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SUBJECT: PF COIL ALIGNMENT AND FIELD ERRORS

References:

[1] NSTX-RQMTS-GRD-018, "NSTX General Requirements Document"
[2] 971108-PPPL-CKessel-01, "PF Coil Error Fields in NSTX"

Per section 2.7.5.a of the GRD (reference [1]):

"To avoid locked modes from non-axisymmetric fields (including those from coil misalignment, bus work, coil feeds, coil cross-overs, and magnetic materials), the m=2 n=1 component of the vacuum error field (at the q=2 surface) shall be limited to 5 gauss"

In reference [2] an estimate of the (2,1) component of field error due to 3 mm radial displacement, and due to 0.2 degree tilt, of each of the PF coils was made.

In practice there will be many sources of field error, including coil misalignments, magnetic materials, bus bars and coil leads, etc. Analysis of the composite effect, explicitly considering each cause of error, is not practical at this time.

However, guidance on allowable PF coil alignment error is needed. Therefore via this memo a general PF misalignment tolerance is derived which is based on the results of [2] and the (admittedly arbitrary) rule that, assuming all misalignments are additive from all PF coils at maximum current, the resulting (2,1) error due to radial displacement, or due to tilt, shall not exceed the criteria.

The following spreadsheet takes the results from [2] (based on 3mm) and (assuming that the derivative of the $B_{2,1}$ error component is linear with position error in the vicinity of 3 mm) shows that if each PF coil (upper and lower included) is offset radially by 5 mm , or tilted by +/- 5 mm, then the sum of the errors will be less than the aforementioned criteria. Therefore, this shall be the guidance on alignment error.

	R	dB/dr	dB/deg	dB/dtilt	
	(mm)	(gauss/mm)	(gauss/deg)	(gauss/mm)	
1	18.3	0.446	0.995	0.994	
2	79.0	0.997	0.990	0.442	
3	1450.0	0.990	4.115	0.622	
4	1700.0	0.992	5.995	0.666	
Shift		5		5	mm
		0.997		0.997	in
Error		4.443		4.339	Gauss

cc:

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NSTX File