Tohoku Bubble Chamber Magnet Vacuum Shell Analysis
(Appendix 1)

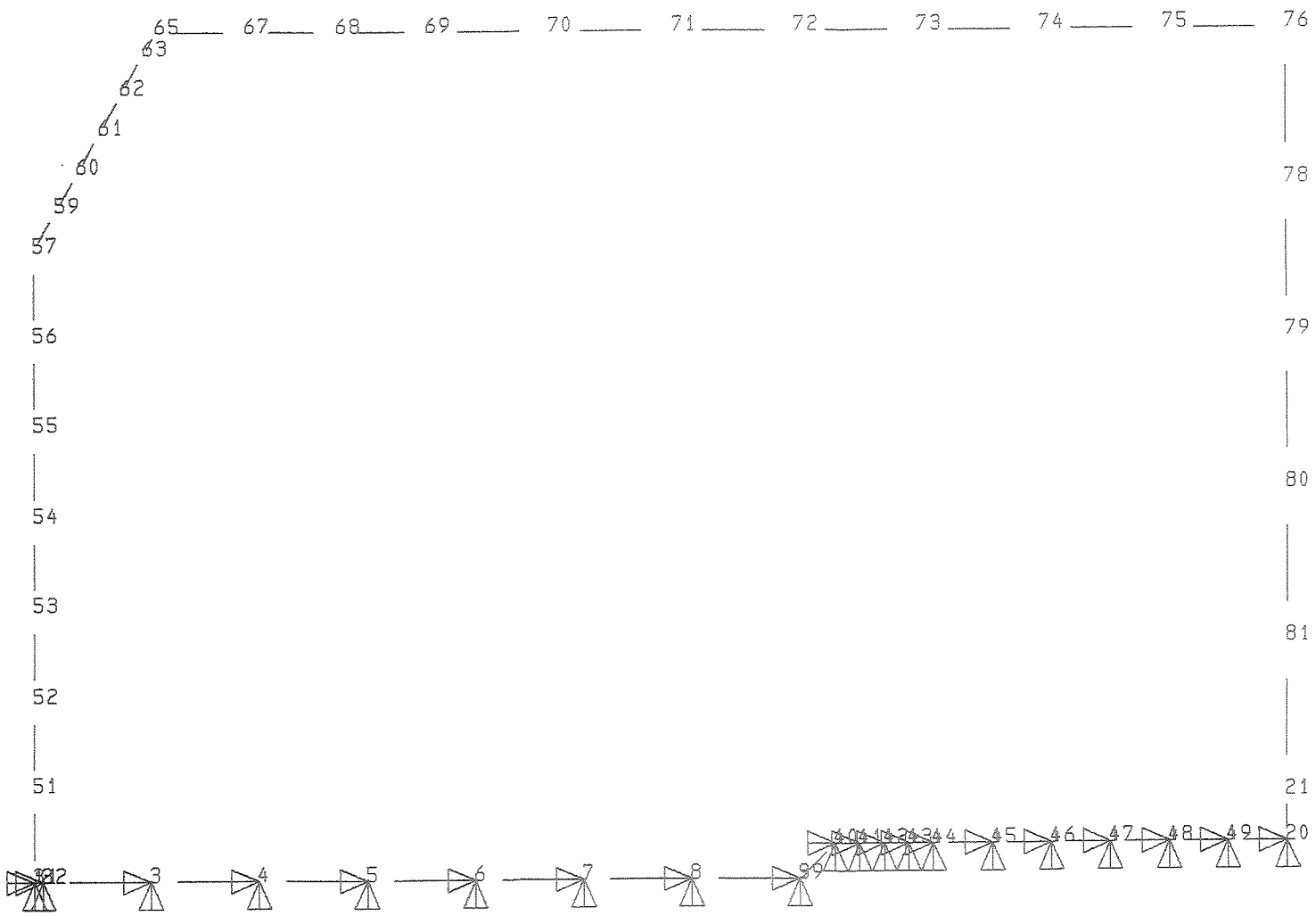
W. Craddock
October 29, 1985

Concern over the true axial force on the magnet arose during testing. Three dial indicators were mounted on the vacuum shell at r = 29.5" to measure the deflection of the posts. Unfortunately, much greater than expected deflections appeared. One source of extra motion not related to true axial force is the deflection of the vacuum shell under the loading of the posts. If the vacuum shell were perfectly flat against the iron, this source of error would not be present. However, the vacuum shell was welded together in the flat position without vacuum loading. This creates a bow in the top and bottom plates. Under axial load the bottom plate flattens until it eventually touches the iron yoke. The top plate on which the dial indicators are mounted can also move creating error, but this effect is very small.

The original 2D axisymmetric model was modified to calculate the deflections. Gap elements (STIF12) were used to simulate the contact of the base plate against the iron. Note from the accompanying figures that a large portion of the base plate has no gap elements. A 0.010" recess was machined in this region, and no contact is assumed. The following deflections were found.

Load (Total Axial Load)	Deflection (inches) Under Posts Node No. 14	Deflection (inches) at Dial Indicators Node No. 69
Vacuum Only	+ 0.0121	- 0.01278"
V + 10,000 lbs	9.91×10^{-3}	- 0.01280"
V + 25,000 lbs	6.62×10^{-3}	- 0.01283"
V + 50,000 lbs	1.13×10^{-3}	- 0.01288"
V + 75,000 lbs	~ 0	- 0.01290"

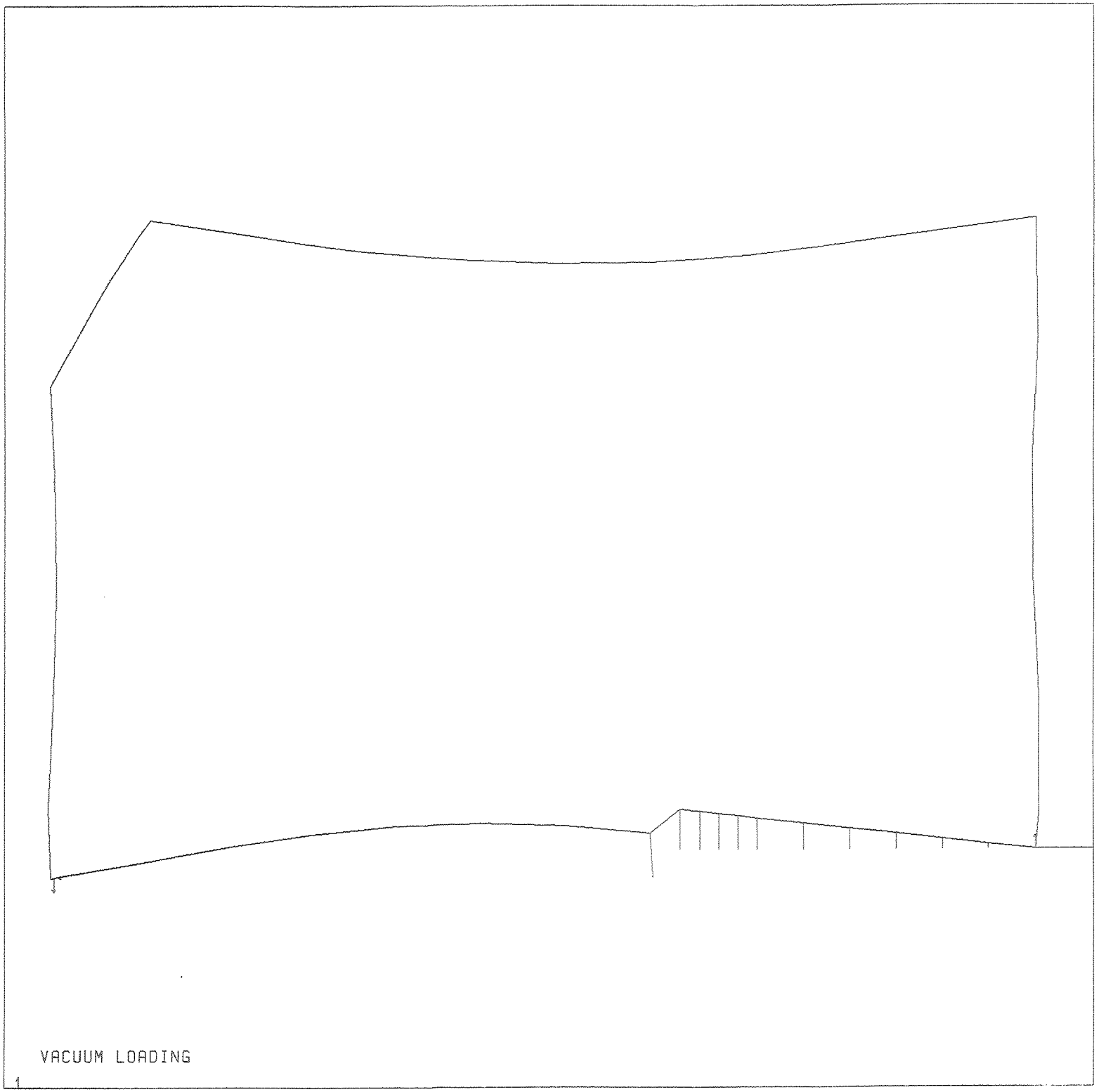
The deflection of the base plate is linear with axial loading. If the base plate were perfectly flat before evacuating, a total axial load of 55,000 lbs would cause the vacuum shell to deflect 0.012" before touching the iron at the location of the posts.



AXISYMMETRIC TOHOKU MAGNET VACUUM SHELL

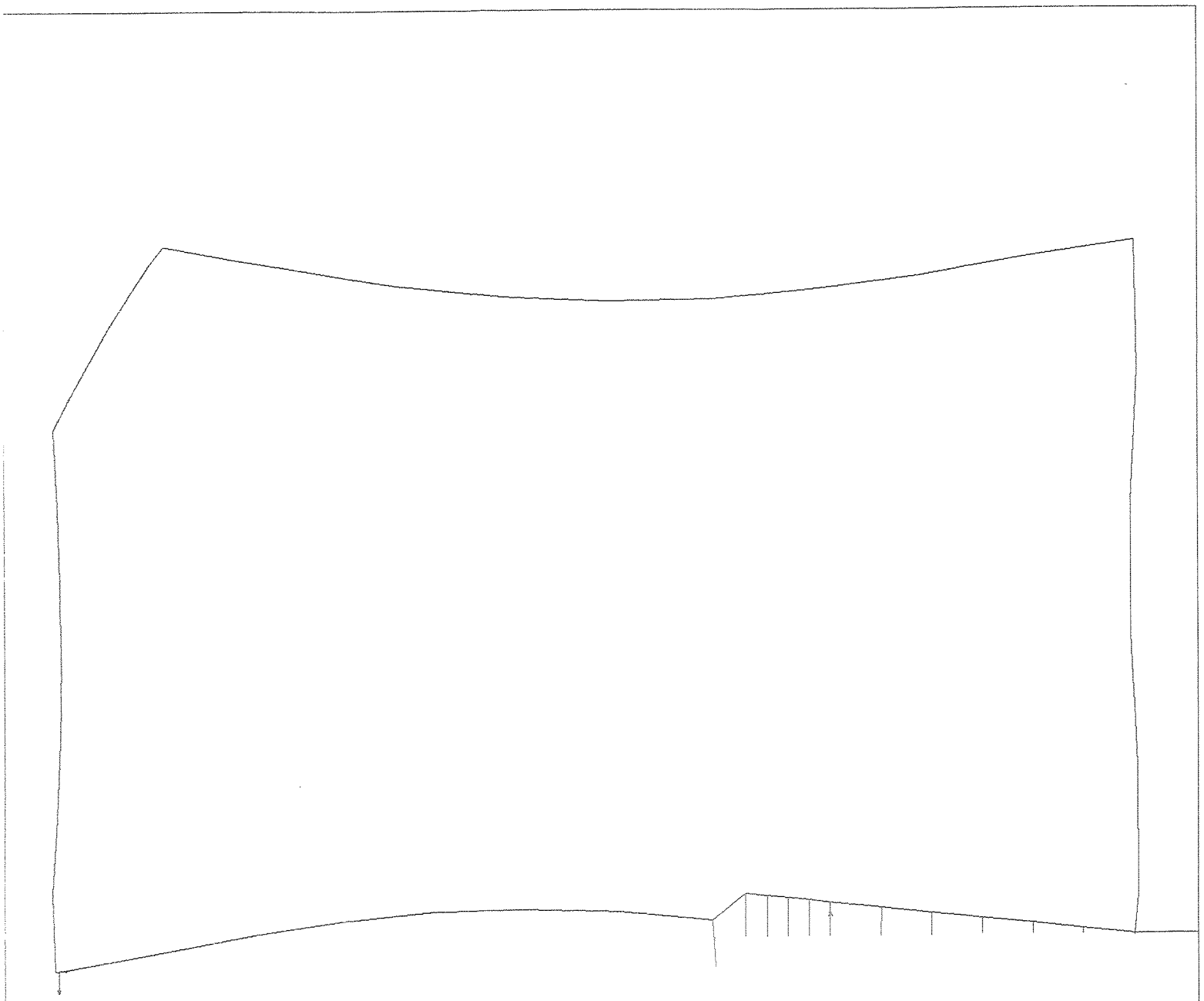
ANSYS
85/10/21
10.6408
PLOT NO. 3
PREP7 ELEMENTS
NNUM=1
TOBC=1

ORIG SCALING
ZV=1
DIST=12.3
XF=33.6
YF=7.89



ANSYS
85/10/21
10.6675
PLOT NO. 5
POST1
STEP=1
ITER=10
DISPLACEMENT

ORIG SCALING
ZV=1
DIST=12.4
XF=33.7
YF=7.89
DMAX=.0207
DSCA=60

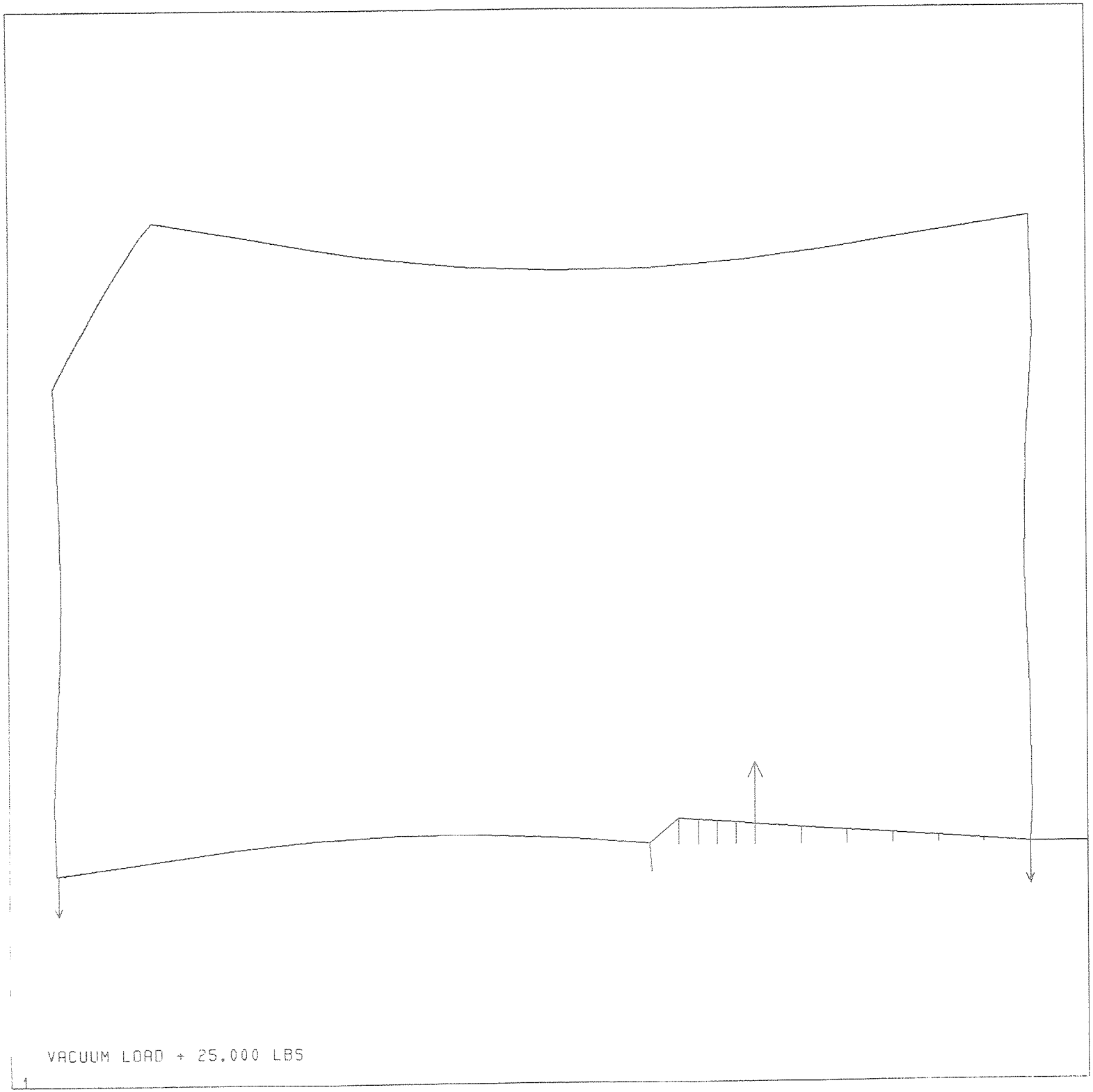


ANSYS
85/10/21
10.6678
PLOT NO. 6
POST1
STEP=2
ITER=10
DISPLACEMENT

ORIG SCALING
ZV=1
DIST=12.4
XF=33.7
YF=7.89
DMAX=.0176
DSCA=70.4

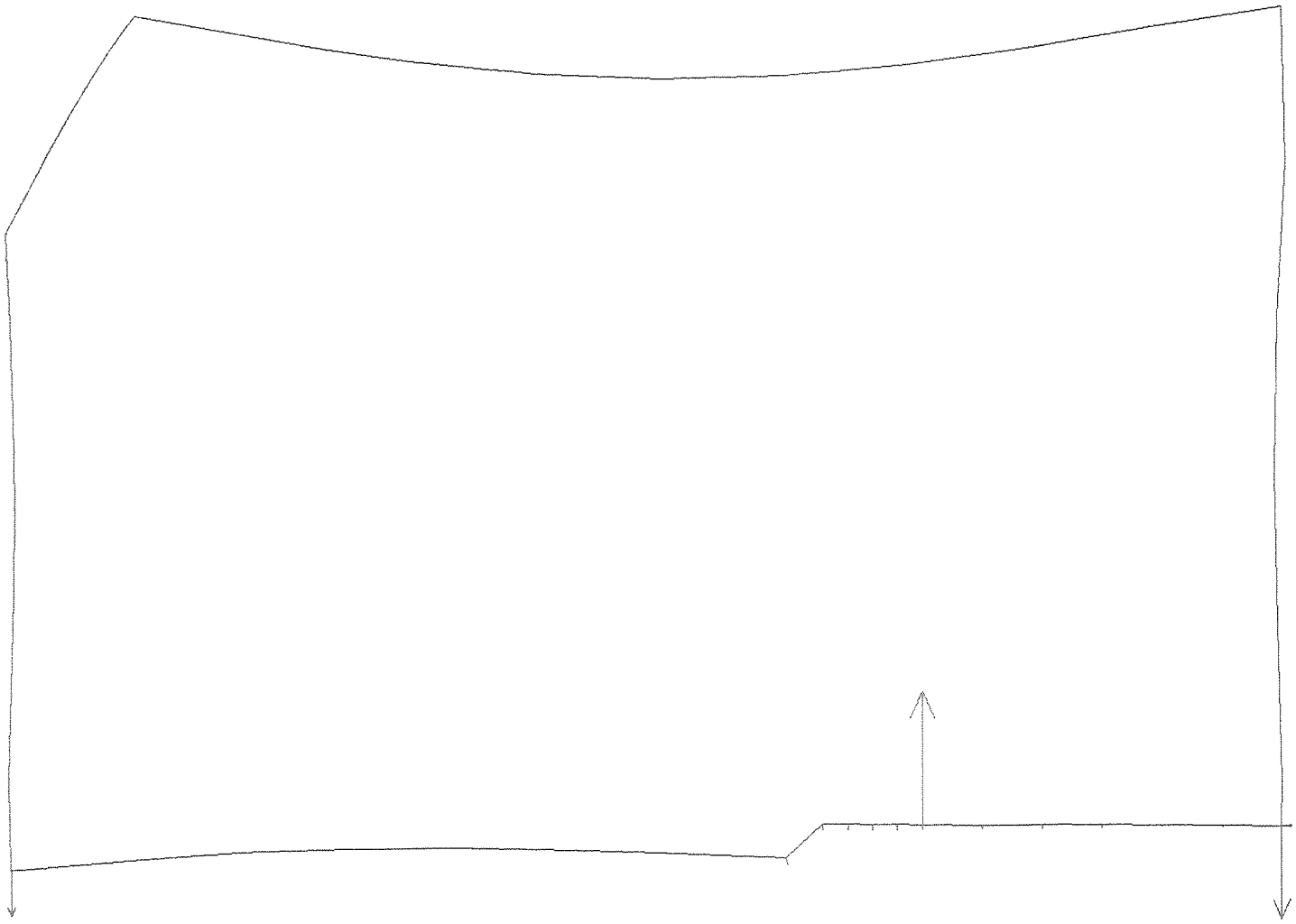
VACUUM LOAD + 10.000 LBS

1



ANSYS
85/10/21
10.6678
PLOT NO. 7
POST1
STEP=3
ITER=10
DISPLACEMENT

ORIG SCALING
ZV=1
DIST=12.4
XF=33.7
YF=7.87
DMAX=.0176
DSCA=70.3



ANSYS

85/10/21

10.6678

PLOT NO. 8

POST1

STEP=4

ITER=10

DISPLACEMENT

ORIG SCALING

ZV=1

DIST=12.3

XF=33.6

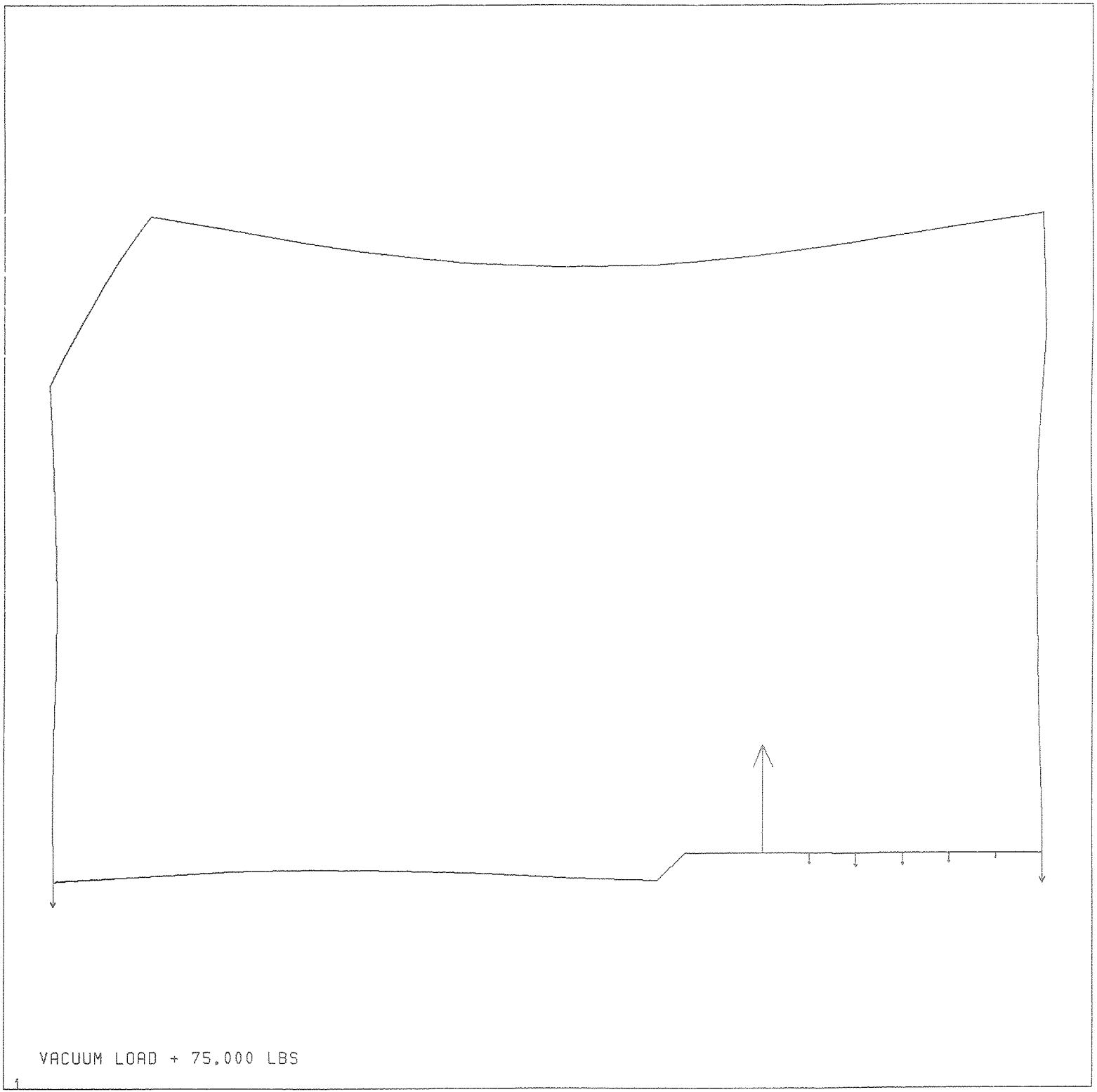
YF=7.87

DMAX=.0177

DSCA=69.6

CVACUUM LOAD + 50,000 LBS

1



ANSYS
85/10/21
10.6681
PLOT NO. 9
POST1
STEP=5
ITER=10
DISPLACEMENT

ORIG SCALING
ZV=1
DIST=12.3
XF=33.6
YF=7.88
DMAX=.0177
DSCA=69.5