13-010523-CLN-01

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FROM: C NEUMEYER
SUBJECT: TF INNER LEG INSULATION SHEAR STRESS

References:

[1] 13-010515-IZ-01, "NSTX Coil Protection Calculator", I. Zatz
[2] NSTX-CALC-13-21, "TF Inner Leg Shear Stress Calculations", I. Zatz
[3] NSTX-CALC-13-12, "Center Stack TF Bundle FEA", H. M. Fan
[4] 13-001206-PJH-01, "Results of Cooling and Shear Stress for NSTX TF Center Stack with No Active Cooling on Turn 6A and Resulting Operational Limitations", P. Heitzenroeder

Recent analysis by I. Zatz [1, 2], using the original H.M. Fan finite element model of the NSTX center stack [3], explored the relationship between TF current, OH current, PF1A current, and PF1B current on the insulation shear stress in the TF inner leg bundle. Based on the range of conditions studied, five critical locations were identified which, under one condition or another, were worst case in terms of stress anywhere in the coil.

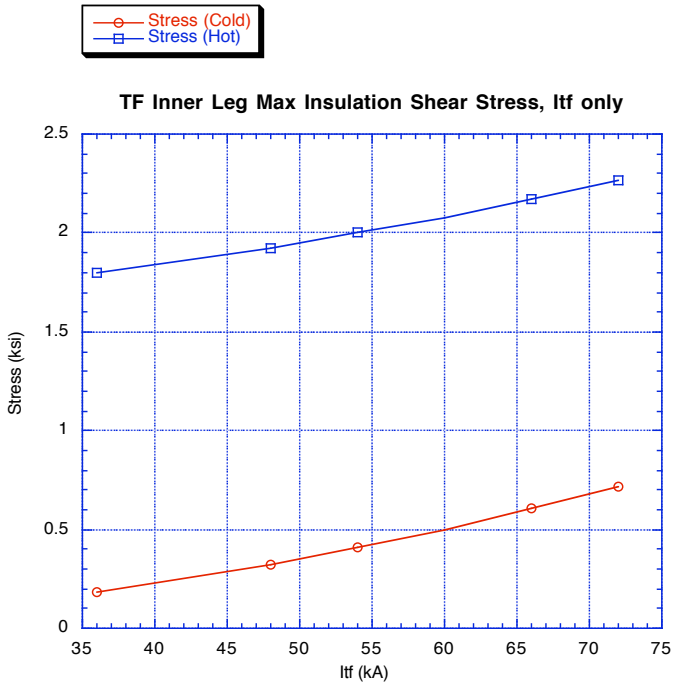
The results were presented in the form of an influence matrix from which one can determine combined effects.

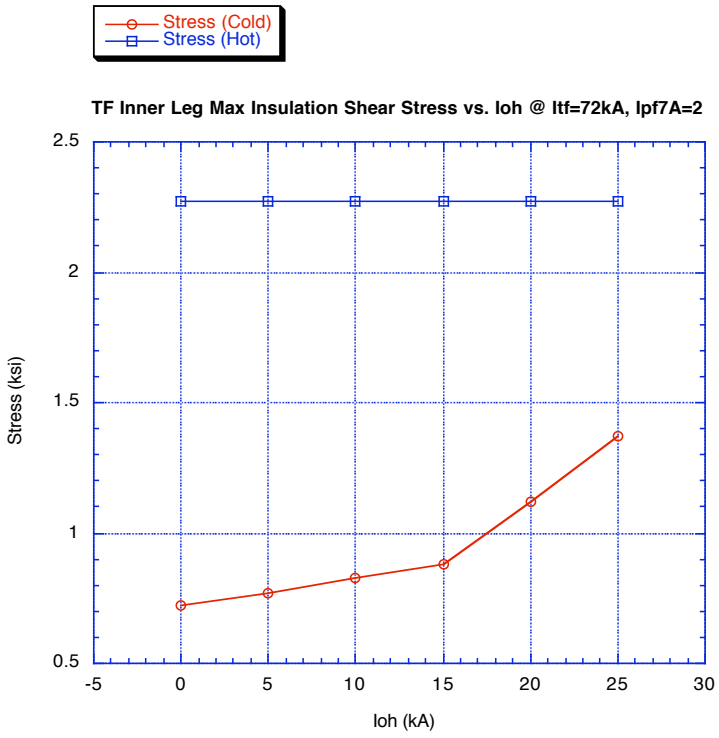
The analysis included thermal effects which could be included or excluded based on 90°C conductor and insulation temperature.

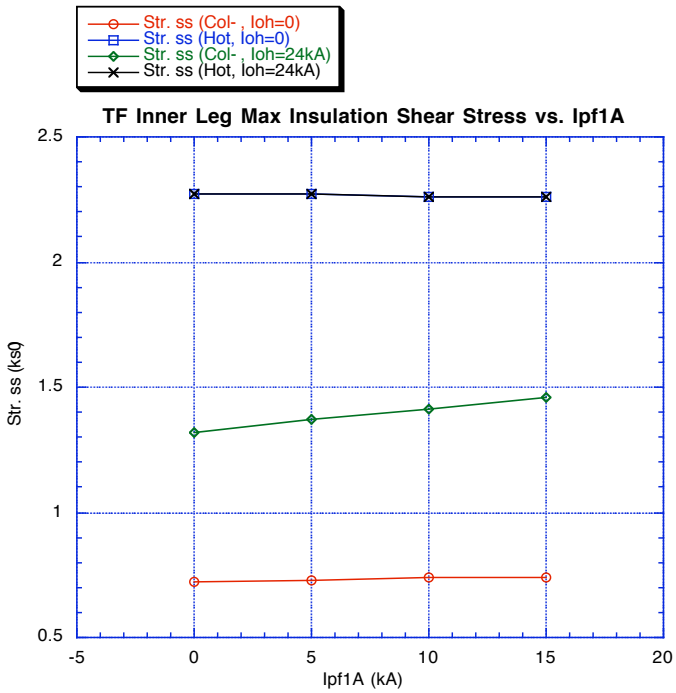
Using this matrix the writer developed the curves given herein, which plot the maximum of the stress at all five critical locations versus coil currents for both hot and cold coil conditions.

These results indicate that the TF inner leg insulation shear stress is dominated by thermal effects, and that the effects of PF1A and PF1B are minor and not limiting. Therefore no interlocks need be incorporated based on combinations of Itf, Ioh, Ipf1a, Ipf1b in terms of their effect on TF inner leg insulation shear.

The highest stresses are of order 2.3ksi, which is safely below the allowable which we have established to be 2.9ksi [4]. The criticality of temperature effects is, however, underlined by these results. In this context I have asked I. Zatz to estimate the time scale on which we might expect significant thermal gradients to appear within the turn insulation, and the extent to which such gradients might suggest a reduction in the I2T rating of the coil for high field (e.g. 6kG), short duration pulses.


Stress (Cold)
Stress (Hot)
TF Inner Leg Max Insulation Shear Stress, Itf only
Stress (ksi)
2.5
2
1.5
1
0.5
0
35
40
45
50
55
60
65
70
75
Itf (kA)


Stress (Cold)
Stress (Hot)
TF Inner Leg Max Insulation Shear Stress vs. Ioh @ Itf=72kA, Ipf7A=2
Stress (ksi)
2.5
2
1.5
1
0.5
-5
0
5
10
15
20
25
30
Ioh (kA)



cc:

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M Peng	E Synakowski	A Von Halle	MWilliams	I Zatz

NSTX File