To: L. Dudek
From: W. Blanchard

Subject: Closeout Summary for NSCX Vacuum Pumping System (WBS22)

Scope
The project scope consisted of a high vacuum pumping system which would be remotely controlled and monitored and included two 1500 l/sec TMPs, two isolation valves, and a vertical pumpduct connected to a transition duct off of one of the neutral beam ports. The TMPs would be backed by existing mechanical pumps. The system would also contain an RGA system, gauging and a roughing line between an existing mechanical pump and the vacuum vessel. The scope included the design, fabrication, installation, and system testing of equipment needed to implement the vacuum pumping system and would utilize major components from PPPL legacy equipment including the TMPs, backing pumps, roughing pump and TMP isolation valves. Possible upgrades included one (or two) additional pumpduct and TMPs connected to one (or both) of the remaining NB transition ducts if required by the project.

Status
This project was in the early design phase and there had not been a PDR.

Interfaces
The only interface for this system was a neutral beam transition duct.

Specification
This work was in the early phase of development and the general requirements were in the GRD.

Schematics
No formal approved schematics or PIDs had been generated for this project at the time of closeout.

Models
No formal approved models had been generated for this project.

Drawings
No formal approved drawings had been generated for this project.

Analysis
A preliminary calculation of the pumping speed was completed (Attached).

Testing
Tests were run on the TMPs and backing pumps to ensure they were in working order.

Costs
There are no pending cost updates for this WBS – the latest Lehman Review data (April 2008) is attached.

Remaining Work
There is no remaining work required to close this project out.

Lessons Learned: NONE

Conclusions: NONE, except that legacy equipment may not be available for reuse at a later date.

NCSX Pumping Speed

Note: All pumping speeds and conductances are for air and in l/s
$1/C_T = 1/C_1 + 1/C_2 + \ldots + 1/C_n$ (for conductances and pumps in series)
$C_T = C_1 + C_2 + \ldots\ldots + C_n$ (for conductances and pumps in parallel)
Reference: A. Roth, Vacuum Technology 3rd Edition

Effective pumping speed of 2 TMPs in parallel to the large pumpduct

	1st pump to 24" main duct	2nd pump up to 24" main duct
TMP=	**1,450**	**1,450**
Component	TIV	TIV
Conductance diameter in inches=	10.0	10.0
Conductance length in inches=	5.5	5.5
Conductance=	**14,196**	**14,196**
Component	Elbow and Spool Piece	Elbow and Spool Piece
Conductance diameter in inches=	13.5	13.5
Conductance length in inches=	32.0	32.0
Conductance=	**6,003**	**6,003**
Effective pumping speed of each TMP to duct=	**1,079**	**1,079**

Effective pumping speed of 2 TMPs in parallel to main duct (S_1) = 2,158

Calculation of conductances in series

Component	Vertical 24" duct
Conductance diameter in inches=	23.25
Conductance length in inches=	90
Conductance=	**10,903**
Component	Transition to NB duct
Conductance diameter in inches=	13.5
Conductance length in inches=	22
Conductance=	**8,732**
Component	Vertical part of NB duct
Length of 1st side in inches=	13.5
Length of 2nd side in inches=	20.0
Conductance length in inches=	17
Conductance=	**29,848**

Component	Horizontal part of NB duct
Length of 1st side in inches=	13.5
Length of 2nd side in inches=	33
Conductance length in inches=	10
Conductance=	**99,522**

Component	NB port spool piece extension
Conductance diameter in inches=	23
Conductance length in inches=	23
Conductance=	**41,303**

Component	NB port spool piece
Conductance diameter in inches=	23
Conductance length in inches=	6
Conductance=	**158,330**

Effective conductance of components in series from 24" main duct to the VV (C_1) = 3567

Approximate effective NCSX pumping speed {$S_{eff}=(S_{1*} C_1)/(S_1+ C_1)$} = 1,345

NCSX Vacuum Pumping Systems

W. Blanchard

WBS 22 Manager

VACUUM PUMPING SYSTEM

Requirements

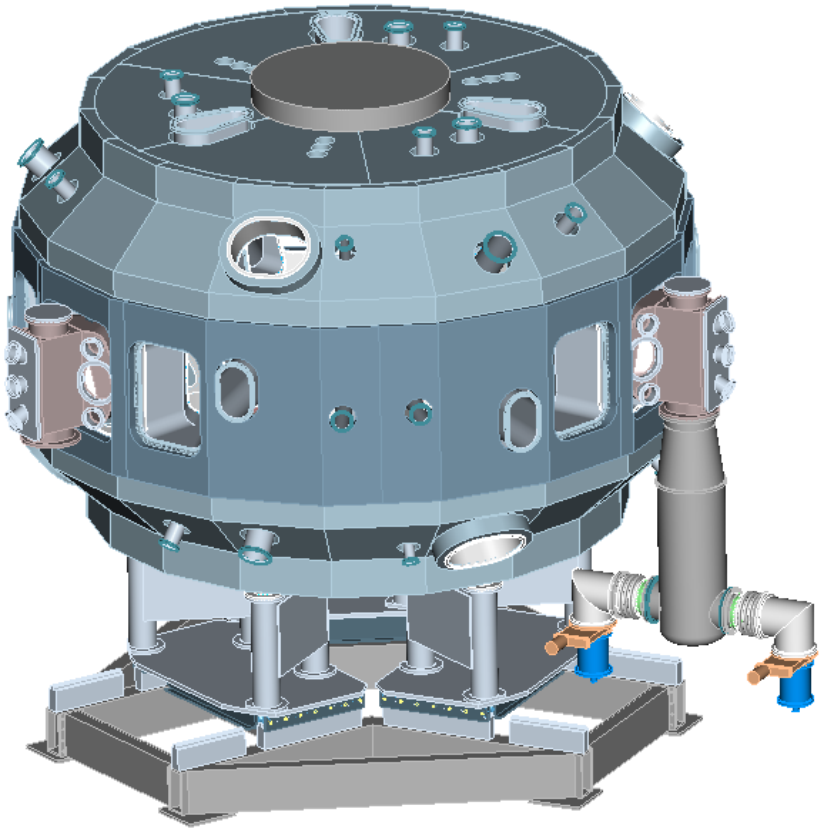
- **Minimum effective pumping speed of 1300 l/s**

Interfaces

- **Design consists of one pumping duct off of one NB transition piece and a vertical 24” duct**

Design Features

- **Two legacy 1500 l/s TMPs**
- **System monitored, controlled and interlocked using a PLC**
- **Differentially pumped RGA**



VACUUM PUMPING SYSTEM

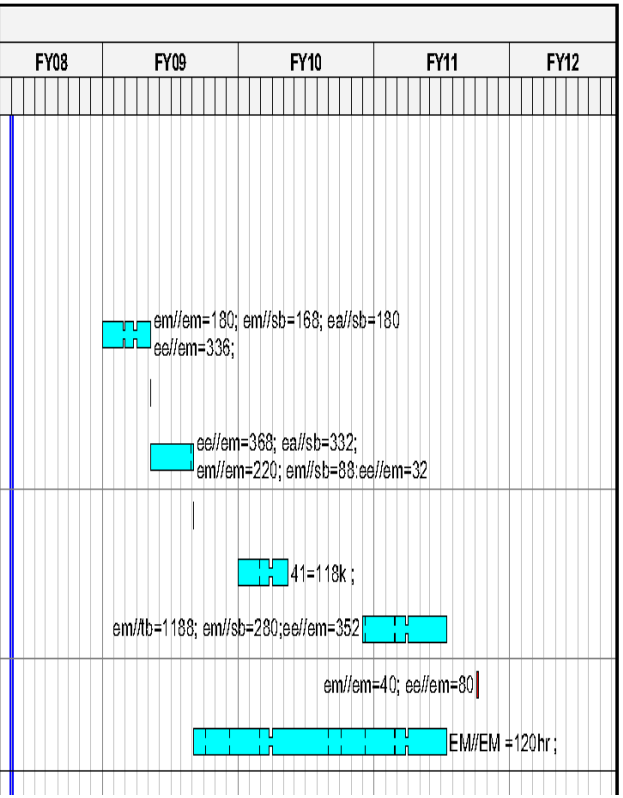
Task ID		$ M&S	Hours EMEM	EMSM	EMSB	EMTB	EAEM	EASB	EEEM	EESM	EESB	EETB
Title I and II Design												
Preliminary Design / Management / Admin												
	Engr Work Planning & Design		180									
	Design Hardware				80							
	Design PLC Controls								336			
	Testing Equipment				88							
	Drafting Support (Electrical)						160					
	Drafting Support (Mechanical)						20					
Final Design / Management / Admin												
	Engr Work Planning & Design		220									
	Mechanical Design				88							
	Design PLC Controls								336			
	Electrical Design								64			
	Electrical Design/Drafting							272				
	Drafting Support (Mechanical)							60				
Subtotal Title I & II Design			***400***	***0***	***256***	***0***	***180***	***332***	***736***	***0***	***0***	***0***
Title III												
	Engr Work Planning & Design		120									
	Maint/Repair Mech Pumps				80							
	Repair/Cal. Instrumentation				80							
	Electrical Installation					668						
	Fabricate/Install Hardware				120	520						
	Fabricate/Install PLC Controls								352			
	Integrated System Testing		40						80			
	Materials and Supplies	$ 118,000										
Subtotal Title III		***$ 118,000***	***160***	***0***	***280***	***1188***	***0***	***0***	***432***	***0***	***0***	***0***

Cost Estimate

* **Based on NSTX costs for system which is similar to the proposed NCSX design**
* **Input from engineers and personnel familiar with various parts of the project**

VACUUM PUMPING SYSTEM

Activity ID	MILE -STONE LEVEL	Activity Description	Duration (work days	SHIFTS	Forecast Start	Forecast Finish	Total Float	Cost to Complete
22 - Torus Vacuum Pumping Systems								
Job: 2201 - Vacuum Pumping Systems-BLANCHARD								
220-101		Preliminary Design	83		01OCT08*	05FEB09	361	126,871.80
220-105		PDR VPS	1		06FEB09	06FEB09	361	0.00
220-109		Final Design	80		09FEB09	01JUN09	361	147,786.60
220-113		FDR VPS	1		02JUN09	02JUN09	361	0.00
220-117		Procure PLC,Values,Hardware	87		01OCT09*	12FEB10	277	157,766.00
220-133		Fabrication and Assemble	154		01SEP10*	15APR11	50	205,043.31
220-137		Test VPS Hardware	3		05JUL11	07JUL11	1	21,609.20
220-116		Title III	463		03JUN09	13APR11	893	20,285.49



Project Schedule

- **Design in FY09, procurements in FY10 and fabrication/installation in FY11**

VACUUM PUMPING SYSTEM

Uncertainty of the Estimate							
		High	Medium	Low	Uncertainty Range (%)	Comments/Other Considerations	
	Design Maturity			X		There have been no design reviews therefore the design is not fixed.	
					-15%/+25%		
	Design Complexity			X		Anticipated to only require standard components	
	Other Comments:						

Risk Assessment: Low

Risk:
*** Equipment or component failure**

Mitigation:
*** All components outside of coils and cryostat and easily accessible**
*** Standard equipment and hardware**
*** Replacement parts for major components in-house**