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 6 & 7
- Startup Staffing and Positions = Slide 8
- Basis of Startup cost & staffing requirements = TFTR (during D-T transition), NSTX
- Risks and Mitigation = Slide 9
- 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

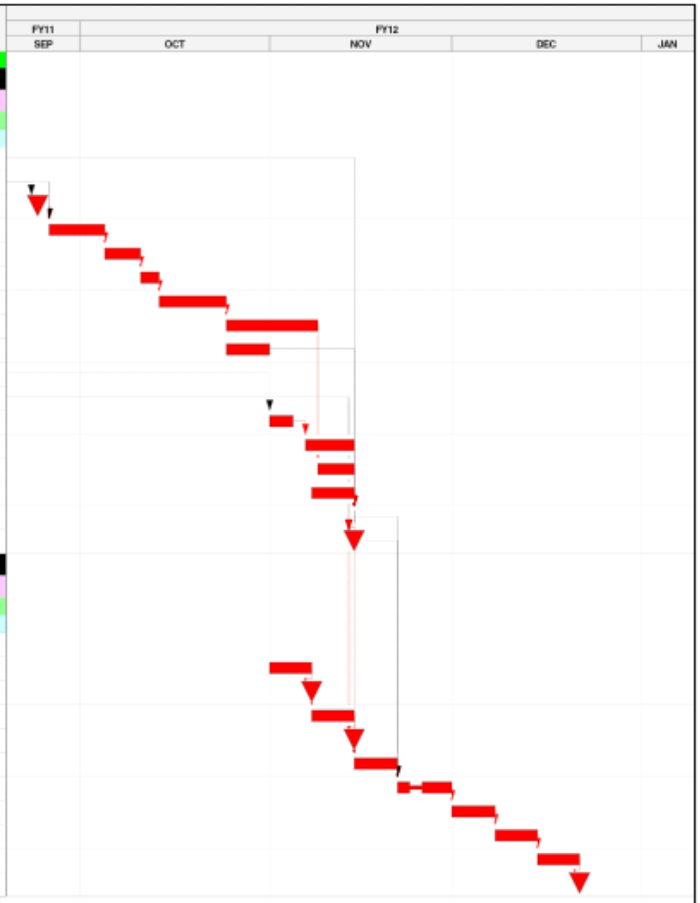
* Ohmically heated (first) plasma
- 1.4 m major radius
- ≥ 0.5 T magnetic field
- ≥ 25 kA plasma current
- coils operated at cryogenic temperatures
- modular coils operated at 12 kA
- TF coils operated at 2 kA
- PF coils operated at 3 kA
- PF5 & PF6 operated at 2 kA
- central solenoid operated at 12 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

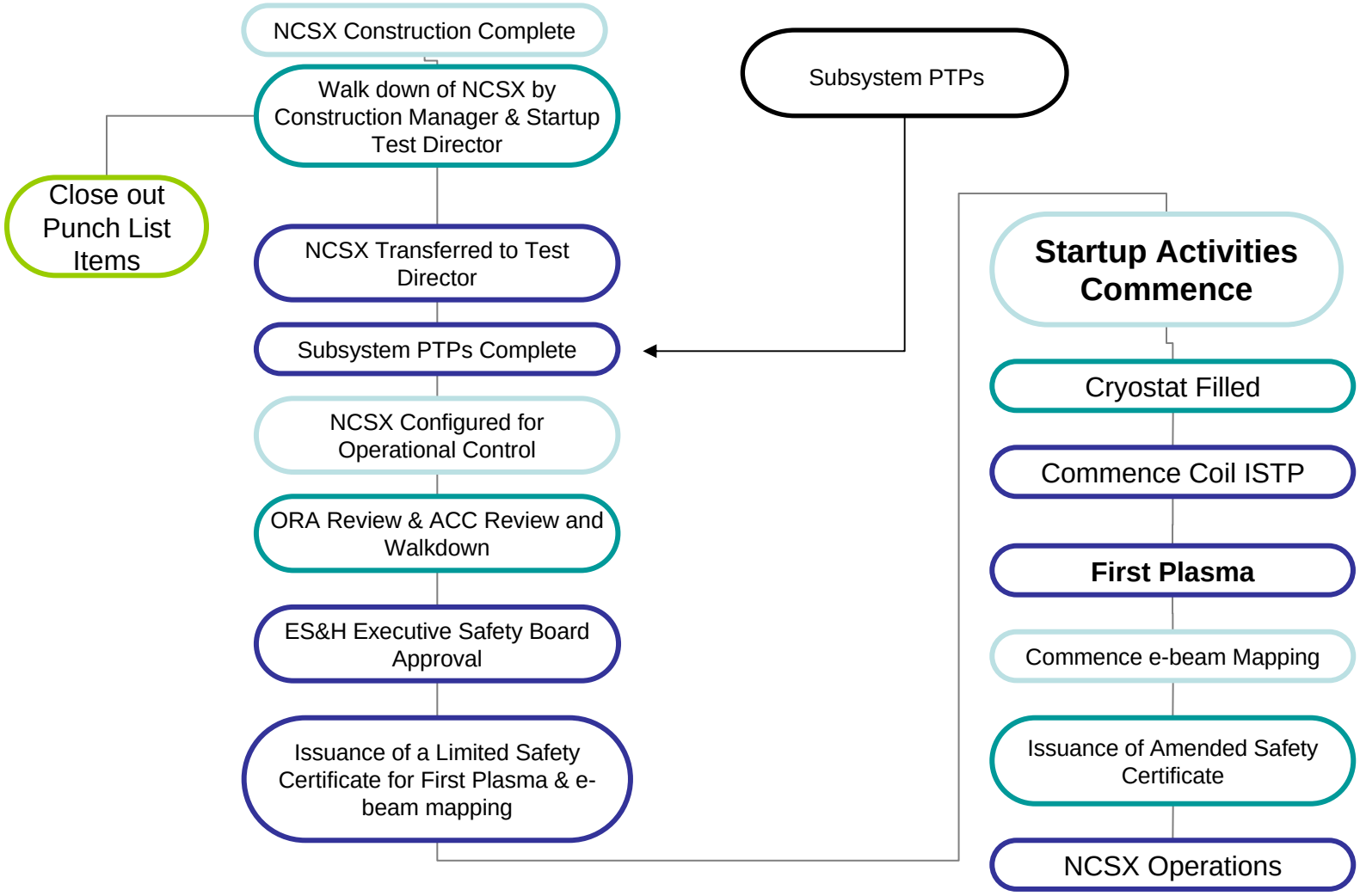
ISTP

Activity ID	Activity Description	Duration (work days)	SHIFTS	Forecast Start	Forecast Finish	Total Float
cc 9450 - NCSX Fabrication (ME)						
75 - Test Cell and Basement Assembly Operations						
Job: 7503 - Machine Assembly (station 6)-PERRY						
25.0 thru 35.0 - Cryostat,NB duct & I&C Routing						
S-6-25	Install NB transition duct Period 2 and 3	2	2	23AUG11	24AUG11	51
S-6-26	Install thermal insulation on all Port 4s	1	2	25JUL11	25JUL11	37
7503-330	Begin Cryostat Installation	0	2		23SEP11	-6
S-6-29.1	Install cryostat base, vapor barrier, port boots	7	NO	26SEP11	04OCT11	-6
S-6-29.2	Install power, LN2 and I&C feedthrus	4	NO	05OCT11	10OCT11	-6
S-6-29.3	Install cryostat cooling system and	3	NO	11OCT11	13OCT11	-6
S-6-29.4	Install cryostat midplane and port boots	7	NO	14OCT11	24OCT11	-6
S-6-29.5	Install cryostat upper section and port boots	11	NO	25OCT11	08NOV11	-6
S-6-31	Final LN2 connections to supplies./incl in	5	2	25OCT11	31OCT11	4
S-6-32.1	Design I&C tray system in NCTC	20	NO	25JUL11*	19AUG11	44
S-6-35	Install all remaining test cell platforms	6	2	28JUN11	06JUL11	91
S-6-32.2	Install I&C tray system in NCTC	4	2	01NOV11	04NOV11	-6
S-6-32.5	Install cable extensions from cryostat to	6	2	07NOV11	14NOV11	-6
S-6-29.6	Install cryostat circulation duct	4	NO	09NOV11	14NOV11	-6
S-6-33	Connect 150 C bakeout system	5	2	08NOV11	14NOV11	-6
S-6-36	PTP and machine cool down	0		15NOV11	14NOV11	-6
730.8200M	Cooldown of Machine	0	2		14NOV11	-1
85 - Integrated Systems Testing						
Job: 8501 - Integrated Systems Testing-GENTILE						
Start-up						
8501-102	Punch list & CSIS & HIS PTP's complete,	5	1	30JUN11*	07JUL11	-6
8501-104	ACC review and ORA	5	1	01NOV11	07NOV11	-6
730.1250	PSO Operational Readiness Assessment	0	1		07NOV11	-6
8501-301	Configure for Startup ISTP	5	1	08NOV11	14NOV11	-6
8501-304	Begin Start-up Testing	0	1		14NOV11	-6
8501-305	Coil Testing at room temp	5	1	15NOV11	21NOV11	-6
8501-106	Coil testing @ cryo temp, Pump-down VV	5	1	22NOV11	30NOV11	-6
8501-107	Combined field testing, Make 1st Plasma	5	1	01DEC11	07DEC11	-6
8501-108	Vent VV, Config for & instl e-beam mapping	5	1	08DEC11	14DEC11	-6
8501-306	E-beam mapping	5	1	15DEC11	21DEC11	-6
8501-110	NCSX Startup Complete	0	1		21DEC11	-6



RB08 NCSX Project final assy and startup Sheet 1 of 1 11MAR08 13:00

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 Control Procedure
- NCSX Interface Control Procedure
- 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.