Fermilab

TS-SSC 91-184
9/24/91
J. Strait

DCA313 Shell Gauge Data During Welding Operation

Attached are shell strain gauge data taken during the welding of DCA313. The gauges are at the same locations as on DCA312 and the same analysis and plots are shown here as for 312[1]. The data are displayed in Table I. The gauge at 36 degrees near the lead end failed when the press was closed and it is not included in the table. The compensating gauge towards the return end (C2) failed during the welding process; its data are included in the table but not in the plots.

Figure 1 plots the data sequentially and Figure 2 shows the strain changes versus press load before welding. There were apparently no data taken after the upper press platen was lowered onto the magnet but before the hydraulic cylinders were energized. Otherwise the data follow the same pattern as DCA312: bending effects drive some gauges positive and others negative as the press closes, strains increase as the shell is welded, and then redistribute themselves slightly as the press is opened. Figure 3 shows the strain change from the press closure versus the angle from the weld. The pattern of bending effects is qualitatively the same as in DCA312. Figure 4 is a plot of the strain change due to welding. As in DCA312, there is a large change in the gauges at 17, 28 and 36 degrees, relatively little change at 61 degrees, and a somewhat larger change at 90 degrees. The change when the press is opened is plotted in Figure 5. As in DCA312 the stress redistributes slightly from the shell parting plane towards 90 degrees.

The effect of welding is a combination of azimuthal tension and further bending as the shell is pulled into better conformance with the yoke. Figure 6 shows crude attempts at correcting for the bending by subtracting from the raw strain change a multiple of the bending observed as the press is closed. Plotted there are the average of the two gauges versus angle from the weld, and this average corrected by subtracting 1 and 1.5 times the change with press closure. The case of a 1.5 times the press closure change yields a smooth distribution over the 17-36 degree gauges (which does not prove that this correction is correct). As with DCA312 the apparent strain change due to shell tension near the weld is on the order of 1500 microstrain, corresponding to a stress of 45 kpsi.

However, the corrected strain changes at 60 and 90 degrees are still quite small and, as with DCA312, a smooth distribution cannot be obtained by this simple correction procedure. It is quite possible that there really is a large loss of stress between the 36 and 61 degree measurements because the shell could be binding on the yoke pack pick-up features near 45 degrees[2]. This does not, however, explain how there can be a substantially larger strain change at 90 degrees than at 61 degrees. The gauges have already been mounted

on the shell for DCA314, but it is planned to change the locations of the gauges on DCA315 to try to understand this pattern.

REFERENCES

[1] J. Strait, DCA312 Shell Gauge Data During Welding Operation, TS-SSC 91-179, 9/13/91.

[2] This was pointed out to me by Eric Haggard.

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Table I

DCA313 50mm Long Magnet Pre-weld Instrumentation Data Files
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CALCULATED STRAIN READINGS

Force	-A1-	-A2-	-A3-	-A4-	-A5-	-A6-	-A7-	-A8-	-A9-	-A10-	-C1-	-C2-				
P(hydr)	17o (L)	28o (L)		61o (L)	90o (L)	17o (R)	28o (R)	36o (R)	61o (R)	90o (R)	-C1-	-C2-				
0	0	0		0	0	0	0	0	0	0	0	0		9/16/91	11:11:31	
0	2	-3		2	2	2	7	2	7	7	2	2				
1000	200	445		55	-180	141	295	-116	109	82	-20	-3				
2000	224	561		10	-182	160	357	-139	112	149	-11	0				
2000	223	555		-1	-178	165	362	-129	111	154	-6	10		9/16/91	13:07:43	
3000	243	622		-14	-158	173	397	-137	114	189	2	8				
4000	237	648		-25	-126	179	424	-137	114	216	2	8				
5000	243	670		-35	-78	179	440	-126	125	253	-3	8				
6000	234	693		-50	-23	180	463	-114	132	293	-1	9				
7000	227	713		-51	23	184	472	-100	141	323	2	13				
6000	223	688		-60	4	180	452	-114	127	309	-1	9				
6000	1209	1833		43	313	768	1668	404	289	603	11	3	root	1st root	9/18/91	7:50:41
6000	1213	1837		35	311	754	1660	398	288	595	9	-4		2nd root	9/18/91	7:53:27
6000	1211	1835		45	321	764	1670	406	292	605	13	6				
5350	1792	2719		80	517	1791	2381	905	368	800	12	1643	fill	1st filler	9/19/91	7:24:05
5360	2081	3191		96	586	2127	2746	1129	385	864	5	-20		2nd filler	9/19/91	13:07:41
5361	2104	3230		90	603	2153	2784	1155	384	886	10	1676				
5200	2111	3237		97	610	2160	2797	1172	401	904	22	1689				
4000	2108	3234		104	612	2162	2798	1164	398	900	24	1691				
2000	2095	3216		129	643	2160	2792	1157	428	920	22	1694				
0	2058	3174		258	749	2150	2770	1146	487	984	22	1689				
0	2056	3172		266	758	2148	2768	1144	491	983	26	1692				

Strain change due to press closure

Angle	17	28	36	61	90
Lead End	227	713		-51	23
turn End	184	472	-100	141	323
Average	206	593	-100	45	173

Strain change due to welding

Angle	17	28	36	61	90
Lead End	1881	2542		150	599
turn End	1973	2332	1269	257	577
Average	1927	2437	1269	204	588
-Closure	1722	1845	1369	159	415
*Closure	1619	1548	1419	136	329

Weld - 1*closure
Weld - 1.5*closure

Strain change due to press opening

Angle	17	28	36	61	90
Lead End	-48	-58	0	176	155
turn End	-5	-16	-11	107	97
Average	-27	-37	-6	142	126

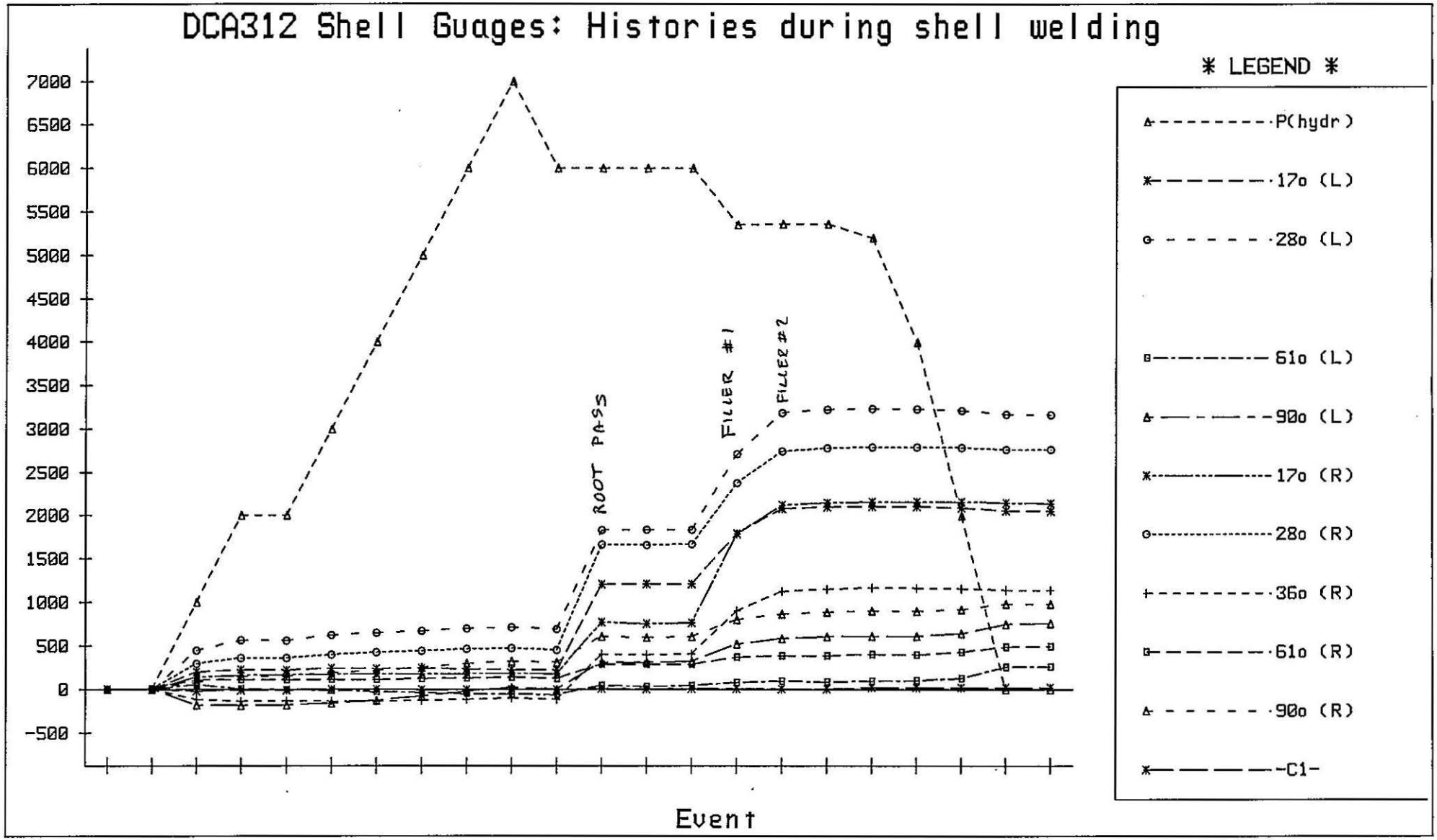
DCA312 Shell Guages: Histories during shell welding
* LEGEND *
P(hydr)
17o (L)
28o (L)
61o (L)
90o (L)
17o (R)
28o (R)
36o (R)
61o (R)
90o (R)
C1-
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
ROOT PASS
FILLER #1
FILLER #2
Event

Figure1

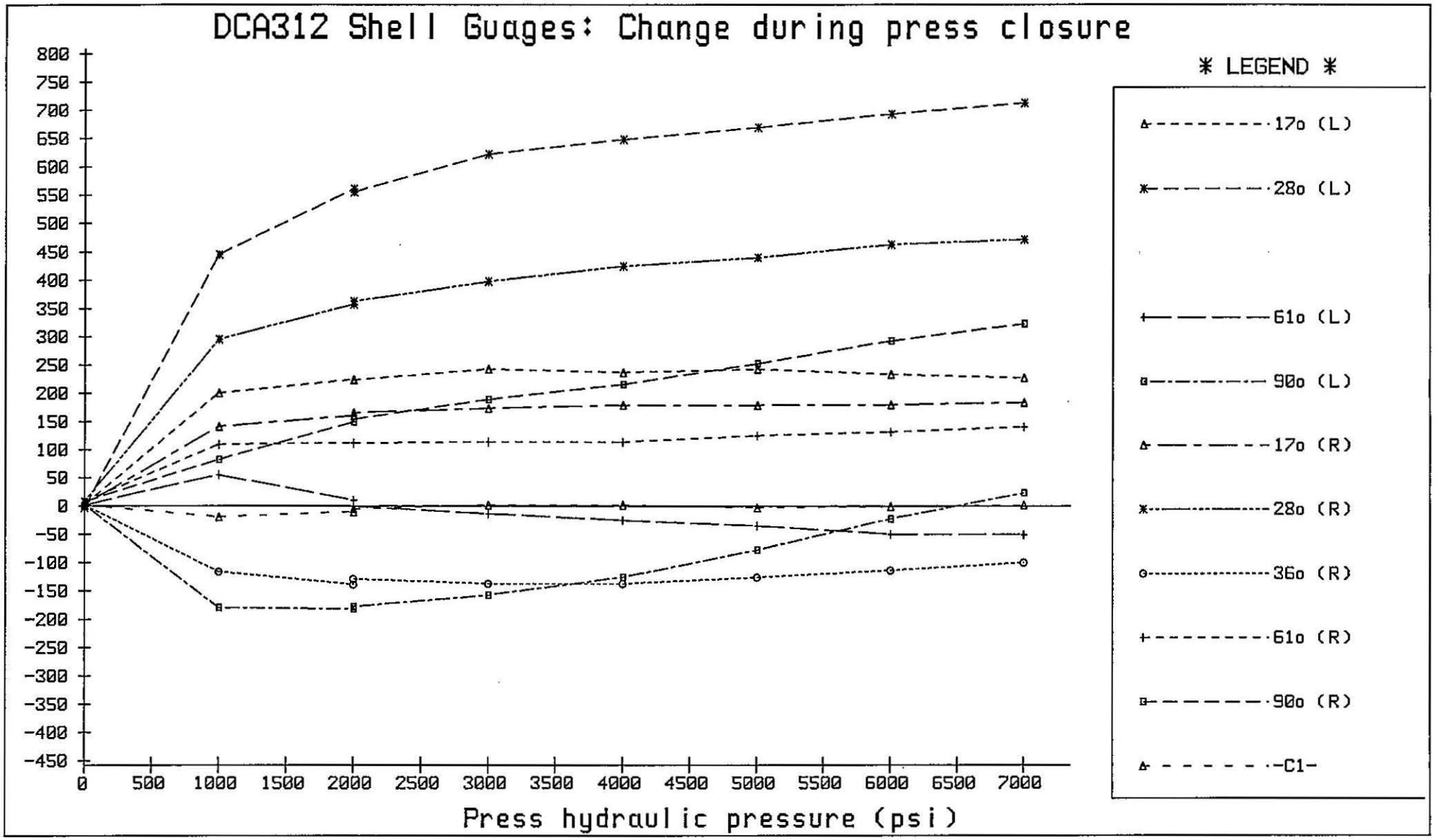
DCA312 Shell Guages: Change during press closure
* LEGEND *
17o (L)
28o (L)
61o (L)
90o (L)
17o (R)
28o (R)
36o (R)
61o (R)
90o (R)
-C1-
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
Press hydraulic pressure (psi)

Figure 2

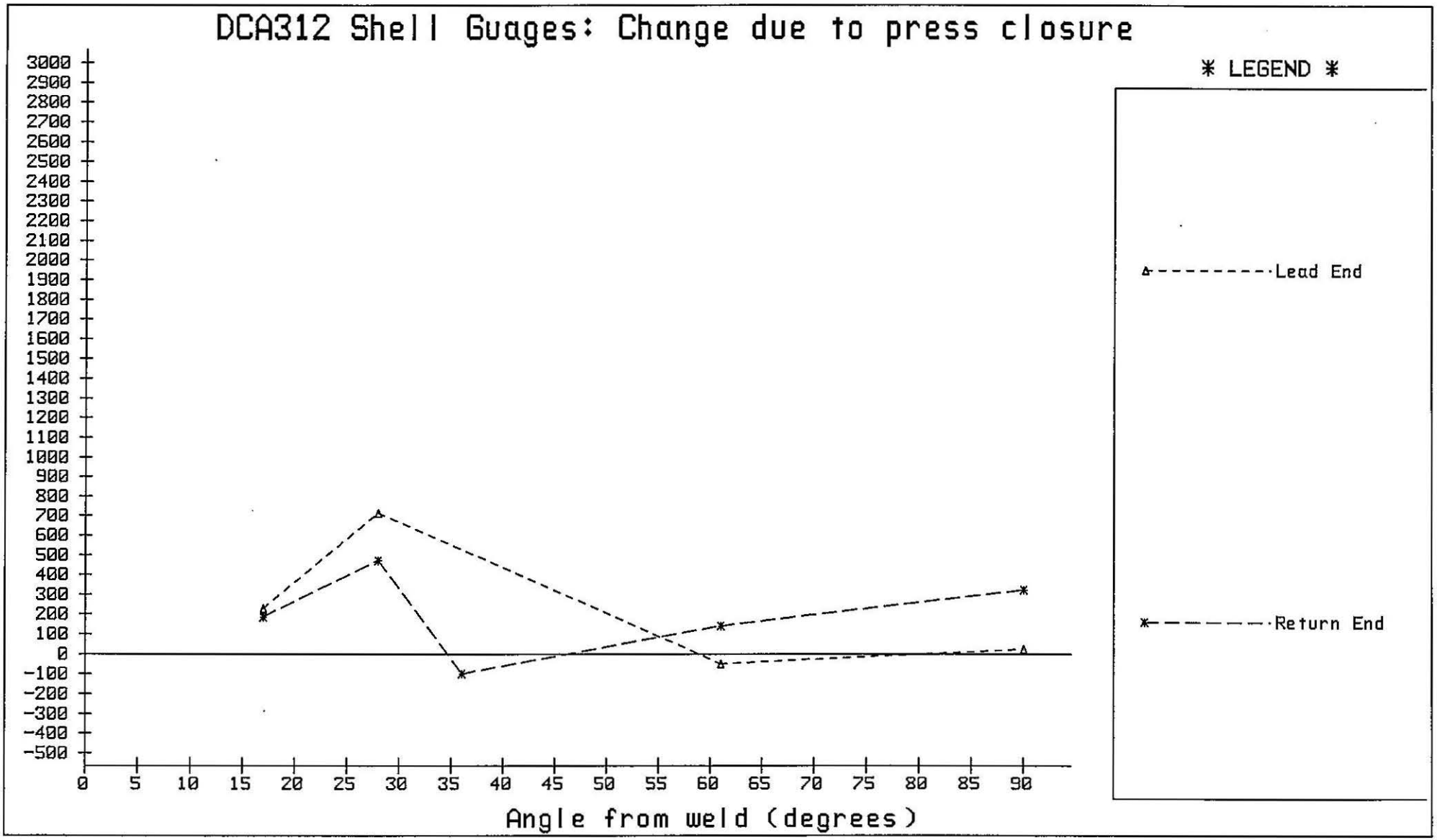
DCA312 Shell Guages: Change due to press closure
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Angle from weld (degrees)
* LEGEND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

Figure 3

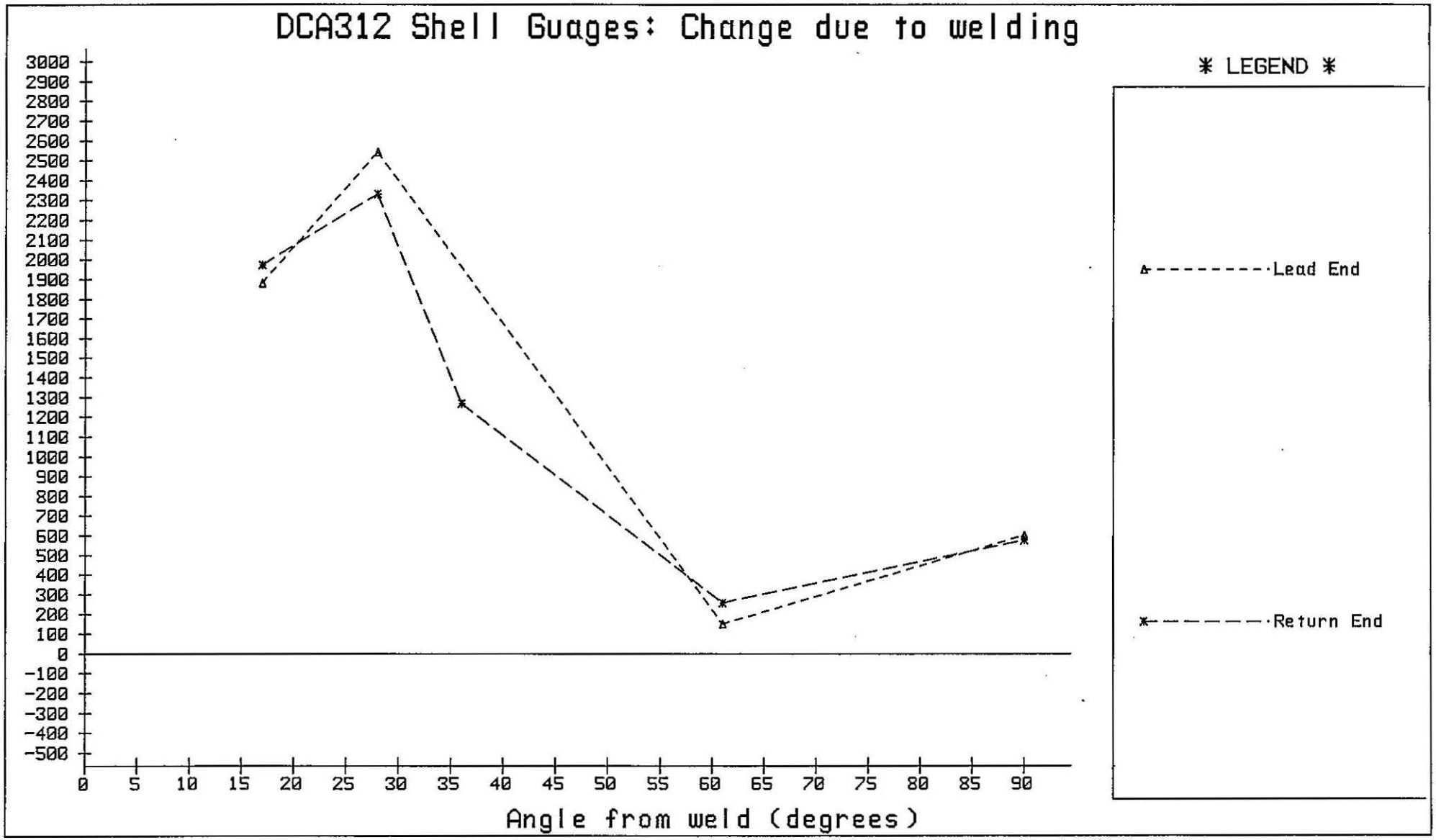
DCA312 Shell Guages: Change due to welding
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Angle from weld (degrees)
* LEGEND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

Figure 4

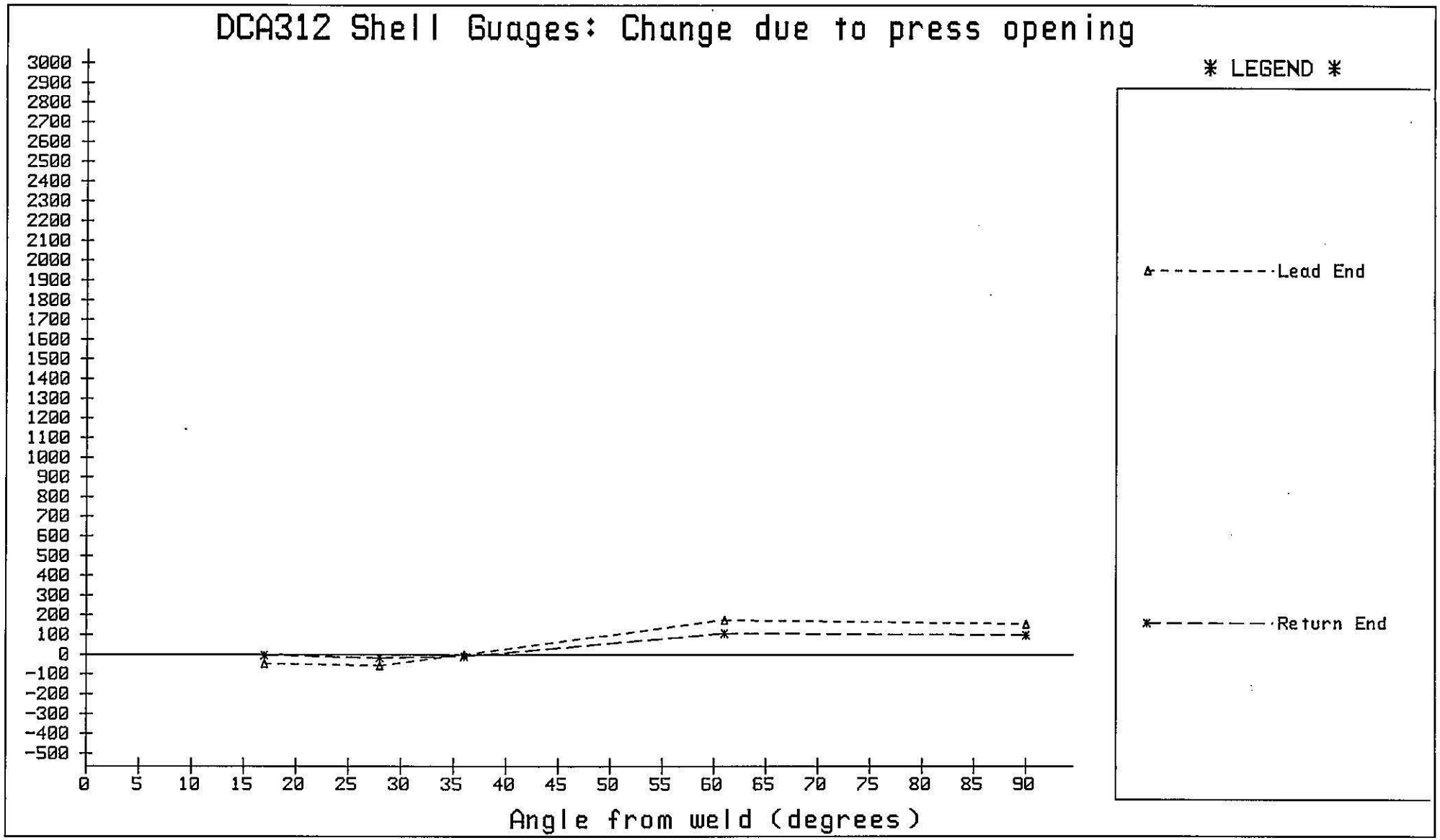
DCA312 Shell Guages: Change due to press opening
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Angle from weld (degrees)
* LEGEND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

Figure 5

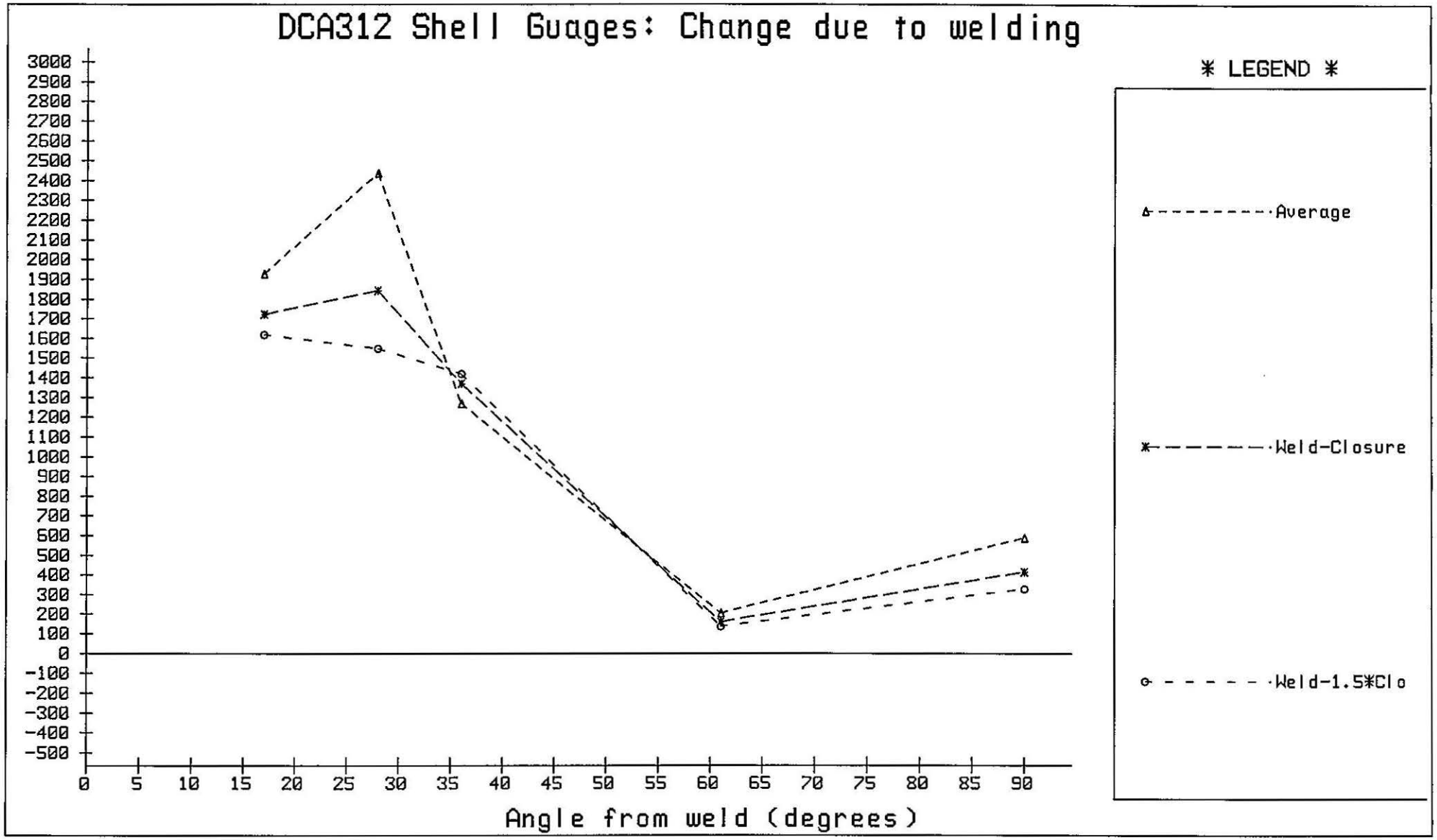
DCA312 Shell Guages: Change due to welding
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Angle from weld (degrees)
* LEGEND *
Average
Weld-Closure
Weld-1.5*Clo

Figure 6