NSTX Upgrade

Moment Influence Coefficients

NSTXU-CALC-13-05-00

Rev 0

January 18 2011

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PPPL Calculation Form

Calculation # **NSTXU-CALC-13-05-00** Revision # 00 WP #, 5200
(ENG-032)

Purpose of Calculation: (Define why the calculation is being performed.)

Force coefficients are an input to the digital coil protection system (DCPS)[7]. This document is a calculation of the moment influence coefficients to be applied to the PF currents. Previously, influence coefficients were computed for only radial and axial loads on the coils. There was no adjustment for the force centroid, which could be substantially displaced from the geometric centroid. Where force centers differ from the coil geometric centers, reaction forces at supports may differ significantly from loads computed with the assumption that the forces are at the coil centroid. Moment coefficients are also being computed by R. Wooley and this calculation may serve as a check for his results, or this calculation may produce coefficients for the DCPS

References (List any source of design information including computer program titles and revision levels.)

Included in the body of the calculations

Assumptions (Identify all assumptions made as part of this calculation.)

Axisymmetry of the coils

Calculation (Calculation is either documented here or attached)

Included in the body of the calculations

Conclusion (Specify whether or not the purpose of the calculation was accomplished.)

Moment influence coefficients have been calculated and tabulated for checking other's work or inclusion in the DCPS

Cognizant Engineer's printed name, signature, and date

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I have reviewed this calculation and, to my professional satisfaction, it is properly performed and correct.

Checker's printed name, signature, and date

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Table of Contents

Executive Summary:

It is usual practice to utilize influence coefficient calculations to determine hoop and axial (vertical for tokamak's) loads from coil currents. However the centroid of the Lorentz loads may not be at the geometric center of the coils. Where there is significant offset between the Lorentz centroid and the geometric center, there will be a moment about the coil geometric center in addition to the net loads. This may be a significant contributor to the support reaction loads and to the stresses in the coils themselves. In design and analysis of coil systems, distributions of fields and forces are typically calculated for a useful structural/magnetic mesh which is typically fine enough to properly distribute the Lorentz forces and resolve any moments about the coil current centers. When influence coefficients are used in operating tokamaks to check coil stresses and support loading the effect of moments has been omitted. To the author's knowledge, this is true of Alcator C-Mod, TFTR and NSTX . Addition of the moment coefficients completes the three degrees of freedom available from the axisymmetric analysis of ring coils. For NSTX the effect of the moment coefficients is small for the compact ring coils but is interesting for the thin solenoids - the OH and PF1a,b,and c. Two plasma shapes have been investigated a rectangular cross section and a shaped plasma.

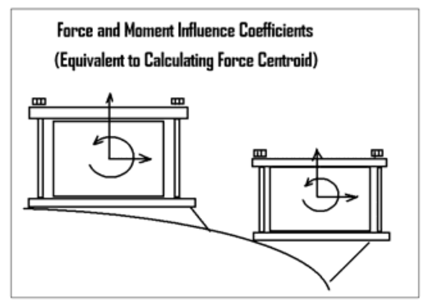


Figure 1 Moments at Current Centers.

Excerpt from the Shaped Plasma Moment Influence Coecfficients

		OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
OH	1	0.00E+00	-20165.7	-9837.4	-5246.08	-5607.03	-3893.17	-1291.17	-1209.61	20165.75	9837.401	5246.083	5607.024	3893.168	1291.17	1209.613	1.582384

The largest moment influence factors are for moments on the OH from PF1aU and L currents as might be expected from the coil geometries. The effect on the outer ring coils is minimal. The results of this calculation were compared with R. Hatchers results for the 2009 coil builds and with R. Woolley's calculations for the 2011 coil builds. The comparison with Wooley's moment coefficients show results typically within 2 to 5 % with two outliers at 8% and large difference ratios when the two analyses are both calculating essentially zero factors.

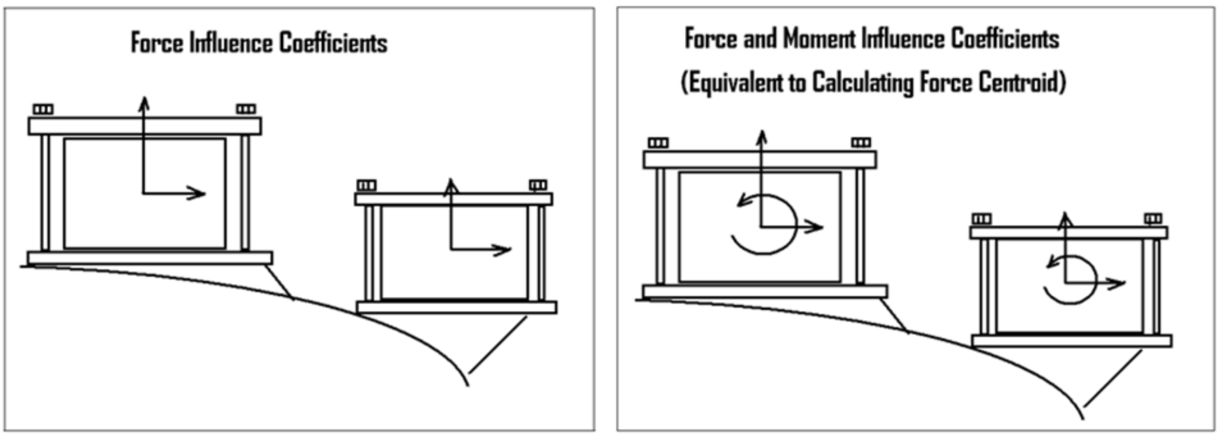
Digital Coil Protection System (DCPS) Input

The proposed DCPS is described in detail in a draft requirements document by Robert Woolley ref [7]. Force influence coefficients are already included in plans for the DCPS. Inclusion of these moment coefficients is proposed, depending on their usefulness in quantifying stresses for specific components. In the description of the DCPS, the “systems code” will actually be the analyses described in the filed structural calculations. There is a global model which is the closest thing we have to a single systems code, but this is augmented in many ways by separate calculations to address specific stress locations and components and support hardware. During the final design activity, Each preparer of a calculation will be assigned the development of “mini algorithms” These may make use of moment influence coefficients. One examples is:

.

PF 2,3 supports, welds bolts – At this stage, these are just calculated from influence coefficient matrix loads divided by weld or bolt area. Addition of moment influence coefficients adds overturning moments to the calculation of the bolt loads .

Addition of Moment Influence Coefficients to DCPS



Bolt Loads are calculated only from the vertical force.

Bolt Loads are calculated from the vertical force and the moment divided by the width of the bolt pattern

References

[1] NSTX Influence Coefficients, calculation # NSTXU 13 03-00, Ron Hatcher DATE: July 9 2009
[2] NSTX-CALC-13-001-00 Rev 1 Global Model – Model Description, Mesh Generation, Results, Peter H. Titus December 2010
[3] NSTX Structural Design Criteria Document, NSTX_DesCrit_IZ_080103.doc I. Zatz
[4] NSTX Design Point Sep 8 2009 http://www.pppl.gov/~neumeyer/NSTX_CSU/Design_Point.html
[5] OOP PF/TF Torques on TF , R. Woolley, NSTXU CALC 132-03-00
[6] "MHD and Fusion Magnets, Field and Force Design Concepts", R.J.Thome, John Tarrh, Wiley Interscience, 1982
[7] DIGITAL COIL PROTECTION SYSTEM (DCPS) REQUIREMENTS DOCUMENT (DRAFT), NSTX-CSU-RD-DCPS for the National Spherical Torus Experiment Center Stack Upgrade, February 5, 2010 R. Woolley
[8] NSTXU-CALC-132-04-00 ANALYSIS OF TF OUTER LEG, Han Zhang, August 31, 2009

Analysis Code, NTFTM

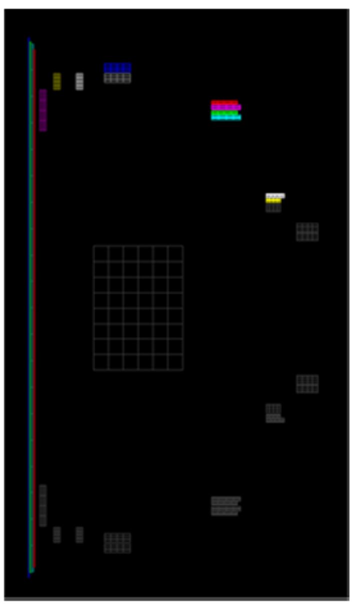
Mesh generation , calculation of the Lorentz forces, and generation of the influence coefficients is done using a code written by the author of this report. The influence coefficient subroutine is included as appendix A The mesh generation feature of the code is checked visually and within ANSYS during the

PREP7 geometry check. . The authors code uses elliptic integrals for 2D field calculations, and Biot Savart solution for 3D field calculations. These are based 2D formulations, and single stick field calculations from Dick Thomes book [8] with some help from Pillsbury's FIELD3D code to catch all the coincident current vectors, and other singularities.

The code in various forms has been used for 20 years and is suitable for structural calculations. It is also being used for calculation of load files in an NSTX global model[8]. Recent checks include NSTX out-of-plane load comparisons with ANSYS [9] and MAXWELL and calculations of trim coil fields for W7X compared with Neil Pomphrey's calculations. The analysts in the first ITER EDA went through an exercise to compare loads calculated by the US (using this code), RF and by Cees Jong in ANSYS, and agreements were good. Some information on the code, named FTM (Win98) and NTFTM2 (NT,XP), is available at: http://198.125.178.188/ftm/manual.pdf). or, within PPPL: at P:\public\Snap-srv\Titus\NTFTM

Axisymmetric Analysis Model

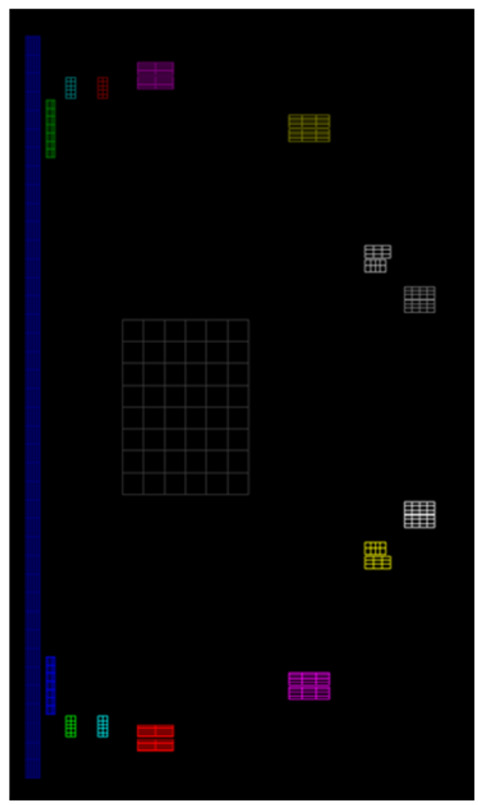
Computation of influence coefficients is done by computing contributions of fields and forces in one element group with respect to other element groups. The element groups are identified by real constant numbers for the elements in the group. This allows coils or sections of coils to be considered in the matrix calculation. For this calculation, the element designations used by Ron Hatcher's calculation [1] have been used to allow a comparison with the force influence coefficients. Moment coefficients require the computation of the force contributions with a running summation of forces multiplied by the element force times the appropriate radial or axial lever arm with respect to the element group centroid. So computation of the moment influence coefficients also produces the force influence coefficients.



PF Model Consistent with J. Menard's 33 coil set Equilibria Used as a starting point to create the model at right.

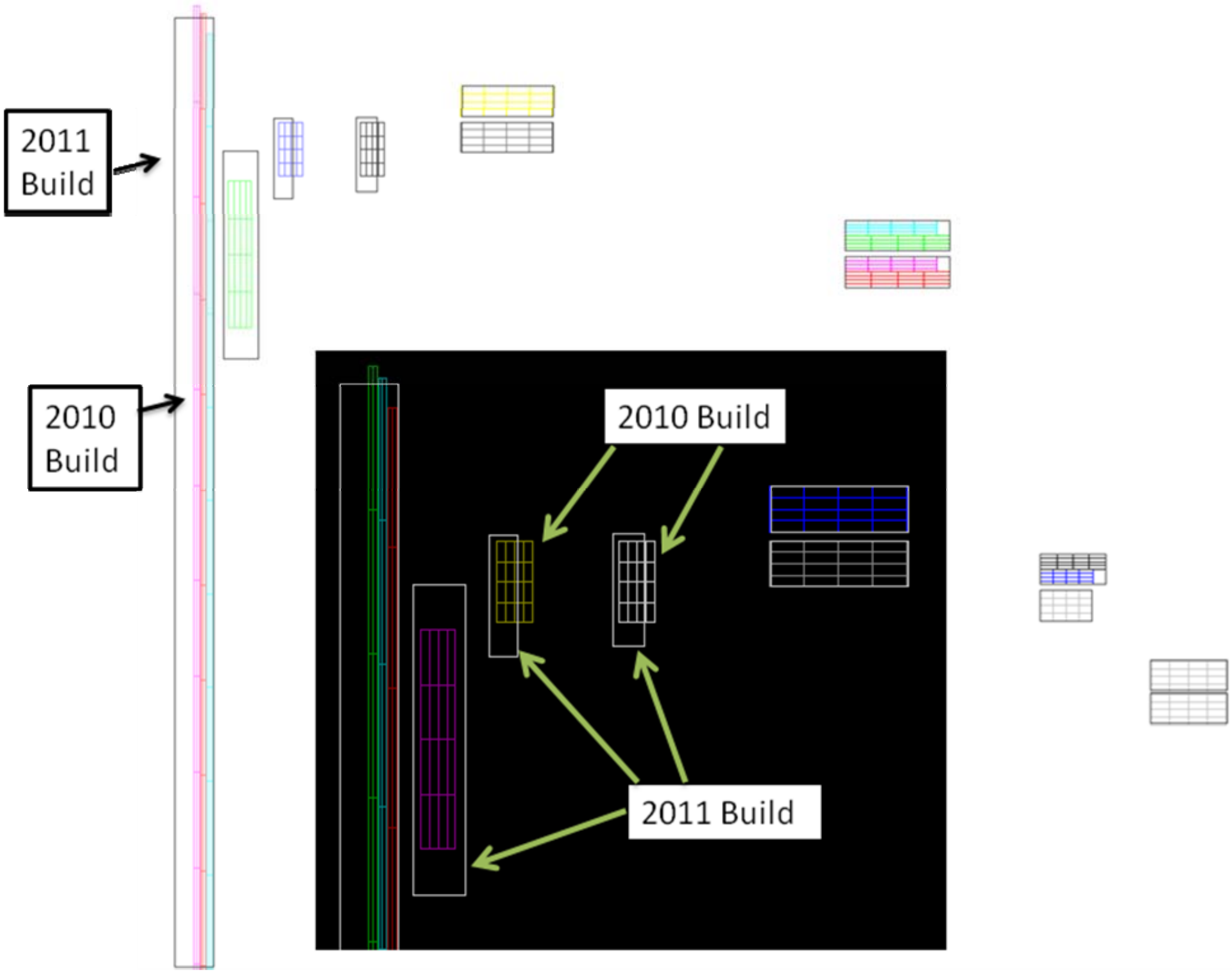
NTFTM InputFile

```
zero
! Influence Coefficient
!Matrix Test
read
ron2
divi
0,2,2,1
sral
1
merge
1,.0001
redu
rcol
16
1,10,80,1029,250
2,4,7,28,250
3,2,5,10,250
4,2,5,10,250
5,4,10,28,250
6,3,10,30,250
7,1,17,17,250
8,4,6,24,250
9,4,7,28,250
10,2,5,10,250
11,2,6,10,250
12,4,10,28,250
13,3,10,30,250
14,1,17,17,250
15,4,6,24,250
16,6,9,28,250
infl
16
copl
r
plce
pl
exit
```



PF Model Consistent with R. Hatcher's 16 coil set Influence Matrix, The geometry is in ron2.dat, read in the script at left.

Figure 2 Axisymmetric Models



Input Geometries

	(cm)	(cm)	(cm)	(cm)				0
OH (half-plane)	24.2083	6.934	106.04	212.08	4	110	442	0.701
PF1a	32.4434	6.2454	159.06	46.3296	4	16	64	0.825
PF1b	40.038	3.36	180.42	18.1167	2	16	32	0.794
PF1c	55.052	3.7258	181.36	16.6379	2	10	20	0.856
PF2a	79.9998	16.271	193.3473	6.797	7	2	14	0.741
PF2b	79.9998	16.271	185.26	6.797	7	2	14	0.741
PF3a	149.446	18.644	163.3474	6.797	7.5	2	15	0.693
PF3b	149.446	18.644	155.26	6.797	7.5	2	15	0.693
PF4b	179.4612	9.1542	80.7212	6.797	2	4	8	0.753
PF4c	180.6473	11.527	88.8086	6.797	4.5	2	9	0.672
PF5a	201.2798	13.533	65.2069	6.858	6	2	12	0.773
PF5b	201.2798	13.533	57.8002	6.858	6	2	12	0.773

```
rcoi
16
1,10,80,884,250    !OH
2,4,7,64,250      !PF1AU
3,2,5,32,250      !PF1bU
4,2,5,20,250      !PF1c
5,4,10,28,250
6,3,10,30,250
7,1,17,17,250
8,4,6,24,250
9,4,7,64,250
10,2,5,32,250
11,2,5,20,250
12,4,10,28,250
13,3,10,30,250
14,1,17,17,250
15,4,6,24,250
16,6,8,1,250
```

PF Builds and Number of Turns from the Design Point Spreadsheet [4]

Results

		OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
FX		Influence	Matrix	N/rad													
OH	1	25230.3	3806.061	1708.908	967.1191	1134.092	1209.182	776.9004	1080.26	3806.043	1708.914	967.123	1134.096	1209.203	776.8887	1080.252	58.04883
PF1AU	2	-140.673	856.7656	804.679	402.8212	385.0967	267.9286	97.79694	113.873	2.693542	1.662048	1.908569	5.065918	19.87793	25.48993	46.92737	1.891357
PF1bU	3	-111.435	-147.157	344.059	462.4921	333.3344	164.4536	52.2583	60.96289	1.346069	0.843353	0.970917	2.600311	10.30087	13.1109	24.38876	0.834534
PF1cU	4	-49.8817	-66.3434	-186.161	152.8504	363.0069	147.4613	44.34793	51.61908	1.111908	0.69957	0.805283	2.161407	8.583679	10.90804	20.36479	0.65506
PF2U	5	-31.1968	-44.1531	-82.4588	-136.834	292.1378	317.2212	81.96744	95.94821	1.96759	1.253113	1.443481	3.899963	15.58963	19.65652	37.01328	1.009399
PF3U	6	-21.5523	-26.2723	-19.4406	-24.8062	-74.7123	400.619	163.52	198.7234	3.382355	2.227905	2.566162	7.052979	28.73105	35.6076	68.99472	0.94574
PF4U	7	-14.8351	-3.98004	-1.31325	-1.43192	-0.89291	16.79922	150.6147	444.4194	2.456009	1.717377	1.986237	5.62558	23.96396	30.02812	62.74477	-0.35266
PF5U	8	-20.3084	-2.72794	-0.53848	-0.5621	1.093414	15.20554	-199.776	300.6638	2.999451	2.246582	2.606537	7.632538	33.50699	39.08331	86.71771	-1.09036
PF1AL	9	-140.673	2.693604	1.662109	1.908752	5.066101	19.87787	25.4903	46.92773	856.7654	804.6786	402.821	385.0972	267.929	97.79706	113.8729	1.891724
PF1bL	10	-111.435	1.3461	0.843353	0.970947	2.600433	10.30093	13.11102	24.38889	-147.157	344.0589	462.4922	333.3345	164.4537	52.25842	60.96298	0.834717
PF1cL	11	-49.8816	1.111908	0.699554	0.805328	2.161484	8.583694	10.90807	20.36481	-66.3433	-186.161	152.8504	363.007	147.4612	44.34799	51.61909	0.655121
PF2L	12	-31.1969	1.96756	1.253174	1.443481	3.900024	15.58957	19.65646	37.01309	-44.1531	-82.459	-136.834	292.1379	317.2212	81.9675	95.9483	1.00943
PF3L	13	-21.5522	3.382446	2.227753	2.566376	7.05304	28.73096	35.6077	68.99469	-26.2725	-19.4405	-24.8061	-74.7123	400.6189	163.5198	198.7233	0.945801
PF4L	14	-14.8352	2.456024	1.717377	1.986221	5.625595	23.96391	30.02812	62.74481	-3.97992	-1.31326	-1.43192	-0.89294	16.79919	150.6147	444.4194	-0.35263
PF5L	15	-20.3084	2.999481	2.246521	2.606598	7.632538	33.50702	39.0834	86.7178	-2.72781	-0.53839	-0.56195	1.093506	15.20557	-199.776	300.6637	-1.09033
Ip	16	-0.65479	0.39844	0.250672	0.287969	0.757769	2.9888	4.106287	6.647198	0.39844	0.250672	0.287969	0.757769	2.9888	4.106287	6.647198	0.205512

FY		Influence	Matrix	N/rad													
OH	1	0.00E+00	101.6216	132.1296	87.8682	115.5602	56.18751	13.25849	12.59733	-101.621	-132.129	-87.8677	-115.56	-56.1874	-13.2583	-12.5974	1.15E-04
PF1AU	2	-101.118	0.00E+00	384.1478	118.9599	77.54909	0.139336	-8.96284	-10.4976	-0.15052	-9.56E-02	-0.14978	-0.4568	-2.08736	-2.97952	-5.23168	-0.41885
PF1bU	3	-131.409	-386.426	0.00E+00	13.84991	35.47831	-9.61017	-7.17572	-7.91616	-9.66E-02	-6.30E-02	-9.43E-02	-0.28422	-1.29785	-1.85637	-3.34522	-0.21371
PF1cU	4	-87.757	-119.389	-13.8709	0.00E+00	67.80286	-13.4356	-8.80649	-9.60769	-0.14898	-9.25E-02	-0.12476	-0.35941	-1.56134	-2.19689	-3.96695	-0.23739
PF2U	5	-115.714	-77.7934	-35.61	-68.2043	0.00E+00	-69.1412	-26.9411	-28.6129	-0.45662	-0.28304	-0.36006	-1.00674	-4.25728	-5.93188	-10.8552	-0.55093
PF3U	6	-56.2119	-0.1395	9.6224	13.45625	69.21666	0.00E+00	-157.733	-149.975	-2.08676	-1.29659	-1.56193	-4.25708	-17.5993	-24.5514	-46.0942	-1.64419
PF4U	7	-13.2569	8.966514	7.175429	8.808064	26.94148	157.7714	0.00E+00	-368.7	-0.83501	0.288889	-5.35E-02	-3.78803	-22.4096	-33.9093	-67.3666	0.65353
PF5U	8	-12.5961	10.50075	7.915802	9.609217	28.61358	149.9904	371.0913	0.00E+00	-5.23136	-3.34403	-3.96774	-10.8557	-46.0978	-69.5098	-140.886	-1.53568
PF1AL	9	101.1179	0.150541	9.56E-02	0.149777	0.456797	2.08738	2.979534	5.231685	0.00E+00	-384.148	-118.96	-77.5491	-0.13934	8.962835	10.49761	0.418849
PF1bL	10	131.4086	9.55E-02	6.19E-02	9.32E-02	0.283148	1.296791	1.855291	3.344139	386.4264	0.00E+00	-13.8499	-35.4783	9.61014	7.175722	7.916151	0.213699
PF1cL	11	87.75694	0.149756	9.33E-02	0.125511	0.360171	1.562139	2.197661	3.967718	119.3888	13.87093	0.00E+00	-67.8029	13.43558	8.80649	9.607681	0.23738
PF2L	12	115.7142	0.456672	0.283127	0.360149	1.00679	4.257355	5.931921	10.85529	77.79339	35.61006	68.20438	0.00E+00	69.14127	26.94106	28.61289	0.550955
PF3L	13	56.21167	2.086667	1.296516	1.561787	4.257044	17.59918	24.55125	46.09405	0.139395	-9.62249	-13.4564	-69.2168	0.00E+00	157.7327	149.9749	1.644278
PF4L	14	13.25691	2.97919	1.855294	2.19768	5.932143	24.55371	36.0535	69.51076	-8.96656	-7.17546	-8.80807	-26.9415	-157.772	0.00E+00	368.6999	-0.65354
PF5L	15	12.59614	5.231288	3.343943	3.967732	10.85565	46.09769	69.50972	140.8862	-10.5008	-7.91585	-9.60928	-28.6136	-149.991	-371.092	0.00E+00	1.535666
Ip	16	-1.55E-08	0.419172	0.212848	0.238377	0.551498	1.645014	1.489633	1.53422	-0.41917	-0.21285	-0.23838	-0.5515	-1.64501	-1.48963	-1.53422	0.00E+00

Moment Influence Coefficients

		OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
MZ		Influence	Matrix	N-m/rad													
OH	1	0.00E+00	-5784.29	-2838.07	-1513.56	-1616.71	-1121.45	-371.817	-348.327	5784.292	2838.077	1513.561	1616.714	1121.453	371.8189	348.3287	1.54E-03
PF1AU	2	7.152492	0.00E+00	-73.6636	-20.0842	-10.7058	-1.67E-02	1.050949	1.221679	4.40E-02	2.56E-02	2.81E-02	7.11E-02	0.266337	0.352855	0.613915	4.54E-02
PF1bU	3	0.450232	-6.49832	0.00E+00	-0.48198	-0.75231	0.146579	0.101039	0.110743	3.10E-03	1.88E-03	2.03E-03	5.06E-03	1.95E-02	2.64E-02	4.72E-02	2.47E-03
PF1cU	4	-4.01E-02	-1.14453	-0.29893	0.00E+00	-1.36518	0.137595	7.59E-02	8.12E-02	2.03E-03	1.17E-03	1.35E-03	3.36E-03	1.35E-02	1.80E-02	3.27E-02	1.64E-03
PF2U	5	3.73E-02	3.25E-02	8.51E-03	-3.28E-02	0.00E+00	-2.93E-02	-9.37E-03	-9.36E-03	1.93E-04	4.89E-04	-2.55E-04	-2.66E-05	-5.84E-04	-1.09E-03	-2.90E-03	-5.31E-05
PF3U	6	3.28E-02	-8.45E-05	-1.69E-02	-2.42E-02	-0.13652	0.00E+00	-0.19286	-0.17624	-1.35E-03	-6.15E-04	-1.23E-03	-2.31E-03	-1.18E-02	-1.78E-02	-3.60E-02	1.01E-05
PF4U	7	1.81E-03	1.45E-02	1.02E-02	1.26E-02	3.48E-02	0.208274	0.00E+00	1.686089	-8.70E-02	-8.69E-02	-8.68E-02	-8.67E-02	-8.36E-02	-7.60E-02	-5.52E-02	-8.88E-02
PF5U	8	6.00E-04	2.37E-03	1.34E-03	1.66E-03	4.70E-03	2.13E-02	0.34347	0.00E+00	3.96E-04	9.27E-05	2.31E-04	5.87E-04	4.05E-03	4.44E-03	1.63E-02	-6.30E-04
PF1AL	9	-7.15235	-4.34E-02	-2.57E-02	-2.80E-02	-7.17E-02	-0.2658	-0.35305	-0.61401	0.00E+00	73.66515	20.08523	10.70527	1.58E-02	-1.05117	-1.22179	-4.59E-02
PF1bL	10	-0.45037	-3.05E-03	-1.71E-03	-1.99E-03	-5.31E-03	-1.96E-02	-2.65E-02	-4.71E-02	6.498307	0.00E+00	0.482262	0.752478	-0.14651	-0.1009	-0.11069	-2.63E-03
PF1cL	11	3.99E-02	-1.98E-03	-1.10E-03	-1.35E-03	-3.52E-03	-1.34E-02	-1.81E-02	-3.26E-02	1.14442	0.298811	0.00E+00	1.365146	-0.13729	-7.59E-02	-8.14E-02	-1.71E-03
PF2L	12	-3.69E-02	-3.48E-04	-3.97E-04	4.51E-05	-2.21E-04	4.78E-04	1.18E-03	2.56E-03	-3.21E-02	-7.84E-03	3.30E-02	0.00E+00	2.88E-02	9.07E-03	8.70E-03	-2.28E-04
PF3L	13	-3.30E-02	1.25E-03	9.91E-04	1.05E-03	2.59E-03	1.25E-02	1.79E-02	3.62E-02	3.17E-04	1.61E-02	2.39E-02	0.136112	0.00E+00	0.193252	0.176294	5.08E-05
PF4L	14	-1.84E-03	-1.38E-04	-1.84E-04	-1.52E-04	-3.86E-04	-3.46E-03	-1.12E-02	-3.20E-02	-0.01459	-1.02E-02	-1.27E-02	-3.48E-02	-0.20831	0.00E+00	-1.68622	8.86E-02
PF5L	15	-5.71E-04	-3.25E-04	-9.78E-05	-4.88E-04	-9.94E-04	-3.86E-03	-4.33E-03	-1.58E-02	-2.34E-03	-1.28E-03	-1.46E-03	-4.74E-03	-2.13E-02	-0.34239	0.00E+00	5.13E-04
Ip	16	-4.60E-10	-1.95E-02	-1.32E-02	-1.53E-02	-4.05E-02	-0.16181	-0.22447	-0.26779	1.95E-02	1.32E-02	1.53E-02	4.05E-02	0.161809	0.224468	0.267794	0.00E+00

			OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
	FX		Influence	Matrix	lb/coil													
OH		1	35636.87	5375.921	2413.77	1366.02	1601.863	1707.925	1097.343	1525.827	5375.896	2413.779	1366.026	1601.869	1707.955	1097.327	1525.816	81.99184
PF1AU		2	-198.695	1210.15	1136.58	568.9702	543.9351	378.4394	138.1346	160.8414	3.80453	2.347582	2.695784	7.155424	28.07685	36.00359	66.28319	2.671473
PF1bU		3	-157.398	-207.854	485.9707	653.2532	470.8225	232.2846	73.81298	86.10785	1.901274	1.191206	1.371384	3.672844	14.54961	18.51867	34.44823	1.178748
PF1cU		4	-70.456	-93.7076	-262.946	215.8956	512.7339	208.2837	62.63983	72.91006	1.570529	0.988117	1.137432	3.052909	12.12413	15.4072	28.76452	0.925248
PF2U		5	-44.0644	-62.3646	-116.47	-193.273	412.634	448.0633	115.776	135.5233	2.779149	1.769976	2.038865	5.508555	22.01978	27.76412	52.2799	1.42574
PF3U		6	-30.4419	-37.1087	-27.4592	-35.0379	-105.528	565.8596	230.966	280.6895	4.777452	3.146835	3.62461	9.962073	40.58155	50.29444	97.45251	1.335823
PF4U		7	-20.9541	-5.62166	-1.85491	-2.02253	-1.26121	23.72829	212.7378	627.7261	3.469023	2.425732	2.805486	7.945925	33.84821	42.41362	88.62468	-0.49812
PF5U		8	-28.6848	-3.85311	-0.76059	-0.79395	1.544408	21.47726	-282.177	424.6766	4.236614	3.173215	3.681638	10.78068	47.32739	55.20375	122.4856	-1.5401
PF1AL		9	-198.695	3.804616	2.347669	2.696043	7.155682	28.07676	36.00411	66.28371	1210.15	1136.579	568.9698	543.9357	378.4399	138.1348	160.8412	2.67199
PF1bL		10	-157.397	1.901317	1.191206	1.371427	3.673017	14.54969	18.51884	34.44841	-207.854	485.9706	653.2534	470.8228	232.2848	73.81311	86.10798	1.179007
PF1cL		11	-70.456	1.570529	0.988095	1.137497	3.053017	12.12415	15.40724	28.76454	-93.7075	-262.946	215.8956	512.7341	208.2836	62.63991	72.91008	0.925334
PF2L		12	-44.0644	2.779106	1.770062	2.038865	5.508642	22.0197	27.76403	52.27964	-62.3647	-116.47	-193.273	412.6341	448.0633	115.7761	135.5235	1.425783
PF3L		13	-30.4417	4.777581	3.146619	3.624912	9.96216	40.58142	50.29457	97.45247	-37.109	-27.459	-35.0377	-105.528	565.8595	230.9658	280.6894	1.335909
PF4L		14	-20.9542	3.469044	2.425732	2.805465	7.945947	33.84815	42.41362	88.62475	-5.62149	-1.85494	-2.02253	-1.26125	23.72825	212.7378	627.7261	-0.49808
PF5L		15	-28.6848	4.236657	3.173129	3.681724	10.78068	47.32743	55.20388	122.4857	-3.85294	-0.76046	-0.79373	1.544537	21.4773	-282.177	424.6765	-1.54005
Ip		16	-0.92487	0.562782	0.354065	0.406746	1.07032	4.22157	5.799981	9.388924	0.562782	0.354065	0.406746	1.07032	4.22157	5.79998	9.388924	0.290278

	FY		Influence	Matrix	lb/coil													
OH		1	0.00E+00	143.5368	186.6282	124.1106	163.2246	79.3628	18.72713	17.79327	-143.536	-186.628	-124.11	-163.224	-79.3626	-18.7268	-17.7933	1.63E-04
PF1AU		2	-142.825	0.00E+00	542.5947	168.0264	109.5352	0.196807	-12.6597	-14.8275	-0.21261	-0.13498	-0.21157	-0.64521	-2.94831	-4.20846	-7.38955	-0.59161
PF1bU		3	-185.61	-545.813	0.00E+00	19.56249	50.1118	-13.574	-10.1355	-11.1813	-0.13644	-8.89E-02	-0.13317	-0.40145	-1.83317	-2.62205	-4.725	-0.30186
PF1cU		4	-123.954	-168.632	-19.5922	0.00E+00	95.76905	-18.9773	-12.4388	-13.5705	-0.21043	-0.13065	-0.17622	-0.50765	-2.20534	-3.10303	-5.60317	-0.3353
PF2U		5	-163.442	-109.88	-50.2978	-96.336	0.00E+00	-97.6594	-38.0533	-40.4146	-0.64495	-0.39979	-0.50857	-1.42198	-6.01325	-8.37857	-15.3326	-0.77818
PF3U		6	-79.3972	-0.19704	13.59129	19.00645	97.76599	0.00E+00	-222.792	-211.834	-2.94748	-1.83139	-2.20618	-6.01297	-24.8583	-34.6779	-65.1063	-2.32235
PF4U		7	-18.7248	12.66487	10.13503	12.44107	38.05385	222.8463	0.00E+00	-520.775	-1.17943	0.408045	-7.56E-02	-5.35045	-31.6527	-47.8957	-95.1529	0.923087
PF5U		8	-17.7915	14.83193	11.18078	13.57267	40.41563	211.856	524.1528	0.00E+00	-7.38911	-4.72331	-5.60429	-15.3333	-65.1114	-98.18	-198.997	-2.16909
PF1AL		9	142.8253	0.212634	0.134995	0.211554	0.645209	2.948348	4.208488	7.389563	0.00E+00	-542.595	-168.026	-109.535	-0.19681	12.65968	14.82749	0.591609
PF1bL		10	185.6099	0.134959	8.74E-02	0.131672	0.399936	1.83167	2.620531	4.723474	545.8131	0.00E+00	-19.5625	-50.1118	13.57397	10.13544	11.18127	0.301843
PF1cL		11	123.9535	0.211524	0.131741	0.17728	0.508729	2.206463	3.104116	5.604257	168.6322	19.59218	0.00E+00	-95.7691	18.97726	12.43884	13.5705	0.335291
PF2L		12	163.4421	0.645032	0.399907	0.508697	1.422053	6.013358	8.378621	15.3327	109.8803	50.2979	96.33618	0.00E+00	97.6595	38.05326	40.41466	0.778203
PF3L		13	79.39692	2.94734	1.831281	2.205967	6.012919	24.8582	34.67775	65.10616	0.19689	-13.5914	-19.0066	-97.7662	0.00E+00	222.7916	211.8341	2.322483
PF4L		14	18.7249	4.207996	2.620535	3.104143	8.378935	34.68122	50.92426	98.1814	-12.6649	-10.1351	-12.4411	-38.0539	-222.846	0.00E+00	520.775	-0.9231
PF5L		15	17.79158	7.389003	4.723197	5.604276	15.33321	65.1113	98.17993	198.9966	-14.832	-11.1809	-13.5728	-40.4157	-211.856	-524.153	0.00E+00	2.169071
Ip		16	-2.20E-08	0.592064	0.30064	0.336698	0.778971	2.323522	2.104052	2.16703	-0.59206	-0.30064	-0.3367	-0.77897	-2.32352	-2.10405	-2.16703	0.00E+00

Moment Influence Coefficients

			OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
	MZ		Influence	Matrix	in-lb/coil													
OH		1	0.00E+00	-321657	-157822	-84167.1	-89903.2	-62362.4	-20676.2	-19370	321656.8	157821.7	84167.15	89903.32	62362.52	20676.36	19370.1	8.54E-02
PF1AU		2	397.7406	0.00E+00	-4096.34	-1116.86	-595.338	-0.92864	58.44186	67.93596	2.444199	1.423487	1.561501	3.951034	14.81066	19.62181	34.139	2.523012
PF1bU		3	25.03682	-361.363	0.00E+00	-26.802	-41.8351	8.151034	5.618644	6.158261	0.172254	0.10466	0.112964	0.281341	1.082232	1.468651	2.622284	0.137351
PF1cU		4	-2.22988	-63.6455	-16.6229	0.00E+00	-75.916	7.651491	4.222968	4.517146	0.112876	6.52E-02	7.51E-02	0.186888	0.749204	1.003491	1.818811	9.10E-02
PF2U		5	2.072851	1.806785	0.473095	-1.82446	0.00E+00	-1.62928	-0.52132	-0.5205	1.08E-02	2.72E-02	-1.42E-02	-1.48E-03	-3.24E-02	-6.05E-02	-0.16128	-2.96E-03
PF3U		6	1.826376	-4.70E-03	-0.94109	-1.34819	-7.59144	0.00E+00	-10.7248	-9.80047	-7.53E-02	-3.42E-02	-6.82E-02	-0.1283	-0.65777	-0.98787	-2.00319	5.60E-04
PF4U		7	0.100596	0.807841	0.565928	0.700303	1.934912	11.58186	0.00E+00	93.76116	-4.84022	-4.83304	-4.82831	-4.82088	-4.64866	-4.22488	-3.06851	-4.93602
PF5U		8	3.33E-02	0.132045	7.43E-02	9.26E-02	0.261356	1.182083	19.09991	0.00E+00	2.20E-02	5.15E-03	1.29E-02	3.26E-02	0.225394	0.246646	0.908687	-3.50E-02
PF1AL		9	-397.733	-2.41395	-1.4274	-1.55944	-3.98945	-14.781	-19.6325	-34.1442	0.00E+00	4096.422	1116.913	595.3058	0.876383	-58.4543	-67.9422	-2.55193
PF1bL		10	-25.0447	-0.16964	-9.51E-02	-0.1107	-0.29508	-1.08845	-1.47231	-2.62085	361.3623	0.00E+00	26.81797	41.84433	-8.14722	-5.61095	-6.15559	-0.14611
PF1cL		11	2.22138	-0.10987	-6.13E-02	-7.48E-02	-0.1958	-0.74686	-1.00631	-1.8136	63.63967	16.61646	0.00E+00	75.91399	-7.63428	-4.22323	-4.52402	-9.52E-02
PF2L		12	-2.05474	-1.93E-02	-2.21E-02	2.51E-03	-1.23E-02	2.66E-02	6.56E-02	0.142118	-1.78606	-0.4361	1.835042	0.00E+00	1.602775	0.504313	0.483915	-1.27E-02
PF3L		13	-1.83614	6.95E-02	5.51E-02	5.81E-02	0.144168	0.694368	0.993703	2.012362	1.76E-02	0.894526	1.327448	7.569005	0.00E+00	10.74651	9.803458	2.82E-03
PF4L		14	-0.10234	-7.69E-03	-1.02E-02	-8.44E-03	-2.15E-02	-0.19217	-0.62038	-1.77811	-0.81144	-0.5678	-0.70574	-1.93624	-11.5836	0.00E+00	-93.7685	4.92904
PF5L		15	-3.17E-02	-1.81E-02	-5.44E-03	-2.72E-02	-5.53E-02	-0.21444	-0.24078	-0.879	-0.12985	-7.13E-02	-8.10E-02	-0.26365	-1.1841	-19.0401	0.00E+00	2.85E-02
Ip		16	-2.56E-08	-1.08623	-0.73522	-0.84979	-2.25193	-8.99796	-12.4824	-14.8917	1.086227	0.735221	0.849789	2.251943	8.997968	12.48235	14.89168	0.00E+00

Comparison with Bob Woolley's Moment Influence Coefficients (2011 Coil Build)

Titus: 14June2011		PF1AU	PF1bU	PF1cU	PF1cL	PF1bL	PF1AL	OH	Ip
PF1AU	2	0.00E+00	-73.66362	-20.08421	2.81E-02	2.56E-02	4.40E-02	7.152492	4.54E-02
PF1bU	3	-6.49832	0.00E+00	-0.4819759	2.03E-03	1.88E-03	3.10E-03	0.4502322	2.47E-03
PF1cU	4	-1.144525	-0.2989268	0.00E+00	1.35E-03	1.17E-03	2.03E-03	-4.01E-02	1.64E-03
PF1cL	11	-1.98E-03	-1.10E-03	-1.35E-03	0.00E+00	0.2988105	1.14442	3.99E-02	-1.71E-03
PF1bL	10	-3.05E-03	-1.71E-03	-1.99E-03	0.4822623	0.00E+00	6.498307	-0.450373	-2.63E-03
PF1AL	9	-4.34E-02	-2.57E-02	-2.80E-02	20.08523	73.66515	0.00E+00	-7.152351	-4.59E-02
OH	1	-5784.291	-2838.073	-1513.561	1513.561	2838.077	5784.292	0.00E+00	1.54E-03
Ip	16	-1.95E-02	-1.32E-02	-1.53E-02	1.53E-02	1.32E-02	1.95E-02	-4.60E-10	0.000E+00

Woolley: 17December 2010	PF1AU	PF1bU	PF1cU	PF1cL	PF1bL	PF1AL	OH	Ip
PF1AU	2.732E-15	7.124E+01	1.957E+01	-2.783E-02	-2.452E-02	-4.129E-02	-7.094E+00	-5.998E-02
PF1bU	6.187E+00	-2.774E-15	4.882E-01	-2.018E-03	-1.770E-03	-2.916E-03	-4.159E-01	-3.896E-03
PF1cU	1.117E+00	3.054E-01	-8.688E-16	-1.353E-03	-1.184E-03	-1.934E-03	5.914E-02	-2.492E-03
PF1cL	1.934E-03	1.184E-03	1.353E-03	-8.688E-16	-3.054E-01	-1.117E+00	-5.914E-02	2.492E-03
PF1bL	2.916E-03	1.770E-03	2.018E-03	-4.882E-01	-2.774E-15	-6.187E+00	4.159E-01	3.896E-03
PF1AL	4.129E-02	2.452E-02	2.783E-02	-1.957E+01	-7.124E+01	2.732E-15	7.094E+00	5.998E-02
OH	5.763E+03	2.824E+03	1.508E+03	-1.508E+03	-2.824E+03	-5.763E+03	8.050E-13	-9.994E-16
Ip	3.579E-02	3.546E-02	4.378E-02	-4.378E-02	-3.546E-02	-3.579E-02	-1.197E-17	-2.262E-19

Ratios=Titus/Woolley	PF1AU	PF1bU	PF1cU	PF1cL	PF1bL	PF1AL	OH	Ip
PF1AU	0.0000	-1.0341	-1.0261	-1.0090	-1.0439	-1.0645	-1.0083	-0.7565
PF1bU	-1.0504	0.0000	-0.9873	-1.0065	-1.0634	-1.0622	-1.0826	-0.6340
PF1cU	-1.0247	-0.9787	0.0000	-0.9979	-0.9901	-1.0495	-0.6781	-0.6563
PF1cL	-1.0216	-0.9309	-0.9948	0.0000	-0.9783	-1.0246	-0.6755	-0.6871
PF1bL	-1.0462	-0.9665	-0.9864	-0.9879	0.0000	-1.0504	-1.0830	-0.6744
PF1AL	-1.0513	-1.0468	-1.0077	-1.0262	-1.0341	0.0000	-1.0083	-0.7652
OH	-1.0037	-1.0049	-1.0040	-1.0040	-1.0049	-1.0037	0.0000	-1.54E+12
Ip	-0.5458	-0.3728	-0.3491	-0.3491	-0.3728	-0.5458	3.85E+07	0.0000

Comparison with Ron Hatcher's Radial Influence Coefficients (2010 Coil Build)

(Titus)

FX	Influence	Matrix	lb/coil/kA													
	OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
1	48286.48	2746.325	859.9474	784.5903	1305.204	1988.13	1277.38	1776.095	2746.336	859.9474	784.6454	1305.243	1988.141	1277.352	1776.073	2673.429
2	-97.565	275.8774	115.838	117.4871	166.6145	166.3844	60.38033	70.24693	0.716404	0.334667	0.599698	2.179581	12.22437	15.67624	28.87584	32.34988
3	-57.6236	0.11217	52.90043	114.077	110.8109	74.87416	23.47889	27.40892	0.260887	0.123932	0.222529	0.815751	4.620879	5.875896	10.94085	10.30711
4	-40.1177	-15.6223	-50.0426	58.41548	191.5191	105.8464	31.54342	36.73657	0.342076	0.163104	0.292742	1.074881	6.101841	7.749259	14.47587	12.90038
5	-35.9941	-18.4135	-29.6678	-76.4916	202.2312	313.6473	81.04058	94.86471	0.844124	0.40732	0.731168	2.698974	15.41392	19.43493	36.59594	27.94646
6	-35.4348	-16.4775	-9.07299	-18.0052	-73.8474	565.8593	230.9662	280.6903	2.077357	1.03745	1.860798	6.9724	40.5816	50.2947	97.4529	37.40968
7	-24.3918	-2.43067	-0.54534	-0.95842	-0.88568	23.72827	212.731	627.7262	1.513631	0.803541	1.44434	5.561359	33.84811	42.41364	88.62479	-13.9465
8	-33.3906	-1.65023	-0.19052	-0.33574	1.078615	21.47709	-282.177	424.716	1.854289	1.056847	1.902265	7.545006	47.32739	55.20401	122.4857	-43.1206
9	-97.5651	0.716383	0.334602	0.599676	2.179495	12.22435	15.6763	28.87582	275.8775	115.8378	117.4868	166.6143	166.3844	60.38029	70.2468	32.34971
10	-57.6236	0.260909	0.123943	0.222535	0.815761	4.620906	5.875912	10.94088	0.112186	52.90041	114.077	110.8109	74.87417	23.47893	27.40894	10.30715
11	-40.1176	0.342081	0.163093	0.292753	1.074903	6.101847	7.749259	14.47586	-15.6223	-50.0426	58.41547	191.5191	105.8464	31.5434	36.73655	12.90037
12	-35.9942	0.844168	0.407234	0.73106	2.698996	15.41388	19.43486	36.59594	-18.4134	-29.6678	-76.4916	202.2312	313.6472	81.04064	94.86464	27.94639
13	-35.435	2.077185	1.037364	1.86041	6.972702	40.5816	50.29483	97.45264	-16.4777	-9.07308	-18.0052	-73.8476	565.8595	230.9662	280.6898	37.40955
14	-24.3918	1.513544	0.803433	1.444232	5.561337	33.84815	42.4136	88.62475	-2.43056	-0.54545	-0.95844	-0.88568	23.72818	212.731	627.7263	-13.9465
15	-33.3906	1.854375	1.05702	1.902308	7.545135	47.32731	55.20388	122.4856	-1.65053	-0.19052	-0.33583	1.078788	21.47722	-282.177	424.7159	-43.1206
16	-30.1441	6.867763	3.246558	5.819321	20.97625	118.2041	162.3995	262.8898	6.867784	3.246515	5.819321	20.97625	118.2041	162.3996	262.8898	227.5779

(Hatcher ref [1])

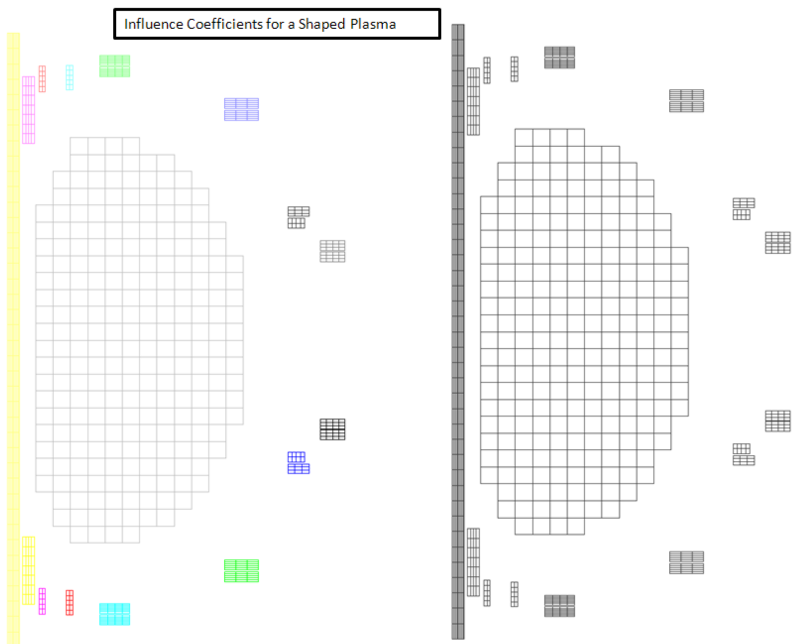
	OH	1AU	1BU	1CU	2U	3U	4U	5U	1AL	1BL	1CL	2L	3L	4L	5L
OH	47683	2736	856	780	1839	1909	1225	1690	2736	856	780	1839	1909	1225	1690
1AU	-134	266	115	117	236	162	58	66	1	0.28	1	3	10	14	26
1BU	-68	-2	49	114	158	73	22	25	0.22	0.10	0.18	1	4	5	10
1CU	-50	-17	-52	54	273	103	30	34	0.28	0.13	0.24	1	5	7	13
2U	-78	-29	-44	-112	380	436	109	125	1	0.45	1	4	18	24	45
3U	-67	-19	-10	-20	-116	495	219	263	2	1	1	7	32	43	84
4U	-44	-3	-1	-2	-5	12	179	617	1	1	1	6	27	37	80
5U	-61	-3	-1	-1	-3	6	-300	353	1	1	1	8	37	47	108
1AL	-134	1	0.28	1	3	10	14	26	266	115	117	236	162	58	66
1BL	-68	0.22	0.10	0.18	1	4	5	10	-2	49	114	158	73	22	25
1CL	-50	0.28	0.13	0.24	1	5	7	13	-17	-52	53	273	103	30	34
2L	-78	1	0.45	1	4	18	24	45	-29	-44	-113	382	436	109	125
3L	-67	2	1	1	7	32	43	84	-19	-10	-20	-116	495	219	263
4L	-44	1	1	1	6	27	37	80	-3	-1	-2	-5	12	178	617
5L	-61	1	1	1	8	37	47	108	-3	-1	-1	-3	6	-300	354

Titus Results for Axial Coefficients

FY	FY Influence	Matrix	lb/coil/kA													
	OH	PF1AU	PF1bU	PF1cU	PF2U	PF3U	PF4U	PF5U	PF1AL	PF1bL	PF1cL	PF2L	PF3L	PF4L	PF5L	Ip
1	0.00E+00	66.64612	73.89371	74.0529	132.9881	92.38018	21.799	20.71244	-66.6462	-73.8939	-74.0536	-132.988	-92.3803	-21.7989	-20.7122	-5.32E-05
2	-66.2398	0.00E+00	82.92657	42.05192	35.86358	8.84E-02	-5.57602	-6.50188	-3.85E-02	-1.95E-02	-4.68E-02	-0.19482	-1.27565	-1.82401	-3.20804	-7.10529
3	-73.5044	-83.1167	0.00E+00	-6.06E-06	9.865533	-5.01383	-3.3919	-3.7269	-1.93E-02	-9.78E-03	-2.24E-02	-9.23E-02	-0.60192	-0.8602	-1.55386	-2.70269
4	-73.9737	-42.1405	8.42E-06	0.00E+00	33.31788	-10.4063	-6.43702	-7.00614	-4.66E-02	-2.24E-02	-4.65E-02	-0.18219	-1.12868	-1.58751	-2.87004	-4.75633
5	-133.317	-36.0703	-9.97832	-34.0005	0.00E+00	-68.3974	-26.6338	-28.2862	-0.19458	-9.22E-02	-0.18216	-0.69652	-4.2084	-5.86372	-10.7307	-15.2492
6	-92.4214	-8.87E-02	5.019825	10.42003	68.38245	0.00E+00	-222.792	-211.834	-1.27531	-0.60189	-1.1287	-4.20892	-24.8586	-34.6781	-65.1065	-65.0293
7	-21.7962	5.577226	3.392086	6.437432	26.63189	222.8464	0.00E+00	-520.775	1.204982	2.168681	1.441272	-2.83587	-31.6523	-47.8954	-95.1527	-55.923
8	-20.7099	6.503157	3.727408	7.006531	28.28558	211.8561	524.153	0.00E+00	-3.20748	-1.55358	-2.86979	-10.7316	-65.1111	-98.1797	-198.996	-60.7369
9	66.23981	3.84E-02	1.93E-02	4.66E-02	0.194658	1.275486	1.823841	3.207869	0.00E+00	-82.9266	-42.0519	-35.8636	-8.84E-02	5.57603	6.501875	7.105299
10	73.5044	1.93E-02	9.77E-03	2.24E-02	9.23E-02	0.601911	0.860187	1.553854	83.11672	0.00E+00	9.09E-06	-9.86554	5.013825	3.39191	3.726894	2.702686
11	73.97371	4.66E-02	2.24E-02	4.65E-02	0.182191	1.128668	1.587507	2.87004	42.14047	0.00E+00	0.00E+00	-33.3179	10.40627	6.437025	7.006148	4.756346
12	133.3172	0.194582	9.23E-02	0.182141	0.696529	4.208402	5.863739	10.73066	36.0703	9.978312	34.00047	0.00E+00	68.3974	26.63383	28.28614	15.24921
13	92.42152	1.275601	0.602023	1.12885	4.209094	24.85861	34.67822	65.10667	8.89E-02	-5.01967	-10.42	-68.3822	0.00E+00	222.7915	211.8342	65.02914
14	21.79631	1.823763	0.860134	1.58746	5.864709	34.6811	50.92421	98.1814	-5.57716	-3.39207	-6.4375	-26.6319	-222.847	0.00E+00	520.775	55.92292
15	20.71029	3.207828	1.553992	2.8702	10.73193	65.1114	98.18004	198.9967	-6.5028	-3.72718	-7.00636	-28.2854	-211.856	-524.153	0.00E+00	60.7369
16	3.45E-06	7.111921	2.705377	4.760818	15.26805	65.0586	58.91345	60.67682	-7.11192	-2.70537	-4.76081	-15.268	-65.0586	-58.9135	-60.6768	0.00E+00

Hatcher Results for Axial Coefficients [1]

	OH	1AU	1BU	1CU	2U	3U	4U	5U	1AL	1BL	1CL	2L	3L	4L	5L
OH	6	73	77	78	201	98	23	22	-73	-78	-78	-201	-98	-23	-22
1AU	-73	-0.02	84	43	52	0	-6	-7	-0.11	-0.05	-0.08	-0.41	-2	-2	-4
1BU	-77	-84	0.10	-0.09	14	-5	-4	-4	-0.05	-0.02	-0.04	-0.18	-1	-1	-2
1CU	-78	-43	-0.02	1	48	-11	-7	-8	-0.08	-0.04	-0.07	-0.33	-1	-2	-3
2U	-203	-52	-14	-48	-1	-102	-40	-43	-0.42	-0.18	-0.33	-2	-7	-9	-17
3U	-104	-0.46	5	10	96	-7	-228	-219	-2	-1	-1	-6	-26	-36	-68
4U	-25	6	3	6	38	222	-3	-530	-2	-1	-2	-9	-35	-52	-100
5U	-25	7	4	7	40	210	527	-2	-3	-2	-3	-15	-65	-99	-201
1AL	73	0.11	0.05	0.08	0.41	2	2	4	0.36	-84	-43	-52	0.27	6	7
1BL	77	0.05	0.02	0.04	0.18	1	1	2	84	0.08	0.10	-14	5	4	4
1CL	78	0.08	0.04	0.07	0.33	1	2	3	43	0.03	-1	-48	11	7	8
2L	203	0.42	0.18	0.33	2	7	9	17	52	14	49	1	102	40	43
3L	104	2	1	1	6	26	36	68	0.46	-5	-10	-96	7	228	219
4L	25	2	1	2	9	35	52	100	-6	-3	-6	-38	-222	1	530
5L	25	3	2	3	15	65	99	201	-7	-4	-7	-40	-210	-526	2



FX Influence Matrix lb/coil

1	2184.633	337.0884	150.602	85.25023	100.0352	106.7215	68.57568	95.35145	337.088	150.6022	85.24972	100.0361	106.7212	68.57516	95.35179	4.36636
2	-13.0325	74.58116	70.85085	35.52862	33.98438	23.64041	8.633018	10.05266	0.237816	0.146751	0.168535	0.4473	1.75518	2.250726	4.143437	0.220924
3	-9.86305	-13.0077	30.02943	40.7569	29.4003	14.51467	4.613392	5.381883	0.118819	7.44E-02	8.57E-02	0.229553	0.909404	1.157479	2.153139	9.16E-02
4	-4.42417	-5.86005	-16.4218	13.3616	31.99938	13.01482	3.915083	4.557014	9.81E-02	6.18E-02	7.11E-02	0.1908	0.757789	0.96299	1.797866	6.94E-02
5	-2.77526	-3.89755	-7.30427	-12.1373	25.79114	28.00179	7.23583	8.470176	0.173665	0.110615	0.127421	0.344258	1.376226	1.735252	3.267518	9.54E-02
6	-1.90668	-2.32413	-1.71882	-2.19336	-6.60047	35.25877	14.42838	17.53952	0.298596	0.196661	0.226562	0.622616	2.536441	3.143634	6.091092	4.55E-02
7	-1.30992	-0.35125	-0.11587	-0.12634	-7.89E-02	1.478745	13.28975	39.2435	0.216831	0.151606	0.175344	0.496588	2.11547	2.651024	5.539451	-4.06E-02
8	-1.793	-0.24064	-4.75E-02	-4.95E-02	9.65E-02	1.340241	-17.6072	26.26867	0.264815	0.198318	0.230105	0.673736	2.957825	3.450646	7.656071	-7.45E-02
9	-13.0325	0.237816	0.146751	0.168535	0.4473	1.75518	2.25072	4.143432	74.58116	70.85085	35.52862	33.98436	23.64041	8.633013	10.05265	0.226263
10	-9.86304	0.118822	7.45E-02	8.57E-02	0.229556	0.90941	1.157487	2.153144	-13.0077	30.02942	40.7569	29.40031	14.51467	4.6134	5.381889	9.28E-02
11	-4.42417	9.81E-02	6.18E-02	7.11E-02	0.190799	0.757788	0.962989	1.797865	-5.86005	-16.4218	13.3616	31.99938	13.01482	3.915082	4.557014	7.01E-02
12	-2.77527	0.173656	0.110615	0.127424	0.34425	1.376226	1.735249	3.26752	-3.89755	-7.30427	-12.1373	25.79114	28.00179	7.235833	8.470171	9.58E-02
13	-1.90666	0.298596	0.196664	0.226562	0.622622	2.536449	3.143647	6.091086	-2.32414	-1.71882	-2.19335	-6.60048	35.25877	14.42838	17.53951	4.50E-02
14	-1.30992	0.216826	0.1516	0.175342	0.496584	2.115465	2.651018	5.539452	-0.35126	-0.11587	-0.12634	-7.89E-02	1.478737	13.28975	39.2435	-4.08E-02
15	-1.793	0.26481	0.198318	0.230105	0.673736	2.957825	3.450652	7.656082	-0.24064	-4.75E-02	-4.95E-02	9.65E-02	1.340244	-17.6072	26.26867	-7.47E-02
16	-5.88E-02	2.04E-02	1.94E-02	2.41E-02	6.99E-02	0.274461	0.306199	0.453967	2.14E-02	2.02E-02	2.50E-02	7.18E-02	0.277376	0.307423	0.455098	7.49E-03

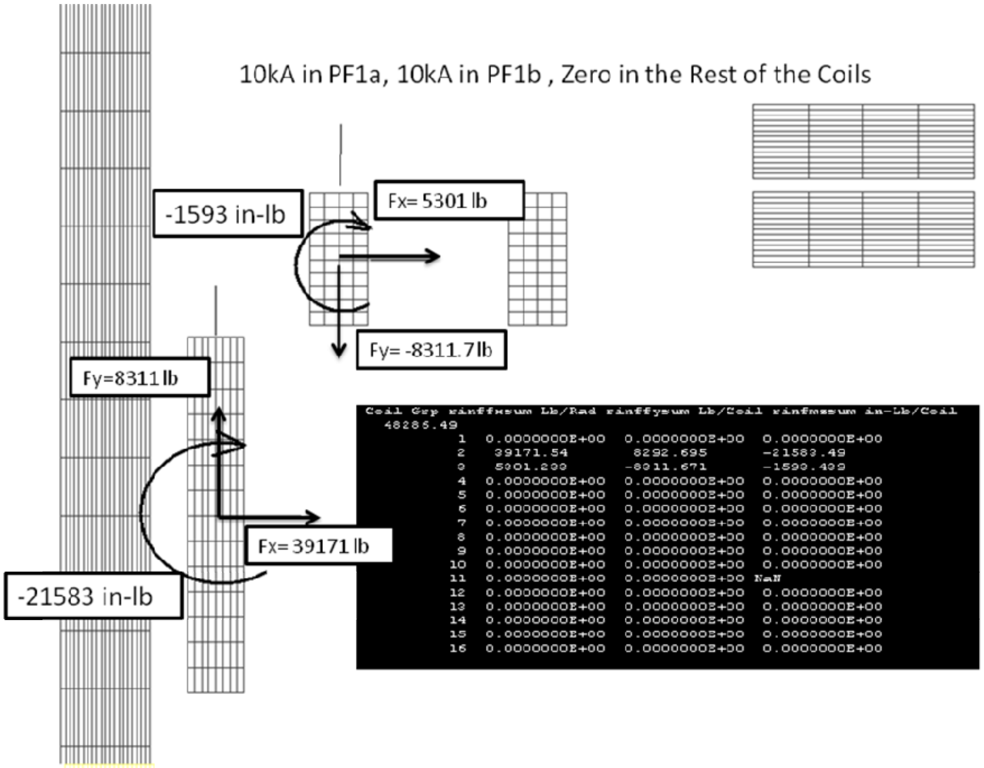
FY Influence Matrix lb/coil

1	0.00E+00	9.084172	11.79914	7.778748	10.1807	4.957735	1.170719	1.1123	-9.08418	-11.7992	-7.77876	-10.1807	-4.95773	-1.17074	-1.11231	-3.35E-04
2	-8.90795	0.00E+00	33.41848	10.41854	6.813034	1.23E-02	-0.79055	-0.92614	-1.33E-02	-8.43E-03	-1.32E-02	-4.03E-02	-0.18431	-0.26305	-0.46184	-5.35E-02
3	-11.5449	-34.244	0.00E+00	1.215617	3.118256	-0.84721	-0.63327	-0.69865	-8.48E-03	-5.51E-03	-8.28E-03	-2.50E-02	-0.11453	-0.16382	-0.29525	-2.86E-02
4	-7.73862	-10.5711	-1.22274	0.00E+00	5.944123	-1.18458	-0.77738	-0.84813	-1.32E-02	-8.24E-03	-1.11E-02	-3.18E-02	-0.13792	-0.19402	-0.35027	-3.18E-02
5	-10.2351	-6.89944	-3.16445	-6.0861	0.00E+00	-6.10059	-2.37802	-2.52554	-4.03E-02	-2.50E-02	-3.18E-02	-8.88E-02	-0.37576	-0.52355	-0.9581	-6.78E-02
6	-4.96639	-1.24E-02	0.851848	1.191608	6.127147	0.00E+00	-13.9167	-13.2359	-0.18414	-0.11443	-0.13786	-0.37572	-1.5534	-2.16692	-4.06834	-0.14459
7	-1.17017	0.791866	0.633507	0.777671	2.378207	13.93041	0.00E+00	-31.9479	0.498561	0.597741	0.56751	0.237863	-1.40619	-2.42129	-5.37498	0.683196
8	-1.11185	0.927222	0.698843	0.84838	2.525815	13.24138	32.79659	0.00E+00	-0.46171	-0.29517	-0.35023	-0.95821	-4.06954	-6.13612	-12.4371	-7.34E-02
9	8.907958	1.33E-02	8.44E-03	1.32E-02	4.03E-02	0.184313	0.263052	0.461845	0.00E+00	-33.4185	-10.4185	-6.81304	-1.23E-02	0.790547	0.926145	5.66E-02
10	11.54489	8.43E-03	5.46E-03	8.23E-03	2.50E-02	0.114481	0.163774	0.295201	34.24399	0.00E+00	-1.21562	-3.11826	0.847207	0.633268	0.698649	2.95E-02
11	7.738616	1.32E-02	8.23E-03	1.11E-02	3.18E-02	0.137909	0.194005	0.350258	10.5711	1.222739	0.00E+00	-5.94412	1.184575	0.777384	0.848128	3.26E-02
12	10.23509	4.03E-02	2.50E-02	3.18E-02	8.88E-02	0.375764	0.523551	0.958107	6.899436	3.164451	6.086101	0.00E+00	6.100593	2.37802	2.525542	6.88E-02
13	4.966392	0.184122	0.11442	0.137849	0.375706	1.553401	2.166912	4.068331	1.24E-02	-0.85185	-1.1916	-6.12715	0.00E+00	13.9167	13.23593	0.144982
14	1.170164	0.262943	0.163759	0.193992	0.523643	2.167689	3.182792	6.136477	-0.79186	-0.63351	-0.77767	-2.3782	-13.9304	0.00E+00	31.94787	-0.6834
15	1.111855	0.461736	0.295182	0.350249	0.958232	4.06956	6.136151	12.43711	-0.92722	-0.69884	-0.84838	-2.5258	-13.2414	-32.7966	0.00E+00	7.30E-02
16	3.36E-04	5.38E-02	2.87E-02	3.19E-02	6.82E-02	0.144496	7.82E-02	7.32E-02	-5.69E-02	-2.96E-02	-3.27E-02	-6.91E-02	-0.14488	-7.79E-02	-7.29E-02	0.00E+00

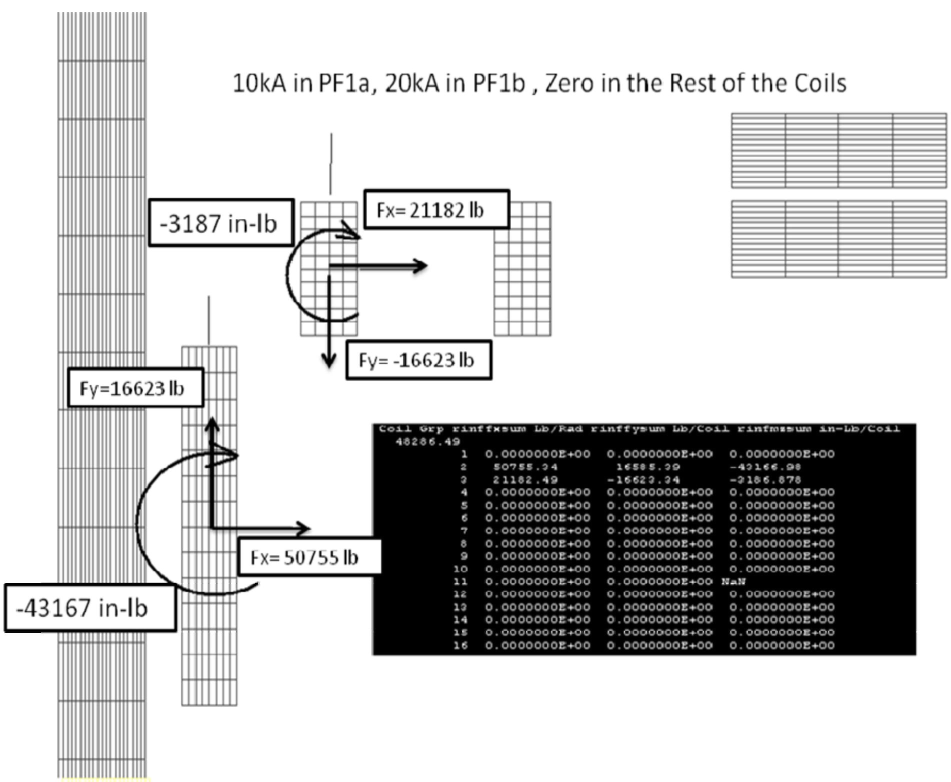
MZ Influence Matrix in-lb/coil

1	0.00E+00	-20165.7	-9837.4	-5246.08	-5607.03	-3893.17	-1291.17	-1209.61	20165.75	9837.401	5246.083	5607.024	3893.168	1291.17	1209.613	1.582384
2	24.48505	0.00E+00	-249.019	-68.2512	-36.4968	-5.93E-02	3.597156	4.181828	0.150695	8.74E-02	9.74E-02	0.246144	0.910378	1.21158	2.102748	0.238253
3	1.561877	-22.3793	0.00E+00	-1.62305	-2.53606	0.495806	0.342246	0.375138	1.03E-02	5.81E-03	7.06E-03	1.78E-02	6.64E-02	8.90E-02	0.159802	1.40E-02
4	-0.12537	-3.91461	-1.01542	0.00E+00	-4.59226	0.466528	0.258501	0.276698	6.85E-03	4.21E-03	4.69E-03	1.18E-02	4.58E-02	6.13E-02	0.110545	8.91E-03
5	8.86E-02	3.45E-02	-3.11E-02	-0.27883	0.00E+00	-1.14E-02	-8.58E-03	-7.34E-03	1.60E-03	7.40E-04	2.57E-04	1.01E-03	1.01E-03	-6.79E-06	-3.68E-04	-2.33E-04
6	9.00E-02	1.22E-03	-3.92E-02	-5.83E-02	-0.33361	0.00E+00	-0.4789	-0.43358	-1.60E-03	-1.95E-03	-2.38E-03	-5.77E-03	-2.91E-02	-4.36E-02	-8.77E-02	2.63E-03
7	2.45E-02	5.89E-02	3.93E-02	4.80E-02	0.129275	0.739098	0.00E+00	4.723598	-0.79548	-0.79455	-0.79473	-0.7995	-0.81921	-0.80366	-0.78433	-0.79449
8	2.84E-03	1.01E-02	6.44E-03	7.02E-03	1.74E-02	8.83E-02	1.399876	0.00E+00	1.08E-03	1.20E-03	2.08E-03	3.77E-03	1.58E-02	1.76E-02	6.35E-02	-1.16E-03
9	-24.4851	-0.15059	-8.70E-02	-9.73E-02	-0.2457	-0.90958	-1.21081	-2.10158	0.00E+00	249.0188	68.25115	36.49831	5.93E-02	-3.59795	-4.18141	-0.25066
10	-1.56241	-1.08E-02	-6.81E-03	-7.76E-03	-1.83E-02	-6.74E-02	-9.01E-02	-0.16021	22.37927	0.00E+00	1.623067	2.536109	-0.49601	-0.34273	-0.37514	-1.42E-02
11	0.125455	-6.82E-03	-4.15E-03	-4.44E-03	-1.19E-02	-4.57E-02	-6.13E-02	-0.11049	3.914487	1.015485	0.00E+00	4.592257	-0.46678	-0.25859	-0.27669	-8.80E-03
12	-8.81E-02	-1.24E-03	-5.91E-04	-8.94E-04	-9.79E-04	-1.72E-03	-1.09E-04	4.62E-05	-3.37E-02	3.17E-02	0.279924	0.00E+00	1.05E-02	8.16E-03	7.37E-03	-3.99E-05
13	-8.99E-02	9.69E-04	9.41E-04	2.02E-03	4.21E-03	2.79E-02	4.14E-02	8.62E-02	-1.28E-03	3.94E-02	5.73E-02	0.333646	0.00E+00	0.479147	0.433768	-3.37E-03
14	-2.47E-02	3.76E-03	2.97E-03	2.90E-03	7.61E-03	2.75E-02	1.17E-02	-7.64E-03	-5.89E-02	-3.94E-02	-4.82E-02	-0.12919	-0.73952	0.00E+00	-4.72365	0.794663
15	-3.01E-03	-2.25E-03	-1.54E-03	-2.56E-03	-5.34E-03	-1.63E-02	-1.85E-02	-6.40E-02	-1.05E-02	-6.80E-03	-8.08E-03	-1.85E-02	-8.90E-02	-1.40106	0.00E+00	6.94E-04
16	-9.10E-03	-3.99E-02	-0.28514	-0.3971	-1.25175	-4.40203	-3.21643	-3.18252	0.120331	0.328038	0.440437	1.313949	4.390471	3.108759	3.006638	0.00E+00

Test Cases

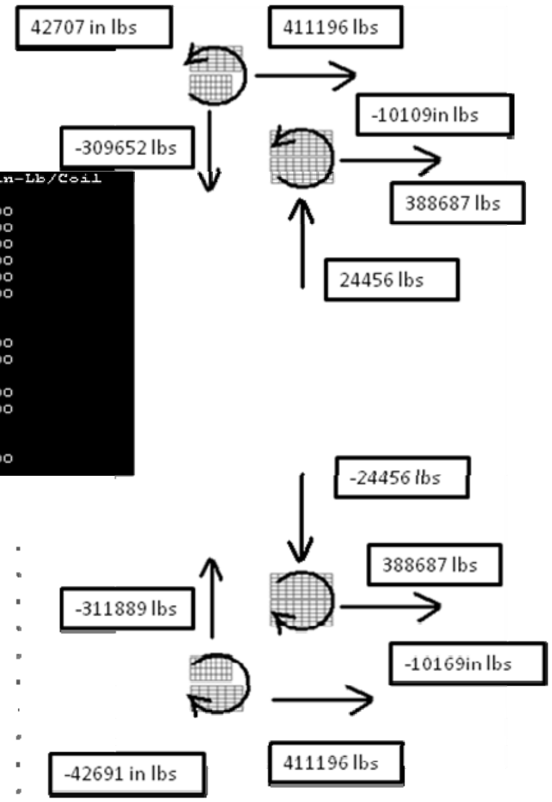


10kA in PF1a, 10kA in PF1b , Zero in the Rest of the Coils
-1593 in-lb
Fx= 5301 lb
Fy= -8311.7 lb
Fy=8311 lb
Fx= 39171 lb
-21583 in-lb
Coil Grp rinffxsum Lb/Rad rinffysum Lb/Coil rinfmzsum in-Lb/Coil
48285.49
1 0.0000000E+00 0.0000000E+00 0.0000000E+00
2 39171.54 8292.695 -21583.49
3 5301.288 -8311.671 -1593.489
4 0.0000000E+00 0.0000000E+00 0.0000000E+00
5 0.0000000E+00 0.0000000E+00 0.0000000E+00
6 0.0000000E+00 0.0000000E+00 0.0000000E+00
7 0.0000000E+00 0.0000000E+00 0.0000000E+00
8 0.0000000E+00 0.0000000E+00 0.0000000E+00
9 0.0000000E+00 0.0000000E+00 0.0000000E+00
10 0.0000000E+00 0.0000000E+00 0.0000000E+00
11 0.0000000E+00 0.0000000E+00 NaN
12 0.0000000E+00 0.0000000E+00 0.0000000E+00
13 0.0000000E+00 0.0000000E+00 0.0000000E+00
14 0.0000000E+00 0.0000000E+00 0.0000000E+00
15 0.0000000E+00 0.0000000E+00 0.0000000E+00
16 0.0000000E+00 0.0000000E+00 0.0000000E+00



10kA in PF1a, 20kA in PF1b , Zero in the Rest of the Coils
-3187 in-lb
Fx= 21182 lb
Fy= -16623 lb
Fy=16623 lb
Fx= 50755 lb
-43167 in-lb
Coil Grp rinffxsum Lb/Rad rinffysum Lb/Coil rinfmzsum in-Lb/Coil
48286.49
1 0.0000000E+00 0.0000000E+00 0.0000000E+00
2 50755.34 16585.39 -43166.98
3 21182.49 -16623.34 -3186.878
4 0.0000000E+00 0.0000000E+00 0.0000000E+00
5 0.0000000E+00 0.0000000E+00 0.0000000E+00
6 0.0000000E+00 0.0000000E+00 0.0000000E+00
7 0.0000000E+00 0.0000000E+00 0.0000000E+00
8 0.0000000E+00 0.0000000E+00 0.0000000E+00
9 0.0000000E+00 0.0000000E+00 0.0000000E+00
10 0.0000000E+00 0.0000000E+00 0.0000000E+00
11 0.0000000E+00 0.0000000E+00 NaN
12 0.0000000E+00 0.0000000E+00 0.0000000E+00
13 0.0000000E+00 0.0000000E+00 0.0000000E+00
14 0.0000000E+00 0.0000000E+00 0.0000000E+00
15 0.0000000E+00 0.0000000E+00 0.0000000E+00
16 0.0000000E+00 0.0000000E+00 0.0000000E+00

-16kA in PF4, -31kA in PF5 U&L , Zero in the Rest of the Coils




```
Coil Grp rinffxsum Lb/Rad rinffysum Lb/Coil rinfmzsum in-Lb/Coil
  48286.49
          1  0.0000000E+00  0.0000000E+00  0.0000000E+00
          2  0.0000000E+00  0.0000000E+00  0.0000000E+00
          3  0.0000000E+00  0.0000000E+00  0.0000000E+00
          4  0.0000000E+00  0.0000000E+00  0.0000000E+00
          5  0.0000000E+00  0.0000000E+00  0.0000000E+00
          6  0.0000000E+00  0.0000000E+00  0.0000000E+00
          7   411197.0      -309652.0       42707.89
          8   388687.1       24456.01       10168.67
          9  0.0000000E+00  0.0000000E+00  0.0000000E+00
         10  0.0000000E+00  0.0000000E+00  0.0000000E+00
         11  0.0000000E+00  0.0000000E+00 NaN
         12  0.0000000E+00  0.0000000E+00  0.0000000E+00
         13  0.0000000E+00  0.0000000E+00  0.0000000E+00
         14   411197.0       311889.6      -46291.92
         15   388687.3      -24456.53      -10109.92
         16  0.0000000E+00  0.0000000E+00  0.0000000E+00
```

Fr(lbf)	PF4U	PF5U	PF5L	PF4L
Min	-152166	37239	37254	-152181
Worst Case Min	-147049	-20978	-20974	-147050
Max	289472	626160	626247	289442
Worst Case Max	468175	667690	667786	468173

Fz(lbf)	PF4U	PF5U	PF5L	PF4L
Min	-203125	-239984	-145159	-134053
Worst Case Min	-415946	-507307	-181134	-74599
Max	134052	145158	239984	180293
Worst Case Max	149102	181376	507307	415946

PF 4 and 5 Moment Study

Attachment A Influence Coefficient Subroutine

```
Subroutine Influence(numcoils)
      include 'scommon.blk'
      DIMENSION rinffx(50,50)
      DIMENSION rinffy(50,50)
      DIMENSION rinfmz(50,50)
        do 9 i=1,50
        do 9 j=1,50
        rinffx(i,j)=0
        rinffy(i,j)=0
        rinfmz(i,j)=0
  9   Continue
        do 10 i=1,numcoils
        do 10 j=1,numcoils
        call snal(0)
        call seal(0)
        ia1=1
        ia2=2
        ia3=3
        ia4=4
        ib1=0
        ib2=0
        ib3=0
        ib4=0
      CALL Sreal(i,i)
        CALL Sreal(j,i)
        call SNELEM(i,i)
      typekeydum=typekey
        typekey=7
        egrpkeydum=egrpkey
        egrpkey=7
      r=0.0
c                                          Creating Current Elements from Quad Elements
      call CCUR(R,i,ia1,ia2,ia3,ia4,ib1,ib2,ib3,ib4)
      call stype(7,70)
        call snelem(70,70)
      call sfield(i)
        call snal(0)
        call seal(0)
      call stype(7,70)
        call gerase(70)
        call reduce
        CALL Sreal(i,i)
      call SNELEM(i,i)
        CALL Sreal(j,j)
      call SNELEM(j,j)
      call mfor(i,ia1,ia2,ia3,ia4,ib1,ib2,ib3,ib4)
        call mfsum(i,i,fxsum,fysum,xmzsum)
        rinffx(i,j)=fxsum
        rinffy(i,j)=fysum
        rinfmz(i,j)=xmzsum
        bxs=0.0
        bys=0.0
        byz=0.0
      call bscale(i,bxs,bys,bzs)
      call fscale(i,bxs,bys,bzs)
      call bscale(j,bxs,bys,bzs)
      call fscale(j,bxs,bys,bzs)

 10   CONTINUE
 54   CONTINUE
        do 15 i=1,numcoils
        do 15 j=1,numcoils
        if (i.ne.j) rinffx(i,j)=rinffx(i,j)-rinffx(i,i)
        rinffy(i,j)=rinffy(i,j)-rinffy(i,i)
        rinfmz(i,j)=rinfmz(i,j)-rinfmz(i,i)
 15   Continue

      write(7,*) 'FX Influence Matrix N/rad'
        do 11 i=1,numcoils
      write(7,*) i,rinffx(i,1),rinffx(i,2),rinffx(i,3),rinffx(i,4),
     c rinffx(i,5),rinffx(i,6),rinffx(i,7),rinffx(i,8),rinffx(i,9),
     c rinffx(i,10),rinffx(i,11),rinffx(i,12),rinffx(i,13),rinffx(i,14),
     c rinffx(i,15),rinffx(i,16),rinffx(i,17),rinffx(i,18),rinffx(i,19)
 11   continue
      write(7,*) 'FY Influence Matrix N/rad'
        do 12 i=1,numcoils
      write(7,*) i,rinffy(i,1),rinffy(i,2),rinffy(i,3),rinffy(i,4),
```

```
     c rinffy(i,5),rinffy(i,6),rinffy(i,7),rinffy(i,8),rinffy(i,9),
     c rinffy(i,10),rinffy(i,11),rinffy(i,12),rinffy(i,13),rinffy(i,14),
     c rinffy(i,15),rinffy(i,16),rinffy(i,17),rinffy(i,18),rinffy(i,19)
 12   continue
      write(7,*) 'MZ Influence Matrix N-m/rad'
       do 13 i=1,numcoils
      write(7,*) i,rinfmz(i,1),rinfmz(i,2),rinfmz(i,3),rinfmz(i,4),
     c rinfmz(i,5),rinfmz(i,6),rinfmz(i,7),rinfmz(i,8),rinfmz(i,9),
     c rinfmz(i,10),rinfmz(i,11),rinfmz(i,12),rinfmz(i,13),rinfmz(i,14),
     c rinfmz(i,15),rinfmz(i,16),rinfmz(i,17),rinfmz(i,18),rinfmz(i,19)
 13   continue

       do 16 i=1,numcoils
       do 16 j=1,numcoils
       rinffx(i,j)=rinffx(i,j)*.2248*2*3.1416
       rinffy(i,j)=rinffy(i,j)*.2248*2*3.1416
       rinfmz(i,j)=rinfmz(i,j)*.2248*2*3.1416*39.37
 16   Continue
      write(7,*) 'FX Influence Matrix lb/coil'
       do 17 i=1,numcoils
      write(7,*) i,rinffx(i,1),rinffx(i,2),rinffx(i,3),rinffx(i,4),
     c rinffx(i,5),rinffx(i,6),rinffx(i,7),rinffx(i,8),rinffx(i,9),
     c rinffx(i,10),rinffx(i,11),rinffx(i,12),rinffx(i,13),rinffx(i,14),
     c rinffx(i,15),rinffx(i,16),rinffx(i,17),rinffx(i,18),rinffx(i,19)
 17   continue
      write(7,*) 'FY Influence Matrix lb/coil'
       do 18 i=1,numcoils
      write(7,*) i,rinffy(i,1),rinffy(i,2),rinffy(i,3),rinffy(i,4),
     c rinffy(i,5),rinffy(i,6),rinffy(i,7),rinffy(i,8),rinffy(i,9),
     c rinffy(i,10),rinffy(i,11),rinffy(i,12),rinffy(i,13),rinffy(i,14),
     c rinffy(i,15),rinffy(i,16),rinffy(i,17),rinffy(i,18),rinffy(i,19)
 18   continue
      write(7,*) 'MZ Influence Matrix in-lb/coil'
       do 19 i=1,numcoils
      write(7,*) i,rinfmz(i,1),rinfmz(i,2),rinfmz(i,3),rinfmz(i,4),
     c rinfmz(i,5),rinfmz(i,6),rinfmz(i,7),rinfmz(i,8),rinfmz(i,9),
     c rinfmz(i,10),rinfmz(i,11),rinfmz(i,12),rinfmz(i,13),rinfmz(i,14),
     c rinfmz(i,15),rinfmz(i,16),rinfmz(i,17),rinfmz(i,18),rinfmz(i,19)
 19   continue

      typekey=typekeydum
       egrpkey=egrpkeydum
      return
      end


      SUBROUTINE mFSUM(IGRPs,igrpe,fxsum,fysum,xmzsum)
      include 'scommon.blk'
      do 13 igrp=igrps,igrpe
       numn=0
       centx=0
       centy=0
      FxSUM=0.
      FYSUM=0.
       xmzsum=0
      ymzsum=0
!      FZSUM=0.
      DO 12  I=1 , N
      IF(NGROUP(I).EQ.IGRP)  THEN
       numn=numn+1
       centx=centx+x(i)
       centy=centy+y(i)
      FXSUM=FXSUM+FX(I)
      FYSUM=FYSUM+FY(I)
!     FZSUM=FZSUM+FZ(I)
       xMZSUM=xMZSUM-FX(I)*Y(I)
      yMZSUM=yMZSUM+FY(I)*X(I)
      end if
 12   CONTINUE
      centx=centx/numn
       centy=centy/numn
       ymom= -xmzsum/fxsum
       xmom=ymzsum/fysum
      xMZSUM=-fxsum*(ymom-centy)+fysum*(xmom-centx)
      print*,igrp,fxsum,fysum,xmzsum
      write(7,*) igrp,',',fxsum,',',fysum,',',fzsum,',',
     cxmxsum,',',xmysum,',',xmzsum
 13   CONTINUE
      RETURN
      END
```

Some of the subroutines in this subroutine may be called in scripts, the script commands are described below:

mfsu	Prompts for the start and end node group Calculates the x force sum, y force sum and moment sum about the centroid of nodes defined by node groups starting at igrps and ending at ,igrpe
mfor	Calculates Lorentz forces on a brick or quad element from fields corner nodes, currents specified as real constants, and current directions specified by inputting an element nodal sequence that defines the brick element start and end face. For an axisymmetric analysis using, the connectivity specification is 1,2,3,4,0,0,0,0. Forces computed for an axisymmetric analysis are per radian. For ANSYS analyses these loads need to be multiplied by 2*pi.
sfie	Computes 2D fields using Elliptic Integrals from loops defined by type 7 elements.

Attachment B
Influence Coefficient Matrix Script

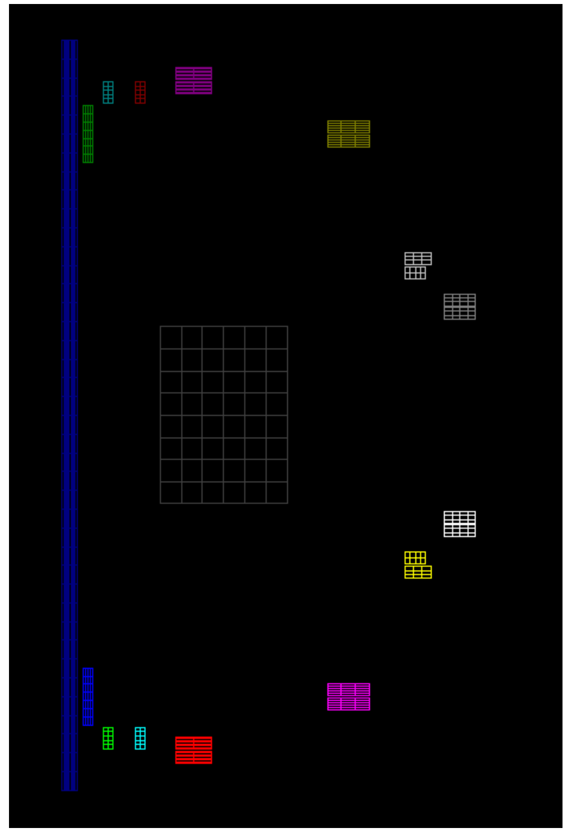
```
zero
!  Influence Coefficient Matrix Test
read
ron2
divi
0,2,2,1
snal
1
merge
1,.0001
redu

rcoi
16
1,10,80,1029,250
2,4,7,28,250
3,2,5,10,250
4,2,5,10,250
5,4,10,28,250
6,3,10,30,250
7,1,17,17,250
8,4,6,24,250
9,4,7,28,250
10,2,5,10,250
11,2,5,10,250
12,4,10,28,250
13,3,10,30,250
14,1,17,17,250
15,4,6,24,250
16,6,8,28,250

infl
16

copt
r
plce
pl

exit
```



Node and Element File ron2.dat
plotted with copt,r