



National Spherical Torus eXperiment Upgrade

Bakeout DC Supply Reconfiguration WBS 1.03.01.05

NSTX-U Recovery Project FDR – March 17-19, 2020

Antonio Falcon - Cognizant Engineer

Last edit: 3/10/20

Outline

1. Overview

2. Scope

3. Requirements and Interfaces

4. Analysis/Prototyping

5. Chit Closure

6. Procurement, Fabrication, Installation, and Test

7. Risk - Project Risks and Design FMECA

8. Quality, Environmental, Safety, and Health

9. Summary

Overview - WBS 1.003.01.05

WBS Title	DC Supply Relocation	WBS #	1.03.01.05
Project Cog.	A. Falcon	Assoc. Proj. Man.	Thomas Jernigan
Design Scope	Permanently install power supplies on the '119 Platform		
Technical Impact of Scope	Connect power supplies to upper CHI flags via permanent power cables during Bakeout Operations		
Design Status	FDR completed on 1/10/2020: review link chits: link calculations: link drawings: link		
Fabrication Status	Fabrication will follow associated drawings and coordination with the machine shop		
Installation Status	Powers Electric will perform installation of the electrical feed, cable tray and cables following CD3B Approval. PPPL employees shall install the water lines, PLC control cables, and modify the 119' Platform.		

Outline

1. Overview

2. Scope

3. Requirements and Interfaces

4. Analysis/Prototyping

5. Chit Closure

6. Procurement, Fabrication, Installation, and Test

7. Risk - Project Risks and Design FMECA

8. Quality, Environmental, Safety, and Health

9. Summary

Scope

- Power Supplies permanently relocated to the 119' Platform
- Permanently installed water lines to the power supplies will be provided
- New dedicated AC power outlets and fused disconnects will be installed on West Wall near the 119' Platform Extension
- The PLC Cable Connections will be permanently installed/connected NOTE: The existing Operational Controls and Interlocks will remain
- Permanent output cables from the power supplies to the Upper CHI Flags(18-777 MCM cables; exact model as cables presently used during bakeout)

DC Supplies and Location

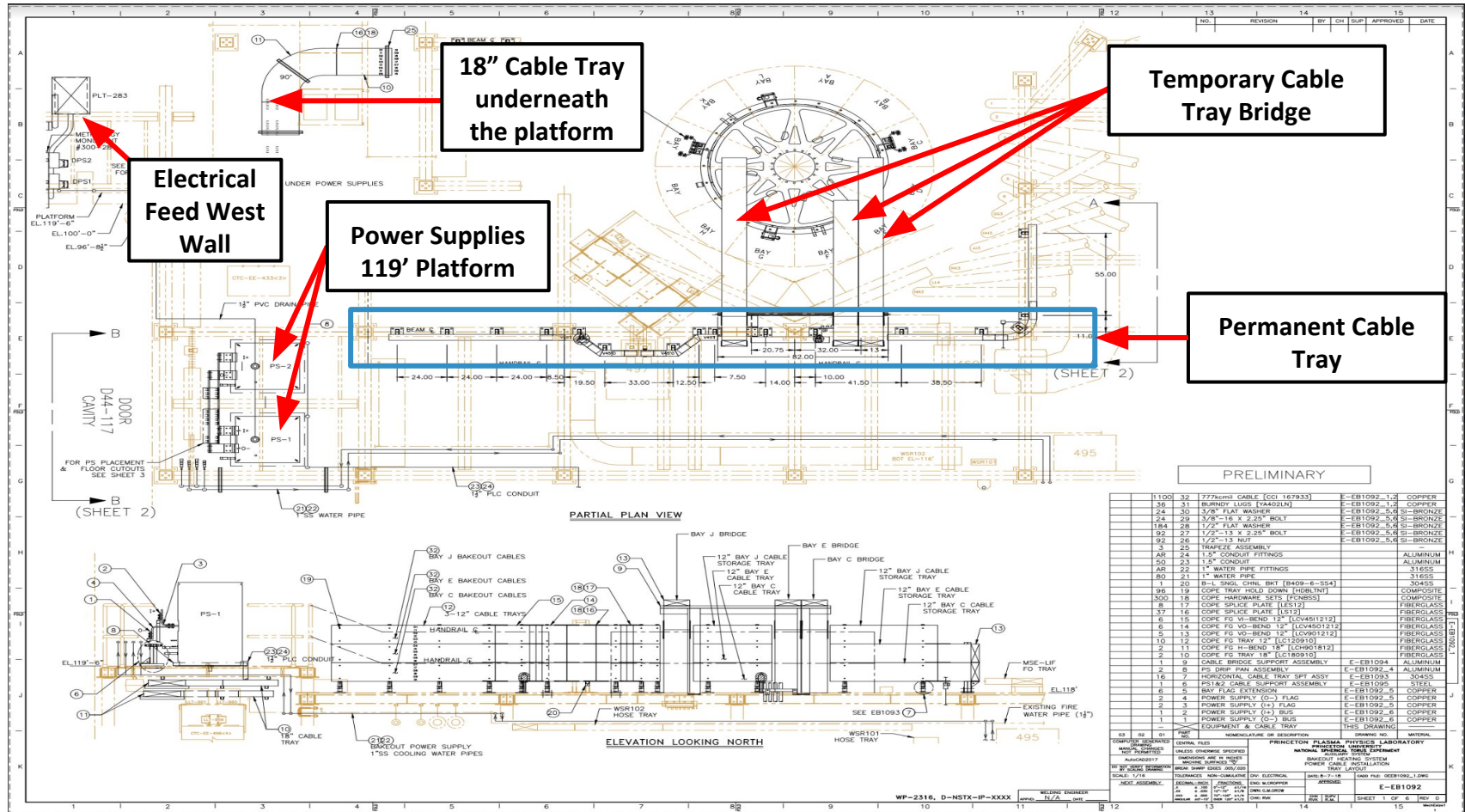


Rear View of Supplies

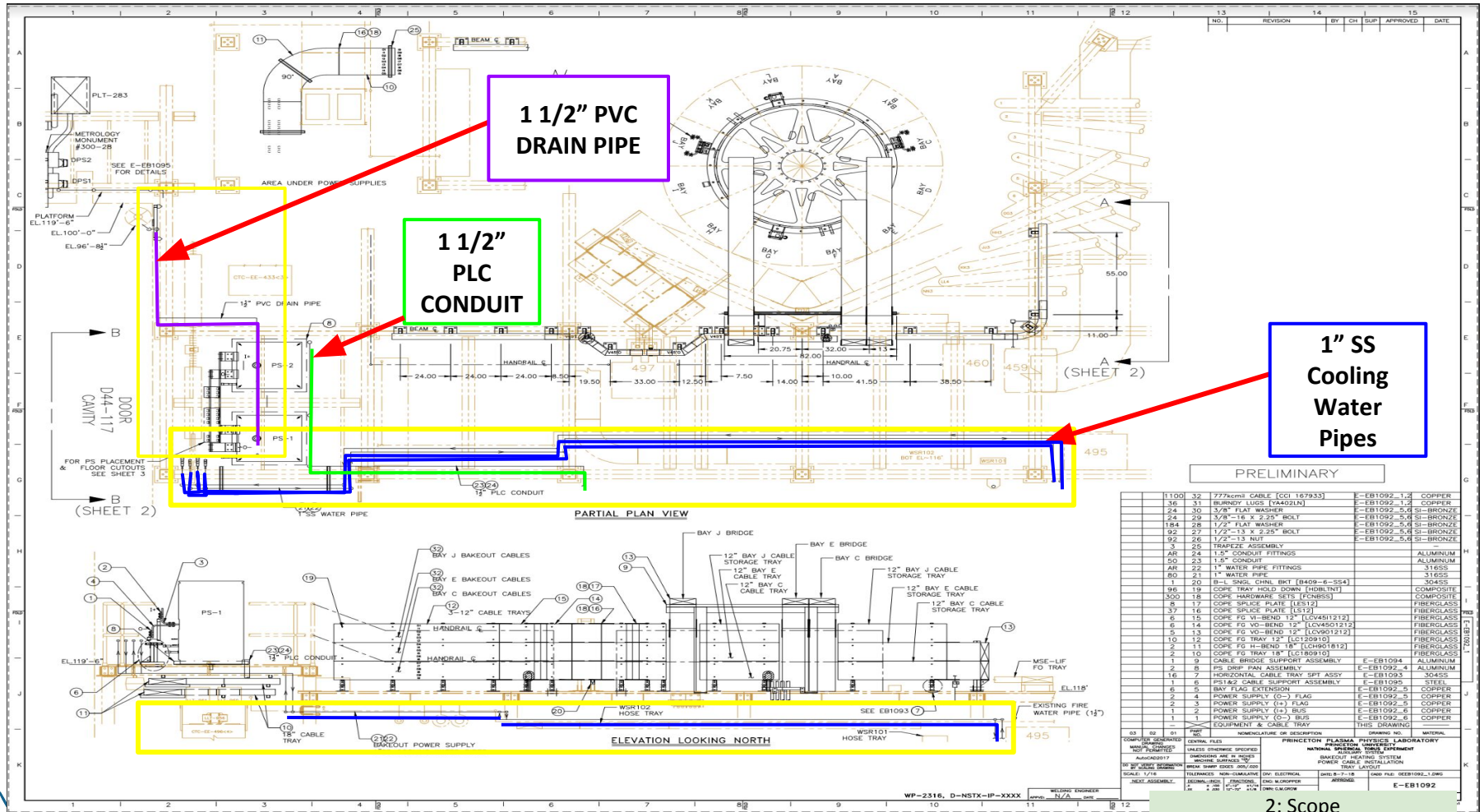


Permanent Location on 119' Platform

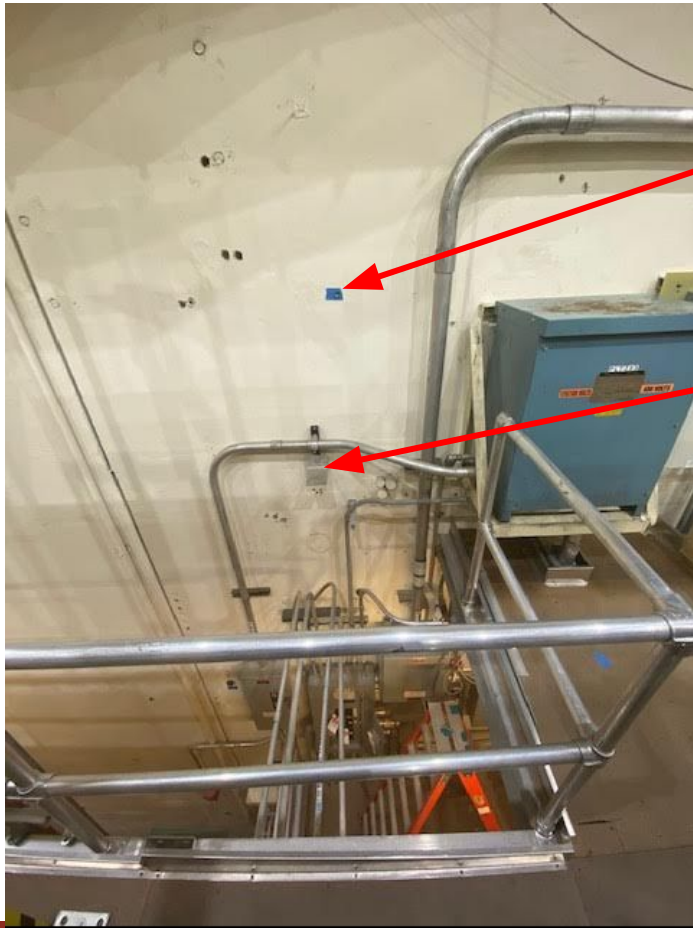
Permanent Installation Has Been Designed & Documented With Drawings (Overall Drawing Below)



Permanently installed water lines to the power supplies will be provided, as well as a drip pan drain and PLC Control Cables



Installation of 119 Platform Extension Gives Access to the West Wall for the Electrical Feed Installation

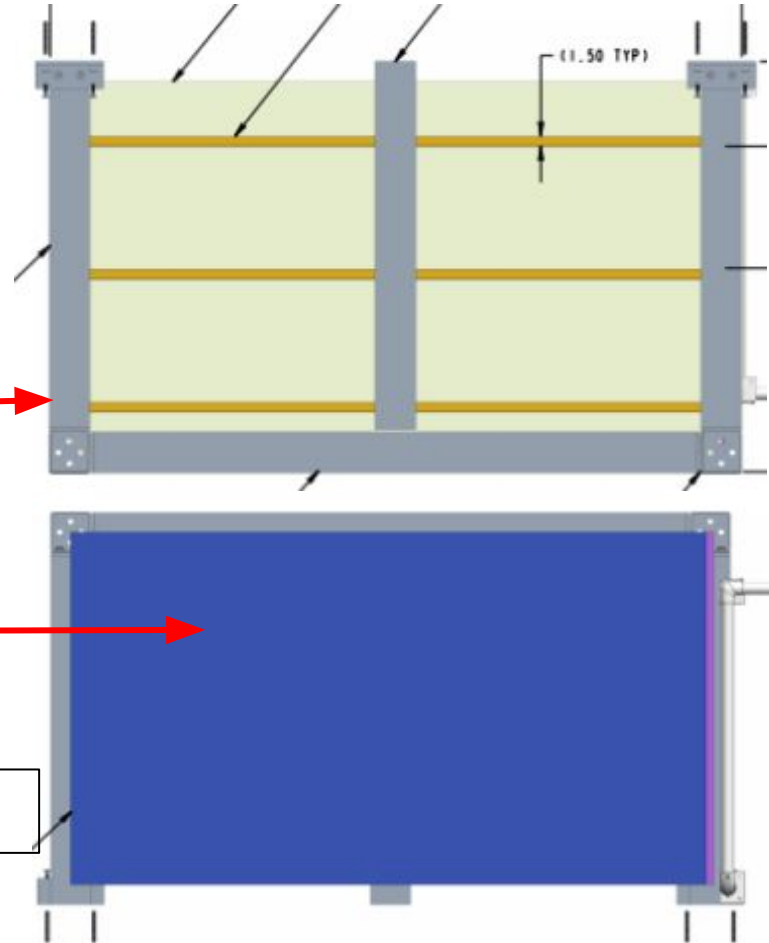


Electrical
Feed
Location on
West Wall

Support
Frame for
Extension

Platform
(Plywood and
masonite)

Drawing: [E-FA1068](#)



119' Platform – Structural Assessment

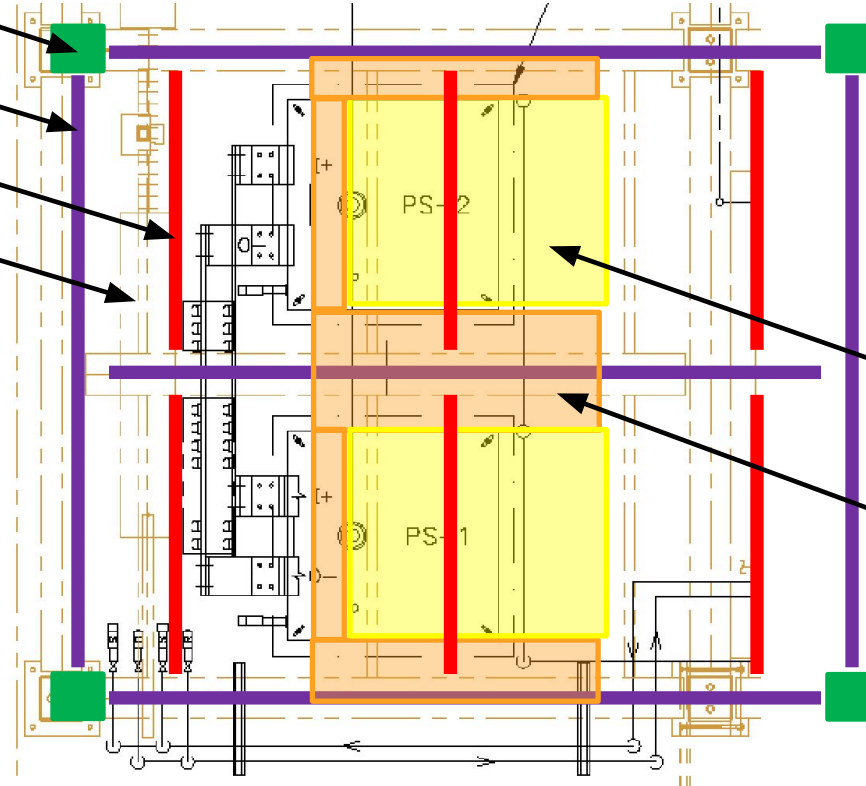
NSTXU 1-8-1-1-1 CALC 100

Aluminum Post, Typ.

Aluminum Beam, Typ.

2x6 Wood Joist, Typ.

1" Thick Plywood



Power Supply Units

Load = 2,268 lbs.

Area = 6.7 sq. ft.

D.L. = 340 psf

Live Load = 150 psf

119' Platform – Structural Retrofit

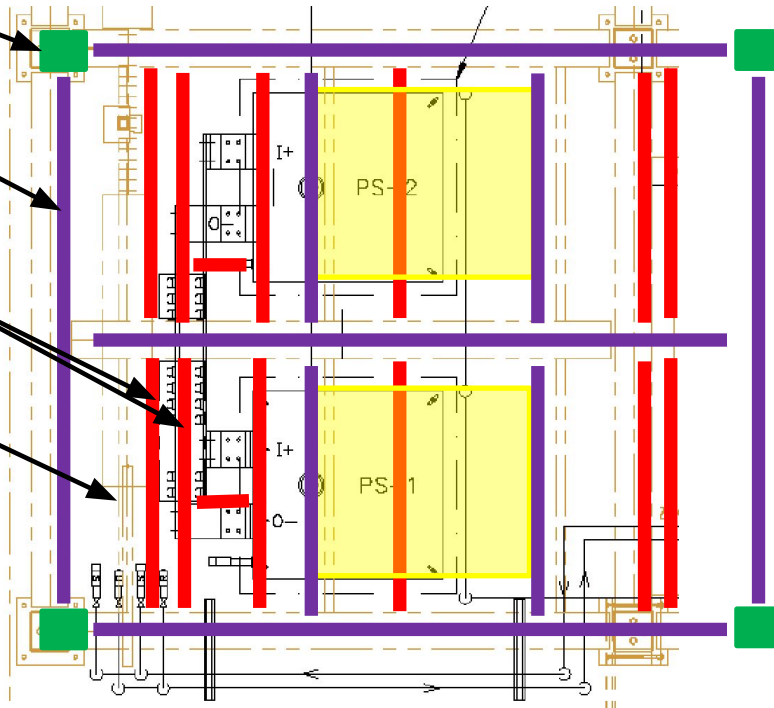
NSTXU 1-8-1-1-1 CALC 102

Aluminum
Post, Typ.

Aluminum
Beam, Typ.

2x6 Wood
Joist, Typ.

1" Thick
Plywood



CONSTRUCTION SEQUENCE

Remove plywood sheets and
2x6 wood joists

Install (4) four-new aluminum
beams

Install 2x6 wood joist centered
on span and around openings

Re-install plywood sheets

Install power supply units

Outline

1. Overview

2. Scope

3. Requirements and Interfaces

4. Analysis/Prototyping

5. Chit Closure

6. Procurement, Fabrication, Installation, and Test

7. Risk - Project Risks and Design FMECA

8. Quality, Environmental, Safety, and Health

9. Summary

Key Requirements Defined and Met

Source	Requirements	Comment	met
NSTX-U-RQMT-RD-015-02	Permanently relocate PS	Power Supplies shall be permanently installed on 119' platform	✓
NSTX-U-RQMT-RD-015-02	Reconfigure cabling, AC power, water lines	Defines need of permanent solutions for items listed	✓
NSTX-U-RQMT-RD-015-02	DC current supplied to top of machine	CHI Ring Bus removed creating the need to supply current to the top of the machine	✓
NSTX-U-RQMT-RD-015-02	Deliver up to 8kA to Center Stack	Same values as previous configuration	✓
NSTX-U-RQMT-RD-015-02	Individual feed points to be 5.3 kA	5.3kA is derived from a ⅓ split of the 8 kA, with a safety factor of 2	✓
NSTX-U-RQMT-RD-015-02	installation for system ready in <2 shifts	This consists of the temporary trays and cable connections	✓
NSTX-U-RQMT-RD-015-02	Maintain current interlocks, inputs, outputs	Interlocks, inputs, and outputs are the same	✓

Details of Interfaces Defined in Interface Control Documents

System 1	System 2	ICD Link	Exposition
Bakeout Systems	Center Stack Structures	link	Defines interfaces between the Bakeout System and the at the flag located on the Center Stack horizontal flange
Bakeout	Cooling	link	Defines interfaces between the Bakeout Bus Bars and the Cooling System
Bakeout Systems	Vacuum Pumping System	link	Defines interfaces between the Bakeout System and the Vacuum pumping System PLC for control
Bakeout	Power Systems	link	Defines interfaces between the Bakeout System and the Power System
Bakeout Systems	Test Cell	link	Defines interfaces between the Bakeout System and the Test Cell platforms

Outline

1. Overview
2. Scope
3. Requirements and Interfaces
4. Analysis/Prototyping
5. Chit Closure
6. Procurement, Fabrication, Installation, and Test
7. Risk - Project Risks and Design FMECA
8. Quality, Environmental, Safety, and Health
9. Summary

Calculations Verify Design Meets Requirements

Physical Quantity	Calculation #	Content
119' Platform As Built	NSTXU_1-8-1-1-1_CALC_100	Calculation of the current design of the platform shows inadequacy to handle the weight of the supplies
119' Platform Redesign	NSTXU_1-8-1-1-1_CALC_102	Calculation of the 119 Platform Redesign verifies the platform can withstand the weight

The design of the new platform is similar to the previous deployment, which utilizes Commercial Off The Shelf components; therefore, no prototyping is required.


Outline

1. Overview
2. Scope
3. Requirements and Interfaces
4. Analysis/Prototyping
5. Chit Closure
6. Procurement, Fabrication, Installation, and Test
7. Risk - Project Risks and Design FMECA
8. Quality, Environmental, Safety, and Health
9. Summary

All Chits have been Closed

- All pre-FDR chits closed at the FDR
- All FDR chits now closed

APPROVED
PPPL

 **PPPL** PRINCETON
PLASMA PHYSICS
LABORATORY

ENG-033 - CRR - CHIT RESOLUTION REPORT
BAKEOUT CHIT RESOLUTION REPORT

NSTXU_1-3-3_CRR_100
Rev. 1

Work Planning #:
Effective Date: **03/06/2020**
Prepared By: **Peter Dugan**

Reviewed By	Joseph Petrella, Cognizant Individual	03/04/2020 11:40:50 AM
Reviewed By	Yuhu Zhai, Project Engineer	03/06/2020 08:12:22 AM
Approved By	Robert A. Ellis, Chief Engineer	03/06/2020 08:23:26 AM

PRINCETON PLASMA PHYSICS LABORATORY
P.O. BOX 451 PRINCETON, N.J. 08543

Chit Resolution Report: [link](#)

Outline

1. Overview
2. Scope
3. Requirements and Interfaces
4. Analysis/Prototyping
5. Chit Closure
6. Procurement, Fabrication, Installation, and Test
7. Risk - Project Risks and Design FMECA
8. Quality, Environmental, Safety, and Health
9. Summary

Manufacturing/Procurement Plan

- The DC Power Supplies are already on hand
- Commercial Off The Shelf power cables
 - CCI Royal 777 KCMIL (393.9MM²) DLO 90C 2000V -- E137925-L UL
- Raw materials and components are off the shelf items

Fabrication/Installation

- Installation will occur in the field using standard installation procedures for the electrical and mechanical components, and follow the associated drawings
- Some portions of the install will be a field fit installation (water lines)
- ENG-014 will be used to guide and document the hydro test of the cooling water hard and soft connections, one time only, prior to beginning bakeout operations

DC Supplies Test Procedure

- Pre-Operational Configuration Check
 - Megger cable connections per PTP-GEN-01
 - Perform Point-To-Point check on control cables
 - Rope off all areas with exposed voltage connections
 - Verify power up
- Pre-Operational Control Check
 - Verify Local E-Stop trip supplies
 - Verify Bakeout PLC interlocks (multiple per Bakeout System commissioning PTP/ISTP on M&RP Bakeout PLC Replacement Scope)
 - Test Bakeout PLC controls (i.e. adjust voltage and current on the supplies)

Outline

1. Overview
2. Scope
3. Requirements and Interfaces
4. Analysis/Prototyping
5. Chit Closure
6. Procurement, Fabrication, Installation, and Test
7. Risk - Project Risks and Design FMECA
8. Quality, Environmental, Safety, and Health
9. Summary

Project Risks are Actively Being Managed

Risk	Score (1-81)	Open/Retired	Risk Retirement Event
No WBS-specific risks in Risk Registry			

Risks related to fitup, etc held at the Project level

FMECA - DC Bakeout System

System	Failure Mode	Failure Cause	Failure Effect	R	Detection/ Mitigation System (1)	Detection/ Mitigation System (2)	Detection/ Mitigation System (3)	R_R
Bakeout DC Power Supplies	Power supply or control failure - no current sourced	internal component failure, (PLC or Power Supply Control) I/O error	Loss of ability to maintain or add heat directly to CS casing, must end bake	6	Bakeout PLC and Controls	None	None	6
Bakeout DC Power Supplies	Power supply or control failure - maximum current sourced	Loss of internal supply regulation, due to component failure; PLC I/O error	excess power delivered to the CS casing	4	Bakeout PLC and Controls	None	None	2
Bakeout DC Power Supplies	Loss of power to DC supply	local breaker opens	Loss of ability to maintain or add heat directly to CS casing, must end bake	4	Bakeout PLC and Controls	None	None	0
Bakeout DC Power Supplies	Terminal overheating on back of power supply	inadequate bolt pressure	failure of connection and inability to use system	4	None	None	None	0
Bakeout DC Power Supplies	Large leak where water is connected to supplies	connections fail at fitting	Water gets caught in drip pan and drained down to sump pump	3	Bakeout PLC and Controls	CWS Flow and Temperature Instrumentation	None	3
Bakeout DC Power Supplies	Loss of cooling to power supply	failure of low pressure pump; debris in line blocks flow	Loss of ability to maintain or add heat directly to CS casing, must end bake	2	Bakeout PLC and Controls	CWS Flow and Temperature Instrumentation	None	2

Outline

1. Overview
2. Scope
3. Requirements and Interfaces
4. Analysis/Prototyping
5. Chit Closure
6. Procurement, Fabrication, Installation, and Test
7. Risk - Project Risks and Design FMECA
8. Quality, Environmental, Safety, and Health
9. Summary

Safety

- Work hazards are standard industrial hazards
 - Hand Tools, LOTO, Ladder Safety, Fall Protection
- Critical Lift
 - Follow ES-MECH-007 “Hoisting and Rigging Standard”
- Hazards mitigated through PPPL ISM and ES&H Internal Procedures
 - ESH-004 Job Hazard Analysis completed prior to start of work
 - Obtain D-Site Work Permit
 - Work scheduled through rollover and work control center to avoid work area conflicts
 - Trained and qualified workers shall follow ESH-016 - Control of Hazardous Energy (Lockout/Tagout)
 - Follow ESH-014 for Hydrostatic testing
- PPPL employees shall supervise work done by subcontractors

Outline

1. Overview
2. Scope
3. Requirements and Interfaces
4. Analysis/Prototyping
5. Chit Closure
6. Procurement, Fabrication, Installation, and Test
7. Risk - Project Risks and Design FMECA
8. Quality, Environmental, Safety, and Health
9. Summary

Summary

- Requirements detailed in the Bakeout Upgrades Requirements Document have been met by the design as supported by analysis and the new/updated drawings.
- Interfaces are considered in the design and documented in the various Bakeout Systems Interface Control Documents
- All associated DC Supply CHITs are summarized and closed in the Bakeout Systems CHIT Report
- All Design Risks have been mitigated through the design
- Environmental, Safety, & Health considerations are standard practices for the laboratory