54-960520-CLN-01

TO: DISTRIBUTION
FROM: C NEUMEYER
SUBJECT: ASSUMPTIONS CONCERNING CHI POWER SUPPLY REQUIREMENTS

The following assumptions are proposed for the conceptual design of the CHI power supply:

a. Operation shall consist of a capacitor bank discharge followed by a power supply current drive;

b. The ratio of the plasma current to the external circuit current shall be 10;

c. The assumed plasma self-inductance shall be 1 μH which, reflected into the external circuit has an apparent value of 100μH;

d. The resistance apparent to the external circuit shall be 37.5mΩ;

e. The cap bank shall drive a plasma current of 500kA via a peak discharge current of 500/10 = 50kA;

f. Two parallel TFTR capacitor banks (15kV, 1MJ each), equipped with discharge inductors of 880μH each, shall be utilized;

g. The total available stored energy will be 2MJ, however only 0.45MJ is required to develop 50kA under the above stated conditions (underdamped LRC circuit), with a peak discharge voltage of 10.2kV;

h. The power supply shall drive a plasma current of 200kA via an external circuit current of 200/10 = 20kA into a resistance of 37.5mΩ, which requires a power of 15MW and a voltage of 750V;

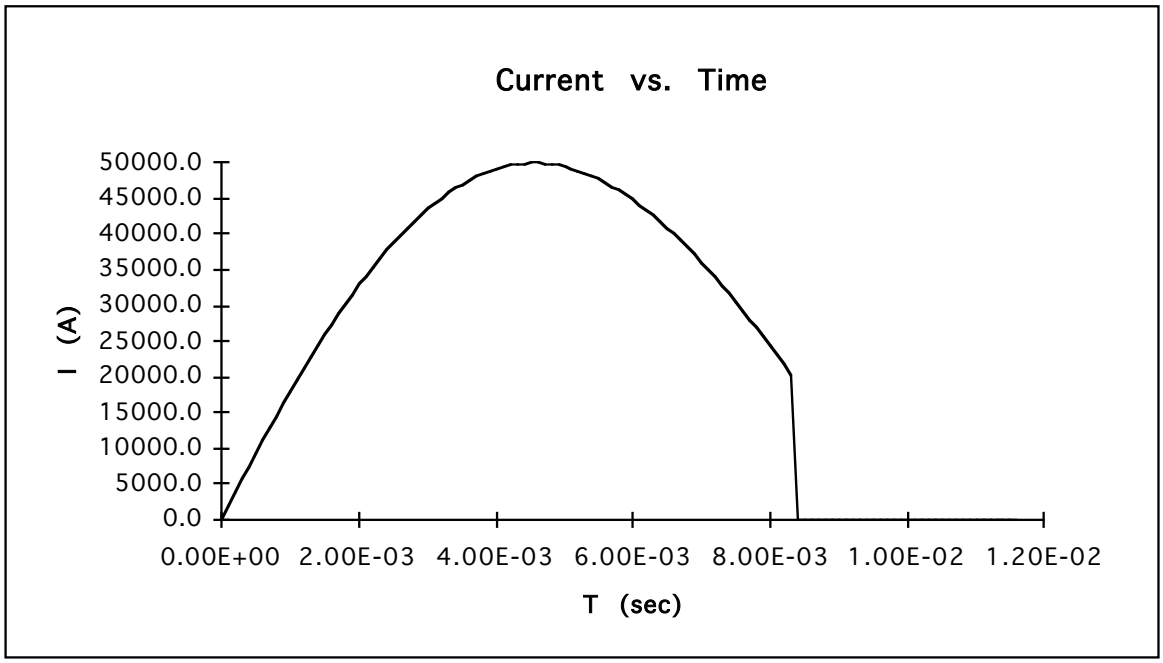
i. The capacitor bank shall be discharged across a diode in series with the power supply so that the power supply automatically picks up the current after the capacitor bank discharge;

j. The equipment shall be designed for a repetition period of 300 seconds.

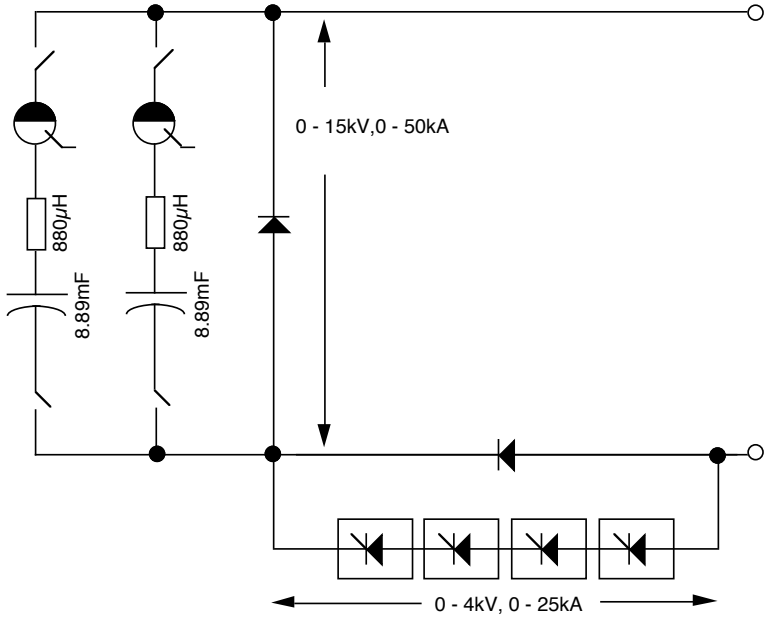
The following spreadsheet gives the circuit parameters.

Ip	5.00E+05	amp
Ip/Ichi	10	
Ichi	50000	amp
Lp	1.00E-06	henry
Wp	125000	joule
Cbank	8.89E-03	farad
Lbank	8.80E-04	henry
Nbank	2	
Lchi	5.40E-04	henry
Cchi	1.78E-02	farad
Rchi	0.0375	ohm
Omega0	320.9	radians/sec
Vchi	10209.9	volt
Prospective Ipeak	58923.7	amp
Ipps	200000	amp
Ichips	20000	amp
Pchips	1.50E+07	watt
Vchips	750	volt
Cap Dschg ∫i^2(t)dt	1.20E+07	amp^2-sec
Cap Dschg Energy	4.50E+05	joule
PS Duration	5.00E+00	sec
Rep Period	3.00E+02	sec
Cap rms	200.0	amp
PS rms	2582.0	amp
Circuit rms	2589.7	amp

The following figure depicts the capacitor bank portion of the discharge waveform.



The following figure shows a possible circuit schematic.



In the above circuit the rectifiers shown would be the same as used for NSTX OH, therefore the CHI power supply driven current would not be available when NSTX was operating inductive discharges using the OH. However, the capacitor discharge would still be available.

The capacitor banks (and associated charge/discharge units) would come from the TFTR inventory which originally consisted of 12 banks intended for plasma

compression experiments, as well as Pulsed Discharge Cleaning. The compression experiments are no longer performed, and the PDC operation only requires three banks. Two banks have already been scavenged by PBX. Therefore from the original 12, there are 12 - 2 - 3 = 7 available. If NSTX takes two, and TFTR is still operational in the NSTX era, then there would still be 5 spares to back up the TFTR PDC operation.

Comments on this proposal and the related assumptions would be most appreciated.

cc:

T Jarboe S Kaye M Ono M Peng NSTX File