BROOKHAVEN NATIONAL LABORATORY

Work Permit # (DRL-2010-11)SS2010-227
Work Order # _____
Job# _____ Activity# _____

1. Work requester fills out this section. ☐ **Standing Work Permit**

Requester: Don Lynch	Date: 07/01/2010	Ext.: 2253	Dept/Div/Group: PO/PHENIX
Other Contact person (if different from requester): Carter Biggs			Ext.: 7515
Work Control Coordinator: Don Lynch		Start Date: 08/01//2010	Est. End Date: 10/1/2010
Brief Description of Work: Install RPC Absorbers			
Building: 1008	Room: IR	Equipment: RPC Absorbers, CM	Service Provider: PHENIX techs

. WCC, Requester/Designee, Service Provider, and ES&H (as necessary) fill out this section or attach analysis

ES&H ANALYSIS				
Radiation Concerns	☒ None	☐ Activation	☐ Airborne	☐ Contamination	☒ Radiation
Radiation Generating Devices:	☐ Radiography	☐ Moisture Density Gauges	☐ Soil Density Gauges	☐ X-ray Equipment
☐ Special nuclear materials involved, notify Isotope Special Materials Group			☐ Fissionable materials involved, notify Laboratory Criticality Officer	
Safety Concerns	☐ None	☐ Ergonomics	☐ Transport of Haz/Rad Material	
☐ Adding/Removing Walls or Roofs	☐ Confined Space*	☐ Explosives	☐ Lead*	☐ Penetrating Fire Walls
	☐ Corrosive	☐ Flammable	☐ Magnetic Field*	☐ Pressurized Systems
☐ Asbestos*	☐ Cryogenic	☐ Fumes/Mist/Dust*	☐ Material Handling	☒ Rigging/Critical Lift
☐ Beryllium*	☐ Electrical	☐ Heat/Cold Stress	☐ Noise*	☐ Toxic Materials*
☐ Biohazard*	☒ Elevated Work*	☐ Hydraulic	☐ Non-ionizing Radiation*	☐ Vacuum
☐ Chemicals*	☐ Excavation	☐ Lasers*	☐ Oxygen Deficiency*	☐ Other
* Does this work require medical clearance or surveillance from the Occupational Medicine Clinic? ☐ Yes ☒ No				
Environmental Concerns		☒ None	☐ Work impacts Environmental Permit No.	
☐ Atmospheric Discharges (rad/non-rad)		☐ Land Use	☐ Soil Activation/contamination	☐ Waste-Mixed
☐ Chemical or Rad Material Storage or Use		☐ Liquid Discharges	☐ Waste-Clean	☐ Waste-Radioactive
☐ Cesspools (UIC)		☐ Oil/PCB Management	☐ Waste-Hazardous	☐ Waste-Regulated Medical
☐ High water/power consumption		☐ Spill potential	☐ Waste-Industrial	☐ Underground Duct/Piping
Waste disposition by:				☐ Other
Pollution Prevention (P2)/Waste Minimization Opportunity:		☒ None ☐ Yes		
FACILITY CONCERNS	☒ None			
☐ Access/Egress Limitations	☐ Electrical Noise	☐ Potential to Cause a False Alarm		☐ Vibrations
	☐ Impacts Facility Use Agreement		☐ Temperature Change	☐ Other
☐ Configuration Control	☐ Maintenance Work on Ventilation Systems		☐ Utility Interruptions	
WORK CONTROLS				
Work Practices				
☐ None	☐ Exhaust Ventilation	☒ Lockout/Tagout	☐ Spill Containment	☐ Security (see Instruction Sheet)
☒ Back-up Person/Watch	☐ HP Coverage	☐ Posting/Warning Signs	☐ Time Limitation	☐ Other
☐ Barricades	☐ IH Survey	☐ Scaffolding-requires inspection	☐ Warning Alarm (i.e. "high level")	
Protective Equipment				
☐ None	☐ Ear Plugs	☐ Gloves	☐ Lab Coat	☒ Safety Glasses
☐ Coveralls	☐ Ear Muffs	☐ Goggles	☐ Respirator	☒ Safety Harness
☐ Disposable Clothing	☐ Face Shield	☒ Hard Hat	☐ Shoe Covers	☒ Safety Shoes ☐ Other
Permits Required (Permits must be valid when job is scheduled.)				
☒ None	☐ Cutting/Welding	☐ Impair Fire Protection Systems		
☐ Concrete/Masonry Penetration	☐ Digging/Core Drilling	☐ Rad Work Permit-RWP No		
☐ Confined Space Entry	☐ Electrical Working Hot	☐ Other		
Dosimetry/Monitoring				
☒ None	☐ Heat Stress Monitor	☐ Real Time Monitor	☐ TLD	
☐ Air Effluent	☐ Noise Survey/Dosimeter	☐ Self-reading Pencil Dosimeter	☐ Waste Characterization	
☐ Ground Water	☐ O_2/Combustible Gas	☐ Self-reading Digital Dosimeter	☐ Other Check O2 level prior to entry	
☐ Liquid Effluent	☐ Passive Vapor Monitor	☐ Sorbent Tube/Filter Pump		
Training Requirements (List below specific training requirements)				
CA –Collider User, PHENIX Awareness, Working at heights, rigging				
Based on analysis above, the Walkdown Team determines the risk, complexity, and coordination ratings below:			**If using the permit when all hazard ratings are low, only the following need to sign: (Although allowed, there is no need to use back of form)**	
ES&H Risk Level:	☐ Low ☒ Moderate ☐ High		WCC:	Date:
Complexity Level:	☐ Low ☒ Moderate ☐ High		Service Provider:	Date:
Work Coordination:	☐ Low ☒ Moderate ☐ High		Authorization to start	Date:
			(Departmental Sup/WCC/Designee)	

3. Both work requester and service provider contribute to work plan (use attachments for detailed plans)

Work Plan (procedures, timing, equipment, and personnel availability need to be addressed): The tasks described in this WP are part of the overall efforts related to the new RPC detector subsystem and are superficially described in the CAD WP SS-2010-197. The tasks described herein are sufficiently complex and require a moderate level of work coordination justifying a separate dedicated procedure which is attached to this WP.
Special Working Conditions Required: None
Operational Limits Imposed: Modification work limited to lower octants easily reachable when standing on lower magnet superstructure.
Post Work Testing Required: No

Job Safety Analysis Required: ☐ Yes ☒ No	Walkdown Required: ☒ Yes ☐ No

Reviewed by: Primary Reviewer will determine the size of the review team and the other signatures required based on hazards and job complexity. Primary Reviewer signature means that the hazards and risks that could impact ES&H have been identified and will be controlled according to BNL requirements.

Title	Name (print)	Signature	Life #	Date
Primary Reviewer				
ES&H Professional				
Other				
Other				
Work Control Coordinator				
Service Provider				
	Review Done: ☐ in series	☐ team		

4. Job site personnel fill out this section.

Note: Signature indicates personnel performing work have read and understand the hazards and permit requirements (including any attachments).			
Job Supervisor:		Contractor Supervisor:	
Workers:	Life#:	Workers :	Life#:
Workers are encouraged to provide feedback on ES&H concerns or on ideas for improved job work flow. Use feedback form or space below.			

5. Departmental Job Supervisor, Work Control Coordinator/Designee

Conditions are appropriate to start work: (Permit has been reviewed, work controls are in place and site is ready for job.)			
Name:	Signature:	Life#:	Date:

6. Departmental Job Supervisor, Work Requester/Designee determines if Post Job Review is required. ☐ Yes ☐ No

Post Job Review (Fill in names of reviewers)			
Name:	Signature:	Life#:	Date:
Name:	Signature:	Life#:	Date:

7. Worker provides feedback.

Worker Feedback (use attached sheets as necessary)
a) WCM/WCC: Is any feedback required? ☐ Yes ☐ No

b) Workers: Are there better methods or safer ways to perform this job in the future? ☐ Yes ☐ No

8. Closeout: Work Control Coordinator (authorizing dept.) checks quality of completed permit and ensures the work site is left in an acceptable condition. (WCC can delegate clean up of work area to work supervisor)

Name:	Signature:	Life#:	Date:
Comments:			

Attachment to W.P. #(DRL-2010-11) SS-2010-227

Installation of the RPC Absorbers in the PHENIX Central Magnet

Introduction

In the 2010 shutdown, the PHENIX experiment plans to install the second station of the new RPC detector subassembly in the RHIC tunnel south of the PHENIX IR. This mirrors the detector subassembly installed during the 2009 shutdown in tunnel north of PHENIX. In order to mask as much background scatter which might otherwise obscure the measurements intended to be made with the new subsystem, the RPC group has determined that a certain mass of material should be inserted between the PHENIX Interaction Point (IP) and the new detectors. RPC experts have calculated that this is best achieved by inserting 35 cm of steel between these points of interest, and furthermore, so as to minimally impact the CM field quality, the steel must be of low permeability. After many tradeoffs, type 310 Stainless steel was chosen.

I. Design

The absorber design requirements call for 35 cm of type 310 stainless steel to be attached to the outer sides of the PHENIX Central Magnet (CM) central poles in the conical cavities surrounding the PHENIX Beam-Beam Counter (BBC) subsystem. Thee BBC's are house in lead enclosures commonly referred to as the north and south "flower pots" (due to their shapes). The shape of the cavity is a frustum (truncated cone) within a frustum, the outer frustum formed by the inner walls of the cavity and the inner frustum by the flower pot, both frustums decreasing in diameter at the ends closest to the PHENIX IP. This creates a difficult design, fabrication and installation problem. PHENIX engineering's scheme for maximal coverage and feasible fabrication and installation is to fabricate the absorber in quadrants and 7 layers. This allows the absorber to be fabricated easily with conventional equipment and installed piecemeal so that the installing technicians have sufficient flexibility to maneuver the segments into place and attach the various sections. (Refer to the attached illustrated absorber installation plan for further information.)

The absorbers are supported initially by the shear strength of bolts attaching the segments to first the backplane of the CM pole, then the segments installed prior, and after positioned the vertical load is taken by 12 welded mounting lugs. These lugs will be welded to the CM in-situ by qualified Central Shops welder(s). The lugs have an adjustable bolt which shall be positioned to take the vertical load when the bottom segments are installed and prior to installation to the corresponding upper segments. (Refer to the attached illustrated absorber installation plan for further information.)

The design also requires a special installation tool for lifting and orienting the absorber segments. This tool is completely described in the PHENIX calculation #DRL-2010-3.

This tool lifts 2 or 3 segments at a time so that the lifting load is nearly uniform between lifts enabling the tool to maintain appropriate verticality for the variety of lifts to be performed. The 2 or 3 segments lifted are preassembled then lifted in to place as described in the procedures herein.

II. Fabrication

Fabrication of the segments has been placed with an outside VENDOR thru the University of Illinois, Urbana. The Vendor, Atlas Tool and Die Works has promised a 6 week delivery schedule with partial delivery of the north absorber segments in early August. Mounting lugs, lifting fixture, base shim and welding the lugs to the PHENIX CM will be handled by BNL Central Shops, with assistance and a welding fixture/template to be fabricated by PHENIX technicians. Controlled drawings have been created, reviewed and approved by PHENIX Engineering and are available in the PHENIX/PHYSICS Design Room.

III. BBC Cable modifications.

Installation of the absorbers requires modification of the BBC patch panels adjacent to the BBC's and flowerpots in both the north and south flowerpot vicinity cavities. The modification involves removing the existing patch panel and reworking the panel or the connectors on the panel to route the BBC cables away from the absorbers (which they would otherwise interfere with) and avoid any other interferences with the existing detectors, support structure and utilities. This is worker planned work that will be accomplished by PHENIX mechanical and electrical technicians in close consultation with PHENIX mechanical and electrical engineers. The modifications will be designed in the field at the point of installation after the absorbers have been installed ands great care shall be taken to avoid damaging any cables or connectors when closing up the large PHENIX subsystems at the end of these efforts.

IV. Procedure

This work is to be done by fully trained and experienced personnel (PHENIX mechanical technicians) during the 2010 summer shutdown.

(Please see the RPC Absorber Illustrated installation plan which accompanies this Work Permit for more detailed descriptions of each of the following steps.)

A. Prior to installation:

1. Design an appropriate absorber lifting fixture (by PHENIX engineering to BNL lab standards for "below-the-hook" lifting fixtures, with documentation detailing design criteria and stress analysis assumptions), analyze the fixture (stress analysis for BNL Lifting Safety Committee [LSC] Review), obtain fixture approval (by independent CAD engineering), fabricate the fixture (using materials with appropriate

material certification documentation) and qualify the fixture (in accordance with BNL standards, with a lift test observed and approved by BNL LSC.

2. Characterize detail absorber pieces and measure tolerance (this may be done at the absorber segment vendor) and the results are to be used by PHENIX engineering to sort the pieces as best would allow the full assembly to meet assembly tolerance goals.

3. Remove the existing beampipe and move the CM off of the Beamline axis to a location in the IR whereat the north and south flowerpot region of the CM are maximally accessible. [Note: this is actually accomplished as part of the concurrent PHENIX beampipe upgrade project and has been planned with a separate work permit, # SS-2010-189. Refer to that WP for further info concerning this step.]

4. Modify the BBC cables and cable management as described above..

5. Install weld fixture and mounting stubs. (Central Shops in close coordination with PHENIX mechanical technicians per PHENIX controlled drawings).

6. A Central Shops certified welder shall weld the 24 mounting stubs (12 each on the north and south sides).

7. Install the threaded jack screws on each mounting stub, threaded away as much as possible from their nominal final design positions.

B. **Absorber Installation**

The RPC Absorber is installed in 2 stations, north and south ends of the CM. The north side will be installed first. Each station includes 2 shim pieces and 28 quadrants. The quadrants are installed in preassembled groups of 3 or 2 layers per controlled drawings (105-0224-082 through 105-0224-085 and 105-0224-095). Installing these will require the use of a manlift and the RPC Absorber lifting fixture. The sequence of installation shall be as follows:

North Side

Note: The CM pole-tip back-planes (inner-most vertical surface in the flower pot cavities) have existing M24 tapped holes at approximately 1/2 the distance between the inner and outer radii of the inner-most absorber segments. These tapped holes are used to attach the inner-most segments to the back-planes and to temporarily hold the shims.

1. Preassemble the 12 North segment assemblies per the applicable drawings. These assemblies include 4 assemblies of the inner most segments (east and west, upper

and lower, layers 1 through 3), 4 assemblies of the mid segments (east and west, upper and lower, layers 4 and 5) and 4 assemblies of the outermost segments (east and west, upper and lower, layers 6 and 7). These preassembled segment assemblies are aligned and bolted together using M14 x 40 cap head screws, torqued to 50 ft-lb, max.

2. Attach the lifting fixture extension to the lifting fixture using (4) 1/2-13 x 1.5 inch grade 8 high strength bolts torqued to 35 ft-lb. Attach the 3/4 inch swivel eye to the appropriate lifting hole and torque the lifting eye to its rated value on the eye itself.

3. Install 2 shims, these are to be positioned in place using M24 x 50 socket head cap screws to attach the shims to the flower pot cavity backplane into the existing M24 tapped holes corresponding to the upper 2 quadrants of the absorber assembly to hold the shim in place until the lower segments are installed. *Do not torque these bolts as they will be removed when the lower segments are installed.*

4. Install the innermost segment assemblies. These 4 segment assemblies are installed one at a time (in the order: a. west lower, b. east lower, c. west upper and d. east upper). Installation for each segment proceeds as follows:

    a. Rotated from flat to vertical installed position using the segment rotating fixture.
    b. Attached the segment to the lifting fixture using (4) 1/2-12 x 1.5 inch grade 8 high strength bolts torqued to 35 ft-lb.
    c. Install the two edge locating pins in the existing M24 tapped holes corresponding to the vertical and horizontal quadrant edges for the segment being lifted.
    d. Attach a guide rope/tether to aid in orienting the segment as it is lifted.
    e. Carefully lift the segment up to its mounting level and move it into mounting position using the locating pins to precisely position the segment assembly into its intended location. (Note: the lift shall involve 3 PHENIX mechanical technicians as follows: one operating the crane, one on a manlift or work platform at installation level, and a third technician as a back-up/watch person to assure that the lift area remains clear of un-involved personnel, to watch for contact between the load, lifting fixture and or crane hoist and other equipment in the vicinity of the lift and to man the tether line to make sure the load does not turn, spin or otherwise move in an unexpected manner. Each of the 3 technicians shall take care to never position themselves below the load and/or lifting fixture.)
    f. When the segment is properly positioned fasten it to the backplane using M-24x50 cap head screws, torqued to 150 ft lbs.
    g. After each lower segment is installed jack the lifting screws in the welded mounting stubs 1/2 turn past initial contact.
    h. After both lower segments have been installed the M-24 bolts that were holding the shims (see step 2 above) shall be removed.

i. After the first and second segments have been installed only one additional locating pin need be installed as the other locating pin is shared with the previously installed segment. After the third segment is installed, the fourth segment's locating pins will already be in place from the installation of the first and third segments.

5. Remove the lifting fixture extension from the lifting fixture.

6. Install the 4 mid segments. These 4 segment assemblies are installed one at a time (in the order: a. west lower, b. east lower, c. west upper and d. east upper). Installation for each segment proceeds as follows:

    a. Rotated from flat to vertical installed position using the segment rotating fixture.
    b. Attached the segment to the lifting fixture using (4) 1/2-13 x 1.5 inch grade 8 high strength bolts torqued to 35 ft-lb.
    c. Install the two edge locating pin mid extensions to the existing locating pins corresponding to the vertical and horizontal quadrant edges for the segment being lifted.
    d. Attach a guide rope/tether to aid in orienting the segment as it is lifted.
    e. Carefully lift the segment up to its mounting level and move it into mounting position using the locating pins to precisely position the segment assembly into its intended location.
    f. When the segment is properly positioned fasten it to the corresponding inner-most segment using (4) 1/2-13 x 1-1/2 inch cap screws, torqued to 35 ft-lb
    g. After each mid segment is installed jack the lifting screws in the welded mounting stubs 1/2 turn past initial contact.
    h. After the first and second segments have been installed only one additional locating pin extension need be installed as the other locating pin extension is shared with the previously installed segment. After the third segment is installed, the fourth segment's locating pin extensions will already be in place from the installation of the first and third segments.

7. Install the 4 mid segments. These 4 segment assemblies are installed one at a time (in the order: a. west lower, b. east lower, c. west upper and d. east upper). Installation for each segment proceeds as follows:

    a. Rotated from flat to vertical installed position using the segment rotating fixture.
    b. Attached the segment to the lifting fixture using (4) 1/2-13 x 1.5 inch grade 8 high strength bolts torqued to 35 ft-lb.
    c. Install the two edge locating pin mid extensions to the existing locating pins corresponding to the vertical and horizontal quadrant edges for the segment being lifted.

d. Attach a guide rope/tether to aid in orienting the segment as it is lifted.
e. Carefully lift the segment up to its mounting level and move it into mounting position using the locating pins to precisely position the segment assembly into its intended location.
f. When the segment is properly positioned fasten it to the corresponding inner-most segment using (4) 1/2-13 x 1-1/2 inch cap screws, torqued to 35 ft-lb
g. After each outer segment is installed jack the lifting screws in the welded mounting stubs 1/2 turn past initial contact.
h. After the first and second segments have been installed only one additional locating pin extension need be installed as the other locating pin extension is shared with the previously installed segment. After the third segment is installed, the fourth segment's locating pin extensions will already be in place from the installation of the first and third segments.

South Side

The installation procedure for the south side is the same as for the north side.

V. Work conclusion

When all work described in this work permit has been completed, the PHENIX work coordinator for this set of tasks shall collect feedback from all parties (BNL trade groups, CAD engineers and technicians, PHENIX engineers and technicians and RPC experts). This feedback shall include critical review of any problems encountered during installation, solutions to such problems, changes to work procedures described herein during the conduct of this work, suggestions for improvements in equipment procedures and techniques and any other information deemed useful and/or relevant by the PHENIX work control coordinator. Such information shall be appropriately disseminated to the various affected/interested parties and a copy of this information shall be attached to this work permit when it is closed out.

RPC Absorber Installation Plan
During the 2010 Summer Shutdown

Don Lynch

8/1/2010

Absorber Installation

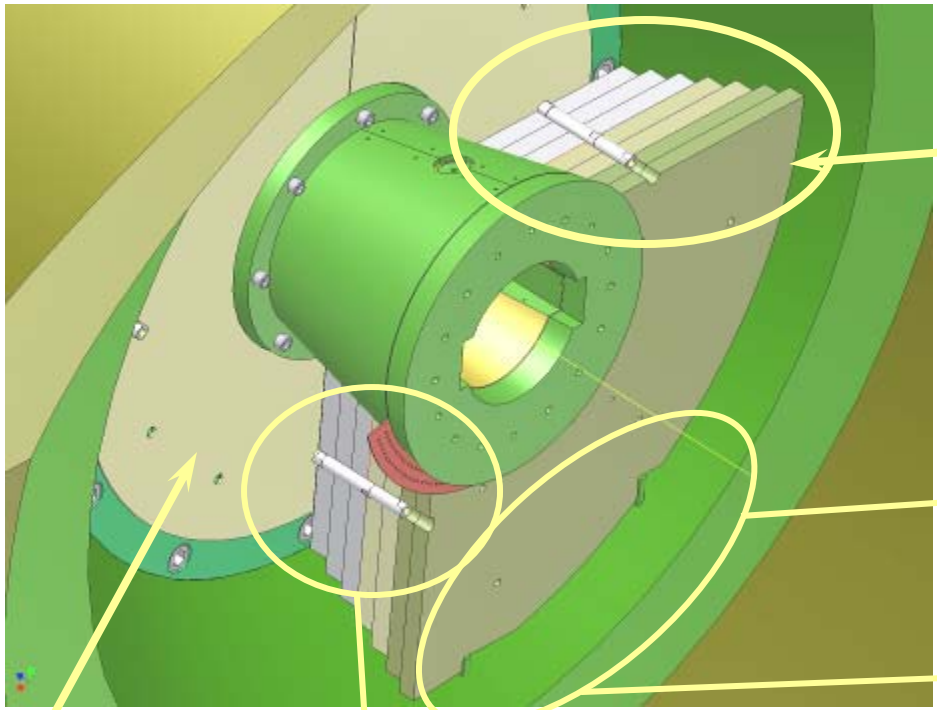
During the summer 2010 shutdown maintenance period PHENIX technicians will install nearly 20 tons of stainless steel in the "flowerpot" cavities on the north and south sides of the PHENIX Central Magnet (CM)

The absorbers will be made of 310 Stainless Steel, scosen for its low permeability and resistance to permeability changes due to thermal and mechanical fabrication processes.

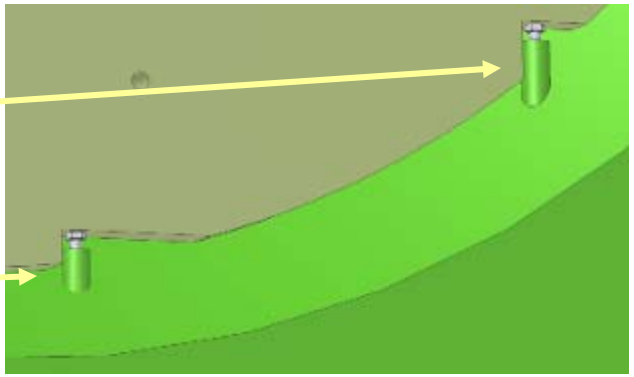
The absorbers will be made of 7 horizontal layers on each the north and south sides of the CM attached by bolts to the back plane of the respecive CM poles at the first layer and each subsequent layer to the layer before it. The first 5 layers are each 2 inches thick while the last layer is 1-3/4 inches thick.

The layers are preassembled into 12 quadrant subassemblies with the four innermost quadrants comprised of the first 3 layers, the four middle quadrants comprised of 2 layers and the outermost quadrants comprised also of 2 layers. An additional shim layer is sandwiched between the innermost layers and the pole backplanes.

Additional support is provided from welded stubs on the conical face of the "flowerpot" cavities. These stubs are welded in 2 positions for each of the 6 lower quadrant subassemblies.

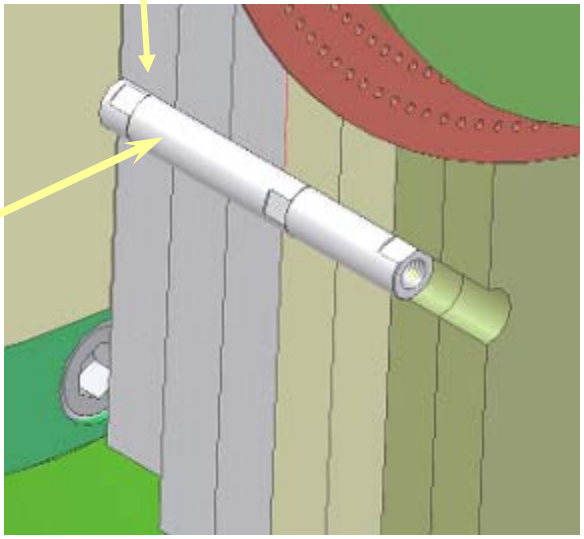


Absorber design concept:
7 layers, 4 quadrants per layer + 1 Shim layer Each layer indexed and bolted to previous layer. Installed 3 in assembled quadrant 2 or 3 layers using a counterbalanced lifting fixture.



Shim layer

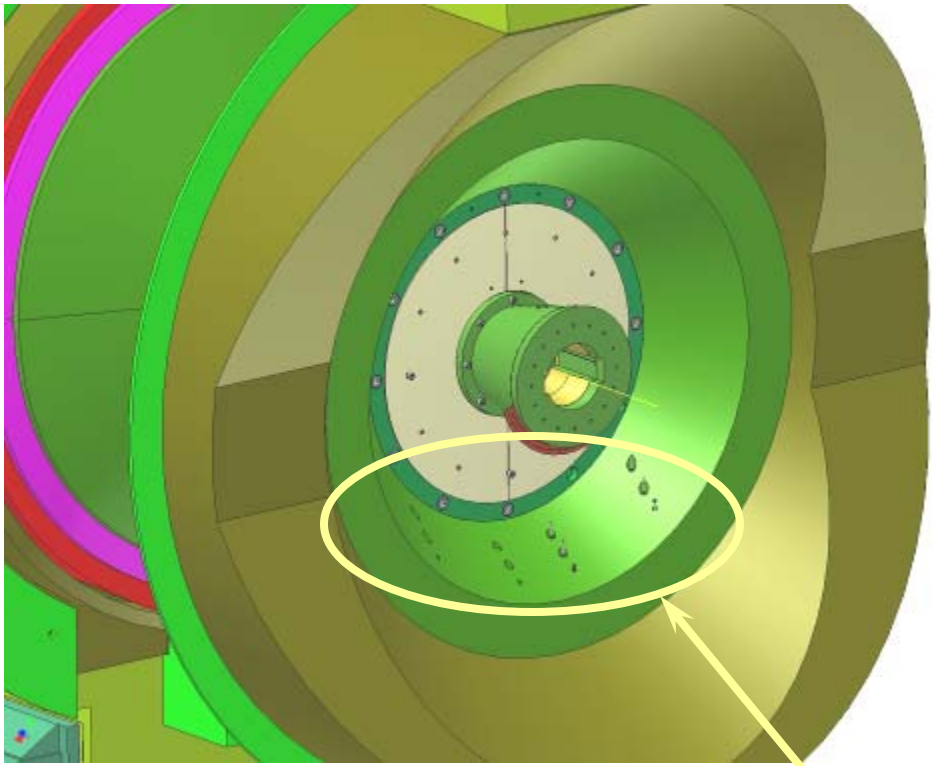
Guide pin and extensions



RPC Absorber Final Design

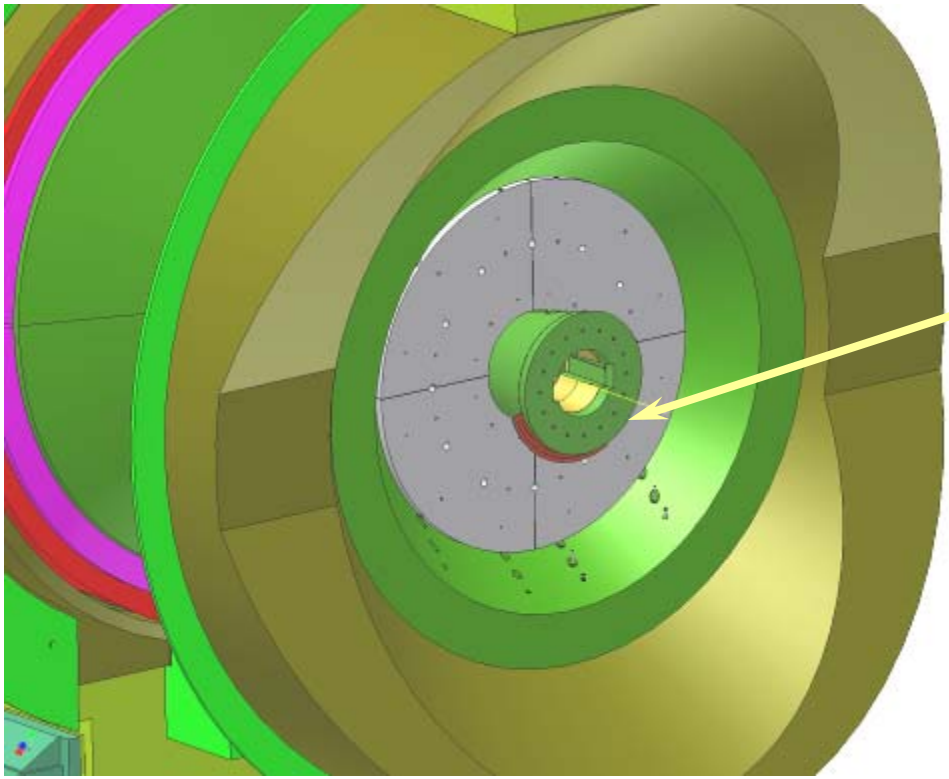
- Welded & tapped vertical support bossess
- 3 stage positioning rod

There are 12 support bosses (on each north and south), each using ½-13 bolts for support. Worst case stress analysis 18,000 lbs, evenly distributed on bolts only= 18000/12/.1416= 10,600 psi per bolt

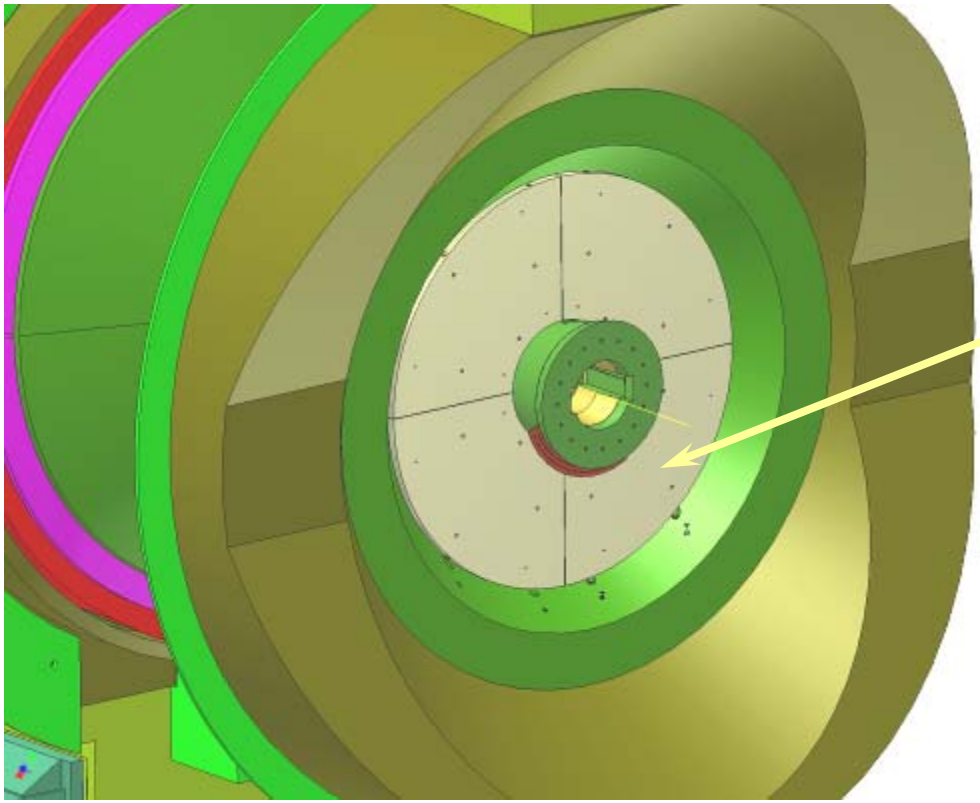


Shim layer installed

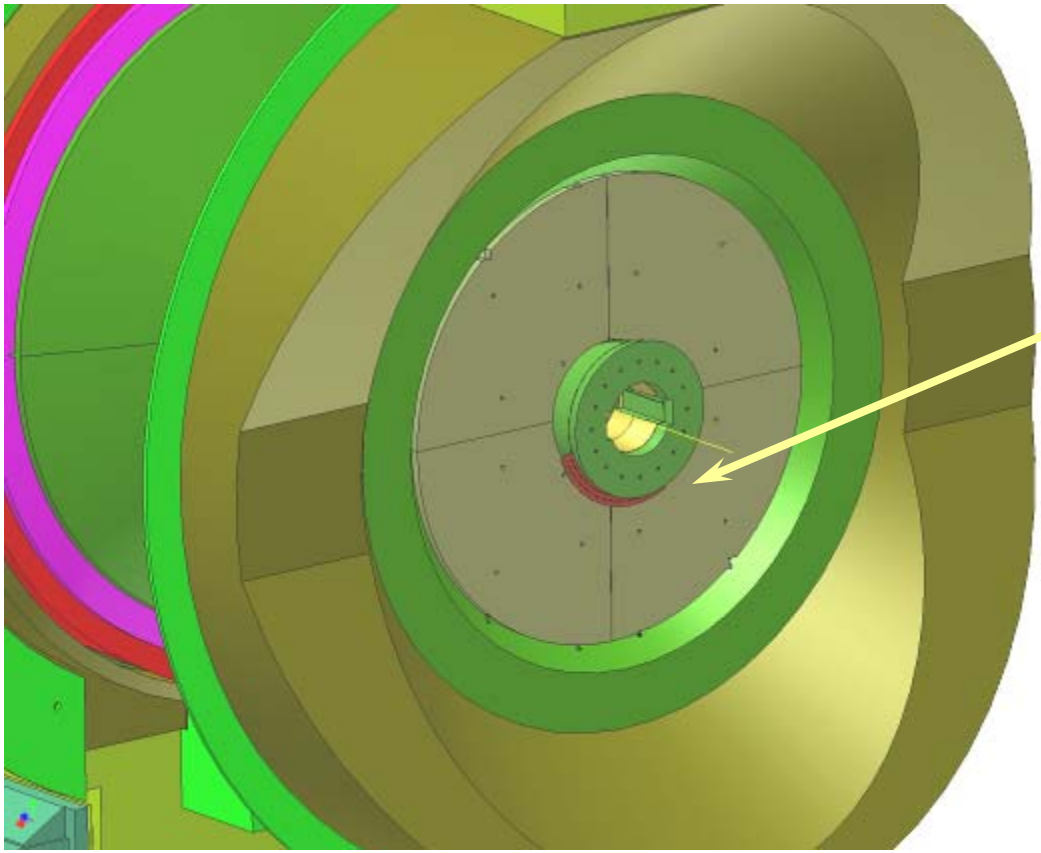
Vertical Support stubs installed



Inner-most quadrant subbassemlies (layers 1-3) installed

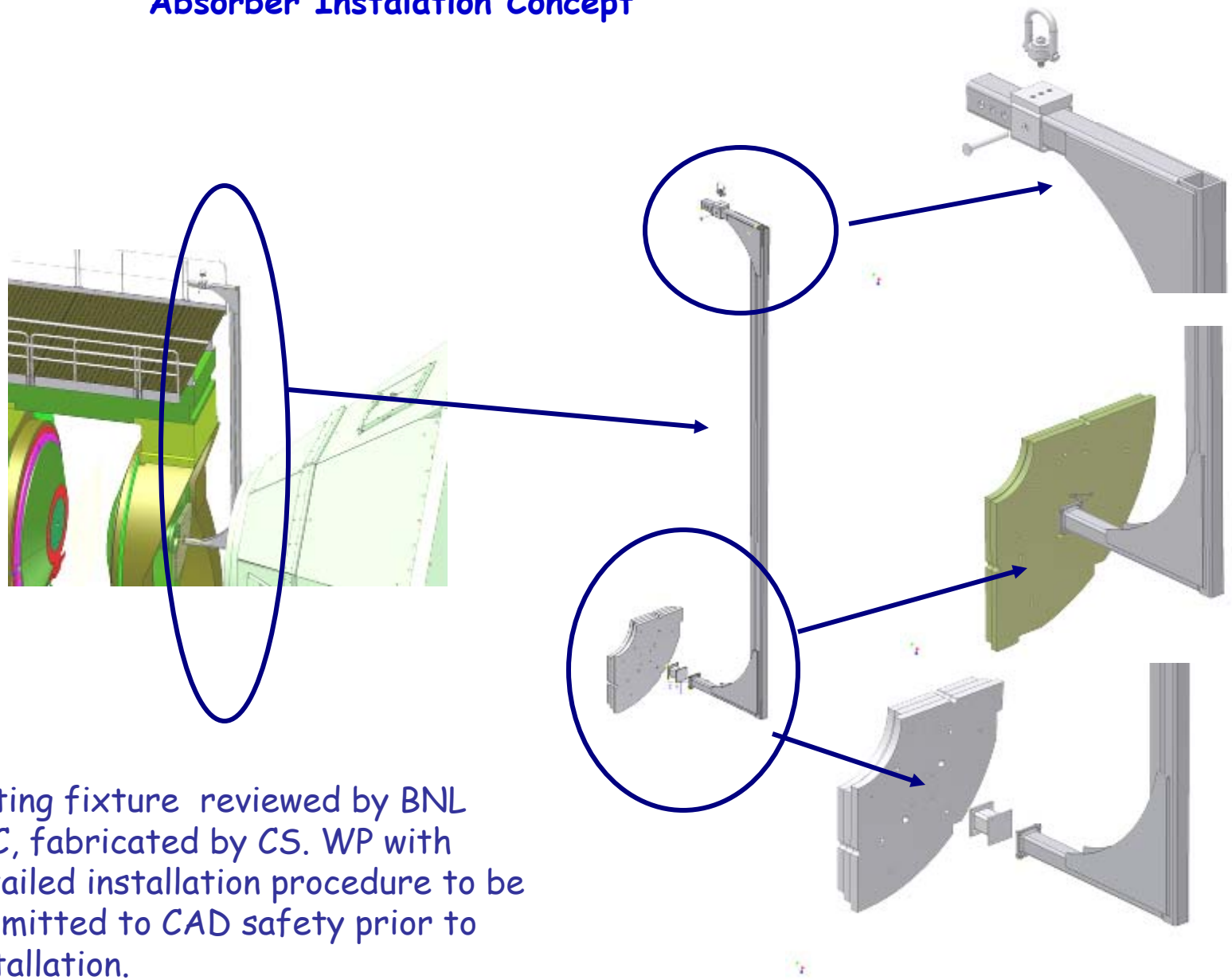


Inner-most quadrant subbassemlies (layers 4 & 5) installed

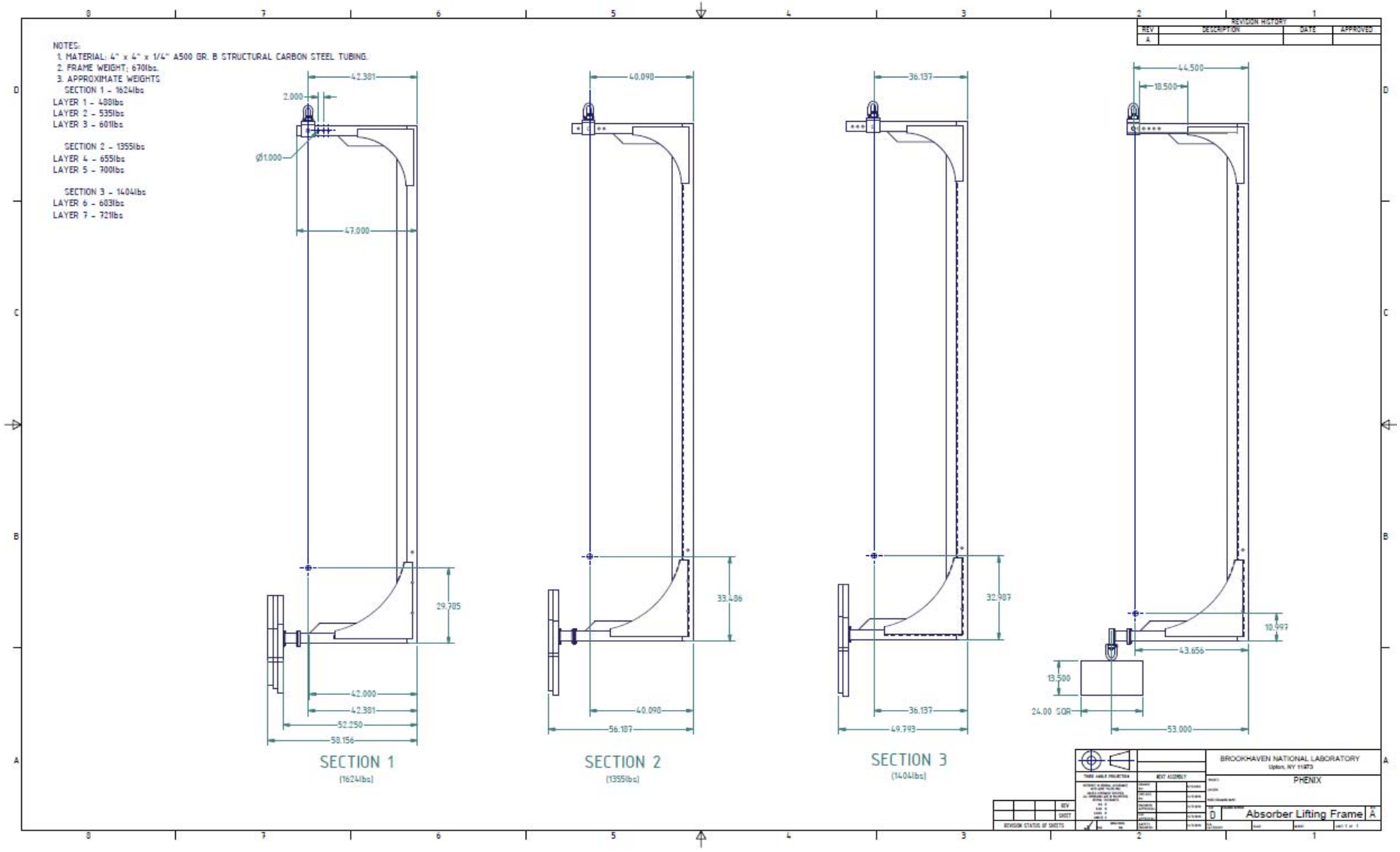


Inner-most quadrant subbassemlies (layers 4 & 5) installed

Absorber Instalation Concept



Lifting fixture reviewed by BNL LSC, fabricated by CS. WP with detailed installation procedure to be submitted to CAD safety prior to installation.



Lift Fixture is designed to work with any quadrant of the 3 subassembly configurations. Also designed for the load test configration.

Safety

- What Safety issues do we know of?
  - Material handling
  - Communication
  - Site hazards (Crane)
  - Work Coordination
  - Other
- What potential hazards may exist that we haven't identified
  - Legacy items
  - Access issues
  - Unplanned changes to work schedule
  - Manpower issues
  - Changes to conditions
- How do we deal with these
  - Stop, ask questions, re examine
  - Stop Work
  - Appropriate PPE
  - Careful planning
  - Practice with lift fixture and loads near ground level to master lift fixture control