Fermilab

TS-SSC 91-179
9/13/91
J. Strait

DCA312 Shell Gauge Data During Welding Operation

Prior to shell welding, strain gauges were mounted on the shell of DCA312 at the locations shown in Fig. 1. Data were collected during the closure and energization of the press, after each weld pass, and as the press was opened. The measured strain changes, without use of the compensating gauges, is shown in Table I. Compensating gauge C1 failed when the press was first closed and its data are not shown. Between the second and third data set the yoking press was closed by lowering the upper platen until it was supported by the magnet. Although the hydraulic pressure listed in column 1 is zero, it is apparent that a considerable load is present due to the weight of the platen and tooling.

Figure 2 plots the data sequentially. As the press is first closed and then energized, the shell is caused to conform to the yoke and irregularities in the local radius of curvature of the shell are brought closer to the radius of the yoke. This causes local bending of the shell which causes some gauges to show positive and some to show negative strain changes. Then the shell is welded and after each weld pass there is an increase in the strain measured by most gauges. Then as the press is opened there is a modest redistribuition of the stresses.

Figure 3 shows the strain changes in each gauge as a function of press load during the initial energization. The offsets result from the load due to the weight of the press platen. The gauges at the same azimuth at each end of the magnet tracke each other reasonably well indicating that the structure of local radius of curvature of the shell is the same along its length. The compensating gauges shows a non-zero effect of press load, but this effect is small compared with the active gauges.

Figure 4 is a plot of the strain change due to closure and loading of the press as a function of angular distance from the weld. Figure 5 shows the change due to welding. This change is a combination of tensile stress and local bending as the azimuthal tension causes the shell to conform further to the shape of the yoke. The bending effects should be of the same sign as those observed during press closure; for example the high point at 28 degrees in Figure 5 appears alos in Figure 4. The circles in Figure 5 are plotted by arbitrarily subtracting the average of the two strains at each azimuth in Figure 4 from those in Figure 5. The data suggest that the strain near the weld, is approximately 1500 - 2000 microstrain, corresponding to a stress of 45 - 60 kpsi. Far from the weld the stress is much lower due to friction between the shell and the yoke and tooling[1]. The gauges at 61 degrees show essentially no strain change, either with press closure (dominantly bending) or welding (tension plus bending). That the gauges at both ends behave in the

same manner suggests that this is not an instrumental effect. It is difficult to understand this behavior as there are no irregularities in the yoke surface in this region.

Figure 6 shows the strain change as the press is opened. As the press load is removed the frictional force (proportional to the radial force between the shell and the yoke and tooling) decreases and the shell stress redistributes. As expected[1] there is a reduction of the stress (by several kpsi) near the weld and a comparable increase far from the weld.

REFERENCES

[1] J. Strait, Analysis of yoke-skin interaction, TS-SSC 90-040, 6/28/90.

Distribution:
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Table I

DCA312 50mm LONG MAGNET PRE-WELD INSTRUMENTATION DATA FILES
R.KUNZELMAN & R.TUSKEY T/S ENGINEERING LAB

FORCE	Sens 2 -A1-	Sens 3 -A2-	Sens 4 -A3-	Sens 6 -A4-	Sens 7 -A5-	Sens 8 -A6-	Sens 9 -A7-	Sens 10 -A8-	Sens 12 -A9-	Sens 13 -A10-	Sens 11 -C2-		
P(hydr)	17o (L)	28o (L)	36o (L)	61o (L)	90o (L)	17o (R)	28o (R)	36o (R)	61o (R)	90o (R)	Comp		
0	0	0	0	0	0	0	0	0	0	0	0	Pre-weld	8/31/91 11:14:44
0	2	2	2	2	2	2	8	2	2	2	2		
0	68	78	-190	139	-15	150	209	-217	204	13	24		9/ 4/91 09:42:14
1000	99	258	-262	12	-103	182	378	-306	187	-59	22		
2000	103	360	-297	-39	-116	191	491	-357	163	-45	21		
3000	107	435	-315	-57	-90	206	571	-380	145	-8	19		
4000	111	494	-327	-70	-53	210	630	-398	138	23	18		
5000	117	560	-332	-75	-15	210	674	-409	139	56	24		
6000	117	620	-338	-80	24	210	712	-409	133	94	23		
7000	122	653	-338	-91	68	210	745	-403	139	128	24		
6000	122	626	-338	-97	51	210	712	-415	133	111	23		
5800	753	2099	189	-91	282	715	1878	52	243	347	13	1st	weld pass 9/6/91 07:41
5800	751	2097	192	-93	280	713	1870	50	236	334	6		
5800	1462	2945	761	-88	416	1265	2586	410	268	541	-6	2nd	weld pass 9/6/91 11:58
5800	1466	2943	760	-90	414	1268	2584	409	266	539	-13		
5800	2069	3496	1105	-85	540	1521	2928	578	233	610	-24	final	weld pass 9/9/91 07:19
5076	2068	3495	1109	-75	545	1531	2938	594	243	620	-14		9/9/91 15:08:46
4000	2070	3498	1106	-78	547	1528	2941	585	251	623	-12		
2000	1939	3433	1096	21	602	1523	2941	591	295	672	-6		
0	1925	3413	1065	133	703	1525	2938	593	407	756	-15		

Strain change due to press closure

Angle	17	28	36	61	90	Comp
Lead End	122	653	-338	-91	68	24
Ret. End	210	745	-403	139	128	
Average	123					

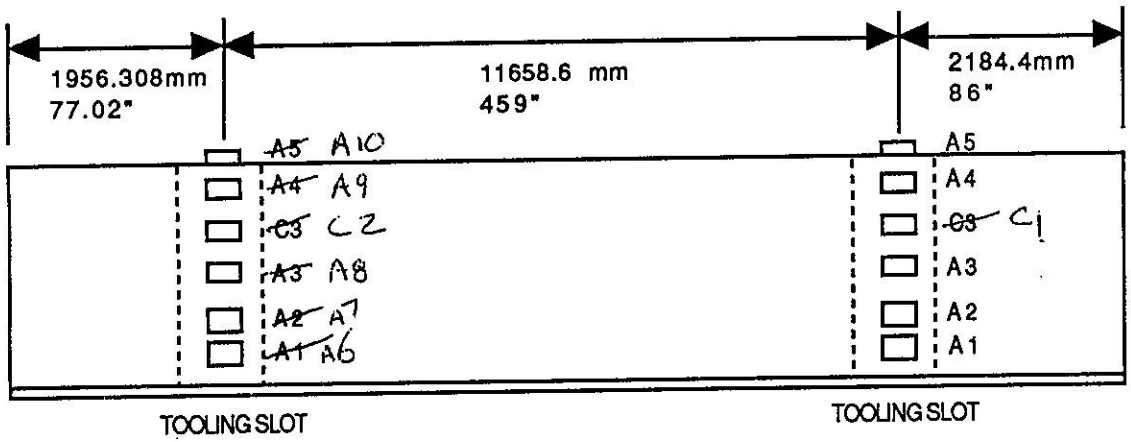
Strain change due to welding

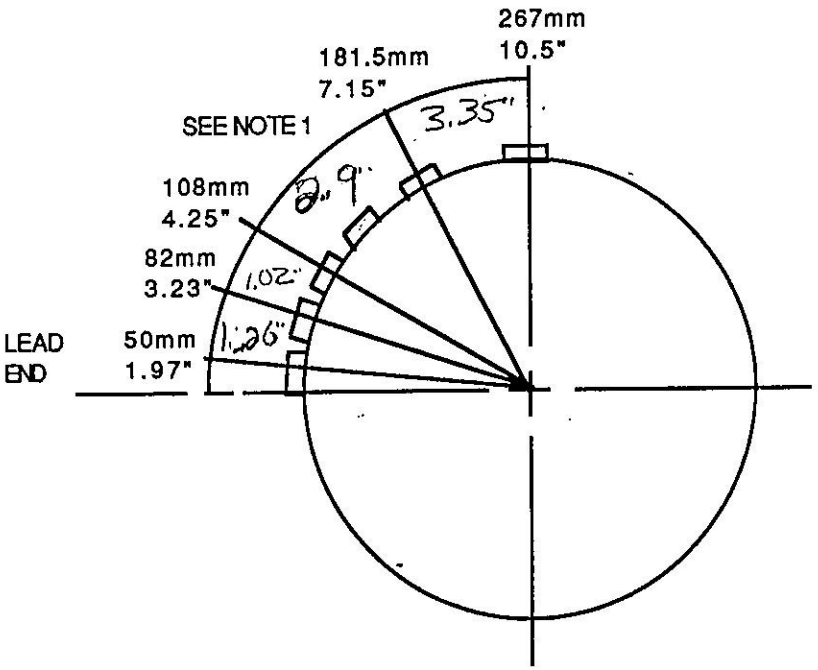
Angle	17	28	36	61	90	Comp
Lead End	1947	2870	1443	12	489	-47
Ret. End	1311	2216	993	100	499	
Average	1188					

Strain change due to press opening

Angle	17	28	36	61	90	Comp
Lead End	-144	-83	-40	218	163	9
Ret. End	4	10	15	174	146	
Average	46					

50MM DIPOLE SKIN STRAIN GAGE PLACEMENT





NOTES:
1. DIMENTIONS ARE RADIAL, FROM CENTER OF ALIGNMENT KEY TO CENTER OF STRAIN GAGE.
2. GAGES LABELED "A" ARE ACTIVE GAGES MEASURING STRAIN IN THE AZIMUTHAL DIRECTION, GAGES LABELED "C"ARE COMPENSATING GAGES.
3. COMENSATING GAGE C3 IS TO BE PLACED BETWEEN ACTIVE 3 AND 4.
4. ONE COMPENSATING BLOCK TO BE WELDED.
5. GAGES AND WIRES MUST FIT WITHIN A 50. MM(2 INCH) WIDE SLOT CENTERED ON THE GAGE.

Figure 1

MIKE GORDON
7/13/91

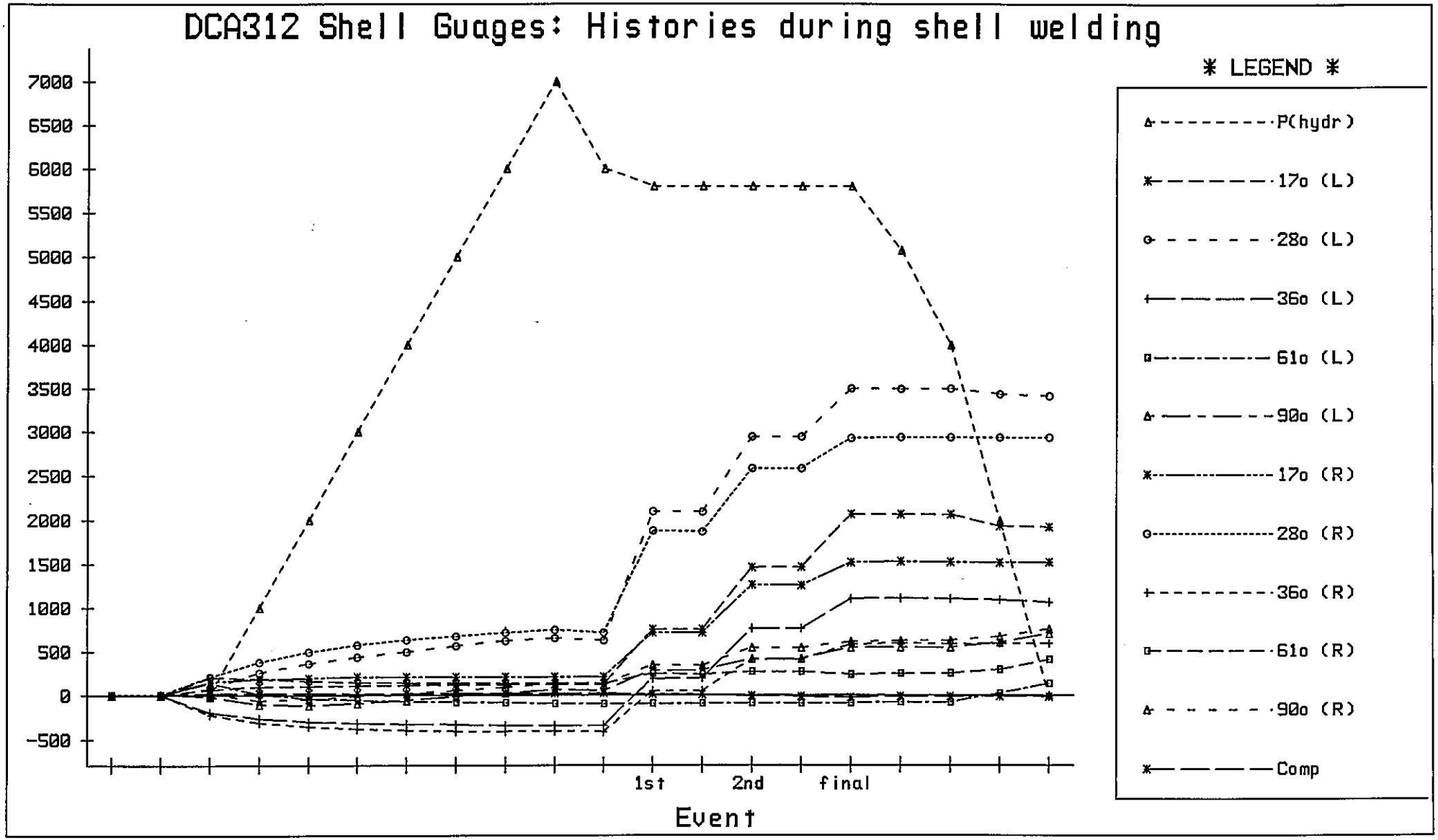

DCA312 Shell Guages: Histories during shell welding
* LEGEND *
P(hydr)
17o (L)
28o (L)
36o (L)
61o (L)
90o (L)
17o (R)
28o (R)
36o (R)
61o (R)
90o (R)
Comp
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
1st
2nd
final
Event

Figure 2

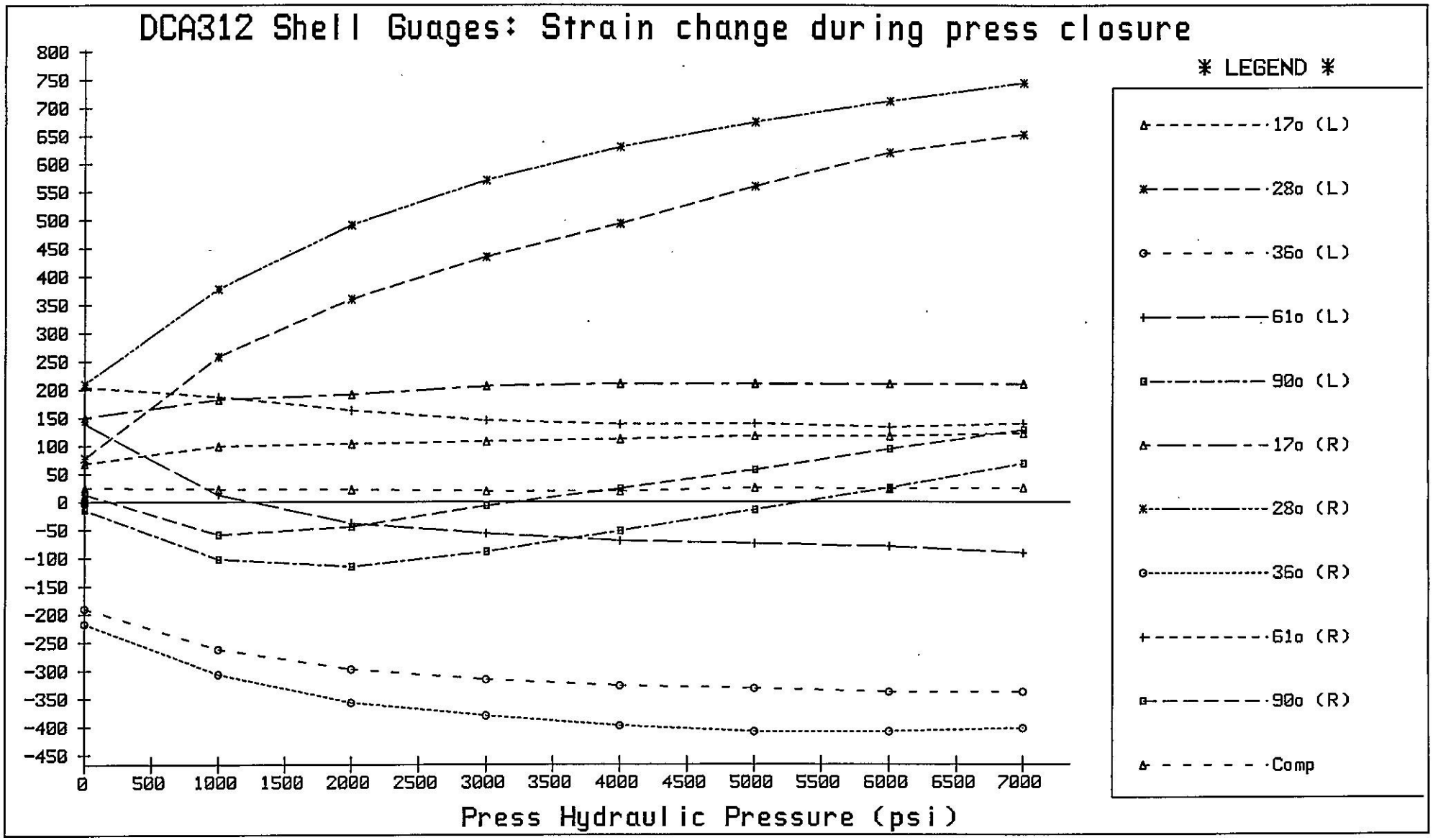

DCA312 Shell Guages: Strain change during press closure
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
Press Hydraulic Pressure (psi)
* LEGEND *
17o (L)
28o (L)
36o (L)
61o (L)
90o (L)
17o (R)
28o (R)
36o (R)
61o (R)
90o (R)
Comp

Figure 3

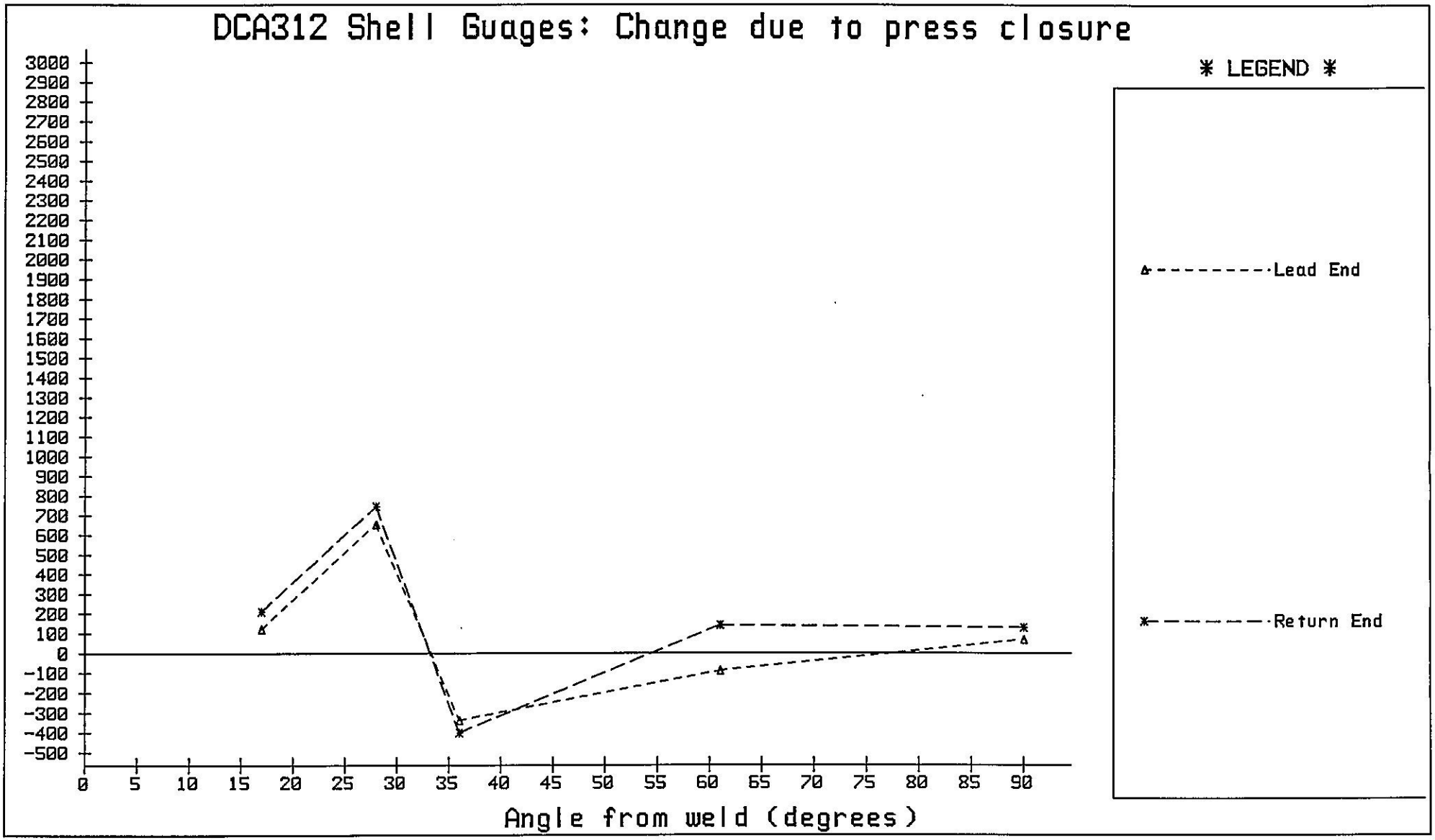

DCA312 Shell Guages: Change due to press closure
* LEGEND *
Lead End
Return End
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Angle from weld (degrees)

Figure 4

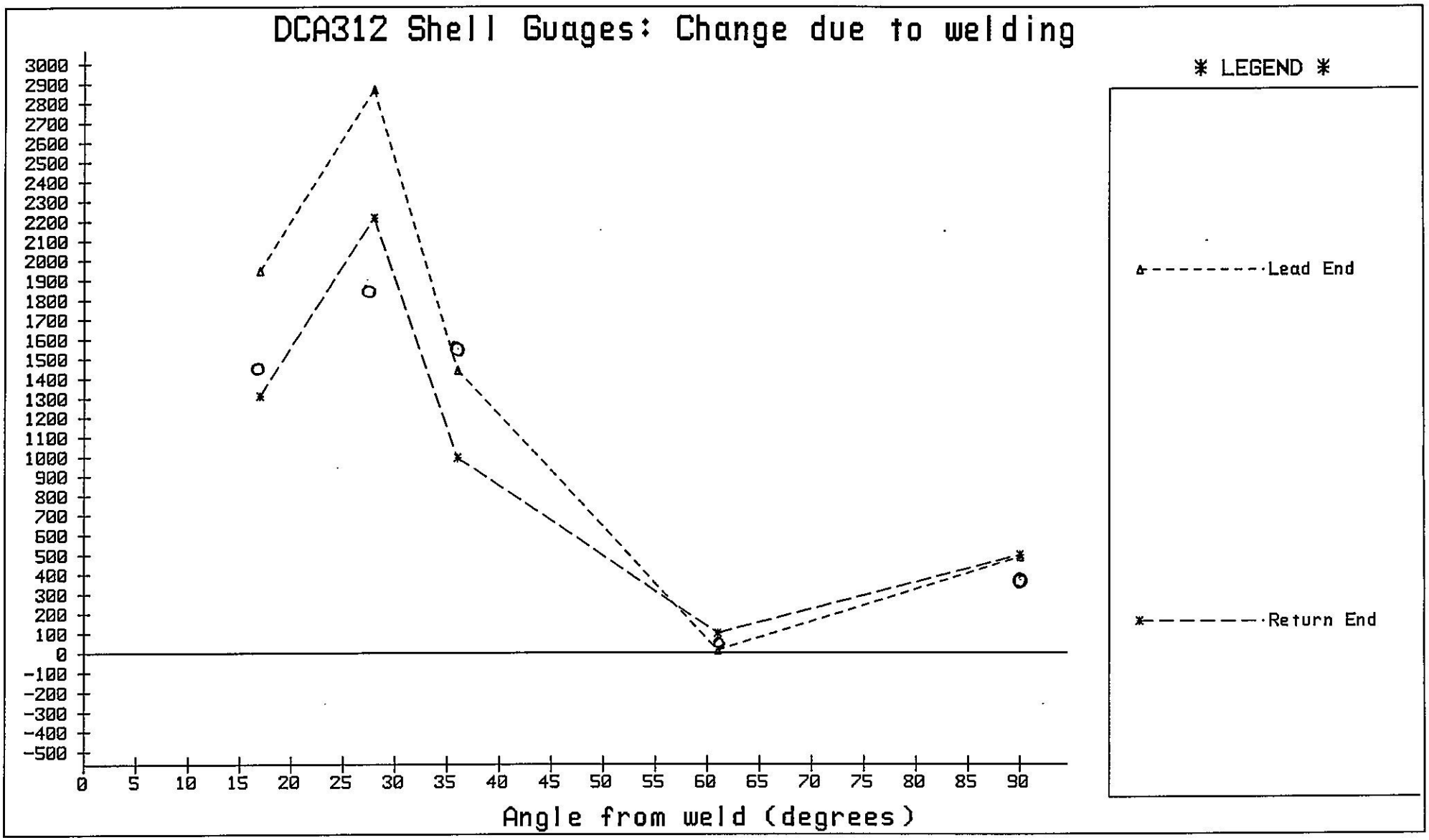

DCA312 Shell Guages: Change due to welding
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Angle from weld (degrees)
* LEGEND *
Lead End
Return End

Figure 5

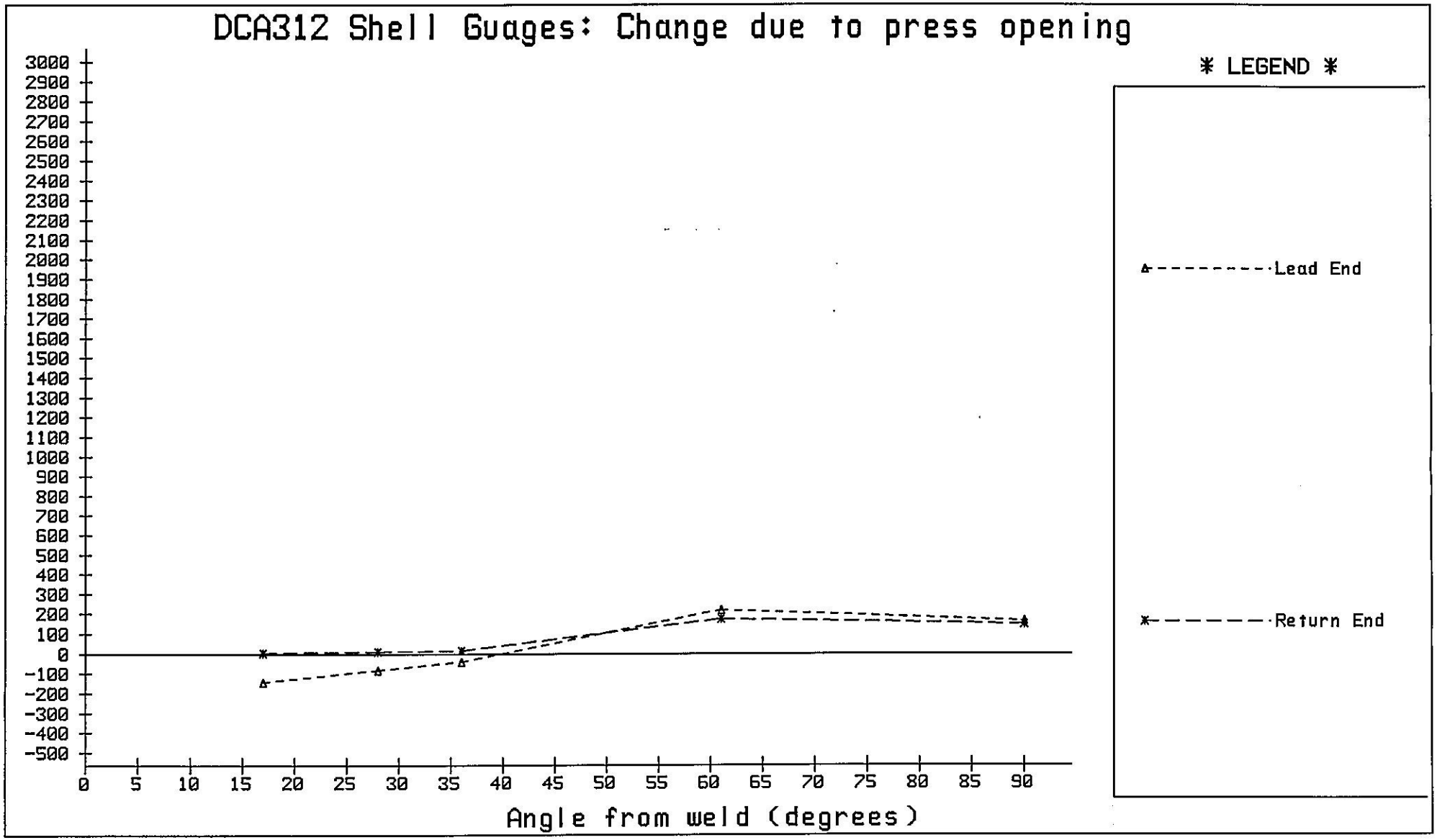

DCA312 Shell Guages: Change due to press opening
* LEGEND *
Lead End
Return End
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Angle from weld (degrees)

Figure 6