

**TO: DISTRIBUTION**  
**FROM: C NEUMEYER**  
**SUBJECT: PF4 AND PF5 FORCES WITH PF4 ENERGIZATION**

References:

[1] NSTX\_CALC\_13\_020, "PF Coil Axial and Radial Force Calculations", 12/8/00

The purpose of this memo is to quantify the increase in EM forces which will occur with the energization of PF4. These changes will primarily effect the PF4 and PF5 coils and coil supports.

The influence matrix created by H. M. Fan [1] is used to perform the calculation.

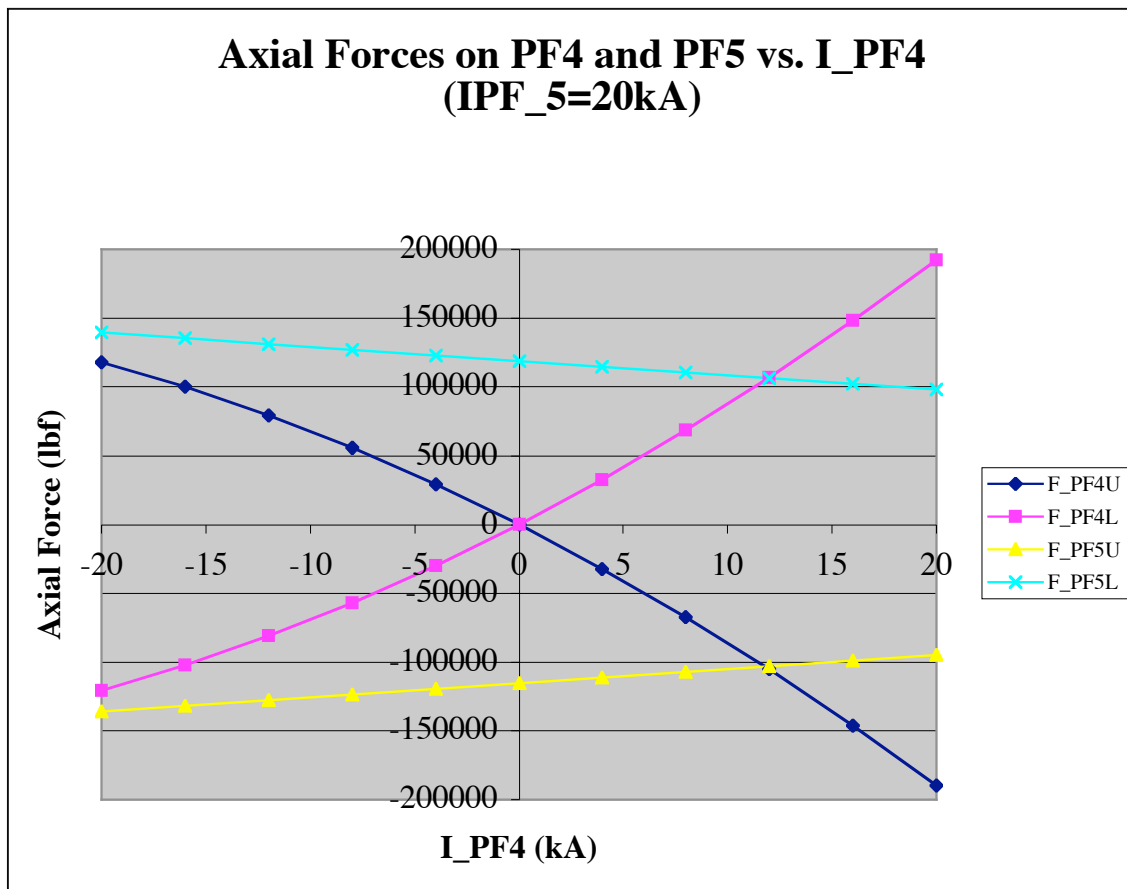
*Axial Forces*

For the axial forces, the following combination of currents was found to produce the maximum forces, as indicated for the case with  $I_{PF4}=0$ .

	Current (kA)	EM Force w/o Plas (lbf)	EM Force w/Plas (lbf)
OH	24.00	25584	25584
PF1AU	-15.00	12451	9151
PF1AL	-15.00	-41614	-38314
PF1BL	-20.00	-6047	-2447
PF2U	-20.00	30093	12293
PF2L	-20.00	-23049	-5249
PF3U	-5.00	38966	26716
PF3L	-5.00	-39792	-27542
PF4U	0.00	0	0
PF4L	0.00	0	0
PF5U	20.00	-115386	-80786
PF5L	20.00	118798	84198
PLU	-1000.00		
PLL	-1000.00		

The following table and figure show the variation in the axial forces with I\_PF4 non-zero. Here the worst case forces occur w/o plasma.

I_PF4 (kA)	F_PF4U (lbf)	F_PF4L (lbf)	F_PF5U (lbf)	F_PF5L (lbf)
-20	117802	-120486	-135954	139366
-16	99987	-102134	-131840	135252
-12	79299	-80909	-127727	131139
-8	55739	-56812	-123613	127025
-4	29306	-29842	-119499	122911
0	0	0	-115386	118798
4	-32178	32715	-111272	114684
8	-67229	68303	-107159	110571
12	-105153	106763	-103045	106457
16	-145949	148096	-98931	102343
20	-189618	192302	-94818	98230



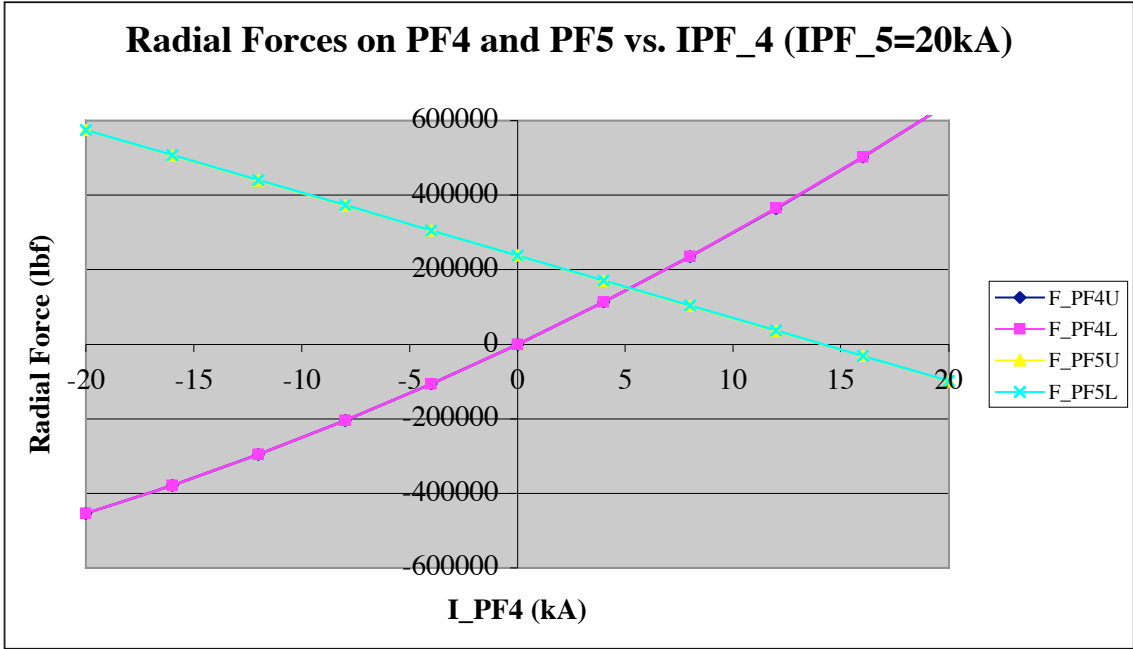
### Radial Forces

For the radial forces, the following combination of currents was found to produce the maximum forces, as indicated for the case with I\_PF4=0.

	Current (kA)	EM Force w/o Plas (lbf)	EM Force w/Plas (lbf)
OH	-24.00	16002736	17159296
PF1AU	-15.00	123516	147366
PF1AL	-15.00	186381	210231
PF1BL	-20.00	202049	219049
PF2U	-20.00	119781	148981
PF2L	-20.00	96817	126017
PF3U	-5.00	-34842	-29092
PF3L	-5.00	-36453	-30703
PF4U	0.00	0	0
PF4L	0.00	0	0
PF5U	20.00	203768	237368
PF5L	20.00	204568	238168
PL-U	-1000.00		
PL-L	-1000.00		

The following table and figure show the variation in the radial forces with I\_PF4 non-zero. Here the worst case forces occur w/plasma.

I_PF4 (kA)	F_PF4U (lbf)	F_PF4L (lbf)	F_PF5U (lbf)	F_PF5L (lbf)
-20	-453449	-453993	573976	574776
-16	-378195	-378630	506655	507455
-12	-295223	-295549	439333	440133
-8	-204533	-204750	372011	372811
-4	-106125	-106234	304690	305490
0	0	0	237368	238168
4	113843	113952	170047	170847
8	235404	235621	102725	103525
12	364682	365009	35403	36203
16	501679	502114	-31918	-31118
20	646393	646937	-99240	-98440



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