NCSX Startup (WBS 85)

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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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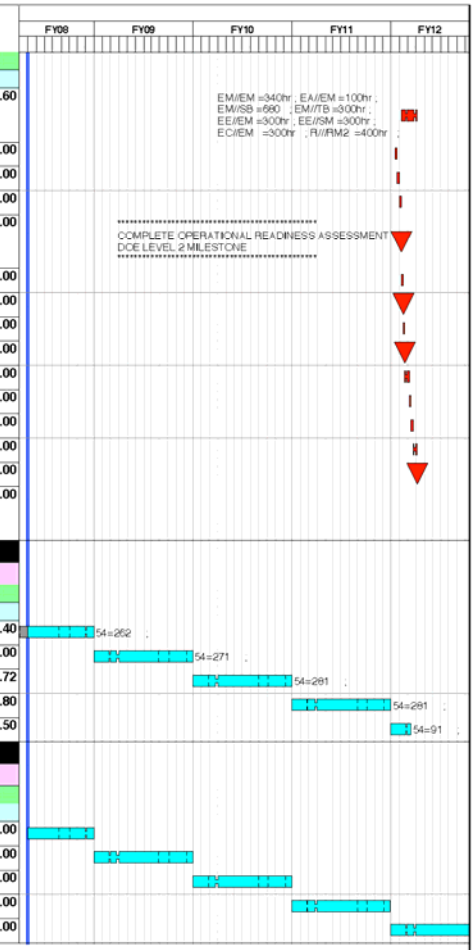
WBS 85 Schedule - 2

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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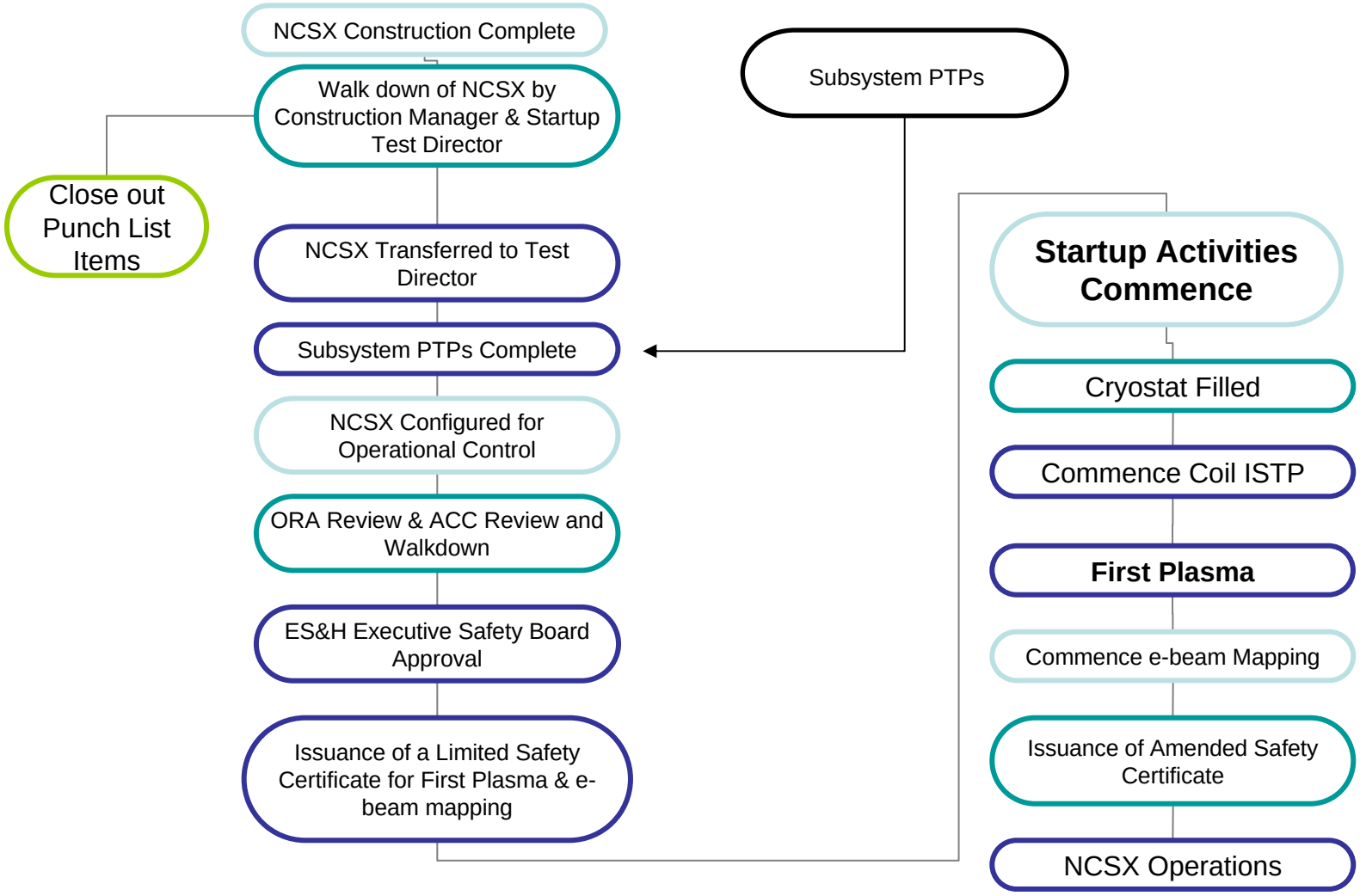
Startup Flow Chart



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.