

REQD FUTURE POWER SYSTEM CHANGES

- ❖ Following additional work is required to be performed to restore full capability of the machine:
 1. Provide power feed to a) PF1bU, b) PF1cU, c) PF1cL coils.
 - *This involves designing the power loop and providing Power Supplies, CLRs, Disconnect & Ground Switches, DCCTs, Protective relaying etc.*
 2. Upgrade PF5 feed such that PF5 coil can be injected up to 34kA
 - *This would require an additional branch to the existing power supply. Note that PF5 is powered up to 24kA in the current set up.*
 3. Upgrade TF feed such that TF can be pulsed every 20 minutes.
 - (Note that we can with appropriate controls, pulse with a period $< 40 / 20$ minutes based on the $I^2 \cdot t$ imposed on the coil system.)
 - *In the current scope the TF can be pulsed only once in 40 minutes. This requires additional power cabling from the Transition area to the NSTX Test Cell, additional changes in the PCTS, enhancing the feed from PCTS to coil terminals.*
 - *We can also consider providing a water cooled bus in the NSTX Test Cell Basement from the place the power cables are terminated.*

POWER SYSTEM CHANGES CONTD.

4. Make changes as needed to operate CHI from 2kV to 4kV.

- *In order to address this requirement we must plan right now to choose the appropriate insulation for the CHI leads and the Inner vessel. Note that the Inner Vessel to Outer Vessel will require to be hipotted at 9kV instead of 5kV as at present.*

5. Convert PF1a circuit from a 3- Wire scheme to a 2 - Wire scheme.

- *This is required to upgrade CHI from 2kV to 4kV. The work involves additional cabling.*

6. Change DCCT positions such that these measure the coil currents directly.

At the present time the DCCTs are above the SDS in some circuits

*7. Repair MG2 weld to restore normal rating

- *At present MG2 can be used only at about 15% of the full energy rating*

*8. Repair MG1 Welds so that it can be an effective standby.

- *This also increases the life of the MGs by alternating usage of the sets*

❖ Following tasks are being performed at present. Part of this task was originally included in the NSTX upgrade scope but were transferred to Operations cost.

- *Change FD/FG for all the supplies needed to power NSTX. Eliminate the PC link.*
- *Note that we are currently performing this task. In this modification we are changing the FD/FG for active rectifiers which will be used for NSTX. Also a slow PLC I/O will be provided in these rectifiers to interface with the main PLC that will be provided in the Control Boards.)*

(* MG information from Mounir Awad)

PWR SUPPLY TABLE

(Extracted information from CN design point spreadsheets)

Circuit	kV available	kV Required	PSS's Needed	Min Current (Reverse)	Max Current	ESW Current	ESW	Base Period	Base RMS Current	Future Period	Future RMS Current
				(kA)	(kA)	(kA)	(sec)	(sec)	(kA)	(sec)	(kA)
TF	1	1	16	0	130	130	7.08	2400	7.06	1200	9.99
OH	6	6	12	-24	24	24	1.47	2400	0.59	1200	0.84
PF1aU	2	1	4	-7	18	18	5.5	2400	0.86	1200	1.22
PF1aL	2	1	4	-7	18	18	5.5	2400	0.86	1200	1.22
PF1bL	2	1	2	0	13	13	2.1	2400	0.38	1200	0.54
PF1bU		1		0	13	13	2.1	2400	0.38	1200	0.54
PF1cU		1		0	16	16	4.34	2400	0.68	1200	0.96
PF1cL		1		0	16	16	4.34	2400	0.68	1200	0.96
PF2U	2	2	2	-11	15	15	5.5	2400	0.72	1200	1.02
PF2L	2	2	2	-11	15	15	5.5	2400	0.72	1200	1.02
PF3U	2	2	4	-16	12	16	5.5	2400	0.77	1200	1.08
PF3L	2	2	4	-16	12	16	5.5	2400	0.77	1200	1.08
PF4	2	2	2	0	16	16	5.5	2400	0.77	1200	1.08
PF5	3	3	3	0	24	24	5.5	2400	1.15	1200	1.62
CHI	2	2	1	0	15	15	0.5	2400	0.22	1200	0.31
P13	2										
P14(RWM)	2	1	1	0	2	2	5.5	2400	0.10	1200	0.14

MG REQUIREMENTS

(Extracted from CN design point spreadsheets)

		NSTX Base	Upgrade
Pulse repetition period	sec	300	2400
MG Peak active power (TF+OH)	MW	230	281
MG Peak reactive power (TF+OH)	MVAR	82	126
MG Peak apparent power (TF+OH)	MVA	244	308
MG Power NBI	MW	32	40
MG Power PF	MW	20	40
MG Energy TF+OH	MJ	101	659
MG Energy NBI	MJ	16	200
MG Energy PF	MG	10	200
MG Total energy	MJ	127	1059
#MG		1	1
MG f_end	Hz	60	60
MG f_start_min	Hz	61.9	74.2

NSTX PRE-UPGRADE CIRCUITS

NSTX Power Supply Configuration for Coils - Pre-Upgrade							
Pwr. Sup. #	NSTX Coil	Required Coil Current	RMS Circuit Current AMPS	Use TFTR PSS	D-Site PSS Config	# of PSS	Comments (PS tags are those of TFTR)
1	TF	35.58kA 5.3s/300s 71.17kA 1.3s/300s	4730	TF1	1s x 4p	4	All Four TF1 branches, unused pss (5s x 4p) in bypass
2	OH	(+/-) 24kA 0.525s/600s	710	TF2	6s x 2 anti-parallel	12	Two TF2 branches 4kV, unused pss in bypass
3	PF1aU	15kA 5s/300s	1937	EF4*	2s x 2 anti-parallel	4	EF4 (2A&2B) supply, unused pss in bypass; EF3 & EF4 with common tie
4	PF1aL	15kA 5s/300s	1937	EF3*	2s x 2 anti-parallel	4	EF3 supply, unused pss in bypass; EF3 & EF4 with common tie
5	PF1b	20kA 1s/300s	1155	EF1	2s x 1p	2	EF4 (1A&1B) supply
6	PF2U	20kA 5s/300s	2582	OH5*	2s x 1p	2	OH5 supply, unused pss in bypass. OH5 & OH3 with common tie
7	PF2L	20kA 5s/300s	2582	OH3*	2s x 1p	2	OH5 supply, unused pss in bypass. OH5 & OH3 with common tie
8	PF3U	20kA 5s/300s	2582	EEF1A *; OH2*	2s x 2 anti-parallel	4	OH4 supply, unused pss in bypass; OH2 & OH4 with common tie; EEF1-PSS forward
9	PF3L	20kA 5s/300s	2582	EEF1B *; OH4*	2s x 2 anti-parallel	4	OH4 supply, unused pss in bypass; OH2 & OH4 with common tie; EEF1-PSS forward
10	PF5	20kA 5s/300s	2582	OH6	3s x 1p	3	OH6 supply, unused pss in bypass
11	PF4	10kA 5s/600s	913	OH6	3s x 1p	2	EF2-1 supply, unused pss in bypass
12	CHI	50kA, 30 ms every 300Seconds	500	OH1	1s x 1p	2	OH1 supply, unused pss in bypass
13	SPA1 DC Link	3kA 2.5s/600s	194	HF	1s x 1p	1	HF Section A
14	SPA2 DC Link	3kA 2.5s/600s	194	HF	1s x 1p	1	HF Section B

* 3-wire configuration