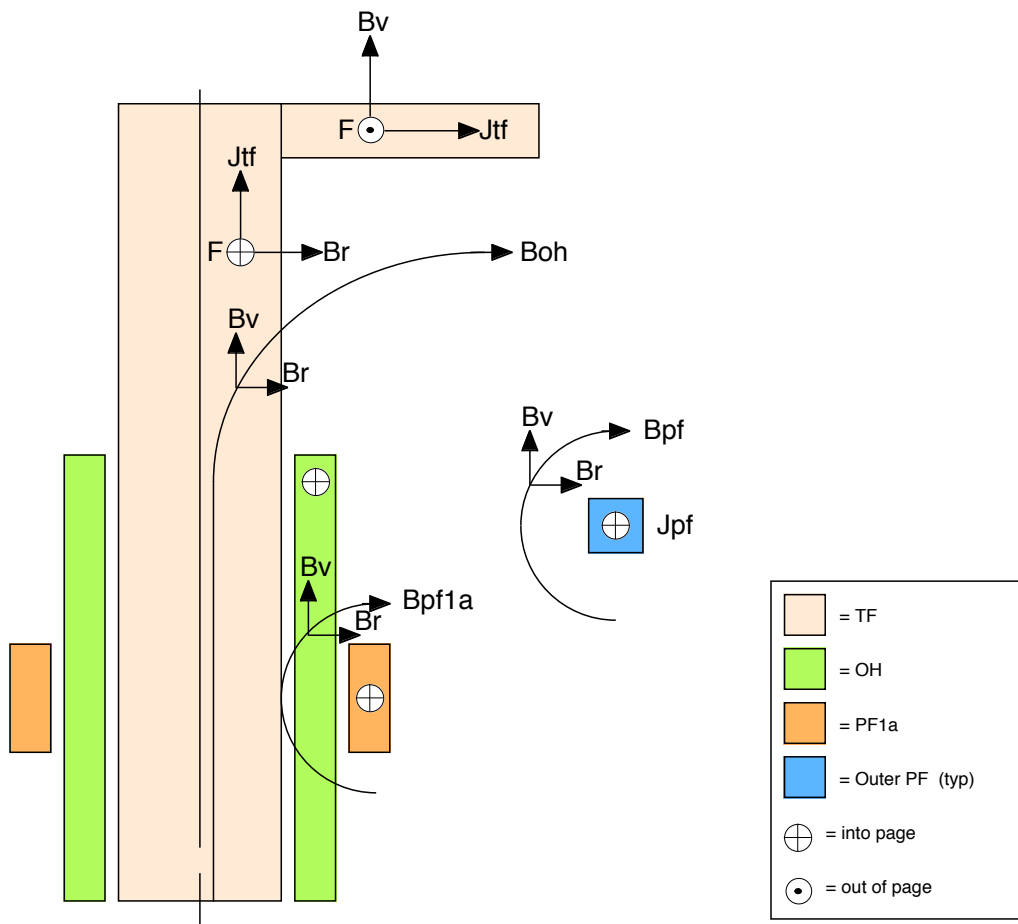


**TO: DISTRIBUTION**  
**FROM: C NEUMEYER**  
**SUBJECT: WORST CASE PF CURRENTS FOR TF LOADING**

This memo provides an explanation for the selection of current polarities in the PF coils to maximize the out-of-plane loads on the TF.

As shown in the sketch below, radial field crossing the vertical TF current in the inner leg bundle causes a force directed into the page, or a counter-clockwise torque viewed from above the machine. Vertical field crossing the radial TF current in the flag causes a force directed out of the page, or a clockwise torque viewed from above. The loading of the flag joint, as well as the shear in the turn-turn insulation in the TF bundle, is maximized when these oppositely directed torques are maximized.



Also shown in the figure are the vertical and radial field directions from the OH, PF1a, and outer PF coils with current flow in the same direction (into the page). *It is noted that in all cases the current flow into the page serves to maximize the vertical and radial fields and hence the loading on the TF coil.*

These observations are consistent with the influence matrix generated by A. Brooks which fed the finite element analysis of the TF joint by I. Zatz. See table below which shows the lateral loads on the inner and outer layer flags.

	OH	PF1a	PF1b	PF2a	PF2b	PF3a	PF3b	PF4b	PF4c	PF5a	PF5b	Total
I(ka-Turn)	11568	720	560	280	280	300	300	160	180	240	240	
Fouter flag(lbf)	-627	-56	-306	-538	-462	-385	-361	-122	-144	-183	-178	-3364
Finner flag(lbf)	-252	-27	-126	-302	-260	-291	-271	-96	-113	-146	-143	-2028

Concerning the turn-turn shear is noted that in NSTX-CALC-13-21 “NSTX Coil Protection Calculation” by I. Zatz, which incorporates both thermal and EM effects, worst case shear in the TF turn-turn insulation occurs with all PF coils in the same current direction. This is consistent with the idea that the maximum twist deformation of the inner leg bundle occurs between the ends of the OH and the flags where the torque reversal occurs.

Finally, it is noted that the plasma is not included in the above analysis. This is because the plasma, at full current, is in the opposite polarity as the OH coil and therefore tends to negate the dominating effect of the OH.

cc: A Brooks P Heitzenroeder M Ono A VonHalle M Williams  
I Zatz