NCSX Closeout Report WBS 85 NCSX ISTP and Startup

To: Al vonHalle

From: Charles Gentile

Subject: WBS - 85 Closeout

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Scope: WBS 85 depicted those action required post NCSX construction that were needed to safely start the device, make first plasma, and perform e-beam mapping on multiple vv surfaces. The work completed on WBS 85 identified the required sub-systems required to fulfill these actions, identified the skill mix of the startup team, identified the documentation required to safely commission the device, and identified a cost and schedule for implementing these actions. The details of this work are depicted in the attached documents.

Status: This work has been closed out due to the cancellation of the NCSX project. The work completed to date is resident in the attachments and includes those items listed in the scope section of this document.

Interfaces: In the physical sense there are no interfaces associated with WBS-85. Administratively there are many interfaces required to safely startup, perform the ISTP, do first plasma, and perform e-beam mapping. These administrative interfaces are detailed in the attached documentation.

Specifications: Specifications include those governing documents, which are the NCSX NEPA form, PPPL ES, &H 5008, applicable DOE orders, PPPL procedures (IP's, GP's' OP's). See attached documents for details regarding required documentation.

Schematics and PID's; N/A

Models: N/A

Drawings: N/A

Analyses: N/A

Testing; N/A

Costs; Please refer to WBS 85 WAF

Remaining Work: Remaining work includes completion of the NCSX ISTP, NCSX SAD, Identify and assemble the startup team, complete sub-system interface procedures, develop FMEA's.

Lessons Learned: Value was provided to the WBS-85 effort due to an already existing technical infrastructure for the development of procedures and associated documentation. Building upon the success of NSTX helped in defining the path for successful NCSX startup

Conclusion: None at this time.

NCSX Startup (WBS 85)

C.A.Gentile

NCSX CD-4 Startup

NCSX Startup

- WBS 85 Objective = Safely bring NCSX on-line
- Concerns = People Safety, Environmental Safety, Machine Safety
- WBS 85 has two main components = Documentation + Safe Startup
- Startup Strategy = 10 week Startup Plan w/ First Plasma @ week 7
- Startup Documentation = Slides 7 & 8
- Startup Staffing and Positions = Slide 9
- Basis of Startup cost & staffing requirements = TFTR (during D-T transition), NSTX
- Risks and Mitigation = Slide 10
- Strong emphasis on pre-operational system testing and Activity Certification Committee (ACC) reviews. ACC is an independent cognizant group made up of PPPL and PSO membership. ACC performs detailed technical reviews including physical walk-down of reviewed system(s). Successfully implemented during NSTX startup.

What Startup Will Demonstrate

* Ohmically heated (first) plasma
- 1.4 m major radius
- ≥ 0.5 T magnetic field
- ≥ 25 kA plasma current
- coils operated at cryogenic temperatures
- modular coils operated at 12 kA
- TF coils operated at 2 kA
- PF coils operated at 3 kA
- PF5 & PF6 operated at 2 kA
- central solenoid operated at 12 kA
- ability to maintain high vacuum in vv
- ability to bake at 150 C
- ability to perform (multiple) e-beam (surface) mapping

* *see Hutch Neilson presentation for additional startup parameters*

WBS 85 Schedule - 1

ISTP

Activity ID	MILE -STONE LEVEL	Activity Description	Duration (work days	SHIFTS	Forecast Start	Forecast Finish	Total Float	Cost to Complete
METFY08RX		Support FPA Station 3	339*		05NOV08	24MAR10	0	90,857.10
METDCP-5	3	Dimensional control plans for station 5	40		11JUN08	06AUG08	161	21,252.00
STAT5PREP		Station 5 preparations	30		13APR09	22MAY09	50	22,491.60
METFY09		Support FPA Station 5	325		02MAR09	17JUN10	44	91,380.18
STAT6PREP		Station 6 preparations	130		29MAY09	02DEC09	45	45,417.43
METDCP-6	3	Dimensional control plans for station 6	80		10AUG09	02DEC09	45	45,688.83
METFY10		Support Final Machine Assy station 6	508		27OCT09*	09NOV11	746	95,643.02
Job: 8215 Plant Design								
FY07 Rebaseline Exercise								
8210-07		Update plant model	19		31JAN08	26FEB08	1,673	15,225.60
8210-08		Plant Design	826*		01OCT07A	31JAN11	945	185,670.65
85 - Integrated Systems Testing								
Job: 8501 - Integrated Systems Testing-GENTILE								
Startup Documentation								
Y								
8501-101		SAD NCSX Safety Assessment Document (SAD)	45		03NOV08*	15JAN09	454	48,131.20
8501-129		NCSX-XX, Administrative Control of Procedures	30		24NOV08	15JAN09	440	24,065.60
8501-133		OP-AD-39, Conduct of Operations	10		16JAN09	29JAN09	440	6,016.40
8501-137		OP-AD-56, Cntrl Equipt & Syst Status (chain of c	10		23JAN09	05FEB09	440	6,016.40
8501-141		OP-AD-24, Cntrl Workplace Cleanliness D-Site Exp	10		30JAN09	12FEB09	440	6,016.40
8501-145		OP-AD-31, D- Site Fire Watch Requirements	10		06FEB09	19FEB09	440	6,016.40
8501-149		OP-AD-03, Experimental Proposals for NCSX	10		13FEB09	26FEB09	440	6,016.40
8501-153		OP-AD-117 Operation of the NCSX Access System	10		20FEB09	05MAR09	440	6,016.40
8501-157		NCSX-OP-XX, Prep of Exper Areas for Machine	30		27FEB09	09APR09	440	18,049.20
8501-161		NCSX-OP-XX, Operation of the NCSX TVPS	30		20MAR09	30APR09	440	18,049.20
8501-165		NCSX-OP-XX, Testing NCSX HIS Safe for Access	30		10APR09	21MAY09	440	18,049.20
8501-169		NCSX-OP-XX, Testing the NCSX Emergency Stop	30		01MAY09	12JUN09	440	18,049.20
8501-173		NCSX-OP-XX, NCSX Training Matrix	30		22MAY09	06JUL09	440	18,049.20
8501-177		NCSX-OP-XX, NCSX Ops Guide -Startup and	30		15JUN09	27JUL09	440	18,049.20
8501-181		NCSX-OP-XX, HPP Daily Operations	20		14JUL09	10AUG09	440	12,032.80
8501-185		NCSX-OP-XX, ACP & PDP Trip Control Settings	20		28JUL09	24AUG09	440	12,032.80
8501-189		NCSX-OP-G-XX Preparation for NCSX pumpdown	30		11AUG09	22SEP09	440	18,049.20
8501-193		NCSX-OP-XX Helium H/C System Operations	30		01SEP09	13OCT09	440	18,207.42
8501-197		NCSX-OP-G-XX Daily Hi-Pot Test Vacuum Vessel	30		23SEP09	03NOV09	440	18,471.12
8501-201		ISTP-NCSX-01 Coil Energization Tests	40		14OCT09	10DEC09	440	24,768.80
8501-205		OP-ECS-245 FCPC Daily Startup/Shutdown	20		25NOV09	05JAN10	440	12,384.40
8501-209		NCSX-XX Leak Checking of NCSX	20		11DEC09	19JAN10	440	12,384.40

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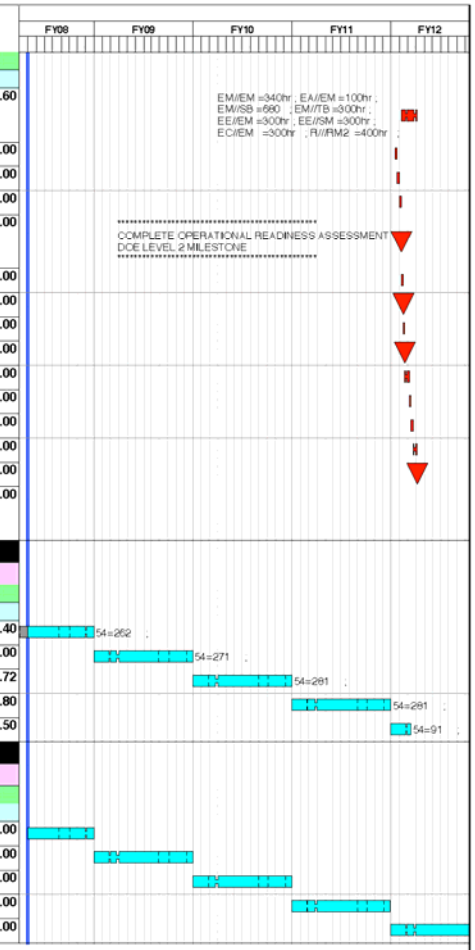
WBS 85 Schedule - 2

ISTP

Activity ID	MILE -STONE LEVEL	Activity Description	Duration (work days	SHIFTS	Forecast Start	Forecast Finish	Total Float	Cost to Complete
Start-up								
920.000		Startup Personnel	35	1	08NOV11	05JAN12	0	449,669.60
8501-102		Punch list & CSIS & HIS PTP's complete,	5	1	18OCT11	24OCT11	0	0.00
8501-103		PTP's complete for ECS,HCS,vac pmpg	5	1	25OCT11	31OCT11	0	0.00
8501-104		ACC review and ORA	5	1	01NOV11	07NOV11	0	0.00
730.1250	2	PSO Operational Readiness Assessment	0	1		07NOV11	0	0.00
8501-301		Configure for Startup ISTP	5	1	08NOV11	14NOV11	0	0.00
8501-304	2	Begin Start-up Testing	0	1		14NOV11	0	0.00
8501-305		Coil Testing at room temp	5	1	15NOV11	21NOV11	0	0.00
730.8200M	2	Cooldown of Machine	0	2		21NOV11	0	0.00
8501-106		Machine cool down and cold test coils	10	1	22NOV11	07DEC11	0	0.00
8501-107		Combined field testing, Make 1st Plasma	5	1	08DEC11	14DEC11	0	0.00
8501-108		Vent VV, Config for & instl e-beam mapping	5	1	15DEC11	21DEC11	0	0.00
8501-306		E-beam mapping	5	1	22DEC11	05JAN12	0	0.00
8501-110	1	NCSX Startup Complete	0	1		05JAN12	0	0.00
730.9000	1	CD-4	0	1		31JUL13*	0	0.00
99 - PPPL Allocations								
Job: 8998 - Allocations-STRYKOWSKY								
99.08		PPPL Allocations FY08 LOE	249*		01OCT07A	29SEP08	1,522	288,467.40
99.081		PPPL Allocations FY09 LOE	247*		01OCT08*	28SEP09	1,274	460,429.00
99.09		PPPL Allocations FY10 LOE	248*		01OCT09*	30SEP10	1,024	488,909.72
99.09A		PPPL Allocations FY11 LOE	250*		01OCT10*	30SEP11	774	513,607.80
99.10		PPPL Allocations FY12	50*		03OCT11*	13DEC11	724	178,194.50
Contingency								
Contingency-Project								
C08		Contingency FY08	170*		31JAN08*	29SEP08	1,522	0.00
C09		Contingency FY09	247*		01OCT08*	28SEP09	1,274	2,730,000.00
C10		Contingency FY10	246*		01OCT09*	28SEP10	1,026	3,044,000.00
C11		Contingency FY11	248*		01OCT10*	28SEP11	776	10,126,000.00
C12		Contingency FY11	252*		03OCT11*	28SEP12	522	7,770,000.00



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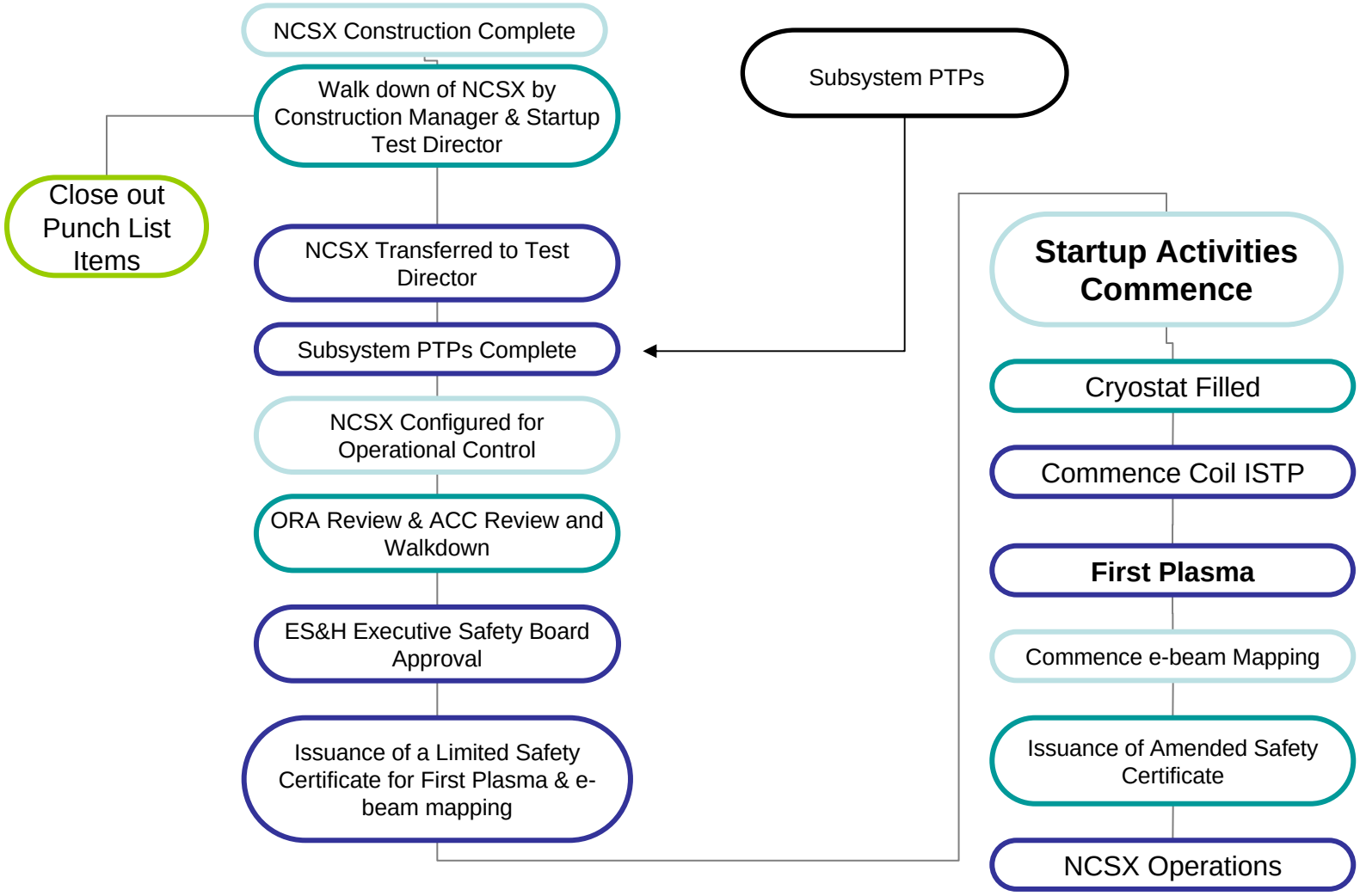
Startup Flow Chart



Documentation needed for Startup

- NCSX Safety Assessment Document (SAD)
- NCSX Integrated System Test Procedure (ISTP)
- Completed (sub-system) Pre-operational Test Procedures (PTP)
- NCSX Configuration and Interface Control Procedures
- NCSX Training Matrix
- First Plasma sub-system support procedures

  Torus VV pumpdown, cryo operations, search & secure procedures, power system procedures, coil operating procedures, bakeout procedures, control system procedures.

Startup Documentation Effort

- Documentation Costs = $345 K
- Documentation Development Team
- Engineer @ 28.5 weeks (1140 hours)
- Senior Lab & Shop @ 28.5 week (1140 hours)
- Total for documentation development = 2280 hours
- Equivalent ~ 1.10 person years of effort

Startup Staffing and Positions

- Startup Team costs = $ 450 K

- (1) Test Director = 10 weeks @ 100 % FTE
- (1) Chief Operations Engineer = 10 weeks @ 85 % FTE
- (1) Project Engineer = 10 weeks @ 75 % FTE
- (2) Machine Technicians = 10 weeks @ 85 % FTE
- (1) FCPC Technician = 10 weeks @ 75 % FTE
- (1) Cryo System Technician = 10 weeks @ 75 % FTE
- (1) AC Power Engineer = 10 weeks @ 75 % FTE
- (1) Computer Engineer = 10 weeks @ 75 % FTE
- Total Startup hours = 2720 hours
- Equivalent ~ 1.3 person years of effort to safely startup NCSX

Risks & Mitigation

- Incorrectly connecting power supply to coil leads - Coil leads to be clearly designated prior to startup, low power compass test.
- Ground Faults - Check for ground fault conditions during assembly (pre-startup) to mitigate impact on startup.
- Loop Faults - Check for loop faults during assembly (pre-startup).
- Control System - Pre-test wave forms and clock cycles to ensure control system operation.
- Loss of sub-system components (i.e., pumps) - repair / replace.

Conclusion

- Based on the startup of similar machines at PPPL NCSX startup requirements are understood. Good experience base and support for e-beam mapping from colleagues at ORNL, UW, Auburn.
- NCSX startup concerns are mostly about safety (people, environment, machine).
- Success of startup the result of prerequisite PTP's, ACC reviews, ES&H Executive Safety Board review, safety certificate issuance, closing out post construction punch list items.
- Completion of NCSX ISTP will transition the machine from startup to operational.