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Isabelle Superconducting Magnets

Second Report

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Prepared By

Magnet Technology Group

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Massachusetts Institute of Technology

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FOREWORD

Subsequent to the issue of the first MIT report at the end of 1980, the Magnet Technology Group has performed a number of tasks in support of the Isabelle project.

All of the results, contained herein, have been reported previously either as MIT reports or as internal BNL reports but for the most part have received rather limited distribution.

The bulk of the work was performed during calendar 1981 by H. Becker, E. Bobrov, N. Diatchenko, A. Hatch, Y. Iwasa, R. Pillsbury, S. Shanfield, J. Schultz, M. Sinclair, J. Tarrh, and R. Thome. Since January 1982 effort has been reduced to a primarily on-site consultation level, the principal contribution being by H. Becker.

Peter G. Marston
Program Manager

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1.0 Introduction

At the beginning of 1981, a number of design and system configurations were being considered to satisfy the general performance requirements as tabulated in the Isabelle parameter list.

The work reported herein not only provided specific support for these various alternative designs but also provided a framework within which the different designs could be compared and evaluated relative to field quality, schedule, cost, stability, maintenance, fabricability and risk.

During 1982, the MIT effort was at a much reduced level focusing primarily on the structural behavior of the winding composite and coil winding manufacturing and assembly problems, particularly as they relate to field quality.

2.0 Summary

Section 3.0 discusses magnet design parameters versus bore and field strength for cosθ type magnets with both cold and warm iron and also for rectangular windings with cold iron. For field strengths of 4, 5, and 6 tesla, it displays the following information as a function of vacuum bore radius: ampere turn requirements, iron mass, conductor mass, structural (stainless) steel mass, and stored energy. It also displays the sensitivity of the total magnet subsystems cost to central field contribution from magnetized iron, maximum helium temperature in the dipole magnets and also for useful aperture variation in the range of 3 to 5 centimeter radius. Complete details of the systems analysis providing this data are included in Appendix A.

The detailed three-dimensional field and force analysis for all alternative dipole designs is presented in Section 3.3 and the effect of winding tolerances and other manufacturing imperfections on harmonic coefficients is presented in Section 3.5.

A discussion of the structural behavior of the winding composite in Section 3.4 presents the results of various tests of the mechanical behavior of the winding/insulation composite and analyzes the impact of this behavior on accuracy of conductor location (field quality).

A methodology for comparative evaluation of the various design alternatives based on field quality, schedule, cost, stability, maintainability reliability, fabricability and risk is presented in Section 4.0.

3.0 Design Alternatives

3.1 Magnet Design Parameters vs. Bore and Field

3.1.1 Introduction

This section presents estimates of selected dipole magnet parameters as a function of bore size and magnetic field level. A magnet length of 5 m was selected as the baseline for all cases. Three basically different cases were chosen: cos θ type windings with cold iron; cos θ type windings with warm iron; and, rectangular windings with cold iron.

3.1.2 Cos θ Windings with Cold Iron

The basic geometry for this case is illustrated in Fig. 3.1.1. It consists of a cos θ type winding with an inner radius r_i, and an outer radius, r_o; iron with an inner radius, r_{mi} and an outer radius, r_{mo}; and a vacuum bore radius, r_b. The computer model was based on the "Palmer-two-layer design using FNAL (Fermi National Accelerator Laboratory) type conductor", but results and trends may be expected to be applicable to the five and six block ISA dipole designs. The variation of average current density with Field and Bore for cos θ windings (with both cold and warm iron) is shown in Table 3.1.1. The radial distance between the vacuum bore and the winding inner radius for these magnets also varied slightly with Field and Bore as follows:

3.4 cm Bore at 4 T ↓ ↓ 5.4 cm Bore at 6 T

$$1.74 \leq r_1 - r_b \leq 1.98$$

The ampere-turn requirements are given in Fig. 3.1.2 as a function of vacuum bore radius for central field levels of 4, 5, and 6 T. The ordinate may also be interpreted as one half of the ampere meters of conductor required per meter of magnet length.

Stored energy for the dipoles is given in Fig. 3.1.3. Results are given for magnet lengths of 5 m, but may be applied to other lengths by first finding the energy per unit length and then scaling linearly.

The iron mass and conductor mass for a 5 m long dipole are given in Figures 3.1.4 and 3.1.5, respectively. The iron was sized in all cases to provide 1.8 T of the total central field requirement. The conductor was assumed to have a copper-to-superconductor ratio of 1.8 for all cases. Estimates for dipoles of other lengths may be found from these results by assuming a linear proportionality with length.

The end turns of the dipole windings are supported by stainless steel structure. The forces in this region may be expected to be independent of magnet length, hence the results in Fig. 3.1.6 may be applied to any relatively long dipole. It should be noted that scaling is based on the "Palmer" design which has rather massive end supports.

3.1.3 Cos θ Windings with Warm Iron

The basic geometry for this case is illustrated in Fig. 3.1.7. It consists of a cos θ type winding with an inner radius, r_i, and an outer radius, r_o. The coil is supported by a cold stainless steel support structure which occupies the region $r_o < r < r_{os}$. The cavity in the warm iron has a radius, r_{mi}, and the gap between r_{mi} and r_{os} contains vacuum space and Dewar components. The computer model was based on the LBL-three-layer design.

The ampere-turn requirements are given in Fig. 3.1.8 as a function of vacuum bore radius for central field levels of 4, 5, and 6 T. The ordinate may also be interpreted as one half the ampere meters of conductor required per meter of magnet length.

Stored energy for the dipoles is given in Fig. 3.1.9. Results are given for magnet lengths of 5 m, but may be applied to other lengths by first finding the energy per unit length and then scaling linearly.

The iron mass and conductor mass for a 5 m long dipole are given in Figures 3.1.10 and 3.1.11, respectively. The iron was sized in all cases to provide about 0.8 T of the total central field requirement. The conductor was assumed to have a copper-to-superconductor ratio of 1.8 for all cases. Estimates for dipoles of other lengths may be found from these results by assuming a linear proportionality with length.

The transverse and end turn forces on the windings are supported by the cold stainless steel structure. The estimated mass of this component for a 5 m long dipole is given in Fig. 3.1.12. Estimates for dipoles of other lengths may be found from these results by assuming a linear proportionality with length.

3.1.4 Rectangular Windings with Cold Iron

The basic geometry for this case is illustrated in Fig. 3.1.13. It consists of a rectangular saddle and two racetrack windings. The coils are mounted on a stainless steel form and held by two iron and two stainless steel plates. The subassembly is supported by cold iron.

The ampere-turn requirements are given in Fig. 3.1.14 as a function of vacuum bore radius for central field levels of 4, 5, and 6 T. The ordinate may also be interpreted as one half the ampere meters of conductor required per meter of magnet length. The nominal average winding current density λJ (5 T and 4.4 cm bore radius) is 1.99×10^4 A/cm^2. The distance between the vacuum bore and the winding $(x_1 - r_b)$ is 1.34 cm for all cases.

Stored energy for the dipoles is given in Fig. 3.1.15. Results are given for magent lengths of 5 m, but may be applied to other lengths by first finding the eenrgy per unit length and then scaling linearly.

The iron mass and conductor mass for a 5 m long dipole are given in Figures 3.1.16 and 3.1.17, respectively. The iron was sized in all cases to provide about 1.35 T of the total central field requirement. Figure 3.1.18 gives the mass of the stainless steel form and the two stainless steel plates for a 5 m long dipole.

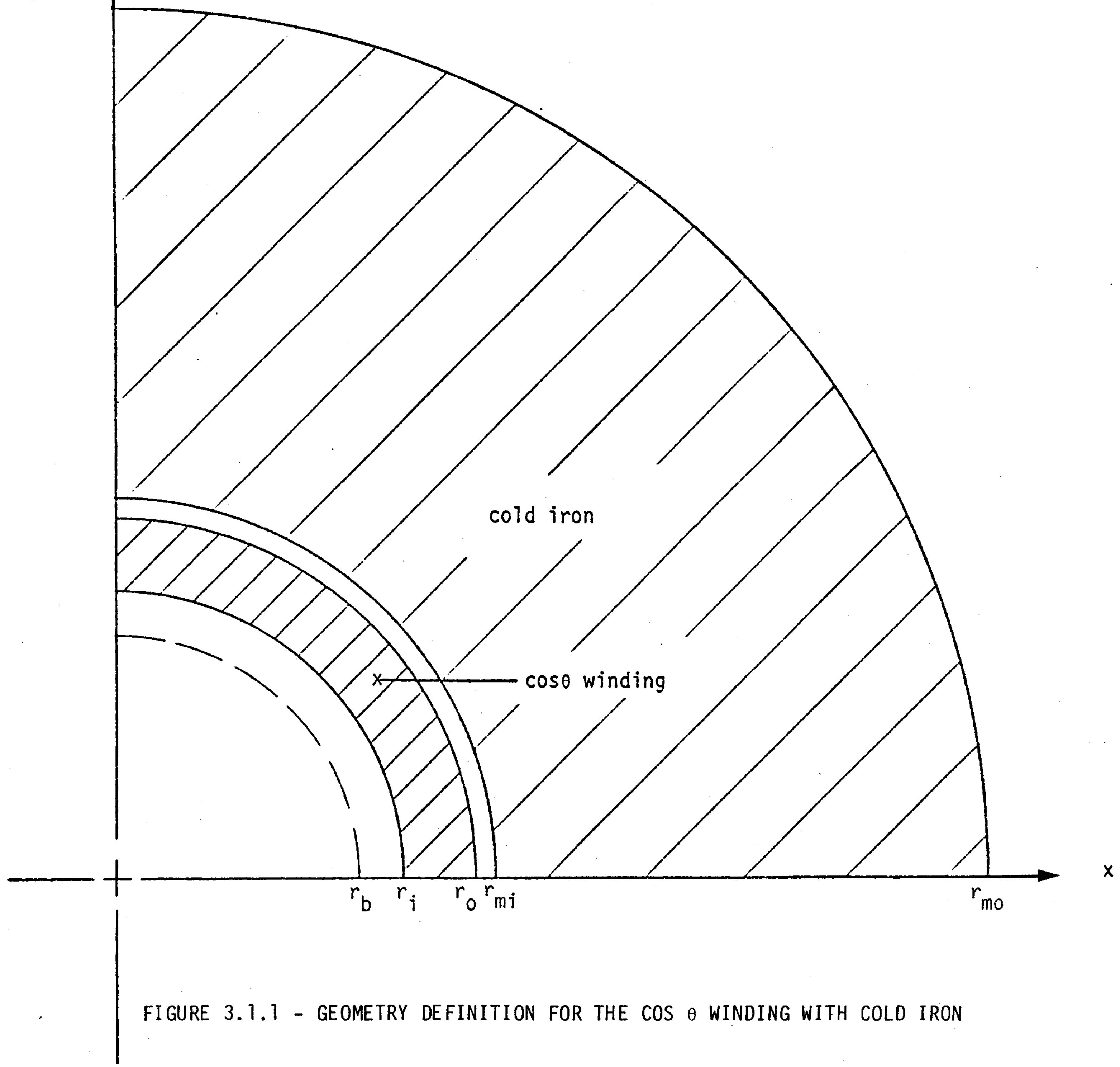


FIGURE 3.1.1 - GEOMETRY DEFINITION FOR THE COS θ WINDING WITH COLD IRON

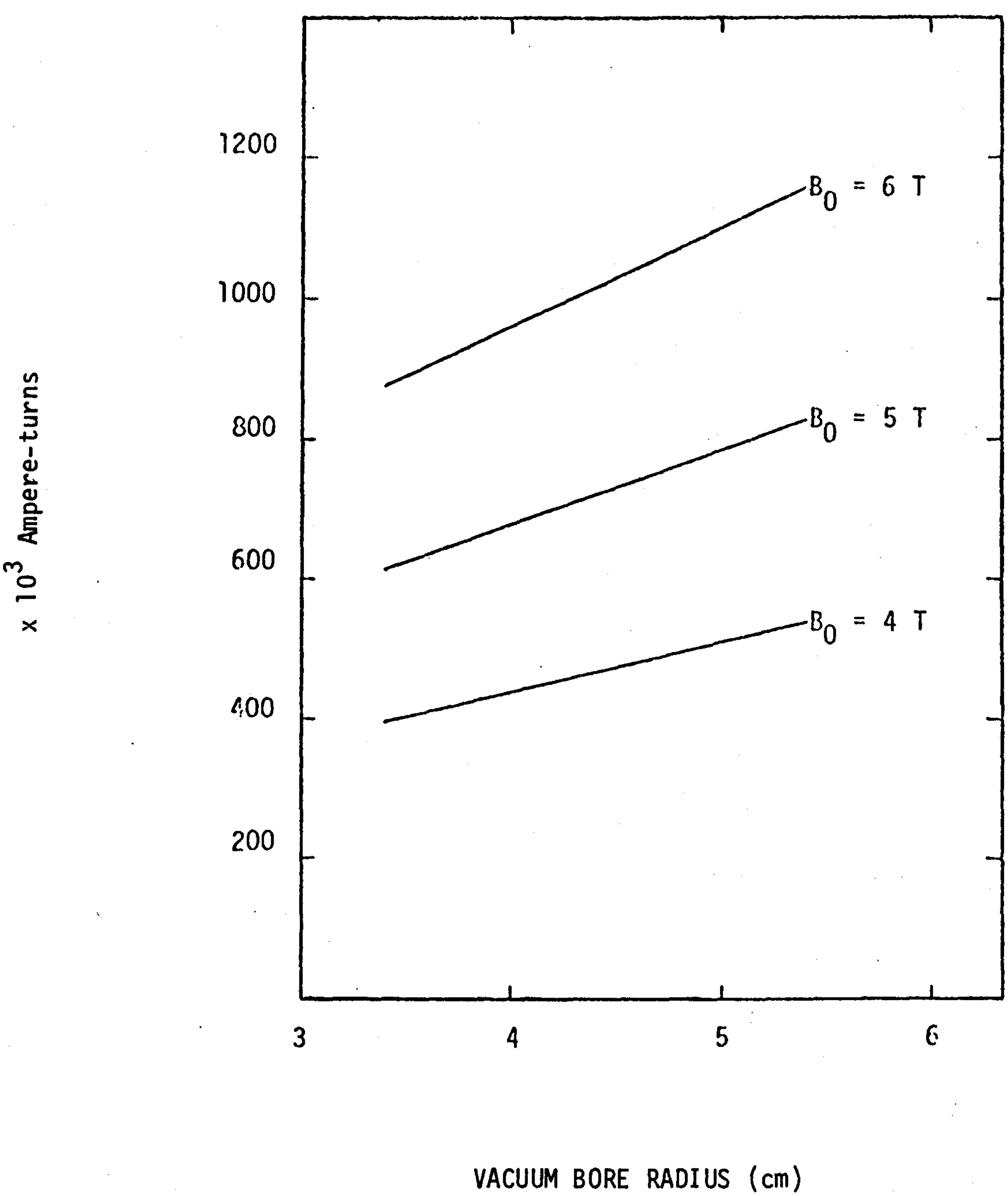


FIGURE 3.1.2 - AMPERE-TURN REQUIREMENTS FOR COS θ TYPE DIPOLES WITH COLD IRON

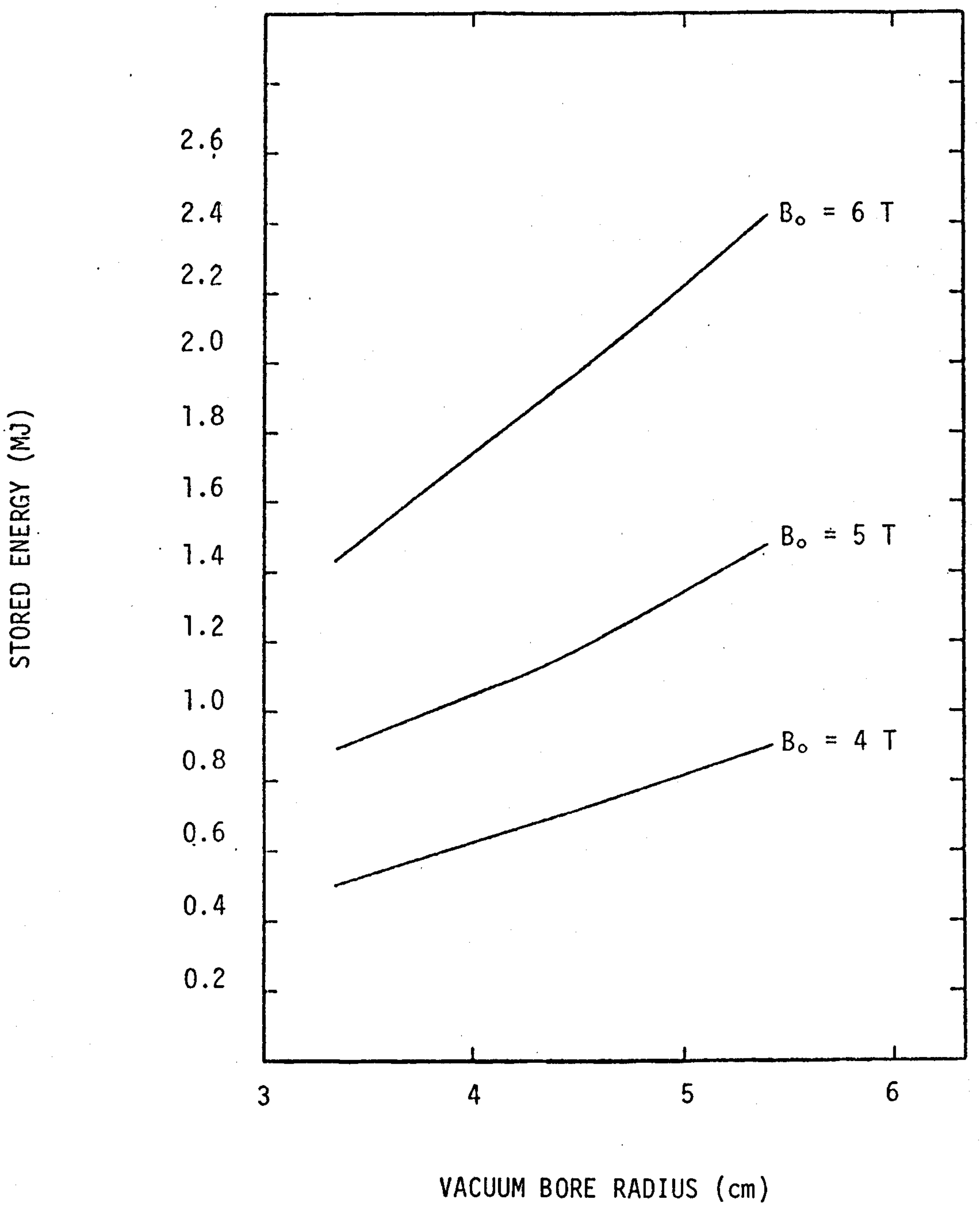


FIGURE 3.1.3 - ENERGY STORED IN A 5 m LONG DIPOLE WITH COS θ WINDINGS AND COLD IRON

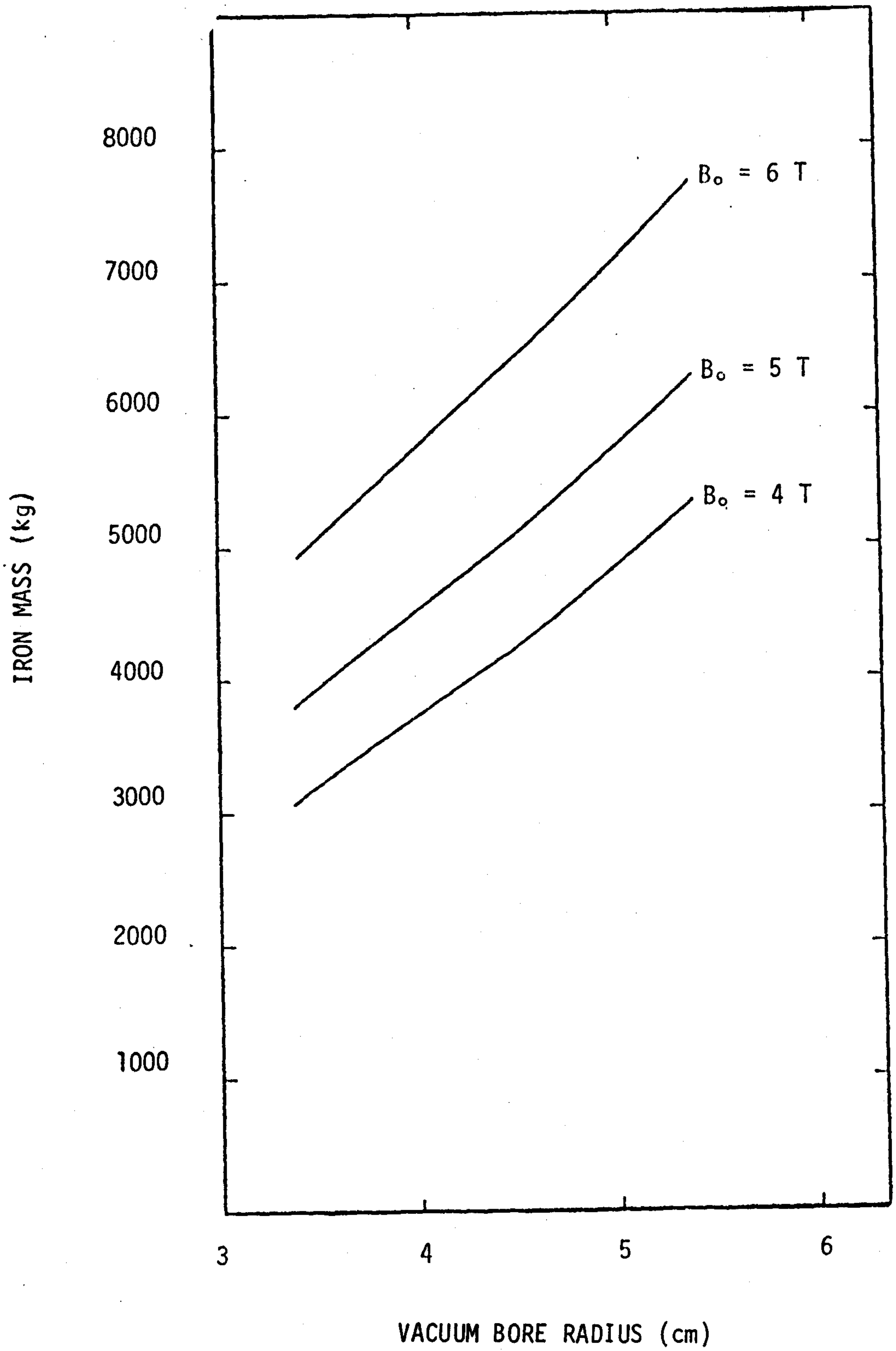


FIGURE 3.1.4 - IRON MASS FOR A 5 m LONG DIPOLE WITH COS θ WINDINGS AND COLD IRON

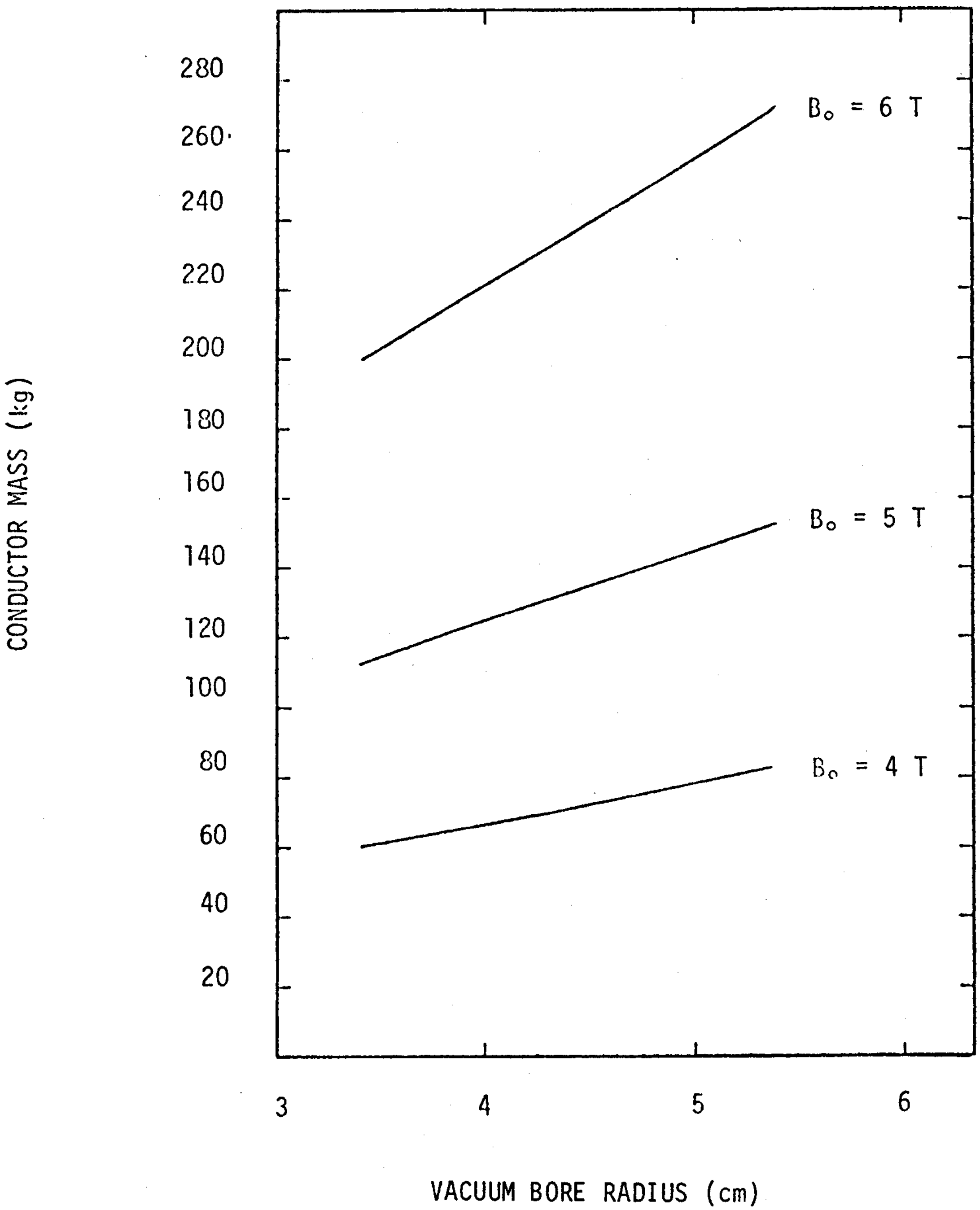


FIGURE 3.1.5 - CONDUCTOR MASS FOR A 5 m LONG DIPOLE WITH COS θ WINDINGS AND COLD IRON

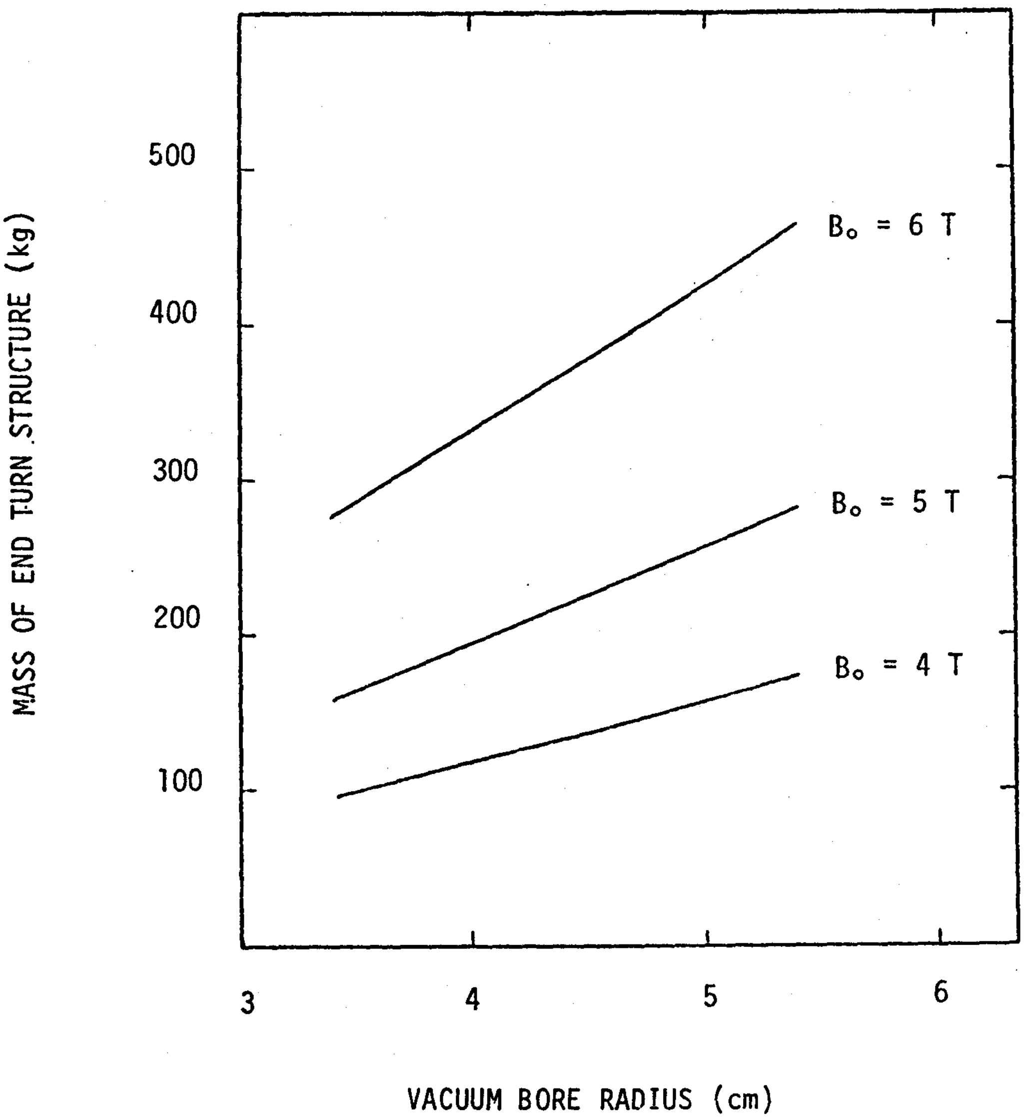


FIGURE 3.1.6 - MASS OF STAINLESS STEEL END-TURN STRUCTURE FOR A DIPOLE WITH COS θ WINDINGS AND COLD IRON

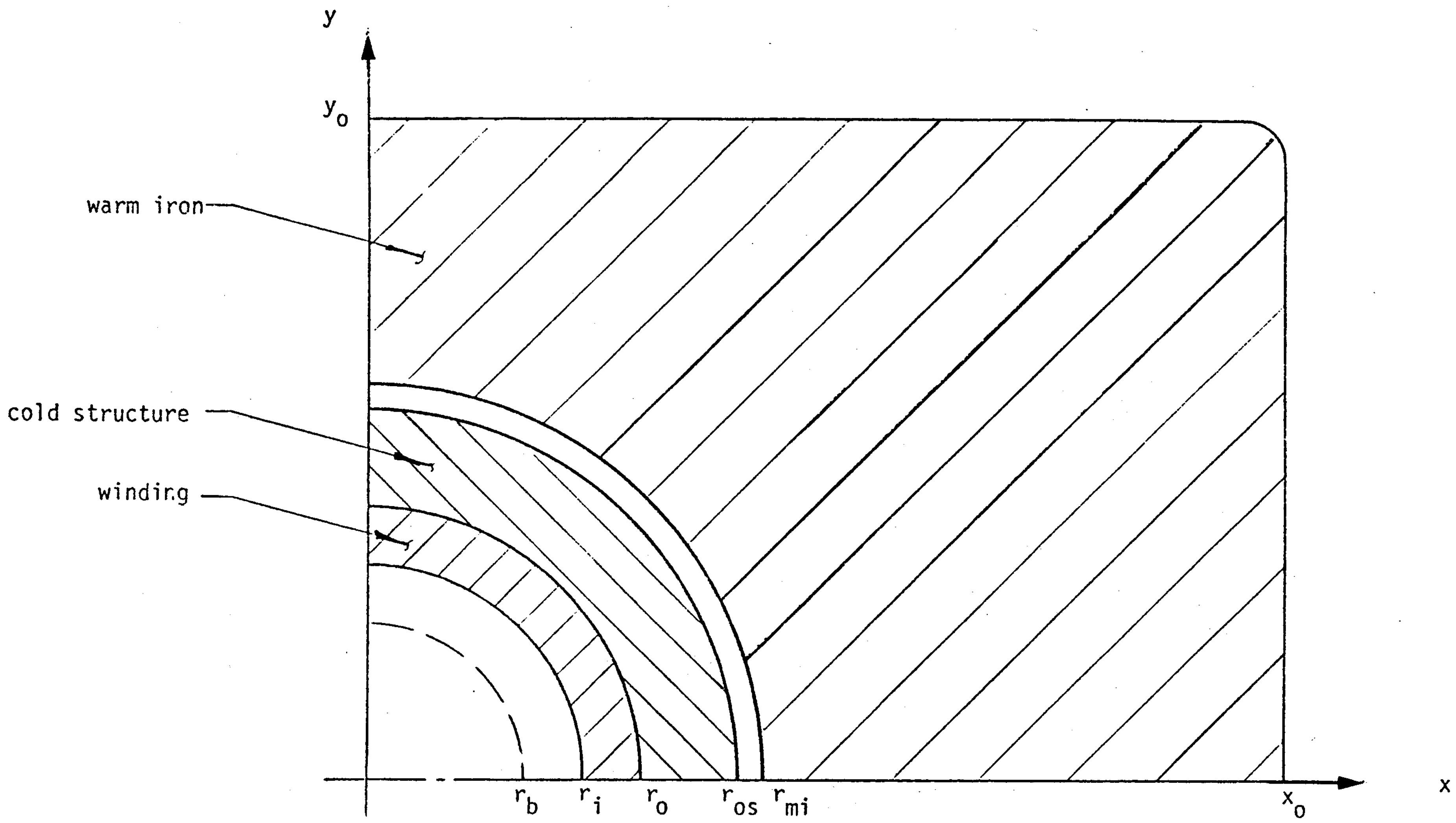


Fig. 3.1.7 - Geometry Definition for the cos θ winding with warm iron

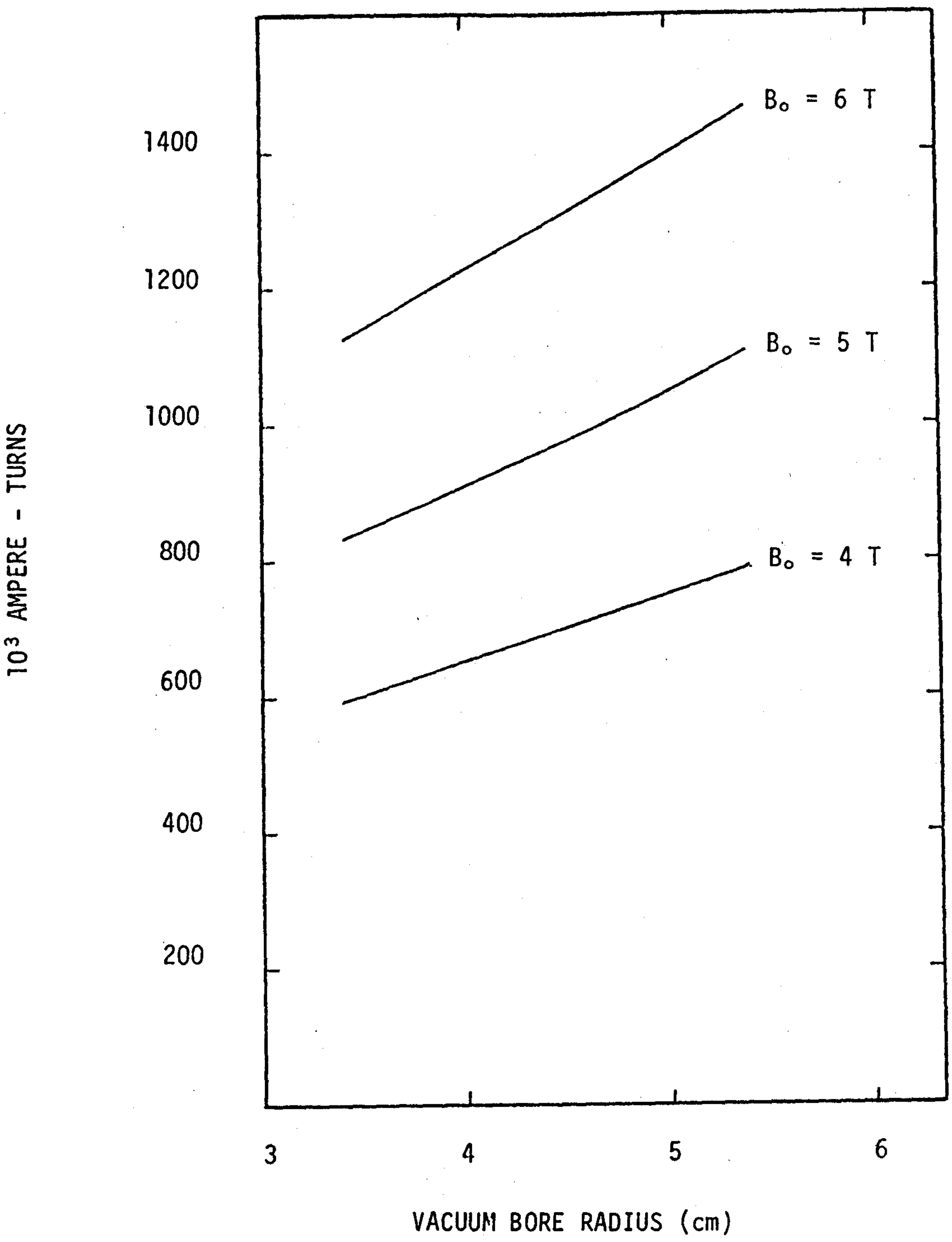


FIGURE 3.1.8 - AMPERE-TURN REQUIREMENTS FOR COS θ TYPE DIPOLES WITH WARM IRON

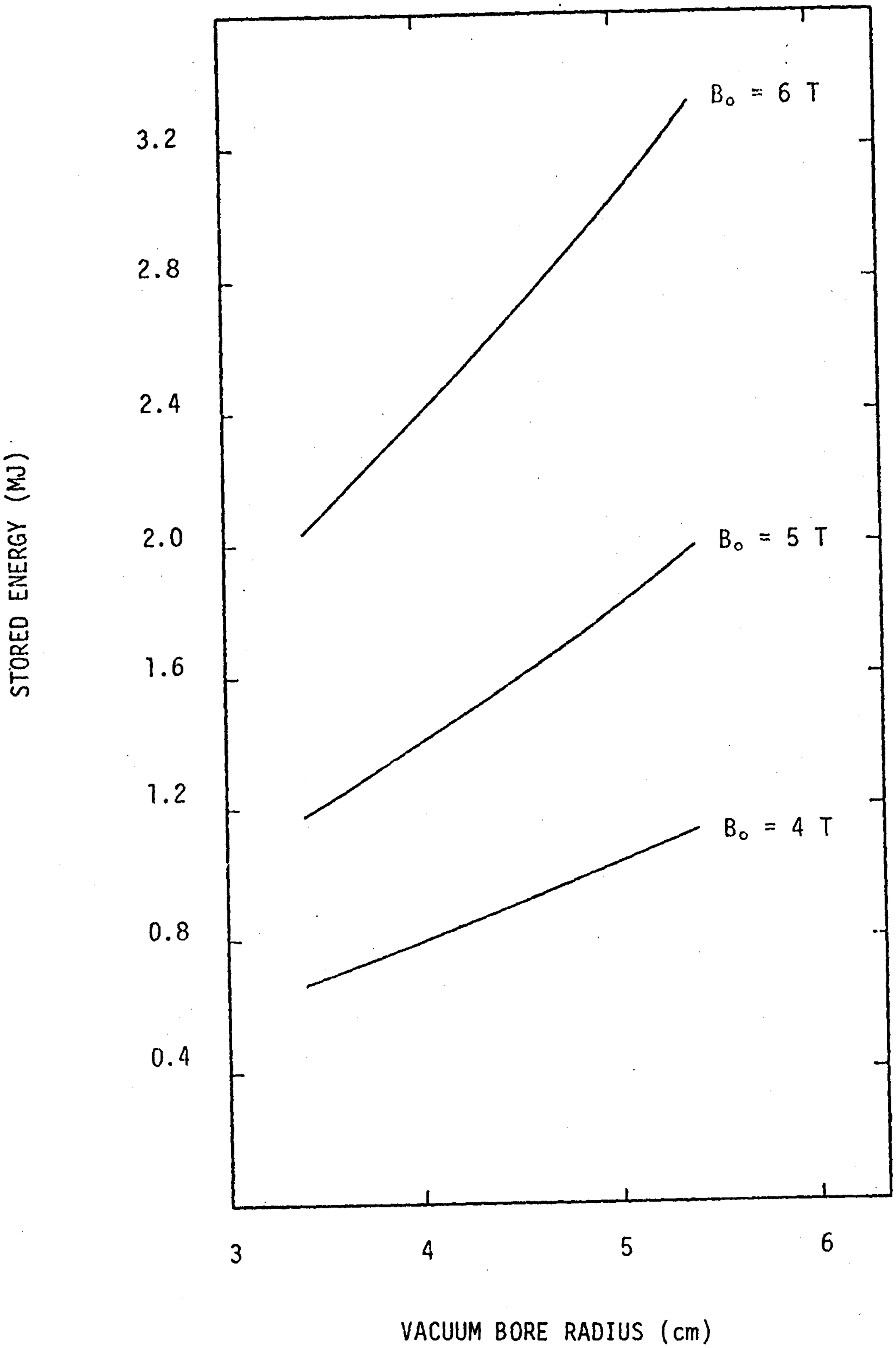


FIGURE 3.1.9 - ENERGY STORED IN A 5 m LONG DIPOLE WITH COS θ WINDING AND WARM IRON

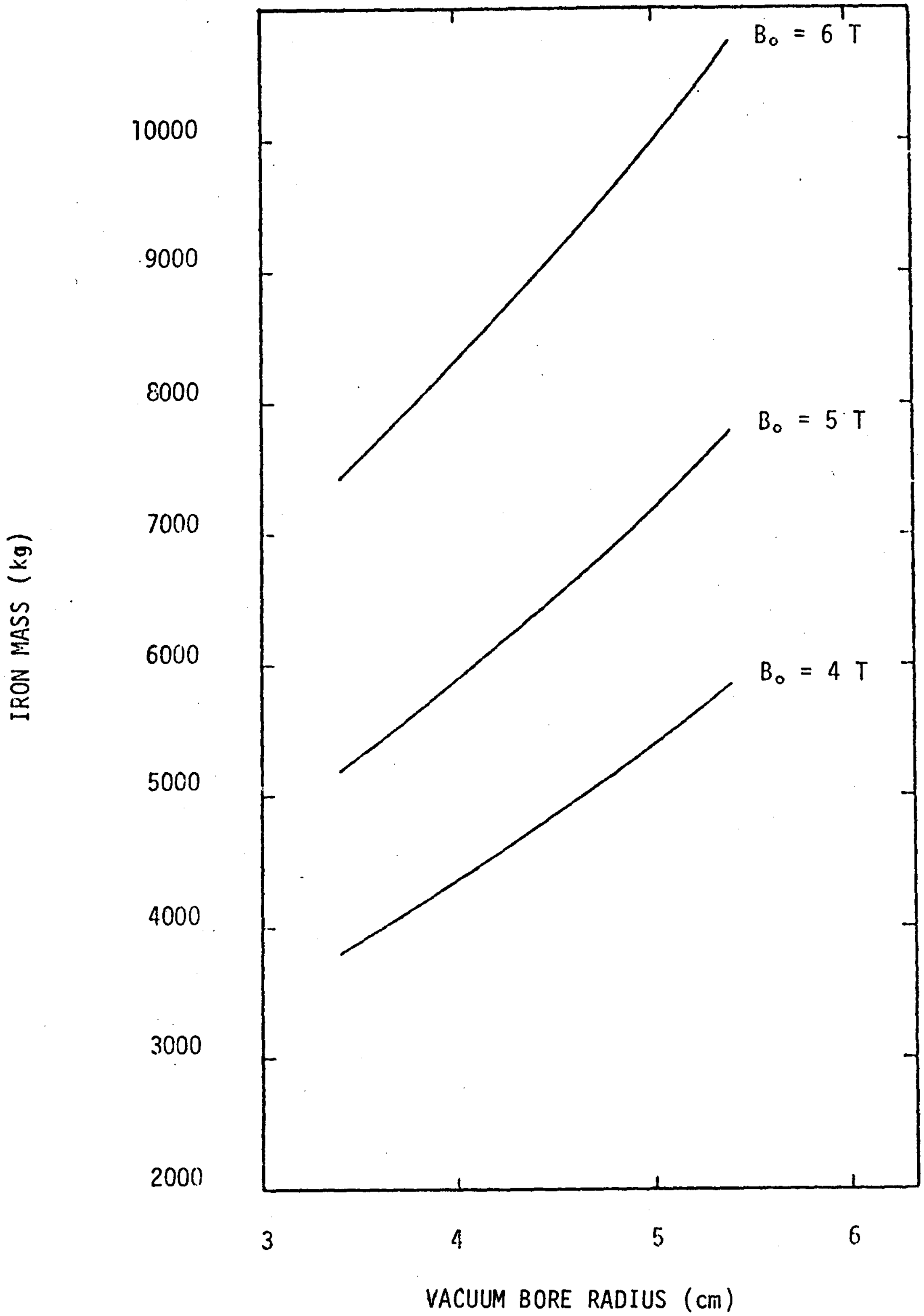


FIGURE 3.1.10 - IRON MASS FOR A 5 m LONG DIPOLE WITH COS θ WINDINGS AND WARM IRON

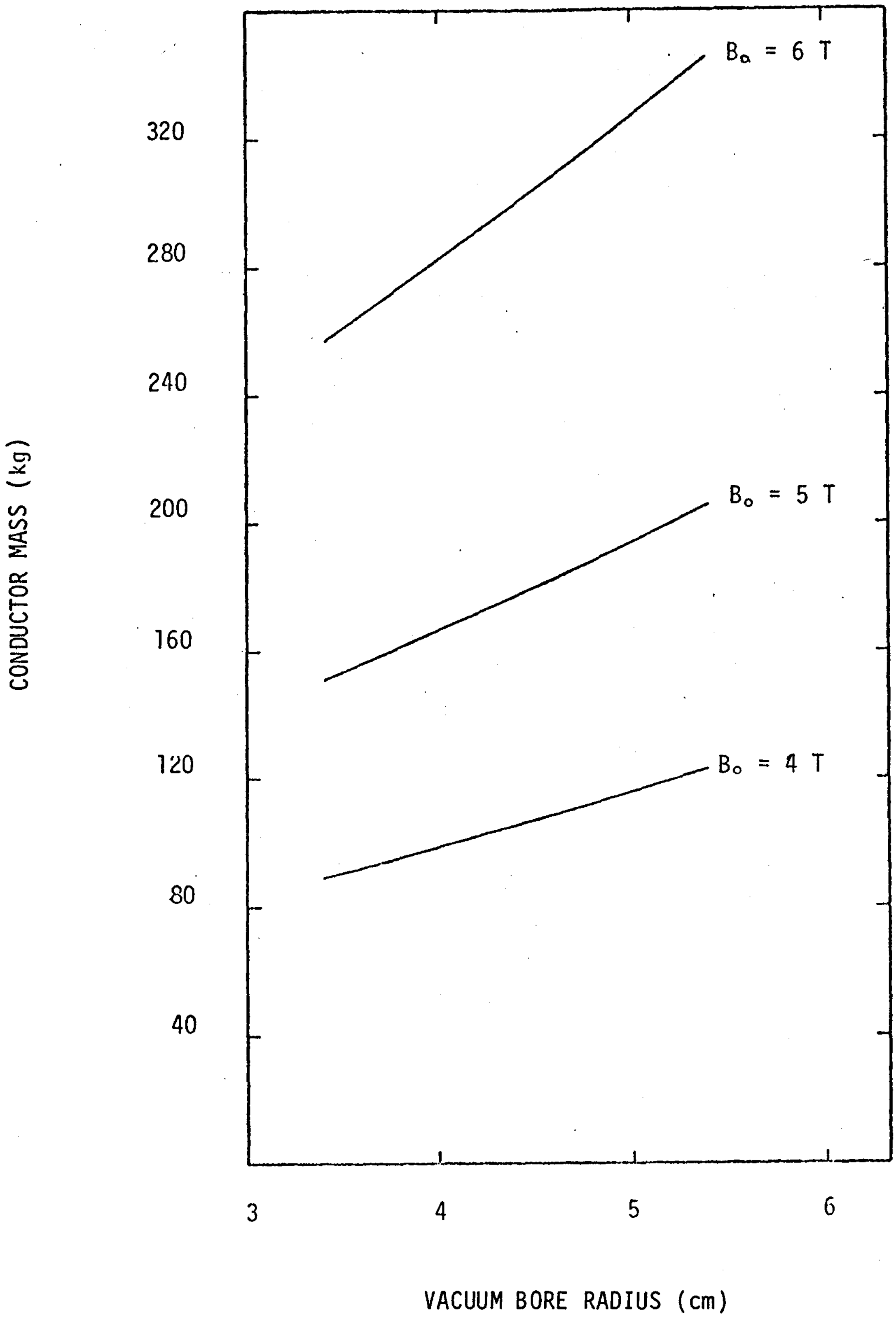


FIGURE 3.1.11 - CONDUCTOR MASS FOR A 5 m LONG DIPOLE WITH COS θ WINDING AND WARM BORE

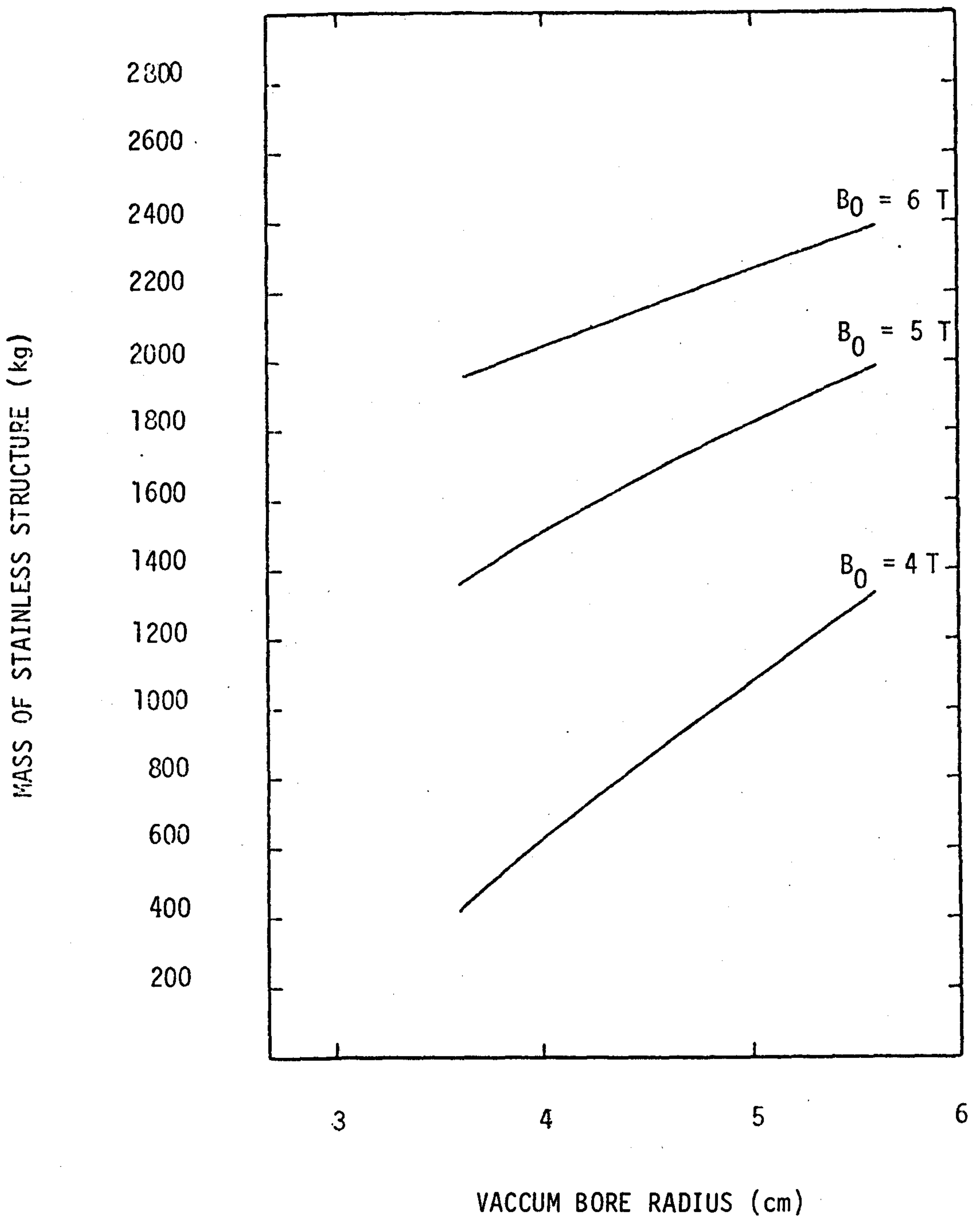


FIGURE 3.1.12 - MASS OF STAINLESS STEEL TRANSVERSE AND END STRUCTURE FOR A DIPOLE WITH COS θ WINDINGS AND WARM IRON

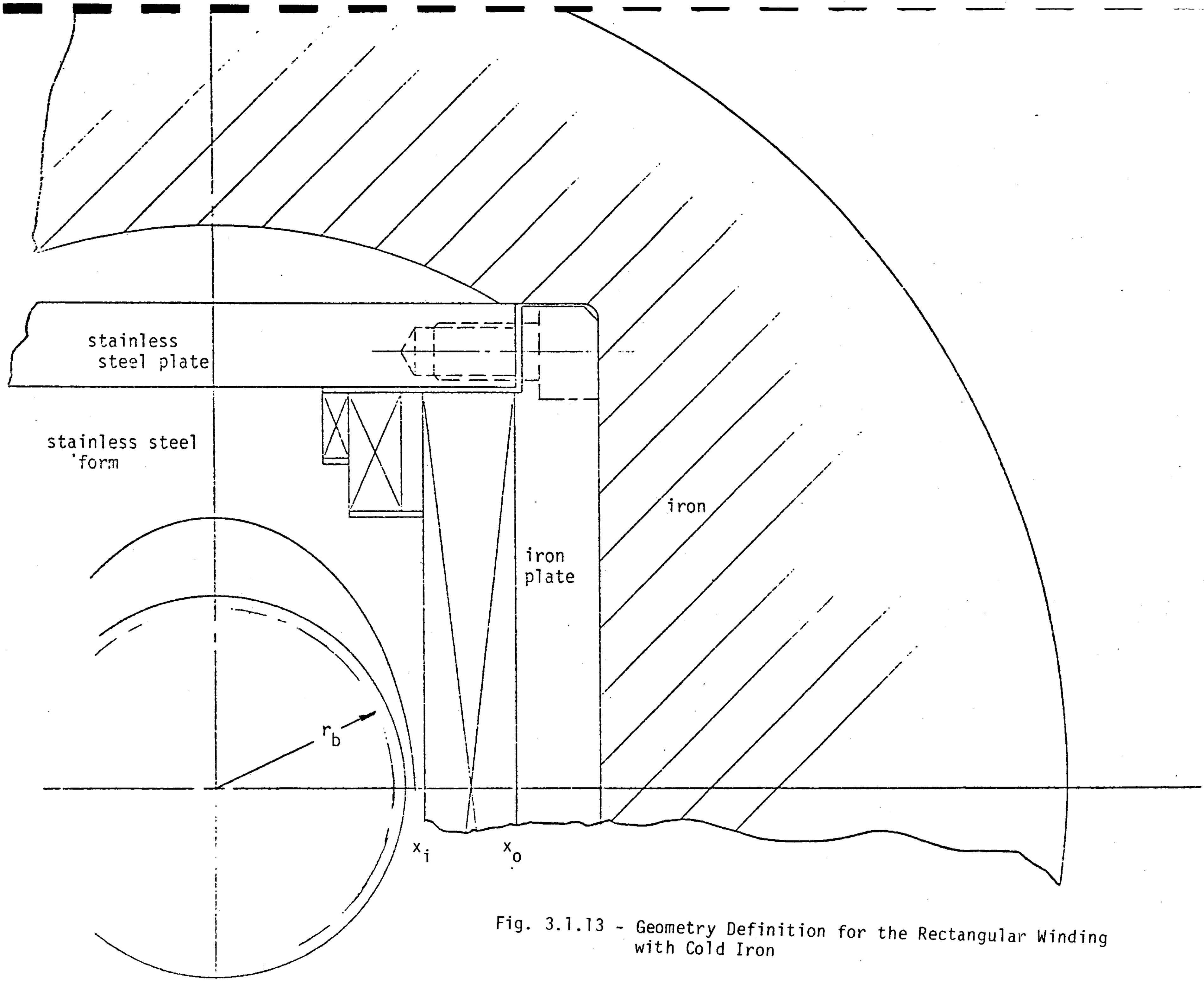


Fig. 3.1.13 - Geometry Definition for the Rectangular Winding with Cold Iron

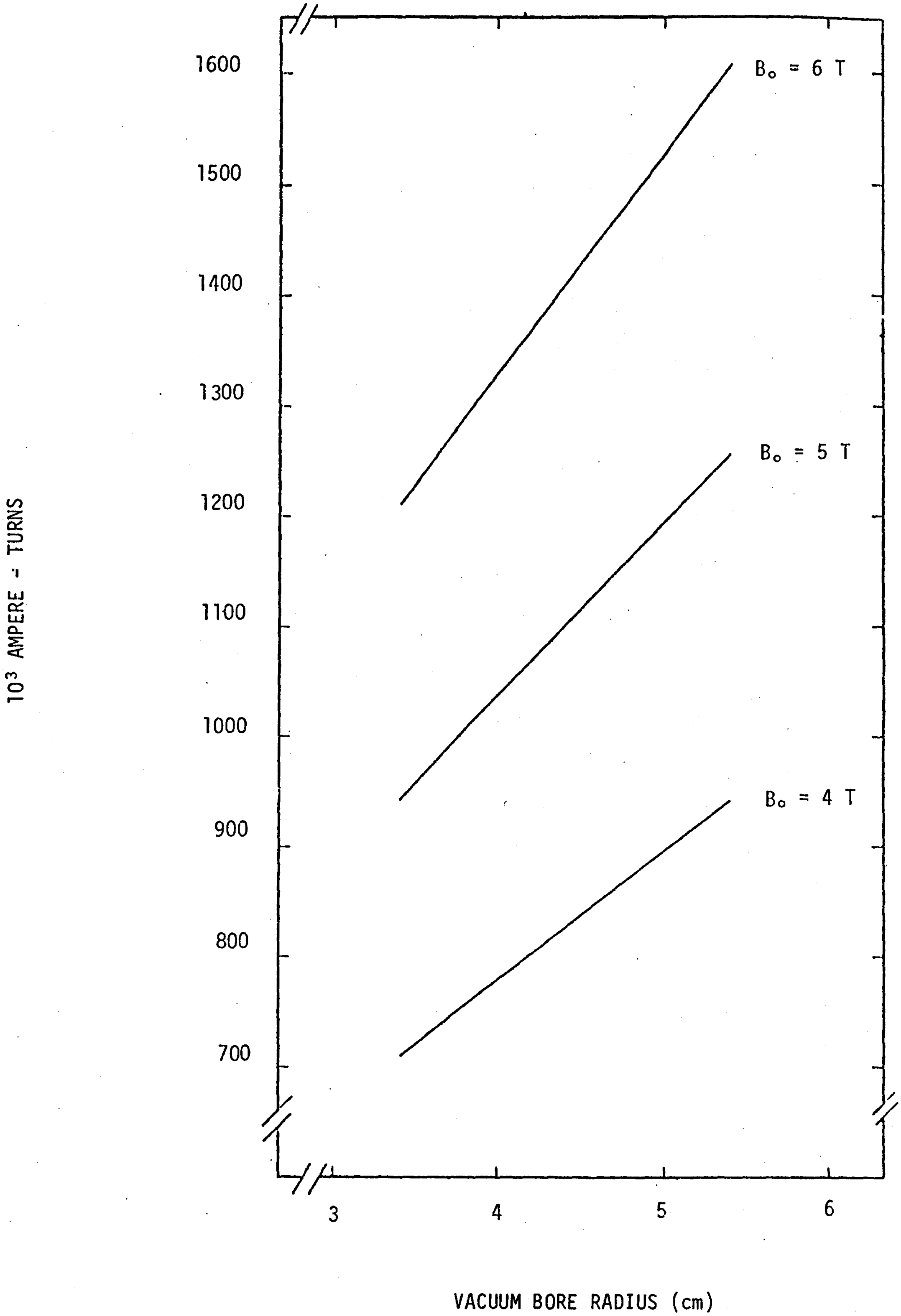


FIGURE 3.1.14 - AMPERE-TURNS FOR THE RECTANGULAR WINDING WITH COLD IRON

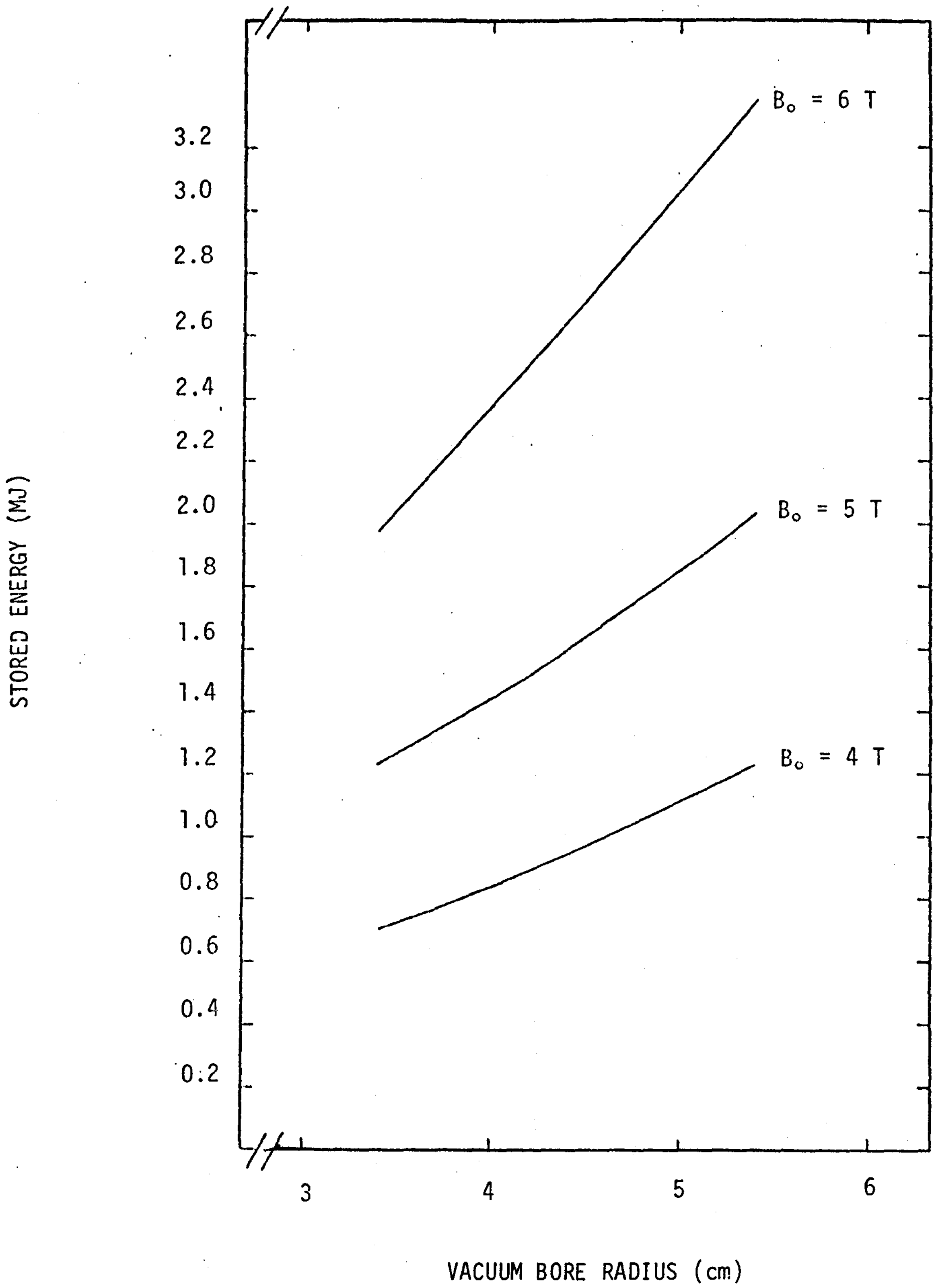


FIGURE 3.1.15 - STORED ENERGY FOR THE RECTANGULAR WINDING WITH COLD IRON

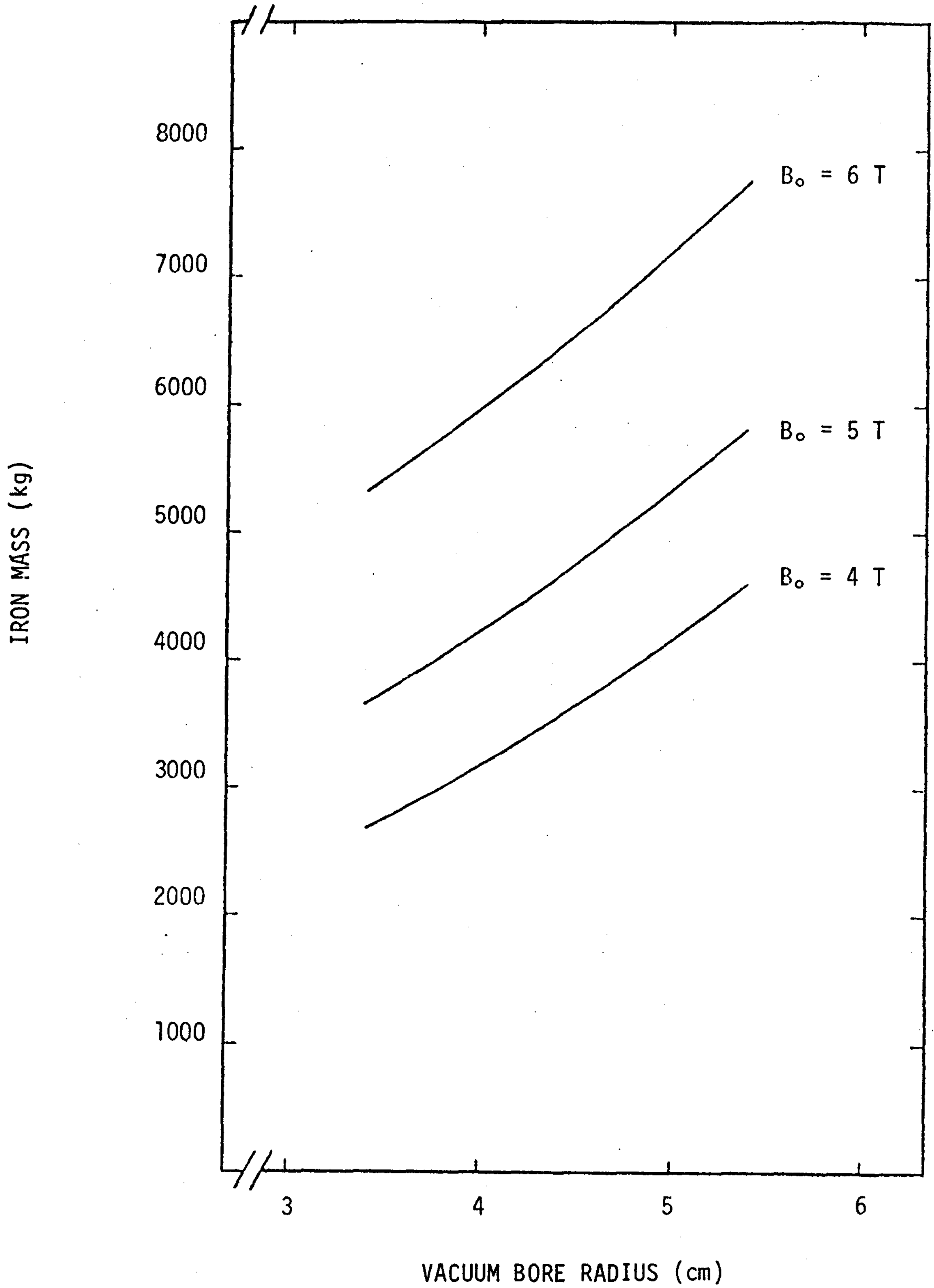


FIGURE 3.1.16 - IRON MASS FOR THE RECTANGULAR SADDLE WITH COLD IRON

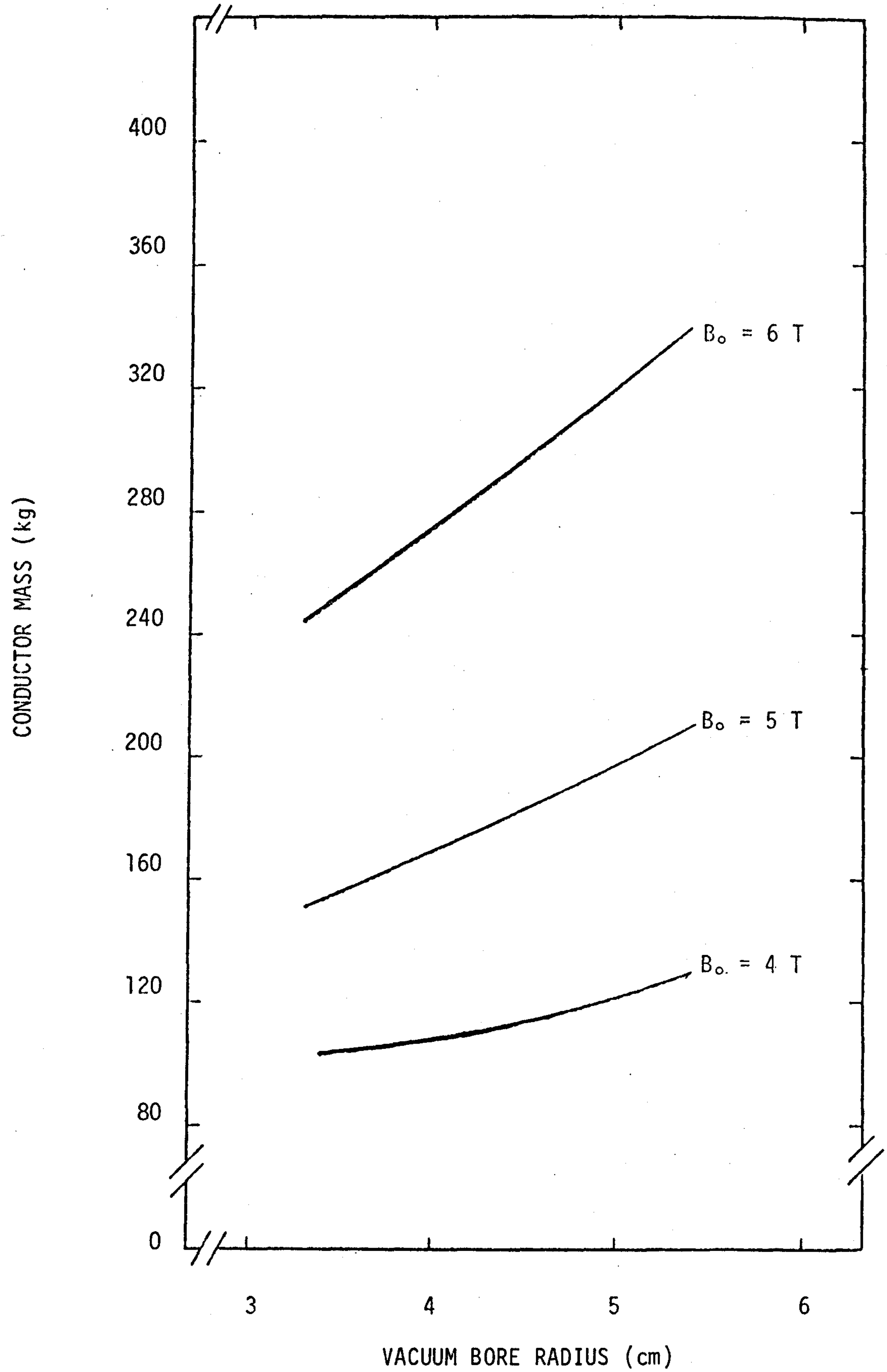


FIGURE 3.1.17 - CONDUCTOR MASS FOR THE RECTANGULAR SADDLE GEOMETRY WITH COLD IRON

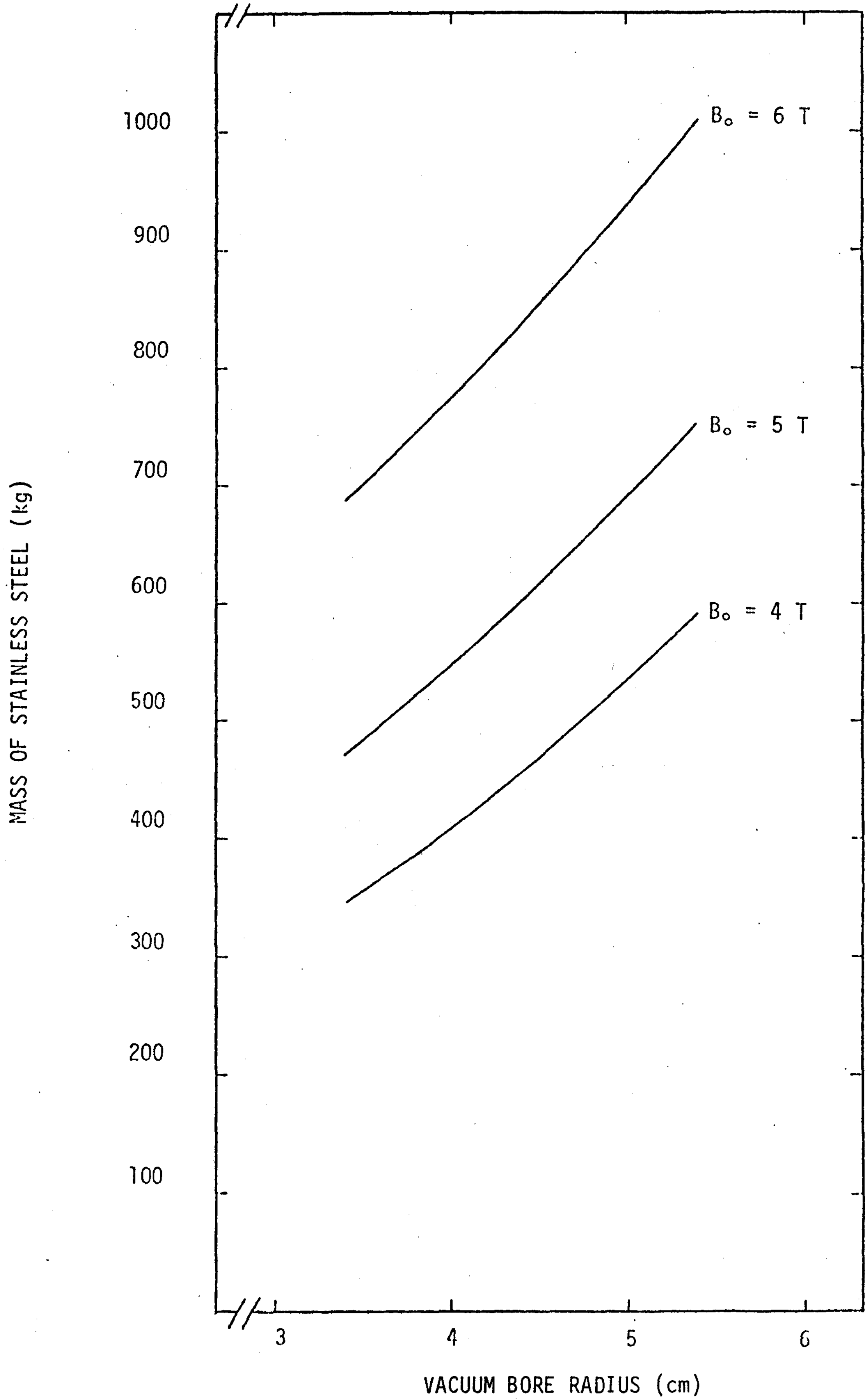


FIGURE 3.1.18 - MASS OF STAINLESS STEEL FOR THE RECTANGULAR WINDING WITH COLD IRON

Table 3.1.1

Peak overall (average) winding current density vs. field strength and vacuum bore for Cos θ magnets (cold and warm iron)

B_o Central Field (T)	Vacuum Bore Radius (cm)	λJ_{max} Peak Overall Current Density (A/cm^2)
4	3.4	3.89×10^4
5	3.4	3.30×10^4
6	3.4	2.70×10^4
4	4.4	4.03×10^4
5	4.4	3.38×10^4
6	4.4	2.76×10^4
4	5.4	4.10×10^4
5	5.4	3.45×10^4
6	5.4	2.82×10^4

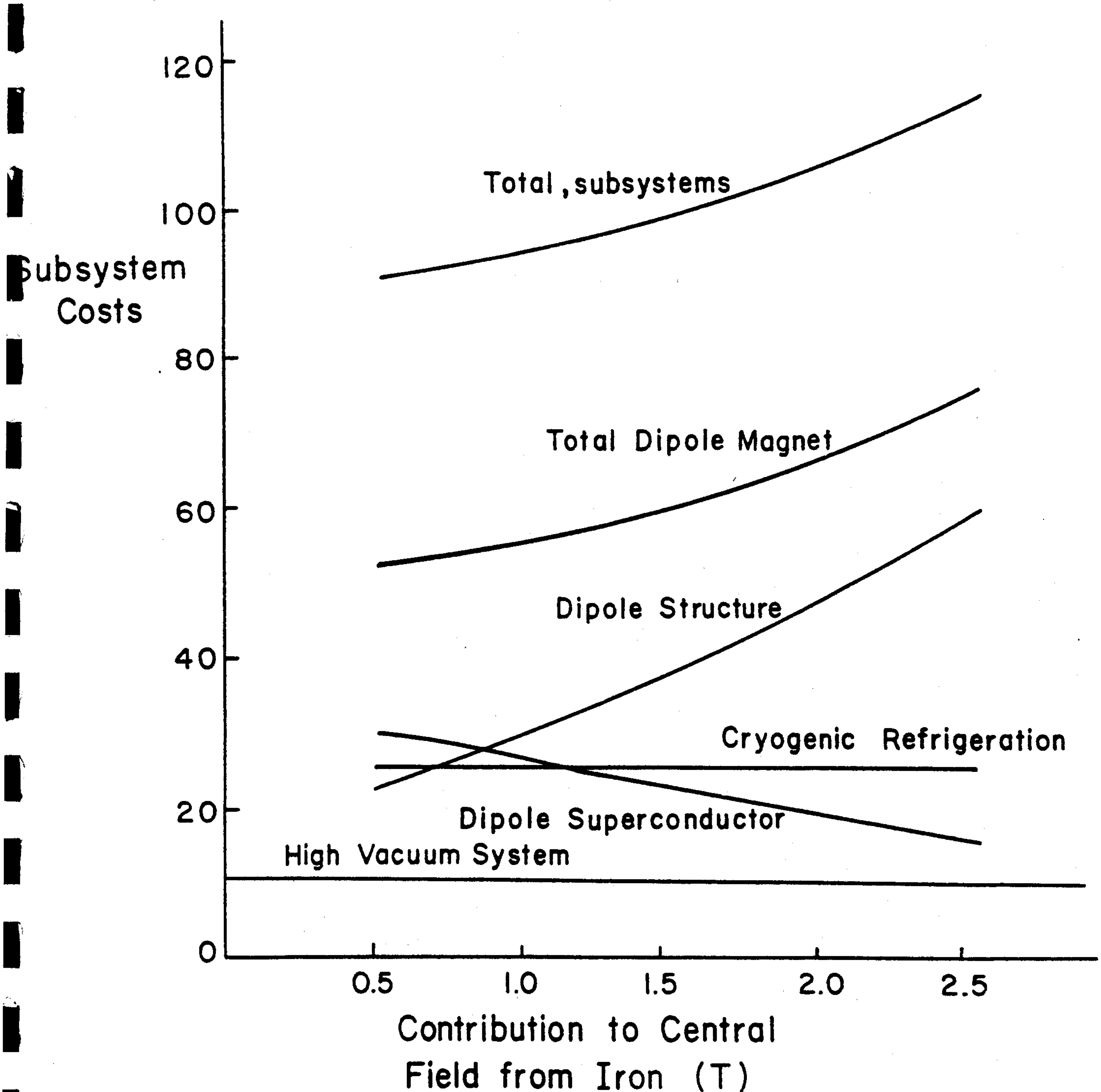
3.2 Design Point Variations (2 Layer, Cos θ, Cold Iron-Palmer Design)

In the course of performing this effort for BNL, MIT has applied selected system modeling techniques to produce a system sizing and modeling computer code. This may be used to carry out trade studies to estimate the sensitivity of overall system characteristics, such as cost, to variations in selected subsystem characteristics (e.g. - dipole aperture).

The code now includes the cost of the dipole magnets, the high vacuum system and the cryogenic refrigeration systems. It is still under development, but preliminary results have been obtained and are reported in this section. Within the limitations of the present model, we have addressed three issues: the optimum amount of iron in the dipole magnets, the optimal maximum helium temperature in the dipole magnets, and the cost/performance tradeoff between useable bore and central field. A more detailed description of the code and its algorithms may be found in Appendix A.

Some of the overall system specifications for Isabelle are given in Table 3.2.1. These are based on the unpublished BNL computer listing "Isabelle Parameter List" dated May 2, 1980. Those parameters which were varied in the present study are specifically identified in the following.

The contribution from the iron in the reference design to the central field of 5.0 T is 1.77 T. In the first part of the study, the contribution to a 5.0 T field was varied parametrically from 0.5 to 2.5 T while holding other system specifications constant. Figure 3.2.1 shows that the total cost of the three subsystems decreases monotonically as the amount of iron is reduced. The smallest overall cost, at a contribution of 0.5 T, is 10% lower than the reference cost. The savings is almost entirely in the magnet structure, which includes the magnet laminations, and which more than balances the increased cost of the superconductor as the iron is reduced. No allowance



Isabelle Subsystem Costs vs. the Contribution to the Central Field from the Iron

FIGURE 3.2.1

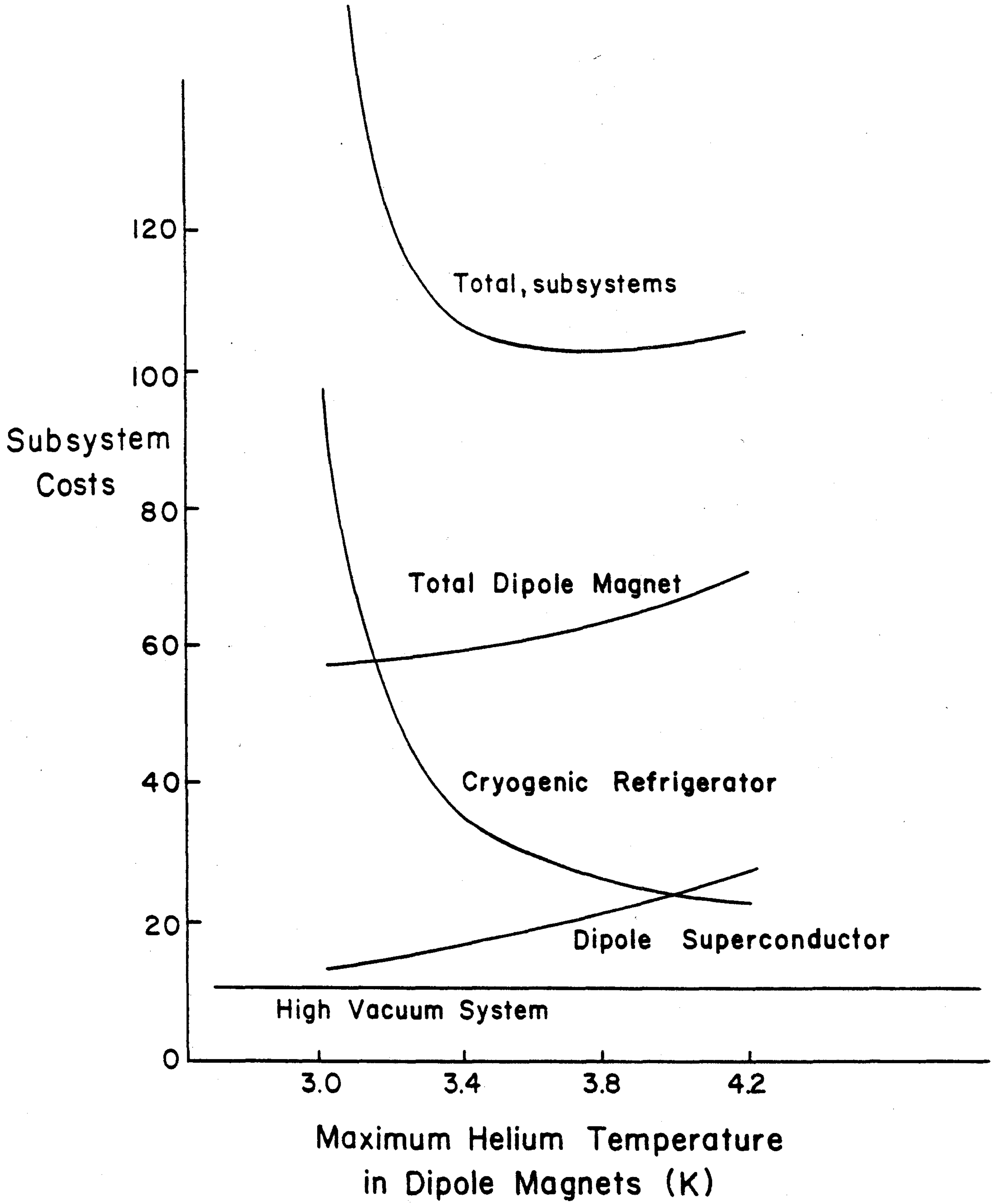
Table 3.2.1

Overall System Specifications

Parameter	Description	Units
B_o	field requirement at the center of the bore	5.0 T
$I_{correct}$	current in the correction coils	100 A
$L_{overall}$	overall length of a dipole magnet	5.03 m
R_{bend}	bending radius in the circular section of each proton storage ring	267 m
R_{ring}	major radius of each proton storage ring	610 m
T_{Hein}	inlet helium temperature of the load transfer lines [BR81]	2.59 K
T_{Heout}	outlet helium temperature of the load transfer lines [BR81]	4.2 K
T_{bmax}	maximum helium temperature at the magnet conductor	3.8 K
aper	usable aperture radius	0.04 m
$aper_{tot}$	total vacuum aperture radius	0.044 m
$n_{dipoles}$	number of dipole magnets in the system	732
$n_{leadscorrect}$	number of leads in the correction coils	3312
$n_{leadsmain}$	number of leads in the main magnets	48
$n_{quadrupoles}$	number of quadrupole magnets in the system	352
P_{Hein}	inlet helium pressure of the load transfer lines [BR81]	5.42×10^5 Pa
P_{Heout}	outlet helium pressure of the load transfer lines [BR81]	4.26×10^5 Pa
t_{fall}	current fall time in the magnets	480 s
t_{flat}	current flat-top time in the magnets	24 hr
t_{rise}	current rise time in the magnets	480 s
tuneshift	acceptable tune shift in the interaction space	0.0056

has been made for the increased risk associated with producing a greater fraction of the total field with superconductor or for costs related to development and demonstration of cable configurations different from the available "FNAL conductor". Although the outer surface area is decreased to first order as the amount of iron decreases, the total cryogenic refrigeration cost is highly insensitive to the amount of iron. The high vacuum system, of course, is not affected at all. As the contribution of the iron changes from 0.5 to 2.0 T, the total cost of dipole structure increases by an estimated $24 M, while the cost of superconductor decreases by $11 M. The effect of iron on field harmonics has not been modeled and it has been assumed that the iron laminations and support tube are structurally adequate to support the dipole Lorentz forces.

The present cryogenic refrigeration system exit temperature is 2.59 K. This temperature increases to a maximum of 3.8 K in the superconducting magnets, and increases further to 4.2 K, by the time it returns to the cold recirculating system. While holding the temperature of 2.59 K constant, we varied the maximum temperature of the helium in the magnet from 3.0 K to 4.2 K as the second part of this study. As the maximum temperature is decreased, less superconductor is required in the magnet, but a higher mass flow is required from the cold recirculator. Figure 3.2.2 shows that the temperature of 3.8 K in the reference design is seen to give the optimal system cost; the cost is, however, flat to within a few percent from 3.4 K to 4.2 K. Below 3.2 K, the cost begins to increase rapidly. This reflects the fact that the energy per unit mass that is being removed from the system is becoming very low at low magnet outlet temperatures. The mass flow through the magnets increases rapidly and the entropy generation in the cold compressor, which was only about 15% of total load entropy generation in the reference design, becomes several times greater than the entropy



Isabelle Subsystems Cost vs. the Maximum Helium Temperature Dipole Magnets for a Refrigerator Outlet Temperature of 2.59 K

FIGURE 3.2.2

generation in the rest of the load. A different design approach to the refrigeration system, such as a superfluid pool, would probably have to be selected, in order to make further subcooling economically attractive.

A tradeoff of central field vs. aperture is shown in Figure 3.2.3. The sensitivity of cost to either aperture or field is approximately the same about the reference point: a 20% decrease in either figure of performance results in about a 10% reduction in cost. Cryogenic system costs are insensitive to changes both in field and in aperture. The high vacuum pumping system is highly sensitive to changes in aperture and completely insensitive to changes in field. The dipole magnets are more sensitive to changes in field than in aperture. This is especially true for the superconductor.

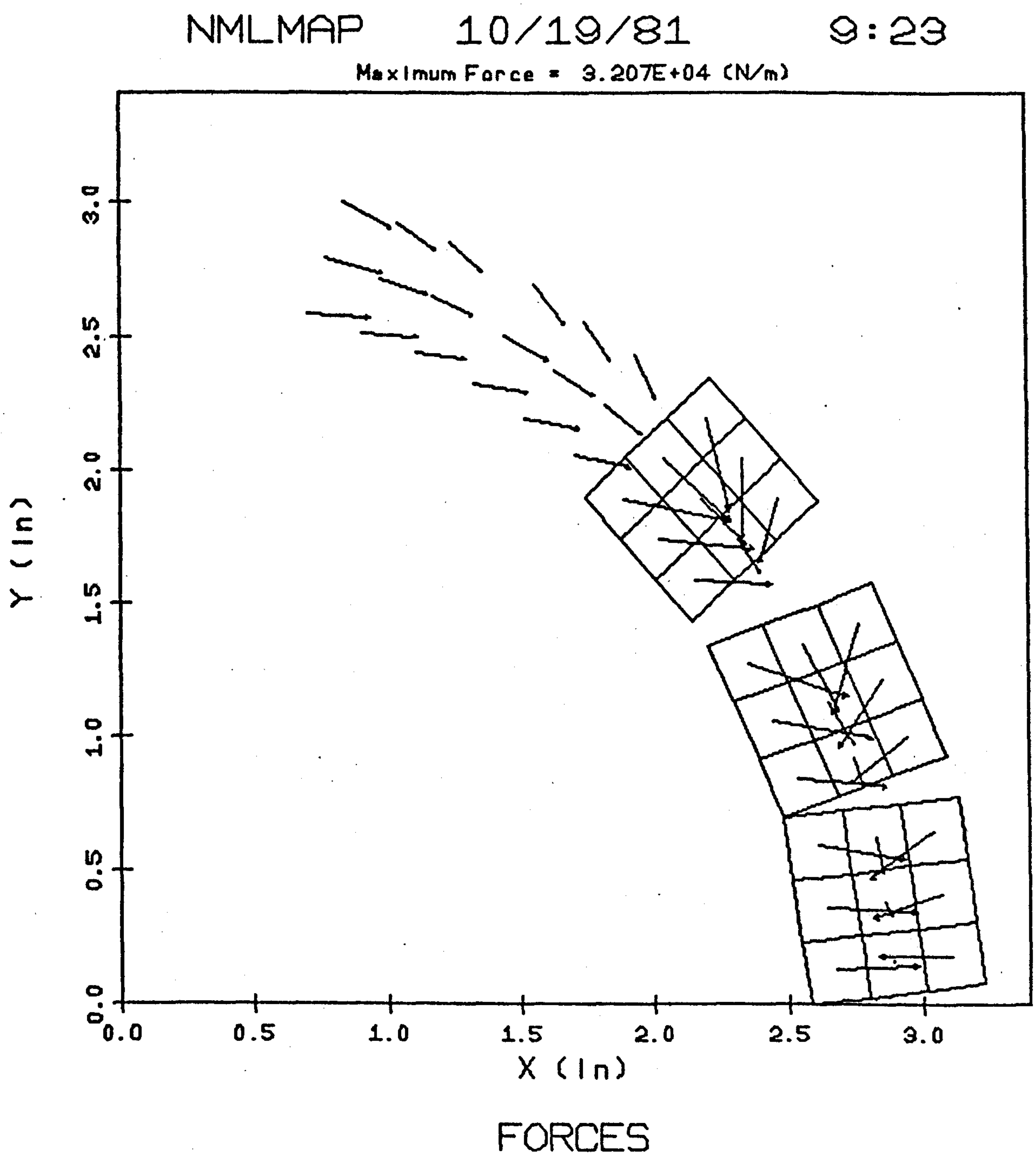


Figure 3.3.10: Air Core Lorentz Body Force Vectors for the Five Block Design

Table 3.3.3: Lorentz Body Force Components for the Five Block Design

ISA1 Ironcore Forces

Element Forces per Unit Length

Nel	mat	i1	j1	xc(in)	yc(in)	Fx(N/m)	Fy(N/m)	Ft(N/m)
301	3	14	2	2.671E+00	1.317E-01	4.5623E+04	1.1976E+03	4.5639E+04
302	3	14	3	2.639E+00	3.628E-01	4.7899E+04	-1.0398E+03	4.7910E+04
303	3	14	4	2.607E+00	5.940E-01	4.7071E+04	-3.7850E+03	4.7223E+04
305	3	14	6	2.538E+00	8.432E-01	4.7416E+04	-2.3927E+03	4.7476E+04
306	3	14	7	2.445E+00	1.058E+00	5.0615E+04	-5.0799E+03	5.0869E+04
307	3	14	8	2.352E+00	1.272E+00	5.0690E+04	-1.0170E+04	5.1700E+04
309	3	14	10	2.159E+00	1.582E+00	4.1100E+04	-1.7498E+03	4.1137E+04
310	3	14	11	2.025E+00	1.738E+00	4.6459E+04	-3.6053E+03	4.6598E+04
311	3	14	12	1.891E+00	1.894E+00	4.9760E+04	-7.8873E+03	5.0382E+04
313	4	14	14	1.710E+00	2.059E+00	2.6385E+04	-4.4468E+03	2.6757E+04
314	4	14	15	1.519E+00	2.191E+00	2.6201E+04	-3.3247E+03	2.6412E+04
315	4	14	16	1.328E+00	2.323E+00	2.6320E+04	-3.0173E+03	2.6493E+04
317	4	14	18	1.108E+00	2.438E+00	2.4090E+04	-1.8605E+03	2.4162E+04
318	4	14	19	9.075E-01	2.510E+00	2.5394E+04	-1.2427E+03	2.5425E+04
319	4	14	20	7.073E-01	2.582E+00	2.7040E+04	-1.5339E+03	2.7084E+04
324	3	15	2	2.886E+00	1.578E-01	2.1051E+04	1.3191E+03	2.1092E+04
325	3	15	3	2.854E+00	3.890E-01	2.3471E+04	-3.9359E+03	2.3798E+04
326	3	15	4	2.822E+00	6.201E-01	2.3553E+04	-9.5976E+03	2.5433E+04
328	3	15	6	2.740E+00	9.208E-01	2.4417E+04	-8.0438E+03	2.5708E+04
329	3	15	7	2.647E+00	1.135E+00	2.9195E+04	-1.3599E+04	3.2207E+04
330	3	15	8	2.554E+00	1.349E+00	3.2198E+04	-2.0803E+04	3.8333E+04
332	3	15	10	2.315E+00	1.732E+00	2.5483E+04	-1.0337E+04	2.7499E+04
333	3	15	11	2.181E+00	1.888E+00	3.1968E+04	-1.4655E+04	3.5167E+04
334	3	15	12	2.047E+00	2.044E+00	3.7724E+04	-1.9900E+04	4.2651E+04
336	4	15	14	1.825E+00	2.243E+00	2.0898E+04	-9.4954E+03	2.2954E+04
337	4	15	15	1.633E+00	2.375E+00	2.1816E+04	-8.2523E+03	2.3324E+04
338	4	15	16	1.442E+00	2.507E+00	2.2764E+04	-7.9108E+03	2.4099E+04
340	4	15	18	1.174E+00	2.645E+00	2.1036E+04	-5.7617E+03	2.1811E+04
341	4	15	19	9.740E-01	2.717E+00	2.3076E+04	-5.0468E+03	2.3622E+04
342	4	15	20	7.738E-01	2.789E+00	2.5448E+04	-4.7258E+03	2.5883E+04
347	3	16	2	3.101E+00	1.839E-01	-4.3694E+02	1.7030E+02	4.6895E+02
348	3	16	3	3.069E+00	4.151E-01	8.0238E+02	-6.4355E+03	6.4853E+03
349	3	16	4	3.037E+00	6.463E-01	2.6104E+03	-1.3102E+04	1.3359E+04
351	3	16	6	2.942E+00	9.983E-01	4.6893E+03	-1.3624E+04	1.4409E+04
352	3	16	7	2.849E+00	1.213E+00	9.0589E+03	-2.0628E+04	2.2530E+04
353	3	16	8	2.757E+00	1.427E+00	1.4394E+04	-2.7660E+04	3.1181E+04
355	3	16	10	2.471E+00	1.883E+00	1.2845E+04	-1.9495E+04	2.3346E+04
356	3	16	11	2.337E+00	2.039E+00	1.8394E+04	-2.4850E+04	3.0917E+04
357	3	16	12	2.203E+00	2.195E+00	2.5133E+04	-2.8995E+04	3.8372E+04
359	4	16	14	1.939E+00	2.427E+00	1.5855E+04	-1.3344E+04	2.0723E+04
360	4	16	15	1.748E+00	2.559E+00	1.7449E+04	-1.2472E+04	2.1448E+04
361	4	16	16	1.557E+00	2.690E+00	1.9072E+04	-1.1893E+04	2.2476E+04
363	4	16	18	1.241E+00	2.851E+00	1.8305E+04	-9.0839E+03	2.0435E+04
364	4	16	19	1.040E+00	2.923E+00	2.0446E+04	-8.4456E+03	2.2121E+04
365	4	16	20	8.402E-01	2.995E+00	2.2878E+04	-7.4465E+03	2.4060E+04

on the windings. Table 3.3.4 lists the values of these forces. The table is keyed to the element numbers given in Figure 3.3.5.

Table 3.3.4: Air Core Lorentz Body Force Components
for the Five Block Design (keyed to Figure 3.3.5)

ISA1 Aircore Forces

Element Forces per Unit Length

Nel	mat	i1	j1	xc(in)	yc(in)	Fx(N/m)	Fy(N/m)	Ft(N/m)
301	3	14	2	2.671E+00	1.317E-01	2.4400E+04	1.1620E+03	2.4428E+04
302	3	14	3	2.639E+00	3.628E-01	2.6599E+04	-1.1081E+03	2.6622E+04
303	3	14	4	2.607E+00	5.940E-01	2.5652E+04	-3.8292E+03	2.5936E+04
305	3	14	6	2.538E+00	8.432E-01	2.5868E+04	-2.3020E+03	2.5971E+04
306	3	14	7	2.445E+00	1.058E+00	2.9026E+04	-4.7871E+03	2.9418E+04
307	3	14	8	2.352E+00	1.272E+00	2.9143E+04	-9.6574E+03	3.0702E+04
309	3	14	10	2.159E+00	1.582E+00	2.2336E+04	-1.0803E+03	2.2362E+04
310	3	14	11	2.025E+00	1.738E+00	2.7832E+04	-2.8700E+03	2.7980E+04
311	3	14	12	1.891E+00	1.894E+00	3.1276E+04	-7.1032E+03	3.2072E+04
313	4	14	14	1.710E+00	2.059E+00	1.6402E+04	-4.0136E+03	1.6885E+04
314	4	14	15	1.519E+00	2.191E+00	1.6307E+04	-2.9149E+03	1.6565E+04
315	4	14	16	1.328E+00	2.323E+00	1.6506E+04	-2.6443E+03	1.6717E+04
317	4	14	18	1.108E+00	2.438E+00	1.5155E+04	-1.5709E+03	1.5236E+04
318	4	14	19	9.075E-01	2.510E+00	1.6496E+04	-1.0043E+03	1.6526E+04
319	4	14	20	7.073E-01	2.582E+00	1.8173E+04	-1.3442E+03	1.8223E+04
324	3	15	2	2.886E+00	1.578E-01	-8.9257E+01	1.2222E+03	1.2254E+03
325	3	15	3	2.854E+00	3.890E-01	2.2016E+03	-4.1249E+03	4.6756E+03
326	3	15	4	2.822E+00	6.201E-01	2.0940E+03	-9.8029E+03	1.0024E+04
328	3	15	6	2.740E+00	9.208E-01	2.6785E+03	-8.0678E+03	8.5008E+03
329	3	15	7	2.647E+00	1.135E+00	7.3588E+03	-1.3327E+04	1.5223E+04
330	3	15	8	2.554E+00	1.349E+00	1.0414E+04	-2.0206E+04	2.2732E+04
332	3	15	10	2.315E+00	1.732E+00	6.6535E+03	-9.5064E+03	1.1603E+04
333	3	15	11	2.181E+00	1.888E+00	1.3288E+04	-1.3763E+04	1.9131E+04
334	3	15	12	2.047E+00	2.044E+00	1.9201E+04	-1.8949E+04	2.6977E+04
336	4	15	14	1.825E+00	2.243E+00	1.0936E+04	-8.9691E+03	1.4144E+04
337	4	15	15	1.633E+00	2.375E+00	1.1959E+04	-7.7584E+03	1.4255E+04
338	4	15	16	1.442E+00	2.507E+00	1.2998E+04	-7.4659E+03	1.4990E+04
340	4	15	18	1.174E+00	2.645E+00	1.2160E+04	-5.4349E+03	1.3320E+04
341	4	15	19	9.740E-01	2.717E+00	1.4232E+04	-4.7791E+03	1.5013E+04
342	4	15	20	7.738E-01	2.789E+00	1.6630E+04	-4.5084E+03	1.7230E+04
347	3	16	2	3.101E+00	1.839E-01	-2.1417E+04	-3.9991E+01	2.1417E+04
348	3	16	3	3.069E+00	4.151E-01	-2.0385E+04	-6.8082E+03	2.1492E+04
349	3	16	4	3.037E+00	6.463E-01	-1.8842E+04	-1.3547E+04	2.3207E+04
351	3	16	6	2.942E+00	9.983E-01	-1.7320E+04	-1.3877E+04	2.2193E+04
352	3	16	7	2.849E+00	1.213E+00	-1.3166E+04	-2.0413E+04	2.4291E+04
353	3	16	8	2.757E+00	1.427E+00	-7.7420E+03	-2.6922E+04	2.8013E+04
355	3	16	10	2.471E+00	1.883E+00	-6.0241E+03	-1.8500E+04	1.9456E+04
356	3	16	11	2.337E+00	2.039E+00	-3.4920E+02	-2.3802E+04	2.3805E+04
357	3	16	12	2.203E+00	2.195E+00	6.5483E+03	-2.7854E+04	2.8613E+04
359	4	16	14	1.939E+00	2.427E+00	5.9238E+03	-1.2706E+04	1.4019E+04
360	4	16	15	1.748E+00	2.559E+00	7.6423E+03	-1.1881E+04	1.4127E+04
361	4	16	16	1.557E+00	2.690E+00	9.3700E+03	-1.1368E+04	1.4732E+04
363	4	16	18	1.241E+00	2.851E+00	9.5008E+03	-8.7272E+03	1.2901E+04
364	4	16	19	1.040E+00	2.923E+00	1.1661E+04	-8.1577E+03	1.4231E+04
365	4	16	20	8.402E-01	2.995E+00	1.4105E+04	-7.2107E+03	1.5841E+04

3.3.2.2 Two-Layer Dipole

The two-layer dipole design [3] was modeled as shown in Figure 3.3.11. The grid included 741 elements and 2302 unknowns. The iron core field lines are presented in Figure 3.3.12. The central field was calculated to be 5.0 T for an operating current of 3500 A. The peak field in the winding was 5.3 T and occurred in the inner layer; the peak field in the second or outer layer was 4.14 T. The iron contribution to the central field is 1.77 T. The transfer functions for the central and two peak fields are 14.11 G/A, 15.14 G/A and 11.83 G/A, respectively.

Figure 3.3.13 shows the Lorentz body force vectors acting on the elements used to model the windings. These vectors represent the integrated J X B body force densities over each of the elements. The components of these forces per unit length are given in Table 3.3.5 . The table is keyed to the element numbers shown in Figure 3.3.14.

Figure 3.3.15 shows the local azimuthal body force versus position for this design. The two curves represent the inner and outer layers of the coil. The discontinuities represent the spacers. Figure 3.3.16 shows the accumulated azimuthal body forces versus position. The assumption is made that the azimuthal loads accumulate and are not reacted by the aluminum ring. Although conservative, it does give an upper bound. The equivalent midplane compressive pressure in the inner and outer layers is 81.8 MPa (11.87 ksi), and 30.7 MPa (4.45 ksi), respectively.

Figure 3.3.17 shows the magnetization vectors in the iron. The peak field in the iron is 3.74 T.

Figure 3.3.18 shows the air core field lines for the design at the operating current. The central and two peak fields are 3.17 and 1.53 T, respectively. Table 3.3.6 gives values for the Lorentz body force vectors acting in the air core two-layer design and Figure 3.3.19 plots three vectors.

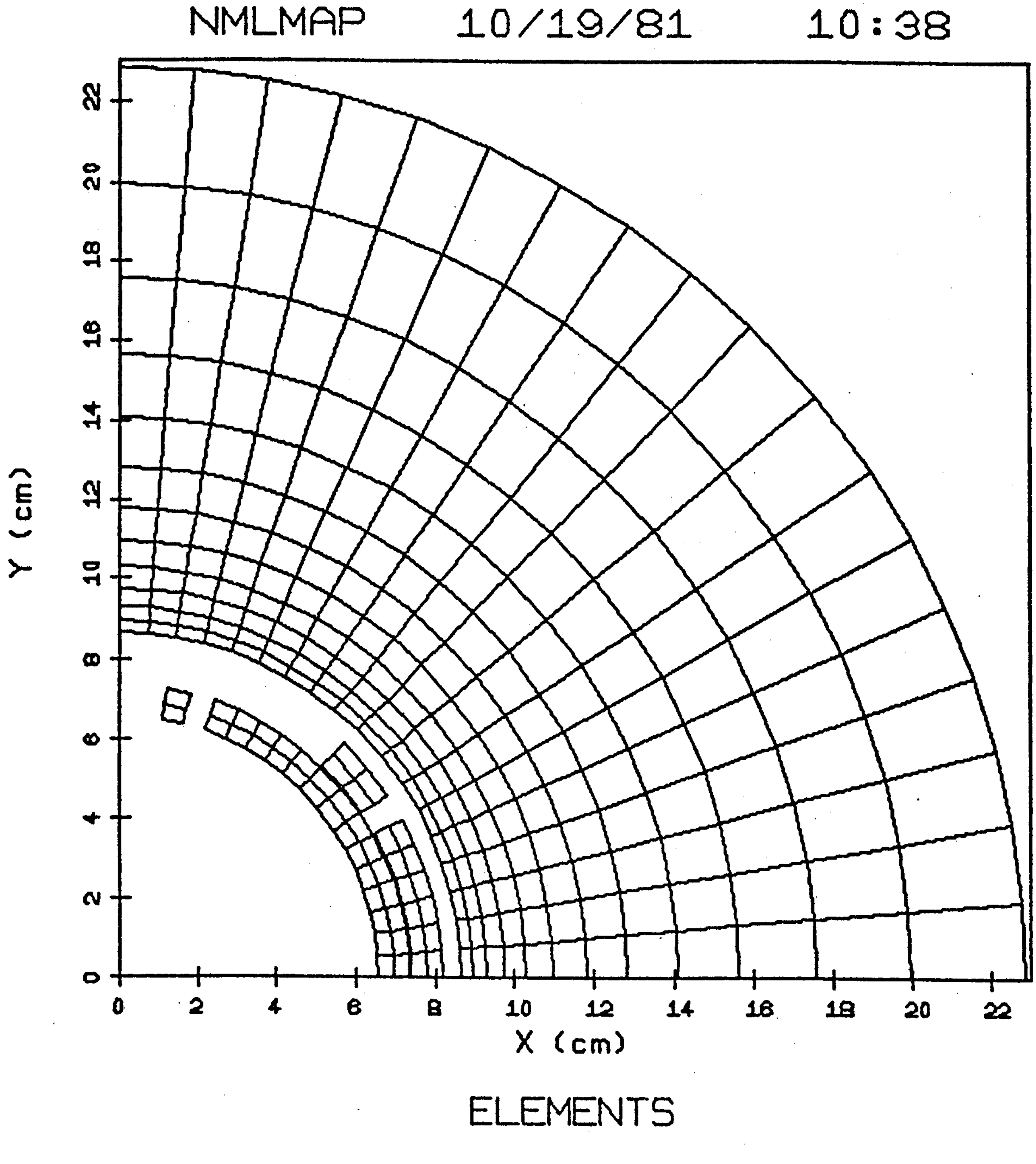


Figure 3.3.11: Model of Two-Layer Dipole Design

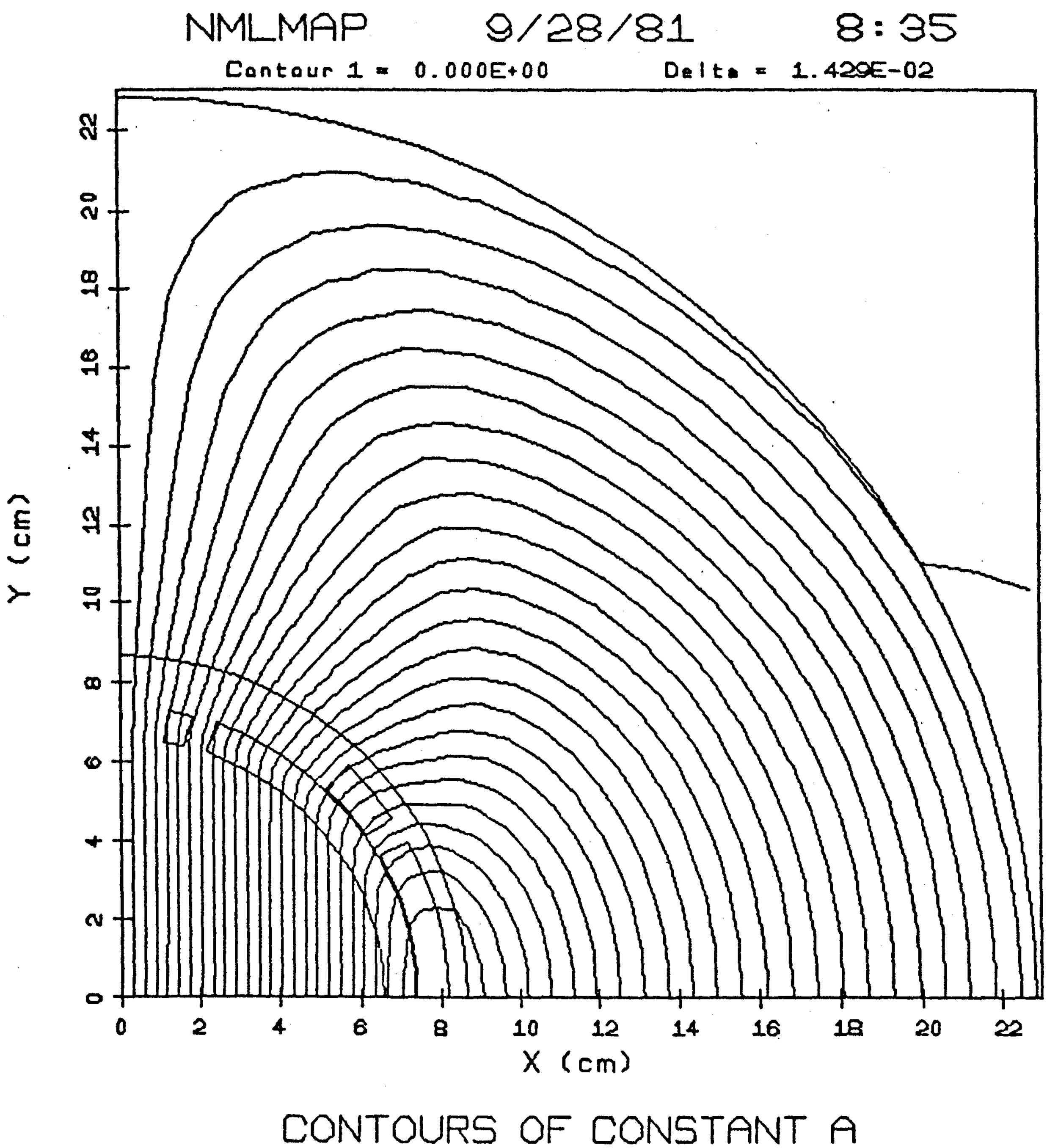


Figure 3.3.12: Iron-Core Field Lines for the Two-Layer Dipole Model

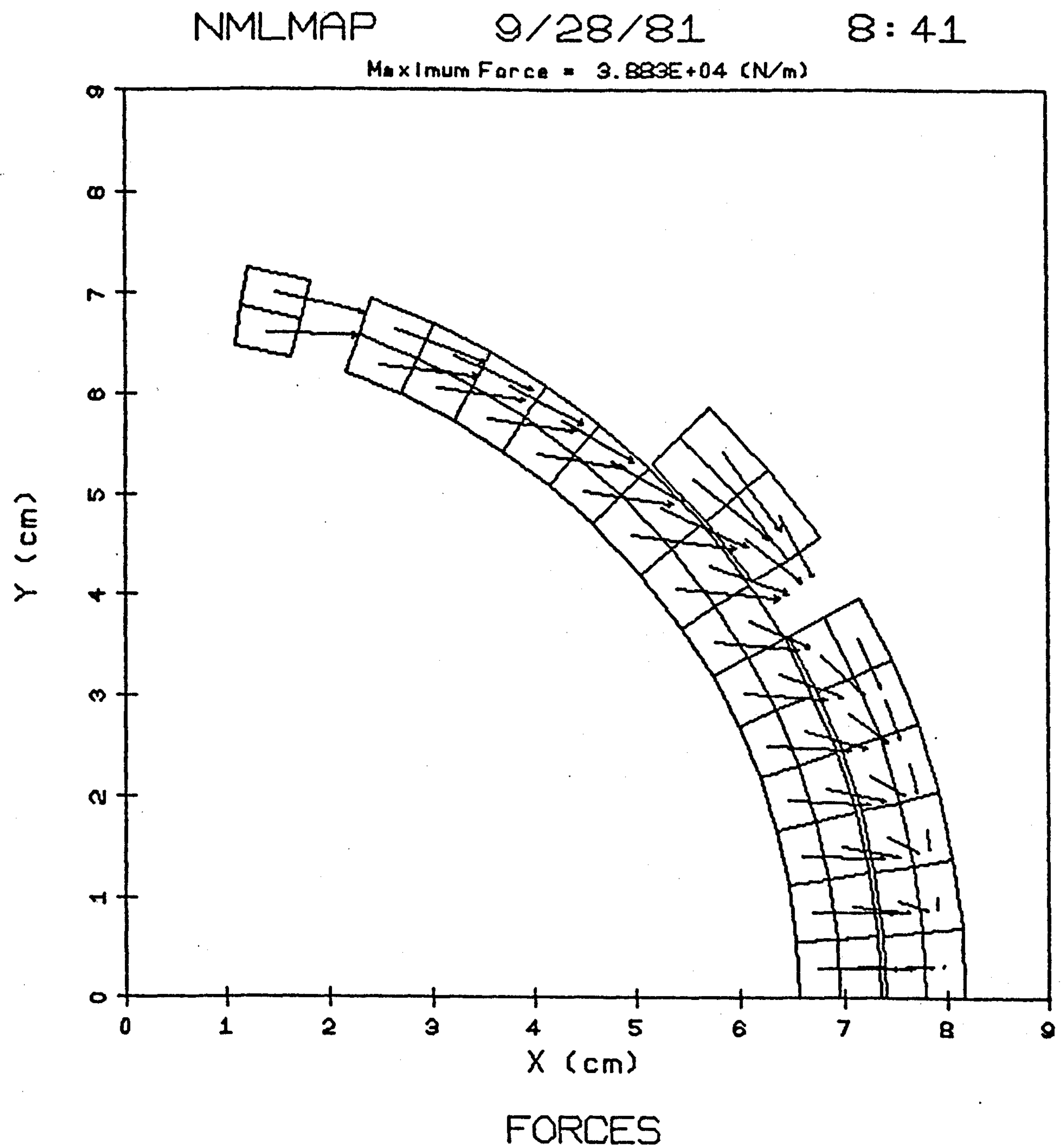


Figure 3.3.13: Lorentz Body Force Vectors (per unit length) Acting on Two-Layer Dipole

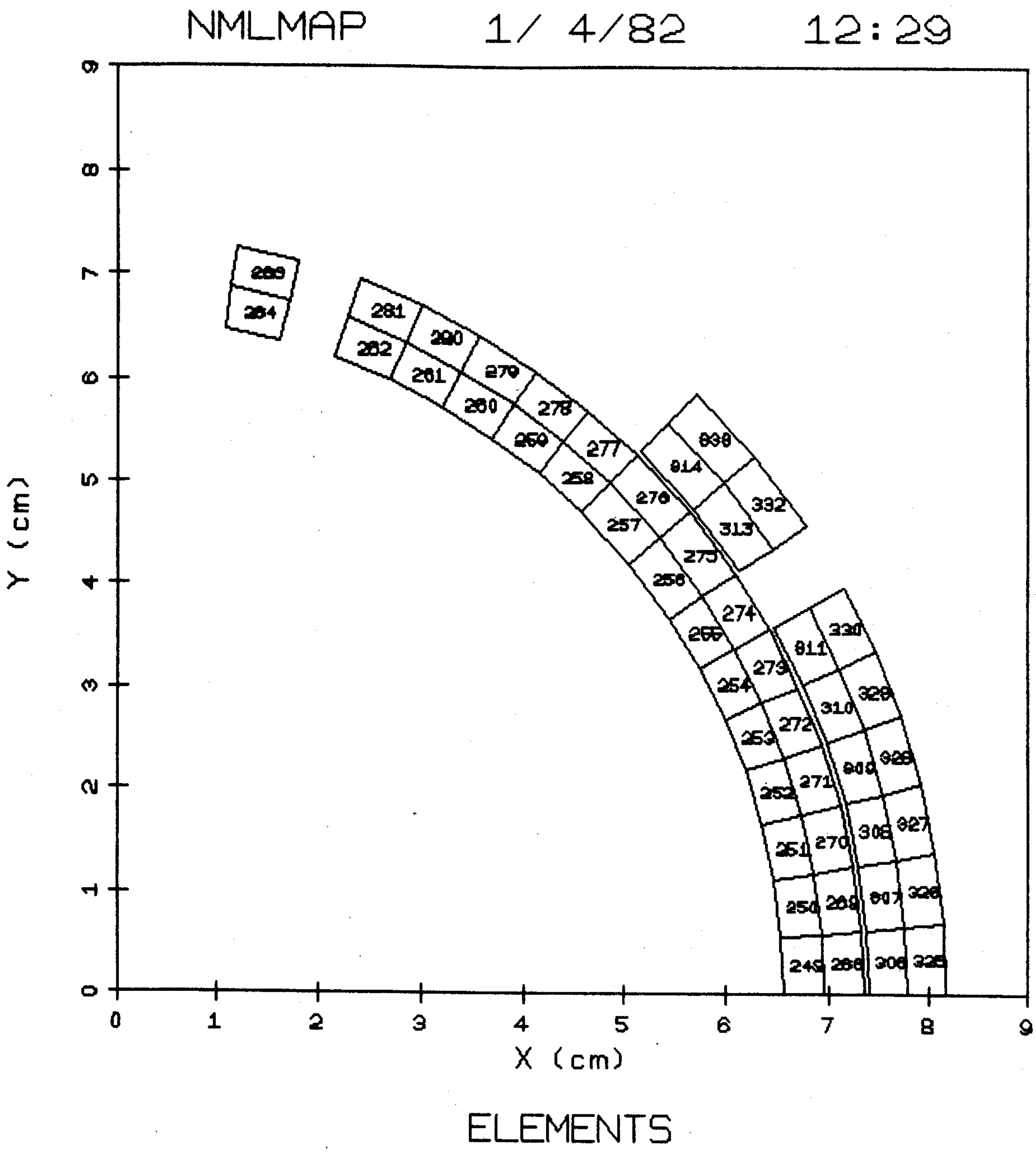


Figure 3.3.14: Finite Element Numbers Assigned to Winding Elements for the Two-Layer Dipole Model. Element Numbers Correspond with those in Table 3.3.5.

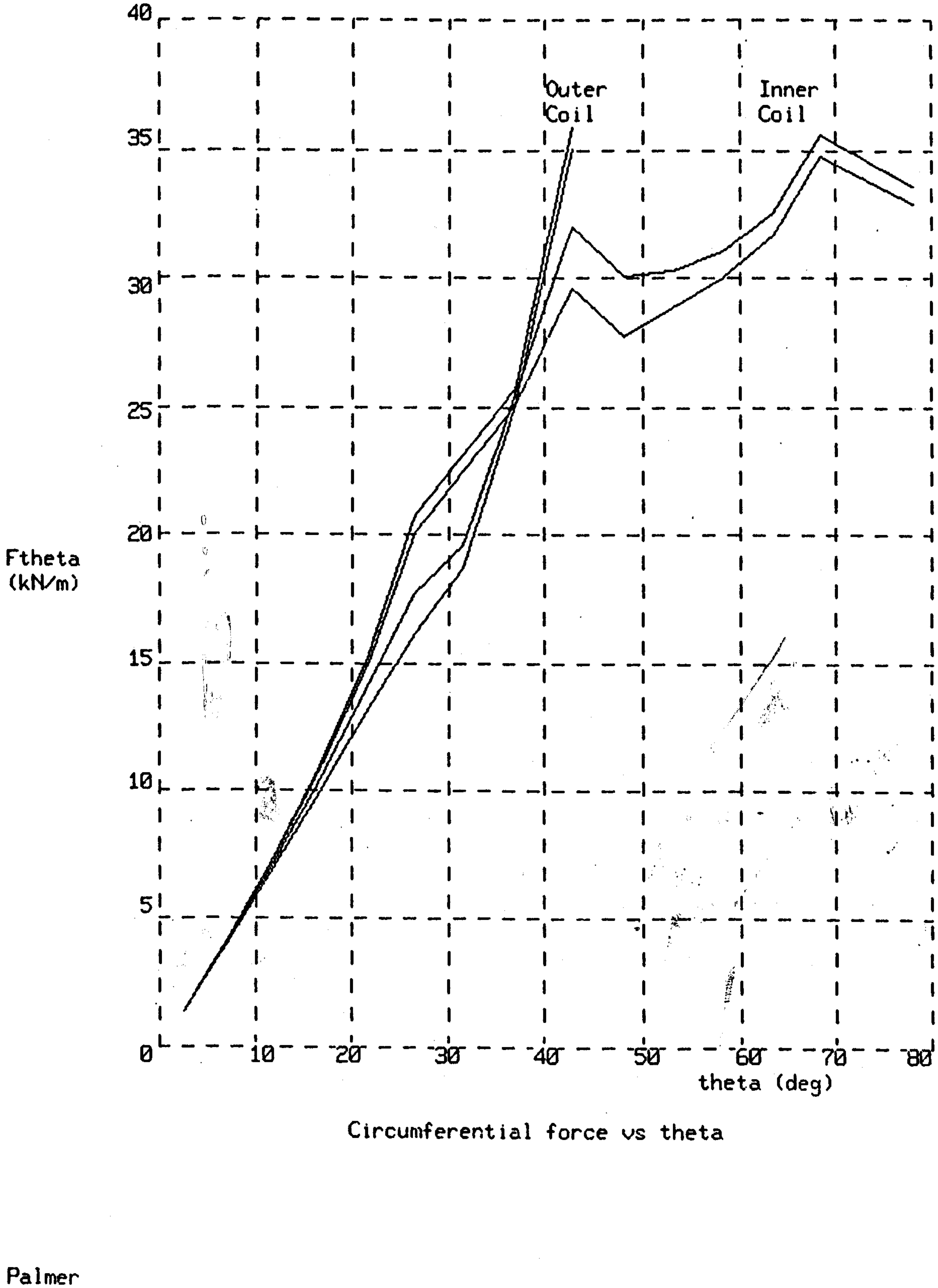
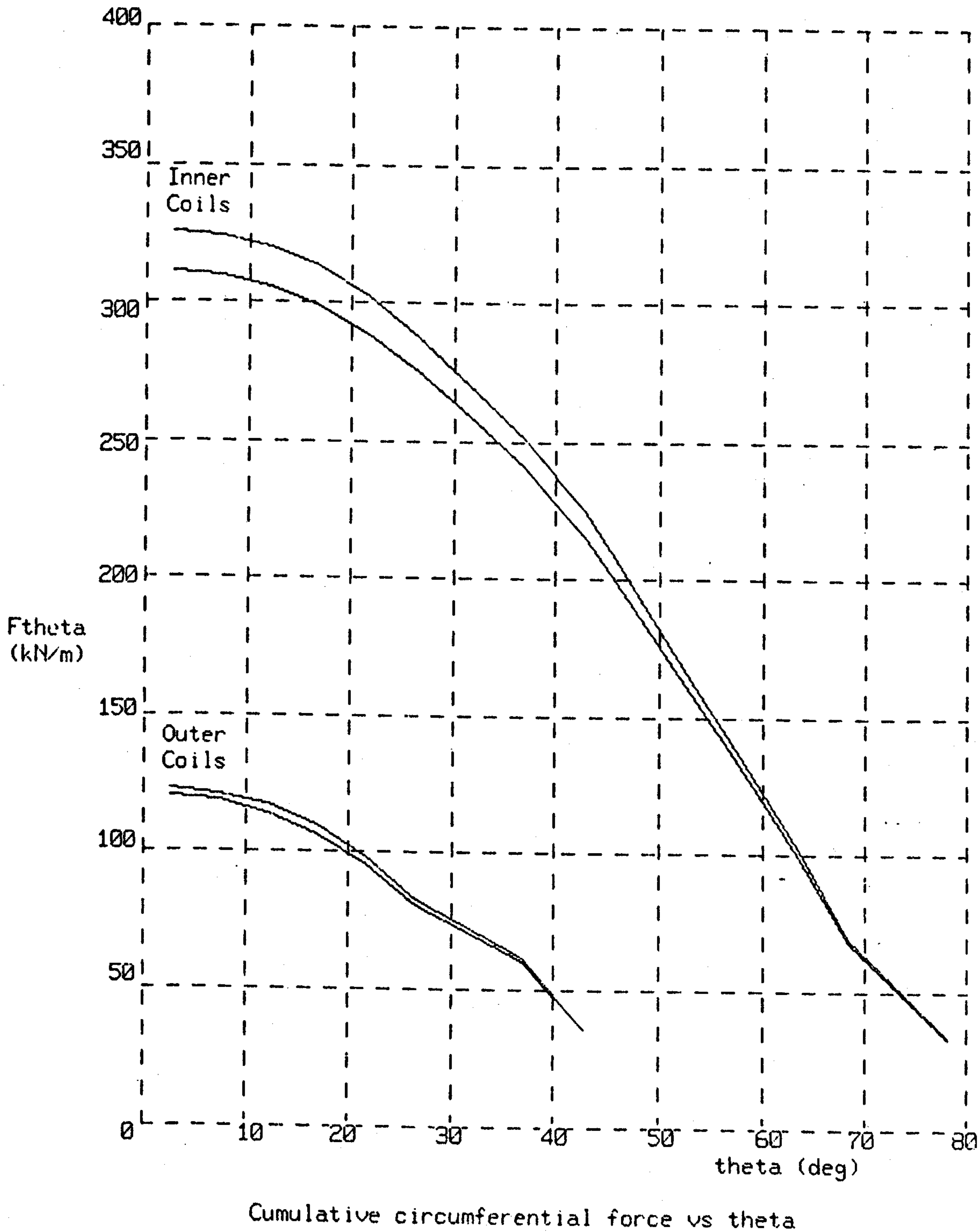


Figure 3.3.15: Local Azimuthal Force Versus Element Position for the Two-Layer Dipole Model



Palmer

Figure 3.3.16: Accumulated Azimuthal Forces Versus Position for the Two-Layer Dipole

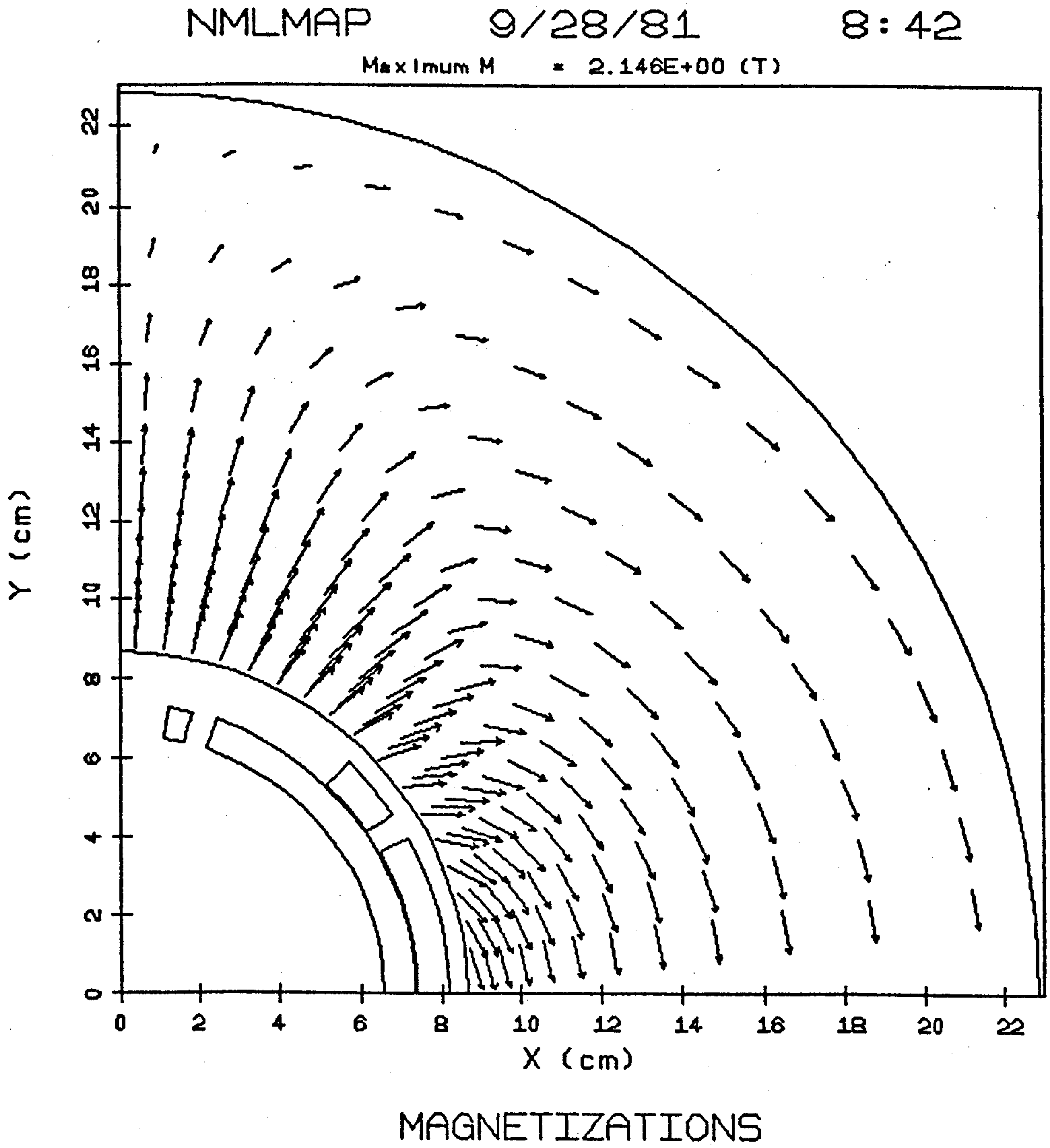


Figure 3.3.17: Magnetization Vectors in the Iron for the Two-Layer Dipole Design

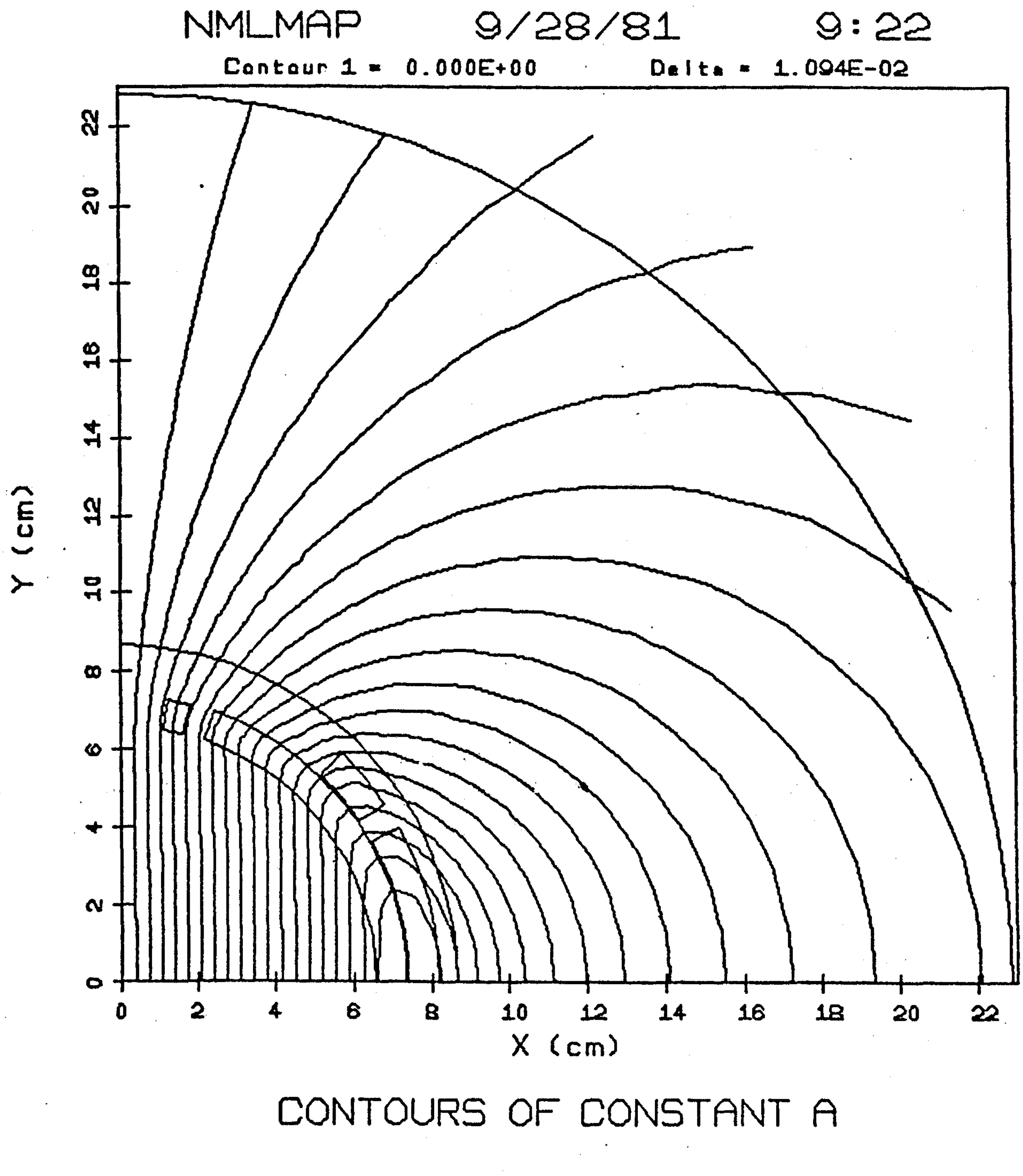


Figure 3.3.18: Air Core Field Lines at Operating Current for the Two-Layer Dipole Design

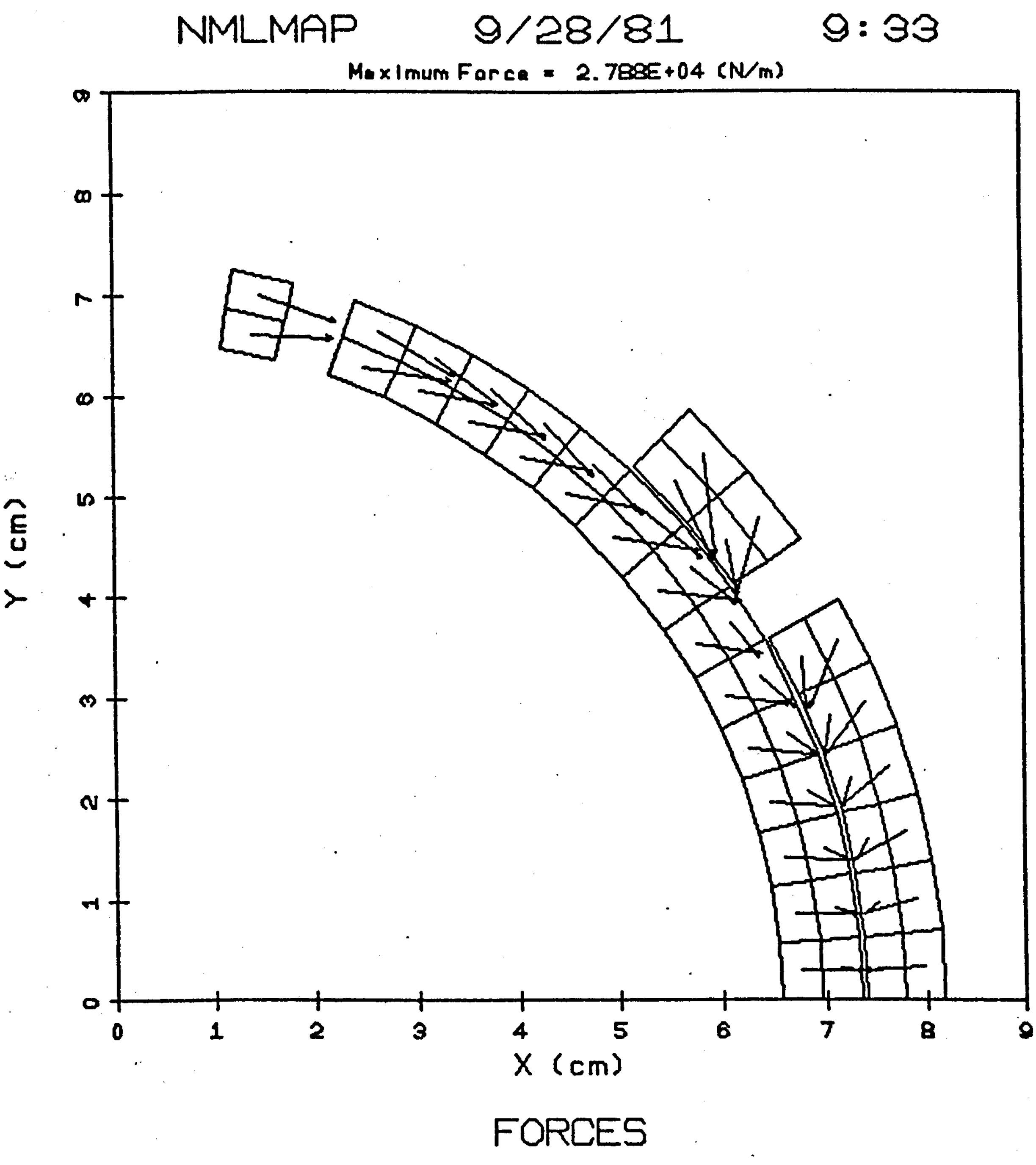


Figure 3.3.19: Air Core Lorentz Body Force Vectors Acting on the Windings for the Two-Layer Dipole Model

Table 3.3.5: Components of Lorentz Body Force Vectors Acting on Each Element for Iron-Core Two-Layer Dipole (keyed to Figure 3.3.14)

$ Palmer Two Layer Dipole - Ironcore
Element Forces per Unit Length

Nel	mat	i1	j1	xc(cm)	yc(cm)	Fx(N/m)	Fy(N/m)	Ft(N/m)
249	2	14	2	6.749E+00	2.891E-01	2.9263E+04	-8.0842E+01	2.9263E+04
250	2	14	3	6.701E+00	8.558E-01	2.9431E+04	-4.6196E+02	2.9435E+04
251	2	14	4	6.605E+00	1.416E+00	2.9688E+04	-9.0652E+02	2.9702E+04
252	2	14	5	6.463E+00	1.967E+00	2.9986E+04	-1.4805E+03	3.0023E+04
253	2	14	6	6.274E+00	2.504E+00	3.0206E+04	-2.2065E+03	3.0286E+04
254	2	14	7	6.042E+00	3.022E+00	3.0068E+04	-2.9794E+03	3.0215E+04
255	2	14	8	5.761E+00	3.527E+00	3.0624E+04	-3.1353E+03	3.0784E+04
256	2	14	9	5.399E+00	4.055E+00	3.7249E+04	-3.4176E+03	3.7406E+04
257	2	14	10	4.954E+00	4.589E+00	3.8543E+04	-4.6766E+03	3.8825E+04
258	2	14	11	4.496E+00	5.041E+00	3.2623E+04	-5.1509E+03	3.3028E+04
259	2	14	12	4.037E+00	5.416E+00	3.2180E+04	-5.1669E+03	3.2592E+04
260	2	14	13	3.548E+00	5.748E+00	3.2410E+04	-4.6473E+03	3.2741E+04
261	2	14	14	3.031E+00	6.037E+00	3.3409E+04	-4.1296E+03	3.3664E+04
262	2	14	15	2.490E+00	6.279E+00	3.5775E+04	-4.2486E+03	3.6026E+04
264	2	14	17	1.383E+00	6.612E+00	3.3373E+04	-1.4605E+03	3.3405E+04
268	2	15	2	7.140E+00	3.058E-01	1.9954E+04	-4.9115E+02	1.9960E+04
269	2	15	3	7.089E+00	9.052E-01	2.0230E+04	-1.7445E+03	2.0305E+04
270	2	15	4	6.987E+00	1.498E+00	2.0742E+04	-3.0795E+03	2.0969E+04
271	2	15	5	6.837E+00	2.081E+00	2.1433E+04	-4.5866E+03	2.1918E+04
272	2	15	6	6.637E+00	2.648E+00	2.2152E+04	-6.4090E+03	2.3060E+04
273	2	15	7	6.391E+00	3.197E+00	2.2367E+04	-8.6224E+03	2.3972E+04
274	2	15	8	6.094E+00	3.731E+00	2.1755E+04	-9.6259E+03	2.3790E+04
275	2	15	9	5.711E+00	4.290E+00	2.8623E+04	-1.0512E+04	3.0492E+04
276	2	15	10	5.240E+00	4.854E+00	3.2132E+04	-1.3880E+04	3.5002E+04
277	2	15	11	4.756E+00	5.333E+00	2.7049E+04	-1.4959E+04	3.0910E+04
278	2	15	12	4.271E+00	5.729E+00	2.6624E+04	-1.5058E+04	3.0588E+04
279	2	15	13	3.753E+00	6.081E+00	2.7547E+04	-1.4493E+04	3.1127E+04
280	2	15	14	3.206E+00	6.386E+00	2.9563E+04	-1.3721E+04	3.2592E+04
281	2	15	15	2.634E+00	6.642E+00	3.3332E+04	-1.2612E+04	3.5639E+04
283	2	15	17	1.463E+00	6.995E+00	3.2877E+04	-7.1528E+03	3.3646E+04
306	2	17	2	7.581E+00	3.247E-01	1.0132E+04	-9.1542E+02	1.0173E+04
307	2	17	3	7.527E+00	9.612E-01	1.0548E+04	-3.0370E+03	1.0976E+04
308	2	17	4	7.419E+00	1.591E+00	1.1370E+04	-5.2529E+03	1.2524E+04
309	2	17	5	7.259E+00	2.209E+00	1.2561E+04	-7.6961E+03	1.4731E+04
310	2	17	6	7.047E+00	2.812E+00	1.4025E+04	-1.0555E+04	1.7553E+04
311	2	17	7	6.786E+00	3.395E+00	1.5794E+04	-1.4606E+04	2.1512E+04
313	2	17	9	6.064E+00	4.555E+00	2.0384E+04	-1.6122E+04	2.5989E+04
314	2	17	10	5.564E+00	5.154E+00	2.7345E+04	-2.2508E+04	3.5417E+04
325	2	18	2	7.971E+00	3.414E-01	-6.7919E+02	-1.3776E+03	1.5359E+03
326	2	18	3	7.914E+00	1.011E+00	-1.4013E+02	-4.3826E+03	4.3848E+03
327	2	18	4	7.801E+00	1.673E+00	1.0077E+03	-7.4840E+03	7.5515E+03
328	2	18	5	7.633E+00	2.323E+00	2.7250E+03	-1.0843E+04	1.1180E+04
329	2	18	6	7.410E+00	2.957E+00	4.9858E+03	-1.4585E+04	1.5414E+04
330	2	18	7	7.135E+00	3.570E+00	8.4487E+03	-1.8977E+04	2.0772E+04
332	2	18	9	6.377E+00	4.789E+00	1.2731E+04	-2.2697E+04	2.6024E+04
333	2	18	10	5.850E+00	5.420E+00	2.1012E+04	-2.9482E+04	3.6204E+04

Table 3.3.6: Values for Lorentz Body Force Vectors Acting in Air Core Two-Layer Dipole Design (keyed to Figure 3.3.14)

$ Palmer Two Layer Dipole - Aircore
Element Forces per Unit Length

Nel	mat	i1	j1	xc(cm)	yc(cm)	Fx(N/m)	Fy(N/m)	Ft(N/m)
249	2	14	2	6.749E+00	2.891E-01	1.6293E+04	-7.6109E+01	1.6293E+04
250	2	14	3	6.701E+00	8.558E-01	1.6425E+04	-4.3563E+02	1.6431E+04
251	2	14	4	6.605E+00	1.416E+00	1.6625E+04	-8.2061E+02	1.6646E+04
252	2	14	5	6.463E+00	1.967E+00	1.6876E+04	-1.2852E+03	1.6924E+04
253	2	14	6	6.274E+00	2.504E+00	1.7090E+04	-1.8624E+03	1.7191E+04
254	2	14	7	6.042E+00	3.022E+00	1.7006E+04	-2.4797E+03	1.7186E+04
255	2	14	8	5.761E+00	3.527E+00	1.7279E+04	-2.4842E+03	1.7457E+04
256	2	14	9	5.399E+00	4.055E+00	2.1597E+04	-2.5166E+03	2.1743E+04
257	2	14	10	4.954E+00	4.589E+00	2.3113E+04	-3.6878E+03	2.3406E+04
258	2	14	11	4.496E+00	5.041E+00	1.9670E+04	-4.2848E+03	2.0132E+04
259	2	14	12	4.037E+00	5.416E+00	1.9404E+04	-4.3267E+03	1.9881E+04
260	2	14	13	3.548E+00	5.748E+00	1.9794E+04	-3.8736E+03	2.0169E+04
261	2	14	14	3.031E+00	6.037E+00	2.0928E+04	-3.4513E+03	2.1210E+04
262	2	14	15	2.490E+00	6.279E+00	2.3400E+04	-3.6837E+03	2.3688E+04
264	2	14	17	1.383E+00	6.612E+00	2.1655E+04	-1.1570E+03	2.1685E+04
268	2	15	2	7.140E+00	3.058E-01	6.2368E+03	-5.0386E+02	6.2571E+03
269	2	15	3	7.089E+00	9.052E-01	6.4514E+03	-1.7623E+03	6.6878E+03
270	2	15	4	6.987E+00	1.498E+00	6.8625E+03	-3.0437E+03	7.5072E+03
271	2	15	5	6.837E+00	2.081E+00	7.4579E+03	-4.4138E+03	8.6662E+03
272	2	15	6	6.637E+00	2.648E+00	8.1479E+03	-6.0298E+03	1.0136E+04
273	2	15	7	6.391E+00	3.197E+00	8.4335E+03	-8.0276E+03	1.1643E+04
274	2	15	8	6.094E+00	3.731E+00	7.5510E+03	-8.8400E+03	1.1626E+04
275	2	15	9	5.711E+00	4.290E+00	1.1995E+04	-9.4296E+03	1.5258E+04
276	2	15	10	5.240E+00	4.854E+00	1.5772E+04	-1.2688E+04	2.0242E+04
277	2	15	11	4.756E+00	5.333E+00	1.3349E+04	-1.3910E+04	1.9279E+04
278	2	15	12	4.271E+00	5.729E+00	1.3146E+04	-1.4044E+04	1.9237E+04
279	2	15	13	3.753E+00	6.081E+00	1.4264E+04	-1.3568E+04	1.9686E+04
280	2	15	14	3.206E+00	6.386E+00	1.6438E+04	-1.2919E+04	2.0907E+04
281	2	15	15	2.634E+00	6.642E+00	2.0329E+04	-1.1949E+04	2.3581E+04
283	2	15	17	1.463E+00	6.995E+00	2.0572E+04	-6.8001E+03	2.1667E+04
306	2	17	2	7.581E+00	3.247E-01	-4.3973E+03	-9.5960E+02	4.5008E+03
307	2	17	3	7.527E+00	9.612E-01	-4.0822E+03	-3.1390E+03	5.1495E+03
308	2	17	4	7.419E+00	1.591E+00	-3.4376E+03	-5.3235E+03	6.3370E+03
309	2	17	5	7.259E+00	2.209E+00	-2.4332E+03	-7.5916E+03	7.9720E+03
310	2	17	6	7.047E+00	2.812E+00	-1.0472E+03	-1.0140E+04	1.0194E+04
311	2	17	7	6.786E+00	3.395E+00	8.2852E+02	-1.3868E+04	1.3893E+04
313	2	17	9	6.064E+00	4.555E+00	2.6428E+03	-1.4809E+04	1.5043E+04
314	2	17	10	5.564E+00	5.154E+00	9.9146E+03	-2.1052E+04	2.3270E+04
325	2	18	2	7.971E+00	3.414E-01	-1.5884E+04	-1.4629E+03	1.5951E+04
326	2	18	3	7.914E+00	1.011E+00	-1.5492E+04	-4.5988E+03	1.6160E+04
327	2	18	4	7.801E+00	1.673E+00	-1.4617E+04	-7.7136E+03	1.6527E+04
328	2	18	5	7.633E+00	2.323E+00	-1.3224E+04	-1.0863E+04	1.7114E+04
329	2	18	6	7.410E+00	2.957E+00	-1.1123E+04	-1.4143E+04	1.7993E+04
330	2	18	7	7.135E+00	3.570E+00	-7.4837E+03	-1.8055E+04	1.9544E+04
332	2	18	9	6.377E+00	4.789E+00	-5.9989E+03	-2.1172E+04	2.2006E+04
333	2	18	10	5.850E+00	5.420E+00	2.6050E+03	-2.7762E+04	2.7884E+04

3.3.2.4 Three-Layer Dipole

The three-layer dipole [4] was modeled as shown in Figure 3.3.20. The grid included 888 elements and 2739 unknowns. The iron core field lines are presented in Figure 3.3.21. The central field was calculated to be 5.5 T for an overall current density 3.2 x 108 A/cm^2. The peak field in the winding was 5.9 T and occurred in the inner layer. The peak fields in the middle and outer layers were 5.29 T, and 3.0 T, respectively. The iron contribution to the central field is 0.8 T.

Figure 3.3.22 shows the Lorentz body force vectors acting on the elements used to model the windings. These vectors represent the integrated J X B body force densities over each of the elements. The components of these forces per unit length are given in Table 3.3.7. The table is keyed to the element numbers shown in Figure 3.3.23.

Figure 3.3.24 shows the local azimuthal body force versus position each layer in this design. The discontinuities represent occur because of the influence of the neighboring layers. Figure 3.3.25 shows the accumulated azimuthal body forces versus position for each layer. The assumption is made that the azimuthal loads accumulate and are not reacted by either the next layer out or the structural ring at the coil outside diameter. Although conservative, it does give an upper bound. The equivalent mid-plane compressive pressures in the inner, middle, and outer layers is 73.2 MPa (10.6 ksi), 44.8 MPa (6.30 ksi), and 18.9 MPa (2.75 ksi), respectively.

Figure 3.3.26 shows the magnetization vectors in the iron. The peak field in the iron is 1.97 T.

Figure 3.3.27 shows the air core field lines for the design at the operating current. The central and three peak fields are 4.69 T, 5.12 T, 4.26 T and 2.94 T, respectively.

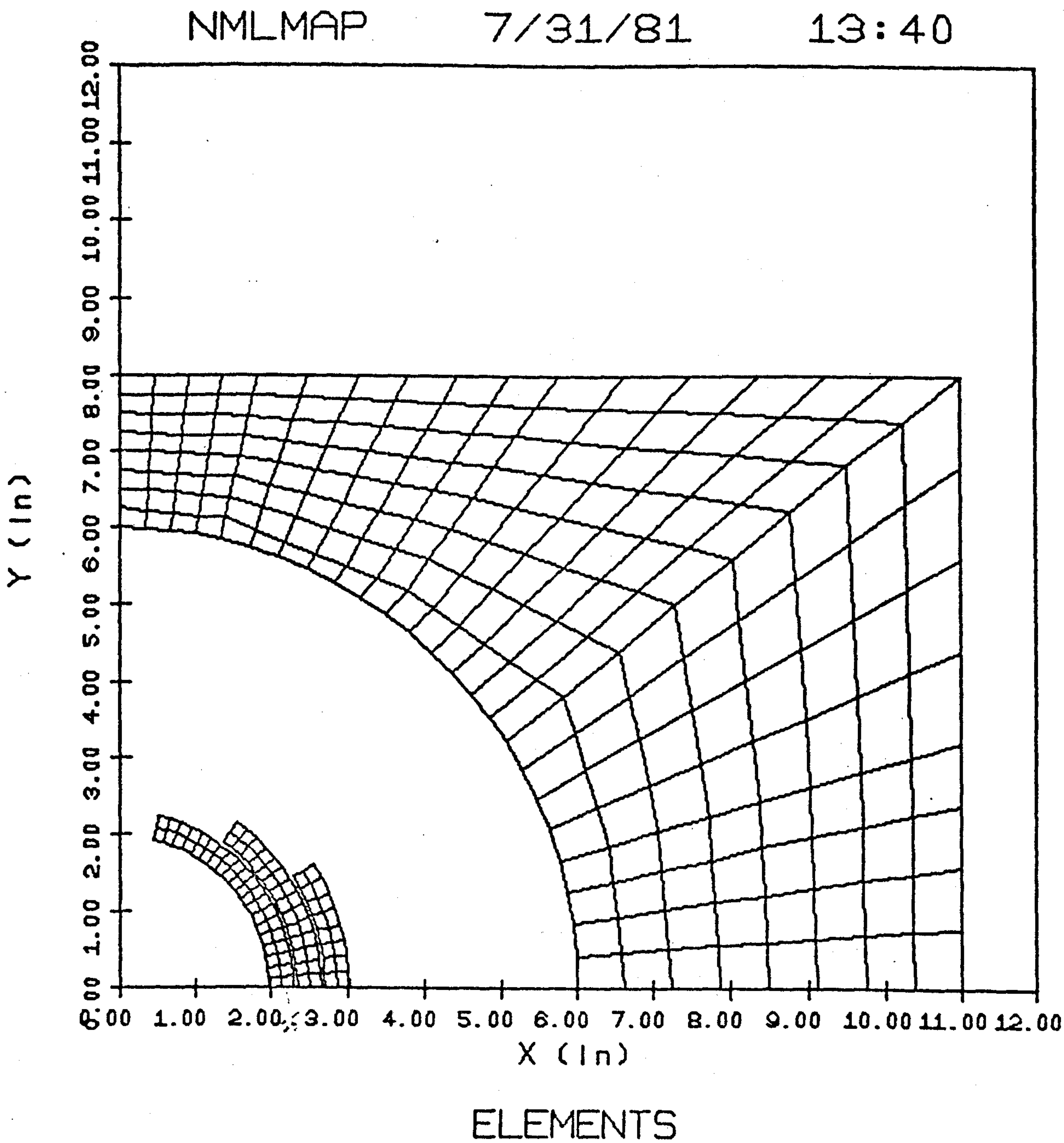


Figure 3.3.20: Model for Analysis of the Three-Layer Dipole Design

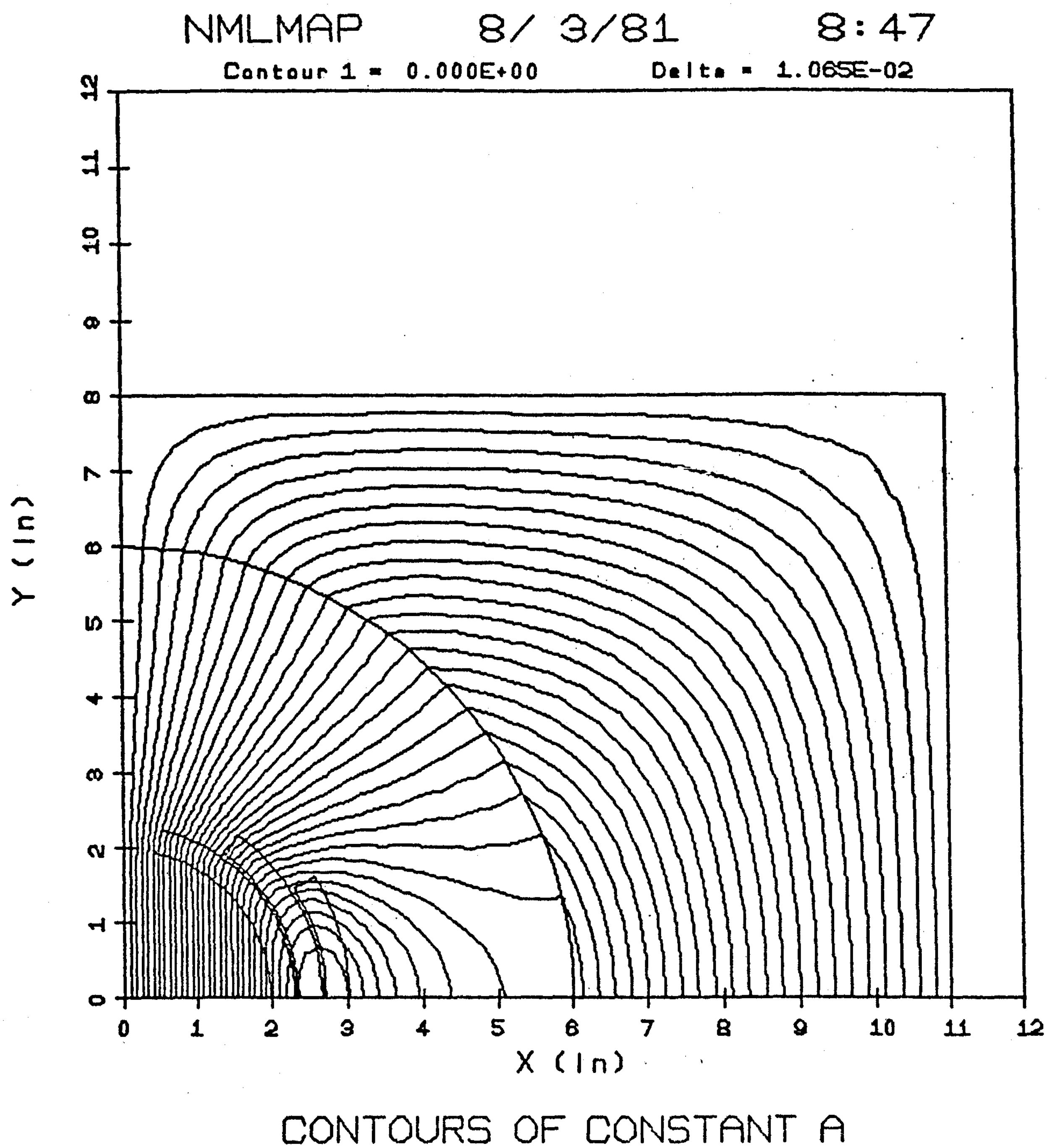


Figure 3.3.21: Iron Core Field Lines for the Three-Layer Dipole Design

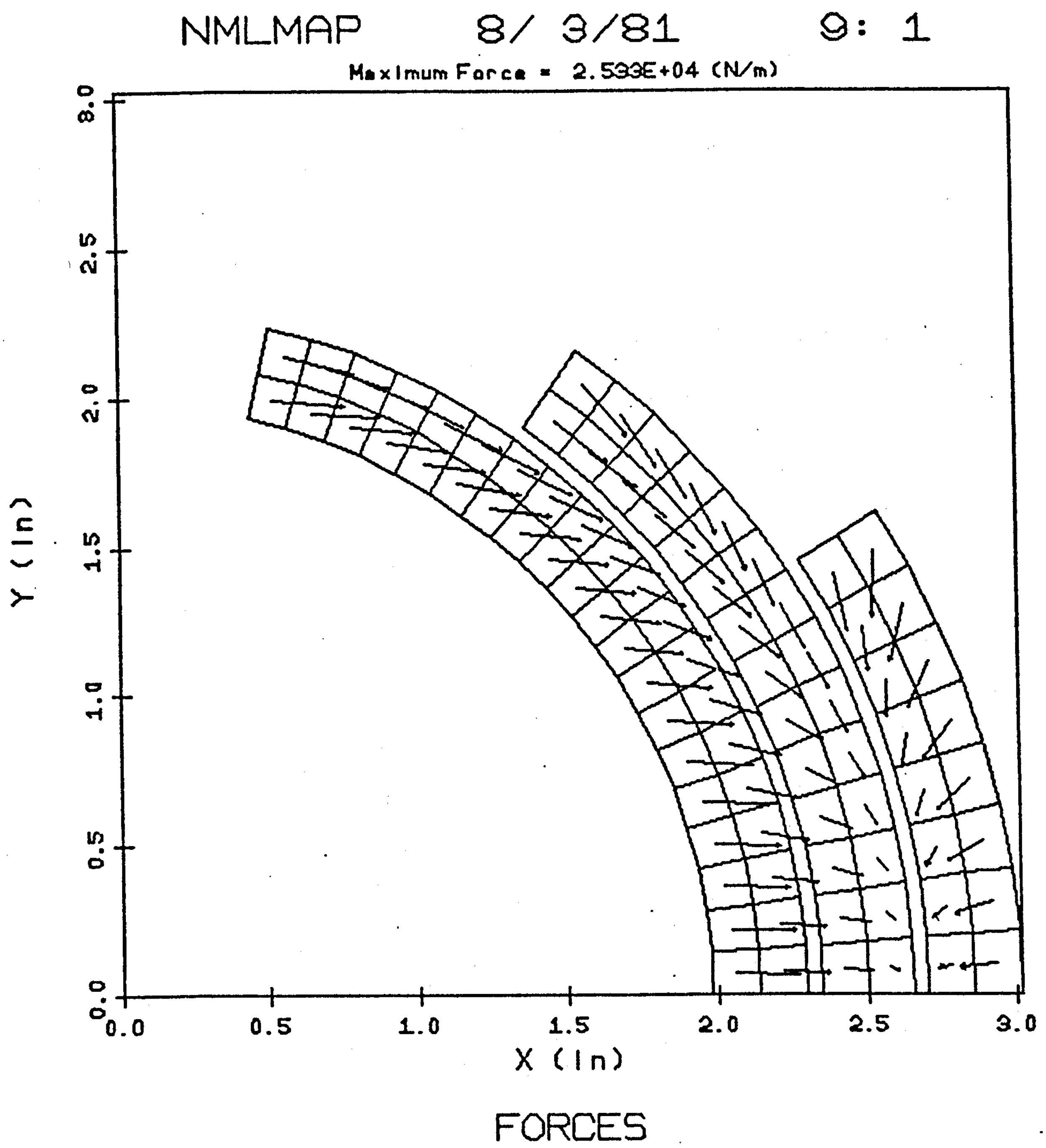


Figure 3.3.22: Lorentz Body-Force Vectors (JxB Body Force Densities over Each Element) Acting on Modeling Elements

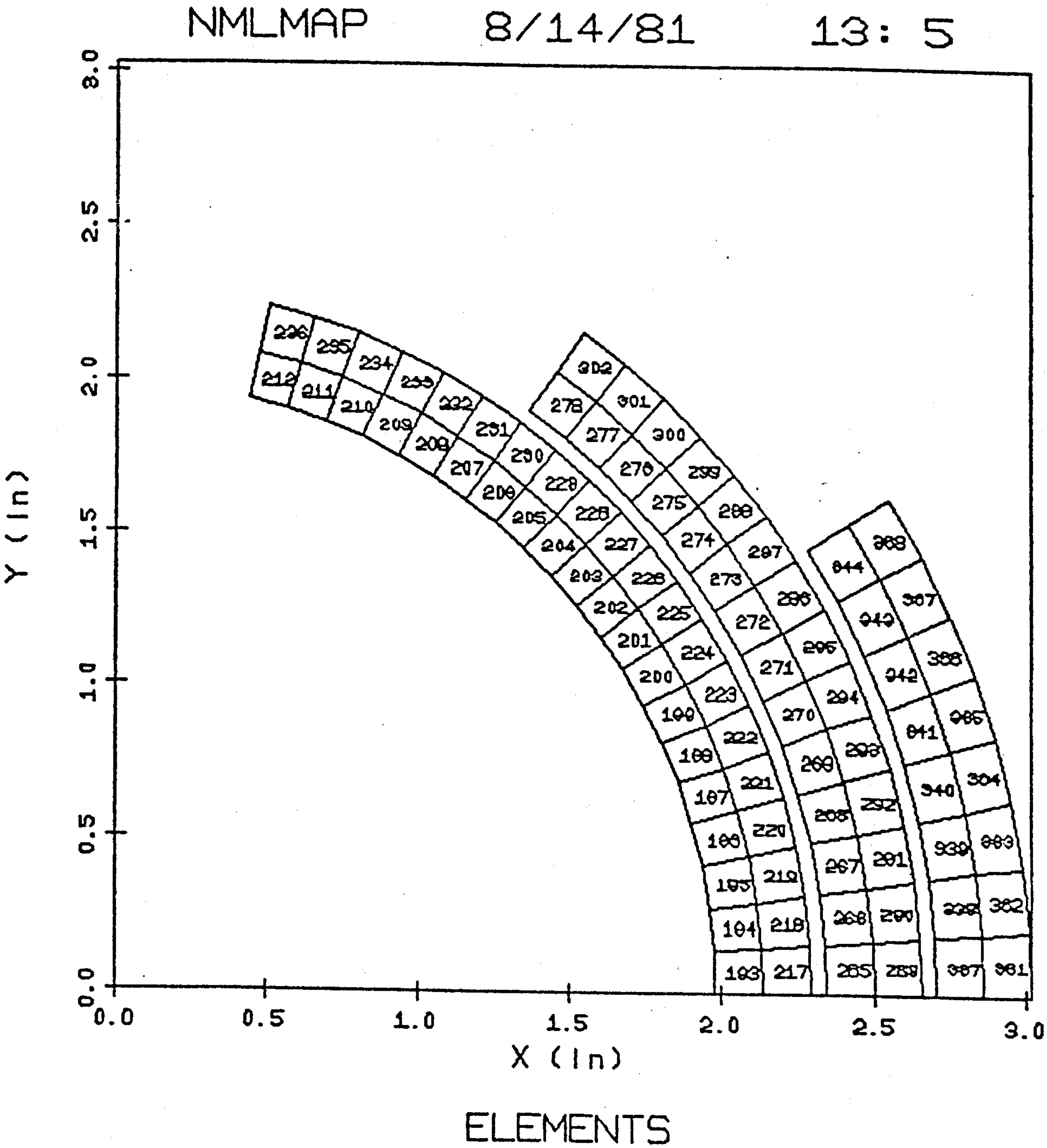
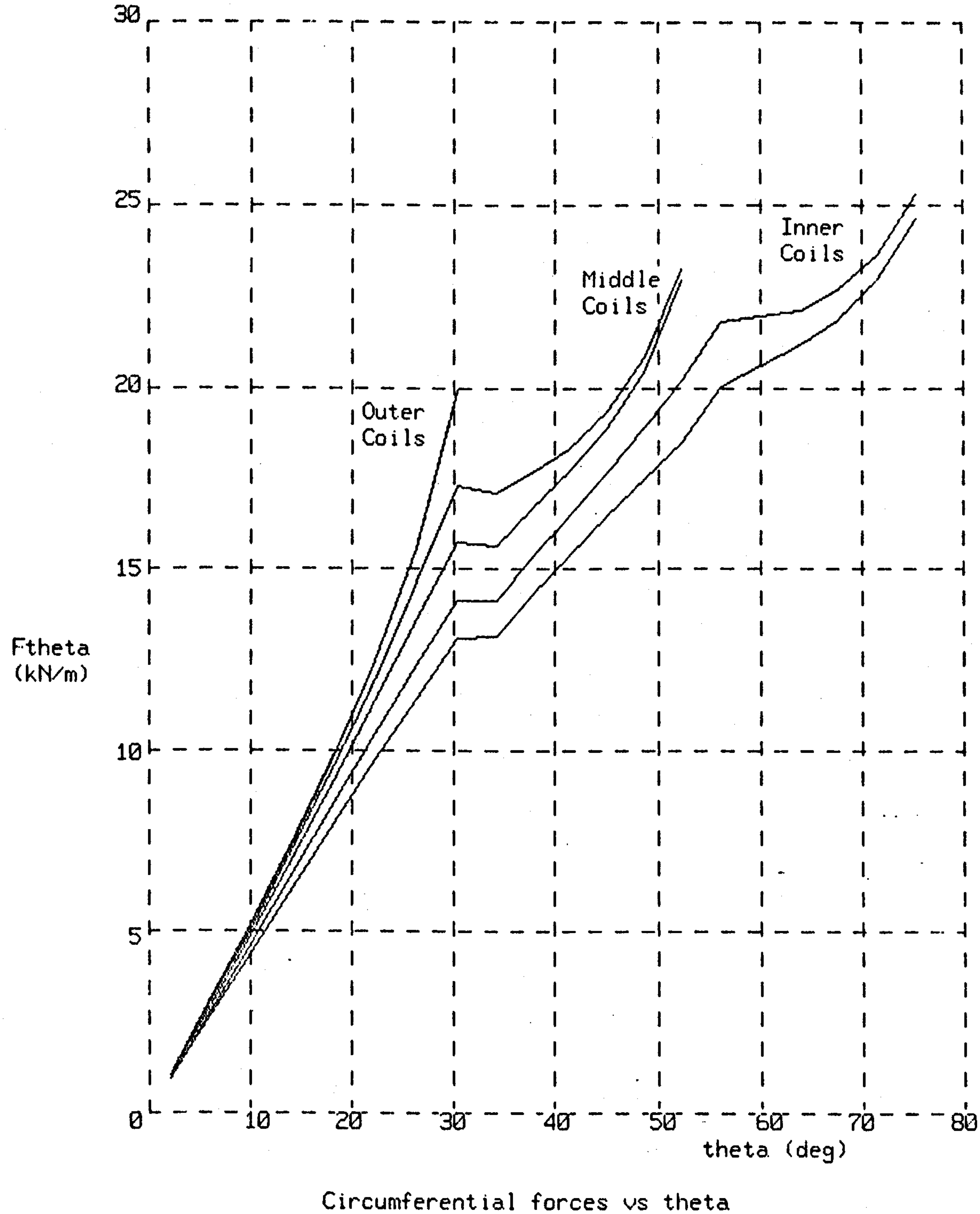


Figure 3.3.23: Finite Elements used in Three-Layer Dipole Analysis. Element Numbers Used in Tables 3.3.7 and 3.3.8.



LBL

Figure 3.3.24: Local Azimuthal Body Force versus Position for each Layer in the Three-Layer Dipole Design

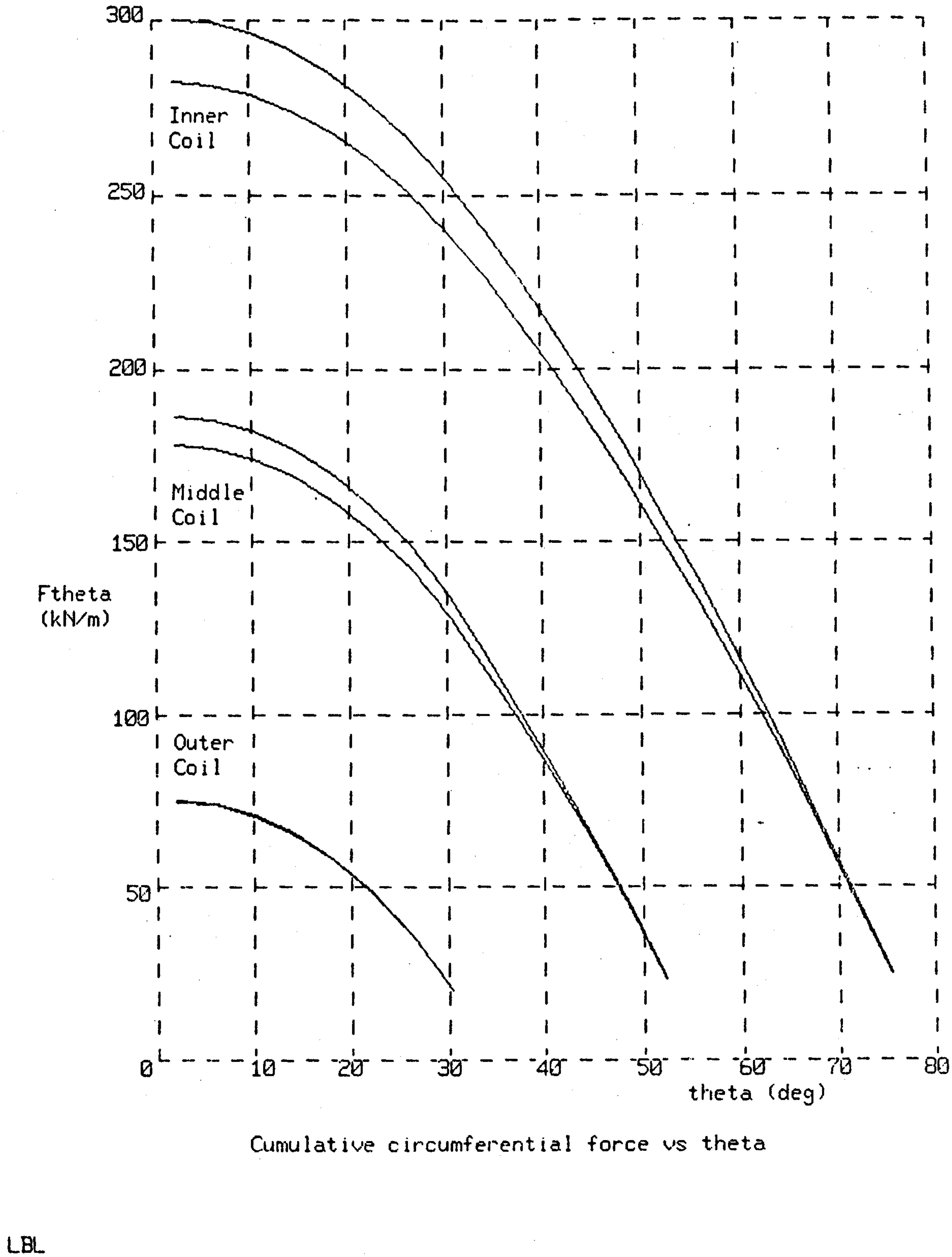


Figure 3.3.25: Cumulative Circumferential Forces in the Iron for the Three-Layer Dipole Design

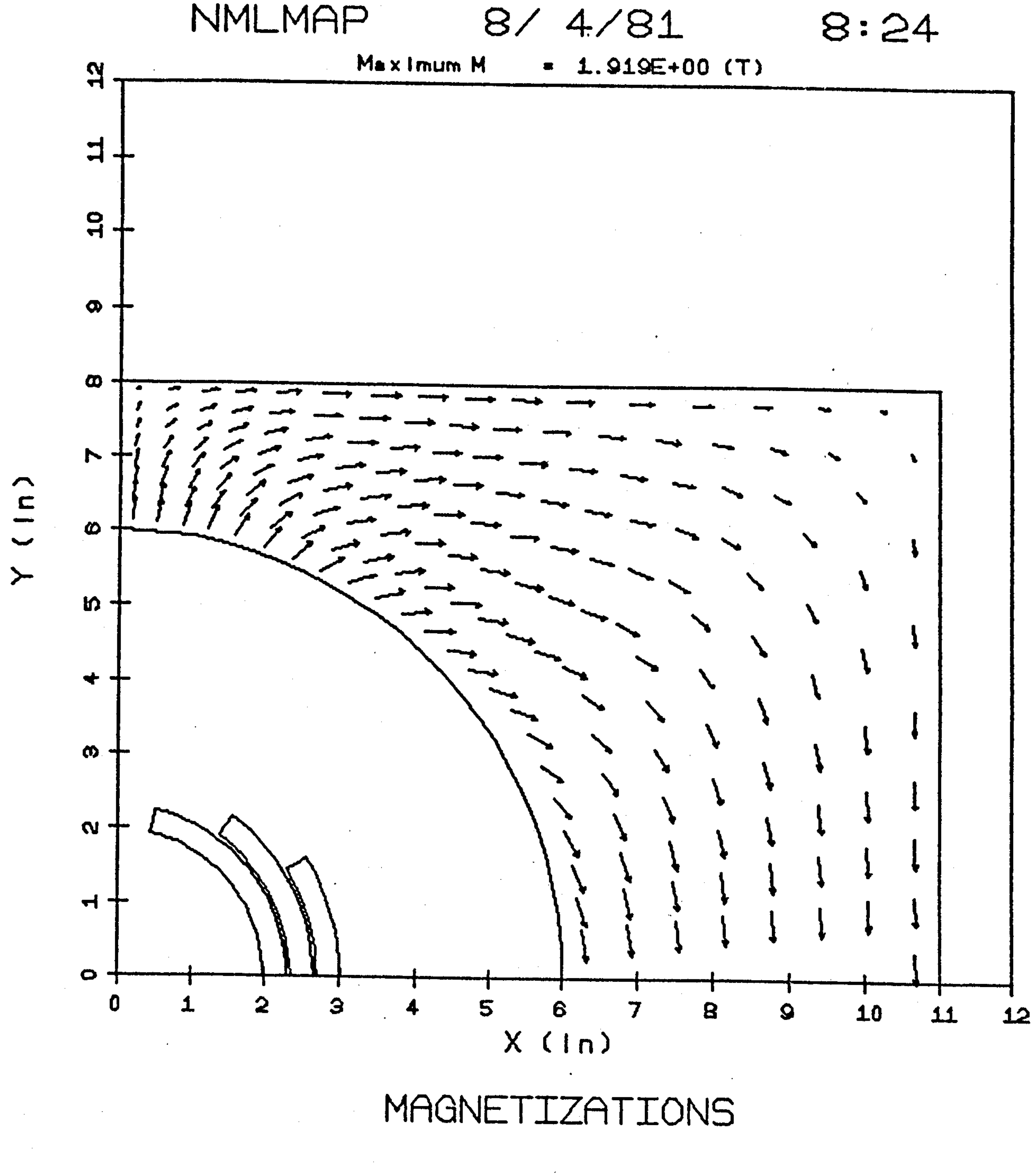


Figure 3.3.26: Magnetization Vectors in the Iron for the Three-Layer Dipole Design

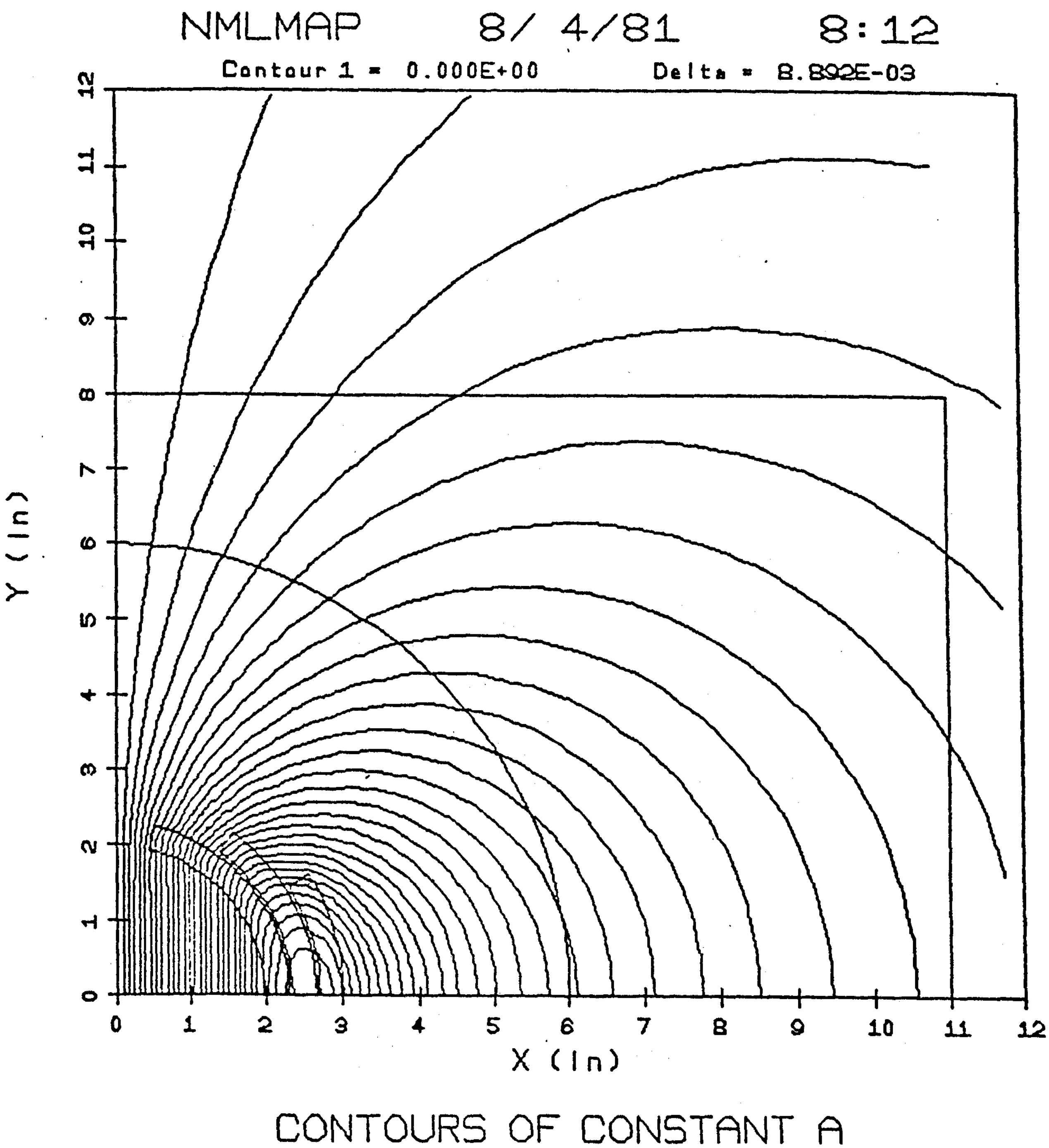


Figure 3.3.27: Air Core Field Lines at Operating Current for the Three-Layer Dipole Design

Table 3.3.7: Lorentz Body Forces per Unit Length for Three-Layer Dipole Magnet (keyed to Figure 3.3.23)

LBL Three Layer Dipole - Warm Iron - B(0,0)=5.5T

Element Forces per Unit Length

Nel	mat	i1	j1	xc(in)	yc(in)	Fx(N/m)	Fy(N/m)	Ft(N/m)
193	2	9	1	2.057E+00	7.273E-02	2.1904E+04	-1.0586E+02	2.1904E+04
194	2	9	2	2.047E+00	2.178E-01	2.1942E+04	-3.2118E+02	2.1945E+04
195	2	9	3	2.027E+00	3.618E-01	2.2017E+04	-5.4711E+02	2.2024E+04
196	2	9	4	1.996E+00	5.040E-01	2.2120E+04	-7.8977E+02	2.2134E+04
197	2	9	5	1.955E+00	6.437E-01	2.2243E+04	-1.0528E+03	2.2267E+04
198	2	9	6	1.905E+00	7.802E-01	2.2369E+04	-1.3345E+03	2.2409E+04
199	2	9	7	1.845E+00	9.128E-01	2.2485E+04	-1.6231E+03	2.2543E+04
200	2	9	8	1.776E+00	1.041E+00	2.2585E+04	-1.8959E+03	2.2664E+04
201	2	9	9	1.703E+00	1.158E+00	2.0468E+04	-1.9155E+03	2.0558E+04
202	2	9	10	1.625E+00	1.264E+00	2.0567E+04	-2.0708E+03	2.0671E+04
203	2	9	11	1.541E+00	1.365E+00	2.0704E+04	-2.2097E+03	2.0822E+04
204	2	9	12	1.451E+00	1.461E+00	2.0879E+04	-2.3642E+03	2.1012E+04
205	2	9	13	1.355E+00	1.550E+00	2.1054E+04	-2.5610E+03	2.1210E+04
206	2	9	14	1.254E+00	1.633E+00	2.1159E+04	-2.7919E+03	2.1342E+04
207	2	9	15	1.144E+00	1.711E+00	2.2083E+04	-3.0639E+03	2.2295E+04
208	2	9	16	1.028E+00	1.784E+00	2.2066E+04	-3.0093E+03	2.2271E+04
209	2	9	17	9.070E-01	1.848E+00	2.2219E+04	-2.7627E+03	2.2391E+04
210	2	9	18	7.820E-01	1.905E+00	2.2645E+04	-2.4332E+03	2.2776E+04
211	2	9	19	6.536E-01	1.952E+00	2.3454E+04	-2.1579E+03	2.3553E+04
212	2	9	20	5.222E-01	1.992E+00	2.4923E+04	-2.1791E+03	2.5018E+04
217	2	10	1	2.213E+00	7.824E-02	1.6037E+04	-3.6328E+02	1.6041E+04
218	2	10	2	2.202E+00	2.343E-01	1.6127E+04	-1.0941E+03	1.6164E+04
219	2	10	3	2.180E+00	3.892E-01	1.6304E+04	-1.8376E+03	1.6407E+04
220	2	10	4	2.147E+00	5.422E-01	1.6558E+04	-2.6029E+03	1.6761E+04
221	2	10	5	2.104E+00	6.925E-01	1.6875E+04	-3.3979E+03	1.7214E+04
222	2	10	6	2.049E+00	8.393E-01	1.7228E+04	-4.2248E+03	1.7739E+04
223	2	10	7	1.985E+00	9.819E-01	1.7581E+04	-5.0681E+03	1.8297E+04
224	2	10	8	1.911E+00	1.120E+00	1.7906E+04	-5.8782E+03	1.8847E+04
225	2	10	9	1.831E+00	1.246E+00	1.6433E+04	-5.9200E+03	1.7467E+04
226	2	10	10	1.748E+00	1.360E+00	1.6745E+04	-6.3940E+03	1.7925E+04
227	2	10	11	1.658E+00	1.468E+00	1.7172E+04	-6.8023E+03	1.8470E+04
228	2	10	12	1.561E+00	1.571E+00	1.7733E+04	-7.2247E+03	1.9148E+04
229	2	10	13	1.458E+00	1.668E+00	1.8384E+04	-7.7710E+03	1.9959E+04
230	2	10	14	1.348E+00	1.757E+00	1.8918E+04	-8.5398E+03	2.0757E+04
231	2	10	15	1.231E+00	1.841E+00	1.9791E+04	-9.6324E+03	2.2011E+04
232	2	10	16	1.106E+00	1.919E+00	1.9757E+04	-9.6619E+03	2.1993E+04
233	2	10	17	9.757E-01	1.988E+00	2.0126E+04	-9.2700E+03	2.2158E+04
234	2	10	18	8.413E-01	2.049E+00	2.0934E+04	-8.6763E+03	2.2661E+04
235	2	10	19	7.031E-01	2.100E+00	2.2249E+04	-7.8969E+03	2.3609E+04
236	2	10	20	5.617E-01	2.142E+00	2.4404E+04	-6.7873E+03	2.5331E+04
265	2	12	1	2.419E+00	8.551E-02	1.0055E+04	-6.2744E+02	1.0074E+04
266	2	12	2	2.407E+00	2.561E-01	1.0209E+04	-1.8873E+03	1.0382E+04
267	2	12	3	2.383E+00	4.254E-01	1.0516E+04	-3.1632E+03	1.0981E+04
268	2	12	4	2.347E+00	5.926E-01	1.0968E+04	-4.4703E+03	1.1844E+04
269	2	12	5	2.299E+00	7.568E-01	1.1549E+04	-5.8300E+03	1.2938E+04
270	2	12	6	2.240E+00	9.173E-01	1.2222E+04	-7.2704E+03	1.4221E+04
271	2	12	7	2.170E+00	1.073E+00	1.2901E+04	-8.8045E+03	1.5619E+04
272	2	12	8	2.088E+00	1.224E+00	1.3431E+04	-1.0365E+04	1.6966E+04
273	2	12	9	2.002E+00	1.361E+00	1.2430E+04	-1.0480E+04	1.6259E+04
274	2	12	10	1.911E+00	1.486E+00	1.2807E+04	-1.1195E+04	1.7010E+04
275	2	12	11	1.812E+00	1.605E+00	1.3498E+04	-1.1699E+04	1.7863E+04
276	2	12	12	1.706E+00	1.717E+00	1.4560E+04	-1.2171E+04	1.8977E+04
277	2	12	13	1.593E+00	1.823E+00	1.6047E+04	-1.2807E+04	2.0531E+04
278	2	12	14	1.474E+00	1.920E+00	1.8146E+04	-1.4036E+04	2.2941E+04
289	2	13	1	2.575E+00	9.102E-02	2.7703E+03	-9.1289E+02	2.9168E+03

Table 3.3.7 (continued)

LBL Three Layer Dipole - Warm Iron - B(0,0)=5.5T

Element Forces per Unit Length

Nel	mat	i1	j1	xc(in)	yc(in)	Fx(N/m)	Fy(N/m)	Ft(N/m)
290	2	13	2	2.562E+00	2.726E-01	2.9898E+03	-2.7427E+03	4.0573E+03
291	2	13	3	2.536E+00	4.528E-01	3.4293E+03	-4.5866E+03	5.7268E+03
292	2	13	4	2.498E+00	6.308E-01	4.0884E+03	-6.4613E+03	7.6461E+03
293	2	13	5	2.447E+00	8.056E-01	4.9613E+03	-8.3985E+03	9.7544E+03
294	2	13	6	2.384E+00	9.764E-01	6.0233E+03	-1.0457E+04	1.2068E+04
295	2	13	7	2.309E+00	1.142E+00	7.1751E+03	-1.2746E+04	1.4627E+04
296	2	13	8	2.223E+00	1.302E+00	8.0505E+03	-1.5340E+04	1.7324E+04
297	2	13	9	2.131E+00	1.449E+00	7.3128E+03	-1.5716E+04	1.7334E+04
298	2	13	10	2.034E+00	1.582E+00	7.5816E+03	-1.6516E+04	1.8173E+04
299	2	13	11	1.929E+00	1.708E+00	8.5150E+03	-1.6985E+04	1.9000E+04
300	2	13	12	1.816E+00	1.828E+00	1.0028E+04	-1.7386E+04	2.0071E+04
301	2	13	13	1.696E+00	1.940E+00	1.2179E+04	-1.7763E+04	2.1537E+04
302	2	13	14	1.569E+00	2.044E+00	1.5433E+04	-1.8115E+04	2.3798E+04
337	2	15	1	2.781E+00	9.829E-02	-4.7068E+03	-1.1977E+03	4.8568E+03
338	2	15	2	2.767E+00	2.944E-01	-4.4127E+03	-3.5941E+03	5.6911E+03
339	2	15	3	2.739E+00	4.890E-01	-3.8192E+03	-5.9957E+03	7.1088E+03
340	2	15	4	2.698E+00	6.812E-01	-2.9142E+03	-8.4144E+03	8.9048E+03
341	2	15	5	2.643E+00	8.700E-01	-1.6762E+03	-1.0880E+04	1.1009E+04
342	2	15	6	2.575E+00	1.054E+00	-6.4021E+01	-1.3471E+04	1.3471E+04
343	2	15	7	2.494E+00	1.234E+00	1.9776E+03	-1.6398E+04	1.6517E+04
344	2	15	8	2.401E+00	1.407E+00	4.5591E+03	-2.0383E+04	2.0887E+04
361	2	16	1	2.936E+00	1.038E-01	-1.3468E+04	-1.5115E+03	1.3553E+04
362	2	16	2	2.922E+00	3.109E-01	-1.3106E+04	-4.5310E+03	1.3867E+04
363	2	16	3	2.892E+00	5.164E-01	-1.2373E+04	-7.5417E+03	1.4490E+04
364	2	16	4	2.849E+00	7.193E-01	-1.1249E+04	-1.0543E+04	1.5418E+04
365	2	16	5	2.791E+00	9.187E-01	-9.6934E+03	-1.3546E+04	1.6657E+04
366	2	16	6	2.719E+00	1.113E+00	-7.6184E+03	-1.6589E+04	1.8255E+04
367	2	16	7	2.634E+00	1.303E+00	-4.7921E+03	-1.9760E+04	2.0332E+04
368	2	16	8	2.535E+00	1.485E+00	-5.1847E+02	-2.3442E+04	2.3448E+04

Figure 3.3.28 shows the air core Lorentz body force vectors acting on the windings. Table 3.3.8 lists the values of these forces. The table is keyed to the element numbers given in Figure 3.3.23.

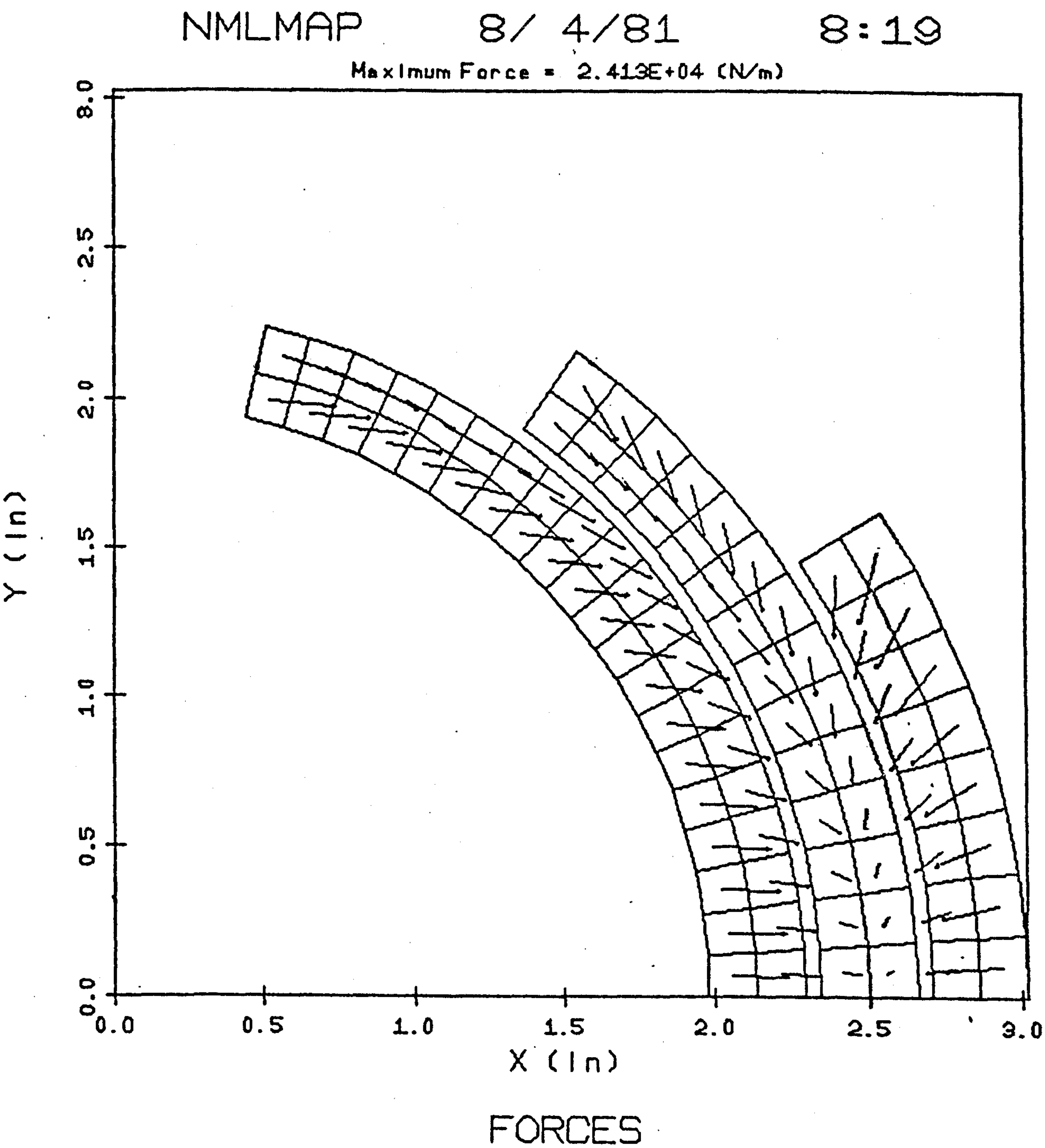


Figure 3.3.28: Air Core Lorentz Body Force Vectors Acting on the Windings

Table 3.3.8 Air-Core Lorentz Body Force Values for the Three-Layer Dipole Design (keyed to Figure 3.3.23)

LBL Three Layer Dipole - Aircore

Element Forces per Unit Length

iel	mat	i1	j1	xc(in)	yc(in)	Fx(N/m)	Fy(N/m)	Ft(N/m)
193	2	9	1	2.057E+00	7.273E-02	1.8147E+04	-1.0475E+02	1.8147E+04
194	2	9	2	2.047E+00	2.178E-01	1.8186E+04	-3.1787E+02	1.8189E+04
195	2	9	3	2.027E+00	3.618E-01	1.8261E+04	-5.4161E+02	1.8269E+04
196	2	9	4	1.996E+00	5.040E-01	1.8366E+04	-7.8219E+02	1.8382E+04
197	2	9	5	1.955E+00	6.437E-01	1.8489E+04	-1.0433E+03	1.8518E+04
198	2	9	6	1.905E+00	7.802E-01	1.8617E+04	-1.3232E+03	1.8664E+04
199	2	9	7	1.845E+00	9.128E-01	1.8734E+04	-1.6103E+03	1.8803E+04
200	2	9	8	1.776E+00	1.041E+00	1.8836E+04	-1.8818E+03	1.8930E+04
201	2	9	9	1.703E+00	1.158E+00	1.7086E+04	-1.9019E+03	1.7191E+04
202	2	9	10	1.625E+00	1.264E+00	1.7186E+04	-2.0566E+03	1.7309E+04
203	2	9	11	1.541E+00	1.365E+00	1.7325E+04	-2.1951E+03	1.7464E+04
204	2	9	12	1.451E+00	1.461E+00	1.7502E+04	-2.3494E+03	1.7659E+04
205	2	9	13	1.355E+00	1.550E+00	1.7679E+04	-2.5463E+03	1.7862E+04
206	2	9	14	1.254E+00	1.633E+00	1.7785E+04	-2.7776E+03	1.8001E+04
207	2	9	15	1.144E+00	1.711E+00	1.8564E+04	-3.0495E+03	1.8813E+04
208	2	9	16	1.028E+00	1.784E+00	1.8549E+04	-2.9958E+03	1.8789E+04
209	2	9	17	9.070E-01	1.848E+00	1.8704E+04	-2.7504E+03	1.8905E+04
210	2	9	18	7.820E-01	1.905E+00	1.9131E+04	-2.4223E+03	1.9284E+04
211	2	9	19	6.536E-01	1.952E+00	1.9941E+04	-2.1485E+03	2.0057E+04
212	2	9	20	5.222E-01	1.992E+00	2.1411E+04	-2.1714E+03	2.1521E+04
217	2	10	1	2.213E+00	7.824E-02	1.1994E+04	-3.6190E+02	1.1999E+04
218	2	10	2	2.202E+00	2.343E-01	1.2084E+04	-1.0899E+03	1.2133E+04
219	2	10	3	2.180E+00	3.892E-01	1.2261E+04	-1.8308E+03	1.2397E+04
220	2	10	4	2.147E+00	5.422E-01	1.2517E+04	-2.5935E+03	1.2782E+04
221	2	10	5	2.104E+00	6.925E-01	1.2835E+04	-3.3861E+03	1.3274E+04
222	2	10	6	2.049E+00	8.393E-01	1.3190E+04	-4.2109E+03	1.3846E+04
223	2	10	7	1.985E+00	9.819E-01	1.3545E+04	-5.0522E+03	1.4457E+04
224	2	10	8	1.911E+00	1.120E+00	1.3872E+04	-5.8607E+03	1.5060E+04
225	2	10	9	1.831E+00	1.246E+00	1.2793E+04	-5.9031E+03	1.4089E+04
226	2	10	10	1.748E+00	1.360E+00	1.3108E+04	-6.3763E+03	1.4576E+04
227	2	10	11	1.658E+00	1.468E+00	1.3536E+04	-6.7842E+03	1.5141E+04
228	2	10	12	1.561E+00	1.571E+00	1.4100E+04	-7.2063E+03	1.5835E+04
229	2	10	13	1.458E+00	1.668E+00	1.4753E+04	-7.7526E+03	1.6666E+04
230	2	10	14	1.348E+00	1.757E+00	1.5290E+04	-8.5219E+03	1.7505E+04
231	2	10	15	1.231E+00	1.841E+00	1.6006E+04	-9.6145E+03	1.8672E+04
232	2	10	16	1.106E+00	1.919E+00	1.5975E+04	-9.6451E+03	1.8661E+04
233	2	10	17	9.757E-01	1.988E+00	1.6345E+04	-9.2547E+03	1.8784E+04
234	2	10	18	8.413E-01	2.049E+00	1.7156E+04	-8.6627E+03	1.9219E+04
235	2	10	19	7.031E-01	2.100E+00	1.8473E+04	-7.8852E+03	2.0085E+04
236	2	10	20	5.617E-01	2.142E+00	2.0629E+04	-6.7777E+03	2.1714E+04
265	2	12	1	2.419E+00	8.551E-02	5.6310E+03	-6.2563E+02	5.6657E+03
266	2	12	2	2.407E+00	2.561E-01	5.7859E+03	-1.8819E+03	6.0842E+03
267	2	12	3	2.383E+00	4.254E-01	6.0933E+03	-3.1544E+03	6.8614E+03
268	2	12	4	2.347E+00	5.926E-01	6.5468E+03	-4.4582E+03	7.9206E+03
269	2	12	5	2.299E+00	7.568E-01	7.1304E+03	-5.8148E+03	9.2008E+03
270	2	12	6	2.240E+00	9.173E-01	7.8055E+03	-7.2523E+03	1.0655E+04
271	2	12	7	2.170E+00	1.073E+00	8.4870E+03	-8.7838E+03	1.2214E+04
272	2	12	8	2.088E+00	1.224E+00	9.0202E+03	-1.0343E+04	1.3723E+04
273	2	12	9	2.002E+00	1.361E+00	8.4508E+03	-1.0458E+04	1.3445E+04
274	2	12	10	1.911E+00	1.486E+00	8.8302E+03	-1.1172E+04	1.4240E+04
275	2	12	11	1.812E+00	1.605E+00	9.5246E+03	-1.1675E+04	1.5067E+04
276	2	12	12	1.706E+00	1.717E+00	1.0590E+04	-1.2146E+04	1.6115E+04
277	2	12	13	1.593E+00	1.823E+00	1.2080E+04	-1.2783E+04	1.7587E+04
278	2	12	14	1.474E+00	1.920E+00	1.4182E+04	-1.4012E+04	1.9937E+04
289	2	13	1	2.575E+00	9.102E-02	-1.9417E+03	-9.1073E+02	2.1447E+03

Table 3.3.8 (continued)

LBL Three Layer Dipole - Aircore
Element Forces per Unit Length

Nel	mat	i1	j1	xc(in)	yc(in)	Fx(N/m)	Fy(N/m)	Ft(N/m)
290	2	13	2	2.562E+00	2.726E-01	-1.7216E+03	-2.7363E+03	3.2329E+03
291	2	13	3	2.536E+00	4.528E-01	-1.2810E+03	-4.5760E+03	4.7520E+03
292	2	13	4	2.498E+00	6.308E-01	-6.2040E+02	-6.4468E+03	6.4766E+03
293	2	13	5	2.447E+00	8.056E-01	2.5471E+02	-8.3802E+03	8.3841E+03
294	2	13	6	2.384E+00	9.764E-01	1.3193E+03	-1.0435E+04	1.0518E+04
295	2	13	7	2.309E+00	1.142E+00	2.4743E+03	-1.2721E+04	1.2960E+04
296	2	13	8	2.223E+00	1.302E+00	3.3534E+03	-1.5312E+04	1.5675E+04
297	2	13	9	2.131E+00	1.449E+00	3.0756E+03	-1.5689E+04	1.5988E+04
298	2	13	10	2.034E+00	1.582E+00	3.3478E+03	-1.6489E+04	1.6825E+04
299	2	13	11	1.929E+00	1.708E+00	4.2848E+03	-1.6956E+04	1.7489E+04
300	2	13	12	1.816E+00	1.828E+00	5.8013E+03	-1.7357E+04	1.8301E+04
301	2	13	13	1.696E+00	1.940E+00	7.9564E+03	-1.7734E+04	1.9437E+04
302	2	13	14	1.569E+00	2.044E+00	1.1214E+04	-1.8087E+04	2.1281E+04
337	2	15	1	2.781E+00	9.829E-02	-9.8006E+03	-1.1950E+03	9.8732E+03
338	2	15	2	2.767E+00	2.944E-01	-9.5058E+03	-3.5862E+03	1.0160E+04
339	2	15	3	2.739E+00	4.890E-01	-8.9110E+03	-5.9826E+03	1.0733E+04
340	2	15	4	2.698E+00	6.812E-01	-8.0040E+03	-8.3963E+03	1.1600E+04
341	2	15	5	2.643E+00	8.700E-01	-6.7633E+03	-1.0858E+04	1.2792E+04
342	2	15	6	2.575E+00	1.054E+00	-5.1479E+03	-1.3443E+04	1.4395E+04
343	2	15	7	2.494E+00	1.234E+00	-3.1024E+03	-1.6367E+04	1.6658E+04
344	2	15	8	2.401E+00	1.407E+00	-5.1631E+02	-2.0349E+04	2.0355E+04
361	2	16	1	2.936E+00	1.038E-01	-1.8852E+04	-1.5083E+03	1.8912E+04
362	2	16	2	2.922E+00	3.109E-01	-1.8489E+04	-4.5218E+03	1.9034E+04
363	2	16	3	2.892E+00	5.164E-01	-1.7754E+04	-7.5265E+03	1.9284E+04
364	2	16	4	2.849E+00	7.193E-01	-1.6628E+04	-1.0522E+04	1.9678E+04
365	2	16	5	2.791E+00	9.187E-01	-1.5070E+04	-1.3520E+04	2.0245E+04
366	2	16	6	2.719E+00	1.113E+00	-1.2991E+04	-1.6557E+04	2.1045E+04
367	2	16	7	2.634E+00	1.303E+00	-1.0160E+04	-1.9723E+04	2.2186E+04
368	2	16	8	2.535E+00	1.485E+00	-5.8810E+03	-2.3401E+04	2.4129E+04

3.3.2.5 Window Frame Dipole

The window frame dipole design [5] was modeled as shown in Figure 3.3.29. The grid included 691 elements and 2156 unknowns. The iron core field lines are presented in Figure 3.3.30. The central field was calculated to be 5.0 T for an operating current of 2097 A. The peak field in the main saddle winding was 5.11 T. The peak field was 5.66 T in the smaller racetrack and 5.52 T in the larger one. The iron contribution to the central field is 1.35 T. The central field transfer function is 23.94 G/A. The peak field transfer functions are 24.37 G/A, 26.99 G/A and 26.32 G/A, respectively.

Figure 3.3.31 shows the Lorentz body force vectors acting on the elements used to model the windings. These vectors represent the integrated J X B body force densities over each of the elements. The components of these forces per unit length are given in Table 3.3.9. The table is keyed to the element numbers shown in Figure 3.3.32.

Figure 3.3.33 shows the local y-directed body force versus position for the saddle coil. The three curves represent the inner, middle, and outer layers of elements. Figure 3.3.34 shows the accumulated y-directed body forces versus position. The assumption is made that these loads accumulate and are not reacted by the structure. Although conservative, it does give an upper bound. The equivalent midplane compressive pressure in the saddle is 14.17 MPa (2.05 ksi).

Figure 3.3.35 shows the magnetization vectors in the iron. The peak field in the iron is 2.92 T.

Figure 3.3.36 shows the air core field lines for the design at the operating current. The central and three peak fields are 3.69 T, 3.75 T, 4.42 T and 4.25 T.

Figure 3.3.37 shows the air core Lorentz body force vectors acting

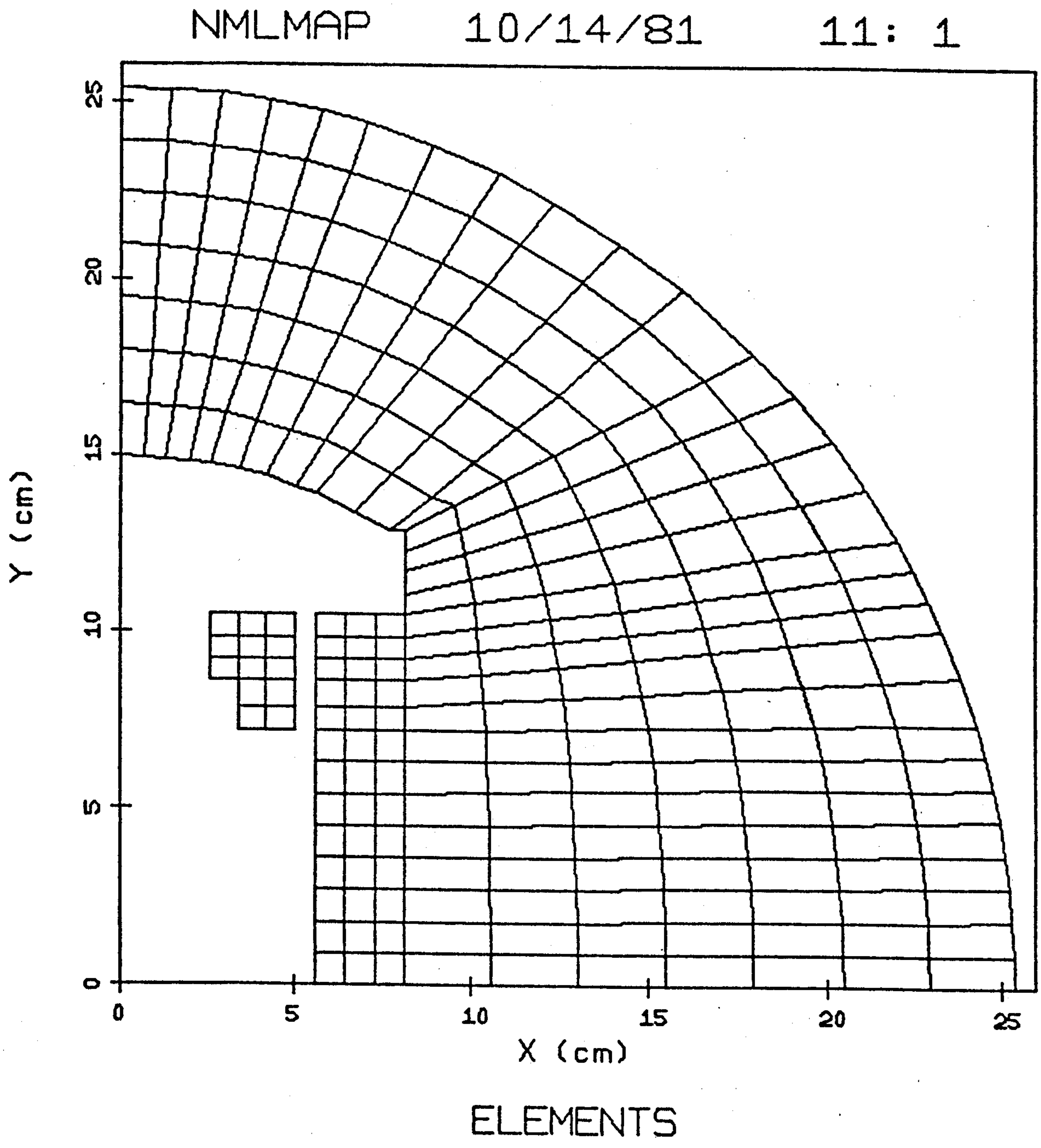


Figure 3.3.29: Model Used for Window Frame Dipole Design Analysis

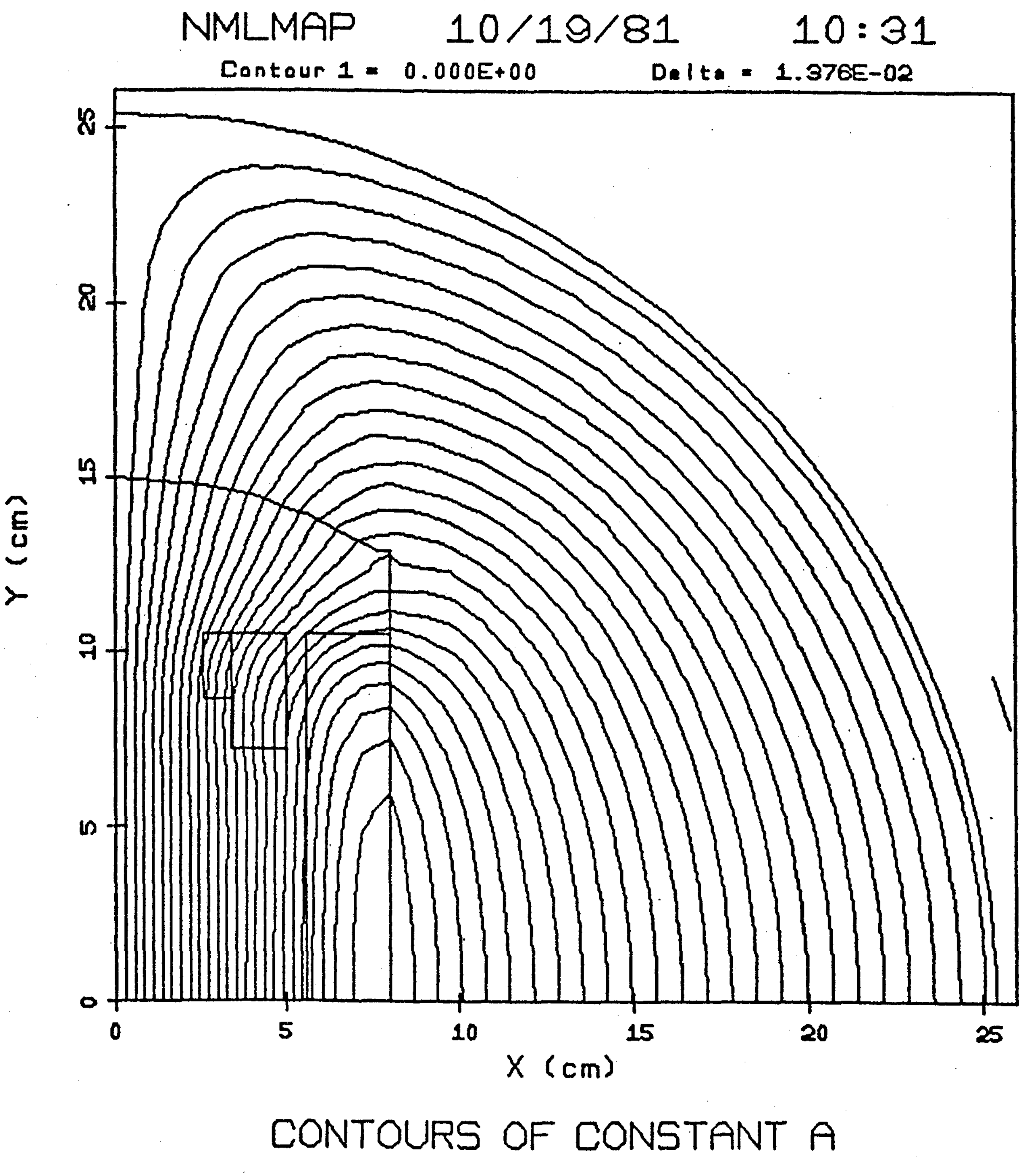


Figure 3.3.30: Iron-Core Field Lines for the Window Frame Dipole Model

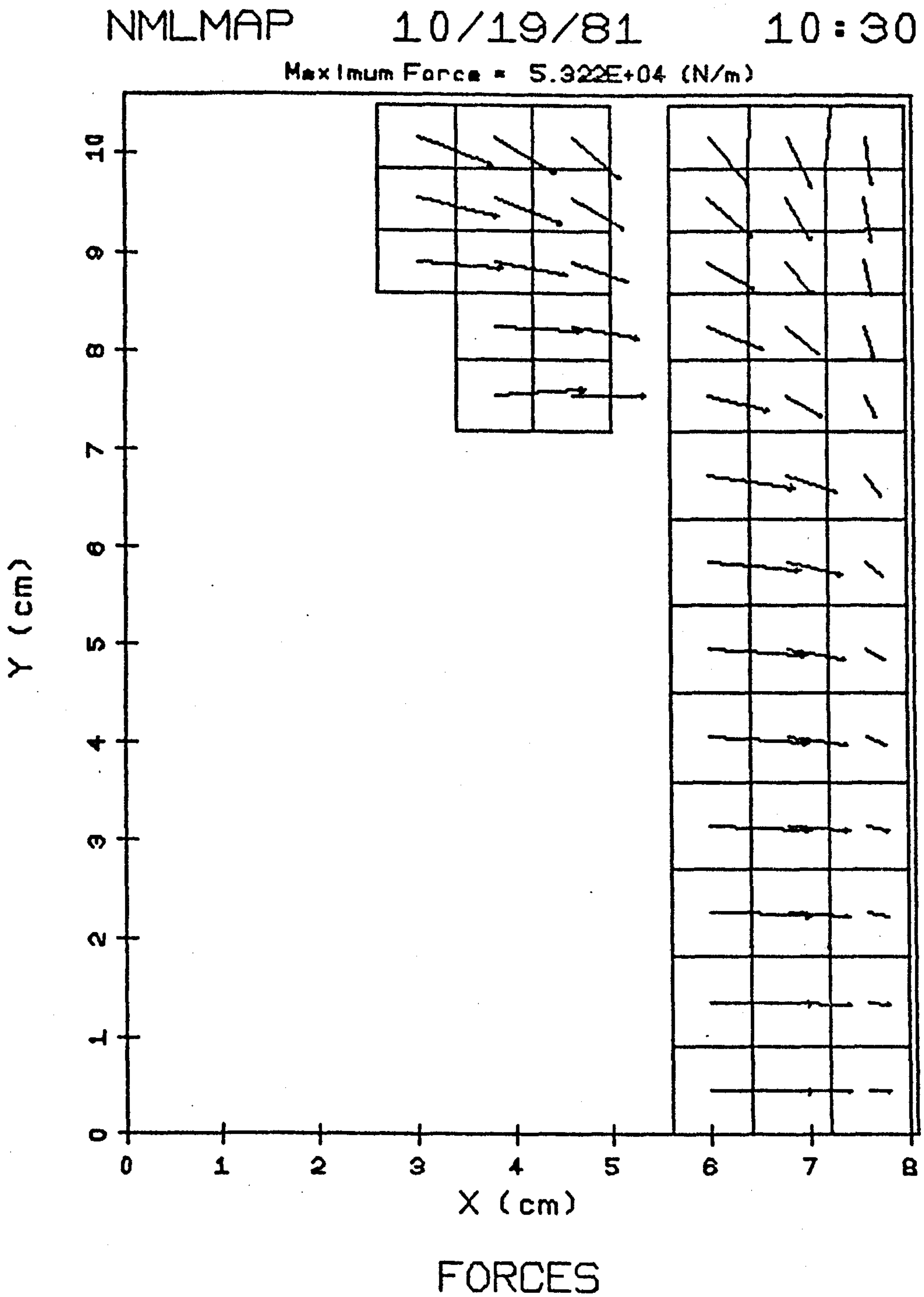


Figure 3.3.31: Lorentz Body Force Vectors (integrated JxB Body Force Densities over each Element) Acting on the Modeling Elements for the Window Frame Dipole Design

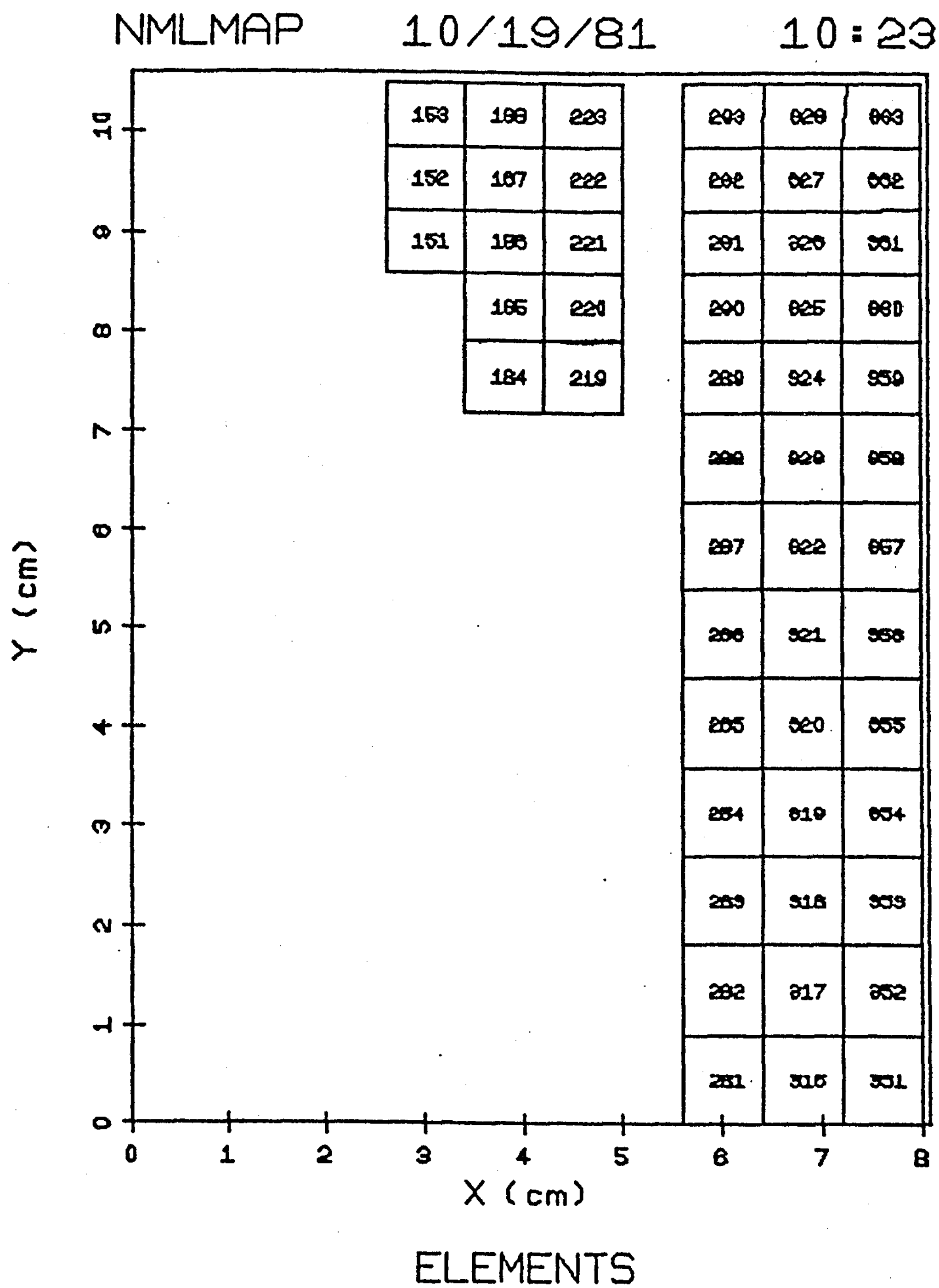


Figure 3.3.32: Finite Element Array Used in Analyzing the Window Frame Dipole Design

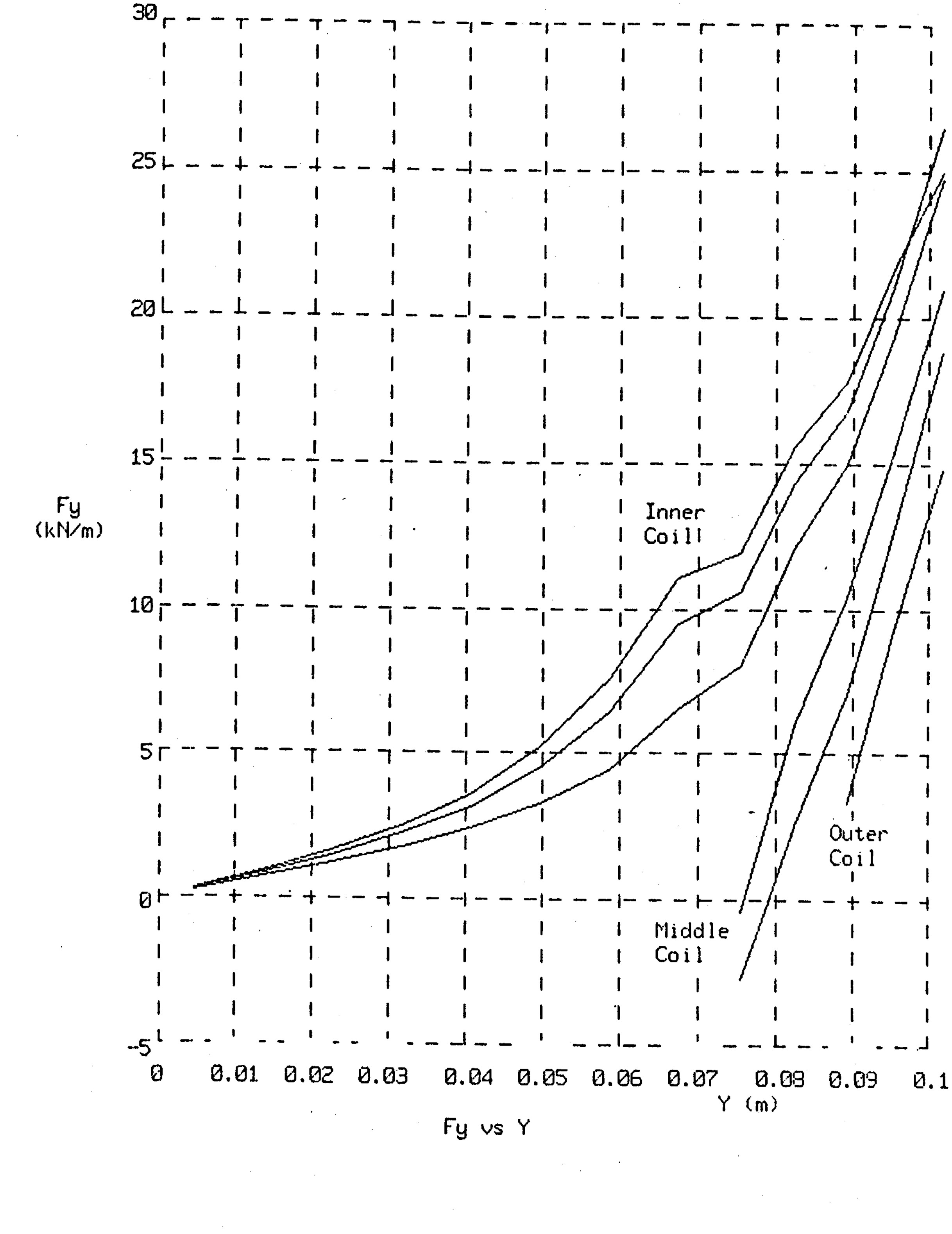


Figure 3.3.33: Local y-Directed Body Force versus Position for the Saddle Coil Section of the Window Frame Dipole Design Showing the Inner, Middle and Outer Element Layers

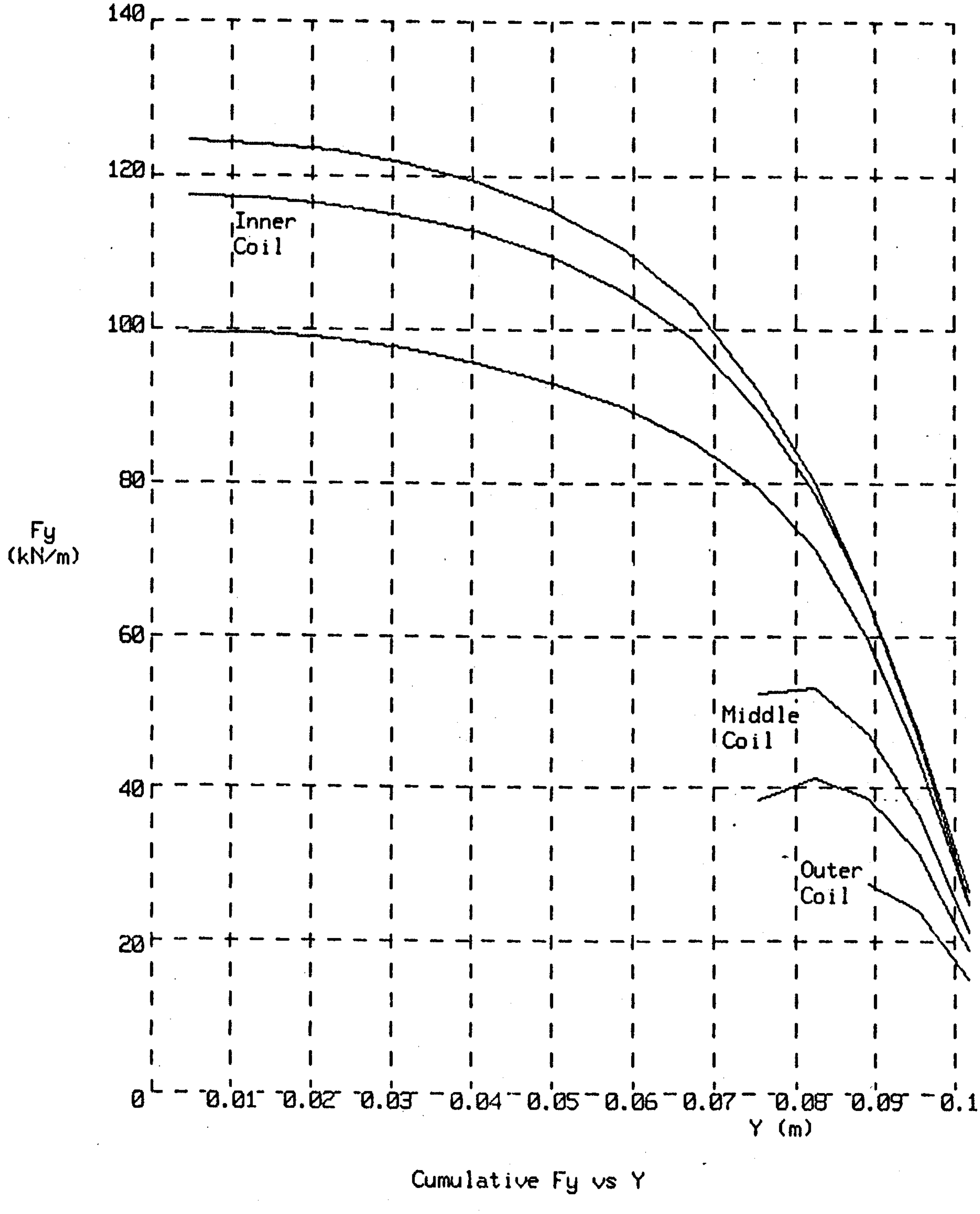


Figure 3.3.34: Accumulated y-Directed Body Force versus Position for the Saddle Coil Section of the Window Frame Dipole Design

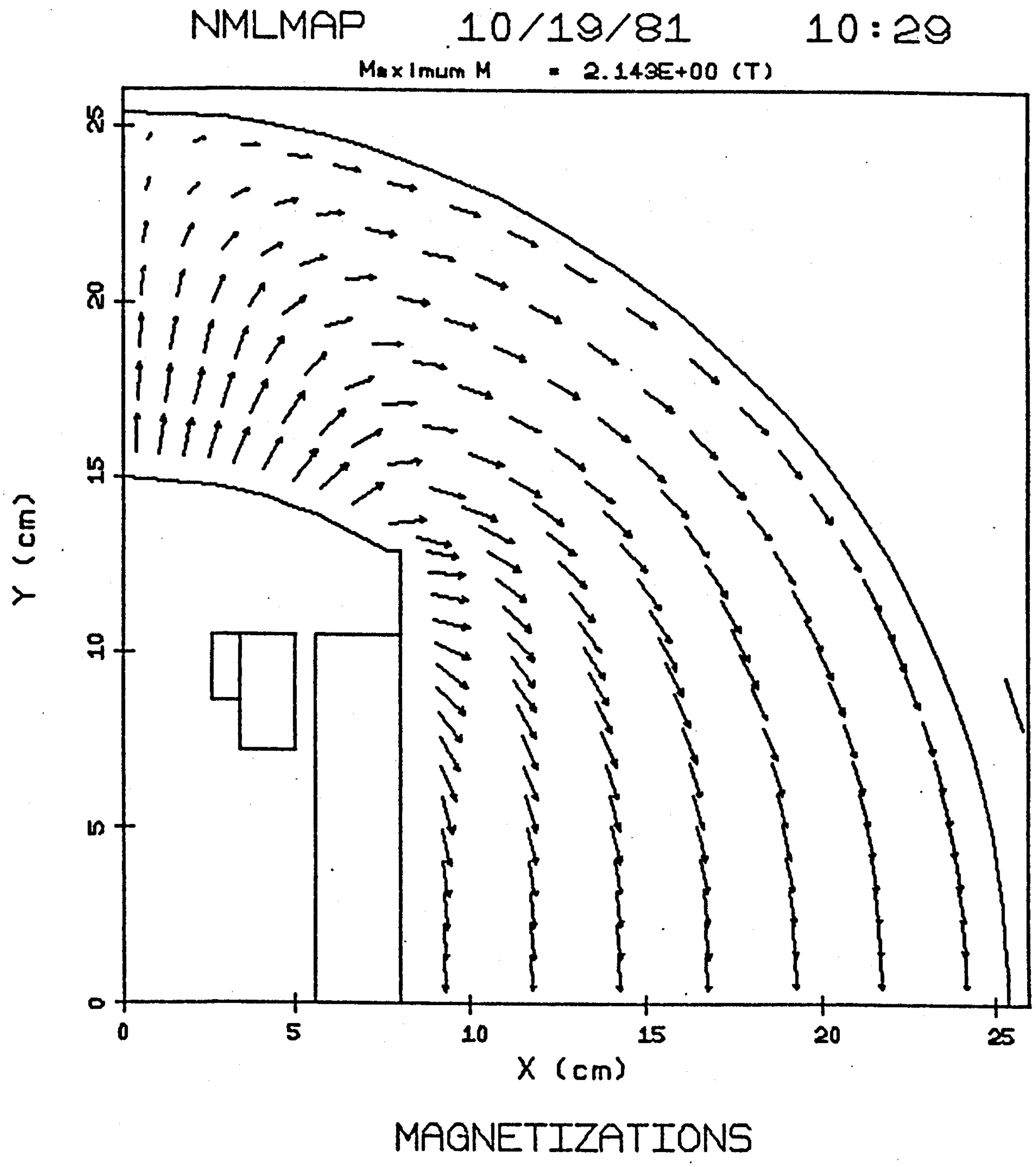


Figure 3.3.35: Magnetization Vectors in the Iron for the Iron Core Window Frame Dipole Design

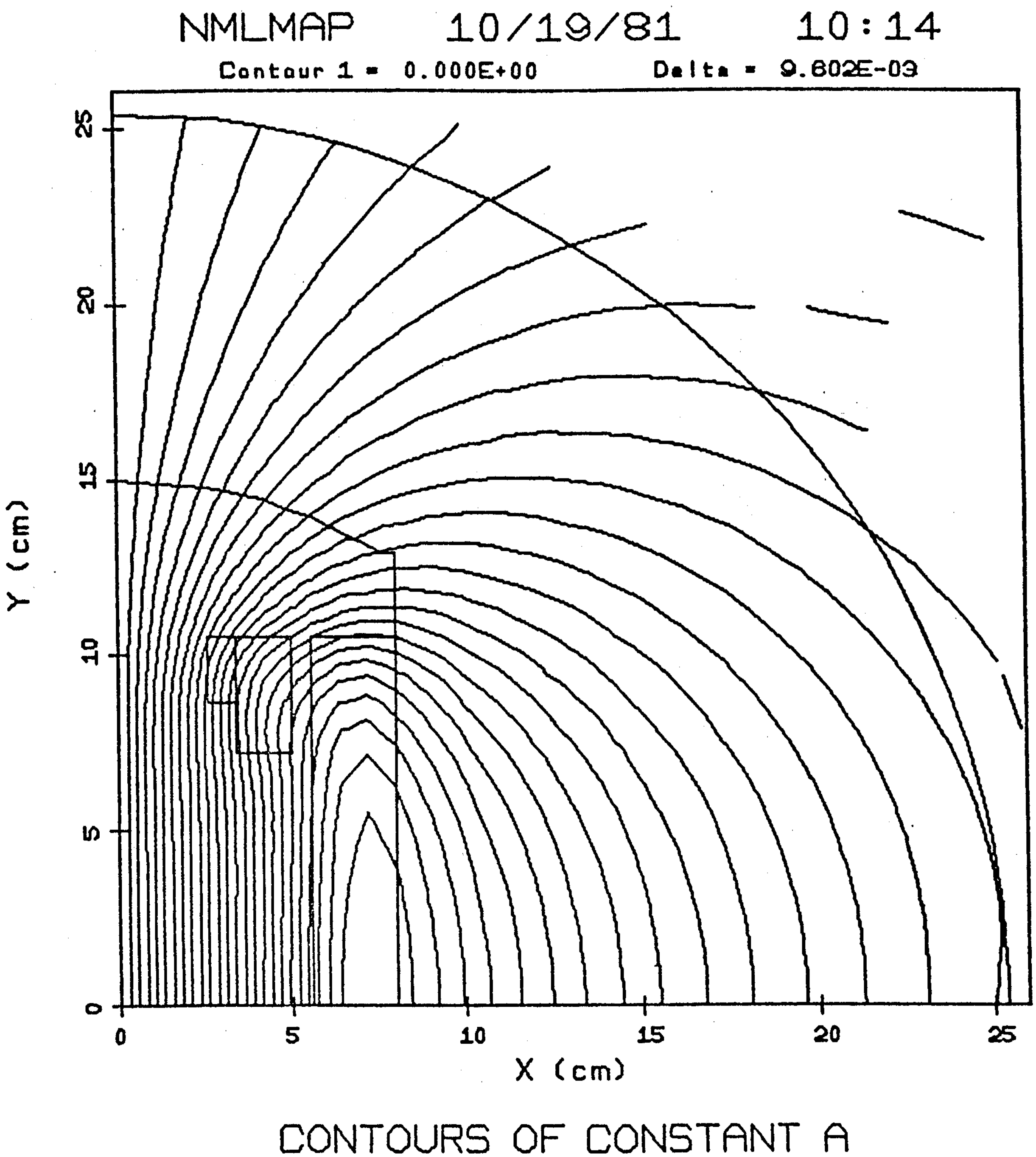


Figure 3.3.36: Air Core Field Lines at Operating Current for the Window Frame Dipole Design

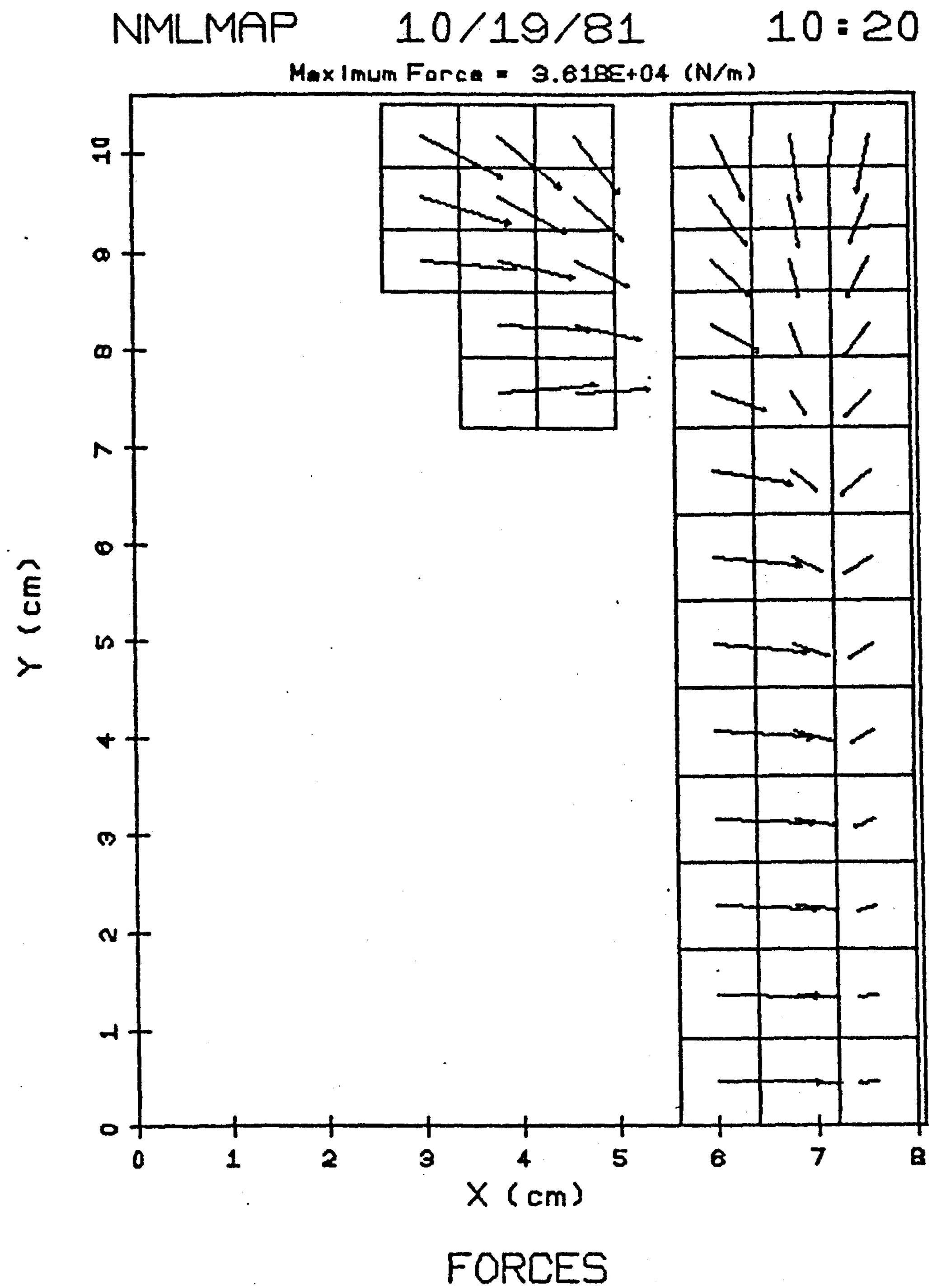


Figure 3.3.37: Lorentz Body Force Vectors Acting on the Windings in the Air Core Window Frame Dipole Design

Table 3.3.9: Components of the Lorentz Body Force Vectors for the Iron Core Window Frame Dipole Design (keyed to Figure 3.3.32)

Window Frame Dipole - Ironcore Forces

Element Forces per Unit Length

Nel	mat	i1	j1	xc(cm)	yc(cm)	Fx(N/m)	Fy(N/m)	Ft(N/m)
151	3	5	11	3.000E+00	8.919E+00	4.6030E+04	-3.3274E+03	4.6150E+04
152	3	5	12	3.000E+00	9.552E+00	4.3894E+04	-9.2739E+03	4.4863E+04
153	3	5	13	3.000E+00	1.018E+01	4.0531E+04	-1.4845E+04	4.3164E+04
184	4	6	9	3.800E+00	7.551E+00	4.8092E+04	2.8031E+03	4.8173E+04
185	4	6	10	3.800E+00	8.252E+00	4.6500E+04	-2.5375E+03	4.6569E+04
186	4	6	11	3.800E+00	8.919E+00	3.8614E+04	-7.0591E+03	3.9254E+04
187	4	6	12	3.800E+00	9.552E+00	3.5854E+04	-1.2684E+04	3.8032E+04
188	4	6	13	3.800E+00	1.018E+01	3.3363E+04	-1.8876E+04	3.8333E+04
219	4	7	9	4.600E+00	7.551E+00	3.9220E+04	4.2590E+02	3.9222E+04
220	4	7	10	4.600E+00	8.252E+00	3.5812E+04	-5.9531E+03	3.6304E+04
221	4	7	11	4.600E+00	8.919E+00	2.9683E+04	-1.0411E+04	3.1456E+04
222	4	7	12	4.600E+00	9.552E+00	2.7528E+04	-1.5475E+04	3.1580E+04
223	4	7	13	4.600E+00	1.018E+01	2.6090E+04	-2.1014E+04	3.3500E+04
281	5	9	1	6.000E+00	4.500E-01	5.3221E+04	-2.2899E+02	5.3222E+04
282	5	9	2	6.000E+00	1.350E+00	5.3117E+04	-6.9747E+02	5.3121E+04
283	5	9	3	6.000E+00	2.250E+00	5.2884E+04	-1.1987E+03	5.2898E+04
284	5	9	4	6.000E+00	3.150E+00	5.2469E+04	-1.7591E+03	5.2499E+04
285	5	9	5	6.000E+00	4.050E+00	5.1764E+04	-2.4157E+03	5.1821E+04
286	5	9	6	6.000E+00	4.950E+00	5.0564E+04	-3.2342E+03	5.0667E+04
287	5	9	7	6.000E+00	5.850E+00	4.8502E+04	-4.3985E+03	4.8701E+04
288	5	9	8	6.000E+00	6.750E+00	4.5005E+04	-6.4944E+03	4.5471E+04
289	5	9	9	6.000E+00	7.551E+00	3.1847E+04	-8.0032E+03	3.2837E+04
290	5	9	10	6.000E+00	8.252E+00	2.9117E+04	-1.2037E+04	3.1507E+04
291	5	9	11	6.000E+00	8.919E+00	2.4283E+04	-1.5011E+04	2.8548E+04
292	5	9	12	6.000E+00	9.552E+00	2.2599E+04	-1.9409E+04	2.9790E+04
293	5	9	13	6.007E+00	1.018E+01	2.1033E+04	-2.4774E+04	3.2498E+04
316	5	10	1	6.800E+00	4.500E-01	3.1753E+04	-2.6850E+02	3.1754E+04
317	5	10	2	6.800E+00	1.350E+00	3.1676E+04	-8.2490E+02	3.1686E+04
318	5	10	3	6.800E+00	2.250E+00	3.1503E+04	-1.4437E+03	3.1536E+04
319	5	10	4	6.800E+00	3.150E+00	3.1194E+04	-2.1827E+03	3.1270E+04
320	5	10	5	6.800E+00	4.050E+00	3.0667E+04	-3.1319E+03	3.0827E+04
321	5	10	6	6.800E+00	4.950E+00	2.9786E+04	-4.4441E+03	3.0116E+04
322	5	10	7	6.800E+00	5.850E+00	2.8350E+04	-6.3953E+03	2.9062E+04
323	5	10	8	6.800E+00	6.750E+00	2.6201E+04	-9.4589E+03	2.7856E+04
324	5	10	9	6.800E+00	7.551E+00	1.8590E+04	-1.0563E+04	2.1381E+04
325	5	10	10	6.800E+00	8.252E+00	1.6973E+04	-1.4328E+04	2.2213E+04
326	5	10	11	6.800E+00	8.919E+00	1.4062E+04	-1.6808E+04	2.1914E+04
327	5	10	12	6.800E+00	9.552E+00	1.3077E+04	-2.1086E+04	2.4812E+04
328	5	10	13	6.820E+00	1.018E+01	1.2287E+04	-2.6513E+04	2.9222E+04
351	5	11	1	7.600E+00	4.500E-01	1.0344E+04	-2.9326E+02	1.0348E+04
352	5	11	2	7.600E+00	1.350E+00	1.0307E+04	-9.0473E+02	1.0347E+04
353	5	11	3	7.600E+00	2.250E+00	1.0226E+04	-1.5970E+03	1.0350E+04
354	5	11	4	7.600E+00	3.150E+00	1.0082E+04	-2.4475E+03	1.0375E+04
355	5	11	5	7.600E+00	4.050E+00	9.8413E+03	-3.5744E+03	1.0470E+04
356	5	11	6	7.600E+00	4.950E+00	9.4475E+03	-5.1734E+03	1.0771E+04
357	5	11	7	7.600E+00	5.850E+00	8.8090E+03	-7.5425E+03	1.1597E+04
358	5	11	8	7.600E+00	6.750E+00	7.8523E+03	-1.1030E+04	1.3540E+04

Table 3.3.9 (continued)

Window Frame Dipole - Ironcore Forces

Element Forces per Unit Length

Nel	mat	i1	j1	xc(cm)	yc(cm)	Fx(N/m)	Fy(N/m)	Ft(N/m)
359	5	11	9	7.600E+00	7.551E+00	5.3035E+03	-1.1915E+04	1.3042E+04
360	5	11	10	7.600E+00	8.252E+00	4.5628E+03	-1.5600E+04	1.6254E+04
361	5	11	11	7.600E+00	8.920E+00	3.5592E+03	-1.7829E+04	1.8181E+04
362	5	11	12	7.600E+00	9.554E+00	3.2078E+03	-2.1696E+04	2.1932E+04
363	5	11	13	7.613E+00	1.018E+01	3.1800E+03	-2.5015E+04	2.5216E+04

on the windings. Table 3.3.10 lists the values of these forces. The table is keyed to the element numbers given in Figure 3.3.32.

Table 3.3.10: Values of the Lorentz Body Force Vector Elements for the Air Core Window Frame Dipole Design (keyed to Figure 3.3.32)

Window Frame Dipole - Aircore Forces

Element Forces per Unit Length

Nel	mat	i1	j1	xc(cm)	yc(cm)	Fx(N/m)	Fy(N/m)	Ft(N/m)
151	3	5	11	3.000E+00	8.919E+00	3.5060E+04	-2.8824E+03	3.5178E+04
152	3	5	12	3.000E+00	9.552E+00	3.3063E+04	-8.9017E+03	3.4241E+04
153	3	5	13	3.000E+00	1.018E+01	2.9815E+04	-1.4583E+04	3.3191E+04
184	4	6	9	3.800E+00	7.551E+00	3.5536E+04	3.5551E+03	3.5713E+04
185	4	6	10	3.800E+00	8.252E+00	3.4175E+04	-1.7631E+03	3.4220E+04
186	4	6	11	3.800E+00	8.919E+00	2.7718E+04	-6.3950E+03	2.8446E+04
187	4	6	12	3.800E+00	9.552E+00	2.5159E+04	-1.2112E+04	2.7923E+04
188	4	6	13	3.800E+00	1.018E+01	2.2843E+04	-1.8458E+04	2.9368E+04
219	4	7	9	4.600E+00	7.551E+00	2.6580E+04	1.4541E+03	2.6620E+04
220	4	7	10	4.600E+00	8.252E+00	2.3475E+04	-4.8534E+03	2.3972E+04
221	4	7	11	4.600E+00	8.919E+00	1.8864E+04	-9.4328E+03	2.1091E+04
222	4	7	12	4.600E+00	9.552E+00	1.7008E+04	-1.4601E+04	2.2416E+04
223	4	7	13	4.600E+00	1.018E+01	1.5846E+04	-2.0345E+04	2.5788E+04
281	5	9	1	6.000E+00	4.500E-01	3.6175E+04	-2.2317E+02	3.6175E+04
282	5	9	2	6.000E+00	1.350E+00	3.6032E+04	-6.6914E+02	3.6038E+04
283	5	9	3	6.000E+00	2.250E+00	3.5727E+04	-1.1144E+03	3.5744E+04
284	5	9	4	6.000E+00	3.150E+00	3.5216E+04	-1.5608E+03	3.5251E+04
285	5	9	5	6.000E+00	4.050E+00	3.4413E+04	-2.0186E+03	3.4472E+04
286	5	9	6	6.000E+00	4.950E+00	3.3152E+04	-2.5287E+03	3.3248E+04
287	5	9	7	6.000E+00	5.850E+00	3.1129E+04	-3.2637E+03	3.1299E+04
288	5	9	8	6.000E+00	6.750E+00	2.7856E+04	-4.8304E+03	2.8271E+04
289	5	9	9	6.000E+00	7.551E+00	1.8811E+04	-6.3192E+03	1.9844E+04
290	5	9	10	6.000E+00	8.252E+00	1.6551E+04	-1.0064E+04	1.9370E+04
291	5	9	11	6.000E+00	8.919E+00	1.3503E+04	-1.3092E+04	1.8808E+04
292	5	9	12	6.000E+00	9.552E+00	1.2446E+04	-1.7535E+04	2.1503E+04
293	5	9	13	6.007E+00	1.018E+01	1.1393E+04	-2.3154E+04	2.5805E+04
316	5	10	1	6.800E+00	4.500E-01	1.4712E+04	-2.8453E+02	1.4715E+04
317	5	10	2	6.800E+00	1.350E+00	1.4576E+04	-8.6069E+02	1.4601E+04
318	5	10	3	6.800E+00	2.250E+00	1.4287E+04	-1.4609E+03	1.4361E+04
319	5	10	4	6.800E+00	3.150E+00	1.3810E+04	-2.1115E+03	1.3971E+04
320	5	10	5	6.800E+00	4.050E+00	1.3084E+04	-2.8622E+03	1.3393E+04
321	5	10	6	6.800E+00	4.950E+00	1.2009E+04	-3.8181E+03	1.2601E+04
322	5	10	7	6.800E+00	5.850E+00	1.0467E+04	-5.2119E+03	1.1693E+04
323	5	10	8	6.800E+00	6.750E+00	8.4293E+03	-7.5109E+03	1.1290E+04
324	5	10	9	6.800E+00	7.551E+00	5.0547E+03	-8.4187E+03	9.8196E+03
325	5	10	10	6.800E+00	8.252E+00	3.9928E+03	-1.1633E+04	1.2300E+04
326	5	10	11	6.800E+00	8.919E+00	3.0962E+03	-1.4003E+04	1.4341E+04
327	5	10	12	6.800E+00	9.552E+00	3.0550E+03	-1.8146E+04	1.8401E+04
328	5	10	13	6.820E+00	1.018E+01	3.2631E+03	-2.3726E+04	2.3950E+04
351	5	11	1	7.600E+00	4.500E-01	-6.6439E+03	-3.4057E+02	6.6526E+03
352	5	11	2	7.600E+00	1.350E+00	-6.7618E+03	-1.0344E+03	6.8405E+03
353	5	11	3	7.600E+00	2.250E+00	-7.0077E+03	-1.7703E+03	7.2279E+03
354	5	11	4	7.600E+00	3.150E+00	-7.4023E+03	-2.5893E+03	7.8421E+03
355	5	11	5	7.600E+00	4.050E+00	-7.9756E+03	-3.5577E+03	8.7331E+03
356	5	11	6	7.600E+00	4.950E+00	-8.7587E+03	-4.7904E+03	9.9831E+03
357	5	11	7	7.600E+00	5.850E+00	-9.7510E+03	-6.4821E+03	1.1709E+04
358	5	11	8	7.600E+00	6.750E+00	-1.0841E+04	-8.9233E+03	1.4041E+04

Table 3.3.10 (continued)

Window Frame Dipole - Aircore Forces

Element Forces per Unit Length

Nel	mat	i1	j1	xc(cm)	yc(cm)	Fx(N/m)	Fy(N/m)	Ft(N/m)
359	5	11	9	7.600E+00	7.551E+00	-9.0679E+03	-9.3205E+03	1.3004E+04
360	5	11	10	7.600E+00	8.252E+00	-9.2506E+03	-1.2044E+04	1.5186E+04
361	5	11	11	7.600E+00	8.920E+00	-8.0407E+03	-1.3792E+04	1.5965E+04
362	5	11	12	7.600E+00	9.554E+00	-6.9936E+03	-1.7079E+04	1.8456E+04
363	5	11	13	7.613E+00	1.018E+01	-4.8770E+03	-2.0462E+04	2.1035E+04

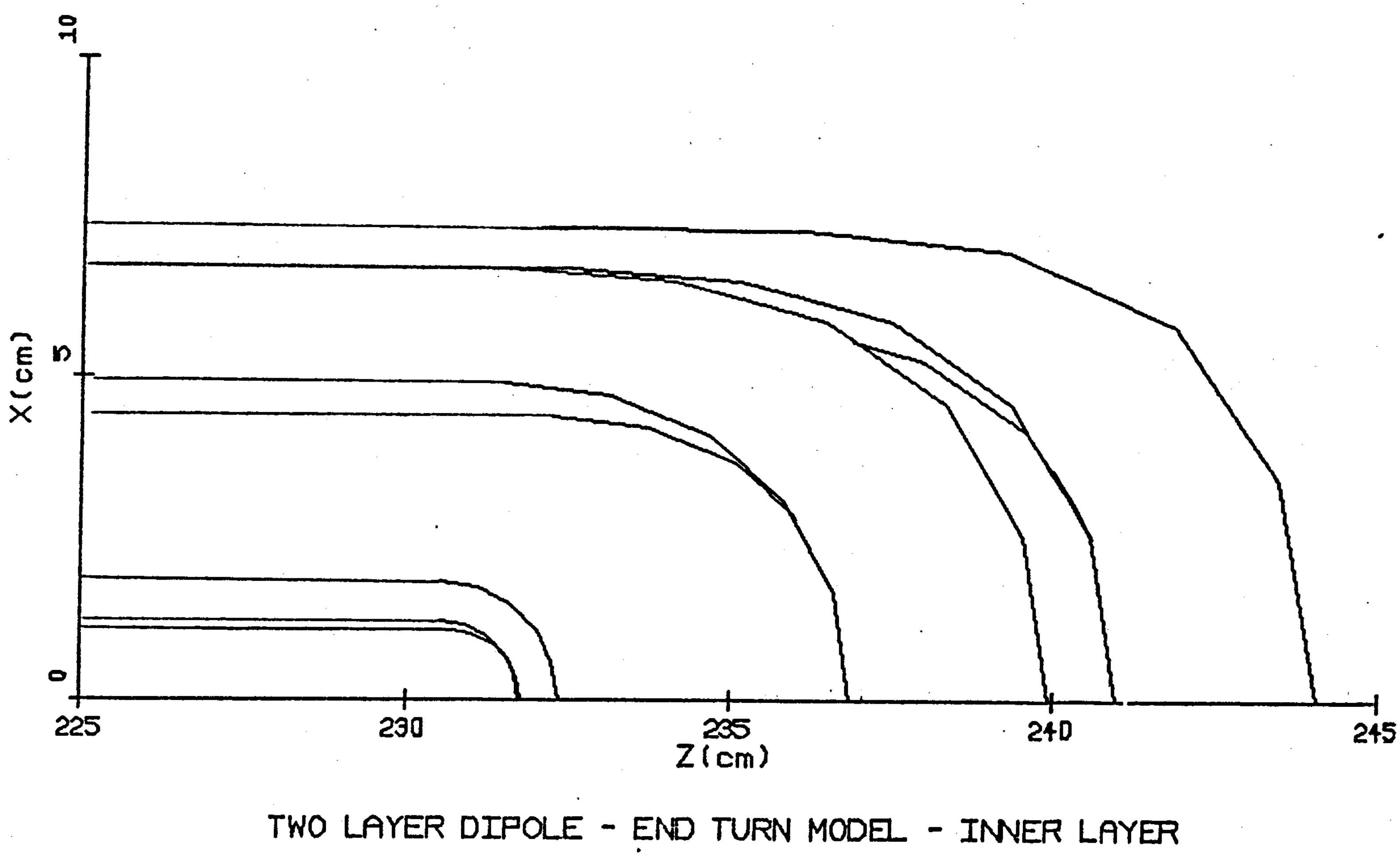
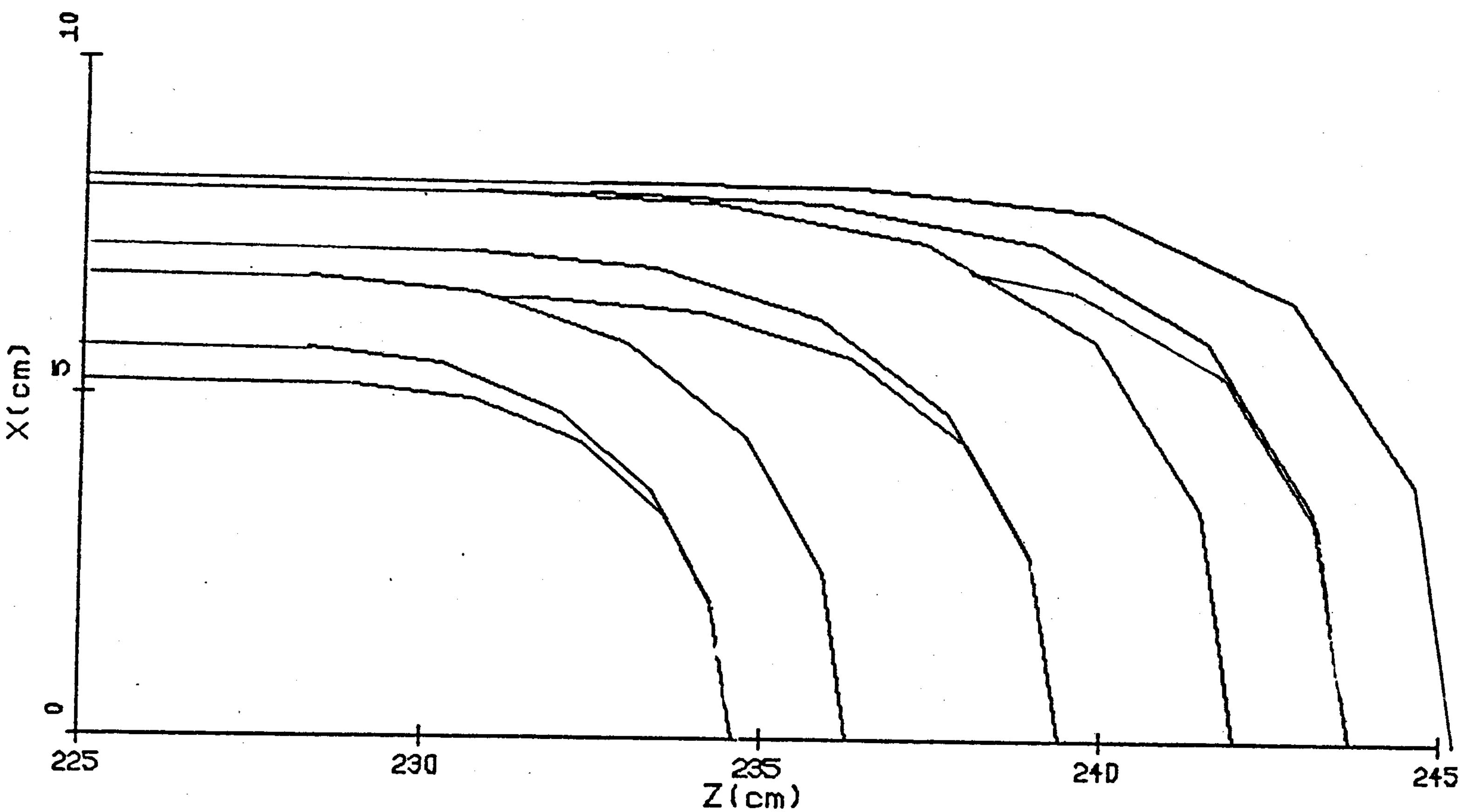


Figure 3.3.47: Top View of the Inner-Layer End-Turn Crossover Model. Two-Layer Dipole Design



TWO LAYER DIPOLE - END TURN MODEL - OUTER LAYER

Figure 3.3.48: Top View of the Outer-Layer End-Turn Crossover Model. Two-Layer Dipole Design

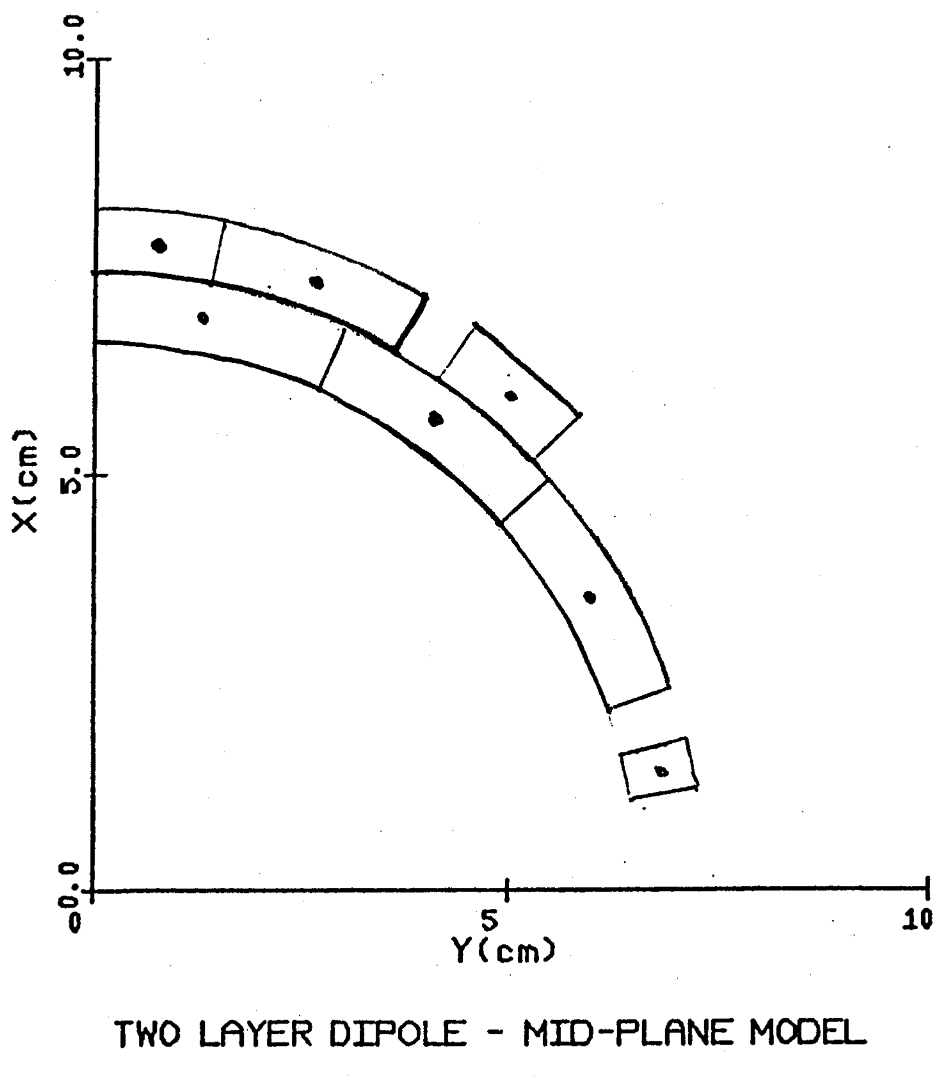


Figure 3.3.49: Midplane Model for the Two-Layer Dipole Design

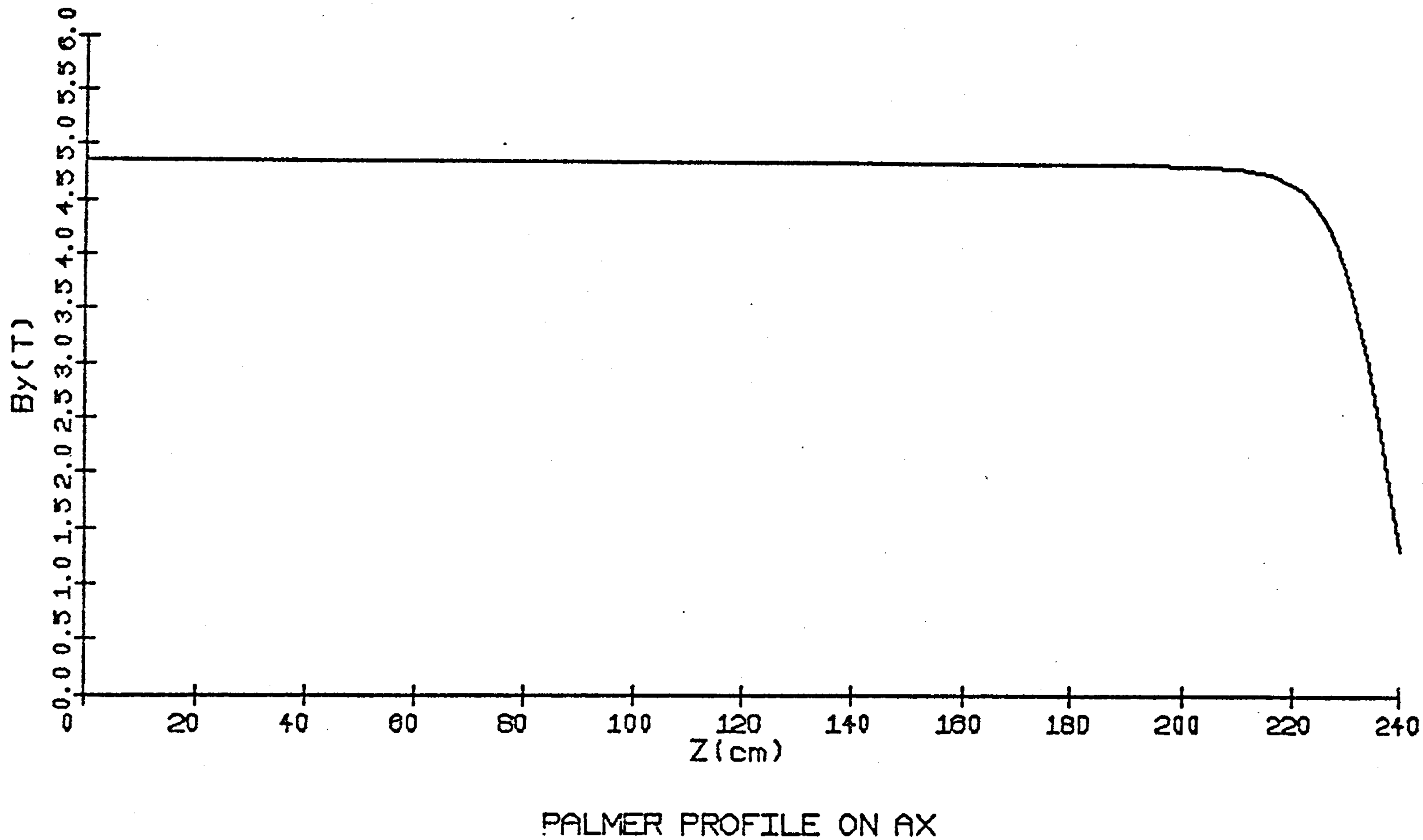


Figure 3.3.50: Axial Field Profile, B_y versus z, for the Two-Layer Dipole Design

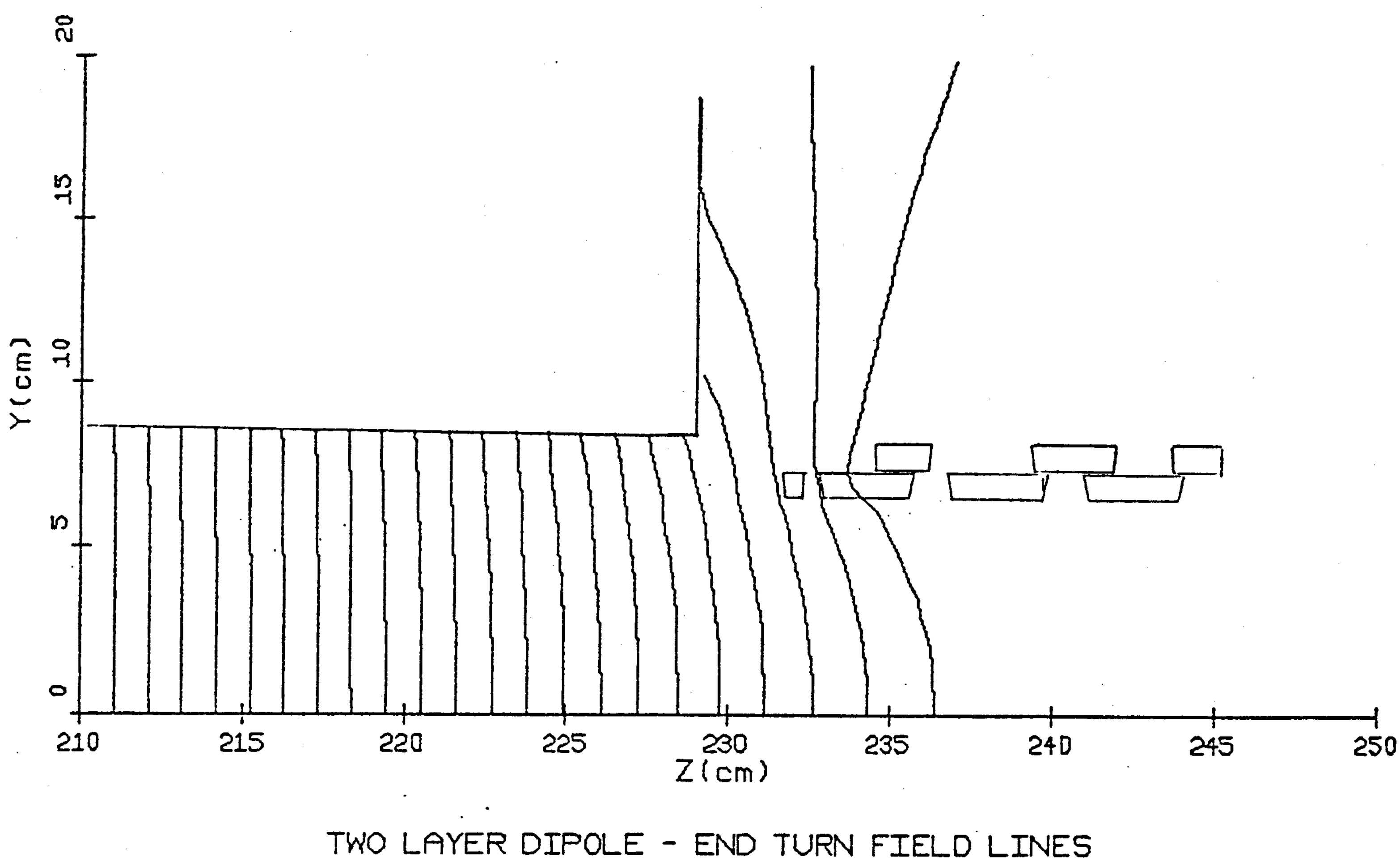


Figure 3.3.51: End-Turn Crossover Field Lines in the X = 0 Plane for the Two-Layer Dipole Model

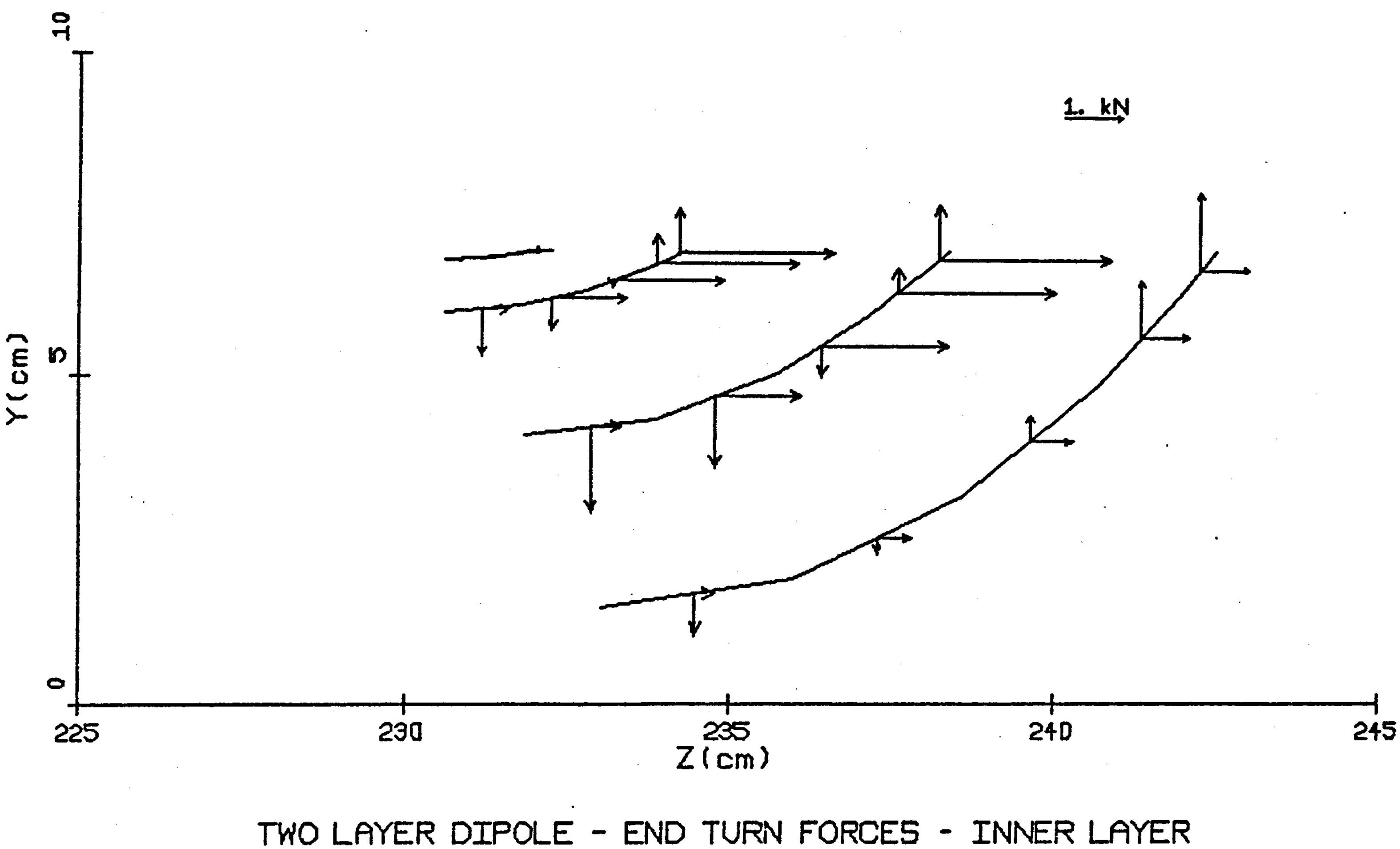


Figure 3.3.52: Stick Model, Side View, Showing Forces Acting on each Stick for the Two-Layer Dipole, Inner Layer

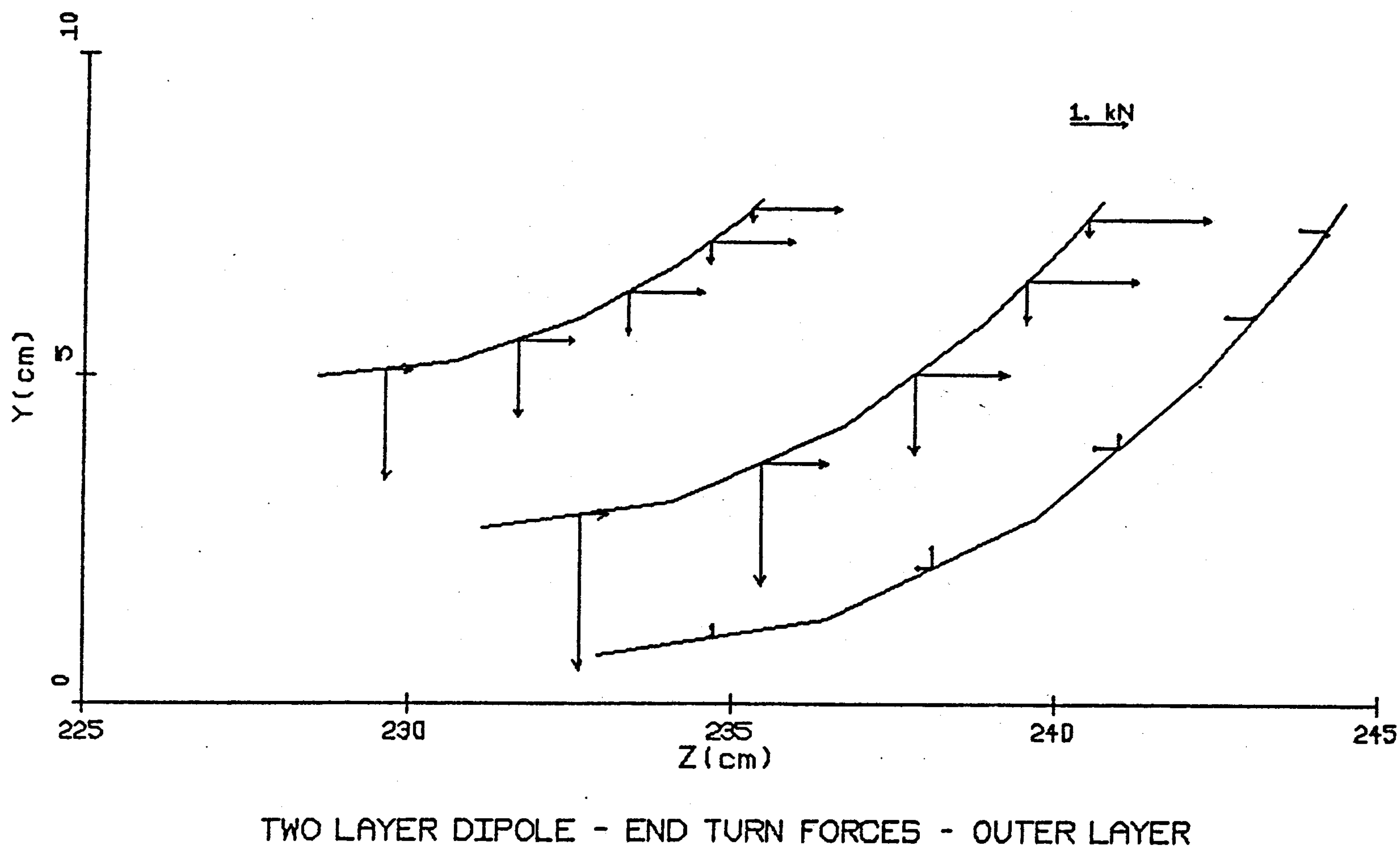


Figure 3.3.53: Stick Model, Side View, Showing Forces Acting on each Stick for the Two-Layer Dipole, Outer Layer

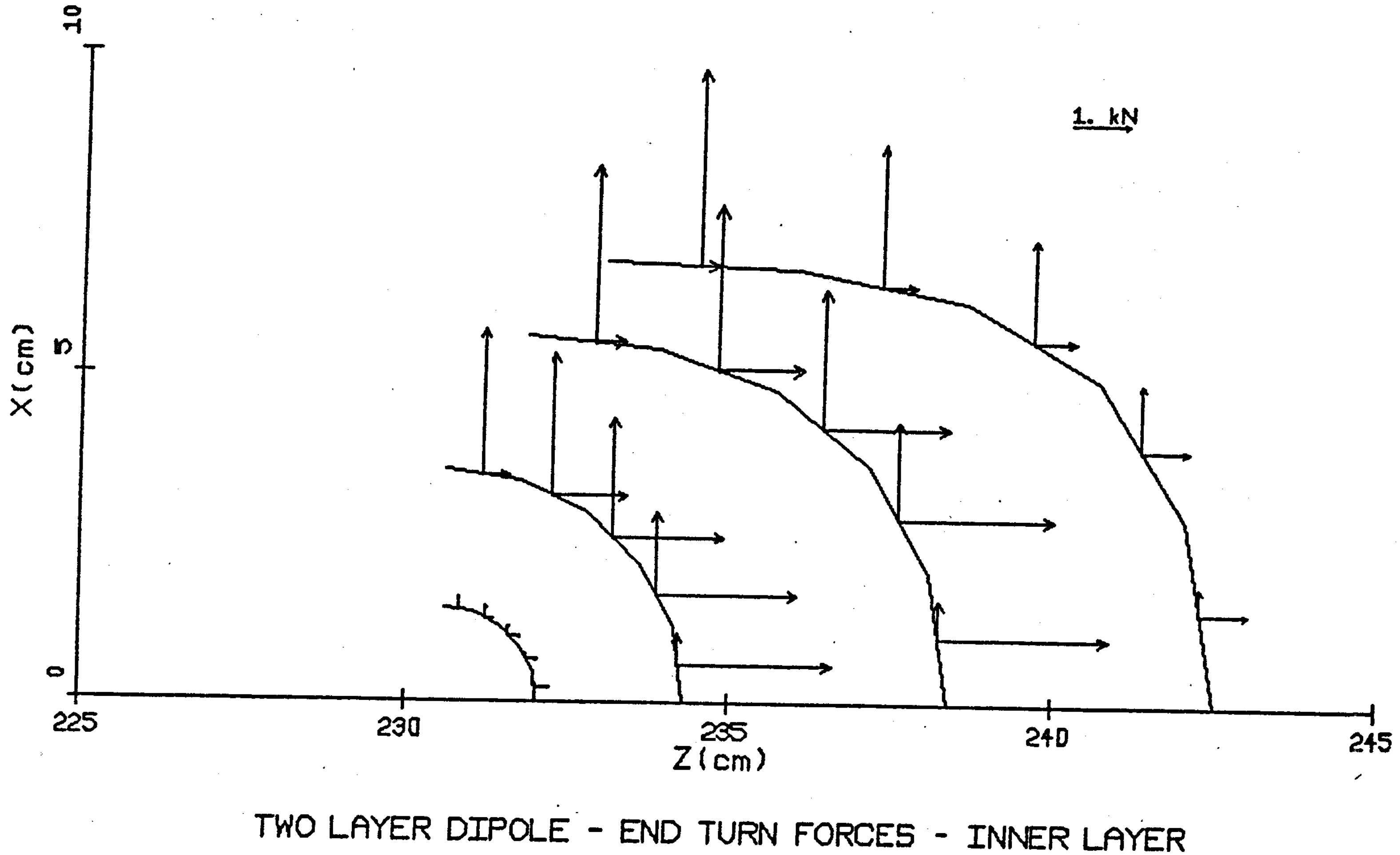
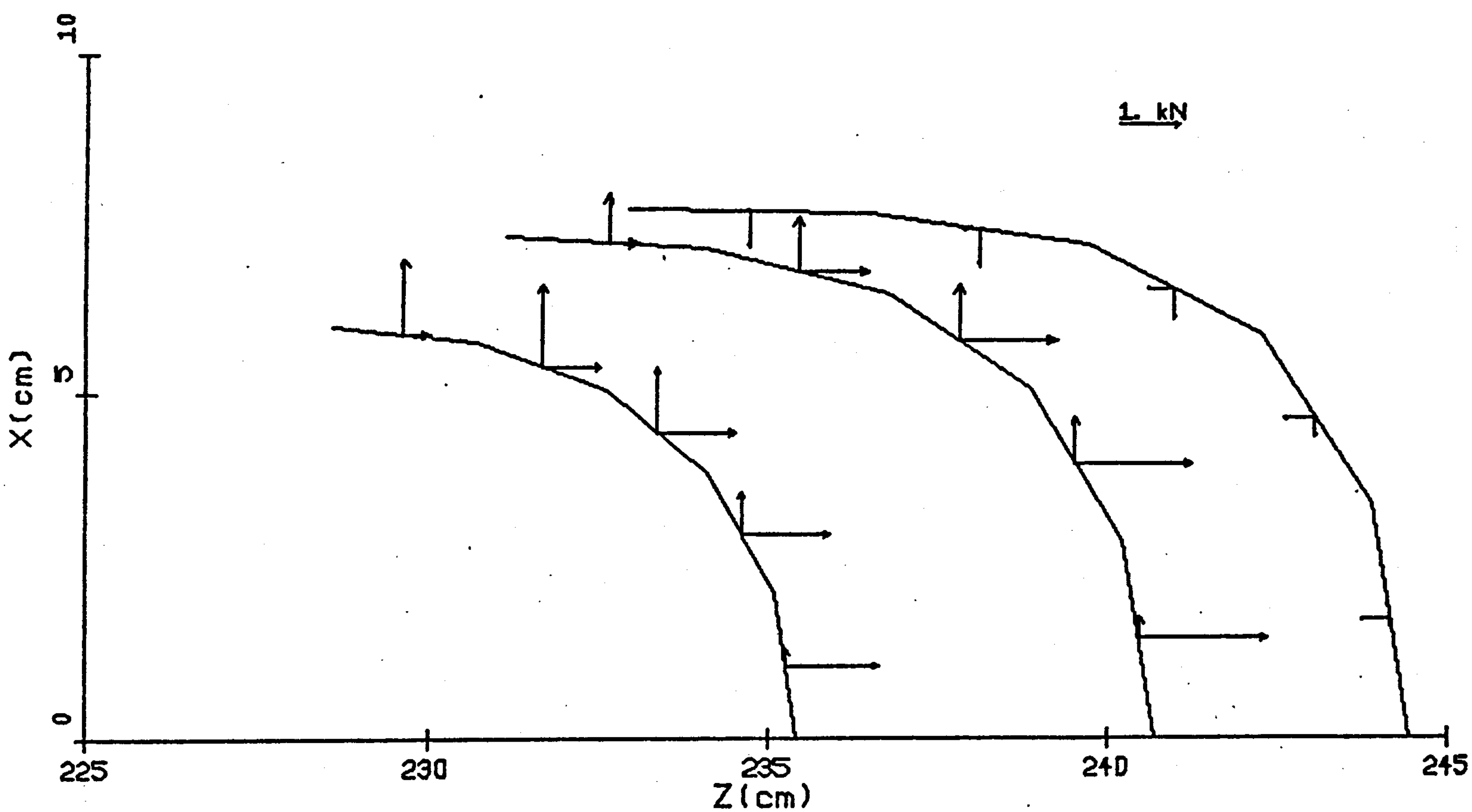


Figure 3.3.54: Stick Model, Top View, Showing Forces Acting on each Stick for the Two-Layer Dipole Design, Inner Layer



TWO LAYER DIPOLE - END TURN FORCES - OUTER LAYER

Figure 3.3.55: Stick Model, Top View, Showing Forces Acting on each Stick for the Two-Layer Dipole Design, Outer Layer

are the iron boundaries and outline of the winding blocks.

Tables 3.3.12 and 3.3.13 present the tabulations of the total force components acting on each stick for the inner and outer layers, respectively. These components are summed within each filament and listed as the TOTAL FOR ALL POINTS entry. These forces are for one octant only. Therefore, the total axial (z-directed) force acting on the end turn would be four times the summation of the totals for each filament.

Table 3.3.12: Lorentz Body Force Component Values for the Two-Layer Dipole Design, Inner Layer

Two Layer Dipole - End Turn Forces - Coil and Iron

Inner Layer - Filament 1

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.8045E-02	1.4488E-02	1.1651E+00	5.34827E+05	-2.34989E+04	0.00000E+00
2	6.7487E-02	1.6737E-02	2.3448E+00	3.41854E+03	-6.22693E+02	2.26013E+02
3	6.4482E-02	2.5238E-02	2.3727E+00	2.48318E+03	-2.17626E+02	5.63520E+02
4	5.5970E-02	3.9980E-02	2.3963E+00	1.79997E+03	4.01463E+02	7.16845E+02
5	3.9155E-02	5.5989E-02	2.4135E+00	1.18333E+03	9.76729E+02	7.99779E+02
6	1.4202E-02	6.6539E-02	2.4226E+00	4.25951E+02	1.35012E+03	8.44486E+02
TOTAL FOR ALL POINTS				5.44138E+05	-2.16109E+04	3.15064E+03

Inner Layer - Filament 2

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	5.6283E-02	4.0892E-02	1.1592E+00	5.77041E+05	-1.00007E+05	0.00000E+00
2	5.5311E-02	4.2168E-02	2.3285E+00	3.08393E+03	-1.42157E+03	4.75150E+02
3	5.1196E-02	4.6876E-02	2.3478E+00	2.86861E+03	-1.18413E+03	1.43097E+03
4	4.2326E-02	5.4736E-02	2.3642E+00	2.42148E+03	-4.56311E+02	2.19073E+03
5	2.8288E-02	6.2903E-02	2.3761E+00	1.67305E+03	3.57433E+02	2.69917E+03
6	9.9882E-03	6.8105E-02	2.3824E+00	6.05228E+02	8.90818E+02	2.95423E+03
TOTAL FOR ALL POINTS				5.87694E+05	-1.01821E+05	9.75025E+03

Inner Layer - Filament 3

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	3.5372E-02	5.9907E-02	1.1530E+00	6.01111E+05	-1.73499E+05	0.00000E+00
2	3.4584E-02	6.0358E-02	2.3117E+00	2.52144E+03	-7.64987E+02	4.06732E+02
3	3.1447E-02	6.2001E-02	2.3226E+00	2.47687E+03	-4.99341E+02	1.24032E+03
4	2.5276E-02	6.4686E-02	2.3319E+00	2.06277E+03	-3.08005E+01	1.93138E+03
5	1.6435E-02	6.7403E-02	2.3387E+00	1.37910E+03	4.38438E+02	2.42352E+03
6	5.7074E-03	6.9099E-02	2.3422E+00	4.86721E+02	7.30767E+02	2.67983E+03
TOTAL FOR ALL POINTS				6.10038E+05	-1.73625E+05	8.68178E+03

Inner Layer - Filament 4

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	1.4245E-02	6.8096E-02	1.1530E+00	1.42244E+05	-1.82418E+04	0.00000E+00
2	1.3901E-02	6.8166E-02	2.3082E+00	2.33093E+02	-2.75503E+01	3.70454E+01
3	1.2555E-02	6.8420E-02	2.3124E+00	2.14826E+02	-9.69441E+00	1.08550E+02
4	9.9821E-03	6.8832E-02	2.3160E+00	1.73578E+02	1.04063E+01	1.70273E+02
5	6.4210E-03	6.9244E-02	2.3186E+00	1.12798E+02	2.81825E+01	2.15296E+02
6	2.2151E-03	6.9499E-02	2.3200E+00	3.91101E+01	3.86543E+01	2.38983E+02
TOTAL FOR ALL POINTS				1.43017E+05	-1.82018E+04	7.70148E+02

Table 3.3.13: Lorentz Body Force Component Values for the Two-Layer Dipole Design, Outer Layer

Two Layer Dipole - End Turn Forces - Coil and Iron

Outer Layer - Filament 1

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.7552E-02	7.3581E-03	1.1646E+00	6.33034E+04	7.60753E+03	0.00000E+00
2	7.7185E-02	1.0148E-02	2.3471E+00	-5.90718E+02	1.85939E+02	-4.13853E+01
3	7.4631E-02	2.0790E-02	2.3809E+00	-5.95046E+02	3.64679E+02	-2.59884E+02
4	6.5934E-02	3.9506E-02	2.4096E+00	-4.90110E+02	2.23952E+02	-4.42042E+02
5	4.6870E-02	6.0152E-02	2.4305E+00	-3.06055E+02	1.58606E+01	-4.89470E+02
6	1.7158E-02	7.3917E-02	2.4415E+00	-1.02301E+02	-9.72577E+01	-4.86098E+02
TOTAL FOR ALL POINTS				6.12191E+04	8.30071E+03	-1.71888E+03

Outer Layer - Filament 2

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.3251E-02	2.6509E-02	1.1558E+00	2.07914E+05	-2.15261E+05	0.00000E+00
2	7.2392E-02	2.8677E-02	2.3262E+00	7.57919E+02	-2.66185E+03	4.36106E+02
3	6.8327E-02	3.6798E-02	2.3542E+00	8.49134E+02	-2.08830E+03	1.14054E+03
4	5.8220E-02	5.0679E-02	2.3781E+00	8.74126E+02	-1.35976E+03	1.59467E+03
5	4.0038E-02	6.5502E-02	2.3954E+00	7.42394E+02	-6.86866E+02	1.93681E+03
6	1.4379E-02	7.5149E-02	2.4045E+00	3.03529E+02	-2.30237E+02	2.14263E+03
TOTAL FOR ALL POINTS				2.11441E+05	-2.22288E+05	7.25075E+03

Outer Layer - Filament 3

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	5.9797E-02	4.9927E-02	1.1430E+00	1.90689E+05	-2.38029E+05	0.00000E+00
2	5.8701E-02	5.1184E-02	2.2965E+00	1.23846E+03	-1.92086E+03	3.58190E+02
3	5.4131E-02	5.5810E-02	2.3166E+00	1.32227E+03	-1.33092E+03	9.55138E+02
4	4.4492E-02	6.3499E-02	2.3336E+00	1.06684E+03	-7.30369E+02	1.29081E+03
5	2.9568E-02	7.1444E-02	2.3460E+00	6.64638E+02	-3.42898E+02	1.45900E+03
6	1.0405E-02	7.6484E-02	2.3525E+00	2.25291E+02	-1.52176E+02	1.53429E+03
TOTAL FOR ALL POINTS				1.95206E+05	-2.42506E+05	5.59743E+03

3.3.3.3 Three-Layer Dipole

Figures 3.3.56 through 3.3.58 show the side views of the inner, middle, and outer layers of the coil model used in the windings for the three-dimensional calculations. Figures 3.3.59 through 3.3.61 show the top views of the three layers. Each layer was modeled with a number of blocks. The inner layer was modeled with three blocks; the middle with two; and the outer with one. The end turn configuration was chosen to reduce the peak field in the ends. Each block was modeled with a single filament placed at its geometric center.

Also indicated in each figure is the location and magnitude of the three-dimensional peak field in the windings. The value of 6.33 T was obtained for this design.

The iron shown in Figures 3.3.56 through 3.3.58 extends to z = 2.286 m (7.5 ft.). One octant of the iron was modeled with 192 elements with constant magnetizations corresponding to those shown in Figure 3.3.26.

Figure 3.3.62 shows the midplane section of the magnet with the blocks outlined. The filaments used to model the windings are enumerated. These numbers correspond to those listed in the force tabulation. Each filament is made up of 6 straight sticks in an octant of the coil. A single stick runs from the midplane to the start of the crossover. There are five straight sticks that model the crossover. The sticks and, hence, the midpoints are numbered consecutively from the midplane to the middle of the crossover.

The profile on axis for this design is presented in Figure 3.3.63. The end turn field lines in the x = 0 plane are shown in Figure 3.3.64. The iron boundaries and coil outlines are also shown.

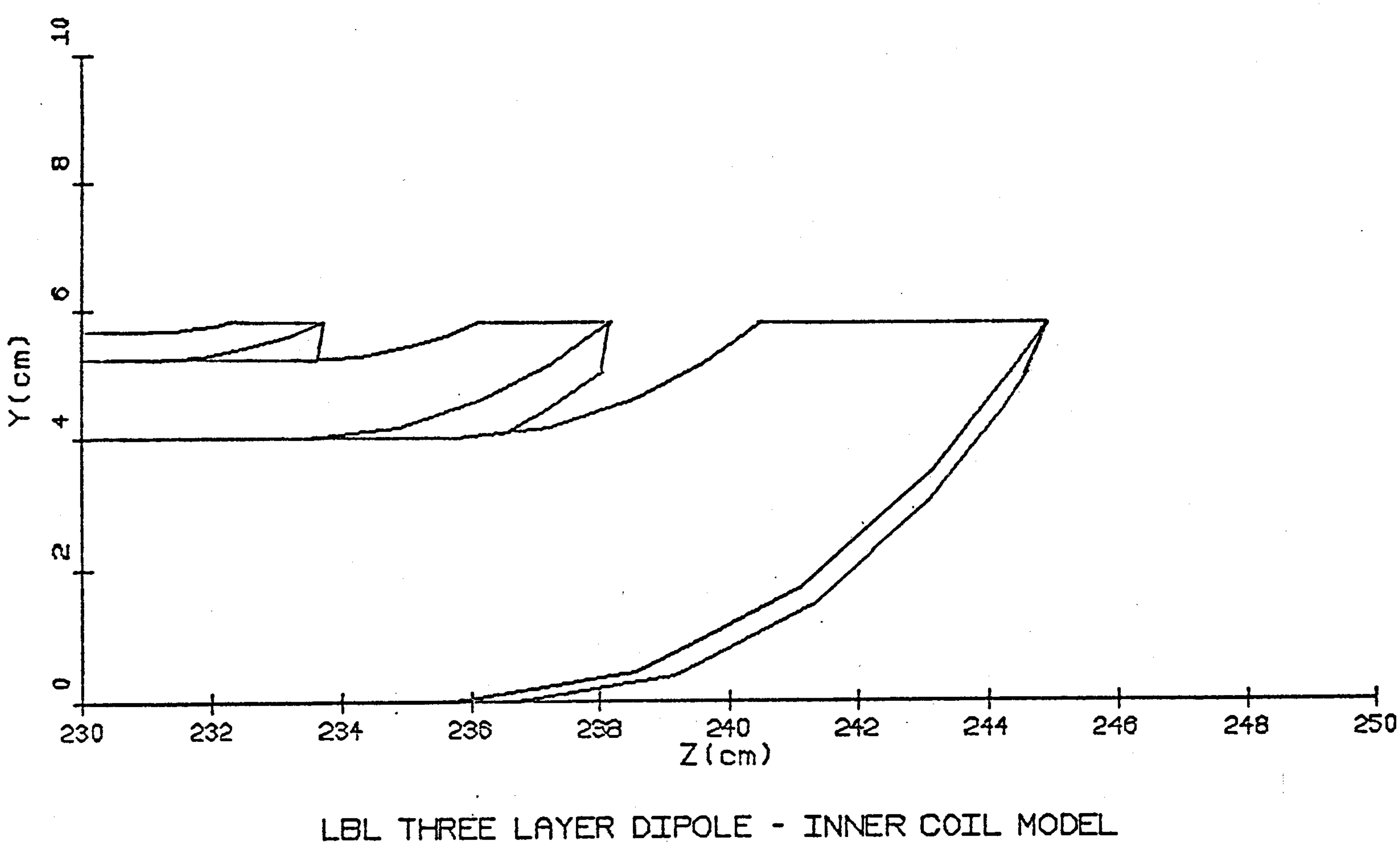
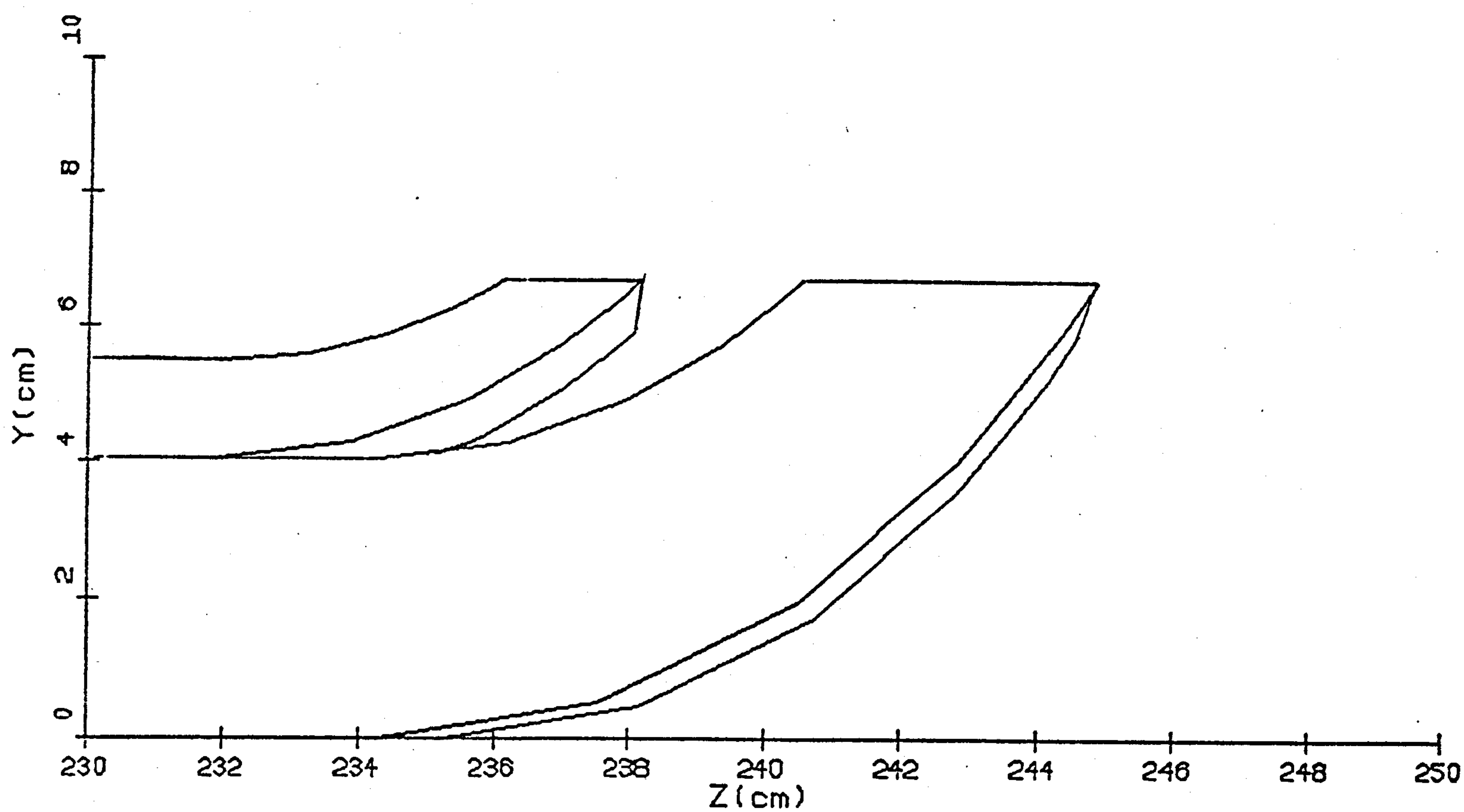


Figure 3.3.56: Side View of the End-Turn Crossover Region for the Three-Layer Dipole, Inner Coil Model



LBL THREE LAYER DIPOLE - MIDDLE COIL MODEL

Figure 3.3.57: Side View of the End-Turn Crossover Region for the Three-Layer Dipole, Middle Coil Model

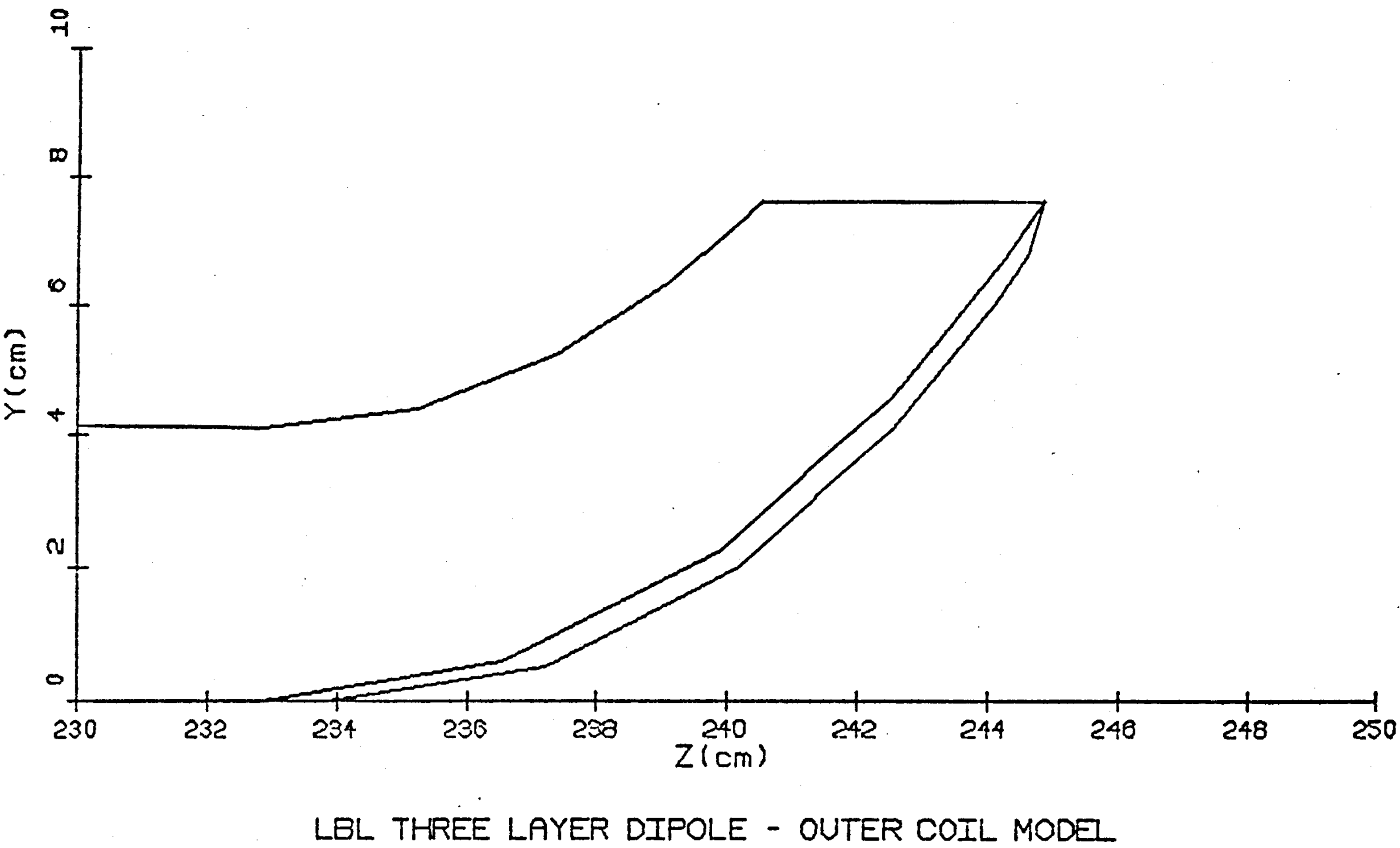
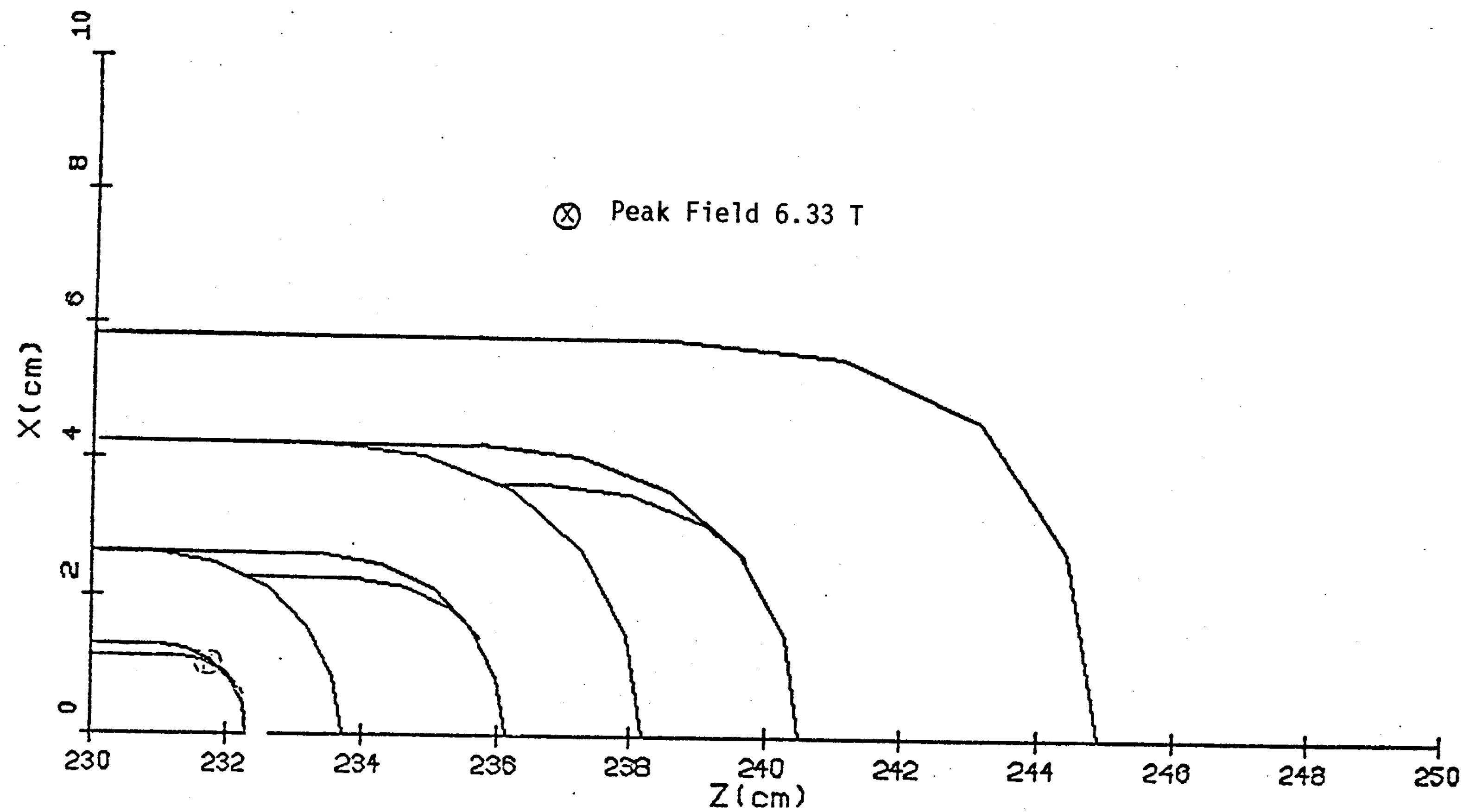


Figure 3.3.58: Side View of the End-Turn Crossover Region for the Three-Layer Dipole, Outer Coil Model



LBL THREE LAYER DIPOLE - INNER COIL MODEL

Figure 3.3.59: Top View of the End-Turn Crossover Region for the Three-Layer Dipole, Inner Coil Model

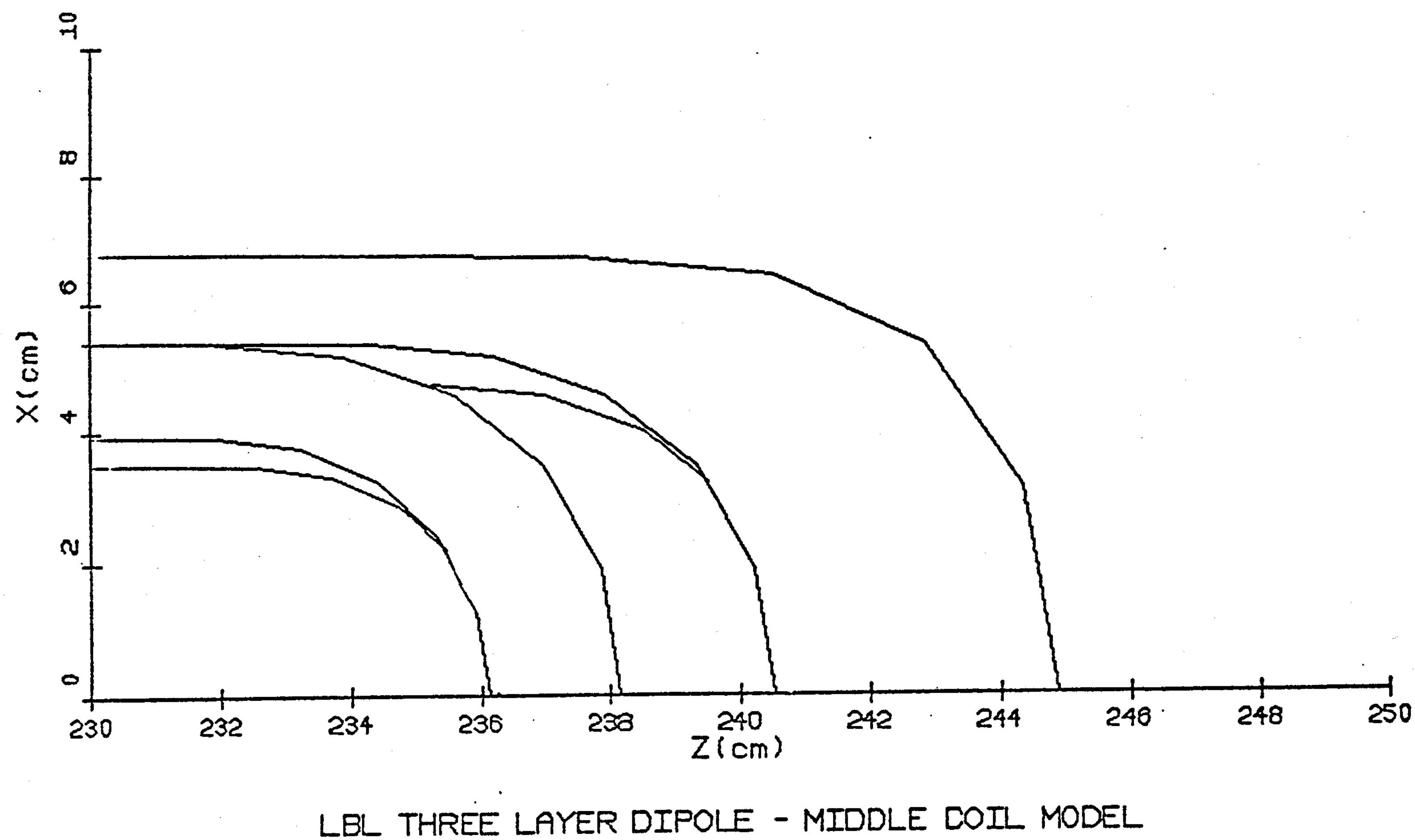


Figure 3.3.60: Top View of the End-Turn Crossover Region for the Three-Layer Dipole, Middle Coil Model

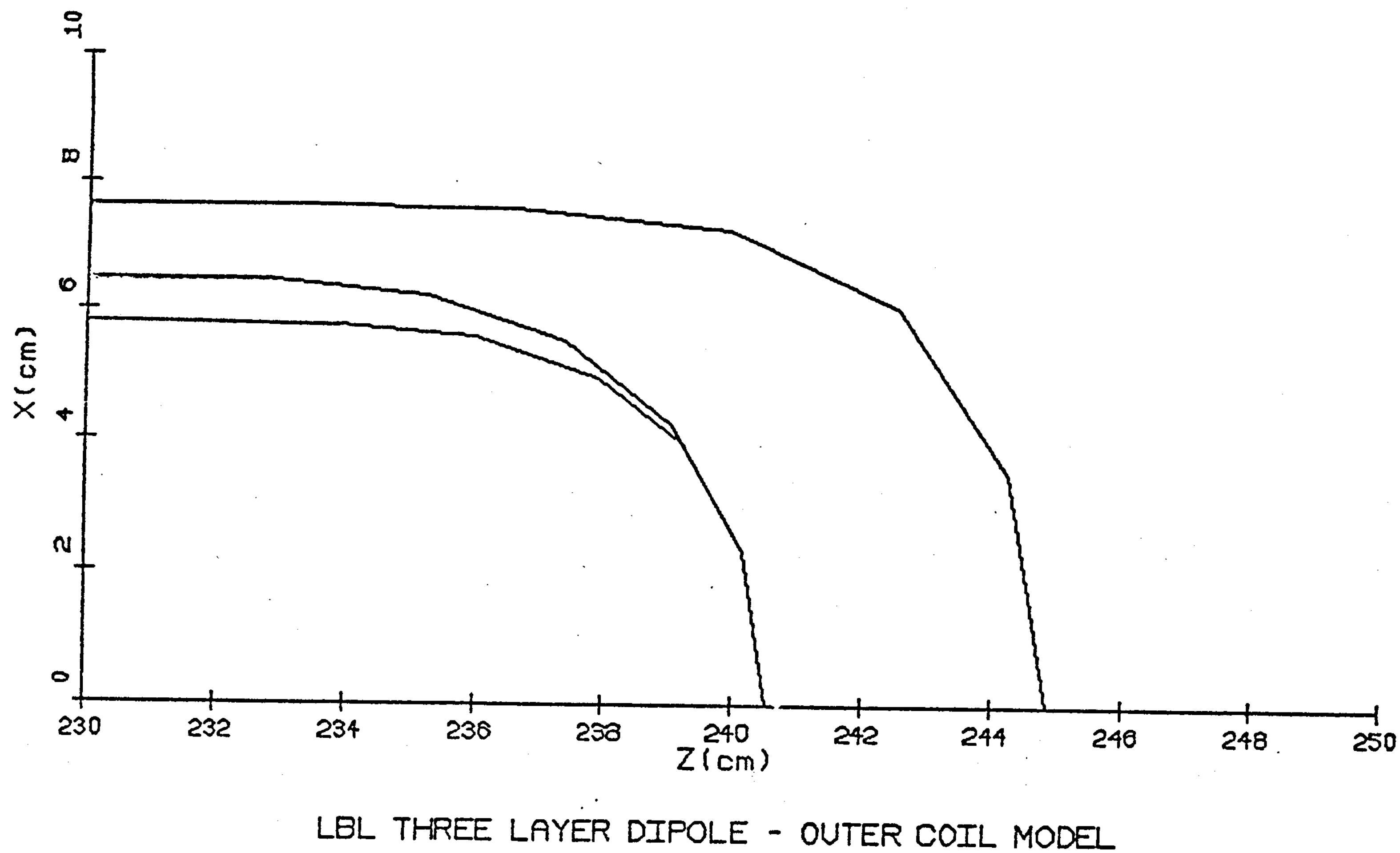


Figure 3.3.61: Top View of the End-Turn Crossover Region for the Three-Layer Dipole, Outer Coil Model

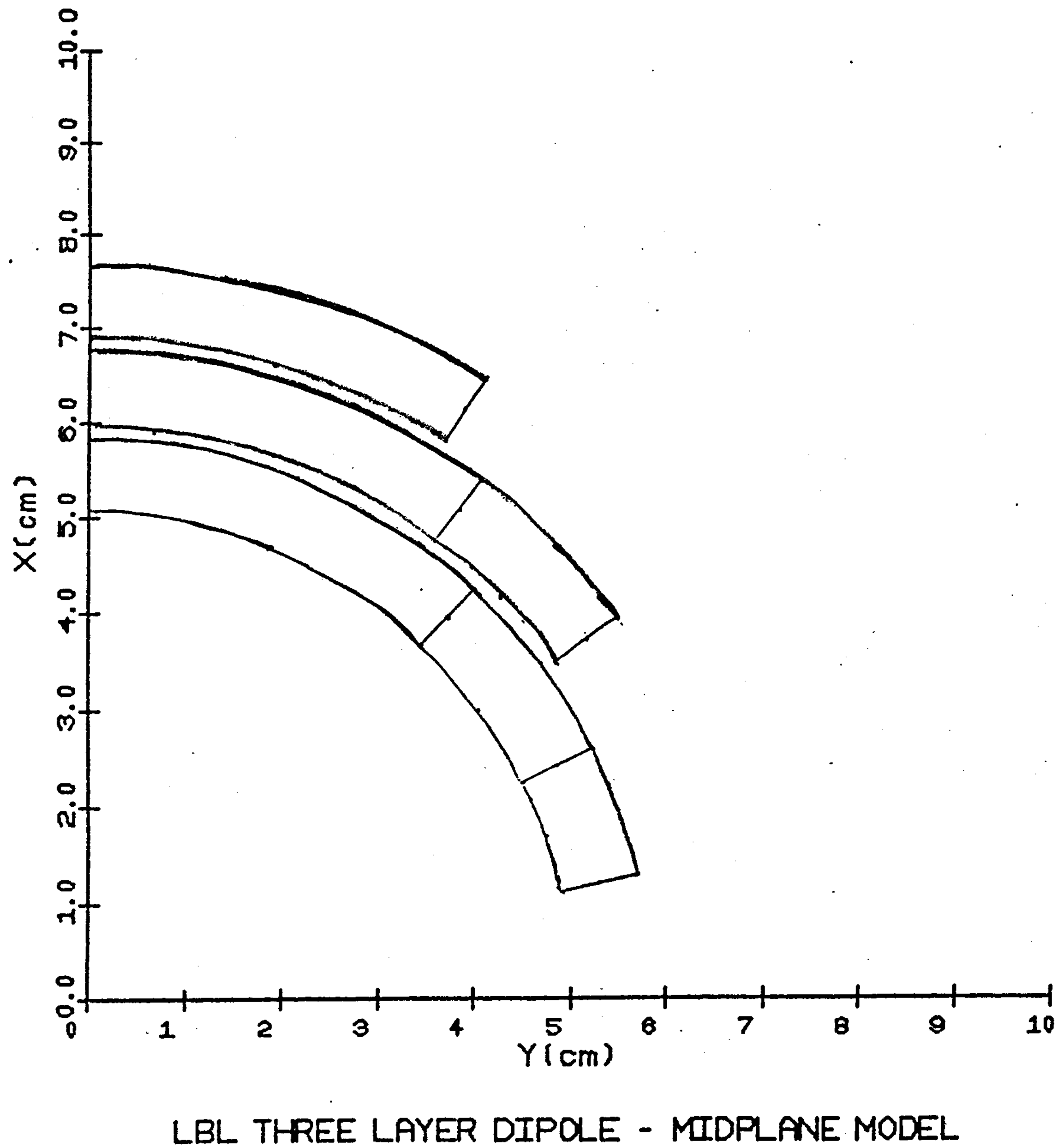


Figure 3.3.62: Midplane model for the Three-Layer Dipole

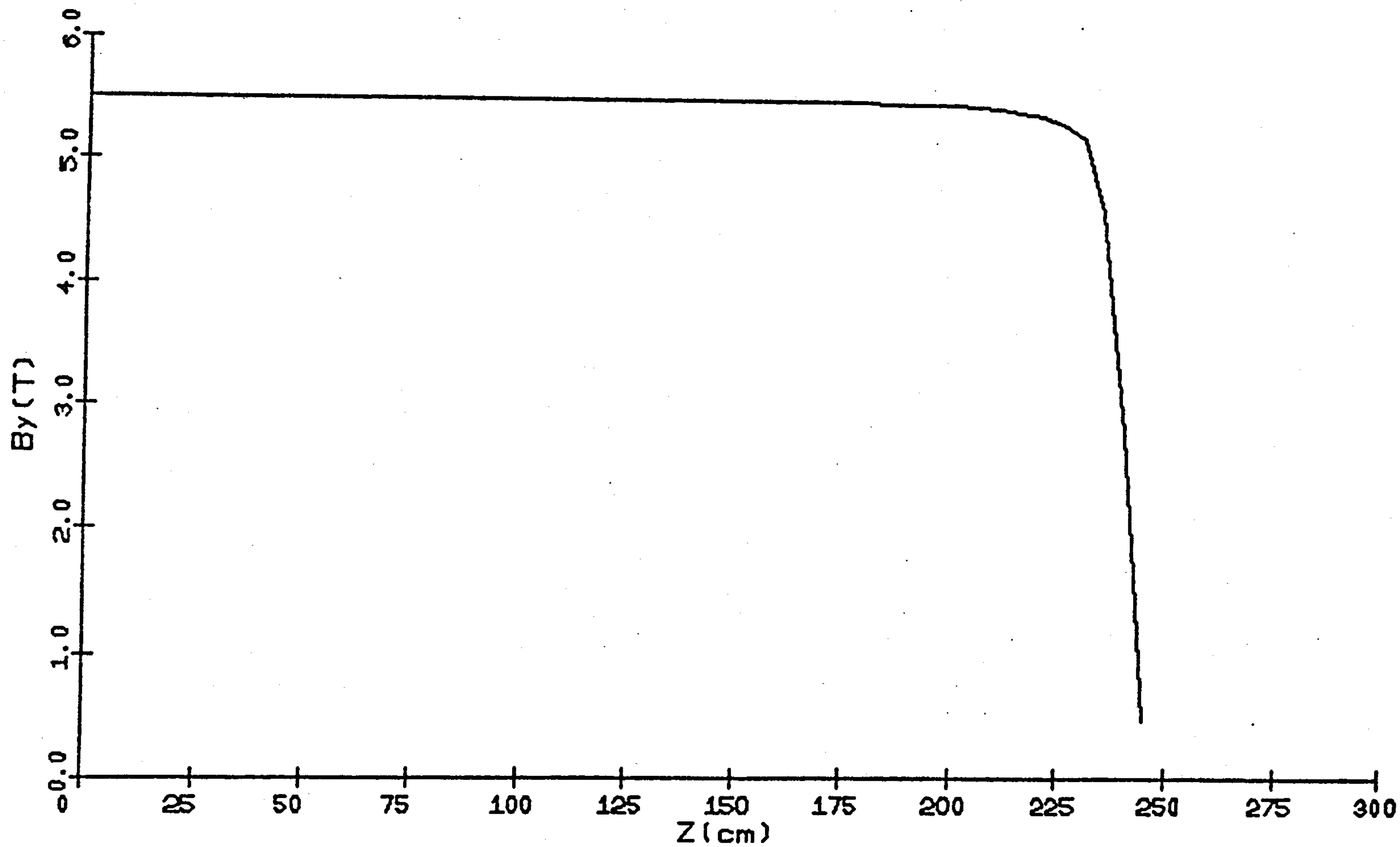


Figure 3.3.63: Axial Field Profile, B_y versus z, for the Three-Layer Dipole Design

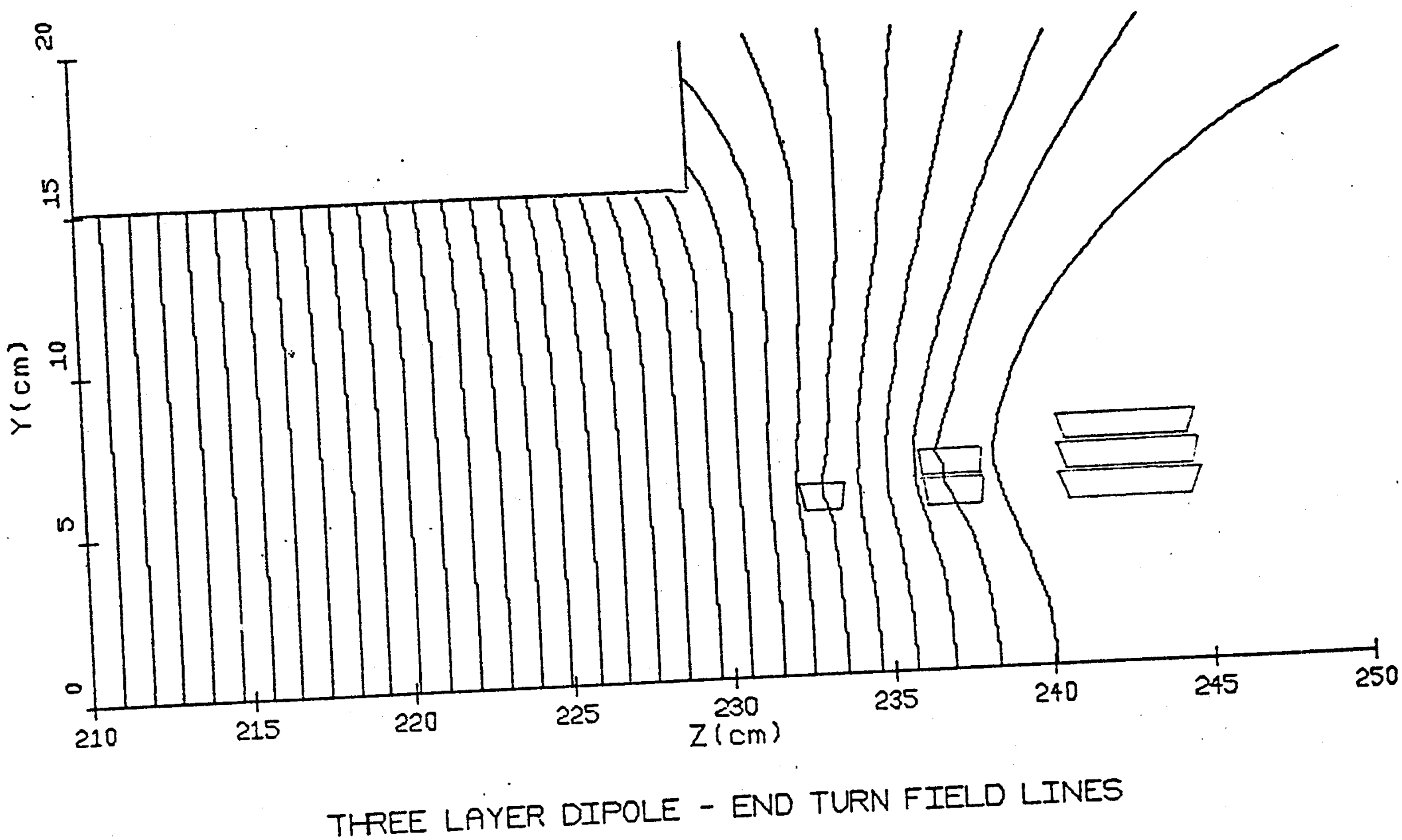


Figure 3.3.64: End-Turn Crossover Region Field Lines in the X = 0 Plane for the Three-Layer Dipole Design

The Lorentz forces acting on the end turn are shown in Figures 3.3.65 through 3.3.70. Figures 3.3.65, 3.3.66, and 3.3.67 show the side view with the y and z components for the three layers. Figures 3.3.68 through 3.3.70 show the top view with the x and z components.

Tables 3.3.14 through 3.3.16 present the tabulations of the total force components acting on each stick for the inner, middle, and outer layers, respectively. These components are summed within each filament and listed as the TOTAL FOR ALL POINTS entry. These forces are for one octant only. Therefore, the total axial (z-directed) force acting on the end turn would be four times the summation of the totals for each filament.

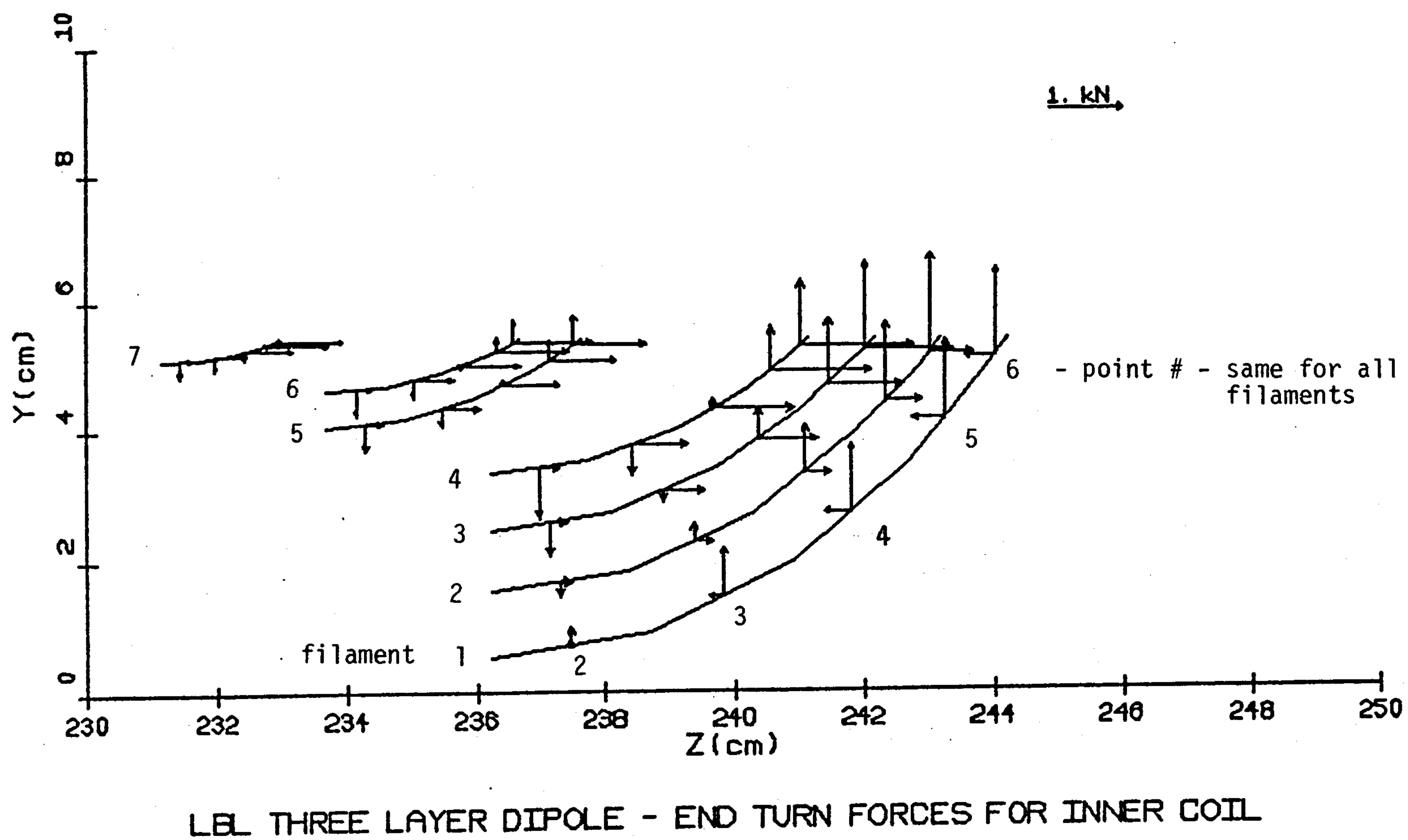


Figure 3.3.65: Stick Model, Side View, Showing End-Turn Forces Acting on each Stick for the Three-Layer Dipole, Inner Coil

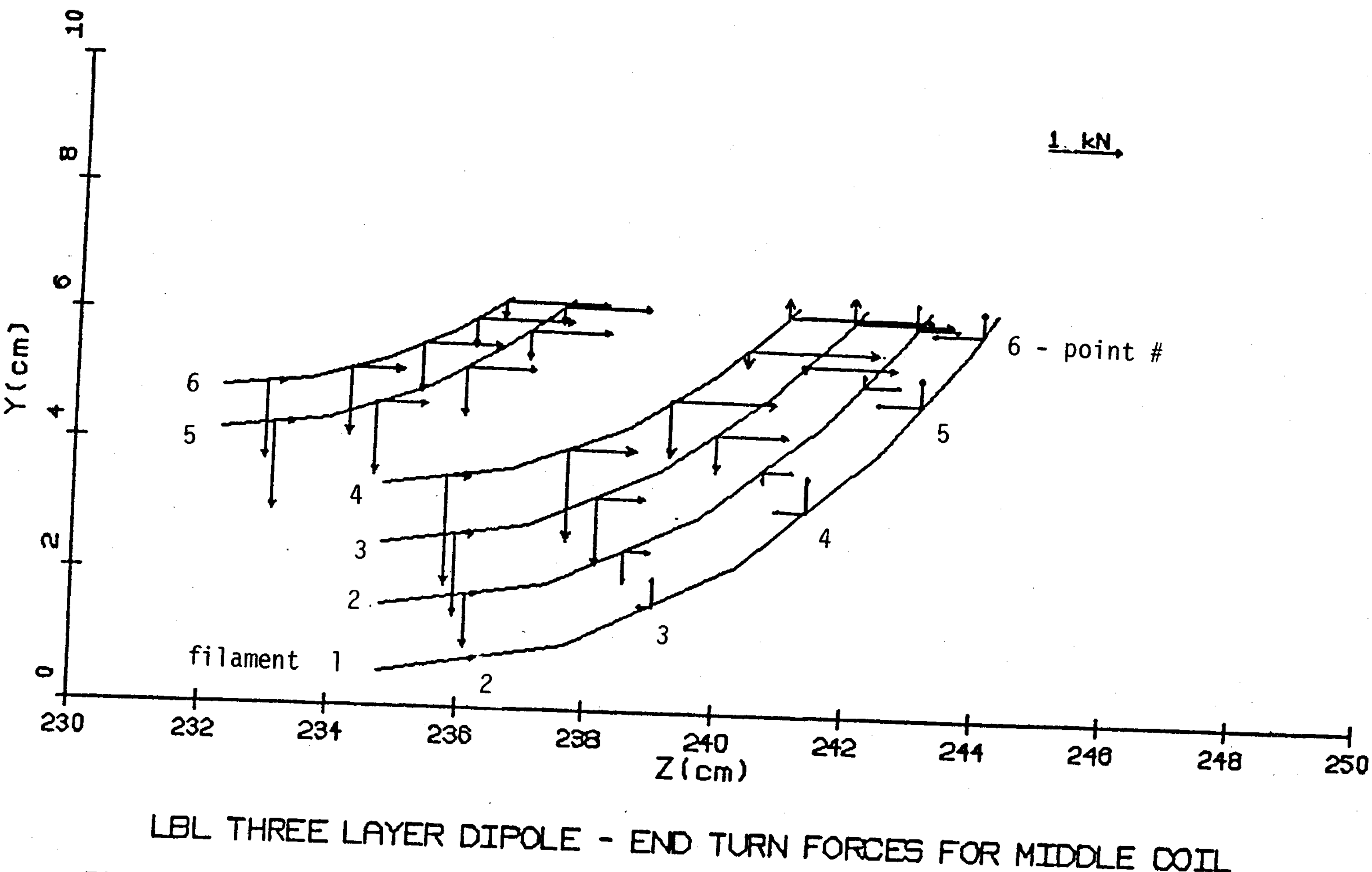
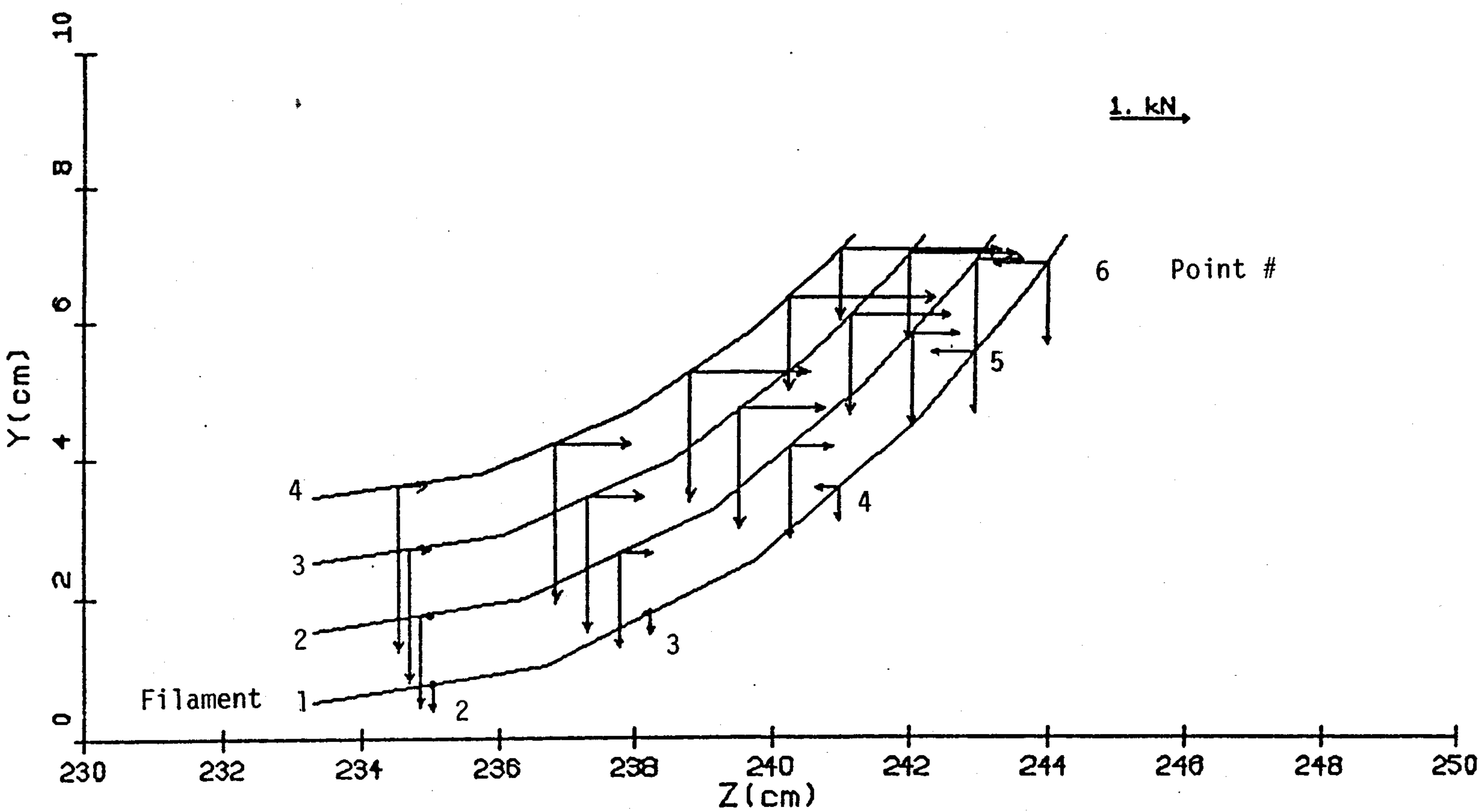
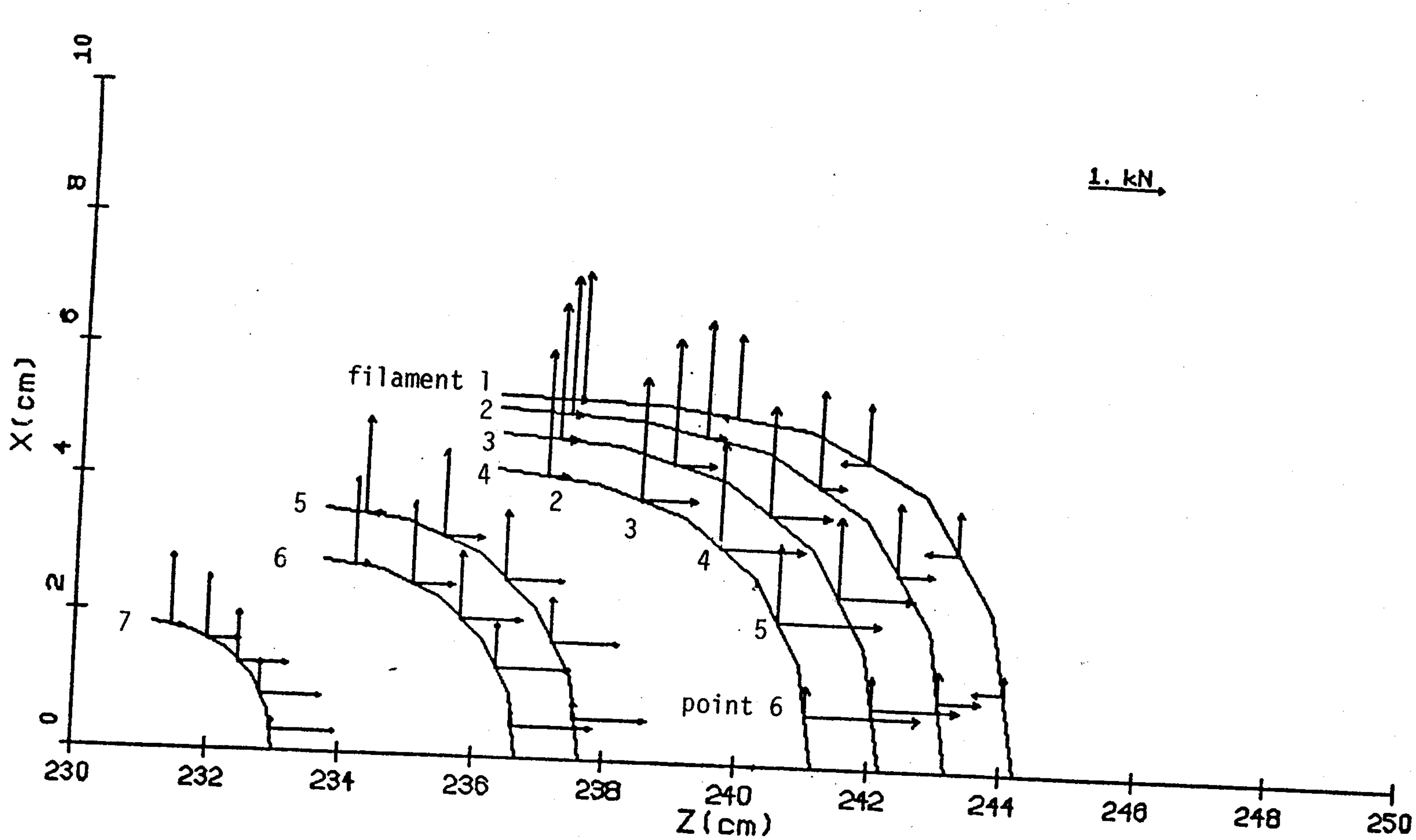


Figure 3.3.66: Stick Model, Side View, Showing End-Turn Forces Acting on each Stick for the Three-Layer Dipole, Middle Coil



LBL THREE LAYER DIPOLE - END TURN FORCES FOR OUTER COIL

Figure 3.3.67: Stick Model, Side View, Showing End-Turn Forces Acting on each Stick for the Three-Layer Dipole, Outer Coil



LBL THREE LAYER DIPOLE - END TURN FORCES FOR INNER COIL

Figure 3.3.68: Stick Model, Top View, Showing End-Turn Forces Acting on each Stick for the Three-Layer Dipole, Inner Coil

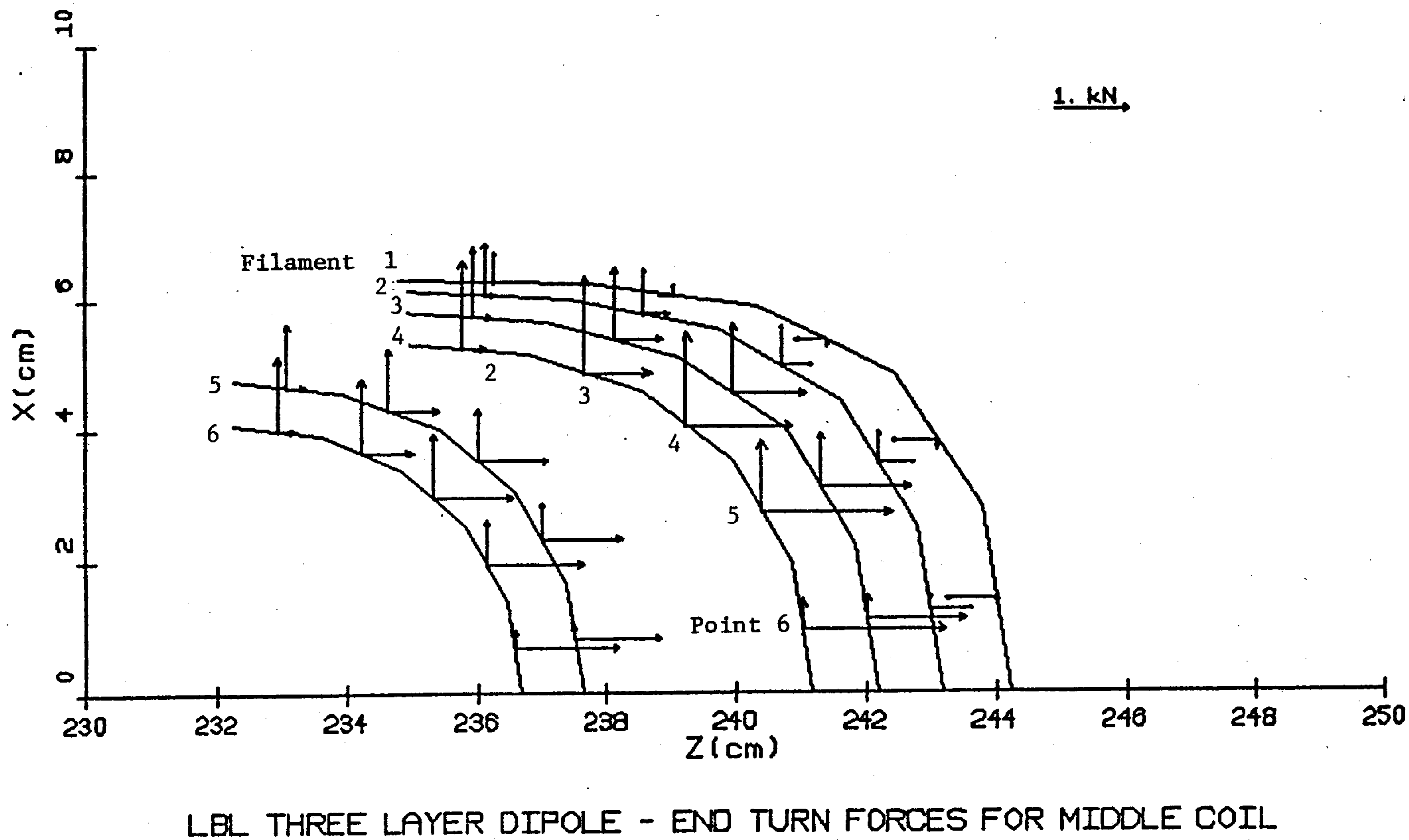


Figure 3.3.69: Stick Model, Top View, Showing End-Turn Forces Acting on each Stick for the Three-Layer Dipole, Middle Coil

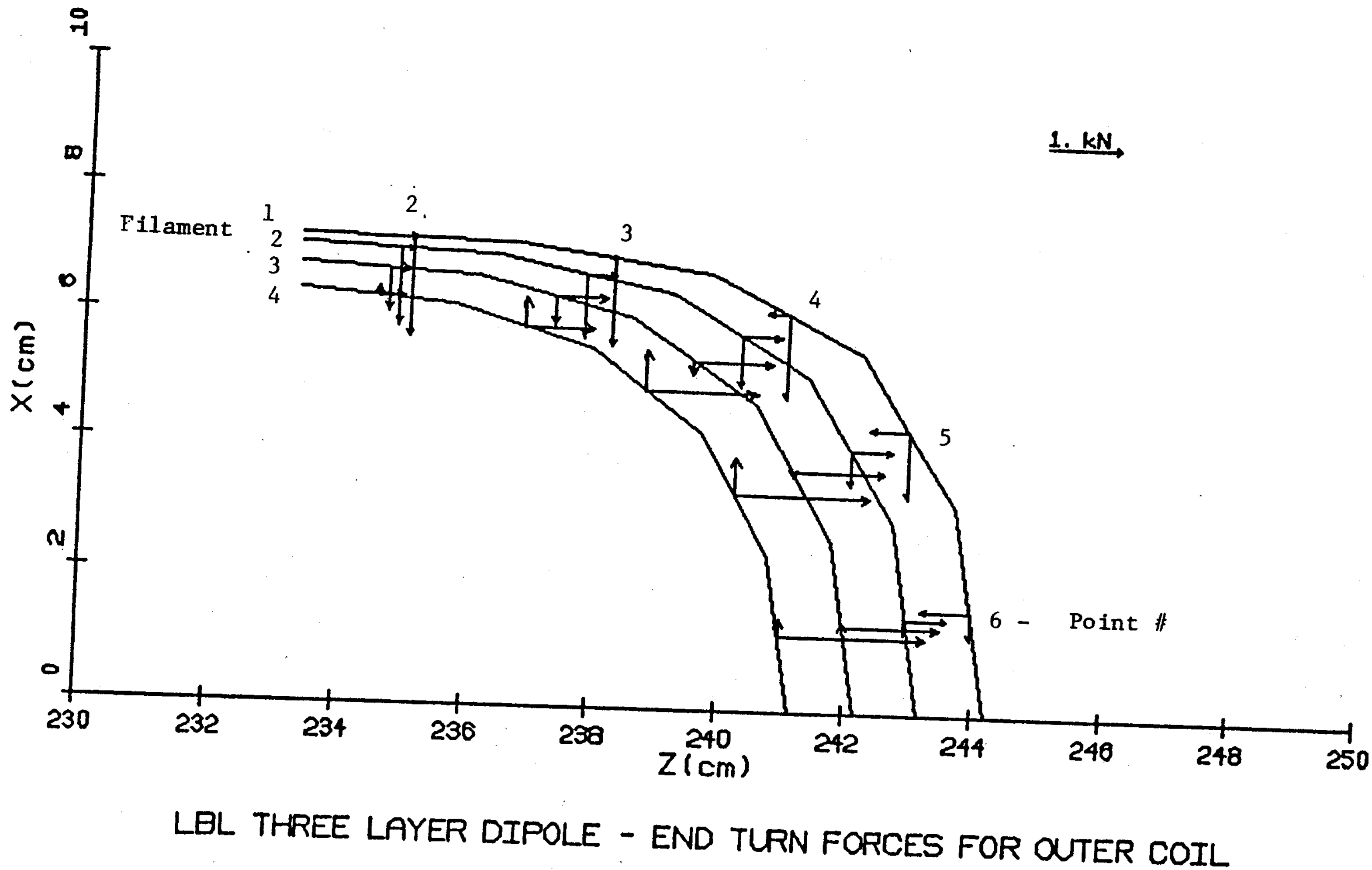


Figure 3.3.70: Stick Model, Top View, Showing End-Turn Forces Acting on each Stick for the Three-Layer Dipole, Outer Coil

Table 3.3.14: Lorentz Body Force Component Values for the Three-Layer Dipole Design, Inner Coil

LBL Three Layer Dipole Total Forces

Inner Coil - Filament 1

t x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
5.4195E-02	3.4225E-03	1.1811E+00	1.60092E+05	-3.57835E+03	0.00000E+00
5.3995E-02	5.4156E-03	2.3749E+00	1.09152E+03	1.77920E+02	-1.07835E+01
5.2393E-02	1.3040E-02	2.3989E+00	6.59152E+02	4.88792E+02	-1.60254E+02
4.6529E-02	2.6505E-02	2.4194E+00	4.27523E+02	6.25140E+02	-3.30047E+02
3.3231E-02	4.1426E-02	2.4343E+00	2.87710E+02	6.93136E+02	-4.07738E+02
1.2197E-02	5.1408E-02	2.4421E+00	1.11379E+02	7.55340E+02	-4.12979E+02
TOTAL FOR ALL POINTS			1.62670E+05	-8.38024E+02	-1.32180E+03

Inner Coil - Filament 2

t x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
5.3333E-02	1.0213E-02	1.1811E+00	1.61760E+05	-1.09103E+04	0.00000E+00
5.2927E-02	1.2003E-02	2.3738E+00	1.17534E+03	-3.37365E+00	4.16850E+01
5.0673E-02	1.8781E-02	2.3958E+00	9.06070E+02	2.57205E+02	3.75024E+01
4.4116E-02	3.0565E-02	2.4146E+00	7.21952E+02	4.87611E+02	1.02927E+01
3.0947E-02	4.3394E-02	2.4282E+00	5.27384E+02	7.03607E+02	4.06459E+01
1.1243E-02	5.1865E-02	2.4354E+00	2.03299E+02	8.69785E+02	9.03586E+01
TOTAL FOR ALL POINTS			1.65294E+05	-8.59550E+03	2.20485E+02

Inner Coil - Filament 3

t x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
5.1625E-02	1.6841E-02	1.1811E+00	1.64762E+05	-1.87538E+04	0.00000E+00
5.1059E-02	1.8410E-02	2.3727E+00	1.20770E+03	-1.44173E+02	8.63491E+01
4.8321E-02	2.4300E-02	2.3928E+00	1.04167E+03	8.99220E+01	1.97259E+02
4.1341E-02	3.4398E-02	2.4098E+00	8.80111E+02	3.73914E+02	2.74610E+02
2.8538E-02	4.5221E-02	2.4222E+00	6.42820E+02	6.65020E+02	3.68484E+02
1.0271E-02	5.2285E-02	2.4287E+00	2.43959E+02	8.74946E+02	4.43744E+02
TOTAL FOR ALL POINTS			1.68778E+05	-1.68942E+04	1.37045E+03

Inner Coil - Filament 4

t x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
4.9096E-02	2.3202E-02	1.1811E+00	1.68314E+05	-2.71329E+04	0.00000E+00
4.8418E-02	2.4540E-02	2.3717E+00	1.20211E+03	-2.57442E+02	1.22430E+02
4.5366E-02	2.9525E-02	2.3897E+00	1.09931E+03	-3.98365E+01	3.22200E+02
3.8225E-02	3.7972E-02	2.4050E+00	9.48622E+02	2.66724E+02	4.78073E+02
2.6012E-02	4.6901E-02	2.4162E+00	6.85372E+02	5.86786E+02	6.15188E+02
9.2841E-03	5.2666E-02	2.4220E+00	2.56413E+02	8.07850E+02	7.05281E+02
TOTAL FOR ALL POINTS			1.72506E+05	-2.57688E+04	2.24317E+03

LBL Three Layer Dipole Total Forces

Inner Coil - Filament 5

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	4.5787E-02	2.9194E-02	1.1811E+00	1.71612E+05	-3.50362E+04	0.00000E+00
2	4.5043E-02	3.0300E-02	2.3706E+00	1.16378E+03	-3.56566E+02	1.49725E+02
3	4.1845E-02	3.4392E-02	2.3866E+00	1.10445E+03	-1.53159E+02	4.17258E+02
4	3.4793E-02	4.1256E-02	2.4002E+00	9.59204E+02	1.53909E+02	6.32723E+02
5	2.3381E-02	4.8423E-02	2.4101E+00	6.83315E+02	4.72668E+02	8.01702E+02
6	8.2828E-03	5.3008E-02	2.4153E+00	2.52193E+02	6.85303E+02	9.01568E+02
TOTAL FOR ALL POINTS				1.75775E+05	-3.42341E+04	2.90298E+03

Inner Coil - Filament 6

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	4.1751E-02	3.4722E-02	1.1811E+00	1.75502E+05	-4.09690E+04	0.00000E+00
2	4.0987E-02	3.5602E-02	2.3696E+00	1.09193E+03	-4.54385E+02	1.67731E+02
3	3.7800E-02	3.8839E-02	2.3836E+00	1.07242E+03	-2.79174E+02	4.90479E+02
4	3.1074E-02	4.4221E-02	2.3955E+00	9.35369E+02	1.10876E+01	7.57748E+02
5	2.0654E-02	4.9783E-02	2.4041E+00	6.57494E+02	3.11313E+02	9.55373E+02
6	7.2689E-03	5.3311E-02	2.4087E+00	2.39631E+02	5.06042E+02	1.06420E+03
TOTAL FOR ALL POINTS				1.79499E+05	-4.08742E+04	3.43553E+03

Inner Coil - Filament 7

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	3.7226E-02	3.9535E-02	1.1684E+00	1.67111E+05	-4.28027E+04	0.00000E+00
2	3.6483E-02	4.0209E-02	2.3431E+00	8.58875E+02	-2.36727E+02	1.25931E+02
3	3.3448E-02	4.2679E-02	2.3552E+00	7.39739E+02	-1.25592E+02	3.35980E+02
4	2.7240E-02	4.6757E-02	2.3654E+00	5.66001E+02	2.28669E+01	4.76991E+02
5	1.7942E-02	5.0934E-02	2.3729E+00	3.59946E+02	1.56810E+02	5.63001E+02
6	6.2800E-03	5.3566E-02	2.3768E+00	1.24351E+02	2.36979E+02	6.04210E+02
TOTAL FOR ALL POINTS				1.69760E+05	-4.27484E+04	2.10611E+03

Inner Coil - Filament 8

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	3.2343E-02	4.3620E-02	1.1684E+00	1.71946E+05	-4.97927E+04	0.00000E+00
2	3.1654E-02	4.4114E-02	2.3422E+00	8.08794E+02	-2.31001E+02	1.25404E+02
3	2.8883E-02	4.5918E-02	2.3523E+00	7.35170E+02	-1.34423E+02	3.53419E+02
4	2.3346E-02	4.8878E-02	2.3610E+00	5.85449E+02	4.82782E+00	5.25770E+02
5	1.5264E-02	5.1889E-02	2.3673E+00	3.80270E+02	1.36050E+02	6.39785E+02
6	5.3186E-03	5.3776E-02	2.3706E+00	1.32468E+02	2.16108E+02	6.96898E+02
TOTAL FOR ALL POINTS				1.74588E+05	-4.98012E+04	2.34128E+03

Table 3.3.14 (continued)

LBL Three Layer Dipole Total Forces

Inner Coil - Filament 9

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
2.7016E-02	4.7105E-02	1.1684E+00	1.72755E+05	-5.19767E+04	0.00000E+00
2.6411E-02	4.7442E-02	2.3412E+00	7.32289E+02	-2.23009E+02	1.18516E+02
2.4006E-02	4.8667E-02	2.3495E+00	6.86105E+02	-1.45071E+02	3.46140E+02
1.9284E-02	5.0667E-02	2.3565E+00	5.56681E+02	-2.73627E+01	5.29707E+02
1.2531E-02	5.2690E-02	2.3617E+00	3.64263E+02	8.52551E+01	6.56232E+02
4.3501E-03	5.3952E-02	2.3644E+00	1.27020E+02	1.53755E+02	7.20544E+02
TOTAL FOR ALL POINTS			1.75221E+05	-5.21331E+04	2.37114E+03

Inner Coil - Filament 10

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
2.1263E-02	4.9966E-02	1.1557E+00	1.80475E+05	-4.71479E+04	0.00000E+00
2.0769E-02	5.0171E-02	2.3148E+00	5.23289E+02	-1.39717E+02	8.50410E+01
1.8820E-02	5.0913E-02	2.3212E+00	4.68777E+02	-1.07086E+02	2.42923E+02
1.5044E-02	5.2121E-02	2.3267E+00	3.61753E+02	-5.49780E+01	3.62689E+02
9.7283E-03	5.3337E-02	2.3306E+00	2.27666E+02	-6.46057E+00	4.41622E+02
3.3670E-03	5.4093E-02	2.3327E+00	7.77115E+01	2.24034E+01	4.80609E+02
TOTAL FOR ALL POINTS			1.82134E+05	-4.74337E+04	1.61288E+03

Inner Coil - Filament 11

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1.5157E-02	5.2144E-02	1.1557E+00	2.00633E+05	-3.97190E+04	0.00000E+00
1.4795E-02	5.2247E-02	2.3138E+00	4.11378E+02	-8.24148E+01	6.62460E+01
1.3376E-02	5.2618E-02	2.3183E+00	3.72977E+02	-6.43029E+01	1.92247E+02
1.0653E-02	5.3220E-02	2.3221E+00	2.95755E+02	-3.54689E+01	2.96914E+02
6.8640E-03	5.3824E-02	2.3249E+00	1.89350E+02	-6.99306E+00	3.70262E+02
2.3703E-03	5.4199E-02	2.3264E+00	6.51272E+01	1.04257E+01	4.07807E+02
TOTAL FOR ALL POINTS			2.01967E+05	-3.98977E+04	1.33348E+03

Table 3.3.15: Lorentz Body Force Component Values for the Three-Layer Dipole Design, Middle Coil

LBL Three Layer Dipole Total Forces

Middle Coil - Filament 1

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.3410E-02	3.4231E-03	1.1739E+00	4.60168E+04	-8.45427E+03	0.00000E+00
2	6.3196E-02	5.7700E-03	2.3626E+00	2.37089E+02	9.55900E+01	-1.16602E+01
3	6.1386E-02	1.4756E-02	2.3909E+00	5.46604E+00	3.79717E+02	-1.87104E+02
4	5.4600E-02	3.0642E-02	2.4150E+00	-1.49678E+02	4.00823E+02	-4.20812E+02
5	3.9049E-02	4.8272E-02	2.4325E+00	-1.53090E+02	2.82823E+02	-5.78360E+02
6	1.4344E-02	6.0078E-02	2.4417E+00	-5.92061E+01	1.95772E+02	-6.44698E+02
TOTAL FOR ALL POINTS				4.58974E+04	-7.09955E+03	-1.84263E+03

Middle Coil - Filament 2

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2673E-02	1.0229E-02	1.1739E+00	4.91474E+04	-2.54875E+04	0.00000E+00
2	6.2246E-02	1.2377E-02	2.3616E+00	3.72143E+02	-2.56370E+02	5.13097E+01
3	5.9759E-02	2.0524E-02	2.3879E+00	2.51007E+02	-5.20617E+01	6.65198E+01
4	5.2240E-02	3.4732E-02	2.4102E+00	1.66245E+02	8.39871E+01	2.20131E+01
5	3.6783E-02	5.0259E-02	2.4265E+00	1.21099E+02	1.62218E+02	3.73841E+00
6	1.3392E-02	6.0540E-02	2.4350E+00	4.92538E+01	2.16984E+02	7.67605E+00
TOTAL FOR ALL POINTS				5.01071E+04	-2.53327E+04	1.51257E+02

Middle Coil - Filament 3

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.1208E-02	1.6917E-02	1.1739E+00	5.53560E+04	-4.30206E+04	0.00000E+00
2	6.0607E-02	1.8847E-02	2.3605E+00	4.84540E+02	-5.10071E+02	9.99152E+01
3	5.7587E-02	2.6115E-02	2.3848E+00	4.41110E+02	-3.48230E+02	2.54056E+02
4	4.9568E-02	3.8635E-02	2.4055E+00	3.93014E+02	-1.33577E+02	3.45764E+02
5	3.4409E-02	5.2128E-02	2.4205E+00	3.06456E+02	7.42506E+01	4.19373E+02
6	1.2425E-02	6.0970E-02	2.4284E+00	1.20970E+02	2.19718E+02	4.68210E+02
TOTAL FOR ALL POINTS				5.71021E+04	-4.37185E+04	1.58732E+03

Middle Coil - Filament 4

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	5.9031E-02	2.3408E-02	1.1739E+00	6.41734E+04	-6.17917E+04	0.00000E+00
2	5.8297E-02	2.5111E-02	2.3595E+00	5.95244E+02	-7.02009E+02	1.39393E+02
3	5.4690E-02	3.1476E-02	2.3817E+00	6.01743E+02	-5.54812E+02	3.97277E+02
4	4.6597E-02	4.2326E-02	2.4007E+00	5.67990E+02	-2.87411E+02	5.92921E+02
5	3.1933E-02	5.3873E-02	2.4144E+00	4.40215E+02	3.31532E+00	7.36488E+02
6	1.1445E-02	6.1368E-02	2.4217E+00	1.70763E+02	2.04315E+02	8.18741E+02
TOTAL FOR ALL POINTS				6.65494E+04	-6.31283E+04	2.68482E+03

Table 3.3.15 (continued)

LBL Three Layer Dipole Total Forces

Middle Coil - Filament 5

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
5.6168E-02	2.9627E-02	1.1739E+00	7.36341E+04	-8.29132E+04	0.00000E+00
5.5342E-02	3.1097E-02	2.3584E+00	7.05026E+02	-8.60488E+02	1.73496E+02
5.1692E-02	3.6560E-02	2.3787E+00	7.49951E+02	-7.08919E+02	5.15046E+02
4.3344E-02	4.5782E-02	2.3959E+00	7.17228E+02	-4.02906E+02	7.95918E+02
2.9362E-02	5.5487E-02	2.4084E+00	5.45932E+02	-6.00336E+01	9.98326E+02
1.0451E-02	6.1733E-02	2.4150E+00	2.08116E+02	1.72644E+02	1.10840E+03
OTAL FOR ALL POINTS			7.65603E+04	-8.47729E+04	3.59118E+03

Middle Coil - Filament 6

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
5.2652E-02	3.5501E-02	1.1739E+00	7.81682E+04	-1.02866E+05	0.00000E+00
5.1773E-02	3.6740E-02	2.3573E+00	8.05083E+02	-1.01664E+03	2.05090E+02
4.8021E-02	4.1318E-02	2.3756E+00	8.96497E+02	-8.53039E+02	6.26896E+02
3.9830E-02	4.8981E-02	2.3911E+00	8.60898E+02	-5.08550E+02	9.86863E+02
2.6703E-02	5.6966E-02	2.4024E+00	6.42795E+02	-1.27755E+02	1.24483E+03
9.4463E-03	6.2065E-02	2.4083E+00	2.41011E+02	1.23604E+02	1.38167E+03
OTAL FOR ALL POINTS			8.16144E+04	-1.05249E+05	4.44535E+03

Middle Coil - Filament 7

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
4.8679E-02	4.0779E-02	1.1612E+00	7.75870E+04	-1.03432E+05	0.00000E+00
4.7785E-02	4.1801E-02	2.3309E+00	5.43738E+02	-7.71558E+02	1.48668E+02
4.4062E-02	4.5559E-02	2.3472E+00	5.22578E+02	-6.26956E+02	4.13213E+02
3.6211E-02	5.1806E-02	2.3611E+00	4.34763E+02	-4.05817E+02	5.87920E+02
2.4061E-02	5.8259E-02	2.3712E+00	2.84717E+02	-2.19155E+02	6.78981E+02
8.4665E-03	6.2353E-02	2.3765E+00	9.95698E+01	-1.13244E+02	7.16986E+02
OTAL FOR ALL POINTS			7.94723E+04	-1.05569E+05	2.54577E+03

Middle Coil - Filament 8

x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
4.4350E-02	4.5449E-02	1.1612E+00	9.19971E+04	-1.08931E+05	0.00000E+00
4.3475E-02	4.6272E-02	2.3299E+00	6.05135E+02	-7.34163E+02	1.49463E+02
3.9890E-02	4.9287E-02	2.3444E+00	5.98358E+02	-6.26743E+02	4.37667E+02
3.2528E-02	5.4268E-02	2.3566E+00	5.13392E+02	-4.36551E+02	6.63973E+02
2.1452E-02	5.9378E-02	2.3656E+00	3.48940E+02	-2.49155E+02	8.08673E+02
7.5140E-03	6.2601E-02	2.3702E+00	1.24206E+02	-1.34261E+02	8.77561E+02
OTAL FOR ALL POINTS			9.41871E+04	-1.11112E+05	2.93734E+03

Table 3.3.15 (continued)

LBL Three Layer Dipole Total Forces

Middle Coil - Filament 9

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	3.9576E-02	4.9662E-02	1.1612E+00	1.18502E+05	-1.17107E+05	0.00000E+00
2	3.8748E-02	5.0300E-02	2.3290E+00	6.92394E+02	-6.82581E+02	1.52845E+02
3	3.5402E-02	5.2631E-02	2.3415E+00	6.83144E+02	-5.87122E+02	4.55612E+02
4	2.8675E-02	5.6462E-02	2.3522E+00	5.91265E+02	-4.09823E+02	7.12094E+02
5	1.8787E-02	6.0368E-02	2.3600E+00	4.04876E+02	-2.24195E+02	8.88171E+02
6	6.5543E-03	6.2819E-02	2.3640E+00	1.44472E+02	-1.07500E+02	9.75878E+02
TOTAL FOR ALL POINTS				1.21018E+05	-1.19118E+05	3.18460E+03

Table 3.3.16: Lorentz Body Force Component Values for the Three-Layer Dipole Design, Outer Coil

LBL Three Layer Dipole Total Forces

Outer Coil - Filament 1

Pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.2612E-02	3.4235E-03	1.1667E+00	-5.66560E+04	-1.12533E+04	0.00000E+00
2	7.2383E-02	6.1237E-03	2.3504E+00	-9.15397E+02	-4.19067E+01	-5.60714E+00
3	7.0366E-02	1.6468E-02	2.3830E+00	-8.22528E+02	4.62437E+01	-1.18215E+02
4	6.2660E-02	3.4775E-02	2.4107E+00	-8.28035E+02	-8.84852E+01	-3.22904E+02
5	4.4859E-02	5.5110E-02	2.4308E+00	-6.58795E+02	-3.86006E+02	-5.20553E+02
6	1.6488E-02	6.8738E-02	2.4414E+00	-2.54086E+02	-6.21459E+02	-6.38820E+02
TOTAL FOR ALL POINTS				-6.01348E+04	-1.23449E+04	-1.60610E+03

Outer Coil - Filament 2

Pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.1968E-02	1.0240E-02	1.1667E+00	-5.29817E+04	-3.37520E+04	0.00000E+00
2	7.1522E-02	1.2743E-02	2.3494E+00	-8.05633E+02	-5.01267E+02	5.57686E+01
3	6.8809E-02	2.2255E-02	2.3799E+00	-7.02009E+02	-4.97713E+02	1.30988E+02
4	6.0341E-02	3.8886E-02	2.4059E+00	-6.23234E+02	-5.40863E+02	1.16539E+02
5	4.2608E-02	5.7112E-02	2.4248E+00	-4.53253E+02	-6.53923E+02	5.40827E+01
6	1.5538E-02	6.9204E-02	2.4347E+00	-1.68270E+02	-7.50725E+02	1.75324E+00
TOTAL FOR ALL POINTS				-5.57341E+04	-3.66964E+04	3.59132E+02

Outer Coil - Filament 3

Pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.0685E-02	1.6966E-02	1.1667E+00	-4.54885E+04	-5.62839E+04	0.00000E+00
	7.0056E-02	1.9256E-02	2.3483E+00	-6.39266E+02	-8.13733E+02	9.74220E+01
	6.6773E-02	2.7897E-02	2.3768E+00	-5.13042E+02	-8.37689E+02	2.92624E+02
4	5.7746E-02	4.2839E-02	2.4011E+00	-3.92831E+02	-8.04274E+02	4.10390E+02
	4.0261E-02	5.9011E-02	2.4187E+00	-2.50691E+02	-7.77328E+02	4.50760E+02
	1.4575E-02	6.9642E-02	2.4280E+00	-8.65189E+01	-7.67388E+02	4.54579E+02
TOTAL FOR ALL POINTS				-4.73709E+04	-6.02843E+04	1.70577E+03

Outer Coil - Filament 4

Pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.8775E-02	2.3541E-02	1.1667E+00	-3.38044E+04	-7.91082E+04	0.00000E+00
	6.7997E-02	2.5607E-02	2.3473E+00	-4.29433E+02	-1.05423E+03	1.32270E+02
	6.4272E-02	3.3352E-02	2.3738E+00	-2.79553E+02	-1.07128E+03	4.18346E+02
4	5.4886E-02	4.6613E-02	2.3963E+00	-1.43470E+02	-9.63991E+02	6.39880E+02
5	3.7823E-02	6.0804E-02	2.4127E+00	-5.02556E+01	-8.21536E+02	7.64055E+02
	1.3599E-02	7.0052E-02	2.4213E+00	-8.78910E+00	-7.26338E+02	8.14479E+02
TOTAL FOR ALL POINTS				-3.47159E+04	-8.37456E+04	2.76903E+03

Table 3.3.16 (continued)

LBL Three Layer Dipole Total Forces

Outer Coil - Filament 5

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.6255E-02	2.9907E-02	1.1667E+00	-1.68391E+04	-1.03235E+05	0.00000E+00
2	6.5364E-02	3.1742E-02	2.3462E+00	-1.77841E+02	-1.24722E+03	1.65369E+02
3	6.1324E-02	3.8583E-02	2.3707E+00	-7.37594E+00	-1.23125E+03	5.28412E+02
4	5.1773E-02	5.0191E-02	2.3915E+00	1.26013E+02	-1.04678E+03	8.37044E+02
5	3.5298E-02	6.2485E-02	2.4067E+00	1.52545E+02	-8.05148E+02	1.03347E+03
6	1.2612E-02	7.0434E-02	2.4146E+00	6.70413E+01	-6.41383E+02	1.12452E+03
TOTAL FOR ALL POINTS				-1.66787E+04	-1.08207E+05	3.68882E+03

Outer Coil - Filament 6

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.3147E-02	3.6008E-02	1.1667E+00	9.58885E+03	-1.33749E+05	0.00000E+00
2	6.2178E-02	3.7610E-02	2.3451E+00	1.44672E+02	-1.43998E+03	2.06984E+02
3	5.7948E-02	4.3552E-02	2.3676E+00	3.31509E+02	-1.35363E+03	6.52226E+02
4	4.8422E-02	5.3555E-02	2.3867E+00	4.41598E+02	-1.06914E+03	1.04224E+03
5	3.2694E-02	6.4050E-02	2.4006E+00	3.78682E+02	-7.28877E+02	1.30761E+03
6	1.1615E-02	7.0787E-02	2.4080E+00	1.49503E+02	-5.03010E+02	1.43932E+03
TOTAL FOR ALL POINTS				1.10348E+04	-1.38844E+05	4.64838E+03

450 lines printed

3.3.3.4 Window Frame Dipole

Figures 3.3.71 and 3.3.72 show the side views of the saddle and racetrack models used in the windings for the three-dimensional calculations, while Figures 3.3.73 and 3.3.74 show the top views. The small racetrack was modeled with a single filament. The large racetrack and saddle coils were modeled with two and twelve filaments, respectively, as is indicated in Figure 3.3.75.

Also indicated in each figure is the location and magnitude of the three-dimensional peak field in the windings. Values of 5.42 T, 5.69 T and 6.38 T were obtained for the saddle and large and small Helmholtz coils, respectively.

The iron shown in Figures 3.3.71 and 3.3.72 extends to z = 2.286 m (7.5 ft.). One octant of the iron was modeled with 196 elements with constant magnetizations corresponding to those shown in Figure 3.3.36.

Figure 3.3.75 shows the midplane section of the magnet with the blocks outlined. The filaments used to model the windings are enumerated. These numbers correspond to those listed in the force tabulation. Each filament is made up of 6 straight sticks in an octant of the coil. A single stick runs from the midplane to the start of the crossover. There are five straight sticks that model the crossover. The sticks and, hence, the midpoints are numbered consecutively from the midplane to the middle of the crossover.

The axial field profile for this design is presented in Figure 3.3.76. The field lines in the end-turn crossover region and in the x = 0 plane are shown in Figure 3.3.77. Also indicated are the iron boundaries and the coil outlines.

The Lorentz forces acting on the end turn are shown in Figures 3.3.78 through 3.3.85. Figures 3.3.78 through 3.3.81 show the side views with

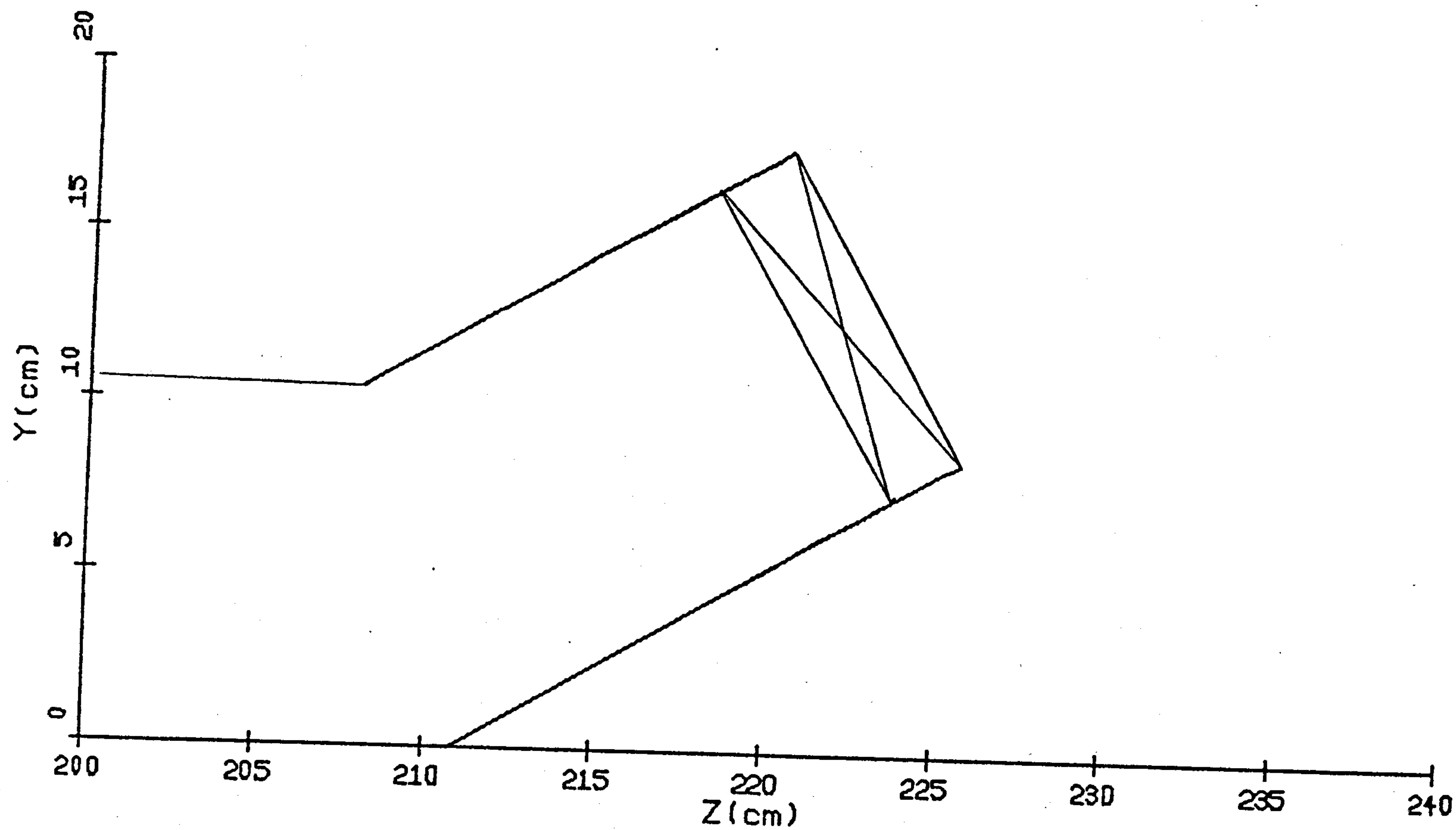


Figure 3.3.71: Side View of the End-Turn Crossover Region Model, Window Frame Dipole Design, Saddle Magnet

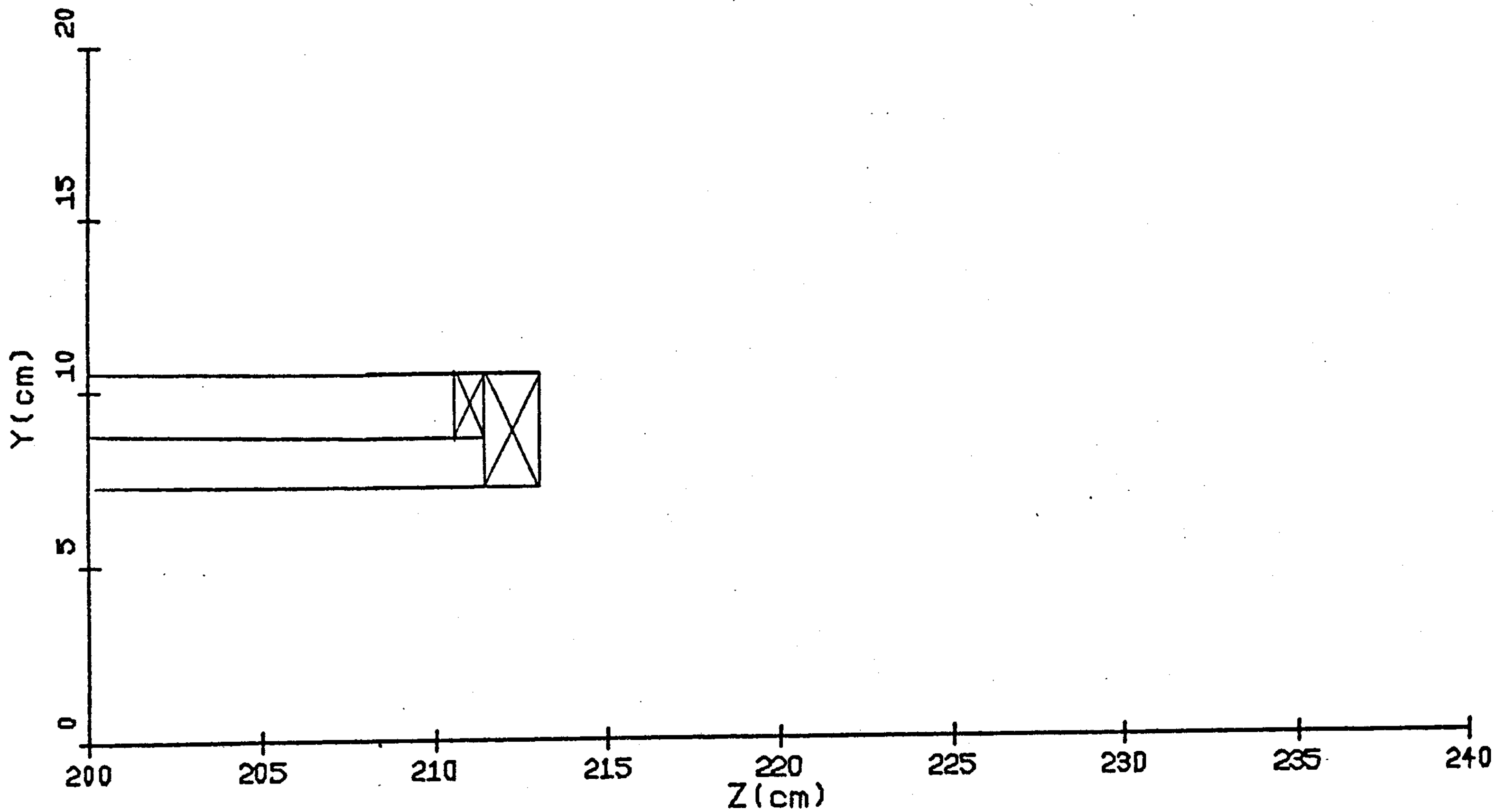


Figure 3.3.72: Side view of the End-Turn Crossover Region Model, Window Frame Dipole Design, Race-Track Magnet

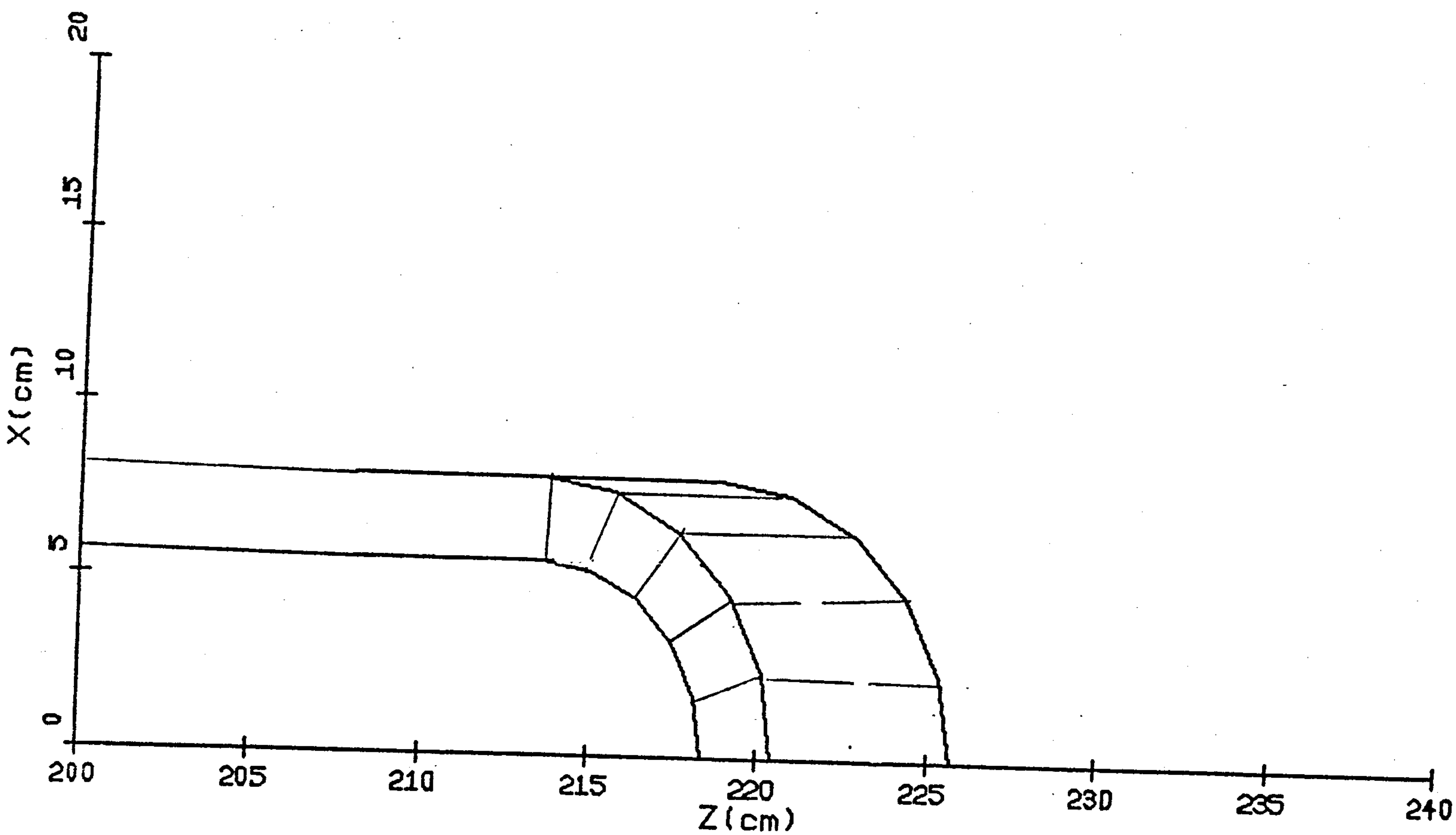


Figure 3.3.73: Top View of the End-Turn Crossover Region Model, Window Frame Dipole Design, Saddle Magnet

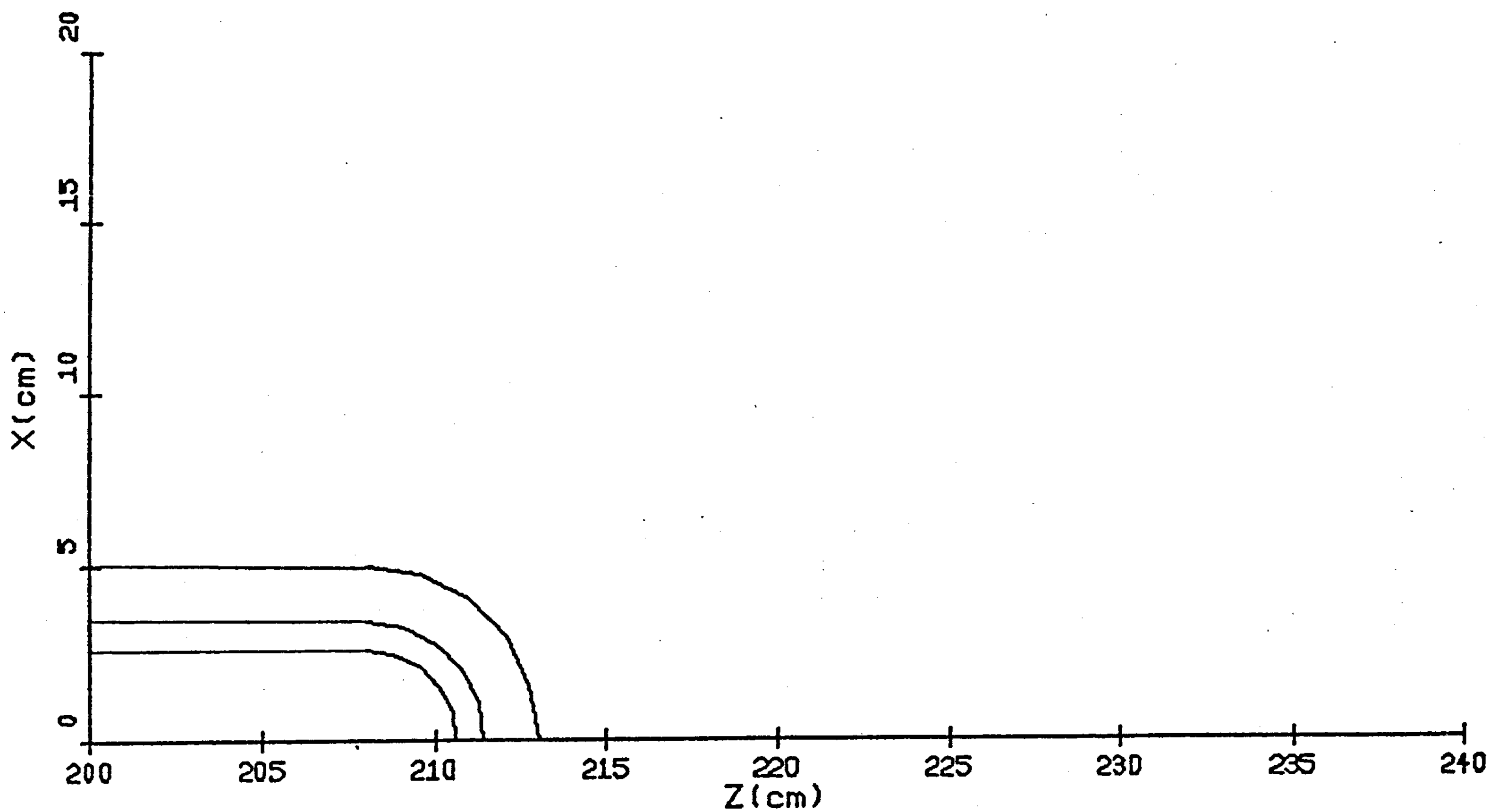


Figure 3.3.74: Top View of the End-Turn Crossover Region Model, Window Frame Dipole Design, Racetrack Magnets

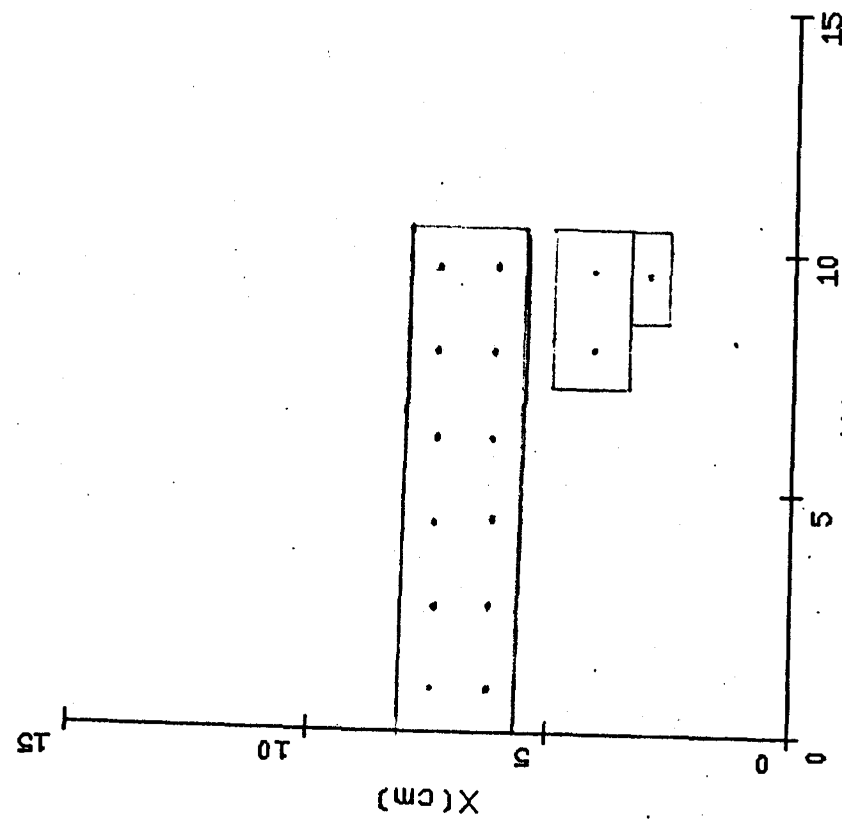


Figure 3.3.75: Midplane Model for the Window Frame Dipole Design

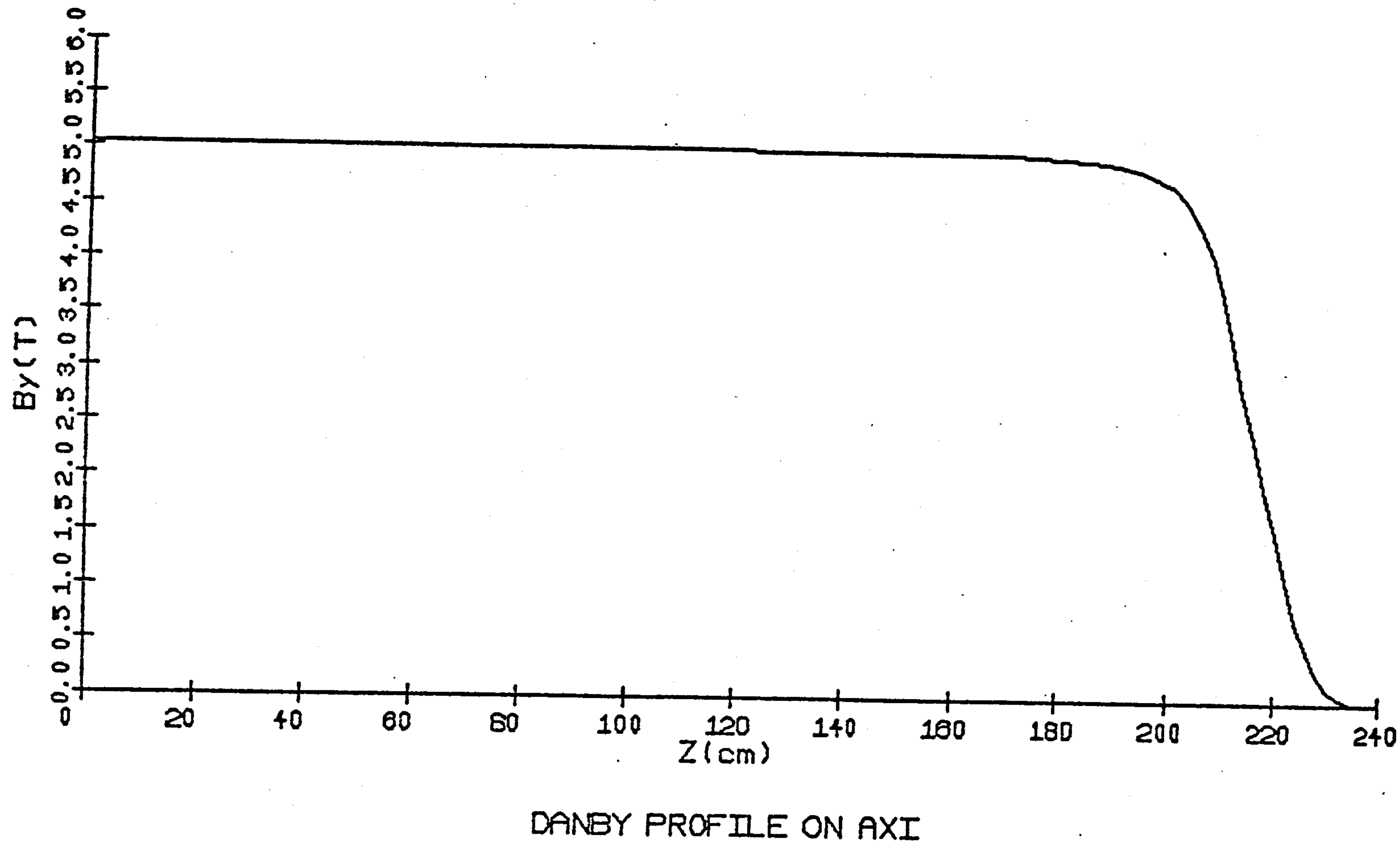


Figure 3.3.76: Axial Field Profile, B_y versus z, for the Window Frame Dipole Design

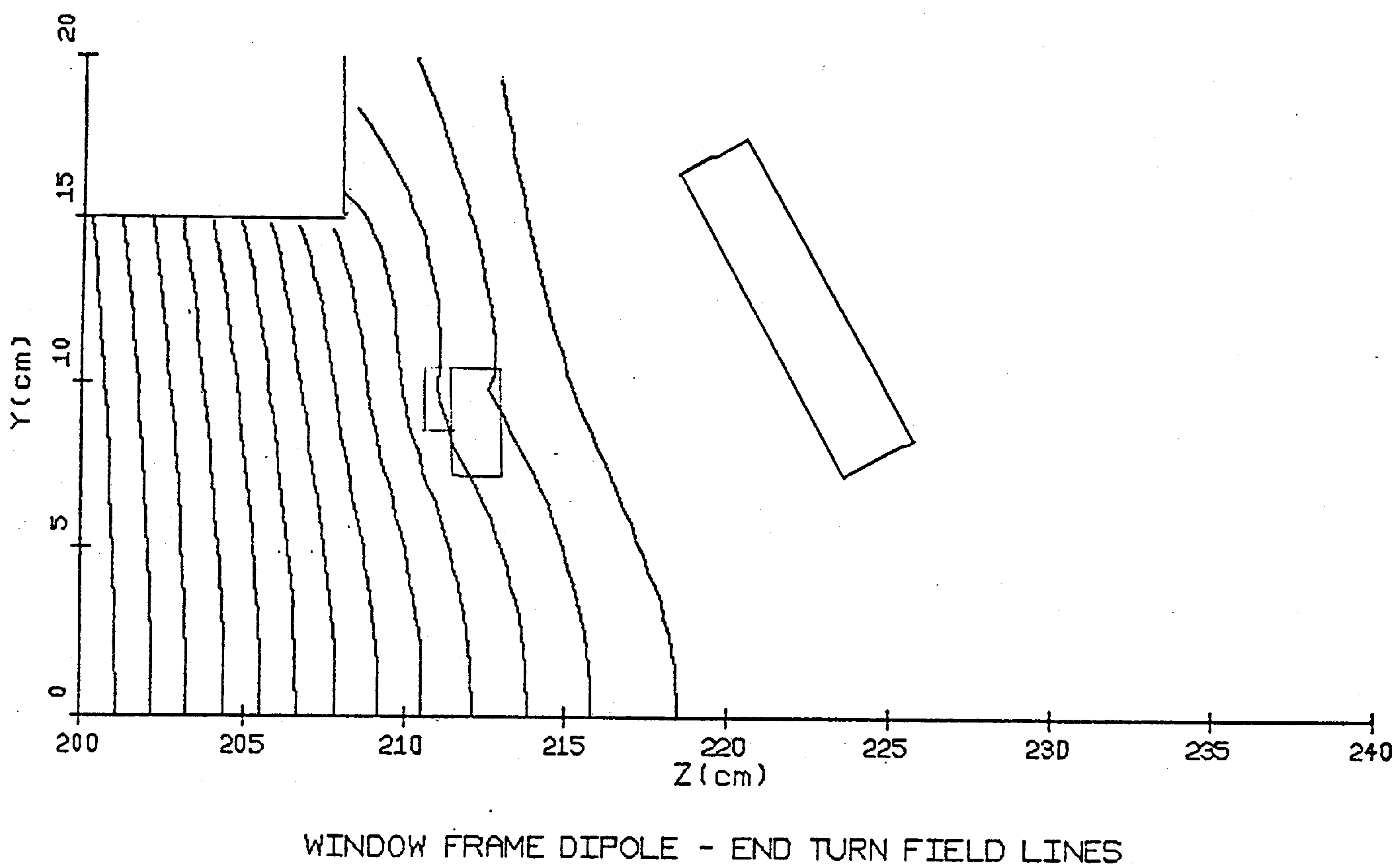


Figure 3.3.77: End-Turn Crossover Region Field Lines in the X = 0 Plane for the Window Frame Dipole Design

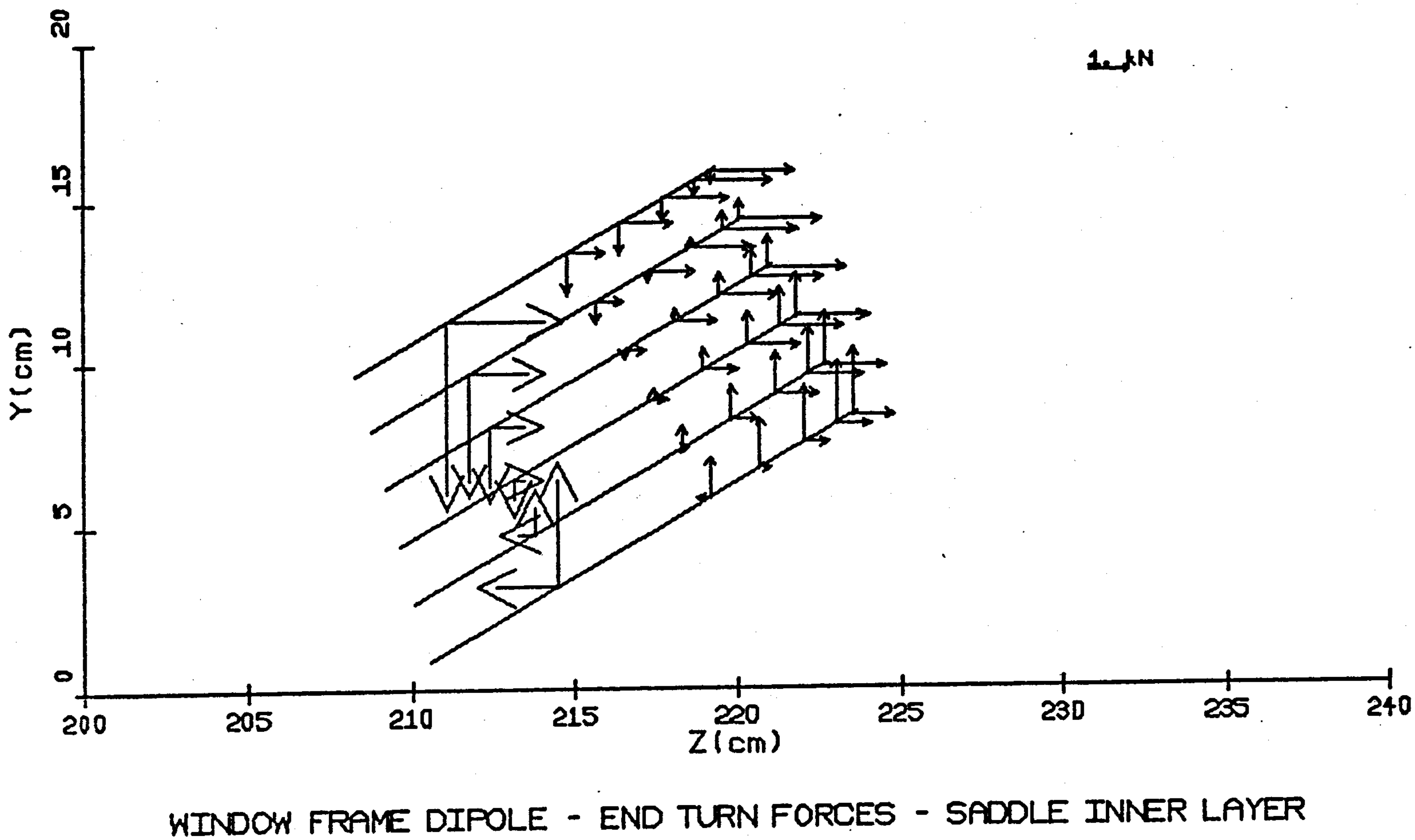


Figure 3.3.78: Stick Model, Side View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Saddle Coil, Inner Layer

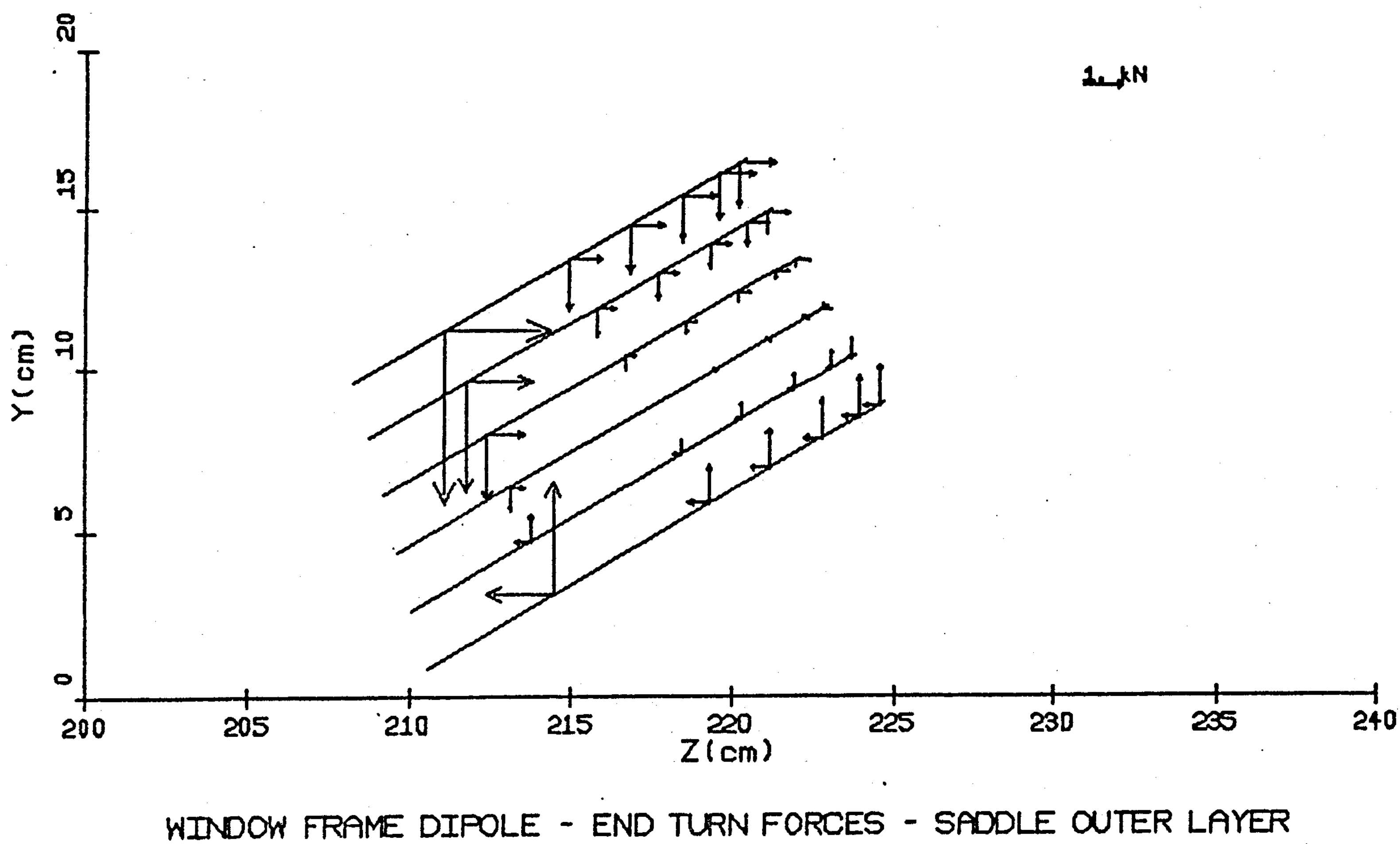


Figure 3.3.79: Stick Model, Side View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Outer Layer

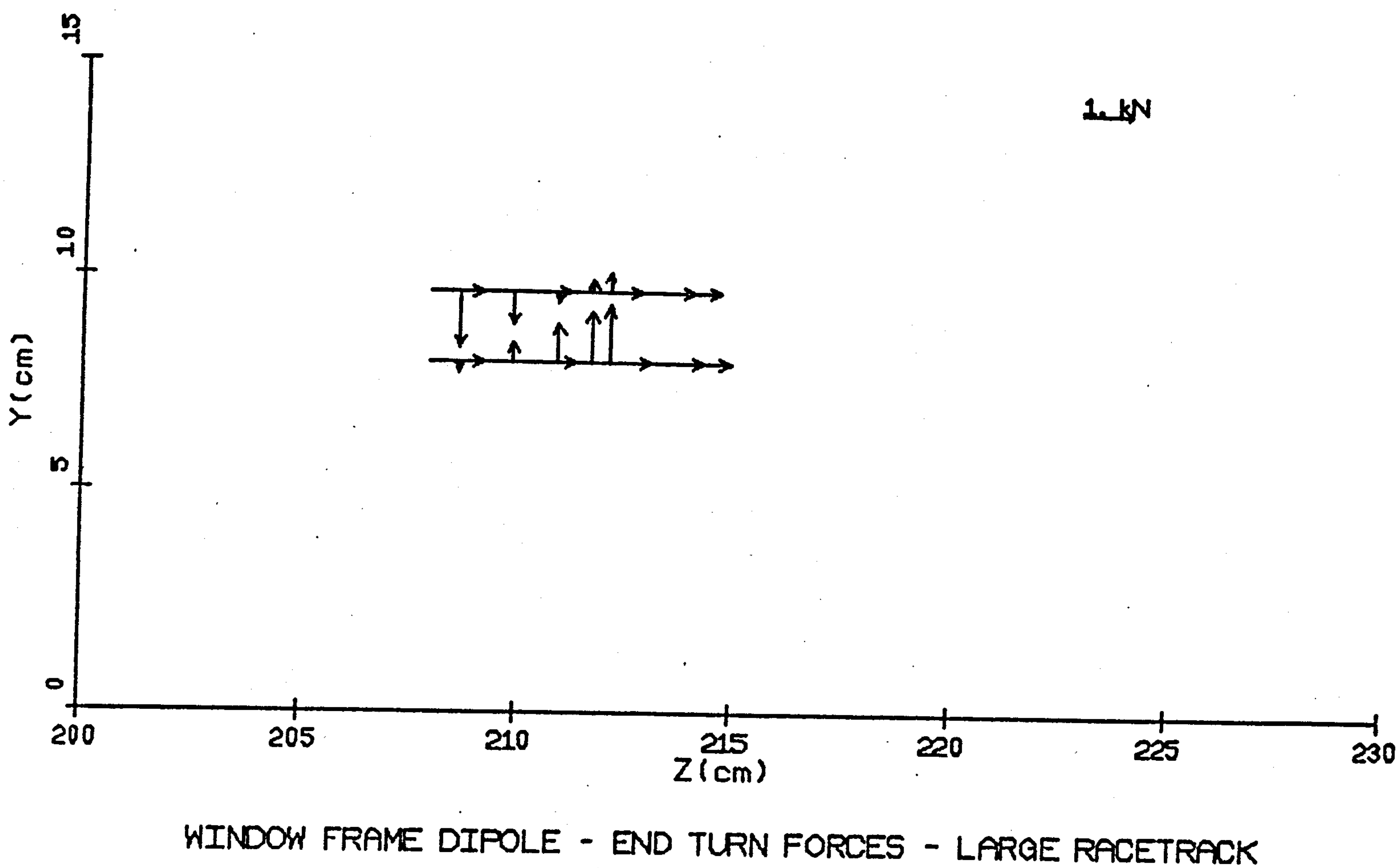


Figure 3.3.80: Stick Model, Side View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Large Racetrack Coil

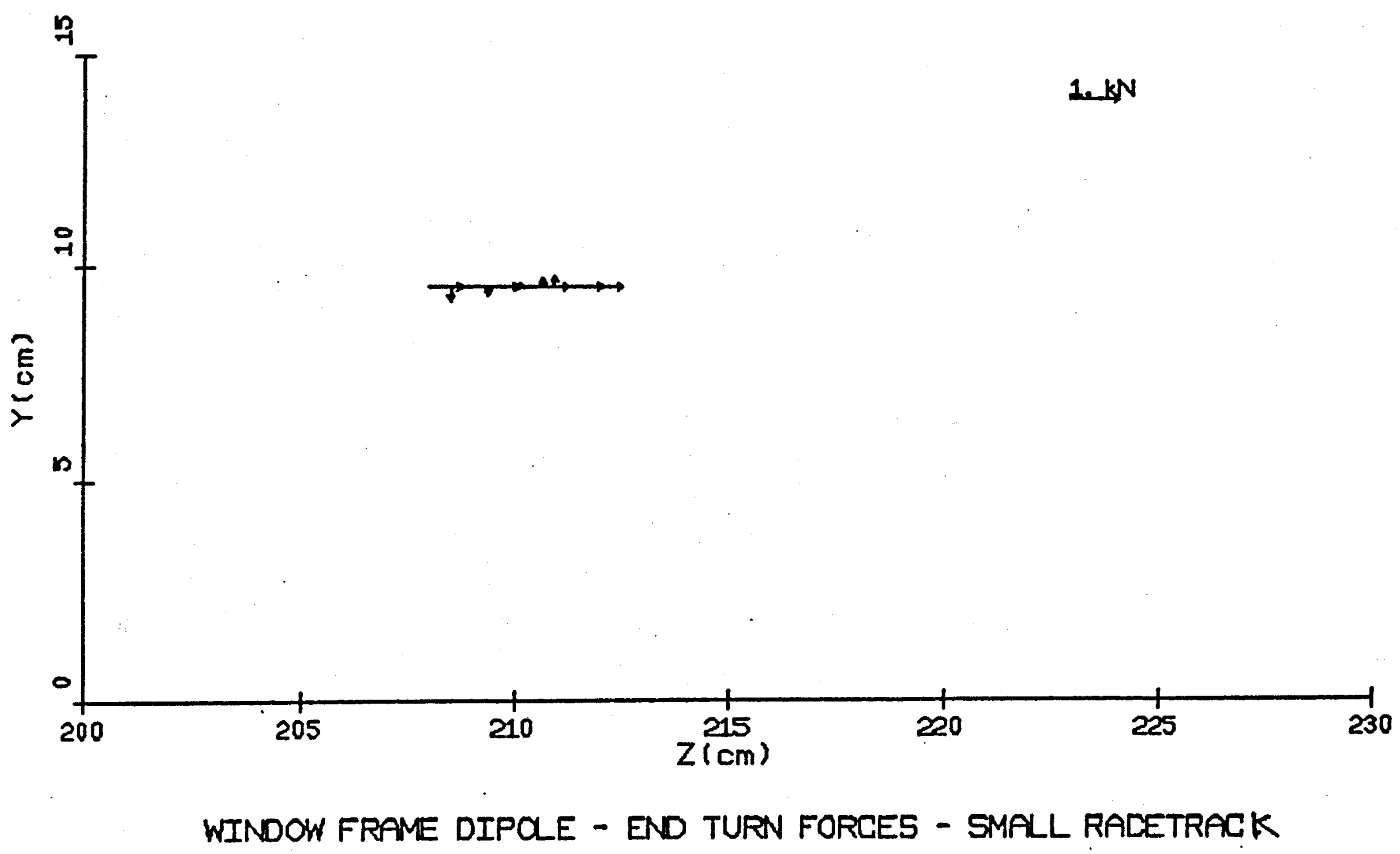


Figure 3.3.81: Stick Model, Side View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Small Racetrack Coil

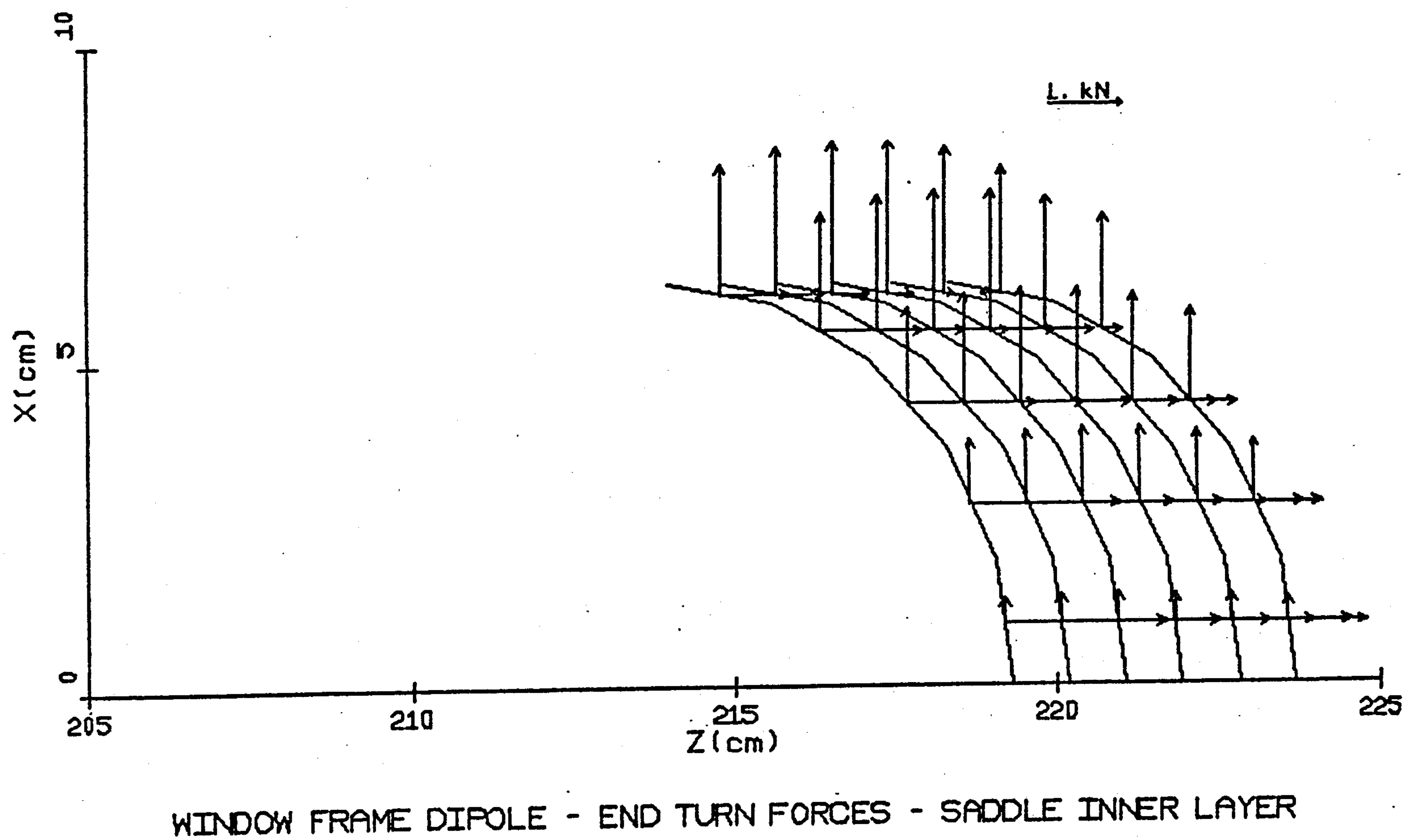


Figure 3.3.82: Stick Model, Top View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Saddle Coil, Inner Layer

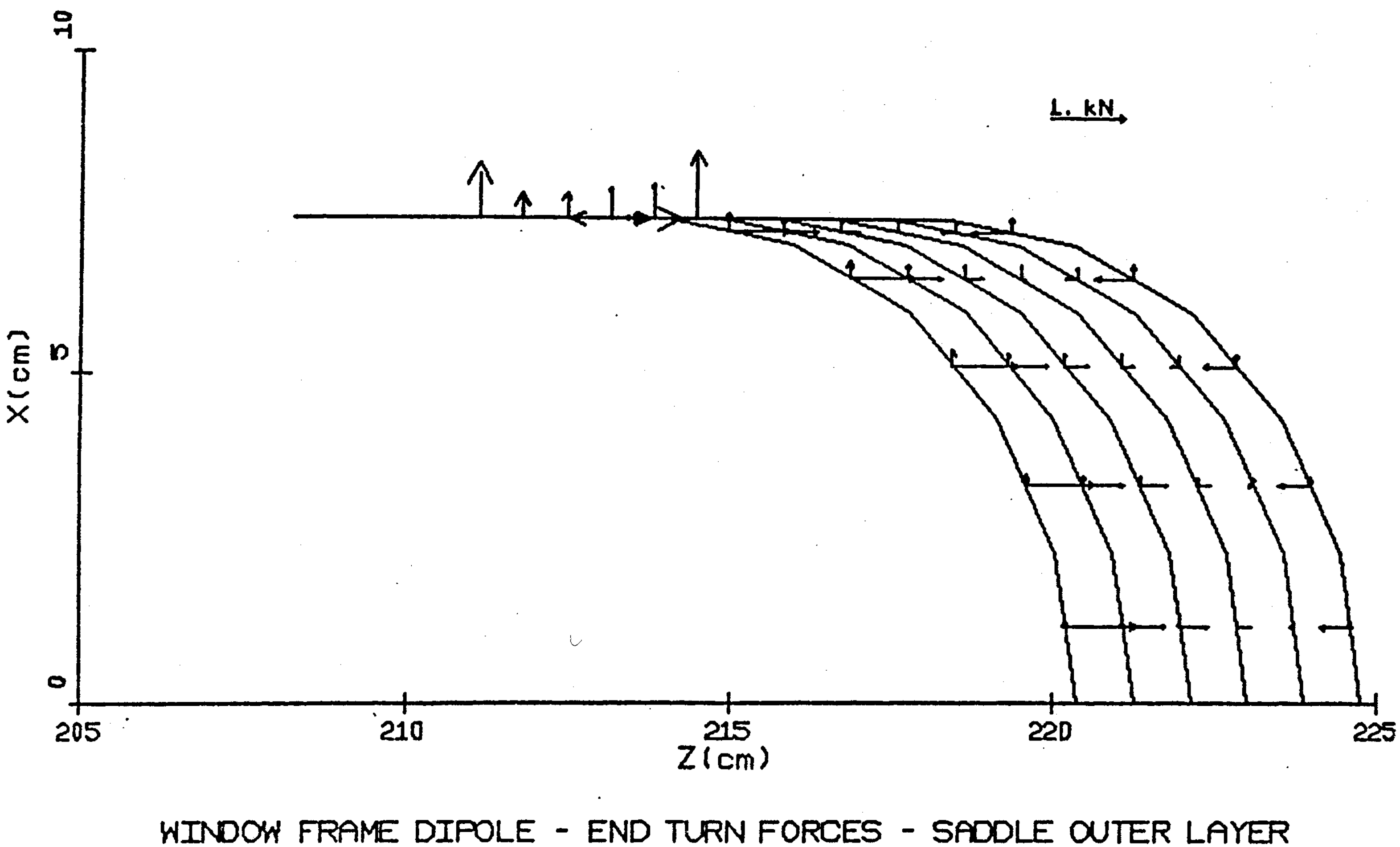


Figure 3.3.83: Stick Model, Top View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Outer Layer

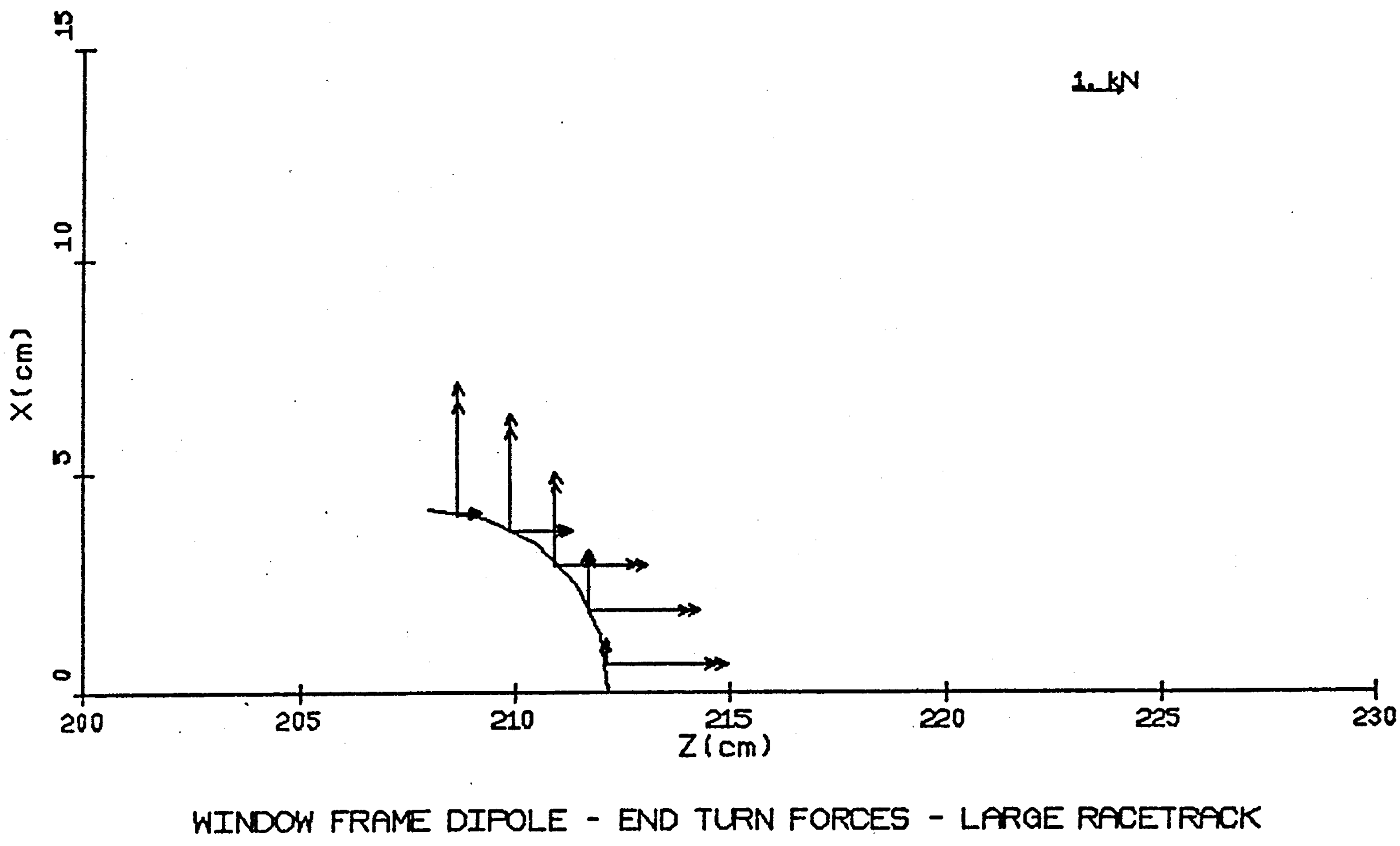


Figure 3.3.84: Stick Model, Top View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Large Racetrack Coil

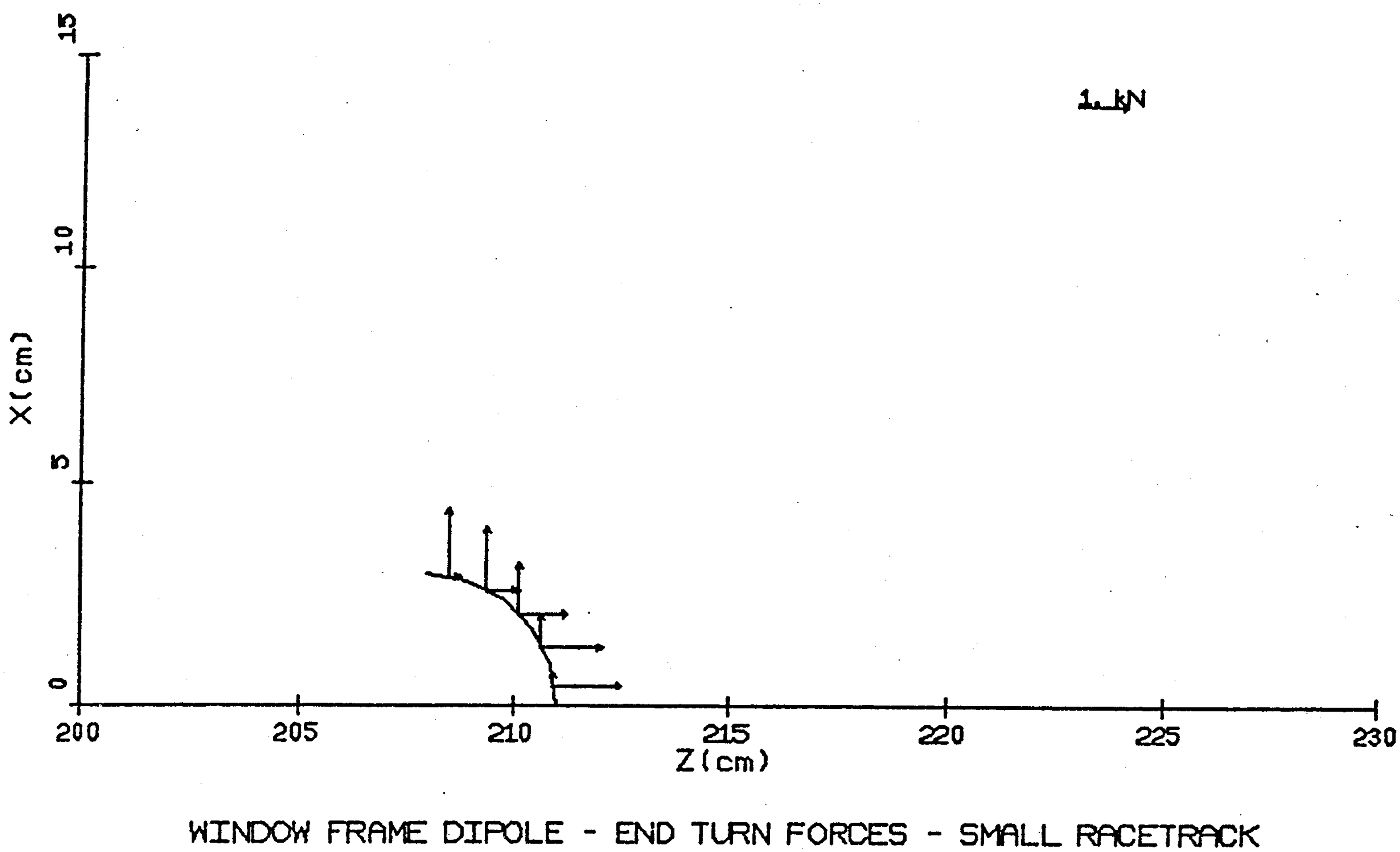


Figure 3.3.85: Stick Model, Top View, Showing Forces Acting on each Stick for the Window Frame Dipole Design, Small Racetrack Coil

the y and z components. Figures 3.3.82 through 3.3.83 show the top view with the x and z components.

Tables 3.3.17 and 3.3.18 present the tabulations of the total force components acting on each stick. Table 3.3.17 is for the saddle coil, and Table 3.3.18 for the two racetracks. These components are summed within each filament and listed as the TOTAL FOR ALL POINTS entry. These forces are for one octant only. Therefore, the total axial (z-directed) force acting on the end turn would be four times the summation of the totals for each filament.

Table 3.3.17: Lorentz Body Force Component Values for the Window Frame Dipole Design, Saddle Coil

Filament 1 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2000E-02	8.7500E-03	1.0529E+00	3.32264E+05	-3.39468E+03	0.00000E+00
2	6.2000E-02	3.1072E-02	2.1445E+00	8.26343E+03	2.88215E+03	-1.66460E+03
3	6.0483E-02	5.8185E-02	2.1914E+00	1.72162E+03	9.68386E+02	-2.44201E+02
4	5.4563E-02	6.7296E-02	2.2072E+00	1.56666E+03	1.23615E+03	2.07733E+02
5	4.3301E-02	7.5045E-02	2.2206E+00	1.24395E+03	1.45875E+03	5.92976E+02
6	2.7801E-02	8.0677E-02	2.2304E+00	7.96586E+02	1.62022E+03	8.72940E+02
7	9.5795E-03	8.3636E-02	2.2355E+00	2.73698E+02	1.70727E+03	1.02072E+03

Filament 2 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2000E-02	2.6250E-02	1.0505E+00	3.28334E+05	-1.08100E+04	0.00000E+00
2	6.2000E-02	4.7400E-02	2.1377E+00	8.76018E+03	7.14796E+02	-4.12495E+02
3	6.0483E-02	7.3340E-02	2.1827E+00	1.98748E+03	4.67727E+02	9.33247E+01
4	5.4563E-02	8.2451E-02	2.1984E+00	1.81802E+03	7.77686E+02	6.23525E+02
5	4.3301E-02	9.0201E-02	2.2118E+00	1.46055E+03	1.04635E+03	1.08042E+03
6	2.7801E-02	9.5832E-02	2.2216E+00	9.37379E+02	1.23963E+03	1.41362E+03
7	9.5795E-03	9.8792E-02	2.2267E+00	3.29855E+02	1.33995E+03	1.58777E+03

Filament 3 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2000E-02	4.3750E-02	1.0482E+00	3.18218E+05	-2.05565E+04	0.00000E+00
2	6.2000E-02	6.3728E-02	2.1310E+00	8.49283E+03	-5.06249E+02	2.92308E+02
3	6.0483E-02	8.8496E-02	2.1739E+00	2.07244E+03	1.54458E+02	2.89651E+02
4	5.4563E-02	9.7607E-02	2.1897E+00	1.91093E+03	4.78488E+02	8.46200E+02
5	4.3301E-02	1.0536E-01	2.2032E+00	1.53001E+03	7.58890E+02	1.32601E+03
6	2.7801E-02	1.1099E-01	2.2129E+00	9.82539E+02	9.64791E+02	1.67594E+03
7	9.5795E-03	1.1395E-01	2.2180E+00	3.37854E+02	1.07540E+03	1.86089E+03

Filament 4 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2000E-02	6.1250E-02	1.0458E+00	2.92279E+05	-3.78337E+04	0.00000E+00
2	6.2000E-02	8.0055E-02	2.1243E+00	7.79704E+03	-1.58996E+03	9.17177E+02
3	6.0483E-02	1.0365E-01	2.1652E+00	2.06857E+03	-1.31559E+02	4.53991E+02
4	5.4563E-02	1.1276E-01	2.1809E+00	1.90172E+03	2.00095E+02	1.00803E+03
5	4.3301E-02	1.2051E-01	2.1944E+00	1.53399E+03	4.87447E+02	1.48709E+03
6	2.7801E-02	1.2614E-01	2.2041E+00	9.85506E+02	6.97352E+02	1.83752E+03
7	9.5795E-03	1.2910E-01	2.2093E+00	3.48704E+02	8.04932E+02	2.02123E+03

Filament 5 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2000E-02	7.8750E-02	1.0435E+00	2.39790E+05	-9.05051E+04	0.00000E+00
2	6.2000E-02	9.6385E-02	2.1175E+00	6.90273E+03	-2.91560E+03	1.68303E+03
3	6.0483E-02	1.1881E-01	2.1564E+00	1.98561E+03	-4.69189E+02	6.33683E+02
4	5.4563E-02	1.2792E-01	2.1722E+00	1.83163E+03	-1.49720E+02	1.16165E+03
5	4.3301E-02	1.3567E-01	2.1856E+00	1.46484E+03	1.27249E+02	1.61503E+03
6	2.7801E-02	1.4130E-01	2.1954E+00	9.39373E+02	3.29864E+02	1.94536E+03
7	9.5795E-03	1.4426E-01	2.2005E+00	3.22394E+02	4.37407E+02	2.11997E+03

Filament 6 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	6.2000E-02	9.6250E-02	1.0412E+00	1.96858E+05	-1.97737E+05	0.00000E+00
2	6.2000E-02	1.1271E-01	2.1109E+00	5.91136E+03	-4.70278E+03	2.71130E+03
3	6.0483E-02	1.3396E-01	2.1477E+00	1.73462E+03	-1.02354E+03	9.07750E+02
4	5.4563E-02	1.4307E-01	2.1635E+00	1.57391E+03	-7.36915E+02	1.35761E+03
5	4.3301E-02	1.5082E-01	2.1768E+00	1.25968E+03	-4.99640E+02	1.73995E+03
6	2.7801E-02	1.5646E-01	2.1866E+00	8.05067E+02	-3.23968E+02	2.01888E+03
7	9.5795E-03	1.5941E-01	2.1917E+00	2.86628E+02	-2.35944E+02	2.16584E+03

Table 3.3.18: Lorentz Body Force Component Values for the Window Frame Dipole Design, Large and Small Racetrack (Helmholtz) Coils

Filament 1 - Large Helmholtz

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	4.2000E-02	8.0250E-02	1.0400E+00	4.63668E+05	-2.28931E+04	0.00000E+00
2	4.0972E-02	8.0250E-02	2.0865E+00	2.69101E+03	-1.07951E+02	4.25594E+02
3	3.6962E-02	8.0250E-02	2.0989E+00	2.38863E+03	3.19759E+02	1.21779E+03
4	2.9333E-02	8.0250E-02	2.1093E+00	1.85326E+03	7.25151E+02	1.85167E+03
5	1.8833E-02	8.0250E-02	2.1170E+00	1.14906E+03	9.92934E+02	2.28020E+03
6	6.4895E-03	8.0250E-02	2.1210E+00	4.03312E+02	1.11799E+03	2.49263E+03

Filament 2 - Large Helmholtz

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	4.2000E-02	9.6750E-02	1.0400E+00	3.77286E+05	-1.92556E+05	0.00000E+00
2	4.0972E-02	9.6750E-02	2.0865E+00	2.29590E+03	-1.08839E+03	3.63105E+02
3	3.6962E-02	9.6750E-02	2.0989E+00	2.08512E+03	-5.96390E+02	1.06305E+03
4	2.9333E-02	9.6750E-02	2.1093E+00	1.64263E+03	-1.41408E+02	1.64122E+03
5	1.8833E-02	9.6750E-02	2.1170E+00	1.02868E+03	1.70142E+02	2.04132E+03
6	6.4895E-03	9.6750E-02	2.1210E+00	3.62974E+02	3.17290E+02	2.24333E+03
TOTAL FOR ALL POINTS				8.56855E+05	-2.13740E+05	1.56199E+04

Filament 1 - Small Helmholtz

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	3.0000E-02	9.5515E-02	1.0400E+00	3.11457E+05	-6.48496E+04	0.00000E+00
2	2.9266E-02	9.5515E-02	2.0847E+00	1.37606E+03	-2.57676E+02	2.17210E+02
3	2.6401E-02	9.5515E-02	2.0935E+00	1.25395E+03	-1.19224E+02	6.43747E+02
4	2.0952E-02	9.5515E-02	2.1010E+00	1.01169E+03	2.05123E+01	1.00218E+03
5	1.3452E-02	9.5515E-02	2.1064E+00	6.32463E+02	1.31132E+02	1.25943E+03
6	4.6353E-03	9.5515E-02	2.1093E+00	2.25270E+02	1.87002E+02	1.39224E+03
TOTAL FOR ALL POINTS				3.15957E+05	-6.48878E+04	4.51480E+03

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Filament 7 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.4000E-02	8.7500E-03	1.0529E+00	9.97022E+04	-4.15089E+03	0.00000E+00
2	7.4000E-02	3.1072E-02	2.1445E+00	8.44222E+02	2.84549E+03	-1.64343E+03
3	7.2189E-02	5.9112E-02	2.1930E+00	1.76682E+02	9.74131E+02	-5.30216E+02
4	6.5123E-02	6.9986E-02	2.2118E+00	1.73539E+02	1.00654E+03	-4.78068E+02
5	5.1681E-02	7.9236E-02	2.2279E+00	1.39885E+02	1.03453E+03	-4.35115E+02
6	3.3182E-02	8.5956E-02	2.2395E+00	9.08041E+01	1.05618E+03	-4.04071E+02
7	1.1434E-02	8.9490E-02	2.2456E+00	3.21613E+01	1.06981E+03	-3.87739E+02

Filament 8 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.4000E-02	2.6250E-02	1.0505E+00	9.77815E+04	-1.37816E+04	0.00000E+00
2	7.4000E-02	4.7400E-02	2.1377E+00	4.56474E+02	6.47237E+02	-3.73508E+02
3	7.2189E-02	7.4267E-02	2.1843E+00	1.34270E+02	3.65370E+02	-1.86430E+02
4	6.5123E-02	8.5142E-02	2.2031E+00	1.55758E+02	4.00876E+02	-1.40330E+02
5	5.1681E-02	9.4392E-02	2.2191E+00	1.35890E+02	4.37190E+02	-9.53340E+01
6	3.3182E-02	1.0111E-01	2.2307E+00	9.06985E+01	4.61785E+02	-6.11126E+01
7	1.1434E-02	1.0464E-01	2.2369E+00	3.12371E+01	4.72574E+02	-4.40817E+01

Filament 9 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.4000E-02	4.3750E-02	1.0482E+00	9.25337E+04	-2.86032E+04	0.00000E+00
2	7.4000E-02	6.3728E-02	2.1310E+00	3.94187E+02	-6.07651E+02	3.50857E+02
3	7.2189E-02	8.9423E-02	2.1755E+00	1.46000E+02	-5.34116E+00	2.97920E+01
4	6.5123E-02	1.0029E-01	2.1944E+00	1.73697E+02	3.80111E+01	8.01028E+01
5	5.1681E-02	1.0954E-01	2.2104E+00	1.51931E+02	7.73164E+01	1.30566E+02
6	3.3182E-02	1.1627E-01	2.2221E+00	1.01863E+02	1.07441E+02	1.68812E+02
7	1.1434E-02	1.1980E-01	2.2282E+00	3.57774E+01	1.25880E+02	1.90412E+02

Filament 10 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.4000E-02	6.1250E-02	1.0458E+00	7.99808E+04	-5.72093E+04	0.00000E+00
2	7.4000E-02	8.0055E-02	2.1243E+00	3.02667E+02	-1.66926E+03	9.62920E+02
3	7.2189E-02	1.0458E-01	2.1668E+00	1.46136E+02	-3.36306E+02	2.21026E+02
4	6.5123E-02	1.1545E-01	2.1856E+00	1.75848E+02	-2.80156E+02	2.66110E+02
5	5.1681E-02	1.2470E-01	2.2016E+00	1.57598E+02	-2.31832E+02	3.15404E+02
6	3.3182E-02	1.3143E-01	2.2133E+00	1.06058E+02	-1.97519E+02	3.54390E+02
7	1.1434E-02	1.3496E-01	2.2194E+00	3.79225E+01	-1.82717E+02	3.74342E+02

Filament 11 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.4000E-02	7.8750E-02	1.0435E+00	5.90306E+04	-1.14929E+05	0.00000E+00
2	7.4000E-02	9.6385E-02	2.1175E+00	2.69812E+02	-2.84989E+03	1.64510E+03
3	7.2189E-02	1.1973E-01	2.1580E+00	1.42413E+02	-7.16760E+02	4.39318E+02
4	6.5123E-02	1.3060E-01	2.1768E+00	1.66770E+02	-6.57211E+02	4.76467E+02
5	5.1681E-02	1.3985E-01	2.1929E+00	1.42985E+02	-6.09158E+02	5.16184E+02
6	3.3182E-02	1.4658E-01	2.2045E+00	9.47222E+01	-5.75024E+02	5.47103E+02
7	1.1434E-02	1.5012E-01	2.2106E+00	3.26298E+01	-5.55460E+02	5.65013E+02

Filament 12 - Saddle Coil

pt	x(m)	y(m)	z(m)	Fx(N)	Fy(N)	Fz(N)
1	7.4000E-02	9.6250E-02	1.0412E+00	4.65962E+04	-2.09206E+05	0.00000E+00
2	7.4000E-02	1.1271E-01	2.1109E+00	6.31958E+02	-4.50688E+03	2.59836E+03
3	7.2189E-02	1.3489E-01	2.1493E+00	1.99729E+02	-1.32770E+03	8.03651E+02
4	6.5123E-02	1.4576E-01	2.1681E+00	1.95048E+02	-1.24863E+03	8.38400E+02
5	5.1681E-02	1.5501E-01	2.1841E+00	1.60259E+02	-1.19987E+03	8.76796E+02
6	3.3182E-02	1.6174E-01	2.1957E+00	1.03685E+02	-1.16390E+03	9.06524E+02
7	1.1434E-02	1.6526E-01	2.2019E+00	3.81839E+01	-1.14815E+03	9.22285E+02
TOTAL FOR ALL POINTS				2.27408E+06	-7.88976E+05	4.9049[illegible]E+04

SYMBOLS

(In Basic Units: f, l, t)

A	Area (l^2)
a	Semi-major axis of contact ellipse between crossed wires (l)
b	Semi-minor axis of contact ellipse between crossed wires (l)
C	Coefficient in nonlinear stress-strain relation (f/l^2)
$\overline{C}$	Coefficient in creep law ($l^{2m} f^{-m} t^{-1}$)
C_1	Coefficient in nonlinear spring deflection law $(f/l^2)^r$
C_2	Coefficient in relaxation law (ft/l^2)
C_D	Coefficient in dashpot equation (ft/l^2)
d	Diameter of wire (l)
E	Young's modulus (f/l^2)
E_s	Secant modulus, σ/ϵ (f/l^2)
E_t	Tangent modulus, $d\sigma/d\epsilon$ (f/l^2)
H	Height of coil (l)
h	Thickness of layer in composite (l)
K	$1/C_1^r$
L	Length of beam (l)
m	Exponent in creep law
n	Exponent in nonlinear stress-strain relation
P	Force (f)
p	Pressure (f/l^2)
R	Radius at interface of outer coil and yoke (l)
r	Exponent in relaxation law
t	Time (t)
V	Shift of interface from midplane (l)
w	Width of test specimen (l)

x,y	Cartesian coordinates (l)
α	Ratio of tangent moduli, Figure 3.4.47
β	Coefficient ($fl^{-2}t^{-1}$)
Δ	Increment symbol
δ	Deflection (l)
ϵ	Strain
$\dot{\epsilon}$	Strain rate (t^{-1})
$\dot{\epsilon}_o$	Reference strain rate (t^{-1})
ϵ_D	Strain in dashpot
ϵ_L	Strain in lower coil
ϵ_l	Loading strain
ϵ_s	Strain in spring
ϵ_{TOT}	Total strain
ϵ_U	Strain in upper coil
ϵ_u	Unloading strain
θ	Angle
μ	Coefficient of friction
ν	Poisson's ratio, strain in given direction resulting from strain applied in perpendicular direction
ν_e	Elastic Poisson's ratio
ν_p	Plastic Poisson's ratio
σ	Stress (f/l^2)
σ_D	Stress in dashpot (f/l^2)
σ_s	Stress in spring (f/l^2)

3.3.3.5 References

1) R.D. Pillsbury, Jr., " NMLMAP - A Two Dimension Finite Element Program for Transient or Static, Linear or Nonlinear Magnetic Field Problems, COMPUMAG, Chicago, Sept. 1981; IEEE Trans. Mag. 18(3): 406-410, 1982.

2) P.F. Dahl and H. Hahn, Isabelle Project Technical Note No. 291, R. & D Dipole and Quadrupole Configurations with Graded Current Density Conductor

3) R.B. Palmer, TLM #11, 2 Layer Magnet Design, Version V, Feb 2, 1981

4) R. Meuser, Private Communication

5) G.T. Danby, J.W. Jackson, Alternate Magnet Magnetic Field Parameter Choices, June 1, 1981 (Internal Meorandum).

3.4 Structures Engineering

3.4.1 GENERAL INTRODUCTION

Structures engineering involves determination or specification of forces and deformations imposed upon the magnet, analysis of the load paths of those forces and deformations throughout the magnet and investigation of the response of the structure to those actions. The force analysis is described in Section 3.3 which relates to calculation of Lorentz loads from the interaction of coil currents with the magnetic fields. Imposed deformations include the interference fit of the coil in the core and the differential contraction of the coil relative to the core. The response analysis involves knowledge of the structural properties of the magnet components.

This section of the ISABELLE report covers the study of coil mechanical properties, the analysis of load paths and the determination of magnet response. In a linear elastic structure, response analysis would involve straightforward application of elasticity theory. The critical structural item, however, is the coil, which exhibits nonlinear inelastic behavior. Consequently, it has been necessary to conduct experiments to determine the coil properties. As will be shown, the properties are complex. As a result, analysis of the magnet response is also complex. Simplifications have been made in order to proceed with the magnet design. However, much additional work remains before the long term structural behavior of an ISABELLE magnet can be defined accurately.

That situation dictates the form of this section on structures engineering. The coil structural behavior will be explored first, beginning with a description of an attempt to develop a mathematical base for prediction of coil mechanical properties and followed by a discussion of measured mechanical properties. The ISABELLE braid was discussed previously (Reference 3.4-1). This report will examine the "Rutherford" cable configuration used in the FNAL "Saver" and also in the "Palmer-Isabelle" design. It will also describe the Danby magnet composite which consists of monolithic conductors separated by aluminum strips.

The second part of this section will describe the general structural behavior of a Fermilab type coil to indicate the effect of the coil nonlinearity upon midplane registration under preload, cooldown and Lorentz loading. It will include the effects of the unequal heights and stiffnesses of the top and bottom coil halves.

The third part of this section will be devoted to theoretical stress analyses of the Danby, LBL, and Palmer magnet support structures.

The concluding topics in this section are friction effects, development of force sensors and testing fixtures and conceptual configurations for magnet design.

3.4.2 COIL STRUCTURAL PROPERTIES

3.4.2.1 Introduction

The superconducting coil composite of the ISABELLE magnet is treated as a structural material to identify mechanical response under applied loads and deformations. The information is necessary to identify the relation of preload movements to preload stresses, to disclose effects of mechanical property variations on midplane registration during and after assembly, and to depict the lifetime reliability of the magnet.

Test data reveal that the coil composite in circumferential compression displays almost every aspect of a structural material except linear elasticity, as mentioned in a previous MIT report on ISABELLE (Reference 3.4-1). Definitions and illustrations of various forms of structural behavior are reproduced in Section 3.4.2.5. Lawrence Berkeley Laboratory (LBL) reported data on Rutherford cable properties (References 3.4-2 and 3.4-3). Results also have been obtained by BNL and NML.

The available data have not been analyzed for consistency nor has a predictive procedure been made available for design purposes. Some attempts at prediction have been described in discussions at BNL. However, a broad framework for performance prediction is lacking. The purpose of the section is to present the initial step in constructing that framework.

The approach will involve presentation of a mathematical formalism for behavior, a critical review of existing data including identification of the limitations of the state of the art, a listing of problems yet to be solved, and recommendations for a cost-and-time-effective program to solve those problems.

3.4.2.2 Mathematical Formalism for Material Properties

3.4.2.2.1 Stress-Strain Curve

The stress-strain curve for superconductor composites is of the form shown in Figure 3.4.1 when the composite is loaded in compression perpendicular to a flat face. The stress is the nominal force applied to the conductor, $\sigma = F/wL$. The strain is $\epsilon = \Delta h/h$. The question arises as to where h and Δh should be measured on a keystoned conductor. The effect of "keystoning" will be discussed subsequently. In the meantime, assume that the conductor is flat.

Measurements indicate that a reasonable fit to the stress-strain curve can be achieved with the relation

$$\sigma = C\epsilon^n \tag{3.4.1}$$

in which n has been found to be between 2.5 and 4.5. C may range from less than 10^8 psi to more than 10^{13} psi.

Two important geometric properties of the stress-strain curve are the secant modulus, $E_s = \sigma/\epsilon$, and the tangent modulus, $E_t = d\sigma/d\epsilon$, at each point on the curve. From Equation (3.4.1), they are

$$E_s = C\epsilon^{n-1} \tag{3.4.2}$$

$$E_t = nC\epsilon^{n-1} \tag{3.4.3}$$

From those relations, it is seen that

$$E_t = nE_s \tag{3.4.4}$$

It is sometimes desirable to express E_s and E_t in terms of stress rather than strain,

$$E_s = C^{1/n}\sigma^{1-1/n} \tag{3.4.5}$$

$$E_t = nC^{1/n}\sigma^{1-1/n} \tag{3.4.6}$$

For small variations in C or n,

$$\frac{dE_s}{E_s} = \frac{1}{n}\left(\frac{dC}{C} - \ln C\frac{dn}{n}\right) \tag{3.4.7}$$

$$\frac{dE_t}{E_t} = \left(1 - \frac{\ln C}{n}\right)\frac{dn}{n} + \frac{1}{n}\frac{dC}{C} \tag{3.4.8}$$

The shape of the stress-strain curve could vary radically with load cycle number (Figure 3.4.2). However, the preceding relations appear to be applicable to any cycle.

3.4.2.2.2 Inelastic Behavior

The circumferential compression stress-strain curves in Figures 3.4.1 and 3.4.2 are shown to be monotonic. If the stress level exceeds the value at which the local stresses in the composite components exceed the local limit of elastic behavior for these components, the curves will begin to become concave downward instead of concave upward and the preceding mathematical relations will require addition of a plasticity term. Test data indicate that the proportional limit stress would be close to applied values to be expected in an ISABELLE coil. It may be possible to increase the proportional limit by overstressing the coil prior to assembly (Reference 3.4-3).

3.4.2.2.3 Time-Dependent Behavior (See Section 3.4.2.5 for definitions)

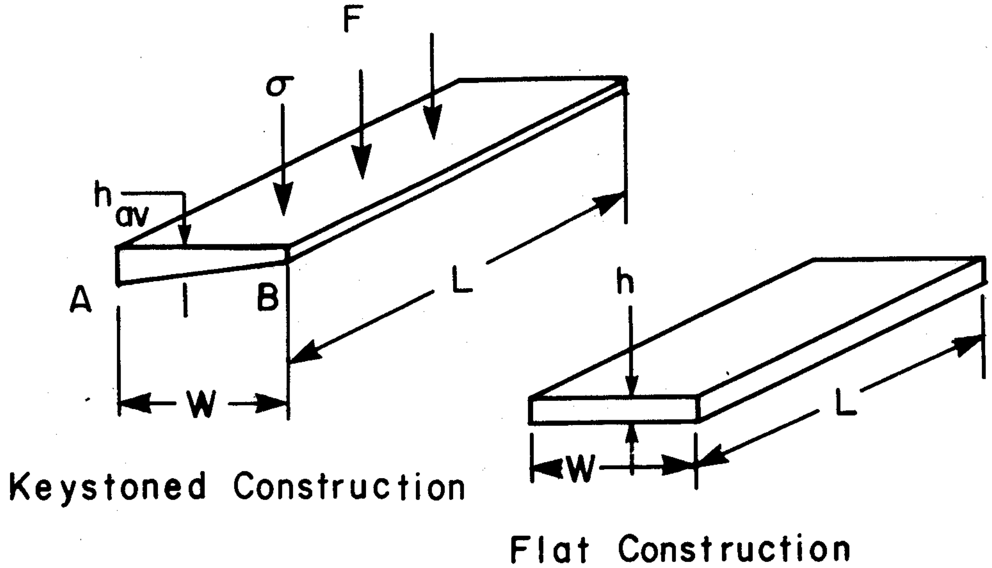
Typically, a stress-strain test is performed in 5 to 10 minutes. If a material creeps rapidly at moderate stress levels, then the shape of the curve can be sensitive to the load rate (or the strain rate). Creep would tend to increase the strain at a specific stress level thereby decreasing the rate of rise of stress with strain (that is, the tangent modulus would be reduced). That could be reflected in reduced C or n values in Equation (3.4.1). It is important to distinguish between inelastic behavior and time-dependent behavior. Not enough data exist to determine whether that distinction applies to Rutherford cables in transverse compression.

3.4.2.2.4 Creep

If a bar of material creeps under constant load, there are two stages of behavior (Figure 3.4.3). The second stage usually is of greatest interest. In a structural material, it might involve thousands of hours, while the other stage would involve minutes.

The change in cross section of a bar usually is negligibly small during the first and second stages. However, the behavior of a Rutherford cable could be presumed to include large changes in the load-carrying area. That would add complexity to creep prediction for ISABELLE coils. A tentative approach is advanced which requires test data for evaluation. It does afford a means of identifying the parameters which would need to be controlled for achievement of long term reliability in ISABELLE magnets.

The contributors to creep in a cable probably are compression at the contact zones of crossing wires and movement of the filler material (fiberglass, kapton, epoxy, etc.) on and between wires. It is likely that creep in a cured cable would consist of filler movement during the first stage and



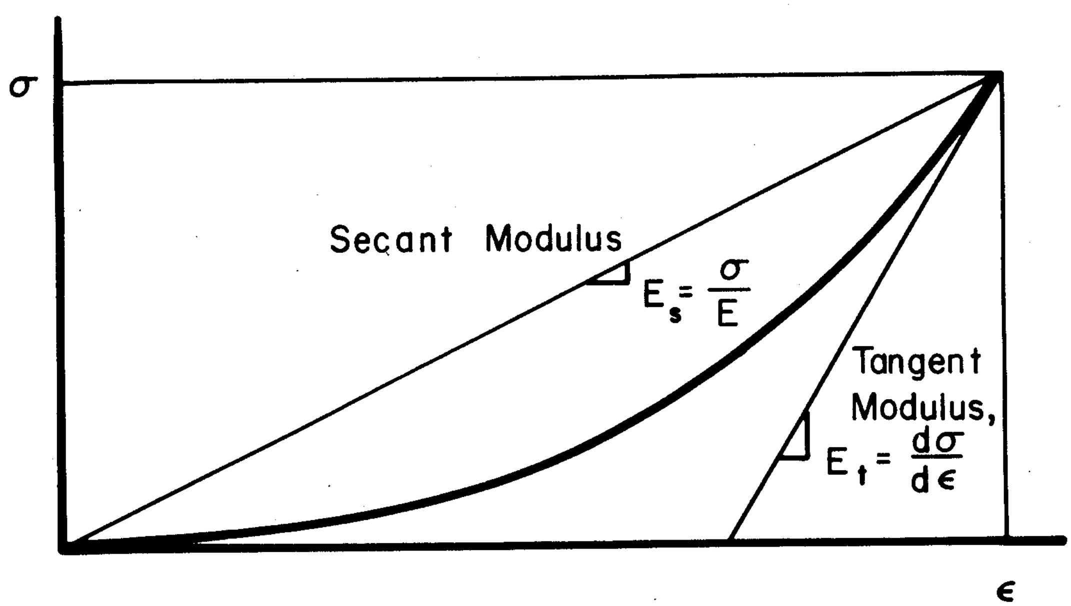


Figure 3.4.1 Typical Stress-Strain Curve for Superconductor Composites in Transverse (or Circumferential) Compression

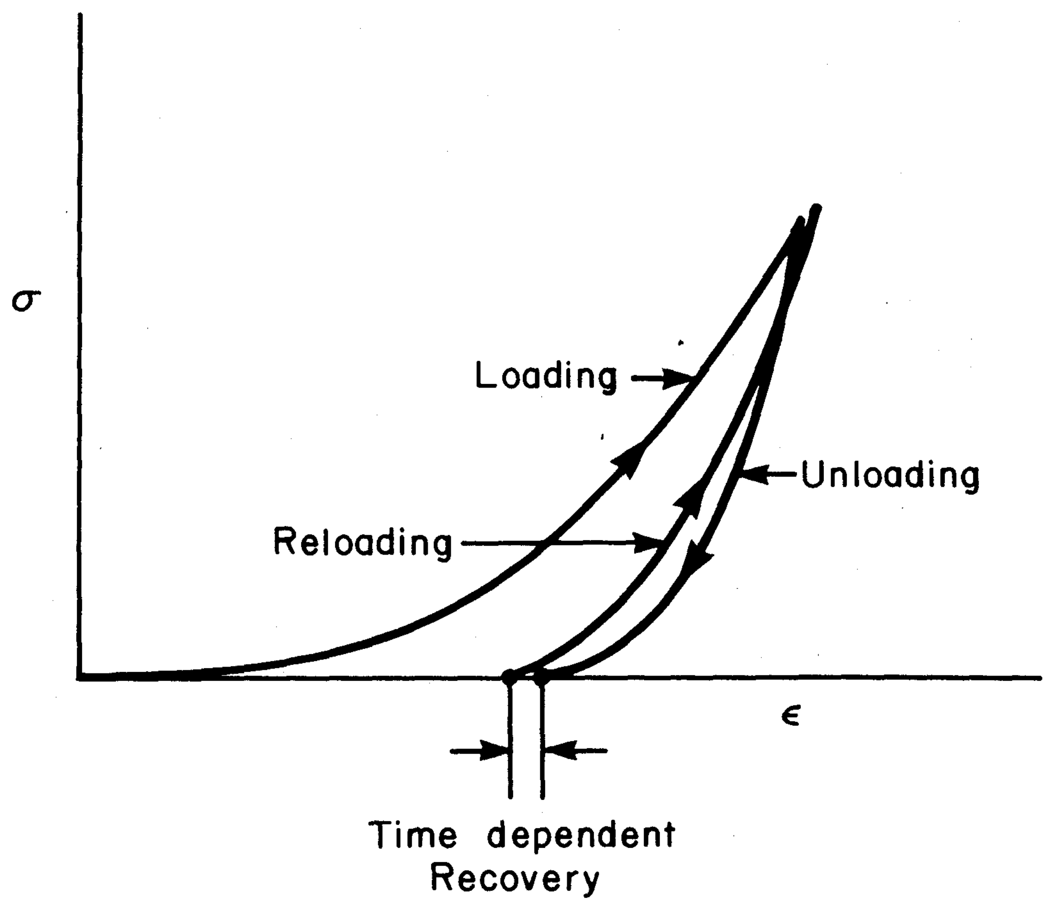
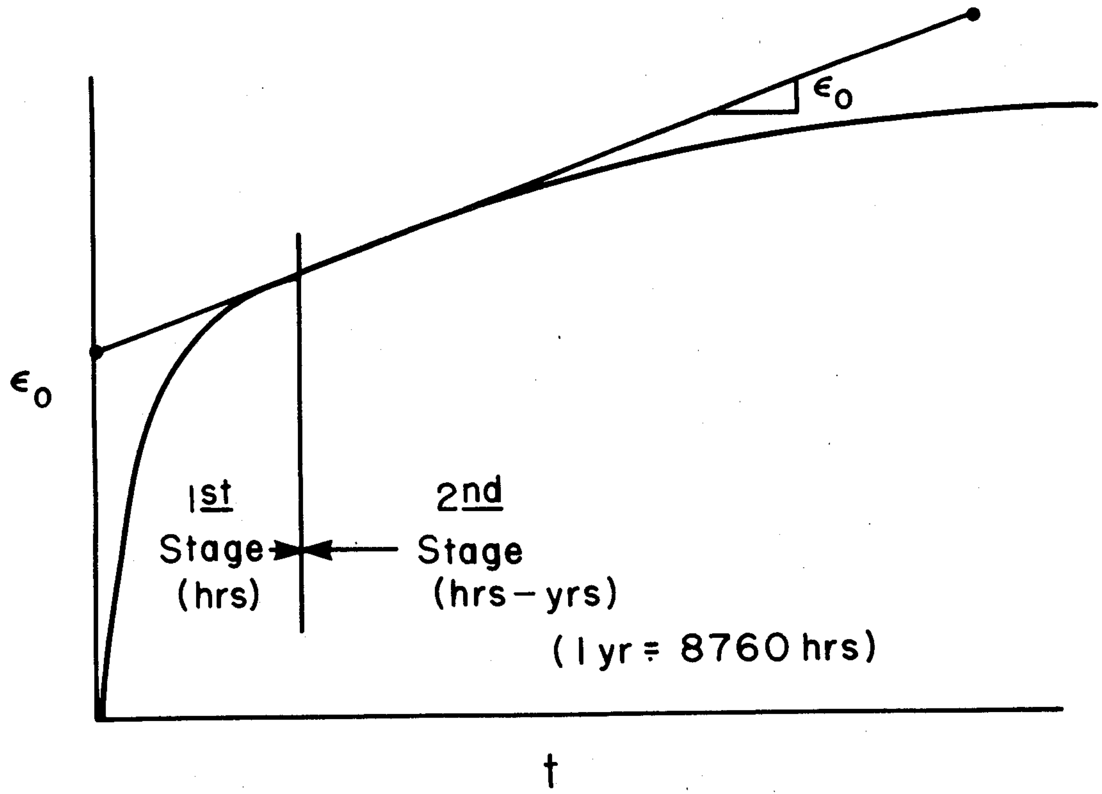


Figure 3.4.2 Effect of Cycling on Shape of Cable Circumferential Compression Stress-Strain Curve



$$\dot{\epsilon} = \frac{\dot{\epsilon}_0}{1 + K \dot{\epsilon}_0 t}$$

$$\epsilon - \epsilon_0 = (1/K) \ell n (1 + K \dot{\epsilon}_0 t) = \Delta\epsilon$$

Let $\Delta\epsilon = 5 \times 10^{-2}$ in 90,000 hr $= \dot{\epsilon}_0 t$

$K = 10$

Then $\epsilon - \epsilon_0 \longrightarrow \dfrac{K \dot{\epsilon}_0 t}{K} = \dot{\epsilon}_0 t$

Figure 3.4.3 Representative Creep Curve of Cable Conductor contact zone deformation in the second. Kaugert's measurements on alternate-layer conductor stacks (Reference 3.4-4) have helped to establish that view. In an uncured cable, it might be all filler movement and the magnitude would be much larger than in a cured cable. Furthermore, during coil fabrication the B-stage epoxy will flow, resulting in a still more rapid creep action.

Exact identification of the relative effects of the filler components would require much additional testing of uncured and cured coils during fabrication, at preload and during storage and, finally, at 4 K.

In order to develop a relatively simple law that reveals the general character of creep in a cable conductor, this analysis has been confined to second stage creep at the contact zones of crossed wires.

The plastic deformation of crossed cable wires tends to induce quasi-elliptic contact zones. (Figure 3.4.4). That would tend to cause a decrease of stress with time as the zone increases in area. However, preliminary BNL tests (discussed later) indicated that it would cause a small perturbation in the creep behavior of a cable conductor in ISABELLE. Consequently, a constant-volume creep process has been assumed.

The derivation is presented in the following sequence:

1. Consider cable behavior only, as stated above.
2. Assume flat spot between crossed wires (Figure 3.4.4)
3. Assume creep law, $d\epsilon/dt = \mathring{\epsilon} = \overline{C}\sigma^m$
4. Assume constant volume creep process at each flat spot,

$$dA/A + dy/y = 0 \quad (Note:\ dy/y = d\epsilon) \tag{3.4.9}$$

5. Force is constant, σ = P/A and, therefore, $d\sigma/\sigma$ = -dA/A = dy/y = d ϵ which can be written,

$$\frac{1}{\sigma}\frac{d\sigma}{dt} = \frac{d\epsilon}{dt} = \mathring{\epsilon} \tag{3.4.10}$$

6. From the creep law, $d\mathring{\epsilon}/\mathring{\epsilon} = m d\sigma/\sigma$, which can be written,

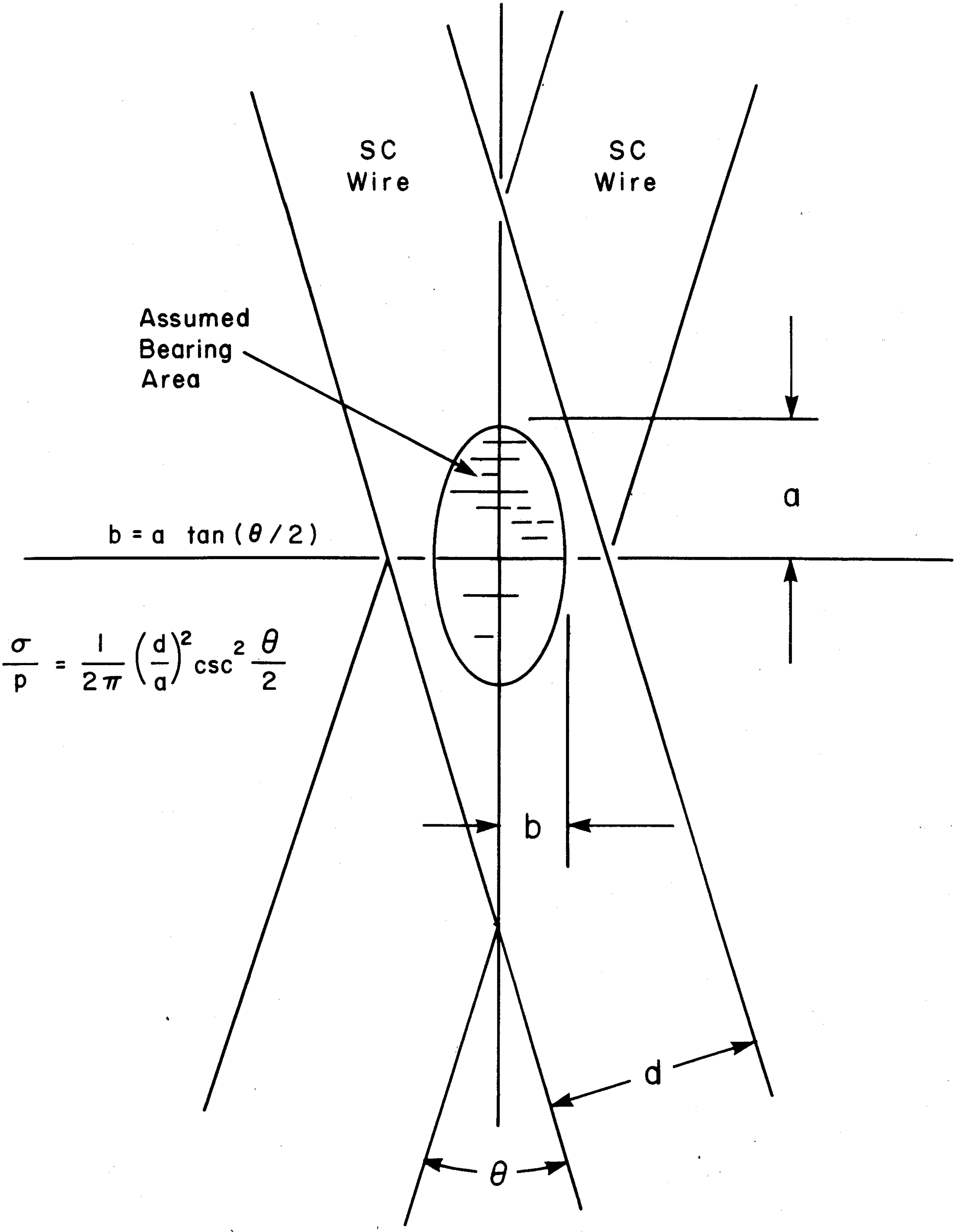


Figure 3.4.4 Plastic Contact Zone Between Crossed Wires

$$\ddot{\epsilon}\ ^{2}d\ddot{\epsilon} = m dt \tag{3.4.11}$$

7. Integrate, using $\dot{\epsilon} = \dot{\epsilon}_o$ at t = 0, to obtain

$$\mathring{\epsilon} = \mathring{\epsilon}_o(1 + m\ddot{\epsilon}_o t)^{\ 1} \tag{3.4.12}$$

Find $\ddot{\epsilon}_o$ from creep tests as shown in Figure 3.4.3.

8. Integrate again, using $\epsilon = \epsilon_o$ at t = 0 (Figure 3.4.3) to obtain

$$\Delta\epsilon = \epsilon - \epsilon_o = (1/m)\ln(1 + m\mathring{\epsilon}_o t) \tag{3.4.13}$$

Figure 3.4.5 displays $\Delta\epsilon$ as a function of t for several values of $\mathring{\epsilon}_o$ and m.

9. For the ISABELLE coils, $m\mathring{\epsilon}_o t$ probably would be much less than unity and, therefore both ϵ_o and $\mathring{\epsilon}_o$ should be obtained from a creep curve taken from the superconductor wire. That would be difficult to accomplish, however. It might be simpler to determine them from a curve for the cable during the first few hours of a creep test.

The machine life is of the order of 10,000 hours. In order to avoid excessive creep strain, it would be necessary to keep $\mathring{\epsilon}_o$ below 10^{-5}/hr for which $\Delta\epsilon$ would be of the order of 0.01.

<u>3.4.2.2.5 Relaxation</u>

The difference between creep and relaxation is depicted in Figure 3.4.6 through simple spring-dashpot models.The relaxation analysis of a cable conductor employed the model shown in that representation. The sequence follows:

1. Total strain = constant. Then, from the equations shown in Figure 3.4.6,

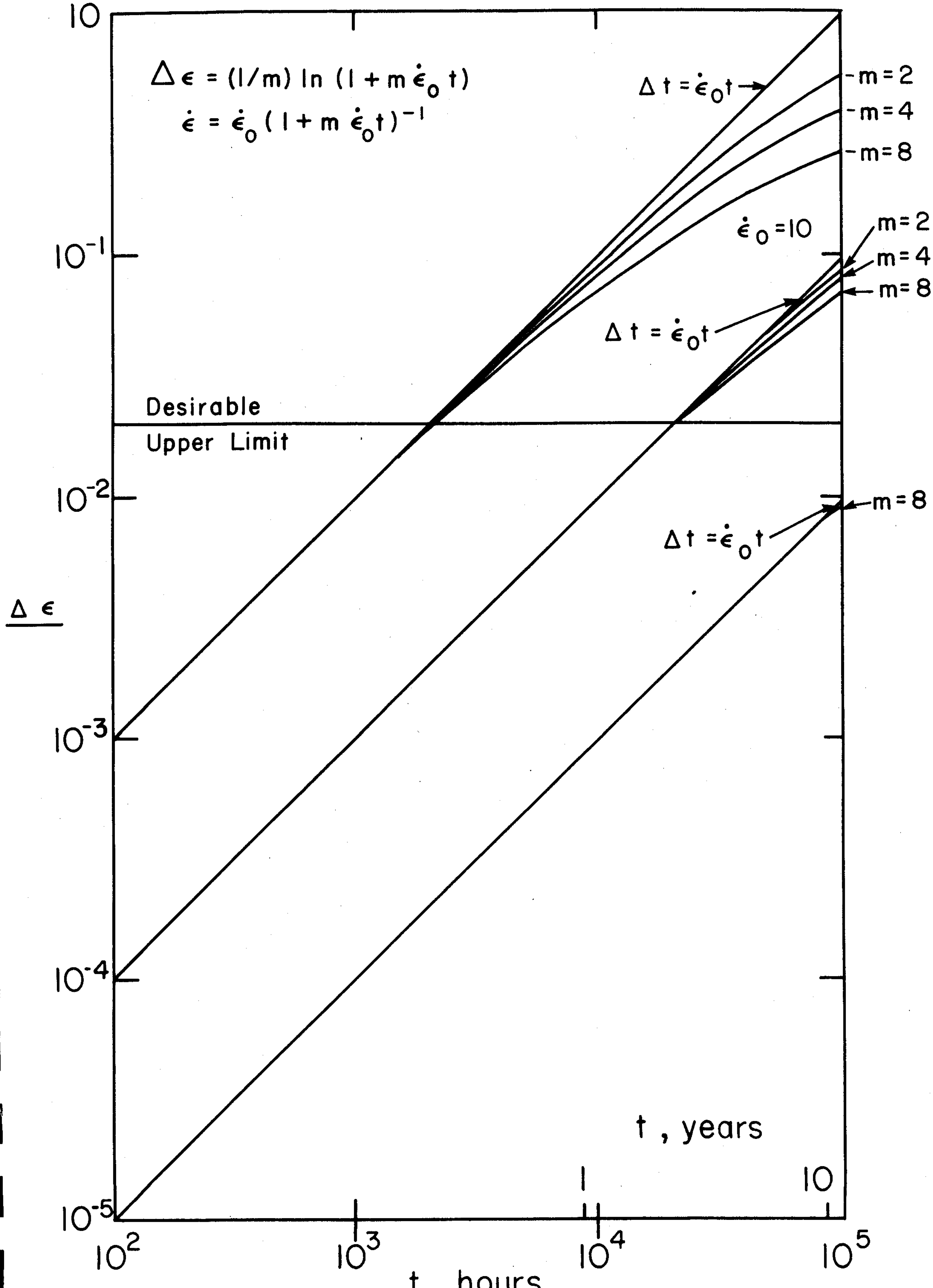
$$\frac{d\epsilon_{TOT}}{dt} = 0 = \frac{C_1}{r}\sigma^{1/r-1}\frac{d\sigma}{dt} + \frac{\sigma}{C_2} \tag{3.4.14}$$

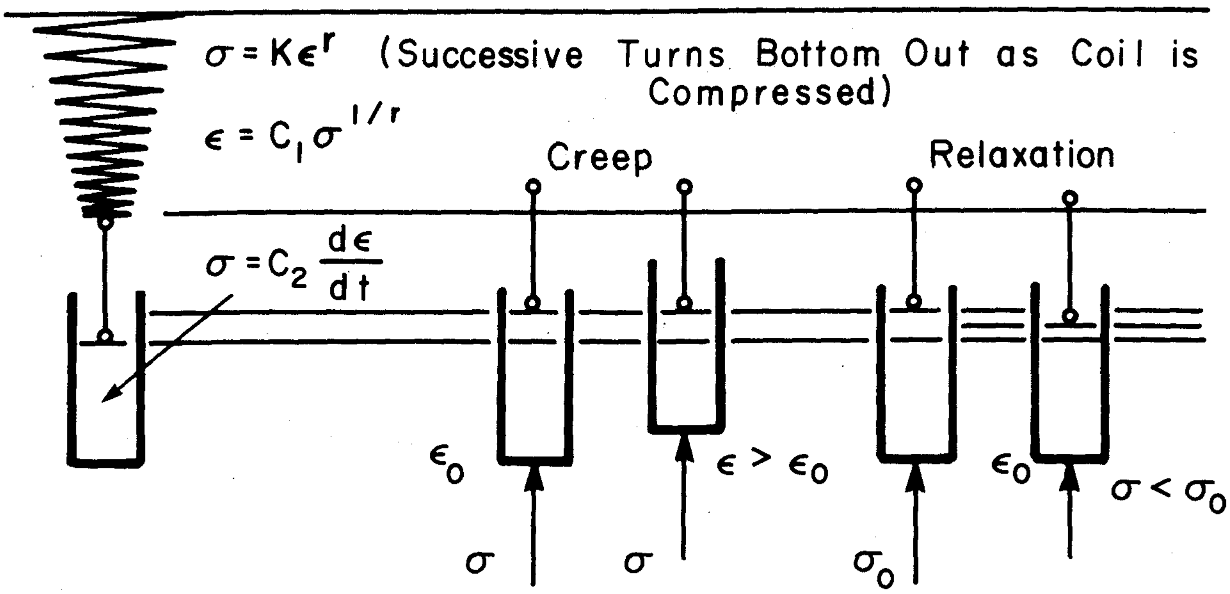
2. Integrate using $\sigma = \sigma_o$ at t = 0 to obtain

$$\frac{\sigma}{\sigma_0} = \left(1 + \frac{(r-1)\sigma_0^{1-1/r}}{C_1C_2}t\right)^{-(1-1/r)} \tag{3.4.15}$$

for r ¿ 1.

Figure 3.4.5 Theoretical Nonlinear Creep Curves





For Relaxation,

$$\frac{\sigma}{\sigma} \quad \left[1 + \frac{(r-1)t\sigma_0^{\,1-1/r}}{C_1 C_2} \right]^{-(1-1/r)}$$

Figure 3.4.6 Models for Creep and Relaxation

3. Selected curves are shown in Figure 3.4.7 for r = 4, which value appears to fit most of the stress-strain curves obtained from tests on Fermilab-type conductors. From the nonlinear spring equation, $C_1 = 2.389 \times 10^{3}$ $(psi)^{1\,4}$ for an assumed $\epsilon = 0.025$ at $\sigma = 12$ ksi. For the dashpot, $C_2 = 12{,}000/\dot{\epsilon}_o$ psi-hr. Find $\dot{\epsilon}_o$ from creep tests, as shown in Figure 3.4.3. The range of $\dot{\epsilon}_o$ is consistent with the data in Figure 3.4.6.

3.4.2.3 Experimental Determination of Conductor Structural Behavior

3.4.2.3.1 Introduction

The Palmer two-layer magnet and the LBL three-layer magnet employ Fermilab-type Rutherford cables in circular cross section coil arrays. Mechanical properties of cable samples were measured circumferentially and radially in compression and axially in tension. Primary attention was devoted to the compression loading curve. A comparison was made with BNL and LBL data. Some unloading curves were obtained. They also were compared to BNL and LBL results.

Most of the MIT data were obtained on stacks of bare wire. Cured stacks were not studied, except for one run on a sample that had been cycled numerous times by BNL. Two tension tests were performed on single lengths of bare wire cable. Studies were also conducted on Danby-magnet monoliths.

The physical basis for the stress-strain curve involves many factors, all of which may differ between the first load cycle and later cycles. They also may be functions of temperature and time. The following discussion does not include the effect of the coil production cycle (pressure/ temperature/ time).

The components of the cable are the wire, fiberglass, kapton and epoxy. There also are spaces between these components. Micrographs show a gap in the interior of a layer that is closed at low pressures. The nonmetallic components may be moved into the grooves between parallel wires in a layer and also may be deformed plastically. The higher the load, the greater the deformation. It is understandable that the first-loading strains may be charged to that combination of effects.

Once the coil has been loaded to 12 ksi or more, most of those changes will have occurred and the nonlinear response at the wire crossings may begin to dominate. Finally, creep will occur in all the components that would cause the stress-strain curve to change from concave upward

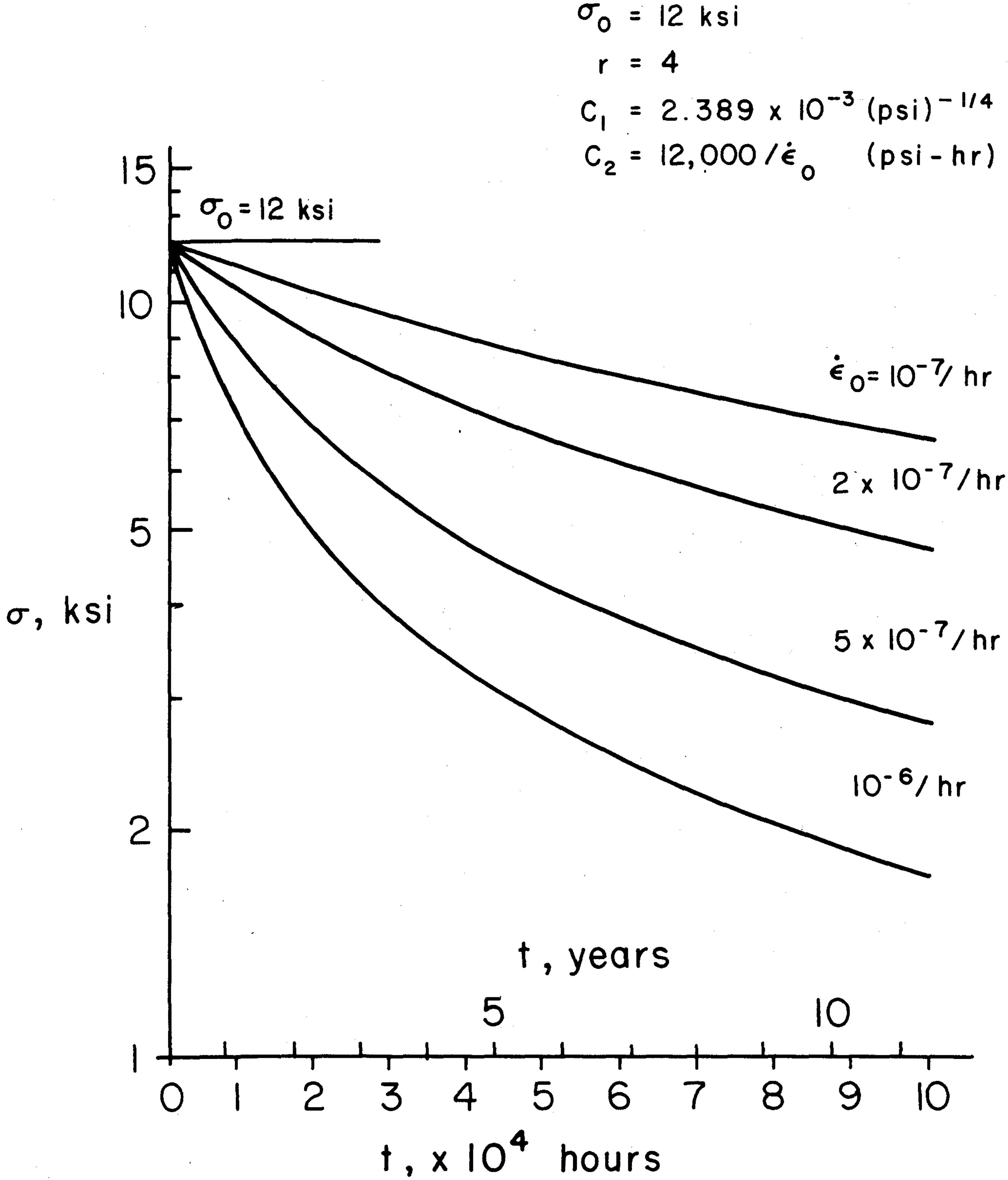


Figure 3.4.7 Fermilab Coil Relaxation (Theoretical)

to concave downward with the point of inflection at approximately 10 ksi (Figure 3.4...).

The micromechanics of coils will require more study before it will be possible to predict the behavior of a coil, knowing the properties of the components and the details of the production cycle.

3.4.2.3.2 Test Arrangements

All MIT tests were conducted in the 60,000 pound Baldwin-Southwark universal tester at Manlabs (a materials testing laboratory located in close proximity to MIT in Cambridge, MA). The general arrangement is depicted schematically in Figure 3.4.8. The stiffness of the load path between the dial gauges is 50 to 100 times that of the compression test specimens, as determined from a simple calculation. Consequently, no fixture correction was made to the deflection measurements.

The dial gauges are marked to 0.0001 inch and readings were estimated to 0.00001 inch. With deflections normally of the order of 0.01 inch, the deflection accuracy was within one percent. The testing machine is calibrated periodically at each loading scale. The maximum force indication error would be less than one percent. Specimen dimensions were measured to the nearest 0.0001 inch.

The compression tests were made on stacks of alternated bare conductor wire strips cut from lengths furnished by BNL and LBL. Force was converted to stress using the area determined from the product of the loaded strip length and width. Strain was calculated from the ratio of height change to original height.

3.4.2.3.3 Circumferential Compression Data

A typical stress-strain loading curve for bare cable is shown in Figure 3.4.9. It agrees reasonably well with BNL data but differs from a typical LBL curve (Figure 3.4.10). The shapes of the curves are similar, except for the large initial deflection of the LBL specimen.

An interesting contrast is provided by the compression behavior of a fully potted superconductor in use at CERN. It was linearly elastic at 3.75 msi up to the proportional limit of 5620 psi. The Young's modulus agreed well with the theoretical value calculated from the component properties as shown in Section 3.4.2.5.10.

Normalized unloading curves are shown in Figure 3.4.11. The M.I.T. unloading curve is seen to be steep, and, in fact, there is evidence of creep during unloading. The BNL and LBL unloading

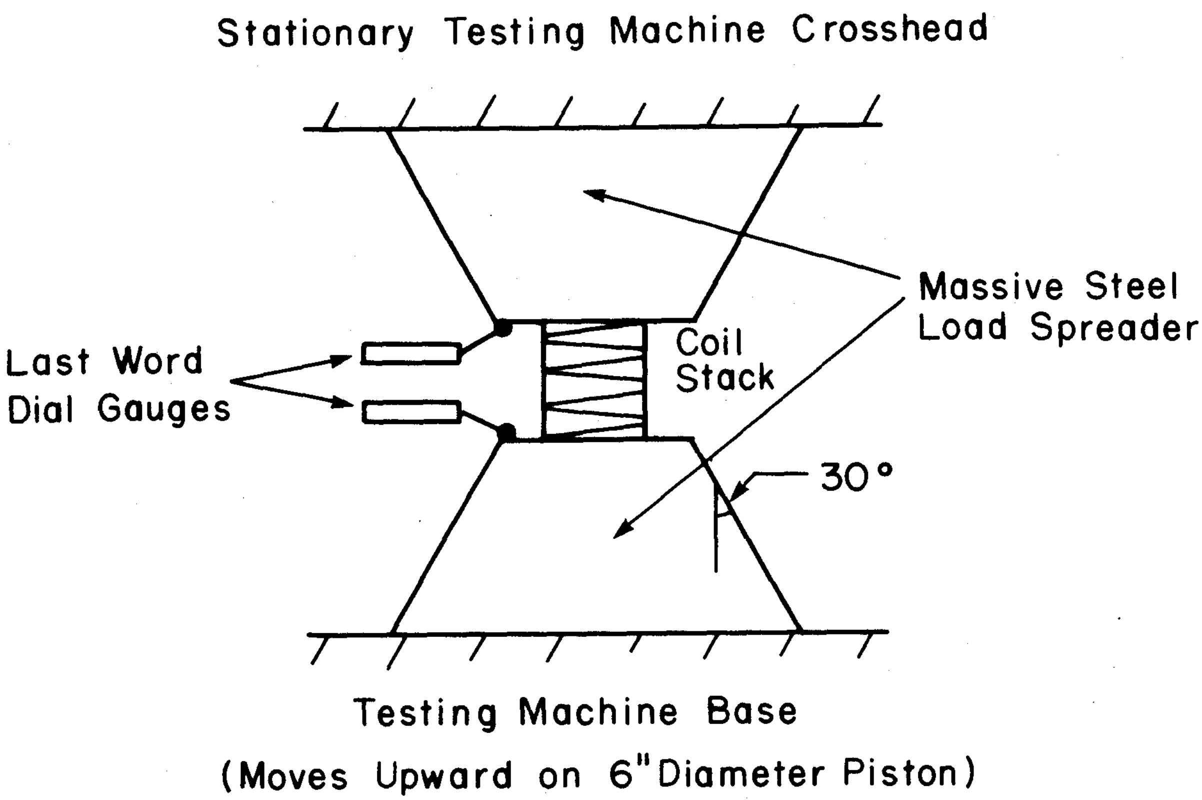


Figure 3.4.8 MIT Test Arrangement for Coil Compression Measurements

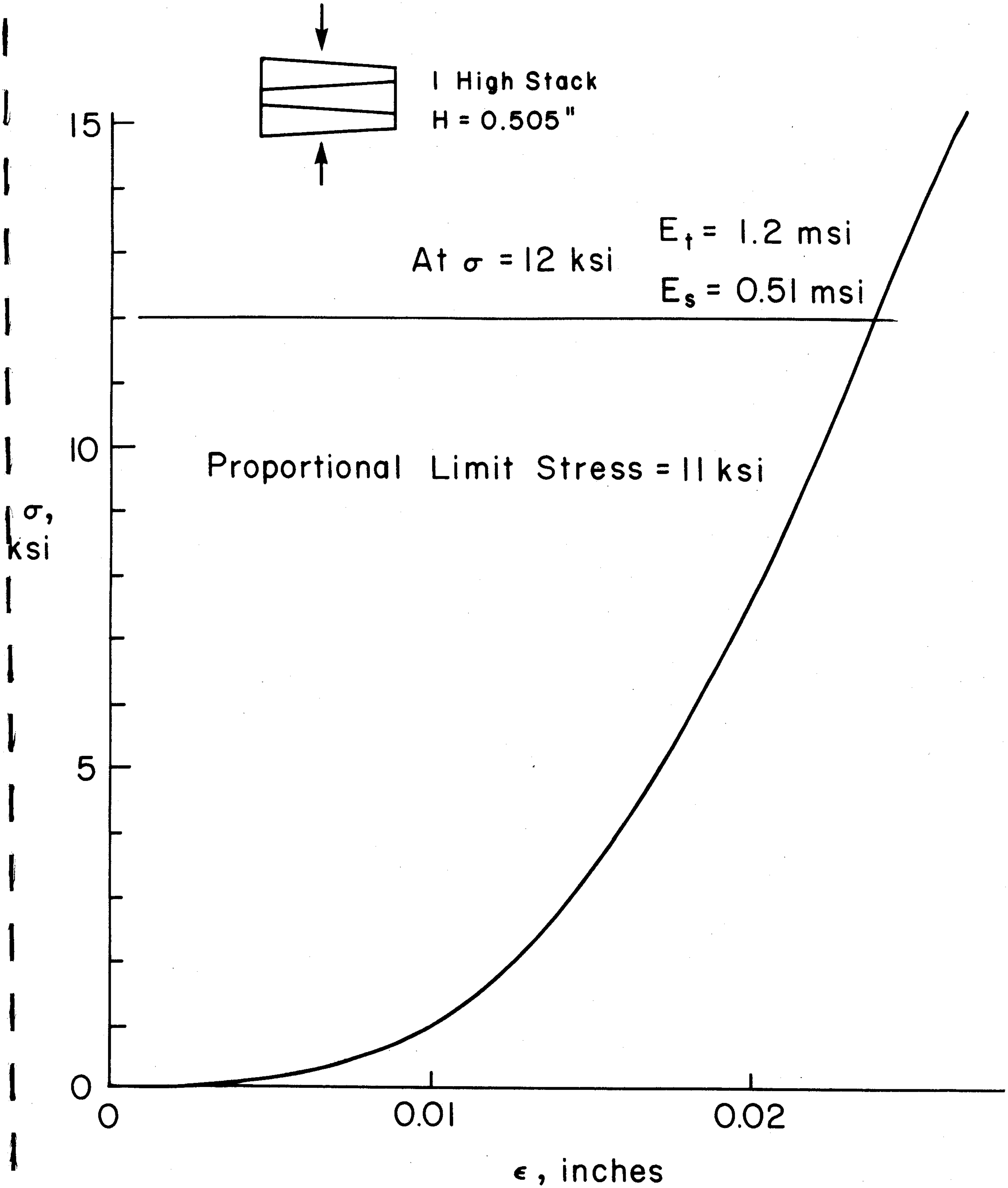


Figure 3.4.9 Typical Stress-Strain Curve Obtained at MIT on an Uncured Stack of Bare Keystone Conductor at RT

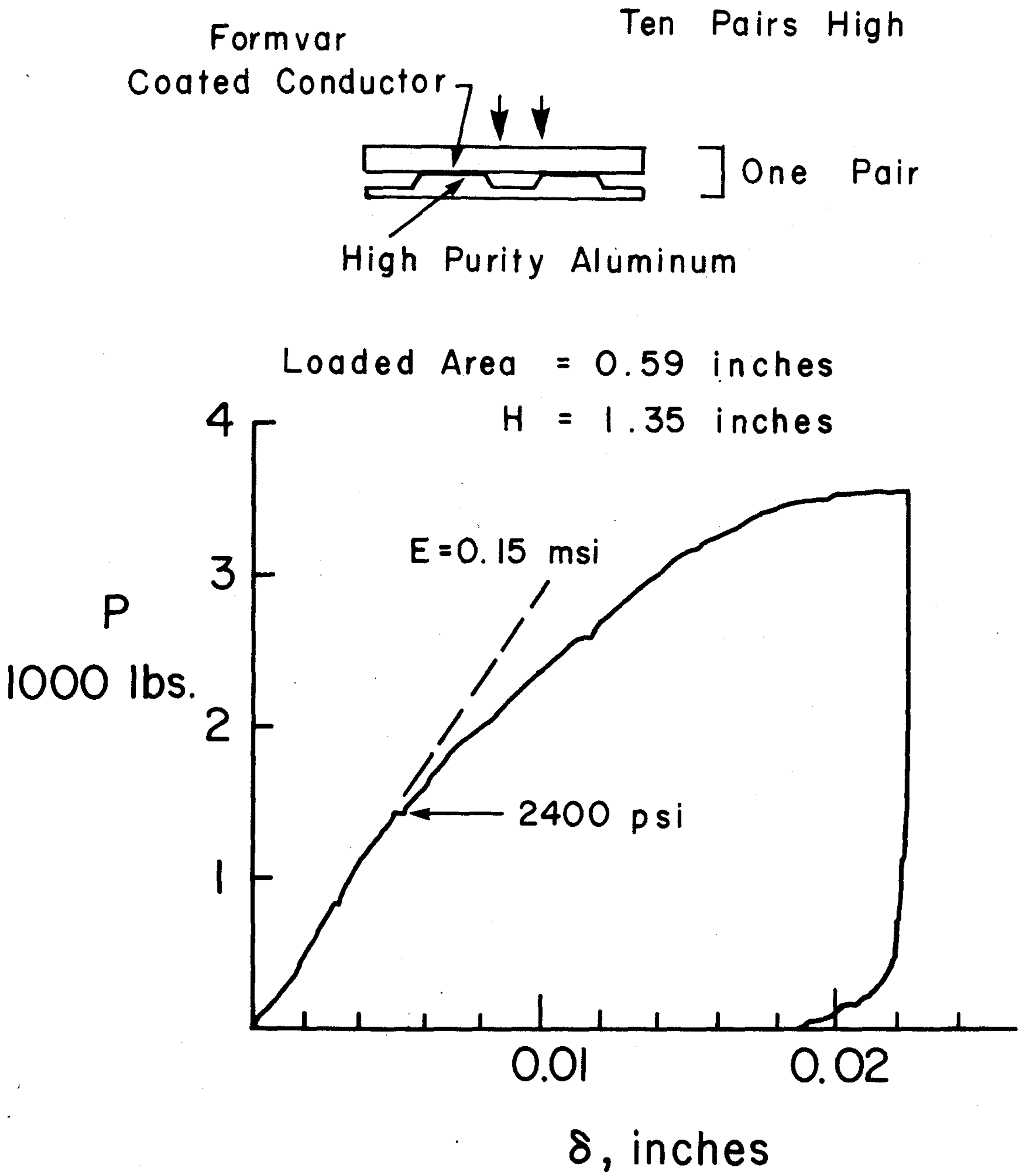
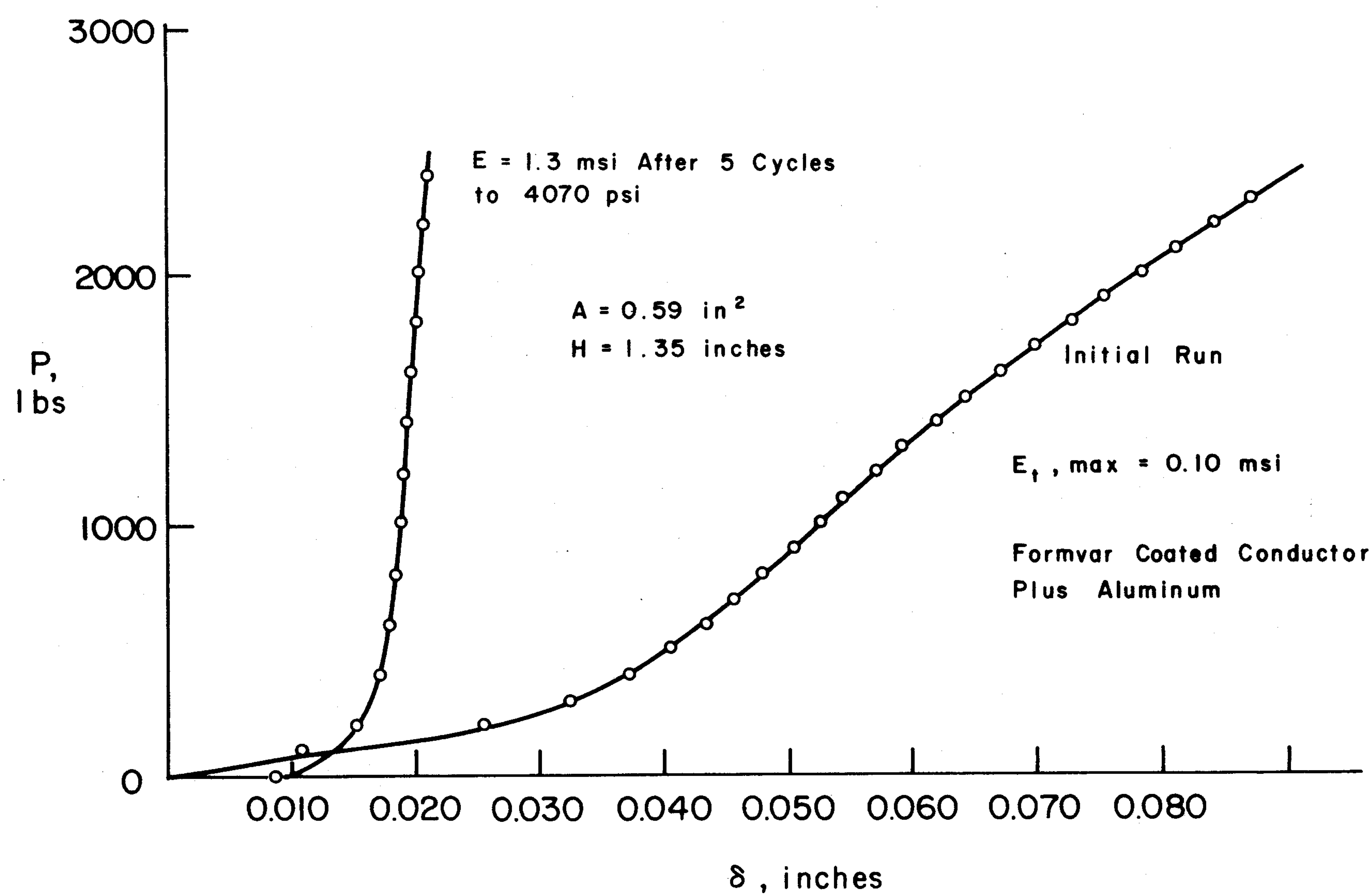


Figure 3.4.21 Conductor with Formvar Plus Aluminum at RT

Figure 3.4.22 Conductor with Formvar Plus Aluminum at RT (Rerun)



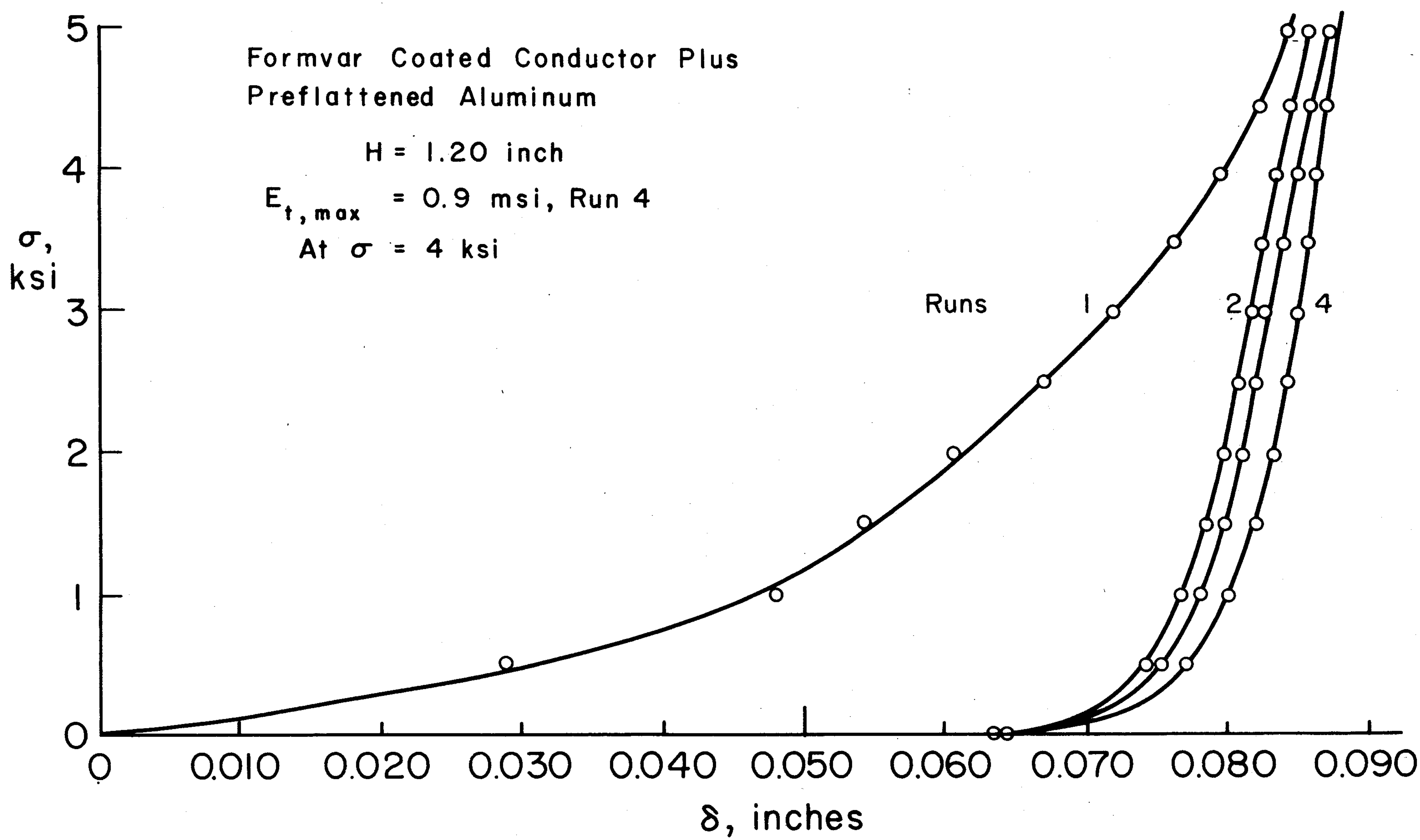


Figure 3.4.23 Previously Used Conductor with Formvar Plus Preflattened Aluminum at 77 K

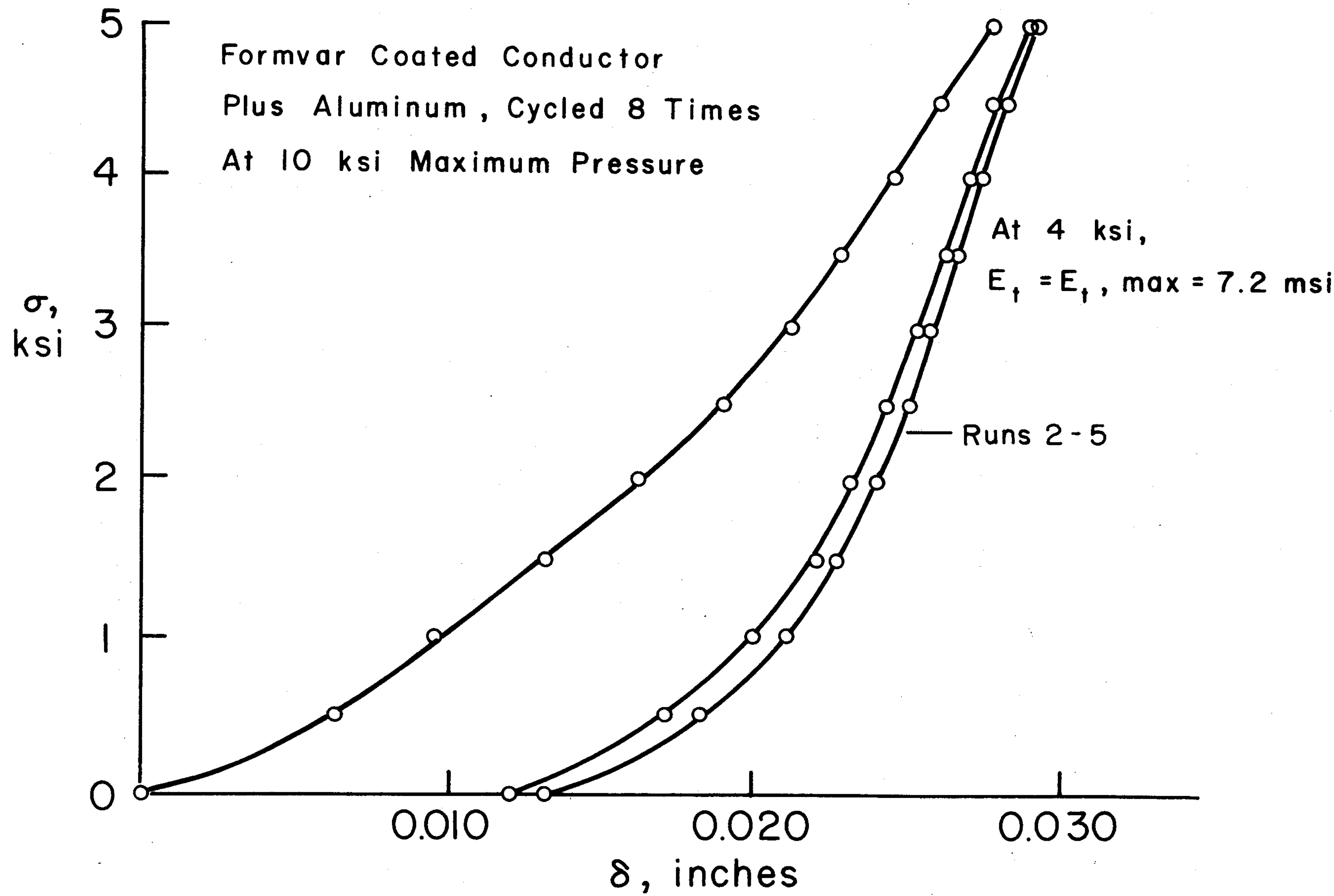


Figure 3.4.24 Conductor Plus Preflattened Aluminum (10 ksi) Precycled 8 Times (at RT)

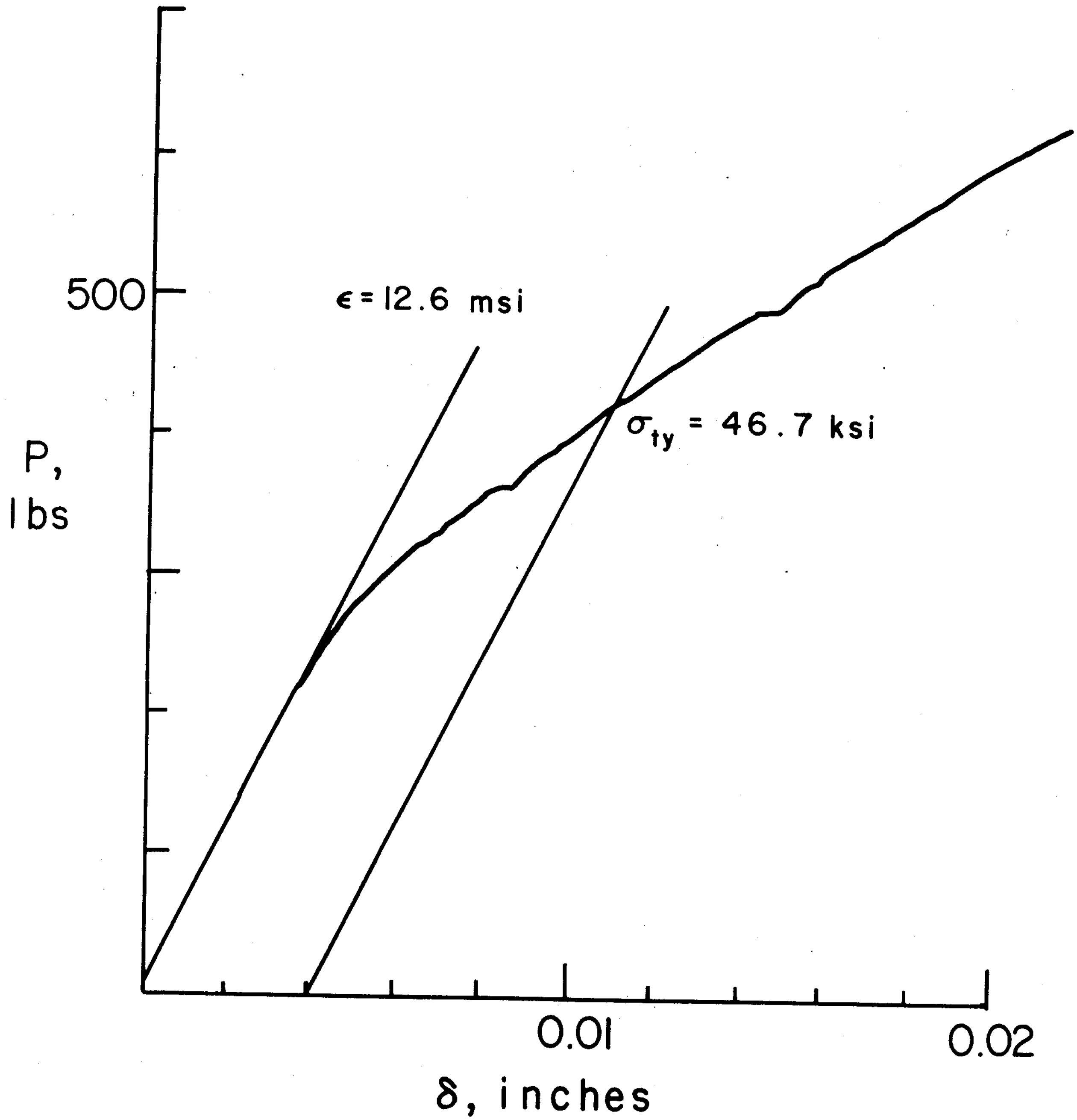


Figure 3.4.25 Tension Test on Danby Monolithic Conductor

of 1 msi could be exceeded at 4 to 5 ksi normal pressure.

3.4.2.4 Recommendations For Further Study

There is a need for cryogenic stress-strain data on cable conductors, at least at 77 K and, desirably, at 4 K. Preliminary tests at Berkeley and Brookhaven showed an increase of the order of 30 to 40 percent in tangent modulus at 77 K compared to RT modulus. Unloading curves are of particular importance, as will be shown in Section 3.4.3.

The degree to which insulation affects short-term stiffness, creep and relaxation is not known, nor have they been considered in analyses of stiffness, as in Section 3.4.2.3.10, for example.

The experimental data that have been reported on keystoned cable relate to straight stacks of alternated conductor instead of curved stacks of direct conductor. The latter must be studied before reliable analysis of coil behavior is possible.

It would be desirable to study other influencing factors such as the thickness and weave of the fiberglass wrap as well as the width and the gap size between adjacent turns, the amount of B-stage epoxy present in the glass weave, the thickness and overlap of kapton, teflon, or other plastics, and the details of the production processing such as cure temperature and pressure.

3.4.2.5 Structural Behavior of Materials

3.4.2.5.1 Introduction

Experiments at BNL, LBL, and NML have shown the circumferential and radial compression responses of ISABELLE dipole coil blocks to be nonlinear and inelastic. The following material property terminology is presented (much of which may be familiar) to ensure consistency of usage.

3.4.2.5.2 Elasticity

A structure is elastic if the load-deformation behavior is identical for both loading and unloading, whether the relationship is linear or not. A spring is the classical model for a linear elastic system in which stiffness is independent of deformation (Figure 3.4.26a). It is possible to combine two springs to obtain a nonlinear elastic system (Figure 3.4.26b). Another form of nonlinear elastic action can be induced by a gradual change in bearing area with load (Figure 3.4.26c). In the latter cases, which correspond to ISABELLE coils under circumferential and radial load, stiffness

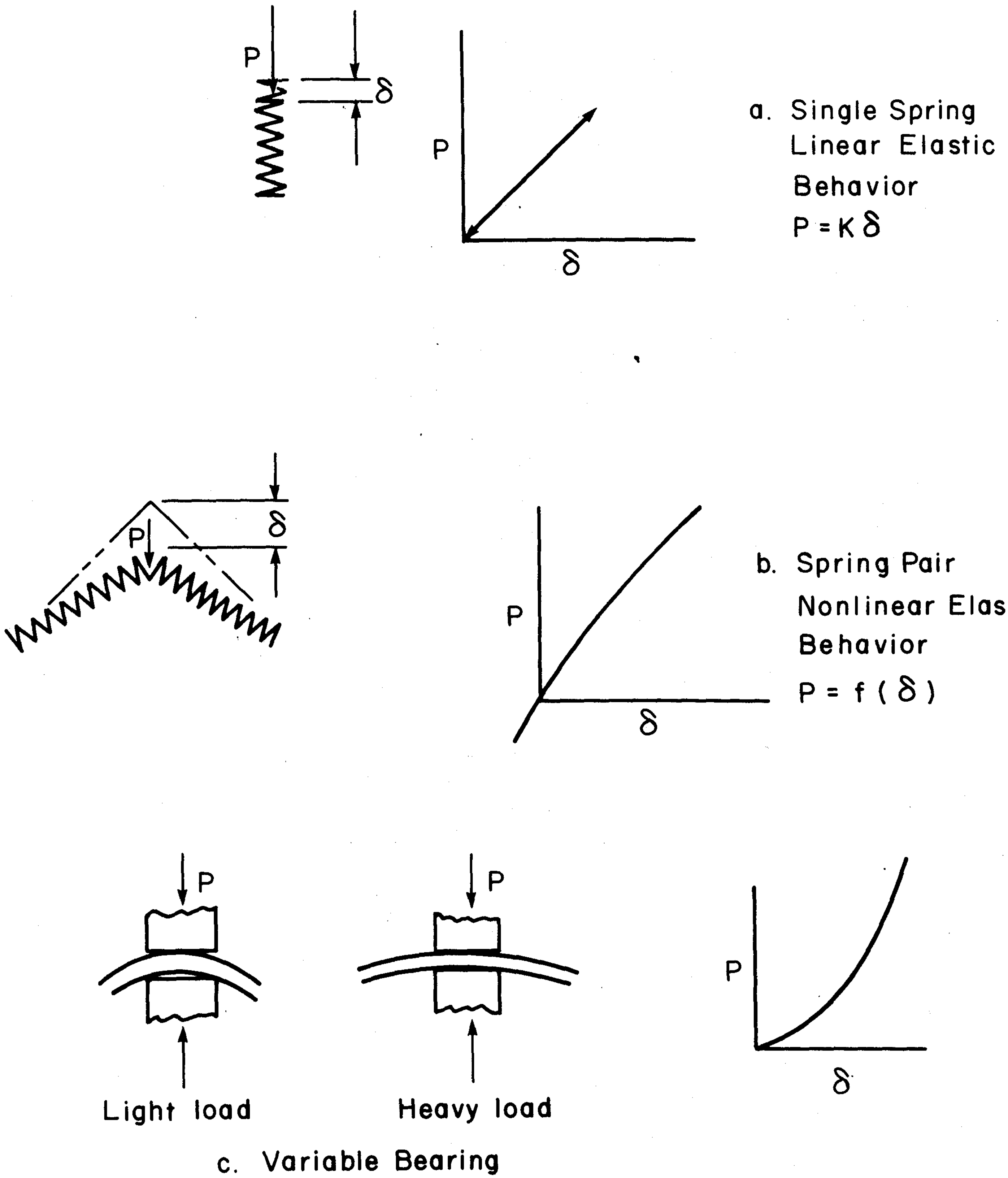


Figure 3.4.26 Linear and Nonlinear Elastic Structures

depends on deformation and, consequently, on stress level. A belleville spring is another example of nonlinear elastic action.

3.4.2.5.3 Anisotropy

A material is termed anisotropic if properties are direction-dependent. ISABELLE coils are in this category.

3.4.2.5.4 Viscoelasticity

In general, it is possible to model a structural material with viscous (dashpot) and elastic (spring) elements as shown in Figure 3.4.27a. The behavior of such a composite is termed viscoelastic (or perhaps viscoplastic).

3.4.2.5.5 Inelasticity

No practical structure is perfectly elastic. The principal structural feature of an inelastic system is the existence of permanent deformation after short-time loading. A simple model of inelastic behavior is shown in Figure 3.4.27. The presence of the dashpot induces time-dependent response to either stress or strain. That contrasts with the time-independent response of an elastic system.

An example of the behavior of the series system appears in Figure 3.4.27c which is seen to have the general character of a stress-strain curve.

3.4.2.5.6 Hysteresis and Recovery

A representative stress-strain curve for a structural material appears in Figure 3.4.28 On the first loading (1), if the stress is a large fraction of the yield then plastic strain is induced. The unloading curve (2) usually starts with a slope equal to Young's modulus but curves towards the origin as the applied stress returns to zero. The next loading (3) begins elastically at the strain at the end of the previous unloading. A loop is generated as a result. The enclosed area represents dissipated energy, usually termed hysteresis. It will occur only in inelastic systems.

An additional feature must be considered. It is sometimes known as recovery. It can be envisioned with the help of the parallel spring-dashpot model in Figure 34.27b. If the load is released from some finite level, the spring will tend to return to the unloaded state, working against the dashpot in the process. The longer the permitted recovery time, the greater the recovered deformation and the wider the hysteresis loop.

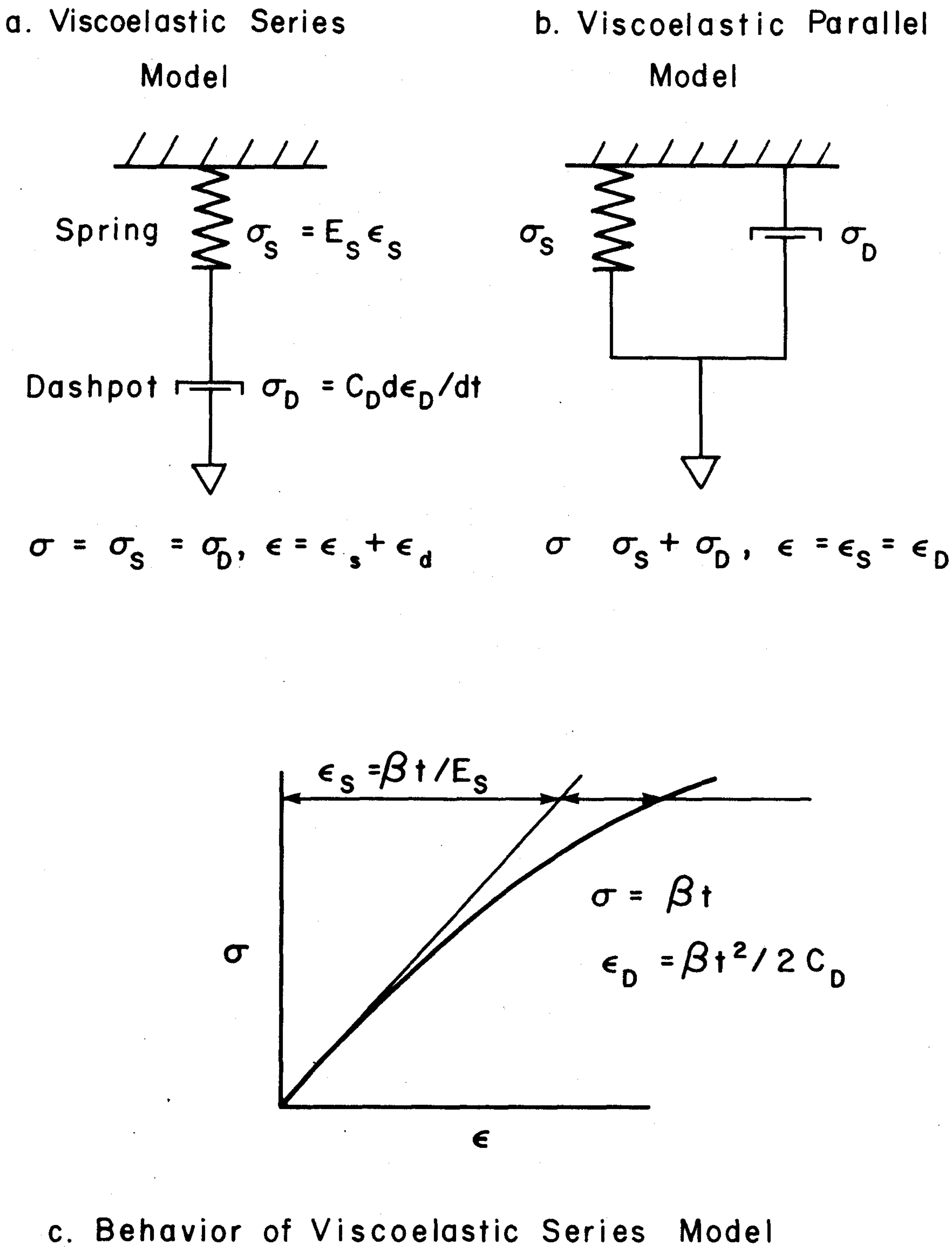


Figure 3.4.27 Models of Viscoelastic and Inelastic Structural Materials

3.4.2.5.7 Creep and Relaxation (Figure 3.4.29)

Creep is strain increase at constant stress, $(\partial\epsilon/\partial t)_\sigma$. It differs from inelasticity only in the usage of the term. Creep usually is associated with long-term loading.

Relaxation is stress decrease at constant strain, $-(\partial\sigma/\partial t)_\epsilon$. Both creep and relaxation can occur simultaneously.

3.4.2.5.8 Poisson's Ratio

When a strain is produced in one direction of a block by a stress applied in the same direction, strains usually are induced in all other directions of the block. The absolute value of the ratio of orthogonal induced strains to applied strains is Poisson's ratio, ν.

The magnitude of ν ranges from 1/4 to 1/3 for most homogeneous and isotropic metals in the elastic range. It may approach zero for a parallel-wire array and 1/2 for a perfectly plastic solid. It has been found to exceed 1/2 in certain directions within highly orthotropic metals for which $\nu_{xy} \neq \nu_{yx}$. That is, the strain in the x direction induced by an applied y strain is not the same as the induced y strain due to an applied x strain.

In orthotropic solids, both E and ν will vary with direction. Cauchy has shown that, based on certain elastic energy considerations, $E_x\nu_{xy} = E_y\nu_{yx}$ (Reference 3.4-5). Experiments, however, have not always substantiated Cauchy's relationship, although it often is used in finite element analysis.

In the inelastic range of many structural metals (Reference 3.4-6)

$$\nu = \nu_p - (\nu_p - \nu_e)E_s/E \qquad (3.4.17)$$

in which ν_p may not necessarily equal 0.5. Poisson's ratio would be 0.5 if there is no plastic volume change. If there is a large volume change, then ν can approach (or possibly exceed) 1 for highly anisotropic systems.

3.4.2.5.9 Structural Instability

Structural instability is a change (often sudden) of structural state at some critical load level. The most familiar form is column buckling. The critical load depends on the column geometry, the column material and the stiffness of the structure supporting the column. The last feature comprises the column boundary conditions.

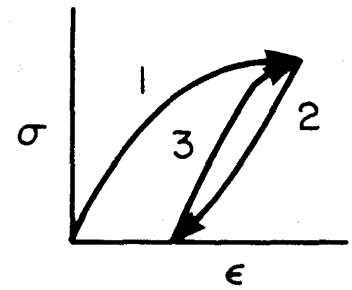
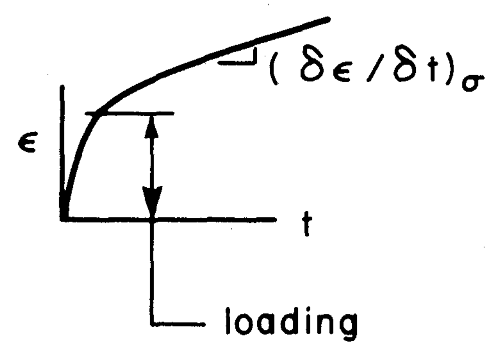
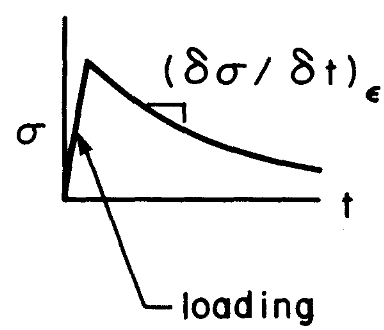


Figure 3.4.28 Representative Stress-Strain Curve for Structural Metals



Creep ; Model in Figure 3.4.27a



Relaxation ; Model in Figure 3.4.27b

Figure 3.4.29 Creep and Relaxation Curves

3.4.2.5.10 Theoretical Stiffness of a Flat Elastic Cable Composite

The model for a flat composite is shown in Figure 3.4.30. The cable, fiberglass, and film are simplified to three springs in series. The stress is the same in all springs and the deflection is the sum of the component deflections. These lead to the relation (using $h = h_1 + h_2 + h_3$),

$$(\sigma/E)h = (\sigma/E_1)h_1 + (\sigma/E_2)h_2 + (\sigma/E_3)h_3 \tag{3.4.18}$$

which provides the expression for the equivalent stiffness,

$$E = \frac{h}{[h_1/E_1 + h_2/E_2 + h_3/E_3]} \tag{3.4.19}$$

As an example, assume the cable $h_1 = 0.041$ inch and $E_1 = 2$ msi, the fiberglass $h_2 = 0.010$ inch and $E_2 = 1$ msi, the kapton $h_3 = 0.006$ inch and $E_3 = 0.4$ msi. Then E = 0.6 msi. Test data in cured stacks indicate $E_t = 1.5$ msi at 12 ksi. Consequently, study is required to explain the discrepancy. One possible explanation is kapton intrusion into the grooves between adjacent wires during a cure. If the remaining thickness of film coating the wires is 0.0007 inch per turn face, the composite stiffness would be 1.5 msi. Measurements indicate a range from 1.5 to 2.0 msi at RT.

The situation is somewhat more complex because the bearing flat spots between adjacent turns have less than half the projected area, which reduces the effective stiffnesses of the fiberglass and kapton (the stiffness of the cable is a measured value which accounts for flat spot size) to less than half the value shown above. The stiffness for an uncured composite would diminish accordingly, as has been demonstrated in Section 3.4.2.3.4.

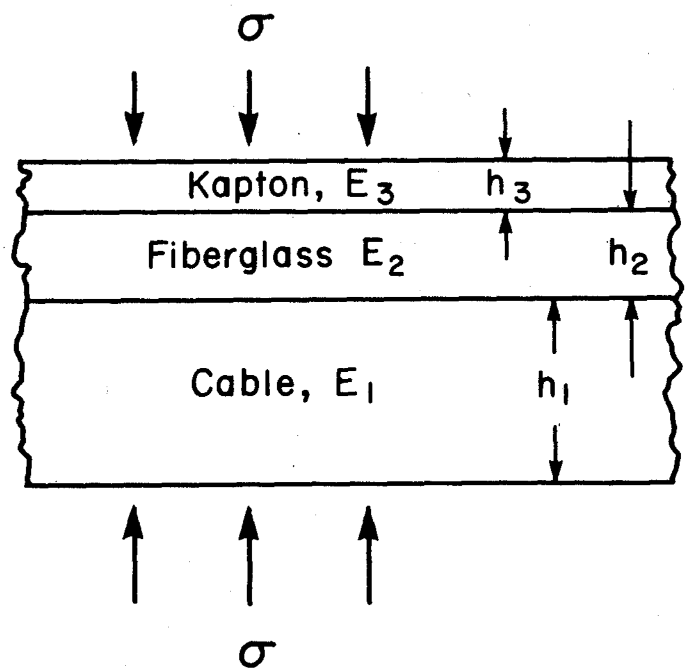


Figure 3.4.30 Theoretical Model of Flat Composite

3.4.3 COIL POSITION CONTROL

3.4.3.1 Introduction

3.4.3.1.1 Scope of Section

This section is a digest of results from a variety of investigations related to the problem of controlling the azimuthal distribution of the coil layers in the Isabelle magnet. The task is to relate the mechanical properties of the finished coil to the processes involved in magnet assembly, storage, cooldown and electromagnetic performance. The goal is achievement of the high field quality demanded for reliable particle beam control.

The preceding portion of this report might appear to indicate that, because of the large variety of complex structural behaviors to be expected in a magnet coil, it could require a Herculean effort to achieve necessary coil position control. This report section indicates that, despite those complexities, it may not be difficult to achieve that control, partly because of compensating factors. It is possible to support that optimism through the qualitative arguments advanced in the succeeding analyses.

3.4.3.1.2 Coil Location Requirements

The magnet is to be assembled with coil halves that match closely in height at a selected circumferential prestress. One limitation is a 2-mil maximum deviation of the coil interface from the magnet midplane. The tolerance on conductor displacements at other azimuthal locations is of comparable magnitude for any field level at 4 K.

The circumferential prestress must be adequate to keep the coil and post in contact through the insulating G-10 when the magnet is fully energized. Figure 3.4.45 (section 3.4.3.3.3) shows a reasonable approximation to the distribution of Lorentz forces tending to compress the coil azimuthally.

The only coil property requirement for midplane registration at assembly is that the compressive prestress in each coil half be exactly the same at the assembled midplane-to-post circumferential coil dimension. This implies that the prestrains to closing need not be the same in the coil halves. However it will be shown that other considerations dictate that the stiffnesses of the upper and lower coil halves be matched closely throughout the range of magnet performance during the following actions:

1. Predeformation as the magnet is assembled
2. Room temperature storage and assembly in the accelerator
3. Cooldown to (and retention at) approximately 4 K
4. Frequent current ramp up and down
5. Possible warmup to RT for maintenance
6. Repeat of steps 1 through 5

To date, the first four items have been explored, the results of which are reported herein. Numerical stress, strain and deflection values are presented. However, the paucity of measured data on coil properties requires that the results be considered only qualitative at present.

Several simplifying assumptions have been made in the following analysis. Radial variation in circumferential stiffness has been neglected although it can be large (Section 3.4.2.3.4). Circumferential variations in stiffness might also be important, but it is assumed that they are not present and therefore they are not considered. The discussion focuses on a cross section near the center of the magnet. Interactions among radial, axial and circumferential behaviors have not been examined.

Accurate prediction of coil behavior involves knowledge of the loading and unloading stress-strain curves from RT to 4 K as well as thermal contractions of the coil and supporting structure. Data were derived from the curves in Section 3.4.2.3. However, as was mentioned above, many more data are required.

A major magnet problem is the presence of friction between the inner and outer coils as well as between the coils and the yoke or extended centerpost. It is shown how friction analysis and stress-strain curves can reveal the behavior observed during magnet assembly and can account for some of the difficulties (Section 3.4.3.4).

Comments are included on the requirements of the coil manufacturing process control to achieve the specified field quality without shims as well as on potential assembly problems.

3.4.3.1.3 Approach Employed

The approach to the investigations included two phases. The first phase developed solutions to a set of classroom-type problems in midplane registration analysis. They involved both equal and unequal coil-half heights and stiffnesses in different combinations to acquire initial insight into expected behavior during precompression and Lorentz loading. The influence of shims was also considered and a preliminary examination was conducted into coil regionalization by determining the required thickness of a stainless steel midplane septum. The second phase considered preloading, stress relaxation, cooldown and Lorentz loading during which the unloading curve shape plays a major role.

3.4.3.2 Elementary Problems in Midplane Registration

Elementary problems in midplane registration analysis are solved in Figures 3.4.31 through 3.4.40. They range from the trivial result of no midplane shift for equally stiff and high halves to determination of shim requirements for halves of unequal height and stiffness. The diagrams depict coil heights as vertical on the assumptions that there is no friction present and that the core is rigid compared to the coil. The first assumption is inaccurate. The second may be reasonably correct.

The effect of Lorentz loading is indicated in Figure 3.4.38. For symmetrically disposed loading, the midplane shift would be small on coils of equal height but unequal stiffness.

The regionalization study is summarized in Figures 3.4.39 and 3.4.40. The indicated septum thickness would be too large for good field quality.

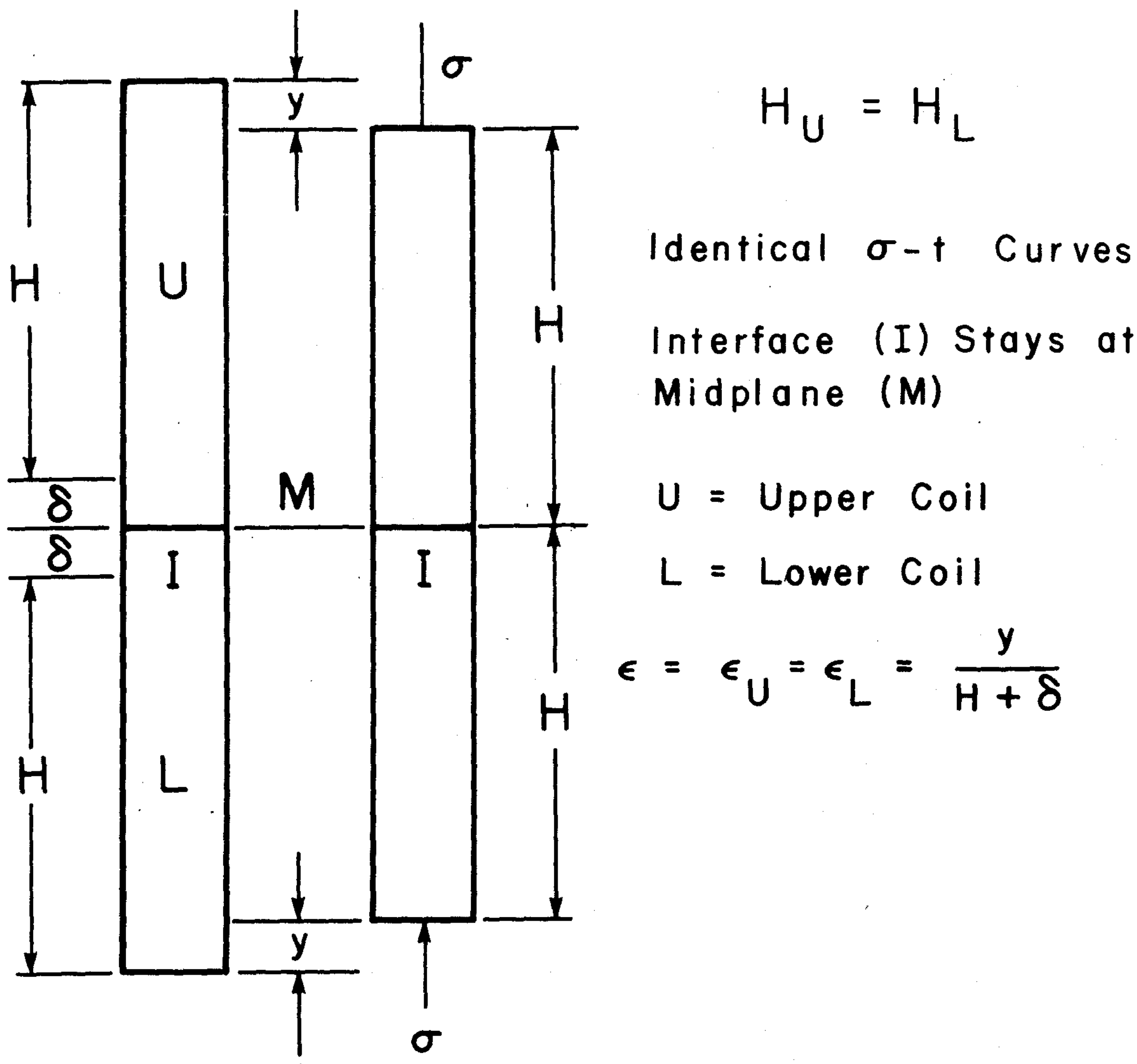
3.4.3.3 Midplane Registration Analysis

3.4.3.3.1 Introduction

This section includes a brief review of the background information required to conduct an accurate analysis of midplane registration. The analysis procedure involves selecting an initial RT predeformation stress on the coil, determining the effect of relaxation on preload after a selected time at RT, analyzing the cooldown stresses and deformations and, finally, evaluating the coil response to Lorentz loading. As was stated above, the investigation should be considered qualitative although numerical data are presented.

In this section the coils are presumed to act without friction on the faces. The influence of friction is discussed in Section 3.4.3.4.

3.4.3.3.2 Background Summary



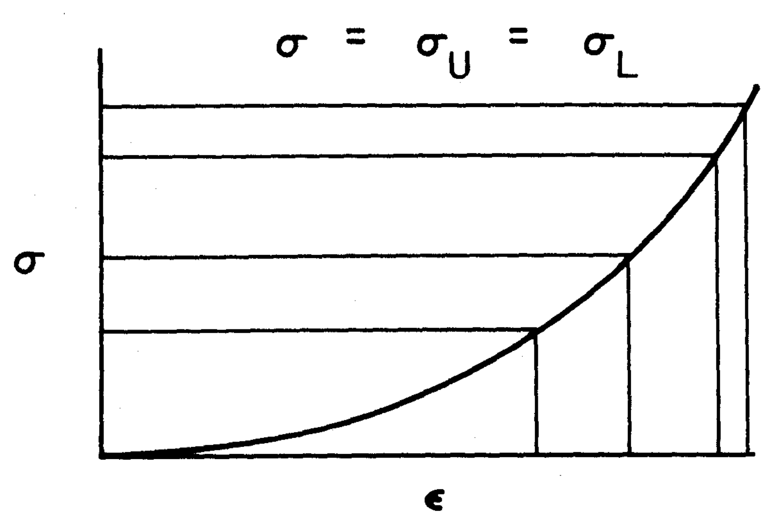
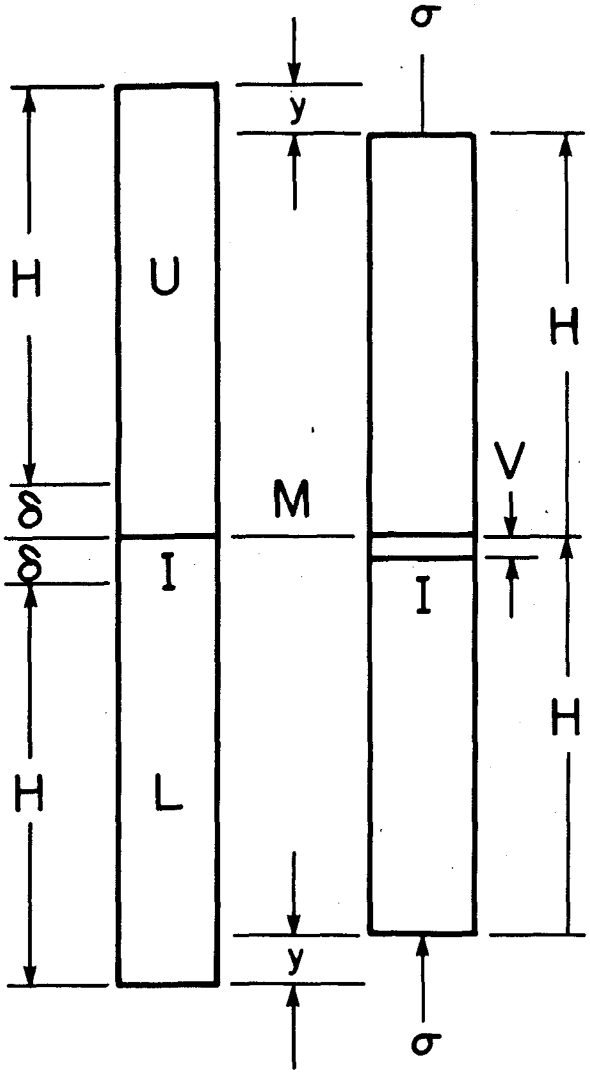


Figure 3.4.31 Classroom Problem I



$$H_U = H_L$$

Upper Coil Half Stiffer than Lower Coil Half

$$\frac{V}{\delta} = \frac{\Delta\epsilon / \epsilon_U}{2 + \Delta\epsilon / \epsilon_U}$$

$$\Delta\epsilon = \epsilon_L - \epsilon_U$$

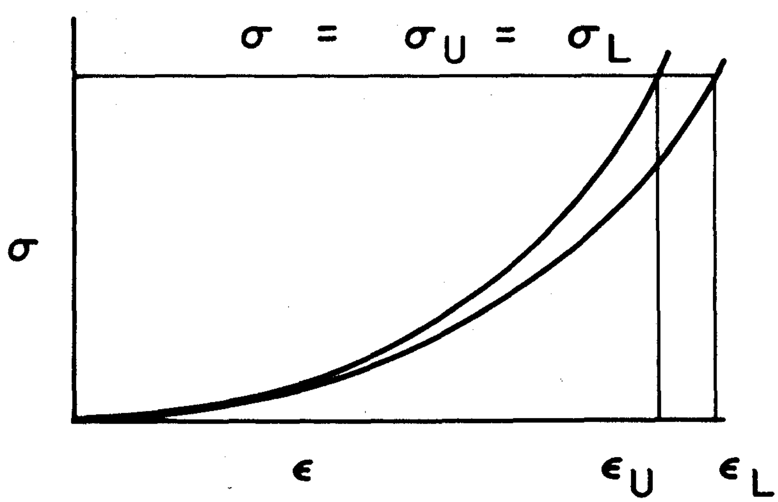
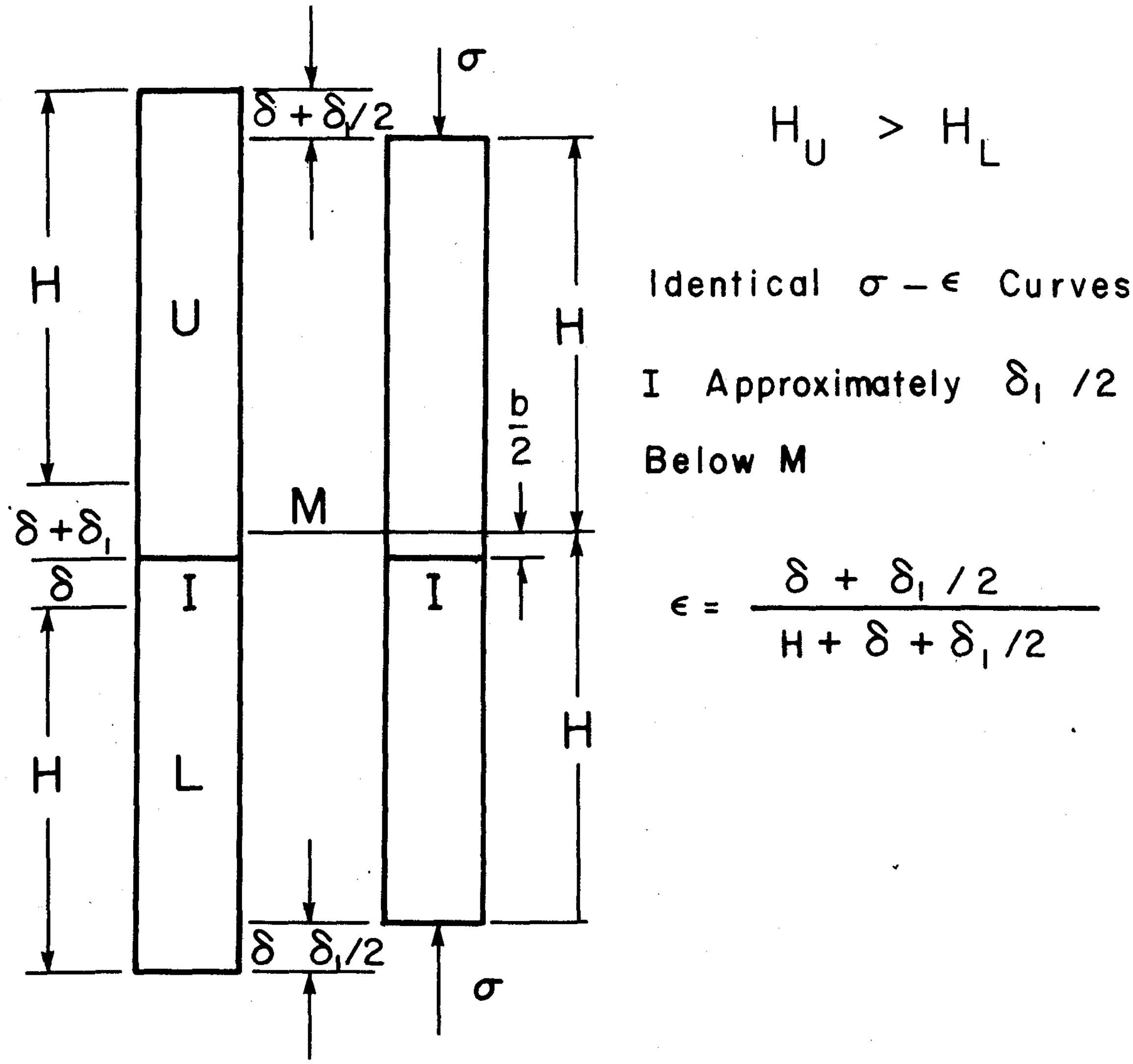


Figure 3.4.32 Classroom Problem II



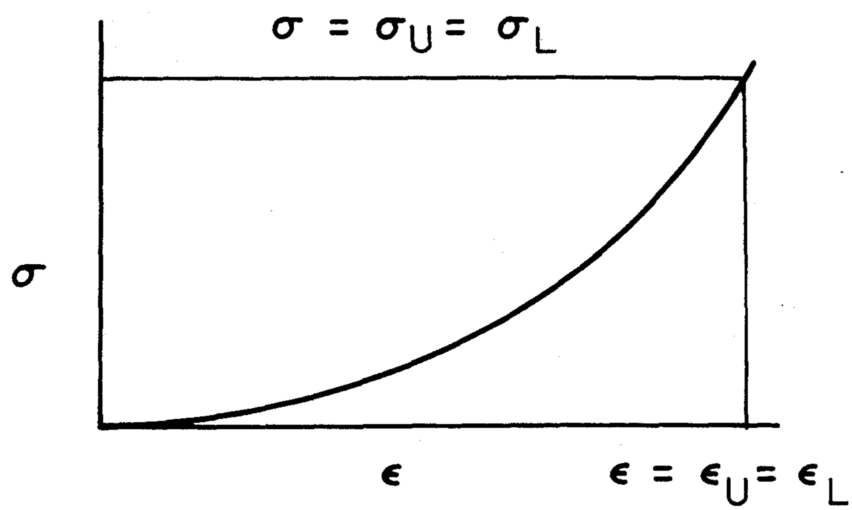
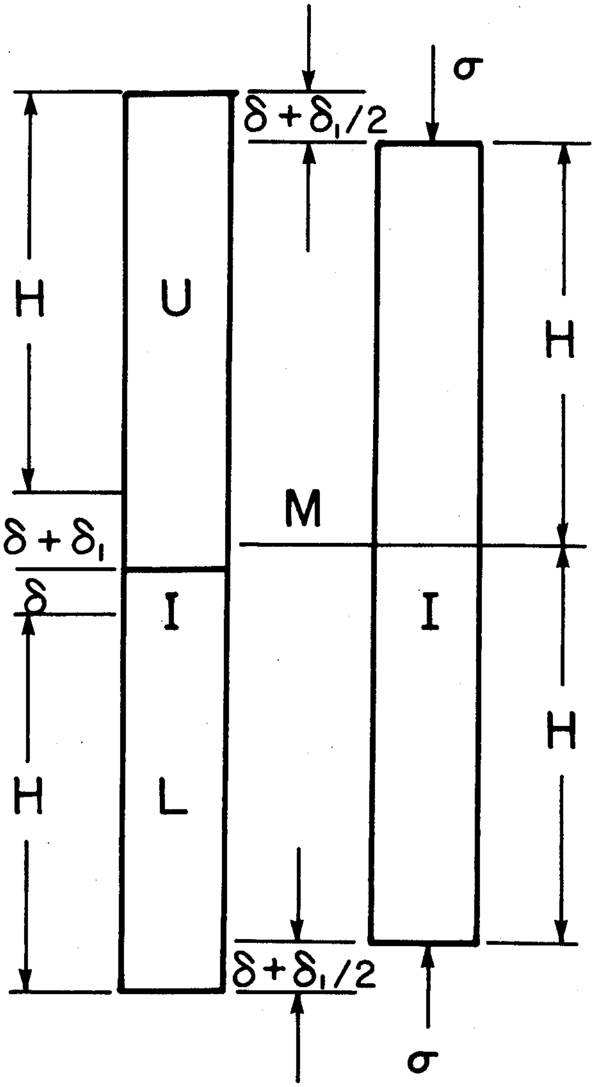


Figure 3.4.33 Classroom Problem III



$H_U > H_L$

Different $\sigma - \epsilon$ Curves

For Registration,

$\epsilon_U / \epsilon_L = (\delta + \delta_1)/\delta$

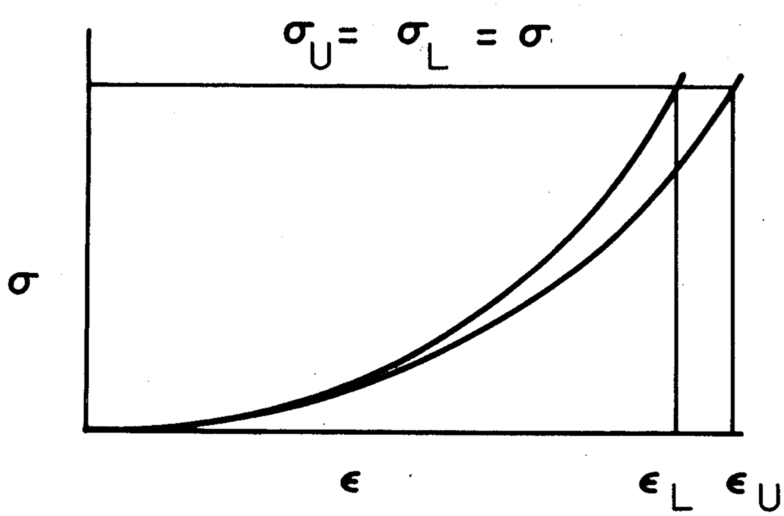
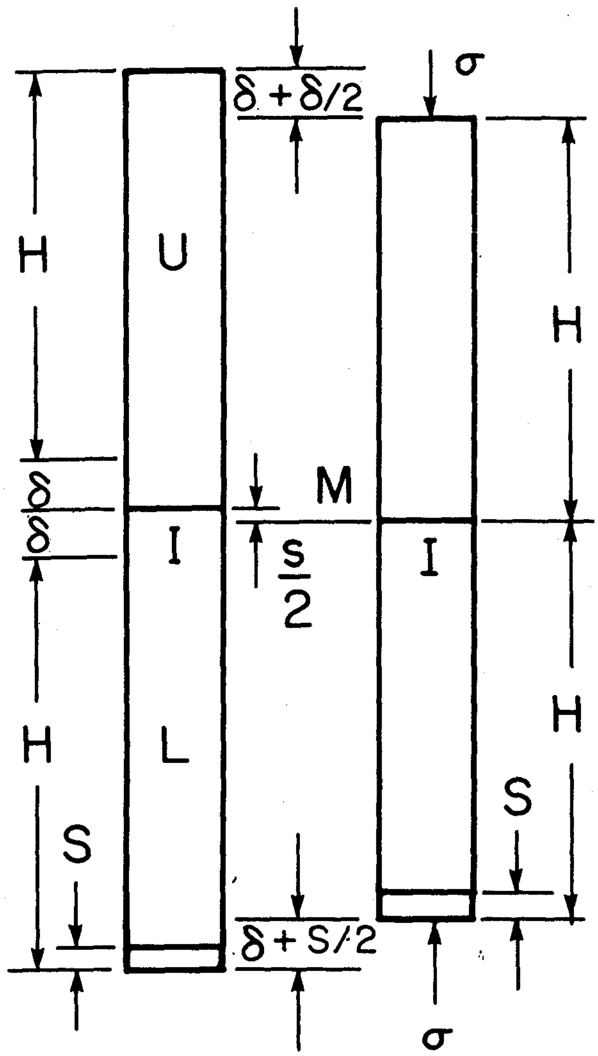


Figure 3.4.34 Classroom Problem IV



$$H_U = H_L$$

Upper Coil Half Stiffer than Lower Coil Half

Rigid Shim of Height S at Lower Post

To Achieve Registration,

$$\frac{S}{H + \delta} = \epsilon_L - \epsilon_U$$

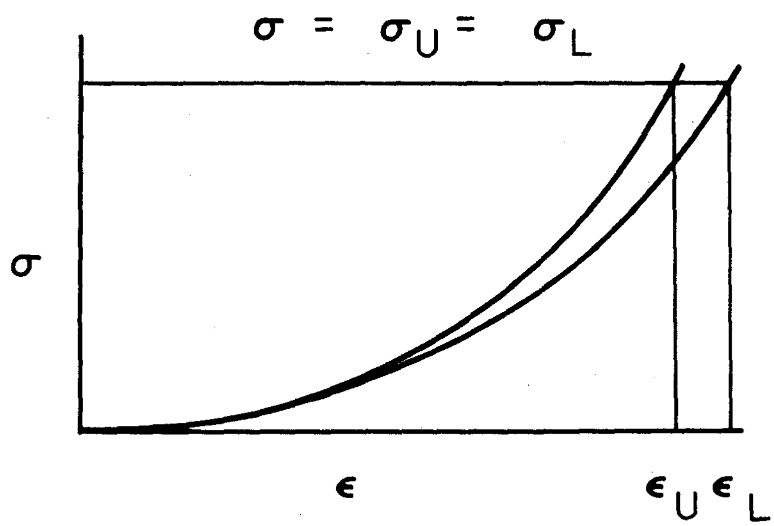


Figure 3.4.35 Classroom Problem V

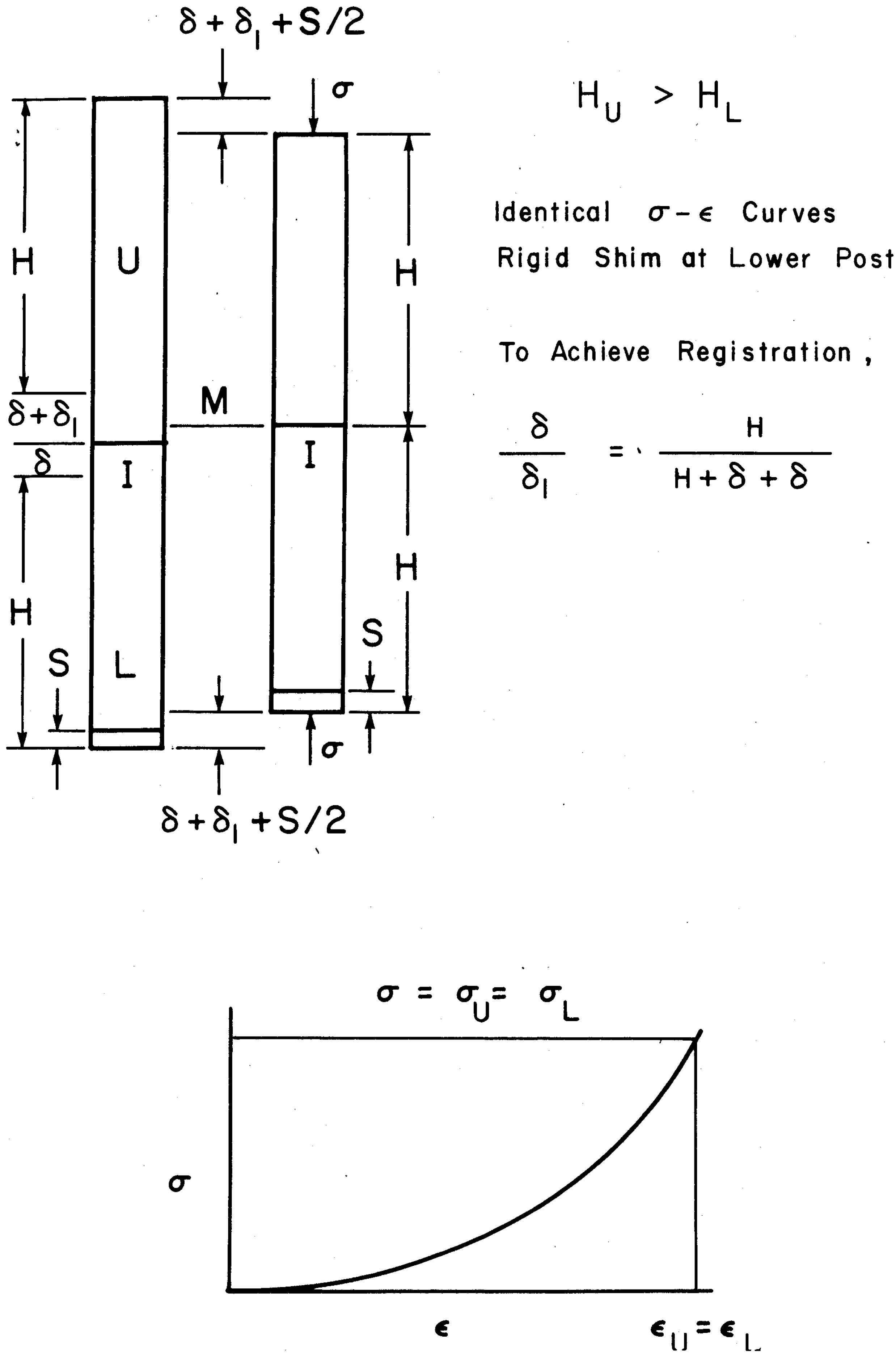
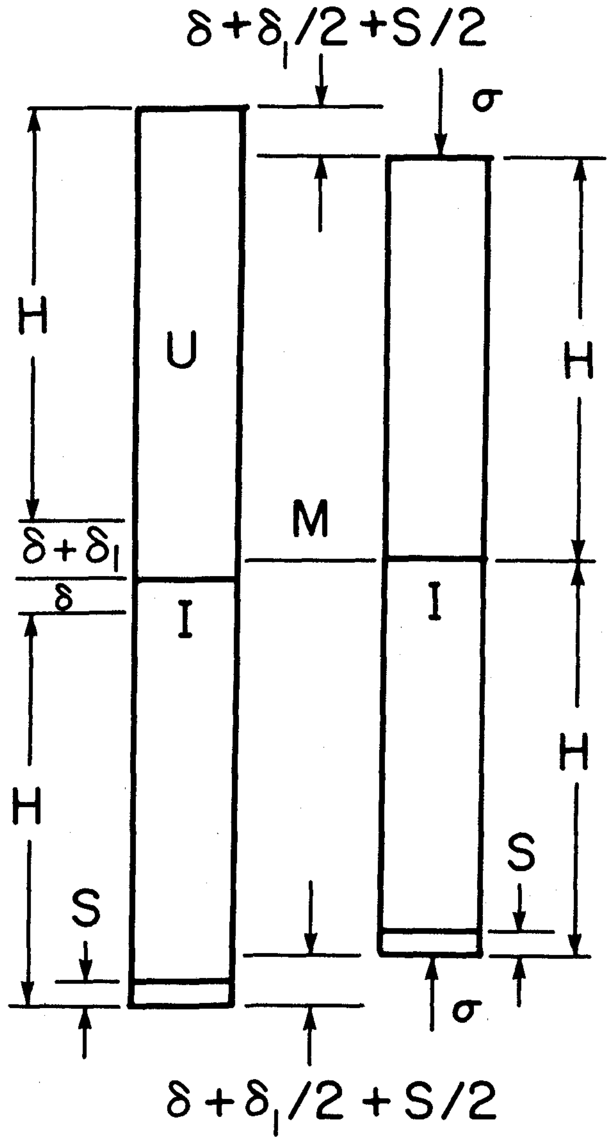


Figure 3.4.36 Classroom Problem VI



$H_U > H_L$

Different $\sigma - \epsilon$ Curves
Rigid Shim at Lower Post

To Achieve Registration,

$$\frac{\delta}{\delta_1} = 1 - \epsilon_U - (H+\delta)(\epsilon_U - \epsilon_L)/\delta_1$$

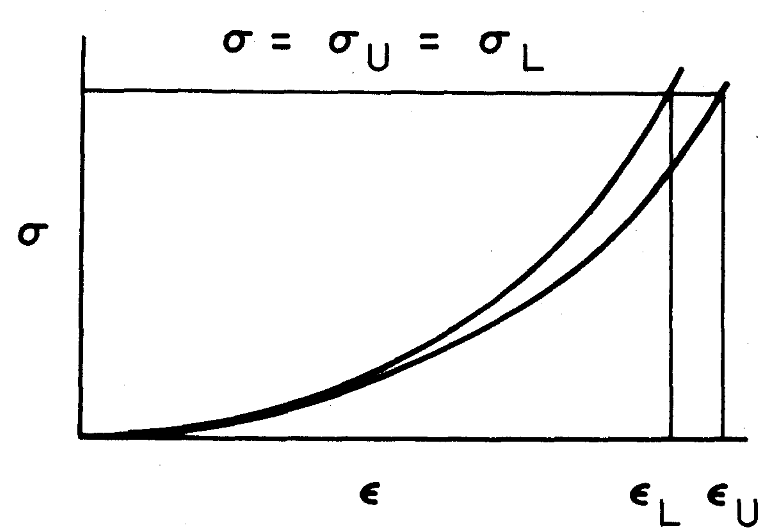


Figure 3.4.37 Classroom Problem VII

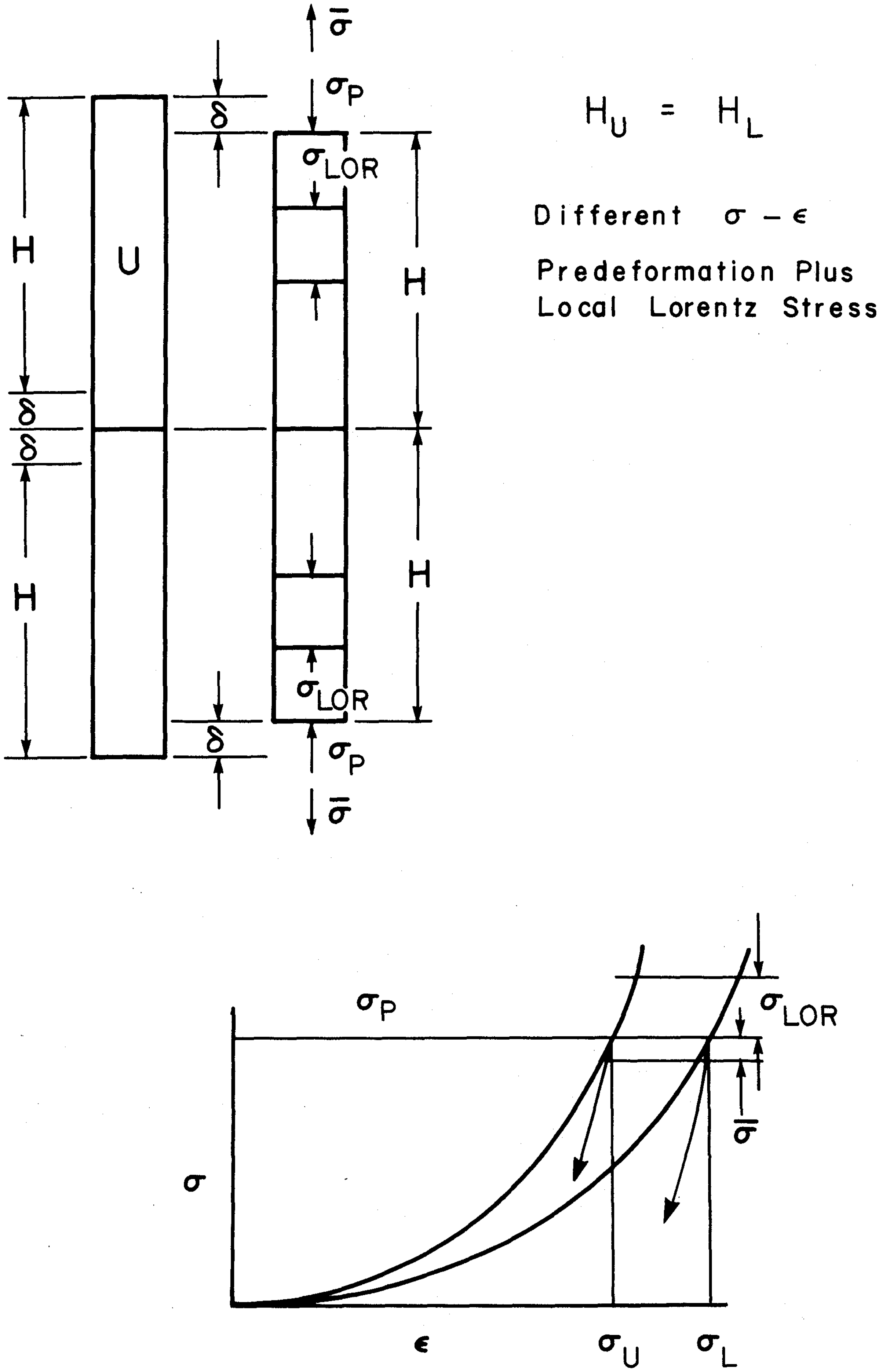


Figure 3.4.38 Classroom Problem VIII

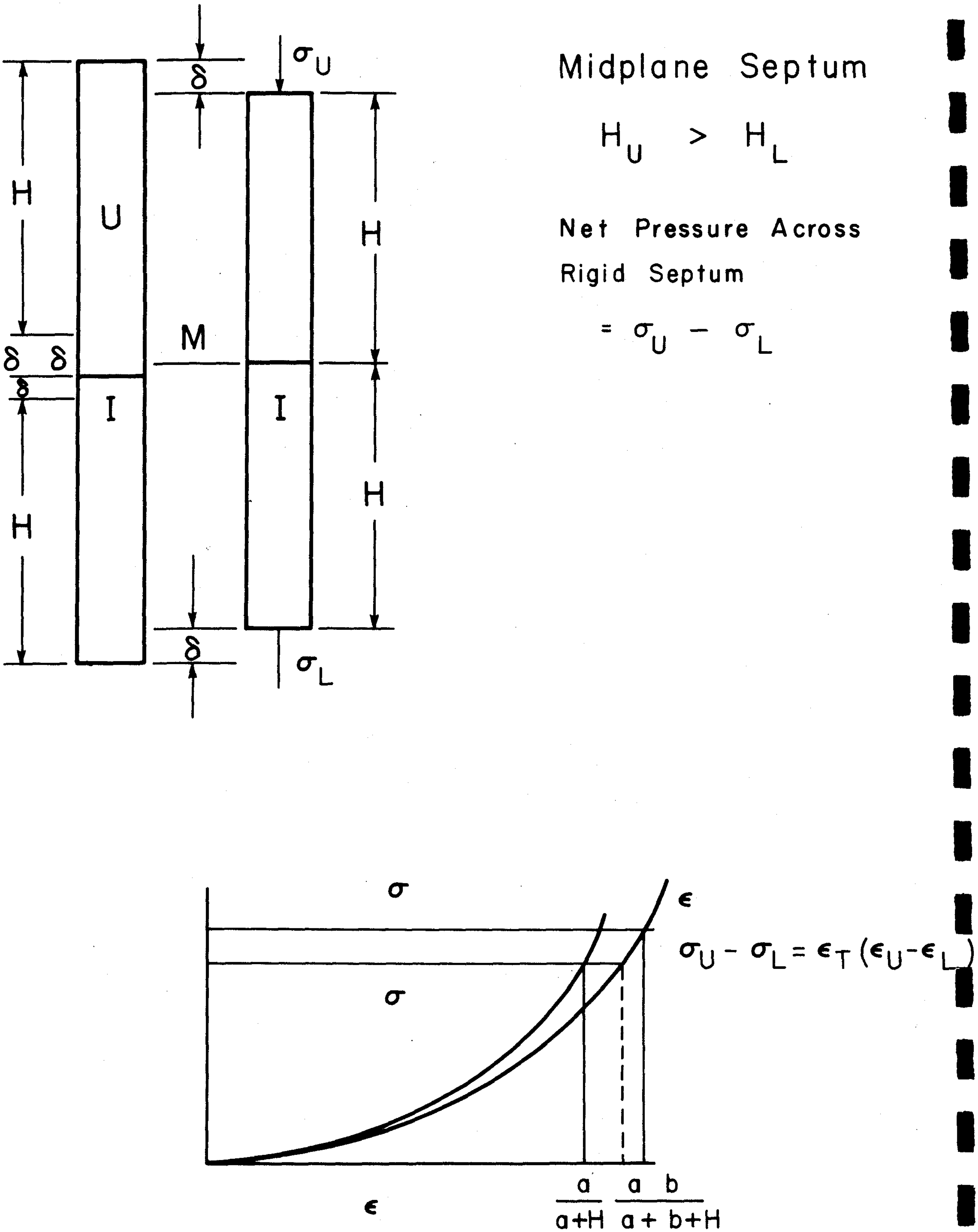
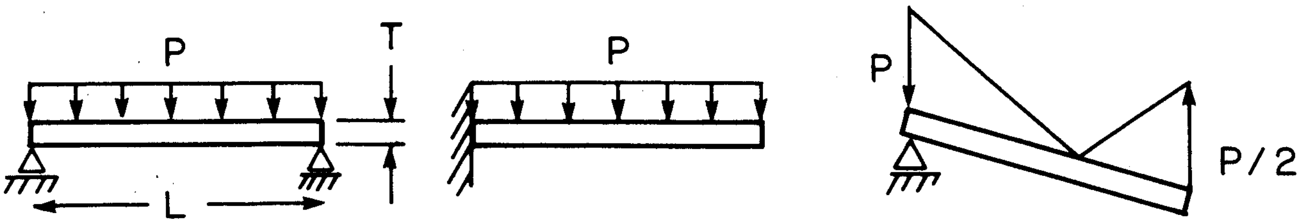


Figure 3.4.39 Classroom Problem IX



$$\sigma = \frac{3}{4} P \left(\frac{L}{h_1}\right)^2 \qquad \sigma = 3P\left(\frac{L}{h_2}\right)^2$$

$$\delta_1 = \frac{5}{32}\ \frac{P\ L^4}{E\ h_1^3} \qquad \delta_2 = \frac{3}{2}\ \frac{P\ L^4}{E\ h_2^3}$$

Let σ = 50 ksi, p = 5 ksi*, $L = \frac{2}{3}$ in

h_1 = 0.183 in , $\delta_1 \doteq 8.4 \times 10^{-4}$ in

h_2 = 0.365 in , $\delta_2 = 8.1 \times 10^{-3}$ in

*Let E_t = 2 msi, ΔH = 0.01 in , H = 4 in

$$\Delta\sigma = E_t\,\Delta t = E_t\,\Delta H/H = 5 \text{ ksi}$$

Figure 3.4.40 Midplane Septum

Representative stress-strain curves for increasing load, decreasing load and reload are shown in Figure 3.4.41 (reproduced from Figure 3.4.10) for alternating-layer straight stacks of conductor. As yet, no comparable data have been obtained on curved stacks. Most available curves apply to RT (References 3.4-1, 3.4-2 and 3.4-3). A few tests were run at 77 K (References 3.4-2 and 3.4-3) and LBL reports data for 4 K (Reference 3.4-3).

It is anticipated that each coil will be tested to at least 12 ksi to determine the compressed height before insertion into a magnet. Consequently, second cycle stress-strain curves might be expected to apply. The BNL curve of Figure 3.4.41 pertains to the fifth cycle. However, BNL data indicate little change after the second.

The RT curves reveal the early stages of plastic deformation at stresses above 10 ksi. Plastic deformation was not observed in the LBL 77 K curves at stresses as high as 15 ksi.

A feature of major importance is the shape of the unloading curve. Data from LBL, BNL, and MIT have been normalized to arbitrary units in Figure 3.4.42 (reproduced from Figure 3.4.11). They reveal large differences, presumably due to the relative stiffnesses of the testing machines used. In fact, it can be seen that the strain actually increases slightly during unloading of the MIT specimen which was tested in a 60,000 pound Baldwin-Southwark machine that is orders-of-magnitude stiffer than the rig constructed at BNL. The LBL tests were conducted in a small Instron Tester which is known to be more flexible than the Baldwin. As a result of this situation, there is uncertainty as to the appropriate unloading curve to be used in coil analysis. The core (or yoke) rigidity will also be an important factor. Furthermore, tests should be conducted on actual curved coils instead of alternating-layer straight stacks of conductor.

It is not known what happens to the stress-strain curve as the result of relaxation. For the ensuing discussion it was assumed that the curve shifts positively on the strain axis to match strains at the relaxed stress level (Figure 3.4.42).

Data from tests by Kaugertz (Reference 3.4-6) reveal creep rates of the order of 10^{-7} to 10^{-6} per hour in the stress range from 10 to 14 ksi. Goodzeit's test on an eleven inch long magnet segment indicates a stress relaxation of the order of 25 percent in one year (Reference 3.4-7). That latter figure will be assumed to apply to this study.

Use will be made of the data from Reference 3.4-8 that indicate a difference in thermal

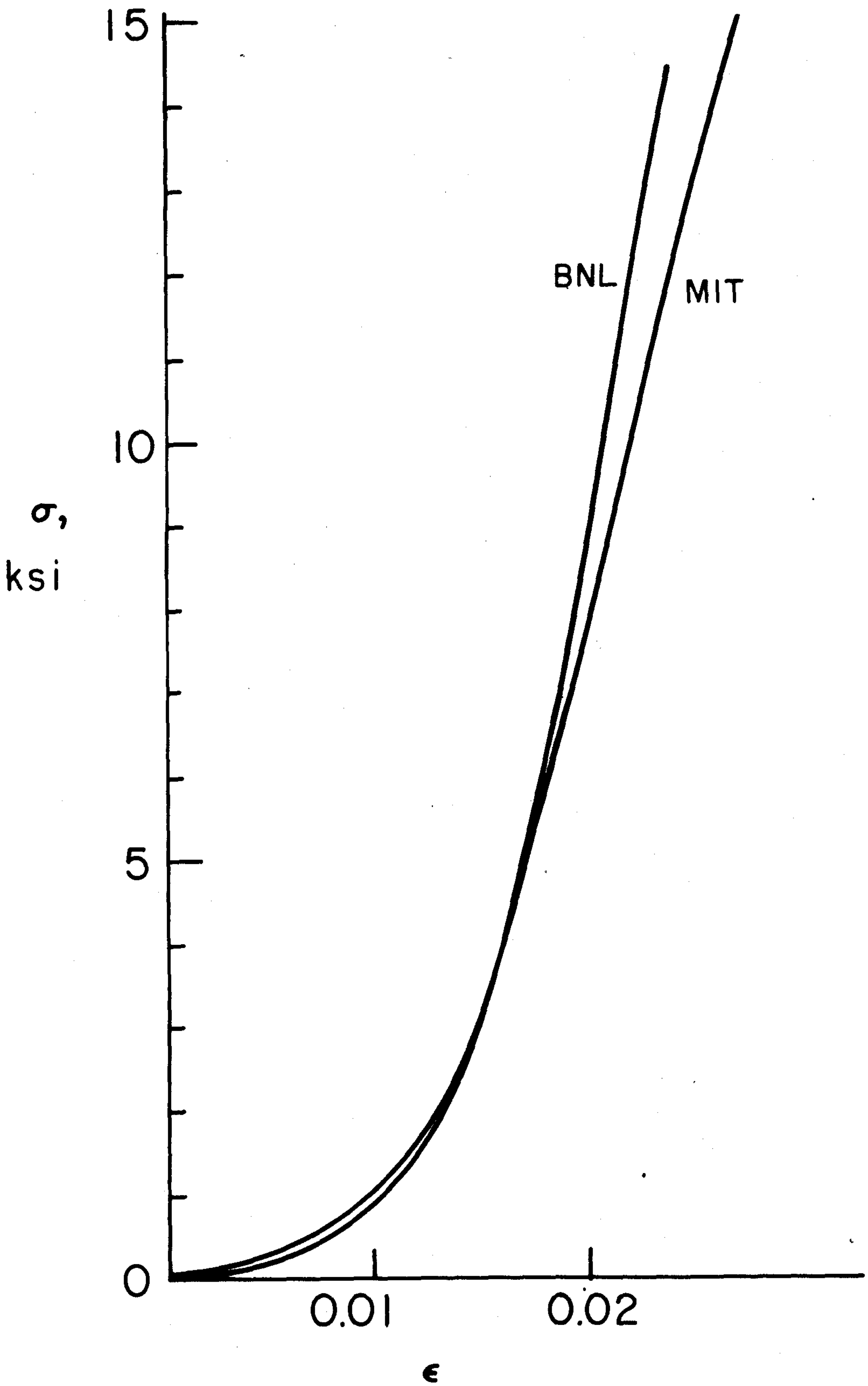


Figure 3.4.41 Representative Circumferential Compression RT Stress-Strain Curves for Fermilab Conductor, Using Alternating-Layer Stacks

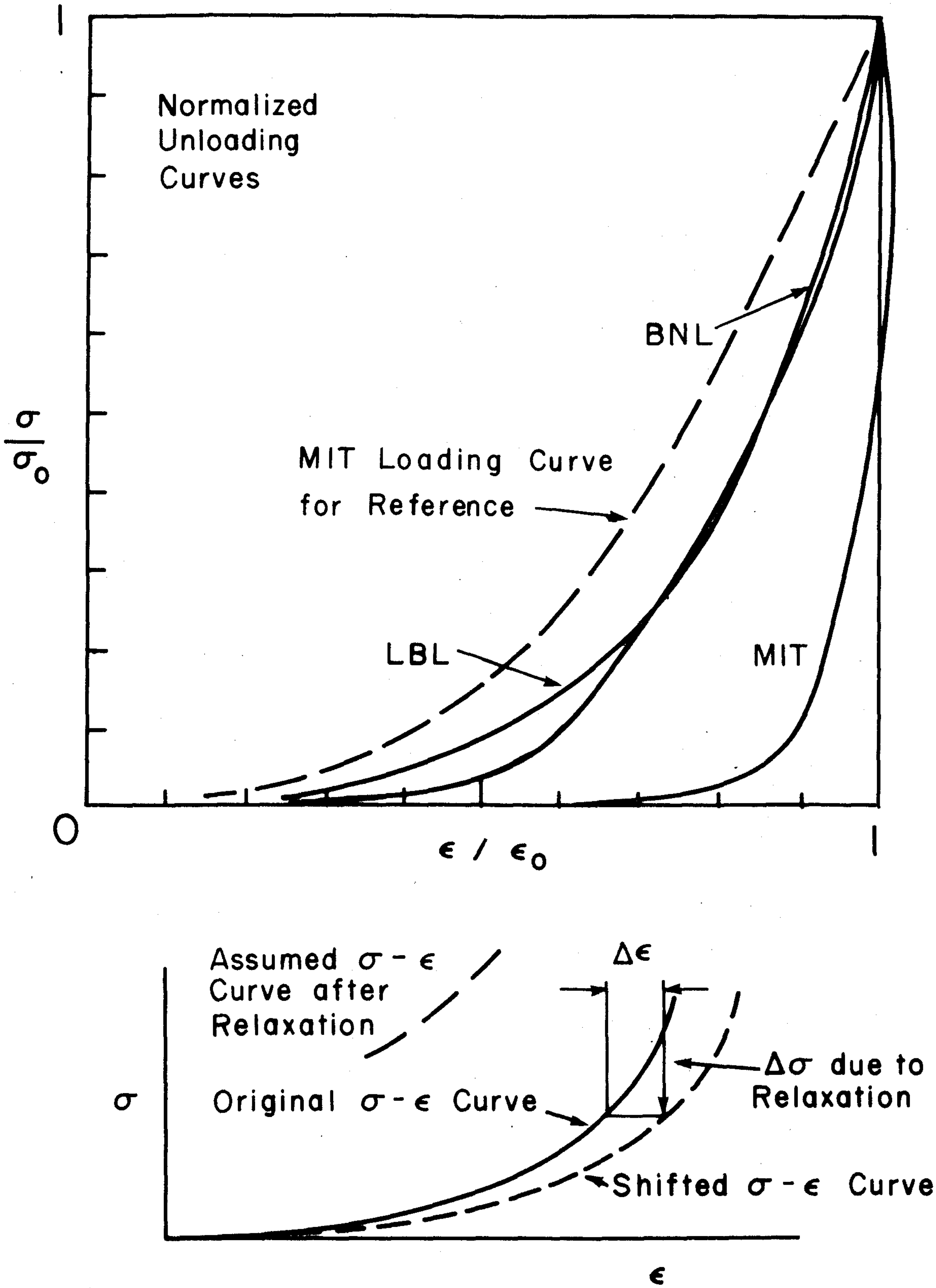


Figure 3.4.42 Unloading and Relaxation

shrinkage (RT to 4 K) of approximately 0.001, arbitrarily assuming the coil to be copper and the core to be carbon steel.

3.4.3.3.3 Behavior of Matched Coil Halves

The initially oversize coil is preloaded by closing the gap between the two halves of the coil case (core). This induces a compression strain of the order of 0.024 which corresponds to a circumferential stress of 12 ksi (Figure 3.4.41). The core is assumed to be much stiffer than the coil. Consequently, the coil mechanical strains should remain constant at RT.

A stress level of 9 ksi before cooldown conforms to 25 percent stress relaxation from the initial prestress. In order to continue this analysis, the stress-strain curves will be assumed to retain shape but to be shifted along the strain axis as shown in Figure 3.4.42.

The coil should become stiffer as the temperature decreases and also should shrink faster than the yoke. Thermal stress theory for elastic materials requires that the final stress state depends on the differential thermal contraction from initial to final temperature and on the stiffnesses of the materials only at the final temperature. That will be assumed to apply to the coil behavior.

The behaviors of two elastic materials are depicted in Figure 3.4.43. The stainless steel stress would be reduced almost 50 percent when cooled under restraint in a carbon steel case, assuming a thermal strain difference of 0.001. For fiberglass, however, the stress could increase by 16 percent under the same incremental strain reduction.

It is conceivable that increasing stiffness and decreasing strain could produce a stress increase, decrease, or no change at all on an ISABELLE coil, depending on the 4 K loading and unloading stress-strain curves. Figure 3.4.44 displays a cold-stress range between 6 and 15 ksi for a RT preload stress of 9 ksi. In the absence of stress-strain data at 4 K, curve A was used for the 4 K loading curve since it appears likely that the coil would begin to yield at approximately 15 ksi.

In a preliminary test (Reference 3.4-9), an alternating-stack coil specimen was clamped in a stiff fixture at RT under 10 ksi preload. It was cooled to 77 K at which the stress was found to be greater than 11 ksi, which would appear to support the case for an increase in preload at 4 K compared to 77 K. Other tests are in progress at BNL.

Lorentz loading induces a compression stress of approximately 9 ksi at the midplane with a near-parabolic variation to the coil extremes (Figure 3.4.45). If the coil were linearly elastic, the

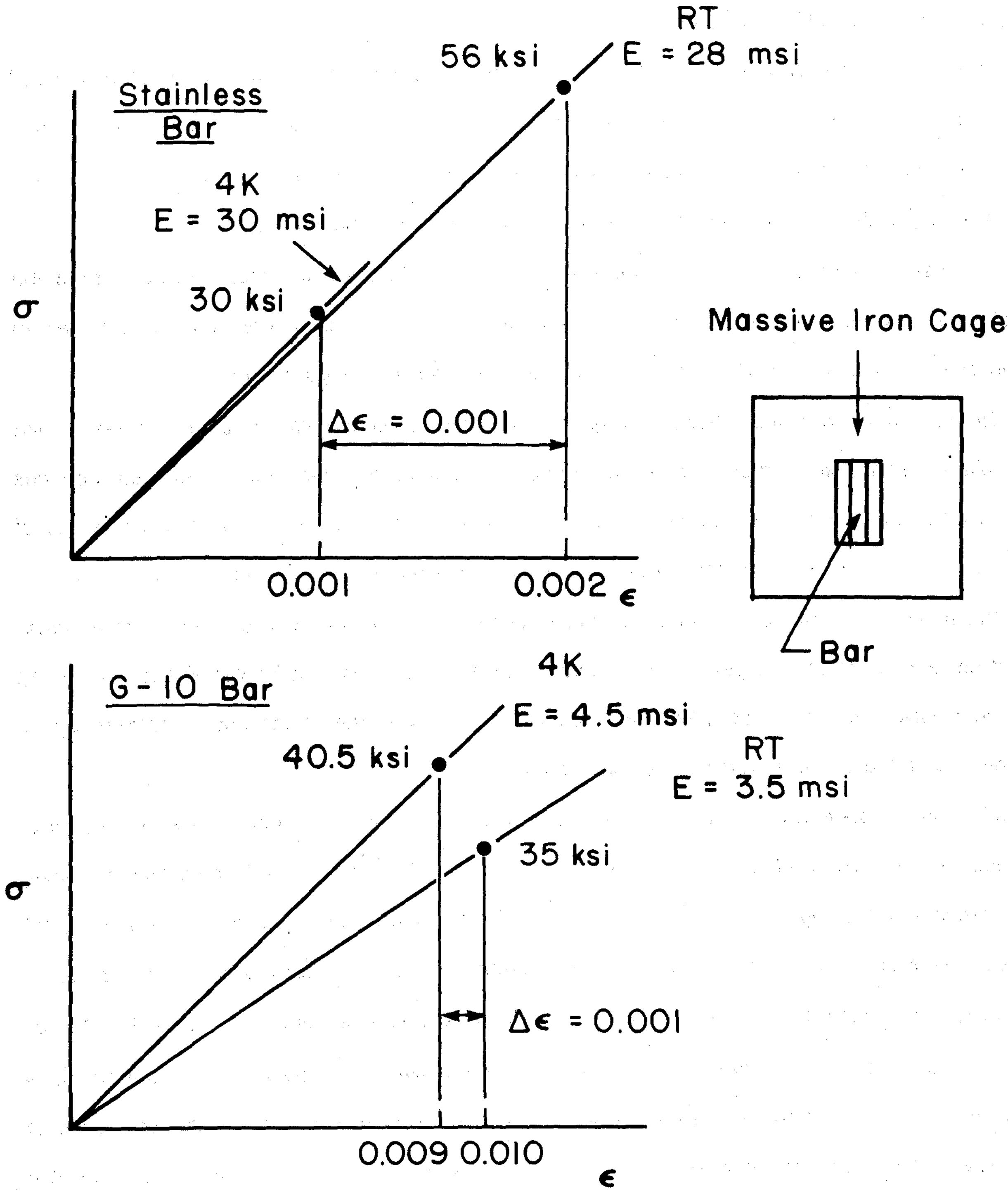


Figure 3.4.43 Cooldown Stresses in Restrained Bars

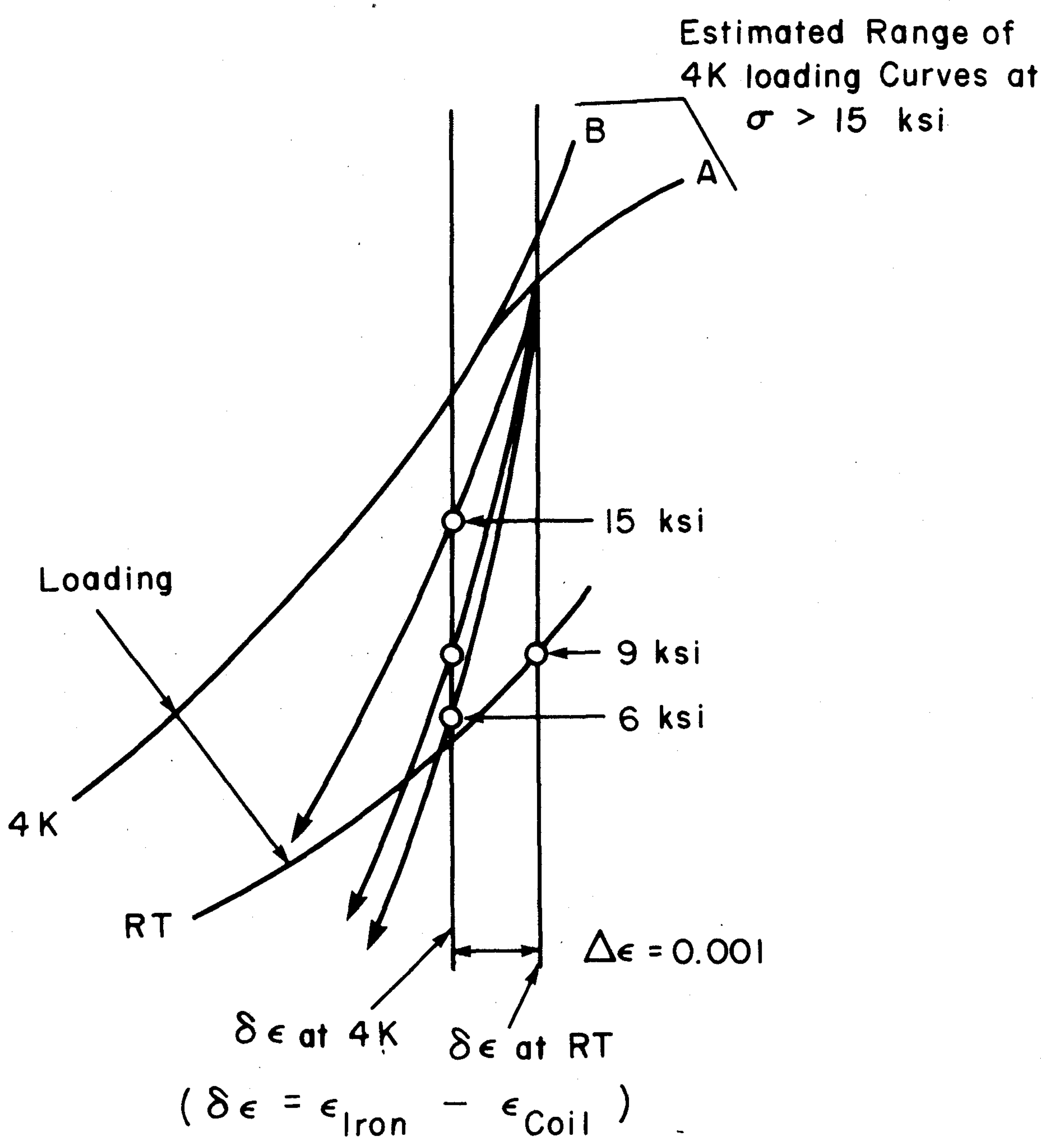


Figure 3.4.44 Range of 4 K Prestress Values

strain ratio, (unloading strain)/(loading strain), would be 2/3 (Figure 3.4.45). A tensile stress of (2/3) 9 ksi, or 6 ksi, would be required to induce an unloading strain that would balance the Lorentz loading strain. The result would be 6 ksi reduction in compression at the post and 3 ksi additional compression at the centerplane. If that is added algebraically to 15 ksi remanent preload shown in Figure 3.4.45, the post elastic compression stress would be 9 ksi and the midplane compression stress would be 18 ksi. For the 6 ksi remanent preload, the corresponding elastic stresses would be zero at the post and 9 ksi at the midplane.

For an elastic coil, the circumferential Lorentz deflection would be a maximum at $y = H/\sqrt{3}$ (Figure 3.4.45) where the magnitude would be $\delta = 0.128\ (\sigma_o\ /E)\ H$. If $\sigma_{L\,or} = 9$ ksi, $E = E_l = 4$ msi (cold) and $H = 4$ inches for the inner coil, then $\delta = 0.0012$ inch. This result is independent of prestress above 6 ksi.

The nonlinear elasticity of the coil can lead to radically different results (Figure 3.4.46). The strain ratio (unloading/loading) no longer would be 2/3. It could be greater or less depending on the 4 K preload stress and applicable unloading curve. The two sets of conditions in Figure 3.4.46 are based on assumed behaviors. The 4 K loading curve is unknown for stresses greater than 15 ksi. It might be well in the plastic range at nominal stresses of the order of 18 ksi, which is the sum of the assumed 3 ksi net Lorentz load increment and the 4 K preload from Figure 3.4.44.

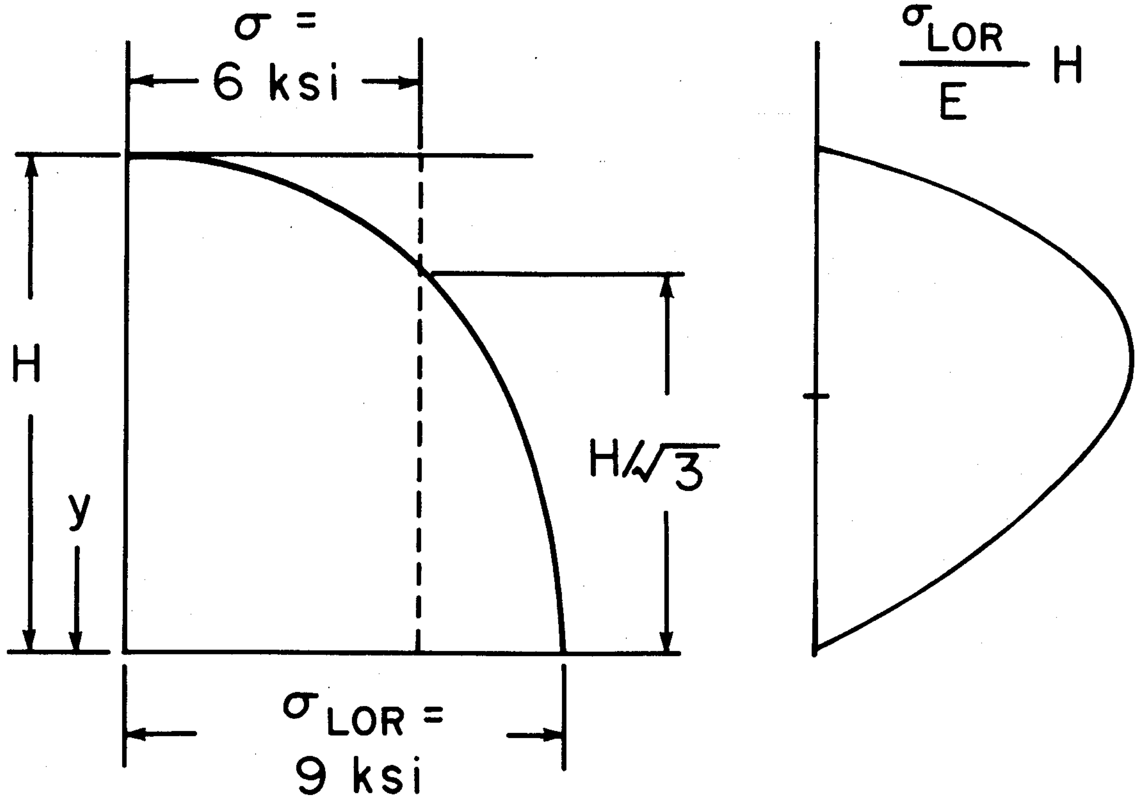
For simplification, the reloading was assumed to retrace the unloading curve. Actually, the reloading curve would be steeper (Figure 3.4.44), the strains would be less and the tension applied to the post would be less. The post would not unload until the 4 K preload was nearly zero.

3.4.3.3.4 Unequally Stiff Coil Halves

The preceding discussion examines the behavior of matched coil halves as affected by variations in the unloading curve. It was concluded that the coil would not unload at the post even though the RT preload was much less than the 12 ksi now being contemplated.

This section examines the possible movement of the midplane between a pair of coil halves of equal height at 12 ksi, but of unequal stiffness, for which midplane registration has been achieved at RT. Since the halves are unequally stiff, the free heights will be different as will the strains induced by the prestress so that the heights will match at RT.

At 4 K, the stresses in the coil halves will be equal for force balance across the interface as



$$(\sigma_1 / E)H = 2/3(\sigma_{LOR} / E)H$$

$$E_{load} = 2/3\ \sigma_{LOR} / E \quad \text{(orig. value)}$$

$$E_{unload} = \sigma_1 / E$$

$$E_{unload} / E_{load} = 2/3$$

Figure 3.4.45 Elastic Lorentz Loading Stresses and Strains

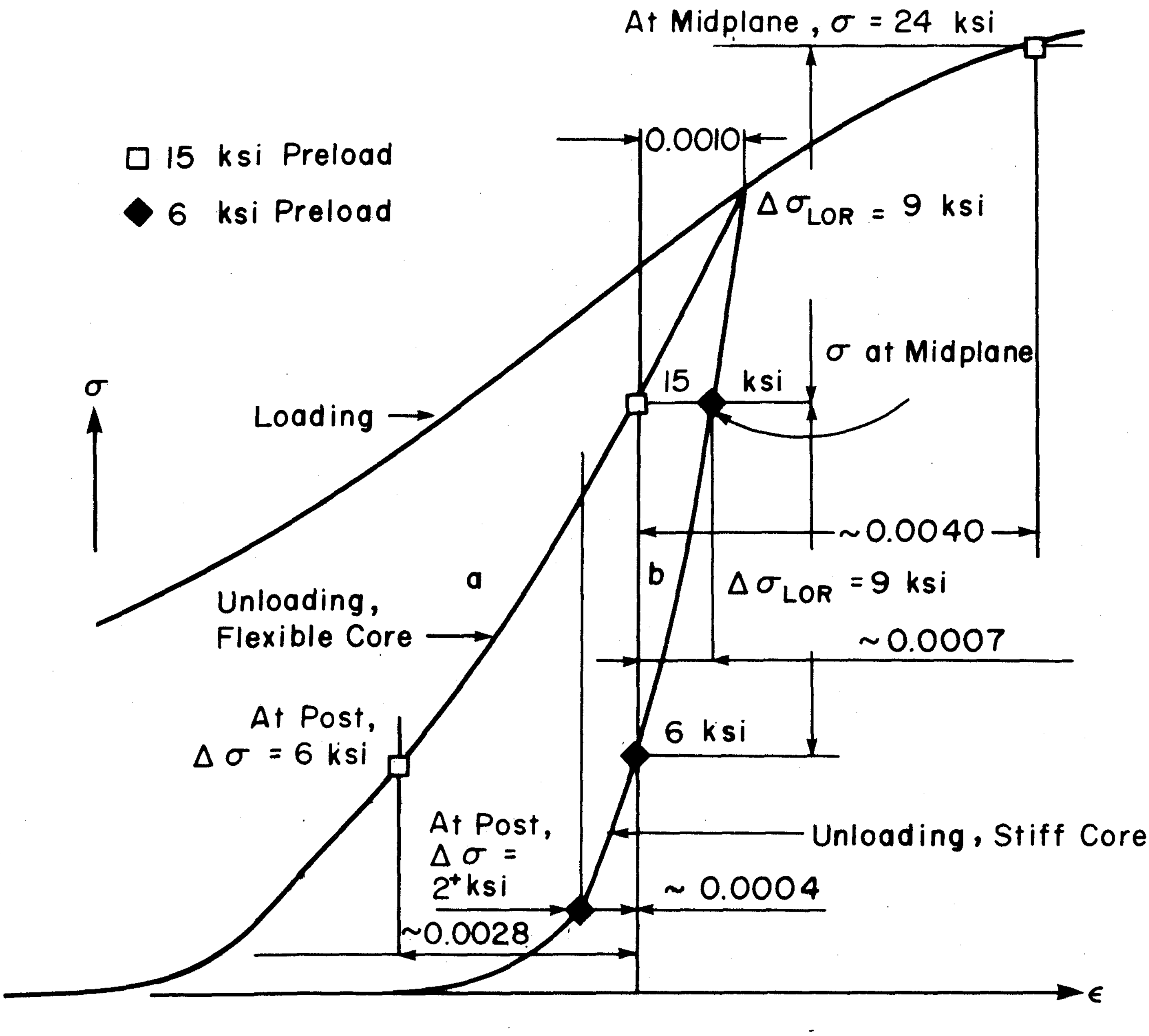


Figure 3.4.46 Lorentz-Induced Coil Stresses for Different 4 K Preloads

shown in Figure 3.4.47 which depicts the loading and unloading curves for both magnet halves. In order to view the cooldown behavior more easily, points 1 and 2 have been merged causing both unloading curves to spring from the same point. The two equations on the figure display the conditions that must be met at 4 K. It shows that the strains on the two curves straddle the cooldown net strain, $\Delta\epsilon_T$. A linearized version of that process is displayed in Figure 3.4.47.

The strain difference should be determined from the nonlinear unloading curves. Consequently, if the tangent moduli at point (2) are used, $\delta\epsilon$ could be underrated. Therefore, as an estimating procedure, assume that $\delta\epsilon$ is twice the value found from the linear diagram in Figure 3.4.47 to account for nonlinearity of the unloading curves. Then $\delta\epsilon = 2\Delta\epsilon_T(1-\alpha)/(1+\alpha)$. Also, assume $\alpha = 1.5$, which is an extreme value. Then $\delta\epsilon = (2/3)\Delta\epsilon_T$. Use $\Delta\epsilon_T = 0.001$ for the RT - 4 K differential shrinkage strain between the coil and the core. The resultant midplane shift, for an inner coil height of 4 inches, would be 4(2/3)(0.001) or 0.0027 inches toward the stiffer coil half. For a more realistic value of α, the shift would be negligible. The stress increments also would be small.

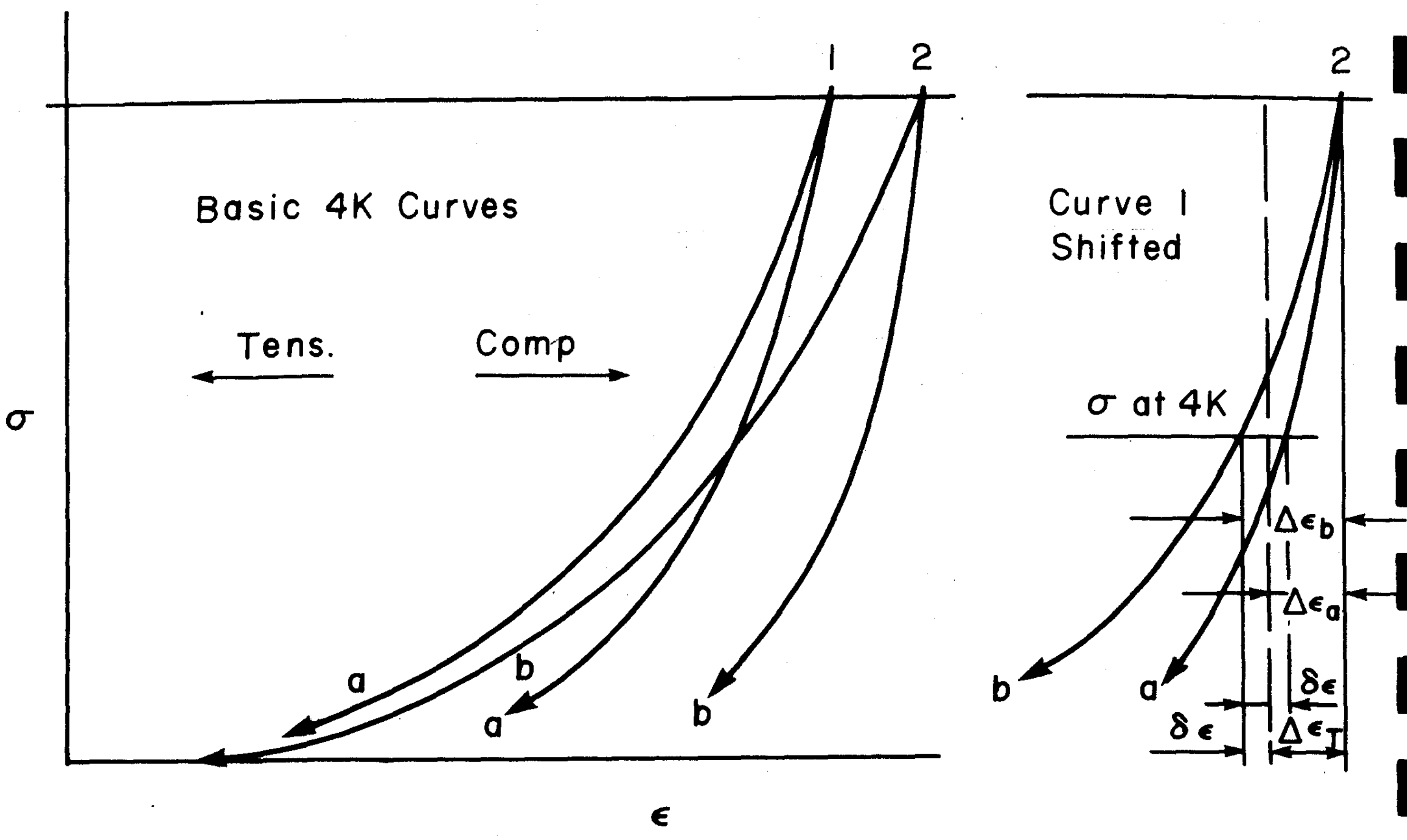
The Lorentz stresses are compressive and, therefore, the strains would be found by rising from ϵ_a and ϵ_b on reloading curves that would be steeper than the unloading curves (Figure 3.4.44). The counterbalancing tension strains would continue down the unloading curves but would be less than the Lorentz strains. As shown above, they would be 2/3 the applied Lorentz compression strains in an elastic coil and would leave a midplane net compression strain of 1/3 the applied Lorentz value. The preceding conclusions concerning post stress from Lorentz loading would apply to unequally stiff coils if α is of the order of 1.1 to 1.2, which seems to be the case based on preliminary comparative data.

3.4.3.4 Effect of Friction

3.4.3.4.1 Introduction

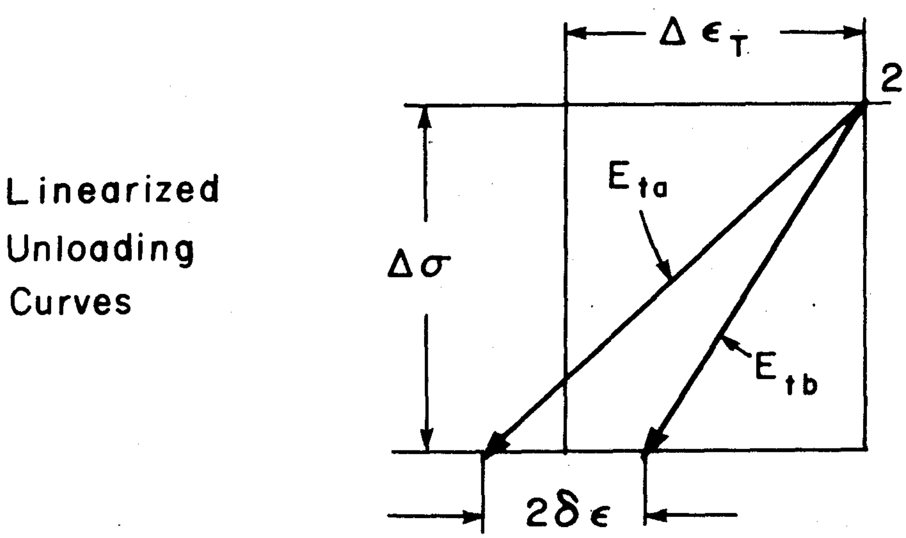
Friction can influence the orientation of coil layers in the magnet. A cross section of a Fermilab magnet reveals both azimuthal displacement and layer tilt, part of which might be charged to friction during assembly and predeformation.

This section examines the effect of friction on layer orientation and indicates it can induce



$$\sigma_a = \sigma_b, \quad 2\Delta\epsilon_T = \Delta\epsilon_a + \Delta\epsilon_b$$

Figure 3.4.47a Cooldown Stresses and Strains for Unequally Stiff Coil Halves



$$E_{tb} = \alpha E_{ta}$$

$$\delta\epsilon = \Delta\epsilon_T \frac{1-\alpha}{1+\alpha}$$

$$\Delta\sigma = 2 E_{ta} \Delta\epsilon_T \frac{\alpha}{1+\alpha}$$

Figure 3.4.47b Components of Coil Layer Reorientation displacements that could lead to the indicated current density variations and consequent field quality alterations.

3.4.3.4.2 Evidence for Presence of Friction

Measurements of bolt forces and average coil stresses have been made on several long magnets. Coil circumferential stress data from the post sensors are displayed in Figure 3.4.48 for LM3, LM5 and LM6. The average stress, σ_0, from the bolt load, F, was calculated using a coil thickness, w = 0.32 inches and a bolt spacing, L = 3 inches.

If the coil surfaces were frictionless, the actual coil stress would be related to the theoretical stress, σ_0 = (bolt force)/(coil area), as displayed in Figure 3.4.49. It is seen to differ greatly from Figure 3.4.48. The difference could be caused by friction alone.

3.4.3.4.3 Theoretical Effect of Friction on Coil Azimuthal Stress

The term, "friction coefficient" (μ) is an inaccurate description. Friction has been modelled as fracture of small surface asperities during mutual sliding of two surfaces in contact. If intercoil insulation were to become corrugated by radial pressure, μ could rise considerably above smooth-surface values. (As an extreme case, meshing gear teeth could lead to a near-infinite value of μ.) Broken fiberglass ends could cause snagging between coils and raise μ. If conductor filaments were to break, they could produce a similar effect. The result could be a "stick-slip" behavior instead of static loading or smooth sliding.

In view of these effects, it is conceivable that μ could change if an assembled magnet were to be disassembled and reassembled.

The coefficient is known to depend on relative sliding speed and temperature (Reference 3.4-12). It also varies radically as a function of material and changes slightly with interface pressure.

It is apparent that reliable analysis and control of friction in a magnet may be difficult to achieve. Nevertheless, the value of μ has been considered constant at each interface between components in the present analysis to achieve a zero order solution to the problem.

If friction is present, then some load would be transmitted to the outer coil, the outer steel post segment and the core steel as soon as the bolts are torqued. The result would be azimuthal stress gradients in the two coils that would tend to alter the azimuthal positions of the layers. Also, the frictional shear stresses would tend to distort the cross section of the coils causing tilting

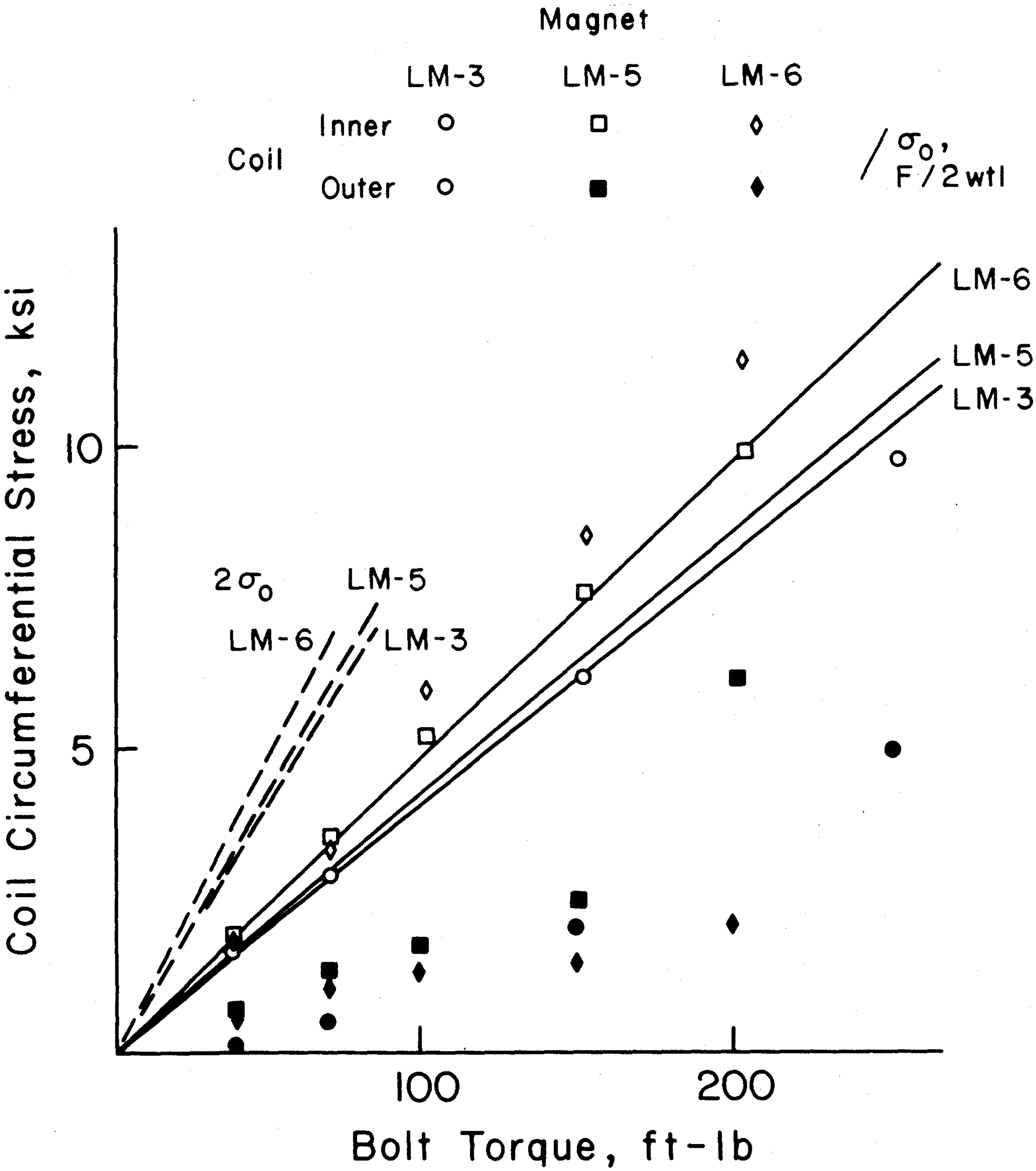


Figure 3.4.48 Coil Stresses at Post

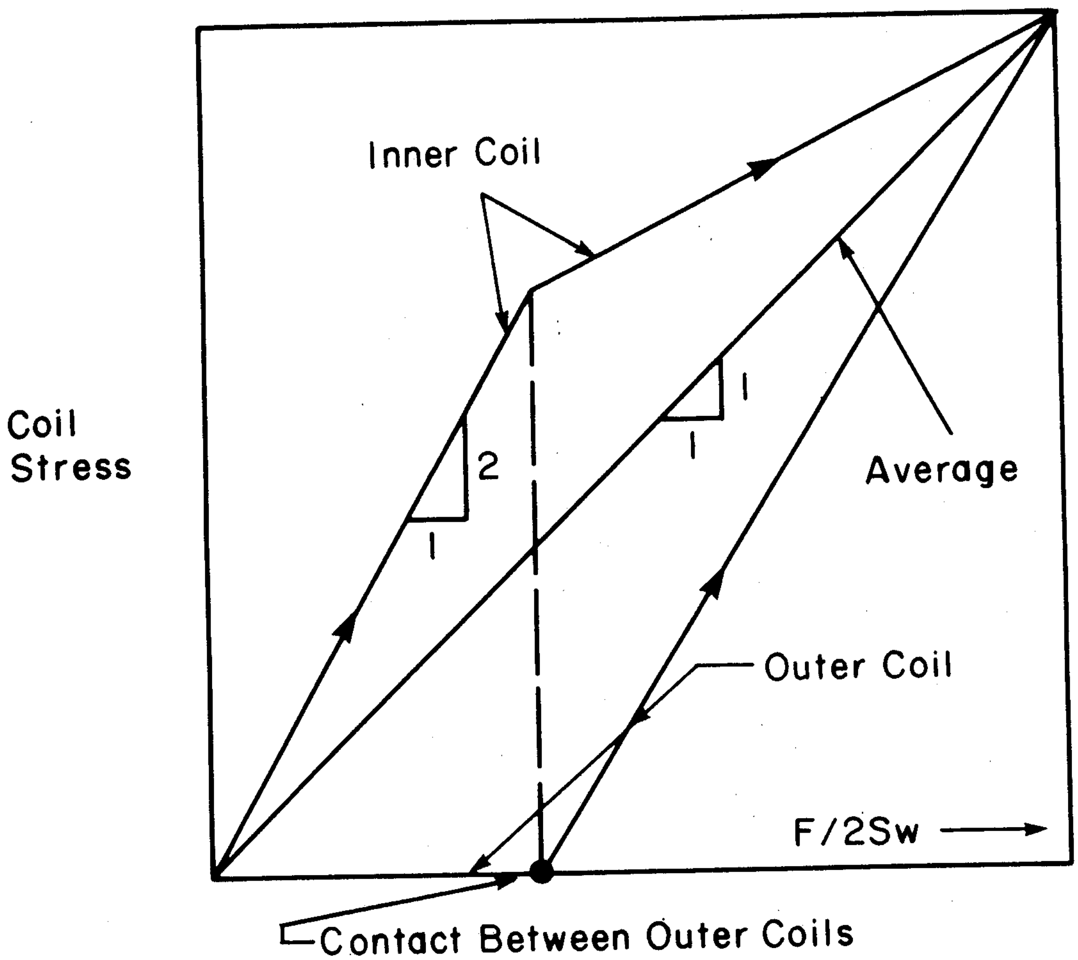


Figure 3.4.49 Frictionless System

action.

A simplified approach to stress analysis is shown in Figure 3.4.50. Force balance on an incremental length of coil is seen to lead to the relation

$$d\sigma/d\phi = -\mu\sigma \tag{3.4.20}$$

When equation (3.4.20) is integrated, it leads to the stress ratio relation,

$$\sigma_2/\sigma_1 = e^{\mu\sigma} \tag{3.4.21}$$

where σ_1 and σ_2 are the applied and reacting stresses at the ends of a coil segment subtending an angle, ϕ, and μ is the friction coefficient.

Test data (Reference 3.4-13) indicated a range of μ values from 0.15 to 0.3, more or less independent of mold release material and layers of interposed material such as kapton. The handbook value is 0.75 for dry steel on dry steel.

3.4.3.4.4 Analysis of Magnet Preload Behavior

The analysis was conducted by employing Equation 3.4.21 together with the stress data from post sensors on the inner and outer coils. The procedure involved inverting Equation 3.4.21 to predict coil average midplane stresses from the post values. It required several trials for each magnet. Different choices were made for μ_1 which applies to the interfaces between coils and between the outer coil and the yoke. The coefficient, μ_2, for the steel-yoke interface was maintained constant at 0.75. Calculations were limited to bolt torques below those at which the yoke faces met at the midplane. The extrapolation factors appear in Figure 3.4.51.

Figure 3.4.52 displays the extrapolated inner and outer coil midplane stresses for the three magnets. Figure 3.4.53 shows that the averages track reasonably well with the bolt-load averages. The values of μ_1 for LM3 and LM6 fall within the range found in Reference 3.4-13. However, the low value of μ_1 for LM5 indicates a near-frictionless condition.

It may be possible to explain that behavior with the aid of Figure 3.4.52 which shows the ragged extrapolated curve for the outer coil of LM5. It may be indicating stick-slip action with nearly full frictionless load recovery after slip, particularly beyond 150 foot-pounds of bolt torque.

$$w\,d\sigma = \tau R\,d\phi = 0$$

$$d\sigma / \sigma = \mu\,d\phi$$

$$\therefore\ \sigma_2 / \sigma_1 = \mu(\phi_2 - \phi_1)$$

AT ANY ϕ_1, ϕ_2

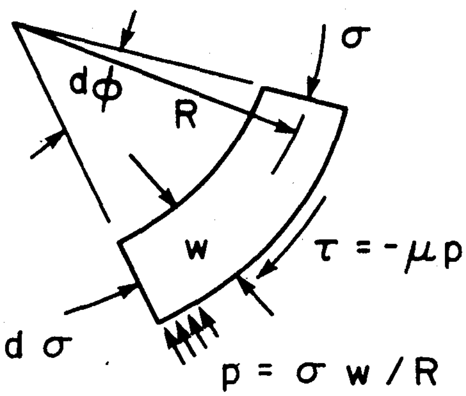


Figure 3.4.50 Simplified Approach to Coil Friction Analysis

F = Bolt Force, S = Bolt Spacing

	$\frac{\sigma_I}{\sigma_1}$	$\frac{\sigma_3}{\sigma_2}$	$\frac{\sigma_O}{\sigma_3}$	$\frac{\sigma_O}{\sigma_2}$	$\frac{\sigma_I + \sigma_O}{2}$
$\mu_1 = 0.05$	1.07	1.45	1.04	1.51	$0.53\sigma_1 + 0.76\sigma_2$
$\mu_1 = 0.2$	1.32	1.45	1.16	1.68	$0.66\sigma_1 + 0.04\sigma_2$
$\mu_1 = -0.3$	1.52	1.45	1.25	1.81	$0.76\sigma_1 + 0.90\sigma_2$

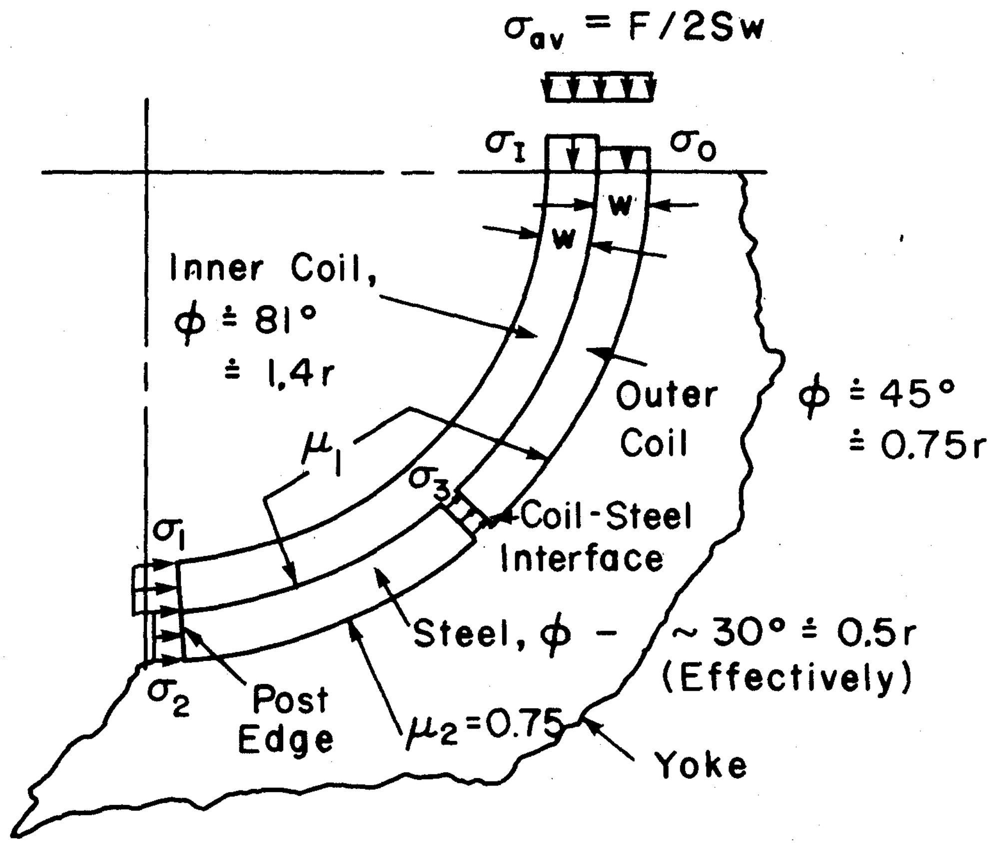


Figure 3.4.51 Extrapolation Factors

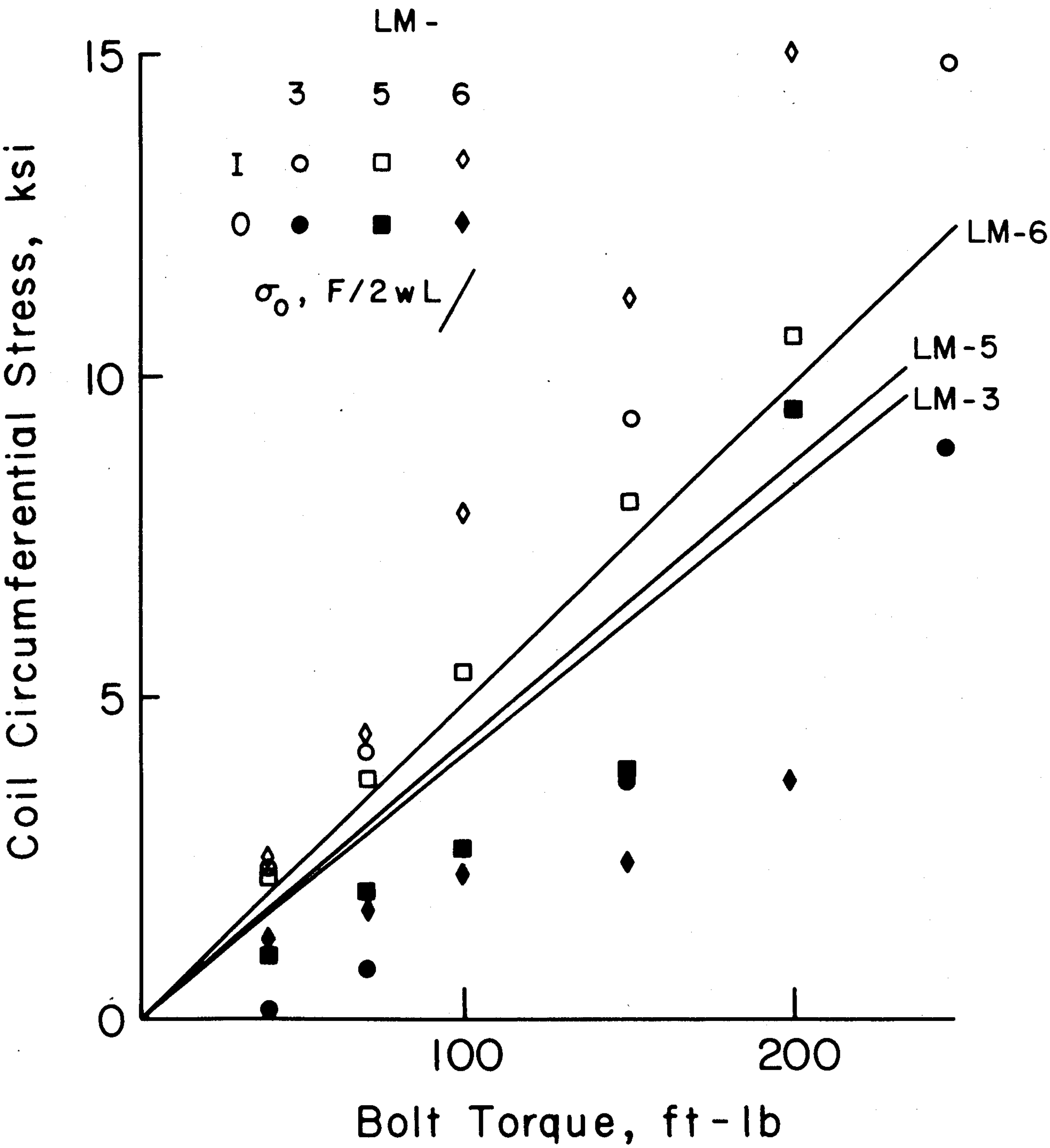


Figure 3.4.52 Extrapolated Coil Stresses at Midplane

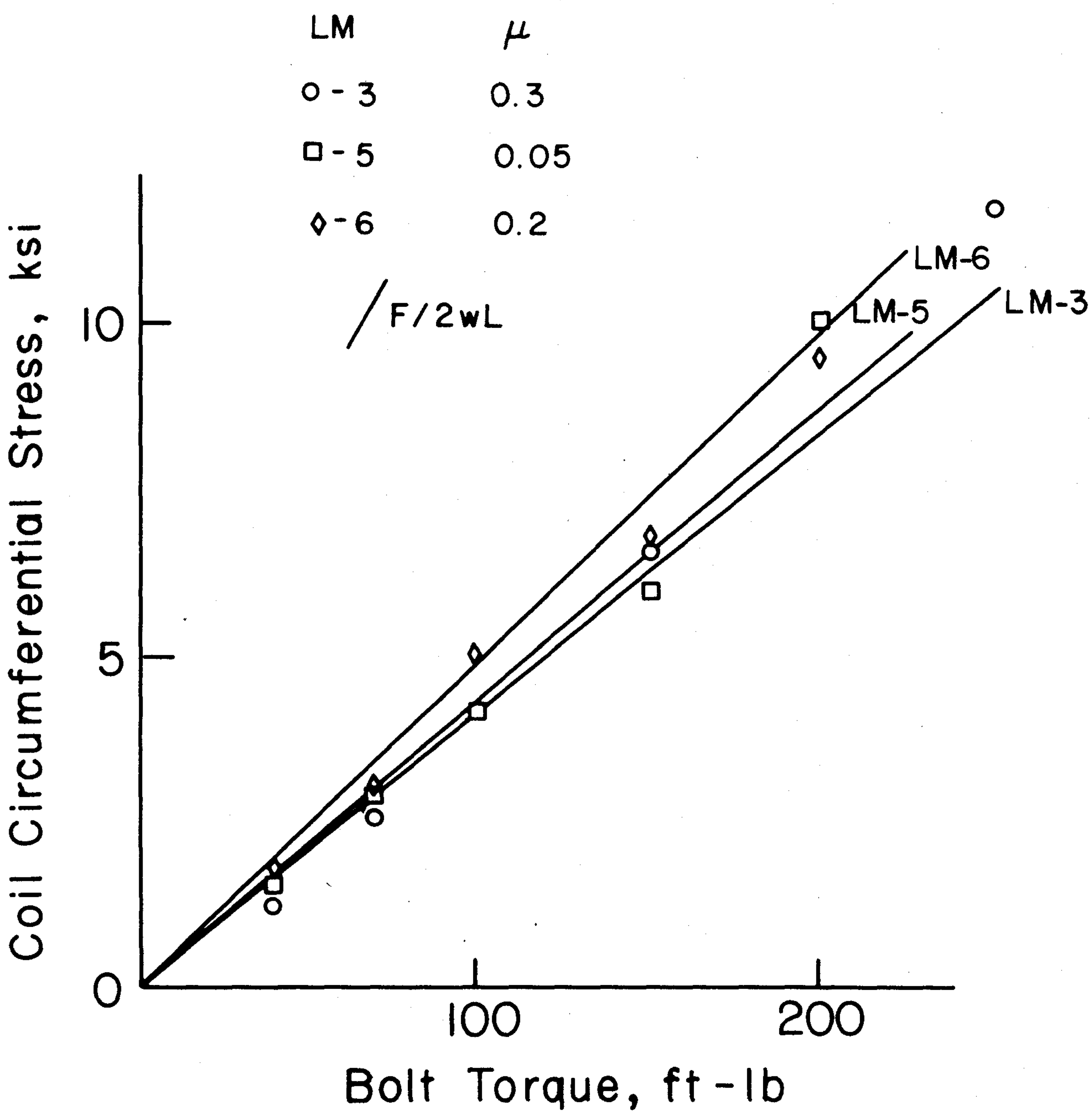


Figure 3.4.53 Average Midplane Coil Stresses Using Extrapolation and Selected Values of μ_1

It follows the "force-balance" curve reasonably well (Figure 3.4.54). (The force balance procedure involves subtracting the inner core post-sensor load from the bolt load to find the outer coil load.) Figure 3.4.54 also shows the disparity between the force-balance stress and the extrapolated value for the outer coils on LM3 and LM6.

If the stress on the inner coil of LM3 actually varies from 14.5 ksi at the midplane (Figure 3.4.52) to 8.5 ksi at the post at 250 foot-pounds (Figure 3.4.51), then the strain difference between those locations would be $\Delta\epsilon = \Delta\sigma/E_t = 0.005$ with $E_t = 1.6$ msi. The strain would be 0.002 greater at the midplane than the mean along the coil and 0.002 less at the post.

It should be noted that the post sensors are generally located in the vicinity of the magnet midlength and that the bolt forces can vary significantly along the magnet. On LM7, for example, the peak-to-peak variation was ± 16 percent at 150 foot-pounds and ± 22 percent at 250 foot-pounds. Also, on some magnets, only circumferential strain data were recorded. That could lead to errors in coil circumferential stress values.

3.4.3.4.5 Behavior Under Lorentz Load

Lorentz loading would induce increased compression stress at the midplane and reduced stress at the post. If the increment is assumed to be 4 ksi (more or less), then $\Delta\epsilon = 400/(3 \times 10^6) = 0.0013$ using an assumed tangent modulus of 3 msi at 4 K. That would tend to worsen further the field quality at high fields. Friction would tend to alleviate the Lorentz-induced effect. However, it probably would not change the order of magnitude.

3.4.3.4.6 Influencing Factors

The above analysis was simplified to focus on basics. Actual numerical values of coil stress would be influenced by variations in friction coefficient. The greater stiffness at the thin edge than at the thick edge of the cable could initiate bending and alter the stress distribution, including shears between coils and between the outer coil and yoke. Stress relaxation in the coil and the stiffness increase at 4 K over RT stiffness would modify the stress distribution from initial preload through coil storage and cooldown. If stick-slip is present, there may be delayed recovery of deformations induced by Lorentz loading. The shears could also change with time if creep and relaxation are present.

3.4.3.4.7 A Possible Preload Scenario

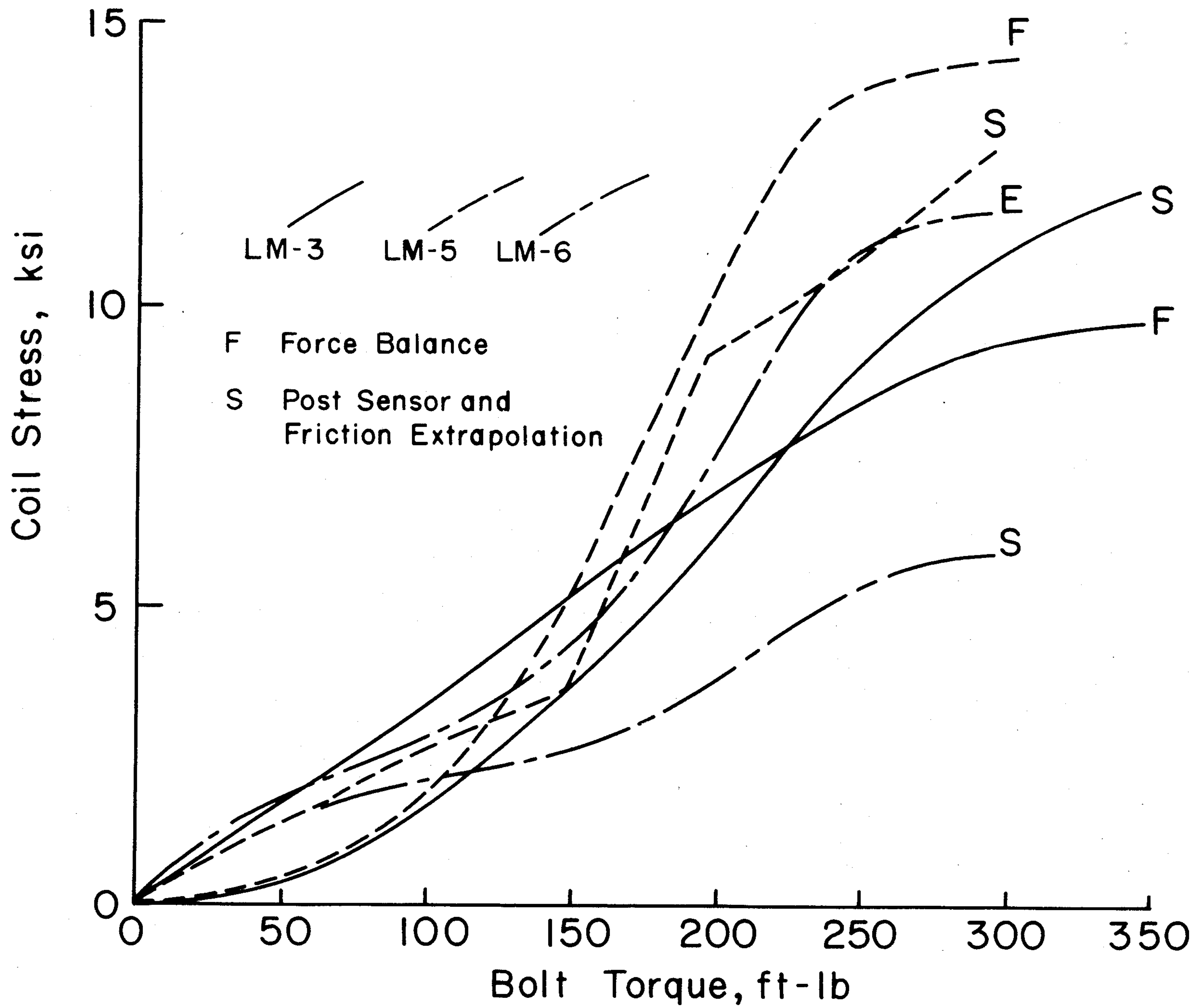


Figure [illegible].4.54 Outer Coil Midplane Stress Extrapolation vs Force Balance

It is possible to construct a scenario for coil behavior during preloading using the extrapolated post sensor data (Figure 3.4.52) and a representative stress-strain curve for a coil (Figure 3.4.55). The sequence is shown in Figure 3.4.56.

Initial contact is made at the inner coil interface at the midplane. As soon as the bolts are loaded, an outward radial pressure is applied to the outer coil. Since the ratio of coil heights is approximately 1/2 (outer to inner coil), the outer coil faces should begin to bear when the nominal strain in the inner coil is half the value at the preload stress level. Assume that value to be 12 ksi. Figure 3.4.55 indicates a corresponding strain of 0.024, half of which is 0.012. The latter value corresponds to 2 ksi midplane stress in the inner coil. Examination of Figure 3.4.52 reveals that this would occur at a bolt torque of approximately 40 foot-pounds as a typical value for all three magnets. Consequently, the outer edges of the outer coils should meet at 30 to 40 foot-pounds. A test on CM5 supported that expectation. A thin shim, inserted between the outer coil faces, was seized at approximately 40 foot-pounds.

Test data (Figure 3.4.13) have identified a large radial variation of circumferential stiffness with the outer edge of a keystoned coil cross section much more flexible than the inner edge. Consequently, loading on the outer coil should accelerate with bolt torque and begin to equal the inner coil loading rate. The curve of outer coil stress as a function of torque should be concave upward. That apparently occurred on LM3. LM5 and LM6 did not seem to display that behavior according to the curves of Figure 3.4.54. However, no strain data were recorded between 0 bolt torque and 40 foot-pounds to test the hypothesis.

3.4.3.4.8 Effect of Friction on Yoke Behavior

Friction can influence the structural deformation of the yoke. A finite element analysis of the yoke (Reference 3.4-14) was based on the assumption that the two coil faces were loaded equally to a circumferential stress σ = 15 ksi. The resultant radial pressure was determinable from the pressure vessel relation, $p = \sigma w/R$, where R is the radius at the interface of the outer coil and the yoke. The midplane interface slope from the pressure was almost completely balanced by the slope induced by the bolts and there was a small outward radial deflection at the midplane. If friction were large, the effect would be to redistribute the loading along the interface of the yoke and outer coil. In the extreme case, the coil interface load and the bolt load would constitute a

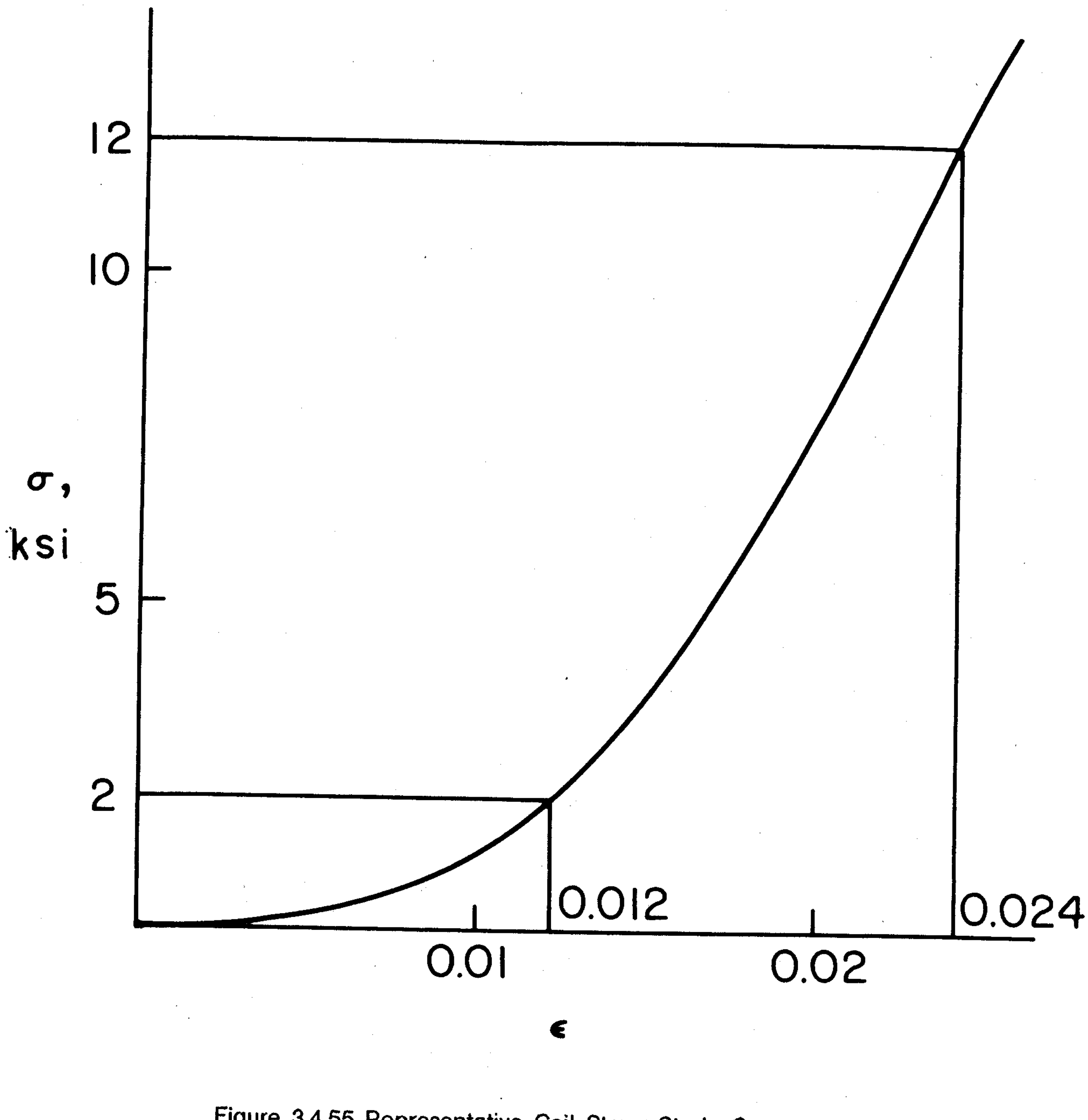


Figure 3.4.55 Representative Coil Stress-Strain Curve

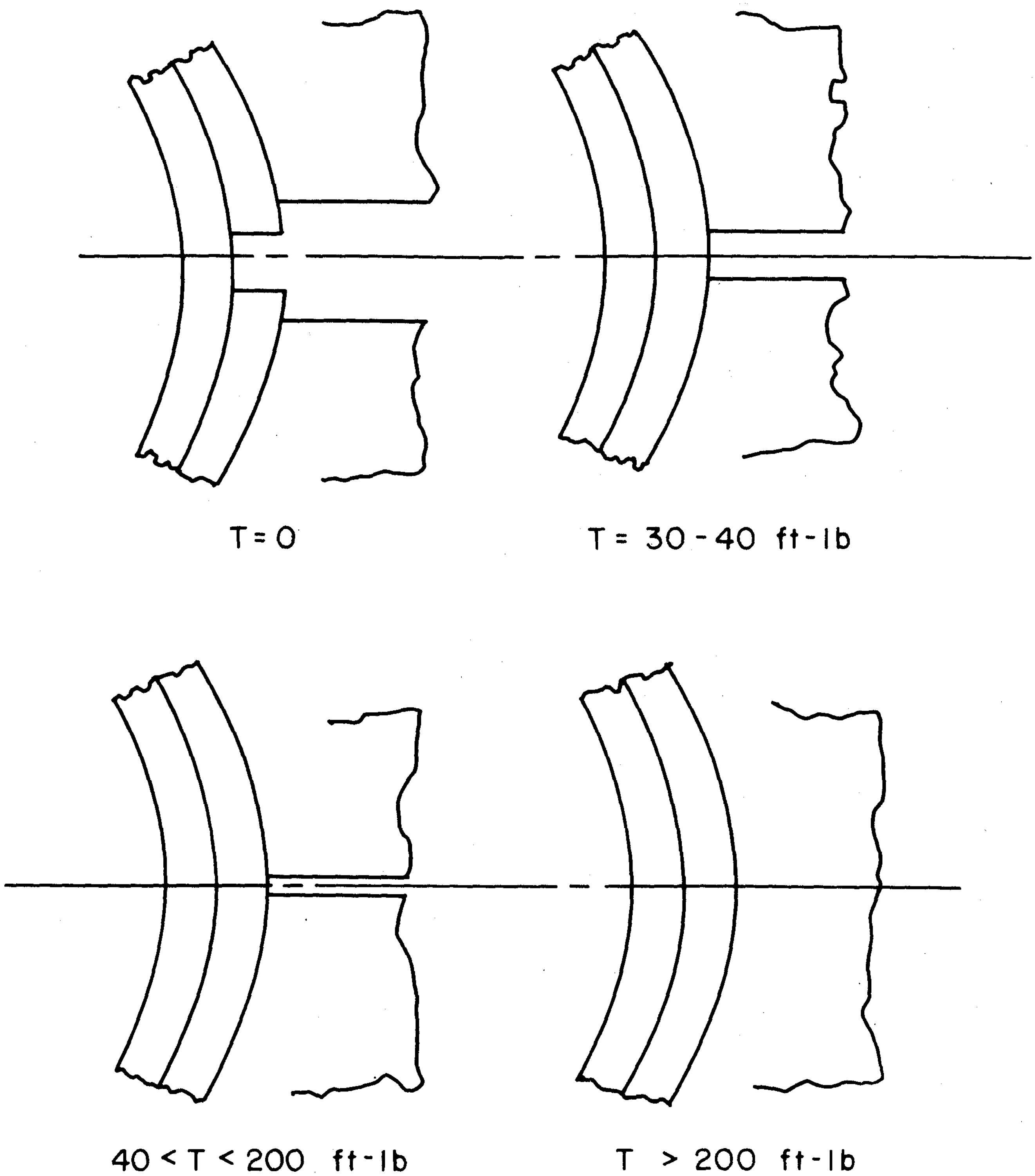


Figure 3.4.56 Possible Magnet Closure Sequence

couple tending to open the yoke centerplane faces at the inner edge and close them at the outer edge while causing a proportionally large inward radial movement. An opening of the yoke at the outer coil may have a deleterious effect on field quality.

The behavior between those two extremes depends upon the effective coefficients of friction between coils, between the outer coil and yoke and between the steel pole piece and the yoke.

3.4.3.4.9 Conclusions

The presence of friction in a magnet apparently can cause local changes in current density large enough to degrade field quality. Furthermore, data from LM3, LM5 and LM6 indicate that the effects may be random and therefore difficult to control, both within a magnet and from magnet to magnet. The data also indicate why it has been difficult to predict shim sizes from measurements made on short test fixtures.

It is conceivable that only field quality data from numerous magnets (perhaps 50 to 100) will provide the base from which to evaluate frictional effects. In the meantime, there may be value in considering redesign on the existing coil assembly in order to avoid the problem or minimize it.

3.4.3.4.10 Recommendations

(1) Attempt to observe directly the midplane gap of the outer coil as a function of bolt force and relate the information to the results from the friction analysis.

(2) Consider redesigning the coil system to minimize the friction problem. (In this connection, several concepts have been generated).

(3) Measure the coil shear rigidity and use the result in an analysis of coil preload, cooldown and Lorentz stresses and deformations including friction.

(4) Measure inner coil forces at the post and midplane using a short segment of curved coil in a test fixture to determine whether frictional forces change with time.

(5) Conduct direct tests on coil/coil and coil/core friction at RT and 77 K to determine sensitivity to coil surface characteristics.

(6) Measure friction on short segments of curved coil at RT and 77 K.

(7) Attempt to eliminate (or minimize) friction between a short coil segment and a test fixture to determine how the stress-strain curve is affected by friction.

(8) Conduct a theoretical analysis of the coil/yoke system including friction and coil finite shear

rigidity.

(9) Employ the "one-foot magnet" designed by Marston and Skaritka to study the effect of friction on coil behavior.

3.4.4 MAGNET STRESS ANALYSIS

3.4.4.1 General Introduction

Theoretical analyses were conducted on the Danby, Palmer, and LBL magnets to determine stresses and deformations. They involved both hand calculations and finite element analyses. This section contains discussions of the approaches, summaries of the results, and reproductions of the computer printouts.

The studies were based upon the assumption that the outer yoke was a continuous ring instead of two half-rings bolted together as in the Palmer and Danby magnets.That would have a large influence on yoke stresses and deformations, but has little impact on coil behavior, which was the principal focus of the exercise.

3.4.4.2 Analysis of LBL Magnet

3.4.4.2.1 Introduction

The Berkeley circular saddle magnet contains three Fermilab-type cable coils that subtend angles of 77.21, 54.32 and 32.39 degrees, inside to outside (Figure 3.4.57). They are encased in a heavy stainless steel ring in the latest configuration. (An earlier design employed an aluminum ring that was too weak and flexible to support the Lorentz loads.) The ferritic return frame is to be maintained at room temperature.

Analyses were conducted to determine coil compression as well as support ring stresses and deflections due to preload and Lorentz loads. Several frictional conditions of coil/coil and coil/frame interfaces were assumed.

The coil movements include the coil deformations together with motions where each coil contacts the post. The post was assumed to be part of the frame in one case, separate from the frame in a second, and finally, divided into three separate strips, one for each coil. Calculations were conducted through a finite element program developed at MIT and also by hand calculations.

3.4.4.2.2 Frame Design

The circular support frame was investigated by means of hand calculations to select the material and thickness required to resist the Lorentz loading which induces large bending stresses and controls the design as a result. The Lorentz pressure distribution (Figures 3.4.58 and 3.4.59)

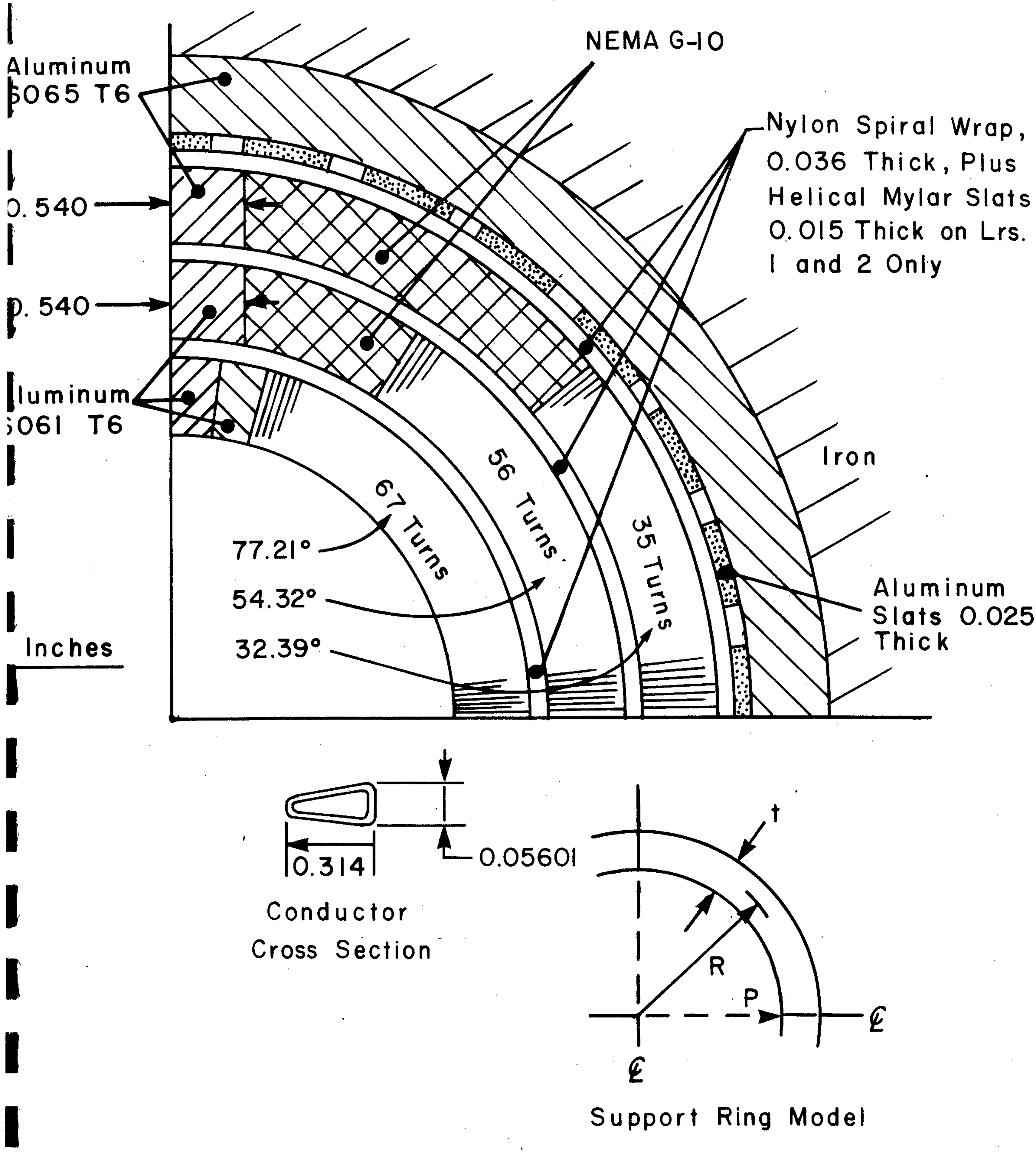


Figure 3.4.57 Schematic of LBL Magnet

was integrated to yield forces of P = 14,400 pounds, which were assumed to be at each end of the horizontal diameter. The ring was assumed to be continuous.

The bending stress

$$\sigma = \frac{6PR}{\pi t^2} \tag{3.4.20}$$

and the radial deflection

$$\delta = 0.89\left(\frac{P}{E}\right)\left(\frac{R}{t}\right)^3 \tag{3.4.21}$$

(both from Reference 3.4-10) were found to be 60 ksi and 0.010 inch, respectively, using R_o = 4.75 inches, R_i = 3.380 inches, R = R_{av} = 4.065 inches, t = 1.37 inches and E = 30 msi for a steel ring. The previous preliminary design in aluminum with a thinner wall was shown to be stressed to 350 ksi and to deflect radially 1/2 inch. This was discarded in favor of the above configuration which employs thick laminated carbon steel plates bolted together longitudinally.

The magnitude of the diametral force, P, was obtained from the Lorentz loads on the three coils (Figure 3.4.58) converted to radial pressures including the radial reactions to the tangential loads. The pressure at each coil centerline appears to scale in Figure 3.4.59.

3.4.4.2.3 Finite Element Analyses

The frame deformations and stresses are presented in Figures 3.4.60 through 3.4.85 for the three assumed post characteristics considering interference, predeformation and Lorentz loading.

The monolithic case considers the coils and yoke to be joined at all surfaces. The partial slip case relates to slip between coils and between coils and yoke, but the post is considered monolithic with the yoke. Full slip assumes the post to be separated into strips with the same radii as the contacting coil and full slip on all surfaces of the coils and strips.

Results are presented for assembly loading (preload) alone and for the total of the Lorentz and preload forces. The Lorentz stresses can be found from the difference of the two.

The stress code is as follows (see Figure 3.4.60):

SIG MAX = maximum principal (normal) stress

SIG MIN = minimum principal stress

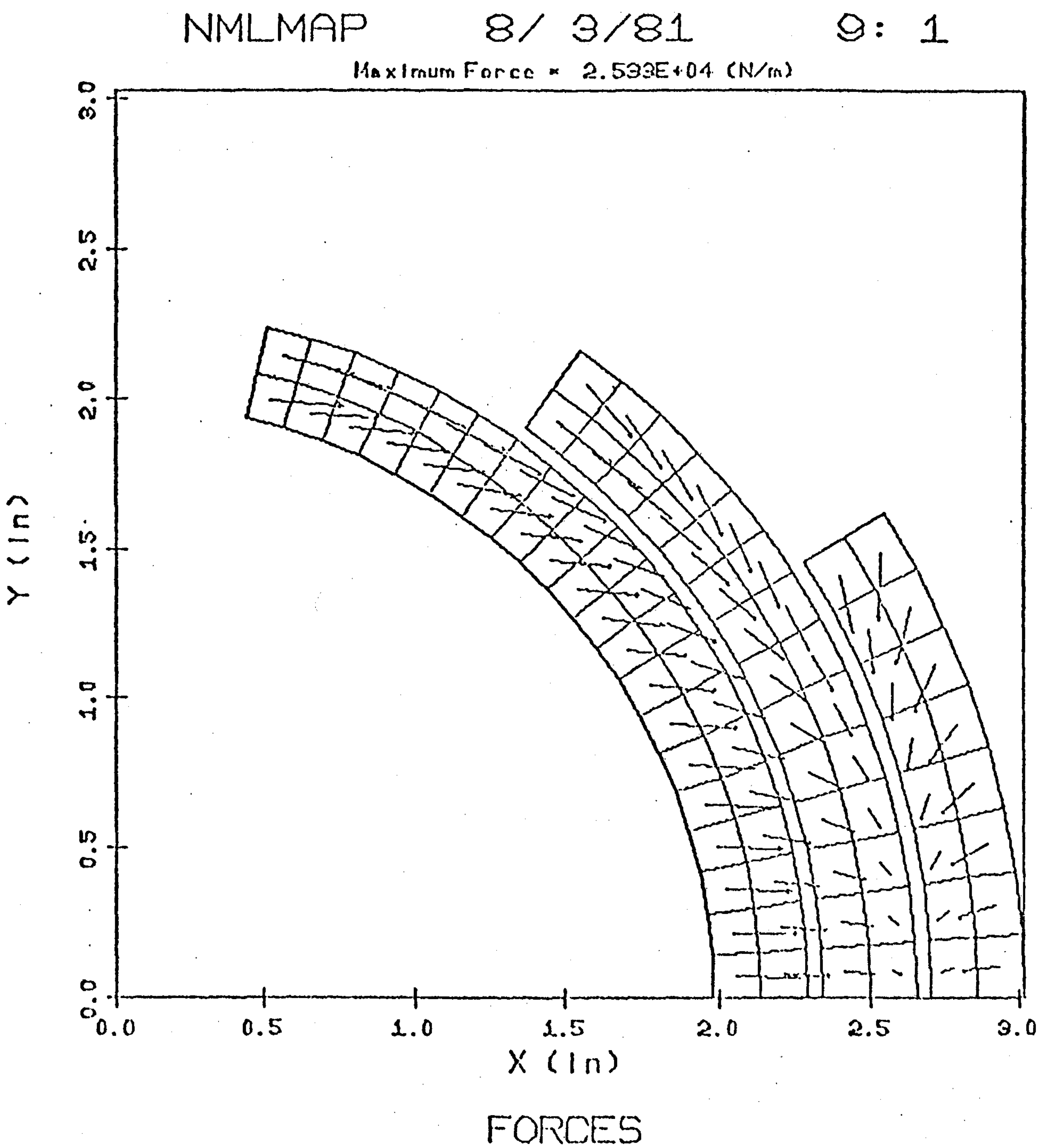


Figure 3.4.58 Lorentz Pressure Distribution on LBL Magnet Coils

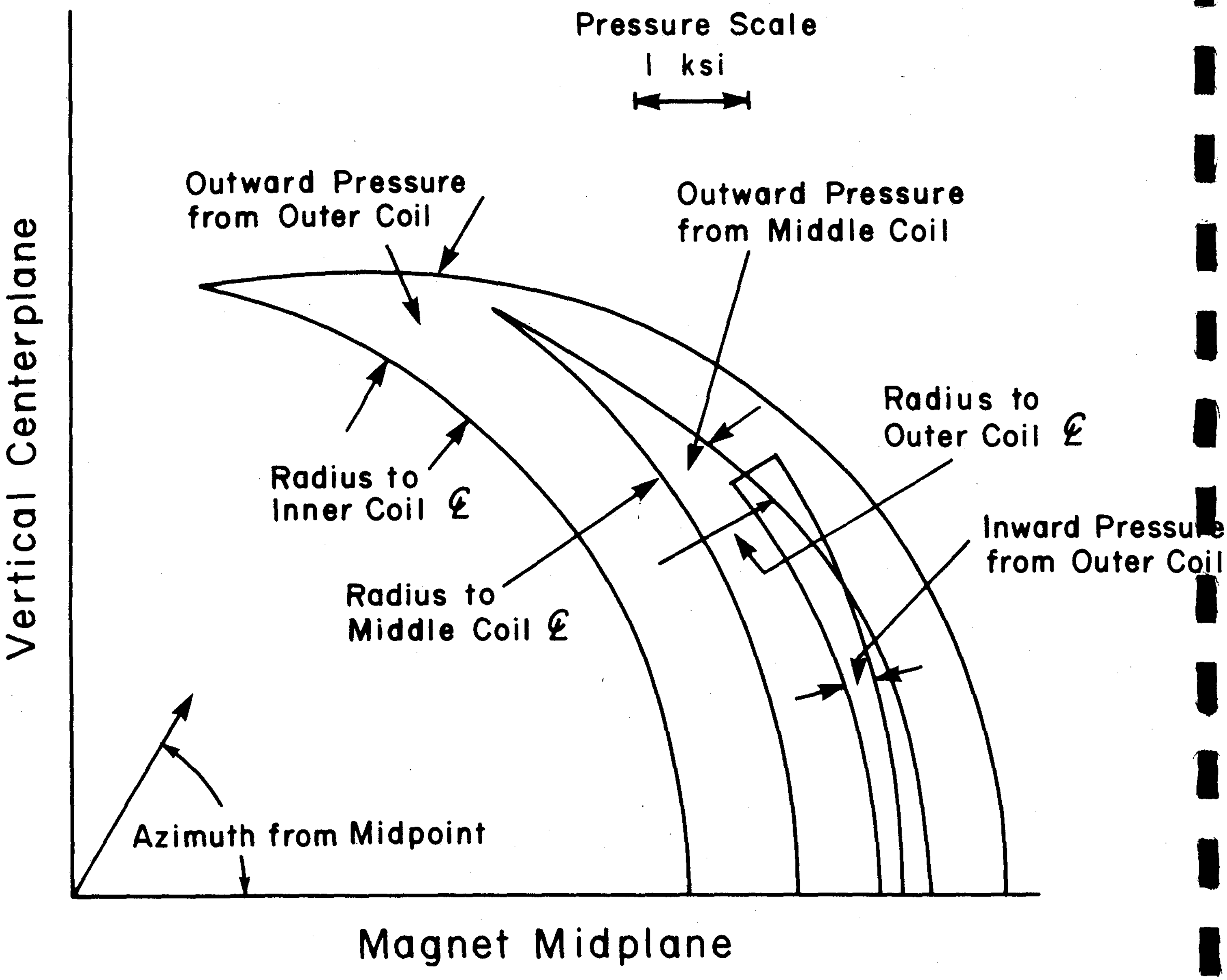


Figure 3.4.59 Total Pressures on LBL Coils

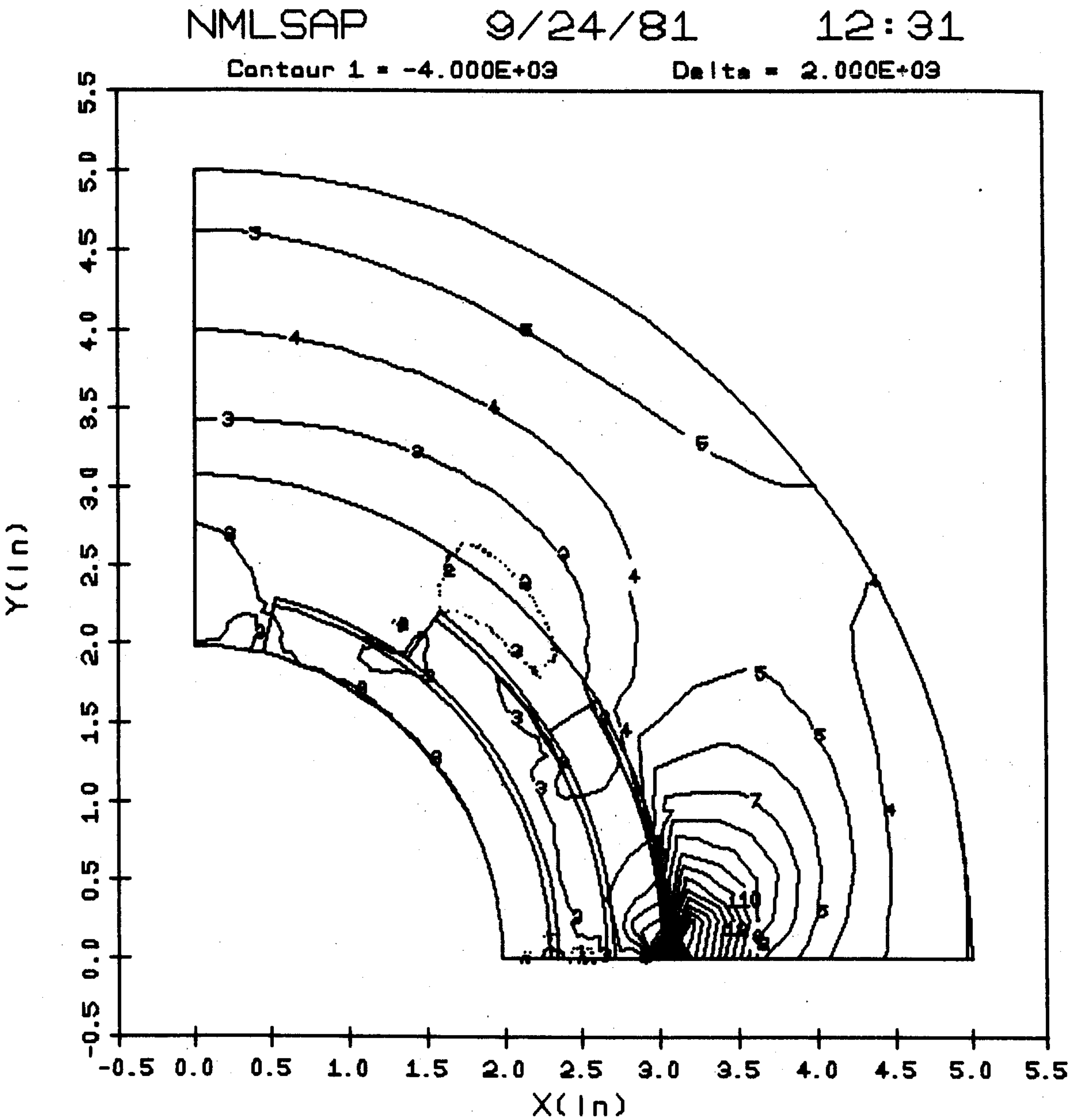


Figure 3.4.60 Contours of Constant SIG MAX

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, ASSEMBLY LOAD

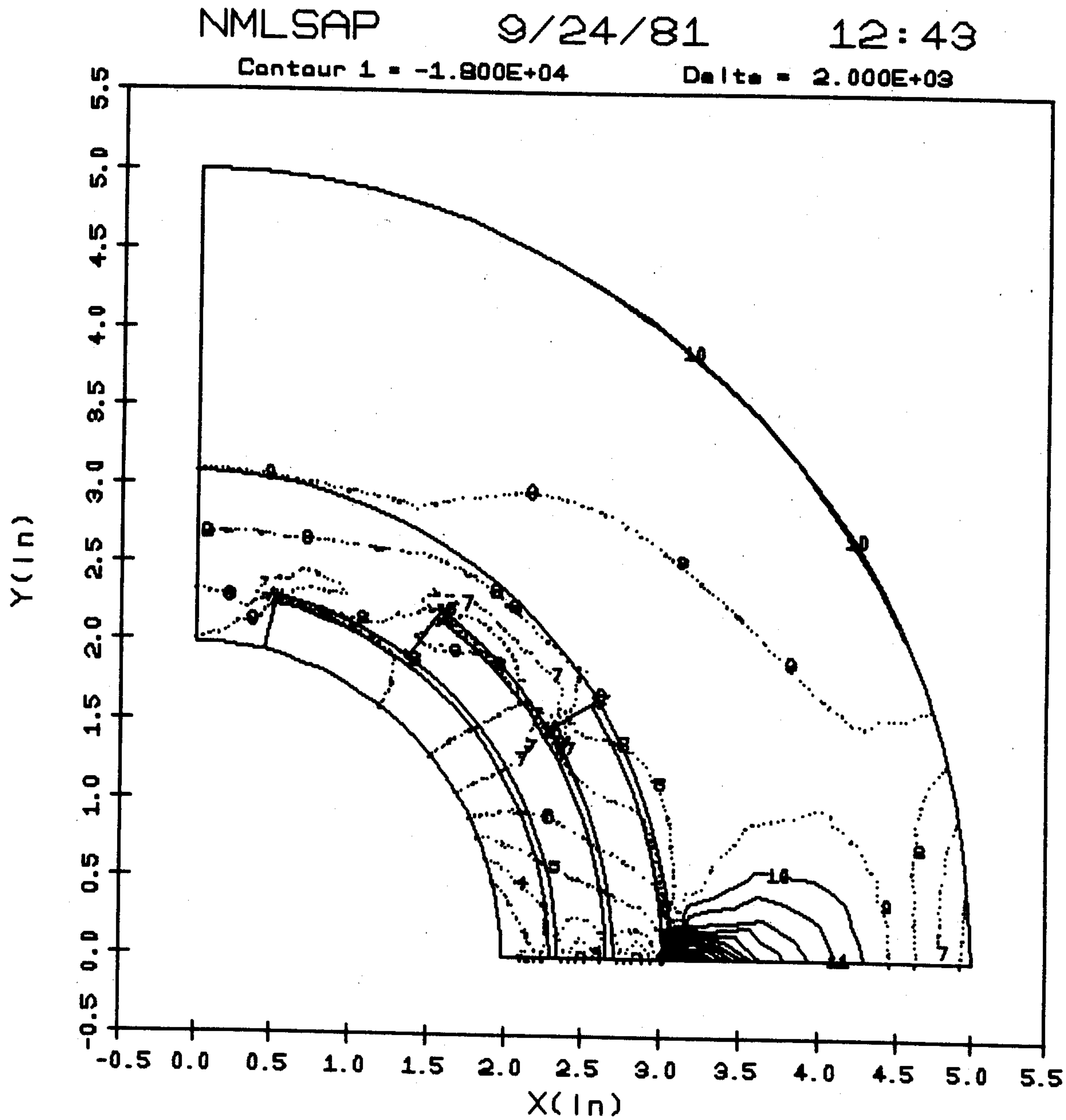


Figure 3.4.61 Contours of Constant SIG MIN

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, ASSEMBLY LOAD

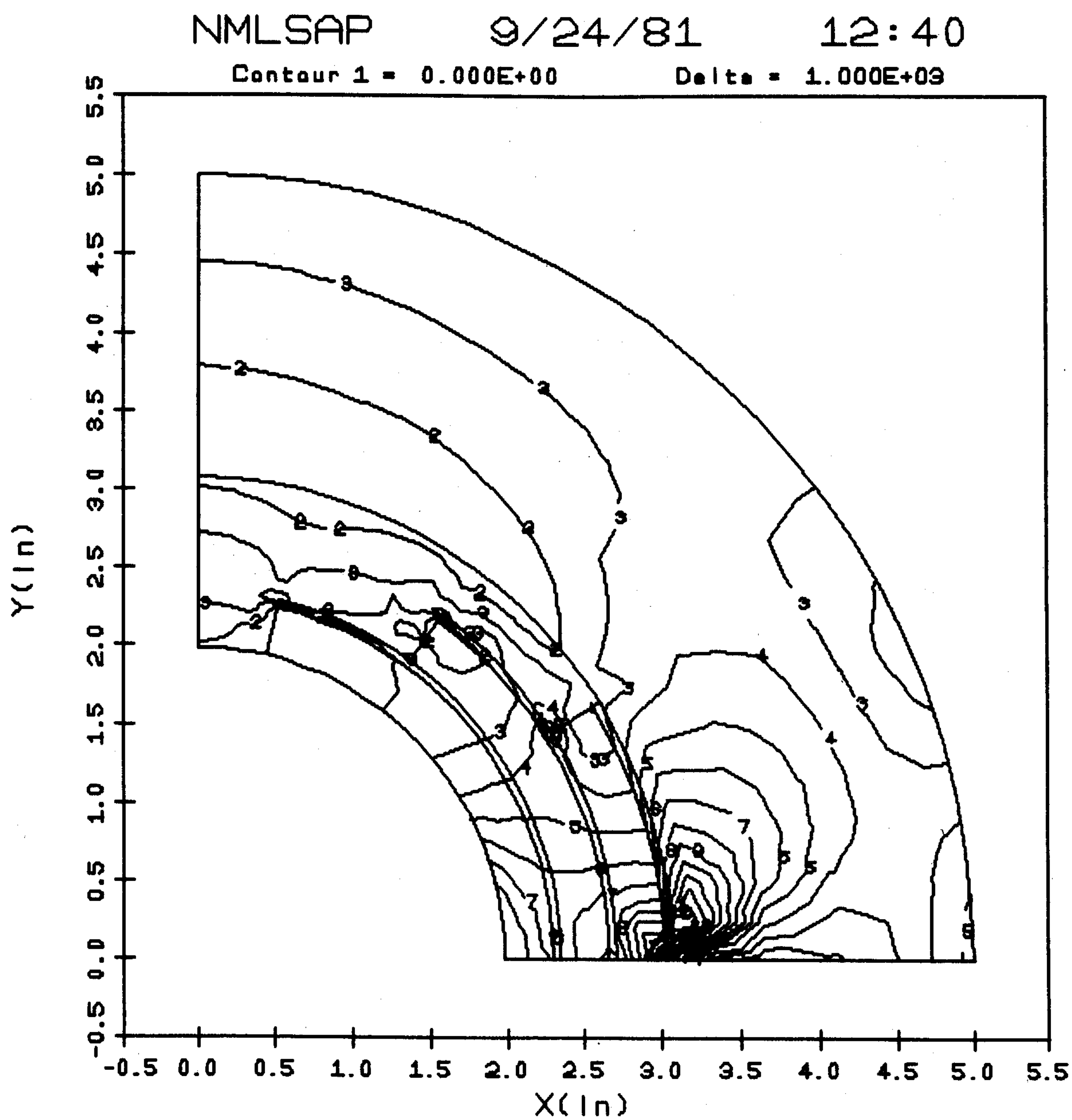


Figure 3.4.62 Contours of Constant TAU MAX

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, ASSEMBLY LOAD

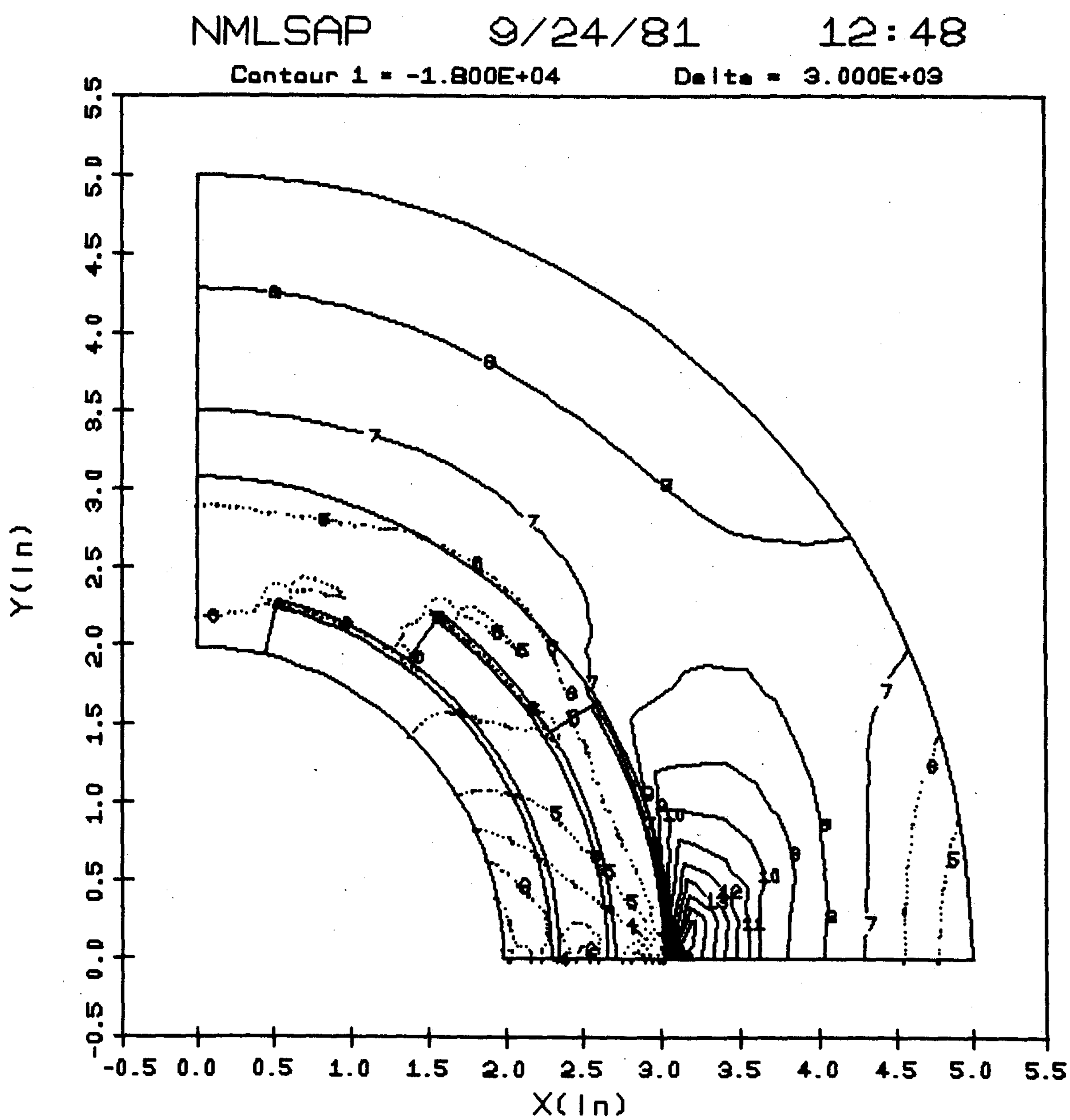


Figure 3.4.63 Contours of Constant SIG TH

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, ASSEMBLY LOAD

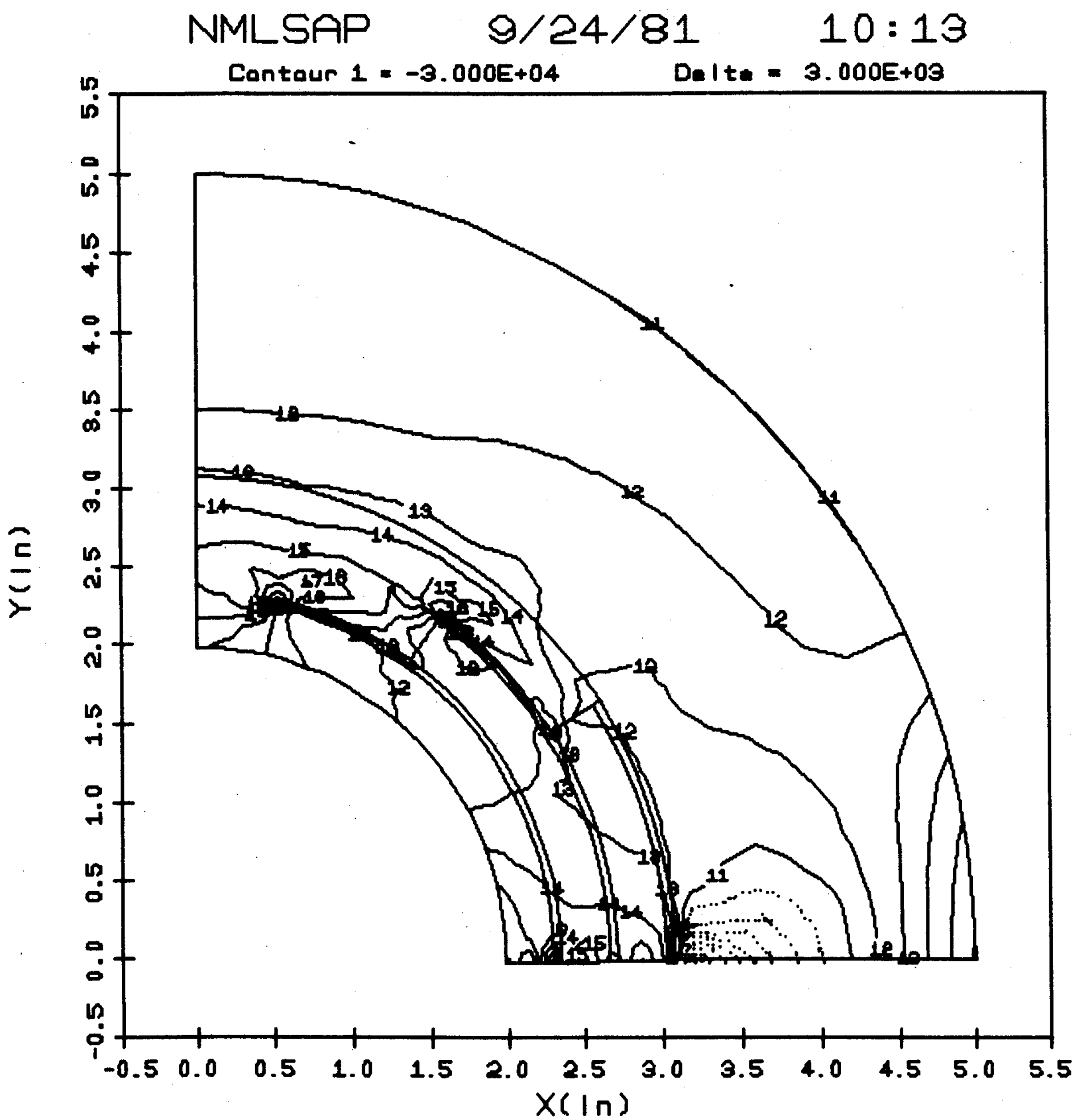


Figure 3.4.64 Contours of Constant SIG MAX

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, TOTAL LOAD

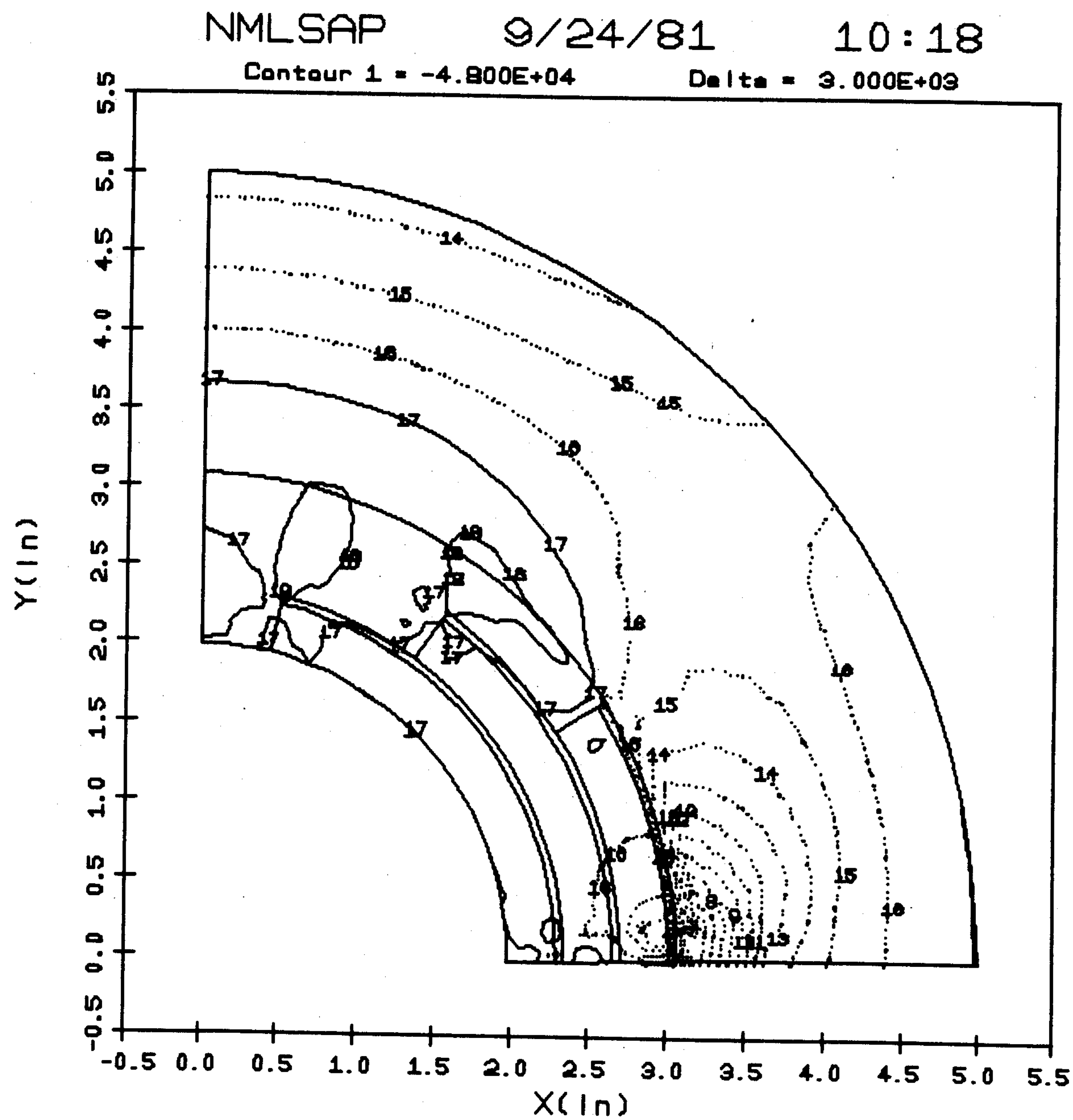


Figure 3.4.65 Contours of Constant SIG MIN

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, TOTAL LOAD

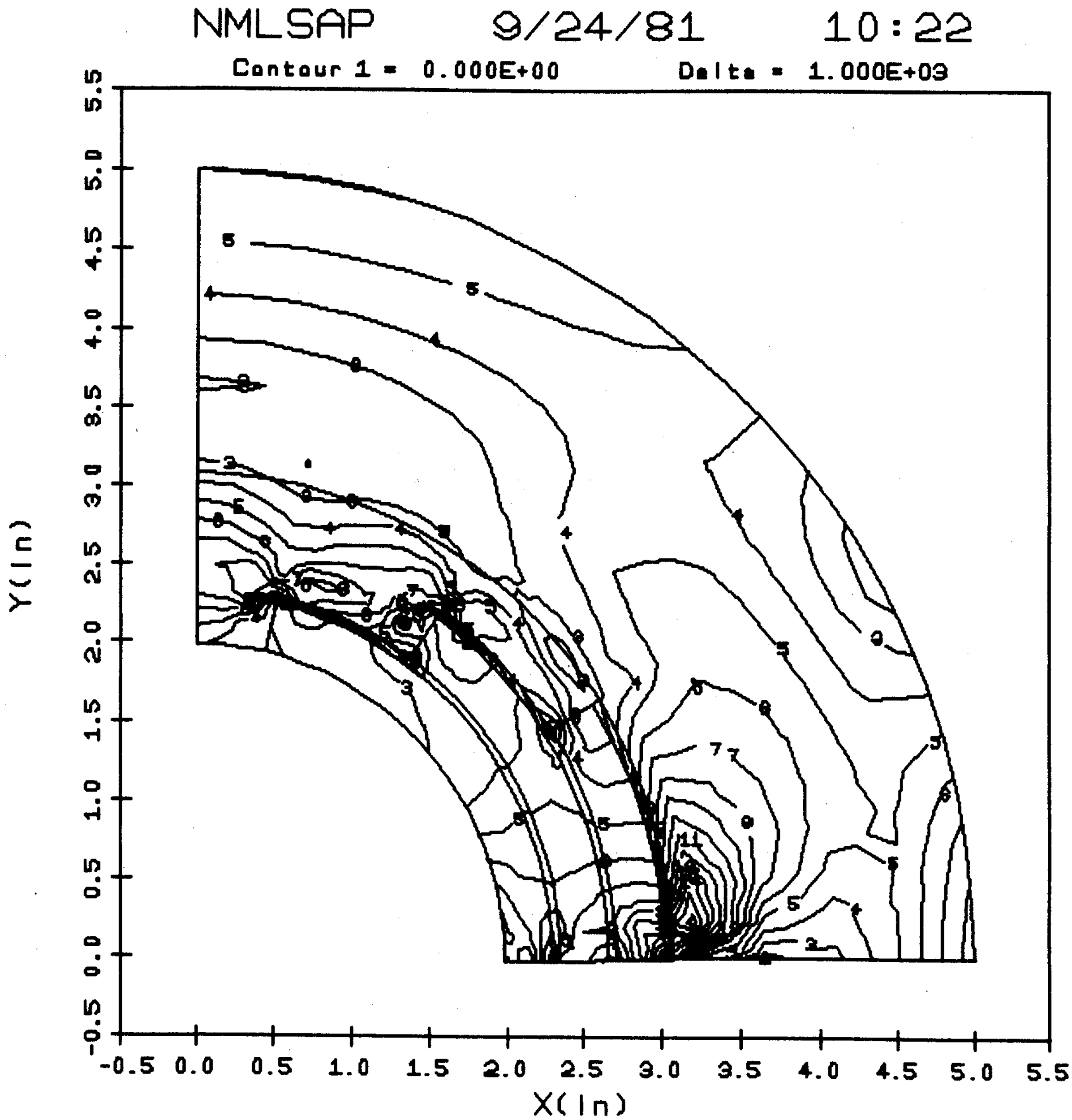


Figure 3.4.66 Contours of Constant TAU MAX

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, TOTAL LOAD

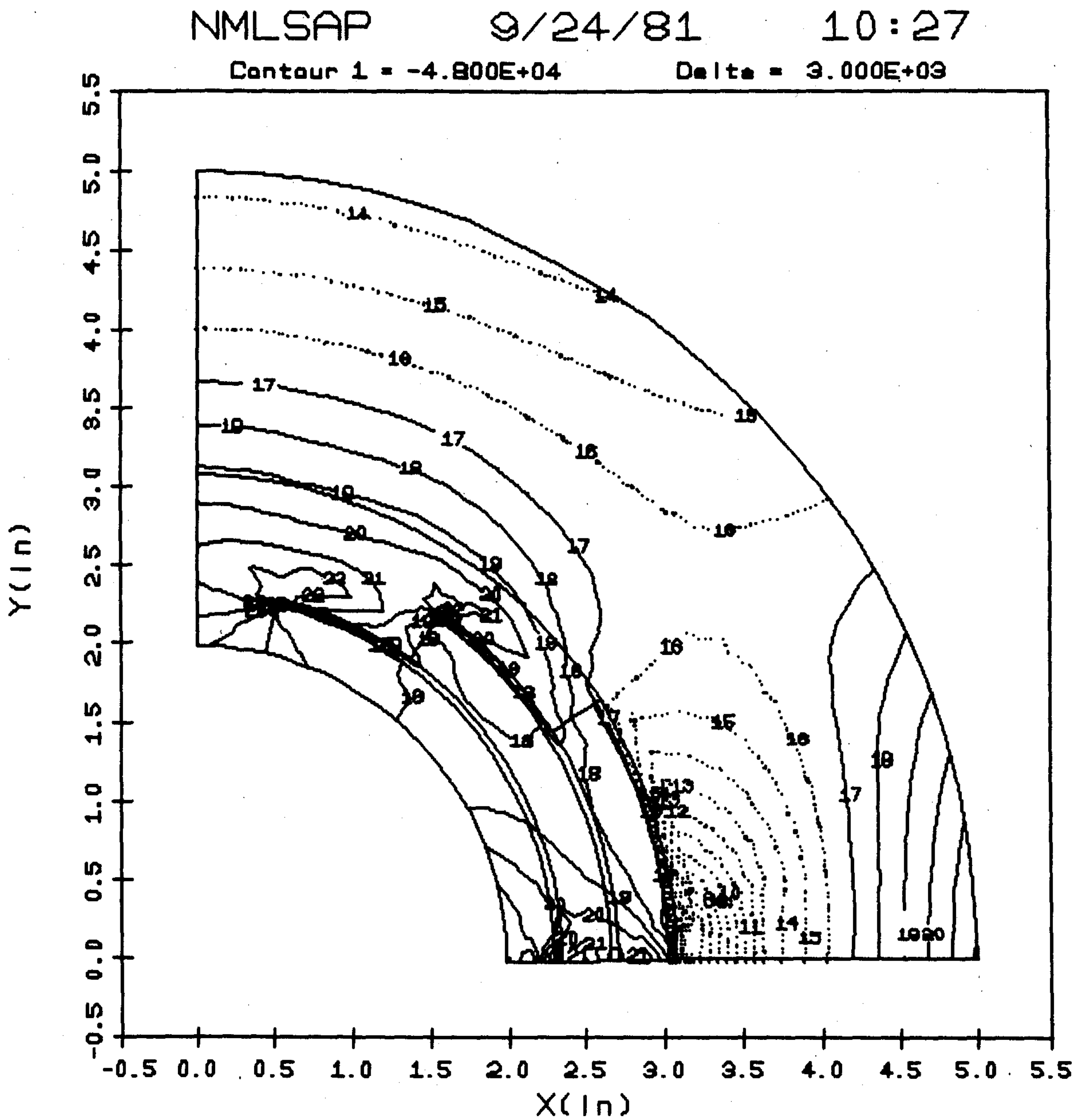


Figure 3.4.67 Contours of Constant SIG TH

BERKELEY 3-LAYER DIPOLE MAGNET
NO SLIP, TOTAL LOAD

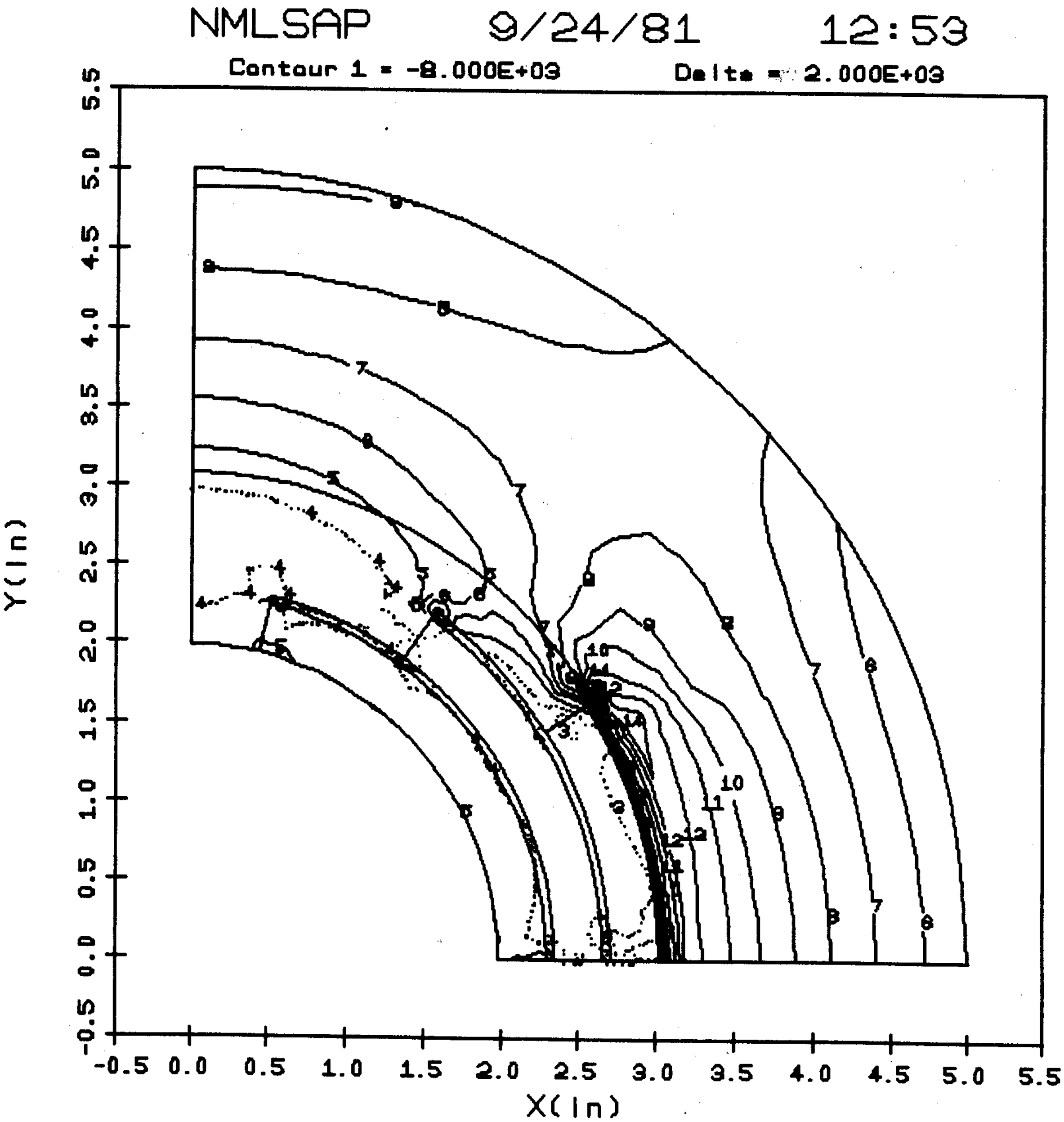


Figure 3.4.68 Contours of Constant SIG MAX

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, ASSEMBLY LOAD

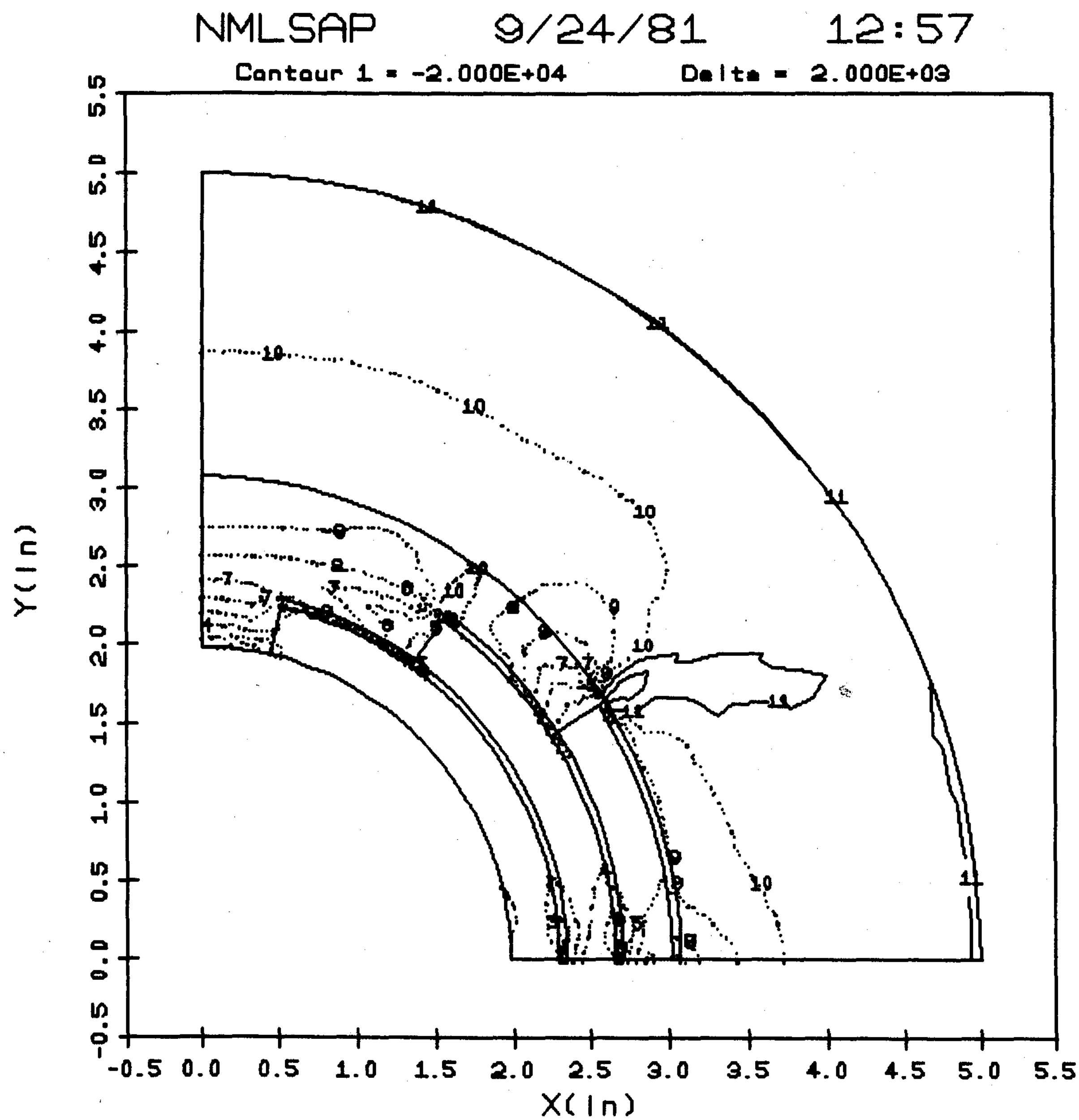


Figure 3.4.69 Contours of Constant SIG MIN

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, ASSEMBLY LOAD

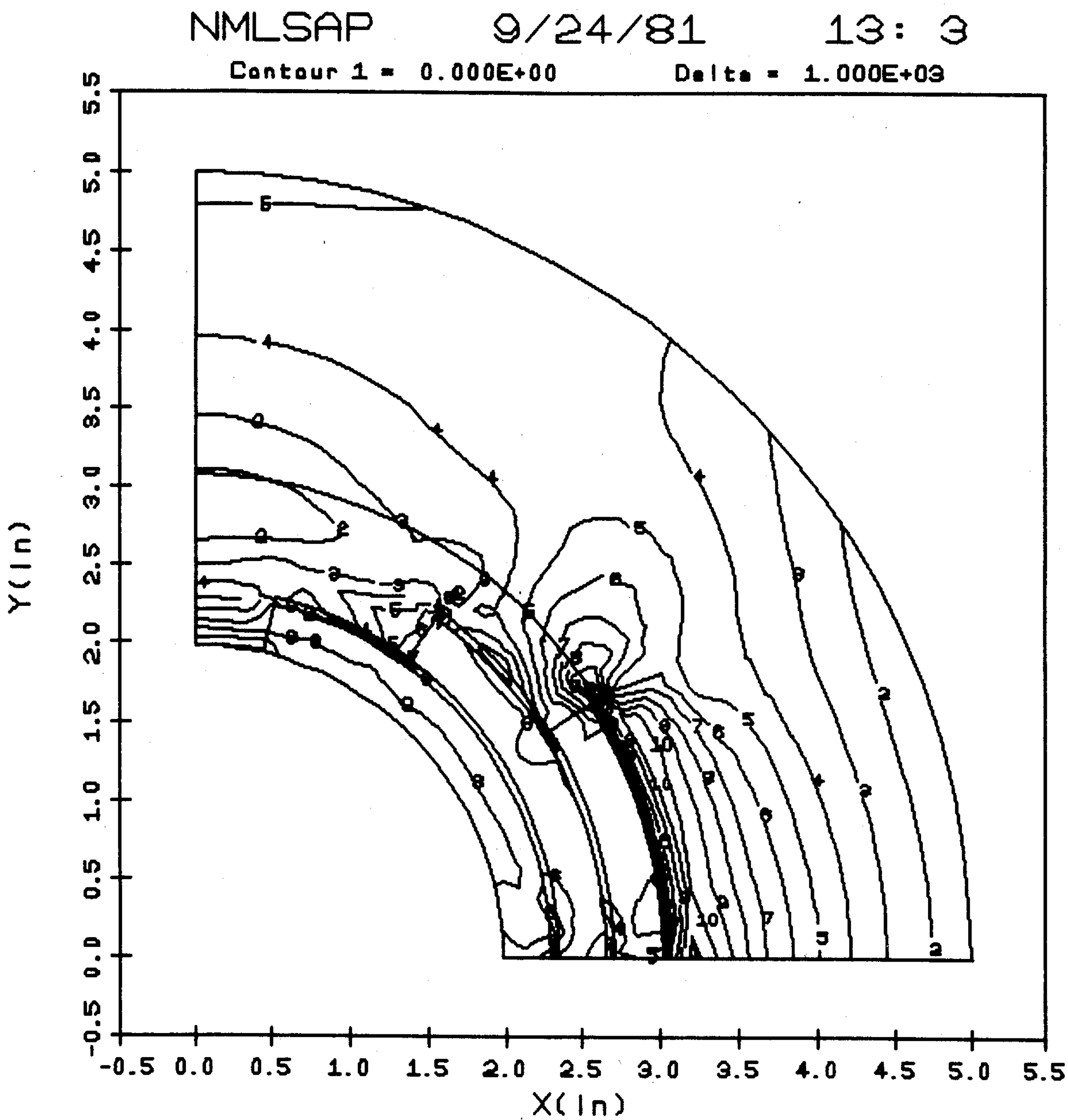


Figure 3.4.70 Contours of Constant TAU MAX

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, ASSEMBLY LOAD

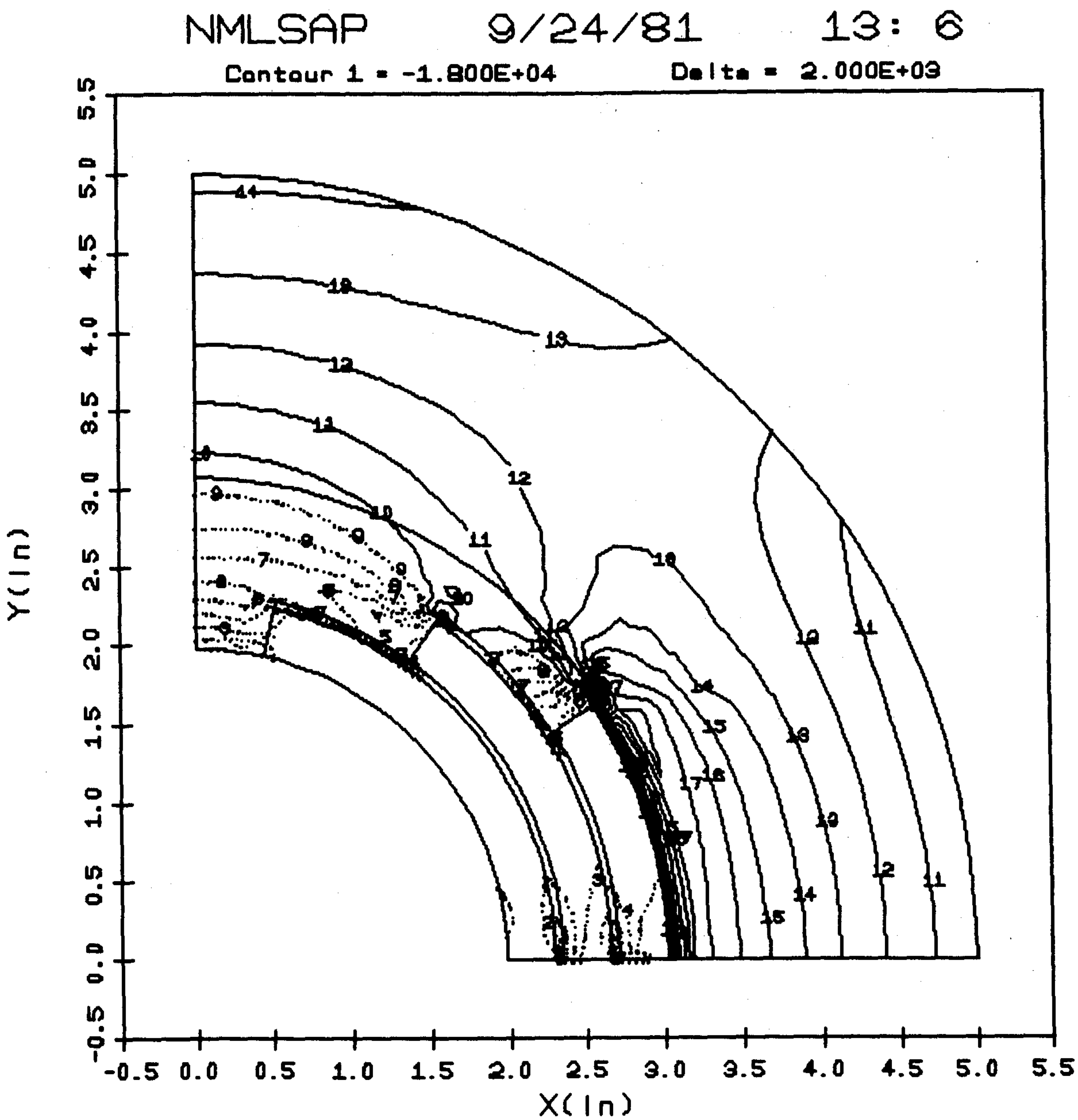


Figure 3.4.71 Contours of Constant SIG TH

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, ASSEMBLY LOAD

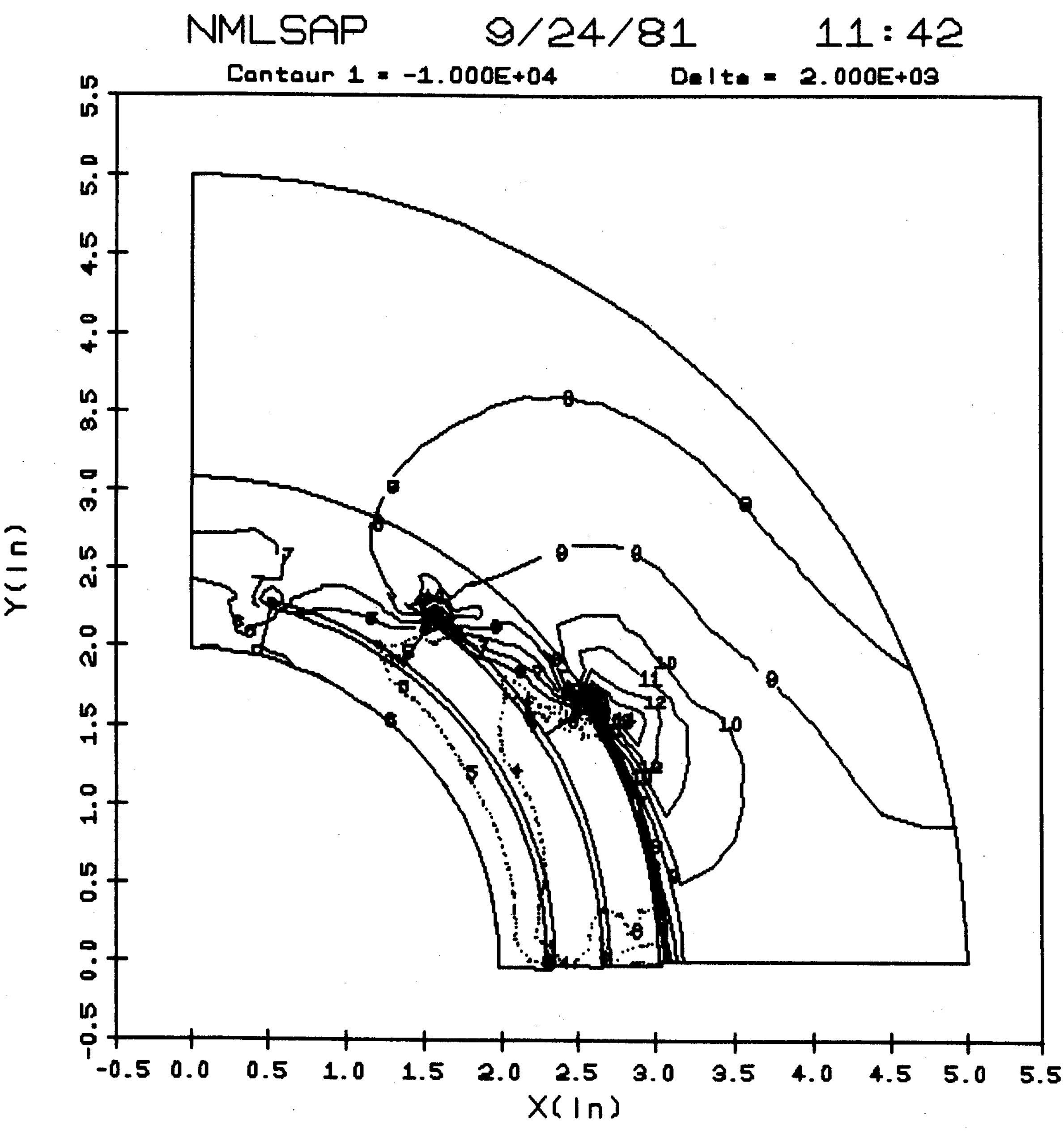


Figure 3.4.72 Contours of Constant SIG MAX

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, TOTAL LOAD

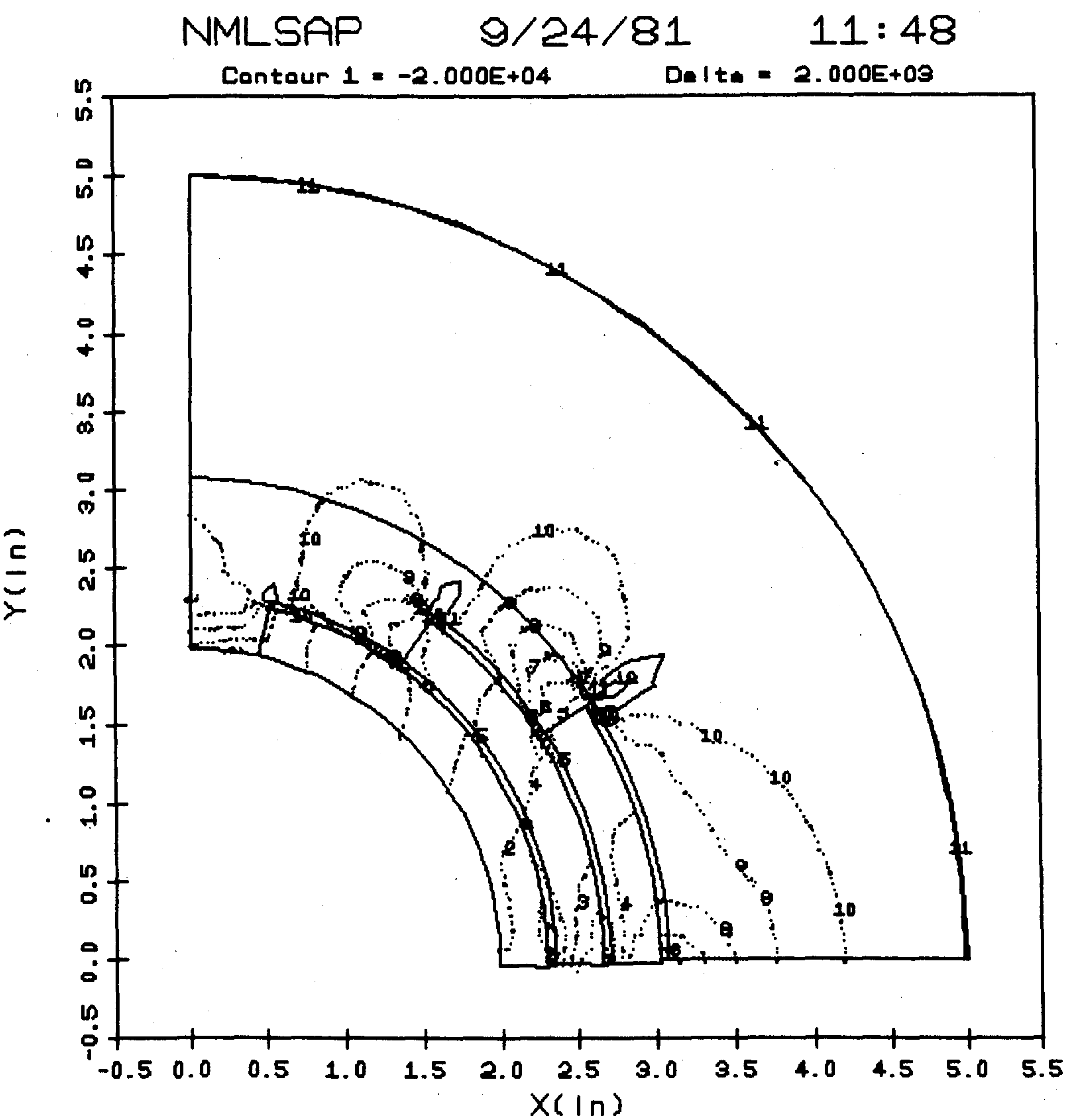


Figure 3.4.73 Contours of Constant SIG MIN

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, TOTAL LOAD

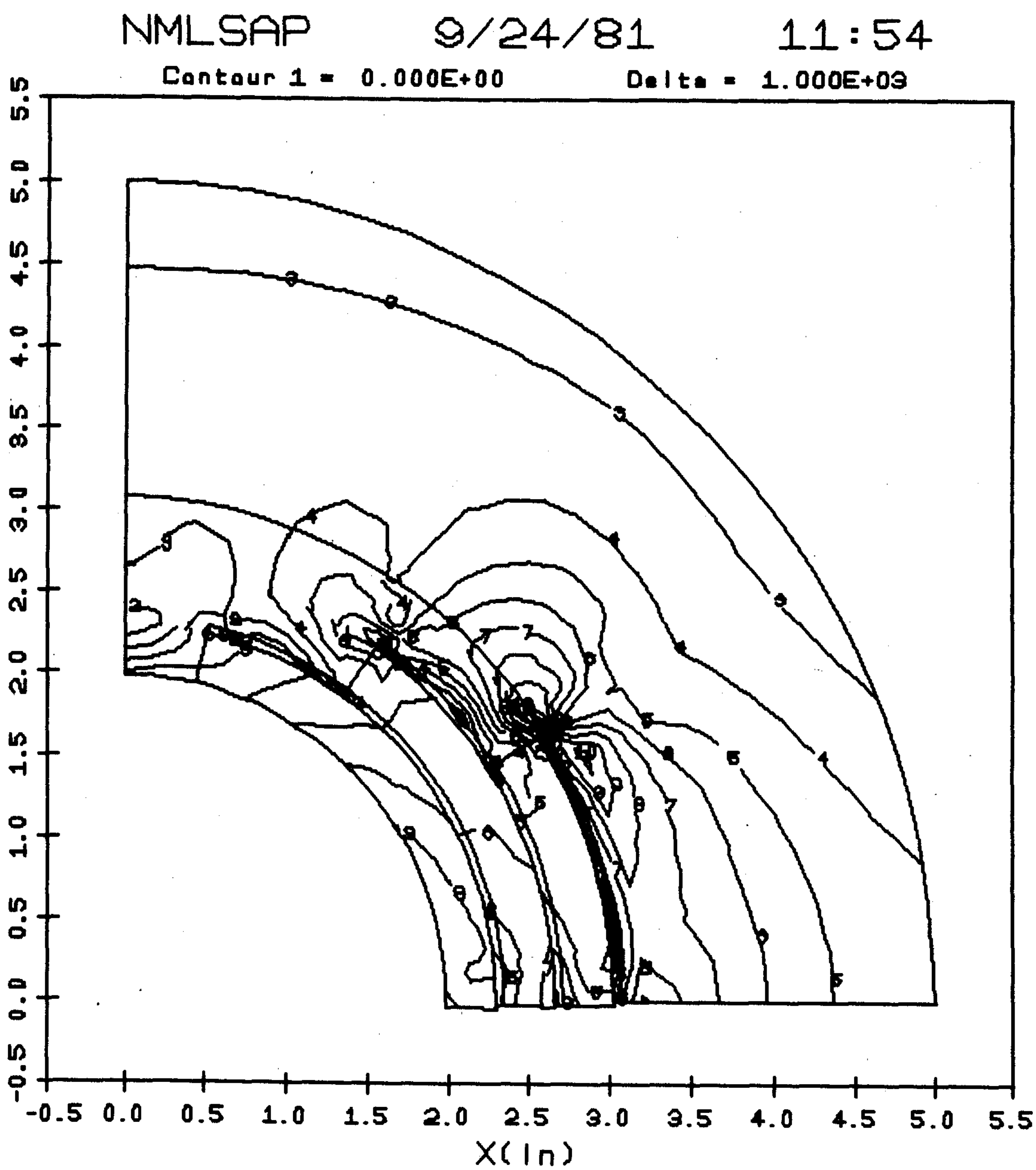


Figure 3.4.74 Contours of Constant TAU MAX

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, TOTAL LOAD

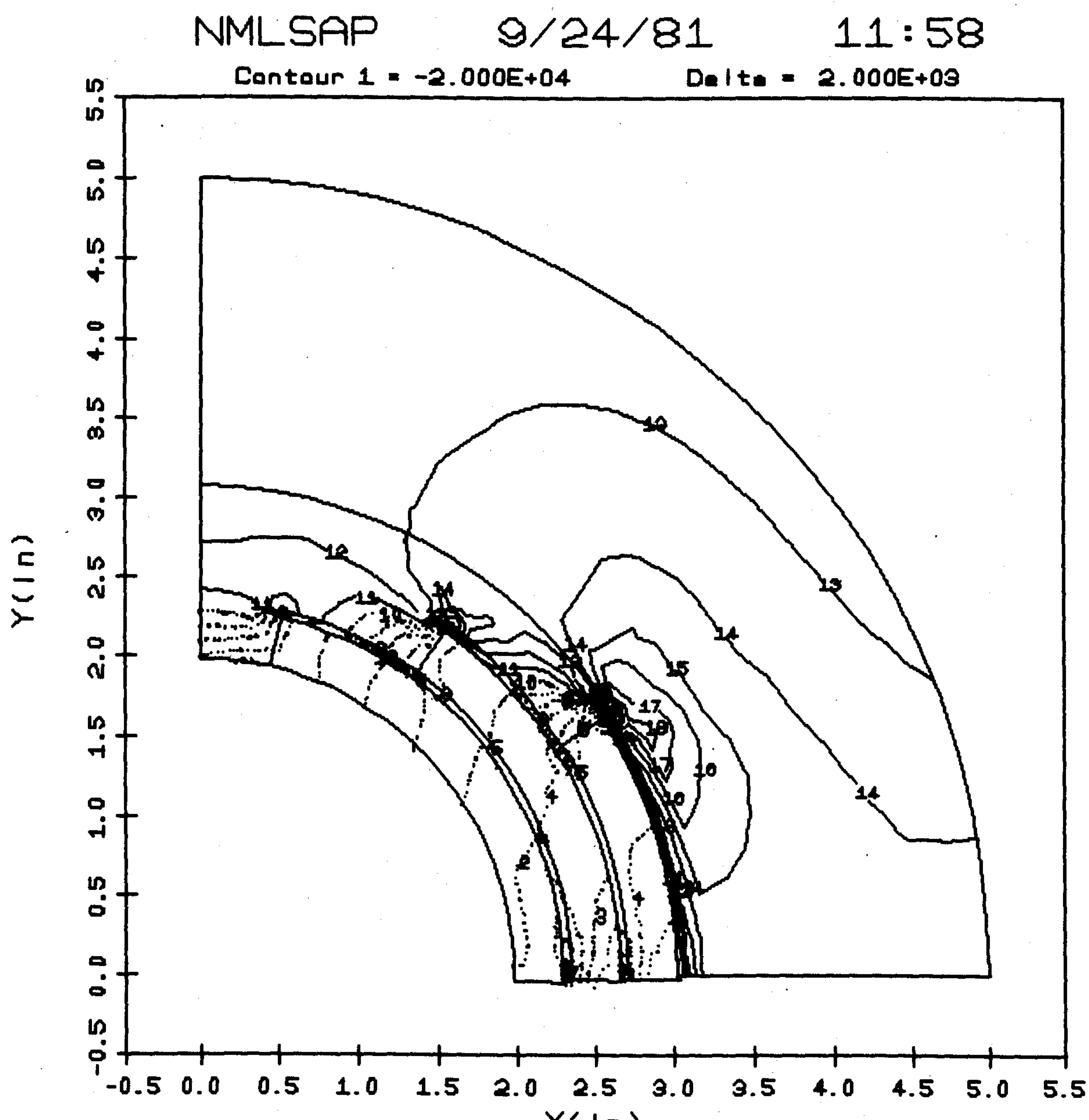


Figure 3.4.75 Contours of Constant SIG TH

BERKELEY 3-LAYER DIPOLE MAGNET
PARTIAL SLIP, TOTAL LOAD

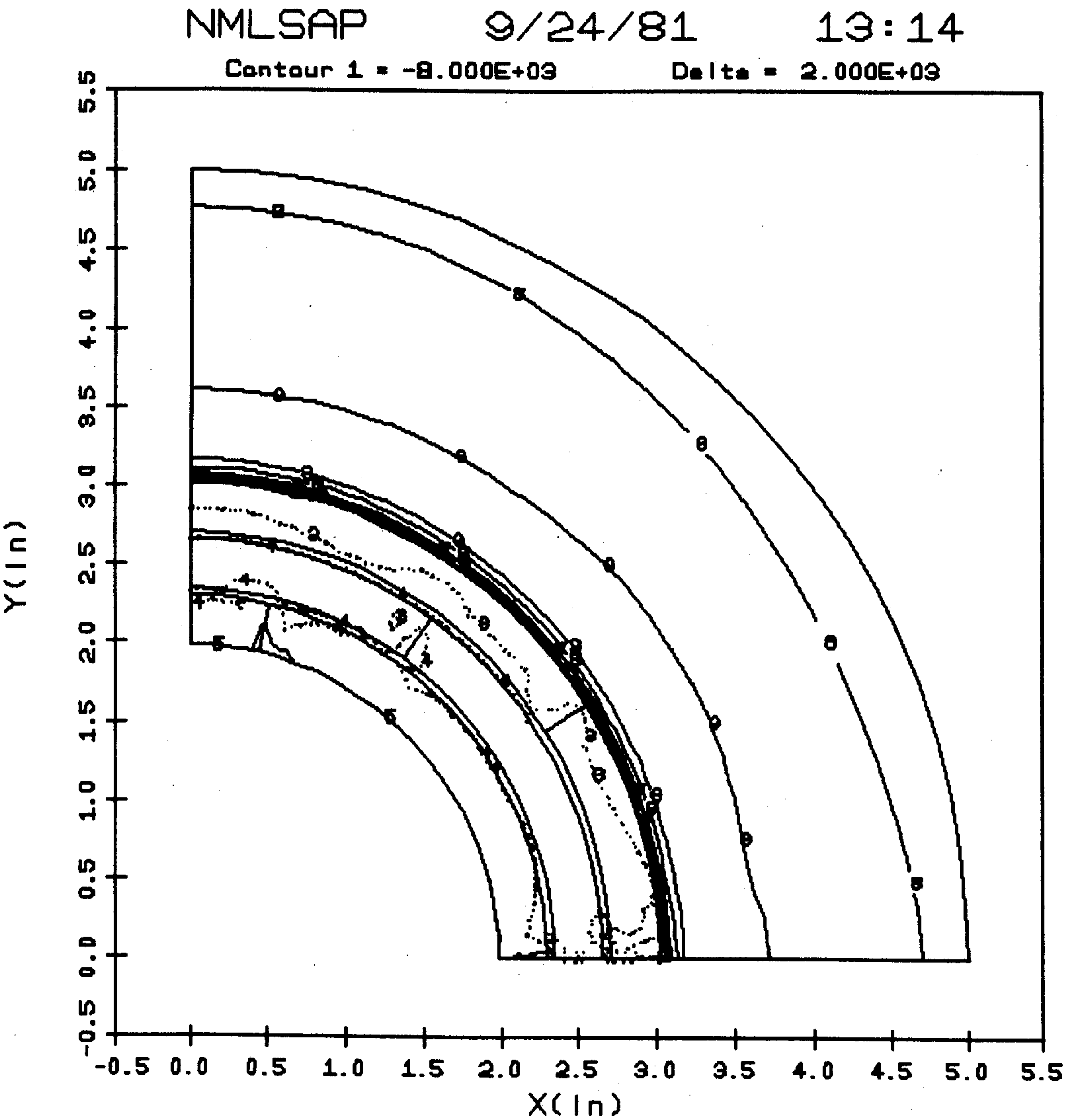


Figure 3.4.76 Contours of Constant SIG MAX

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, ASSEMBLY LOAD

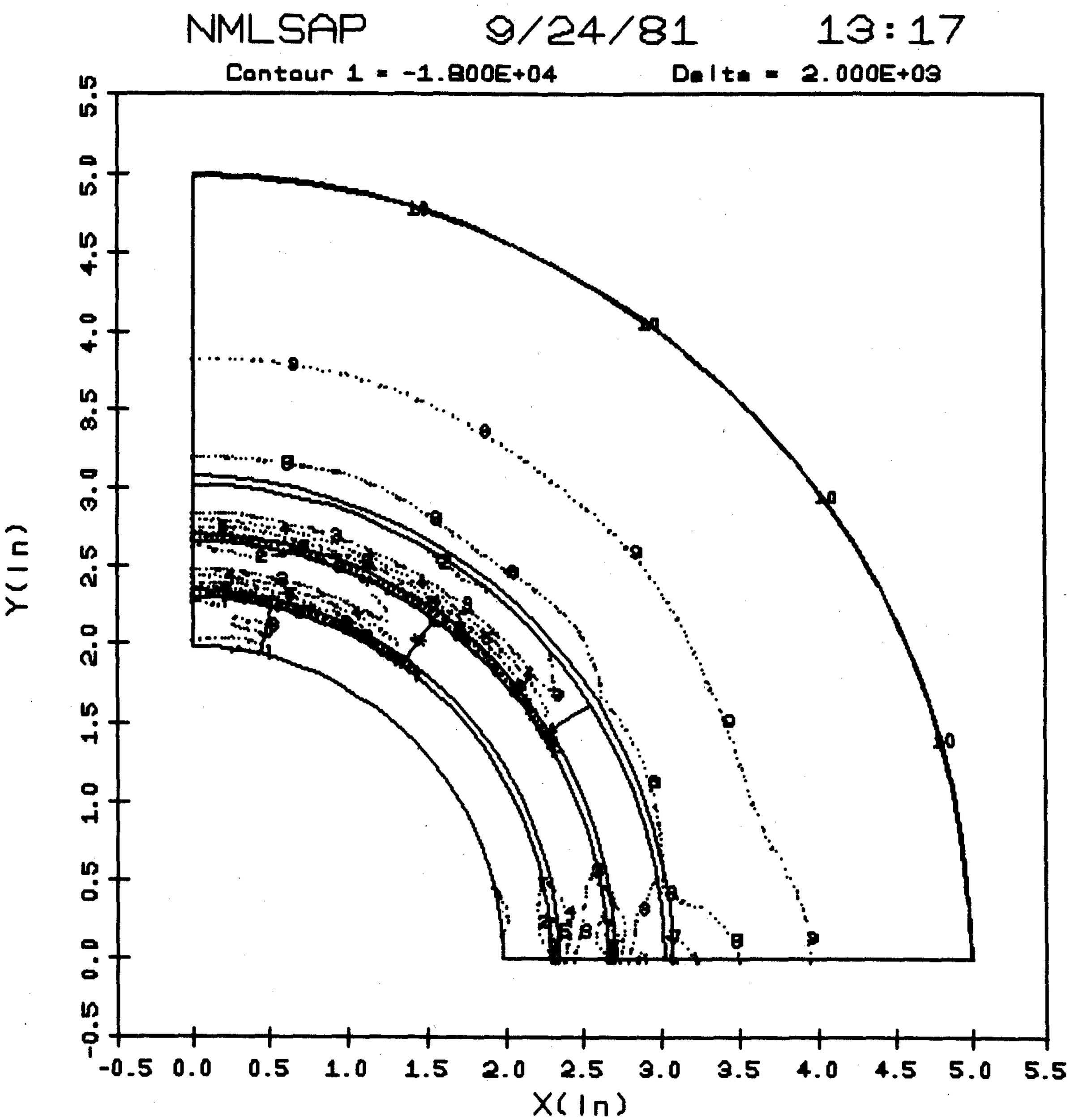


Figure 3.4.77 Contours of Constant SIG MIN

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, ASSEMBLY LOAD

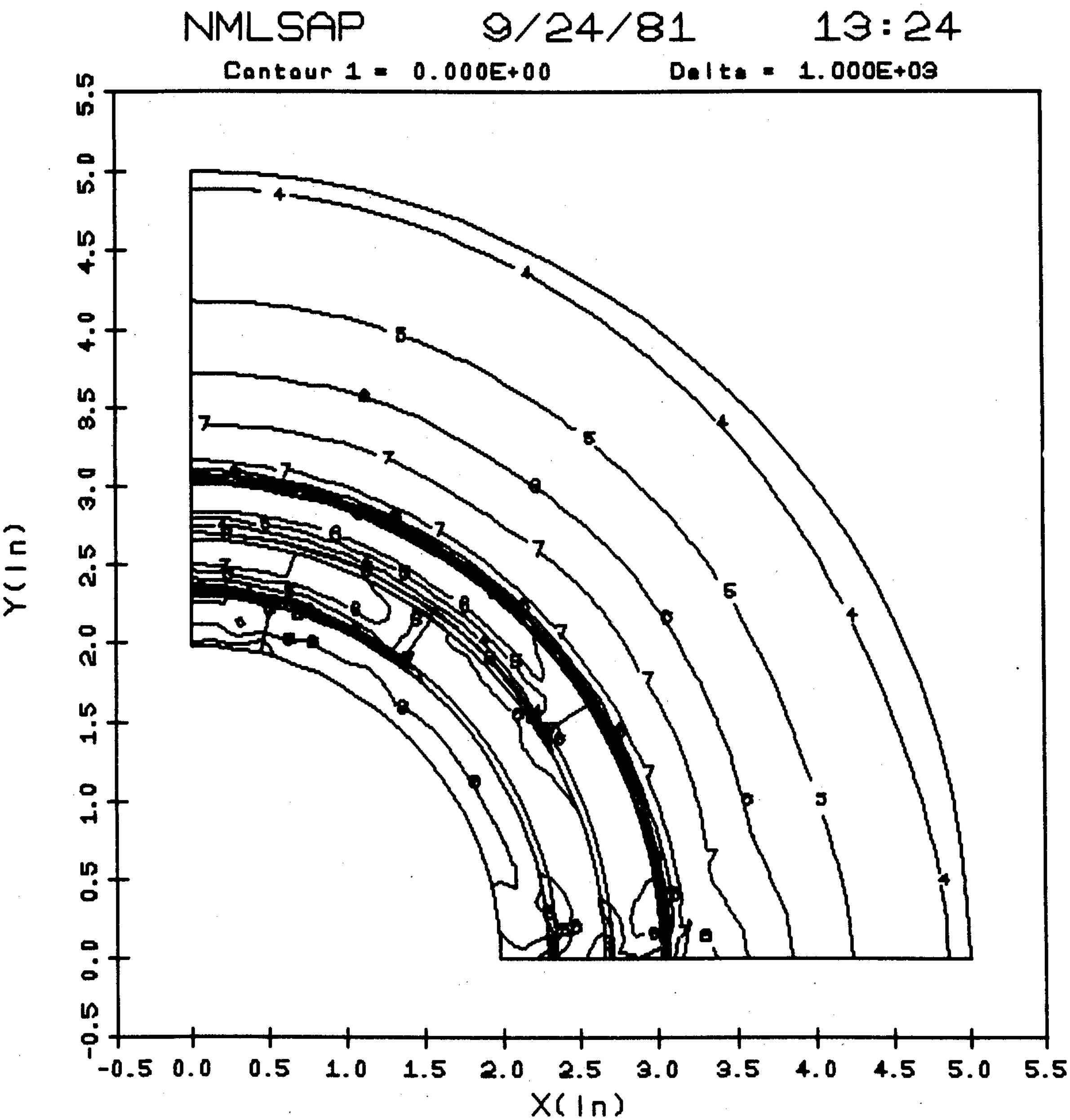


Figure 3.4.78 Contours of Constant TAU MAX

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, ASSEMBLY LOAD

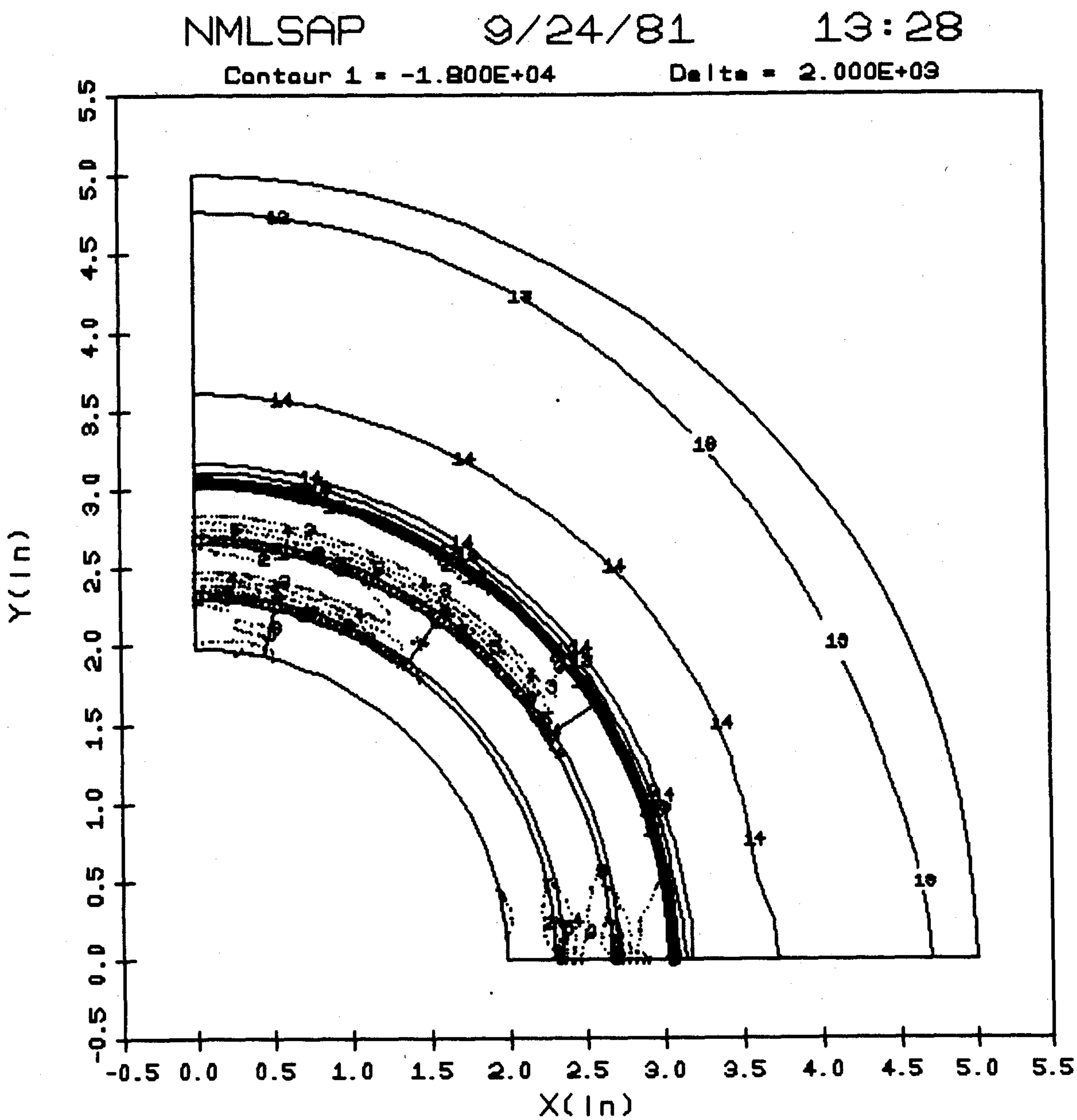


Figure 3.4.79 Contours of Constant SIG TH

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, ASSEMBLY LOAD

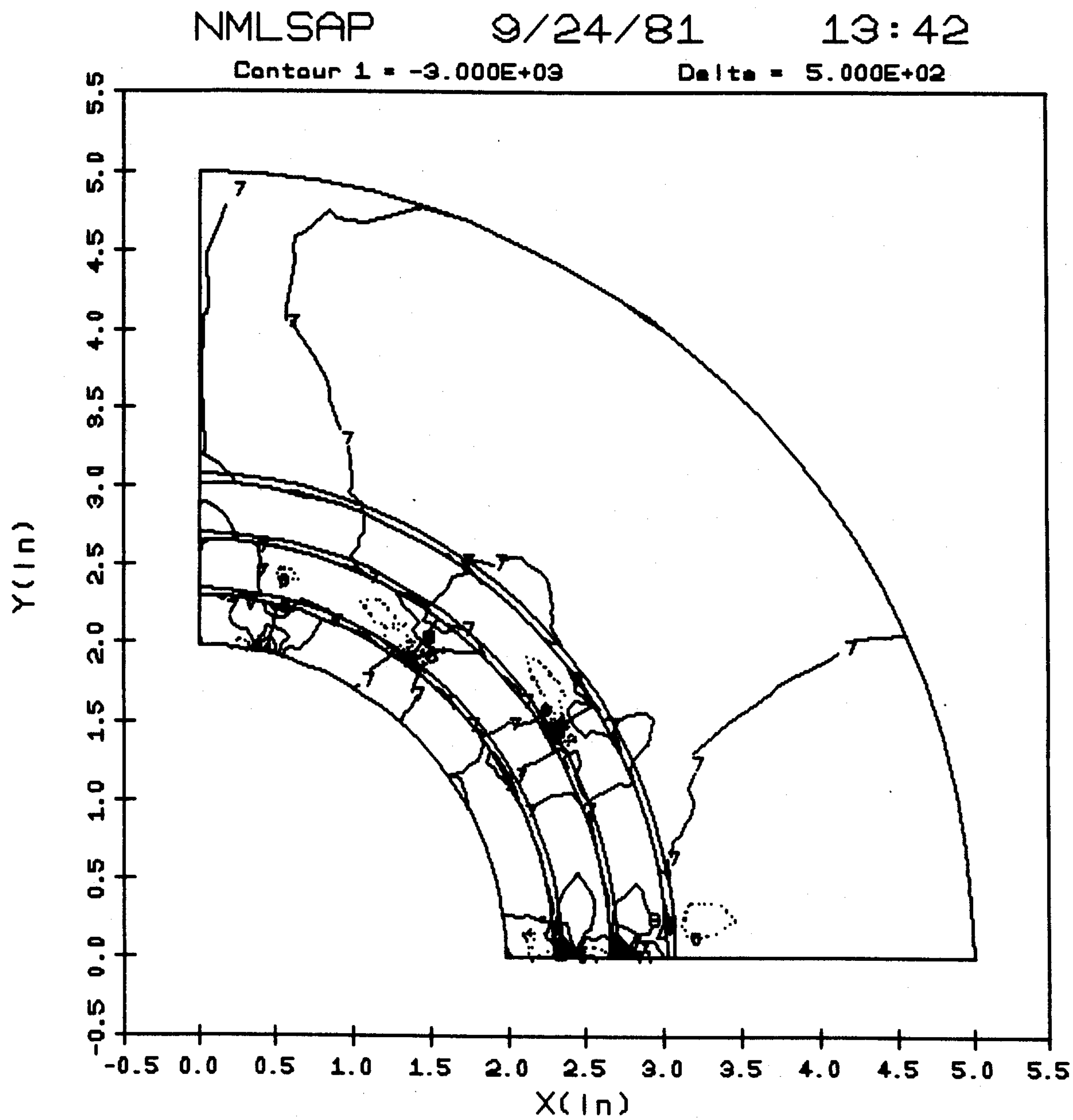


Figure 3.4.80 Contours of Constant TAU RTH

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, ASSEMBLY LOAD

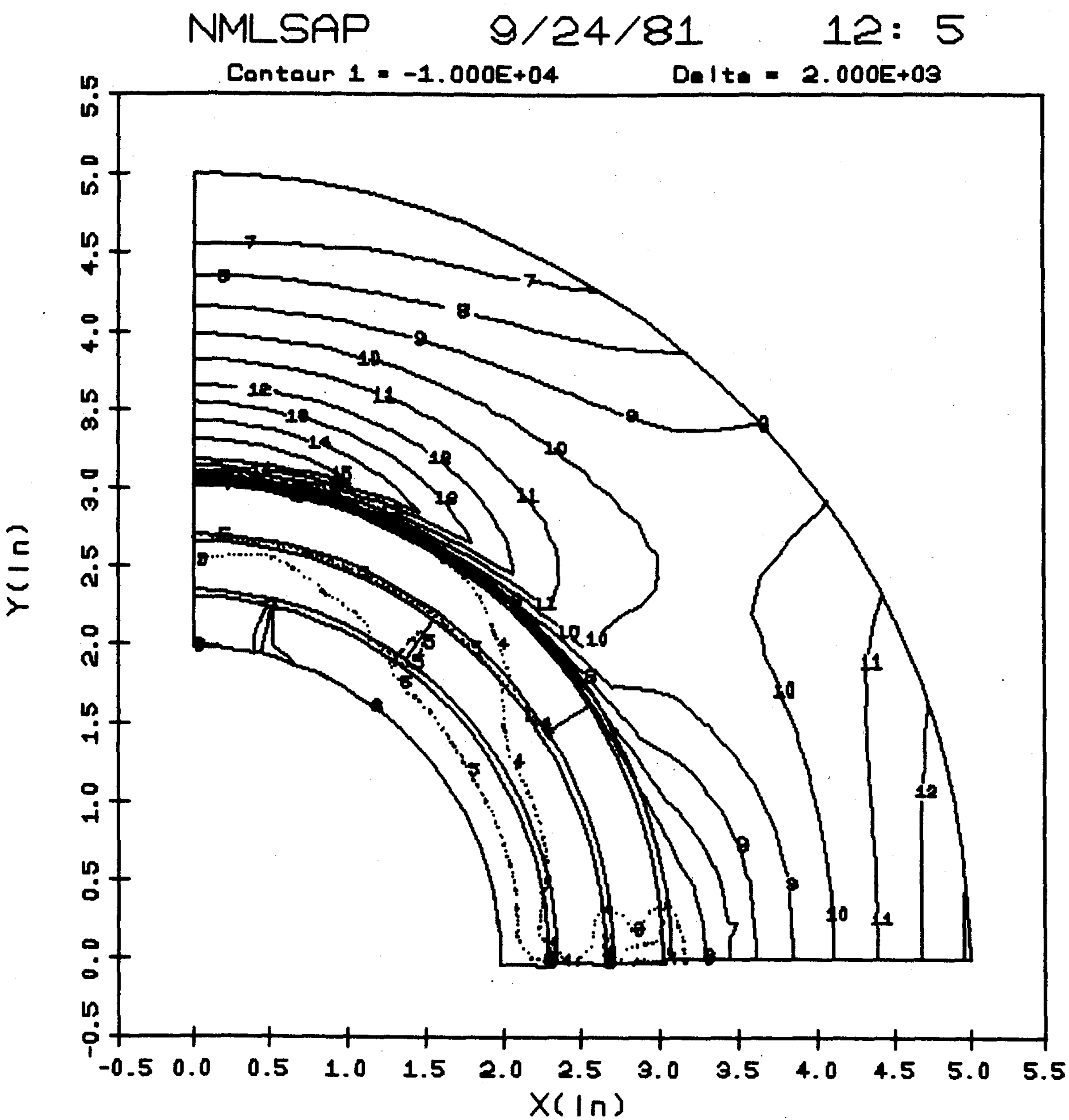


Figure 3.4.81 Contours of Constant SIG MAX

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, TOTAL LOAD

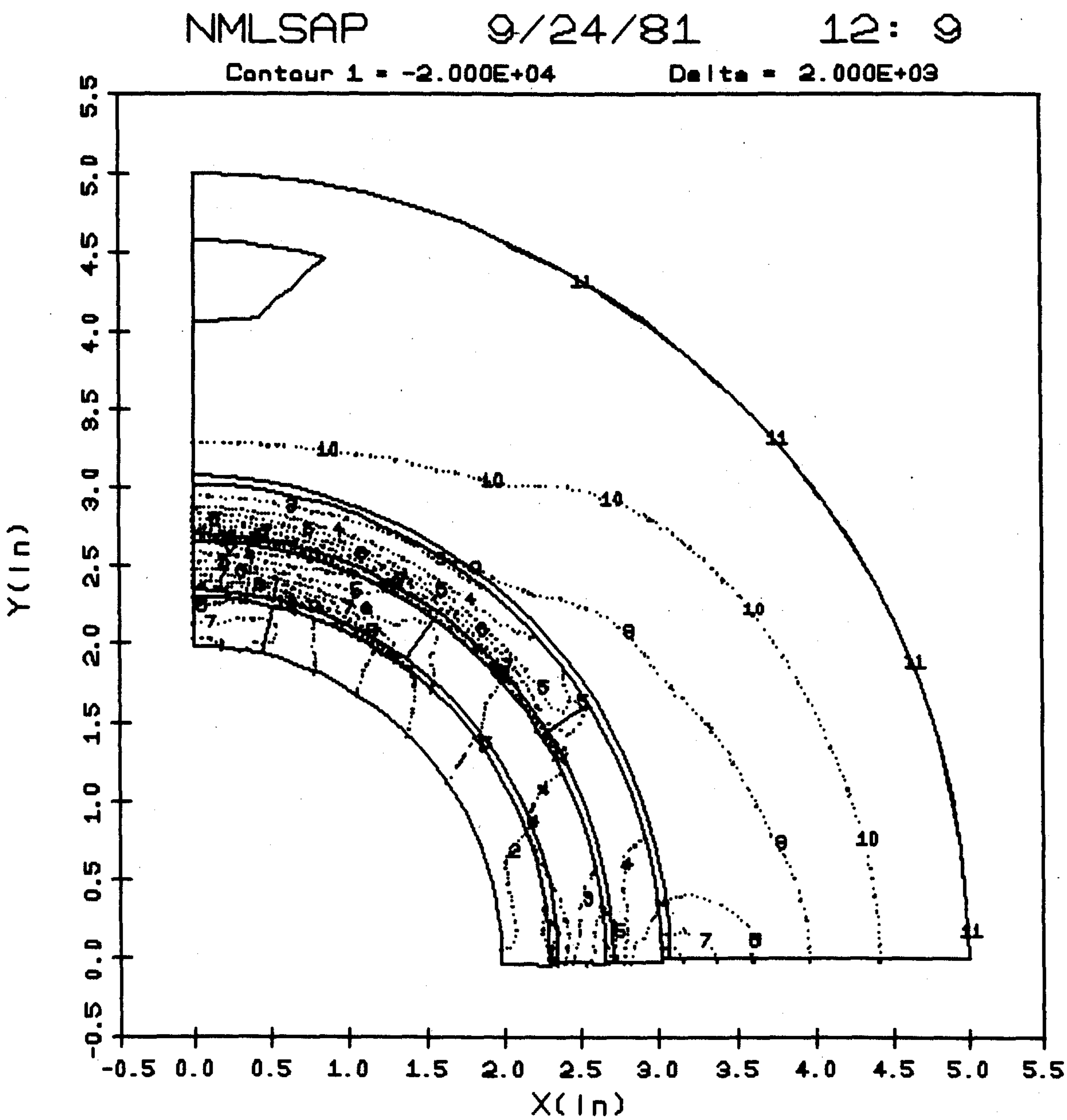


Figure 3.4.82 Contours of Constant SIG MIN

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, TOTAL LOAD

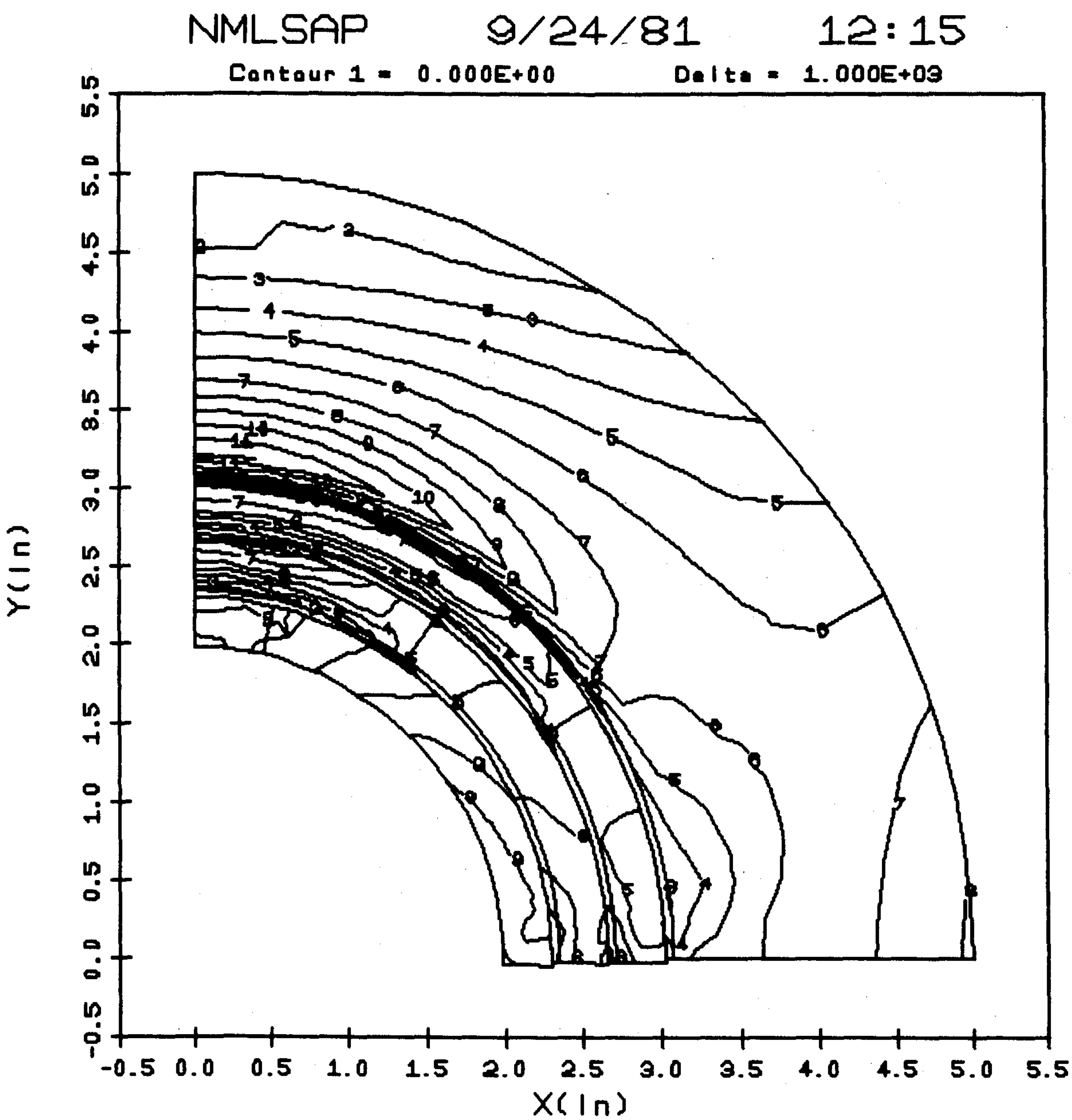


Figure 3.4.83 Contours of Constant TAU MAX

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, TOTAL LOAD

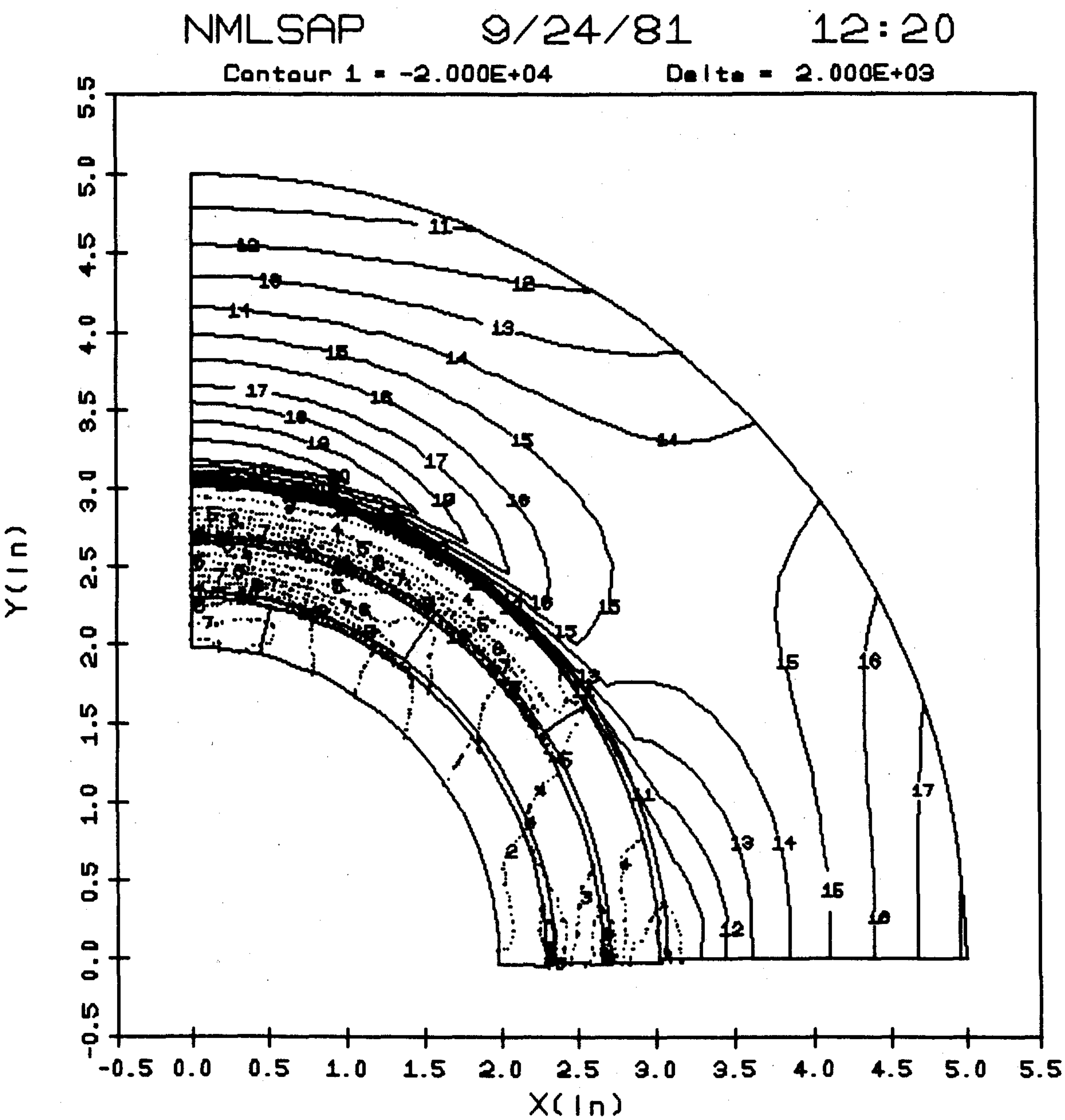


Figure 3.4.84 Contours of Constant SIG TH

BERKELEY 3-LAYER DIPOLE MAGNET
TOTAL SLIP, TOTAL LOAD

Coil Theoretical Deflections at Midplane
Applied Load = 15 ksi
All Deflections, 0.001 Inch

Coil	Condition	Partial Slip		Total Slip	
		At A	At B	At A	At B
Inner (I)	Preload	43.4	0.8	43.8	0.6
	Total Load	43.8	0.3	43.8	0.0
Middle (M)	Preload	31.8	1.9	32.4	1.7
	Total Load	32.4	0.6	32.4	0.3
Outer (O)	Preload	21.9	2.0	23.2	2.7
	Total Load	23.2	0.6	23.2	1.2

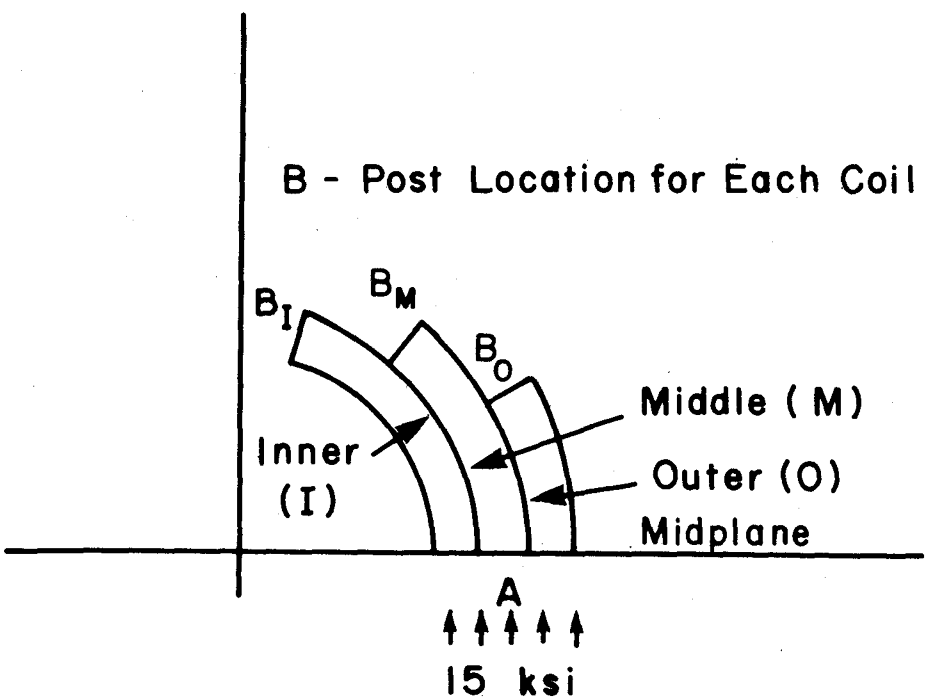


Figure 3.4.85 Coil Theoretical Tangential Deflections at Midplane

SIG TH = tangential normal stress

TAU MAX = maximum shear stress = (SIG MAX - SIG MIN)/2

TAU RTH = shear stress acting radially and tangentially

X is the horizontal coordinate and Y is the vertical coordinate.

Each figure contains a stress level (in psi) for contour 1 and an incremental value, Delta. The stress at any location is obtained by finding the local contour number, multiplying that number by C - 1 (where C is the contour number) and adding it algebraically to the stress for contour 1. Tension is positive. For example, in Figure 3.4.60, the maximum principal stress is -4 ksi on contour 1. At the outer boundary of the outer coil at the post, the local contour number is 3. Consequently, SIG MAX at that location is -4 + (3 - 1)(2000) = 0.

The predeformation analysis was conducted in two steps. In the first, a uniform (or tangential) pressure of 15 ksi was applied at the midplane to each coil with full slip between coils and circumferential restraint at the post. The resultant movement then was applied to the coil/frame system to find stresses and strains.

One extreme is the monolithic case (Figures 3.4.59 through 3.4.67). The full-slip case is close to hydrostatic loading on the inner boundary of the frame inducing essentially Lame stresses and deflections (Figures 3.4.76 through 3.4.84). The partial-slip results fall between those limits (Figures 3.4.68 through 3.4.75). The maximum stresses and deflections appear in Figure 3.4.85 for all cases.

It can be seen that the tangential movements at the coil/post interfaces are small. The coil deformations are seen to be so much larger that, as a reasonable approximation, the frame movements can be neglected in determining coil movements.

3.4.4.3 Analysis of Palmer Magnet

3.4.4.3.1 General Arrangement

The Palmer two-layer magnet consists of two Fermilab-type coils and several separators in a cold iron case. The schematic arrangement is shown in Figure 3.4.86. The outer boundary of the case was assumed to be a circle 18 inches in diameter.

The analysis employed a finite element stress analysis program, NMLSAP, developed at the National Magnet Laboratory. The elements appear in Figure 3.4.87. Stresses and deflections were calculated for preload alone and for preload plus Lorentz loads. Full slip was assumed between coils and between the outer coil and case.

3.4.4.3.2 Results of Finite Element Analysis

The results of the analysis appear in Figures 3.4.88 through 3.4.95 for preload alone and in Figures 3.4.96 through 3.4.102 for total load. The small-scale printouts of each section show the stresses throughout the coils and case. They are followed by enlarged views of the coil region.

Maximum stresses and peak deflections are summarized in Table 3.4.1 for preload alone, for Lorentz load alone, and for the sum of the two. Figure 3.4.103 displays the distribution of circumferential motion. The stresses in Table 3.4.1 are in approximate agreement with the theoretical treatment of Section 3.4.3.3.3 which shows 6 ksi Lorentz tension at the post and 3 ksi Lorentz compression at the midplane. When these are combined with the 12 ksi preload assumed for the finite element analysis, the midplane compression becomes 15 ksi and the post compression is 6 ksi.

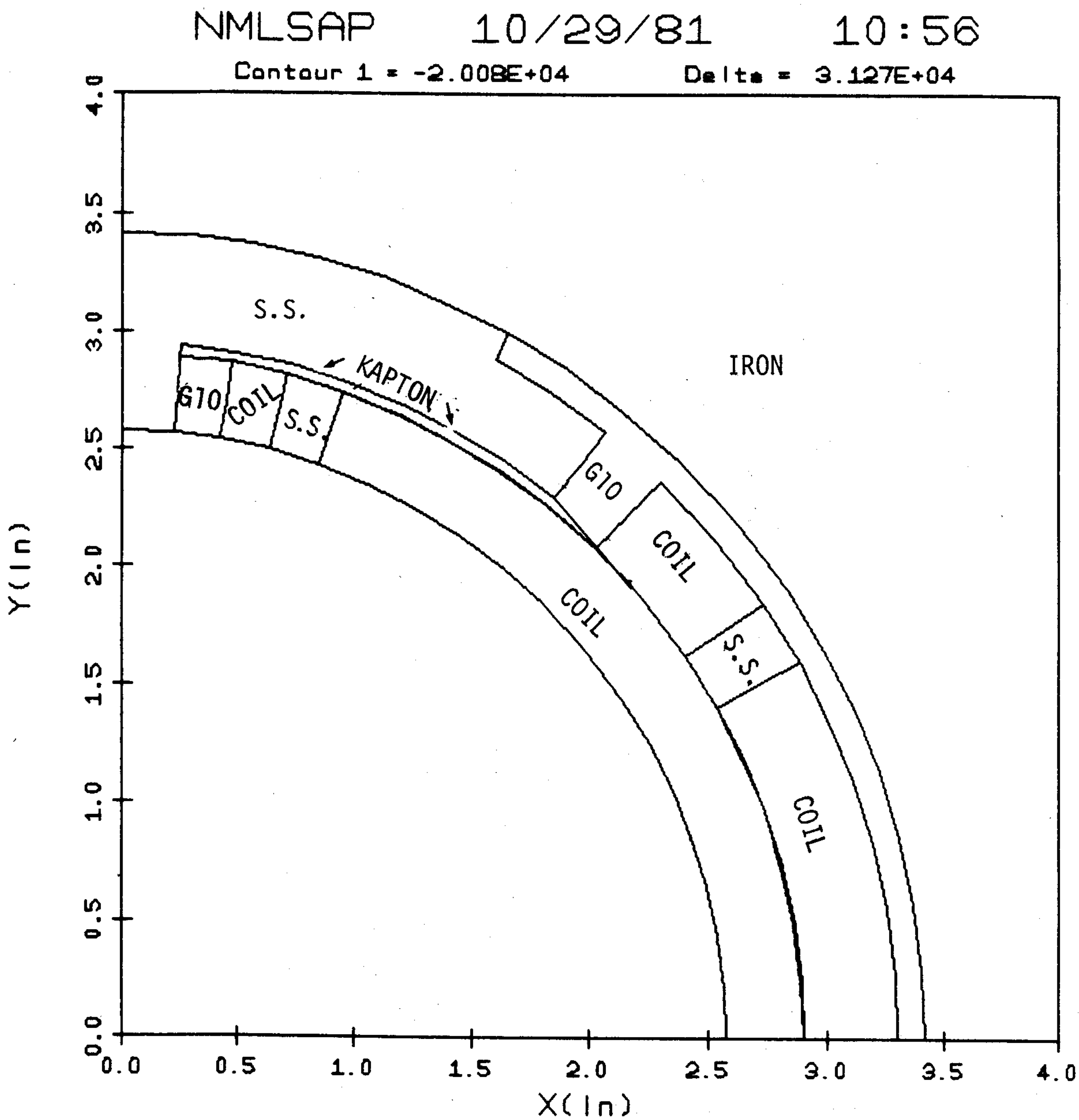


Figure 3.4.86 Coil Configuration

PALMER 2-LAYER DIPOLE MAGNET

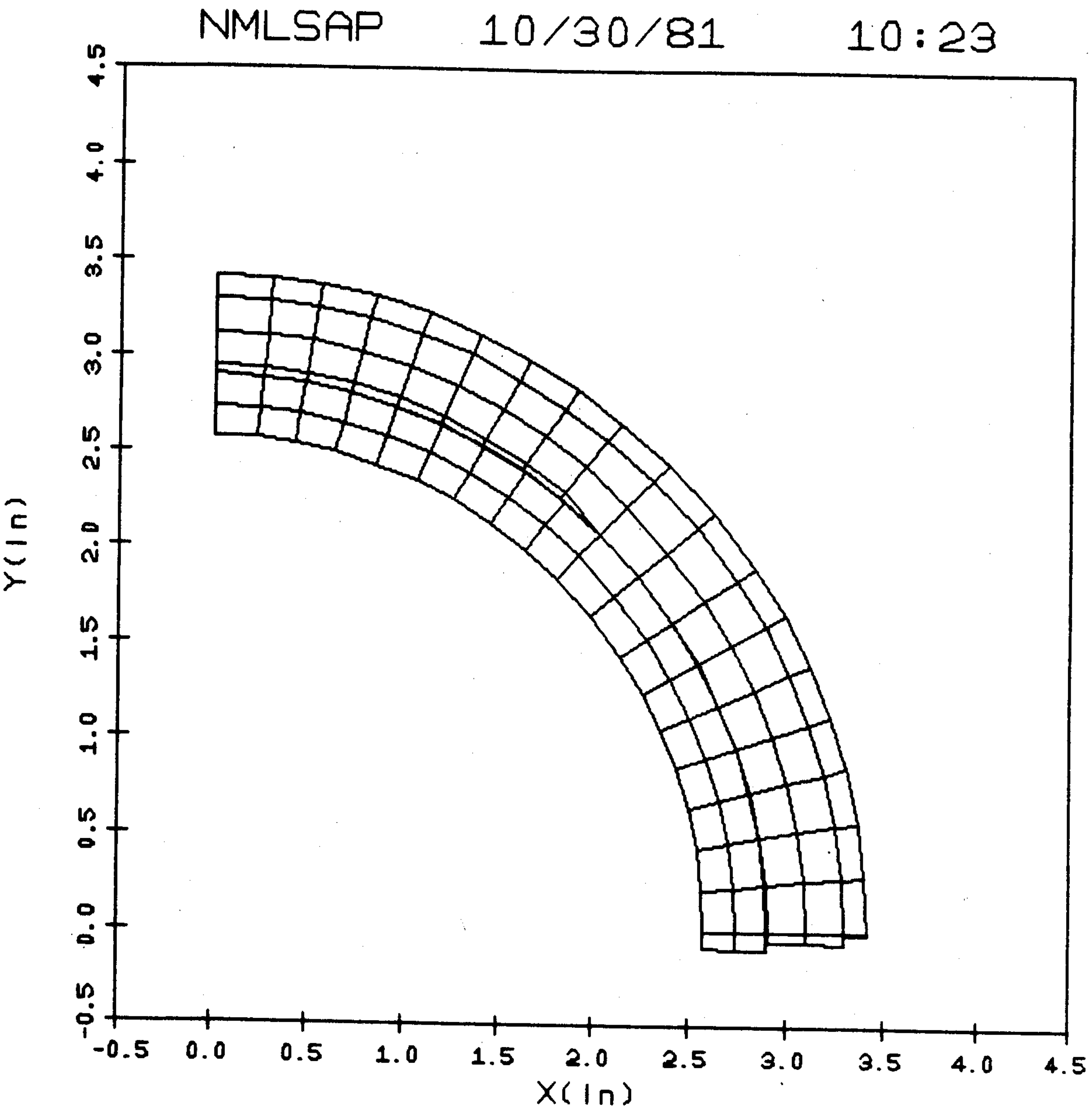


Figure 3.4.87 Elements

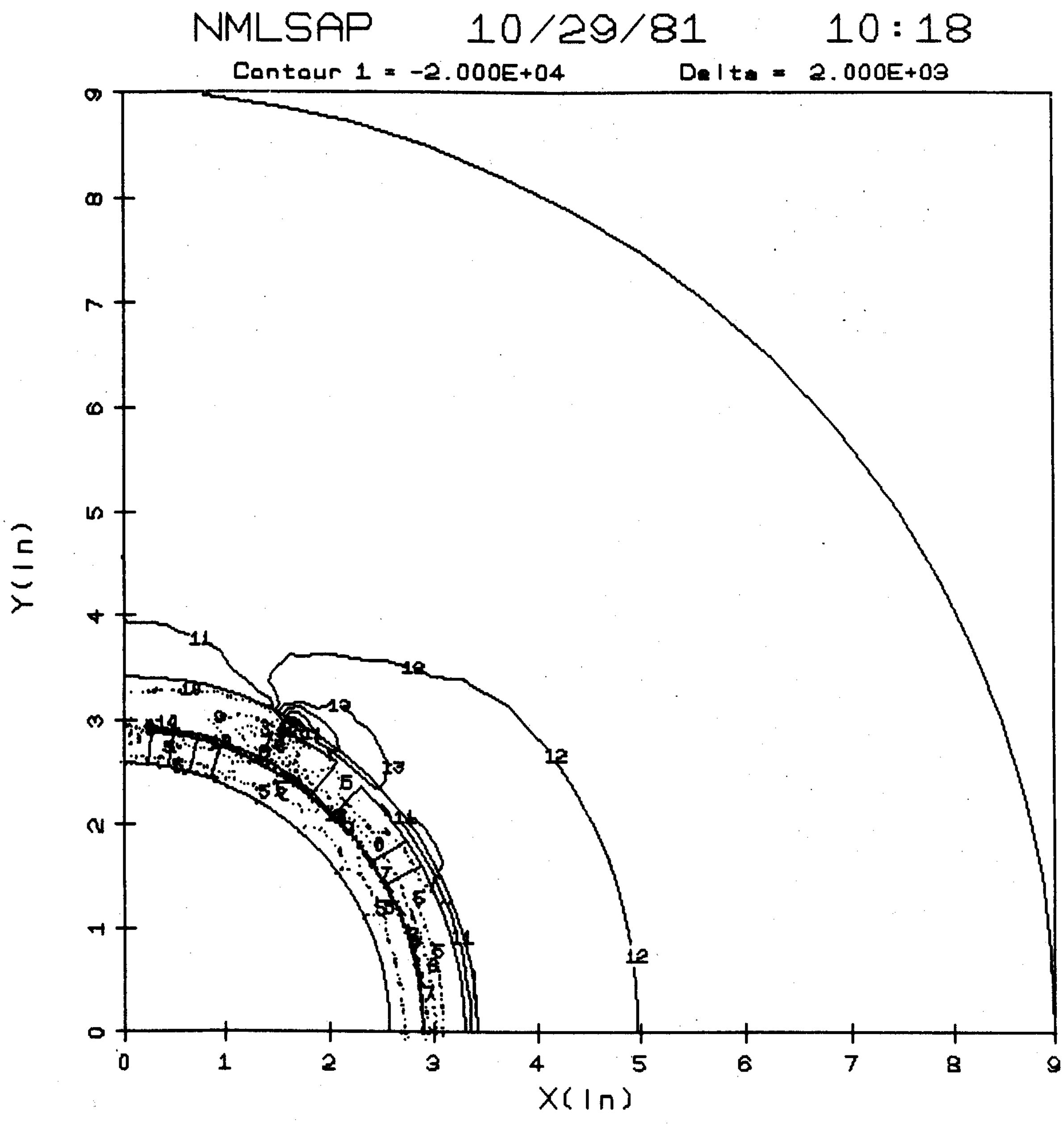


Figure 3.4.88 Contours of Constant SIG TH

PALMER 2-LAYER DIPOLE MAGNET ASSEMBLY LOAD

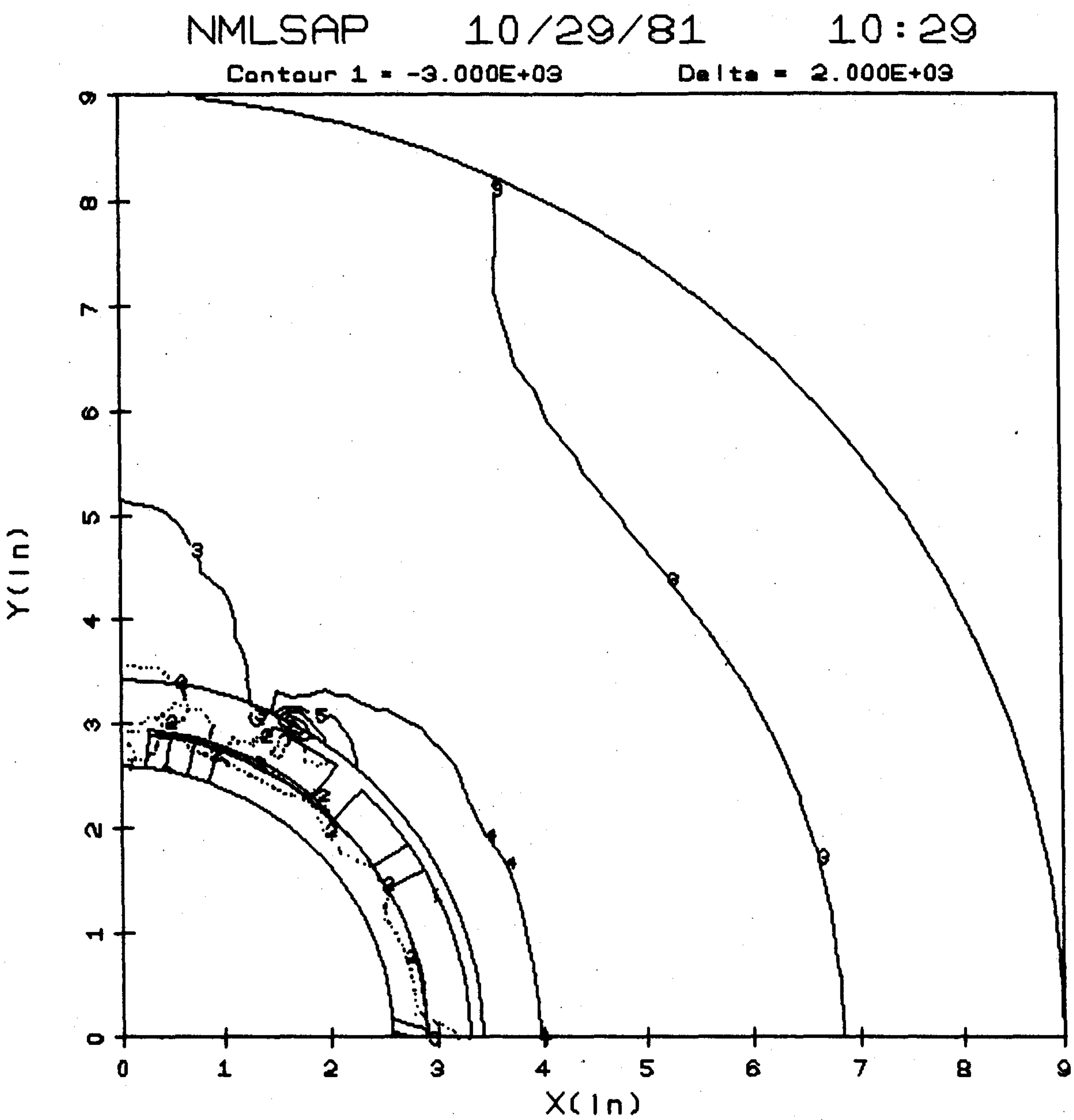


Figure 3.4.89 Contours of Constant SIG MAX

PALMER 2-LAYER DIPOLE MAGNET ASSEMBLY LOAD

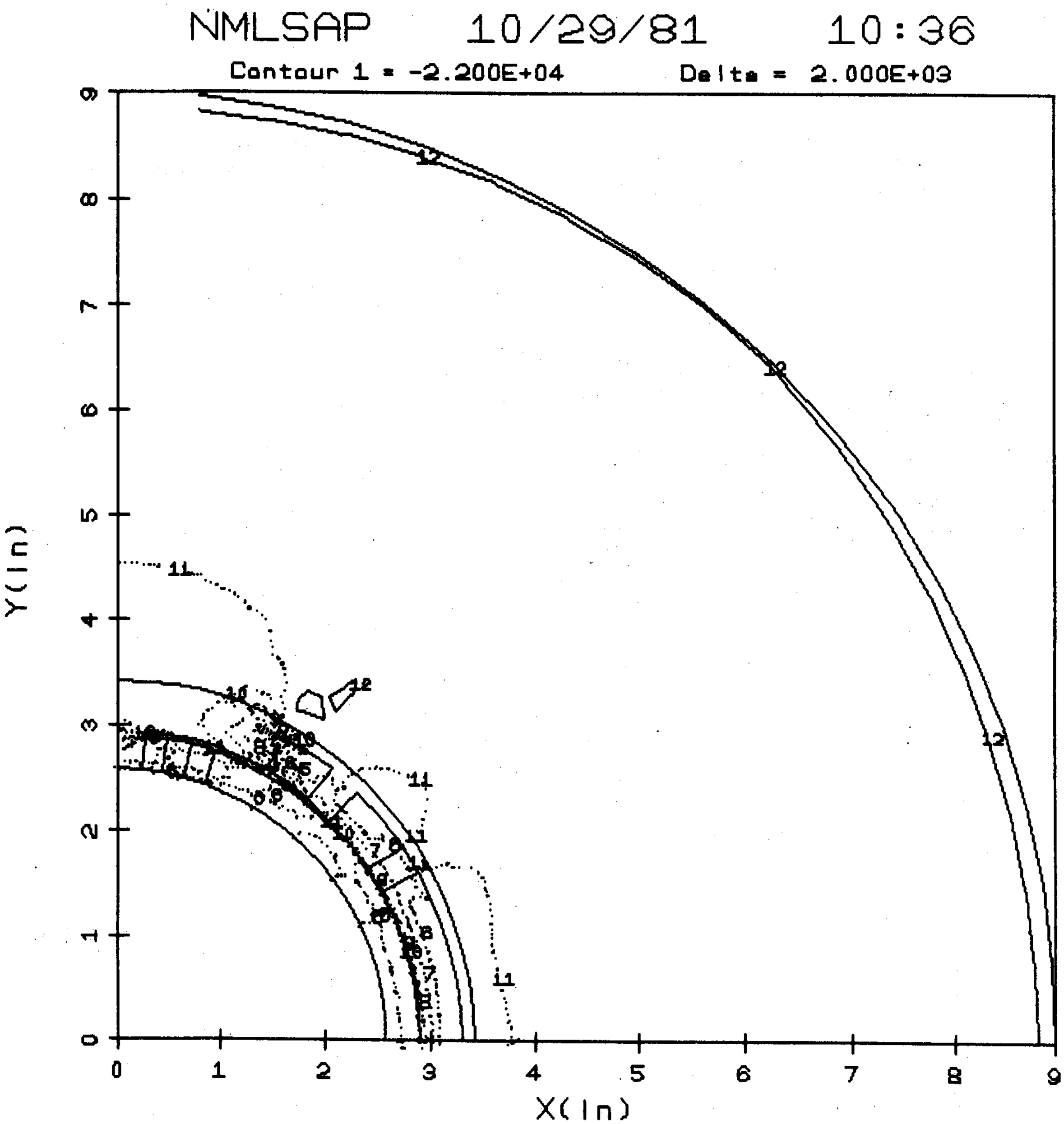


Figure 3.4.90 Contours of Constant SIG MIN

PALMER 2-LAYER DIPOLE MAGNET ASSEMBLY LOAD

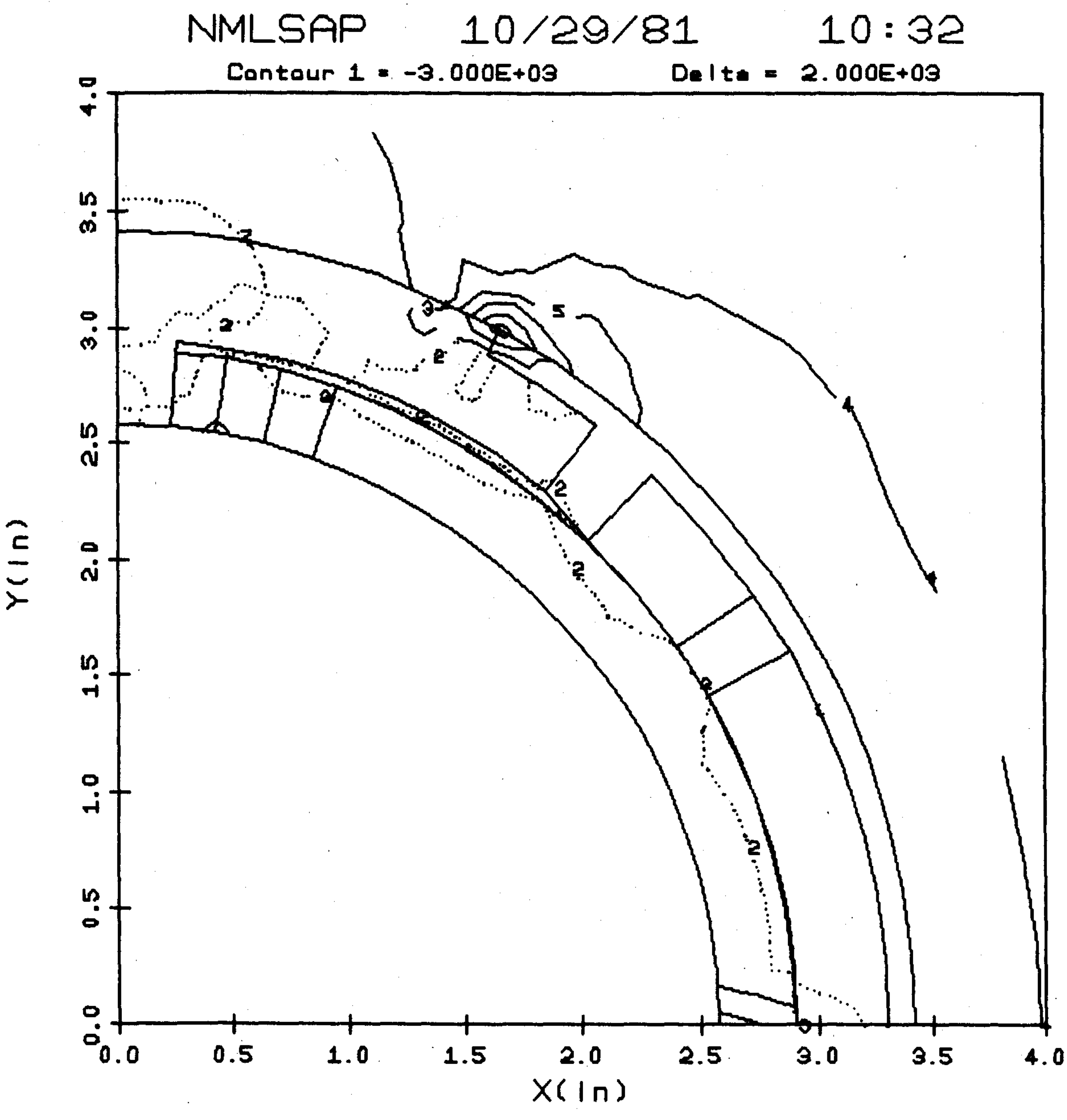


Figure 3.4.91 Contours of Constant SIG MAX

PALMER 2-LAYER DIPOLE MAGNET ASSEMBLY LOAD

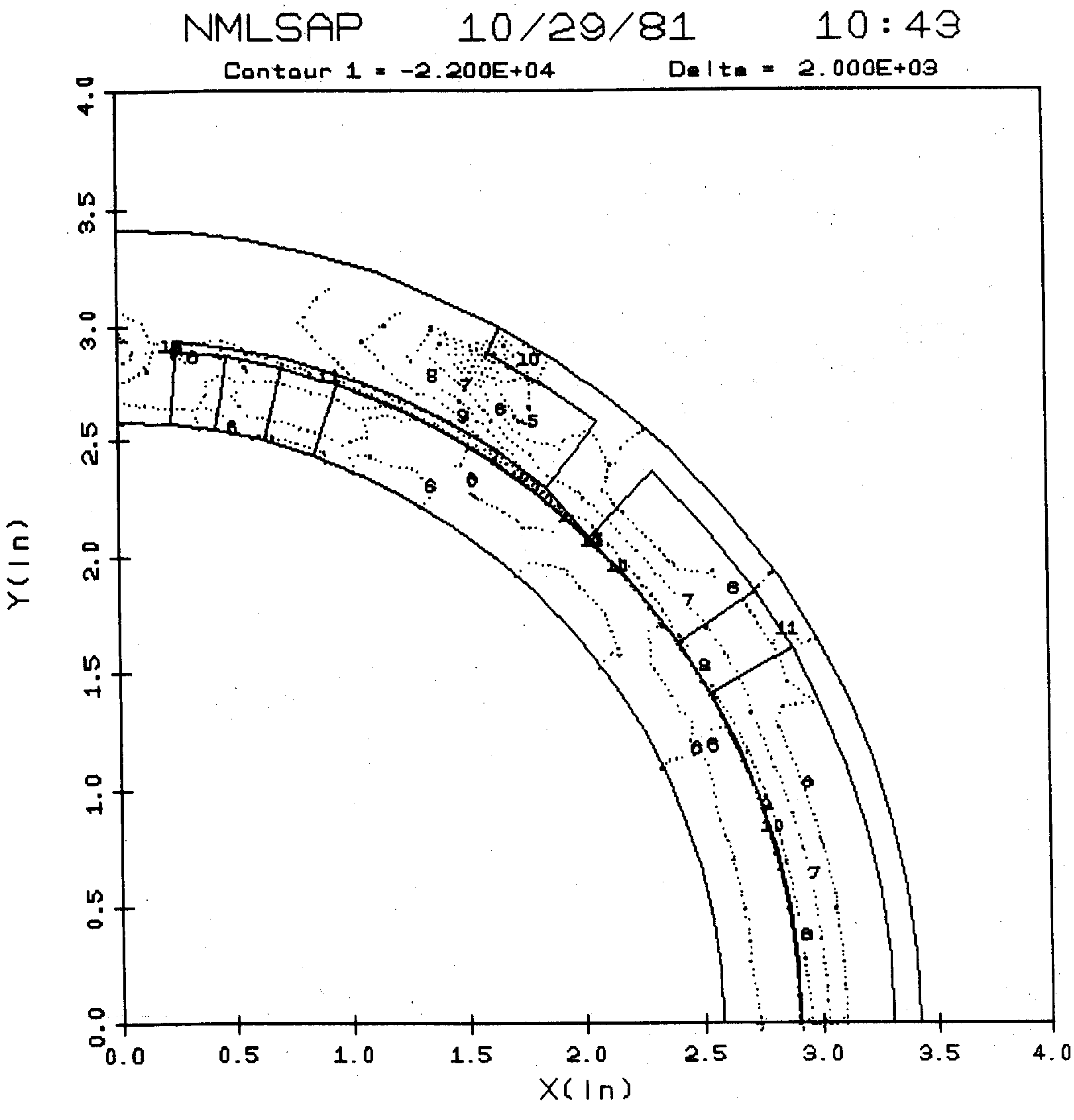


Figure 3.4.92 Contours of Constant SIG MIN

PALMER 2-LAYER DIPOLE MAGNET ASSEMBLY LOAD

time in plot = 8.573E+01 seconds
CO
MMAND

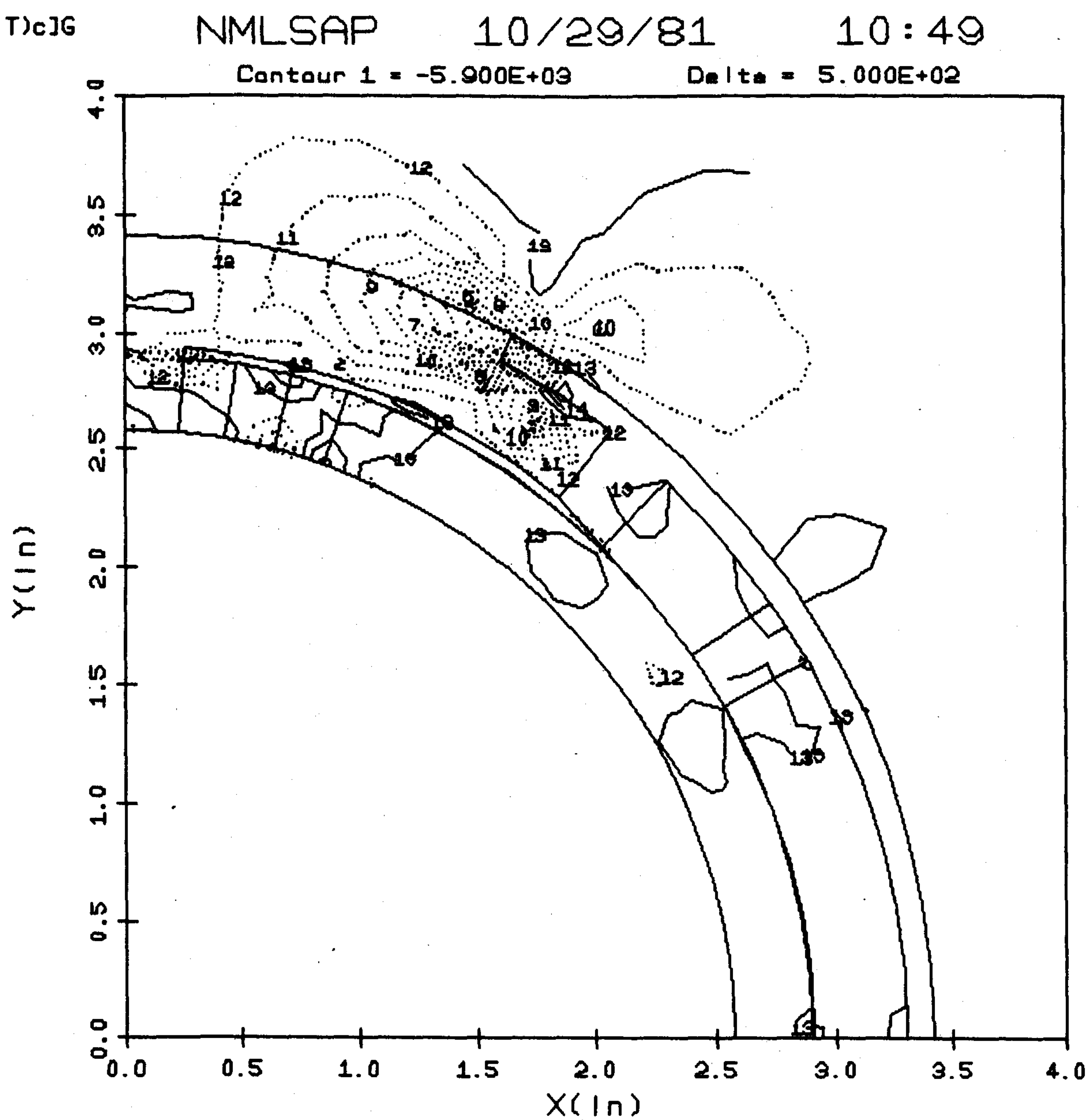


Figure 3.4.93 Contours of Constant TAU RTH

PALMER 2-LAYER DIPOLE MAGNET ASSEMBLY LOAD

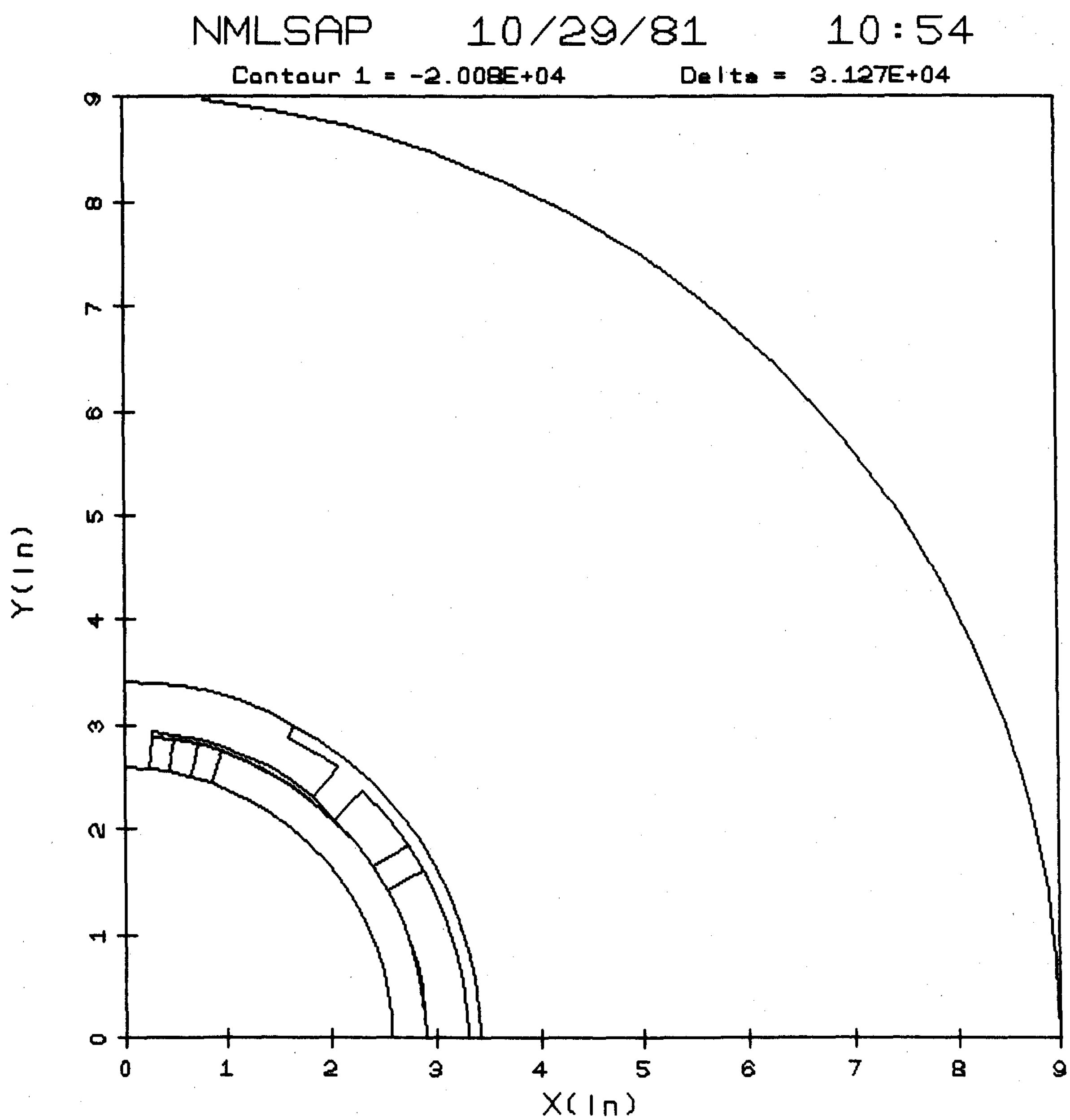


Figure 3.4.94 Contours of Constant SIG TH

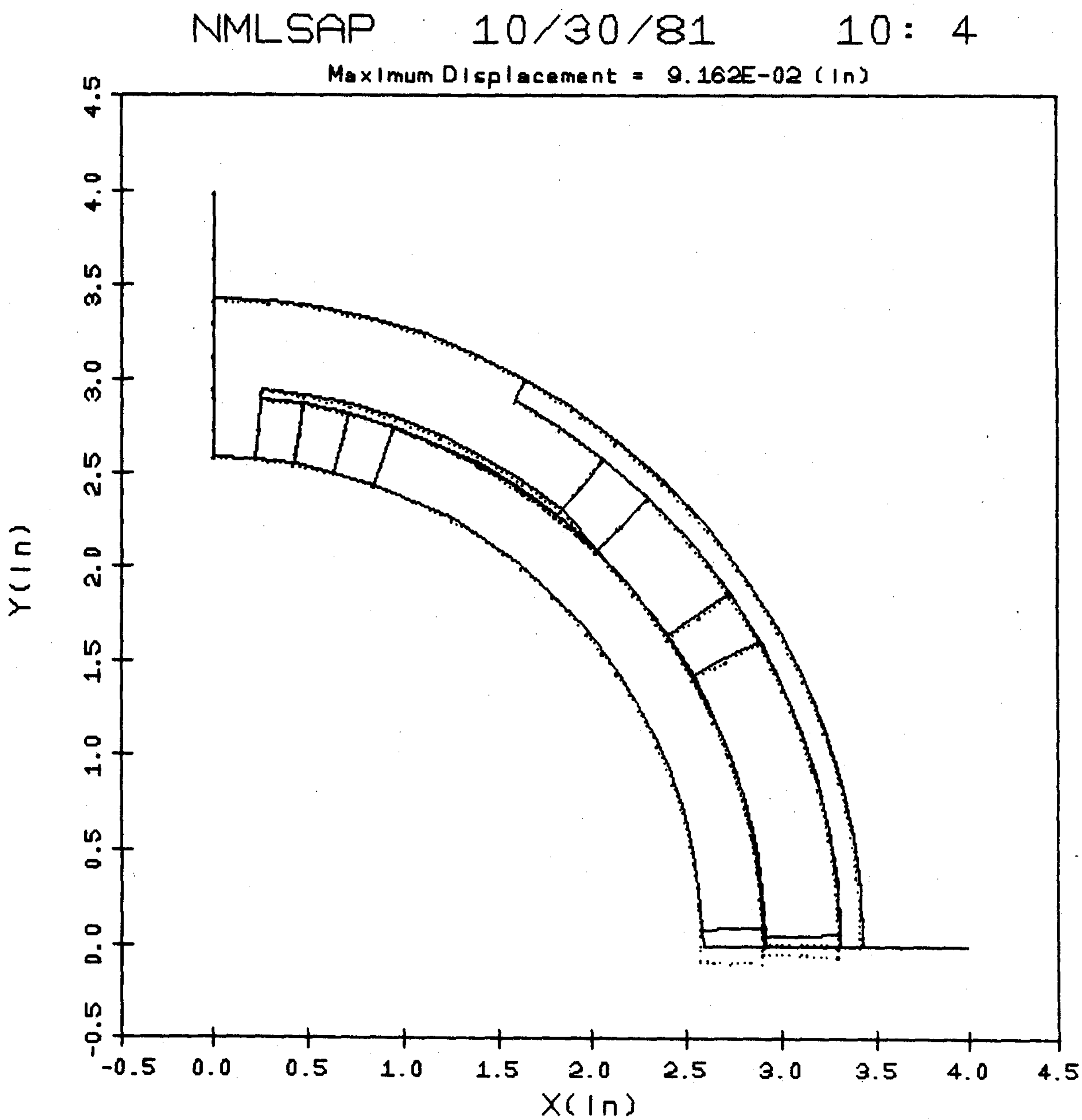


Figure 3.4.95 Deformed Grid

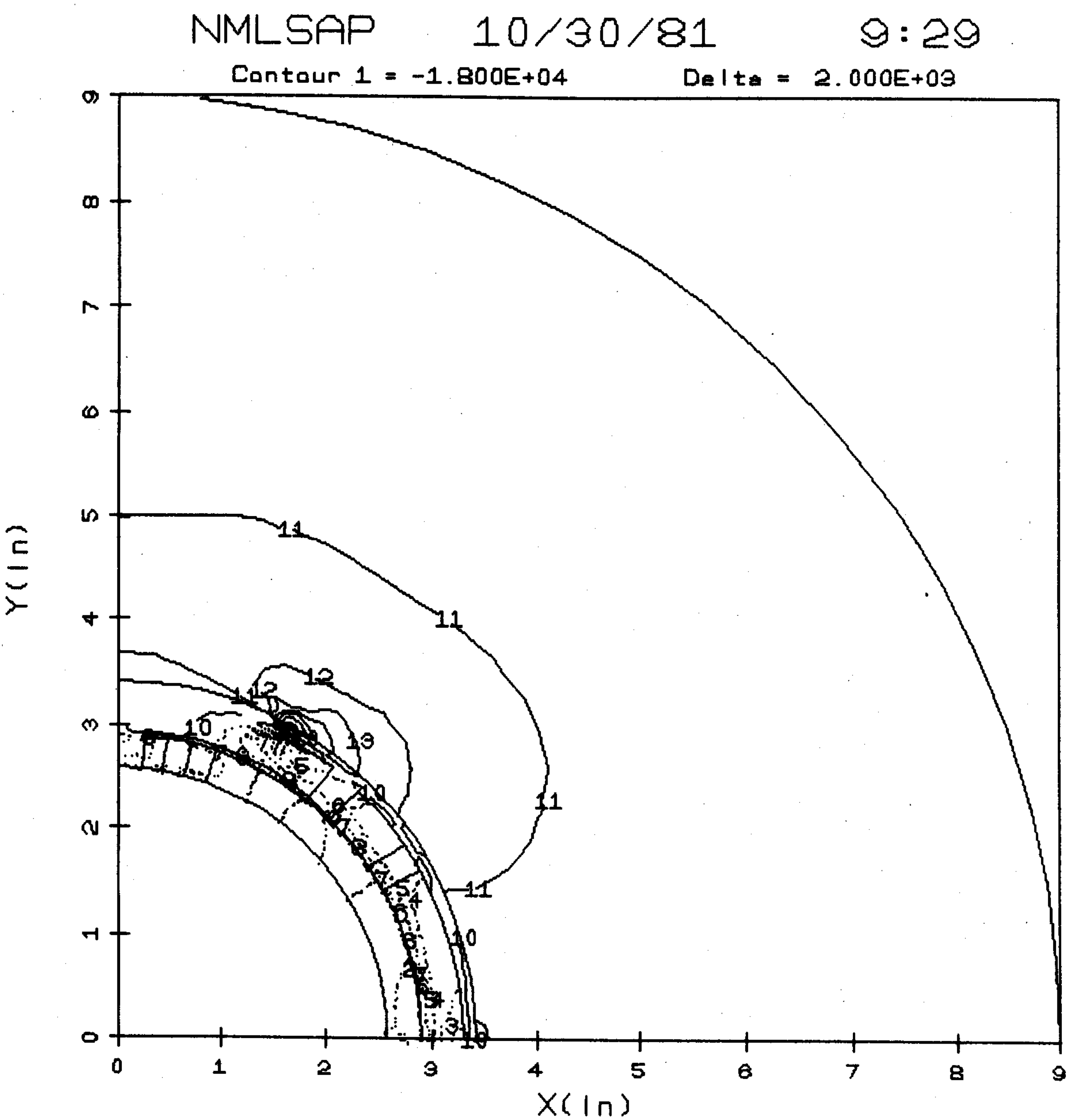


Figure 3.4.96 Contours of Constant SIG TH

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

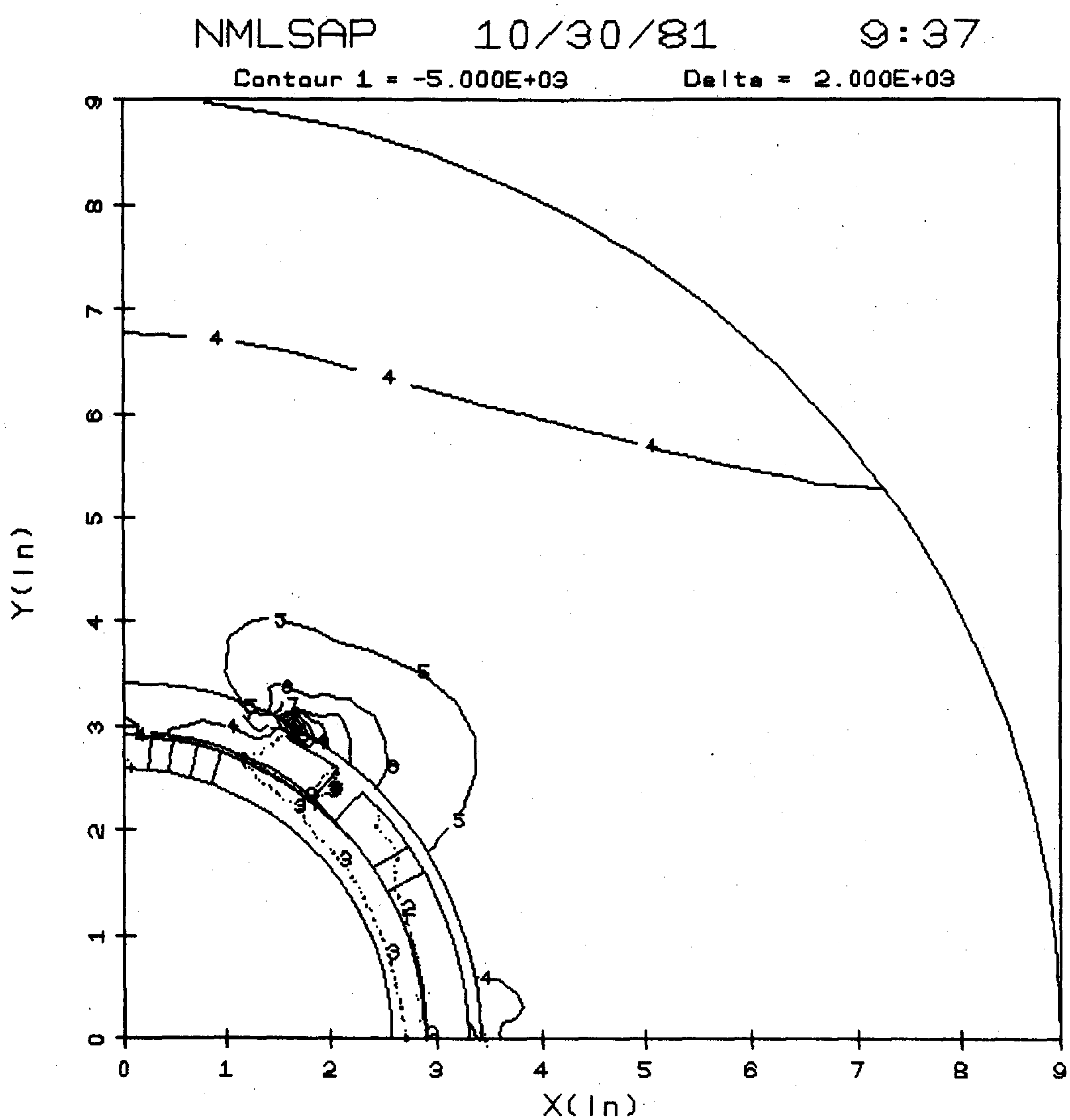


Figure 3.4.97 Contours of Constant SIG MAX

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

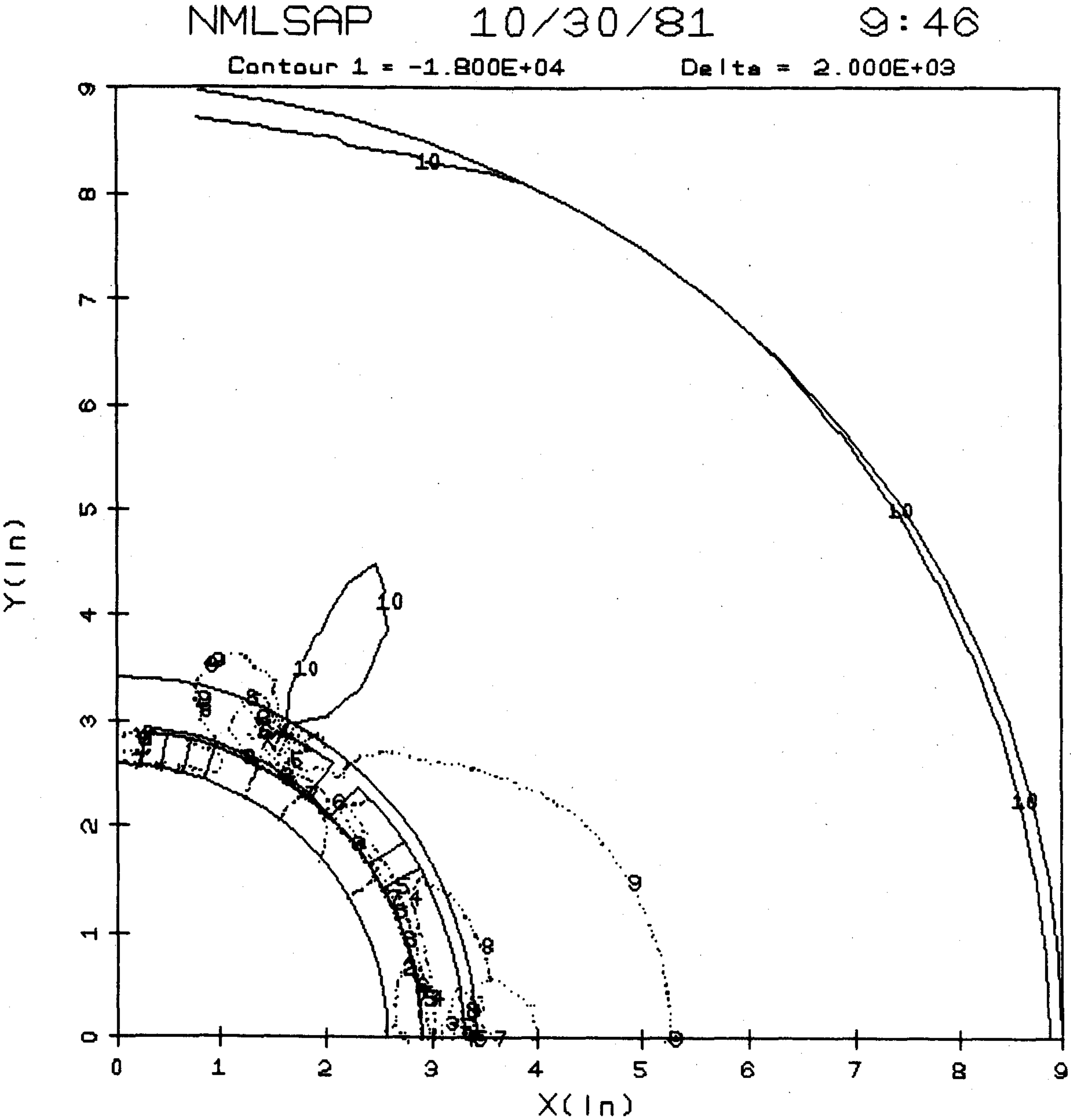


Figure 3.4.98 Contours of Constant SIG MIN

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

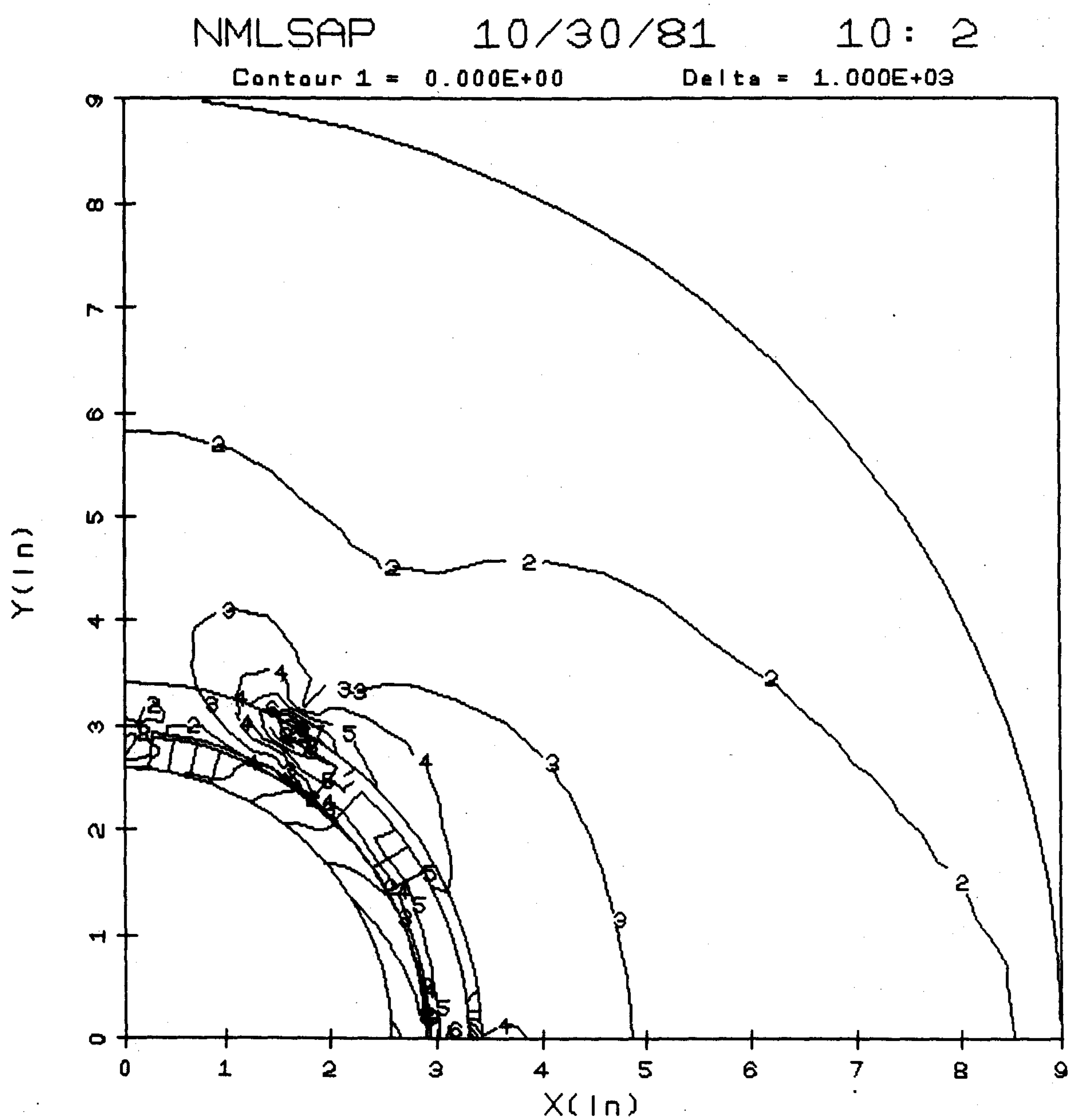


Figure 3.4.99 Contours of Constant TAU MAX

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

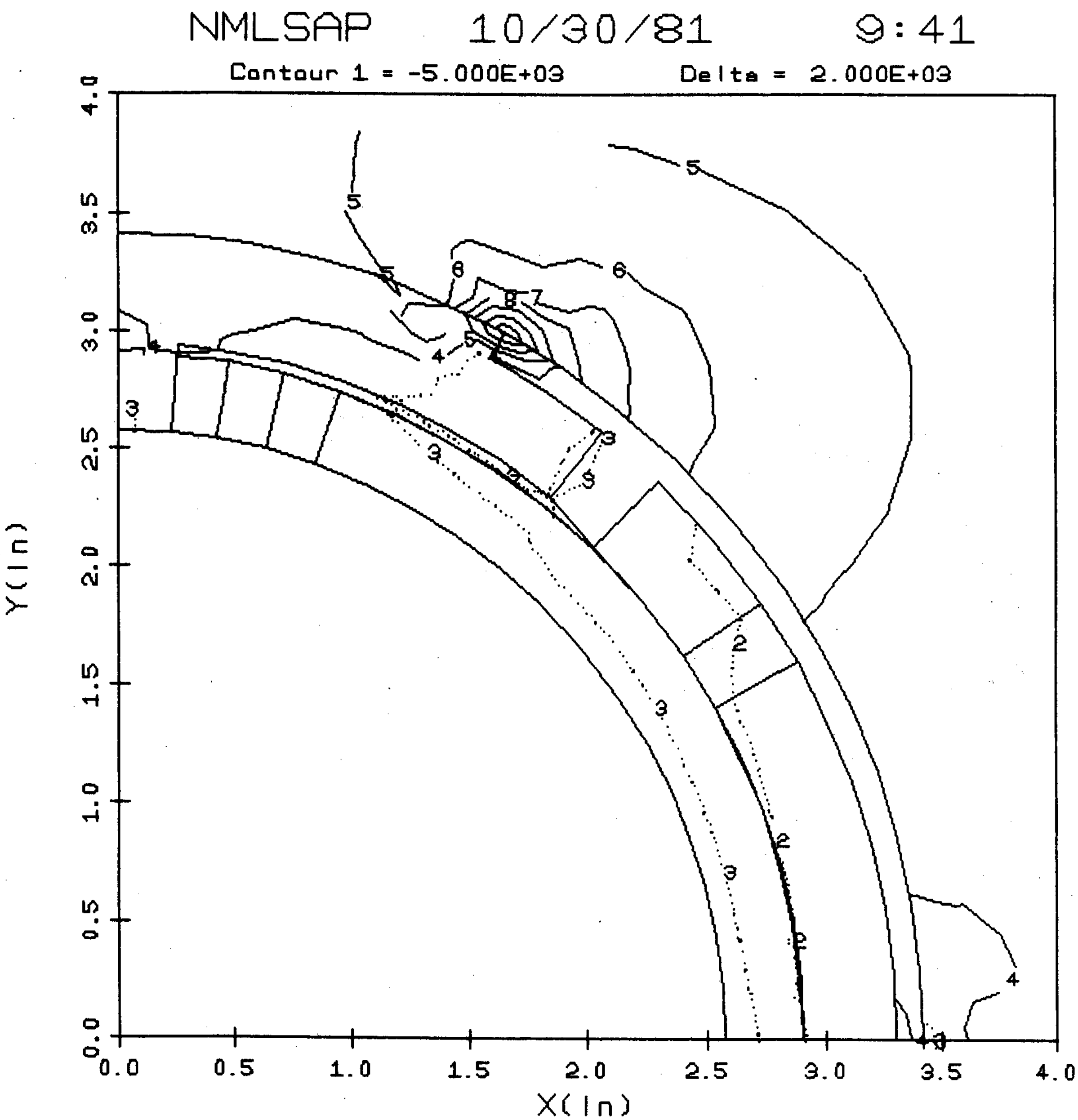


Figure 3.4.100 Contours of Constant SIG MAX

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

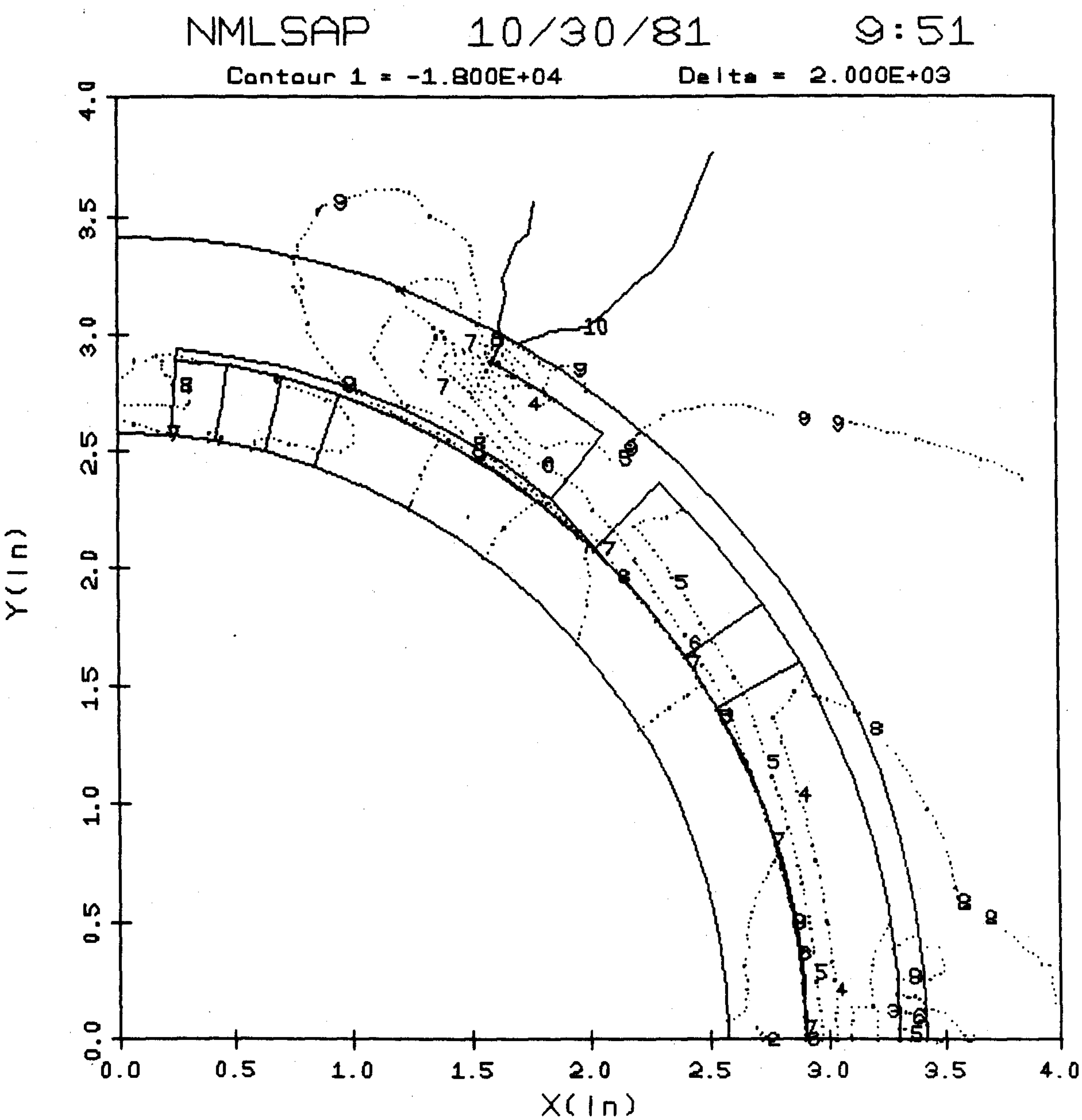


Figure 3.4.101 Contours of Constant SIG MIN

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

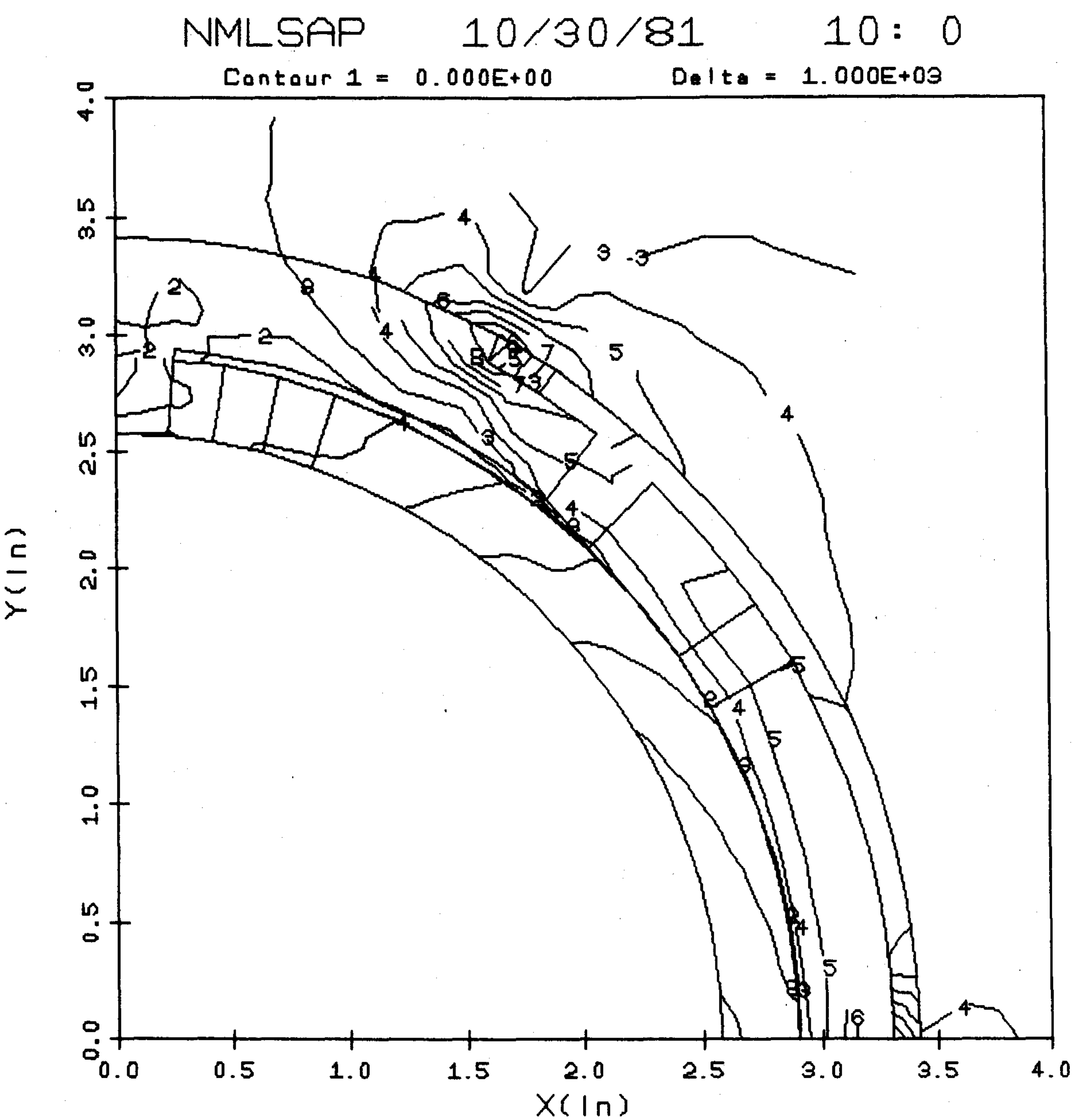


Figure 3.4.102 Contours of Constant TAU MAX

PALMER 2-LAYER DIPOLE MAGNET

TOTAL LOAD

3.4.4.3.3 Palmer Magnet Bolt Preload

The peak RT preload is envisioned to be 15 ksi average on the inner and outer coils per side which leads to a bolt force of 28,800 pounds (for 3 inch bolt spacing). The thread root working stress is taken to be 1/4 of the nominal RT ultimate tensile strength of 150 ksi, which is a typical value for 1/2 hard stainless steels. Therefore, the required root area is 28,800/37,500 or 0.77 square inches. That would require a nominal bolt diameter of 1.125 inches.

The stress level of 37.5 ksi is below 3/4 of the proportional limit stress which should ensure elastic behavior during preloading. The stress at 3/4 of the 60 ksi proportional limit satisfies the typical preloading procedure for good practice.

If it is desirable to have 500 psi minimum at the interface of the yoke halves, that would add 7,500 pounds to the bolt load, which would raise the preload stress 20 %.

3.4.4.4 Analysis of Danby Magnet

3.4.4.4.1 Simplified Stress-Deflection Analyses

A simple analysis of the window frame magnet was performed using NMLSAP. The program assumes linear elastic, homogeneous and isotropic material properties. The Lorentz body force densities for the main and graded saddle coils were used. The coil was divided into 24 elements over which these body force densities were assumed to be constant. No consideration was given to possible effects on the saddles of circumferential and radial forces along the straight sides. No cooldown or prestress was included.

Two cases were run. In both cases, the iron was assumed to be infinitely rigid. For the first case, the outer coil boundary was assumed to be fixed at all points - no motion in either direction. In the second case the outer coil boundary was allowed to move vertically (y-direction), but not horizontally (x-direction).

3.4.4.4.2 Results

The deformation (multiplied by 100) is shown in Figures 3.4.104 and 3.4.105. Figure 3.4.106 shows the shear stress on the surface. Also shown is the summation of the vertical Lorentz force per unit length (divided by the element height to give a stress) for comparison. The peak shear stress is 6.18 MPa (880 psi). The maximum deflection is 0.038 mm (0.0015 in).

Figure 3.4.107 displays the product of the normal stress and tangential displacement. The peak value is 1274 N/m, which corresponds to 4 J/m with a coefficient of friction of 0.3.

Although conservative, these analyses indicate that a stick-slip condition at the coil-iron interface would have a catastrophic effect on the winding.

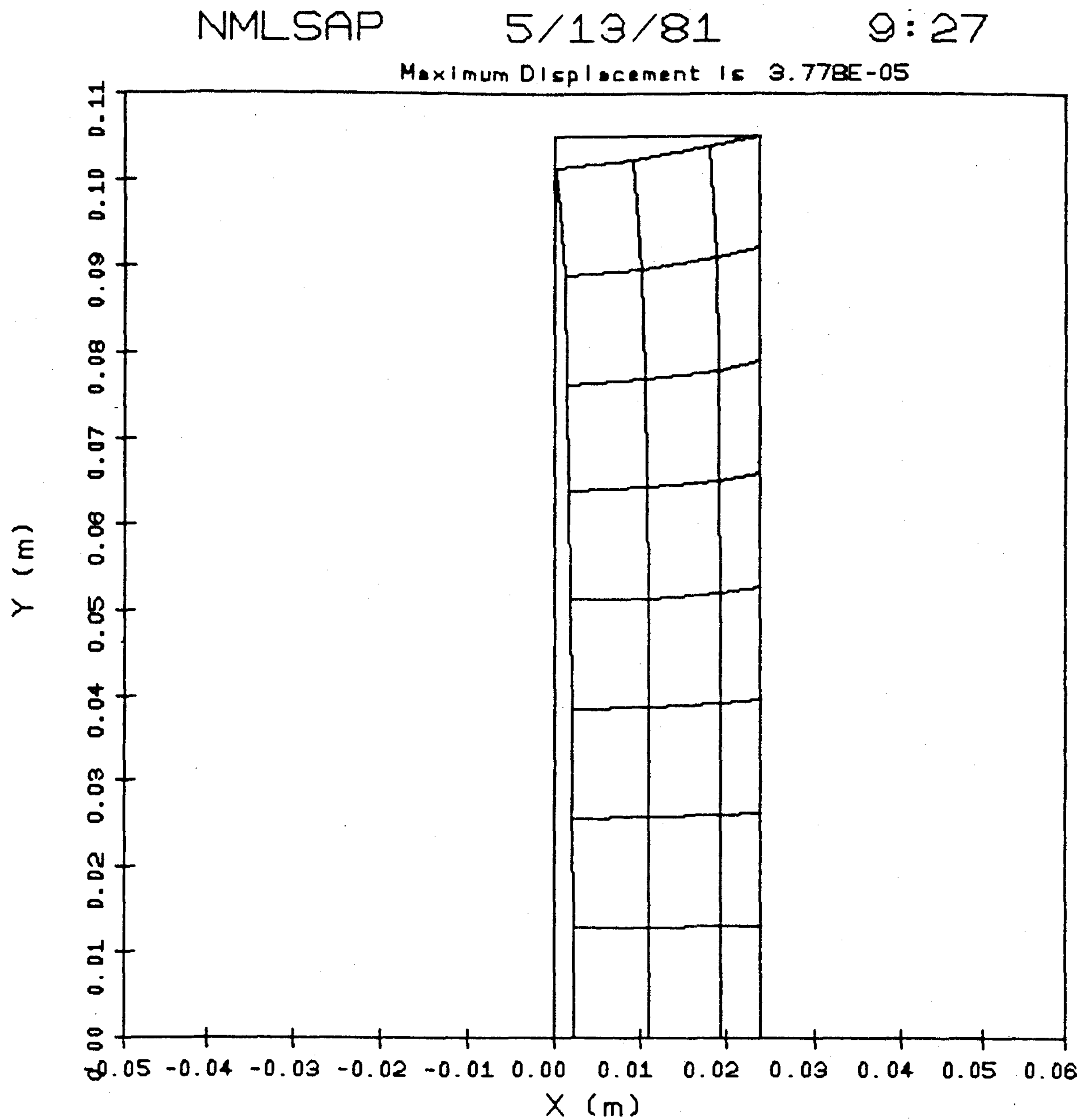


Figure 3.4.104 Deformed Grid

DANBY WINDOW FRAME MAGNET

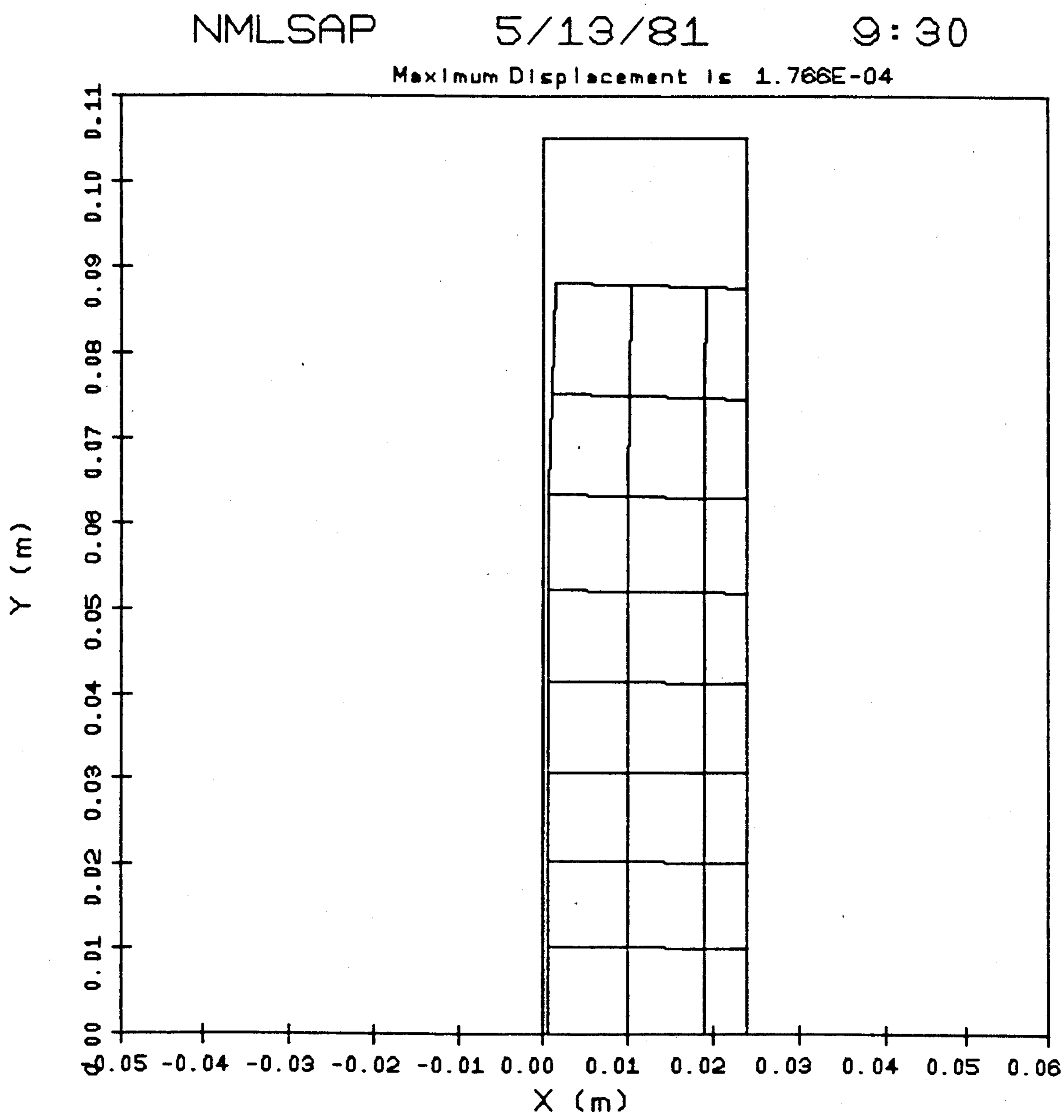


Figure 3.4.105 Deformed Grid

DANBY WINDOW FRAME MAGNET

Section 3.4 SYMBOLS

(In Basic Units: f, l, t)

A	Area (l^2)
a	Semi-major axis of contact ellipse between crossed wires (l)
b	Semi-minor axis of contact ellipse between crossed wires (l)
C	Coefficient in nonlinear stress-strain relation (f/l^2)
$\overline{C}$	Coefficient in creep law ($l^{2m}f^{-m}t^{-1}$)
C_1	Coefficient in nonlinear spring deflection law $(f/l^2)^r$
C_2	Coefficient in relaxation law (ft/l^2)
C_D	Coefficient in dashpot equation (ft/l^2)
d	Diameter of wire (l)
E	Young's modulus (f/l^2)
E_s	Secant modulus, σ/ϵ (f/l^2)
E_t	Tangent modulus, $d\sigma/d\epsilon$ (f/l^2)
H	Height of coil (l)
h	Thickness of layer in composite (l)
K	$1/C_1^r$
L	Length of beam (l)
m	Exponent in creep law
n	Exponent in nonlinear stress-strain relation
P	Force (f)
p	Pressure (f/l^2)
R	Radius at interface of outer coil and yoke (l)
r	Exponent in relaxation law
t	Time (t)
V	Shift of interface from midplane (l)
w	Width of test specimen (l)

x,y	Cartesian coordinates (l)
α	Ratio of tangent moduli, Figure 3.4.47
β	Coefficient ($fl^{-2}t^{-1}$)
Δ	Increment symbol
δ	Deflection (l)
ϵ	Strain
$\mathring{\epsilon}$	Strain rate (t^{-1})
$\mathring{\epsilon}_o$	Reference strain rate (t^{-1})
ϵ_D	Strain in dashpot
ϵ_L	Strain in lower coil
ϵ_l	Loading strain
ϵ_s	Strain in spring
ϵ_{TOT}	Total strain
ϵ_U	Strain in upper coil
ϵ_u	Unloading strain
θ	Angle
μ	Coefficient of friction
ν	Poisson's ratio, strain in given direction resulting from strain applied in perpendicular direction
ν_e	Elastic Poisson's ratio
ν_p	Plastic Poisson's ratio
σ	Stress (f/l^2)
σ_D	Stress in dashpot (f/l^2)
σ_s	Stress in spring (f/l^2)

3.4.7 REFERENCES

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3.5 Conductor Bundle Tolerance: Effects on Harmonic Coefficients

3.5.0 Introduction

This section documents the harmonic analyses performed to provide the data base for a study of design sensitivity to perturbations of the windings. These perturbations may arise either in the manufacturing process or due to thermal or electromagnetic loading. Results are tabulated and may be used to determine the changes in the harmonic coefficients due to a variety of perturbations.

Four design alternatives are considered. The baseline or ideal dimensions assumed for each case are defined. Then tables are presented which give the ideal coefficients and the perturbation in the ideal coefficients due to displacements of the boundaries of the windings. Both symmetric and asymmetric coil boundary placement errors are treated. Results may be superposed for estimation purposes.

The next section contains the equations which formed the basis for the analysis. This is followed by sections with the tabulated results for: (1) a five-block design; (2) a two-layer dipole; (3) a three-layer dipole with warm iron; and (4) a window frame or rectangular dipole.

3.5.1 Governing Equations

The governing equations for the harmonic analyses performed fall into three basic categories. The categories depend on the winding and iron shield geometries. The basic categories are: (1) a rectangular conductor or winding blocks in a circular cavity; (2) a circular winding in a circular cavity; and (3)

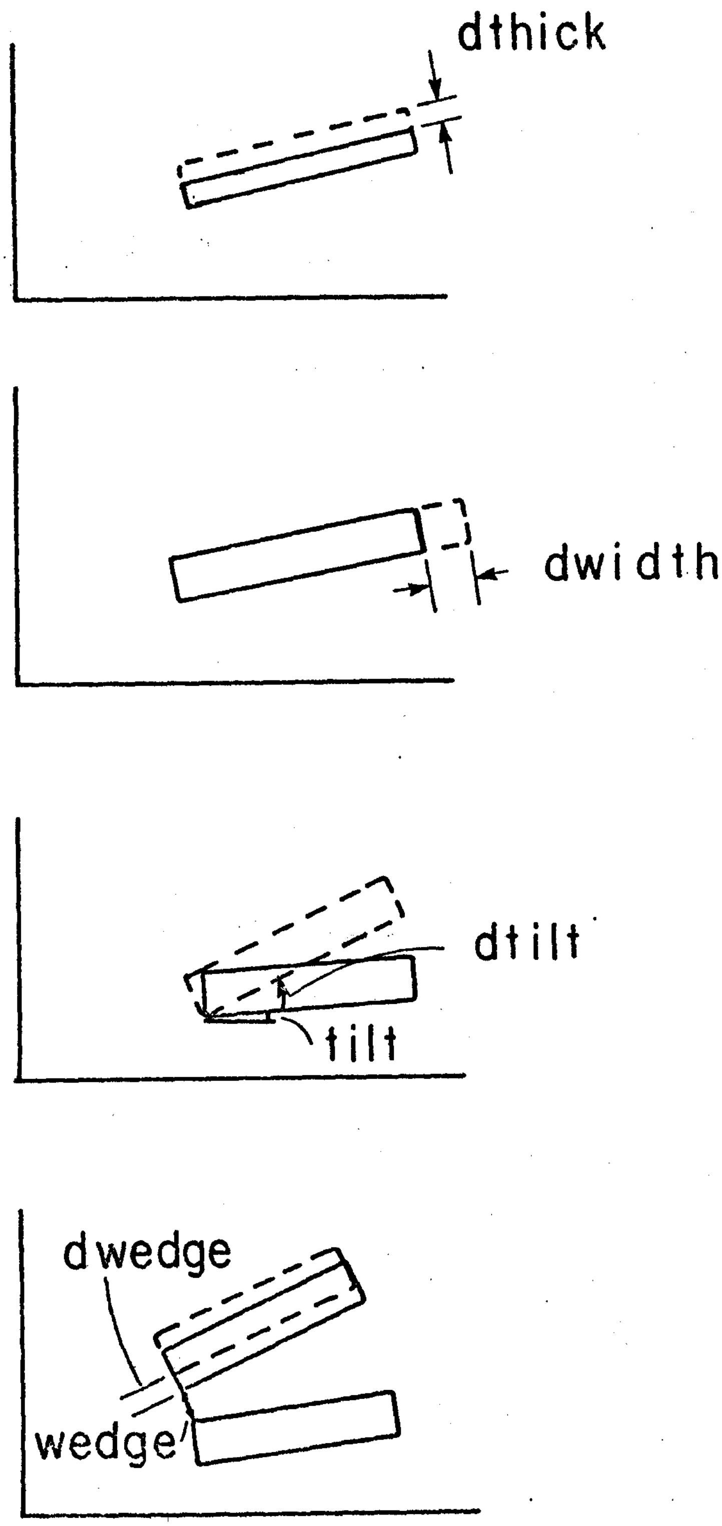

Figure 3.5. 5 Definition of Perturbations for the Five-Block Design

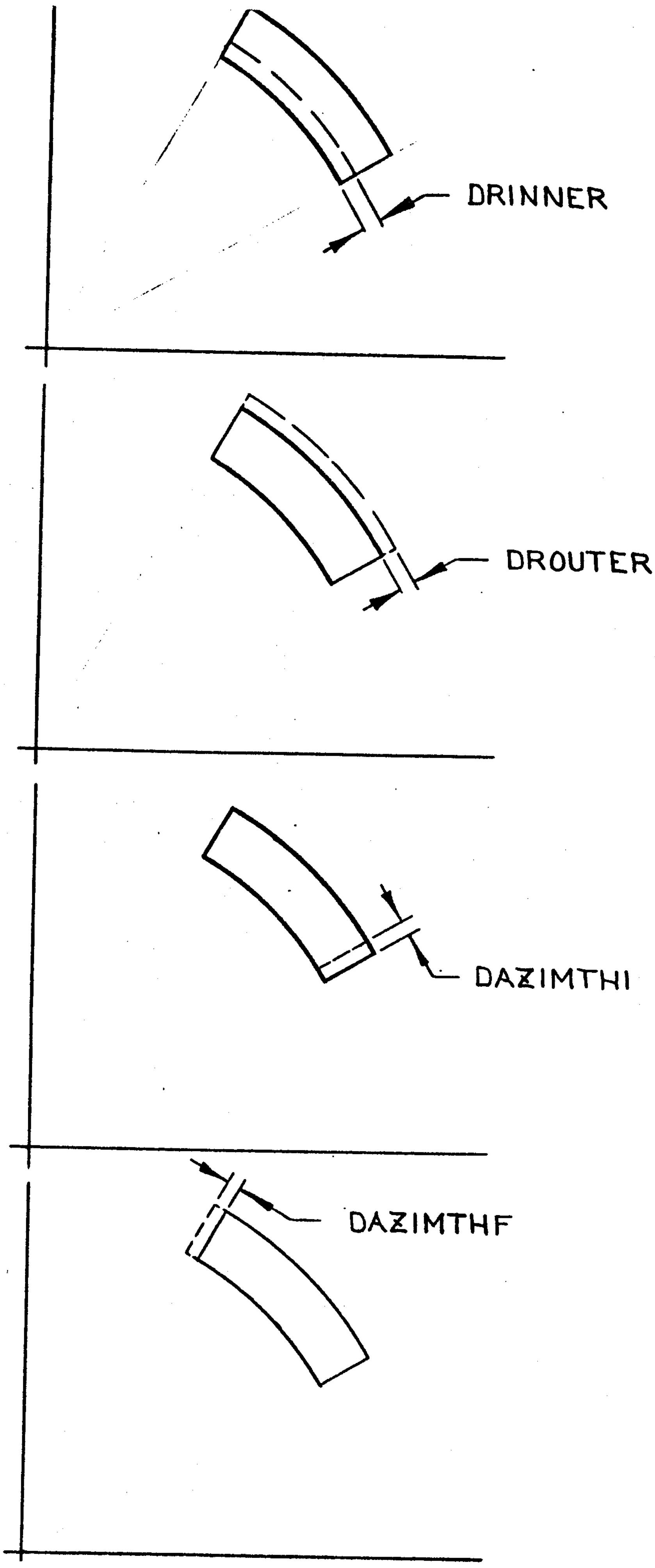

Figure 3.5.6 Definition of Perturbations for the Two and Three Layer Dipoles

Table 3.5.1

Definition of Symmetry Codes
(see Fig. 3.5.7 for + displacement definition)

Symmetry	Definition
1	+ displacement of region boundary in quadrant 1 only
2	+ displacement of region boundary in quadrant 2 only
3	+ displacement of region boundary in quadrant 3 only
4	+ displacement of region boundary in quadrant 4 only
5	+ displacement of region boundary in all 4 quadrants (e.g. - see Fig. 3.5.8)
ab	+ displacement of region boundary in quadrant a and in quadrant b (e.g. - see Fig. 3.5.9)
-ab	+ displacement of region boundary in quadrant a and - displacement of region boundary in quadrant b (e.g. - see Fig. 3.5.10)
1xx	a linear variation in the current density with respect to azimuthal position with the region. The value of drinner is the % change in λJ from the average value, e.g., an isym = 105 with drinner = .01 implies a perturbation in all four quadrants with Jfinal=1.01 Jave and Jinitial=.99 Jave.
200	Special code for perturbation of iron shield inner by an amount drinner. Perturbation is symmetric.

the circular dipoles. The notations drinner and drouter represent changes in the inner and outer radii, respectively. The notations dazimthi and dazimthf denote a movement of the initial and the final azimuthal boundaries of the region. Figure 3.5.7 shows the definition of the positive perturbations in each of the four quadrants. A radial perturbation is positive outward, and an azimuthal perturbation is positive away from the midplane and toward the post. As an example, Figure 3.5.8 shows the perturbed shape of a region with a positive dazimthi and a symmetry code of 5.

Perturbations for the window frame dipole are similar with the exception that instead of azimuthal movement of the region, a vertical movement is assumed as is shown in Figure 3.5.9. The variables drinner and drouter correspond to a horizontal motion of the inner and outer vertical boundaries. The variables dheighti and dheighto correspond to a vertical motion of the horizontal boundaries. A positive vertical perturbation is away from the midplane and a positive horizontal motion is away from the origin.

In all cases, the ampere-turns in the region being perturbed were assumed to be constant - e.g., the current density increases or decreases with the decrease or increase in the region cross-sectional area.

The ideal coefficients for each design were calculated, then the perturbations in the harmonic coefficients were calculated according to the following algorithm. The coefficients due to the unperturbed region(s) in question for the quadrants in question were found. Then the coefficients for the perturbed geometry and symmetries were calculated and the perturbation in coefficients taken to be:

$$db = b_{perturbed} - b_{unperturbed}$$

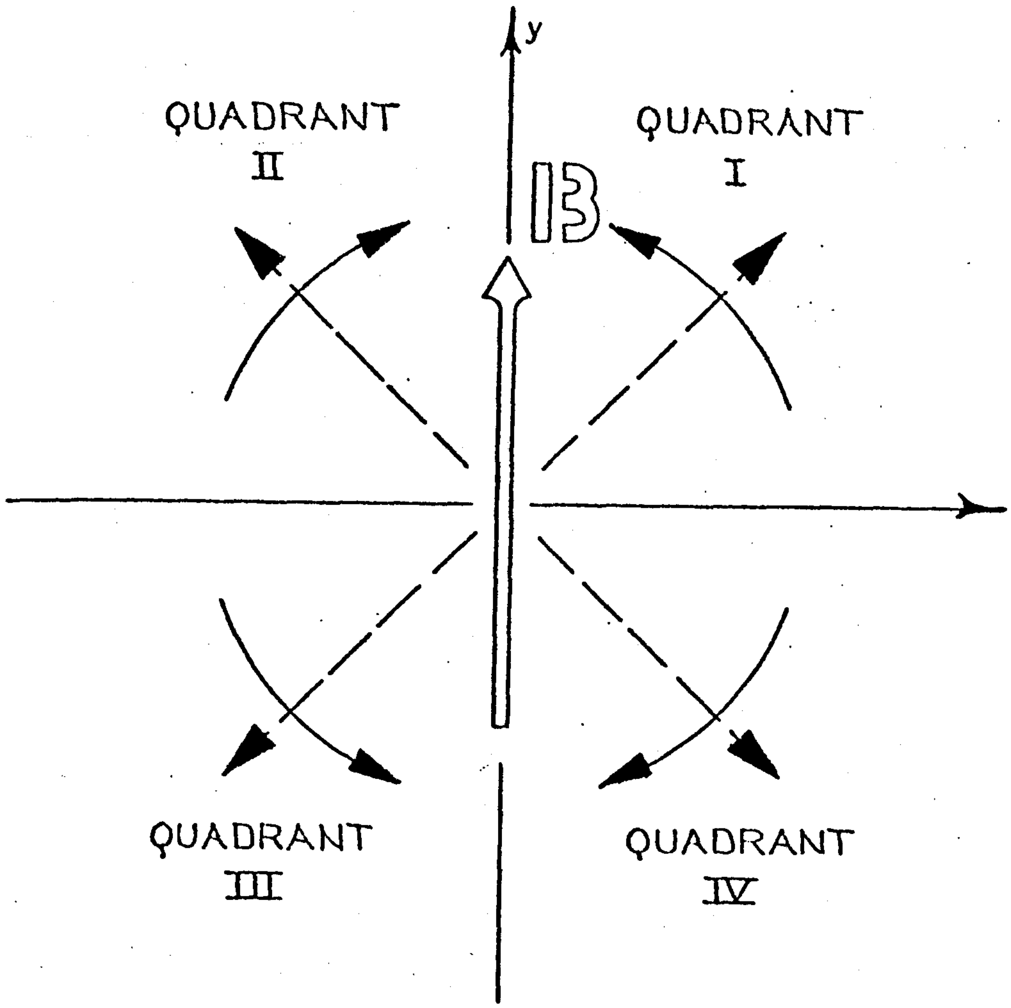

Figure 3.5.7 - Definition of positive directions for boundary displacements in each of the four quadrants

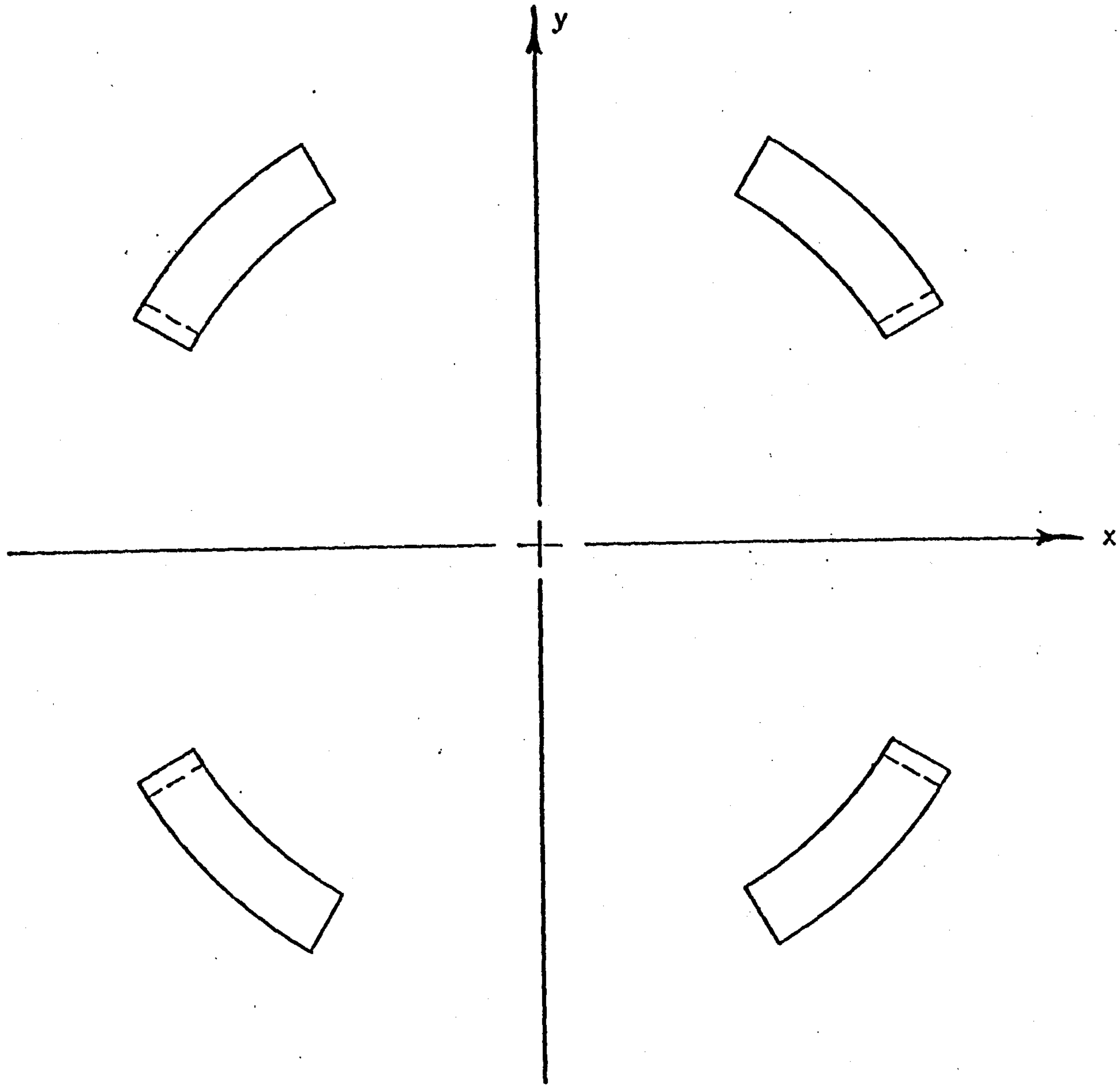

Figure 3.5.8 - Illustration of a +displacement for dazimthi with symmetry code 5.

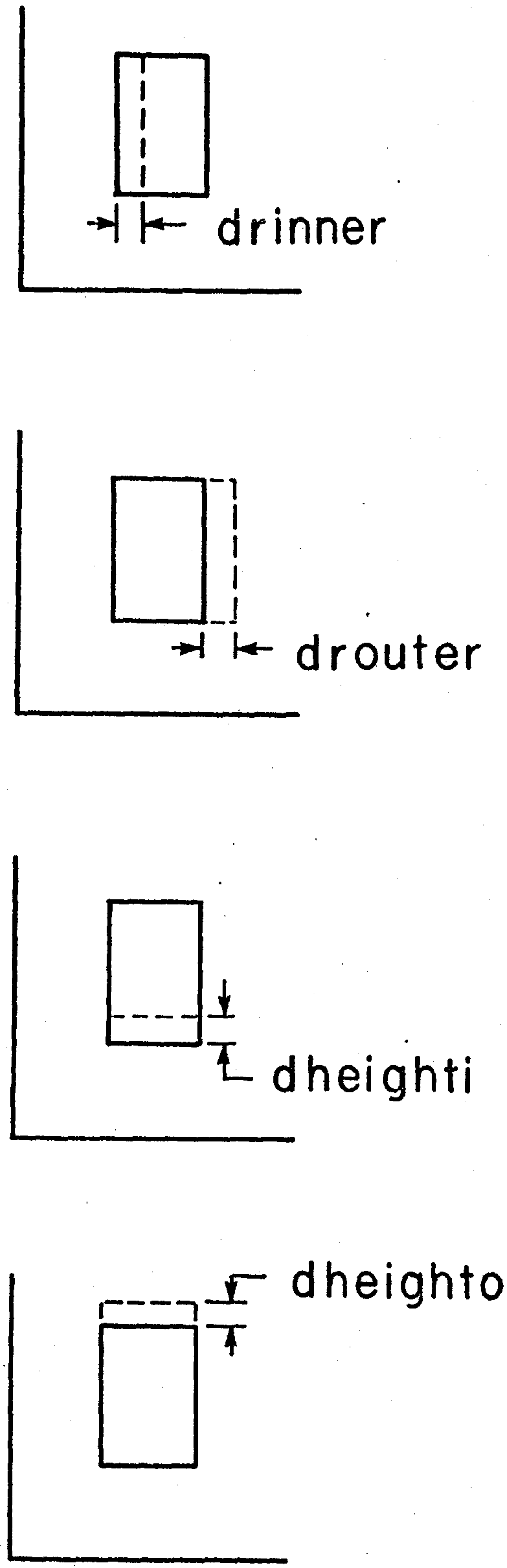

Figure 3.5.9 Definition of Perturbations for the Window Frame Dipole

Therefore, the total harmonic content of the design with the perturbation is the sum of the ideal and the perturbation.

3.5.3 Superposition of Results

Since the governing equations are linear for a constant permeability, the harmonic coefficients that arise from several current-carrying regions can be superposed. Similarly, perturbations to the geometries of the regions can also be superposed. In addition, the periodicity of the solution may be used to obtain values of the perturbations for symmetries other than those presented in the tables which follow. If a positive perturbation is applied to a current region in quadrant 1, then the effect on the harmonic coefficients for an equal perturbation in any of the other four quadrants can be found with the aid of Figure 3.5.10. For example, a positive motion of a boundary in quadrant 1 will produce perturbations in all coefficients - $b_0, b_1, b_2, \ldots$ as well as in $a_0, a_1, a_2, \ldots$. If the perturbation induced by the same motion in quadrant 4 is sought, Figure 3.5.10 indicates that the b's retain their signs and the a's change in sign. A superposition of the motion in both quadrants 1 and 4 will result, therefore, in the doubling of the first quadrant b's and a cancellation in the a's.

The perturbation in coefficients also appears to be fairly linear over the range of perturbations assumed. Although not always applicable, some superposition of this type is possible. Whenever feasible, the individual perturbations were run for a wide range of values to show linearity or its absence.

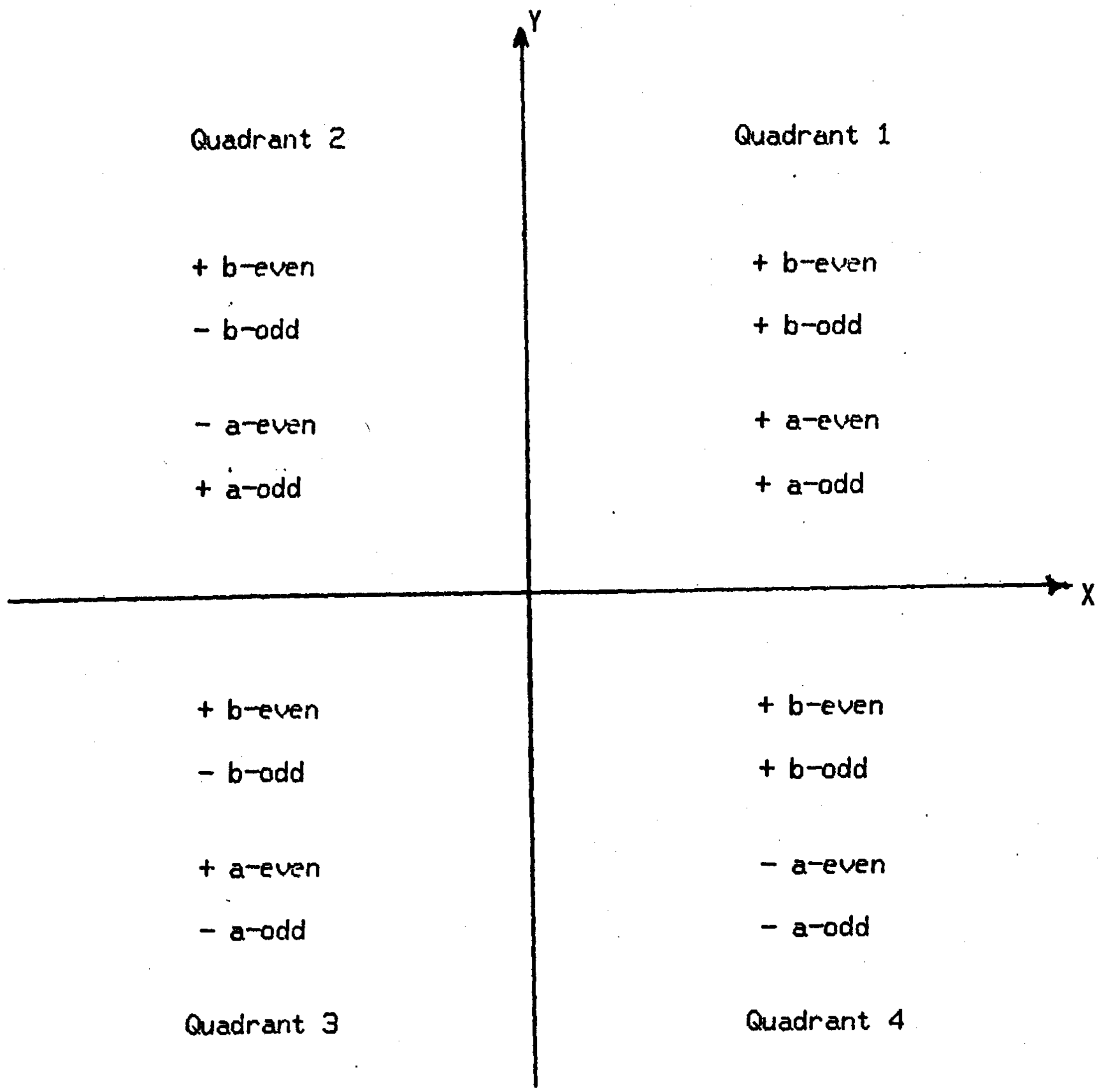

Figure 3.5.10 - Signs of Harmonic Coefficients for a Positive Displacement as a Function of Quadrant

3.5.4 Five-Block Dipole

The ideal winding cross section of the five-block dipole is shown in Figure 3.5.11 along with the iron inner boundary. The ideal block data used is shown in Table 3.5.2 which gives the block number, the number of turns in the block, the turn thickness and width, the tilt angle and the thickness of the wedge at the inner diameter surface. The blocks are numbered from the midplane to the post. Each of the 95 turns was placed in the correct location and the harmonic coefficients and their perturbations were calculated.

Table 3.5.2

Ideal Winding Block Locations for the Five-Block Dipole

Block Number	Number of Turns	Inner Radius (in)	Thickness Turn (in)	Width (in)	Tilt (Deg)	Wedge (in)	Current (Ampere)
1	25	2.5775	0.028	0.65	6.923	0.003	4160
2	25	2.5775	0.028	0.65	20.978	0.0005	4160
3	22	2.5775	0.028	0.65	44.022	0.1035	4160
4	12	2.5775	0.056	0.65	58.076	0.0005	4160
5	11	2.5775	0.056	0.65	72.132	0.0005	4160

Radius of the iron = 8.635 cm.

The fundamental dipole coefficient, b_0, computed on the basis of this data was 5.848 T. The transfer function is then 14.06 G/A. All other coefficients and their perturbations are presented in Table 3.5.3 and are normalized to the fundamental and a radius of 4.4 cm.

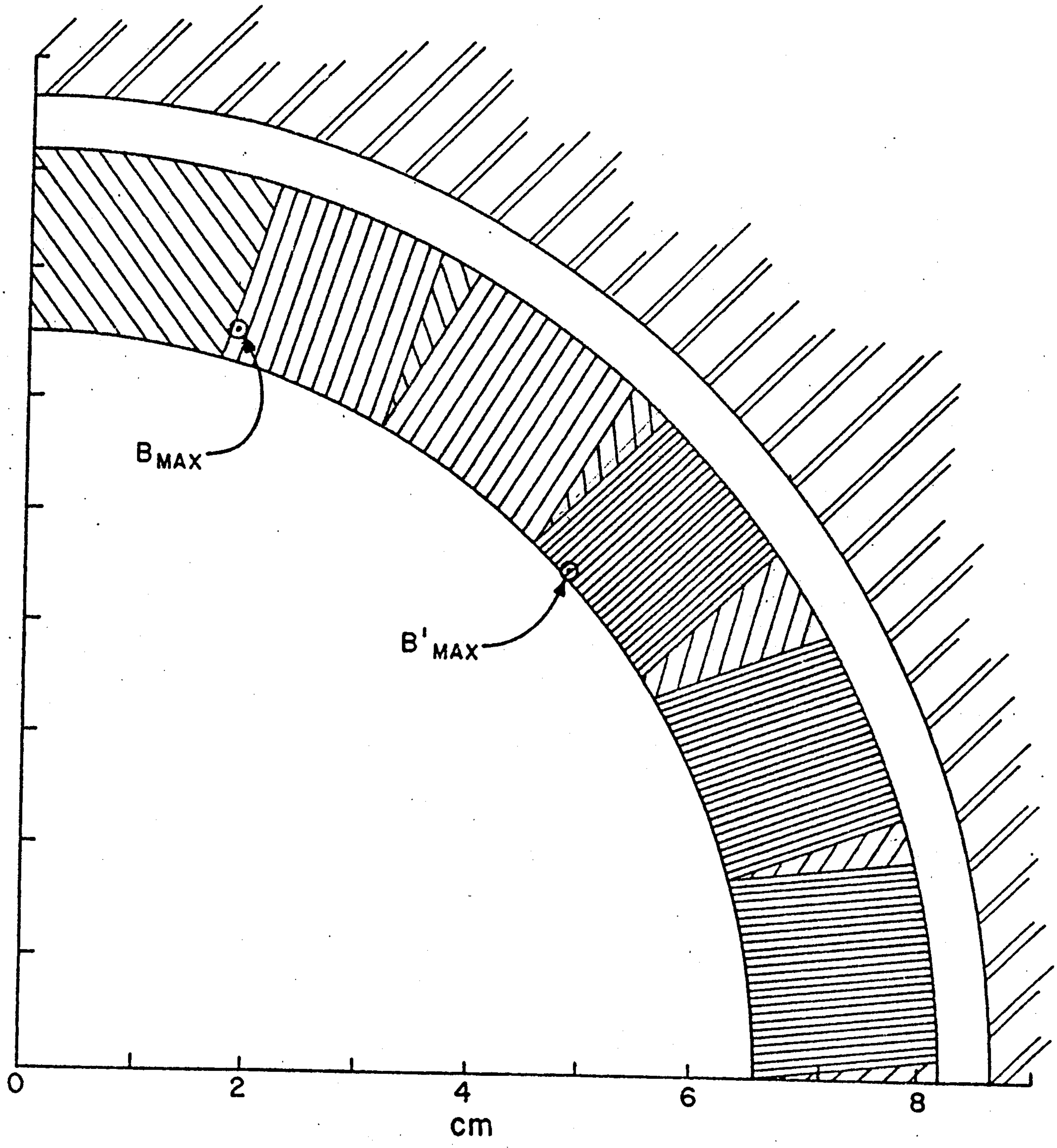

Figure 3.5.11 Five-Block Dipole Design

Each of the major parameters in Table 3.5.2 was varied for a range of perturbations and for several symmetry codes. Since the five-block dipole is treated by building up the location of each turn from the location of the preceding turn, a perturbation in turn thickness in block 1 will cause all other blocks to shift their location.

Each column in Table 3.5.3 corresponds to a specific case. The first column labeled "bideal" gives the first fourteen normalized coefficients for the ideal, unperturbed case. Columns two to nine are labeled "db" and "da" and give the changes in the coefficients as a result of the perturbation defined by the six lines at the top of the column. The first line defines the blocks which have been perturbed. The next four lines define the magnitude of the perturbation and the fifth line gives the symmetry code. The latter defines the quadrants which are affected.

The first perturbations are for an increase in turn thickness for turns in blocks 1, 2 and 3. The perturbation was assumed to occur in quadrants 1 and 2, since an increase in thickness would occur in the entire half coil wound with the oversized conductor. Increases in thickness from 0.2 to 2 mils were run. Similar increases in thickness for turns in blocks 4 and 5 with symmetry 12 were also run. Finally, an increase in thickness in blocks 1, 2, and 3 and then in 4 and 5 were run with a full four-quadrant symmetry assumption. In all cases, it can be seen that the perturbations in the coefficients are relatively linear with thickness increase for the range studied.

The next set of perturbations was for a 1 mil increase in turn thickness for turns in all blocks. This increase was applied to each quadrant separately to aid in superposition.

block(s)	=	123	123	123	123	45	45	45	45
dthick	(in)=	2.000D-04	5.000D-04	1.000D-03	2.000D-03	2.000D-04	5.000D-04	1.000D-03	2.000D-03
dwidth	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt	( )=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwedge	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	12	12	12	12	12	12	12	12

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.277D-03	3.207D-03	6.462D-03	1.312D-02	1.109D-04	2.779D-04	5.566D-04	1.115D-03
1	0.000D+00	1.692D+01	4.231D+01	8.466D+01	1.695D+02	9.174D-01	2.286D+00	4.563D+00	9.073D+00
2	-6.106D+01	7.984D+00	1.975D+01	3.876D+01	7.452D+01	-3.543D-01	-8.876D-01	-1.797D+00	-3.665D+00
3	0.000D+00	4.358D-01	8.839D-01	1.098D+00	-4.659D-01	-7.195D-01	-1.798D+00	-3.595D+00	-7.179D+00
4	2.549D+00	-1.162D+00	-2.953D+00	-6.061D+00	-1.261D+01	-2.060D-01	-5.097D-01	-1.003D+00	-1.938D+00
5	0.000D+00	-2.573D-01	-6.132D-01	-1.118D+00	-1.740D+00	2.151D-01	5.401D-01	1.088D+00	2.205D+00
6	3.304D+00	1.913D-01	4.958D-01	1.049D+00	2.313D+00	1.878D-01	4.675D-01	9.288D-01	1.831D+00
7	0.000D+00	2.153D-02	5.121D-02	9.179D-02	1.262D-01	7.688D-04	-3.675D-04	-8.330D-03	-4.665D-02
8	2.845D-02	-7.655D-02	-1.887D-01	-3.682D-01	-6.961D-01	-7.038D-02	-1.760D-01	-3.527D-01	-7.041D-01
9	0.000D+00	2.991D-02	8.357D-02	1.960D-01	5.029D-01	-2.864D-02	-7.047D-02	-1.371D-01	-2.589D-01
10	1.159D-01	1.034D-01	2.598D-01	5.214D-01	1.032D+00	1.407D-02	3.571D-02	7.306D-02	1.525D-01
11	0.000D+00	5.162D-02	1.210D-01	2.137D-01	3.044D-01	1.459D-02	3.614D-02	7.115D-02	1.376D-01
12	-2.185D+00	-2.719D-02	-7.561D-02	-1.758D-01	-4.407D-01	-5.092D-04	-1.642D-03	-4.498D-03	-1.372D-02
13	0.000D+00	-4.851D-02	-1.224D-01	-2.470D-01	-4.875D-01	-5.312D-03	-1.327D-02	-2.648D-02	-5.252D-02
14	5.008D-01	-2.447D-02	-5.821D-02	-1.056D-01	-1.626D-01	-1.086D-03	-2.541D-03	-4.508D-03	-6.720D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.855D-07	2.654D-07	2.084D-07	2.897D-07	2.571D-07	2.597D-07	2.509D-07	2.497D-07
1	0.000D+00	1.500D-04	1.848D-04	1.389D-04	1.375D-04	2.003D-04	1.644D-04	1.847D-04	1.389D-04
2	0.000D+00	-6.892D-05	-2.716D-05	-2.106D-04	-9.684D-05	-1.169D-04	-1.444D-04	-1.274D-04	-1.318D-04
3	0.000D+00	2.910D-05	2.659D-05	3.520D-05	3.981D-05	1.513D-05	1.421D-05	1.772D-05	2.032D-05
4	0.000D+00	4.830D-06	3.268D-06	-3.531D-06	-3.383D-06	-8.501D-07	-2.075D-06	-1.067D-06	-2.578D-06
5	0.000D+00	-5.292D-06	-2.993D-06	-5.203D-06	-4.398D-06	-7.020D-06	-7.374D-06	-6.976D-06	-7.184D-06
6	0.000D+00	-1.950D-06	-3.968D-06	-3.605D-07	-7.503D-07	-2.965D-06	-2.737D-06	-3.149D-06	-2.678D-06
7	0.000D+00	3.595D-07	2.229D-07	-4.757D-07	2.332D-07	7.050D-07	5.440D-07	5.335D-07	6.306D-07
8	0.000D+00	-3.922D-08	5.608D-08	-7.153D-07	-6.812D-07	-5.557D-07	-6.018D-07	-5.410D-07	-5.373D-07
9	0.000D+00	-1.286D-07	9.507D-08	-1.693D-07	-2.264D-08	-1.412D-07	-1.533D-07	-1.323D-07	-1.365D-07
10	0.000D+00	2.597D-08	-2.200D-07	-8.415D-08	-7.074D-08	-1.036D-07	-1.402D-07	-1.136D-07	-1.115D-07
11	0.000D+00	-9.121D-08	-6.670D-08	-6.172D-08	-1.272D-08	-9.746D-08	-5.725D-08	-6.899D-08	-8.330D-08
12	0.000D+00	-3.132D-08	-4.757D-08	-6.461D-08	-7.035D-08	-2.392D-08	-3.200D-08	-2.777D-08	-3.141D-08
13	0.000D+00	-4.173D-08	-4.471D-08	-3.095D-08	-5.268D-08	-3.700D-08	-3.077D-08	-3.684D-08	-3.049D-08
14	0.000D+00	-1.619D-08	-3.069D-08	-2.439D-08	-1.433D-08	-2.611D-08	-2.427D-08	-2.349D-08	-2.373D-08

Table 3.5.3 Five Block Dipole Perturbation Effects

block(s) =		123	123	123	123	45	45	45	45
dthick (in)=		2.000D-04	5.000D-04	1.000D-03	2.000D-03	2.000D-04	5.000D-04	1.000D-03	2.000D-03
dwidth (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt ( )=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwedge (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		5	5	5	5	5	5	5	5
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.555D-03	6.415D-03	1.293D-02	2.623D-02	2.276D-04	5.567D-04	1.114D-03	2.231D-03
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-6.106D+01	1.597D+01	3.949D+01	7.754D+01	1.490D+02	-7.068D-01	-1.778D+00	-3.591D+00	-7.328D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	2.549D+00	-2.323D+00	-5.907D+00	-1.212D+01	-2.521D+01	-4.115D-01	-1.019D+00	-2.005D+00	-3.876D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	3.304D+00	3.628D-01	9.919D-01	2.097D+00	4.626D+00	3.756D-01	9.353D-01	1.858D+00	3.662D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	2.645D-02	-1.531D-01	-3.773D-01	-7.363D-01	-1.392D+00	-1.408D-01	-3.520D-01	-7.042D-01	-1.408D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	1.159D-01	2.069D-01	5.197D-01	1.043D+00	2.064D+00	2.815D-02	7.139D-02	1.462D-01	3.052D-01
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	-2.185D+00	-5.439D-02	-1.512D-01	-3.515D-01	-8.814D-01	-1.017D-03	-3.282D-03	-8.993D-03	-2.744D-02
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	5.008D-01	-4.892D-02	-1.164D-01	-2.113D-01	-3.253D-01	-2.170D-03	-5.082D-03	-9.015D-03	-1.344D-02
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.3 Cont.

block(s) =	12345	12345	12345	12345	1	1	1	1
dthick (in)=	1.000D-03	1.000D-03	1.000D-03	1.000D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt ( )=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwedge (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	1.000D-03	2.000D-03	3.000D-03	5.000D-03
symmetry =	1	2	3	4	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	3.513D-03	3.513D-03	3.513D-03	3.513D-03	2.194D-04	4.391D-04	6.590D-04	1.100D-03
1	0.000D+00	4.453D+01	4.453D+01	-4.448D+01	-4.448D+01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-6.106D+01	1.831D+01	1.831D+01	1.831D+01	1.831D+01	1.981D+00	3.959D+00	5.938D+00	9.897D+00
3	0.000D+00	-1.251D+00	-1.251D+00	1.251D+00	1.251D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	2.549D+00	-3.390D+00	-3.390D+00	-3.390D+00	-3.390D+00	3.045D-01	6.087D-01	9.130D-01	1.521D+00
5	0.000D+00	6.773D-02	6.773D-02	-6.771D-02	-6.771D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	3.304D+00	9.506D-01	9.506D-01	9.506D-01	9.506D-01	1.879D-01	3.758D-01	5.638D-01	9.397D-01
7	0.000D+00	-2.098D-02	-2.098D-02	2.099D-02	2.099D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	2.845D-02	-3.706D-01	-3.706D-01	-3.706D-01	-3.706D-01	4.441D-02	8.881D-02	1.332D-01	2.220D-01
9	0.000D+00	5.350D-02	5.350D-02	-5.350D-02	-5.350D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	1.159D-01	3.111D-01	3.111D-01	3.111D-01	3.111D-01	3.579D-02	7.158D-02	1.074D-01	1.790D-01
11	0.000D+00	1.373D-01	1.373D-01	-1.373D-01	-1.373D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	-2.185D+00	-9.730D-02	-9.730D-02	-9.730D-02	-9.730D-02	4.338D-03	8.625D-03	1.286D-02	2.119D-02
13	0.000D+00	-1.364D-01	-1.364D-01	1.364D-01	1.364D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	5.008D-01	-5.187D-02	-5.187D-02	-5.187D-02	-5.187D-02	-7.146D-04	-1.416D-03	-2.103D-03	-3.438D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-3.489D-03	3.489D-03	-3.489D-03	3.489D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	5.883D-01	-5.878D-01	-5.878D-01	5.883D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	1.977D+01	-1.977D+01	1.977D+01	-1.977D+01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	1.225D+01	-1.225D+01	-1.225D+01	1.225D+01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	1.793D+00	-1.793D+00	1.793D+00	-1.793D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	-7.613D-01	7.613D-01	7.613D-01	-7.613D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	4.877D-01	-4.877D-01	4.877D-01	-4.877D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	7.924D-01	-7.924D-01	-7.924D-01	7.924D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	6.732D-02	-6.732D-02	6.732D-02	-6.732D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	-2.625D-01	2.625D-01	2.625D-01	-2.625D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	3.576D-03	-3.576D-03	3.576D-03	-3.576D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	2.475D-01	-2.475D-01	-2.475D-01	2.475D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	1.870D-01	-1.870D-01	1.870D-01	-1.870D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
13	0.000D+00	1.489D-02	-1.489D-02	-1.489D-02	1.489D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	0.000D+00	-6.222D-02	6.222D-02	-6.222D-02	6.222D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.3 Cont.

block(s)	=	1	1	1	1	1	1	1	1
dthick	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt	( )=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwedge	(in)=	1.000D-03	2.000D-03	3.000D-03	5.000D-03	1.000D-03	2.000D-03	3.000D-03	5.000D-03
symmetry	=	14	14	14	14	23	23	23	23

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.092D-04	2.191D-04	3.291D-04	5.493D-04	1.092D-04	2.191D-04	3.291D-04	5.493D-04
1	0.000D+00	1.261D-03	1.335D-03	1.483D-03	1.115D-03	1.790D-03	1.777D-03	1.651D-03	1.606D-03
2	-6.106D+01	9.887D-01	1.979D+00	2.968D+00	4.946D+00	9.887D-01	1.979D+00	2.968D+00	4.946D+00
3	0.000D+00	1.354D-04	1.302D-04	1.399D-04	1.407D-04	1.228D-04	1.380D-04	1.308D-04	1.352D-04
4	2.549D+00	1.521D-01	3.042D-01	4.563D-01	7.605D-01	1.521D-01	3.043D-01	4.565D-01	7.605D-01
5	0.000D+00	1.441D-05	2.081D-05	1.634D-05	1.883D-05	1.250D-05	8.577D-06	1.015D-05	1.115D-05
6	3.304D+00	9.390D-02	1.879D-01	2.819D-01	4.699D-01	9.390D-02	1.879D-01	2.819D-01	4.699D-01
7	0.000D+00	1.434D-06	2.319D-06	2.129D-06	2.031D-06	2.571D-06	1.744D-06	2.057D-06	2.048D-06
8	2.845D-02	2.220D-02	4.439D-02	6.659D-02	1.110D-01	2.220D-02	4.439D-02	6.659D-02	1.110D-01
9	0.000D+00	9.599D-07	8.753D-07	1.056D-06	1.106D-06	9.043D-07	1.040D-06	9.674D-07	8.635D-07
10	1.159D-01	1.789D-02	3.579D-02	5.369D-02	8.948D-02	1.789D-02	3.579D-02	5.369D-02	8.948D-02
11	0.000D+00	3.023D-07	2.458D-07	2.652D-07	2.827D-07	2.378D-07	2.232D-07	2.281D-07	2.233D-07
12	-2.185D+00	2.168D-03	4.312D-03	6.429D-03	1.060D-02	2.168D-03	4.312D-03	6.429D-03	1.060D-02
13	0.000D+00	1.759D-08	-4.416D-09	1.126D-08	-4.508D-08	4.659D-09	2.806D-08	1.485D-08	4.156D-08
14	5.008D-01	-3.575D-04	-7.080D-04	-1.052D-03	-1.720D-03	-3.575D-04	-7.080D-04	-1.052D-03	-1.720D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.462D-07	2.580D-07	2.259D-07	1.506D-07	2.603D-07	2.103D-07	2.686D-07	2.811D-07
1	0.000D+00	-7.836D-01	-1.568D+00	-2.351D+00	-3.913D+00	7.845D-01	1.569D+00	2.351D+00	3.913D+00
2	0.000D+00	-1.183D-04	-8.458D-05	-1.087D-04	-5.523D-05	-8.255D-05	-4.825D-05	-7.297D-05	-1.316D-04
3	0.000D+00	1.285D-01	2.578D-01	3.877D-01	6.494D-01	-1.285D-01	-2.578D-01	-3.876D-01	-6.494D-01
4	0.000D+00	7.166D-06	4.798D-06	5.274D-06	9.730D-06	-9.202D-06	-6.064D-06	9.734D-07	-1.283D-05
5	0.000D+00	-3.387D-02	-6.753D-02	-1.009D-01	-1.671D-01	3.387D-02	6.752D-02	1.009D-01	1.669D-01
6	0.000D+00	-5.222D-07	-2.622D-06	-6.805D-07	-4.812D-07	-2.552D-06	-1.422D-06	-1.422D-06	-1.955D-06
7	0.000D+00	9.901D-03	1.994D-02	3.012D-02	5.089D-02	-9.901D-03	-1.993D-02	-3.012D-02	-5.089D-02
8	0.000D+00	-2.218D-07	-3.443D-07	-1.402D-07	-2.050D-07	-7.960D-07	-5.600D-07	-5.213D-07	-5.952D-07
9	0.000D+00	-5.875D-03	-1.168D-02	-1.742D-02	-2.872D-02	5.875D-03	1.168D-02	1.742D-02	2.872D-02
10	0.000D+00	-1.364D-08	-5.426D-08	6.663D-08	5.758D-08	-2.505D-07	-1.600D-07	-2.079D-07	-2.285D-07
11	0.000D+00	5.805D-03	1.166D-02	1.756D-02	2.949D-02	-5.805D-03	-1.166D-02	-1.756D-02	-2.949D-02
12	0.000D+00	-2.779D-08	-1.170D-08	-2.006D-08	2.929D-08	-7.424D-08	-5.297D-08	-6.629D-08	-7.508D-08
13	0.000D+00	1.108D-03	2.210D-03	3.308D-03	5.488D-03	-1.108D-03	-2.210D-03	-3.308D-03	-5.488D-03
14	0.000D+00	-1.549D-08	-2.301D-10	-1.523D-08	-1.201D-08	-2.762D-08	-4.933D-08	-3.159D-08	-2.415D-08

Table 3.5.3 Cont.

block(s)	=	1	1	1	1	1	1	1	1
dthick	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt	( )=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwedge	(in)=	1.000D-03	2.000D-03	3.000D-03	5.000D-03	1.000D-03	2.000D-03	3.000D-03	5.000D-03
symmetry	=	-14	-14	-14	-14	-23	-23	-23	-23

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-5.266D-07	-3.739D-07	-1.574D-07	5.912D-07	-5.309D-07	-3.355D-07	-1.053D-07	5.699D-07
1	0.000D+00	1.587D+00	3.172D+00	4.756D+00	7.929D+00	1.588D+00	3.173D+00	4.756D+00	7.929D+00
2	-6.106D+01	-5.901D-04	-4.559D-04	-2.037D-04	8.482D-04	-6.195D-04	-5.901D-04	-3.866D-04	8.364D-04
3	0.000D+00	3.775D-01	7.547D-01	1.132D+00	1.887D+00	3.775D-01	7.547D-01	1.132D+00	1.887D+00
4	2.549D+00	-1.097D-04	-2.020D-04	-3.052D-04	-6.788D-04	-1.044D-04	-1.903D-04	-2.998D-04	-6.612D-04
5	0.000D+00	1.225D-01	2.451D-01	3.674D-01	6.125D-01	1.225D-01	2.451D-01	3.674D-01	6.125D-01
6	3.304D+00	-1.368D-05	1.892D-05	7.062D-05	2.191D-04	-1.509D-05	2.036D-05	7.219D-05	2.168D-04
7	0.000D+00	4.792D-02	9.585D-02	1.438D-01	2.396D-01	4.792D-02	9.585D-02	1.438D-01	2.396D-01
8	2.845D-02	-9.817D-06	-1.455D-05	-2.342D-05	-4.608D-05	-9.775D-06	-1.510D-05	-2.419D-05	-4.619D-05
9	0.000D+00	1.901D-02	3.801D-02	5.702D-02	9.501D-02	1.901D-02	3.801D-02	5.702D-02	9.501D-02
10	1.159D-01	-9.663D-07	2.956D-06	1.015D-05	3.470D-05	-8.762D-07	2.850D-06	1.001D-05	3.460D-05
11	0.000D+00	1.034D-02	2.068D-02	3.102D-02	5.168D-02	1.034D-02	2.068D-02	3.102D-02	5.168D-02
12	-2.185D+00	-1.255D-05	-4.952D-05	-1.102D-04	-3.048D-04	-1.255D-05	-4.953D-05	-1.103D-04	-3.049D-04
13	0.000D+00	-1.050D-03	-2.099D-03	-3.149D-03	-5.248D-03	-1.050D-03	-2.099D-03	-3.149D-03	-5.248D-03
14	5.008D-01	3.000D-06	1.307D-05	2.977D-05	8.311D-05	3.016D-06	1.308D-05	2.979D-05	8.312D-05

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.729D-04	-3.458D-04	-5.189D-04	-8.650D-04	1.734D-04	3.462D-04	5.193D-04	8.655D-04
1	0.000D+00	1.849D-03	3.831D-03	6.116D-03	1.511D-02	-1.381D-03	-3.084D-03	-5.680D-03	-1.468D-02
2	0.000D+00	2.674D-02	5.330D-02	8.017D-02	1.339D-01	-2.697D-02	-5.351D-02	-8.044D-02	-1.341D-01
3	0.000D+00	2.232D-04	1.164D-03	2.786D-03	7.902D-03	-2.048D-04	-1.160D-03	-2.734D-03	-7.641D-03
4	0.000D+00	2.591D-03	5.210D-03	7.774D-03	1.295D-02	-2.605D-03	-5.210D-03	-7.774D-03	-1.295D-02
5	0.000D+00	1.267D-04	4.768D-04	1.092D-03	3.048D-03	-1.381D-04	-4.916D-04	-1.105D-03	-3.059D-03
6	0.000D+00	-3.623D-03	-7.245D-03	-1.086D-02	-1.811D-02	3.619D-03	7.242D-03	1.066D-02	1.810D-02
7	0.000D+00	7.490D-05	2.904D-04	6.516D-04	1.790D-03	-7.417D-05	-2.885D-04	-6.513D-04	-1.789D-03
8	0.000D+00	-2.505D-04	-5.066D-04	-7.540D-04	-1.259D-03	2.496D-04	5.055D-04	7.531D-04	1.259D-03
9	0.000D+00	3.122D-05	1.302D-04	2.931D-04	8.141D-04	-3.121D-05	-1.306D-04	-2.935D-04	-8.141D-04
10	0.000D+00	-1.304D-04	-2.604D-04	-3.908D-04	-6.519D-04	1.302D-04	2.603D-04	3.906D-04	6.516D-04
11	0.000D+00	2.310D-05	9.267D-05	2.079D-04	5.784D-04	-2.328D-05	-9.292D-05	-2.081D-04	-5.785D-04
12	0.000D+00	5.104D-03	1.021D-02	1.531D-02	2.552D-02	-5.104D-03	-1.021D-02	-1.531D-02	-2.552D-02
13	0.000D+00	-2.166D-06	-9.844D-06	-2.197D-05	-6.079D-05	2.097D-06	9.758D-06	2.169D-05	6.072D-05
14	0.000D+00	-1.350D-03	-2.699D-03	-4.048D-03	-6.747D-03	1.350D-03	2.698D-03	4.048D-03	6.747D-03

Table 3.5.3 Cont.

block(s) =		1	1	1	1	2	2	2	2
dthick (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt ( )=		1.000D-02	2.000D-02	5.000D-02	1.000D-01	1.000D+02	2.000D-02	5.000D-02	1.000D-01
dwedge (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-4.078D-07	-2.810D-07	-5.922D-08	4.348D-07	-6.447D-08	3.243D-07	1.596D-06	3.674D-06
1	0.000D+00	4.059D-03	6.666D-03	1.456D-02	2.809D-02	1.069D-02	1.998D-02	4.765D-02	9.381D-02
2	-6.106D+01	3.185D-03	7.428D-03	1.996D-02	4.108D-02	1.017D-02	2.147D-02	5.475D-02	1.105D-01
3	0.000D+00	4.647D-03	9.234D-03	2.284D-02	4.568D-02	9.617D-03	1.915D-02	4.769D-02	9.524D-02
4	2.549D+00	3.804D-03	7.706D-03	1.944D-02	3.902D-02	5.963D-03	1.204D-02	3.025D-02	6.061D-02
5	0.000D+00	2.964D-03	5.897D-03	1.472D-02	2.945D-02	2.896D-03	5.769D-03	1.438D-02	2.873D-02
6	3.304D+00	2.070D-03	4.159D-03	1.043D-02	2.090D-02	8.236D-04	1.665D-03	4.183D-03	8.381D-03
7	0.000D+00	1.450D-03	2.900D-03	7.248D-03	1.450D-02	-1.207D-04	-2.469D-04	-6.258D-04	-1.264D-03
8	2.845D-02	9.568D-04	1.927D-03	4.830D-03	9.668D-03	-4.730D-04	-9.411D-04	-2.340D-03	-4.681D-03
9	0.000D+00	6.118D-04	1.224D-03	3.060D-03	6.122D-03	-5.001D-04	-1.002D-03	-2.504D-03	-5.012D-03
10	1.159D-01	3.699D-04	7.414D-04	1.858D-03	3.721D-03	-3.952D-04	-7.874D-04	-1.964D-03	-3.925D-03
11	0.000D+00	2.262D-04	4.507D-04	1.127D-03	2.255D-03	-2.397D-04	-4.796D-04	-1.200D-03	-2.399D-03
12	-2.185D+00	1.367D-04	2.737D-04	6.856D-04	1.371D-03	-1.134D-04	-2.259D-04	-5.634D-04	-1.126D-03
13	0.000D+00	8.111D-05	1.624D-04	4.064D-04	8.111D-04	-3.684D-05	-7.353D-05	-1.836D-04	-3.677D-04
14	5.008D-01	4.439D-05	8.902D-05	2.230D-04	4.455D-04	-4.093D-06	-7.814D-06	-1.914D-05	-3.820D-05

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.192D-06	-2.598D-06	-6.850D-06	-1.417D-05	-1.004D-06	-2.265D-06	-6.078D-06	-1.241D-05
1	0.000D+00	-1.513D-02	-3.095D-02	-7.819D-02	-1.564D-01	-1.151D-02	-2.307D-02	-5.848D-02	-1.171D-01
2	0.000D+00	-1.243D-02	-2.523D-02	-6.313D-02	-1.259D-01	-6.257D-03	-1.237D-02	-3.074D-02	-6.126D-02
3	0.000D+00	-8.491D-03	-1.696D-02	-4.246D-02	-8.474D-02	-7.142D-04	-1.297D-03	-3.229D-03	-6.202D-03
4	0.000D+00	-5.109D-03	-1.019D-02	-2.546D-02	-5.086D-02	2.434D-03	4.888D-03	1.226D-02	2.462D-02
5	0.000D+00	-2.894D-03	-5.761D-03	-1.440D-02	-2.879D-02	3.112D-03	6.234D-03	1.561D-02	3.125D-02
6	0.000D+00	-1.576D-03	-3.150D-03	-7.888D-03	-1.576D-02	2.516D-03	5.040D-03	1.259D-02	2.519D-02
7	0.000D+00	-8.081D-04	-1.620D-03	-4.055D-03	-8.094D-03	1.646D-03	3.289D-03	8.212D-03	1.643D-02
8	0.000D+00	-3.648D-04	-7.290D-04	-1.823D-03	-3.641D-03	9.204D-04	1.842D-03	4.601D-03	9.199D-03
9	0.000D+00	-1.350D-04	-2.654D-04	-6.632D-04	-1.325D-03	4.155D-04	8.301D-04	2.076D-03	4.148D-03
10	0.000D+00	-3.381D-05	-6.497D-05	-1.629D-04	-3.234D-04	1.029D-04	2.055D-04	5.138D-04	1.026D-03
11	0.000D+00	4.604D-06	9.710D-06	2.393D-05	5.145D-05	-4.799D-05	-9.643D-05	-2.413D-04	-4.829D-04
12	0.000D+00	1.981D-05	3.936D-05	9.794D-05	1.988D-04	-8.604D-05	-1.722D-04	-4.309D-04	-8.619D-04
13	0.000D+00	2.479D-05	4.972D-05	1.242D-04	2.495D-04	-6.990D-05	-1.398D-04	-3.496D-04	-6.994D-04
14	0.000D+00	2.291D-05	4.615D-05	1.154D-04	2.307D-04	-4.306D-05	-8.608D-05	-2.150D-04	-4.305D-04

Table 3.5.3 Cont.

block(s) =		3	3	3	3	4	4	4	4
dthick (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt ( )=		1.000D-02	2.000D-02	5.000D-02	1.000D-01	1.000D-02	2.000D-02	5.000D-02	1.000D-01
dwedge (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	7.213D-07	1.831D-06	5.321D-06	1.098D-05	3.240D-07	1.054D-06	3.357D-06	7.178D-06
1	0.000D+00	1.651D-02	3.571D-02	8.672D-02	1.722D-01	1.028D-02	1.901D-02	4.501D-02	6.835D-02
2	-6.106D+01	9.450D-03	1.994D-02	5.117D-02	1.033D-01	3.601D-04	1.771D-03	5.903D-03	1.273D-02
3	0.000D+00	1.825D-03	3.545D-03	8.604D-03	1.702D-02	-3.554D-03	-7.234D-03	-1.833D-02	-3.665D-02
4	2.549D+00	-3.043D-03	-5.967D-03	-1.478D-02	-2.949D-02	-3.466D-03	-6.814D-03	-1.687D-02	-3.365D-02
5	0.000D+00	-3.500D-03	-7.001D-03	-1.755D-02	-3.511D-02	-8.073D-04	-1.638D-03	-4.106D-03	-8.216D-03
6	3.304D+00	-2.270D-03	-4.515D-03	-1.125D-02	-2.247D-02	7.278D-04	1.474D-03	3.736D-03	7.518D-03
7	0.000D+00	-8.068D-04	-1.616D-03	-4.039D-03	-8.075D-03	8.336D-04	1.666D-03	4.160D-03	8.324D-03
8	2.845D-02	1.045D-04	2.159D-04	5.553D-04	1.121D-03	2.880D-04	5.860D-04	1.472D-03	2.947D-03
9	0.000D+00	4.470D-04	8.932D-04	2.235D-03	4.471D-03	-9.278D-05	-1.856D-04	-4.668D-04	-9.383D-04
10	1.159D-01	3.651D-04	7.727D-04	1.938D-03	3.881D-03	-1.719D-04	-3.411D-04	-8.477D-04	-1.694D-03
11	0.000D+00	1.867D-04	3.729D-04	9.323D-04	1.864D-03	-8.599D-05	-1.727D-04	-4.310D-04	-8.617D-04
12	-2.185D+00	1.980D-05	4.021D-05	1.013D-04	2.027D-04	-3.060D-06	-5.602D-06	-1.284D-05	-2.433D-05
13	0.000D+00	-5.007D-05	-1.002D-04	-2.509D-04	-5.027D-04	2.884D-05	5.776D-05	1.440D-04	2.882D-04
14	5.008D-01	-5.070D-05	-1.012D-04	-2.529D-04	-5.057D-04	2.172D-05	4.374D-05	1.096D-04	2.194D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-9.570D-07	-2.191D-06	-5.924D-06	-1.204D-05	-2.365D-07	-7.402D-07	-2.254D-06	-4.786D-06
1	0.000D+00	-1.127D-03	-2.405D-03	-6.310D-03	-1.299D-02	3.932D-03	7.665D-03	1.861D-02	3.694D-02
2	0.000D+00	7.878D-03	1.579D-02	4.019D-02	8.052D-02	7.142D-03	1.444D-02	3.615D-02	7.243D-02
3	0.000D+00	8.851D-03	1.774D-02	4.446D-02	8.902D-02	3.624D-03	7.260D-03	1.810D-02	3.620D-02
4	0.000D+00	5.097D-03	1.022D-02	2.557D-02	5.116D-02	-7.016D-04	-1.397D-03	-3.508D-03	-7.039D-03
5	0.000D+00	1.308D-03	2.624D-03	6.546D-03	1.309D-02	-2.030D-03	-4.052D-03	-1.013D-02	-2.027D-02
6	0.000D+00	-7.532D-04	-1.502D-03	-3.769D-03	-7.554D-03	-1.135D-03	-2.272D-03	-5.671D-03	-1.134D-02
7	0.000D+00	-1.264D-03	-2.523D-03	-6.328D-03	-1.266D-02	-1.383D-05	-3.196D-05	-7.423D-05	-1.409D-04
8	0.000D+00	-9.513D-04	-1.904D-03	-4.760D-03	-9.520D-03	4.044D-04	8.090D-04	2.024D-03	4.054D-03
9	0.000D+00	-4.190D-04	-8.376D-04	-2.094D-03	-4.187D-03	2.841D-04	5.695D-04	1.422D-03	2.844D-03
10	0.000D+00	-1.440D-05	-2.842D-05	-6.968D-05	-1.383D-04	5.460D-05	1.107D-04	2.755D-04	5.494D-04
11	0.000D+00	1.551D-04	3.101D-04	7.768D-04	1.554D-03	-6.074D-05	-1.213D-04	-3.030D-04	-6.068D-04
12	0.000D+00	1.470D-04	2.939D-04	7.356D-04	1.472D-03	-6.266D-05	-1.255D-04	-3.131D-04	-6.261D-04
13	0.000D+00	7.333D-05	1.466D-04	3.667D-04	7.335D-04	-2.393D-05	-4.796D-05	-1.197D-04	-2.391D-04
14	0.000D+00	1.245D-05	2.485D-05	6.209D-05	1.239D-04	5.019D-06	1.006D-05	2.505D-05	5.029D-05

Table 3.5.3 Cont.

block(s)	=	5	5	5	5	1	1	1	1
dthick	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt	( )=	1.000D-02	2.000D-02	5.000D-02	1.000D-01	1.000D-02	2.000D-02	5.000D-02	1.000D-01
dwedge	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.603D-07	9.764D-07	3.059D-06	6.581D-06	6.222D-08	5.695D-07	1.457D-06	3.433D-06
1	0.000D+00	6.710D-03	1.180D-02	2.721D-02	5.280D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-6.106D+01	-3.889D-03	-6.838D-03	-1.568D-02	-3.040D-02	1.642D-02	3.340D-02	8.350D-02	1.680D-01
3	0.000D+00	-4.230D-03	-8.604D-03	-2.170D-02	-4.357D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	2.549D+00	-7.672D-04	-1.413D-03	-3.366D-03	-6.608D-03	1.569D-02	3.130D-02	7.822D-02	1.566D-01
5	0.000D+00	1.661D-03	3.315D-03	8.257D-03	1.651D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	3.304D+00	9.898D-04	2.009D-03	5.061D-03	1.014D-02	8.388D-03	1.674D-02	4.183D-02	8.367D-02
7	0.000D+00	-2.223D-04	-4.476D-04	-1.120D-03	-2.245D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	2.845D-02	-5.119D-04	-1.019D-03	-2.536D-03	-5.064D-03	3.855D-03	7.738D-03	1.934D-02	3.870D-02
9	0.000D+00	-1.305D-04	-2.623D-04	-6.564D-04	-1.312D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	1.159D-01	1.358D-04	2.750D-04	6.914D-04	1.387D-03	1.491D-03	2.975D-03	7.441D-03	1.489D-02
11	0.000D+00	1.094D-04	2.190D-04	5.466D-04	1.093D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	-2.185D+00	-6.561D-06	-1.248D-05	-3.015D-05	-6.008D-05	5.497D-04	1.098D-03	2.745D-03	5.487D-03
13	0.000D+00	-4.281D-05	-8.588D-05	-2.146D-04	-4.293D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	5.008D-01	-1.588D-05	-3.161D-05	-7.858D-05	-1.568D-04	1.785D-04	3.570D-04	8.932D-04	1.783D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	8.465D-09	-2.555D-07	-1.047D-06	-2.363D-06	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	6.169D-03	1.201D-02	2.970D-02	5.905D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	5.285D-03	1.073D-02	2.708D-02	5.423D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	-5.908D-04	-1.194D-03	-3.022D-03	-6.072D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	-2.917D-03	-5.843D-03	-1.460D-02	-2.920D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	-1.076D-03	-2.149D-03	-5.360D-03	-1.071D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	7.518D-04	1.508D-03	3.772D-03	7.554D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	7.736D-04	1.549D-03	3.870D-03	7.739D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	3.654D-05	7.381D-05	1.853D-04	3.690D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	-2.874D-04	-5.760D-04	-1.439D-03	-2.879D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	-1.382D-04	-2.769D-04	-6.911D-04	-1.382D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	5.040D-05	1.012D-04	2.529D-04	5.067D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	7.314D-05	1.466D-04	3.664D-04	7.329D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
13	0.000D+00	1.197D-05	2.400D-05	5.994D-05	1.197D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	0.000D+00	-2.172D-05	-4.356D-05	-1.088D-04	-2.177D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.3 Cont.

block(s) =	2	2	2	2	3	3	3	3
dthick (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt ( )=	1.000D-02	2.000D-02	5.000D-02	1.000D-01	1.000D-02	2.000D-02	5.000D-02	1.000D-01
dwedse (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	5	5	5	5	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.436D-06	2.990D-06	8.076D-06	1.639D-05	4.578D-06	9.018D-06	2.298D-05	4.561D-05
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-6.106D+01	4.435D-02	8.954D-02	2.226D-01	4.457D-01	4.147D-02	8.346D-02	2.083D-01	4.162D-01
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	2.549D+00	2.433D-02	4.861D-02	1.215D-01	2.429D-01	-1.170D-02	-2.339D-02	-5.866D-02	-1.175D-01
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	3.304D+00	3.402D-03	6.770D-03	1.684D-02	3.363D-02	-8.969D-03	-1.795D-02	-4.487D-02	-8.976D-02
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	2.845D-02	-1.864D-03	-3.737D-03	-9.332D-03	-1.870D-02	4.458D-04	8.918D-04	2.249D-03	4.511D-03
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	1.159D-01	-1.569D-03	-3.139D-03	-7.844D-03	-1.569D-02	1.551D-03	3.103D-03	7.762D-03	1.553D-02
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	-2.185D+00	-4.506D-04	-9.004D-04	-2.250D-03	-4.502D-03	8.214D-05	1.638D-04	4.081D-04	8.135D-04
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	5.008D-01	-1.546D-05	-3.035D-05	-7.569D-05	-1.519D-04	-2.019D-04	-4.037D-04	-1.011D-03	-2.022D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.3 Cont.

block(s)	=	4	4	4	4	5	5	5	5
dthick	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dwidth	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dtilt	( )=	1.000D-02	2.000D-02	5.000D-02	1.000D-01	1.000D-02	2.000D-02	5.000D-02	1.000D-01
dwedse	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	5	5	5	5	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.989D-06	5.910D-06	1.512D-05	3.041D-05	2.735D-06	5.599D-06	1.393D-05	2.802D-05
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-6.106D+01	5.121D-03	1.076D-02	2.730D-02	5.458D-02	-1.187D-02	-2.368D-02	-5.905D-02	-1.179D-01
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	2.549D+00	-1.339D-02	-2.678D-02	-6.702D-02	-1.341D-01	-2.595D-03	-5.160D-03	-1.297D-02	-2.596D-02
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	3.304D+00	3.018D-03	6.007D-03	1.506D-02	3.018D-02	4.067D-03	8.142D-03	2.035D-02	4.069D-02
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	2.845D-02	1.180D-03	2.371D-03	5.914D-03	1.182D-02	-2.020D-03	-4.049D-03	-1.011D-02	-2.023D-02
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	1.159D-01	-6.764D-04	-1.354D-03	-3.381D-03	-6.764D-03	5.543D-04	1.111D-03	2.777D-03	5.556D-03
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	-2.185D+00	-9.330D-06	-1.950D-05	-4.843D-05	-9.441D-05	-2.334D-05	-4.701D-05	-1.177D-04	-2.373D-04
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	5.006D-01	8.781D-05	1.758D-04	4.392D-04	8.783D-04	-6.264D-05	-1.256D-04	-3.135D-04	-6.264D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
14	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.3 Cont.

block(s) =	12345	12345	12345	12345	123	12345	1	1
dthick (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-1.000D-03	0.000D+00	0.000D+00	0.000D+00
dwidth (in)=	1.000D-03	2.000D-03	3.000D-03	5.000D-03	0.000D+00	-1.000D-03	0.000D+00	0.000D+00
dtilt ( )=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-1.000D-02	0.000D+00
dwedge (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-1.000D-03
symmetry =	5	5	5	5	5	5	5	4

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.307D-05	4.622D-05	6.922D-05	1.153D-04	-1.255D-02	-2.311D-05	-5.381D-07	-5.537D-05
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	7.938D-01
2	-6.106D+01	-1.412D-02	-2.796D-02	-4.122D-02	-6.944D-02	-8.315D+01	1.430D-02	-1.637D-02	-4.954D-01
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	1.288D-01
4	2.549D+00	-1.755D-02	-3.513D-02	-5.266D-02	-8.778D-02	1.068D+01	1.762D-02	-1.554D-02	-7.624D-02
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	6.123D-02
6	3.304D+00	-1.136D-03	-2.270D-03	-3.408D-03	-5.674D-03	-1.633D+00	1.137D-03	-8.338D-03	-4.699D-02
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	2.397D-02
8	2.845D-02	4.629D-04	9.234D-04	1.380D-03	2.303D-03	8.051D-01	-4.629D-04	-3.876D-03	-1.111D-02
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	9.501D-03
10	1.159D-01	7.175D-04	1.432D-03	2.146D-03	3.568D-03	-9.946D-01	-7.199D-04	-1.490D-03	-8.948D-03
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	5.174D-03
12	-2.185D+00	-2.528D-03	-5.051D-03	-7.566D-03	-1.258D-02	1.448D-01	2.534D-03	-5.497D-04	-1.097D-03
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-5.279D-04
14	5.008D-01	5.901D-04	1.179D-03	1.767D-03	2.938D-03	2.819D-01	-5.915D-04	-1.794D-04	1.817D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-8.631D-03
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	3.939D-01
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	1.277D-02
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-6.401D-03
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	1.227D-03
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	1.707D-02
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-1.875D-03
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-4.875D-03
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-1.441D-04
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	2.969D-03
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-8.236D-05
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-2.879D-03
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	2.548D-03
13	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-5.560D-04
14	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	-6.741D-04

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Table 3.5.3 Cont.

The (half-) thickness of the wedge at the midplane was then increased 1, 2, 3, and 5 mils for a variety of symmetry codes. As can be seen, the linearity of the change in coefficients with thickness increase holds. The symmetry codes -14 and -23 represent a shift in the midplane wedge location by the amount of the perturbation.

The tilt angle of each block was perturbed by deltas of 0.01, 0.02, 0.05 and 0.1 degrees. The linearity in these cases is not retained as can be seen. The perturbation was assumed to apply in the first quadrant only and in all four quadrants.

The next perturbation was an increase in turn width of all turns in all blocks of the magnet. The increases were from 1 to 5 mils and the linearity seems to hold.

Finally, a few cases with a negative perturbation were run to investigate the symmetry of the perturbation in coefficients.

3.5.5 Two-Layer Dipole

The coefficient perturbations due to winding bundle displacements were calculated for the two-layer design shown in Fig. 3.5.12. The current density was assumed to vary inversely with radius to model the keystoning of the conductor. The ideal bundle locations are given in Table 3.5.4.

Table 3.5.4

Ideal Winding Bundle Locations for the Two-Layer Dipole

Bundle Number	Inner Radius (cm)	Outer Radius (cm)	Initial Angle (Deg)	Final Angle (Deg)	Overall Current Density ($10^8 A/m^2$)
1	6.566	7.348	0.04	70.88	3.165
2	6.566	7.348	75.58	80.59	3.165
3	7.399	8.181	0.04	28.99	3.145
4	7.399	8.181	33.96	45.76	3.145

Iron inner radius = 8.655 cm.

The fundamental dipole coefficient computed on the basis of these data was 5.131 T. The transfer function was 15.07 G/A. All other coefficients and their perturbations presented in Table 3.5.5 are normalized to the fundamental and radii are normalized to a radius of 4.4 cm. Each of the four current-carrying regions in Table 3.5.4 was subjected to boundary displacements for a variety of symmetry codes.

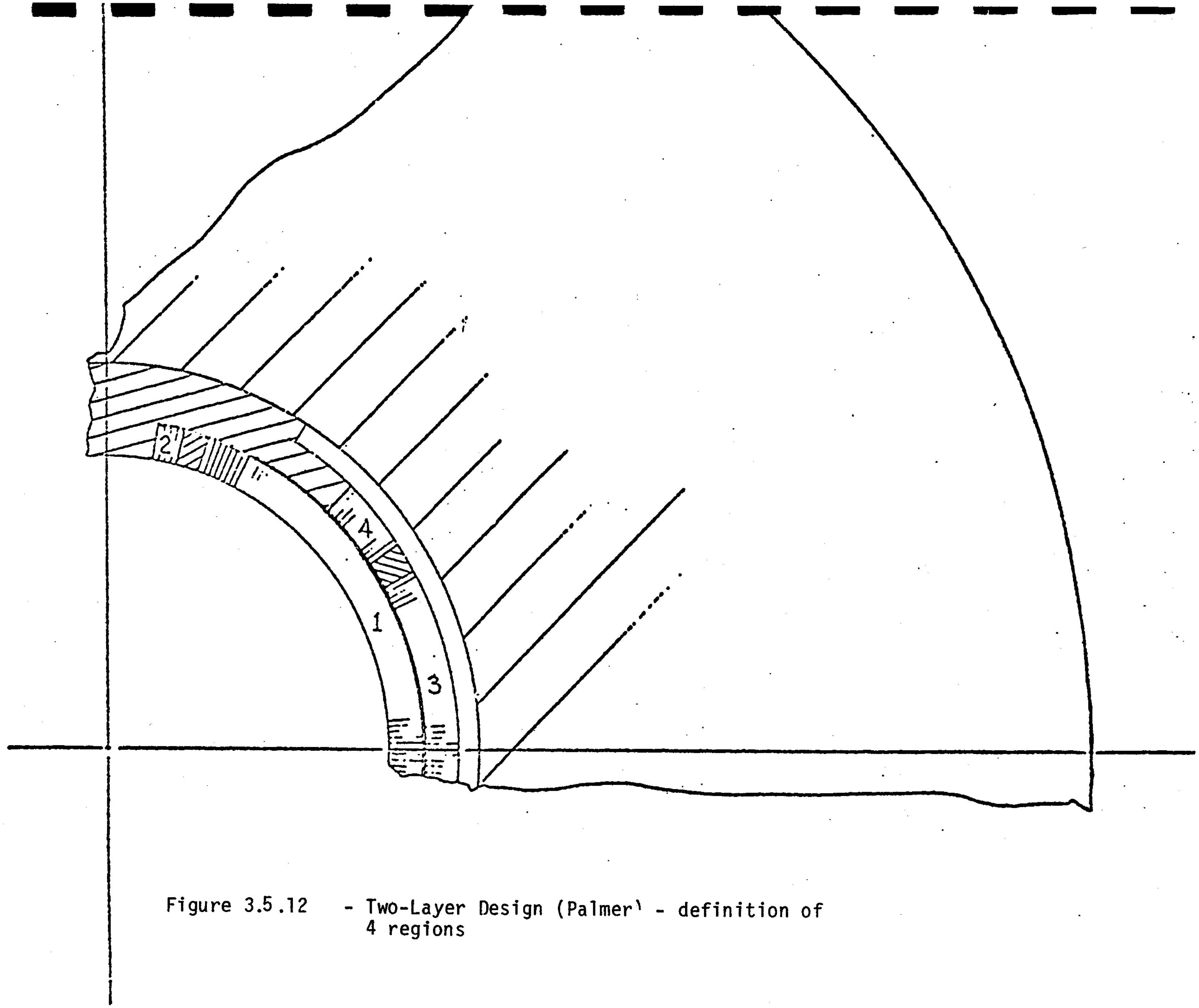

Figure 3.5.12 - Two-Layer Design (Palmer) - definition of 4 regions

The format in Table 3.5.5 is similar to that in Table 3.5.3 with displacements defined as shown in Figure 3.5.6. The first set of perturbations considered was a 1 mil motion of each boundary of each current region. The change in coefficients was calculated for both first quadrant and all four quadrant motion. Then the same changes were applied with symmetry codes 12 and 14 to simulate a magnet-half-to-magnet-half variation. The 12 code models a variation from top to bottom, the 14 code, from side to side. Finally, a -14 code was used to model a shift in the midplane of one side of the magnet.

The next set of perturbations was used to model the effect of a rigid body motion of the winding with respect to the iron shield. To this end, a 1 mil increase of both the inner and outer radii of each bundle was applied in quadrants 1 and 4 and a 1 mil decrease of the radii was applied in quadrants 2 and 3. There is an assumption inherent in the analysis that the angular locations of the bundle boundaries remain constant, and, as such, do represent an approximation. The same perturbations and symmetries were then run to model a 10 mil shift.

Next, the effect of increasing the midplane wedge thickness was investigated by imposing a 2, 4, 6, and 8 mil azimuthal motion on bundles 1 and 3 (the azimuthal movement of bundle 3 is slightly larger due to the increased radius). All quadrants are affected.

The effect of a perturbation in the iron shield radius was then modeled. The special symmetry code of 200 is used. In this case, the perturbation drinner is interpreted as the change in shield radius. A range of changes from -50 to +50 mils was run.

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-6.189D-06	-5.010D-06	-1.295D-05	-2.388D-05	-2.476D-05	-2.004D-05	-5.179D-05	-9.552D-05
1	0.000D+00	-4.238D-02	-3.403D-02	-2.242D-01	-3.093D-01	1.521D-16	9.933D-17	-3.034D-16	5.997D-16
2	-1.126D+01	2.973D-02	2.356D-02	-1.946D-01	-1.181D-01	1.189D-01	9.427D-02	-7.786D-01	-4.724D-01
3	0.000D+00	3.875D-02	3.017D-02	-1.194D-01	4.304D-02	5.846D-17	5.354D-17	-7.144D-17	1.547D-16
4	-2.532D+00	2.771D-03	2.111D-03	-6.109D-02	6.077D-02	1.109D-02	8.446D-03	-2.444D-01	2.431D-01
5	0.000D+00	-1.667D-02	-1.239D-02	-3.239D-02	1.089D-02	3.517D-17	2.683D-17	-1.997D-17	-1.314D-16
6	8.174D-02	-8.407D-03	-6.076D-03	-2.112D-02	-1.838D-02	-3.363D-02	-2.430D-02	-8.447D-02	-7.352D-02
7	0.000D+00	3.698D-03	2.594D-03	-1.507D-02	-1.214D-02	5.757D-17	4.042D-17	-1.452D-17	6.524D-17
8	-1.701D-01	5.241D-03	3.562D-03	-9.913D-03	2.082D-03	2.096D-02	1.425D-02	-3.965D-02	8.329D-03
9	0.000D+00	6.905D-04	4.542D-04	-5.869D-03	5.758D-03	3.881D-19	2.612D-19	-1.639D-18	-8.073D-18
10	2.479D-01	-1.913D-03	-1.217D-03	-3.447D-03	1.618D-03	-7.652D-03	-4.867D-03	-1.379D-02	6.473D-03
11	0.000D+00	-1.094D-03	-6.725D-04	-2.230D-03	-1.649D-03	1.378D-17	8.464D-18	-2.007D-18	-4.373D-18
12	-4.072D-01	3.552D-04	2.109D-04	-1.538D-03	-1.362D-03	1.421D-03	8.436D-04	-6.150D-03	-5.446D-03
13	0.000D+00	6.229D-04	3.573D-04	-1.019D-03	9.751D-05	3.921D-16	2.244D-18	-6.965D-19	6.577D-18
14	-1.710D-01	1.204D-04	6.671D-05	-6.279D-04	6.017D-04	4.818D-04	2.669D-04	-2.512D-03	2.407D-03
15	0.000D+00	-2.093D-04	-1.120D-04	-3.810D-04	2.158D-04	8.334D-19	4.476D-19	-1.516D-19	-2.932D-18
16	1.145D-01	-1.379D-04	-7.129D-05	-2.455D-04	-1.567D-04	-5.518D-04	-2.852D-04	-9.821D-04	-6.268D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.408D-06	-3.568D-06	2.974D-05	2.195D-05	1.576D-20	1.918D-20	9.266D-21	1.334D-19
1	0.000D+00	-1.225D-01	-9.837D-02	2.153D-01	-3.087D-02	1.288D-16	-2.222D-17	-2.175D-17	-2.175D-17
2	0.000D+00	-1.011D-01	-8.014D-02	8.390D-02	-1.759D-01	-7.961D-17	-8.001D-17	5.796D-16	-4.767D-17
3	0.000D+00	-3.045D-02	-2.371D-02	1.511D-02	-1.124D-01	-1.070D-18	5.082D-18	-1.128D-18	1.182D-16
4	0.000D+00	-1.307D-04	-9.957D-05	-2.183D-04	-5.854D-03	-1.079D-17	-1.116D-17	2.899D-16	-2.929D-16
5	0.000D+00	-1.073D-02	-7.972D-03	2.698D-03	3.061D-02	1.074D-18	-1.419D-19	4.376D-18	-9.005D-17
6	0.000D+00	-2.104D-02	-1.521D-02	4.421D-03	1.130D-02	5.313D-17	4.069D-17	1.399D-16	1.630D-16
7	0.000D+00	-1.519D-02	-1.066D-02	2.651D-03	-9.312D-03	8.133D-19	-9.914D-19	8.215D-19	6.260D-18
8	0.000D+00	-4.534D-03	-3.081D-03	6.328D-04	-9.709D-03	-4.458D-17	-3.046D-17	8.544D-17	-3.165D-17
9	0.000D+00	-6.527D-05	-4.293D-05	-4.198D-05	-1.120D-03	5.402D-20	-2.397D-19	-5.748D-19	3.431D-19
10	0.000D+00	-1.107D-03	-7.042D-04	9.828D-05	3.043D-03	2.001D-17	1.275D-17	3.607D-17	-1.285D-17
11	0.000D+00	-2.403D-03	-1.477D-03	2.364D-04	1.519D-03	-2.063D-19	-9.284D-20	-9.625D-20	-4.827D-18
12	0.000D+00	-1.831D-03	-1.087D-03	1.633D-04	-7.327D-04	-4.165D-18	-2.725D-18	1.912D-17	1.469D-17
13	0.000D+00	-5.924D-04	-3.397D-04	4.151D-05	-1.015D-03	7.409D-20	7.928D-20	1.130D-19	1.325D-18
14	0.000D+00	-1.714D-05	-9.495D-06	-6.743D-06	-1.783D-04	-1.713D-18	-9.433D-19	3.952D-18	-9.054D-18
15	0.000D+00	-1.083D-04	-5.793D-05	2.700D-06	3.137D-04	5.237D-21	2.208D-21	2.197D-21	-3.852D-19
16	0.000D+00	-2.686D-04	-1.388D-04	1.529D-05	1.896D-04	2.226D-18	1.145D-18	3.964D-18	2.996D-18

Table 3.5.5 Coefficient perturbations due to winding bundle displacements for two-layer dipole design. The fundamental dipole coefficient as computed is 5.131 T.

region =		2	2	2	2	2	2	2	2
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.127D-07	-9.118D-08	-2.243D-06	-2.256D-06	-4.506D-07	-3.647D-07	-8.970D-06	-9.023D-06
1	0.000D+00	1.054D-02	8.465D-03	-1.068D-02	-9.394D-03	-1.004D-17	-1.172D-18	6.443D-16	4.630D-18
2	-1.126D+01	7.997D-03	6.337D-03	1.686D-02	1.790D-02	3.199D-02	2.535D-02	6.743D-02	7.159D-02
3	0.000D+00	-9.014D-03	-7.018D-03	1.287D-02	1.160D-02	-2.450D-17	-1.427D-17	-1.532D-16	-2.446D-17
4	-2.532D+00	-9.800D-03	-7.467D-03	-5.687D-03	-7.193D-03	-3.920D-02	-2.987D-02	-2.275D-02	-2.877D-02
5	0.000D+00	3.009D-03	2.236D-03	-8.936D-03	-8.427D-03	2.453D-17	1.905D-17	1.694D-17	1.229D-17
6	8.174D-02	7.023D-03	5.076D-03	2.001D-04	1.498D-03	2.809D-02	2.030D-02	8.003D-04	5.992D-03
7	0.000D+00	4.174D-04	2.928D-04	4.688D-03	4.771D-03	-2.060D-17	-1.369D-17	1.763D-17	-5.579D-19
8	-1.701D-01	-3.722D-03	-2.530D-03	1.350D-03	5.305D-04	-1.489D-02	-1.012D-02	5.398D-03	2.122D-03
9	0.000D+00	-1.320D-03	-8.679D-04	-1.919D-03	-2.233D-03	1.207D-17	7.876D-18	-1.303D-17	-4.018D-18
10	2.479D-01	1.527D-03	9.712D-04	-1.247D-03	-8.542D-04	6.108D-03	3.885D-03	-4.988D-03	-3.417D-03
11	0.000D+00	1.104D-03	6.788D-04	5.506D-04	8.543D-04	-4.825D-18	-2.841D-18	1.328D-17	4.655D-18
12	-4.072D-01	-4.377D-04	-2.599D-04	7.624D-04	6.331D-04	-1.751D-03	-1.040D-03	3.050D-03	2.532D-03
13	0.000D+00	-6.625D-04	-3.800D-04	-3.180D-05	-2.388D-04	1.170D-18	6.595D-19	-6.071D-18	-3.612D-18
14	-1.710D-01	2.293D-05	1.270D-05	-3.673D-04	-3.593D-04	9.171D-05	5.080D-05	-1.469D-03	-1.437D-03
15	0.000D+00	3.220D-04	1.723D-04	-9.468D-05	1.801D-05	3.971D-19	1.993D-19	2.417D-18	1.917D-18
16	1.145D-01	7.959D-05	4.114D-05	1.417D-04	1.708D-04	3.184D-04	1.645D-04	5.670D-04	6.832D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-5.385D-07	-4.359D-07	5.017D-07	4.387D-07	2.124D-21	4.398D-21	1.277D-19	3.609D-21
1	0.000D+00	-4.613D-03	-3.704D-03	-2.267D-02	-2.324D-02	2.025D-18	-4.340D-18	9.528D-17	7.176D-17
2	0.000D+00	1.123D-02	8.902D-03	-1.309D-02	-1.163D-02	-1.479D-17	-1.109D-17	-4.444D-16	-3.102D-17
3	0.000D+00	9.755D-03	7.595D-03	1.063D-02	1.200D-02	-2.214D-18	-7.278D-18	-1.083D-16	-7.376D-17
4	0.000D+00	-5.871D-03	-4.473D-03	1.119D-02	1.028D-02	4.563D-17	3.080D-17	7.028D-17	9.743D-18
5	0.000D+00	-8.683D-03	-6.453D-03	-2.283D-03	-3.747D-03	1.661D-18	-2.035D-18	5.857D-17	4.928D-17
6	0.000D+00	8.990D-04	6.498D-04	-6.672D-03	-6.504D-03	-4.690D-17	-3.503D-17	8.466D-18	-4.324D-18
7	0.000D+00	5.280D-03	3.704D-03	-9.027D-04	1.642D-04	-7.372D-19	-7.404D-20	-1.555D-17	-1.691D-17
8	0.000D+00	1.091D-03	7.415D-04	3.101D-03	3.340D-03	3.171D-17	2.133D-17	-2.684D-17	-5.015D-18
9	0.000D+00	-2.466D-03	-1.622D-03	1.402D-03	8.135D-04	-4.432D-20	-1.306D-20	1.617D-18	8.306D-18
10	0.000D+00	-1.280D-03	-8.139D-04	-1.093D-03	-1.421D-03	-1.593D-17	-1.008D-17	2.058D-17	8.544D-18
11	0.000D+00	8.697D-04	5.346D-04	-1.009D-03	-7.693D-04	-3.213D-21	-2.476D-20	-6.222D-19	-3.480D-18
12	0.000D+00	8.815D-04	5.234D-04	2.184D-04	4.773D-04	5.459D-18	3.159D-18	-1.161D-17	-8.348D-18
13	0.000D+00	-1.725D-04	-9.890D-05	5.435D-04	4.891D-04	-2.043D-21	5.891D-21	-4.514D-19	5.012D-19
14	0.000D+00	-4.730D-04	-2.620D-04	6.008D-05	-9.661D-05	-3.161D-19	-1.901D-19	6.540D-18	5.129D-18
15	0.000D+00	-5.123D-05	-2.741D-05	-2.352D-04	-2.528D-04	-1.075D-20	2.362D-21	3.352D-19	-2.365D-19
16	0.000D+00	2.089D-04	1.080D-04	-9.768D-05	-2.066D-05	-1.289D-18	-6.649D-19	-2.569D-18	-2.758D-18

Table 3.5.5 Cont.

region =	3	3	3	3	3	3	3	3
drinner (in)=	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =	1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.622D-06	-1.140D-06	-2.269D-06	-4.470D-06	-6.487D-06	-4.559D-06	-9.078D-06	-1.788D-05
1	0.000D+00	-2.908D-02	-2.037D-02	-4.521D-02	-8.556D-02	-1.770D-17	-9.729D-18	3.199D-16	-4.303D-16
2	-1.126D+01	-2.647D-02	-1.843D-02	-4.994D-02	-8.808D-02	-1.059D-01	-7.374D-02	-1.998D-01	-3.523D-01
3	0.000D+00	-1.645D-02	-1.137D-02	-4.294D-02	-6.795D-02	4.062D-17	3.744D-17	3.364D-17	2.270D-17
4	-2.532D+00	-6.825D-03	-4.667D-03	-3.194D-02	-4.306D-02	-2.730D-02	-1.867D-02	-1.277D-01	-1.722D-01
5	0.000D+00	-7.619D-04	-5.147D-04	-2.153D-02	-2.286D-02	4.264D-17	2.872D-17	3.853D-17	9.380D-17
6	8.174D-02	1.821D-03	1.213D-03	-1.348D-02	-9.795D-03	7.283D-03	4.852D-03	-5.390D-02	-3.918D-02
7	0.000D+00	2.212D-03	1.450D-03	-7.954D-03	-2.787D-03	1.731D-17	1.146D-17	2.833D-18	3.726D-17
8	-1.701D-01	1.658D-03	1.068D-03	-4.475D-03	2.273D-04	6.632D-03	4.273D-03	-1.790D-02	9.093D-04
9	0.000D+00	9.375D-04	5.926D-04	-2.422D-03	1.078D-03	3.064D-18	1.910D-18	2.472D-18	8.489D-18
10	2.479D-01	3.883D-04	2.404D-04	-1.275D-03	9.944D-04	1.553D-03	9.618D-04	-5.100D-03	3.978D-03
11	0.000D+00	7.486D-05	4.535D-05	-6.616D-04	6.468D-04	3.535D-20	1.300D-20	2.317D-18	-8.901D-19
12	-4.072D-01	-5.644D-05	-3.342D-05	-3.441D-04	3.280D-04	-2.257D-04	-1.337D-04	-1.376D-03	1.312D-03
13	0.000D+00	-8.302D-05	-4.800D-05	-1.827D-04	1.206D-04	2.363D-19	1.338D-19	4.803D-19	-1.268D-18
14	-1.710D-01	-6.531D-05	-3.684D-05	-1.005D-04	1.528D-05	-2.612D-04	-1.474D-04	-4.021D-04	6.112D-05
15	0.000D+00	-3.825D-05	-2.103D-05	-5.755D-05	-2.351D-05	3.749D-19	2.075D-19	5.161D-20	-3.768D-19
16	1.145D-01	-1.674D-05	-8.967D-06	-3.404D-05	-2.843D-05	-6.695D-05	-3.587D-05	-1.362D-04	-1.137D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.199D-07	-2.951D-07	1.329D-05	1.272D-05	-4.567D-21	4.301D-20	-2.903D-20	9.120D-21
1	0.000D+00	-1.614D-02	-1.130D-02	1.290D-01	1.065D-01	-8.284D-18	-1.279D-16	3.085D-17	1.888D-16
2	0.000D+00	-2.516D-02	-1.752D-02	9.071D-02	5.442D-02	4.346D-17	3.226D-17	1.387D-16	3.592D-16
3	0.000D+00	-2.639D-02	-1.823D-02	5.462D-02	1.444D-02	-1.900D-17	-7.480D-18	-7.779D-18	6.881D-17
4	0.000D+00	-2.175D-02	-1.487D-02	2.952D-02	-6.026D-03	3.732D-17	3.512D-17	1.604D-16	2.446D-16
5	0.000D+00	-1.499D-02	-1.013D-02	1.454D-02	-1.231D-02	1.234D-18	5.457D-18	5.445D-18	5.445D-18
6	0.000D+00	-8.866D-03	-5.906D-03	6.511D-03	-1.131D-02	-8.243D-18	-6.844D-18	8.971D-17	6.417D-17
7	0.000D+00	-4.511D-03	-2.958D-03	2.614D-03	-7.890D-03	1.212D-18	1.188D-18	1.197D-18	-4.933D-18
8	0.000D+00	-1.932D-03	-1.245D-03	9.066D-04	-4.556D-03	-1.416D-17	-9.139D-18	3.823D-17	-1.176D-17
9	0.000D+00	-6.528D-04	-4.126D-04	2.487D-04	-2.180D-03	1.023D-19	8.714D-20	9.220D-20	-2.916D-18
10	0.000D+00	-1.439D-04	-8.911D-05	3.972D-05	-7.967D-04	-4.067D-18	-2.514D-18	1.341D-17	-1.188D-17
11	0.000D+00	-7.630D-06	-4.623D-06	-4.255D-06	-1.350D-04	2.071D-20	-7.692D-21	-2.831D-20	8.207D-20
12	0.000D+00	-8.631D-06	-5.111D-06	-1.672D-06	1.026D-04	6.862D-19	3.971D-19	4.246D-18	-3.838D-18
13	0.000D+00	-3.560D-05	-2.058D-05	6.265D-06	1.372D-04	3.662D-21	2.275D-21	5.464D-22	8.694D-20
14	0.000D+00	-5.052D-05	-2.850D-05	9.723D-06	9.976D-05	9.327D-19	5.244D-19	1.433D-18	3.939D-20
15	0.000D+00	-4.938D-05	-2.716D-05	9.111D-06	5.330D-05	3.259D-21	2.873D-21	2.949D-21	6.547D-20
16	0.000D+00	-3.897D-05	-2.088D-05	6.725D-06	1.989D-05	2.715D-19	1.462D-19	5.507D-19	4.850D-19

Table 3.5.5 Cont.

region =		4	4	4	4	4	4	4	4
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		1	1	1	1	5	5	5	5
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-5.288D-07	-3.717D-07	-3.397D-06	-3.688D-06	-2.115D-06	-1.487D-06	-1.359D-05	-1.475D-05
1	0.000D+00	-2.508D-03	-1.756D-03	-5.529D-02	-5.669D-02	4.495D-18	1.686D-17	2.159D-16	4.315D-17
2	-1.126D+01	7.974D-03	5.553D-03	-4.078D-02	-3.624D-02	3.190D-02	2.221D-02	-1.631D-01	-1.450D-01
3	0.000D+00	1.376D-02	9.508D-03	-1.484D-02	-6.814D-03	1.158D-17	1.745D-17	-3.518D-17	-1.227D-16
4	-2.532D+00	1.111D-02	7.601D-03	3.374D-03	1.007D-02	4.446D-02	3.040D-02	1.349D-02	4.027D-02
5	0.000D+00	4.464D-03	3.016D-03	9.679D-03	1.247D-02	-2.104D-17	-1.527D-17	-4.549D-17	1.136D-17
6	8.174D-02	-9.552D-04	-6.363D-04	8.211D-03	7.582D-03	-3.821D-03	-2.545D-03	3.284D-02	3.033D-02
7	0.000D+00	-3.085D-03	-2.023D-03	4.262D-03	2.145D-03	-9.990D-18	-6.506D-18	-9.773D-18	-1.757D-18
8	-1.701D-01	-2.668D-03	-1.719D-03	1.025D-03	-9.012D-04	-1.067D-02	-6.875D-03	4.099D-03	-3.605D-03
9	0.000D+00	-1.326D-03	-8.381D-04	-5.866D-04	-1.596D-03	5.006D-18	3.369D-18	-3.400D-18	-4.904D-18
10	2.479D-01	-2.115D-04	-1.310D-04	-9.253D-04	-1.095D-03	-8.460D-04	-5.239D-04	-3.701D-03	-4.379D-03
11	0.000D+00	3.072D-04	1.861D-04	-6.625D-04	-3.979D-04	3.269D-18	1.973D-18	1.813D-18	3.594D-18
12	-4.072D-01	3.627D-04	2.148D-04	-2.954D-04	3.635D-05	1.451D-03	8.592D-04	-1.182D-03	1.454D-04
13	0.000D+00	2.212D-04	1.279D-04	-4.521D-05	1.704D-04	-4.951D-19	-2.598D-19	1.305D-18	1.091D-18
14	-1.710D-01	7.268D-05	4.100D-05	5.964D-05	1.352D-04	2.907D-04	1.640D-04	2.386D-04	5.409D-04
15	0.000D+00	-1.073D-05	-5.901D-06	7.060D-05	5.835D-05	-5.984D-19	-3.296D-19	1.591D-19	-2.548D-19
16	1.145D-01	-3.372D-05	-1.807D-05	4.497D-05	4.212D-06	-1.349D-04	-7.226D-05	1.799D-04	1.685D-05
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.415D-07	-3.103D-07	4.364D-06	4.120D-06	2.867D-21	1.164D-20	-1.591D-20	-9.984D-20
1	0.000D+00	-1.383D-02	-9.684D-03	1.400D-02	6.288D-03	-3.311D-19	1.984D-17	-2.568D-16	-9.887D-17
2	0.000D+00	-1.405D-02	-9.783D-03	-1.789D-02	-2.587D-02	-1.421D-17	-4.245D-18	-4.033D-16	-3.661D-18
3	0.000D+00	-5.162D-03	-3.566D-03	-2.741D-02	-3.041D-02	3.804D-18	-4.427D-18	-5.638D-17	-4.402D-18
4	0.000D+00	3.892D-03	2.662D-03	-2.033D-02	-1.798D-02	-5.631D-17	-4.124D-17	-3.112D-17	3.792D-17
5	0.000D+00	7.476D-03	5.051D-03	-8.943D-03	-4.261D-03	-5.114D-19	-5.382D-19	2.895D-17	-2.369D-17
6	0.000D+00	6.017D-03	4.008D-03	-7.068D-04	3.226D-03	6.309D-18	4.184D-18	-4.703D-17	-2.050D-17
7	0.000D+00	2.693D-03	1.766D-03	2.754D-03	4.598D-03	-4.362D-19	1.192D-20	5.679D-18	2.026D-20
8	0.000D+00	5.868D-05	3.780D-05	2.914D-03	2.954D-03	2.290D-17	1.486D-17	-1.594D-18	1.806D-18
9	0.000D+00	-1.059D-03	-6.691D-04	1.769D-03	9.600D-04	1.465D-19	2.515D-19	1.296D-18	2.916D-18
10	0.000D+00	-1.036D-03	-6.414D-04	6.236D-04	-2.136D-04	2.240D-18	1.406D-18	9.800D-18	8.391D-18
11	0.000D+00	-5.701D-04	-3.454D-04	-4.222D-05	-5.309D-04	2.649D-20	9.289D-21	-1.655D-18	-2.453D-20
12	0.000D+00	-1.452D-04	-8.600D-05	-2.588D-04	-3.908D-04	-4.504D-18	-2.670D-18	3.494D-18	6.078D-19
13	0.000D+00	7.203D-05	4.165D-05	-2.266D-04	-1.559D-04	-8.895D-21	-4.899D-21	-1.385D-19	2.277D-19
14	0.000D+00	1.159D-04	6.535D-05	-1.215D-04	-3.564D-07	-1.042D-18	-5.900D-19	-9.976D-19	-1.820D-18
15	0.000D+00	7.874D-05	4.330D-05	-3.520D-05	5.297D-05	1.148D-21	8.674D-22	5.554D-21	-8.340D-21
16	0.000D+00	3.077D-05	1.648D-05	8.543D-06	4.553D-05	5.466D-19	2.929D-19	-7.270D-19	-1.565D-19

Table 3.5.5 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.238D-05	-1.002D-05	-2.569D-05	-4.776D-05	-1.238D-05	-1.002D-05	-2.569D-05	-4.776D-05
1	0.000D+00	-3.003D-17	-4.569D-18	9.112D-18	9.112D-18	-8.476D-02	-6.805D-02	-4.485D-01	-6.185D-01
2	-1.126D+01	5.945D-02	4.711D-02	-3.893D-01	-2.362D-01	5.945D-02	4.711D-02	-3.893D-01	-2.362D-01
3	0.000D+00	-3.433D-17	-1.298D-17	-1.335D-17	-1.138D-16	7.750D-02	6.034D-02	-2.389D-01	8.608D-02
4	-2.532D+00	5.543D-03	4.223D-03	-1.222D-01	1.215D-01	5.543D-03	4.223D-03	-1.222D-01	1.215D-01
5	0.000D+00	-1.214D-17	-9.693D-18	-9.446D-18	4.938D-17	-3.334D-02	-2.478D-02	-6.479D-02	2.177D-02
6	8.174D-02	-1.681D-02	-1.215D-02	-4.224D-02	-3.676D-02	-1.681D-02	-1.215D-02	-4.224D-02	-3.676D-02
7	0.000D+00	-2.681D-17	-2.030D-17	6.214D-19	-1.796D-17	7.396D-03	5.188D-03	-3.014D-02	-2.428D-02
8	-1.701D-01	1.048D-02	7.125D-03	-1.983D-02	4.164D-03	1.048D-02	7.125D-03	-1.983D-02	4.164D-03
9	0.000D+00	-8.659D-20	-9.002D-20	-1.968D-18	-5.313D-18	1.381D-03	9.083D-04	-1.174D-02	1.152D-02
10	2.479D-01	-3.826D-03	-2.434D-03	-6.893D-03	3.236D-03	-3.826D-03	-2.434D-03	-6.893D-03	3.236D-03
11	0.000D+00	-6.852D-18	-4.237D-18	-5.737D-20	3.688D-18	-2.188D-03	-1.345D-03	-4.459D-03	-3.298D-03
12	-4.072D-01	7.104D-04	4.218D-04	-3.075D-03	-2.723D-03	7.104D-04	4.218D-04	-3.075D-03	-2.723D-03
13	0.000D+00	-2.002D-18	-1.128D-18	-2.463D-19	-3.398D-18	1.246D-03	7.145D-04	-2.038D-03	1.950D-04
14	-1.710D-01	2.409D-04	1.334D-04	-1.256D-03	1.203D-03	2.409D-04	1.334D-04	-1.256D-03	1.203D-03
15	0.000D+00	-4.054D-19	-2.117D-19	-1.184D-19	1.200D-18	-4.185D-04	-2.239D-04	-7.619D-04	4.316D-04
16	1.145D-01	-2.759D-04	-1.426D-04	-4.911D-04	-3.134D-04	-2.759D-04	-1.426D-04	-4.911D-04	-3.134D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	7.791D-22	1.825D-21	-7.542D-22	-7.542D-22	1.249D-20	1.425D-20	-4.525D-21	3.685D-20
1	0.000D+00	-2.451D-01	-1.967D-01	4.305D-01	-6.175D-02	-4.287D-17	-1.605D-17	1.288D-16	4.298D-16
2	0.000D+00	-1.927D-18	-3.071D-17	1.913D-16	2.027D-17	2.198D-17	-3.558D-17	2.945D-16	1.234D-16
3	0.000D+00	-6.090D-02	-4.741D-02	3.021D-02	-2.248D-01	-7.461D-17	-5.630D-17	2.250D-16	-1.330D-16
4	0.000D+00	-9.619D-19	-1.047D-18	7.267D-17	-7.148D-17	-5.407D-18	-5.578D-18	1.417D-16	-1.464D-16
5	0.000D+00	-2.146D-02	-1.594D-02	5.396D-03	6.123D-02	4.813D-17	3.535D-17	9.262D-17	-1.729D-17
6	0.000D+00	1.246D-17	8.508D-18	3.497D-17	2.837D-17	2.551D-17	2.100D-17	7.058D-17	7.058D-17
7	0.000D+00	-3.039D-02	-2.132D-02	5.302D-03	-1.862D-02	-1.268D-17	-1.010D-17	5.702D-17	4.252D-17
8	0.000D+00	-1.102D-17	-7.491D-18	2.123D-17	8.670D-19	-2.238D-17	-1.526D-17	4.267D-17	-1.332D-17
9	0.000D+00	-1.305D-04	-8.586D-05	-8.395D-05	-2.239D-03	-3.223D-18	-2.189D-18	2.763D-17	-2.804D-17
10	0.000D+00	4.947D-18	3.148D-18	9.042D-18	-5.607D-18	1.003D-17	6.429D-18	1.805D-17	-7.125D-18
11	0.000D+00	-4.806D-03	-2.954D-03	4.728D-04	3.038D-03	6.235D-18	3.794D-18	1.272D-17	1.015D-17
12	0.000D+00	-9.660D-19	-7.239D-19	4.795D-18	3.747D-18	-2.076D-18	-1.350D-18	9.569D-18	7.125D-18
13	0.000D+00	-1.185D-03	-6.795D-04	8.301D-05	-2.030D-03	-4.173D-18	-2.359D-18	6.798D-18	-1.307D-18
14	0.000D+00	-4.202D-19	-2.241D-19	2.233D-18	-2.148D-18	-8.496D-19	-4.761D-19	4.476D-18	-4.199D-18
15	0.000D+00	-2.166D-04	-1.159D-04	5.401D-06	6.275D-04	1.599D-18	8.537D-19	2.904D-18	-1.450D-18
16	0.000D+00	5.557D-19	2.831D-19	9.971D-19	6.264D-19	1.110D-18	5.762D-19	1.982D-18	1.732D-18

Table 3.5.5 Cont.

region =		2	2	2	2	2	2	2	2
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.253D-07	-1.824D-07	-4.485D-06	-4.511D-06	-2.253D-07	-1.824D-07	-4.485D-06	-4.511D-06
1	0.000D+00	-2.220D-18	1.222D-17	-1.470D-19	-9.553D-18	2.109D-02	1.693D-02	-2.136D-02	-1.879D-02
2	-1.126D+01	1.599D-02	1.267D-02	3.372D-02	3.579D-02	1.599D-02	1.267D-02	3.372D-02	3.579D-02
3	0.000D+00	7.151D-18	1.139D-17	8.648D-18	1.179D-17	-1.803D-02	-1.404D-02	2.574D-02	2.320D-02
4	-2.532D+00	-1.960D-02	-1.493D-02	-1.137D-02	-1.439D-02	-1.960D-02	-1.493D-02	-1.137D-02	-1.439D-02
5	0.000D+00	-1.216D-17	-8.476D-18	-2.960D-18	-4.508D-18	6.017D-03	4.471D-03	-1.787D-02	-1.685D-02
6	8.174D-02	1.405D-02	1.015D-02	4.002D-04	2.996D-03	1.405D-02	1.015D-02	4.002D-04	2.996D-03
7	0.000D+00	9.576D-18	7.438D-18	-1.313D-18	-3.828D-20	8.347D-04	5.856D-04	9.376D-03	9.542D-03
8	-1.701D-01	-7.445D-03	-5.060D-03	2.699D-03	1.061D-03	-7.445D-03	-5.060D-03	2.699D-03	1.061D-03
9	0.000D+00	-5.730D-18	-3.592D-18	5.698D-18	1.699D-18	-2.639D-03	-1.736D-03	-3.839D-03	-4.465D-03
10	2.479D-01	3.054D-03	1.942D-03	-2.494D-03	-1.708D-03	3.054D-03	1.942D-03	-2.494D-03	-1.708D-03
11	0.000D+00	2.598D-18	1.584D-18	-2.800D-18	-2.110D-18	2.209D-03	1.358D-03	1.101D-03	1.709D-03
12	-4.072D-01	-8.754D-04	-5.198D-04	1.525D-03	1.266D-03	-8.754D-04	-5.198D-04	1.525D-03	1.266D-03
13	0.000D+00	-5.861D-19	-3.464D-19	1.806D-18	1.217D-18	-1.325D-03	-7.599D-04	-6.360D-05	-4.777D-04
14	-1.710D-01	4.586D-05	2.540D-05	-7.347D-04	-7.186D-04	4.586D-05	2.540D-05	-7.347D-04	-7.186D-04
15	0.000D+00	-1.917D-19	-1.049D-19	-9.015D-19	-9.640D-19	6.440D-04	3.446D-04	-1.894D-04	3.601D-05
16	1.145D-01	1.592D-04	8.227D-05	2.835D-04	3.416D-04	1.592D-04	8.227D-05	2.835D-04	3.416D-04
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.204D-21	4.367D-21	2.869D-21	2.869D-21	3.909D-21	4.666D-21	9.670D-20	3.636D-20
1	0.000D+00	-9.226D-03	-7.407D-03	-4.535D-02	-4.647D-02	-1.551D-17	-3.000D-17	2.176D-16	3.414D-17
2	0.000D+00	3.491D-18	-6.251D-19	-8.882D-18	-1.754D-18	3.184D-18	-2.670D-18	-3.161D-16	-1.344D-16
3	0.000D+00	1.951D-02	1.519D-02	2.126D-02	2.401D-02	1.505D-17	7.765D-18	-1.805D-16	-6.120D-17
4	0.000D+00	9.625D-18	3.116D-18	1.078D-17	-1.495D-17	2.410D-17	1.711D-17	4.001D-17	3.547D-17
5	0.000D+00	-1.737D-02	-1.291D-02	-4.566D-03	-7.494D-03	-9.381D-18	-6.198D-18	1.128D-16	4.928D-17
6	0.000D+00	-1.108D-17	-8.491D-18	-6.133D-19	4.132D-18	-2.441D-17	-1.757D-17	7.538D-18	-5.562D-18
7	0.000D+00	1.056D-02	7.407D-03	-1.805D-03	3.283D-04	-1.877D-18	-1.242D-18	-4.138D-17	-2.643D-17
8	0.000D+00	8.064D-18	5.195D-18	-6.042D-18	-1.524D-18	1.559D-17	1.041D-17	-1.494D-17	-2.024D-18
9	0.000D+00	-4.932D-03	-3.244D-03	2.803D-03	1.627D-03	6.313D-18	4.086D-18	1.427D-17	1.339D-17
10	0.000D+00	-4.086D-18	-2.486D-18	4.861D-18	1.830D-18	-7.892D-18	-4.895D-18	1.099D-17	4.840D-18
11	0.000D+00	1.739D-03	1.069D-03	-2.019D-03	-1.539D-03	-6.245D-18	-3.885D-18	-4.023D-18	-6.585D-18
12	0.000D+00	1.396D-18	7.636D-19	-2.302D-18	-2.535D-18	2.772D-18	1.568D-18	-5.787D-18	-4.448D-18
13	0.000D+00	-3.449D-04	-1.978D-04	1.087D-03	9.781D-04	4.410D-18	2.537D-18	-4.341D-19	1.584D-18
14	0.000D+00	-7.857D-20	-4.702D-20	1.293D-18	1.293D-18	-1.410D-19	-1.036D-19	4.258D-18	2.266D-18
15	0.000D+00	-1.025D-04	-5.482D-05	-4.704D-04	-5.056D-04	-2.452D-18	-1.308D-18	1.235D-18	-2.599D-19
16	0.000D+00	-3.222D-19	-1.625D-19	-5.799D-19	-6.933D-19	-6.486D-19	-3.346D-19	-1.215D-18	-1.782D-18

Table 3.5.5 Cont.

region =		3	3	3	3	3	3	3	3
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-3.244D-06	-2.280D-06	-4.539D-06	-8.940D-06	-3.244D-06	-2.280D-06	-4.539D-06	-8.940D-06
1	0.000D+00	-1.191D-19	-3.738D-18	2.064D-16	-3.054D-17	-5.817D-02	-4.074D-02	-9.042D-02	-1.711D-01
2	-1.126D+01	-5.295D-02	-3.687D-02	-9.988D-02	-1.762D-01	-5.295D-02	-3.687D-02	-9.988D-02	-1.762D-01
3	0.000D+00	-2.491D-17	-1.258D-17	9.335D-17	2.770D-17	-3.291D-02	-2.273D-02	-8.588D-02	-1.359D-01
4	-2.532D+00	-1.365D-02	-9.335D-03	-6.387D-02	-8.612D-02	-1.365D-02	-9.335D-03	-6.387D-02	-8.612D-02
5	0.000D+00	-2.145D-17	-1.452D-17	2.172D-17	1.851D-18	-1.524D-03	-1.029D-03	-4.305D-02	-4.573D-02
6	8.174D-02	3.642D-03	2.426D-03	-2.695D-02	-1.959D-02	3.642D-03	2.426D-03	-2.695D-02	-1.959D-02
7	0.000D+00	-8.526D-18	-5.505D-18	8.720D-18	-1.344D-17	4.424D-03	2.901D-03	-1.591D-02	-5.574D-03
8	-1.701D-01	3.316D-03	2.136D-03	-8.949D-03	4.547D-04	3.316D-03	2.136D-03	-8.949D-03	4.547D-04
9	0.000D+00	-1.677D-18	-9.740D-19	-1.596D-19	-5.598D-18	1.875D-03	1.185D-03	-4.844D-03	2.157D-03
10	2.479D-01	7.766D-04	4.809D-04	-2.550D-03	1.989D-03	7.766D-04	4.809D-04	-2.550D-03	1.989D-03
11	0.000D+00	-2.555D-20	-1.973D-20	1.990D-20	-9.386D-19	1.497D-04	9.071D-05	-1.323D-03	1.294D-03
12	-4.072D-01	-1.129D-04	-6.684D-05	-6.882D-04	6.560D-04	-1.129D-04	-6.684D-05	-6.882D-04	6.560D-04
13	0.000D+00	-1.197D-19	-6.865D-20	2.369D-19	3.151D-19	-1.660D-04	-9.600D-05	-3.654D-04	2.412D-04
14	-1.710D-01	-1.306D-04	-7.368D-05	-2.010D-04	3.056D-05	-1.306D-04	-7.368D-05	-2.010D-04	3.056D-05
15	0.000D+00	-1.882D-19	-1.047D-19	6.709D-20	2.083D-19	-7.650D-05	-4.207D-05	-1.151D-04	-4.703D-05
16	1.145D-01	-3.348D-05	-1.793D-05	-6.809D-05	-5.686D-05	-3.348D-05	-1.793D-05	-6.809D-05	-5.686D-05

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	4.696D-22	3.261D-20	-1.702D-20	-2.846D-20	-9.123D-21	2.797D-20	-6.139D-21	2.819D-20
1	0.000D+00	-3.228D-02	-2.261D-02	2.579D-01	2.131D-01	3.383D-17	-3.637D-17	3.085D-17	3.073D-16
2	0.000D+00	3.184D-18	8.237D-18	3.435D-17	-7.591D-17	2.191D-17	2.995D-18	5.599D-17	1.111D-16
3	0.000D+00	-5.279D-02	-3.647D-02	1.092D-01	2.889D-02	2.189D-17	1.574D-17	6.881D-17	1.892D-16
4	0.000D+00	1.068D-17	1.487D-17	4.615D-17	4.615D-17	2.388D-17	2.293D-17	8.550D-17	1.417D-16
5	0.000D+00	-2.998D-02	-2.025D-02	2.907D-02	-2.461D-02	3.689D-19	4.696D-19	6.019D-17	6.440D-17
6	0.000D+00	-1.361D-18	-5.341D-19	2.164D-17	2.164D-17	-3.473D-18	-3.765D-18	4.452D-17	3.076D-17
7	0.000D+00	-9.023D-03	-5.916D-03	5.228D-03	-1.578D-02	-8.384D-18	-5.384D-18	3.043D-17	5.441D-18
8	0.000D+00	-3.574D-18	-2.376D-18	9.582D-18	-1.528D-18	-7.043D-18	-4.443D-18	1.902D-17	-6.441D-18
9	0.000D+00	-1.306D-03	-8.252D-04	4.974D-04	-4.361D-03	-4.413D-18	-2.809D-18	1.149D-17	-8.123D-18
10	0.000D+00	-9.921D-19	-6.300D-19	3.365D-18	-2.596D-18	-2.045D-18	-1.264D-18	6.697D-18	-6.664D-18
11	0.000D+00	-1.526D-05	-9.246D-06	-8.511D-06	-2.701D-04	-4.232D-19	-2.590D-19	3.749D-18	-3.718D-18
12	0.000D+00	1.601D-19	9.248D-20	1.071D-18	-9.740D-19	3.422D-19	2.052D-19	2.123D-18	-1.975D-18
13	0.000D+00	-7.120D-05	-4.117D-05	1.253D-05	2.743D-04	5.495D-19	3.183D-19	1.212D-18	-7.214D-19
14	0.000D+00	2.325D-19	1.321D-19	3.599D-19	4.671D-20	4.677D-19	2.623D-19	7.158D-19	-8.462D-21
15	0.000D+00	-9.877D-05	-5.431D-05	1.822D-05	1.066D-04	2.919D-19	1.612D-19	4.383D-19	2.438D-19
16	0.000D+00	6.811D-20	3.696D-20	1.384D-19	1.061D-19	1.365D-19	7.247D-20	2.754D-19	2.555D-19

Table 3.5.5 Cont.

region =		4	4	4	4	4	4	4	4
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.058D-06	-7.433D-07	-6.794D-06	-7.376D-06	-1.058D-06	-7.433D-07	-6.794D-06	-7.376D-06
1	0.000D+00	-2.090D-17	1.894D-17	4.072D-17	4.072D-17	-5.015D-03	-3.513D-03	-1.106D-01	-1.134D-01
2	-1.126D+01	1.595D-02	1.111D-02	-8.156D-02	-7.249D-02	1.595D-02	1.111D-02	-8.156D-02	-7.249D-02
3	0.000D+00	-5.210D-18	3.294D-19	-4.736D-17	-3.590D-18	2.753D-02	1.902D-02	-2.969D-02	-1.363D-02
4	-2.532D+00	2.223D-02	1.520D-02	6.747D-03	2.014D-02	2.223D-02	1.520D-02	6.747D-03	2.014D-02
5	0.000D+00	1.231D-17	6.505D-18	-1.165D-17	-6.382D-18	8.927D-03	6.031D-03	1.936D-02	2.494D-02
6	8.174D-02	-1.910D-03	-1.273D-03	1.642D-02	1.516D-02	-1.910D-03	-1.273D-03	1.642D-02	1.516D-02
7	0.000D+00	5.335D-18	3.134D-18	5.471D-18	6.414D-18	-6.170D-03	-4.045D-03	8.525D-03	4.290D-03
8	-1.701D-01	-5.336D-03	-3.437D-03	2.049D-03	-1.802D-03	-5.336D-03	-3.437D-03	2.049D-03	-1.802D-03
9	0.000D+00	-2.555D-18	-1.469D-18	5.163D-18	2.501D-18	-2.652D-03	-1.676D-03	-1.173D-03	-3.193D-03
10	2.479D-01	-4.230D-04	-2.619D-04	-1.851D-03	-2.189D-03	-4.230D-04	-2.619D-04	-1.851D-03	-2.189D-03
11	0.000D+00	-1.637D-18	-9.847D-19	-8.668D-20	-9.622D-19	6.144D-04	3.723D-04	-1.325D-03	-7.959D-04
12	-4.072D-01	7.255D-04	4.296D-04	-5.908D-04	7.270D-05	7.255D-04	4.296D-04	-5.908D-04	7.270D-05
13	0.000D+00	2.363D-19	1.530D-19	-8.271D-19	-5.638D-19	4.423D-04	2.556D-04	-9.042D-05	3.408D-04
14	-1.710D-01	1.454D-04	8.199D-05	1.193D-04	2.704D-04	1.454D-04	8.199D-05	1.193D-04	2.704D-04
15	0.000D+00	3.002D-19	1.648D-19	-1.552D-19	1.805D-19	-2.146D-05	-1.180D-05	1.412D-04	1.167D-04
16	1.145D-01	-6.744D-05	-3.613D-05	8.994D-05	8.425D-06	-6.744D-05	-3.613D-05	8.994D-05	8.425D-06
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	9.709D-21	6.085D-21	1.833D-20	-7.451D-22	1.247D-20	1.703D-20	-1.210D-20	-5.406D-20
1	0.000D+00	-2.765D-02	-1.937D-02	2.799D-02	1.258D-02	8.365D-18	5.621D-18	-1.976D-16	-3.950D-16
2	0.000D+00	2.851D-18	8.371D-18	1.906D-17	-6.363D-17	-9.148D-18	-1.065D-17	-4.585D-16	3.768D-17
3	0.000D+00	-1.032D-02	-7.132D-03	-5.481D-02	-6.082D-02	-2.761D-17	-2.285D-17	-3.723D-17	1.475D-17
4	0.000D+00	-1.426D-17	-1.142D-17	-1.554D-18	1.015D-17	-2.733D-17	-1.921D-17	-2.176D-17	4.754D-19
5	0.000D+00	1.495D-02	1.010D-02	-1.789D-02	-8.522D-03	-1.249D-17	-7.861D-18	3.685D-18	-3.632D-17
6	0.000D+00	1.804D-18	1.794D-18	-2.085D-17	-4.145D-18	3.235D-18	2.147D-18	-1.952D-17	-5.764D-18
7	0.000D+00	5.386D-03	3.531D-03	5.509D-03	9.196D-03	1.188D-17	7.904D-18	-9.882D-18	-8.939D-18
8	0.000D+00	5.701D-18	3.682D-18	-2.212D-18	2.743D-18	1.145D-17	7.428D-18	-8.559D-19	1.365D-16
9	0.000D+00	-2.117D-03	-1.338D-03	3.538D-03	1.920D-03	6.361D-18	3.960D-18	3.958D-18	6.040D-18
10	0.000D+00	6.395D-19	4.596D-19	2.617D-18	2.500D-18	1.146D-18	7.875D-19	4.985D-18	4.045D-18
11	0.000D+00	-1.140D-03	-6.908D-04	-8.445D-05	-1.062D-03	-1.741D-18	-1.100D-18	2.119D-18	2.300D-18
12	0.000D+00	-1.126D-18	-6.672D-19	7.703D-19	-6.251D-21	-2.249D-18	-1.332D-18	1.675D-18	6.078D-19
13	0.000D+00	1.441D-04	8.330D-05	-4.533D-04	-3.118D-04	-1.476D-18	-8.560D-19	1.619D-19	-6.033D-19
14	0.000D+00	-2.631D-19	-1.501D-19	-2.749D-19	-5.489D-19	-5.220D-19	-2.957D-19	-4.887D-19	-8.541D-19
15	0.000D+00	1.575D-04	8.660D-05	-7.040D-05	1.059D-04	8.326D-20	4.617D-20	-5.317D-19	-4.668D-19
16	0.000D+00	1.372D-19	7.269D-20	-2.103D-19	-2.671D-20	2.730D-19	1.463D-19	-3.351D-19	-8.331D-20

Table 3.5.5 Cont.

region =		1	1	2	2	3	3	4	4
drinner (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		1.000D-03	0.000D+00	1.000D-03	0.000D+00	0.000D+00	1.000D-03	0.000D+00	1.000D-03
dazimthf (in)=		0.000D+00	1.000D-03	0.000D+00	1.000D-03	1.000D-03	0.000D+00	1.000D-03	0.000D+00
symmetry =		-14	-14	-14	-14	-14	-14	-14	-14

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-7.630D-09	-4.787D-09	-1.260D-10	-1.030D-10	-2.729D-09	-2.915D-09	-8.822D-10	-9.615D-10
1	0.000D+00	-1.321D-04	4.762D-05	1.097D-05	1.138D-05	-4.345D-05	-5.806D-05	-1.895D-06	-6.922D-06
2	-1.126D+01	-1.145D-04	1.701D-04	9.825D-06	8.226D-06	-2.864D-05	-6.411D-05	1.812D-05	1.031D-05
3	0.000D+00	-7.011D-05	1.162D-04	-1.000D-05	-1.201D-05	-2.723D-06	-5.510D-05	2.695D-05	2.302D-05
4	-2.532D+00	-3.569D-05	-2.519D-05	-1.387D-05	-1.223D-05	1.698D-05	-4.096D-05	1.873D-05	2.255D-05
5	0.000D+00	-1.879D-05	-7.984D-05	2.781D-06	5.988D-06	2.493D-05	-2.758D-05	3.928D-06	1.308D-05
6	8.174D-02	-1.218D-05	-2.975D-05	1.141D-05	1.098D-05	2.343D-05	-1.725D-05	-6.362D-06	2.616D-06
7	0.000D+00	-8.663D-06	2.629D-05	2.283D-06	-8.327D-07	1.725D-05	-1.016D-05	-8.642D-06	-3.825D-06
8	-1.701D-01	-5.665D-06	2.838D-05	-6.624D-06	-7.413D-06	1.035D-05	-5.704D-06	-5.623D-06	-5.499D-06
9	0.000D+00	-3.318D-06	6.939D-07	-3.758D-06	-1.613D-06	4.861D-06	-3.078D-06	-1.536D-06	-4.168D-06
10	2.479D-01	-1.922D-06	-1.371D-05	2.677D-06	3.997D-06	1.401D-06	-1.613D-06	1.032D-06	-1.970D-06
11	0.000D+00	-1.230D-06	-6.843D-06	3.103D-06	2.053D-06	-3.107D-07	-8.324D-07	1.658D-06	-2.557D-07
12	-4.072D-01	-8.431D-07	3.411D-06	-4.707D-07	-1.701D-06	-8.658D-07	-4.300D-07	1.132D-06	5.698D-07
13	0.000D+00	-5.536D-07	4.860D-06	-1.877D-06	-1.601D-06	-8.210D-07	-2.266D-07	3.715D-07	6.923D-07
14	-1.710D-01	-3.353D-07	6.227D-07	-3.657D-07	4.925D-07	-5.627D-07	-1.238D-07	-1.172D-07	4.743D-07
15	0.000D+00	-1.990D-07	-2.006D-06	8.826D-07	9.873D-07	-3.005D-07	-7.043D-08	-2.569D-07	2.033D-07
16	1.145D-01	-1.262D-07	-1.206D-06	4.805D-07	3.003D-09	-1.144D-07	-4.147D-08	-1.881D-07	1.754D-08

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	5.949D-05	4.391D-05	1.004D-06	8.780D-07	2.545D-05	2.659D-05	8.241D-06	8.728D-06
1	0.000D+00	4.306D-01	-6.159D-02	-4.534D-02	-4.647D-02	2.131D-01	2.579D-01	1.260D-02	2.802D-02
2	0.000D+00	1.679D-01	-3.518D-01	-2.619D-02	-2.327D-02	1.089D-01	1.814D-01	-5.171D-02	-3.574D-02
3	0.000D+00	3.035D-02	-2.249D-01	2.125D-02	2.400D-02	2.895D-02	1.093D-01	-6.082D-02	-5.480D-02
4	0.000D+00	-3.269D-04	-1.182D-02	2.238D-02	2.058D-02	-1.200D-02	5.907D-02	-3.598D-02	-4.067D-02
5	0.000D+00	5.476D-03	6.121D-02	-4.553D-03	-7.481D-03	-2.458D-02	2.910D-02	-8.539D-03	-1.790D-02
6	0.000D+00	8.898D-03	2.265D-02	-1.334D-02	-1.301D-02	-2.260D-02	1.304D-02	6.441D-03	-1.426D-03
7	0.000D+00	5.343D-03	-1.859D-02	-1.814D-03	3.190D-04	-1.578D-02	5.242D-03	9.193D-03	5.500D-03
8	0.000D+00	1.295D-03	-1.943D-02	6.199D-03	6.679D-03	-9.116D-03	1.823D-03	5.910D-03	5.826D-03
9	0.000D+00	-6.285D-05	-2.261D-03	2.808D-03	1.633D-03	-4.366D-03	5.037D-04	1.924D-03	3.538D-03
10	0.000D+00	2.113D-04	6.081D-03	-2.182D-03	-2.840D-03	-1.598D-03	8.348D-05	-4.245D-04	1.249D-03
11	0.000D+00	4.830D-04	3.045D-03	-2.020D-03	-1.541D-03	-2.727D-04	-6.010D-06	-1.061D-03	-8.263D-05
12	0.000D+00	3.336D-04	-1.459D-03	4.342D-04	9.527D-04	2.038D-04	-1.819D-06	-7.819D-04	-5.165D-04
13	0.000D+00	8.791D-05	-2.031D-03	1.087D-03	9.791D-04	2.738D-04	1.345D-05	-3.124D-04	-4.530D-04
14	0.000D+00	-1.010D-05	-3.600D-04	1.215D-04	-1.919D-04	1.995D-04	2.000D-05	-1.183D-06	-2.431D-04
15	0.000D+00	7.717D-06	6.263D-04	-4.699D-04	-5.057D-04	1.067D-04	1.855D-05	1.058D-04	-7.063D-05
16	0.000D+00	3.215D-05	3.802D-04	-1.959D-04	-4.204D-05	3.996D-05	1.365D-05	9.109D-05	1.690D-05

Table 3.5.5 Cont.

region =	1	2	3	4	1	2	3	4
drinner (in)=	1.000D-03	1.000D-03	1.000D-03	1.000D-03	-1.000D-03	-1.000D-03	-1.000D-03	-1.000D-03
drouter (in)=	1.000D-03	1.000D-03	1.000D-03	1.000D-03	-1.000D-03	-1.000D-03	-1.000D-03	-1.000D-03
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	14	14	14	14	23	23	23	23

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.239D-05	-4.075D-07	-5.520D-06	-1.800D-06	2.244D-05	4.084D-07	5.539D-06	1.806D-06
1	0.000D+00	-1.528D-01	3.800D-02	-9.885D-02	-8.523D-03	-1.531D-01	3.809D-02	-9.919D-02	-8.553D-03
2	-1.126D+01	1.065D-01	2.866D-02	-8.976D-02	2.704D-02	-1.068D-01	-2.872D-02	9.008D-02	-2.713D-02
3	0.000D+00	1.378D-01	-3.205D-02	-5.561D-02	4.651D-02	1.381D-01	-3.213D-02	-5.581D-02	4.668D-02
4	-2.532D+00	9.761D-03	-3.452D-02	-2.297D-02	3.741D-02	-9.787D-03	3.461D-02	2.306D-02	-3.754D-02
5	0.000D+00	-5.809D-02	1.048D-02	-2.552D-03	1.495D-02	-5.826D-02	1.051D-02	-2.561D-03	1.501D-02
6	8.174D-02	-2.895D-02	2.418D-02	6.064D-03	-3.181D-03	2.904D-02	-2.426D-02	-6.088D-03	3.194D-03
7	0.000D+00	1.258D-02	1.420D-03	7.320D-03	-1.021D-02	1.262D-02	1.424D-03	7.350D-03	-1.025D-02
8	-1.701D-01	1.760D-02	-1.250D-02	5.448D-03	-8.767D-03	-1.766D-02	1.255D-02	-5.472D-03	8.805D-03
9	0.000D+00	2.288D-03	-4.372D-03	3.058D-03	-4.325D-03	2.297D-03	-4.390D-03	3.072D-03	-4.345D-03
10	2.479D-01	-6.255D-03	4.993D-03	1.257D-03	-6.844D-04	6.283D-03	-5.015D-03	-1.262D-03	6.877D-04
11	0.000D+00	-3.531D-03	3.564D-03	2.402D-04	9.859D-04	-3.548D-03	3.581D-03	2.414D-04	9.908D-04
12	-4.072D-01	1.131D-03	-1.394D-03	-1.796D-04	1.154D-03	-1.137D-03	1.401D-03	1.805D-04	-1.160D-03
13	0.000D+00	1.959D-03	-2.083D-03	-2.618D-04	6.975D-04	1.970D-03	-2.095D-03	-2.632D-04	7.013D-04
14	-1.710D-01	3.740D-04	7.119D-05	-2.041D-04	2.271D-04	-3.762D-04	-7.162D-05	2.053D-04	-2.284D-04
15	0.000D+00	-6.418D-04	9.876D-04	-1.165D-04	-3.323D-05	-6.459D-04	9.939D-04	-1.192D-04	-3.343D-05
16	1.145D-01	-4.180D-04	2.412D-04	-5.136D-05	-1.035D-04	4.208D-04	-2.428D-04	5.168D-05	1.041D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.333D-21	1.489D-21	-1.405D-20	1.463D-20	-9.649D-21	1.556D-21	2.476D-20	-1.393D-20
1	0.000D+00	-4.208D-17	-5.489D-17	3.888D-17	1.356D-17	1.138D-16	-1.390D-18	8.140D-17	-1.976D-17
2	0.000D+00	-2.035D-17	-1.056D-17	4.736D-17	-2.861D-17	3.231D-17	3.002D-17	-7.455D-17	1.607D-17
3	0.000D+00	-1.335D-16	2.377D-17	4.335D-17	-4.708D-17	-1.249D-16	3.613D-17	4.584D-17	-5.374D-17
4	0.000D+00	-9.733D-18	4.149D-17	3.550D-17	-4.470D-17	1.972D-17	-4.598D-17	-2.679D-17	4.366D-17
5	0.000D+00	8.285D-17	-1.517D-17	-4.637D-19	-2.153D-17	8.134D-17	-1.587D-17	5.226D-18	-2.180D-17
6	0.000D+00	4.810D-17	-3.936D-17	-8.375D-18	5.174D-18	-4.691D-17	4.023D-17	1.119D-17	-4.364D-18
7	0.000D+00	-2.341D-17	-2.956D-18	-1.386D-17	1.954D-17	-2.444D-17	-2.272D-18	-1.432D-17	1.997D-17
8	0.000D+00	-3.729D-17	2.638D-17	-1.164D-17	1.874D-17	3.791D-17	-2.685D-17	1.168D-17	-1.886D-17
9	0.000D+00	-5.566D-18	1.046D-17	-7.252D-18	1.033D-17	-5.614D-18	1.047D-17	-7.276D-18	1.020D-17
10	0.000D+00	1.642D-17	-1.309D-17	-3.301D-18	1.868D-18	-1.649D-17	1.322D-17	3.320D-18	-1.833D-18
11	0.000D+00	1.007D-17	-1.019D-17	-6.790D-19	-2.828D-18	1.018D-17	-1.021D-17	-6.911D-19	-2.875D-18
12	0.000D+00	-3.547D-18	4.343D-18	5.550D-19	-3.579D-18	3.419D-18	-4.403D-18	-5.620D-19	3.583D-18
13	0.000D+00	-6.511D-18	6.941D-18	8.727D-19	-2.329D-18	-6.568D-18	6.947D-18	8.756D-19	-2.334D-18
14	0.000D+00	-1.354D-18	-2.486D-19	7.302D-19	-8.119D-19	1.339D-18	2.313D-19	-7.326D-19	8.092D-19
15	0.000D+00	2.446D-18	-3.755D-18	4.525D-19	1.279D-19	2.460D-18	-3.788D-18	4.536D-19	1.321D-19
16	0.000D+00	1.694D-18	-9.819D-19	2.079D-19	4.187D-19	-1.708D-18	9.768D-19	-2.088D-19	-4.206D-19

Table 3.5.5 Cont.

region	=	1	2	3	4	1	2	3	4
drinner	(in)=	1.000D-02	1.000D-02	1.000D-02	1.000D-02	-1.000D-03	-1.000D-03	-1.000D-03	-1.000D-03
drouter	(in)=	1.000D-02	1.000D-02	1.000D-02	1.000D-02	-1.000D-03	-1.000D-03	-1.000D-03	-1.000D-03
dazimthi	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	14	14	14	14	23	23	23	23
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.218D-04	-4.038D-06	-5.436D-05	-1.772D-05	2.244D-05	4.084D-07	5.539D-06	1.806D-06
1	0.000D+00	-1.513D+00	3.764D-01	-9.732D-01	-8.392D-02	-1.531D-01	3.809D-02	-9.919D-02	-8.553D-03
2	-1.126D+01	1.054D+00	2.837D-01	-8.835D-01	2.661D-01	-1.068D-01	-2.872D-02	9.008D-02	-2.713D-02
3	0.000D+00	1.363D+00	-3.170D-01	-5.472D-01	4.577D-01	1.381D-01	-3.213D-02	-5.581D-02	4.668D-02
4	-2.532D+00	9.645D-02	-3.411D-01	-2.259D-01	3.679D-01	-9.787D-03	3.461D-02	2.306D-02	-3.754D-02
5	0.000D+00	-5.734D-01	1.035D-01	-2.508D-02	1.469D-01	-5.826D-02	1.051D-02	-2.561D-03	1.501D-02
6	8.174D-02	-2.854D-01	2.384D-01	5.956D-02	-3.125D-02	2.904D-02	-2.426D-02	-6.088D-03	3.194D-03
7	0.000D+00	1.238D-01	1.397D-02	7.165D-02	-1.002D-01	1.262D-02	1.424D-03	7.350D-03	-1.025D-02
8	-1.701D-01	1.730D-01	-1.229D-01	5.344D-02	-8.599D-02	-1.766D-02	1.255D-02	-5.472D-03	8.805D-03
9	0.000D+00	2.246D-02	-4.291D-02	2.997D-02	-4.238D-02	2.297D-03	-4.390D-03	3.072D-03	-4.345D-03
10	2.479D-01	-6.130D-02	4.893D-02	1.230D-02	-6.701D-03	6.283D-03	-5.015D-03	-1.262D-03	6.877D-04
11	0.000D+00	-3.455D-02	3.487D-02	2.350D-03	9.642D-03	-3.548D-03	3.581D-03	2.414D-04	9.908D-04
12	-4.072D-01	1.105D-02	-1.362D-02	-1.754D-03	1.128D-02	-1.137D-03	1.401D-03	1.805D-04	-1.160D-03
13	0.000D+00	1.910D-02	-2.032D-02	-2.555D-03	6.807D-03	1.970D-03	-2.095D-03	-2.632D-04	7.013D-04
14	-1.710D-01	3.641D-03	6.932D-04	-1.990D-03	2.214D-03	-3.762D-04	-7.162D-05	2.053D-04	-2.284D-04
15	0.000D+00	-6.239D-03	9.601D-03	-1.153D-03	-3.235D-04	-6.459D-04	9.939D-04	-1.192D-04	-3.343D-05
16	1.145D-01	-4.057D-03	2.341D-03	-4.994D-04	-1.006D-03	4.208D-04	-2.428D-04	5.168D-05	1.041D-04
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	5.068D-20	3.104D-21	3.719D-20	7.293D-21	-9.649D-21	1.556D-21	2.476D-20	-1.393D-20
1	0.000D+00	5.237D-16	-2.015D-16	4.234D-16	3.796D-17	1.138D-16	-1.390D-18	8.140D-17	-1.976D-17
2	0.000D+00	-7.376D-16	-1.918D-16	6.234D-16	-1.819D-16	3.231D-17	3.002D-17	-7.455D-17	1.607D-17
3	0.000D+00	-1.293D-15	2.988D-16	5.070D-16	-4.277D-16	-1.249D-16	3.613D-17	4.584D-17	-5.374D-17
4	0.000D+00	-1.166D-16	4.044D-16	2.741D-16	-4.364D-16	1.972D-17	-4.598D-17	-2.679D-17	4.366D-17
5	0.000D+00	8.191D-16	-1.460D-16	3.837D-17	-2.092D-16	8.134D-17	-1.587D-17	5.226D-18	-2.180D-17
6	0.000D+00	4.730D-16	-3.963D-16	-9.951D-17	5.164D-17	-4.691D-17	4.023D-17	1.119D-17	-4.364D-18
7	0.000D+00	-2.360D-16	-2.697D-17	-1.365D-16	1.904D-16	-2.444D-17	-2.272D-18	-1.432D-17	1.997D-17
8	0.000D+00	-3.704D-16	2.628D-16	-1.144D-16	1.840D-16	3.791D-17	-2.685D-17	1.168D-17	-1.886D-17
9	0.000D+00	-5.341D-17	1.022D-16	-7.123D-17	1.008D-16	-5.614D-18	1.047D-17	-7.276D-18	1.020D-17
10	0.000D+00	1.605D-16	-1.278D-16	-3.217D-17	1.762D-17	-1.649D-17	1.322D-17	3.320D-18	-1.833D-18
11	0.000D+00	9.856D-17	-9.949D-17	-6.704D-18	-2.757D-17	1.018D-17	-1.021D-17	-6.911D-19	-2.825D-18
12	0.000D+00	-3.418D-17	4.214D-17	5.428D-18	-3.489D-17	3.419D-18	-4.403D-18	-5.620D-19	3.583D-18
13	0.000D+00	-6.363D-17	6.763D-17	8.510D-18	-2.269D-17	-6.568D-18	6.947D-18	8.756D-19	-2.334D-18
14	0.000D+00	-1.300D-17	-2.446D-18	7.101D-18	-7.902D-18	1.339D-18	2.313D-19	-7.326D-19	8.092D-19
15	0.000D+00	2.376D-17	-3.654D-17	4.392D-18	1.233D-18	2.460D-18	-3.788D-18	4.536D-19	1.321D-19
16	0.000D+00	1.642D-17	-9.476D-18	2.019D-18	4.071D-18	-1.708D-18	9.768D-19	-2.088D-19	-4.206D-19

Table 3.5.5 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	1.000D-03	5.000D-03	1.000D-02	2.000D-02	3.000D-02	4.000D-02	5.000D-02	6.000D-02
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.416D-05	-1.209D-04	-2.418D-04	-4.842D-04	-7.269D-04	-9.702D-04	-1.214D-03	-1.458D-03
1	0.000D+00	-3.148D-01	-1.574D+00	-3.146D+00	-6.287D+00	-9.423D+00	-1.255D+01	-1.568D+01	-1.880D+01
2	-1.126D+01	-1.204D-01	-6.004D-01	-1.197D+00	-2.376D+00	-3.537D+00	-4.682D+00	-5.809D+00	-6.918D+00
3	0.000D+00	4.384D-02	2.204D-01	4.437D-01	8.991D-01	1.366D+00	1.844D+00	2.334D+00	2.834D+00
4	-2.532D+00	6.175D-02	3.085D-01	6.163D-01	1.230D+00	1.840D+00	2.448D+00	3.052D+00	3.653D+00
5	0.000D+00	1.103D-02	5.434D-02	1.067D-01	2.052D-01	2.957D-01	3.781D-01	4.524D-01	5.187D-01
6	8.174D-02	-1.857D-02	-9.314D-02	-1.870D-01	-3.769D-01	-5.695D-01	-7.647D-01	-9.624D-01	-1.162D+00
7	0.000D+00	-1.223D-02	-6.090D-02	-1.211D-01	-2.395D-01	-3.551D-01	-4.678D-01	-5.775D-01	-6.842D-01
8	-1.701D-01	2.094D-03	1.076D-02	2.222D-02	4.726D-02	7.506D-02	1.056D-01	1.388D-01	1.746D-01
9	0.000D+00	5.782D-03	2.892D-02	5.784D-02	1.157D-01	1.734D-01	2.310D-01	2.884D-01	3.454D-01
10	2.479D-01	1.623D-03	7.978D-03	1.561D-02	2.983D-02	4.264D-02	5.404D-02	6.400D-02	7.253D-02
11	0.000D+00	-1.653D-03	-8.332D-03	-1.683D-02	-3.431D-02	-5.240D-02	-7.107D-02	-9.027D-02	-1.100D-01
12	-4.072D-01	-1.364D-03	-6.784D-03	-1.348D-02	-2.659D-02	-3.930D-02	-5.159D-02	-6.343D-02	-7.480D-02
13	0.000D+00	9.762D-05	5.367D-04	1.194D-03	2.869D-03	5.017D-03	7.631D-03	1.070D-02	1.421D-02
14	-1.710D-01	6.022D-04	3.017D-03	6.047D-03	1.214D-02	1.825D-02	2.438D-02	3.049D-02	3.657D-02
15	0.000D+00	2.159D-04	1.060D-03	2.068D-03	3.930D-03	5.580D-03	7.014D-03	8.229D-03	9.222D-03
16	1.845D-01	-1.568D-04	-7.957D-04	-1.621D-03	-3.355D-03	-5.196D-03	-7.136D-03	-9.166D-03	-1.128D-02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.221D-05	1.110D-04	2.218D-04	4.430D-04	6.635D-04	8.833D-04	1.103D-03	1.321D-03
1	0.000D+00	-3.143D-02	-1.587D-01	-3.213D-01	-6.581D-01	-1.010D+00	-1.378D+00	-1.761D+00	-2.160D+00
2	0.000D+00	-1.794D-01	-8.975D-01	-1.796D+00	-3.598D+00	-5.404D+00	-7.216D+00	-9.032D+00	-1.085D+01
3	0.000D+00	-1.145D-01	-5.713D-01	-1.140D+00	-2.270D+00	-3.389D+00	-4.498D+00	-5.595D+00	-6.683D+00
4	0.000D+00	-5.948D-03	-2.860D-02	-5.434D-02	-9.731D-02	-1.290D-01	-1.495D-01	-1.589D-01	-1.573D-01
5	0.000D+00	3.102D-02	1.552D-01	3.108D-01	6.231D-01	9.366D-01	1.251D+00	1.567D+00	1.883D+00
6	0.000D+00	1.142D-02	5.658D-02	1.119D-01	2.188D-01	3.207D-01	4.174D-01	5.090D-01	5.954D-01
7	0.000D+00	-9.385D-03	-4.724D-02	-9.528D-02	-1.937D-01	-2.952D-01	-3.996D-01	-5.069D-01	-6.169D-01
8	0.000D+00	-9.765D-03	-4.872D-02	-9.719D-02	-1.933D-01	-2.882D-01	-3.819D-01	-4.743D-01	-5.652D-01
9	0.000D+00	-1.124D-03	-5.408D-03	-1.028D-02	-1.842D-02	-2.443D-02	-2.833D-02	-3.011D-02	-2.981D-02
10	0.000D+00	3.053D-03	1.532D-02	3.077D-02	6.205D-02	9.379D-02	1.259D-01	1.584D-01	1.911D-01
11	0.000D+00	1.522D-03	7.535D-03	1.488D-02	2.896D-02	4.224D-02	5.468D-02	6.626D-02	7.697D-02
12	0.000D+00	-7.338D-04	-3.731D-03	-7.615D-03	-1.583D-02	-2.463D-02	-3.400D-02	-4.390D-02	-5.432D-02
13	0.000D+00	-1.016D-03	-5.071D-03	-1.012D-02	-2.014D-02	-3.002D-02	-3.976D-02	-4.932D-02	-5.869D-02
14	0.000D+00	-1.784D-04	-8.587D-04	-1.633D-03	-2.930D-03	-3.890D-03	-4.512D-03	-4.797D-03	-4.749D-03
15	0.000D+00	3.139D-04	1.581D-03	3.190D-03	6.485D-03	9.874D-03	1.334D-02	1.688D-02	2.047D-02
16	0.000D+00	1.897D-04	9.381D-04	1.850D-03	3.591D-03	5.216D-03	6.720D-03	8.097D-03	9.342D-03

Table 3.5.5 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1
n	**bideal**	**db**	**db**	**db**	**db**	**db**	**db**	**db**	**db**
0	1.000D+00	5.893D-06	2.955D-05	5.931D-05	1.195D-04	1.805D-04	2.423D-04	3.050D-04	3.686D-04
1	0.000D+00	4.082D-02	2.047D-01	4.109D-01	8.260D-01	1.251D+00	1.681D+00	2.116D+00	2.558D+00
2	-1.126D+01	-2.890D-02	-1.450D-01	-2.911D-01	-5.868D-01	-8.872D-01	-1.192D+00	-1.502D+00	-1.817D+00
3	0.000D+00	-3.796D-02	-1.905D-01	-3.826D-01	-7.718D-01	-1.168D+00	-1.571D+00	-1.980D+00	-2.397D+00
4	-2.532D+00	-2.731D-03	-1.371D-02	-2.755D-02	-5.563D-02	-8.424D-02	-1.134D-01	-1.431D-01	-1.734D-01
5	0.000D+00	1.651D-02	8.290D-02	1.667D-01	3.369D-01	5.107D-01	6.882D-01	8.695D-01	1.055D+00
6	8.174D-02	8.355D-03	4.197D-02	8.442D-02	1.708D-01	2.593D-01	3.498D-01	4.425D-01	5.374D-01
7	0.000D+00	-3.685D-03	-1.852D-02	-3.728D-02	-7.553D-02	-1.148D-01	-1.551D-01	-1.964D-01	-2.388D-01
8	-1.701D-01	-5.234D-03	-2.632D-02	-5.301D-02	-1.075D-01	-1.636D-01	-2.214D-01	-2.808D-01	-3.419D-01
9	0.000D+00	-6.905D-04	-3.474D-03	-7.003D-03	-1.423D-02	-2.168D-02	-2.937D-02	-3.731D-02	-4.550D-02
10	2.479D-01	1.916D-03	9.643D-03	1.945D-02	3.957D-02	6.039D-02	8.194D-02	1.042D-01	1.273D-01
11	0.000D+00	1.097D-03	5.524D-03	1.115D-02	2.272D-02	3.472D-02	4.719D-02	6.012D-02	7.356D-02
12	-4.072D-01	-3.563D-04	-1.796D-03	-3.627D-03	-7.402D-03	-1.133D-02	-1.542D-02	-1.968D-02	-2.412D-02
13	0.000D+00	-6.252D-04	-3.153D-03	-6.374D-03	-1.303D-02	-1.998D-02	-2.723D-02	-3.481D-02	-4.274D-02
14	-1.710D-01	-1.209D-04	-6.103D-04	-1.235D-03	-2.528D-03	-3.882D-03	-5.301D-03	-6.789D-03	-8.348D-03
15	0.000D+00	2.102D-04	1.061D-03	2.149D-03	4.407D-03	6.780D-03	9.274D-03	1.190D-02	1.466D-02
16	1.145D-01	1.386D-04	7.004D-04	1.419D-03	2.915D-03	4.492D-03	6.156D-03	7.910D-03	9.763D-03
n	**aideal**	**da**	**da**	**da**	**da**	**da**	**da**	**da**	**da**
0	0.000D+00	4.198D-06	2.105D-05	4.224D-05	8.509D-05	1.285D-04	1.726D-04	2.173D-04	2.626D-04
1	0.000D+00	1.180D-01	5.918D-01	1.188D+00	2.394D+00	3.617D+00	4.859D+00	6.118D+00	7.397D+00
2	0.000D+00	9.833D-02	4.932D-01	9.903D-01	1.996D+00	3.018D+00	4.057D+00	5.111D+00	6.182D+00
3	0.000D+00	2.983D-02	1.497D-01	3.006D-01	6.065D-01	9.177D-01	1.234D+00	1.556D+00	1.884D+00
4	0.000D+00	1.288D-04	6.465D-04	1.299D-03	2.623D-03	3.973D-03	5.348D-03	6.749D-03	8.178D-03
5	0.000D+00	1.062D-02	5.334D-02	1.072D-01	2.168D-01	3.286D-01	4.428D-01	5.595D-01	6.786D-01
6	0.000D+00	2.091D-02	1.050D-01	2.113D-01	4.275D-01	6.489D-01	8.755D-01	1.107D+00	1.345D+00
7	0.000D+00	1.514D-02	7.609D-02	1.532D-01	3.103D-01	4.716D-01	6.371D-01	8.069D-01	9.812D-01
8	0.000D+00	4.527D-03	2.276D-02	4.585D-02	9.302D-02	1.415D-01	1.915D-01	2.429D-01	2.958D-01
9	0.000D+00	6.528D-05	3.284D-04	6.619D-04	1.345D-03	2.049D-03	2.776D-03	3.526D-03	4.301D-03
10	0.000D+00	1.109D-03	5.581D-03	1.126D-02	2.290D-02	3.495D-02	4.742D-02	6.033D-02	7.370D-02
11	0.000D+00	2.409D-03	1.213D-02	2.449D-02	4.990D-02	7.626D-02	1.036D-01	1.321D-01	1.616D-01
12	0.000D+00	1.836D-03	9.254D-03	1.869D-02	3.815D-02	5.840D-02	7.949D-02	1.014D-01	1.243D-01
13	0.000D+00	5.945D-04	2.998D-03	6.061D-03	1.239D-02	1.900D-02	2.590D-02	3.311D-02	4.064D-02
14	0.000D+00	1.721D-05	8.686D-05	1.757D-04	3.597D-04	5.525D-04	7.545D-04	9.662D-04	1.188D-03
15	0.000D+00	1.088D-04	5.493D-04	1.112D-03	2.281D-03	3.508D-03	4.799D-03	6.156D-03	7.584D-03
16	0.000D+00	2.700D-04	1.364D-03	2.764D-03	5.678D-03	8.749D-03	1.199D-02	1.541D-02	1.901D-02

Table 3.5.5 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	4.712D-06	2.363D-05	4.744D-05	9.559D-05	1.445D-04	1.941D-04	2.444D-04	2.954D-04
1	0.000D+00	3.239D-02	1.625D-01	3.262D-01	6.574D-01	9.936D-01	1.335D+00	1.681D+00	2.033D+00
2	-1.126D+01	-2.266D-02	-1.136D-01	-2.282D-01	-4.600D-01	-6.955D-01	-9.348D-01	-1.178D+00	-1.425D+00
3	0.000D+00	-2.927D-02	-1.468D-01	-2.949D-01	-5.947D-01	-8.996D-01	-1.210D+00	-1.525D+00	-1.845D+00
4	-2.532D+00	-2.063D-03	-1.035D-02	-2.079D-02	-4.196D-02	-6.350D-02	-8.542D-02	-1.077D-01	-1.304D-01
5	0.000D+00	1.217D-02	6.110D-02	1.228D-01	2.479D-01	3.754D-01	5.053D-01	6.377D-01	7.726D-01
6	8.174D-02	5.999D-03	3.012D-02	6.054D-02	1.223D-01	1.853D-01	2.496D-01	3.152D-01	3.822D-01
7	0.000D+00	-2.571D-03	-1.291D-02	-2.596D-02	-5.248D-02	-7.958D-02	-1.073D-01	-1.356D-01	-1.645D-01
8	-1.701D-01	-3.540D-03	-1.778D-02	-3.577D-02	-7.238D-02	-1.098D-01	-1.482D-01	-1.874D-01	-2.276D-01
9	0.000D+00	-4.524D-04	-2.273D-03	-4.574D-03	-9.263D-03	-1.407D-02	-1.899D-02	-2.404D-02	-2.922D-02
10	2.479D-01	1.214D-03	6.103D-03	1.229D-02	2.490D-02	3.784D-02	5.114D-02	6.479D-02	7.881D-02
11	0.000D+00	6.720D-04	3.379D-03	6.805D-03	1.380D-02	2.099D-02	2.839D-02	3.600D-02	4.383D-02
12	-4.072D-01	-2.110D-04	-1.061D-03	-2.138D-03	-4.339D-03	-6.607D-03	-8.942D-03	-1.135D-02	-1.383D-02
13	0.000D+00	-3.577D-04	-1.800D-03	-3.627D-03	-7.368D-03	-1.123D-02	-1.521D-02	-1.932D-02	-2.356D-02
14	-1.710D-01	-6.684D-05	-3.364D-04	-6.782D-04	-1.379D-03	-2.103D-03	-2.851D-03	-3.625D-03	-4.424D-03
15	0.000D+00	1.122D-04	5.649D-04	1.140D-03	2.319D-03	3.539D-03	4.802D-03	6.110D-03	7.465D-03
16	1.145D-01	7.149D-05	3.600D-04	7.264D-04	1.479D-03	2.259D-03	3.068D-03	3.907D-03	4.778D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	3.356D-06	1.683D-05	3.379D-05	6.809D-05	1.029D-04	1.382D-04	1.740D-04	2.104D-04
1	0.000D+00	9.365D-02	4.697D-01	9.430D-01	1.901D+00	2.873D+00	3.859D+00	4.861D+00	5.878D+00
2	0.000D+00	7.708D-02	3.866D-01	7.763D-01	1.565D+00	2.366D+00	3.180D+00	4.007D+00	4.847D+00
3	0.000D+00	2.300D-02	1.154D-01	2.317D-01	4.673D-01	7.069D-01	9.504D-01	1.198D+00	1.450D+00
4	0.000D+00	9.729D-05	4.882D-04	9.807D-04	1.979D-03	2.995D-03	4.029D-03	5.081D-03	6.151D-03
5	0.000D+00	7.834D-03	3.932D-02	7.901D-02	1.595D-01	2.416D-01	3.252D-01	4.103D-01	4.971D-01
6	0.000D+00	1.501D-02	7.537D-02	1.515D-01	3.061D-01	4.638D-01	6.248D-01	7.890D-01	9.565D-01
7	0.000D+00	1.056D-02	5.304D-02	1.066D-01	2.156D-01	3.270D-01	4.407D-01	5.570D-01	6.758D-01
8	0.000D+00	3.063D-03	1.538D-02	3.094D-02	6.261D-02	9.501D-02	1.282D-01	1.621D-01	1.969D-01
9	0.000D+00	4.277D-05	2.149D-04	4.324D-04	8.756D-04	1.330D-03	1.795D-03	2.273D-03	2.762D-03
10	0.000D+00	7.027D-04	3.532D-03	7.110D-03	1.441D-02	2.190D-02	2.960D-02	3.750D-02	4.561D-02
11	0.000D+00	1.476D-03	7.421D-03	1.495D-02	3.031D-02	4.611D-02	6.236D-02	7.908D-02	9.627D-02
12	0.000D+00	1.087D-03	5.469D-03	1.102D-02	2.236D-02	3.405D-02	4.609D-02	5.850D-02	7.128D-02
13	0.000D+00	3.401D-04	1.711D-03	3.449D-03	7.006D-03	1.068D-02	1.446D-02	1.837D-02	2.241D-02
14	0.000D+00	9.513D-06	4.787D-05	9.652D-05	1.962D-04	2.993D-04	4.058D-04	5.158D-04	6.297D-04
15	0.000D+00	5.807D-05	2.923D-04	5.897D-04	1.200D-03	1.831D-03	2.485D-03	3.162D-03	3.863D-03
16	0.000D+00	1.392D-04	7.011D-04	1.415D-03	2.881D-03	4.400D-03	5.976D-03	7.610D-03	9.305D-03

Table 3.5.5 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.309D-05	6.538D-05	1.306D-04	2.604D-04	3.894D-04	5.176D-04	6.451D-04	7.718D-04
1	0.000D+00	2.281D-01	1.139D+00	2.275D+00	4.537D+00	6.785D+00	9.019D+00	1.124D+01	1.345D+01
2	-1.126D+01	1.983D-01	9.906D-01	1.978D+00	3.945D+00	5.899D+00	7.842D+00	9.772D+00	1.169D+01
3	0.000D+00	1.216D-01	6.072D-01	1.213D+00	2.418D+00	3.616D+00	4.806D+00	5.989D+00	7.163D+00
4	-2.532D+00	6.203D-02	3.098D-01	6.187D-01	1.234D+00	1.844D+00	2.451D+00	3.054D+00	3.652D+00
5	0.000D+00	3.280D-02	1.638D-01	3.271D-01	6.521D-01	9.749D-01	1.295D+00	1.613D+00	1.928D+00
6	8.174D-02	2.132D-02	1.065D-01	2.126D-01	4.239D-01	6.337D-01	8.418D-01	1.048D+00	1.253D+00
7	0.000D+00	1.518D-02	7.580D-02	1.514D-01	3.018D-01	4.510D-01	5.991D-01	7.459D-01	8.912D-01
8	-1.701D-01	9.965D-03	4.976D-02	9.938D-02	1.981D-01	2.960D-01	3.932D-01	4.893D-01	5.845D-01
9	0.000D+00	5.891D-03	2.942D-02	5.874D-02	1.171D-01	1.749D-01	2.322D-01	2.889D-01	3.449D-01
10	2.479D-01	3.455D-03	1.726D-02	3.446D-02	6.867D-02	1.026D-01	1.361D-01	1.692D-01	2.019D-01
11	0.000D+00	2.233D-03	1.115D-02	2.227D-02	4.437D-02	6.627D-02	8.791D-02	1.093D-01	1.303D-01
12	-4.072D-01	1.539D-03	7.687D-03	1.535D-02	3.058D-02	4.566D-02	6.056D-02	7.525D-02	8.969D-02
13	0.000D+00	1.020D-03	5.092D-03	1.017D-02	2.025D-02	3.024D-02	4.009D-02	4.980D-02	5.933D-02
14	-1.710D-01	6.280D-04	3.136D-03	6.262D-03	1.247D-02	1.861D-02	2.467D-02	3.062D-02	3.645D-02
15	0.000D+00	3.810D-04	1.903D-03	3.799D-03	7.564D-03	1.128D-02	1.494D-02	1.853D-02	2.204D-02
16	1.145D-01	2.455D-04	1.226D-03	2.448D-03	4.873D-03	7.267D-03	9.619D-03	1.192D-02	1.416D-02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-3.009D-05	-1.505D-04	-3.011D-04	-6.024D-04	-9.039D-04	-1.206D-03	-1.508D-03	-1.810D-03
1	0.000D+00	-2.192D-01	-1.097D+00	-2.196D+00	-4.402D+00	-6.616D+00	-8.840D+00	-1.107D+01	-1.331D+01
2	0.000D+00	-8.569D-02	-4.298D-01	-8.631D-01	-1.740D+00	-2.631D+00	-3.535D+00	-4.452D+00	-5.383D+00
3	0.000D+00	-1.553D-02	-7.902D-02	-1.615D-01	-3.368D-01	-5.258D-01	-7.283D-01	-9.442D-01	-1.173D+00
4	0.000D+00	1.103D-04	-5.621D-04	-3.901D-03	-1.886D-02	-4.477D-02	-8.153D-02	-1.290D-01	-1.872D-01
5	0.000D+00	-2.814D-03	-1.487D-02	-3.173D-02	-7.142D-02	-1.190D-01	-1.743D-01	-2.374D-01	-3.081D-01
6	0.000D+00	-4.523D-03	-2.318D-02	-4.777D-02	-1.011D-01	-1.601D-01	-2.245D-01	-2.943D-01	-3.695D-01
7	0.000D+00	-2.713D-03	-1.397D-02	-2.895D-02	-6.195D-02	-9.895D-02	-1.399D-01	-1.848D-01	-2.335D-01
8	0.000D+00	-6.662D-04	-3.627D-03	-7.993D-03	-1.893D-02	-3.277D-02	-4.949D-02	-6.905D-02	-9.142D-02
9	0.000D+00	2.097D-05	-1.067D-04	-7.406D-04	-3.580D-03	-8.497D-03	-1.547D-02	-2.446D-02	-3.545D-02
10	0.000D+00	-1.133D-04	-7.139D-04	-1.795D-03	-5.051D-03	-9.752D-03	-1.568D-02	-2.342D-02	-3.234D-02
11	0.000D+00	-2.471D-04	-1.337D-03	-2.927D-03	-6.861D-03	-1.179D-02	-1.770D-02	-2.458D-02	-3.241D-02
12	0.000D+00	-1.706D-04	-9.233D-04	-2.022D-03	-4.741D-03	-8.150D-03	-1.224D-02	-1.699D-02	-2.241D-02
13	0.000D+00	-4.645D-05	-2.812D-04	-6.843D-04	-1.854D-03	-3.502D-03	-5.623D-03	-8.208D-03	-1.125D-02
14	0.000D+00	3.359D-06	-1.703D-05	-1.184D-04	-5.723D-04	-1.357D-03	-2.469D-03	-3.900D-03	-5.643D-03
15	0.000D+00	-5.019D-06	-4.823D-05	-1.541D-04	-5.377D-04	-1.148D-03	-1.980D-03	-3.031D-03	-4.294D-03
16	0.000D+00	-1.687D-05	-1.001D-04	-2.394D-04	-6.346D-04	-1.184D-03	-1.864D-03	-2.732D-03	-3.723D-03

Table 3.5.5 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.416D-05	1.207D-04	2.414D-04	4.822D-04	7.226D-04	9.625D-04	1.202D-03	1.441D-03
1	0.000D+00	3.149D-01	1.575D+00	3.151D+00	6.306D+00	9.466D+00	1.263D+01	1.580D+01	1.897D+01
2	-1.126D+01	1.206D-01	6.048D-01	1.214D+00	2.445D+00	3.694D+00	4.959D+00	6.242D+00	7.543D+00
3	0.000D+00	-4.372D-02	-2.174D-01	-4.319D-01	-8.517D-01	-1.259D+00	-1.655D+00	-2.038D+00	-2.408D+00
4	-2.532D+00	-6.177D-02	-3.091D-01	-6.189D-01	-1.240D+00	-1.864D+00	-2.489D+00	-3.116D+00	-3.745D+00
5	0.000D+00	-1.111D-02	-5.636D-02	-1.147D-01	-2.376D-01	-3.685D-01	-5.074D-01	-6.544D-01	-8.095D-01
6	8.174D-02	1.854D-02	9.239D-02	1.840D-01	3.649D-01	5.425D-01	7.166D-01	8.873D-01	1.054D+00
7	0.000D+00	1.226D-02	6.157D-02	1.238D-01	2.501D-01	3.789D-01	5.101D-01	6.436D-01	7.793D-01
8	-1.701D-01	-2.066D-03	-1.004D-02	-1.937D-02	-3.584D-02	-4.939D-02	-5.998D-02	-6.758D-02	-7.217D-02
9	0.000D+00	-5.782D-03	-2.890D-02	-5.777D-02	-1.154D-01	-1.728D-01	-2.299D-01	-2.866D-01	-3.429D-01
10	2.479D-01	-1.637D-03	-8.322D-03	-1.698D-02	-3.533D-02	-5.500D-02	-7.599D-02	-9.826D-02	-1.218D-01
11	0.000D+00	1.646D-03	8.160D-03	1.614D-02	3.157D-02	4.624D-02	6.012D-02	7.318D-02	8.540D-02
12	-4.072D-01	1.367D-03	6.869D-03	1.382D-02	2.795D-02	4.237D-02	5.704D-02	7.193D-02	8.700D-02
13	0.000D+00	-9.276D-05	-4.150D-04	-7.078D-04	-9.243D-04	-6.462D-04	1.288D-04	1.402D-03	3.172D-03
14	-1.710D-01	-6.015D-04	-3.001D-03	-5.984D-03	-1.189D-02	-1.769D-02	-2.338D-02	-2.894D-02	-3.434D-02
15	0.000D+00	-2.179D-04	-1.110D-03	-2.269D-03	-4.732D-03	-7.381D-03	-1.021D-02	-1.321D-02	-1.637D-02
16	1.145D-01	1.556D-04	7.656D-04	1.500D-03	2.873D-03	4.113D-03	5.214D-03	6.171D-03	6.980D-03

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-2.222D-05	-1.111D-04	-2.225D-04	-4.456D-04	-6.693D-04	-8.937D-04	-1.119D-03	-1.344D-03
1	0.000D+00	3.127D-02	1.548D-01	3.057D-01	5.957D-01	8.701D-01	1.129D+00	1.372D+00	1.599D+00
2	0.000D+00	1.793D-01	8.961D-01	1.791D+00	3.576D+00	5.356D+00	7.130D+00	8.898D+00	1.066D+01
3	0.000D+00	1.146D-01	5.739D-01	1.150D+00	2.311D+00	3.481D+00	4.661D+00	5.851D+00	7.051D+00
4	0.000D+00	6.062D-03	3.146D-02	6.579D-02	1.431D-01	2.320D-01	3.326D-01	4.450D-01	5.691D-01
5	0.000D+00	-3.100D-02	-1.548D-01	-3.092D-01	-6.167D-01	-9.223D-01	-1.226D+00	-1.527D+00	-1.825D+00
6	0.000D+00	-1.146D-02	-5.782D-02	-1.169D-01	-2.386D-01	-3.652D-01	-4.965D-01	-6.325D-01	-7.731D-01
7	0.000D+00	9.353D-03	4.644D-02	9.206D-02	1.808D-01	2.662D-01	3.481D-01	4.265D-01	5.012D-01
8	0.000D+00	9.775D-03	4.897D-02	9.818D-02	1.973D-01	2.972D-01	3.978D-01	4.990D-01	6.008D-01
9	0.000D+00	1.146D-03	5.944D-03	1.242D-02	2.699D-02	4.371D-02	6.257D-02	8.356D-02	1.067D-01
10	0.000D+00	-3.047D-03	-1.518D-02	-3.020D-02	-5.978D-02	-8.868D-02	-1.169D-01	-1.442D-01	-1.708D-01
11	0.000D+00	-1.530D-03	-7.725D-03	-1.564D-02	-3.200D-02	-4.907D-02	-6.681D-02	-8.519D-02	-1.042D-01
12	0.000D+00	7.276D-04	3.575D-03	6.993D-03	1.335D-02	1.905D-02	2.408D-02	2.843D-02	3.208D-02
13	0.000D+00	1.017D-03	5.091D-03	1.020D-02	2.045D-02	3.074D-02	4.103D-02	5.130D-02	6.153D-02
14	0.000D+00	1.818D-04	9.424D-04	1.968D-03	4.268D-03	6.896D-03	9.847D-03	1.311D-02	1.669D-02
15	0.000D+00	-3.127D-04	-1.552D-03	-3.072D-03	-6.015D-03	-8.817D-03	-1.147D-02	-1.396D-02	-1.627D-02
16	0.000D+00	-1.907D-04	-9.636D-04	-1.952D-03	-3.998D-03	-6.132D-03	-8.344D-03	-1.063D-02	-1.297D-02

Table 3.5.5 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		0.000D+00	1.000D-03	1.000D-03	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	1.000D-03	1.000D-03	0.000D+00	1.000D-03
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	1.000D-03	0.000D+00	1.000D-03	1.000D-03
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	1.000D-03	1.000D-03	1.000D-03
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-4.226D-20	-1.059D-05	-1.898D-05	-3.005D-05	-1.780D-05	-2.887D-05	-3.726D-05	-4.785D-05
1	0.000D+00	-5.283D-17	-7.308D-02	-2.690D-01	-3.555D-01	-2.606D-01	-3.471D-01	-5.431D-01	-6.160D-01
2	-1.126D+01	2.641D-17	5.146D-02	-1.695D-01	-9.153D-02	-1.758D-01	-9.778D-02	-3.189D-01	-2.672D-01
3	0.000D+00	1.321D-17	6.709D-02	-8.369D-02	8.171D-02	-9.239D-02	7.304D-02	-7.777D-02	-1.060D-02
4	-2.532D+00	8.254D-19	4.783D-03	-5.929D-02	6.442D-02	-5.997D-02	6.377D-02	-2.854D-04	4.498D-03
5	0.000D+00	-3.302D-18	-2.861D-02	-4.926D-02	-5.457D-03	-4.494D-02	-1.131D-03	-2.177D-02	-5.035D-02
6	8.174D-02	-3.302D-18	-1.431D-02	-2.964D-02	-2.688D-02	-2.730D-02	-2.454D-02	-3.990D-02	-5.412D-02
7	0.000D+00	1.238D-18	6.237D-03	-1.149D-02	-8.538D-03	-1.261D-02	-9.655D-03	-2.742D-02	-2.111D-02
8	-1.701D-01	8.254D-19	8.746D-03	-4.733D-03	7.309D-03	-6.425D-03	5.624D-03	-7.873D-03	8.976D-04
9	0.000D+00	1.548D-19	1.139D-03	-5.193D-03	6.458D-03	-5.434D-03	6.225D-03	-1.082D-04	1.031D-03
10	2.479D-01	-1.032D-19	-3.118D-03	-5.358D-03	-2.900D-04	-4.663D-03	4.096D-04	-1.833D-03	-4.943D-03
11	0.000D+00	-1.548D-19	-1.761D-03	-3.321D-03	-2.741D-03	-2.901D-03	-2.320D-03	-3.887D-03	-5.632D-03
12	-4.072D-01	5.159D-20	5.647D-04	-1.181D-03	-1.005D-03	-1.327D-03	-1.151D-03	-2.904D-03	-2.325D-03
13	0.000D+00	7.738D-20	9.783D-04	-3.943D-04	7.198D-04	-6.617D-04	4.540D-04	-9.222D-04	6.079D-05
14	-1.710D-01	1.290D-20	1.868D-04	-5.057D-04	7.204D-04	-5.605D-04	6.676D-04	-2.585D-05	1.611D-04
15	0.000D+00	-2.579D-20	-3.207D-04	-5.889D-04	5.914D-06	-4.922D-04	1.036D-04	-1.651D-04	-4.848D-04
16	1.145D-01	-1.935D-20	-2.089D-04	-3.825D-04	-2.940D-04	-3.163D-04	-2.277D-04	-4.024D-04	-6.088D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-2.113D-20	-7.540D-06	2.590D-05	1.802D-05	2.674D-05	1.886D-05	5.230D-05	4.476D-05
1	0.000D+00	-3.170D-16	-2.113D-01	1.012D-01	-1.493D-01	1.256D-01	-1.249D-01	1.876D-01	-2.371D-02
2	0.000D+00	-1.585D-16	-1.751D-01	-1.265D-02	-2.775D-01	8.573D-03	-2.563D-01	-9.392D-02	-2.689D-01
3	0.000D+00	-3.302D-17	-5.272D-02	-1.440D-02	-1.442D-01	-7.580D-03	-1.374D-01	-9.912D-02	-1.517D-01
4	0.000D+00	-1.599D-18	-2.256D-04	-3.502D-04	-6.071D-03	-3.188D-04	-6.041D-03	-6.171D-03	-6.388D-03
5	0.000D+00	-1.651D-18	-1.841D-02	-7.871D-03	2.036D-02	-5.088D-03	2.317D-02	3.376D-02	1.528D-02
6	0.000D+00	-6.603D-18	-3.582D-02	-1.640D-02	-9.460D-03	-1.052D-02	-3.579D-03	1.586D-02	-1.996D-02
7	0.000D+00	-3.302D-18	-2.563D-02	-1.243D-02	-2.447D-02	-7.870D-03	-1.991D-02	-6.717D-03	-3.232D-02
8	0.000D+00	-4.127D-19	-7.565D-03	-3.879D-03	-1.426D-02	-2.420D-03	-1.281D-02	-9.132D-03	-1.667D-02
9	0.000D+00	1.290D-19	-1.077D-04	-1.071D-04	-1.187D-03	-8.476D-05	-1.165D-03	-1.167D-03	-1.270D-03
10	0.000D+00	-1.032D-19	-1.805D-03	-1.007D-03	1.940D-03	-6.025D-04	2.347D-03	3.152D-03	1.335D-03
11	0.000D+00	-4.127D-19	-3.869D-03	-2.163D-03	-8.816D-04	-1.235D-03	4.776D-05	1.760D-03	-2.117D-03
12	0.000D+00	-2.064D-19	-2.911D-03	-1.666D-03	-2.561D-03	-9.210D-04	-1.817D-03	-5.705D-04	-3.479D-03
13	0.000D+00	-1.032D-19	-9.303D-04	-5.506D-04	-1.605D-03	-2.976D-04	-1.353D-03	-9.747D-04	-1.900D-03
14	0.000D+00	-3.224D-21	-2.659D-05	-2.386D-05	-1.949D-04	-1.622D-05	-1.876D-04	-1.852D-04	-2.108D-04
15	0.000D+00	-1.290D-20	-1.660D-04	-1.056D-04	2.044D-04	-5.518D-05	2.554D-04	3.167D-04	1.489D-04
16	0.000D+00	-1.290D-20	-4.069D-04	-2.533D-04	-7.968D-05	-1.235D-04	5.053D-05	2.050D-04	-2.032D-04

Table 3.5.5 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	2	3	4	12	14	23	34

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-5.885D-06	-5.885D-06	-5.885D-06	-5.885D-06	-1.177D-05	-1.177D-05	-1.177D-05	-1.177D-05
1	0.000D+00	-4.076D-02	4.076D-02	4.076D-02	-4.076D-02	-2.729D-17	-8.152D-02	8.152D-02	1.848D-16
2	-1.126D+01	2.886D-02	2.886D-02	2.886D-02	2.886D-02	5.771D-02	5.771D-02	5.771D-02	5.771D-02
3	0.000D+00	3.790D-02	-3.790D-02	-3.790D-02	3.790D-02	-3.380D-17	7.580D-02	-7.580D-02	9.020D-17
4	-2.532D+00	2.726D-03	2.726D-03	2.726D-03	2.726D-03	5.453D-03	5.453D-03	5.453D-03	5.453D-03
5	0.000D+00	-1.648D-02	1.648D-02	1.648D-02	-1.648D-02	-1.192D-17	-3.295D-02	3.295D-02	4.663D-17
6	8.174D-02	-8.335D-03	-8.335D-03	-8.335D-03	-8.335D-03	-1.667D-02	-1.667D-02	-1.667D-02	-1.667D-02
7	0.000D+00	3.676D-03	-3.676D-03	-3.676D-03	3.676D-03	-2.864D-17	7.352D-03	-7.352D-03	8.603D-17
8	-1.701D-01	5.219D-03	5.219D-03	5.219D-03	5.219D-03	1.044D-02	1.044D-02	1.044D-02	1.044D-02
9	0.000D+00	6.884D-04	-6.884D-04	-6.884D-04	6.884D-04	-8.560D-20	1.377D-03	-1.377D-03	4.680D-19
10	2.479D-01	-1.909D-03	-1.909D-03	-1.909D-03	-1.909D-03	-3.818D-03	-3.818D-03	-3.818D-03	-3.818D-03
11	0.000D+00	-1.093D-03	1.093D-03	1.093D-03	-1.093D-03	-6.842D-18	-2.185D-03	2.185D-03	2.059D-17
12	-4.072D-01	3.548D-04	3.548D-04	3.548D-04	3.548D-04	7.097D-04	7.097D-04	7.097D-04	7.097D-04
13	0.000D+00	6.225D-04	-6.225D-04	-6.225D-04	6.225D-04	-2.001D-18	1.245D-03	-1.245D-03	5.950D-18
14	-1.710D-01	1.204D-04	1.204D-04	1.204D-04	1.204D-04	2.408D-04	2.408D-04	2.408D-04	2.408D-04
15	0.000D+00	-2.092D-04	2.092D-04	2.092D-04	-2.092D-04	-4.053D-19	-4.184D-04	4.184D-04	1.239D-18
16	1.145D-01	-1.379D-04	-1.379D-04	-1.379D-04	-1.379D-04	-2.758D-04	-2.758D-04	-2.758D-04	-2.758D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.192D-06	4.192D-06	-4.192D-06	4.192D-06	6.987D-22	1.246D-20	2.918D-22	1.413D-20
1	0.000D+00	-1.178D-01	-1.178D-01	1.178D-01	1.178D-01	-2.357D-01	-4.590D-17	7.468D-18	2.357D-01
2	0.000D+00	-9.817D-02	9.817D-02	-9.817D-02	9.817D-02	-9.276D-19	2.449D-17	-9.902D-17	-5.543D-17
3	0.000D+00	-2.978D-02	-2.978D-02	2.978D-02	2.978D-02	-5.956D-02	-7.301D-17	7.347D-17	5.956D-02
4	0.000D+00	-1.286D-04	1.286D-04	-1.286D-04	1.286D-04	-8.710D-19	-5.281D-18	-5.265D-18	-9.665D-18
5	0.000D+00	-1.060D-02	-1.060D-02	1.060D-02	1.060D-02	-2.120D-02	4.758D-17	-4.860D-17	2.120D-02
6	0.000D+00	-2.086D-02	2.086D-02	-2.086D-02	2.086D-02	1.233D-17	2.525D-17	2.748D-17	3.894D-17
7	0.000D+00	-1.510D-02	-1.510D-02	1.510D-02	1.510D-02	-3.020D-02	-1.258D-17	1.326D-17	3.020D-02
8	0.000D+00	-4.514D-03	4.514D-03	-4.514D-03	4.514D-03	-1.097D-17	-2.228D-17	-2.199D-17	-3.357D-17
9	0.000D+00	-6.507D-05	-6.507D-05	6.507D-05	6.507D-05	-1.301D-04	-3.213D-18	3.260D-18	1.301D-04
10	0.000D+00	-1.105D-03	1.105D-03	-1.105D-03	1.105D-03	4.937D-18	1.001D-17	9.919D-18	1.498D-17
11	0.000D+00	-2.400D-03	-2.400D-03	2.400D-03	2.400D-03	-4.799D-03	6.227D-18	-6.286D-18	4.799D-03
12	0.000D+00	-1.829D-03	1.829D-03	-1.829D-03	1.829D-03	-9.647D-19	-2.073D-18	-2.133D-18	-3.174D-18
13	0.000D+00	-5.920D-04	-5.920D-04	5.920D-04	5.920D-04	-1.184D-03	-4.171D-18	4.161D-18	1.184D-03
14	0.000D+00	-1.713D-05	1.713D-05	-1.713D-05	1.713D-05	-4.200D-19	-8.492D-19	-8.631D-19	-1.293D-18
15	0.000D+00	-1.083D-04	-1.083D-04	1.083D-04	1.083D-04	-2.165D-04	1.599D-18	-1.593D-18	2.165D-04
16	0.000D+00	-2.686D-04	2.686D-04	-2.686D-04	2.686D-04	5.556D-19	1.110D-18	1.119D-18	1.668D-18

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Table 3.5.5 Completed.

The effect of uneven compression of the bundles either during assembly or during charge was modeled as a linear variation in the current density about the nominal value. For this case the special symmetry code 1 xx (where xx is the usual quadrant symmetry) is used. Here the perturbation drinner is interpreted as the percentage change in the current density from the nominal. A negative drinner implies that the current density at the lower angle is higher than the nominal and that the current density at the upper angle is lower. That is, a -0.05 drinner means that the current density varies from 1.05 to 0.95 of the nominal when moving from the midplane. A range of perturbations from 0.1% to 10% was run for both bundles 1 and 3.

Next the various boundaries of bundle 1 in quadrant 1 were perturbed with a range of values from 0 to 60 mils and then from -1 to -60 mils to investigate the linearity of the changes in coefficients. Finally, a bundle 1 drinner was applied for a variety of symmetries to show the superposition.

3.5.6 Three-Layer Dipole

The coefficient perturbations due to winding bundle displacements were calculated for the three-layer design in Figure 3.5.13. The current density was assumed to vary inversely with radius to model the keystoning of the conductor. The ideal bundle locations are given in Table 3.5.6.

Table 3.5.6

Ideal Winding Bundle Locations for the Three-Layer Dipole

Bundle Number	Inner Radius (cm)	Outer Radius (cm)	Initial Angle (Deg)	Final Angle (Deg)	Overall Current Density ($10^8 A/m^2$)
1	5.034	5.8265	0.00	77.215	3.20
2	5.954	6.7465	0.00	54.322	3.20
3	6.873	7.6655	0.00	32.392	3.20

Iron inner radius = 15.24 cm.

The fundamental dipole coefficient computed on the basis of this data was 5.148 T. All other coefficients and their perturbations presented in Table 3.5.7 are normalized to this value and are normalized using a radius of 4.4 cm. Each of the four current-carrying regions in Table 3.5.6 was subjected to boundary displacements for a variety of symmetry codes.

The format in Table 3.5.7 is similar to that described for Table 3.5.5 with displacements defined as shown in Figure 3.5.6. The first set of perturbations considered was a 1 mil motion of each boundary of each current region. The change in coefficients was calculated for both a first quadrant and an all four quadrant motion. Then the same changes were applied with symmetry codes 12 and 14

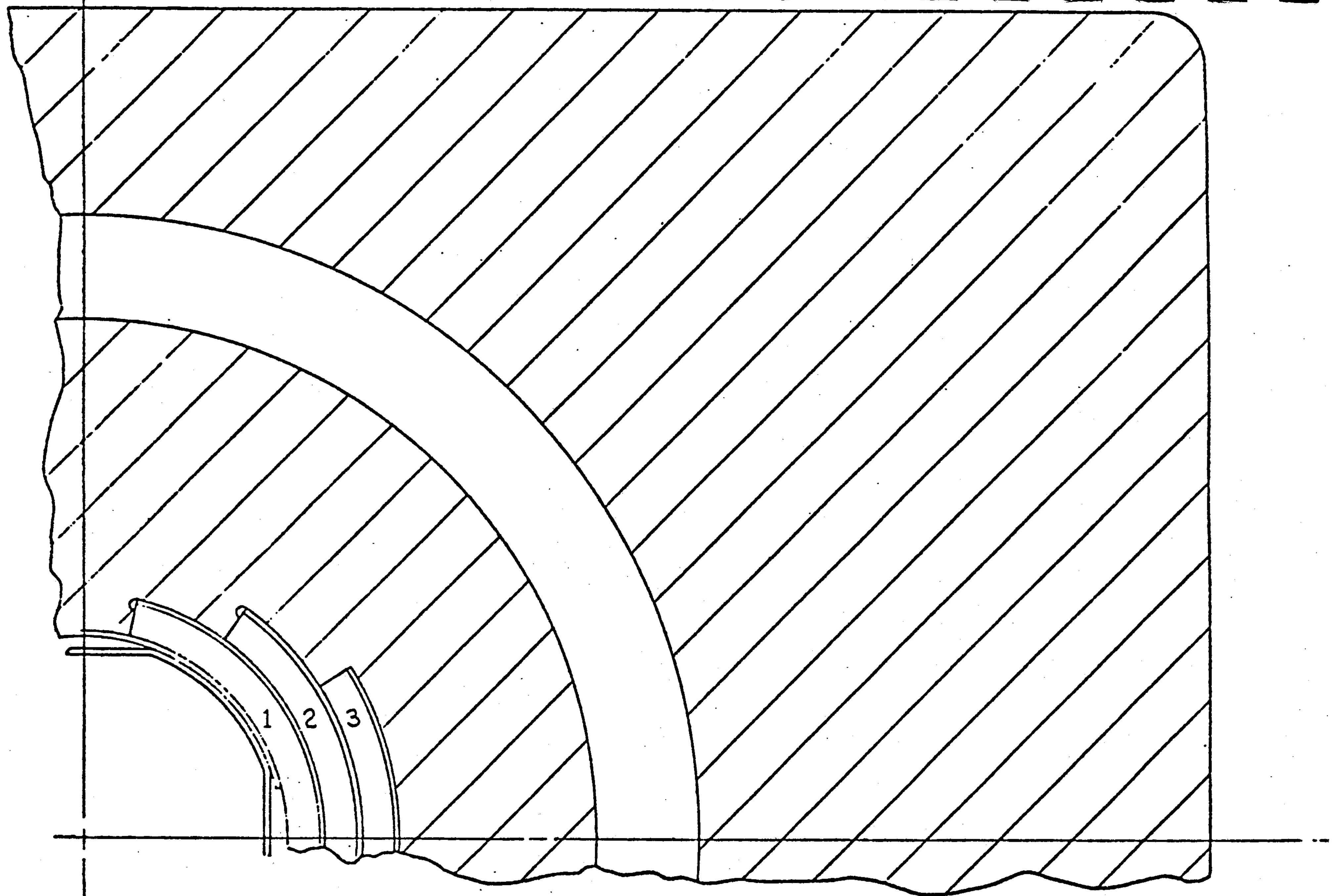

Figure 3.5.13 Ideal Three Layer

region =	1	1	1	1	1	1	1	1
drinner (in)=	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =	1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.931D-05	-1.727D-05	-1.333D-05	-2.423D-05	-7.724D-05	-6.909D-05	-5.332D-05	-9.690D-05
1	0.000D+00	-7.980D-02	-6.873D-02	-2.971D-01	-3.755D-01	3.058D-16	2.789D-16	-5.749D-16	6.971D-16
2	1.292D-04	1.225D-01	1.008D-01	-3.393D-01	-1.210D-01	4.901D-01	4.031D-01	-1.357D+00	-4.839D-01
3	0.000D+00	1.018D-01	7.979D-02	-2.649D-01	1.787D-01	8.612D-17	6.709D-17	-2.771D-16	1.054D-16
4	3.197D-05	-4.804D-02	-3.589D-02	-1.769D-01	1.574D-01	-1.922D-01	-1.436D-01	-7.074D-01	6.296D-01
5	0.000D+00	-8.904D-02	-6.340D-02	-1.363D-01	-5.444D-02	3.288D-16	2.285D-16	-2.350D-16	-3.354D-16
6	-8.324D-06	6.750D-04	4.581D-04	-1.272D-01	-1.269D-01	2.700D-03	1.833D-03	-5.089D-01	-5.075D-01
7	0.000D+00	6.283D-02	4.066D-02	-1.139D-01	-1.255D-02	2.974D-16	1.942D-16	-1.550D-16	4.744D-16
8	-2.386D+01	2.287D-02	1.412D-02	-8.898D-02	8.090D-02	9.149D-02	5.648D-02	-3.559D-01	3.236D-01
9	0.000D+00	-3.583D-02	-2.110D-02	-6.674D-02	3.919D-02	8.193D-17	4.869D-17	-3.688D-17	-3.869D-16
10	2.715D+01	-2.951D-02	-1.659D-02	-5.549D-02	-4.027D-02	-1.180D-01	-6.638D-02	-2.220D-01	-1.611D-01
11	0.000D+00	1.438D-02	7.723D-03	-4.977D-02	-4.188D-02	3.474D-16	1.873D-16	-8.504D-17	1.832D-16
12	-2.589D+01	2.630D-02	1.350D-02	-4.235D-02	1.190D-02	1.052D-01	5.399D-02	-1.694D-01	4.760D-02
13	0.000D+00	-4.022D-04	-1.974D-04	-3.326D-02	3.323D-02	-4.704D-20	-3.221D-20	-6.150D-19	-9.274D-17
14	1.732D+01	-1.888D-02	-8.859D-03	-2.633D-02	4.209D-03	-7.551D-02	-3.544D-02	-1.053D-01	1.684D-02
15	0.000D+00	-6.772D-03	-3.041D-03	-2.258D-02	-2.141D-02	2.369D-16	1.065D-16	-4.010D-17	-1.759D-17
16	-7.984D+00	1.095D-02	4.710D-03	-1.986D-02	-1.091D-02	4.380D-02	1.884D-02	-7.943D-02	-4.363D-02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.542D-05	-1.379D-05	2.786D-05	1.916D-05	1.304D-20	8.875D-21	7.398D-21	1.012D-19
1	0.000D+00	-3.517D-01	-3.029D-01	2.495D-01	-9.703D-02	1.993D-16	1.993D-16	1.993D-16	3.368D-16
2	0.000D+00	-2.532D-01	-2.083D-01	1.137D-01	-3.366D-01	-3.484D-16	-2.972D-16	9.355D-16	-5.869D-17
3	0.000D+00	-4.870D-02	-3.818D-02	1.578D-02	-1.960D-01	-3.390D-18	-3.666D-18	7.689D-18	-3.559D-18
4	0.000D+00	-1.112D-02	-8.311D-03	2.636D-03	8.044D-02	2.328D-16	1.617D-16	8.577D-16	-4.983D-16
5	0.000D+00	-1.125D-01	-8.011D-02	2.335D-02	1.271D-01	1.291D-17	2.664D-18	-7.293D-18	9.309D-17
6	0.000D+00	-1.533D-01	-1.041D-01	2.674D-02	-2.825D-02	-1.227D-17	-1.157D-17	8.454D-16	8.595D-16
7	0.000D+00	-7.798D-02	-5.047D-02	1.155D-02	-1.138D-01	1.294D-17	7.891D-18	2.815D-18	1.297D-17
8	0.000D+00	-5.084D-03	-3.139D-03	4.866D-04	-3.690D-02	-1.948D-16	-1.168D-16	7.631D-16	-7.673D-16
9	0.000D+00	-1.753D-02	-1.033D-02	1.867D-03	5.401D-02	2.369D-18	2.082D-19	2.847D-18	-7.983D-17
10	0.000D+00	-6.237D-02	-3.508D-02	6.304D-03	3.869D-02	3.077D-16	1.749D-16	5.809D-16	5.560D-16
11	0.000D+00	-6.088D-02	-3.270D-02	5.537D-03	-2.744D-02	2.449D-18	2.568D-18	5.687D-18	-1.314D-17
12	0.000D+00	-2.062D-02	-1.058D-02	1.622D-03	-4.065D-02	-3.255D-16	-1.670D-16	5.236D-16	-2.580D-16
13	0.000D+00	-3.542D-06	-1.738D-06	-1.087D-04	6.945D-04	1.842D-19	1.102D-18	3.545D-19	-7.469D-19
14	0.000D+00	-1.535D-02	-7.202D-03	9.923D-04	2.600D-02	2.697D-16	1.265D-16	3.758D-16	-6.739D-18
15	0.000D+00	-3.111D-02	-1.397D-02	1.953D-03	7.448D-03	1.965D-19	-9.135D-19	-2.032D-18	2.054D-19
16	0.000D+00	-2.213D-02	-9.519D-03	1.270D-03	-1.664D-02	-1.774D-16	-7.614D-17	3.213D-16	1.493D-16

Table 3.5.7 Three-layer dipole responses to perturbations. Data normalized to a fundamental dipole coefficient of 5.148 T using a 4.4 cm radius.

region =		2	2	2	2	2	2	2	2
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		1	1	1	1	5	5	5	5
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.308D-05	-1.183D-05	-6.220D-06	-1.188D-05	-5.233D-05	-4.732D-05	-2.488D-05	-4.751D-05
1	0.000D+00	-1.262D-01	-1.108D-01	-1.325D-01	-2.169D-01	1.848D-16	1.495D-16	6.466D-17	-2.363D-16
2	1.292D-04	-2.836D-02	-2.398D-02	-1.613D-01	-1.903D-01	-1.134D-01	-9.592D-02	-6.451D-01	-7.611D-01
3	0.000D+00	4.184D-02	3.397D-02	-1.446D-01	-7.915D-02	2.266D-16	1.863D-16	2.939D-17	3.647D-17
4	3.197D-05	4.912D-02	3.828D-02	-1.052D-01	2.083D-02	1.965D-01	1.531D-01	-4.208D-01	8.333D-02
5	0.000D+00	1.959D-02	1.465D-02	-6.664D-02	5.622D-02	1.387D-17	8.455D-18	6.066D-17	2.629D-16
6	-8.324D-06	-8.624D-03	-6.189D-03	-4.020D-02	3.753D-02	-3.450D-02	-2.476D-02	-1.608D-01	1.501D-01
7	0.000D+00	-1.712D-02	-1.179D-02	-2.597D-02	4.074D-03	4.909D-17	3.224D-17	2.347D-17	-7.945D-17
8	-2.386D+01	-9.858D-03	-6.520D-03	-1.892D-02	-1.498D-02	-3.943D-02	-2.608D-02	-7.566D-02	-5.994D-02
9	0.000D+00	5.080D-04	3.227D-04	-1.469D-02	-1.448D-02	8.586D-17	5.452D-17	1.436D-17	-3.320D-19
10	2.715D+01	5.450D-03	3.376D-03	-1.109D-02	-4.655D-03	2.180D-02	1.330D-02	-4.438D-02	-1.862D-02
11	0.000D+00	4.285D-03	2.512D-03	-7.810D-03	3.292D-03	1.682D-17	9.763D-18	6.059D-18	4.900D-17
12	-2.589D+01	7.886D-04	4.444D-04	-5.185D-03	5.037D-03	3.154D-03	1.778D-03	-2.074D-02	2.015D-02
13	0.000D+00	-1.536D-03	-8.322D-04	-3.411D-03	2.543D-03	3.796D-18	2.048D-18	1.259D-17	-1.513D-17
14	1.732D+01	-1.687D-03	-8.795D-04	-2.355D-03	-3.979D-04	-6.750D-03	-3.518D-03	-9.419D-03	-1.592D-03
15	0.000D+00	-6.224D-04	-3.121D-04	-1.729D-03	-1.599D-03	1.716D-17	8.607D-18	3.702D-19	-8.630D-18
16	-7.984D+00	3.468D-04	1.674D-04	-1.298D-03	-1.128D-03	1.387D-03	6.696D-04	-5.191D-03	-4.510D-03
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-6.712D-06	-6.069D-06	1.908D-05	1.618D-05	1.061D-20	1.512D-21	-8.444D-21	-5.780D-20
1	0.000D+00	-1.758D-01	-1.544D-01	1.842D-01	6.653D-02	1.407D-16	-3.968D-17	8.089D-17	8.089D-17
2	0.000D+00	-1.894D-01	-1.601D-01	1.235D-01	-7.102D-02	7.148D-17	1.275D-16	4.588D-16	4.044D-16
3	0.000D+00	-1.240D-01	-1.007D-01	5.893D-02	-1.345D-01	3.187D-17	3.110D-18	3.166D-17	3.321D-18
4	0.000D+00	-4.776D-02	-3.721D-02	1.773D-02	-1.046D-01	-2.245D-16	-1.700D-16	4.978D-16	8.705D-17
5	0.000D+00	-6.003D-03	-4.469D-03	1.757D-03	-3.572D-02	-3.806D-19	1.675D-18	3.142D-20	-1.203D-17
6	0.000D+00	-1.540D-03	-1.106D-03	3.358D-04	1.433D-02	5.756D-17	4.180D-17	2.703D-16	-2.515D-16
7	0.000D+00	-1.303D-02	-8.979D-03	2.826D-03	2.574D-02	-5.220D-19	-3.169D-19	-1.219D-18	-3.757D-19
8	0.000D+00	-2.062D-02	-1.364D-02	3.933D-03	1.219D-02	8.574D-17	5.511D-17	1.612D-16	8.968D-17
9	0.000D+00	-1.807D-02	-1.148D-02	3.050D-03	-3.926D-03	-7.263D-19	6.039D-19	6.018D-19	-7.263D-19
10	0.000D+00	-9.925D-03	-6.056D-03	1.490D-03	-1.018D-02	-5.715D-17	-3.527D-17	1.162D-16	7.926D-17
11	0.000D+00	-2.898D-03	-1.699D-03	3.810D-04	-7.088D-03	9.956D-20	2.019D-19	2.084D-19	-2.254D-18
12	0.000D+00	-9.552D-05	-5.383D-05	-1.290D-06	-1.212D-03	-9.783D-18	-5.700D-18	6.393D-17	-5.709D-17
13	0.000D+00	-5.667D-04	-3.071D-04	5.473D-05	2.271D-03	7.109D-20	-3.263D-21	-6.824D-22	-6.824D-22
14	0.000D+00	-1.836D-03	-9.570D-04	1.855D-04	2.328D-03	2.416D-17	1.252D-17	3.363D-17	-4.506D-18
15	0.000D+00	-2.256D-03	-1.131D-03	2.135D-04	6.929D-04	1.274D-19	2.482D-20	2.503D-20	2.503D-20
16	0.000D+00	-1.669D-03	-8.056D-04	1.463D-04	-6.585D-04	-5.653D-18	-2.686D-18	2.098D-17	1.928D-17

Table 3.5.7 Cont.

region =		3	3	3	3	3	3	3	3
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		1	1	1	1	5	5	5	5
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-7.076D-06	-6.441D-06	-2.098D-06	-4.127D-06	-2.831D-05	-2.576D-05	-8.390D-06	-1.651D-05
1	0.000D+00	-8.997D-02	-8.004D-02	-4.156D-02	-7.776D-02	-1.270D-18	1.489D-16	-1.927D-16	-1.927D-16
2	1.292D-04	-6.338D-02	-5.466D-02	-5.040D-02	-8.617D-02	-2.535D-01	-2.186D-01	-2.016D-01	-3.447D-01
3	0.000D+00	-3.071D-02	-2.559D-02	-4.821D-02	-7.147D-02	1.191D-16	9.987D-17	-1.493D-16	7.904D-17
4	3.197D-05	-7.647D-03	-6.148D-03	-3.954D-02	-4.703D-02	-3.059D-02	-2.459D-02	-1.581D-01	-1.881D-01
5	0.000D+00	3.792D-03	2.941D-03	-2.900D-02	-2.417D-02	8.620D-17	6.732D-17	-6.119D-17	1.339D-16
6	-8.324D-06	6.903D-03	5.166D-03	-1.950D-02	-8.229D-03	2.761D-02	2.066D-02	-7.799D-02	-3.291D-02
7	0.000D+00	5.771D-03	4.166D-03	-1.223D-02	3.017D-04	2.712D-17	1.839D-17	-1.621D-17	5.108D-17
8	-2.386D+01	3.391D-03	2.362D-03	-7.256D-03	3.378D-03	1.356D-02	9.447D-03	-2.903D-02	1.351D-02
9	0.000D+00	1.332D-03	8.956D-04	-4.141D-03	3.421D-03	1.910D-18	1.282D-18	-2.932D-18	4.189D-18
10	2.715D+01	9.030D-05	5.859D-05	-2.318D-03	2.311D-03	3.612D-04	2.344D-04	-9.272D-03	9.243D-03
11	0.000D+00	-4.193D-04	-2.627D-04	-1.306D-03	1.130D-03	5.977D-19	3.872D-19	-9.528D-19	-7.014D-18
12	-2.589D+01	-4.751D-04	-2.874D-04	-7.587D-04	3.116D-04	-1.900D-03	-1.150D-03	-3.035D-03	1.246D-03
13	0.000D+00	-3.369D-04	-1.969D-04	-4.618D-04	-9.999D-05	2.370D-18	1.387D-18	-2.447D-20	-3.049D-18
14	1.732D+01	-1.702D-04	-9.607D-05	-2.935D-04	-2.216D-04	-6.808D-04	-3.843D-04	-1.174D-03	-8.865D-04
15	0.000D+00	-4.842D-05	-2.641D-05	-1.913D-04	-1.934D-04	1.919D-18	1.045D-18	-4.410D-19	1.102D-19
16	-7.984D+00	1.509D-05	7.953D-06	-1.251D-04	-1.180D-04	6.034D-05	3.181D-05	-5.002D-04	-4.720D-04
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-2.055D-06	-1.871D-06	1.100D-05	1.042D-05	1.428D-20	1.541D-20	3.009D-21	8.212D-21
1	0.000D+00	-5.708D-02	-5.078D-02	1.055D-01	8.250D-02	4.852D-17	4.786D-17	4.817D-17	1.834D-16
2	0.000D+00	-7.186D-02	-6.198D-02	8.049D-02	3.989D-02	1.871D-16	1.623D-16	1.479D-16	3.164D-16
3	0.000D+00	-6.521D-02	-5.433D-02	5.289D-02	3.398D-03	4.003D-18	-5.007D-18	-1.472D-17	3.285D-17
4	0.000D+00	-4.818D-02	-3.874D-02	3.060D-02	-1.691D-02	3.443D-17	3.227D-17	1.780D-16	2.427D-16
5	0.000D+00	-3.012D-02	-2.336D-02	1.565D-02	-2.238D-02	2.893D-18	1.223D-17	1.223D-17	7.542D-18
6	0.000D+00	-1.597D-02	-1.195D-02	6.992D-03	-1.900D-02	-4.488D-17	-3.445D-17	1.307D-16	4.989D-17
7	0.000D+00	-6.984D-03	-5.041D-03	2.626D-03	-1.249D-02	1.038D-18	9.910D-19	1.659D-18	-4.874D-18
8	0.000D+00	-2.307D-03	-1.607D-03	7.536D-04	-6.459D-03	-2.917D-17	-2.021D-17	6.212D-17	-3.807D-17
9	0.000D+00	-4.339D-04	-2.917D-04	1.207D-04	-2.327D-03	-9.443D-20	-4.580D-21	-2.705D-20	5.826D-19
10	0.000D+00	-2.905D-06	-1.885D-06	-3.646D-06	-1.437D-04	-9.226D-19	-6.630D-19	2.419D-17	-2.445D-17
11	0.000D+00	-1.073D-04	-6.721D-05	2.251D-05	6.512D-04	-4.712D-21	1.122D-19	5.985D-20	4.177D-19
12	0.000D+00	-2.604D-04	-1.696D-04	5.860D-05	6.935D-04	5.887D-18	3.566D-18	9.393D-18	-3.981D-18
13	0.000D+00	-3.581D-04	-2.092D-04	6.954D-05	4.560D-04	-2.251D-21	-2.364D-22	-2.025D-20	-1.198D-18
14	0.000D+00	-3.332D-04	-1.881D-04	5.984D-05	2.015D-04	2.438D-18	1.378D-18	4.184D-18	4.206D-18
15	0.000D+00	-2.523D-04	-1.376D-04	4.197D-05	3.073D-05	-2.435D-20	1.119D-21	-2.477D-20	2.711D-20
16	0.000D+00	-1.616D-04	-8.517D-05	2.495D-05	-4.832D-05	-2.477D-19	-1.273D-19	2.019D-18	1.959D-18

Table 3.5.7 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-3.862D-05	-3.454D-05	-2.666D-05	-4.845D-05	-3.862D-05	-3.454D-05	-2.666D-05	-4.845D-05
1	0.000D+00	-1.934D-16	-1.810D-16	7.453D-17	-6.298D-17	-1.596D-01	-1.375D-01	-5.942D-01	-7.511D-01
2	1.292D-04	2.450D-01	2.016D-01	-6.786D-01	-2.420D-01	2.450D-01	2.016D-01	-6.786D-01	-2.420D-01
3	0.000D+00	-3.853D-17	-2.860D-17	-8.524D-18	-1.773D-16	2.035D-01	1.596D-01	-5.298D-01	3.574D-01
4	3.197D-05	-9.608D-02	-7.178D-02	-3.537D-01	3.148D-01	-9.608D-02	-7.178D-02	-3.537D-01	3.148D-01
5	0.000D+00	-1.526D-16	-1.174D-16	5.913D-17	1.595D-16	-1.781D-01	-1.268D-01	-2.726D-01	-1.089D-01
6	-8.324D-06	1.350D-03	9.163D-04	-2.544D-01	-2.538D-01	1.350D-03	9.163D-04	-2.544D-01	-2.538D-01
7	0.000D+00	-1.457D-16	-8.908D-17	4.342D-18	-2.139D-16	1.257D-01	8.133D-02	-2.278D-01	-2.510D-02
8	-2.386D+01	4.574D-02	2.824D-02	-1.780D-01	1.618D-01	4.574D-02	2.824D-02	-1.780D-01	1.618D-01
9	0.000D+00	-4.215D-17	-2.415D-17	-2.201D-17	1.268D-16	-7.165D-02	-4.221D-02	-1.335D-01	7.837D-02
10	2.715D+01	-5.902D-02	-3.319D-02	-1.110D-01	-8.055D-02	-5.902D-02	-3.319D-02	-1.110D-01	-8.055D-02
11	0.000D+00	-1.734D-16	-9.246D-17	2.215D-17	-1.049D-16	2.876D-02	1.545D-02	-9.954D-02	-8.376D-02
12	-2.589D+01	5.260D-02	2.699D-02	-8.470D-02	2.380D-02	5.260D-02	2.699D-02	-8.470D-02	2.380D-02
13	0.000D+00	-7.978D-20	-2.938D-20	-3.698D-17	-1.530D-17	-8.045D-04	-3.947D-04	-6.652D-02	6.646D-02
14	1.732D+01	-3.775D-02	-1.772D-02	-5.266D-02	8.418D-03	-3.775D-02	-1.772D-02	-5.266D-02	8.418D-03
15	0.000D+00	-1.182D-16	-5.309D-17	3.384D-18	2.828D-17	-1.354D-02	-6.083D-03	-4.516D-02	-4.282D-02
16	-7.984D+00	2.190D-02	9.420D-03	-3.971D-02	-2.181D-02	2.190D-02	9.420D-03	-3.971D-02	-2.181D-02
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.714D-22	-7.318D-22	-3.516D-21	-3.516D-21	5.533D-21	3.448D-21	-1.978D-21	4.490D-20
1	0.000D+00	-7.033D-01	-6.058D-01	4.989D-01	-1.941D-01	1.462D-16	4.310D-17	3.368D-16	6.118D-16
2	0.000D+00	-8.642D-17	-1.015D-16	2.345D-16	-6.012D-17	-1.853D-16	-1.410D-16	4.568D-16	-9.551D-17
3	0.000D+00	-9.739D-02	-7.635D-02	3.157D-02	-3.920D-01	-2.048D-16	-1.602D-16	5.026D-16	-5.154D-16
4	0.000D+00	5.869D-17	4.459D-17	2.151D-16	-1.866D-16	1.060D-16	7.821D-17	4.339D-16	-3.108D-16
5	0.000D+00	-2.250D-01	-1.602D-01	4.670D-02	2.542D-01	2.510D-16	1.756D-16	3.842D-16	3.440D-16
6	0.000D+00	-1.091D-17	-7.221D-18	2.035D-16	2.176D-16	-2.105D-17	-1.367D-17	4.219D-16	4.219D-16
7	0.000D+00	-1.560D-01	-1.009D-01	2.311D-02	-2.275D-01	-2.385D-16	-1.554D-16	4.342D-16	-4.286D-17
8	0.000D+00	-4.976D-17	-2.970D-17	1.925D-16	-1.882D-16	-9.594D-17	-5.890D-17	3.811D-16	-3.916D-16
9	0.000D+00	-3.506D-02	-2.065D-02	3.733D-03	1.080D-01	1.709D-16	9.992D-17	3.184D-16	-1.439D-16
10	0.000D+00	7.580D-17	4.257D-17	1.430D-16	1.182D-16	1.546D-16	8.822D-17	2.912D-16	2.560D-16
11	0.000D+00	-1.218D-01	-6.539D-02	1.107D-02	-5.489D-02	-8.278D-17	-4.331D-17	2.849D-16	2.096D-16
12	0.000D+00	-8.133D-17	-4.173D-17	1.305D-16	-5.908D-17	-1.629D-16	-8.353D-17	2.621D-16	-1.627D-16
13	0.000D+00	-7.084D-06	-3.476D-06	-2.175D-04	1.389D-03	2.927D-18	1.738D-18	2.213D-16	-2.214D-16
14	0.000D+00	6.741D-17	3.171D-17	9.393D-17	-1.506D-17	1.351D-16	6.309D-17	1.883D-16	2.336D-17
15	0.000D+00	-6.222D-02	-2.794D-02	3.906D-03	1.490D-02	5.133D-17	2.247D-17	1.703D-16	1.714D-16
16	0.000D+00	-4.401D-17	-1.866D-17	8.050D-17	4.407D-17	-8.843D-17	-3.759D-17	1.611D-16	8.830D-17

Table 3.5.7 Cont.

region =		2	2	2	2	2	2	2	2
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.616D-05	-2.366D-05	-1.244D-05	-2.375D-05	-2.616D-05	-2.366D-05	-1.244D-05	-2.375D-05
1	0.000D+00	-1.284D-16	-8.024D-17	5.220D-17	-7.995D-18	-2.525D-01	-2.217D-01	-2.650D-01	-4.339D-01
2	1.292D-04	-5.672D-02	-4.796D-02	-3.225D-01	-3.806D-01	-5.672D-02	-4.796D-02	-3.225D-01	-3.806D-01
3	0.000D+00	-1.225D-16	-9.825D-17	5.435D-17	-1.298D-16	8.367D-02	6.794D-02	-2.892D-01	-1.583D-01
4	3.197D-05	9.824D-02	7.655D-02	-2.104D-01	4.166D-02	9.824D-02	7.655D-02	-2.104D-01	4.166D-02
5	0.000D+00	-7.336D-18	-5.205D-18	-1.618D-17	-3.226D-17	3.918D-02	2.930D-02	-1.333D-01	1.124D-01
6	-8.324D-06	-1.725D-02	-1.238D-02	-8.040D-02	7.505D-02	-1.725D-02	-1.238D-02	-8.040D-02	7.505D-02
7	0.000D+00	-2.582D-17	-1.830D-17	6.353D-18	5.022D-17	-3.423D-02	-2.358D-02	-5.184D-02	8.148D-03
8	-2.386D+01	-1.972D-02	-1.304D-02	-3.783D-02	-2.997D-02	-1.972D-02	-1.304D-02	-3.783D-02	-2.997D-02
9	0.000D+00	-4.291D-17	-2.728D-17	-1.866D-18	-2.987D-18	1.016D-03	6.454D-04	-2.939D-02	-2.897D-02
10	2.715D+01	1.090D-02	6.651D-03	-2.219D-02	-9.310D-03	1.090D-02	6.651D-03	-2.219D-02	-9.310D-03
11	0.000D+00	-8.159D-18	-4.804D-18	-1.440D-18	-1.949D-17	8.570D-03	5.025D-03	-1.562D-02	6.583D-03
12	-2.589D+01	1.577D-03	8.888D-04	-1.037D-02	1.007D-02	1.577D-03	8.888D-04	-1.037D-02	1.007D-02
13	0.000D+00	-1.883D-18	-1.041D-18	-2.543D-19	7.548D-18	-3.071D-03	-1.664D-03	-6.822D-03	5.086D-03
14	1.732D+01	-3.375D-03	-1.759D-03	-4.710D-03	-7.958D-04	-3.375D-03	-1.759D-03	-4.710D-03	-7.958D-04
15	0.000D+00	-8.594D-18	-4.319D-18	8.408D-19	2.595D-18	-1.245D-03	-6.242D-04	-3.458D-03	-3.197D-03
16	-7.984D+00	6.935D-04	3.348D-04	-2.595D-03	-2.255D-03	6.935D-04	3.348D-04	-2.595D-03	-2.255D-03
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-8.426D-21	-5.824D-21	-1.076D-20	-8.868D-22	1.038D-21	-3.420D-21	-1.338D-20	-3.312D-20
1	0.000D+00	-3.516D-01	-3.087D-01	3.684D-01	1.331D-01	1.297D-16	7.583D-17	1.411D-16	-9.970D-17
2	0.000D+00	1.635D-17	4.369D-17	1.266D-16	1.811D-16	1.999D-17	7.533D-17	2.409D-16	2.409D-16
3	0.000D+00	-2.480D-01	-2.014D-01	1.179D-01	-2.691D-01	-9.963D-17	-5.793D-17	2.867D-16	2.300D-16
4	0.000D+00	-5.271D-17	-3.868D-17	1.261D-16	1.555D-17	-1.121D-16	-8.498D-17	2.450D-16	6.335D-17
5	0.000D+00	-1.201D-02	-8.977D-03	3.515D-03	-7.144D-02	-5.626D-17	-4.209D-17	1.885D-16	-1.246D-16
6	0.000D+00	1.551D-17	1.153D-17	6.941D-17	-6.177D-17	2.939D-17	2.154D-17	1.343D-16	-1.251D-16
7	0.000D+00	-2.607D-02	-1.796D-02	5.652D-03	5.148D-02	6.499D-17	4.467D-17	9.748D-17	-4.677D-17
8	0.000D+00	2.213D-17	1.418D-17	4.044D-17	2.467D-17	4.347D-17	2.774D-17	8.022D-17	2.555D-17
9	0.000D+00	-3.614D-02	-2.296D-02	6.099D-03	-7.851D-03	-3.201D-18	-1.801D-18	6.833D-17	6.966D-17
10	0.000D+00	-1.439D-17	-8.991D-18	2.907D-17	1.550D-17	-2.880D-17	-1.767D-17	5.805D-17	4.151D-17
11	0.000D+00	-5.795D-03	-3.398D-03	7.620D-04	-1.418D-02	-2.451D-17	-1.427D-17	4.452D-17	-1.142D-17
12	0.000D+00	-2.435D-18	-1.498D-18	1.597D-17	-1.524D-17	-4.802D-18	-2.760D-18	3.195D-17	-2.757D-17
13	0.000D+00	-1.133D-03	-6.142D-04	1.095D-04	4.542D-03	1.027D-17	5.541D-18	2.271D-17	-1.695D-17
14	0.000D+00	6.040D-18	3.088D-18	8.425D-18	-1.619D-20	1.206D-17	6.229D-18	1.683D-17	-1.513D-16
15	0.000D+00	-4.512D-03	-2.263D-03	4.271D-04	1.386D-03	4.750D-18	2.373D-18	1.314D-17	1.111D-17
16	0.000D+00	-1.391D-18	-6.319D-19	6.250D-18	4.572D-18	-2.798D-18	-1.353D-18	1.048D-17	9.666D-18

Table 3.5.7 Cont.

region =		3	3	3	3	3	3	3	3
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		12	12	12	12	14	14	14	14
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.415D-05	-1.288D-05	-4.195D-06	-8.253D-06	-1.415D-05	-1.288D-05	-4.195D-06	-8.253D-06
1	0.000D+00	-5.147D-17	8.906D-18	-9.931D-18	-9.931D-18	-1.799D-01	-1.601D-01	-8.312D-02	-1.555D-01
2	1.292D-04	-1.268D-01	-1.093D-01	-1.008D-01	-1.723D-01	-1.268D-01	-1.093D-01	-1.008D-01	-1.723D-01
3	0.000D+00	-6.277D-17	-5.090D-17	2.378D-18	3.567D-17	-6.141D-02	-5.117D-02	-9.642D-02	-1.429D-01
4	3.197D-05	-1.529D-02	-1.230D-02	-7.907D-02	-9.407D-02	-1.529D-02	-1.230D-02	-7.907D-02	-9.407D-02
5	0.000D+00	-4.269D-17	-3.276D-17	5.761D-18	-5.368D-18	7.584D-03	5.883D-03	-5.799D-02	-4.833D-02
6	-8.324D-06	1.381D-02	1.033D-02	-3.900D-02	-1.646D-02	1.381D-02	1.033D-02	-3.900D-02	-1.646D-02
7	0.000D+00	-1.283D-17	-9.779D-18	-1.294D-18	-2.285D-17	1.154D-02	8.332D-03	-2.446D-02	6.034D-04
8	-2.386D+01	6.782D-03	4.724D-03	-1.451D-02	6.756D-03	6.782D-03	4.724D-03	-1.451D-02	6.756D-03
9	0.000D+00	-1.079D-18	-7.088D-19	-1.872D-18	-6.261D-18	2.665D-03	1.791D-03	-8.281D-03	6.842D-03
10	2.715D+01	1.806D-04	1.172D-04	-4.636D-03	4.621D-03	1.806D-04	1.172D-04	-4.636D-03	4.621D-03
11	0.000D+00	-3.093D-19	-1.833D-19	-7.938D-19	5.463D-19	-8.386D-04	-5.253D-04	-2.611D-03	2.260D-03
12	-2.589D+01	-9.502D-04	-5.748D-04	-1.517D-03	6.231D-04	-9.502D-04	-5.748D-04	-1.517D-03	6.231D-04
13	0.000D+00	-1.200D-18	-7.185D-19	-8.154D-20	1.489D-18	-6.739D-04	-3.937D-04	-9.236D-04	-2.000D-04
14	1.732D+01	-3.404D-04	-1.921D-04	-5.870D-04	-4.432D-04	-3.404D-04	-1.921D-04	-5.870D-04	-4.432D-04
15	0.000D+00	-9.583D-19	-5.223D-19	4.106D-20	2.340D-19	-9.683D-05	-5.281D-05	-3.626D-04	-3.868D-04
16	-7.984D+00	3.017D-05	1.591D-05	-2.501D-04	-2.360D-04	3.017D-05	1.591D-05	-2.501D-04	-2.360D-04
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	4.083D-21	-6.973D-22	1.045D-20	-1.817D-20	8.675D-21	1.962D-20	3.009D-21	2.643D-20
1	0.000D+00	-1.142D-01	-1.016D-01	2.110D-01	1.650D-01	1.051D-16	9.049D-17	4.817D-17	2.104D-16
2	0.000D+00	4.085D-17	4.559D-17	3.653D-17	-6.878D-17	9.360D-17	8.157D-17	6.368D-17	1.900D-16
3	0.000D+00	-1.304D-01	-1.087D-01	1.058D-01	6.797D-03	7.158D-17	5.531D-17	8.993D-17	1.755D-16
4	0.000D+00	1.238D-17	9.554D-18	4.136D-17	5.060D-17	1.841D-17	1.276D-17	8.561D-17	1.133D-16
5	0.000D+00	-6.023D-02	-4.672D-02	3.131D-02	-4.476D-02	-1.042D-17	-4.557D-18	8.720D-17	6.846D-17
6	0.000D+00	-1.119D-17	-7.936D-18	3.333D-17	6.406D-18	-2.435D-17	-1.801D-17	6.458D-17	3.765D-17
7	0.000D+00	-1.397D-02	-1.008D-02	5.252D-03	-2.499D-02	-2.187D-17	-1.575D-17	4.674D-17	-6.834D-18
8	0.000D+00	-7.279D-18	-5.062D-18	1.544D-17	-3.890D-18	-1.455D-17	-1.008D-17	3.109D-17	-2.371D-17
9	0.000D+00	-8.677D-04	-5.833D-04	2.413D-04	-4.655D-03	-6.422D-18	-4.249D-18	1.975D-17	-1.788D-17
10	0.000D+00	-2.469D-19	-2.097D-19	6.052D-18	-6.128D-18	-4.937D-19	-3.098D-19	1.212D-17	-1.236D-17
11	0.000D+00	-2.146D-04	-1.344D-04	4.502D-05	1.302D-03	2.400D-18	1.565D-18	7.484D-18	-6.017D-18
12	0.000D+00	1.469D-18	8.985D-19	2.354D-18	-2.248D-18	2.951D-18	1.790D-18	4.705D-18	-8.960D-19
13	0.000D+00	-7.163D-04	-4.185D-04	1.391D-04	9.119D-04	2.243D-18	1.315D-18	3.063D-18	2.154D-19
14	0.000D+00	6.115D-19	3.477D-19	1.038D-18	7.901D-19	1.219D-18	6.872D-19	2.090D-18	2.282D-18
15	0.000D+00	-5.047D-04	-2.752D-04	8.395D-05	6.147D-05	3.702D-19	2.055D-19	1.454D-18	1.519D-18
16	0.000D+00	-6.100D-20	-3.655D-20	5.020D-19	5.020D-19	-1.205D-19	-6.407D-20	1.013D-18	9.754D-19

Table 3.5.7 Cont.

region =		1	1	1	1	2	2	2	2
drinner (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		1.000D-03	0.000D+00	1.000D-03	0.000D+00	1.000D-03	0.000D+00	1.000D-03	0.000D+00
dazimthf (in)=		0.000D+00	1.000D-03	0.000D+00	1.000D-03	0.000D+00	1.000D-03	0.000D+00	1.000D-03
symmetry =		-14	-14	-23	-23	-14	-14	-23	-23
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-9.251D-09	-5.181D-09	-9.251D-09	-5.181D-09	-5.246D-09	-4.085D-09	-5.246D-09	-4.085D-09
1	0.000D+00	-2.061D-04	1.179D-04	2.061D-04	-1.179D-04	-1.118D-04	-1.764D-05	1.118D-04	1.764D-05
2	1.292D-04	-2.354D-04	3.967D-04	-2.354D-04	3.967D-04	-1.360D-04	9.742D-05	-1.360D-04	9.742D-05
3	0.000D+00	-1.838D-04	2.131D-04	1.838D-04	-2.131D-04	-1.220D-04	1.877D-04	1.220D-04	-1.877D-04
4	3.197D-05	-1.227D-04	-3.038D-04	-1.227D-04	-3.038D-04	-8.873D-05	1.561D-04	-8.873D-05	1.561D-04
5	0.000D+00	-9.457D-05	-3.854D-04	9.457D-05	3.854D-04	-5.620D-05	3.410D-05	5.620D-05	-3.410D-05
6	-8.324D-06	-8.828D-05	9.178D-05	-8.828D-05	9.178D-05	-3.391D-05	-7.279D-05	-3.391D-05	-7.279D-05
7	0.000D+00	-7.905D-05	3.906D-04	7.905D-05	-3.906D-04	-2.186D-05	-9.503D-05	2.186D-05	9.503D-05
8	-2.386D+01	-6.174D-05	9.716D-05	-6.174D-05	9.716D-05	-1.595D-05	-4.566D-05	-1.595D-05	-4.566D-05
9	0.000D+00	-4.631D-05	-2.890D-04	4.631D-05	2.890D-04	-1.239D-05	1.551D-05	1.239D-05	-1.551D-05
10	2.715D+01	-3.851D-05	-2.049D-04	-3.851D-05	-2.049D-04	-9.357D-06	4.204D-05	-9.357D-06	4.204D-05
11	0.000D+00	-3.454D-05	1.507D-04	3.454D-05	-1.507D-04	-6.587D-06	2.939D-05	6.587D-06	-2.939D-05
12	-2.589D+01	-2.939D-05	2.287D-04	-2.939D-05	2.287D-04	-4.373D-06	2.063D-06	-4.373D-06	2.063D-06
13	0.000D+00	-2.308D-05	-2.692D-05	2.308D-05	2.692D-05	-2.877D-06	-1.519D-05	2.877D-06	1.519D-05
14	1.732D+01	-1.827D-05	-1.930D-04	-1.827D-05	-1.930D-04	-1.986D-06	-1.460D-05	-1.986D-06	-1.480D-05
15	0.000D+00	-1.567D-05	-5.677D-05	1.567D-05	5.677D-05	-1.458D-06	-4.523D-06	1.458D-06	4.523D-06
16	-7.984D+00	-1.378D-05	1.289D-04	-1.378D-05	1.289D-04	-1.094D-06	4.382D-06	-1.094D-06	4.382D-06

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	5.573D-05	3.832D-05	-5.573D-05	-3.832D-05	3.817D-05	3.236D-05	-3.817D-05	-3.236D-05
1	0.000D+00	4.991D-01	-1.938D-01	4.991D-01	-1.938D-01	3.685D-01	1.332D-01	3.685D-01	1.332D-01
2	0.000D+00	2.277D-01	-6.732D-01	-2.277D-01	6.732D-01	2.472D-01	-1.419D-01	-2.472D-01	1.419D-01
3	0.000D+00	3.199D-02	-3.924D-01	3.199D-02	-3.924D-01	1.180D-01	-2.690D-01	1.180D-01	-2.690D-01
4	0.000D+00	5.713D-03	1.605D-01	-5.713D-03	-1.605D-01	3.561D-02	-2.092D-01	-3.561D-02	2.092D-01
5	0.000D+00	4.711D-02	2.544D-01	4.711D-02	2.544D-01	3.659D-03	-7.159D-02	3.659D-03	-7.159D-02
6	0.000D+00	5.387D-02	-5.611D-02	-5.387D-02	5.611D-02	7.900D-04	2.856D-02	-7.900D-04	-2.856D-02
7	0.000D+00	2.349D-02	-2.275D-01	2.349D-02	-2.275D-01	5.745D-03	5.148D-02	5.745D-03	5.148D-02
8	0.000D+00	1.335D-03	-7.416D-02	-1.335D-03	7.416D-02	7.938D-03	2.444D-02	-7.938D-03	-2.444D-02
9	0.000D+00	4.063D-03	1.078D-01	4.063D-03	1.078D-01	6.155D-03	-7.796D-03	6.155D-03	-7.796D-03
10	0.000D+00	1.290D-02	7.759D-02	-1.290D-02	-7.759D-02	3.023D-03	-2.034D-02	-3.023D-03	2.034D-02
11	0.000D+00	1.134D-02	-5.466D-02	1.134D-02	-5.466D-02	7.963D-04	-1.419D-02	7.963D-04	-1.419D-02
12	0.000D+00	3.487D-03	-8.139D-02	-3.487D-03	8.139D-02	2.385D-05	-2.452D-03	-2.385D-05	2.452D-03
13	0.000D+00	4.714D-07	1.172D-03	4.714D-07	1.172D-03	1.295D-04	4.528D-03	1.295D-04	4.528D-03
14	0.000D+00	2.178D-03	5.197D-02	-2.178D-03	-5.197D-02	3.859D-04	4.658D-03	-3.859D-04	-4.658D-03
15	0.000D+00	4.077D-03	1.506D-02	4.077D-03	1.506D-02	4.384D-04	1.396D-03	4.384D-04	1.396D-03
16	0.000D+00	2.691D-03	-3.319D-02	-2.691D-03	3.319D-02	3.011D-04	-1.310D-03	-3.011D-04	1.310D-03

Table 3.5.7 Cont.

region =		3	3	3	3	1	1	1	1
drinner (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		1.000D-03	0.000D+00	1.000D-03	0.000D+00	1.000D-03	-1.000D-03	1.000D-03	-1.000D-03
dazimthf (in)=		0.000D+00	1.000D-03	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		-14	-14	-23	-23	1	4	2	3
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.591D-09	-2.385D-09	-2.591D-09	-2.385D-09	-1.333D-05	1.332D-05	-1.333D-05	1.332D-05
1	0.000D+00	-5.134D-05	-3.529D-05	5.134D-05	3.529D-05	-2.971D-01	2.969D-01	2.971D-01	-2.969D-01
2	1.292D-04	-6.226D-05	-1.972D-05	-6.226D-05	-1.972D-05	-3.393D-01	3.390D-01	-3.393D-01	3.390D-01
3	0.000D+00	-5.955D-05	9.602D-06	5.955D-05	-9.602D-06	-2.649D-01	2.647D-01	2.649D-01	-2.647D-01
4	3.197D-05	-4.884D-05	3.416D-05	-4.884D-05	3.416D-05	-1.769D-01	1.767D-01	-1.769D-01	1.767D-01
5	0.000D+00	-3.582D-05	4.393D-05	3.582D-05	-4.393D-05	-1.363D-01	1.362D-01	1.363D-01	-1.362D-01
6	-8.324D-06	-2.409D-05	3.951D-05	-2.409D-05	3.951D-05	-1.272D-01	1.271D-01	-1.272D-01	1.271D-01
7	0.000D+00	-1.511D-05	2.721D-05	1.511D-05	-2.721D-05	-1.139D-01	1.138D-01	1.139D-01	-1.138D-01
8	-2.386D+01	-8.964D-06	1.377D-05	-8.964D-06	1.377D-05	-8.898D-02	8.892D-02	-8.898D-02	8.892D-02
9	0.000D+00	-5.115D-06	3.485D-06	5.115D-06	-3.485D-06	-6.674D-02	6.669D-02	6.674D-02	-6.669D-02
10	2.715D+01	-2.864D-06	-2.291D-06	-2.864D-06	-2.291D-06	-5.549D-02	5.545D-02	-5.549D-02	5.545D-02
11	0.000D+00	-1.613D-06	-4.228D-06	1.613D-06	4.228D-06	-4.977D-02	4.973D-02	4.977D-02	-4.973D-02
12	-2.589D+01	-9.372D-07	-3.810D-06	-9.372D-07	-3.810D-06	-4.235D-02	4.232D-02	-4.235D-02	4.232D-02
13	0.000D+00	-5.705D-07	-2.456D-06	5.705D-07	2.456D-06	-3.326D-02	3.324D-02	3.326D-02	-3.324D-02
14	1.732D+01	-3.626D-07	-1.104D-06	-3.626D-07	-1.104D-06	-2.633D-02	2.631D-02	-2.633D-02	2.631D-02
15	0.000D+00	-2.363D-07	-1.735D-07	2.363D-07	1.735D-07	-2.258D-02	2.257D-02	2.258D-02	-2.257D-02
16	-7.984D+00	-1.545D-07	2.809D-07	-1.545D-07	2.809D-07	-1.986D-02	1.984D-02	-1.986D-02	1.984D-02
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.201D-05	2.083D-05	-2.201D-05	-2.083D-05	2.786D-05	2.786D-05	-2.786D-05	-2.786D-05
1	0.000D+00	2.110D-01	1.650D-01	2.110D-01	1.650D-01	2.495D-01	2.496D-01	2.495D-01	2.496D-01
2	0.000D+00	1.610D-01	7.984D-02	-1.610D-01	-7.984D-02	1.137D-01	1.140D-01	-1.137D-01	-1.140D-01
3	0.000D+00	1.058D-01	6.866D-03	1.058D-01	6.866D-03	1.578D-02	1.620D-02	1.578D-02	1.620D-02
4	0.000D+00	6.124D-02	-3.376D-02	-6.124D-02	3.376D-02	2.636D-03	3.077D-03	-2.636D-03	-3.077D-03
5	0.000D+00	3.135D-02	-4.474D-02	3.135D-02	-4.474D-02	2.335D-02	2.377D-02	2.335D-02	2.377D-02
6	0.000D+00	1.402D-02	-3.799D-02	-1.402D-02	3.799D-02	2.674D-02	2.714D-02	-2.674D-02	-2.714D-02
7	0.000D+00	5.276D-03	-2.500D-02	5.276D-03	-2.500D-02	1.155D-02	1.194D-02	1.155D-02	1.194D-02
8	0.000D+00	1.526D-03	-1.293D-02	-1.526D-03	1.293D-02	4.866D-04	8.480D-04	-4.866D-04	-8.480D-04
9	0.000D+00	2.542D-04	-4.668D-03	2.542D-04	-4.668D-03	1.867D-03	2.197D-03	1.867D-03	2.197D-03
10	0.000D+00	1.519D-06	-2.963D-04	-1.519D-06	2.963D-04	6.304D-03	6.600D-03	-6.304D-03	-6.600D-03
11	0.000D+00	5.088D-05	1.298D-03	5.088D-05	1.298D-03	5.537D-03	5.805D-03	5.537D-03	5.805D-03
12	0.000D+00	1.210D-04	1.386D-03	-1.210D-04	-1.386D-03	1.622D-03	1.865D-03	-1.622D-03	-1.865D-03
13	0.000D+00	1.416D-04	9.126D-04	1.416D-04	9.126D-04	-1.087D-04	1.092D-04	-1.087D-04	1.092D-04
14	0.000D+00	1.213D-04	4.042D-04	-1.213D-04	-4.042D-04	9.923D-04	1.186D-03	-9.923D-04	-1.186D-03
15	0.000D+00	8.501D-05	6.254D-05	8.501D-05	6.254D-05	1.953D-03	2.124D-03	1.953D-03	2.124D-03
16	0.000D+00	5.059D-05	-9.599D-05	-5.059D-05	9.599D-05	1.270D-03	1.421D-03	-1.270D-03	-1.421D-03

Table 3.5.7 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	1.000D-03	1.000D-03	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	5.000D-03
drouter (in)=	1.000D-03	0.000D+00	0.000D+00	1.000D-03	1.000D-03	0.000D+00	1.000D-03	5.000D-03
dazimthi (in)=	0.000D+00	1.000D-03	0.000D+00	0.000D+00	1.000D-03	1.000D-03	1.000D-03	5.000D-03
dazimthf (in)=	0.000D+00	0.000D+00	1.000D-03	1.000D-03	0.000D+00	1.000D-03	1.000D-03	5.000D-03
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-3.658D-05	-3.264D-05	-4.353D-05	-4.149D-05	-3.060D-05	-3.756D-05	-7.412D-05	-3.702D-04
1	0.000D+00	-1.485D-01	-3.767D-01	-4.551D-01	-4.441D-01	-3.657D-01	-6.726D-01	-8.205D-01	-4.090D+00
2	1.292D-04	2.232D-01	-2.165D-01	1.637D-03	-2.012D-02	-2.383D-01	-4.602D-01	-2.363D-01	-1.170D+00
3	0.000D+00	1.815D-01	-1.629D-01	2.803D-01	2.584D-01	-1.849D-01	-8.605D-02	9.560D-02	4.803D-01
4	3.197D-05	-8.389D-02	-2.247D-01	1.091D-01	1.213D-01	-2.126D-01	-1.935D-02	-1.037D-01	-5.146D-01
5	0.000D+00	-1.524D-01	-2.251D-01	-1.434D-01	-1.178D-01	-1.995D-01	-1.907D-01	-3.425D-01	-1.701D+00
6	-8.324D-06	1.132D-03	-1.263D-01	-1.260D-01	-1.263D-01	-1.266D-01	-2.541D-01	-2.521D-01	-1.244D+00
7	0.000D+00	1.034D-01	-5.082D-02	5.031D-02	2.813D-02	-7.308D-02	-1.264D-01	-2.253D-02	-1.038D-01
8	-2.386D+01	3.696D-02	-6.587D-02	1.036D-01	9.489D-02	-7.471D-02	-8.017D-03	2.898D-02	1.453D-01
9	0.000D+00	-5.688D-02	-1.024D-01	3.243D-03	1.801D-02	-8.772D-02	-2.751D-02	-8.426D-02	-4.183D-01
10	2.715D+01	-4.606D-02	-8.481D-02	-6.965D-02	-5.679D-02	-7.198D-02	-9.576D-02	-1.413D-01	-6.963D-01
11	0.000D+00	2.208D-02	-3.520D-02	-2.735D-02	-3.407D-02	-4.195D-02	-9.165D-02	-6.904D-02	-3.350D-01
12	-2.589D+01	3.976D-02	-1.587D-02	3.815D-02	2.537D-02	-2.876D-02	-3.043D-02	9.518D-03	5.098D-02
13	0.000D+00	-5.989D-04	-3.352D-02	3.268D-02	3.296D-02	-3.339D-02	-7.080D-06	-6.060D-04	-3.023D-03
14	1.732D+01	-2.770D-02	-4.508D-02	-1.469D-02	-4.660D-03	-3.513D-02	-2.211D-02	-4.965D-02	-2.449D-01
15	0.000D+00	-9.801D-03	-2.923D-02	-2.807D-02	-2.440D-02	-2.557D-02	-4.399D-02	-5.345D-02	-2.605D-01
16	-7.984D+00	1.564D-02	-8.793D-03	1.053D-04	-6.171D-03	-1.510D-02	-3.076D-02	-1.487D-02	-6.958D-02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-2.921D-05	1.244D-05	3.735D-06	5.363D-06	1.406D-05	4.702D-05	1.779D-05	8.876D-05
1	0.000D+00	-6.544D-01	-1.023D-01	-4.486D-01	-3.999D-01	-5.354D-02	1.523D-01	-5.022D-01	-2.511D+00
2	0.000D+00	-4.613D-01	-1.396D-01	-5.896D-01	-5.447D-01	-9.464D-02	-2.231D-01	-6.841D-01	-3.412D+00
3	0.000D+00	-8.684D-02	-3.293D-02	-2.445D-01	-2.340D-01	-2.241D-02	-1.803D-01	-2.668D-01	-1.327D+00
4	0.000D+00	-1.943D-02	-8.491D-03	6.921D-02	7.205D-02	-5.677D-03	8.311D-02	6.349D-02	3.136D-01
5	0.000D+00	-1.925D-01	-8.921D-02	1.435D-02	4.682D-02	-5.679D-02	1.505D-01	-4.249D-02	-2.199D-01
6	0.000D+00	-2.572D-01	-1.266D-01	-1.815D-01	-1.323D-01	-7.736D-02	-1.535D-03	-2.588D-01	-1.292D+00
7	0.000D+00	-1.284D-01	-6.645D-02	-1.915D-01	-1.641D-01	-3.893D-02	-1.023D-01	-2.302D-01	-1.143D+00
8	0.000D+00	-8.217D-03	-4.599D-03	-4.189D-02	-3.998D-02	-2.653D-03	-3.643D-02	-4.449D-02	-2.193D-01
9	0.000D+00	-2.784D-02	-1.567D-02	3.631D-02	4.358D-02	-8.464D-03	5.589D-02	2.779D-02	1.339D-01
10	0.000D+00	-9.736D-02	-5.609D-02	-2.382D-02	3.537D-03	-2.678D-02	4.500D-02	-5.260D-02	-2.669D-01
11	0.000D+00	-9.348D-02	-5.536D-02	-8.822D-02	-6.008D-02	-2.717D-02	-2.192D-02	-1.153D-01	-5.731D-01
12	0.000D+00	-3.118D-02	-1.901D-02	-6.111D-02	-5.115D-02	-8.966D-03	-3.905D-02	-6.998D-02	-3.448D-01
13	0.000D+00	-5.274D-06	-1.118D-04	6.879D-04	6.913D-04	-1.102D-04	5.861D-04	5.769D-04	2.807D-03
14	0.000D+00	-2.252D-02	-1.436D-02	1.052D-02	1.874D-02	-6.212D-03	2.700D-02	4.281D-03	1.780D-02
15	0.000D+00	-4.503D-02	-2.917D-02	-8.370D-02	-6.541D-03	-1.202D-02	9.403D-03	-3.569D-02	-1.794D-01
16	0.000D+00	-3.161D-02	-2.087D-02	-3.867D-02	-2.611D-02	-8.252D-03	-1.537D-02	-4.686D-02	-2.315D-01

Table 3.5.7 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	1.000D-03	5.000D-03	1.000D-02	2.000D-02	3.000D-02	4.000D-02	5.000D-02	6.000D-02
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.931D-05	-9.640D-05	-1.924D-04	-3.834D-04	-5.730D-04	-7.612D-04	-9.480D-04	-1.133D-03
1	0.000D+00	-7.980D-02	-3.982D-01	-7.943D-01	-1.581D+00	-2.359D+00	-3.129D+00	-3.892D+00	-4.647D+00
2	1.292D-04	1.225D-01	6.109D-01	1.218D+00	2.419D+00	3.604D+00	4.774D+00	5.928D+00	7.066D+00
3	0.000D+00	1.018D-01	5.071D-01	1.010D+00	2.003D+00	2.979D+00	3.938D+00	4.882D+00	5.810D+00
4	3.197D-05	-4.804D-02	-2.392D-01	-4.759D-01	-9.421D-01	-1.399D+00	-1.846D+00	-2.284D+00	-2.714D+00
5	0.000D+00	-8.904D-02	-4.430D-01	-8.806D-01	-1.740D+00	-2.579D+00	-3.397D+00	-4.197D+00	-4.977D+00
6	-8.324D-06	6.750D-04	3.356D-03	6.665D-03	1.314D-02	1.944D-02	2.557D-02	3.153D-02	3.733D-02
7	0.000D+00	6.283D-02	3.121D-01	6.193D-01	1.219D+00	1.800D+00	2.363D+00	2.908D+00	3.437D+00
8	-2.386D+01	2.287D-02	1.135D-01	2.250D-01	4.421D-01	6.516D-01	8.538D-01	1.049D+00	1.237D+00
9	0.000D+00	-3.583D-02	-1.777D-01	-3.519D-01	-6.900D-01	-1.015D+00	-1.327D+00	-1.628D+00	-1.917D+00
10	2.715D+01	-2.951D-02	-1.462D-01	-2.893D-01	-5.661D-01	-8.312D-01	-1.085D+00	-1.328D+00	-1.561D+00
11	0.000D+00	1.438D-02	7.120D-02	1.407D-01	2.748D-01	4.027D-01	5.247D-01	6.410D-01	7.521D-01
12	-2.589D+01	2.630D-02	1.301D-01	2.569D-01	5.008D-01	7.323D-01	9.523D-01	1.161D+00	1.360D+00
13	0.000D+00	-4.022D-04	-1.989D-03	-3.922D-03	-7.629D-03	-1.113D-02	-1.445D-02	-1.759D-02	-2.056D-02
14	1.732D+01	-1.888D-02	-9.324D-02	-1.837D-01	-3.566D-01	-5.194D-01	-6.729D-01	-8.175D-01	-9.539D-01
15	0.000D+00	-6.772D-03	-3.342D-02	-6.577D-02	-1.274D-01	-1.852D-01	-2.395D-01	-2.904D-01	-3.382D-01
16	-7.984D+00	1.095D-02	5.400D-02	1.062D-01	2.052D-01	2.977D-01	3.842D-01	4.650D-01	5.406D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.542D-05	-7.698D-05	-1.537D-04	-3.062D-04	-4.576D-04	-6.078D-04	-7.569D-04	-9.050D-04
1	0.000D+00	-3.517D-01	-1.755D+00	-3.500D+00	-6.965D+00	-1.039D+01	-1.379D+01	-1.715D+01	-2.048D+01
2	0.000D+00	-2.532D-01	-1.263D+00	-2.516D+00	-4.999D+00	-7.448D+00	-9.865D+00	-1.225D+01	-1.460D+01
3	0.000D+00	-4.870D-02	-2.426D-01	-4.832D-01	-9.582D-01	-1.425D+00	-1.884D+00	-2.336D+00	-2.780D+00
4	0.000D+00	-1.112D-02	-5.539D-02	-1.102D-01	-2.182D-01	-3.239D-01	-4.275D-01	-5.290D-01	-6.285D-01
5	0.000D+00	-1.125D-01	-5.599D-01	-1.113D+00	-2.199D+00	-3.259D+00	-4.293D+00	-5.303D+00	-6.290D+00
6	0.000D+00	-1.533D-01	-7.623D-01	-1.514D+00	-2.985D+00	-4.416D+00	-5.808D+00	-7.161D+00	-8.478D+00
7	0.000D+00	-7.798D-02	-3.874D-01	-7.686D-01	-1.513D+00	-2.234D+00	-2.932D+00	-3.609D+00	-4.265D+00
8	0.000D+00	-5.084D-03	-2.524D-02	-5.003D-02	-9.828D-02	-1.448D-01	-1.898D-01	-2.332D-01	-2.751D-01
9	0.000D+00	-1.753D-02	-8.696D-02	-1.722D-01	-3.376D-01	-4.966D-01	-6.495D-01	-7.965D-01	-9.380D-01
10	0.000D+00	-6.237D-02	-3.091D-01	-6.115D-01	-1.197D+00	-1.757D+00	-2.293D+00	-2.807D+00	-3.300D+00
11	0.000D+00	-6.088D-02	-3.015D-01	-5.957D-01	-1.164D+00	-1.705D+00	-2.221D+00	-2.714D+00	-3.184D+00
12	0.000D+00	-2.062D-02	-1.020D-01	-2.015D-01	-3.927D-01	-5.743D-01	-7.468D-01	-9.107D-01	-1.067D+00
13	0.000D+00	-3.542D-06	-1.751D-05	-3.453D-05	-6.718D-05	-9.805D-05	-1.273D-04	-1.549D-04	-1.811D-04
14	0.000D+00	-1.535D-02	-7.581D-02	-1.494D-01	-2.899D-01	-4.223D-01	-5.471D-01	-6.647D-01	-7.756D-01
15	0.000D+00	-3.111D-02	-1.535D-01	-3.021D-01	-5.853D-01	-8.509D-01	-1.100D+00	-1.334D+00	-1.554D+00
16	0.000D+00	-2.213D-02	-1.091D-01	-2.145D-01	-4.148D-01	-6.017D-01	-7.764D-01	-9.398D-01	-1.093D+00

Table 3.5.7 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	1.000D-03	5.000D-03	1.000D-02	2.000D-02	3.000D-02	4.000D-02	5.000D-02	6.000D-02
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.727D-05	-8.624D-05	-1.722D-04	-3.432D-04	-5.131D-04	-6.818D-04	-8.495D-04	-1.016D-03
1	0.000D+00	-6.873D-02	-3.430D-01	-6.846D-01	-1.363D+00	-2.036D+00	-2.702D+00	-3.363D+00	-4.018D+00
2	1.292D-04	1.008D-01	5.027D-01	1.003D+00	1.994D+00	2.974D+00	3.943D+00	4.900D+00	5.848D+00
3	0.000D+00	7.979D-02	3.978D-01	7.928D-01	1.575D+00	2.345D+00	3.106D+00	3.855D+00	4.595D+00
4	3.197D-05	-3.589D-02	-1.789D-01	-3.562D-01	-7.065D-01	-1.051D+00	-1.390D+00	-1.723D+00	-2.051D+00
5	0.000D+00	-6.340D-02	-3.158D-01	-6.285D-01	-1.245D+00	-1.850D+00	-2.443D+00	-3.026D+00	-3.598D+00
6	-8.324D-06	4.581D-04	2.281D-03	4.537D-03	8.977D-03	1.332D-02	1.758D-02	2.174D-02	2.582D-02
7	0.000D+00	4.066D-02	2.023D-01	4.023D-01	7.950D-01	1.178D+00	1.553D+00	1.919D+00	2.276D+00
8	-2.386D+01	1.412D-02	7.023D-02	1.395D-01	2.755D-01	4.079D-01	5.370D-01	6.628D-01	7.854D-01
9	0.000D+00	-2.110D-02	-1.049D-01	-2.084D-01	-4.109D-01	-6.078D-01	-7.993D-01	-9.855D-01	-1.167D+00
10	2.715D+01	-1.659D-02	-8.246D-02	-1.637D-01	-3.224D-01	-4.765D-01	-6.260D-01	-7.711D-01	-9.120D-01
11	0.000D+00	7.723D-03	3.836D-02	7.610D-02	1.498D-01	2.211D-01	2.902D-01	3.572D-01	4.221D-01
12	-2.589D+01	1.350D-02	6.702D-02	1.329D-01	2.613D-01	3.854D-01	5.054D-01	6.214D-01	7.337D-01
13	0.000D+00	-1.974D-04	-9.796D-04	-1.942D-03	-3.814D-03	-5.621D-03	-7.364D-03	-9.048D-03	-1.067D-02
14	1.732D+01	-8.859D-03	-4.396D-02	-8.708D-02	-1.709D-01	-2.517D-01	-3.295D-01	-4.045D-01	-4.768D-01
15	0.000D+00	-3.041D-03	-1.509D-02	-2.988D-02	-5.859D-02	-8.620D-02	-1.128D-01	-1.383D-01	-1.630D-01
16	-7.984D+00	4.710D-03	2.336D-02	4.623D-02	9.060D-02	1.332D-01	1.741D-01	2.134D-01	2.513D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.379D-05	-6.886D-05	-1.375D-04	-2.741D-04	-4.097D-04	-5.445D-04	-6.783D-04	-8.113D-04
1	0.000D+00	-3.029D-01	-1.512D+00	-3.017D+00	-6.007D+00	-8.970D+00	-1.191D+01	-1.482D+01	-1.771D+01
2	0.000D+00	-2.083D-01	-1.039D+00	-2.072D+00	-4.120D+00	-6.145D+00	-8.147D+00	-1.013D+01	-1.208D+01
3	0.000D+00	-3.818D-02	-1.903D-01	-3.794D-01	-7.534D-01	-1.122D+00	-1.486D+00	-1.845D+00	-2.198D+00
4	0.000D+00	-8.311D-03	-4.141D-02	-8.248D-02	-1.636D-01	-2.434D-01	-3.219D-01	-3.991D-01	-4.750D-01
5	0.000D+00	-8.011D-02	-3.990D-01	-7.942D-01	-1.573D+00	-2.338D+00	-3.088D+00	-3.824D+00	-4.546D+00
6	0.000D+00	-1.041D-01	-5.180D-01	-1.031D+00	-2.039D+00	-3.026D+00	-3.992D+00	-4.938D+00	-5.864D+00
7	0.000D+00	-5.047D-02	-2.511D-01	-4.992D-01	-9.867D-01	-1.463D+00	-1.927D+00	-2.382D+00	-2.825D+00
8	0.000D+00	-3.139D-03	-1.561D-02	-3.102D-02	-6.123D-02	-9.067D-02	-1.194D-01	-1.473D-01	-1.746D-01
9	0.000D+00	-1.033D-02	-5.134D-02	-1.020D-01	-2.011D-01	-2.974D-01	-3.911D-01	-4.823D-01	-5.709D-01
10	0.000D+00	-3.508D-02	-1.743D-01	-3.460D-01	-6.816D-01	-1.007D+00	-1.323D+00	-1.630D+00	-1.928D+00
11	0.000D+00	-3.270D-02	-1.624D-01	-3.222D-01	-6.341D-01	-9.361D-01	-1.229D+00	-1.512D+00	-1.787D+00
12	0.000D+00	-1.058D-02	-5.256D-02	-1.042D-01	-2.049D-01	-3.022D-01	-3.963D-01	-4.873D-01	-5.754D-01
13	0.000D+00	-1.738D-06	-8.626D-06	-1.710D-05	-3.358D-05	-4.949D-05	-6.485D-05	-7.967D-05	-9.399D-05
14	0.000D+00	-7.202D-03	-3.574D-02	-7.080D-02	-1.390D-01	-2.046D-01	-2.679D-01	-3.289D-01	-3.877D-01
15	0.000D+00	-1.397D-02	-6.931D-02	-1.372D-01	-2.692D-01	-3.960D-01	-5.180D-01	-6.355D-01	-7.486D-01
16	0.000D+00	-9.519D-03	-4.720D-02	-9.343D-02	-1.831D-01	-2.692D-01	-3.519D-01	-4.314D-01	-5.078D-01

Table 3.5.7 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	1.000D-03	5.000D-03	1.000D-02	2.000D-02	3.000D-02	4.000D-02	5.000D-02	6.000D-02
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.333D-05	-6.675D-05	-1.337D-04	-2.684D-04	-4.040D-04	-5.405D-04	-6.779D-04	-8.162D-04
1	0.000D+00	-2.971D-01	-1.487D+00	-2.980D+00	-5.981D+00	-9.002D+00	-1.204D+01	-1.510D+01	-1.819D+01
2	1.292D-04	-3.393D-01	-1.699D+00	-3.403D+00	-6.830D+00	-1.028D+01	-1.375D+01	-1.725D+01	-2.076D+01
3	0.000D+00	-2.649D-01	-1.326D+00	-2.657D+00	-5.333D+00	-8.025D+00	-1.073D+01	-1.346D+01	-1.620D+01
4	3.197D-05	-1.769D-01	-8.855D-01	-1.774D+00	-3.559D+00	-5.355D+00	-7.160D+00	-8.974D+00	-1.080D+01
5	0.000D+00	-1.363D-01	-6.824D-01	-1.367D+00	-2.742D+00	-4.125D+00	-5.513D+00	-6.906D+00	-8.303D+00
6	-8.324D-06	-1.272D-01	-6.370D-01	-1.276D+00	-2.559D+00	-3.849D+00	-5.144D+00	-6.442D+00	-7.743D+00
7	0.000D+00	-1.139D-01	-5.703D-01	-1.142D+00	-2.291D+00	-3.445D+00	-4.603D+00	-5.763D+00	-6.924D+00
8	-2.386D+01	-8.898D-02	-4.455D-01	-8.923D-01	-1.789D+00	-2.690D+00	-3.592D+00	-4.494D+00	-5.395D+00
9	0.000D+00	-6.674D-02	-3.341D-01	-6.692D-01	-1.341D+00	-2.015D+00	-2.689D+00	-3.362D+00	-4.031D+00
10	2.715D+01	-5.549D-02	-2.778D-01	-5.564D-01	-1.115D+00	-1.675D+00	-2.233D+00	-2.790D+00	-3.342D+00
11	0.000D+00	-4.977D-02	-2.492D-01	-4.990D-01	-9.999D-01	-1.501D+00	-2.002D+00	-2.499D+00	-2.993D+00
12	-2.589D+01	-4.235D-02	-2.120D-01	-4.246D-01	-8.506D-01	-1.277D+00	-1.701D+00	-2.123D+00	-2.540D+00
13	0.000D+00	-3.326D-02	-1.665D-01	-3.334D-01	-6.678D-01	-1.002D+00	-1.333D+00	-1.662D+00	-1.985D+00
14	1.732D+01	-2.633D-02	-1.318D-01	-2.639D-01	-5.282D-01	-7.917D-01	-1.053D+00	-1.310D+00	-1.563D+00
15	0.000D+00	-2.258D-02	-1.130D-01	-2.263D-01	-4.529D-01	-6.785D-01	-9.018D-01	-1.122D+00	-1.336D+00
16	-7.984D+00	-1.986D-02	-9.940D-02	-1.990D-01	-3.981D-01	-5.963D-01	-7.921D-01	-9.845D-01	-1.172D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.786D-05	1.393D-04	2.785D-04	5.566D-04	8.344D-04	1.112D-03	1.389D-03	1.666D-03
1	0.000D+00	2.495D-01	1.246D+00	2.487D+00	4.959D+00	7.414D+00	9.853D+00	1.228D+01	1.468D+01
2	0.000D+00	1.137D-01	5.653D-01	1.123D+00	2.213D+00	3.271D+00	4.295D+00	5.287D+00	6.245D+00
3	0.000D+00	1.578D-02	7.469D-02	1.388D-01	2.349D-01	2.880D-01	2.977D-01	2.635D-01	1.850D-01
4	0.000D+00	2.636D-03	8.770D-03	6.474D-03	-3.153D-02	-1.145D-01	-2.427D-01	-4.167D-01	-6.367D-01
5	0.000D+00	2.335D-02	1.125D-01	2.146D-01	3.869D-01	5.166D-01	6.033D-01	6.466D-01	6.463D-01
6	0.000D+00	2.674D-02	1.297D-01	2.494D-01	4.587D-01	6.276D-01	7.556D-01	8.426D-01	8.883D-01
7	0.000D+00	1.155D-02	5.393D-02	9.825D-02	1.579D-01	1.786D-01	1.600D-01	1.020D-01	4.434D-03
8	0.000D+00	4.866D-04	-1.188D-03	-1.145D-02	-5.938D-02	-1.441D-01	-2.658D-01	-4.246D-01	-6.207D-01
9	0.000D+00	1.867D-03	6.026D-03	3.761D-03	-2.579D-02	-8.889D-02	-1.857D-01	-3.164D-01	-4.808D-01
10	0.000D+00	6.304D-03	2.855D-02	4.964D-02	6.935D-02	5.893D-02	1.828D-02	-5.265D-02	-1.538D-01
11	0.000D+00	5.537D-03	2.500D-02	4.328D-02	5.954D-02	4.864D-02	1.050D-02	-5.486D-02	-1.473D-01
12	0.000D+00	1.622D-03	5.679D-03	5.263D-03	-1.395D-02	-5.774D-02	-1.262D-01	-2.192D-01	-3.366D-01
13	0.000D+00	-1.087D-04	-2.727D-03	-1.093D-02	-4.383D-02	-9.878D-02	-1.758D-01	-2.748D-01	-3.955D-01
14	0.000D+00	9.923D-04	3.025D-03	1.195D-03	-1.709D-02	-5.491D-02	-1.122D-01	-1.889D-01	-2.848D-01
15	0.000D+00	1.953D-03	8.053D-03	1.182D-02	6.424D-03	-1.621D-02	-5.603D-02	-1.129D-01	-1.865D-01
16	0.000D+00	1.270D-03	4.828D-03	5.850D-03	-3.563D-03	-2.826D-02	-6.815D-02	-1.231D-01	-1.927D-01

Table 3.5.7 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	1.000D-03	5.000D-03	1.000D-02	2.000D-02	3.000D-02	4.000D-02	5.000D-02	6.000D-02
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.423D-05	-1.212D-04	-2.425D-04	-4.855D-04	-7.290D-04	-9.730D-04	-1.218D-03	-1.463D-03
1	0.000D+00	-3.755D-01	-1.876D+00	-3.750D+00	-7.488D+00	-1.121D+01	-1.493D+01	-1.863D+01	-2.232D+01
2	1.292D-04	-1.210D-01	-6.009D-01	-1.192D+00	-2.344D+00	-3.457D+00	-4.530D+00	-5.564D+00	-6.559D+00
3	0.000D+00	1.787D-01	8.957D-01	1.797D+00	3.614D+00	5.451D+00	7.307D+00	9.182D+00	1.107D+01
4	3.197D-05	1.574D-01	7.839D-01	1.560D+00	3.089D+00	4.587D+00	6.052D+00	7.485D+00	8.885D+00
5	0.000D+00	-5.444D-02	-2.760D-01	-5.616D-01	-1.161D+00	-1.798D+00	-2.471D+00	-3.179D+00	-3.923D+00
6	-8.324D-06	-1.269D-01	-6.335D-01	-1.265D+00	-2.519D+00	-3.761D+00	-4.991D+00	-6.206D+00	-7.406D+00
7	0.000D+00	-1.255D-02	-5.885D-02	-1.079D-01	-1.769D-01	-2.072D-01	-1.989D-01	-1.523D-01	-6.784D-02
8	-2.386D+01	8.090D-02	4.055D-01	8.131D-01	1.635D+00	2.463D+00	3.296D+00	4.133D+00	4.973D+00
9	0.000D+00	3.919D-02	1.930D-01	3.788D-01	7.280D-01	1.047D+00	1.336D+00	1.593D+00	1.820D+00
10	2.715D+01	-4.027D-02	-2.034D-01	-4.118D-01	-8.428D-01	-1.292D+00	-1.758D+00	-2.239D+00	-2.734D+00
11	0.000D+00	-4.188D-02	-2.079D-01	-4.118D-01	-8.074D-01	-1.186D+00	-1.545D+00	-1.886D+00	-2.206D+00
12	-2.589D+01	1.190D-02	6.178D-02	1.292D-01	2.806D-01	4.536D-01	6.473D-01	8.609D-01	1.093D+00
13	0.000D+00	3.323D-02	1.659D-01	3.309D-01	6.577D-01	9.791D-01	1.294D+00	1.600D+00	1.897D+00
14	1.732D+01	4.209D-03	1.911D-02	3.340D-02	4.747D-02	4.230D-02	1.802D-02	-2.510D-02	-8.672D-02
15	0.000D+00	-2.141D-02	-1.076D-01	-2.164D-01	-4.373D-01	-6.613D-01	-8.873D-01	-1.114D+00	-1.340D+00
16	-7.984D+00	-1.091D-02	-5.324D-02	-1.032D-01	-1.929D-01	-2.687D-01	-3.303D-01	-3.772D-01	-4.094D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.916D-05	9.571D-05	1.912D-04	3.816D-04	5.711D-04	7.598D-04	9.477D-04	1.135D-03
1	0.000D+00	-9.703D-02	-4.874D-01	-9.807D-01	-1.984D+00	-3.011D+00	-4.060D+00	-5.132D+00	-6.227D+00
2	0.000D+00	-3.366D-01	-1.683D+00	-3.367D+00	-6.735D+00	-1.010D+01	-1.347D+01	-1.684D+01	-2.021D+01
3	0.000D+00	-1.960D-01	-9.758D-01	-1.941D+00	-3.842D+00	-5.701D+00	-7.519D+00	-9.296D+00	-1.103D+01
4	0.000D+00	8.044D-02	4.056D-01	8.197D-01	1.673D+00	2.558D+00	3.475D+00	4.424D+00	5.402D+00
5	0.000D+00	1.271D-01	6.335D-01	1.262D+00	2.505D+00	3.726D+00	4.926D+00	6.103D+00	7.257D+00
6	0.000D+00	-2.825D-02	-1.452D-01	-3.003D-01	-6.398D-01	-1.018D+00	-1.434D+00	-1.889D+00	-2.380D+00
7	0.000D+00	-1.138D-01	-5.688D-01	-1.138D+00	-2.274D+00	-3.408D+00	-4.539D+00	-5.664D+00	-6.782D+00
8	0.000D+00	-3.690D-02	-1.810D-01	-3.531D-01	-6.706D-01	-9.523D-01	-1.198D+00	-1.408D+00	-1.582D+00
9	0.000D+00	5.401D-02	2.717D-01	5.473D-01	1.110D+00	1.686D+00	2.275D+00	2.874D+00	3.483D+00
10	0.000D+00	3.869D-02	1.912D-01	3.769D-01	7.311D-01	1.062D+00	1.368D+00	1.649D+00	1.904D+00
11	0.000D+00	-2.744D-02	-1.394D-01	-2.844D-01	-5.902D-01	-9.165D-01	-1.262D+00	-1.626D+00	-2.007D+00
12	0.000D+00	-4.065D-02	-2.024D-01	-4.024D-01	-7.949D-01	-1.176D+00	-1.545D+00	-1.900D+00	-2.240D+00
13	0.000D+00	6.945D-04	5.642D-03	1.669D-02	5.482D-02	1.140D-01	1.938D-01	2.936D-01	4.129D-01
14	0.000D+00	2.600D-02	1.302D-01	2.607D-01	5.223D-01	7.832D-01	1.042D+00	1.298D+00	1.550D+00
15	0.000D+00	7.448D-03	3.562D-02	6.714D-02	1.178D-01	1.517D-01	1.687D-01	1.689D-01	1.522D-01
16	0.000D+00	-1.664D-02	-8.397D-02	-1.698D-01	-3.467D-01	-5.295D-01	-7.171D-01	-9.083D-01	-1.102D+00

Table 3.5.7 Cont.

n	bideal	db	db	db	db	db	db	db	db
region =		1	1	1	1	1	1	1	1
drinner (in)=		-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1
0	1.000D+00	1.932D-05	9.677D-05	1.939D-04	3.893D-04	5.862D-04	7.845D-04	9.845D-04	1.186D-03
1	0.000D+00	7.988D-02	4.002D-01	8.025D-01	1.613D+00	2.433D+00	3.261D+00	4.097D+00	4.943D+00
2	1.292D-04	-1.227D-01	-6.151D-01	-1.234D+00	-2.486D+00	-3.755D+00	-5.042D+00	-6.346D+00	-7.669D+00
3	0.000D+00	-1.019D-01	-5.115D-01	-1.027D+00	-2.073D+00	-3.137D+00	-4.219D+00	-5.321D+00	-6.442D+00
4	3.197D-05	4.814D-02	2.417D-01	4.860D-01	9.873D-01	1.489D+00	2.007D+00	2.536D+00	3.077D+00
5	0.000D+00	8.926D-02	4.485D-01	9.026D-01	1.828D+00	2.776D+00	3.749D+00	4.747D+00	5.770D+00
6	-8.324D-06	-6.769D-04	-3.404D-03	-6.857D-03	-1.391D-02	-2.118D-02	-2.865D-02	-3.635D-02	-4.428D-02
7	0.000D+00	-6.303D-02	-3.172D-01	-6.396D-01	-1.300D+00	-1.983D+00	-2.689D+00	-3.418D+00	-4.173D+00
8	-2.386D+01	-2.295D-02	-1.156D-01	-2.333D-01	-4.754D-01	-7.265D-01	-9.870D-01	-1.258D+00	-1.538D+00
9	0.000D+00	3.597D-02	1.813D-01	3.663D-01	7.478D-01	1.145D+00	1.559D+00	1.991D+00	2.441D+00
10	2.715D+01	2.964D-02	1.495D-01	3.024D-01	6.186D-01	9.494D-01	1.295D+00	1.658D+00	2.037D+00
11	0.000D+00	-1.445D-02	-7.295D-02	-1.477D-01	-3.028D-01	-4.657D-01	-6.368D-01	-8.168D-01	-1.006D+00
12	-2.589D+01	-2.644D-02	-1.336D-01	-2.708D-01	-5.563D-01	-8.575D-01	-1.175D+00	-1.511D+00	-1.865D+00
13	0.000D+00	4.045D-04	2.046D-03	4.151D-03	8.546D-03	1.320D-02	1.814D-02	2.337D-02	2.893D-02
14	1.732D+01	1.899D-02	9.613D-02	1.953D-01	4.029D-01	6.239D-01	8.591D-01	1.110D+00	1.377D+00
15	0.000D+00	6.816D-03	3.453D-02	7.021D-02	1.452D-01	2.253D-01	3.110D-01	4.027D-01	5.009D-01
16	-7.984D+00	-1.103D-02	-5.591D-02	-1.138D-01	-2.359D-01	-3.670D-01	-5.078D-01	-6.591D-01	-8.218D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.543D-05	7.727D-05	1.548D-04	3.108D-04	4.681D-04	6.265D-04	7.861D-04	9.470D-04
1	0.000D+00	3.520D-01	1.764D+00	3.537D+00	7.110D+00	1.072D+01	1.437D+01	1.806D+01	2.178D+01
2	0.000D+00	2.535D-01	1.271D+00	2.551D+00	5.137D+00	7.760D+00	1.042D+01	1.311D+01	1.585D+01
3	0.000D+00	4.878D-02	2.447D-01	4.916D-01	9.918D-01	1.501D+00	2.019D+00	2.546D+00	3.083D+00
4	0.000D+00	1.115D-02	5.597D-02	1.125D-01	2.275D-01	3.448D-01	4.647D-01	5.872D-01	7.124D-01
5	0.000D+00	1.128D-01	5.668D-01	1.141D+00	2.310D+00	3.509D+00	4.738D+00	5.999D+00	7.292D+00
6	0.000D+00	1.538D-01	7.732D-01	1.557D+00	3.160D+00	4.810D+00	6.508D+00	8.256D+00	1.006D+01
7	0.000D+00	7.823D-02	3.937D-01	7.938D-01	1.614D+00	2.461D+00	3.337D+00	4.243D+00	5.179D+00
8	0.000D+00	5.103D-03	2.570D-02	5.187D-02	1.057D-01	1.615D-01	2.194D-01	2.795D-01	3.420D-01
9	0.000D+00	1.760D-02	8.872D-02	1.793D-01	3.659D-01	5.604D-01	7.630D-01	9.742D-01	1.194D+00
10	0.000D+00	6.265D-02	3.161D-01	6.392D-01	1.308D+00	2.007D+00	2.738D+00	3.504D+00	4.306D+00
11	0.000D+00	6.117D-02	3.088D-01	6.253D-01	1.282D+00	1.971D+00	2.696D+00	3.458D+00	4.259D+00
12	0.000D+00	2.073D-02	1.048D-01	2.123D-01	4.362D-01	6.724D-01	9.216D-01	1.185D+00	1.463D+00
13	0.000D+00	3.562D-06	1.802D-05	3.655D-05	7.526D-05	1.163D-04	1.597D-04	2.058D-04	2.547D-04
14	0.000D+00	1.544D-02	7.816D-02	1.587D-01	3.276D-01	5.072D-01	6.984D-01	9.021D-01	1.119D+00
15	0.000D+00	3.131D-02	1.586D-01	3.225D-01	6.671D-01	1.035D+00	1.429D+00	1.850D+00	2.301D+00
16	0.000D+00	2.229D-02	1.130D-01	2.300D-01	4.768D-01	7.417D-01	1.026D+00	1.332D+00	1.661D+00

Table 3.5.7 Cont.

region	=	1	1	1	1	1	1	1	1
drinner	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter	(in)=	-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
dazimthi	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.728D-05	8.653D-05	1.734D-04	3.479D-04	5.237D-04	7.006D-04	8.788D-04	1.058D-03
1	0.000D+00	6.879D-02	3.446D-01	6.907D-01	1.388D+00	2.091D+00	2.800D+00	3.517D+00	4.239D+00
2	1.292D-04	-1.009D-01	-5.056D-01	-1.014D+00	-2.040D+00	-3.078D+00	-4.129D+00	-5.191D+00	-6.266D+00
3	0.000D+00	-7.990D-02	-4.006D-01	-8.041D-01	-1.620D+00	-2.447D+00	-3.287D+00	-4.138D+00	-5.003D+00
4	3.197D-05	3.595D-02	1.804D-01	3.622D-01	7.307D-01	1.105D+00	1.487D+00	1.874D+00	2.269D+00
5	0.000D+00	6.352D-02	3.188D-01	6.407D-01	1.294D+00	1.960D+00	2.640D+00	3.333D+00	4.040D+00
6	-8.324D-06	-4.591D-04	-2.306D-03	-4.637D-03	-9.376D-03	-1.422D-02	-1.918D-02	-2.424D-02	-2.942D-02
7	0.000D+00	-4.076D-02	-2.048D-01	-4.121D-01	-8.343D-01	-1.267D+00	-1.710D+00	-2.165D+00	-2.631D+00
8	-2.386D+01	-1.416D-02	-7.116D-02	-1.433D-01	-2.904D-01	-4.415D-01	-5.968D-01	-7.564D-01	-9.204D-01
9	0.000D+00	2.116D-02	1.064D-01	2.144D-01	4.351D-01	6.623D-01	8.962D-01	1.137D+00	1.385D+00
10	2.715D+01	1.665D-02	8.374D-02	1.688D-01	3.429D-01	5.225D-01	7.079D-01	8.993D-01	1.097D+00
11	0.000D+00	-7.748D-03	-3.899D-02	-7.864D-02	-1.599D-01	-2.440D-01	-3.309D-01	-4.208D-01	-5.139D-01
12	-2.589D+01	-1.354D-02	-6.819D-02	-1.376D-01	-2.801D-01	-4.277D-01	-5.807D-01	-7.394D-01	-9.039D-01
13	0.000D+00	1.981D-04	9.977D-04	2.014D-03	4.104D-03	6.273D-03	8.525D-03	1.087D-02	1.330D-02
14	1.732D+01	8.893D-03	4.481D-02	9.049D-02	1.846D-01	2.824D-01	3.842D-01	4.901D-01	6.005D-01
15	0.000D+00	3.054D-03	1.539D-02	3.110D-02	6.348D-02	9.722D-02	1.324D-01	1.691D-01	2.073D-01
16	-7.984D+00	-4.730D-03	-2.385D-02	-4.820D-02	-9.848D-02	-1.510D-01	-2.057D-01	-2.630D-01	-3.228D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.380D-05	6.910D-05	1.384D-04	2.778D-04	4.181D-04	5.594D-04	7.017D-04	8.450D-04
1	0.000D+00	3.032D-01	1.518D+00	3.044D+00	6.115D+00	9.214D+00	1.234D+01	1.550D+01	1.868D+01
2	0.000D+00	2.085D-01	1.045D+00	2.096D+00	4.216D+00	6.361D+00	8.532D+00	1.073D+01	1.295D+01
3	0.000D+00	3.823D-02	1.917D-01	3.848D-01	7.751D-01	1.171D+00	1.573D+00	1.980D+00	2.394D+00
4	0.000D+00	8.325D-03	4.176D-02	8.388D-02	1.692D-01	2.560D-01	3.442D-01	4.340D-01	5.253D-01
5	0.000D+00	8.027D-02	4.029D-01	8.097D-01	1.635D+00	2.477D+00	3.336D+00	4.212D+00	5.105D+00
6	0.000D+00	1.043D-01	5.237D-01	1.053D+00	2.130D+00	3.230D+00	4.355D+00	5.506D+00	6.683D+00
7	0.000D+00	5.059D-02	2.542D-01	5.114D-01	1.035D+00	1.572D+00	2.123D+00	2.687D+00	3.265D+00
8	0.000D+00	3.147D-03	1.582D-02	3.185D-02	6.456D-02	9.815D-02	1.327D-01	1.681D-01	2.046D-01
9	0.000D+00	1.036D-02	5.208D-02	1.049D-01	2.129D-01	3.241D-01	4.386D-01	5.565D-01	6.780D-01
10	0.000D+00	3.518D-02	1.770D-01	3.568D-01	7.248D-01	1.104D+00	1.496D+00	1.901D+00	2.319D+00
11	0.000D+00	3.280D-02	1.651D-01	3.329D-01	6.770D-01	1.033D+00	1.401D+00	1.782D+00	2.176D+00
12	0.000D+00	1.062D-02	5.348D-02	1.079D-01	2.196D-01	3.354D-01	4.554D-01	5.798D-01	7.088D-01
13	0.000D+00	1.744D-06	8.785D-06	1.773D-05	3.613D-05	5.524D-05	7.507D-05	9.568D-05	1.171D-04
14	0.000D+00	7.230D-03	3.643D-02	7.357D-02	1.500D-01	2.296D-01	3.123D-01	3.985D-01	4.882D-01
15	0.000D+00	1.403D-02	7.071D-02	1.429D-01	2.916D-01	4.466D-01	6.082D-01	7.767D-01	9.525D-01
16	0.000D+00	9.559D-03	4.820D-02	9.741D-02	1.990D-01	3.051D-01	4.158D-01	5.315D-01	6.524D-01

Table 3:5.7 Cont.

region	=	1	1	1	1	1	1	1	1
drinner	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi	(in)=	-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
dazimthf	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.332D-05	6.652D-05	1.328D-04	2.647D-04	3.956D-04	5.257D-04	6.547D-04	7.829D-04
1	0.000D+00	2.969D-01	1.482D+00	2.959D+00	5.898D+00	8.816D+00	1.171D+01	1.459D+01	1.744D+01
2	1.292D-04	3.390D-01	1.693D+00	3.380D+00	6.736D+00	1.007D+01	1.337D+01	1.666D+01	1.992D+01
3	0.000D+00	2.647D-01	1.322D+00	2.639D+00	5.259D+00	7.859D+00	1.044D+01	1.300D+01	1.554D+01
4	3.197D-05	1.767D-01	8.824D-01	1.762D+00	3.510D+00	5.245D+00	6.964D+00	8.668D+00	1.035D+01
5	0.000D+00	1.362D-01	6.800D-01	1.357D+00	2.704D+00	4.040D+00	5.362D+00	6.671D+00	7.965D+00
6	-8.324D-06	1.271D-01	6.347D-01	1.267D+00	2.524D+00	3.770D+00	5.003D+00	6.222D+00	7.427D+00
7	0.000D+00	1.138D-01	5.683D-01	1.135D+00	2.260D+00	3.374D+00	4.477D+00	5.567D+00	6.642D+00
8	-2.386D+01	8.892D-02	4.439D-01	8.861D-01	1.765D+00	2.634D+00	3.493D+00	4.340D+00	5.174D+00
9	0.000D+00	6.669D-02	3.330D-01	6.646D-01	1.323D+00	1.974D+00	2.616D+00	3.247D+00	3.867D+00
10	2.715D+01	5.545D-02	2.769D-01	5.526D-01	1.100D+00	1.640D+00	2.172D+00	2.695D+00	3.206D+00
11	0.000D+00	4.973D-02	2.483D-01	4.955D-01	9.862D-01	1.470D+00	1.947D+00	2.414D+00	2.871D+00
12	-2.589D+01	4.232D-02	2.113D-01	4.216D-01	8.389D-01	1.250D+00	1.655D+00	2.050D+00	2.436D+00
13	0.000D+00	3.324D-02	1.659D-01	3.311D-01	6.586D-01	9.809D-01	1.297D+00	1.605D+00	1.904D+00
14	1.732D+01	2.631D-02	1.313D-01	2.621D-01	5.209D-01	7.754D-01	1.024D+00	1.266D+00	1.499D+00
15	0.000D+00	2.257D-02	1.127D-01	2.248D-01	4.467D-01	6.645D-01	8.771D-01	1.083D+00	1.282D+00
16	-7.984D+00	1.984D-02	9.905D-02	1.976D-01	3.927D-01	5.840D-01	7.704D-01	9.509D-01	1.124D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-2.786D-05	-1.394D-04	-2.788D-04	-5.579D-04	-8.373D-04	-1.117D-03	-1.397D-03	-1.677D-03
1	0.000D+00	-2.496D-01	-1.250D+00	-2.503D+00	-5.022D+00	-7.556D+00	-1.011D+01	-1.267D+01	-1.525D+01
2	0.000D+00	-1.140D-01	-5.733D-01	-1.155D+00	-2.341D+00	-3.558D+00	-4.807D+00	-6.086D+00	-7.395D+00
3	0.000D+00	-1.620D-02	-8.523D-02	-1.810D-01	-4.037D-01	-6.676D-01	-9.725D-01	-1.318D+00	-1.703D+00
4	0.000D+00	-3.077D-03	-1.978D-02	-5.051D-02	-1.446D-01	-2.817D-01	-4.615D-01	-6.833D-01	-9.466D-01
5	0.000D+00	-2.377D-02	-1.230D-01	-2.564D-01	-5.542D-01	-8.929D-01	-1.272D+00	-1.691D+00	-2.149D+00
6	0.000D+00	-2.714D-02	-1.396D-01	-2.892D-01	-6.176D-01	-9.849D-01	-1.390D+00	-1.834D+00	-2.314D+00
7	0.000D+00	-1.194D-02	-6.350D-02	-1.365D-01	-3.108D-01	-5.225D-01	-7.710D-01	-1.056D+00	-1.376D+00
8	0.000D+00	-8.480D-04	-7.846D-03	-2.468D-02	-8.508D-02	-1.807D-01	-3.111D-01	-4.757D-01	-6.738D-01
9	0.000D+00	-2.197D-03	-1.428D-02	-3.676D-02	-1.061D-01	-2.077D-01	-3.409D-01	-5.053D-01	-7.001D-01
10	0.000D+00	-6.600D-03	-3.596D-02	-7.930D-02	-1.879D-01	-3.254D-01	-4.913D-01	-6.850D-01	-9.060D-01
11	0.000D+00	-5.805D-03	-3.170D-02	-7.005D-02	-1.666D-01	-2.891D-01	-4.372D-01	-6.104D-01	-8.079D-01
12	0.000D+00	-1.865D-03	-1.175D-02	-2.952D-02	-8.301D-02	-1.601D-01	-2.603D-01	-3.831D-01	-5.278D-01
13	0.000D+00	-1.092D-04	-2.721D-03	-1.086D-02	-4.323D-02	-9.676D-02	-1.710D-01	-2.654D-01	-3.794D-01
14	0.000D+00	-1.186D-03	-7.857D-03	-2.052D-02	-6.011D-02	-1.184D-01	-1.951D-01	-2.895D-01	-4.012D-01
15	0.000D+00	-2.124D-03	-1.232D-02	-2.889D-02	-7.464D-02	-1.369D-01	-2.153D-01	-3.094D-01	-4.185D-01
16	0.000D+00	-1.421D-03	-8.618D-03	-2.100D-02	-5.696D-02	-1.076D-01	-1.724D-01	-2.511D-01	-3.430D-01

Table 3.5.7 Cont.

region	=	1	1	1	1	1	1	1	1
drinner	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf	(in)=	-1.000D-03	-5.000D-03	-1.000D-02	-2.000D-02	-3.000D-02	-4.000D-02	-5.000D-02	-6.000D-02
symmetry	=	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.422D-05	1.210D-04	2.420D-04	4.834D-04	7.243D-04	9.647D-04	1.205D-03	1.444D-03
1	0.000D+00	3.756D-01	1.879D+00	3.762D+00	7.535D+00	1.132D+01	1.512D+01	1.892D+01	2.274D+01
2	1.292D-04	1.214D-01	6.108D-01	1.232D+00	2.503D+00	3.814D+00	5.165D+00	6.556D+00	7.987D+00
3	0.000D+00	-1.785D-01	-8.904D-01	-1.775D+00	-3.529D+00	-5.259D+00	-6.966D+00	-8.649D+00	-1.031D+01
4	3.197D-05	-1.577D-01	-7.915D-01	-1.591D+00	-3.211D+00	-4.860D+00	-6.538D+00	-8.244D+00	-9.976D+00
5	0.000D+00	5.405D-02	2.664D-01	5.231D-01	1.007D+00	1.451D+00	1.854D+00	2.217D+00	2.538D+00
6	-8.324D-06	1.270D-01	6.358D-01	1.274D+00	2.555D+00	3.844D+00	5.137D+00	6.435D+00	7.735D+00
7	0.000D+00	1.294D-02	6.861D-02	1.470D-01	3.331D-01	5.584D-01	8.226D-01	1.126D+00	1.468D+00
8	-2.386D+01	-8.080D-02	-4.030D-01	-8.034D-01	-1.596D+00	-2.375D+00	-3.141D+00	-3.891D+00	-4.624D+00
9	0.000D+00	-3.948D-02	-2.003D-01	-4.076D-01	-8.435D-01	-1.307D+00	-1.797D+00	-2.313D+00	-2.853D+00
10	2.715D+01	4.007D-02	1.983D-01	3.913D-01	7.609D-01	1.108D+00	1.431D+00	1.729D+00	2.001D+00
11	0.000D+00	4.203D-02	2.116D-01	4.269D-01	8.676D-01	1.321D+00	1.785D+00	2.260D+00	2.742D+00
12	-2.589D+01	-1.167D-02	-5.606D-02	-1.063D-01	-1.893D-01	-2.483D-01	-2.831D-01	-2.933D-01	-2.787D-01
13	0.000D+00	-3.326D-02	-1.665D-01	-3.336D-01	-6.684D-01	-1.003D+00	-1.336D+00	-1.666D+00	-1.992D+00
14	1.732D+01	-4.402D-03	-2.394D-02	-5.268D-02	-1.245D-01	-2.153D-01	-3.248D-01	-4.524D-01	-5.978D-01
15	0.000D+00	2.135D-02	1.062D-01	2.108D-01	4.146D-01	6.104D-01	7.969D-01	9.731D-01	1.138D+00
16	-7.984D+00	1.104D-02	5.646D-02	1.161D-01	2.444D-01	3.842D-01	5.347D-01	6.951D-01	8.643D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.917D-05	-9.591D-05	-1.920D-04	-3.849D-04	-5.786D-04	-7.731D-04	-9.685D-04	-1.165D-03
1	0.000D+00	9.680D-02	4.817D-01	9.575D-01	1.892D+00	2.803D+00	3.690D+00	4.555D+00	5.395D+00
2	0.000D+00	3.366D-01	1.683D+00	3.365D+00	6.729D+00	1.009D+01	1.345D+01	1.680D+01	2.016D+01
3	0.000D+00	1.964D-01	9.860D-01	1.982D+00	4.005D+00	6.068D+00	8.171D+00	1.031D+01	1.250D+01
4	0.000D+00	-8.010D-02	-3.971D-01	-7.855D-01	-1.536D+00	-2.251D+00	-2.929D+00	-3.570D+00	-4.173D+00
5	0.000D+00	-1.273D-01	-6.382D-01	-1.281D+00	-2.580D+00	-3.895D+00	-5.227D+00	-6.573D+00	-7.932D+00
6	0.000D+00	2.786D-02	1.353D-01	2.607D-01	4.813D-01	6.614D-01	8.009D-01	8.993D-01	9.564D-01
7	0.000D+00	1.138D-01	5.687D-01	1.137D+00	2.273D+00	3.405D+00	4.532D+00	5.653D+00	6.767D+00
8	0.000D+00	3.726D-02	1.898D-01	3.884D-01	8.119D-01	1.270D+00	1.762D+00	2.288D+00	2.848D+00
9	0.000D+00	-5.384D-02	-2.675D-01	-5.307D-01	-1.043D+00	-1.537D+00	-2.010D+00	-2.460D+00	-2.888D+00
10	0.000D+00	-3.890D-02	-1.967D-01	-3.987D-01	-8.182D-01	-1.257D+00	-1.715D+00	-2.190D+00	-2.682D+00
11	0.000D+00	2.722D-02	1.338D-01	2.620D-01	5.007D-01	7.152D-01	9.050D-01	1.069D+00	1.207D+00
12	0.000D+00	4.074D-02	2.045D-01	4.111D-01	8.294D-01	1.254D+00	1.682D+00	2.114D+00	2.547D+00
13	0.000D+00	-4.770D-04	-2.052D-04	5.055D-03	3.206D-02	8.113D-02	1.523D-01	2.455D-01	3.605D-01
14	0.000D+00	-2.598D-02	-1.296D-01	-2.586D-01	-5.136D-01	-7.638D-01	-1.008D+00	-1.244D+00	-1.472D+00
15	0.000D+00	-7.610D-03	-3.966D-02	-8.333D-02	-1.824D-01	-2.968D-01	-4.258D-01	-5.688D-01	-7.251D-01
16	0.000D+00	1.656D-02	8.195D-02	1.617D-01	3.144D-01	4.569D-01	5.884D-01	7.080D-01	8.150D-01

Table 3.5.7 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	2	3	4	5	12	14	23

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.931D-05	-1.931D-05	-1.931D-05	-1.931D-05	-7.724D-05	-3.862D-05	-3.862D-05	-3.862D-05
1	0.000D+00	-7.980D-02	7.980D-02	7.980D-02	-7.980D-02	3.058D-16	-1.934D-16	-1.596D-01	1.596D-01
2	1.292D-04	1.225D-01	1.225D-01	1.225D-01	1.225D-01	4.901D-01	2.450D-01	2.450D-01	2.450D-01
3	0.000D+00	1.018D-01	-1.018D-01	-1.018D-01	1.018D-01	8.612D-17	-3.853D-17	2.035D-01	-2.035D-01
4	3.197D-05	-4.804D-02	-4.804D-02	-4.804D-02	-4.804D-02	-1.922D-01	-9.608D-02	-9.608D-02	-9.608D-02
5	0.000D+00	-8.904D-02	8.904D-02	8.904D-02	-8.904D-02	3.288D-16	-1.526D-16	-1.781D-01	1.781D-01
6	-8.324D-06	6.750D-04	6.750D-04	6.750D-04	6.750D-04	2.700D-03	1.350D-03	1.350D-03	1.350D-03
7	0.000D+00	6.283D-02	-6.283D-02	-6.283D-02	6.283D-02	2.974D-16	-1.457D-16	1.257D-01	-1.257D-01
8	-2.386D+01	2.287D-02	2.287D-02	2.287D-02	2.287D-02	9.149D-02	4.574D-02	4.574D-02	4.574D-02
9	0.000D+00	-3.583D-02	3.583D-02	3.583D-02	-3.583D-02	8.193D-17	-4.215D-17	-7.165D-02	7.165D-02
10	2.715D+01	-2.951D-02	-2.951D-02	-2.951D-02	-2.951D-02	-1.180D-01	-5.902D-02	-5.902D-02	-5.902D-02
11	0.000D+00	1.438D-02	-1.438D-02	-1.438D-02	1.438D-02	3.474D-16	-1.734D-16	2.876D-02	-2.876D-02
12	-2.589D+01	2.630D-02	2.630D-02	2.630D-02	2.630D-02	1.052D-01	5.260D-02	5.260D-02	5.260D-02
13	0.000D+00	-4.022D-04	4.022D-04	4.022D-04	-4.022D-04	-4.704D-20	-7.978D-20	-8.045D-04	8.045D-04
14	1.732D+01	-1.888D-02	-1.888D-02	-1.888D-02	-1.888D-02	-7.551D-02	-3.775D-02	-3.775D-02	-3.775D-02
15	0.000D+00	-6.772D-03	6.772D-03	6.772D-03	-6.772D-03	2.369D-16	-1.182D-16	-1.354D-02	1.354D-02
16	-7.984D+00	1.095D-02	1.095D-02	1.095D-02	1.095D-02	4.380D-02	2.190D-02	2.190D-02	2.190D-02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-1.542D-05	1.542D-05	-1.542D-05	1.542D-05	1.304D-20	1.714D-22	5.533D-21	1.066D-20
1	0.000D+00	-3.517D-01	-3.517D-01	3.517D-01	3.517D-01	1.993D-16	-7.033D-01	1.462D-16	-8.499D-17
2	0.000D+00	-2.532D-01	2.532D-01	-2.532D-01	2.532D-01	-3.484D-16	-8.642D-17	-1.853D-16	-1.685D-16
3	0.000D+00	-4.870D-02	-4.870D-02	4.870D-02	4.870D-02	-3.390D-18	-9.739D-02	-2.048D-16	1.997D-16
4	0.000D+00	-1.112D-02	1.112D-02	-1.112D-02	1.112D-02	2.328D-16	5.869D-17	1.060D-16	1.264D-16
5	0.000D+00	-1.125D-01	-1.125D-01	1.125D-01	1.125D-01	1.291D-17	-2.250D-01	2.510D-16	-2.428D-16
6	0.000D+00	-1.533D-01	1.533D-01	-1.533D-01	1.533D-01	-1.227D-17	-1.091D-17	-2.105D-17	-3.688D-18
7	0.000D+00	-7.798D-02	-7.798D-02	7.798D-02	7.798D-02	1.294D-17	-1.560D-01	-2.365D-16	2.400D-16
8	0.000D+00	-5.084D-03	5.084D-03	-5.084D-03	5.084D-03	-1.948D-16	-4.976D-17	-9.594D-17	-9.898D-17
9	0.000D+00	-1.753D-02	-1.753D-02	1.753D-02	1.753D-02	2.369D-18	-3.506D-02	1.709D-16	-1.695D-16
10	0.000D+00	-6.237D-02	6.237D-02	-6.237D-02	6.237D-02	3.077D-16	7.580D-17	1.546D-16	1.532D-16
11	0.000D+00	-6.088D-02	-6.088D-02	6.088D-02	6.088D-02	2.449D-18	-1.218D-01	-8.278D-17	8.330D-17
12	0.000D+00	-2.062D-02	2.062D-02	-2.062D-02	2.062D-02	-3.255D-16	-8.133D-17	-1.629D-16	-1.622D-16
13	0.000D+00	-3.542D-06	-3.542D-06	3.542D-06	3.542D-06	1.842D-19	-7.084D-06	2.927D-18	-2.743D-18
14	0.000D+00	-1.535D-02	1.535D-02	-1.535D-02	1.535D-02	2.697D-16	6.741D-17	1.351D-16	1.346D-16
15	0.000D+00	-3.111D-02	-3.111D-02	3.111D-02	3.111D-02	1.965D-19	-6.222D-02	5.133D-17	-5.111D-17
16	0.000D+00	-2.213D-02	2.213D-02	-2.213D-02	2.213D-02	-1.774D-16	-4.401D-17	-8.843D-17	-8.909D-17

Table 3.5.7 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	5.000D-03	1.000D-02	5.000D-02	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		200	200	200	200	200	200	200	200
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	4.000D+00	3.999D+00	3.998D+00	3.989D+00	4.003D+00	4.001D+00	4.007D+00	4.012D+00
1	0.000D+00	-5.044D-12	-5.044D-12	-5.043D-12	-5.039D-12	-5.045D-12	-5.045D-12	-5.045D-12	-5.047D-12
2	1.292D-04	-2.423D-02	-1.150D-01	-2.210D-01	-1.153D+00	2.659D-01	1.197D-01	2.248D-01	1.226D+00
3	0.000D+00	-2.064D-12	-2.064D-12	-2.064D-12	-2.064D-12	-2.064D-12	-2.064D-12	-2.064D-12	-2.064D-12
4	3.197D-05	1.570D-04	2.670D-04	3.875D-04	1.462D-03	-1.797D-04	-1.263D-05	-1.369D-04	-1.339D-03
5	0.000D+00	-1.113D-12	-1.113D-12	-1.113D-12	-1.113D-12	-1.113D-12	-1.113D-12	-1.113D-12	-1.113D-12
6	-8.324D-06	-2.728D-05	-4.583D-06	2.018D-05	2.378D-04	-9.593D-05	-6.238D-05	-8.621D-05	-3.418D-04
7	0.000D+00	-6.833D-13	-6.833D-13	-6.833D-13	-6.833D-13	-6.833D-13	-6.833D-13	-6.833D-13	-6.833D-13
8	-2.386D+01	-9.544D+01	-9.544D+01	-9.544D+01	-9.544D+01	-9.544D+01	-9.544D+01	-9.544D+01	-9.544D+01
9	0.000D+00	-2.539D-13	-2.539D-13	-2.539D-13	-2.539D-13	-2.539D-13	-2.539D-13	-2.539D-13	-2.539D-13
10	2.715D+01	1.086D+02	1.086D+02	1.086D+02	1.086D+02	1.086D+02	1.086D+02	1.086D+02	1.086D+02
11	0.000D+00	-3.951D-13	-3.951D-13	-3.951D-13	-3.951D-13	-3.951D-13	-3.951D-13	-3.951D-13	-3.951D-13
12	-2.589D+01	-1.036D+02	-1.036D+02	-1.036D+02	-1.036D+02	-1.036D+02	-1.036D+02	-1.036D+02	-1.036D+02
13	0.000D+00	-7.099D-15	-7.099D-15	-7.099D-15	-7.099D-15	-7.099D-15	-7.099D-15	-7.099D-15	-7.099D-15
14	1.732D+01	6.927D+01	6.927D+01	6.927D+01	6.927D+01	6.927D+01	6.927D+01	6.927D+01	6.927D+01
15	0.000D+00	-1.966D-13	-1.966D-13	-1.966D-13	-1.966D-13	-1.966D-13	-1.966D-13	-1.966D-13	-1.966D-13
16	-7.984D+00	-3.193D+01	-3.193D+01	-3.193D+01	-3.193D+01	-3.193D+01	-3.193D+01	-3.193D+01	-3.193D+01
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-9.511D-16	-9.509D-16	-9.507D-16	-9.485D-16	-9.518D-16	-9.515D-16	-9.517D-16	-9.539D-16
1	0.000D+00	1.364D-16	1.365D-16	1.365D-16	1.369D-16	1.360D-16	1.364D-16	1.363D-16	1.359D-16
2	0.000D+00	1.764D-15	1.850D-15	1.924D-15	2.589D-15	1.577D-15	1.691D-15	1.606D-15	8.970D-16
3	0.000D+00	-1.173D-16	-1.173D-16	-1.173D-16	-1.173D-16	-1.172D-16	-1.173D-16	-1.172D-16	-1.172D-16
4	0.000D+00	-5.228D-16	-5.230D-16	-5.231D-16	-5.244D-16	-5.224D-16	-5.226D-16	-5.225D-16	-5.211D-16
5	0.000D+00	-2.642D-16	-2.642D-16	-2.642D-16	-2.642D-16	-2.642D-16	-2.642D-16	-2.642D-16	-2.642D-16
6	0.000D+00	-2.142D-17	-2.146D-17	-2.150D-17	-2.187D-17	-2.131D-17	-2.137D-17	-2.132D-17	-2.090D-17
7	0.000D+00	1.586D-16	1.586D-16	1.586D-16	1.586D-16	1.586D-16	1.586D-16	1.586D-16	1.586D-16
8	0.000D+00	2.046D-13	2.046D-13	2.046D-13	2.046D-13	2.046D-13	2.046D-13	2.046D-13	2.046D-13
9	0.000D+00	3.269D-16	3.269D-16	3.269D-16	3.269D-16	3.269D-16	3.269D-16	3.269D-16	3.269D-16
10	0.000D+00	-2.845D-13	-2.845D-13	-2.845D-13	-2.845D-13	-2.845D-13	-2.845D-13	-2.845D-13	-2.845D-13
11	0.000D+00	4.330D-17	4.330D-17	4.330D-17	4.330D-17	4.330D-17	4.330D-17	4.330D-17	4.330D-17
12	0.000D+00	3.204D-13	3.204D-13	3.204D-13	3.204D-13	3.204D-13	3.204D-13	3.204D-13	3.204D-13
13	0.000D+00	-6.418D-18	-6.418D-18	-6.418D-18	-6.418D-18	-6.418D-18	-6.418D-18	-6.418D-18	-6.418D-18
14	0.000D+00	-2.474D-13	-2.474D-13	-2.474D-13	-2.474D-13	-2.474D-13	-2.474D-13	-2.474D-13	-2.474D-13
15	0.000D+00	2.656D-18	2.656D-18	2.656D-18	2.656D-18	2.656D-18	2.656D-18	2.656D-18	2.656D-18
16	0.000D+00	1.292D-13	1.292D-13	1.292D-13	1.292D-13	1.292D-13	1.292D-13	1.292D-13	1.292D-13

Table 3.5.7 Cont.

region	=	1	1	1	1	2	2	2	2
drinner	(in)=	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02
drouter	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	105	105	105	105	105	105	105	105

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	7.455D-05	3.727D-04	7.455D-04	3.727D-03	2.910D-05	1.455D-04	2.910D-04	1.455D-03
1	0.000D+00	1.127D-16	3.879D-16	7.662D-16	3.999D-15	6.473D-17	5.468D-16	1.089D-15	5.126D-15
2	1.292D-04	1.284D+00	6.421D+00	1.284D+01	6.421D+01	6.487D-01	3.243D+00	6.487D+00	3.243D+01
3	0.000D+00	-4.571D-16	-2.246D-15	-4.518D-15	-2.256D-14	-8.397D-17	-3.957D-16	-7.854D-16	-3.882D-15
4	3.197D-05	-1.324D-01	-6.620D-01	-1.324D+00	-6.620D+00	2.449D-01	1.224D+00	2.449D+00	1.224D+01
5	0.000D+00	-7.439D-17	-4.157D-16	-8.273D-16	-4.150D-15	-1.485D-16	-7.299D-16	-1.461D-15	-7.293D-15
6	-8.324D-06	6.718D-02	3.359D-01	6.718D-01	3.359D+00	-1.984D-02	-9.920D-02	-1.984D-01	-9.920D-01
7	0.000D+00	-9.409D-17	-5.154D-16	-1.028D-15	-5.134D-15	-3.390D-17	-1.773D-16	-3.562D-16	-1.784D-15
8	-2.386D+01	3.587D-02	1.793D-01	3.587D-01	1.793D+00	-9.170D-03	-4.585D-02	-9.170D-02	-4.585D-01
9	0.000D+00	-1.113D-16	-5.398D-16	-1.081D-15	-5.391D-15	-2.490D-19	-1.328D-18	-2.615D-18	-1.289D-17
10	2.715D+01	-2.514D-02	-1.257D-01	-2.514D-01	-1.257D+00	1.062D-02	5.310D-02	1.062D-01	5.310D-01
11	0.000D+00	-6.600D-18	-3.876D-17	-7.798D-17	-3.945D-16	-1.282D-17	-6.534D-17	-1.313D-16	-6.576D-16
12	-2.589D+01	2.792D-02	1.396D-01	2.792D-01	1.396D+00	9.521D-04	4.761D-03	9.521D-03	4.761D-02
13	0.000D+00	-6.765D-17	-3.382D-16	-6.764D-16	-3.382D-15	-7.152D-18	-3.539D-17	-7.086D-17	-3.543D-16
14	1.732D+01	-1.419D-02	-7.097D-02	-1.419D-01	-7.097D-01	-1.424D-03	-7.121D-03	-1.424D-02	-7.121D-02
15	0.000D+00	-9.419D-19	-5.697D-18	-1.157D-17	-5.941D-17	-1.637D-19	-7.738D-19	-1.562D-18	-7.918D-18
16	-7.984D+00	9.025D-03	4.513D-02	9.025D-02	4.513D-01	4.738D-04	2.369D-03	4.738D-03	2.369D-02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-3.016D-20	-1.053D-19	-1.805D-19	-8.850D-19	-8.465D-21	-2.826D-20	-6.784D-20	-3.449D-19
1	0.000D+00	3.370D-16	1.994D-16	1.994D-16	6.180D-17	2.071D-17	-9.980D-17	8.097D-17	2.071D-17
2	0.000D+00	-9.057D-16	-4.588D-15	-9.192D-15	-4.587D-14	-4.130D-16	-2.320D-15	-4.555D-15	-2.308D-14
3	0.000D+00	-3.559D-18	2.065D-18	2.065D-18	7.690D-18	3.321D-18	3.166D-17	-2.502D-17	-5.336D-17
4	0.000D+00	1.526D-16	7.667D-16	1.563D-15	7.879D-15	-2.842D-16	-1.445D-15	-2.923D-15	-1.457D-14
5	0.000D+00	-1.733D-17	2.745D-18	2.745D-18	1.278D-17	2.329D-18	4.628D-18	1.755D-18	6.059D-19
6	0.000D+00	-1.287D-16	-5.663D-16	-1.131D-15	-5.592D-15	3.311D-17	1.660D-16	3.328D-16	1.653D-15
7	0.000D+00	1.804D-17	1.804D-17	7.891D-18	7.891D-18	-1.219D-18	-3.757D-19	-1.219D-18	-3.757D-19
8	0.000D+00	-7.197D-17	-3.795D-16	-7.715D-16	-3.839D-15	1.924D-17	9.704D-17	1.959D-16	9.811D-16
9	0.000D+00	2.158D-18	2.158D-18	9.150D-20	-1.286D-18	-7.263D-19	-7.263D-19	-7.263D-19	-2.054D-18
10	0.000D+00	6.568D-17	3.326D-16	6.574D-16	3.289D-15	-2.763D-17	-1.388D-16	-2.775D-16	-1.389D-15
11	0.000D+00	-3.726D-18	5.687D-18	5.687D-18	-3.726D-18	7.159D-20	-6.518D-20	2.084D-19	2.084D-19
12	0.000D+00	-8.647D-17	-4.320D-16	-8.634D-16	-4.317D-15	-2.905D-18	-1.470D-17	-2.940D-17	-1.472D-16
13	0.000D+00	1.812D-19	-7.325D-19	2.064D-19	2.931D-19	-6.824D-22	5.755D-20	2.843D-20	1.158D-19
14	0.000D+00	5.025D-17	2.539D-16	5.067D-16	2.536D-15	5.010D-18	2.542D-17	5.090D-17	2.540D-16
15	0.000D+00	-9.135D-19	-9.135D-19	-9.135D-19	-9.135D-19	2.503D-20	2.284D-19	2.503D-20	2.503D-20
16	0.000D+00	-3.677D-17	-1.825D-16	-3.659D-16	-1.825D-15	-1.982D-18	-9.635D-18	-1.918D-17	-9.578D-17

Table 3.5.7 Cont.

resion =	3	3	3	3
drinner (in)=	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthi (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dazimthf (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	105	105	105	105

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	6.768D-06	3.384D-05	6.768D-05	3.384D-04				
1	0.000D+00	1.321D-16	2.946D-16	5.655D-16	2.570D-15				
2	1.292D-04	1.549D-01	7.747D-01	1.549D+00	7.747D+00				
3	0.000D+00	3.148D-17	1.599D-16	3.169D-16	1.582D-15				
4	3.197D-05	1.088D-01	5.438D-01	1.088D+00	5.438D+00				
5	0.000D+00	-6.132D-18	-3.308D-17	-6.588D-17	-3.263D-16				
6	-8.324D-06	4.252D-02	2.126D-01	4.252D-01	2.126D+00				
7	0.000D+00	-1.621D-17	-8.481D-17	-1.697D-16	-8.512D-16				
8	-2.386D+01	9.195D-03	4.597D-02	9.195D-02	4.597D-01				
9	0.000D+00	-1.035D-17	-5.171D-17	-1.028D-16	-5.143D-16				
10	2.715D+01	1.550D-04	7.748D-04	1.550D-03	7.748D-03				
11	0.000D+00	-3.329D-18	-1.652D-17	-3.318D-17	-1.657D-16				
12	-2.589D+01	-5.570D-04	-2.785D-03	-5.570D-03	-2.785D-02				
13	0.000D+00	-4.957D-19	-2.459D-18	-4.953D-18	-2.469D-17				
14	1.732D+01	-1.079D-04	-5.397D-04	-1.079D-03	-5.397D-03				
15	0.000D+00	1.621D-21	1.135D-20	2.756D-20	1.508D-19				
16	-7.984D+00	4.935D-05	2.468D-04	4.935D-04	2.468D-03				

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.085D-20	-2.202D-21	-1.786D-20	-7.268D-20				
1	0.000D+00	7.534D-17	7.534D-17	2.116D-17	4.825D-17				
2	0.000D+00	-1.049D-16	-5.474D-16	-1.095D-15	-5.500D-15				
3	0.000D+00	4.311D-18	2.334D-17	4.311D-18	-1.472D-17				
4	0.000D+00	-1.361D-16	-6.536D-16	-1.291D-15	-6.466D-15				
5	0.000D+00	7.542D-18	1.223D-17	1.223D-17	1.223D-17				
6	0.000D+00	-7.005D-17	-3.540D-16	-7.065D-16	-3.539D-15				
7	0.000D+00	1.006D-18	2.312D-18	1.659D-18	1.006D-18				
8	0.000D+00	-1.945D-17	-9.836D-17	-1.968D-16	-9.834D-16				
9	0.000D+00	-7.583D-20	-7.583D-20	-5.144D-20	-1.002D-19				
10	0.000D+00	-3.619D-19	-2.015D-18	-4.109D-18	-2.032D-17				
11	0.000D+00	-1.071D-21	-8.685D-21	5.223D-20	4.462D-20				
12	0.000D+00	1.741D-18	8.600D-18	1.722D-17	8.612D-17				
13	0.000D+00	-2.025D-20	1.902D-20	1.902D-20	1.902D-20				
14	0.000D+00	3.909D-19	1.922D-18	3.857D-18	1.929D-17				
15	0.000D+00	-1.180D-20	1.165D-21	-2.477D-20	-1.180D-20				
16	0.000D+00	-2.036D-19	-9.921D-19	-1.998D-18	-9.973D-18				

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Table 3.5.7 Completed

to simulate a magnet-half-to-magnet-half variation. The 12 code models a variation from top to bottom; the 14 code, from side to side. Finally, a -14 code is used to model a shift in the midplane of one side of the magnet and a -23 code used to model the shift on the other. In addition, a 1 mil azimuthal movement of the lower edge of bundle 1 was applied for each quadrant with the appropriate sign to yield the components of the -14 and -23 symmetry codes.

Next the various boundaries of bundle 1 in quadrant 1 were perturbed with a range of values from 1 to 60 mils and then from -1 to -60 mils to investigate the linearity of the changes in coefficients. Finally, a bundle 1 drinner was applied for a variety of symmetries to show the superposition.

The effect of a perturbation in the iron shield was then modeled using the special symmetry code of 200. In this case, the perturbation drinner is interpreted as the change in shield radius. A range of changes from -50 to +50 mils was run.

The effect of uneven compression of the bundles either during assembly or during charge was modeled as a linear variation in the current density about the nominal value. For this case the special symmetry code 1xx (where xx is the usual quadrant symmetry) is used. Here the perturbation drinner is interpreted as the percentage change in the current density from the nominal. A negative drinner implies that the current density at the lower angle is higher than the nominal and that the current density at the upper angle is lower. That is, a -0.05 drinner means that the current density varies from 1.05 to 0.95 of the nominal when moving from the midplane. A range of perturbations from 0.1% to 10% was run for all bundles.

3.5.7 Window Frame Dipole

The coefficient perturbations due to winding bundle displacements were calculated for the window frame design in Figure 3.5.14. The ideal bundle locations are given in Table 3.5.8.

Table 3.5.8

Ideal Winding Bundle Locations for the Window Frame Dipole

Bundle Number	Inner Radius (cm)	Outer Radius (cm)	Lower Height (cm)	Upper Height (cm)	Overall Current Density ($10^8 A/m^2$)
1	2.60	3.40	8.603	10.51	1.74
2	3.40	5.00	7.200	10.51	1.74
3	5.60	8.000	0.000	10.51	1.74

Iron shield half width = 8.0 cm.

Iron shield half height = 14.0 cm.

The fundamental dipole coefficient computed on the basis of this data was 5.163 T. All other coefficients and their perturbations presented in Table 3.5.9 are normalized to this value and are normalized using a radius of 4.4 cm. Each of the three current-carrying regions in Table 3.5.8 was subjected to boundary displacements for a variety of symmetry codes.

The format in Table 3.5.9 is similar to that described for Table 3.5.7 with displacements defined as shown in Figure 3.5.9. The first set of perturbations considered was a 1 mil motion of each boundary of each current region. The change in coefficients was calculated for both a first quadrant and all four quadrant motion. Finally, a -14 code was used to model a shift in the midplane of one side of the magnet and a -23 code used to model the shift on the other.

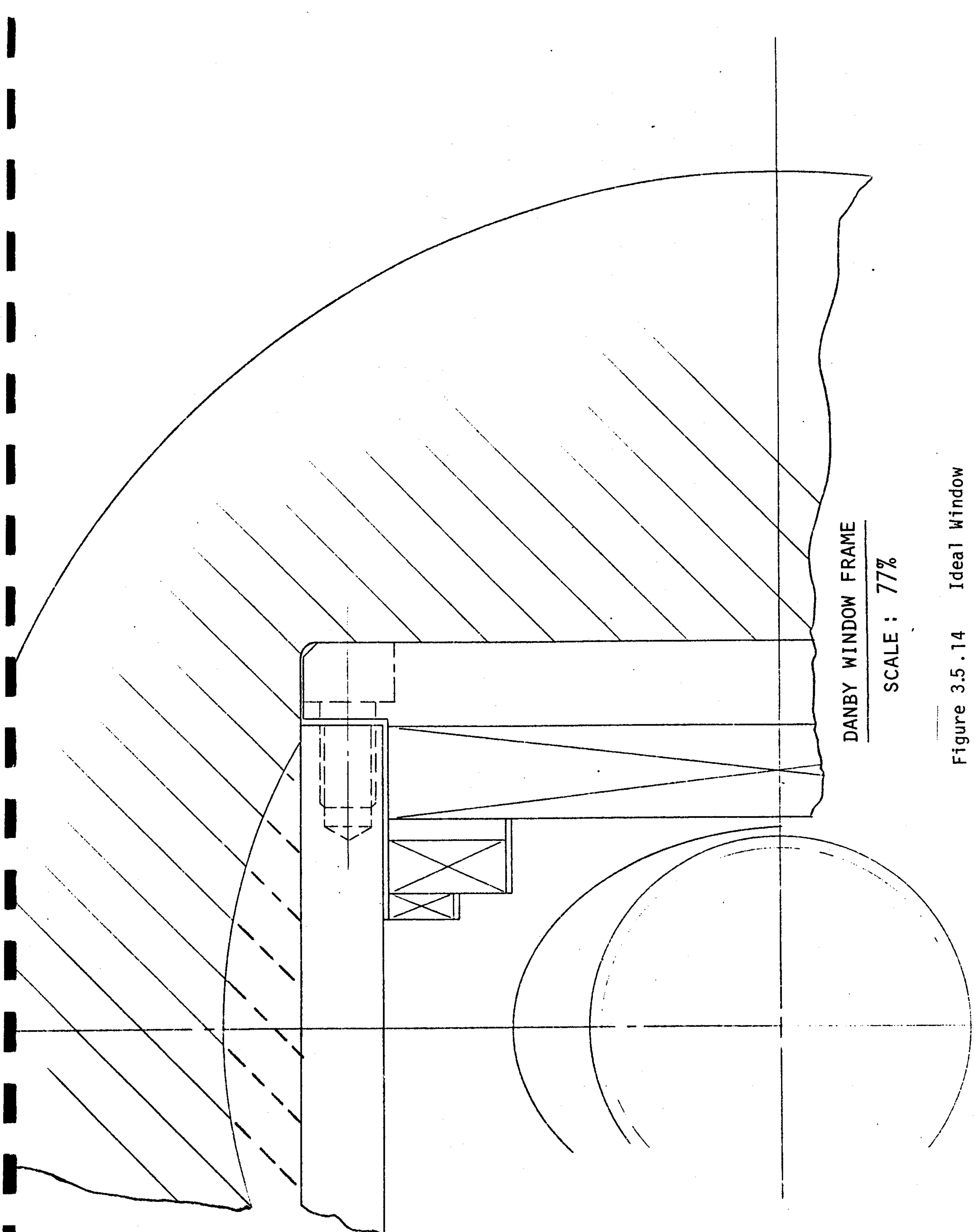

Figure 3.5.14 Ideal Window

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dheighti (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =		1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.521D-06	1.450D-06	-9.044D-07	-7.382D-07	6.083D-06	5.800D-06	-3.618D-06	-2.953D-06
1	0.000D+00	8.351D-03	8.554D-03	2.691D-03	2.197D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-2.640D+01	-4.859D-03	-4.052D-03	7.277D-03	5.427D-03	-1.944D-02	-1.621D-02	2.912D-02	2.170D-02
3	0.000D+00	-5.141D-03	-4.948D-03	-4.336D-04	-6.695D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	4.164D+01	-1.024D-03	-1.106D-03	-4.730D-03	-3.653D-03	-4.097D-03	-4.423D-03	-1.892D-02	-1.461D-02
5	0.000D+00	-2.701D-04	4.901D-04	-9.301D-03	-7.726D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	-5.591D-01	-4.011D-03	-1.055D-03	-2.786D-02	-2.418D-02	-1.604D-02	-4.220D-03	-1.115D-01	-9.673D-02
7	0.000D+00	-1.160D-02	-4.339D-03	-8.205D-02	-7.120D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	1.268D+01	-2.574D-02	-9.719D-03	-2.096D-01	-1.818D-01	-1.029D-01	-3.887D-02	-8.384D-01	-7.270D-01
9	0.000D+00	-4.650D-02	-1.664D-02	-4.730D-01	-4.107D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	5.121D+01	-7.966D-02	-3.168D-02	-9.593D-01	-8.344D-01	-3.185D-01	-1.267D-01	-3.838D+00	-3.337D+00
11	0.000D+00	-1.122D-01	-4.720D-02	-1.766D+00	-1.540D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	1.029D+02	-1.308D-01	-6.066D-02	-2.980D+00	-2.603D+00	-5.231D-01	-2.426D-01	-1.192D+01	-1.041D+01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.896D-07	-4.451D-07	3.885D-06	4.055D-06	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	-1.821D-02	-1.757D-02	1.965D-02	1.700D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	-3.903D-03	-4.565D-03	-3.963D-03	-3.132D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	5.045D-03	4.045D-03	-5.129D-03	-3.643D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	5.989D-03	3.756D-03	1.119D-03	6.379D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	1.363D-02	4.486D-03	1.571D-03	-1.003D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	4.594D-02	1.481D-02	-3.406D-05	-6.608D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	1.324D-01	4.393D-02	5.527D-04	-1.871D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	3.287D-01	1.095D-01	6.424D-03	-4.358D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	7.238D-01	2.413D-01	2.385D-02	-9.093D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	1.433D+00	4.779D-01	6.565D-02	-1.706D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	2.576D+00	8.602D-01	1.514D-01	-2.897D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	4.241D+00	1.418D+00	3.048D-01	-4.488D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.9 Coefficient perturbations for the window frame dipole in response to winding bundle displacements normalized to a fundamental dipole coefficient of 5.163 T.

region =	2	2	2	2	2	2	2	2
drinner (in)=	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =	1	1	1	1	5	5	5	5

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	4.597D-06	3.945D-06	-4.996D-06	-3.673D-06	1.839D-05	1.578D-05	-1.998D-05	-1.469D-05
1	0.000D+00	3.998D-02	3.703D-02	-1.118D-02	-5.689D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-2.840D+01	-1.539D-03	2.935D-03	2.947D-02	2.023D-02	-6.155D-03	1.174D-02	1.179D-01	6.089D-02
3	0.000D+00	-1.833D-02	-1.380D-02	1.602D-02	7.578D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	4.164D+01	-1.066D-02	-1.022D-02	-3.140D-03	-3.227D-03	-4.262D-02	-4.089D-02	-1.256D-02	-1.291D-02
5	0.000D+00	2.066D-04	-1.619D-03	-7.723D-03	-3.843D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	-5.591D-01	3.001D-03	1.984D-03	-3.558D-03	-1.231D-03	1.200D-02	7.938D-03	-1.423D-02	-4.927D-03
7	0.000D+00	5.769D-04	1.360D-03	-1.390D-03	-1.091D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	1.268D+01	-2.539D-03	-1.543D-04	-4.726D-03	-4.136D-03	-1.016D-02	-6.181D-04	-1.891D-02	-1.655D-02
9	0.000D+00	-5.417D-03	-1.105D-03	-1.344D-02	-1.042D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	5.121D+01	-9.364D-03	-1.762D-03	-2.850D-02	-2.141D-02	-3.745D-02	-7.050D-03	-1.140D-01	-8.562D-02
11	0.000D+00	-1.552D-02	-2.700D-03	-5.283D-02	-3.953D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	1.029D+02	-2.394D-02	-4.125D-03	-8.956D-02	-6.698D-02	-9.578D-02	-1.650D-02	-3.583D-01	-2.679D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-8.352D-07	-5.544D-07	1.180D-05	1.349D-05	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	-6.081D-02	-5.192D-02	1.043D-01	8.395D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	-3.233D-02	-3.146D-02	1.143D-02	3.516D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	4.197D-03	-3.939D-04	-2.475D-02	-1.670D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	1.308D-02	1.010D-02	-1.028D-02	-3.100D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	5.472D-03	5.540D-03	3.419D-03	2.954D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	1.967D-04	3.284D-04	4.729D-03	1.684D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	2.478D-03	-6.730D-04	6.951D-04	-8.084D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	1.074D-02	1.079D-03	-2.162D-03	-2.461D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	2.539D-02	3.999D-03	-3.321D-03	-4.437D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	5.032D-02	8.167D-03	-4.411D-03	-8.102D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	9.057D-02	1.456D-02	-6.133D-03	-1.411D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	1.500D-01	2.400D-02	-7.861D-03	-2.257D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.9 Cont.

region =		3	3	3	3	3	3	3	
drinner (in)=		1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+0
drouter (in)=		0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+0
dheighti (in)=		0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+0
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-0
symmetry =		1	1	1	1	5	5	5	
n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.241D-06	-1.127D-06	-3.082D-05	-2.965D-05	-8.965D-06	-4.507D-06	-1.233D-04	-1.186D-0
1	0.000D+00	-1.151D-02	-5.971D-03	-4.244D-01	-2.888D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+0
2	-2.840D+01	4.623D-03	2.265D-03	-3.351D-01	-1.107D-01	1.929D-02	9.057D-03	-1.340D+00	-4.426D-0
3	0.000D+00	4.842D-03	2.443D-03	-2.320D-01	-2.325D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+0
4	4.164D+01	1.489D-03	8.152D-04	-1.503D-01	2.576D-03	5.956D-03	3.261D-03	-6.016D-01	1.030D-0
5	0.000D+00	-2.317D-04	-7.970D-05	-9.854D-02	2.756D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+0
6	-5.591D-01	-3.234D-04	-1.599D-04	-6.559D-02	8.011D-04	-1.294D-03	-6.396D-04	-2.624D-01	3.204D-0
7	0.000D+00	-9.997D-05	-5.744D-05	-4.460D-02	-2.594D-06	0.000D+00	0.000D+00	0.000D+00	0.000D+0
8	1.268D+01	4.660D-06	-1.887D-06	-3.085D-02	-8.117D-05	1.864D-05	-7.548D-06	-1.234D-01	-3.247D-0
9	0.000D+00	1.517D-05	7.022D-06	-2.163D-02	-2.830D-05	0.000D+00	0.000D+00	0.000D+00	0.000D+0
10	5.121D+01	4.939D-06	3.111D-06	-1.532D-02	-1.684D-06	1.975D-05	1.245D-05	-6.128D-02	-6.737D-0
11	0.000D+00	-6.735D-07	3.052D-07	-1.095D-02	1.301D-06	0.000D+00	0.000D+00	0.000D+00	0.000D+0
12	1.029D+02	-1.899D-06	-3.731D-07	-7.888D-03	-1.369D-06	-7.598D-06	-1.492D-06	-3.155D-02	-5.476D-0
n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.050D-05	5.135D-06	-6.927D-05	1.687D-05	0.000D+00	0.000D+00	0.000D+00	0.000D+0
1	0.000D+00	1.337D-01	6.358D-02	-5.326D-01	2.961D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+0
2	0.000D+00	1.100D-01	5.010D-02	-2.176D-01	1.998D-01	0.000D+00	0.000D+00	0.000D+00	0.000D+0
3	0.000D+00	8.490D-02	3.653D-02	-5.472D-02	8.595D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+0
4	0.000D+00	6.807D-02	2.783D-02	-2.374D-02	3.002D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+0
5	0.000D+00	5.233D-02	2.025D-02	-1.172D-02	1.090D-02	0.000D+00	0.000D+00	0.000D+00	0.000D+0
6	0.000D+00	3.908D-02	1.422D-02	-6.614D-03	5.801D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+0
7	0.000D+00	2.873D-02	9.760D-03	-3.841D-03	3.729D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+0
8	0.000D+00	2.106D-02	6.645D-03	-2.284D-03	2.381D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+0
9	0.000D+00	1.547D-02	4.526D-03	-1.390D-03	1.470D-03	0.000D+00	0.000D+00	0.000D+00	0.000D+0
10	0.000D+00	1.139D-02	3.090D-03	-8.671D-04	9.117D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+0
11	0.000D+00	8.401D-03	2.116D-03	-5.529D-04	5.806D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+0
12	0.000D+00	6.208D-03	1.453D-03	-3.586D-04	3.791D-04	0.000D+00	0.000D+00	0.000D+00	0.000D+0

Table 3.5.9 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =	-14	-14	-14	-14	-23	-23	-23	-23

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	3.042D-06	2.900D-06	-1.809D-06	-1.477D-06	3.042D-06	2.900D-06	-1.809D-06	-1.477D-06
1	0.000D+00	1.670D-02	1.711D-02	5.381D-03	4.395D-03	-1.670D-02	-1.711D-02	-5.381D-03	-4.395D-03
2	-2.840D+01	-9.725D-03	-8.108D-03	1.456D-02	1.086D-02	-9.725D-03	-8.108D-03	1.456D-02	1.086D-02
3	0.000D+00	-1.028D-02	-9.898D-03	-8.655D-04	-1.337D-03	1.028D-02	9.898D-03	8.655D-04	1.337D-03
4	4.164D+01	-2.049D-03	-2.210D-03	-9.464D-03	-7.301D-03	-2.049D-03	-2.210D-03	-9.464D-03	-7.301D-03
5	0.000D+00	-5.516D-04	9.789D-04	-1.860D-02	-1.543D-02	5.516D-04	-9.789D-04	1.860D-02	1.543D-02
6	-5.591D-01	-8.062D-03	-2.116D-03	-5.572D-02	-4.829D-02	-8.062D-03	-2.118D-03	-5.572D-02	-4.829D-02
7	0.000D+00	-2.369D-02	-8.697D-03	-1.641D-01	-1.422D-01	2.369D-02	8.697D-03	1.641D-01	1.422D-01
8	1.268D+01	-5.167D-02	-1.948D-02	-4.192D-01	-3.630D-01	-5.167D-02	-1.948D-02	-4.192D-01	-3.630D-01
9	0.000D+00	-9.735D-02	-3.736D-02	-9.463D-01	-8.202D-01	9.735D-02	3.736D-02	9.463D-01	8.202D-01
10	5.121D+01	-1.599D-01	-6.351D-02	-1.919D+00	-1.667D+00	-1.599D-01	-6.351D-02	-1.919D+00	-1.667D+00
11	0.000D+00	-2.251D-01	-9.462D-02	-3.535D+00	-3.077D+00	2.251D-01	9.462D-02	3.535D+00	3.077D+00
12	1.029D+02	-2.622D-01	-1.216D-01	-5.960D+00	-5.201D+00	-2.622D-01	-1.216D-01	-5.960D+00	-5.201D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	2.866D-10	2.770D-10	4.849D-10	4.212D-10	-2.866D-10	-2.770D-10	-4.849D-10	-4.212D-10
1	0.000D+00	3.578D-06	4.519D-06	-8.536D-06	-5.746D-06	3.578D-06	4.519D-06	-8.536D-06	-5.746D-06
2	0.000D+00	-5.283D-06	-3.396D-06	3.280D-06	2.887D-06	5.283D-06	3.396D-06	-3.280D-06	-2.887D-06
3	0.000D+00	-9.890D-06	-4.621D-06	1.199D-05	8.485D-06	-9.890D-06	-4.621D-06	1.199D-05	8.485D-06
4	0.000D+00	-3.206D-05	-5.510D-06	3.172D-05	2.677D-05	3.206D-05	5.510D-06	-3.172D-05	-2.677D-05
5	0.000D+00	-1.307D-04	-2.221D-05	1.220D-04	1.067D-04	-1.307D-04	-2.221D-05	1.220D-04	1.067D-04
6	0.000D+00	-4.382D-04	-7.851D-05	4.113D-04	3.575D-04	4.382D-04	7.851D-05	-4.113D-04	-3.575D-04
7	0.000D+00	-1.243D-03	-2.246D-04	1.170D-03	1.016D-03	-1.243D-03	-2.246D-04	1.170D-03	1.016D-03
8	0.000D+00	-3.078D-03	-5.566D-04	2.900D-03	2.523D-03	3.078D-03	5.566D-04	-2.900D-03	-2.523D-03
9	0.000D+00	-6.768D-03	-1.226D-03	6.379D-03	5.561D-03	-6.768D-03	-1.226D-03	6.379D-03	5.561D-03
10	0.000D+00	-1.339D-02	-2.427D-03	1.262D-02	1.103D-02	1.339D-02	2.427D-03	-1.262D-02	-1.103D-02
11	0.000D+00	-2.404D-02	-4.367D-03	2.267D-02	1.986D-02	-2.404D-02	-4.367D-03	2.267D-02	1.986D-02
12	0.000D+00	-3.953D-02	-7.193D-03	3.728D-02	3.277D-02	3.953D-02	7.193D-03	-3.728D-02	-3.277D-02

Table 3.5.9 Cont.

region =	2	2	2	2	3	3	3	3
drinner (in)=	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	1.000D-03	0.000D+00	0.000D+00	0.000D+00	1.000D-03
symmetry =	-14	-14	-14	-14	-14	-14	-14	-14

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	9.196D-06	7.892D-06	-9.994D-06	-7.348D-06	-4.485D-06	-2.256D-06	-6.162D-05	-5.931D-05
1	0.000D+00	7.995D-02	7.405D-02	-2.239D-02	-1.138D-02	-2.303D-02	-1.195D-02	-8.488D-01	-5.777D-01
2	-2.840D+01	-3.096D-03	5.860D-03	5.895D-02	4.046D-02	9.651D-03	4.534D-03	-6.699D-01	-2.215D-01
3	0.000D+00	-3.667D-02	-2.761D-02	3.206D-02	1.516D-02	9.685D-03	4.890D-03	-4.638D-01	-4.652D-02
4	4.164D+01	-2.131D-02	-2.046D-02	-6.274D-03	-6.454D-03	2.979D-03	1.632D-03	-3.006D-01	5.150D-03
5	0.000D+00	4.207D-04	-3.236D-03	-1.546D-02	-7.688D-03	-4.639D-04	-1.596D-04	-1.971D-01	5.515D-03
6	-5.591D-01	6.002D-03	3.971D-03	-7.121D-03	-2.462D-03	-6.472D-04	-3.201D-04	-1.311D-01	1.603D-03
7	0.000D+00	1.143D-03	2.720D-03	-2.776D-03	-2.173D-03	-2.000D-04	-1.150D-04	-8.921D-02	-4.939D-06
8	1.268D+01	-5.102D-03	-3.110D-04	-9.436D-03	-8.252D-03	9.359D-06	-3.779D-06	-6.170D-02	-1.624D-04
9	0.000D+00	-1.088D-02	-2.214D-03	-2.685D-02	-2.079D-02	3.037D-05	1.405D-05	-4.324D-02	-5.668D-05
10	5.121D+01	-1.882D-02	-3.530D-03	-5.698D-02	-4.273D-02	9.873D-06	6.228D-06	-3.062D-02	-3.378D-06
11	0.000D+00	-3.119D-02	-5.407D-03	-1.056D-01	-7.889D-02	-1.357D-06	6.109D-07	-2.190D-02	2.615D-06
12	1.029D+02	-4.810D-02	-8.261D-03	-1.791D-01	-1.337D-01	-3.813D-06	-7.466D-07	-1.577D-02	-2.720D-06

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.044D-09	7.377D-10	3.179D-09	2.127D-09	-1.213D-08	-1.086D-08	4.095D-08	2.636D-08
1	0.000D+00	2.759D-05	2.829D-05	-3.926D-05	-2.459D-05	-1.710D-04	-1.347D-04	6.406D-04	5.821D-05
2	0.000D+00	-2.538D-06	7.202D-06	-2.325D-05	-5.647D-06	-1.624D-04	-1.067D-04	5.864D-04	-6.398D-05
3	0.000D+00	-1.845D-05	-1.067D-05	1.532D-05	9.183D-06	-1.469D-04	-7.739D-05	4.654D-04	-6.380D-05
4	0.000D+00	-9.303D-06	-9.340D-06	2.192D-05	5.761D-06	-1.336D-04	-5.896D-05	3.648D-04	-2.359D-05
5	0.000D+00	-5.266D-07	-1.003D-06	7.009D-06	1.132D-06	-1.163D-04	-4.291D-05	2.810D-04	-6.156D-06
6	0.000D+00	-1.033D-05	2.421D-06	5.311D-06	7.322D-06	-9.840D-05	-3.014D-05	2.167D-04	-1.894D-06
7	0.000D+00	-4.489D-05	-6.366D-08	3.116D-05	2.725D-05	-8.196D-05	-2.068D-05	1.674D-04	-1.347D-06
8	0.000D+00	-1.172D-04	-5.430D-06	9.126D-05	6.948D-05	-6.771D-05	-1.408D-05	1.296D-04	-1.103D-06
9	0.000D+00	-2.577D-04	-1.309D-05	2.048D-04	1.530D-04	-5.559D-05	-9.587D-06	1.005D-04	-7.473D-07
10	0.000D+00	-5.108D-04	-2.532D-05	4.061D-04	3.041D-04	-4.537D-05	-6.549D-06	7.811D-05	-4.488D-07
11	0.000D+00	-9.226D-04	-4.519D-05	7.340D-04	5.496D-04	-3.681D-05	-4.484D-06	6.076D-05	-2.585D-07
12	0.000D+00	-1.527D-03	-7.482D-05	1.217D-03	9.104D-04	-2.972D-05	-3.078D-06	4.728D-05	-1.409D-07

Table 3.5.9 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02	1.000D-03	5.000D-03	1.000D-02	5.000D-02
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	105	105	105	105	105	105	105	105

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	8.142D-07	4.071D-06	8.142D-06	4.071D-05	-8.142D-07	-4.071D-06	-8.142D-06	-4.071D-05
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-2.840D+01	3.040D+00	1.520D+01	3.040D+01	1.520D+02	-3.040D+00	-1.520D+01	-3.040D+01	-1.520D+02
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	4.164D+01	6.282D-02	3.141D-01	6.282D-01	3.141D+00	-6.282D-02	-3.141D-01	-6.282D-01	-3.141D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	-5.591D-01	-1.338D-02	-6.689D-02	-1.338D-01	-6.689D-01	1.338D-02	6.689D-02	1.338D-01	6.689D-01
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	1.268D+01	-2.609D-02	-1.305D-01	-2.609D-01	-1.305D+00	2.609D-02	1.305D-01	2.609D-01	1.305D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	5.121D+01	-1.294D-01	-6.468D-01	-1.294D+00	-6.468D+00	1.294D-01	6.468D-01	1.294D+00	6.468D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	1.029D+02	-4.106D-01	-2.053D+00	-4.106D+00	-2.053D+01	4.106D-01	2.053D+00	4.106D+00	2.053D+01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.9 Cont.

region =	2	2	2	2	2	2	2	2
driinner (in)=	1.000D-03	5.000D-03	1.000D-02	5.000D-02	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	105	105	105	105	105	105	105	105

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-7.431D-06	-3.716D-05	-7.431D-05	-3.716D-04	7.431D-06	3.716D-05	7.431D-05	3.716D-04
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-2.840D+01	-3.012D+00	-1.506D+01	-3.012D+01	-1.506D+02	3.012D+00	1.506D+01	3.012D+01	1.506D+02
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	4.164D+01	-1.917D-01	-9.584D-01	-1.917D+00	-9.584D+00	1.917D-01	9.584D-01	1.917D+00	9.584D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	-5.591D-01	1.765D-02	8.824D-02	1.765D-01	8.824D-01	-1.765D-02	-8.824D-02	-1.765D-01	-8.824D-01
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	1.268D+01	8.484D-04	4.243D-03	8.484D-03	4.243D-02	-8.484D-04	-4.243D-03	-8.484D-03	-4.243D-02
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	5.121D+01	1.682D-03	8.409D-03	1.682D-02	8.409D-02	-1.682D-03	-8.409D-03	-1.682D-02	-8.409D-02
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	1.029D+02	7.972D-03	3.986D-02	7.972D-02	3.986D-01	-7.972D-03	-3.986D-02	-7.972D-02	-3.986D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.9 Cont.

resion =	3	3	3	3	3	3	3	3
drinner (in)=	1.000D-03	5.000D-03	1.000D-02	5.000D-02	-1.000D-03	-5.000D-03	-1.000D-02	-5.000D-02
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheishti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheishto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	105	105	105	105	105	105	105	105

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.918D-04	-9.591D-04	-1.918D-03	-9.591D-03	1.918D-04	9.591D-04	1.918D-03	9.591D-03
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	-2.840D+01	-1.990D-01	-9.951D-01	-1.990D+00	-9.951D+00	1.990D-01	9.951D-01	1.990D+00	9.951D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	4.164D+01	-5.768D-02	-2.885D-01	-5.768D-01	-2.885D+00	5.768D-02	2.885D-01	5.768D-01	2.885D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	-5.591D-01	-1.343D-03	-6.716D-03	-1.343D-02	-6.716D-02	1.343D-03	6.716D-03	1.343D-02	6.716D-02
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	1.268D+01	2.930D-04	1.465D-03	2.930D-03	1.465D-02	-2.930D-04	-1.465D-03	-2.930D-03	-1.465D-02
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	5.121D+01	-1.073D-05	-5.363D-05	-1.073D-04	-5.363D-04	1.073D-05	5.363D-05	1.073D-04	5.363D-04
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	1.029D+02	-7.256D-07	-3.628D-06	-7.256D-06	-3.628D-05	7.256D-07	3.628D-06	7.256D-06	3.628D-05

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
1	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
2	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
3	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
4	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
5	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
6	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
7	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
8	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
9	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
10	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
11	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
12	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00

Table 3.5.9 Cont.

region =		1	1	1	1	2	2	3	3
drinner (in)=		-1.000D-03	-5.000D-03	1.000D-03	5.000D-03	-1.000D-03	1.000D-03	-1.000D-03	1.000D-03
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		101	101	101	101	101	101	101	101

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	2.035D-07	1.018D-06	-2.035D-07	-1.018D-06	1.858D-06	-1.858D-06	4.796D-05	-4.796D-05
1	0.000D+00	1.792D+00	8.958D+00	-1.792D+00	-8.958D+00	1.567D+00	-1.567D+00	2.667D-02	-2.667D-02
2	-2.840D+01	7.601D-01	3.800D+00	-7.601D-01	-3.800D+00	7.531D-01	-7.531D-01	4.976D-02	-4.976D-02
3	0.000D+00	2.070D-01	1.035D+00	-2.070D-01	-1.035D+00	2.567D-01	-2.567D-01	3.418D-02	-3.418D-02
4	4.164D+01	1.570D-02	7.852D-02	-1.570D-02	-7.852D-02	4.790D-02	-4.790D-02	1.442D-02	-1.442D-02
5	0.000D+00	-6.636D-03	-3.318D-02	6.636D-03	3.318D-02	6.303D-04	-6.303D-04	3.655D-03	-3.655D-03
6	-5.591D-01	-3.344D-03	-1.673D-02	3.344D-03	1.673D-02	-4.411D-03	4.411D-03	3.358D-04	-3.358D-04
7	0.000D+00	-2.382D-03	-1.191D-02	2.382D-03	1.191D-02	-1.763D-03	1.763D-03	-1.495D-04	1.495D-04
8	1.268D+01	-6.523D-03	-3.262D-02	6.523D-03	3.262D-02	-2.121D-04	2.121D-04	-7.326D-05	7.326D-05
9	0.000D+00	-1.569D-02	-7.844D-02	1.569D-02	7.844D-02	-6.546D-06	6.546D-06	-1.076D-05	1.076D-05
10	5.121D+01	-3.234D-02	-1.617D-01	3.234D-02	1.617D-01	-4.205D-04	4.205D-04	2.682D-06	-2.682D-06
11	0.000D+00	-6.019D-02	-3.010D-01	6.019D-02	3.010D-01	-1.086D-03	1.086D-03	1.690D-06	-1.690D-06
12	1.029D+02	-1.026D-01	-5.132D-01	1.026D-01	5.132D-01	-1.993D-03	1.993D-03	1.814D-07	-1.814D-07

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.377D-04	6.884D-04	-1.377D-04	-6.884D-04	2.014D-04	-2.014D-04	-1.531D-04	1.531D-04
1	0.000D+00	9.944D-01	4.972D+00	-9.944D-01	-4.972D+00	1.644D+00	-1.644D+00	-1.243D+00	1.243D+00
2	0.000D+00	3.003D-01	1.501D+00	-3.003D-01	-1.501D+00	6.218D-01	-6.218D-01	-5.738D-01	5.738D-01
3	0.000D+00	-9.064D-03	-4.533D-02	9.064D-03	4.533D-02	6.781D-02	-6.781D-02	-1.998D-01	1.998D-01
4	0.000D+00	-1.739D-02	-8.696D-02	1.739D-02	8.696D-02	-1.896D-02	1.896D-02	-1.019D-01	1.019D-01
5	0.000D+00	-3.610D-03	-1.806D-02	3.610D-03	1.806D-02	-1.652D-02	1.652D-02	-5.277D-02	5.277D-02
6	0.000D+00	1.120D-03	5.603D-03	-1.120D-03	-5.603D-03	-2.945D-03	2.945D-03	-2.870D-02	2.870D-02
7	0.000D+00	-1.056D-03	-5.281D-03	1.056D-03	5.281D-03	1.502D-03	-1.502D-03	-1.624D-02	1.624D-02
8	0.000D+00	-4.827D-03	-2.413D-02	4.827D-03	2.413D-02	9.908D-04	-9.908D-04	-9.631D-03	9.631D-03
9	0.000D+00	-1.016D-02	-5.082D-02	1.016D-02	5.082D-02	-2.948D-04	2.948D-04	-5.928D-03	5.928D-03
10	0.000D+00	-1.866D-02	-9.331D-02	1.866D-02	9.331D-02	-1.183D-03	1.183D-03	-3.745D-03	3.745D-03
11	0.000D+00	-3.129D-02	-1.564D-01	3.129D-02	1.564D-01	-1.972D-03	1.972D-03	-2.413D-03	2.413D-03
12	0.000D+00	-4.782D-02	-2.391D-01	4.782D-02	2.391D-01	-3.059D-03	3.059D-03	-1.580D-03	1.580D-03

Table 3.5.9 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	2	3	4	12	13	14	23

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.521D-06	1.521D-06	-1.521D-06	-1.521D-06	3.041D-06	1.051D-25	-1.714D-23	1.709D-23
1	0.000D+00	8.351D-03	-8.351D-03	8.351D-03	-8.351D-03	0.000D+00	1.670D-02	-2.397D-19	2.397D-19
2	-2.840D+01	-4.859D-03	-4.859D-03	4.859D-03	4.859D-03	-9.721D-03	0.000D+00	-3.653D-19	3.653D-19
3	0.000D+00	-5.141D-03	5.141D-03	-5.141D-03	5.141D-03	0.000D+00	-1.028D-02	-4.616D-19	4.616D-19
4	4.164D+01	-1.024D-03	-1.024D-03	1.024D-03	1.024D-03	-2.048D-03	0.000D+00	-4.258D-19	4.258D-19
5	0.000D+00	-2.701D-04	2.701D-04	-2.701D-04	2.701D-04	0.000D+00	-5.401D-04	-7.205D-19	7.205D-19
6	-5.591D-01	-4.011D-03	-4.011D-03	4.011D-03	4.011D-03	-8.025D-03	0.000D+00	-5.584D-19	5.584D-19
7	0.000D+00	-1.180D-02	1.180D-02	-1.180D-02	1.180D-02	0.000D+00	-2.360D-02	-9.537D-19	9.537D-19
8	1.268D+01	-2.574D-02	-2.574D-02	2.574D-02	2.574D-02	-5.147D-02	0.000D+00	-9.134D-19	9.134D-19
9	0.000D+00	-4.850D-02	4.850D-02	-4.850D-02	4.850D-02	0.000D+00	-9.698D-02	-1.571D-18	1.571D-18
10	5.121D+01	-7.966D-02	-7.966D-02	7.966D-02	7.966D-02	-1.593D-01	0.000D+00	-1.579D-18	1.579D-18
11	0.000D+00	-1.122D-01	1.122D-01	-1.122D-01	1.122D-01	0.000D+00	-2.245D-01	-2.724D-18	2.724D-18
12	1.029D+02	-1.308D-01	-1.308D-01	1.308D-01	1.308D-01	-2.616D-01	0.000D+00	-1.850D-18	1.850D-18

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.896D-07	4.896D-07	4.896D-07	-4.896D-07	1.057D-24	1.057D-24	-9.792D-07	9.792D-07
1	0.000D+00	-1.821D-02	-1.821D-02	-1.821D-02	-1.821D-02	-3.642D-02	-3.642D-02	-3.642D-02	-3.642D-02
2	0.000D+00	-3.903D-03	3.903D-03	3.903D-03	-3.903D-03	0.000D+00	0.000D+00	-7.806D-03	7.806D-03
3	0.000D+00	5.045D-03	5.045D-03	5.045D-03	5.045D-03	1.009D-02	1.009D-02	1.009D-02	1.009D-02
4	0.000D+00	5.989D-03	-5.989D-03	-5.989D-03	5.989D-03	0.000D+00	0.000D+00	1.198D-02	-1.198D-02
5	0.000D+00	1.363D-02	1.363D-02	1.363D-02	1.363D-02	2.726D-02	2.726D-02	2.726D-02	2.726D-02
6	0.000D+00	4.594D-02	-4.594D-02	-4.594D-02	4.594D-02	0.000D+00	0.000D+00	9.186D-02	-9.186D-02
7	0.000D+00	1.324D-01	1.324D-01	1.324D-01	1.324D-01	2.648D-01	2.648D-01	2.648D-01	2.648D-01
8	0.000D+00	3.287D-01	-3.287D-01	-3.287D-01	3.287D-01	0.000D+00	0.000D+00	6.576D-01	-6.576D-01
9	0.000D+00	7.238D-01	7.238D-01	7.238D-01	7.238D-01	1.448D+00	1.448D+00	1.448D+00	1.448D+00
10	0.000D+00	1.433D+00	-1.433D+00	-1.433D+00	1.433D+00	0.000D+00	0.000D+00	2.867D+00	-2.867D+00
11	0.000D+00	2.576D+00	2.576D+00	2.576D+00	2.576D+00	5.152D+00	5.152D+00	5.152D+00	5.152D+00
12	0.000D+00	4.241D+00	-4.241D+00	-4.241D+00	4.241D+00	0.000D+00	0.000D+00	8.483D+00	-8.483D+00

Table 3.5.9 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03	1.000D-03
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		-12	-13	-14	-23	-21	-23	-24	-34

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-4.323D-10	3.042D-06	3.042D-06	3.042D-06	-4.323D-10	3.042D-06	3.042D-06	4.323D-10
1	0.000D+00	1.670D-02	1.850D-06	1.670D-02	-1.670D-02	-1.670D-02	-1.670D-02	-1.850D-06	1.670D-02
2	-2.840D+01	5.343D-06	-9.725D-03	-9.725D-03	-9.725D-03	5.343D-06	-9.725D-03	-9.725D-03	-5.343D-06
3	0.000D+00	-1.028D-02	1.208D-06	-1.028D-02	1.028D-02	1.028D-02	1.028D-02	-1.208D-06	-1.028D-02
4	4.164D+01	1.026D-06	-2.049D-03	-2.049D-03	-2.049D-03	1.026D-06	-2.049D-03	-2.049D-03	-1.026D-06
5	0.000D+00	-5.516D-04	1.155D-05	-5.516D-04	5.516D-04	5.516D-04	5.516D-04	-1.155D-05	-5.516D-04
6	-5.591D-01	3.847D-05	-8.062D-03	-8.062D-03	-8.062D-03	3.847D-05	-8.062D-03	-8.062D-03	-3.847D-05
7	0.000D+00	-2.369D-02	9.550D-05	-2.369D-02	2.369D-02	2.369D-02	2.369D-02	-9.550D-05	-2.369D-02
8	1.268D+01	2.019D-04	-5.167D-02	-5.167D-02	-5.167D-02	2.019D-04	-5.167D-02	-5.167D-02	-2.019D-04
9	0.000D+00	-9.735D-02	3.662D-04	-9.735D-02	9.735D-02	9.735D-02	9.735D-02	-3.662D-04	-9.735D-02
10	5.121D+01	5.619D-04	-1.599D-01	-1.599D-01	-1.599D-01	5.619D-04	-1.599D-01	-1.599D-01	-5.619D-04
11	0.000D+00	-2.251D-01	7.009D-04	-2.251D-01	2.251D-01	2.251D-01	2.251D-01	-7.009D-04	-2.251D-01
12	1.029D+02	6.182D-04	-2.622D-01	-2.622D-01	-2.622D-01	6.182D-04	-2.622D-01	-2.622D-01	-6.182D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-9.795D-07	-9.795D-07	2.866D-10	-2.866D-10	9.795D-07	-2.866D-10	9.795D-07	9.795D-07
1	0.000D+00	3.578D-06	3.578D-06	3.578D-06	3.578D-06	3.578D-06	3.578D-06	3.578D-06	3.578D-06
2	0.000D+00	-7.800D-03	-7.800D-03	-5.283D-06	5.283D-06	7.800D-03	5.283D-06	7.800D-03	7.800D-03
3	0.000D+00	-9.890D-06	-9.890D-06	-9.890D-06	-9.890D-06	-9.890D-06	-9.890D-06	-9.890D-06	-9.890D-06
4	0.000D+00	1.201D-02	1.201D-02	-3.206D-05	3.206D-05	-1.201D-02	3.206D-05	-1.201D-02	-1.201D-02
5	0.000D+00	-1.307D-04	-1.307D-04	-1.307D-04	-1.307D-04	-1.307D-04	-1.307D-04	-1.307D-04	-1.307D-04
6	0.000D+00	9.230D-02	9.230D-02	-4.382D-04	4.382D-04	-9.230D-02	4.382D-04	-9.230D-02	-9.230D-02
7	0.000D+00	-1.243D-03	-1.243D-03	-1.243D-03	-1.243D-03	-1.243D-03	-1.243D-03	-1.243D-03	-1.243D-03
8	0.000D+00	6.607D-01	6.607D-01	-3.078D-03	3.078D-03	-6.607D-01	3.078D-03	-6.607D-01	-6.607D-01
9	0.000D+00	-6.768D-03	-6.768D-03	-6.768D-03	-6.768D-03	-6.768D-03	-6.768D-03	-6.768D-03	-6.768D-03
10	0.000D+00	2.880D+00	2.880D+00	-1.339D-02	1.339D-02	-2.880D+00	1.339D-02	-2.880D+00	-2.880D+00
11	0.000D+00	-2.404D-02	-2.404D-02	-2.404D-02	-2.404D-02	-2.404D-02	-2.404D-02	-2.404D-02	-2.404D-02
12	0.000D+00	8.525D+00	8.525D+00	-3.953D-02	3.953D-02	-8.525D+00	3.953D-02	-8.525D+00	-8.525D+00

Table 3.5.9 Cont.

region =		1	1	1	1	1	1	1	2
drinner (in)=		1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.521D-06	3.041D-06	7.599D-06	1.519D-05	3.033D-05	7.550D-05	1.054D-04	4.494D-04
1	0.000D+00	8.351D-03	1.670D-02	4.176D-02	8.356D-02	1.673D-01	4.196D-01	5.887D-01	3.966D+00
2	-2.840D+01	-4.859D-03	-9.715D-03	-2.424D-02	-4.836D-02	-9.618D-02	-2.366D-01	-3.274D-01	-6.470D-02
3	0.000D+00	-5.141D-03	-1.028D-02	-2.569D-02	-5.136D-02	-1.026D-01	-2.556D-01	-3.571D-01	-1.760D+00
4	4.164D+01	-1.024D-03	-2.047D-03	-5.109D-03	-1.020D-02	-2.032D-02	-5.049D-02	-7.058D-02	-1.071D+00
5	0.000D+00	-2.701D-04	-5.287D-04	-1.237D-03	-2.198D-03	-3.349D-03	-1.454D-03	3.453D-03	-1.551D-02
6	-5.591D-01	-4.011D-03	-7.982D-03	-1.968D-02	-3.843D-02	-7.336D-02	-1.595D-01	-2.040D-01	2.924D-01
7	0.000D+00	-1.180D-02	-2.351D-02	-5.804D-02	-1.138D-01	-2.188D-01	-4.879D-01	-6.344D-01	9.674D-02
8	1.268D+01	-2.574D-02	-5.126D-02	-1.267D-01	-2.485D-01	-4.783D-01	-1.069D+00	-1.394D+00	-1.620D-01
9	0.000D+00	-4.850D-02	-9.667D-02	-2.389D-01	-4.690D-01	-9.043D-01	-2.028D+00	-2.648D+00	-3.664D-01
10	5.121D+01	-7.966D-02	-1.588D-01	-3.927D-01	-7.719D-01	-1.491D+00	-3.364D+00	-4.409D+00	-6.171D-01
11	0.000D+00	-1.122D-01	-2.238D-01	-5.542D-01	-1.091D+00	-2.116D+00	-4.823D+00	-6.353D+00	-1.013D+00
12	1.029D+02	-1.308D-01	-2.610D-01	-6.476D-01	-1.280D+00	-2.498D+00	-5.797D+00	-7.714D+00	-1.568D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.896D-07	-9.789D-07	-2.445D-06	-4.883D-06	-9.738D-06	-2.413D-05	-3.356D-05	-7.847D-05
1	0.000D+00	-1.821D-02	-3.642D-02	-9.104D-02	-1.819D-01	-3.636D-01	-9.060D-01	-1.266D+00	-5.944D+00
2	0.000D+00	-3.903D-03	-7.810D-03	-1.957D-02	-3.926D-02	-7.905D-02	-2.013D-01	-2.852D-01	-3.241D+00
3	0.000D+00	5.045D-03	1.009D-02	2.513D-02	5.002D-02	9.915D-02	2.413D-01	3.324D-01	3.314D-01
4	0.000D+00	5.989D-03	1.195D-02	2.962D-02	5.847D-02	1.141D-01	2.660D-01	3.572D-01	1.262D+00
5	0.000D+00	1.363D-02	2.713D-02	6.687D-02	1.306D-01	2.494D-01	5.452D-01	7.009D-01	5.485D-01
6	0.000D+00	4.594D-02	9.143D-02	2.254D-01	4.404D-01	8.410D-01	1.839D+00	2.364D+00	-1.020D-02
7	0.000D+00	1.324D-01	2.636D-01	6.500D-01	1.270D+00	2.427D+00	5.322D+00	6.852D+00	6.917D-02
8	0.000D+00	3.287D-01	6.545D-01	1.614D+00	3.154D+00	6.028D+00	1.322D+01	1.703D+01	6.514D-01
9	0.000D+00	7.236D-01	1.441D+00	3.552D+00	6.942D+00	1.327D+01	2.911D+01	3.750D+01	1.610D+00
10	0.000D+00	1.433D+00	2.853D+00	7.033D+00	1.375D+01	2.628D+01	5.763D+01	7.425D+01	3.190D+00
11	0.000D+00	2.576D+00	5.129D+00	1.265D+01	2.471D+01	4.725D+01	1.037D+02	1.335D+02	5.735D+00
12	0.000D+00	4.241D+00	8.446D+00	2.082D+01	4.070D+01	7.782D+01	1.707D+02	2.199D+02	9.494D+00

Table 3.5.9 Cont.

region =	2	2	2	2	2	2	2	2
drinner (in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	4.597D-06	9.192D-06	2.296D-05	4.588D-05	9.155D-05	2.273D-04	3.168D-04	4.494D-04
1	0.000D+00	3.998D-02	7.995D-02	1.998D-01	3.995D-01	7.986D-01	1.991D+00	2.783D+00	3.966D+00
2	-2.840D+01	-1.539D-03	-3.059D-03	-7.506D-03	-1.455D-02	-2.724D-02	-5.442D-02	-6.369D-02	-6.470D-02
3	0.000D+00	-1.833D-02	-3.665D-02	-9.149D-02	-1.826D-01	-3.638D-01	-8.987D-01	-1.248D+00	-1.760D+00
4	4.164D+01	-1.066D-02	-2.132D-02	-5.330D-02	-1.066D-01	-2.135D-01	-5.345D-01	-7.492D-01	-1.071D+00
5	0.000D+00	2.066D-04	4.060D-04	9.595D-04	1.735D-03	2.731D-03	1.312D-03	-3.274D-03	-1.551D-02
6	-5.591D-01	3.001D-03	6.002D-03	1.500D-02	2.998D-02	5.987D-02	1.487D-01	2.070D-01	2.924D-01
7	0.000D+00	5.769D-04	1.164D-03	2.989D-03	6.232D-03	1.343D-02	3.997D-02	6.111D-02	9.674D-02
8	1.268D+01	-2.539D-03	-5.053D-03	-1.245D-02	-2.432D-02	-4.640D-02	-1.010D-01	-1.293D-01	-1.620D-01
9	0.000D+00	-5.417D-03	-1.079D-02	-2.662D-02	-5.210D-02	-9.989D-02	-2.210D-01	-2.864D-01	-3.664D-01
10	5.121D+01	-9.364D-03	-1.864D-02	-4.596D-02	-8.989D-02	-1.719D-01	-3.772D-01	-4.863D-01	-6.171D-01
11	0.000D+00	-1.552D-02	-3.089D-02	-7.616D-02	-1.489D-01	-2.843D-01	-6.224D-01	-8.006D-01	-1.013D+00
12	1.029D+02	-2.394D-02	-4.766D-02	-1.175D-01	-2.297D-01	-4.391D-01	-9.625D-01	-1.238D+00	-1.568D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-8.352D-07	-1.669D-06	-4.166D-06	-8.305D-06	-1.651D-05	-4.050D-05	-5.598D-05	-7.847D-05
1	0.000D+00	-6.081D-02	-1.216D-01	-3.038D-01	-6.068D-01	-1.211D+00	-3.007D+00	-4.190D+00	-5.944D+00
2	0.000D+00	-3.233D-02	-6.466D-02	-1.617D-01	-3.233D-01	-6.470D-01	-1.619D+00	-2.267D+00	-3.241D+00
3	0.000D+00	4.197D-03	8.375D-03	2.080D-02	4.114D-02	8.046D-02	1.877D-01	2.503D-01	3.314D-01
4	0.000D+00	1.308D-02	2.615D-02	6.529D-02	1.304D-01	2.598D-01	6.424D-01	8.928D-01	1.262D+00
5	0.000D+00	5.472D-03	1.094D-02	2.736D-02	5.469D-02	1.094D-01	2.736D-01	3.833D-01	5.485D-01
6	0.000D+00	1.967D-04	3.833D-04	8.838D-04	1.529D-03	2.179D-03	1.847D-04	-3.336D-03	-1.020D-02
7	0.000D+00	2.478D-03	4.910D-03	1.195D-02	2.283D-02	4.163D-02	7.781D-02	8.838D-02	8.917D-02
8	0.000D+00	1.074D-02	2.137D-02	5.255D-02	1.023D-01	1.940D-01	4.155D-01	5.267D-01	6.514D-01
9	0.000D+00	2.539D-02	5.053D-02	1.244D-01	2.427D-01	4.622D-01	1.003D+00	1.282D+00	1.610D+00
10	0.000D+00	5.032D-02	1.001D-01	2.465D-01	4.808D-01	9.157D-01	1.986D+00	2.541D+00	3.190D+00
11	0.000D+00	9.057D-02	1.802D-01	4.439D-01	8.657D-01	1.648D+00	3.572D+00	4.569D+00	5.735D+00
12	0.000D+00	1.500D-01	2.984D-01	7.345D-01	1.433D+00	2.729D+00	5.913D+00	7.561D+00	9.494D+00

Table 3.5.9 Cont.

region	=	3	3	3	3	3	3	3	3
drinner	(in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
drouter	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto	(in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry	=	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-2.241D-06	-4.480D-06	-1.118D-05	-2.231D-05	-4.439D-05	-1.092D-04	-1.513D-04	-2.126D-04
1	0.000D+00	-1.151D-02	-2.301D-02	-5.746D-02	-1.146D-01	-2.282D-01	-5.628D-01	-7.806D-01	-1.099D+00
2	-2.840D+01	4.823D-03	9.639D-03	2.405D-02	4.794D-02	9.527D-02	2.335D-01	3.225D-01	4.517D-01
3	0.000D+00	4.842D-03	9.677D-03	2.416D-02	4.820D-02	9.592D-02	2.360D-01	3.271D-01	4.598D-01
4	4.164D+01	1.489D-03	2.977D-03	7.436D-03	1.485D-02	2.959D-02	7.320D-02	1.018D-01	1.438D-01
5	0.000D+00	-2.317D-04	-4.628D-04	-1.153D-03	-2.292D-03	-4.534D-03	-1.095D-02	-1.497D-02	-2.066D-02
6	-5.591D-01	-3.234D-04	-6.465D-04	-1.614D-03	-3.219D-03	-6.404D-03	-1.575D-02	-2.181D-02	-3.064D-02
7	0.000D+00	-9.997D-05	-1.999D-04	-4.994D-04	-9.977D-04	-1.991D-03	-4.946D-03	-6.890D-03	-9.767D-03
8	1.268D+01	4.660D-06	9.283D-06	2.293D-05	4.493D-05	8.616D-05	1.885D-04	2.398D-04	2.930D-04
9	0.000D+00	1.517D-05	3.034D-05	7.572D-05	1.510D-04	3.002D-04	7.374D-04	1.019D-03	1.428D-03
10	5.121D+01	4.939D-06	9.878D-06	2.472D-05	4.953D-05	9.932D-05	2.499D-04	3.508D-04	5.018D-04
11	0.000D+00	-6.735D-07	-1.337D-06	-3.262D-06	-6.271D-06	-1.156D-05	-2.234D-05	-2.592D-05	-2.695D-05
12	1.029D+02	-1.899D-06	-3.784D-06	-9.357D-06	-1.837D-05	-3.542D-05	-7.982D-05	-1.048D-04	-1.369D-04

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.050D-05	2.099D-05	5.239D-05	1.045D-04	2.077D-04	5.103D-04	7.060D-04	9.907D-04
1	0.000D+00	1.337D-01	2.673D-01	6.666D-01	1.329D+00	2.642D+00	6.477D+00	8.954D+00	1.254D+01
2	0.000D+00	1.100D-01	2.199D-01	5.487D-01	1.093D+00	2.170D+00	5.307D+00	7.320D+00	1.023D+01
3	0.000D+00	8.490D-02	1.697D-01	4.230D-01	8.425D-01	1.670D+00	4.070D+00	5.601D+00	7.799D+00
4	0.000D+00	6.807D-02	1.360D-01	3.390D-01	6.747D-01	1.336D+00	3.245D+00	4.456D+00	6.184D+00
5	0.000D+00	5.233D-02	1.045D-01	2.604D-01	5.180D-01	1.025D+00	2.479D+00	3.397D+00	4.698D+00
6	0.000D+00	3.908D-02	7.808D-02	1.944D-01	3.864D-01	7.634D-01	1.839D+00	2.512D+00	3.463D+00
7	0.000D+00	2.873D-02	5.737D-02	1.428D-01	2.836D-01	5.594D-01	1.341D+00	1.827D+00	2.507D+00
8	0.000D+00	2.106D-02	4.205D-02	1.046D-01	2.075D-01	4.085D-01	9.747D-01	1.323D+00	1.808D+00
9	0.000D+00	1.547D-02	3.088D-02	7.677D-02	1.522D-01	2.990D-01	7.096D-01	9.599D-01	1.305D+00
10	0.000D+00	1.139D-02	2.273D-02	5.649D-02	1.119D-01	2.194D-01	5.178D-01	6.982D-01	9.443D-01
11	0.000D+00	8.401D-03	1.677D-02	4.164D-02	8.236D-02	1.613D-01	3.785D-01	5.086D-01	6.843D-01
12	0.000D+00	6.208D-03	1.238D-02	3.074D-02	6.076D-02	1.187D-01	2.771D-01	3.710D-01	4.966D-01

Table 3.5.9 Cont.

region =		1	1	1	1	1	1	1	1
drinner (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
dheighti (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	1.450D-06	2.900D-06	7.245D-06	1.448D-05	2.891D-05	7.193D-05	1.004D-04	1.427D-04
1	0.000D+00	8.554D-03	1.711D-02	4.279D-02	8.558D-02	1.712D-01	4.286D-01	6.006D-01	8.589D-01
2	-2.840D+01	-4.052D-03	-8.098D-03	-2.021D-02	-4.029D-02	-8.011D-02	-1.967D-01	-2.713D-01	-3.812D-01
3	0.000D+00	-4.948D-03	-9.898D-03	-2.473D-02	-4.942D-02	-9.873D-02	-2.457D-01	-3.429D-01	-4.876D-01
4	4.164D+01	-1.106D-03	-2.213D-03	-5.540D-03	-1.111D-02	-2.234D-02	-5.675D-02	-8.028D-02	-1.165D-01
5	0.000D+00	4.901D-04	9.814D-04	2.462D-03	4.956D-03	1.002D-02	2.574D-02	3.653D-02	5.294D-02
6	-5.591D-01	-1.055D-03	-2.101D-03	-5.194D-03	-1.019D-02	-1.961D-02	-4.373D-02	-5.674D-02	-7.236D-02
7	0.000D+00	-4.339D-03	-8.656D-03	-2.148D-02	-4.243D-02	-8.288D-02	-1.934D-01	-2.590D-01	-3.471D-01
8	1.268D+01	-9.719D-03	-1.939D-02	-4.814D-02	-9.516D-02	-1.860D-01	-4.349D-01	-5.836D-01	-7.839D-01
9	0.000D+00	-1.864D-02	-3.718D-02	-9.229D-02	-1.825D-01	-3.567D-01	-8.338D-01	-1.119D+00	-1.503D+00
10	5.121D+01	-3.168D-02	-6.321D-02	-1.569D-01	-3.103D-01	-6.065D-01	-1.420D+00	-1.905D+00	-2.560D+00
11	0.000D+00	-4.720D-02	-9.419D-02	-2.340D-01	-4.626D-01	-9.049D-01	-2.121D+00	-2.849D+00	-3.833D+00
12	1.029D+02	-6.066D-02	-1.211D-01	-3.007D-01	-5.950D-01	-1.165D+00	-2.737D+00	-3.682D+00	-4.962D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-4.451D-07	-8.900D-07	-2.223D-06	-4.439D-06	-8.850D-06	-2.192D-05	-3.049D-05	-4.315D-05
1	0.000D+00	-1.757D-02	-3.513D-02	-8.782D-02	-1.755D-01	-3.505D-01	-8.730D-01	-1.219D+00	-1.734D+00
2	0.000D+00	-4.565D-03	-9.134D-03	-2.286D-02	-4.581D-02	-9.194D-02	-2.323D-01	-3.274D-01	-4.722D-01
3	0.000D+00	4.045D-03	8.086D-03	2.018D-02	4.024D-02	8.003D-02	1.968D-01	2.724D-01	3.827D-01
4	0.000D+00	3.756D-03	7.507D-03	1.873D-02	3.732D-02	7.414D-02	1.817D-01	2.514D-01	3.533D-01
5	0.000D+00	4.486D-03	8.950D-03	2.221D-02	4.388D-02	8.571D-02	2.000D-01	2.683D-01	3.605D-01
6	0.000D+00	1.481D-02	2.954D-02	7.329D-02	1.446D-01	2.819D-01	6.542D-01	8.737D-01	1.165D+00
7	0.000D+00	4.393D-02	8.761D-02	2.174D-01	4.294D-01	8.378D-01	1.949D+00	2.607D+00	3.487D+00
8	0.000D+00	1.095D-01	2.186D-01	5.423D-01	1.071D+00	2.090D+00	4.865D+00	6.510D+00	8.713D+00
9	0.000D+00	2.413D-01	4.813D-01	1.194D+00	2.359D+00	4.603D+00	1.072D+01	1.433D+01	1.919D+01
10	0.000D+00	4.779D-01	9.535D-01	2.366D+00	4.673D+00	9.119D+00	2.123D+01	2.839D+01	3.802D+01
11	0.000D+00	8.602D-01	1.716D+00	4.258D+00	8.410D+00	1.641D+01	3.821D+01	5.112D+01	6.844D+01
12	0.000D+00	1.418D+00	2.828D+00	7.019D+00	1.386D+01	2.705D+01	6.297D+01	8.425D+01	1.128D+02

Table 3.5.9 Cont.

region =	2	2	2	2	2	2	2	2
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	3.945D-06	7.888D-06	1.971D-05	3.936D-05	7.851D-05	1.947D-04	2.712D-04	3.844D-04
1	0.000D+00	3.703D-02	7.405D-02	1.850D-01	3.697D-01	7.383D-01	1.836D+00	2.561D+00	3.639D+00
2	-2.840D+01	2.935D-03	5.880D-03	1.477D-02	2.980D-02	6.054D-02	1.584D-01	2.281D-01	3.388D-01
3	0.000D+00	-1.380D-02	-2.758D-02	-6.886D-02	-1.374D-01	-2.734D-01	-6.737D-01	-9.336D-01	-1.314D+00
4	4.164D+01	-1.022D-02	-2.045D-02	-5.109D-02	-1.021D-01	-2.038D-01	-5.067D-01	-7.065D-01	-1.003D+00
5	0.000D+00	-1.619D-03	-3.242D-03	-8.134D-03	-1.636D-02	-3.308D-02	-8.531D-02	-1.218D-01	-1.786D-01
6	-5.591D-01	1.984D-03	3.964D-03	9.883D-03	1.968D-02	3.900D-02	9.484D-02	1.303D-01	1.810D-01
7	0.000D+00	1.360D-03	2.720D-03	6.794D-03	1.358D-02	2.711D-02	6.740D-02	9.396D-02	1.333D-01
8	1.268D+01	-1.545D-04	-3.071D-04	-7.530D-04	-1.457D-03	-2.724D-03	-5.461D-03	-6.466D-03	-6.879D-03
9	0.000D+00	-1.105D-03	-2.207D-03	-5.494D-03	-1.091D-02	-2.149D-02	-5.145D-02	-7.003D-02	-9.597D-02
10	5.121D+01	-1.762D-03	-3.519D-03	-8.763D-03	-1.740D-02	-3.432D-02	-8.238D-02	-1.123D-01	-1.545D-01
11	0.000D+00	-2.700D-03	-5.391D-03	-1.341D-02	-2.663D-02	-5.249D-02	-1.257D-01	-1.711D-01	-2.349D-01
12	1.029D+02	-4.125D-03	-8.240D-03	-2.050D-02	-4.069D-02	-8.014D-02	-1.917D-01	-2.609D-01	-3.577D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-5.544D-07	-1.108D-06	-2.764D-06	-5.511D-06	-1.095D-05	-2.683D-05	-3.707D-05	-5.191D-05
1	0.000D+00	-5.192D-02	-1.038D-01	-2.593D-01	-5.179D-01	-1.033D+00	-2.562D+00	-3.567D+00	-5.051D+00
2	0.000D+00	-3.146D-02	-6.294D-02	-1.573D-01	-3.144D-01	-6.280D-01	-1.564D+00	-2.184D+00	-3.109D+00
3	0.000D+00	-3.939D-04	-7.983D-04	-2.076D-03	-4.416D-03	-9.881D-03	-3.239D-02	-5.229D-02	-8.919D-02
4	0.000D+00	1.010D-02	2.018D-02	5.037D-02	1.005D-01	2.001D-01	4.932D-01	6.844D-01	9.640D-01
5	0.000D+00	5.540D-03	1.108D-02	2.769D-02	5.535D-02	1.106D-01	2.756D-01	3.849D-01	5.479D-01
6	0.000D+00	3.284D-04	6.592D-04	1.666D-03	3.392D-03	7.024D-03	1.932D-02	2.863D-02	4.423D-02
7	0.000D+00	-6.730D-04	-1.346D-03	-3.365D-03	-6.734D-03	-1.346D-02	-3.356D-02	-4.681D-02	-6.638D-02
8	0.000D+00	1.079D-03	2.152D-03	5.340D-03	1.055D-02	2.058D-02	4.782D-02	6.384D-02	8.502D-02
9	0.000D+00	3.999D-03	7.986D-03	1.986D-02	3.941D-02	7.757D-02	1.850D-01	2.513D-01	3.436D-01
10	0.000D+00	8.167D-03	1.631D-02	4.058D-02	8.056D-02	1.587D-01	3.797D-01	5.165D-01	7.079D-01
11	0.000D+00	1.456D-02	2.907D-02	7.234D-02	1.436D-01	2.829D-01	6.765D-01	9.206D-01	1.263D+00
12	0.000D+00	2.400D-02	4.794D-02	1.193D-01	2.367D-01	4.663D-01	1.115D+00	1.517D+00	2.080D+00

Table 3.5.9 Cont.

region =		3	3	3	3	3	3	3	3
driuner (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		1.000D-03	2.000D-03	5.000D-03	1.000D-01	2.000D-02	5.000D-02	7.000D-02	1.000D-01
dheighti (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-1.127D-06	-2.251D-06	-5.610D-06	-1.009D-04	-2.208D-05	-5.341D-05	-7.311D-05	-1.009D-04
1	0.000D+00	-5.971D-03	-1.193D-02	-2.972D-02	-5.342D-01	-1.170D-01	-2.830D-01	-3.872D-01	-5.342D-01
2	-2.840D+01	2.265D-03	4.524D-03	1.127D-02	2.029D-01	4.437D-02	1.074D-01	1.470D-01	2.029D-01
3	0.000D+00	2.443D-03	4.880D-03	1.216D-02	2.187D-01	4.787D-02	1.158D-01	1.585D-01	2.187D-01
4	4.164D+01	8.152D-04	1.629D-03	4.059D-03	7.290D-02	1.597D-02	3.864D-02	5.289D-02	7.290D-02
5	0.000D+00	-7.970D-05	-1.592D-04	-3.968D-04	-7.172D-03	-1.562D-03	-3.783D-03	-5.185D-03	-7.172D-03
6	-5.591D-01	-1.599D-04	-3.195D-04	-7.960D-04	-1.432D-02	-3.134D-03	-7.583D-03	-1.038D-02	-1.432D-02
7	0.000D+00	-5.744D-05	-1.148D-04	-2.860D-04	-5.134D-03	-1.126D-03	-2.722D-03	-3.726D-03	-5.134D-03
8	1.268D+01	-1.887D-06	-3.771D-06	-9.395D-06	-1.644D-04	-3.695D-05	-8.886D-05	-1.208D-04	-1.644D-04
9	0.000D+00	7.022D-06	1.403D-05	3.493D-05	6.292D-04	1.375D-04	3.329D-04	4.557D-04	6.292D-04
10	5.121D+01	3.111D-06	6.217D-06	1.549D-05	2.780D-04	6.098D-05	1.474D-04	2.017D-04	2.780D-04
11	0.000D+00	3.052D-07	6.096D-07	1.519D-06	2.688D-05	5.976D-06	1.441D-05	1.963D-05	2.688D-05
12	1.029D+02	-3.731D-07	-7.451D-07	-1.857D-06	-3.362D-05	-7.314D-06	-1.771D-05	-2.429D-05	-3.362D-05

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	5.135D-06	1.026D-05	2.557D-05	4.598D-04	1.006D-04	2.435D-04	3.332D-04	4.598D-04
1	0.000D+00	6.358D-02	1.271D-01	3.166D-01	5.694D+00	1.246D+00	3.015D+00	4.127D+00	5.694D+00
2	0.000D+00	5.010D-02	1.001D-01	2.494D-01	4.490D+00	9.819D-01	2.375D+00	3.252D+00	4.490D+00
3	0.000D+00	3.653D-02	7.297D-02	1.819D-01	3.274D+00	7.158D-01	1.732D+00	2.372D+00	3.274D+00
4	0.000D+00	2.783D-02	5.558D-02	1.386D-01	2.496D+00	5.453D-01	1.320D+00	1.808D+00	2.496D+00
5	0.000D+00	2.025D-02	4.045D-02	1.008D-01	1.817D+00	3.970D-01	9.606D-01	1.316D+00	1.817D+00
6	0.000D+00	1.422D-02	2.842D-02	7.082D-02	1.277D+00	2.788D-01	6.748D-01	9.245D-01	1.277D+00
7	0.000D+00	9.760D-03	1.950D-02	4.859D-02	8.771D-01	1.913D-01	4.630D-01	6.344D-01	8.771D-01
8	0.000D+00	6.645D-03	1.327D-02	3.308D-02	5.975D-01	1.302D-01	3.154D-01	4.321D-01	5.975D-01
9	0.000D+00	4.526D-03	9.043D-03	2.253D-02	4.073D-01	8.870D-02	2.148D-01	2.944D-01	4.073D-01
10	0.000D+00	3.090D-03	6.174D-03	1.539D-02	2.782D-01	6.060D-02	1.467D-01	2.011D-01	2.782D-01
11	0.000D+00	2.116D-03	4.228D-03	1.054D-02	1.908D-01	4.149D-02	1.005D-01	1.377D-01	1.908D-01
12	0.000D+00	1.453D-03	2.902D-03	7.235D-03	1.310D-01	2.848D-02	6.898D-02	9.457D-02	1.310D-01

Table 3.5.9 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-9.044D-07	-1.808D-06	-4.517D-06	-9.021D-06	-1.799D-05	-4.461D-05	-6.211D-05	-8.600D-05
1	0.000D+00	2.691D-03	5.381D-03	1.344D-02	2.683D-02	5.353D-02	1.329D-01	1.851D-01	2.625D-01
2	-2.840D+01	7.277D-03	1.455D-02	3.632D-02	7.250D-02	1.444D-01	3.566D-01	4.952D-01	6.991D-01
3	0.000D+00	-4.338D-04	-8.689D-04	-2.185D-03	-4.406D-03	-8.927D-03	-2.255D-02	-3.108D-02	-4.172D-02
4	4.164D+01	-4.730D-03	-9.460D-03	-2.363D-02	-4.719D-02	-9.393D-02	-2.285D-01	-3.106D-01	-4.172D-01
5	0.000D+00	-9.301D-03	-1.860D-02	-4.649D-02	-9.286D-02	-1.847D-01	-4.416D-01	-5.858D-01	-7.400D-01
6	-5.591D-01	-2.786D-02	-5.573D-02	-1.393D-01	-2.782D-01	-5.529D-01	-1.315D+00	-1.731D+00	-2.147D+00
7	0.000D+00	-8.205D-02	-1.641D-01	-4.100D-01	-8.183D-01	-1.625D+00	-3.854D+00	-5.070D+00	-6.271D+00
8	1.268D+01	-2.096D-01	-4.191D-01	-1.047D+00	-2.089D+00	-4.143D+00	-9.799D+00	-1.286D+01	-1.586D+01
9	0.000D+00	-4.730D-01	-9.457D-01	-2.362D+00	-4.710D+00	-9.334D+00	-2.200D+01	-2.880D+01	-3.536D+01
10	5.121D+01	-9.593D-01	-1.918D+00	-4.787D+00	-9.544D+00	-1.889D+01	-4.439D+01	-5.796D+01	-7.082D+01
11	0.000D+00	-1.766D+00	-3.531D+00	-8.815D+00	-1.756D+01	-3.472D+01	-8.130D+01	-1.059D+02	-1.286D+02
12	1.029D+02	-2.980D+00	-5.955D+00	-1.486D+01	-2.958D+01	-5.845D+01	-1.364D+02	-1.771D+02	-2.144D+02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	3.885D-06	7.771D-06	1.943D-05	3.887D-05	7.780D-05	1.949D-04	2.731D-04	3.909D-04
1	0.000D+00	1.965D-02	3.930D-02	9.816D-02	1.962D-01	3.915D-01	9.724D-01	1.356D+00	1.924D+00
2	0.000D+00	-3.963D-03	-7.922D-03	-1.979D-02	-3.948D-02	-7.862D-02	-1.942D-01	-2.695D-01	-3.802D-01
3	0.000D+00	-5.129D-03	-1.025D-02	-2.552D-02	-5.074D-02	-1.003D-01	-2.418D-01	-3.306D-01	-4.562D-01
4	0.000D+00	1.119D-03	2.270D-03	5.914D-03	1.263D-02	2.845D-02	9.479D-02	1.537D-01	3.599D-01
5	0.000D+00	1.571D-03	3.264D-03	9.079D-03	2.122D-02	5.475D-02	2.277D-01	3.991D-01	7.238D-01
6	0.000D+00	-3.406D-05	3.437D-04	3.952D-03	1.824D-02	7.786D-02	4.993D-01	9.673D-01	1.895D+00
7	0.000D+00	5.527D-04	2.277D-03	1.449D-02	5.833D-02	2.341D-01	1.448D+00	2.784D+00	5.418D+00
8	0.000D+00	6.424D-03	1.575D-02	6.115D-02	1.950D-01	6.604D-01	3.830D+00	7.219D+00	1.384D+01
9	0.000D+00	2.385D-02	5.409D-02	1.831D-01	5.260D-01	1.690D+00	8.882D+00	1.650D+01	3.122D+01
10	0.000D+00	6.565D-02	1.439D-01	4.545D-01	1.225D+00	3.710D+00	1.845D+01	3.378D+01	6.321D+01
11	0.000D+00	1.514D-01	3.255D-01	9.838D-01	2.535D+00	7.326D+00	3.472D+01	6.277D+01	1.161D+02
12	0.000D+00	3.048D-01	6.466D-01	1.897D+00	4.724D+00	1.315D+01	5.971D+01	1.067D+02	1.953D+02

Table 3.5.9 Cont.

region =	2	2	2	2	2	2	2	2
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
dheighto (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-4.996D-06	-9.989D-06	-2.495D-05	-4.985D-05	-9.946D-05	-2.468D-04	-3.439D-04	-4.877D-04
1	0.000D+00	-1.116D-02	-2.236D-02	-5.579D-02	-1.112D-01	-2.211D-01	-5.421D-01	-7.498D-01	-1.052D+00
2	-2.840D+01	2.947D-02	5.891D-02	1.472D-01	2.939D-01	5.860D-01	1.452D+00	2.021D+00	2.861D+00
3	0.000D+00	1.602D-02	3.202D-02	7.989D-02	1.592D-01	3.163D-01	7.746D-01	1.070D+00	1.498D+00
4	4.164D+01	-3.140D-03	-6.286D-03	-1.574D-02	-3.159D-02	-6.361D-02	-1.618D-01	-2.289D-01	-3.314D-01
5	0.000D+00	-7.723D-03	-1.544D-02	-3.854D-02	-7.687D-02	-1.529D-01	-3.755D-01	-5.192D-01	-7.270D-01
6	-5.591D-01	-3.558D-03	-7.110D-03	-1.773D-02	-3.532D-02	-7.000D-02	-1.692D-01	-2.304D-01	-3.127D-01
7	0.000D+00	-1.390D-03	-2.785D-03	-6.992D-03	-1.406D-02	-2.828D-02	-6.852D-02	-9.004D-02	-1.083D-01
8	1.268D+01	-4.726D-03	-9.466D-03	-2.377D-02	-4.779D-02	-9.623D-02	-2.367D-01	-3.178D-01	-4.049D-01
9	0.000D+00	-1.344D-02	-2.690D-02	-6.744D-02	-1.352D-01	-2.712D-01	-6.639D-01	-8.932D-01	-1.153D+0
10	5.121D+01	-2.850D-02	-5.706D-02	-1.429D-01	-2.864D-01	-5.730D-01	-1.395D+00	-1.873D+00	-2.413D+0
11	0.000D+00	-5.283D-02	-1.057D-01	-2.647D-01	-5.301D-01	-1.039D+00	-2.568D+00	-3.437D+00	-4.405D+0
12	1.029D+02	-8.956D-02	-1.792D-01	-4.485D-01	-8.978D-01	-1.791D+00	-4.324D+00	-5.771D+00	-7.356D+0

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.180D-05	2.359D-05	5.901D-05	1.181D-04	2.365D-04	5.937D-04	8.333D-04	1.195D-03
1	0.000D+00	1.043D-01	2.086D-01	5.214D-01	1.041D+00	2.079D+00	5.170D+00	7.212D+00	1.024D+01
2	0.000D+00	1.143D-02	2.284D-02	5.692D-02	1.133D-01	2.242D-01	5.438D-01	7.463D-01	1.034D+0
3	0.000D+00	-2.475D-02	-4.950D-02	-1.236D-01	-2.469D-01	-4.922D-01	-1.219D+00	-1.696D+00	-2.400D+0
4	0.000D+00	-1.028D-02	-2.054D-02	-5.116D-02	-1.018D-01	-2.015D-01	-4.876D-01	-6.687D-01	-9.250D-01
5	0.000D+00	3.419D-03	6.844D-03	1.717D-02	3.450D-02	6.968D-02	1.793D-01	2.553D-01	3.732D-01
6	0.000D+00	4.729D-03	9.462D-03	2.370D-02	4.754D-02	9.564D-02	2.434D-01	3.447D-01	4.995D-01
7	0.000D+00	6.951D-04	1.421D-03	3.790D-03	8.371D-03	1.995D-02	7.404D-02	1.255D-01	2.220D-01
8	0.000D+00	-2.162D-03	-4.233D-03	-9.894D-03	-1.748D-02	-2.567D-02	5.317D-03	6.989D-02	2.224D-01
9	0.000D+00	-3.321D-03	-6.435D-03	-1.455D-02	-2.393D-02	-2.709D-02	8.697D-02	2.600D-01	6.410D-01
10	0.000D+00	-4.411D-03	-8.418D-03	-1.799D-02	-2.574D-02	-1.039D-02	2.790D-01	6.617D-01	1.471D+0
11	0.000D+00	-6.133D-03	-1.153D-02	-2.330D-02	-2.813D-02	1.778D-02	5.922D-01	1.314D+00	2.812D+0
12	0.000D+00	-7.861D-03	-1.451D-02	-2.712D-02	-2.365D-02	7.514D-02	1.090D+00	2.321D+00	4.839D+0

Table 3.5.9 Cont.

region =		3	3	3	3	3	3	3	3
drinner (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=		1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
dheighto (in)=		0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
symmetry =		1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-3.082D-05	-6.165D-05	-1.542D-04	-3.088D-04	-6.191D-04	-1.559D-03	-2.192D-03	-3.153D-03
1	0.000D+00	-4.244D-01	-8.492D-01	-2.124D+00	-4.253D+00	-8.527D+00	-2.147D+01	-3.019D+01	-4.340D+01
2	-2.840D+01	-3.351D-01	-6.702D-01	-1.677D+00	-3.357D+00	-6.731D+00	-1.694D+01	-2.381D+01	-3.423D+01
3	0.000D+00	-2.320D-01	-4.641D-01	-1.161D+00	-2.325D+00	-4.660D+00	-1.172D+01	-1.647D+01	-2.366D+01
4	4.164D+01	-1.503D-01	-3.006D-01	-7.526D-01	-1.507D+00	-3.020D+00	-7.594D+00	-1.067D+01	-1.529D+01
5	0.000D+00	-9.854D-02	-1.971D-01	-4.933D-01	-9.875D-01	-1.979D+00	-4.974D+00	-6.979D+00	-9.991D+00
6	-5.591D-01	-6.559D-02	-1.312D-01	-3.283D-01	-6.572D-01	-1.317D+00	-3.307D+00	-4.636D+00	-6.622D+00
7	0.000D+00	-4.460D-02	-8.924D-02	-2.233D-01	-4.470D-01	-8.956D-01	-2.246D+00	-3.146D+00	-4.483D+00
8	1.268D+01	-3.085D-02	-6.173D-02	-1.544D-01	-3.092D-01	-6.194D-01	-1.552D+00	-2.170D+00	-3.084D+00
9	0.000D+00	-2.163D-02	-4.326D-02	-1.082D-01	-2.167D-01	-4.340D-01	-1.086D+00	-1.516D+00	-2.148D+00
10	5.121D+01	-1.532D-02	-3.065D-02	-7.667D-02	-1.535D-01	-3.073D-01	-7.681D-01	-1.071D+00	-1.511D+00
11	0.000D+00	-1.095D-02	-2.191D-02	-5.481D-02	-1.097D-01	-2.197D-01	-5.480D-01	-7.625D-01	-1.072D+00
12	1.029D+02	-7.888D-03	-1.578D-02	-3.947D-02	-7.898D-02	-1.581D-01	-3.938D-01	-5.471D-01	-7.661D-01

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	-6.927D-05	-1.385D-04	-3.459D-04	-6.908D-04	-1.378D-03	-3.413D-03	-4.748D-03	-6.719D-03
1	0.000D+00	-5.328D-01	-1.065D+00	-2.658D+00	-5.298D+00	-1.053D+01	-2.585D+01	-3.573D+01	-5.003D+01
2	0.000D+00	-2.176D-01	-4.346D-01	-1.082D+00	-2.151D+00	-4.242D+00	-1.015D+01	-1.380D+01	-1.880D+01
3	0.000D+00	-5.472D-02	-1.090D-01	-2.689D-01	-5.262D-01	-1.005D+00	-2.159D+00	-2.689D+00	-3.121D+00
4	0.000D+00	-2.374D-02	-4.711D-02	-1.151D-01	-2.210D-01	-4.052D-01	-7.354D-01	-7.684D-01	-5.349D-01
5	0.000D+00	-1.172D-02	-2.315D-02	-5.577D-02	-1.045D-01	-1.807D-01	-2.380D-01	-1.325D-01	2.423D-01
6	0.000D+00	-6.614D-03	-1.301D-02	-3.090D-02	-5.637D-02	-9.092D-02	-6.271D-02	6.655D-02	4.259D-01
7	0.000D+00	-3.841D-03	-7.516D-03	-1.753D-02	-3.087D-02	-4.489D-02	1.475D-02	1.395D-01	4.531D-01
8	0.000D+00	-2.264D-03	-4.439D-03	-1.012D-02	-1.700D-02	-2.095D-02	4.583D-02	1.558D-01	4.178D-01
9	0.000D+00	-1.390D-03	-2.680D-03	-5.943D-03	-9.365D-03	-8.617D-03	5.453D-02	1.472D-01	3.605D-01
10	0.000D+00	-8.671D-04	-1.656D-03	-3.555D-03	-5.148D-03	-2.442D-03	5.293D-02	1.289D-01	3.000D-01
11	0.000D+00	-5.529D-04	-1.045D-03	-2.155D-03	-2.788D-03	5.318D-04	4.716D-02	1.065D-01	2.441D-01
12	0.000D+00	-3.586D-04	-6.698D-04	-1.320D-03	-1.453D-03	1.845D-03	4.022D-02	8.914D-02	1.961D-01

Table 3.5.9 Cont.

region =	1	1	1	1	1	1	1	1
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-7.382D-07	-1.476D-06	-3.687D-06	-7.364D-06	-1.469D-05	-3.643D-05	-5.072D-05	-7.188D-05
1	0.000D+00	2.197D-03	4.393D-03	1.097D-02	2.191D-02	4.370D-02	1.083D-01	1.508D-01	2.136D-01
2	-2.840D+01	5.427D-03	1.085D-02	2.708D-02	5.409D-02	1.078D-01	2.664D-01	3.704D-01	5.239D-01
3	0.000D+00	-6.695D-04	-1.340D-03	-3.361D-03	-6.751D-03	-1.360D-02	-3.417D-02	-4.746D-02	-6.592D-02
4	4.164D+01	-3.653D-03	-7.309D-03	-1.830D-02	-3.666D-02	-7.346D-02	-1.821D-01	-2.507D-01	-3.441D-01
5	0.000D+00	-7.726D-03	-1.547D-02	-3.882D-02	-7.802D-02	-1.571D-01	-3.904D-01	-5.328D-01	-7.113D-01
6	-5.591D-01	-2.416D-02	-4.843D-02	-1.215D-01	-2.444D-01	-4.923D-01	-1.223D+00	-1.665D+00	-2.210D+00
7	0.000D+00	-7.120D-02	-1.426D-01	-3.576D-01	-7.190D-01	-1.447D+00	-3.589D+00	-4.885D+00	-6.475D+00
8	1.268D+01	-1.818D-01	-3.640D-01	-9.130D-01	-1.835D+00	-3.690D+00	-9.131D+00	-1.242D+01	-1.644D+01
9	0.000D+00	-4.107D-01	-8.221D-01	-2.062D+00	-4.143D+00	-8.326D+00	-2.057D+01	-2.795D+01	-3.693D+01
10	5.121D+01	-8.344D-01	-1.670D+00	-4.188D+00	-8.412D+00	-1.690D+01	-4.167D+01	-5.654D+01	-7.460D+01
11	0.000D+00	-1.540D+00	-3.083D+00	-7.729D+00	-1.552D+01	-3.116D+01	-7.670D+01	-1.039D+02	-1.369D+02
12	1.029D+02	-2.603D+00	-5.211D+00	-1.306D+01	-2.622D+01	-5.261D+01	-1.293D+02	-1.750D+02	-2.300D+02

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	4.055D-06	8.110D-06	2.028D-05	4.057D-05	8.118D-05	2.033D-04	2.848D-04	4.075D-04
1	0.000D+00	1.700D-02	3.399D-02	8.492D-02	1.698D-01	3.389D-01	8.430D-01	1.176D+00	1.672D+00
2	0.000D+00	-3.132D-03	-6.263D-03	-1.563D-02	-3.119D-02	-6.211D-02	-1.531D-01	-2.124D-01	-2.993D-01
3	0.000D+00	-3.643D-03	-7.277D-03	-1.8[illegible]3D-02	-3.605D-02	-7.125D-02	-1.718D-01	-2.349D-01	-3.244D-01
4	0.000D+00	6.379D-04	1.302D-03	3.458D-03	7.586D-03	1.787D-02	6.458D-02	1.080D-01	1.883D-01
5	0.000D+00	-1.003D-03	-1.896D-03	-3.945D-03	-5.208D-03	3.117D-04	7.985D-02	1.816D-01	3.946D-01
6	0.000D+00	-6.808D-03	-1.326D-02	-3.045D-02	-5.193D-02	-6.795D-02	9.448D-02	3.653D-01	9.723D-01
7	0.000D+00	-1.871D-02	-3.640D-02	-8.333D-02	-1.412D-01	-1.804D-01	2.981D-01	1.077D+00	2.810D+00
8	0.000D+00	-4.358D-02	-8.464D-02	-1.926D-01	-3.220D-01	-3.912D-01	8.758D-01	2.855D+00	7.212D+00
9	0.000D+00	-9.093D-02	-1.764D-01	-3.991D-01	-6.589D-01	-7.609D-01	2.174D+00	6.614D+00	1.631D+01
10	0.000D+00	-1.706D-01	-3.302D-01	-7.425D-01	-1.209D+00	-1.316D+00	4.770D+00	1.372D+01	3.313D+01
11	0.000D+00	-2.897D-01	-5.594D-01	-1.249D+00	-2.002D+00	-2.021D+00	9.418D+00	2.581D+01	6.104D+01
12	0.000D+00	-4.488D-01	-8.651D-01	-1.917D+00	-3.013D+00	-2.760D+00	1.691D+01	4.440D+01	1.030D+02

Table 3.5.9 Cont.

region =	2	2	2	2	2	2	2	2
drinner (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
drouter (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighti (in)=	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00	0.000D+00
dheighto (in)=	1.000D-03	2.000D-03	5.000D-03	1.000D-02	2.000D-02	5.000D-02	7.000D-02	1.000D-01
symmetry =	1	1	1	1	1	1	1	1

n	bideal	db	db	db	db	db	db	db	db
0	1.000D+00	-3.673D-06	-7.345D-06	-1.835D-05	-3.665D-05	-7.314D-05	-1.816D-04	-2.530D-04	-3.589D-04
1	0.000D+00	-5.689D-03	-1.137D-02	-2.840D-02	-5.667D-02	-1.129D-01	-2.787D-01	-3.869D-01	-5.460D-01
2	-2.840D+01	2.023D-02	4.044D-02	1.010D-01	2.017D-01	4.023D-01	9.974D-01	1.389D+00	1.967D+00
3	0.000D+00	7.578D-03	1.515D-02	3.781D-02	7.546D-02	1.502D-01	3.703D-01	5.137D-01	7.239D-01
4	4.164D+01	-3.227D-03	-6.454D-03	-1.612D-02	-3.221D-02	-6.432D-02	-1.598D-01	-2.226D-01	-3.157D-01
5	0.000D+00	-3.843D-03	-7.682D-03	-1.918D-02	-3.831D-02	-7.632D-02	-1.885D-01	-2.614D-01	-3.676D-01
6	-5.591D-01	-1.231D-03	-2.463D-03	-6.173D-03	-1.237D-02	-2.482D-02	-6.174D-02	-8.512D-02	-1.168D-01
7	0.000D+00	-1.091D-03	-2.189D-03	-5.530D-03	-1.124D-02	-2.306D-02	-5.932D-02	-8.167D-02	-1.078D-01
8	1.268D+01	-4.136D-03	-8.291D-03	-2.086D-02	-4.214D-02	-8.564D-02	-2.173D-01	-2.998D-01	-4.036D-01
9	0.000D+00	-1.042D-02	-2.087D-02	-5.248D-02	-1.058D-01	-2.144D-01	-5.417D-01	-7.467D-01	-1.006D+00
10	5.121D+01	-2.141D-02	-4.289D-02	-1.078D-01	-2.173D-01	-4.401D-01	-1.109D+00	-1.527D+00	-2.058D+00
11	0.000D+00	-3.953D-02	-7.918D-02	-1.990D-01	-4.010D-01	-8.115D-01	-2.043D+00	-2.809D+00	-3.778D+00
12	1.029D+02	-6.698D-02	-1.342D-01	-3.371D-01	-6.792D-01	-1.374D+00	-3.451D+00	-4.740D+00	-6.366D+00

n	aideal	da	da	da	da	da	da	da	da
0	0.000D+00	1.349D-05	2.699D-05	6.749D-05	1.350D-04	2.703D-04	6.773D-04	9.496D-04	1.360D-03
1	0.000D+00	8.395D-02	1.679D-01	4.194D-01	8.382D-01	1.674D+00	4.167D+00	5.817D+00	8.272D+00
2	0.000D+00	3.516D-03	7.028D-03	1.753D-02	3.491D-02	6.927D-02	1.691D-01	2.329D-01	3.251D-01
3	0.000D+00	-1.670D-02	-3.338D-02	-8.339D-02	-1.665D-01	-3.322D-01	-8.236D-01	-1.147D+00	-1.625D+00
4	0.000D+00	-3.100D-03	-6.196D-03	-1.545D-02	-3.075D-02	-6.091D-02	-1.481D-01	-2.035D-01	-2.828D-01
5	0.000D+00	2.954D-03	5.909D-03	1.478D-02	2.959D-02	5.930D-02	1.492D-01	2.098D-01	3.011D-01
6	0.000D+00	1.684D-03	3.376D-03	8.497D-03	1.718D-02	3.512D-02	9.361D-02	1.363D-01	2.052D-01
7	0.000D+00	-8.084D-04	-1.589D-03	-3.767D-03	-6.842D-03	-1.089D-02	-6.085D-03	1.071D-02	5.364D-02
8	0.000D+00	-2.461D-03	-4.852D-03	-1.161D-02	-2.145D-02	-3.579D-02	-3.585D-02	-1.519D-03	9.477D-02
9	0.000D+00	-4.437D-03	-8.722D-03	-2.065D-02	-3.741D-02	-5.917D-02	-3.016D-02	6.447D-02	3.042D-01
10	0.000D+00	-8.102D-03	-1.590D-02	-3.745D-02	-6.720D-02	-1.033D-01	-2.508D-02	1.759D-01	6.696D-01
11	0.000D+00	-1.411D-02	-2.767D-02	-6.503D-02	-1.161D-01	-1.762D-01	-1.990D-02	3.517D-01	1.254D+00
12	0.000D+00	-2.257D-02	-4.423D-02	-1.037D-01	-1.844D-01	-2.761D-01	4.452D-03	6.318D-01	2.138D+00

Table 3.5.9 Cont.

Strand dia.	in.	.0437	.0208	.0560	.0281	.1119	.0560	.0536	.0268	.064	.032
No. of filaments	-	2072	→								
Filament dia.	μ	14.5	6.9	18.6	9.3	37.1	18.6				
Cable twist pitch	in.	5.0	4.8	6.4	6.4	6.4	6.4				
" width	in.	.500	.474	.638	.641	.638	.638	(.611)	.676	.547	.608
" thickness	in.	.0803	.0378	.1008	.0506	.2014	.1008	.096	.058	.115	.058
Insulation thickness											
Kapton	in.	.002	→								
Epoxy-glass	in.	.005	.003	.005	.003	.005	.005	.005	.003	.005	.003
Total (after cure)	in.	.006	.0043	.006	.0043	.006	.006	.006	.0043	.006	.0043
O.A. width	in.	.512	.483	.650	.650	.650	.650	(.623)	.685	.559	.617
O.A. thickness	in.	.0923	.0464	.1128	.0592	.2134	.1128	.108	.067	.127	.667
No. of turns	-	64	128	92		48		84		82	
I oper	A	9051	4526	6296		12068		6896		7064	
I crit.(4.5 K 5T) *1	A	13128	6207	21599	11328	44911	22497		10304		11936
% of crit.	-	69%	73%	29%	56%	27%	54%		67%		59%

*1 = I crit (4.5 K, 5T) ≅ 0.9 I spec. (4.2 K, 5T)

3.6.2 ISABELLE RUTHERFORD CABLE OPTIONS

Crit. Current Density in Wire	A/cm^2	← 62896 →	← 57729 →		
Crit. Current Density in Filament	A/mm^2	← 1472 →	← 1853 →		
Cond. Env. Area		.3537	.3515	.3368	.3074
Wire Area	cm^2	← .01167 →	← .01318 →		

3.7.2 DESIGN A4

Considerable effort has been made in developing design A4, Variation I, the preferred variation, which is shown in Fig. 3.7.4, left side. The design parameters are listed in Table 3.7.2.

TABLE 3.7.2

WINDING DESIGN PARAMETERS - DESIGN A4

Winding inside diameter		5.155 in.
Winding build		~ 0.65 in.
No. of "blocks" per quadrant		3
No. of turns, total		66
Design current		10.5 kA
Ampere turns		6.93×10^5
Turn-to-turn insulation thickness		0.006 in.
Coil-to-ground insulation thickness		
Conductor wrap	0.003	
Perforated sheet	<u>0.030</u>	
		0.033 in.
LHe in winding, percent of conductor by volume (including spiral wrap gaps)		2.7%
Winding prestress, circumferential, at room temperature		2 ksi
Winding prestress, circumferential at 4.2 K		~ 2 ksi
Prestress in bands, 4.2 K		42 ksi
Tension stress in substructure after cool-down, 0 current		~ 16.8 ksi
Tension force, 4.2 K, 0 current		~ 65,000 lbs.

<u>Note</u>: Tension force at full current will be only *slightly* higher, because superstructure is *very stiff.* Relative motion between windings and substructure in axial direction will be *minimal*

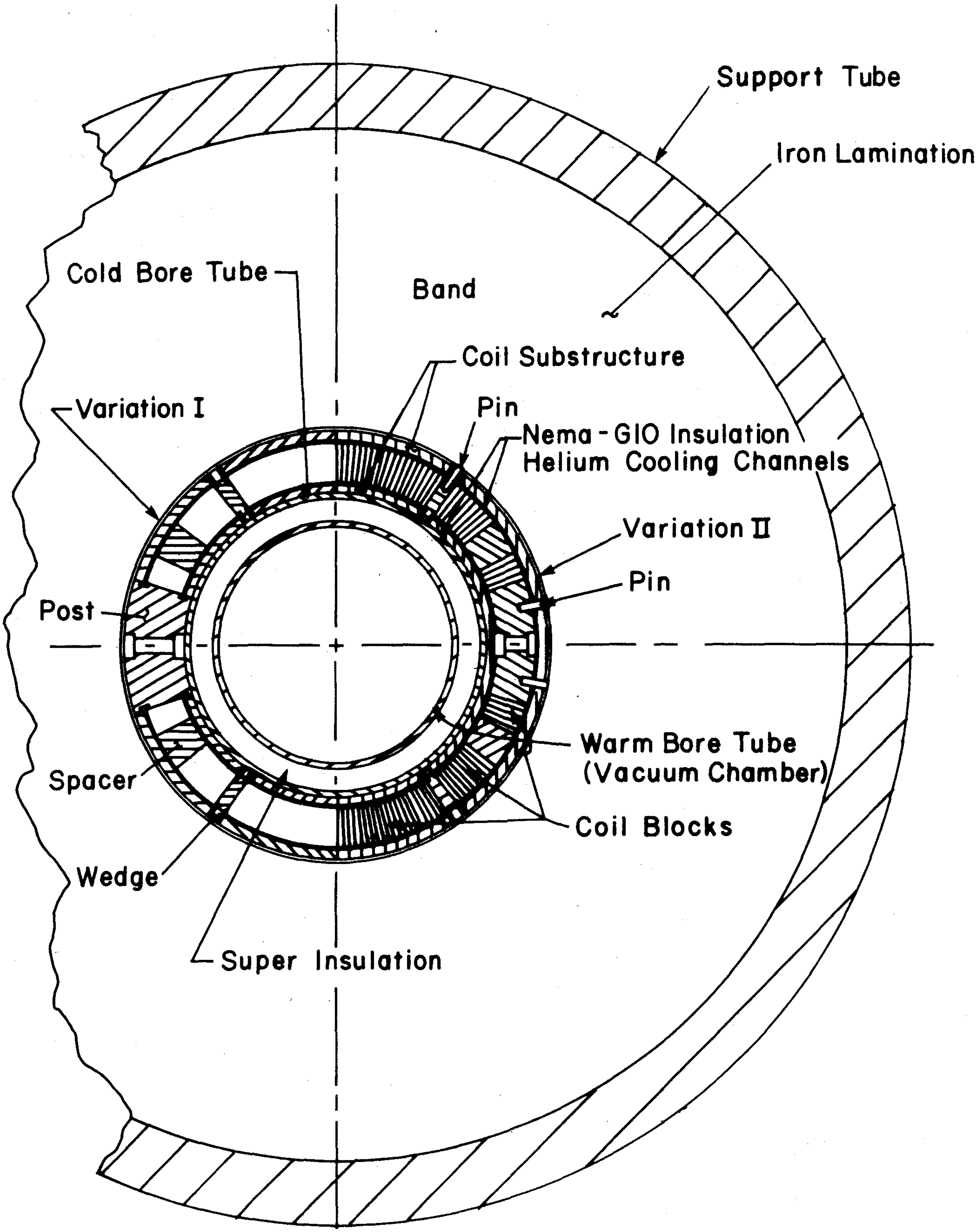

Fig. 3.7.4 Alternative Design A4. Three-Block Winding with Banded Substructure. Variation I (left side) has Post and Wedge Butted to Substructure. Variation II (right side) has Post and Wedge Pinned to Substructure.

3.7.2.1 Winding

The winding is a single-layer, 3-block design using Rutherford cable conductor about 0.65 in. wide, (Ref. Sect. 3.6) 33 turns per half. It is the same winding as described in a BNL (R. Rau) memorandum of April 14, 1981.

The conductor is keystoned and insulated with a closed wrap of double-butted mylar or kapton plus an open wrap of B-stage fiberglass epoxy (0.375 in. wide, 0.100 in. gap). Total insulation thickness is 0.003 in.

The winding is made in a winding fixture, (similar to that suggested for the 5 Block design shown in Fig. 3.7.6 of Section 3.7.5) with centerpost, fillers, wedges and end-turn crescents installed during winding. Curing takes place in two steps in the fixture. The substructure shells are added after the winding is completed and removed from the fixture. The detailed manufacturing procedure is presented in Section 3.7.4.

3.7.2.2 Substructure

The substructure consists of centerposts, wedges, end-turn crescents, inner and outer shells and bands, all of austenitic stainless steel. These parts are precision-machined so they fit together along the straight section of the magnet as shown in the cross-sectional sketch, Fig. 3.7.4.

The shells are continuous for the full length of the magnet. They are fastened to the end-turn crescents with pins, so that the ends of the coils are contained and do not move relative to the shells when longitudinal magnetic forces act on the end turns.

The centerposts, wedges and crescents are wound into the coils, using a full-length fixture. The shells are installed later, and bands are shrunk around the assembly to clamp the shells and coils together into a rigid system, with coils precompressed circumferentially. Note that each winding region is supported individually. This azimuthal mechanical regionalization reduces the required azimuthal compressive prestress to ~ 2 ksi.

3.7.2.3 Superstructure (Laminated Steel Flux Path)

The superstructure consists of steel laminations pressed into steel pipe, extending the full length of the coils. The superstructure is shrunk on, over the coil and substructure assembly.

Shoulder rings are welded to the substructure which projects slightly beyond the laminations at each end. These rings, bearing against the ends of the stack of laminations, control lengths during cool-down so that the coil and substructure go into pretension and do *not* shorten relative to the superstructure due to differential contraction.

3.7.2.4 Trim Coils

Space is provided for trim coils radially inward from the main coils. They could be placed in slots in the substructure inner shells, or in a separate cylindrical shell concentric with the substructure inner shells. Trim coil design was not completed.

3.7.2.5 Other Components

The vacuum jacket, warm bore tube, thermal shielding and low-heat-leak support system were not designed.

3.7.2.6 Prestress and Shrink Fits

Results of preliminary calculations are:

(1)	Reduction of mean diameter of winding needed to obtain 2 ksi prestress*	=	0.005 in.
(2)	Circumferential force	=	1300 lbs/in.
(3)	Prestress in band for 2 ksi in winding	=	32.5 ksi
(4)	Design prestress in band (29% margin)	=	42 ksi
(5)	Design I.D. of band, room temperature unstressed (~ 0.008 interference)	<	6.7947 in.
(6)	I.D. of band, assembled	=	6.805 in.
(7)	Temp. of band, heated	>	650 F
(8)	Design I.D. of laminations, r.t. (0.005 interference)	=	6.880 in.
(9)	Temp. of laminations, heated	>	500 F
(10)	Winding prestress, cold (4.2 K)	~	2 ksi

*at room temperature

3.7.3 DESIGNS A5 AND A6

The winding design parameters for designs A5 and A6 are listed in Table 3.7.3.

Table 3.7.3

Winding Design Parameters, Designs A5 and A6

	Design A5	Design A6
Winding inside diameter (in.)	5.155	~ 5.5
Winding build (in.)	0.512	0.512
No. of "blocks" per quadrant	3	3
No. of turns, total	66	66

Design A5, shown in cross-sectional layout, Fig. 3.7.5, has a continuous cylindrical inner shell approximately 0.20 in. thick (instead of the segmented type of inner shell used on the earlier designs). The outer shell is omitted and the superstructure laminations are extended inward to support the outer (insulated) surface of the windings directly. Center posts and wedges are keyed into the laminations to ensure accurate circumferential positioning of the winding blocks. The laminations are split into quadrants.

Precompression of the windings is achieved during final assembly by forcing the lamination quadrants inward against the outside diameter of the windings using a special fixture. The outside steel pipe is then installed over the laminations with a shrink fit.

Design A6 is the same as design A5 except that the I.D. and O.D. of the windings are increased to utilize the full inside diameter of the laminations (superstructure) that was available in designs A1 through A4. Design A6 provides a larger bore than any of the other alternative designs, while retaining the same flux return path cross section as designs A1 though A4.

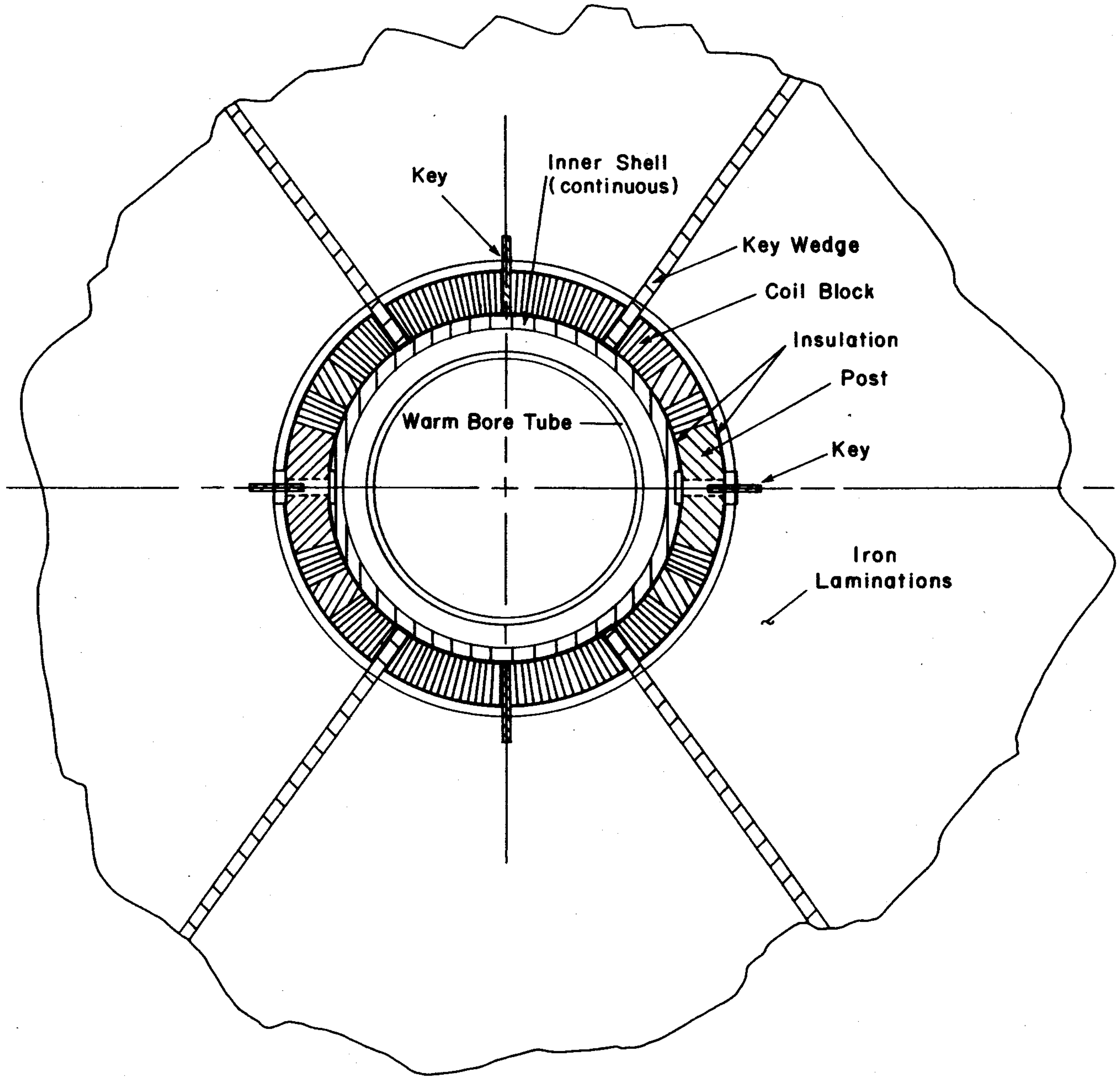

Fig. 3.7.5 Alternative Design A5. Three-Block Winding with Continuous Inner Shell and with Laminations Extended Inward to Support Windings Directly (Outer Shell Omitted)

3.7.4 MANUFACTURING

3.7.4.1 Conductor

Airco can make Rutherford cable (32 to 8 strand), in its own facility. Delivery of a sample amount would be expected in approximately 6 weeks, following placement of order if BNL stock is used.

The conductor used in design A4 is Rutherford cable approximately 0.65 in wide by 0.084 in thick, which can be made with either BNL or FNAL wire which is described in Section 3.6, Table 3.6.1.

3.7.4.2 Substructure Machining

Ideally, shells would be made by slicing sections of pipe (overthick) and then machining all over in long-bed lathes, using grinding heads.

3.7.4.3 Coil Winding and Assembly

The manufacturing procedure will be generally similar to that for design A3, described in Section 3.7.5. Consideration should be given to winding coils (blocks) separately and making interconnecting splices in the end turn region.

3.7.4.4 Alternative Design A4 Layout Drawings

Figure 3.7.4 shows a layout of the midplane cross section. Details of vacuum jacket, power leads at ends, etc. were not established.

3.7.5 MANUFACTURING PROCEDURE FOR DESIGN A3

Design A3 is a 5-block winding which uses an unwelded, banded substructure. The manufacturing sequence for this design is illustrated in Figures 3.7.6 through 3.7.15 which follow. Figure 3.7.6 shows the basic tooling. Figure 3.7.7 shows the first three blocks lateral to the centerpost completely wound. The insulation (B-stage fiberglass epoxy wrap) is then cured with pressure bars forced against the fillers and the winding guide to control the stack dimensions which are held constant throughout the cure process.

Following the first cure stage, blocks 4 and 5 are wound (Figure 3.7.8). These are located at the edges of the coil. These are then cured in a similar fashion with the pressure bars forced against the fillers and guide. The insulation under the pressure bar's wedge- shaped lower surface is omitted so that when it is added later the winding will be prestressed. Once curing is complete the guide is removed and perforated insulation is added to the inward facing surfaces of the two groups of blocks, 1-3 and 4-5 (Fig. 3.7.9). Inner shells A and B are positioned and insulation is added under the wedges. Insulation is not added on block 5. (This is done at a later stage, illustrated in Figure 3.7.11 and will provide precompression for the winding.)

Figure 3.7.10 shows the coil assembly inverted and the female winding fixture removed. Perforated insulation is then added to the external surfaces of the windings and the final shells are added.

Once two coil halves are wound, insulation is added to block 5. The two halves are then assembled as shown in Figure 3.7.11, with median wedges positioned, an expanding mandrel placed in its expanded state, (equal to the desired I.D. of the dipole,) and the halves clamped together using temporary external clamps. The coil is clamped to design precompression and the mandrel is collapsed for removal. Temporary clamps are then applied to hold the substructure and winding together tightly. The gaps are then measured; if they meet the design specifications, wire bands are added to hold the assembly together once the clamps are removed. The clamps are then removed and 0.040 inch thick, one foot long stainless steel bands are then shrunk on, starting in the middle and working toward the coil ends. The bands, placed contiguously along the dipole's length, precompress the windings and close gaps. These steps are shown in Figure 3.7.12 which

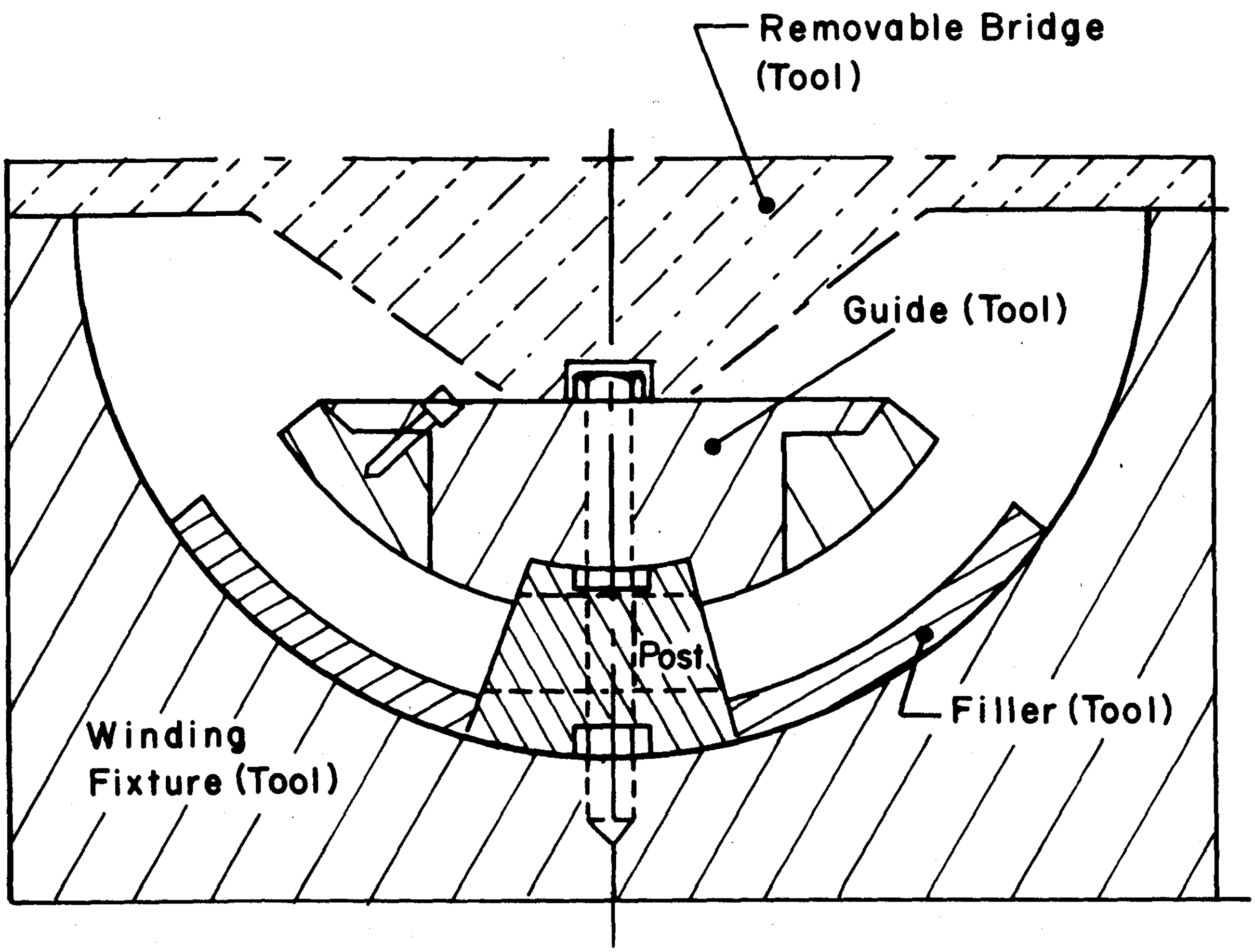

Fig. 3.7.6 Manufacturing Procedure. Basic Tooling for Starting Winding

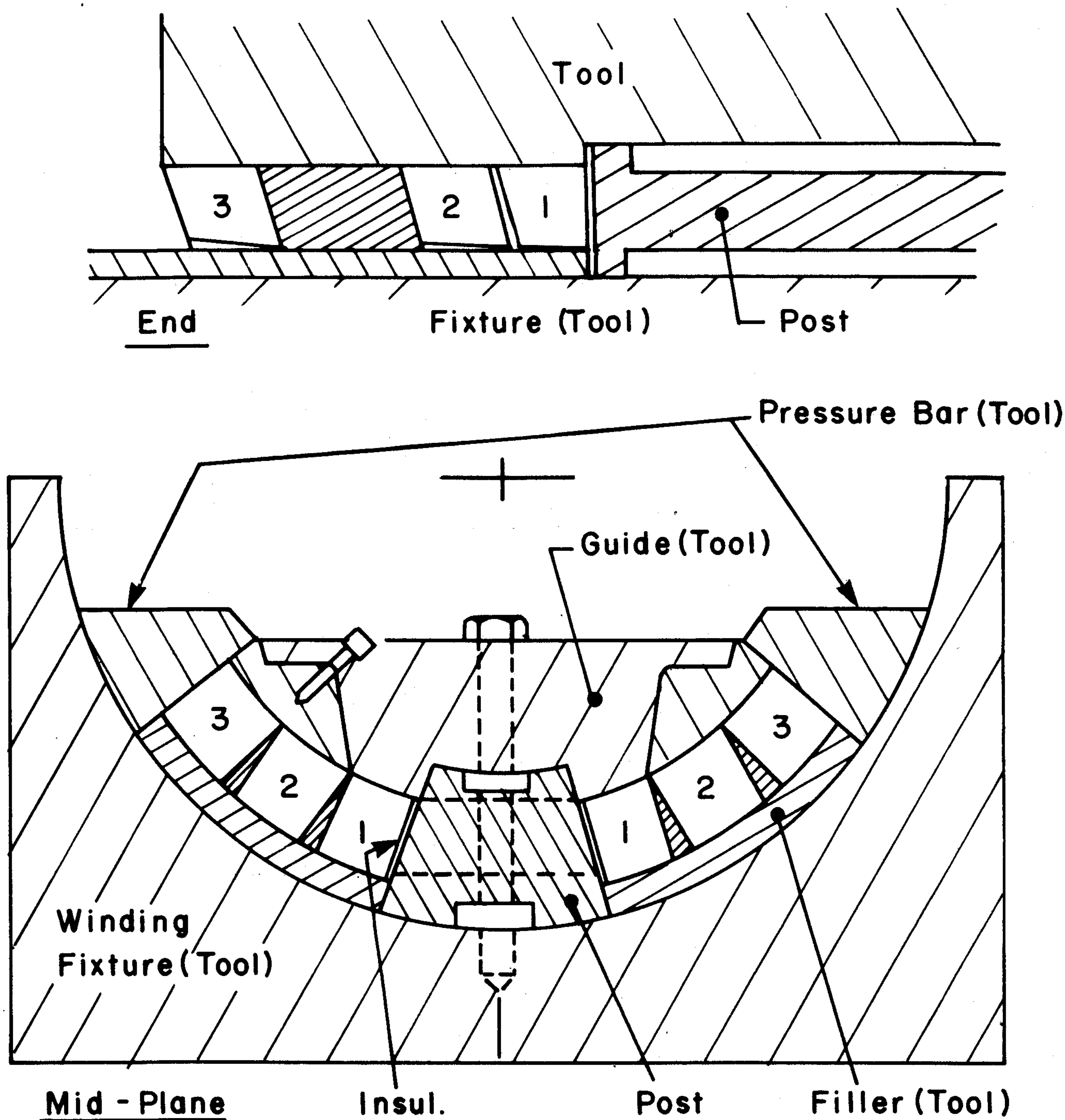

Fig. 3.7.7 Manufacturing Procedure. First Three Blocks Wound in Fixture, Cured with Pressure Bars in Place

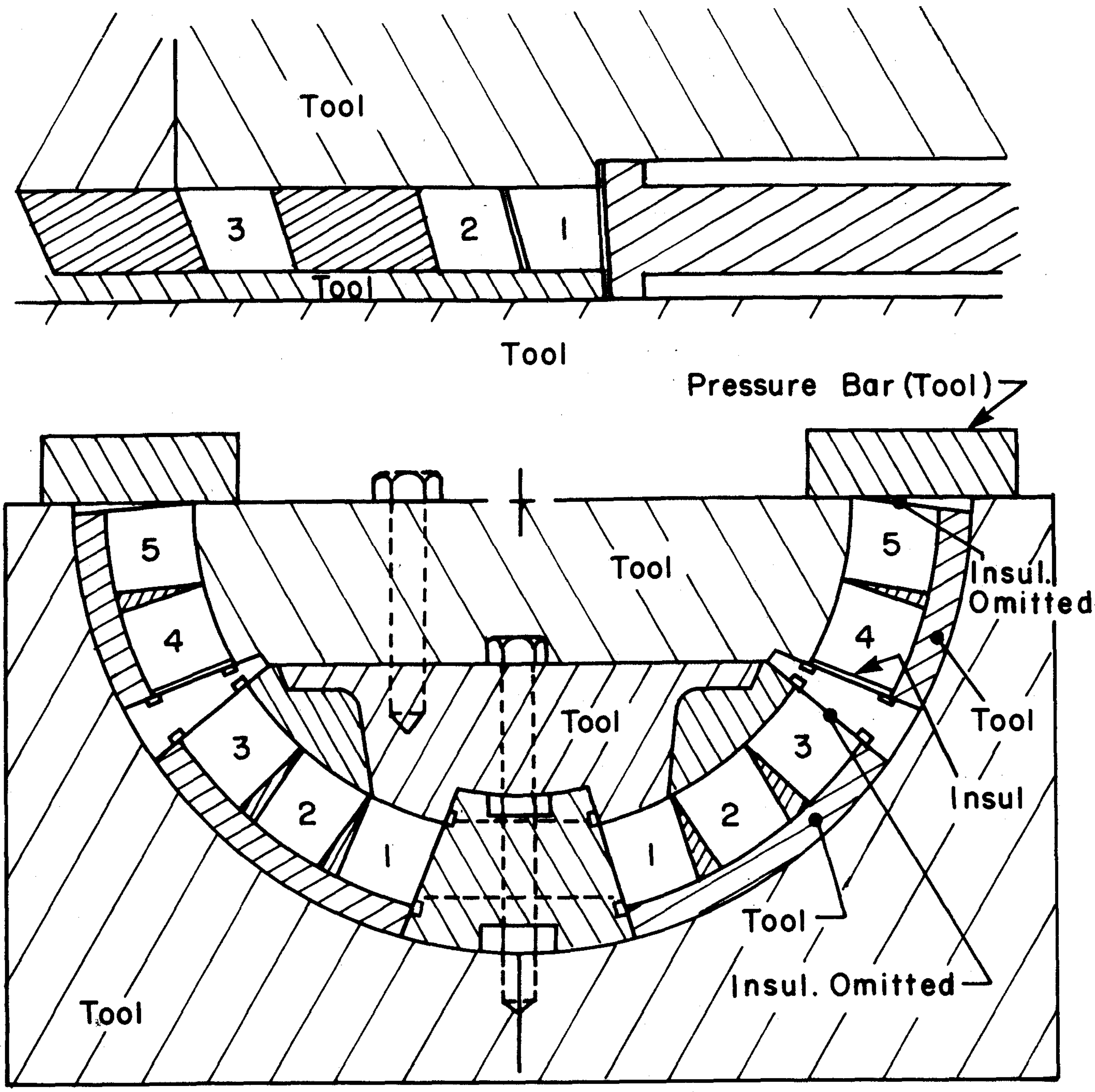

Fig. 3.7.8 Manufacturing Procedure. All Five Blocks Wound in Fixture, Second Cure with Pressure Bars in Place

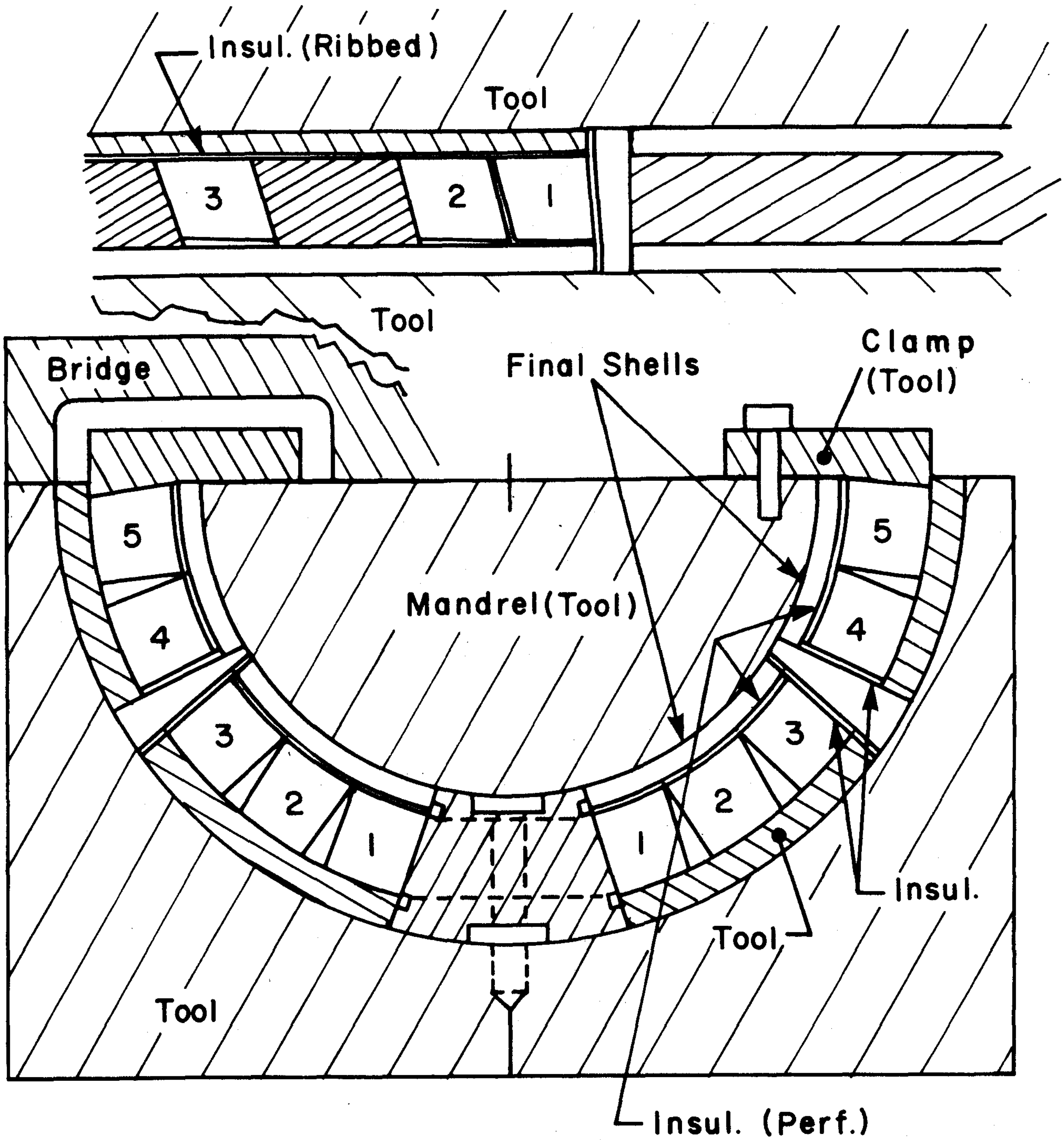

Fig. 3.7.9 Coil Half (5 Blocks) After Curing, with Inner Guide Removed, Insulation and Inner Shells Installed

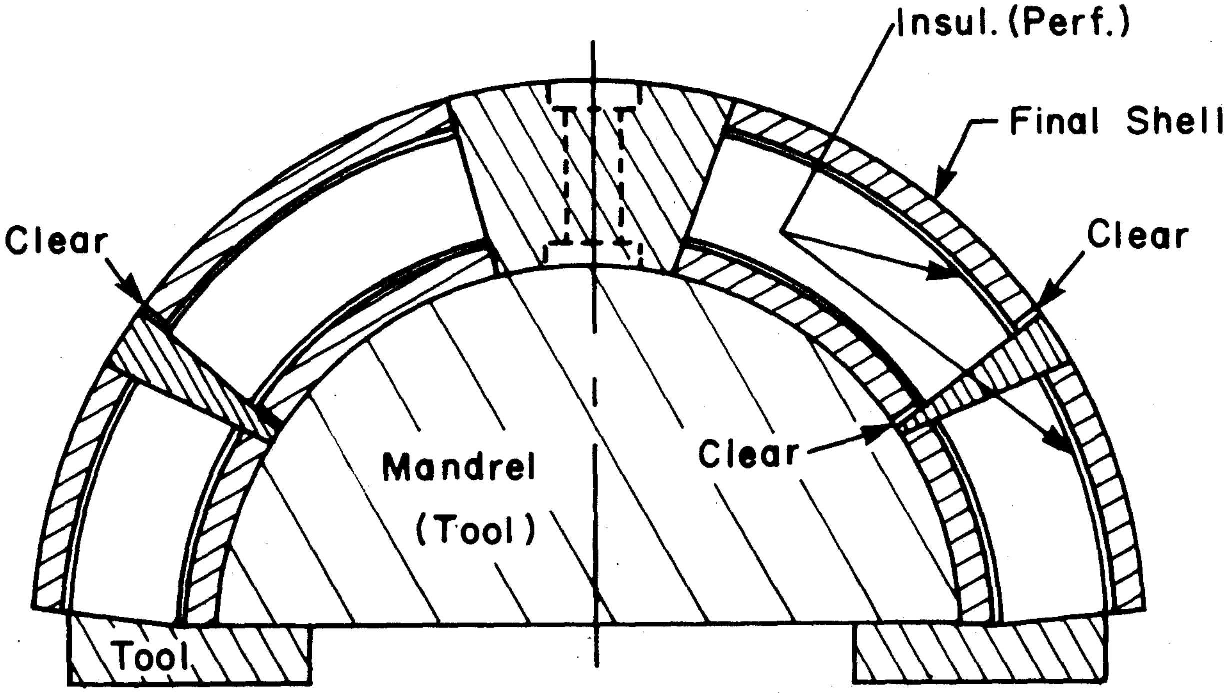

Fig. 3.7.10 Coil Half Inverted, Outer (Female) Winding Fixture Removed, Insulation and Outer Shells Installed

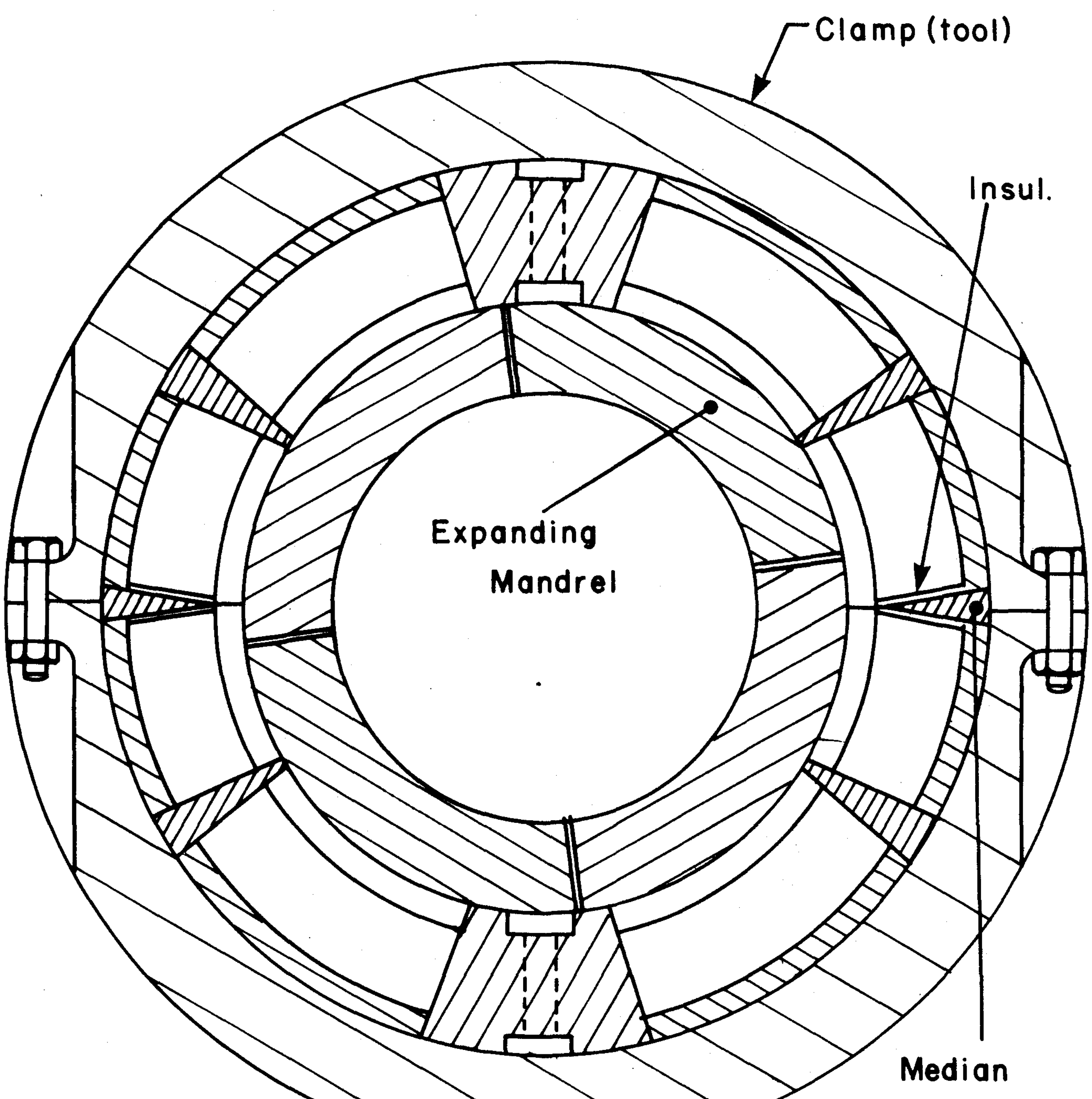

Fig. 3.7.11 Assembly of Two Coil Halves, with Expanding Mandrel Inside and Temporary Clamps Around Outside

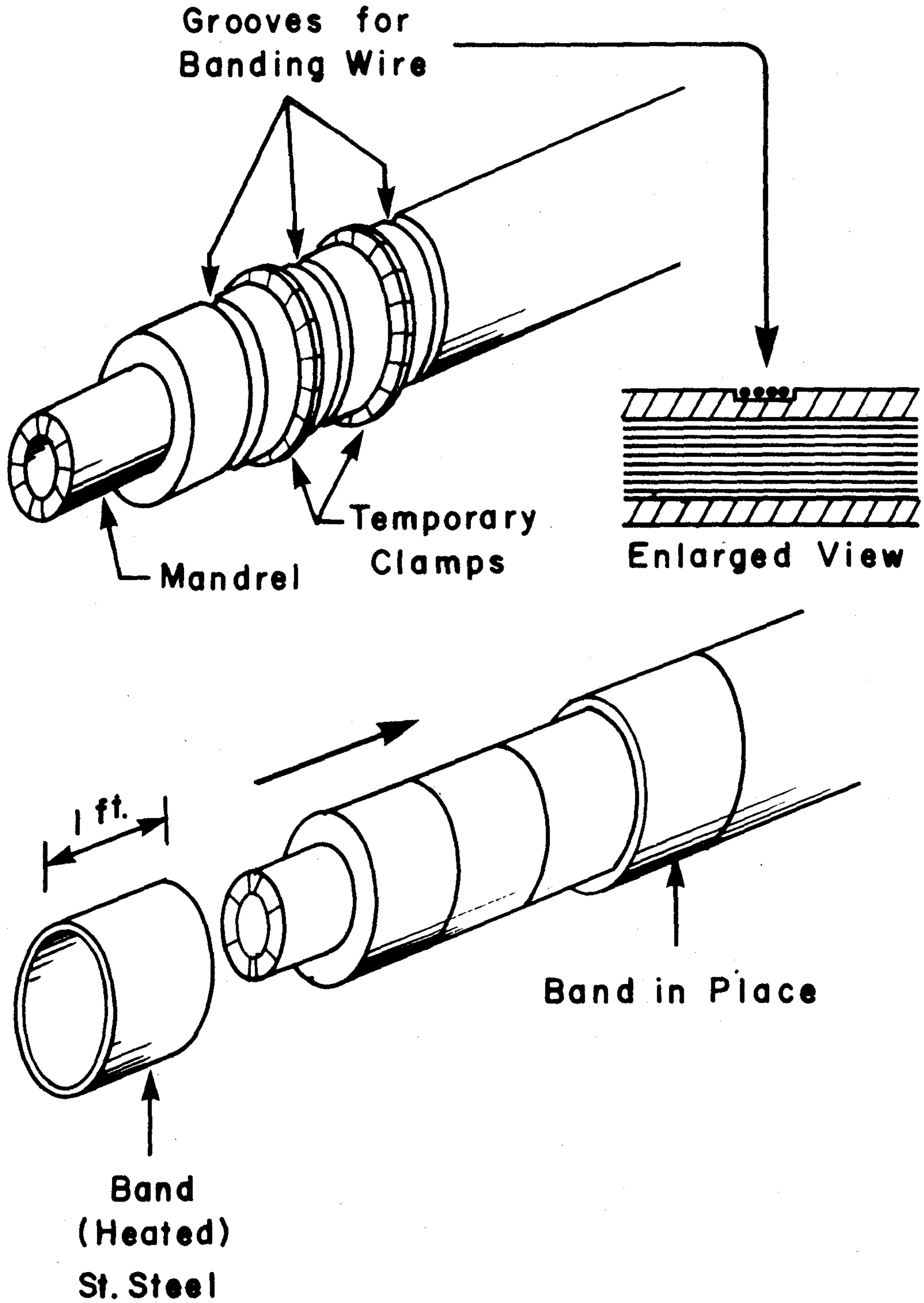

Fig. 3.7.12 Assembly with Final Banding. Upper View Shows Wire Bands Added. Lower View Shows Temporary Clamps Removed and Stainless Steel Bands Being Shrunk On.

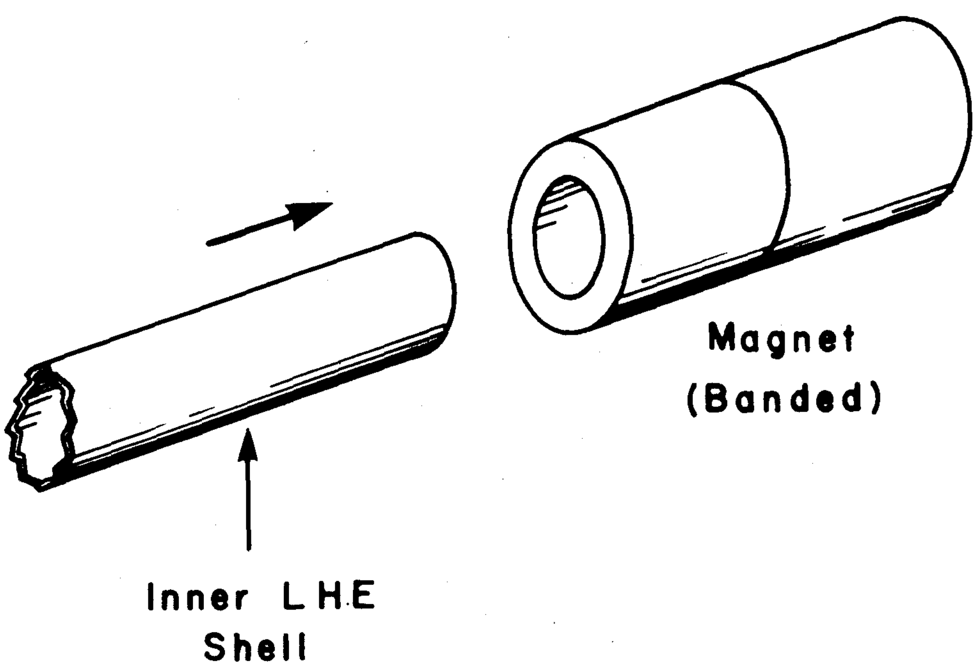

Fig. 3.7.13 Banded Magnet Assembly with Inner Liquid Helium Shell Being Installed

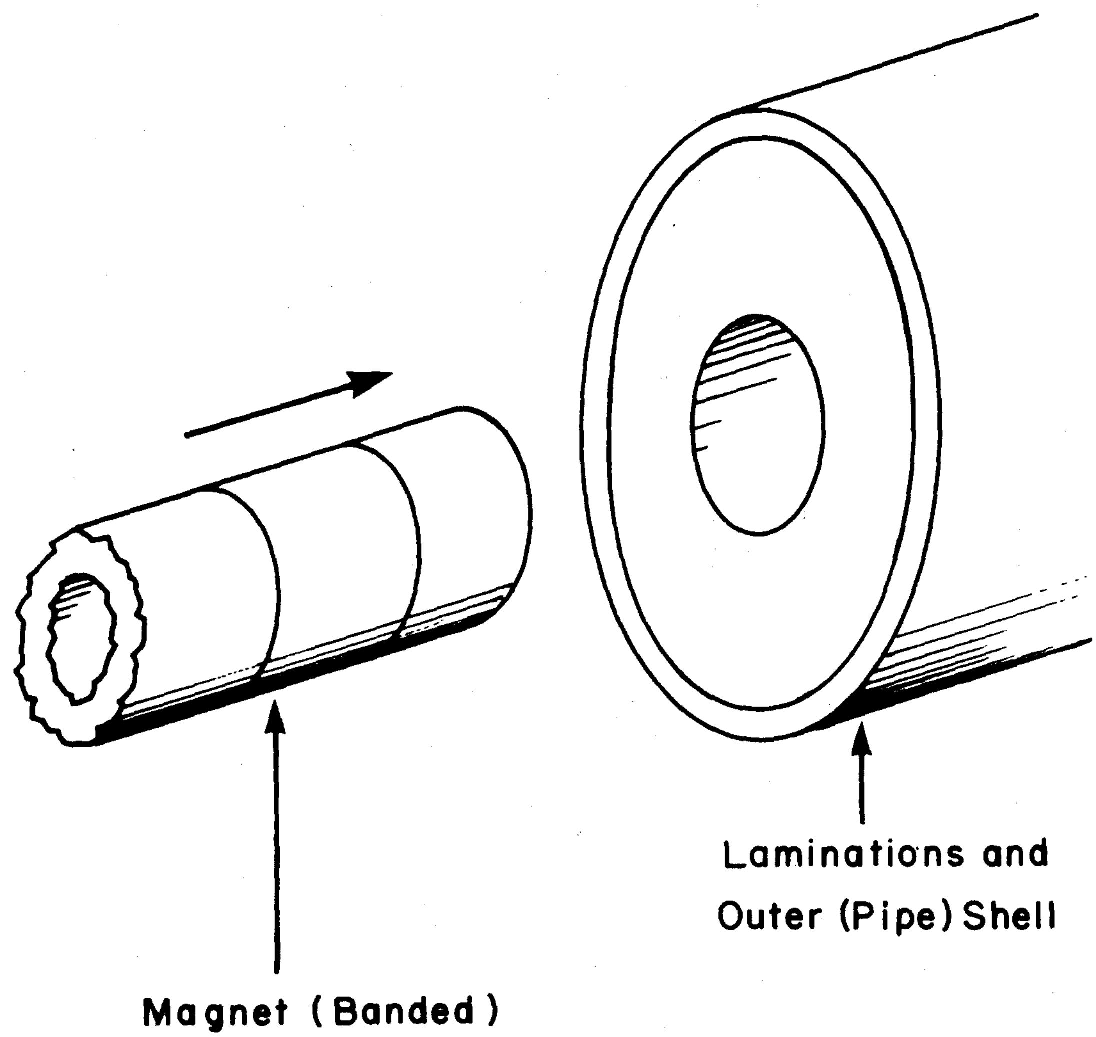

Fig. 3.7.14 Magnet Assembly and Inner Shell Being Installed in Laminations and Outer (Pipe) Shell.

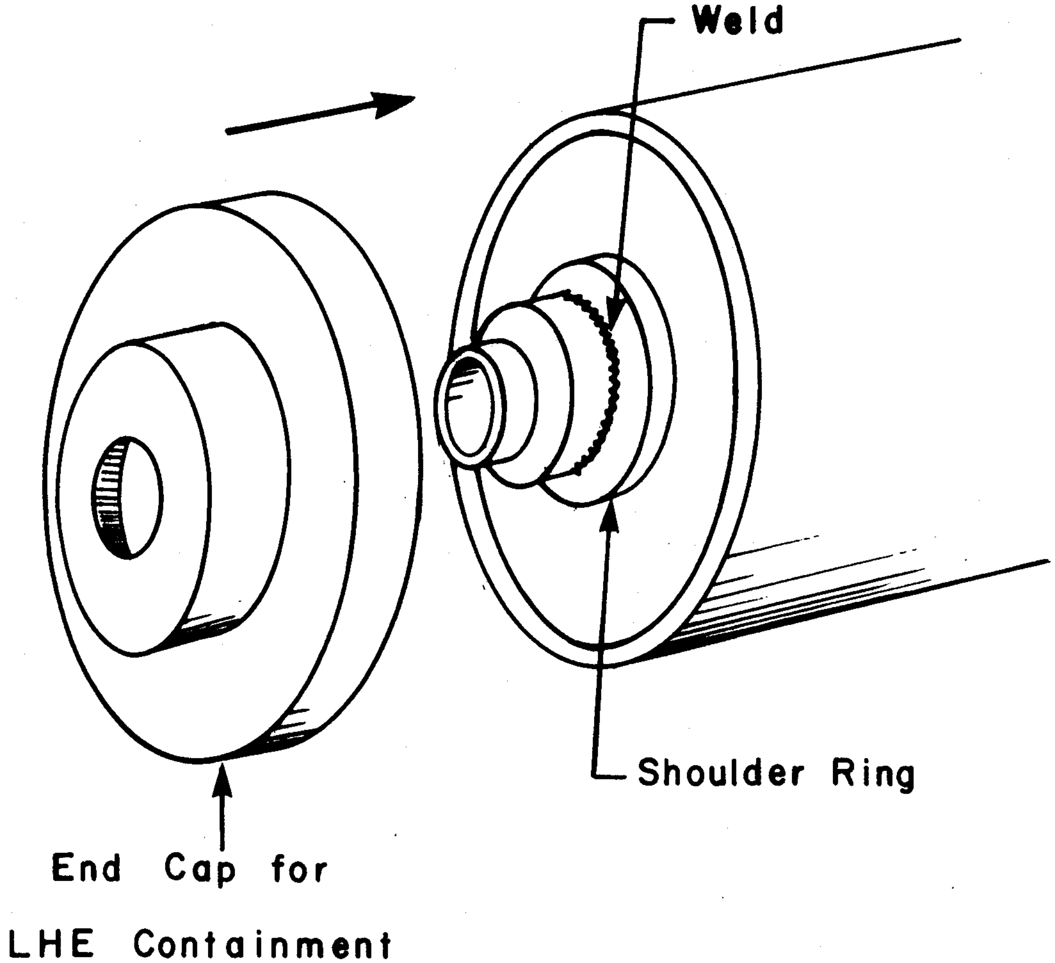

Fig. 3.7.15 Magnet, Laminations and Outer Shell Assembly Showing Installation of Shoulder Ring and End Cap

also show removal of the mandrel.

Once banding is complete the inner LHe shell can be installed (Figure 3.7.13). To ensure a tight fit it may be desirable to precool the shell in LN_2 before insertion. The outer surfaces of the bands are then checked for diameter and roundness to ensure proper fit of the magnet winding in the lamination and proper assembly shown in Figure 3.7.14. The I.D. of the lamination and pipe assembly is very precise in both dimension and shape so that it will force the banded dipole into roundness if it was found to be slightly out-of-round in the preceding step. The lamination and pipe assembly is preheated prior to magnet insertion in order to obtain a shrink fit.

In the final step, Figure 3.7.15, shoulder rings are added to each end to fasten the ends of the substructure to the lamination stack. End caps are then welded into place to complete the LHe containment vessel.

3.7.6 COIL WINDING: CURE TO PRESSURE VS CURE TO SIZE TOOLING REQUIREMENTS

A few of the dominant considerations in the coil manufacturing process are raised herein; from these it is thought possible to determine the design requirements for prototype manufacturing equipment.

Field quality requirements dictate precise control of the location of each conductor in the winding composite (in the assembled magnet). In general, conductors should be within $\pm$ 0.002 in. of their prescribed azimuthal location. On a 60 turn coil this could be interpreted as a manufacturing control requirement of 0.004/60 ~ 6 $\times 10^{-5}$ in/turn (azimuthal location).

The effective thickness tolerance on the insulated conductor is approximately 5 $\times 10^{-4}$ in/turn (~ 1% and also approximately 9 times that required for the finished composite).

One would intuitively expect that the thickness variation over the length of conductor required to make a single coil would be somewhat less than that of an entire production lot. The evidence from the FNAL data base however, suggests that it may be entirely random. Conversations with Bob Meserve of New England Electric tend to confirm this. The FNAL data for the outer, 21 turn, coil shows overall height variations of approximately 10 mils and side-to-side variations, in a single coil, of 5 to 6 mils. Their experts agree, however, that the major problem is imperfect azimuthal distribution of the conductors within a winding quadrant. Adequate median plane registration would appear, from their measurements, to be achieved by mixing and matching.

It is obvious that conductor thickness tolerance is not the only factor contributing to imperfect distribution. Control of friction in the winding and assembly process is equally important. For instance, the Berkeley process, wherein azimuthal compression during winding, curing and final assembly is achieved by purely radial loading, appears to give very uniform azimuthal conductor distribution.[a] The related experience with the Palmer magnets is also relatively good. Although the total required field quality is yet to be achieved, the correlation between predictions and measurements indicate that winding (conductor) location control problems are dominantly overall dimension problems (which one can learn to control) rather than nonuniform azimuthal distribution (within the overall dimension).

Difficulty with magnet assembly (inability to measure - shim and assemble to prestress) may however, indicate adequate friction to affect field quality.

The winding process and tooling should be capable of monitoring and controlling random variation of conductor and insulation thickness. This implies essentially independent control of each side of a single coil winding. It is assumed (perhaps incorrectly) that longitudinal variations (per side) can be "averaged out."

Kaugerts has shown that the cumulative thickness tolerance (0.033 in. on a 66 turn coil) can be overcome by varying the cure pressure. Recent measurements of the variation of mechanical properties as a function of cure pressure do not indicate any severe problems relative to field quality if coils are "mixed and matched."[b]

The basic coil manufacturing process control problem is thus to develop the empirical relationship between cure pressure and coil size (size is presently defined as height at 10 ksi or H_{10}) and to establish a reference from which cure pressure can be predicted (with a minimum number of iterative cures).

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[a]Note, however, that the Berkeley technique, wherein two coil halves (360°) are radially compressed as a single unit, does not permit individual control (for each coil half) of cumulative conductor thickness tolerance build up and may thus make it impossible to achieve the required median plane registration accuracy. (Also, there is no opportunity to mix and match.)

[b]Except that it is possible that long term relaxation might be significantly influenced by cure pressure.

PROCESS REQUIREMENTS

The following discussion relates only to achievement of median plane registration; it does not address the problem of uniform conductor distribution between median plane and post.

Prestress "Window"

Prestress should be adequate to maintain contact between the winding and the "post" at maximum field. This implies a "cold" (4.2 K) prestress in the inner coil of approximately 8 ksi (the outer coil requires only approximately half that), which in turn implies a room temperature precompression of approximately 12 ksi.[a] The maximum prestress is limited by the core bolts. A reasonable upper limit would be 18 ksi (with 10 ksi in the outer coil or 14 ksi average). The inner coil prestress window is thus 15 $\pm$ 3 ksi. For coil height $\simeq$ 4 in. and $E_t \simeq 2 \times 10^6$ this implies a coil height tolerance of $\pm$ 6 mils ($H_{15} \simeq 4 \pm$ 0.006 in.).[b] This is the minimum level of dimensional control which must be achieved to avoid "shimming" each magnet at assembly. Note that this is needed to meet the "prestress window" requirements only (minimum determined by conductor-motion; maximum determined by bolt diameter which should be 1-1/8 in. for the limits recommended here). "Mixing and matching" will be required to achieve median plane registration. Although $\pm$ 6 mils would seem to be an achievable goal it is worth noting that it is a factor of two to three better than that achieved at FNAL by curing all coils to the same size.

CURE PROCESS

The following relates to the basic cure process only and does not discuss overall QA and winding details.

[a]Based on a 25 % room temperature relaxation and considering the increase in winding modulus during cooldown.

[b]This discussion specifically recommends that the nominal, warm, assembly prestress for the inner coil be 15 ksi and thus will refer to the final size of this coil as H_{15} (height at 15 ksi). We don't know that this is really required but do know that 12 ksi (minimum) prestress magnets work!

"Cure to Pressure" vs "Cure to Size"

"Cure to pressure" means that the mold never closes during the cure. H_{15} is achieved by controlling only the pressure on the coil throughout the cure cycle. The cure pressure is normally considered to be held constant but other pressure vs time profiles could prove to be more suitable. There will be considerable compressive deformation of the coil during the cure. Most of this motion occurs during the first 30 minutes.

"Cure to size" means that at some point during the cure the mold closes. This may be prior to applying heat or perhaps sometime during the first 30 minute (large deformation) portion of the cure. This process also assumes that the height of the coil in the *closed* mold can be varied by use of interchangeable "molding shims."

Thus, in the former process H_{15} is achieved by controlling the cure pressure (stress) and in the latter process it is achieved by controlling the cure size (strain).

If H_{15} is primarily influenced by the final size of the coil during cure the two processes are roughly equivalent. If the predicted behavior during cure indicated by Figure 3.7.16 is reasonably correct it is also reasonable to expect that H_{15} is independent of the time-deformation path to H_c (height of end of cure).

Time vs Deformation **(Ref. Fig. 3.7.16)**

Solid lines indicate cures at constant pressures of 5 and 10 ksi. The dotted line indicates "cure to size" initially loaded to 10 ksi but "stopped" (mold closed) at H_{c5}. The assumption of this discussion is that the final size (H_{15}) achieved with this latter process would be essentially the same as the final size of the 5 ksi "cure to pressure" process.

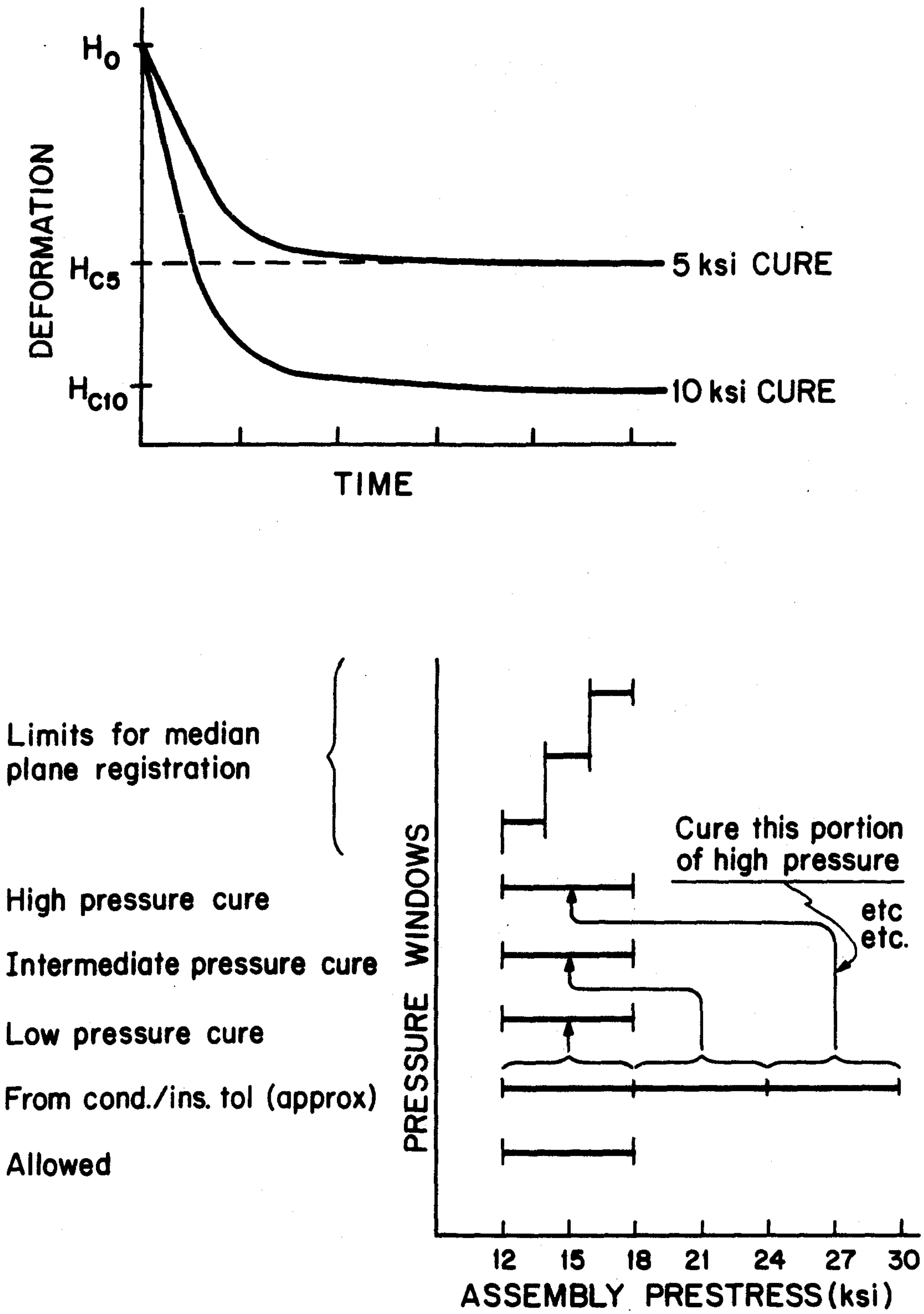

Fig. 3.7.16 Plots of Coil Behavior During Cure. Upper Curves Show Time vs. Deformation in Curing Process. Lower Plot Shows Limits for Median Plane Registration vs. Assembly Prestress.

REFERENCE DIMENSIONS

Either process requires some reference dimension from which to determine either the cure pressure or the cure size. These could include;

- measurement of conductor and insulation thickness (difficult in production)
- measurement of the uncured (or partially cured) stack in the mold. (Best but unproven; initial creep rate will be too large to get a reliable measurement but may stabilize adequately in 5-15 minutes)
- measurement of a cured stack [proven but implies at least a two-stage cure process, first cure should be "to pressure" for most reliable prediction of second cure parameters (pressure or size) to achieve the required final size]

Extreme care must be taken with the method and the consistency of the method by which reference measurements are taken. The stack should be cycled to pressure (or size) three or four times. The timing of the cycling and of taking the reference data points should be identical for each measurement.

It is suggested that a reference of pressure at size (P_h) may be a bit more useful than size at pressure (H_p):

- it represents "real life" in the magnet and is thus best for mixing and matching (matched size at any reference pressure does not ensure median plane registration unless that size is identical to the size in the assembled magnet)
- it should give the best practical combined match of median plane registration, modulus, cooldown characteristic and relaxation characteristic provided that mixing and matching is done within coils which have been cured at the same pressure (or size)
- it is somewhat easier to measure

OTHER CONSIDERATIONS

Cure to Pressure

The best dimensional reference from which final size vs cure (or recure) cycle can be predicted is now H_{10} of a coil, pressure cured, at 5 ksi. This implies a two-cure (at least) process. The second cure could be to "pressure" or to "size."

The tooling requirements for a "pressure" cure may be more stringent (costly) than those for "size" cure due to:

- pressure control and continuous instrumentation
- straightness and stiffness of "top hat" and mold. The longitudinal variations in composite properties, temperature, epoxy, etc. will result in longitudinal variation of "size" unless both top hat and mold are both very stiff and very straight (difficult in a 15 ft long, temperature and load cycled device). Even with straight, stiff elements the relative end-to-end squeeze must be controlled to maintain a uniform longitudinal dimension of the coil.

Cure to Size

Probably the greatest difference between "pressure" and "size" curing is the relative requirement for straight, stiff elements. In the "cure to size" device all that is important is the azimuthal dimension (at any longitudinal position) in the closed mold. The effects of longitudinal warping or twisting are easily squeezed out of the coil in the magnet core. Thus "top hat" and "mold" dimensions need to be accurate "on the machine bed" only. Note however, that in the cure to size process the above-mentioned longitudinal variations in composite properties will result in a longitudinal variation of "stiffness" which must be considered in the measurement technique.

It should be possible to learn to use the dimension of the uncured (or partially cured) coil to determine the cure size (thickness of curing shim). The mold would be closed on the uncured coil and after suitable cycling and allowance for relaxation the pressure would be recorded and used to predict the size of the curing shim (the higher the pressure, the thicker the shim).

P_d and H_p are equivalently unique dimensional characterizations. The difficulty with the one step process (to size or pressure) is reliable measurement of the uncured composite with the high initial creep (or relaxation) rate.

Reference to a first cure "to size" will not be very good. Thick insulated conductors will obviously be cured at a higher pressure than thin ones and the inherent dimensional character of the elemental components in the composite is lost.

MIXING AND MATCHING

It is necessary to achieve median plane registration, at assembly, during warm relaxation, after cooldown(s), and during magnetic cycling.

It is also necessary to match azimuthal winding deformations during magnetic cycling. It is thus necessary to match:

- P_d (or H_p)
- relaxation characteristics (warm)
- cooldown characteristics including ΔE, ΔL, dE/dT and dL/dT
- E_t (tangent modulus) cold

All of these properties will vary with cure pressure.

Figure 3.7.17 illustrates graphically the curing increments and selection basis for mixing and matching for the inner coil. It is simplified and approximate but is expected to represent a worst case. It assumes:

- Total insulated conductor tolerance = 0.036 in.
- $E_t = 2 \times 10^6$ (linear in stress range)
- Coil dimension = 4 in. ($d\sigma/dE$ = 500 psi/mil)
- Prestress window = $\pm$ 3 ksi ($\pm$ 6 mils)
- Median plane registration window = $\pm$ 1 ksi ($\pm$ 2 mils)

It also assumes that the above-referenced properties which must be matched are adequately influenced by cure pressure to dictate that both coil halves within a single magnet must be cured at the same pressure. Thus each successive 12 mil increment of the total thickness tolerance must be cured at successively higher pressure (to achieve the required prestress window only)

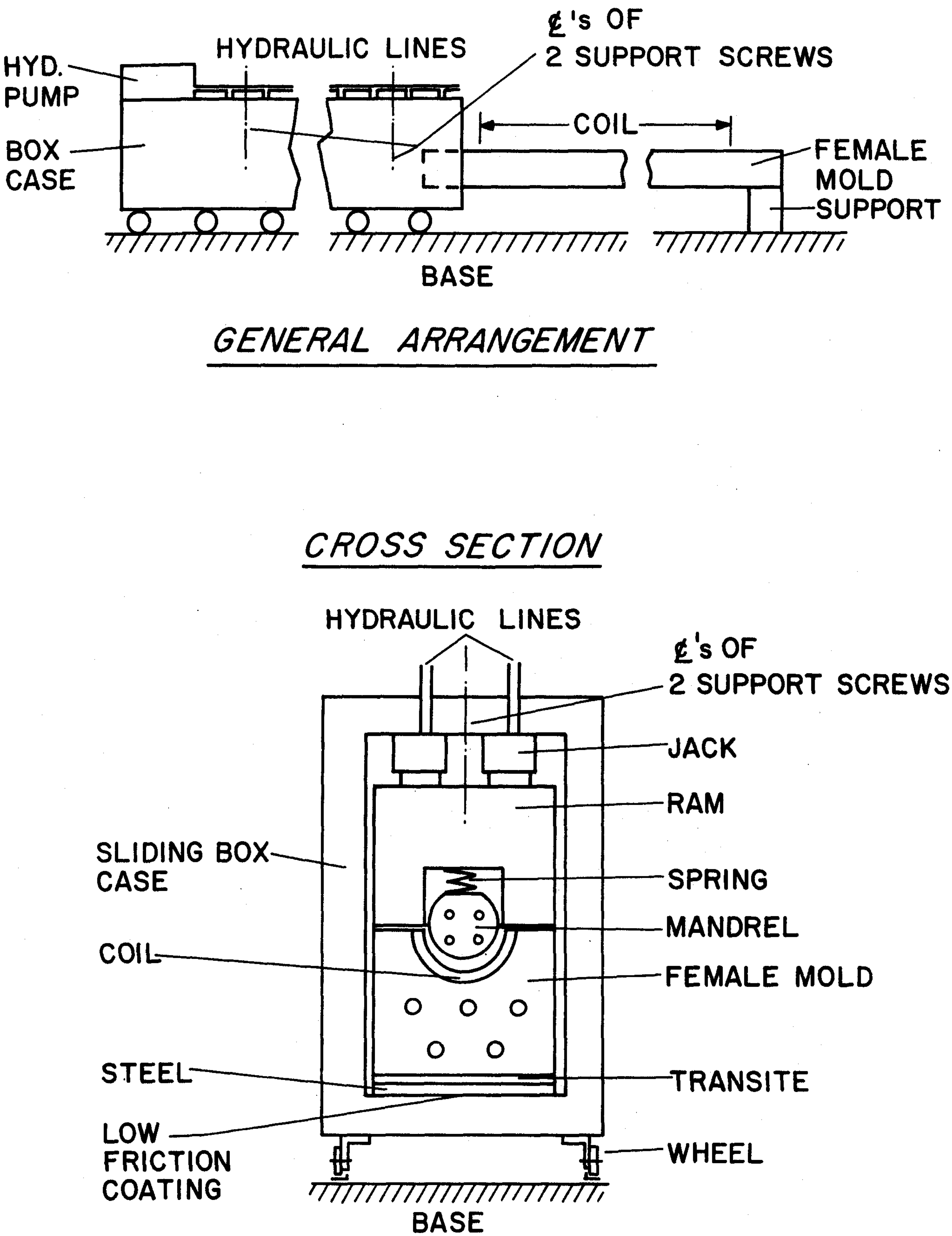

Fig. 3.7.17 Graphic Illustration of Curing Increments and Basis for Mixing and Matching Inner Coil

and within each such increment coils must be measured (P_d or H_p), selected, and matched to achieve median plane registration.

PRODUCTION TOOLING REQUIREMENTS

It is recommended that effort be started immediately to design a production prototype winding/curing device. A few considerations for such a device are discussed below. These are embodied in the device shown in Fig. 3.7.18.

1. Maximum safe working (cure) pressure 25 ksi (may want to cure above operating stress and/or use for test at/or above assembly prestress).
2. Controls, and instrumentation (including automatic data acquisition) for "cure to pressure" process.
3. Additional considerations (obviously minimal) for "cure to size" process. This might consider strain gauges in the "post" to monitor pressure change during cure.
4. All of the above should be essentially independent for each side of the half coil.
5. Ability to vary the pressure longitudinally should be evaluated.
6. Frequent intermediate squeezing (or 10% curing) should be facilitated including the ability to measure P_{dim} for each such intermediate squeeze/cure. This may be desirable as often as every 10 turns to achieve uniform azimuthal distribution of conductor (with varying thickness). Such intermediate squeeze may not need the male curing mandrel which should thus be detachable. Individual turn clamping at moderately high pressure may be desirable.
7. A convenient means of forming the saddles with adequate precision to control $\int B d\ell$ and harmonic contribution must be incorporated.
8. Control of axial *and transverse* temperature distribution during cure. Consider electrical heat instead of steam.
9. Rapid cooling without excessive thermal stress.
10. Ease of operation (Ref., Becker, Marston, memo dated 1-14-82).
11. Axial straightness and stiffness requirements of mold and clamping structure suitable for "pressure" cure.

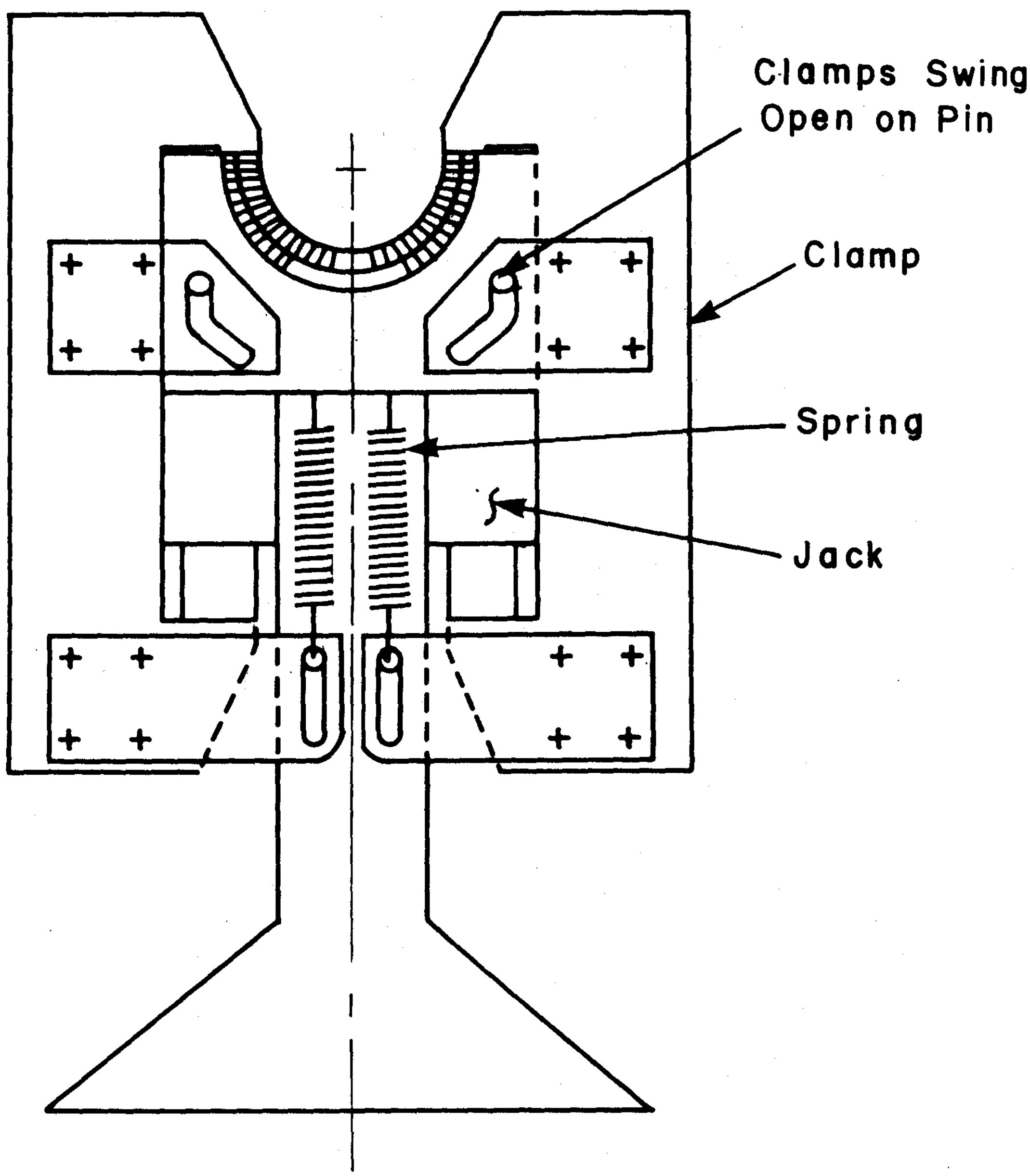

Fig. 3.7.18 Conceptual Design for Prototype Winding/Curing Device.

12. Saddle clamp tooling enabling uniform distribution of winding tension around the saddle. In the present process the total 50 lbs. will be absorbed over a rather small angular portion of the saddle periphery. This will build in a large torsional prestress and could develop adequate local shear stress on the insulation to create incipient (or real) shorts. Curved end tooling only one winding section deep might allow the winder to simply heave the conductor around the end at 50 lbs. A difference sequence of "clamping-in-the-tension" might be more effective. This implies some kind of end clamp and perhaps an additional tensioner (at 90°) at each end.

13. It is appropriate to evaluate the relative merits of "male vs female" winding, considering the ease of tamping each turn into place (to achieve uniform azimuthal distribution) in the female "mold" versus the relative ease of forming the saddles on a male mandrel.

14. It would be useful if the curing mold could load the coil to the assembly prestress. It could thus be used to measure the coil and also to test for "shorts." With the male mandrel removed, turn-to-turn voltage drop measurements can determine the exact location of a short. Pressure can then be relaxed, the short repaired and retested, quickly and easily.

3.8 ISABELLE DIPOLE SIMULATION MODELS

A simulation test of the Isabelle dipole magnets was designed in which the field and force distributions of the actual circular cross section cos θ winding was closely duplicated in a pair of flat "racetrack" pancake windings of rectangular cross section. Figure 3.8.1 shows the arrangement of the conductor blocks in one quadrant of the 6-block design cross section. This dipole was wound of Isabelle braid conductor. Block 1 of the dipole is at the upper left of the figure and is positioned against the centerpost while block 6 is at the midplane shown in the lower right in the figure. Figure 3.8.2 shows the two-dimensional finite element model used in analyzing this winding.

The first quadrant of the rectangular cross section simulation array is shown schematically in Figure 3.8.3. The array consists of two six-block flat pancake coils wound in a racetrack configuration and two background field or trim coils which are shown at the upper right. Block 1, equivalent to block 1 of Figure 3.8.1 is at the left in the figure. This is at the inside of the coil, while block 6 is at the right, or outside.

Current distribution in the 6 pancake coil blocks is the same as that in the 6 cos θ coil blocks shown in Figure 3.8.1 and modeled in Figure 3.8.2. Current distribution in the background field coils is the same as that in blocks 5 and 6 of the pancake. Magnetic field lines for the cos θ dipole are shown in Figure 3.8.4 while those for the simulation array are shown in Figure 3.8.5. Similarly, force vectors for the cos θ coil and for the pancake simulation are shown in Figures 3.8.6 and 3.8.7, respectively. When these pairs of computer printouts are compared, it becomes evident that the field and force distributions are quite similar even for this simple simulation array. Note, in particular, that the inside block of the pancake experiences a field of about 5 T parallel to the conductor width, while the outside blocks experience a field perpendicular to the conductor which varies from 0 to 5 T across its width.

Figure 3.8.8 shows a 6-block pancake simulation with an improved background coil array.

The magnitudes of the radial, circumferential and total magnetic field loads for the 6-block cos θ Isabelle dipole were plotted and are shown in Figures 3.8.9, 3.8.10 and 3.8.11, respectively. Similar magnetic field loads for the simulation shown in Figure 3.8.8 were calculated and plotted. Figure 3.8.12 shows the vertical fields which compare with the radial fields of Figure 3.8.9; Figure 3.8.13 shows the horizontal fields which correspond to the circumferential fields of Figure 3.8.10. The total field is shown is Figure 3.8.14. It can be seen from comparing these two groups of figures that the field distribution of the simulation is remarkably close to that of the 6-block cos θ Isabelle magnet.

The z and x pressure distributions for the simulation shown in Figure 3.8.8 are presented in Figures 3.8.15 and 3.8.16, respectively. These correspond to the radial and circumferential pressure distributions for the Isabelle magnet as modeled in Figure 3.8.2. Once again, these pressure distributions are remarkably close to those of the real magnet.

Another of the Isabelle alternative designs, a 5-block design which is similar to design A4 discussed in the previous section, is shown in Figure 3.8.17. A translation of this dipole design to a pancake racetrack simulation experiment design mounted as it would have been for a simulation experiment, is shown in Figure 3.8.18.

Had the simulation experiment test coils actually been built, the magnet length assumed would have cost slightly over a meter. The first experiment would have been approximately the same amount as the cost to build a dipole of comparable length. Once the background field system was in place, however, the pancake coils could be tested at less than one-fifth the cost of the dipoles. It would, then, have been comparatively fast and inexpensive to test numerous design alternatives in which conductor, insulator and structure could be varied and, based on the comparisons between the computer simulations and the results for the actual Isabelle 6-block cos θ winding shown in Figures 3.8.1 through 3.8.16, the data obtained could be expected to be highly reliable.

In addition, the simplicity of the configuration would have greatly facilitated all instrumentation. In particular it would be possible to measure directly (and to vary) the compressive prestress of the winding at assembly, the loss of this prestress with time (relaxation) at room temperature, the change in prestress during cooldown and the load variation at the inside and outside of the pancake (comparable to the "post" and midplane of the cos θ winding) throughout the energizing cycle.

The experiment would be been instrumented for the following measurements:

- Assembly prestress
- Room temperature relaxation
- Change in prestress during cooldown
- Low temperature relaxation
- Overall field distribution
- Load variation during energizing cycle
- Conductor motion during energizing cycle
- Stability (via heaters)
- Quench propagation
- $\dot{B}$ effect on stability
- Current sharing (with large field gradient across the conductor width)
- Acoustic Emission Triangulation to determine magnitude and location of conductor and structure motion (frictional heat)

The simple configuration also facilitates varying the cooling geometry and conditions (e.g., pool boiling at 4.2 K, supercritical at 3.8 K and superfluid at 1.8 K).

Should such a simulation test facility have been constructed it would have been possible to have learned a great deal about the many suggested Isabelle alternative designs at a relatively modest cost.

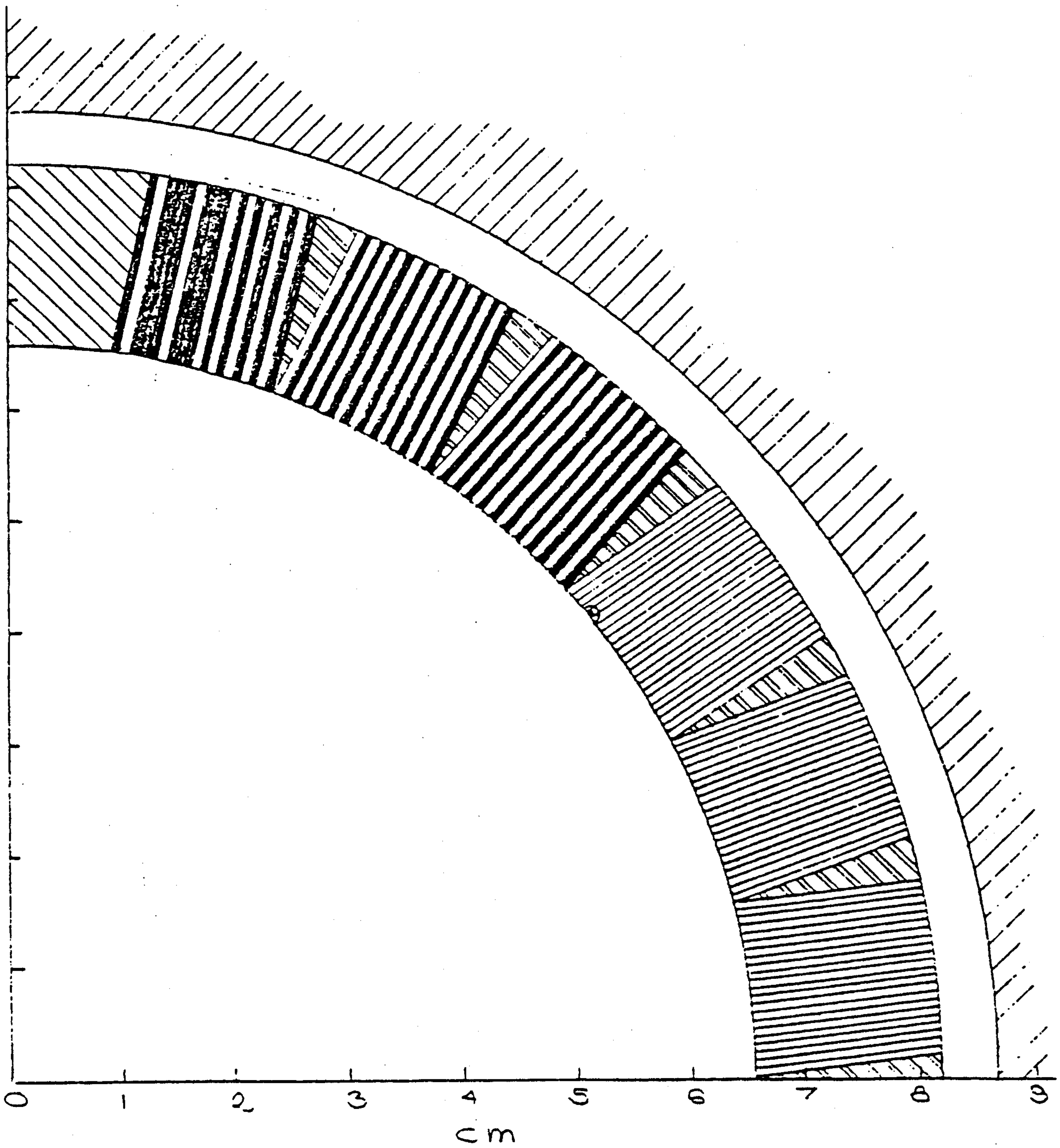

Figure 3.8.1: Shows the Arrangement of the Conductor Blocks in the 6 Block, Braid, Cos θ Magnet. Only the First Quadrant is Shown. Block 1 is at the Upper Left (at the Post). Block 6 is at the Lower Right (at the Midplane).

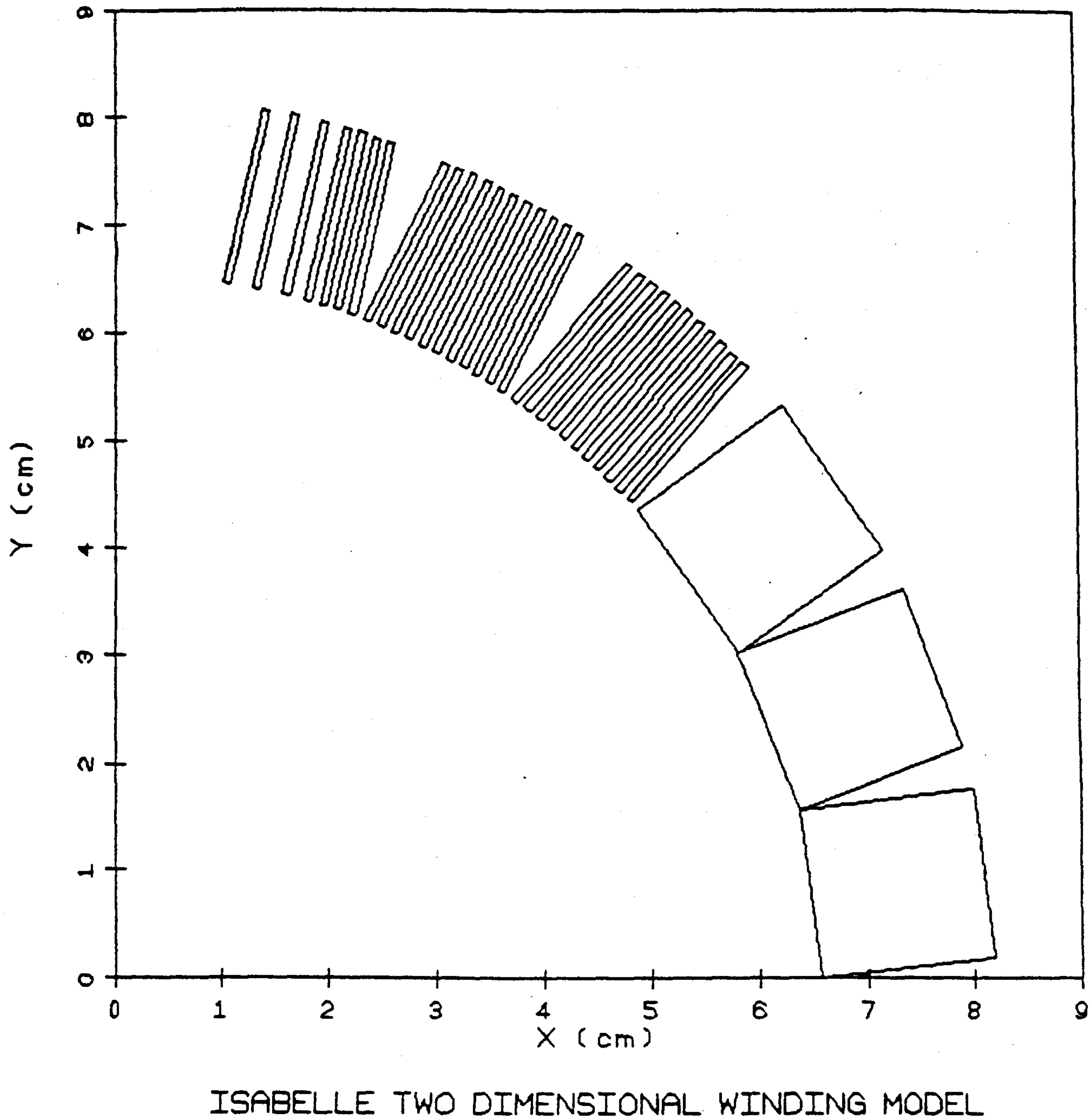

Figure 3.8.2: Shows the 2-D Computer Model of Figure 3.8.1.

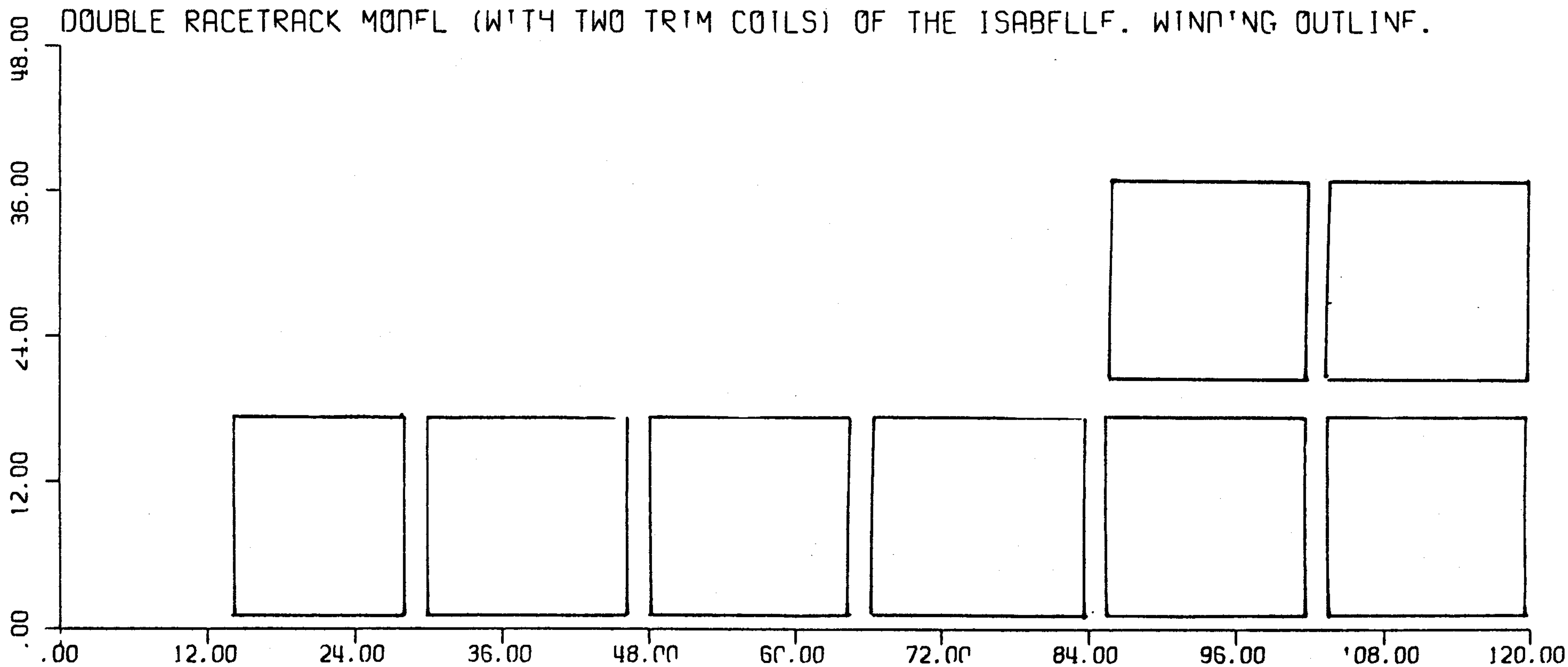

Figure 3.8.3: Shows the First Quadrant of the Simulation Array Consisting of Two Six Block Flat Pancake (Racetrack) Coils with Two Background Field (Trim) Coils Shown at the Upper Right. Block 1 is at the Left (Inside) of the 6 Block Pancake Coil; Block 6 is at the Right (Outside). The Current Distribution in the 6 Blocks of the Pancake is the Same as That of the Six Blocks of Figures 3.8.1 and 3.8.2. The Current Distribution in the Background Field Coils is the Same as That of Blocks 5 and 6 of the Pancake Coil.

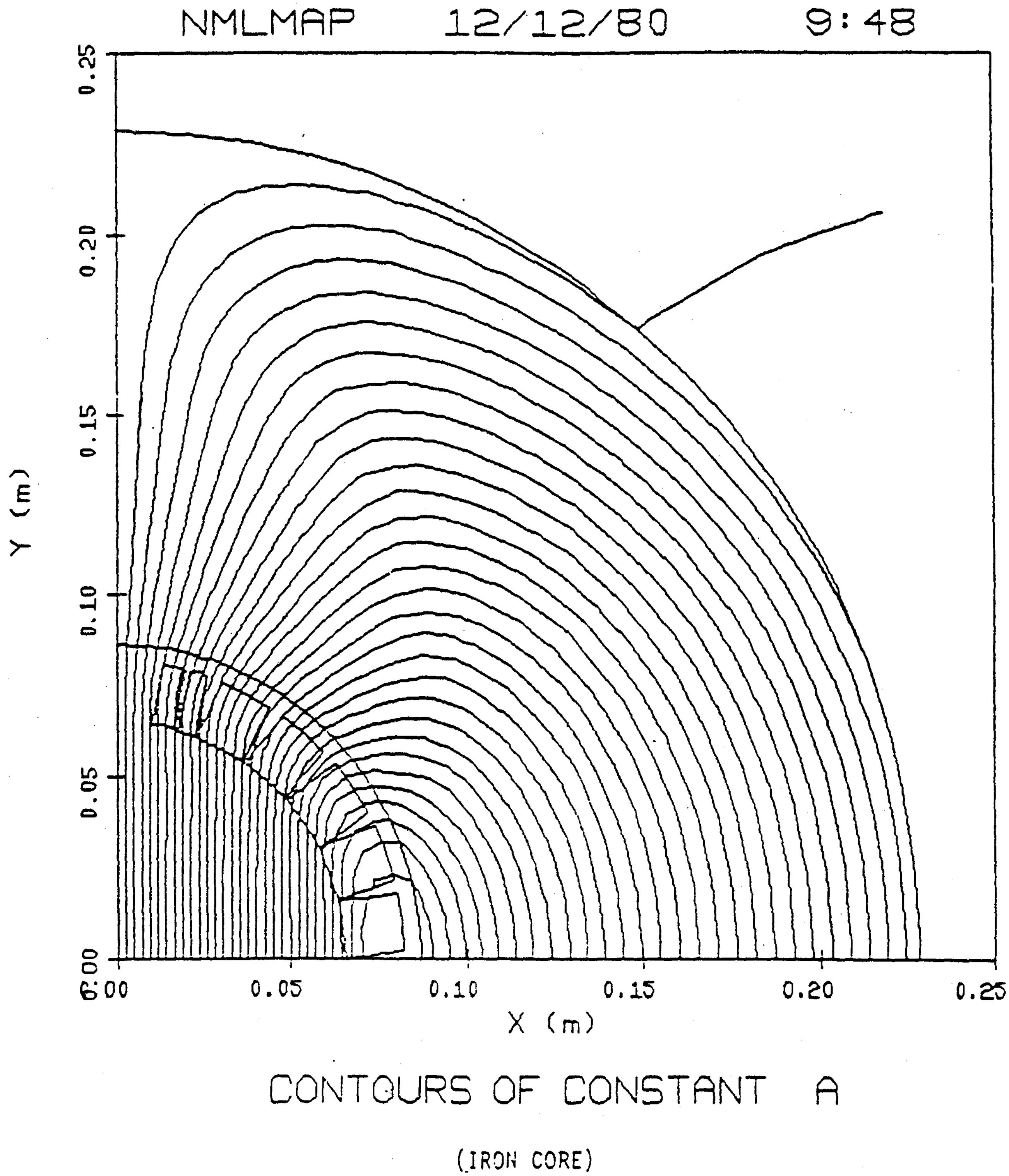

Figure 3.8.4: Shows the Magnetic Field Lines in the Magnet of Figure 3.8.1.

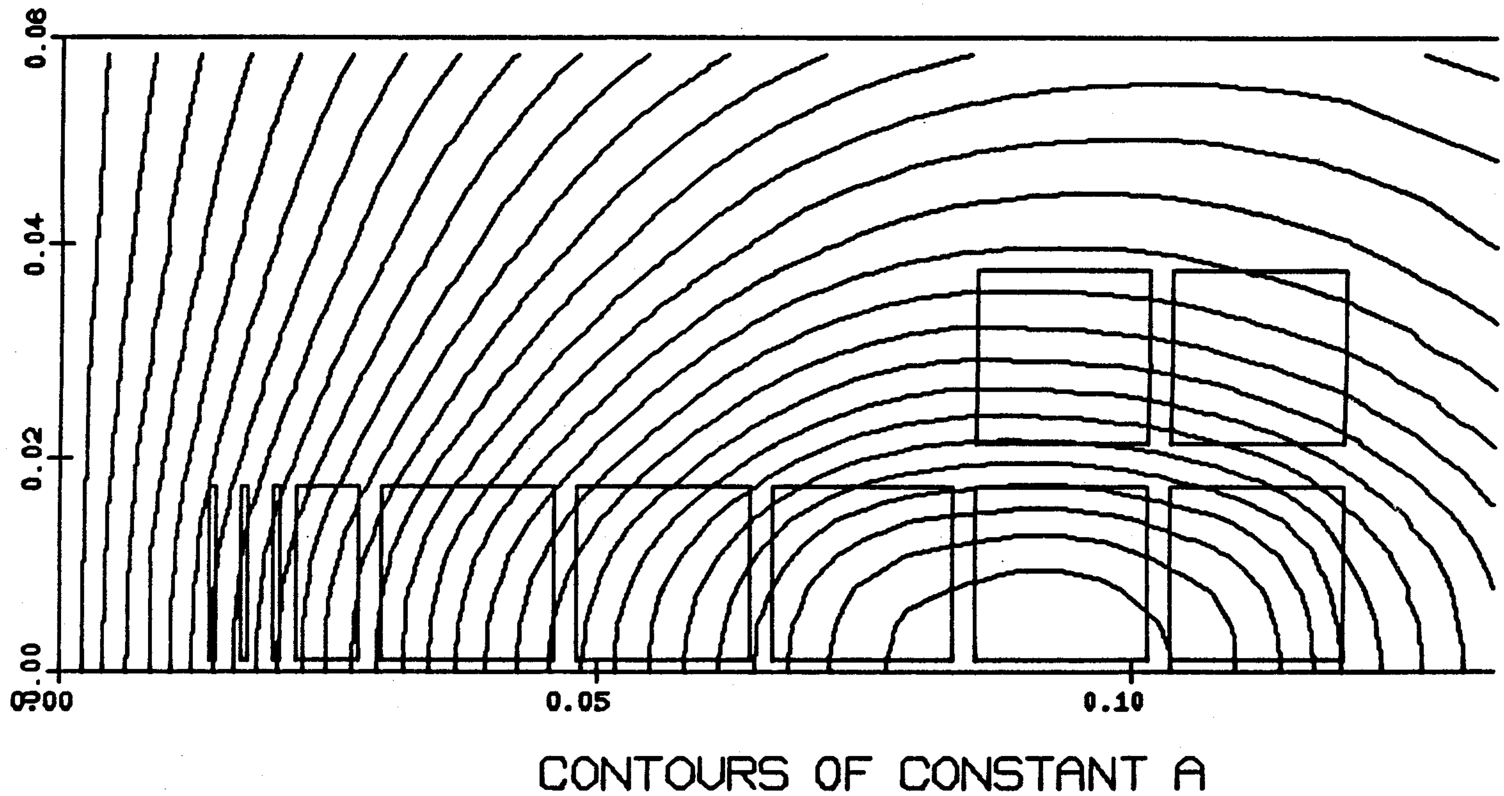

Figure 3.8.5: Shows the Field Lines of the Simulation Array (of Figure 3.8.3)

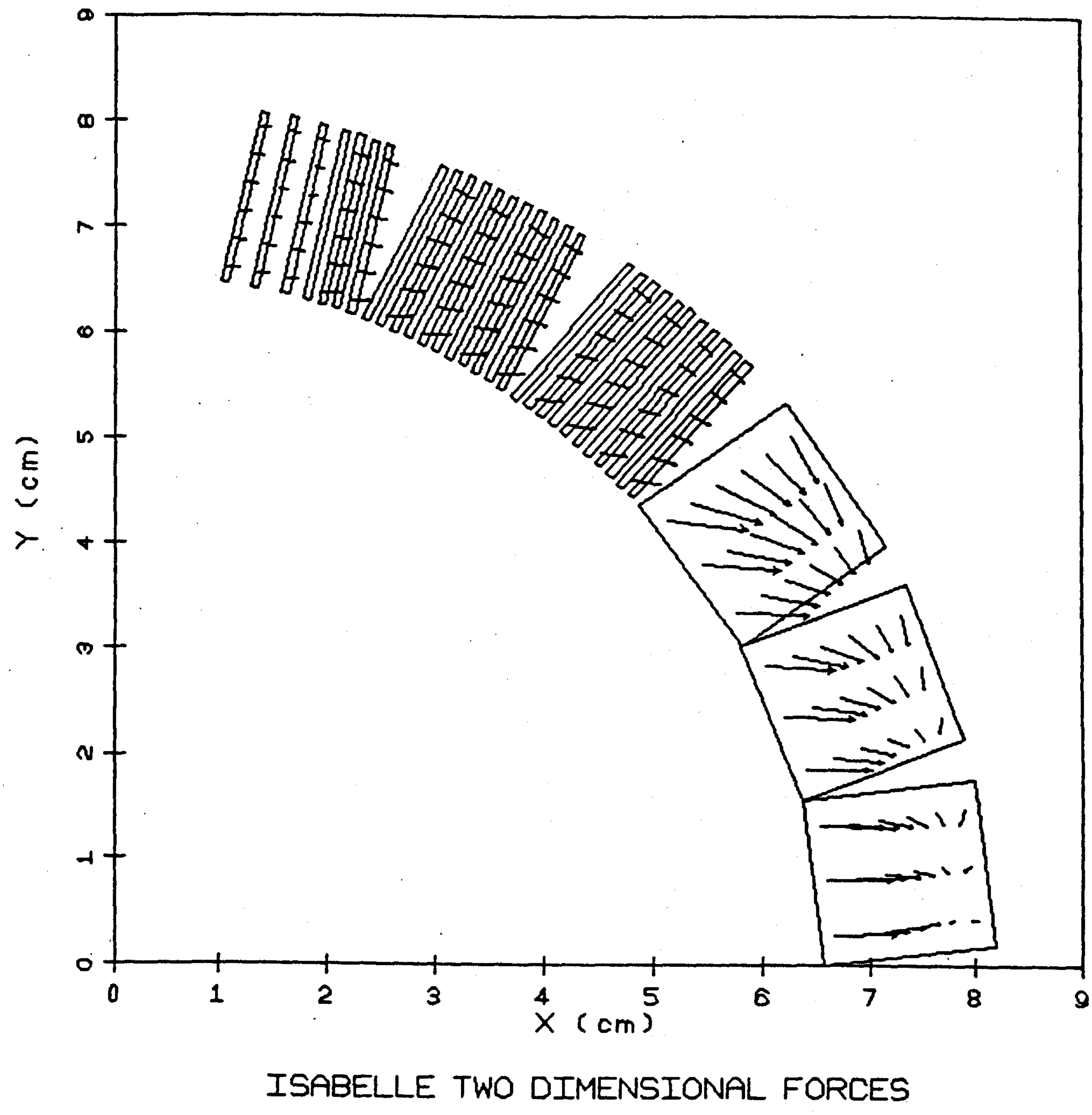

Figure 3.8.6: Shows the Force Vectors Corresponding to Figure 3.8.4

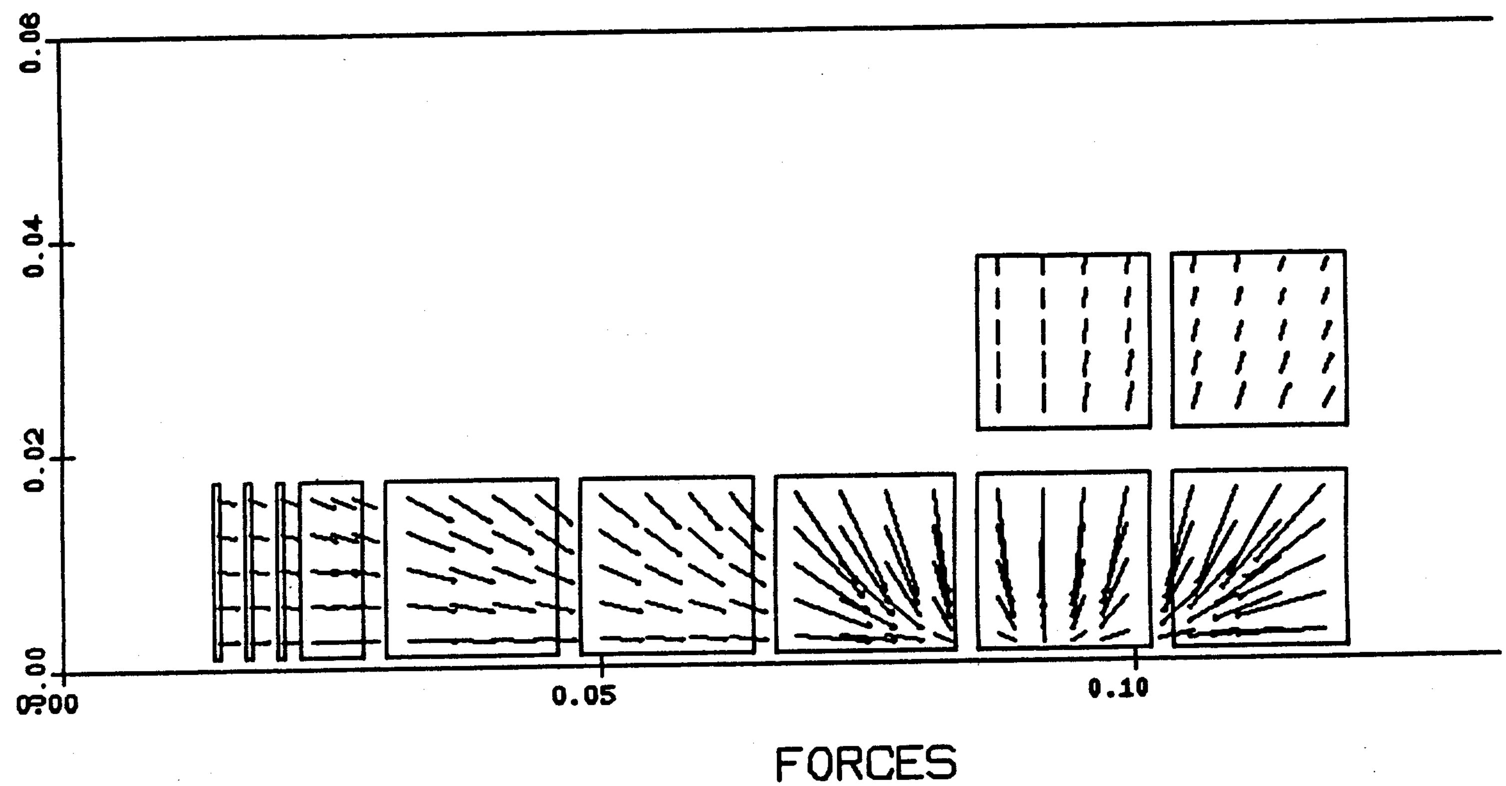

Figure 3.8.7: Shows the Force Vectors Corresponding to Figure 3.8.5
It Can Be Seen That the Field and Force Distributions
Are Quite Similar Even for This Simple Array.

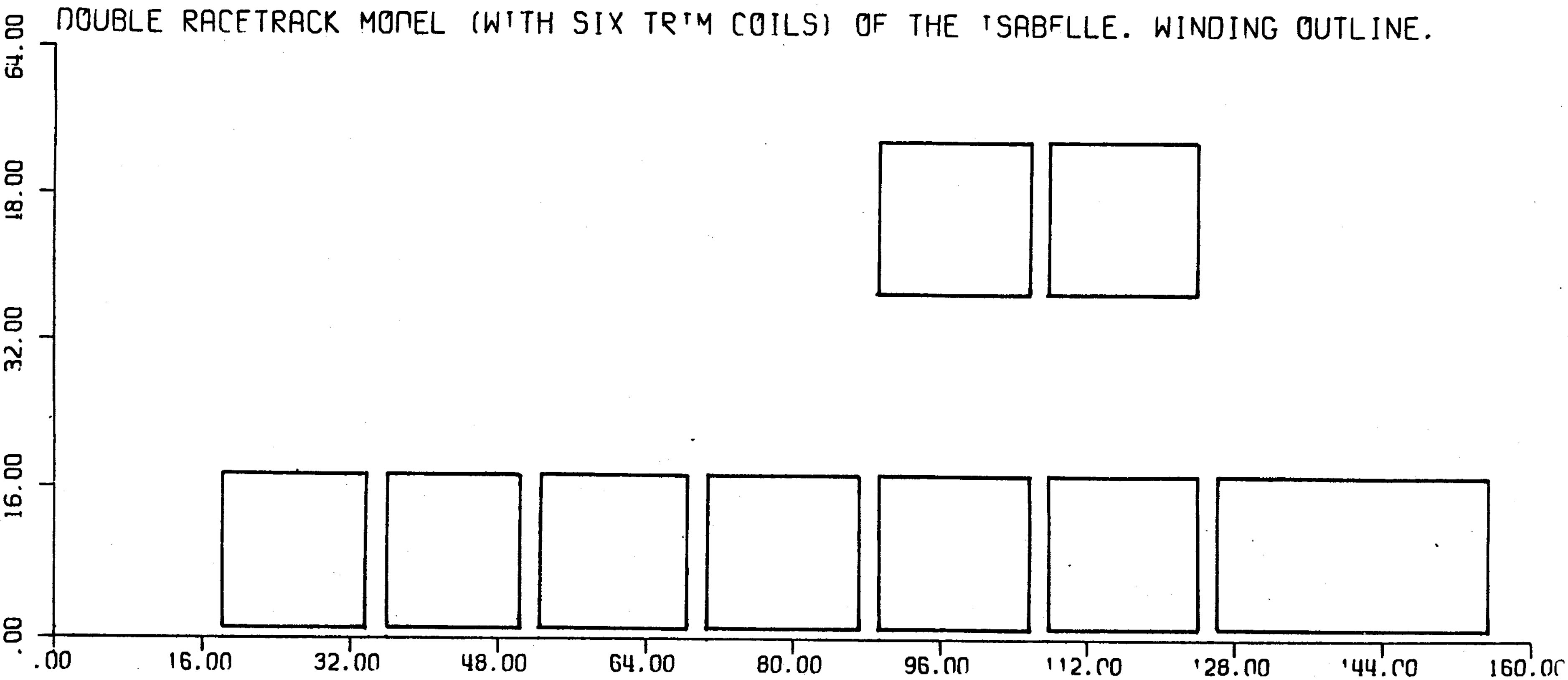

Figure 3.8.8: Shows an Improved Array of Background Coils for the 6 Block, Flat Pancake Simulation. The Background Array Consists of the Two Trim Coils in the Upper Right and the One Large Trim Coil at the Lower, Far Right.

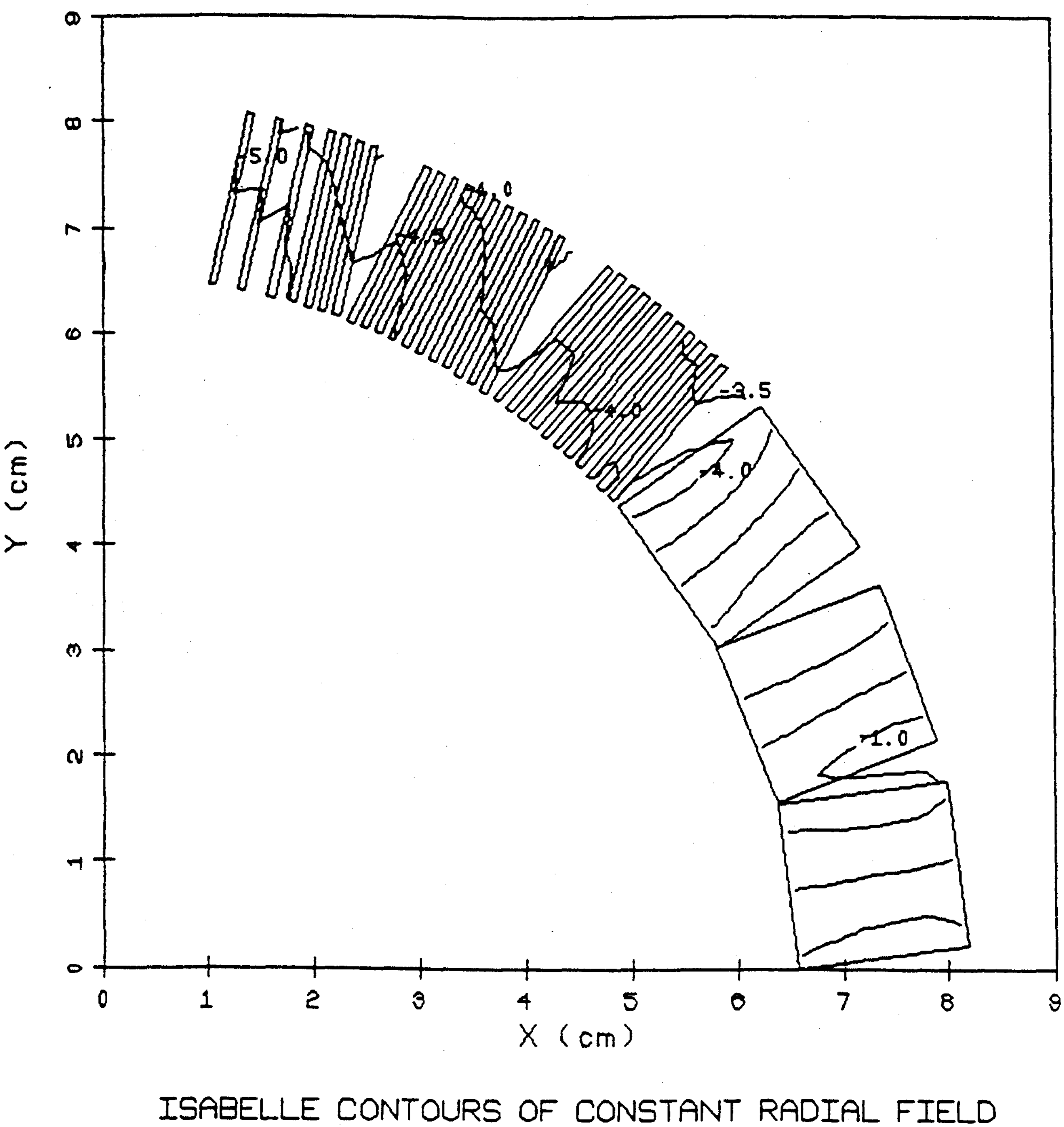

Figure 3.8.9: Shows the Contours of Radial Field Corresponding to the Configuration of Figure 3.8.1 and 3.8.2.

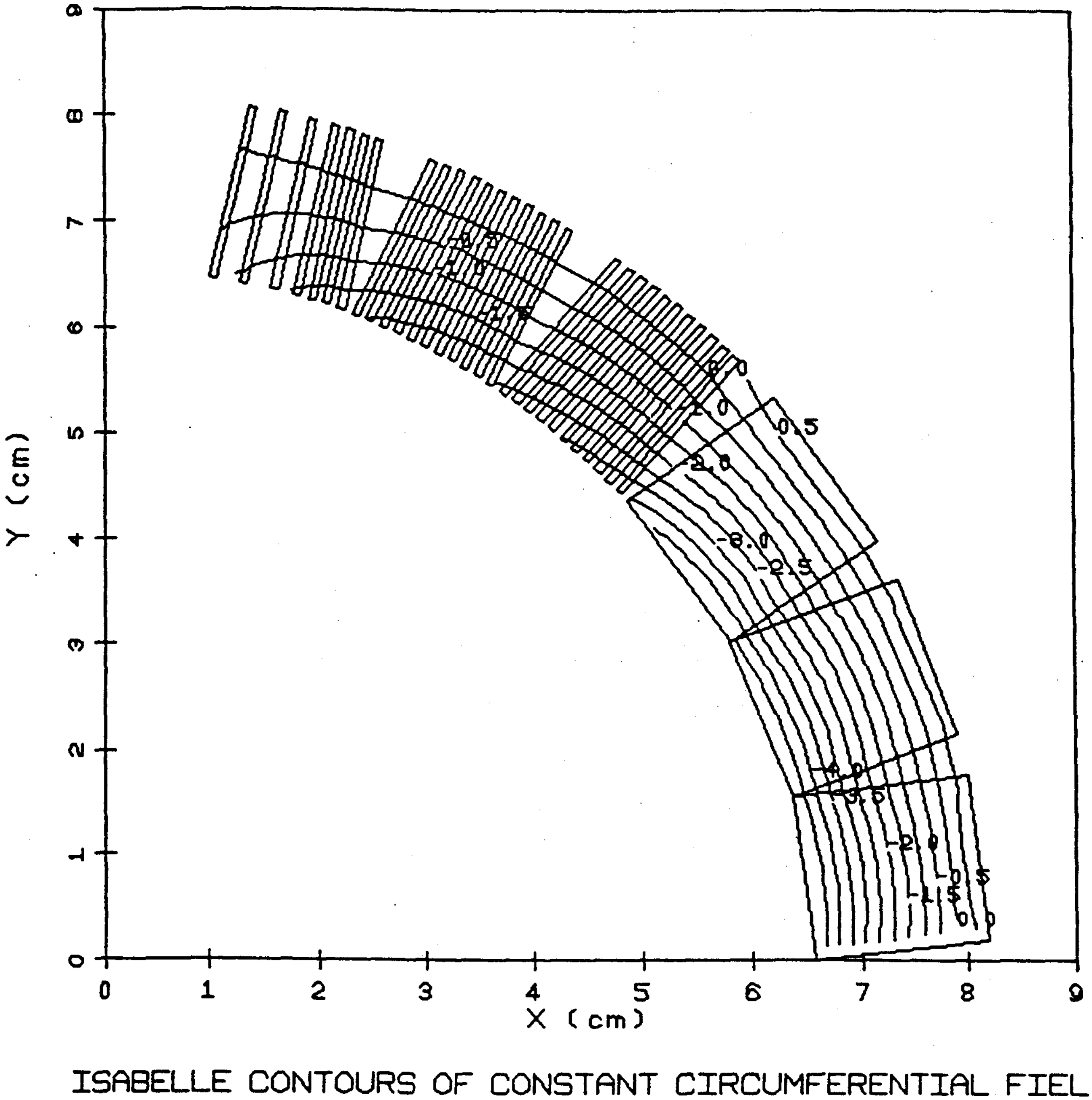

Figure 3.8.10: Shows the Contours of Circumferential Field Corresponding to the Configuration of Figures 3.8.1 and 3.8.2.

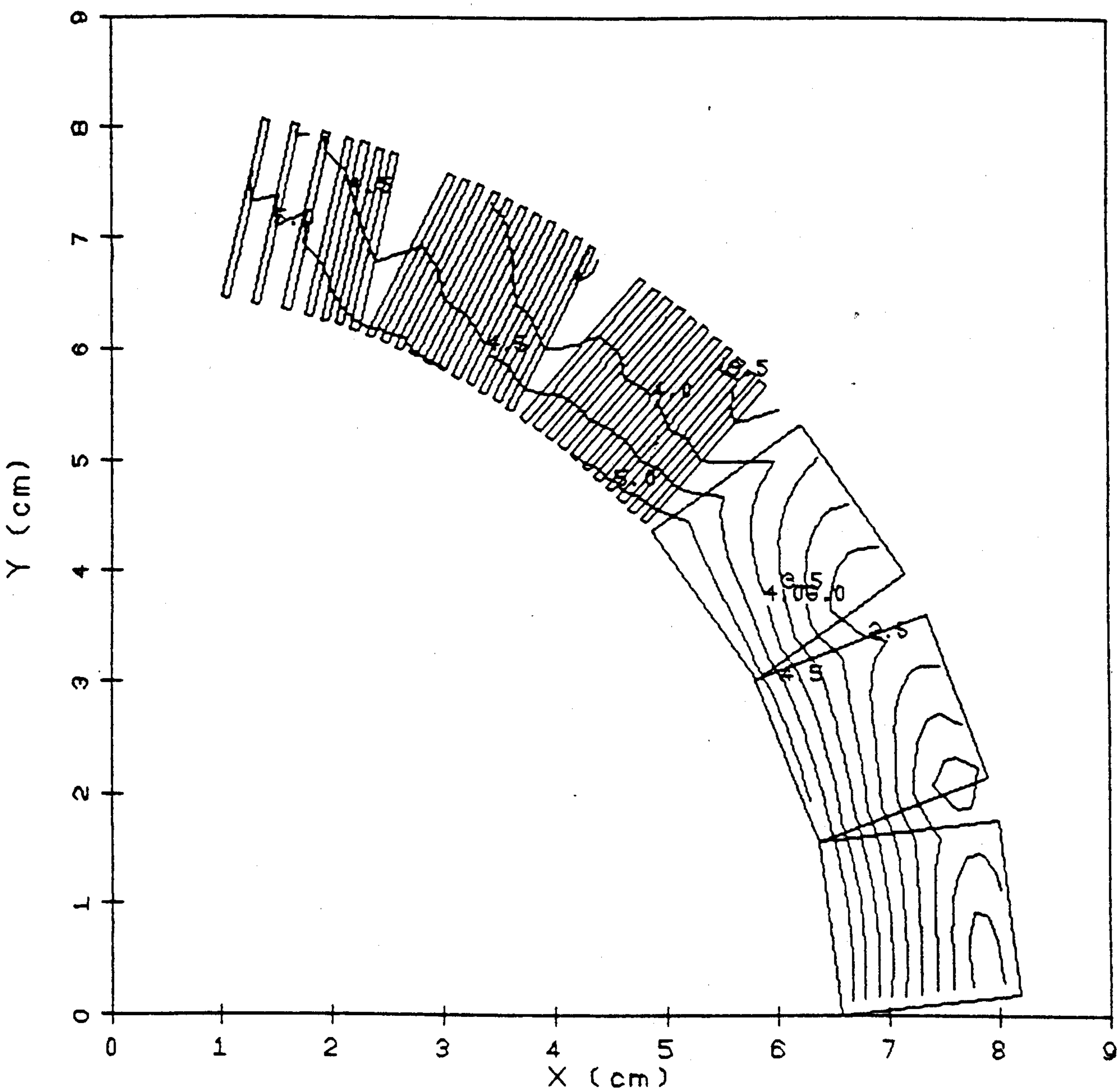

Figure 3.8.11: Shows the Contours of Total Magnitude of the Field Corresponding to the Configuration of Figures 3.8.1 and 3.8.2.

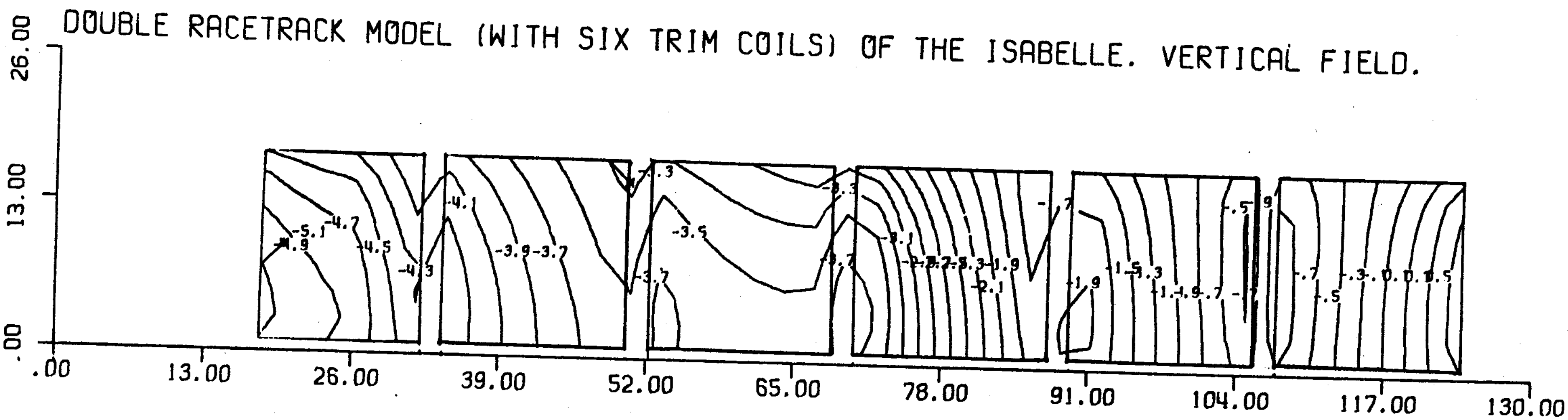

Figure 3.8.12: Shows the Same Information for the Radial (Vertical) Field for the Configuration of 3.8.8.

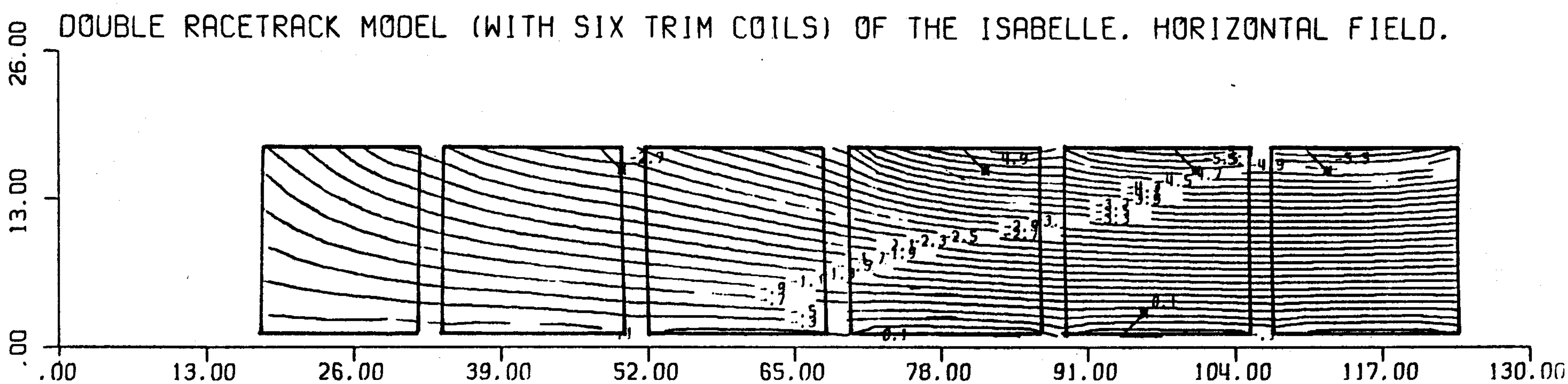

Figure 3.8.13: Shows the Same Information for the Circumferential (Horizontal) Field for the Configuration 3.8.8.

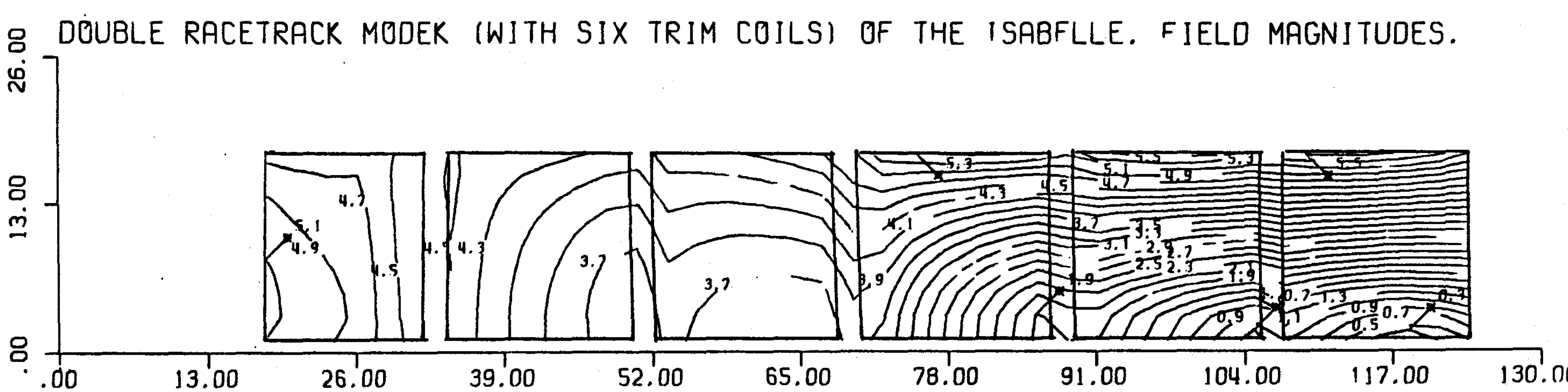

Figure 3.8.14: Shows the Same Information for the Total Field Magnitudes for the Configuration of Figure 3.8.8. (Note that Radial Compares to Vertical and Circumferential to Horizontal.) It Can Be Seen That the Field Distribution of the Simulation is Remarkably Close to That of the Real Magnet.

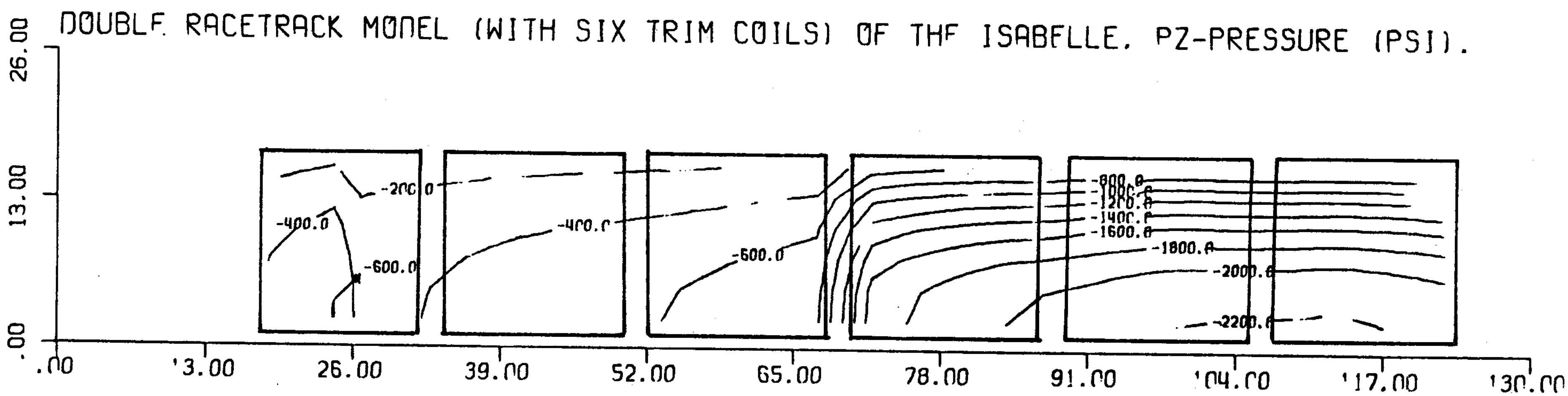

Figure 3.8.15: Shows the Z Pressure Distribution for the Configuration of Figure 3.8.8. This Would Correspond to the Radial Pressure Distribution for Figure 3.8.2.

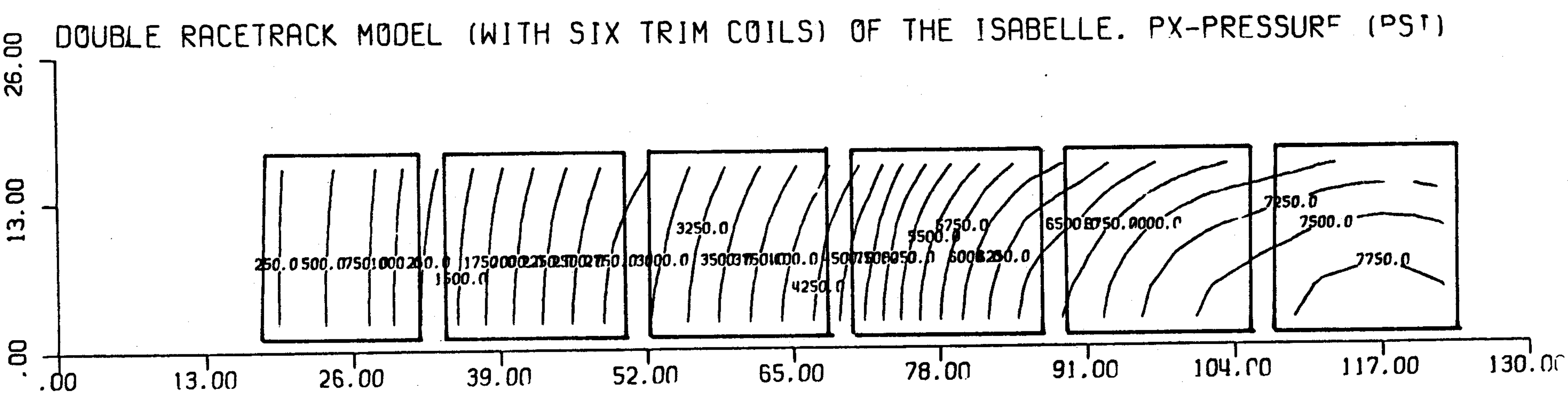

Figure 3.8.16: Shows the X Pressure Distribution for the Configuration of Figure 3.8.8. This would correspond to the Circumferential Pressure Distribution for Figure 3.8.2.

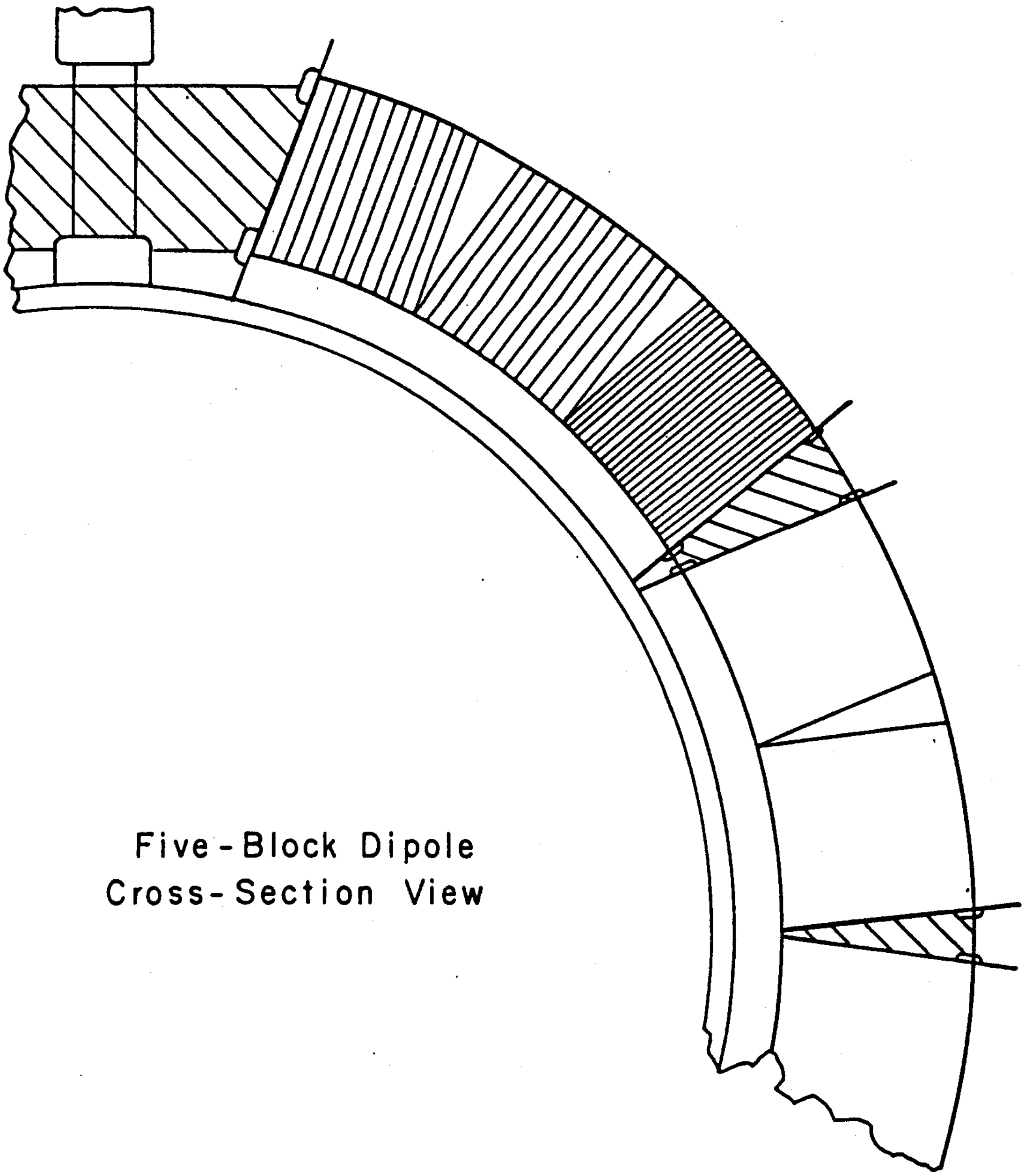

Figure 3.8.17: Shows a 5 Block Braid Cos θ Magnet Having a Mechanically Supported Wedge Between Blocks 3 and 4. This Mechanical Regionalization Reduced the Conductor Motion by a Factor of Approximately 4 and Also Reduced the Required Compressive Prestress by a Factor of Approximately 2.

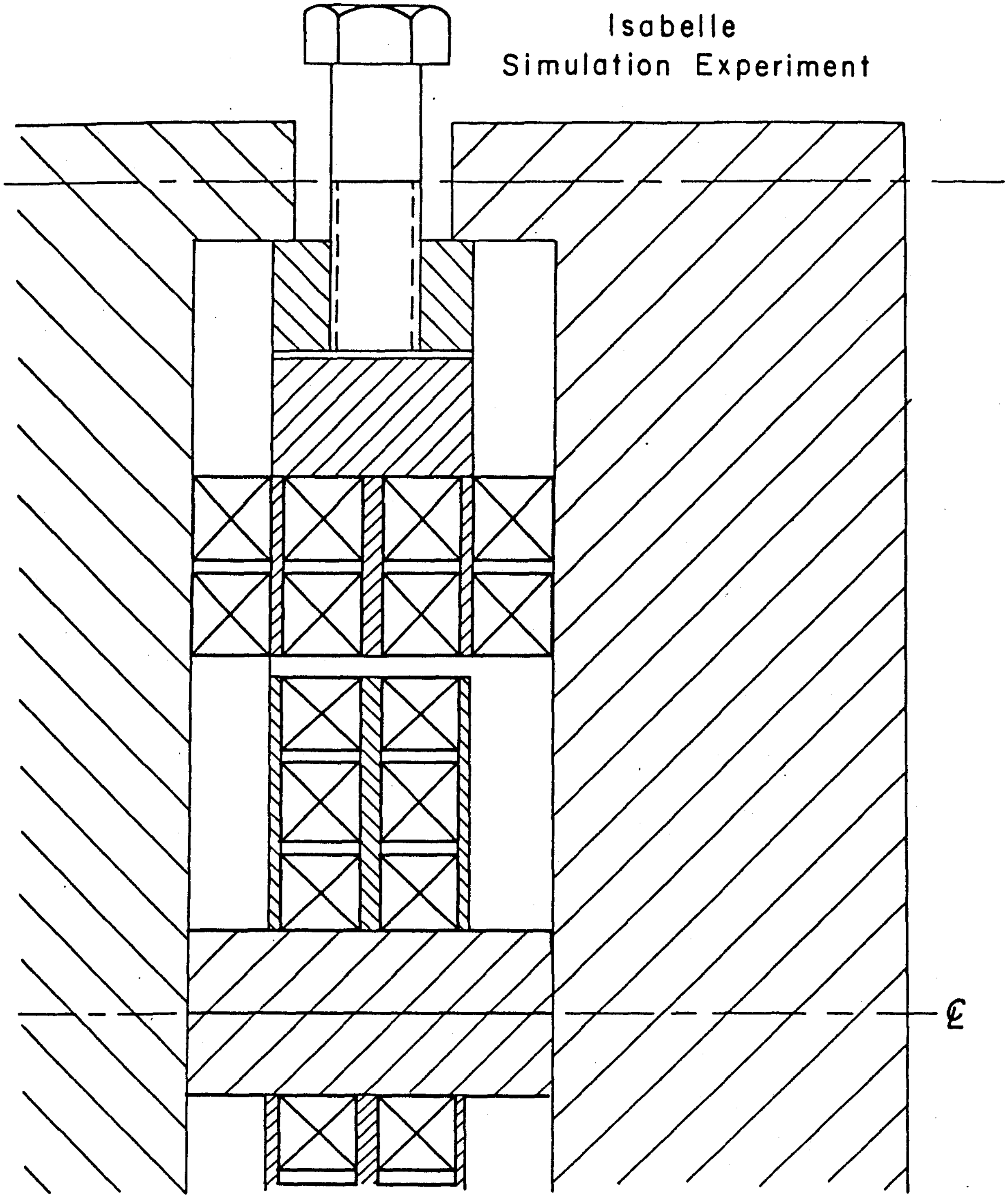

Figure 3.8.18: Shows a 5 Block Simulation Array (Similar to that of Figure 3.8.3) Demonstrating the Ease with Which the Structural Variation of Figure 3.8.17 Can be Modeled.

4.0 COMPARATIVE EVALUATION METHODOLOGY FOR AN ASSESSMENT OF ISABELLE MAGNET STATUS

4.1 Introduction

A methodology has been established to enable a comparative evaluation of 5 magnet designs (plus alternatives) for BNL, to assess the magnet status of Isabelle. It includes definitions of terms, the rationale for selection of the evaluation criteria, a discussion of top-level rating methodologies (which define how to combine the scoring for each criterion to arrive at a total score and rank, including a description of equally-weighted, rank-weighted, and nonlinearly-weighted criteria, a recommendation for use of a particular methodology, and a description of a weighting sensitivity analysis), a description of a second-level rating methodology (which presents the critical parameters, basis for evaluation, and rating methodology for each criterion), and an evaluation scoring format to document and summarize the comparative evaluation.

4.2 Definitions

4.2.1 Comparative Evaluation - The process of using a rating methodology to evaluate the 5 dipole magnet designs (plus alternates) relative to each other.

4.2.2 Rating Methodology - A specific procedure for assigning numerical values to each design (and to each alternate) relative to evaluaation criteria (in this case, 8 criteria), and combining the values for each criterion to arrive at a total numerical score. These are called second-level and top-level rating methodologies, respectively.

4.2.3 Evaluation Criteria - Those aspects common to all magnet designs which are arbitrarily chosen as significant, and for which a standard of evaluation can be established.

4.2.4 Standard of Evaluation - For a given criterion, the arbitrary but specific baseline against which all designs are compared and evaluated.

4.3 Selection of Evaluation Criteria

The following evaluation criteria are recommended:

Field Quality
Stability
Reliability
Maintainability
Fabricability
Schedule
Cost
Risk

These 8 include all of the proposed criteria. Of these, field quality and stability are included because they both critically impact the basic performance of the machine in its ability to provide a unique regime for experimental physics. Cost and schedule are included as critical programmatic parameters. Maintainability and reliability are included because they critically impact the usefulness of the machine. Fabricability and risk are included because they critically impact the probability for success of the program.

Strategic considerations are not included among the criteria because this is intended to be a strictly technical evaluation. Considerations relating to the quadrupoles are not included because they are beyond the scope of this evaluation. Considerations such as outside width and length dimensions, use of existing cryostat design, and the ability to test vertically are judged to be minor considerations relative to the recommended criteria, and are therefore not included. Safety is not included because all designs present equivalent personnel hazards.

4.4 Top-level Rating Methodology

The top-level rating methodology defines the procedure for how to combine the scoring on the criteria to arrive at a total score for each design.

4.4.1 Equally-Weighted Criteria

With this method, the criteria scores are simply added to determine the total score. Thus, if each of the 8 criteria is assigned a 0 to 10 point scale for scoring purposes, the total score range will be 0 to 80 points. While this method is simple and easy to use and understand, it does not provide a realistic comparison because it ignores the fact that some criteria are more important (i.e., more critical to success) than others. This could be cured by assigning a different range for each criterion, but this unnecessarily complicates the weighting sensitivity analysis.

4.4.2 Rank-Weighted Criteria

With this method, the criteria are ranked relative to their importance (i.e., their criticality to the success of the project). The criteria are then numbered from 1 to 8, starting with the least important. Each criterion is assigned a 0 to 10 point scale base for scoring purposes, and the base score for each criterion is multiplied by its rank number. The total score for each design is the sum of the rank-weighted criteria base scores. The total score range is thus 0 to 360 points.

While this method is a significant improvement over the equally-weighted criteria method, it ignores the fact that some criteria may be judged to be equally important, or some may be judged to be significantly more (or less) important than others.

4.4.3 Nonlinearly-Weighted Criteria

With this method, each criterion is assigned a numerical value related to the perceived importance of that criterion (the more important the criterion, the higher the numerical value). Each criterion is again assigned a 0 to 10 point scale base for scoring purposes, and the score for each criterion is weighted by multiplying the base points by the numerical value associated with the importance of that criterion. The total score is the sum of the weighted scores for each criterion. The total score range is thus from 0 to 10 times the sum of the weighting factors.

4.4.4 Recommended Top-Level Rating Methodology

While all three top-level rating methodologies should be used, the results of the nonlinearly-weighted criteria method should form the basis for any recommendations regarding selection of a preferred design, since this method is capable of more adequately assessing the relative importance of the evaluation criteria. (Both the equally-weighted and rank-weighted criteria methods are special cases of the nonlinearly-weighted method, and can thus be easily performed once the nonlinearly-weighted methodology is established.)

4.4.5 Weighting Sensitivity Analysis

Once the base scores for each design on each criterion are established (using the second-level rating methodology presented hereinbelow), the top-level rating methodology can be easily applied to determine a total score (and rank). However, the rank may be sensitive to minor changes in the perceived relative importance of the criteria. Because these perceptions may be somewhat subjective and may change, an analysis of the sensitivity of the results to the chosen weighting factors must be performed. This will indicate whether one design is clearly superior to the rest, or whether some (or all) of the designs are equally good (or bad).

It is recommended that the top-level rating be performed and the designs ranked using as a minimum the following three sets of weighting factors:

Criteria	Case A	Case B	Case C
Field Quality	8	10	10
Stability	6	5	5
Reliability	4	4	5
Maintainability	1	1	2
Fabricability	5	5	5
Schedule	2	1	3
Cost	3	2	3
Risk	7	6	8
Total	36	34	41

Note that Case A is equivalent to rank-weighting the criteria, while the criteria for Cases B and C are non-linearly weighted.

While there is a 2 point difference in the field quality weighting factors between Cases A and B, and a difference of only 1 point or less for all other criteria, Case B has a larger spread and places more emphasis on those criteria considered most important. For example, grouping the criteria consistent with the discussion of Section 4.3 yields the following for the weighting factors:

Consideration	Case A	Case B
Basic machine performance	14	15
Probability of program success	12	11
Programmatic (cost and schedule)	5	3
Machine usefulness	5	5
Total	36	34

Note that the probability of program success is given a third of the total points for both cases. However, for Case A, the spread between machine performance (14) and all others (programmatic plus machine usefulness = 10) is only 40%, while for Case B, the spread (15 to 8) is nearly a factor of two. Thus Case B gives much more emphasis to machine performance than does Case A, even though the hierarchical order among the criteria is essentially the same for both cases.

4.5 Second-Level Rating Method

The second-level rating method defines the procedure for numerically scoring each design based on how well (or how poorly) it meets each criterion, relative to the other designs. Any evaluation process presumes the existence of a standard of evaluation. One possible standard that could be chosen for this analysis is the data contained in the Isabelle parameter list. However, this would only serve to define the standard for some criteria (such as field quality) but not all criteria (such as cost, schedule, risk, etc.). Because this analysis is a comparison of each design to the others, a reasonable standard can be established by evaluating all of the other designs (and design alternates) relative to the one design which has received the most effort in terms of design, analysis, manufacture, and testing, and for which the most data exists. In our case, this is the cos θ design with braid conductor, 5-block winding, and shrink-fit assembly, which will be called the ISA1 design.

In addition to the ISA1 design, the cos θ design with cable conductor, 5-block mechanically-regionalized winding, and split steel will be called the ISA2 design. The so-called Danby design, Palmer design, and LBL design (all defined elsewhere) complete the 5 specific dipole magnet designs to be evaluated.

The evaluation criteria are considered separately in the following subsections. For each criterion, the critical parameters are defined (for the cost criterion, for example, the critical parameter is Isabelle total magnet system cost), the basis for the evaluation is discussed, and the rating methodology is defined.

Evaluation relative to each criterion is discussed in general terms only, but has its basis in the field, force, stress and harmonic sensitivity analyses which form the bulk of this report.

A (second-level) rating method is defined for each criterion. These are generally based on a 0 to 10 point scale for each criterion except for cost and schedule, for which limits on the score range are not fixed. The standard (the ISA1 design) is assigned a score of 5 points for each criterion, and the other designs (and alternates) scored on a relative basis. The risk criterion is the sole exception, as discussed in detail in Section 4.5.8.

Note that some criteria are more amenable to the assignment of numerical scores than others. For example, the total magnet system cost can be estimated for each design and numerical values assigned based on total system costs. The scoring for some other criteria (such as risk, for example) will necessarily be somewhat subjective relative to objectively (but possibly not clearly) defined standards. This indicates the essentially qualitative nature of the results of the comparative evaluation, though these are stated in quantitative terms.

4.5.1 Field Quality

The critical parameters for field quality are the corrected and uncorrected field coefficients, including the fundamental.

Field quality will be evaluated based in part on the results of the system-level tolerance study (described elsewhere), including manufacturing tolerances, inherent structural integrity (deformation under load based on field, force, and stress analysis) and iron saturation and eddy current effects. In addition, the evaluation will be based on the ability of each design to correct the coefficients, along with an attempt to assess the real requirements for field quality in terms of the coefficients.

The rating method consists of assigning the ISA1 design a score of 5 points, while the other designs are scored higher for better field quality and lower for poorer field quality than can be achieved with ISA1 design, within the range of 0 to 10 points.

4.5.2 Schedule

The critical parameter for schedule is the total time required to complete manufacture, installation, and test of the magnet system, including the time required for additional R&D, design, tooling fabrication, material procurement, manufacturing process development, and prototype construction, test, and evaluation. Note that schedule risk is treated separately.

The basis for the evaluation of schedule will be the manufacturing plans, the fabricability assessment associated with the comparative evaluation, and the status of each design (plus alternates) relative to the requirements for the preproduction manufacturing effort.

The rating method consists of assigning the ISA1 design a score of 5 points as the baseline, then scoring the other designs on the comparative basis of 4 points per year of schedule differential, with increased schedule time reducing the score. (For example, if a particular design would require a 6 month longer schedule than the ISA1 design, its score would be 3.) The total score range on this criterion should not be limited. For example, if a particular design would require a 2 year longer schedule than ISA1, its score would be 5 - (4 X 2) = -3.

4.5.3 Cost

The critical parameter for cost is the total Isabelle magnet system cost, including component construction costs (equipment, tooling fabrication, materials, and production manufacturing labor costs) and EDIA (engineering design, integration, and assembly) costs which generally cover everything else, including all R&D, design, manufacturing process development, prototype construction, test, and evaluation, system integration, assembly, G&A, fees, etc. Note that the larger-bore alternate designs will have higher materials costs for production manufacture, but should not have significantly higher production manufacturing labor costs and that the EDIA costs may in fact be reduced due to the impact of reduced-tolerance-related costs. Cost risk is treated separately.

The basis for the evaluation of cost will be the MIT systems modeling code (described elsewhere) plus ROM estimates of other costs (or differential costs) where necessary. It is recognized that the absolute accuracy of these estimates may not be as good as existing

BNL estimates but it is expected that the consistency of method should give better comparative results.

The rating method consists of application of the following:

$$\text{Score} = 15 - 10 \ \frac{\text{Total Cost}}{\text{Baseline Cost}}$$

where the Total Cost is the total magnet system cost of the design being evaluated and the Baseline Cost is the total magnet system cost for the ISA1 design, then scoring the other designs on the comparative basis of 1 point for every 10% of cost differential (with increased cost leading to a reduced score). The total score range on this criterion should not be limited. For example, if a particular design costs 50% more than the baseline (Total Cost = 1.5 X Baseline Cost), then its score would be 15 - (10 X 1.5) = 0.

4.5.4 Stability

The critical parameters for stability are the conductor stability margin and the ability of the magnet to be self-protecting.

The basis for the evaluation of stability for each design will be the conductor stability margin as a percentage of the short sample temperature margin and current margin, and the MPZ energy relative to a credible events analysis, if available, including ac losses. Each design will be examined for self-protection based on existing analyses, if available. Applicable data will be examined for consistency with analytical results.

The rating methodology consists of assigning the ISA1 design a score of 5 points, then scoring the other designs on the basis of comparative stability margin (the larger the stability margin the larger the score) within the range of 0 to 10 points. If any design is determined to be not self-protecting, its score on this criterion should be divided by 2.

4.5.5 Maintainability

The critical parameters for maintainability are the change-out time (defined as the time required to remove a cold magnet from the ring, replace it with an available working magnet, and cool the system down) and cost (including change-out costs and repair costs).

The basis for the evaluation of maintainability will be design analyses (bore tube thermal stress) and manufacturing plans.

The rating methodology consists of assigning the ISA1 design a score of 5 points, then scoring the other designs on the basis of comparative cost and time estimates (with increased cost and time requirements given a reduced score) within the range of 0 to 10 points. Any magnet that cannot be repaired should be given a zero score on this criterion, unless the ability to sacrifice the magnet significantly improves the change-out time and cost.

4.5.6 Reliability

The critical parameter for reliability is the susceptibility of the system to failure.

The basis for the evaluation of reliability should be a detailed fault/failure analysis for each design, including a criticality analysis. If such analyses are not available, an abbreviated preliminary failure analysis should be performed. The undesired events should be defined (premature quench, repeated premature quenching, coil shorts, etc.), and each weighted in accordance with its criticality (i.e., shorts requiring magnet change-out are more severe than one premature quench). Review each design for its susceptibility to the defined undesired events. As a basis use design data, manufacturing plans, track record, and existing technology base. Assume that each magnet is without latent defects (i.e., it is good when it is installed in the ring).

The rating methodology consists of assigning the ISA1 design a score of 5 points, then scoring the other designs on the basis of comparative susceptibility to failures, especially critical failures, (with an increased susceptibility to failure given a reduced score) within the range of 0 to 10 points.

4.5.7 Fabricability

The critical parameter for fabricability is the potential ability of the design to be built.

The basis for the evaluation of fabricability will be manufacturing plans, track record, design analyses, and the existing technology base.

The rating methodology consists of assigning the ISA1 design a score of 5 points, then scoring the other designs on the basis of comparative ability to be built (with increased fabricability given an increased score) within the range of 0 to 10 points.

4.5.8 Risk

The critical parameter for this criterion is the risk of failure to achieve the major technical, schedule, and cost goals of the program.

The basis for the evaluation of risk for each design will be all of the data used to evaluate the other 7 criteria.

The rating methodology takes into account both the probability of failure and the criticality of a failure in each area. The rating method is as follows: First, establish an expectation (or goal) for each design on each of the other 7 criteria, using the data obtained from the comparative evaluation to this point. (For example, for the cost criteria, the goal would be the total magnet system cost established for each design.) Assess the risk of failure of each design to achieve the specific goal established for each criterion. Score as follows:

Risk of Failure	Score
Near Zero	10
Very Low	9
Low	7
Moderate	5
High	3
Very High	1
Near Infinite	0

for each design and each criterion. Multiply the scores for each criterion by the same weighting factor used in the top-level rating methodology. Compute the sum of the risk-weighted scores for each design; divide these by the sum of the weighting factors used in the top-level rating methodology for the other 7 criteria. This will yield a quantitative score for the risk criterion for each design which can range from 0 to 10 points, and which will include not only the probability of failure, but the criticality of failure in a specific area, as well.

4.6 Comparative Evaluation Documentation

In this section various forms are proposed to document, perform, and summarize the comparative evaluation.

4.6.1 Evaluation Worksheets

A *Second-Level Comparative Evaluation Worksheet* is provided to document the results of the second-level evaluation. This is performed only once for each design. The results on this form feed into the top-level evaluation.

A *Top-Level Comparative Evaluation Worksheet* is provided to assist in performing and documenting the top-level evaluation. Since many different top-level evaluations may be performed on the single second-level evaluation by using different weighting factors, these forms are to be numbered for tracking purposes. While within a given worksheet the designs can be ranked based on their total weighted scores, the Tot/Wt Tot. (total weighted score divided by the sum of the weights) will yield a 0 to 10 score for each design (unless upset by severely out-of-range second-level cost and schedule scores) to allow easy comparison of evaluation results based on (potentially) very different top-level weighting schemes.

4.6.2 Comparative Evaluation Summary

The Comparative Evaluation Summary form is provided to summarize all the data from the top-level worksheets. The normalized scores (Tot/Wt Tot. entries) are to be entered in the summary, and then added for each design to obtain a total score. The designs analyzed can then be ranked accordingly.

COMPARATIVE EVALUATION SUMMARY

July 1981
Date - Revision

Design	Normalized Score from Worksheet Nos. 1	2	3	4	5	Score Totals	Rank
ISA1	1.0	4.61	4.65	4.61	-	14.87	5
ISA2	1.34	6.44	6.53	6.39	-	20.70	4
Palmer	1.55	7.33	7.23	7.39	-	23.50	1
LBL	1.42	6.77	6.94	6.88	-	22.01	3
Danby	1.45	7.0	7.0	6.90	-	22.35	2

Notes: (1) Worksheets are identified as follows:

Worksheet No.	Date - Revision
1	July 1981
2	July 1981
3	July 1981
4	July 1981

SECOND-LEVEL COMPARATIVE EVALUATION WORKSHEET

July 1981
Date - Revision

Criteria	Designs Analyzed ISA1	ISA2	Palmer	LBL	Danby
Field Quality	5	7	6	8	7
Schedule	5	6	10	8	8
Cost	5	5	4	3	4
Stability	5	8	7	7	10
Maintainability	5	7	7	8	7
Reliability	5	6	8	7	6
Fabricability	5	7	8	7	7
Risk	3	5	9	6	6

TOP-LEVEL COMPARATIVE EVALUATION WORKSHEET NO. 1

July 1981
Date - Revision

Criteria	Weight	ISA1	ISA2	Palmer	LBL	Danby
		Designs Analyzed				
Field Quality						
Schedule						
Cost						
Stability						
Maintainability	Equal					
Reliability						
Fabricability						
Risk						
Totals (From 2nd Level Worksheet)		38	51	59	54	55
Tot/Wt Tot.		1	1.34	1.55	1.42	1.45
Rank		5	4	1	3	2

Notes: (1) Based on Second-Level Comparative Evaluation Worksheet dated July 1981.

TOP-LEVEL COMPARATIVE EVALUATION WORKSHEET NO. 2

July 1981
Date - Revision

Criteria	Weight	Designs Analyzed				
		ISA1	ISA2	Palmer	LBL	Danby
Field Quality	8	40	56	48	64	56
Schedule	2	10	12	20	16	16
Cost	3	15	15	12	9	12
Stability	6	30	48	42	42	60
Maintainability	1	5	7	7	8	7
Reliability	4	20	24	32	28	24
Fabricability	5	25	35	40	35	35
Risk	7	21	35	63	42	42
Totals	36	166	232	264	244	252
Tot/Wt Tot.		4.61	6.44	7.33	6.77	7.0
Rank		5	4	1	3	2

Notes: (1) Based on Second-Level Comparative Evaluation Worksheet dated July 1981.

TOP-LEVEL COMPARATIVE EVALUATION WORKSHEET NO. 3

July 1981
Date - Revision

Criteria	Weight	Designs Analyzed				
		ISA1	ISA2	Palmer	LBL	Danby
Field Quality	10	50	70	60	80	70
Schedule	1	5	6	10	8	8
Cost	2	10	10	8	6	8
Stability	5	25	40	35	35	50
Maintainability	1	5	7	7	8	7
Reliability	4	20	24	32	28	24
Fabricability	5	25	35	40	35	35
Risk	6	18	30	54	36	36
Totals	34	158	222	246	236	238
Tot/Wt Tot.		4.65	6.53	7.23	6.94	7.0
Rank		5	4	1	3	2

Notes: (1) Based on Second-Level Comparative Evaluation Worksheet dated July 1981.

TOP-LEVEL COMPARATIVE EVALUATION WORKSHEET NO. 4

July 1981
Date - Revision

Criteria	Weight	Designs Analyzed				
		ISA1	ISA2	Palmer	LBL	Danby
Field Quality	10	50	70	60	80	70
Schedule	3	15	18	30	24	24
Cost	3	15	15	12	9	12
Stability	5	25	40	35	35	50
Maintainability	2	10	14	14	16	14
Reliability	5	25	30	40	35	30
Fabricability	5	25	35	40	35	35
Risk	8	24	40	72	48	48
Totals	41	189	262	303	282	283
Tot/Wt Tot.		4.61	6.39	7.39	6.88	6.90
Rank		5	4	1	3	2

Notes: (1) Based on Second-Level Comparative Evaluation Worksheet dated July 1981.