector Package** will need to be evaluated!

* **Gasses**

All the electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Lead**

Is there lead in this?

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Radiation**

After Beam has been introduced into the Hall the area around the Coordinate Detector will be cleared by a radiation survey prior to accessing the area.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

**4.4.9 Electronics, shielding and Cabling**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Spectrometer Support Group  Jack Segal | SSG  SSG | W.B.  7242 | [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

“W.B.” stands for the white board in the counting house.

What electronics that are not required to be mounted on the detectors themselves will be house in shield huts to protect them from the effects of radiation. Cable bundles will be protected at cross over points and the shield huts will be located as far from the radiation source as the cable length capabilities of the electronics will allow. This is me making stuff up but it sounds good! Still being designed

**Hazards & Mitigations**

* **Electrical/ electronics**

The majority of the electronics and controls will be located in this shield hut Will local power panels and outlets be installed for plugging in the electronics platforms or will berthas be used

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

The majority of the electronics and controls will be located in this shield hut. It will likely need fire suppression and possibly VESDA. Has this been looked at or evaluated by Tim Minga?

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Radiation**

That’s what the shield hut is for. Will RCG diagnostics be requested/ required for the shield huts?

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* **Stored energy**

Electronics AC power with backups and power supplies are all possible sources of stored energy that could be in the shield huts.

**4.4.10 Gas systems Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM but can be part of the spectrometer OSP**

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| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Spectrometer Support Group  Jack Segal | SSG  SSG | W.B.  7242 | [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

“W.B.” stands for the white board in the counting house.

The SBS Detector gas systems are a copy of the Bigbite Detector gas systems and can be found in the Hall A Standard equipment manual at <https://hallaweb.jlab.org/> under “Documentation” so it will not be described in this document

**Hazards & Mitigations**

* **Electrical/ electronics**

All the electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done.

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

Is fire suppression required for the gas shed addition?

* **Gasses**

All the electronics for the SBS gas system are located in the Hall A gas shed outside the truck access of Hall A No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Pressure vessels /vacuum windows**

Given that the gas delivered to the detectors of the SBS Spectrometer is less than 15 psi and is not flammable or explosive it represents no hazard.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

**4.4.11 Big Bite Spectrometer**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Tech-on-Call  Jessie Butler | Hall-A  Hall-A | W.B.  5544 | [jbutler@jlab.org](mailto:jbutler@jlab.org) | *Contact* |

“W.B.” stands for the white board in the counting house.

The BigBite magnet, the key component to several 12GeV Hall A approved experiments, was originally commissioned to 550 A under TOSP PHY-04-014 and subsequently to 800 A under TOSP PHY-05-015. The purpose of this document is to describe the hazards and safety procedures for operating this magnet. These procedures include running the magnet during an experiment and making field measurements. The Big Box power supply being used with BigBite was commissioned during Hall A experiment E99-114 (TSOP PHY-02-003) and this document presents an updated version of the procedures for safely operating the supply. This BigBite dipole magnet document is an update to the expired OSP PHY-05-001 and OSP PHY-08-002.under which the BigBite dipole was run during the 6GeV era. This document does not attempt to describe the function or operation of the dipole or power supply.

With the permission of the Hall A work coordinator, physics users may make field measurements of the area around the magnet. The guidelines for safely performing these measurements can be found in Section 7.3. During these measurements, the current to the magnet may be changed using the Big Box GUI. Once the measurements have been completed, authorized personnel secure the system

**4.4.12 Big Bite Magnet System Due to having “NEW” equipment as part of this system AN OSP WILL BE REQUIRED FOR THIS SYSTEM but can be part of the spectrometer OSP**

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| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Tech on call  Jessie Butler | Hall A  Hall A | W.B.  5544 | [jbutler@jlab.org](mailto:jbutler@jlab.org) | *Contact* |

“W.B.” stands for the white board in the counting house.

The Bigbite Magnet assembly, its power supply and its carriage are part of the Hall A Standard Equipment and can be found in the Hall A Standard equipment manual at <https://hallaweb.jlab.org/> under “Documentation” so it will not be addressed in this document

**Hazards & Mitigations**

* **Electrical/ electronics**

The BigBite (BB) magnet is a conventional magnet and have a power supply capable of producing 800? Amps. The power supply will be located in a shield hut and will contain 480 VAC, LCW and control electronics. The magnets will be labeled and guarded as per the ES&H manual chapter 6200. An OSP will be required for these power supplies and operation of the magnets. An OSP will be required for these power supplies and operation of the magnets before being energized, the magnet’s exposed current bus must be covered to mitigate the shock hazard. The power supply bus must be covered and all doors secured. Also, to keep the current of the BigBite magnet within operational limits, the over-current circuit in the Big Box power supply should be set to no more than 800 A. The power supply has a maximum output current of 1050 A at a voltage of 250 V and thus presents a potentially lethal hazard. A hazard also arises from the power bus on the magnet itself. Access to the power supply or magnet can only be made after following “Lockout/Tagout Procedures” as described in Chapter 6110 of the Jefferson Lab EH&S manual and the *Hall A power supply test and maintenance* safety procedure. When working on the power supply, the responsible people will follow the guidelines in the electrical safety chapter of the EH&S manual.

magnet controls- since the magnet will be capable of steering the beam will MCC control it?

detector electronics and High Voltage

* **Elevated work / fall protection**

Much of the assembly and work on the BigBite Spectrometer will require elevation of more than four feet from the floor. Platforms with guard rails will be provided where possible. Where they are not possible elevation may be from ladder, scaffold or man lift, will require appropriate training and may require an elevated work permit or OSP depending on the nature of the work

* **Fire**

The magnet coils are protected from over-heating by Klixon devices in- stalled on the magnet and interlocked to the power supply that will shut off the power supply in case of the coil over-heating. Magnet power supplies have the potential to produce fire

Fire risk for the magnet, detectors and the electronics hut will need to be evaluated!

We have not needed it before ant it will be difficult to provide but we need to look at it.

* **Gasses**

No flammable or explosive gasses will be used on the BB spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Hot work**

Hot work may be needed in the form of grinding cutting or welding on the BB Spectrometer. Before any such work may take place, proper training and a Hot Work Permit or OSP will be required.

* **Lead**

Lead in the form of collimators and shielding will be required on the SBS Spectrometer. All lead work must be in compliance with the ES&H manual Chapter 6680 and will require evaluation by Industrial Hygiene.

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Magnetic fields**

The possible presence of high magnetic fields will be indicated by standard Jefferson Lab signs and by a flashing beacon. The area surrounding the magnet will be roped off whenever it is possible that the magnet will be energized. The ropes will be at a distance from the magnet such that the fringe fields are less than 500 *µ*T (5 G) at the maximum allowed current of 800 A. This should be roughly one meter, but should be checked as soon as possible once the magnet has been energized. Personnel with ferromagnetic implants and those wearing electronic medical devices are not allowed inside the roped off area. Due to the large magnet gap size, personnel working inside the roped-off area should be aware of the possible presence of a magnetic fringe field, as well as a high field in the magnet gap.

The magnet produces a central field of 0.92 T at 518 A. As the magnet has a return yoke and a front field clamp, the external field is much smaller than the central field. Although the magnetic field is primarily confined to the magnet gap, fringe fields are strong enough to accelerate unsecured metal objects in the vicinity of the magnet. In addition these fields may present a particularly large hazard to individuals using a pacemaker. An additional hazard arises due to the close proximity of the magnet to the target area where an unsecured metal object could destroy the scattering chamber.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Pressure vessels /vacuum windows**

It should be noted that the beam pipe is a pressure vessel and that there is a possibility of close proximity.

LCW manifolds and supply lines operate at a pressure greater than 15 psi and must be evaluated by a design authority and documented as a pressure system.

* **Radiation**

During installation there should be no problem with Radiation but after the SBS magnet has been in the Hall with Beam on there is a possibility that parts of it could become activated. As per the standing RWP the SBS Magnet components should be considered activated until cleared by the RCG.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

* **Stored energy**

Magnet power supplies have the capability to store multiple sources of energy. It is important to follow the OSP and to use LTT. The Power supply and the magnet have stored energy in the form of water pressure and the magnet collimator/ sieve in the up position is stored energy.

**4.4.13 Big Bite Detector Package Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM**

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| Name (first, last) | Dept. | Call | e-mail | Comment |
| Bogdan Wojtsekhowski  Jack Segal | Hall A  SSG | 7191  7242 | [bogdanw@jlab.org](mailto:bogdanw@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

Need good description of GEMs here.

Front GEMs x4 (3 modules each)

Cherenkov, Gas Ring Imaging Cherenkov (GRINCH)

Consists of

* an Array of 510 x 1” PMTs
* Four cylindrical mirrors on sliding rail system
* NINO front end cards
* Find timing clusters for *e-* PID
* VETROC/FPGA DAQ

Timing

Online cluster finding for trigger

Back layer GEM (4 modules)

Pre Shower

* Pb-glass blocks

Pre-shower layer - 10 rad. length.

Hodoscope

The timing hodoscope of BigBite (BB) (Fig.1) electron-arm spectrometer pro- vides an event reference time, which can be correlated with RF beam buckets from the CEBAF accelerator, and with signals from the SBS hadron arm for time of flight determination in (e,e’N) experiments. It consists of an array of 90, EJ-200 plastic scintillators, each of dimensions 600 x 25 x 25 mm, which are stacked in a vertical “ladder”, sandwiched between the pre-shower and shower arrays of the BB electromagnetic calorimeter.

Scintillation light from each bar is read out at each end, through acrylic light guides, glued to the scintillator using UV-cure, optical epoxy. Two type ET- 9142, 29 mm diameter photomultipliers (PMT) collect the scintillation light. They are clamped in position at the end of the light guide by an assembly which encloses the PMT, along with its custom-built voltage-divider base chain, and incorporates mu-metal shielding from stray magnetic fields. Anode signals from the PMTs are output from MCX coaxial connectors on the HV base and fed, via 2 m of RG179 cable to amplifier-discriminator cards based on the NINO chip. The latter, mounted close to the PMTs, provide amplified anode signals for pulse amplitude measurement and LVDS logic signals for timing measurements. The typical mean-time resolution for a hodoscope bar is around 150 ps.

**Hazards & Mitigations**

* **Electrical/ electronics**

The PMTs are operated typically at voltages of -1000 V to -1200 V. HV is sup- plied over shielded cable and the PMT bases are encased in a plastic jacket which insulates internal base terminals from the outer Al PMT container. The PMTs themselves are supplied with an integral mu-metal shield and outer insulating plastic jacket. Thus the PMT cathode at -1 kV is insulated from any potential contact with the Al outer case. A more substantial mu-metal shield fits outside of the Al case and provides most of the shielding from stray magnetic fields.

The PMT base chain draws a current of around 200 mA and operates with- out the need for forced cooling. In the event that an over-current condition is detected the current-limited HV supply will power down. The amplifier/discriminator cards operate from a +5 V power supply and each 16-channel card draws a current of 1*.*25 A. A common LV supply will power (15 A total current) the 12 cards required to read out 180 PMTs. This will be current limited and will have individual fuses on the supply lines to each card.

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

Fire risk for the **Bigbite Detector Package** will need to be evaluated!

* **Gasses**

No flammable or explosive gasses will be used on the BB spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Lead**

Lead shielding will be used to protect the detectors from radiation from the beam line. The will be painted and must be in compliance with the ES&H manual Chapter 6680 and will require evaluation by Industrial Hygiene.

* **Lifting / moving heavy objects**

Material handling in the form of crane usage, fork lifting and manual lifting will be required during the SMS installation, operation and disassembly. Proper use of planning, permits and documentation will be required.

* **Magnetic fields**

The 5 gauss field line will be painted on the floor and labeled as a keep out zone for when the magnet is on.

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Pressure vessels /vacuum windows**

Given that the gas delivered to the detectors of the SBS Spectrometer is less than 15 psi and is not flammable or explosive it represents no hazard.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.

**4.4.14 Big Bite Electronics, shielding and Cabling**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Bogdan Wojtsekhowski  Jack Segal | Hall A  SSG | 7191  7242 | [bogdanw@jlab.org](mailto:bogdanw@jlab.org)  [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

Electronics that are not required to be mounted on the detectors themselves will be house in shield huts to protect them from the effects of radiation. Cable bundles will be protected at cross over points and the shield huts will be located as far from the radiation source as the cable length capabilities of the electronics will allow.

**Hazards & Mitigations**

* **Electrical/ electronics**

I am assuming that BB will use the same shield hut as SBS so no addition requirements are necessary?

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Radiation**

That’s what the shield hut is for.

Do we want to go into the design requirements?

Will RCG diagnostics be requested/ required for the shield huts?

**4.4.15 Big Bite Gas system Due to being “NEW” equipment AN OSP WILL BE REQUIRED FOR THIS SYSTEM but can be part of the spectrometer OSP**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name (first, last) | Dept. | Call | e-mail | Comment |
| Spectrometer Support Group  Jack Segal | SSG  SSG | W.B.  7242 | [segal@jlab.org](mailto:segal@jlab.org) | *Contact* |

“W.B.” stands for the white board in the counting house.

The Bigbite Detector gas systems are part of the Hall A Standard Equipment and can be found in the Hall A Standard equipment manual at <https://hallaweb.jlab.org/> under “Documentation” so it will not be described in this document

**Hazards & Mitigations**

* **Electrical/ electronics**

All the electronics for the BB gas system are located in the Hall A gas shed outside the truck access of Hall A need more here

* **Elevated work / fall protection**

Elevated work during installation and maintenance using man lift and ladder will require training, proper PPE and an elevated work permit or OSP if required

* **Fire**

Is fire suppression required for the gas shed addition?

* **Gasses**

No flammable or explosive gasses will be used on the SBS spectrometer so no fire or combustible evaluations need to be done. It is also my understanding that all gasses will be supplied from the gas shed outside the Hall at less than 15 psi. Due to the total volume of gas and the fact that the gas is supplied by gas cylinders to the gas shed, a pressure vessel signoff will be required by a Design Authority (DA).

* **Portable hand tools**

Portable Hand tools are a staple of any experiment installation. Anyone using portable hand tools must make themselves familiar this ES&H manual chapter 6120 prior to their use

* **Pressure vessels /vacuum windows**

Given that the gas delivered to the detectors of the SBS Spectrometer is less than 15 psi and is not flammable or explosive it represents no hazard.

* **Sharp edges/pinch points**

Any movement of heavy equipment carries with it a chance of pinch point or smashed pinky. Proper PPE and tag lines must be used.

* **Slips, trips and falls**

During any installation it is important to keep the work area clear and clean to prevent Slips, trips and falls.