January 24, 2023

Engineering Evaluation Report

Report No. CH327.I.EER.005, Issue 2

Part:

Ninety-Six (96) Competitor Long Life Igniter Assemblies

Table 1: Igniter Serial Numbers

Igniter #	Serial Number
1	LGM502
2	LGM516
3	LGM518
4	LGM529
5	LJH436
6	LJH449
7	LJJ595
8	LJJ596
9	LJJ610
10	LJK838
11	LJN404
12	LJN405
13	LJP312
14	LJT566
15	LJT571
16	LJT573
17	LJT578
18	LJT583
19	LJT790
20	LLD289
21	LLE048
22	LLE080
23	LLE095
24	LLE142
25	LPH198
26	LPY082
27	LPY084
28	LPY088
29	LPY092
30	LPY095
31	LPY114
32	LRE411
33	LRE423

Igniter #	Serial Number
34	LRE494
35	LRF360
36	LRH697
37	LRH702
38	LRH710
39	LRH716
40	LRH779
41	LRH894
42	LRH921
43	LRH945
44	LRH954
45	LRJ186
46	LRJ199
47	LRJ937
48	LRJ978
49	LRJ984
50	LRK018
51	LRK021
52	LRK024
53	LRK038
54	LRK042
55	LRK045
56	LRK116
57	LRK296
58	LRK298
59	LRK304
60	LRK320
61	LRK329
62	LRK337
63	LRK366
64	LRK377
65	LRK387
66	LRL508
67	LRL530
68	LRL536
69	LRL548
70	LRL550
71	LRL976
72	LRL978
73	LRM607
74	LRR121
75	LRW596
76	LRW623
77	LRW633
78	LRW641
79	LRW675

Igniter #	Serial Number
80	LRW744
81	LRW749
82	LRW802
83	LTC903
84	LTC926
85	LTH778
86	LTL150
87	LTL164
88	LTL170
89	LTM261
90	LTM508
91	LTP278
92	LTP343
93	LTP355
94	LTR079
95	LTR103
96	LTW708

Hours of Operation:
Unknown

Reason for Investigation:
These igniters were returned for evaluation.

Details of Investigation:
The ninety-six (96) igniter assemblies were visually examined. The following summary presents the results of visual review for each igniter assembly:

VISUAL:
(As Received)

All ninety-six (96) igniters had the external appearance for a used igniter. There was normal heat discoloration to the igniter bodies below the installation threads as well as residue of anti-seize compound in the installation threads as can be seen in **Figure 1**. **Photograph 1 through Photograph 20** are of all the examined parts. Igniters are labeled from top to bottom in the photo description.

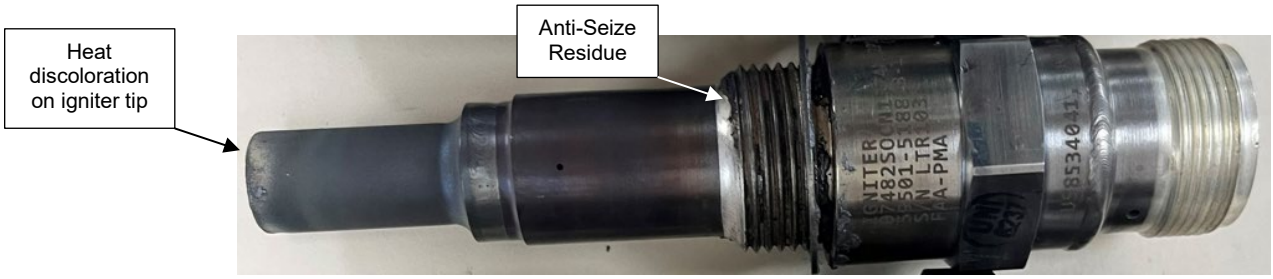


Figure 1: Typical Competitor Long Life Igniter Visual Examination

Photograph 1: Serial Numbers
LGM516 LPY084 LPY092 LRL976 LRK045

Photograph 2: Serial Numbers
LJH436 LRK116 LRK337 LGM529 LRW59

Photograph 3: Serial Numbers
LJJ595 LJJ596 LJT578 LPH198 LRF360

Photograph 4: Serial Numbers
LJK838 LRH716 LRH894 LRK304 LRH702

Photograph 5: Serial Numbers
LJT790 LTH778 LRW749 LTW708 LRJ984

Photograph 6: Serial Numbers
LLE095 LTM508 LRK038 LRL978 LPY114

Photograph 7: Serial Numbers
LLE142 LRL536 LRK018 LGM518 LJH449

Photograph 8: Serial Numbers
LRE411 LRE423 LTR079 LRK296 LTP278

Photograph 9: Serial Numbers
LRH697 LRH710 LRK366 LRJ186 LRK937

Photograph 10: Serial Numbers
LRH954 LJP312 LPY095 LTP343 LPY082

Photograph 11: Serial Numbers
LRJ199 LRM607 LJT573 LTL150 LRK024

Photograph 12: Serial Numbers
LRK298 LRK320 LRJ978 LRW641 LRK387

Photograph 13: Serial Numbers
LRK377 LRK021 LRL530 LRL550 LRW80

Photograph 14: Serial Numbers
LRW623 LRK042 LRW633 LJJ610 LRK32

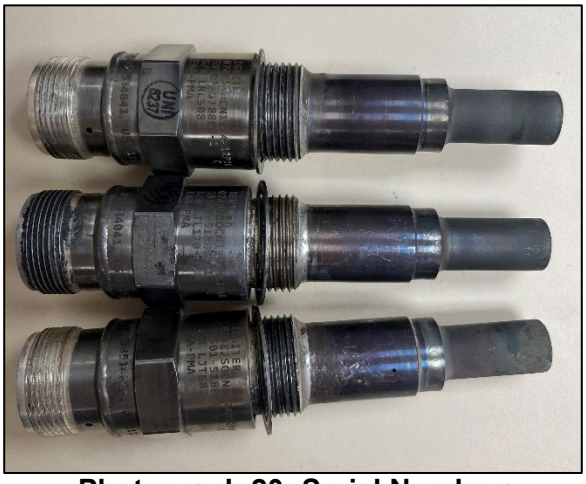
Photograph 15: Serial Numbers
LTC903 LTC926 LLE080 LTR103 LJN405

Photograph 16: Serial Numbers
LTL164 LRR121 LJT566 LJT571 LRH921

Photograph 17: Serial Numbers
LTM261 LLD289 LJN404 LRE494 LPY088

Photograph 18: Serial Numbers
LTP355 LGM502 LLE048 LRW675 LRW74

Photograph 19: Serial Numbers
LRH779 LRH945 LRL548



Photograph 20: Serial Numbers
LRL508 LTL170 LJT583

Terminal End:

Roughly 55% of the terminal wells inspected were clean, with the rest exhibiting some level of contamination. This could possibly be from the anti-seize compound noted in the installation threads. The photos in **Figure 4** show the varying levels of contaminates in the igniters.

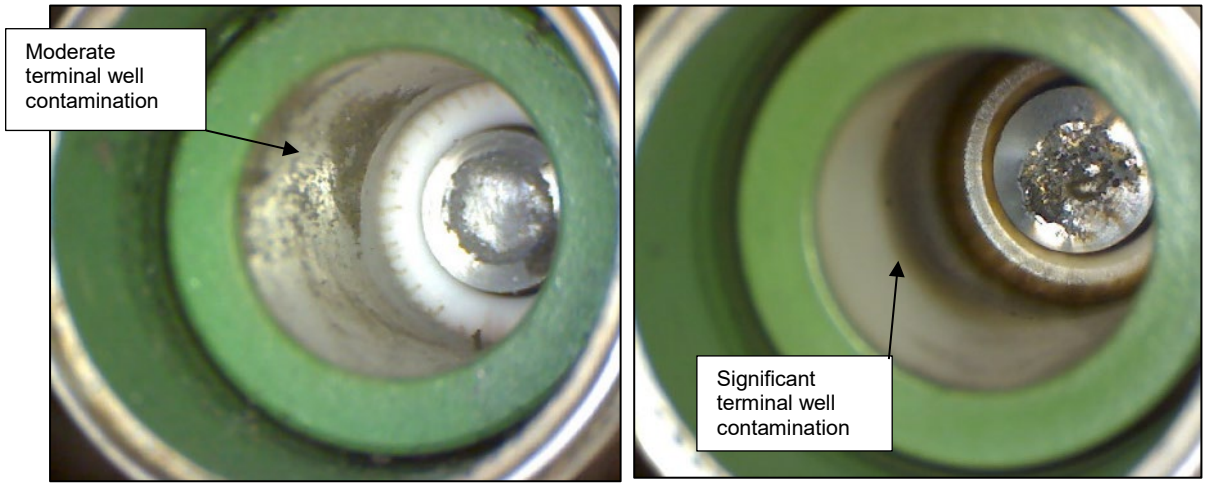


Figure 2: Terminal Well Contamination Example

In addition, roughly 31% of the contact buttons show signs of arcing on the button while the remaining units appeared to be clean. An example of this arcing can be found below in **Figure 3**.

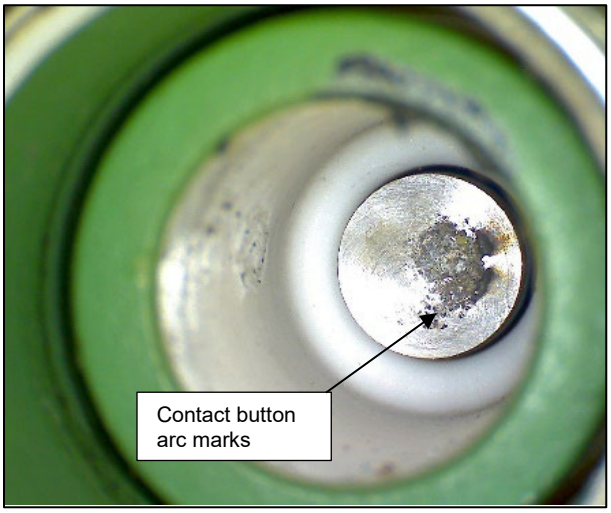
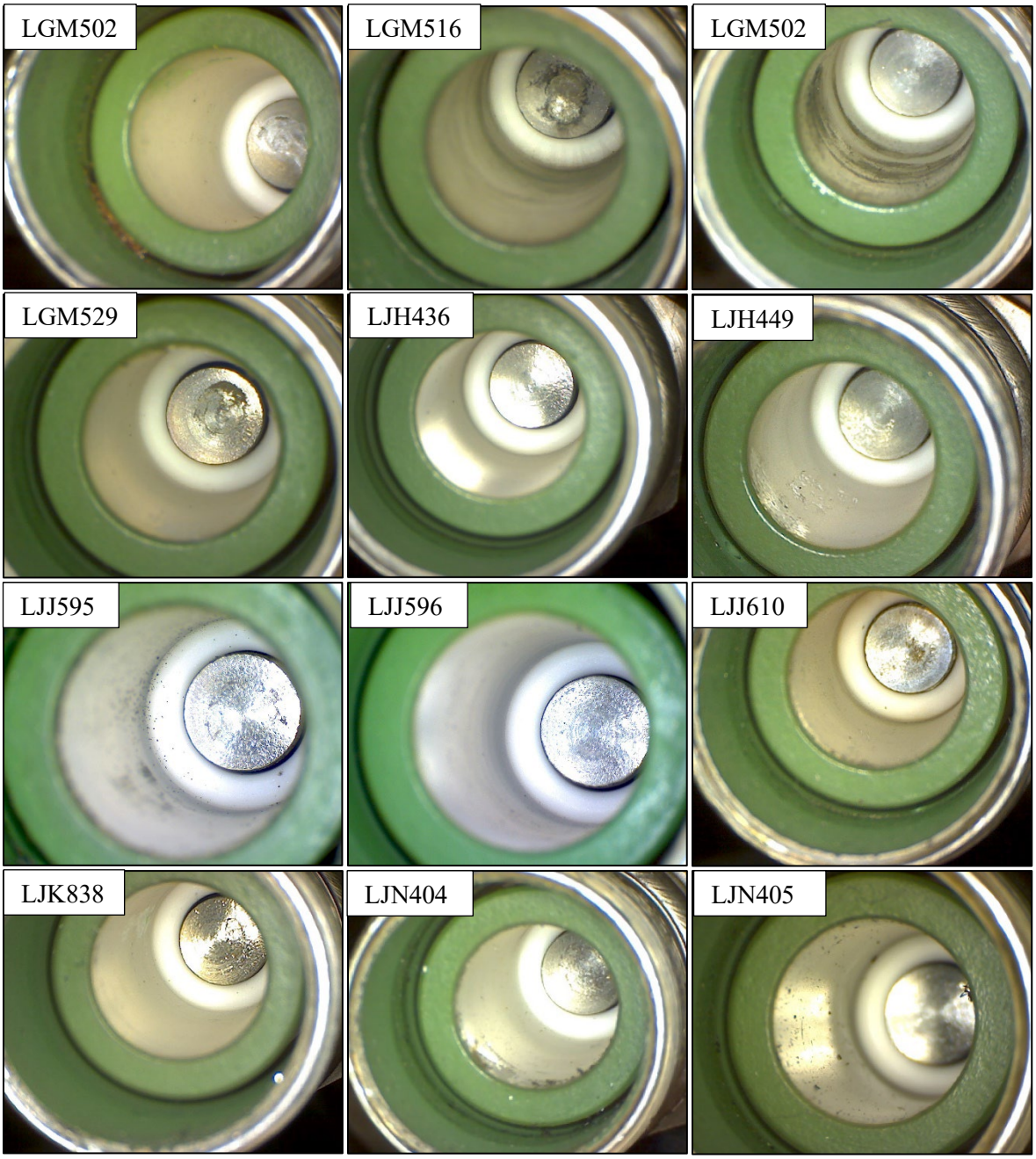
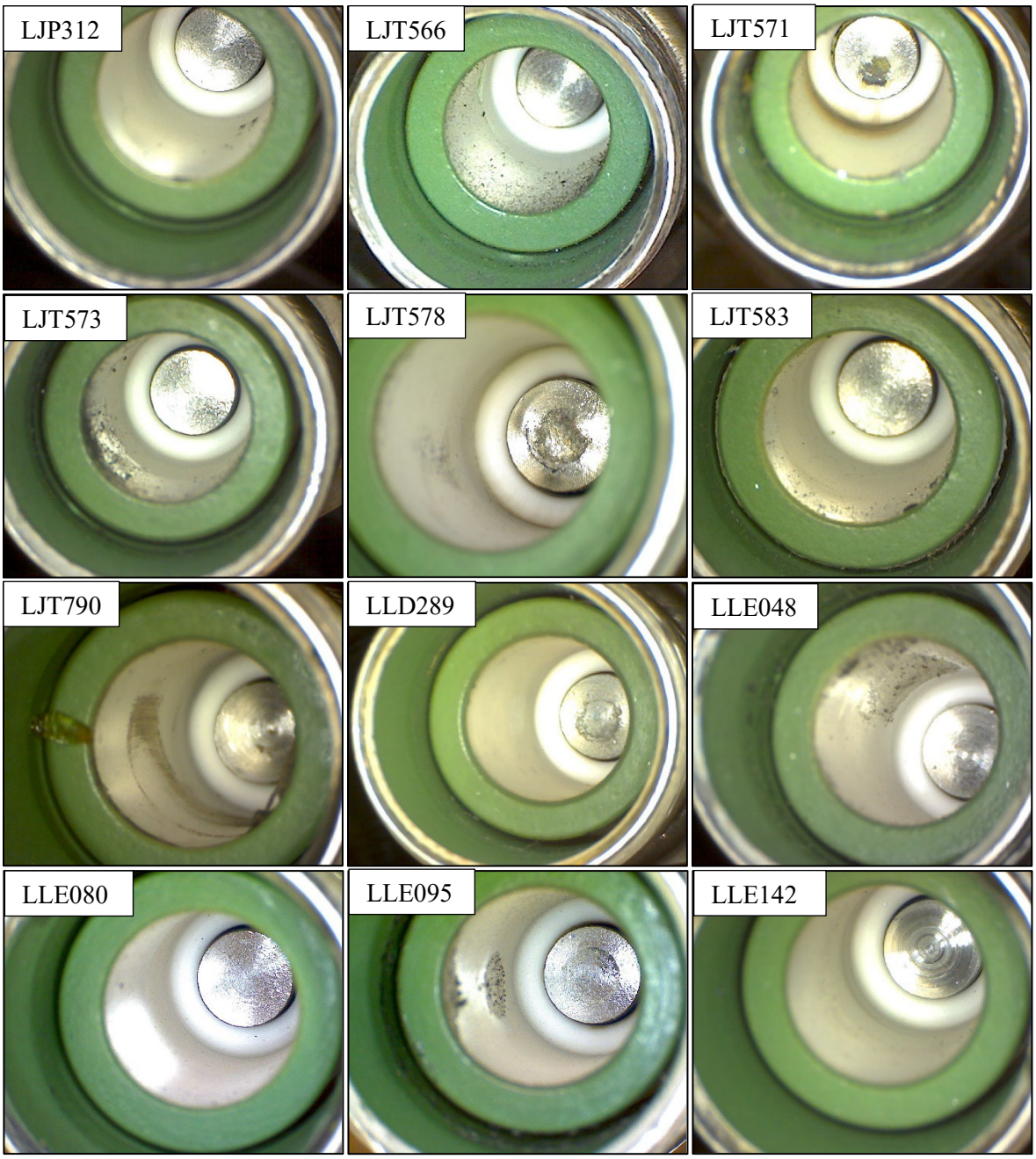
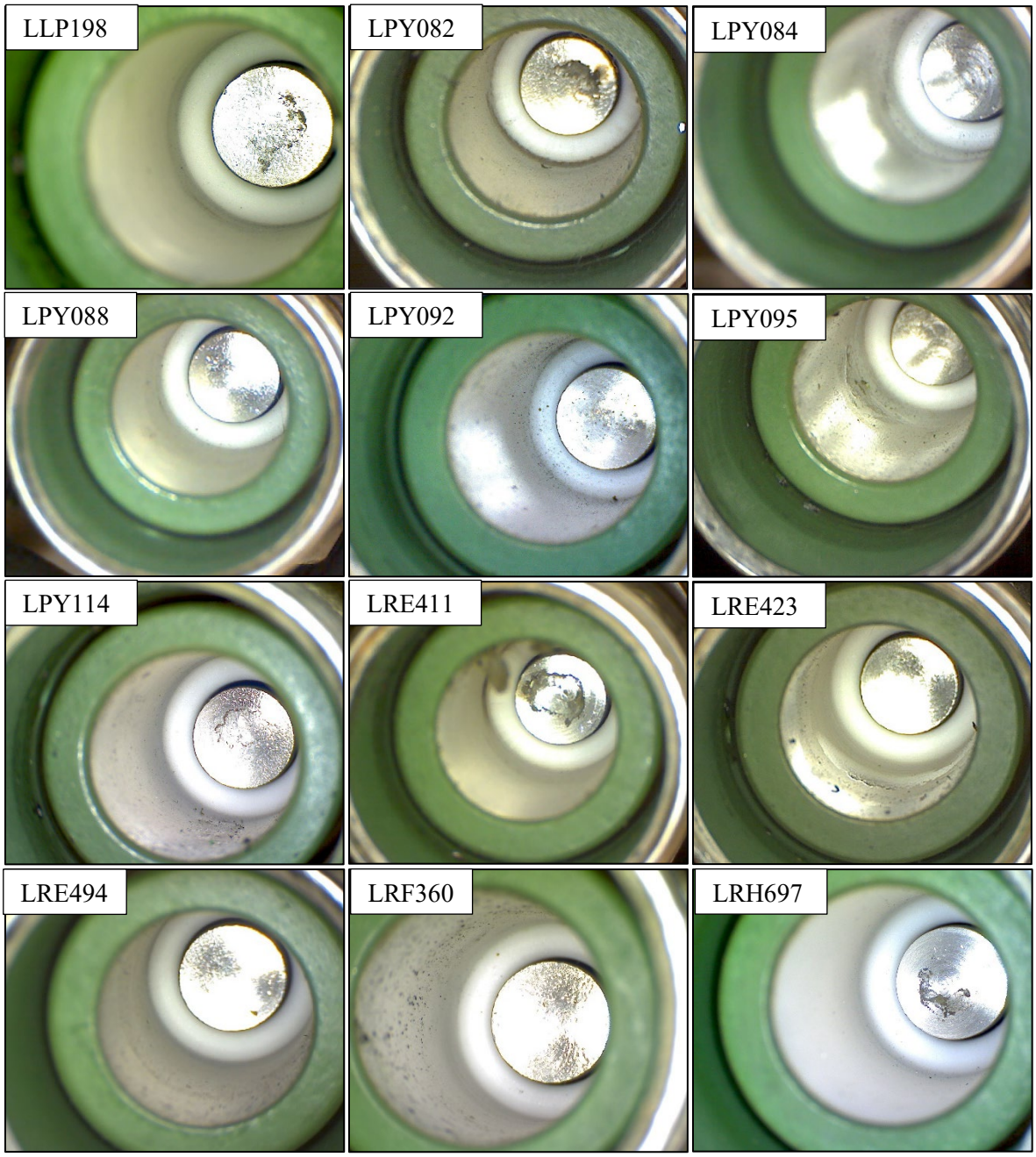


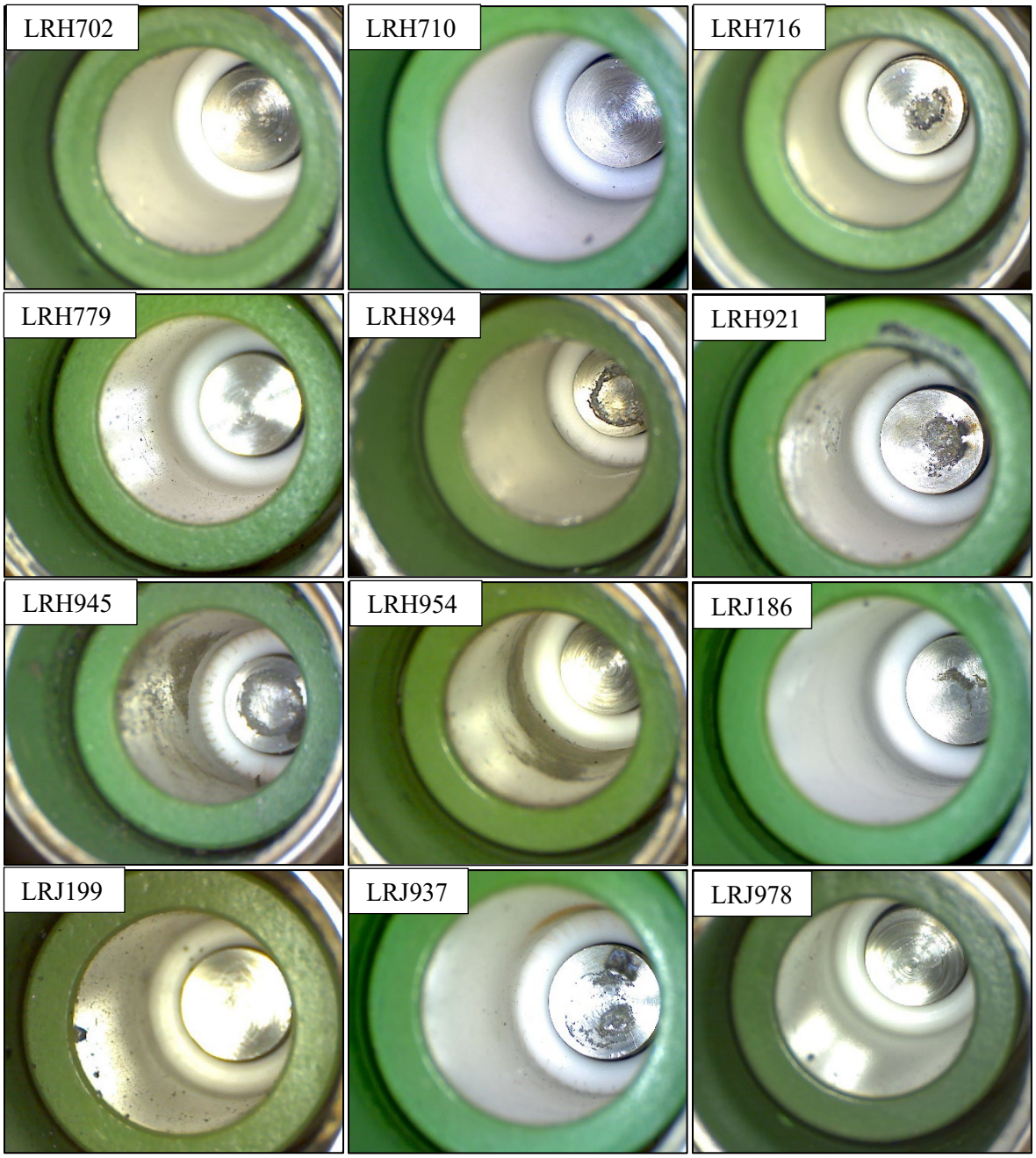
Figure 3: Contact Button Arcing Example

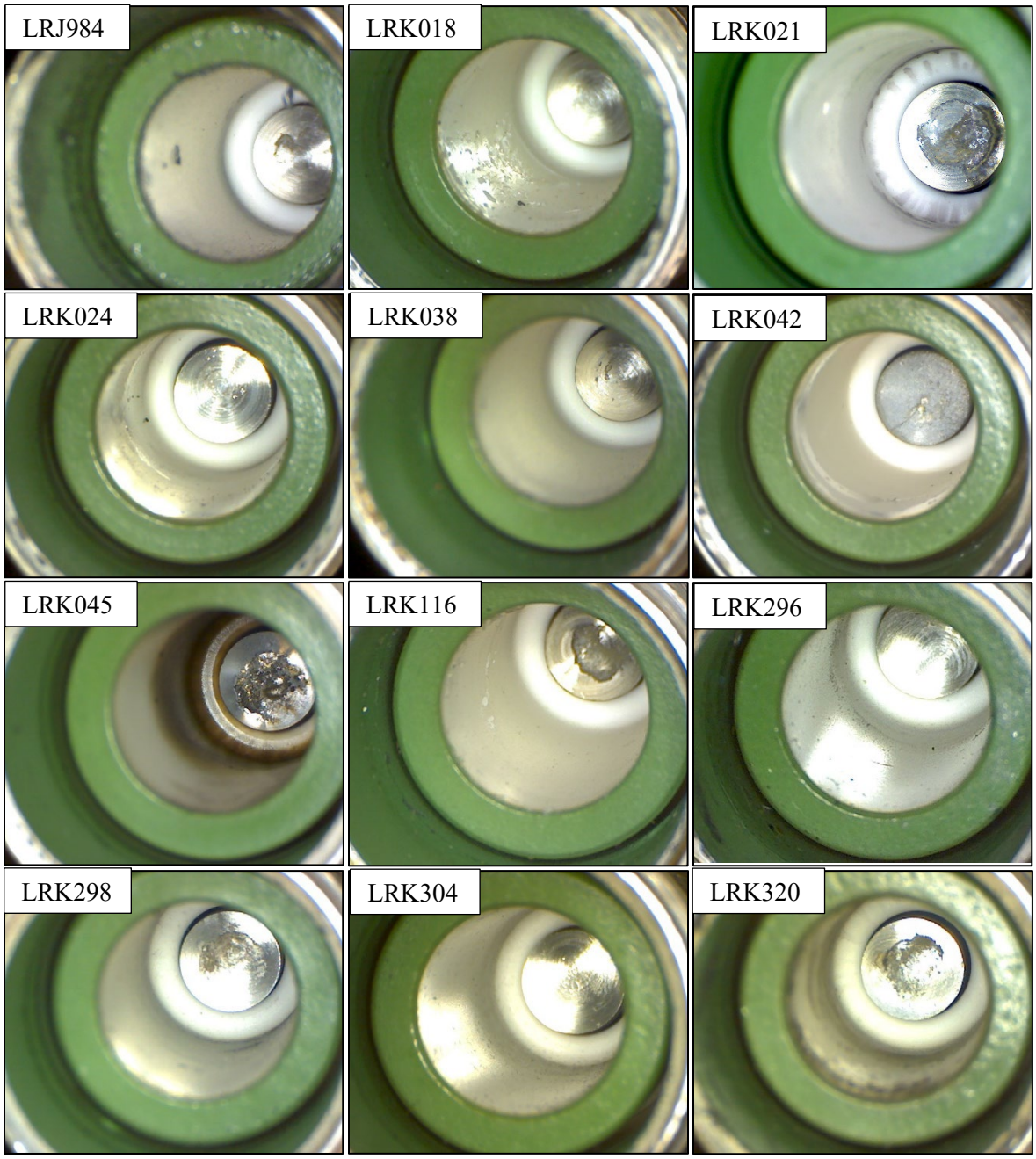
The photos in **Figure 4**Figure 4 below show the as received condition of all ninety-six (96) igniter terminal wells.

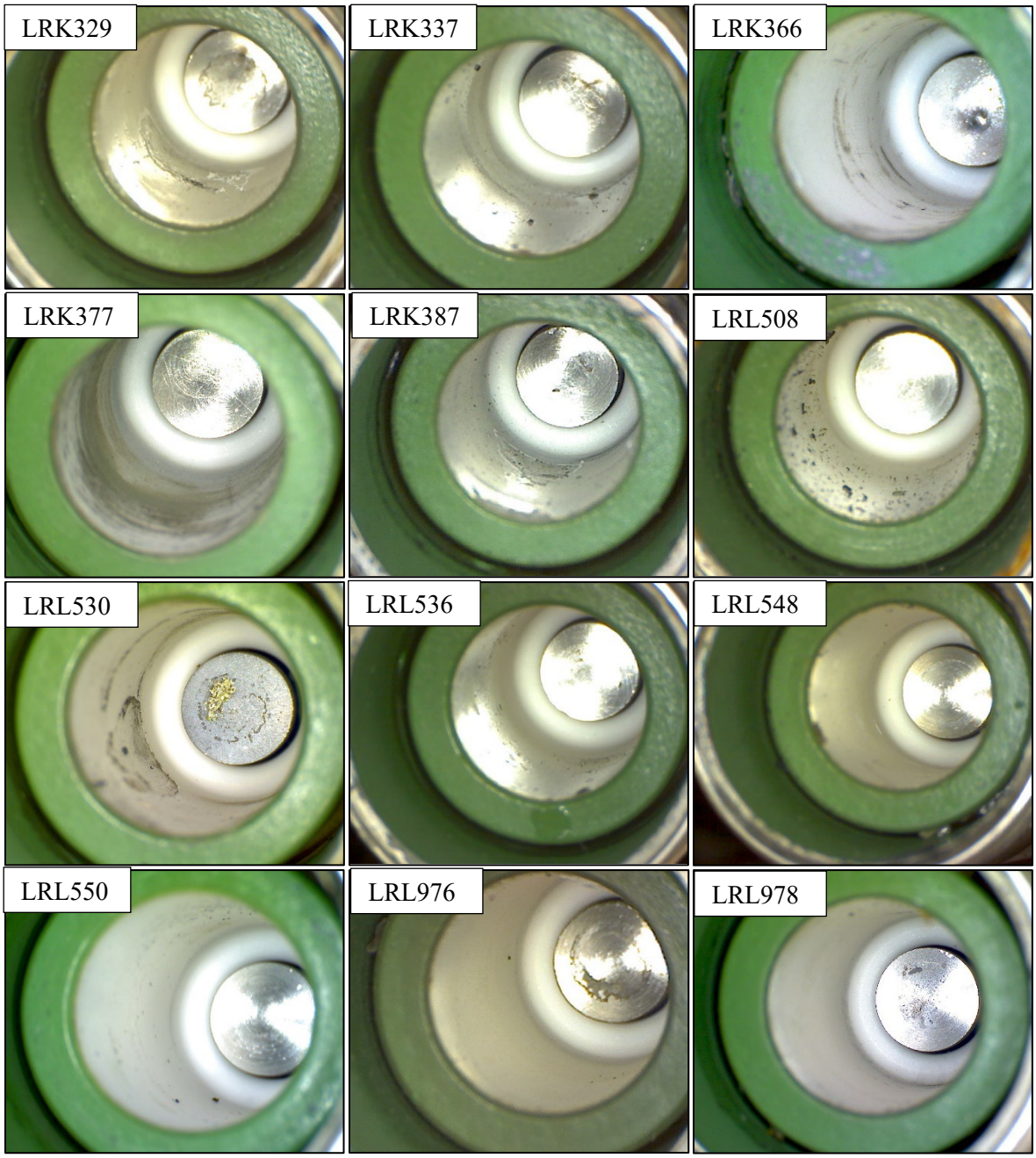


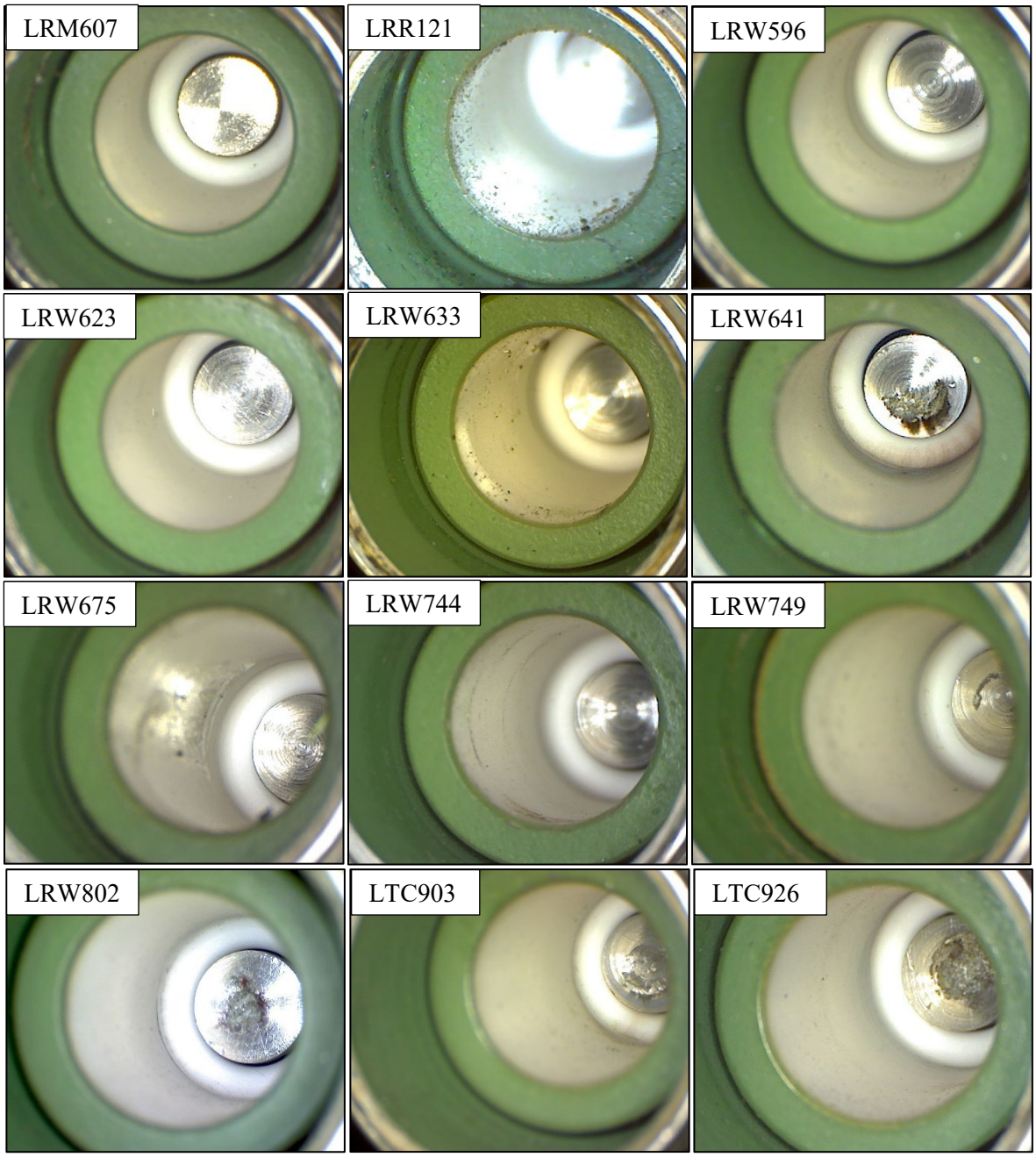












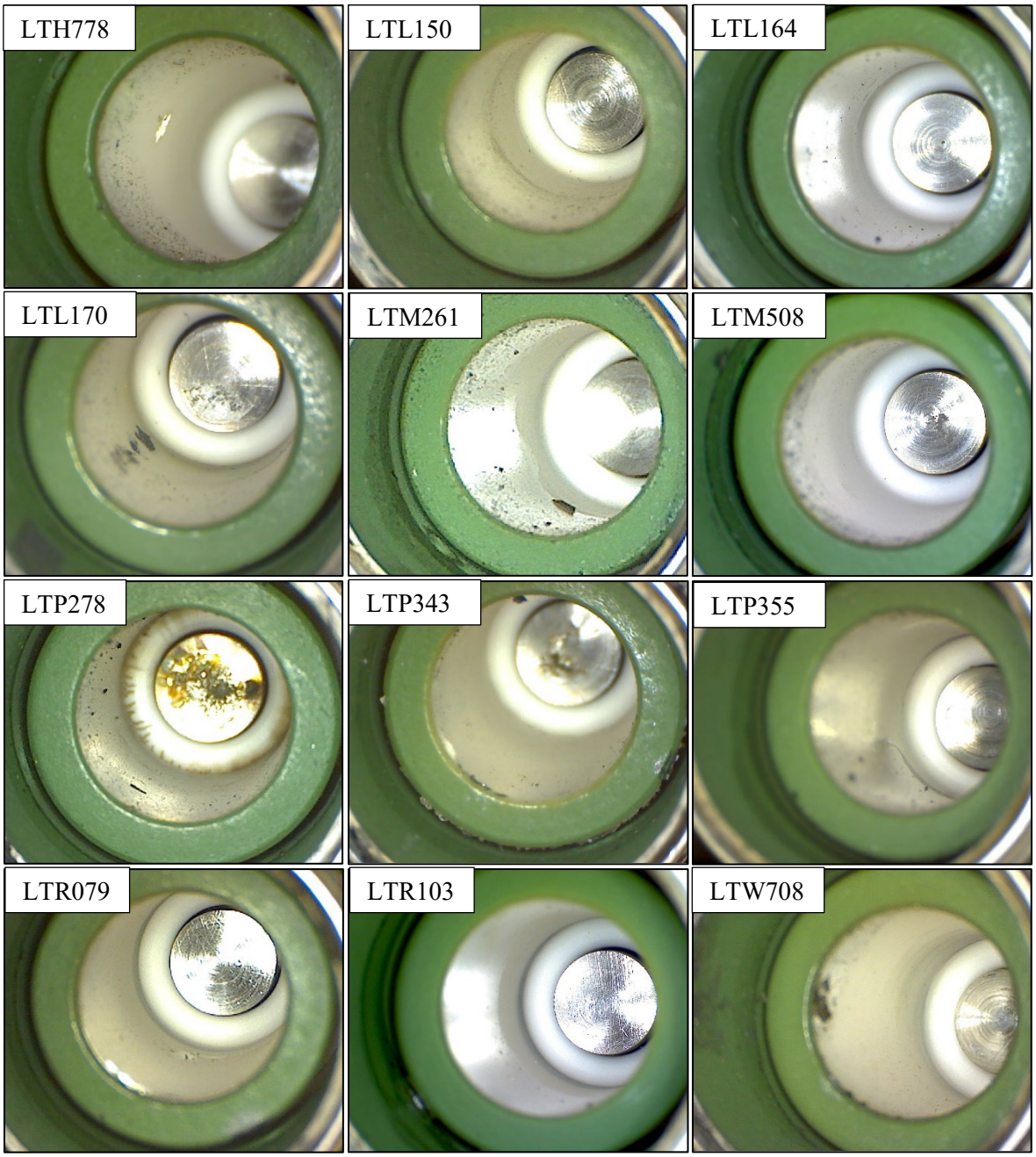


Figure 4: Competitor Long Life Igniter Terminal Well Contamination

Firing Tip End:

The firing ends of all igniters were visually examined, then measured for wear and abnormalities. A majority of the igniter tips appeared to have normal shell erosion to the I.D with thirteen (13) of the ninety-six (96) units having shell I.D's measure over 0.200". However, a couple did exhibit excessive wear as seen in **Figure 5**. In addition to the excessive wear, there were a small number of igniters that were missing material to the ground shell, similar to **Figure 6**, while the I.D was still within the normal wear expectation. **Figure 7** shows a group of photographs of all the igniter firing ends.

Figure 5: Excessive Shell Erosion

Figure 6: Firing End Shell Missing Material

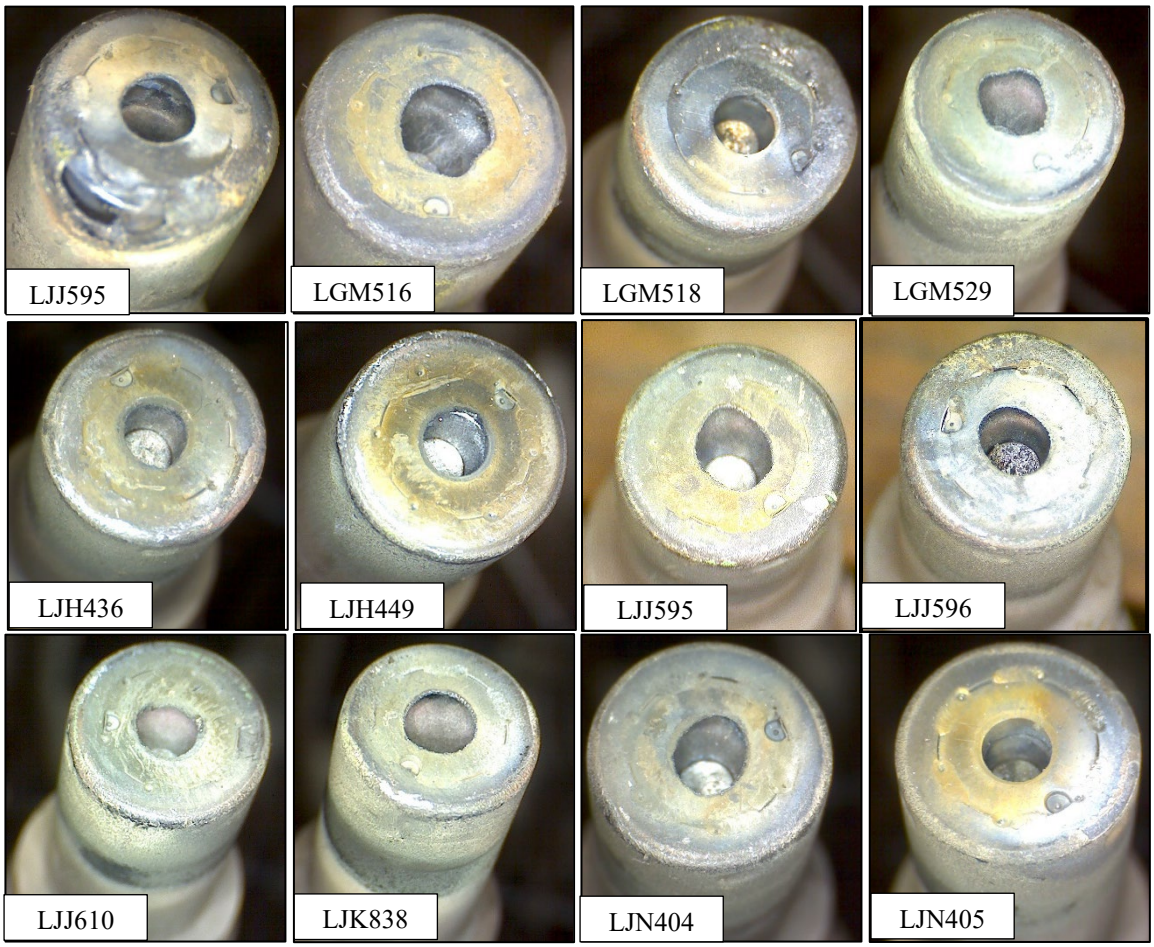


Figure 7: Competitor Long Life Firing Ends

The igniter shell O.D's were measured to the in addition to the shell I.D and electrode depth measurements. These recordings can be found below in **Table 2**. Of the ninety-six (96) units, eleven units measured to be over the n.500 which points to swelling of the igniter tip.

Table 2: Igniter Wear Measurements

Igniter Number	Serial Number	Center Electrode Depth (inches)	Shell Inner Diameter (inches)	Igniter Outside Diameter	Number of Pins
1	LGM502	0.2010	0.1540	0.5000	0
2	LGM516	0.2330	0.1865	0.4980	2
3	LGM518	0.2000	0.1410	0.5050	1
4	LGM529	0.2250	0.1665	0.4955	2.5
5	LJH436	0.1930	0.1500	0.4970	3
6	LJH449	0.1950	0.1400	0.4970	3
7	LJJ595	0.2520	0.1910	0.4960	3
8	LJJ596	0.2020	0.1650	0.4960	2
9	LJJ610	0.2210	0.1530	0.4980	3
10	LJK838	0.2650	0.1770	0.4960	3
11	LJN404	0.2090	0.1710	0.4970	3
12	LJN405	0.1940	0.1400	0.4980	3
13	LJP312	0.1940	0.1410	0.4980	1
14	LJT566	0.1950	0.1410	0.4980	3
15	LJT571	0.2330	0.1520	0.4975	3
16	LJT573	0.1960	0.1465	0.4980	3
17	LJT578	0.2570	0.3115	0.5160	0
18	LJT583	0.2040	0.1530	0.4965	1
19	LJT790	0.2230	0.1890	0.4985	2
20	LLD289	0.2170	0.1990	0.4980	2.5
21	LLE048	0.2270	0.2220	0.4930	1
22	LLE080	0.1980	0.1425	0.5025	2
23	LLE095	0.2340	0.3370	0.5030	0
24	LLE142	0.2380	0.1990	0.4965	2

Igniter Number	Serial Number	Center Electrode Depth (inches)	Ground Electrode Diameter (ID in inches)	Igniter Outside Diameter	Number of Pins
25	LPH198	0.2230	0.3500 - intact (shell punctured)	0.4965 - intact	0
26	LPY082	0.2140	0.1390	0.4940	3
27	LPY084	0.1980	0.1400	0.4970	1
28	LPY088	0.2030	0.1600	0.4960	3
29	LPY092	0.1990	0.1400	0.4970	3
30	LPY095	0.2010	0.1415	0.4945	0
31	LPY114	0.2050	0.1670	0.4970	3
32	LRE411	0.2340	0.1560	0.4965	3
33	LRE423	0.2035	0.1460	0.4975	3
34	LRE494	0.1970	0.1510	0.5030	0
35	LRF360	0.1960	0.1435	0.4960	1.5
36	LRH697	0.2390	0.1930	0.4940	3
37	LRH702	0.2070	0.1445	0.4960	2
38	LRH710	0.1990	0.1455	0.4945	1
39	LRH716	0.2300	0.1520	0.4960	3
40	LRH779	0.1960	0.1415	0.4965	0
41	LRH894	0.2190	0.2215	0.4980	1
42	LRH921	0.2100	0.1415	0.4975	3
43	LRH945	0.2230	0.1430	0.4960	3
44	LRH954	0.1980	0.1410	0.5030	1.5
45	LRJ186	0.2130	0.3020 - intact (shell punctured)	0.4970 - intact	0
46	LRJ199	0.1950	0.1425	0.4985	3
47	LRJ937	0.2050	0.1610	0.4970	3
48	LRJ978	0.1950	0.1420	0.4965	3
49	LRJ984	0.2070	0.2360	0.5035	2
50	LRK018	0.2110	0.2170	0.4945	3
51	LRK021	0.2260	0.2390	0.4950	2.5
52	LRK024	0.1970	0.1485	0.4970	3
53	LRK038	0.2300	0.1940	0.4970	2.5
54	LRK042	0.2120	0.1540	0.4950	3
55	LRK045	0.1960	0.1445	0.4965	3
56	LRK116	0.2240	0.1780	0.4955	3
57	LRK296	0.1990	0.1410	0.4980	1
58	LRK298	0.2370	0.1860	0.4955	3
59	LRK304	0.1970	0.1500	0.4970	1
60	LRK320	0.2380	0.1520	0.4970	3
61	LRK329	0.2010	0.1840	0.4970	2.5
62	LRK337	0.2260	0.1415	0.4935	3
63	LRK366	0.1970	0.1460	0.4940	0
64	LRK377	0.1980	0.1450	0.4965	0

Igniter Number	Serial Number	Center Electrode Depth (inches)	Ground Electrode Diameter (ID in inches)	Igniter Outside Diameter	Number of Pins
65	LRK387	0.2230	0.2240	0.4970	1
66	LRL508	0.1990	0.1420	0.4980	2
67	LRL530	0.2080	0.1640	0.4950	3
68	LRL536	0.2060	0.1410	0.4970	0
69	LRL548	0.2370	0.2130	0.4950	2
70	LRL550	0.2010	0.1500	0.4960	0
71	LRL976	0.2430	0.2275	0.4980	1
72	LRL978	0.2000	0.1470	0.4975	3
73	LRM607	0.2010	0.1600	0.4960	3
74	LRR121	0.2110	0.1440	0.4975	3
75	LRW596	0.1950	0.1415	0.4970	3
76	LRW623	0.1980	0.1390	0.4935	3
77	LRW633	0.1980	0.1440	0.4960	3
78	LRW641	0.1970	0.1390	0.4985	3
79	LRW675	0.2110	0.1860	0.4975	3
80	LRW744	0.1955	0.1385	0.4980	3
81	LRW749	0.2030	0.2065	0.4970	2
82	LRW802	0.1950	0.1410	0.4980	3
83	LTC903	0.1950	0.1395	0.4970	3
84	LTC926	0.1950	0.1410	0.5010	1.5
85	LTH778	0.1970	0.1410	0.4980	1
86	LTL150	0.1945	0.1410	0.4980	3
87	LTL164	0.1960	0.1400	0.5010	3
88	LTL170	0.1960	0.1410	0.4985	3
89	LTM261	0.1980	0.1405	0.4980	3
90	LTM508	0.1990	0.1770	0.5120	1
91	LTP278	0.1950	0.1380	0.4950	3
92	LTP343	0.1950	0.1430	0.4970	3
93	LTP355	0.2010	0.1705	0.4960	3
94	LTR079	0.1930	0.1450	0.4970	3
95	LTR103	0.1990	0.1620	0.4975	2.5
96	LTW708	0.1960	0.1400	0.4950	3

In order to better review the ground pin wear, the firing tip end of each igniter was removed. **Figure 8** below shows the geometry of the Champion and Competitor Long Life igniter firing end tip designs for reference throughout this report. The Champion igniter design utilizes ground pins installed perpendicular to the center electrode equally spaced around the ground shell diameter, which are brazed into the firing end shell. In contrast, the Competitor Long Life igniter design features ground pins installed in a triangular pattern inside a metallic insert that in turn is welded into the firing end shell.

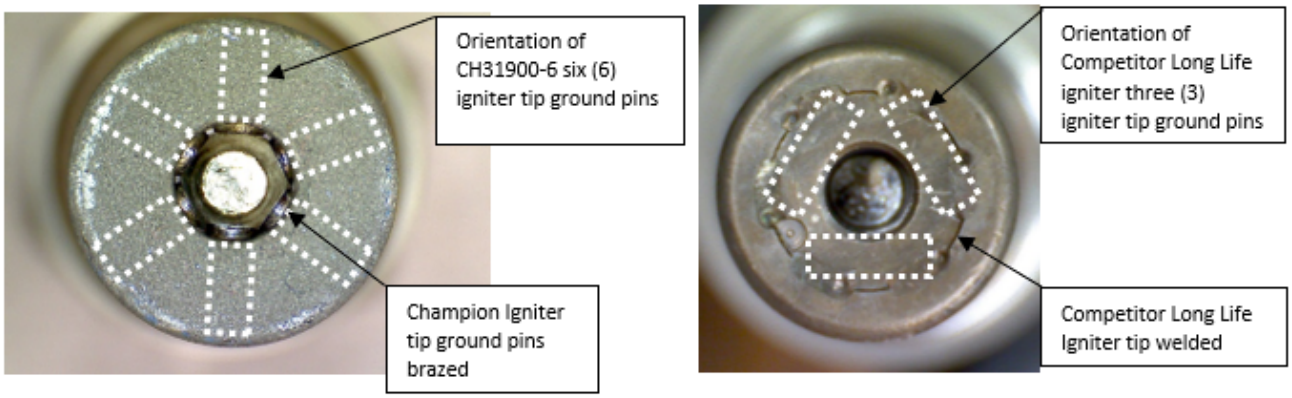
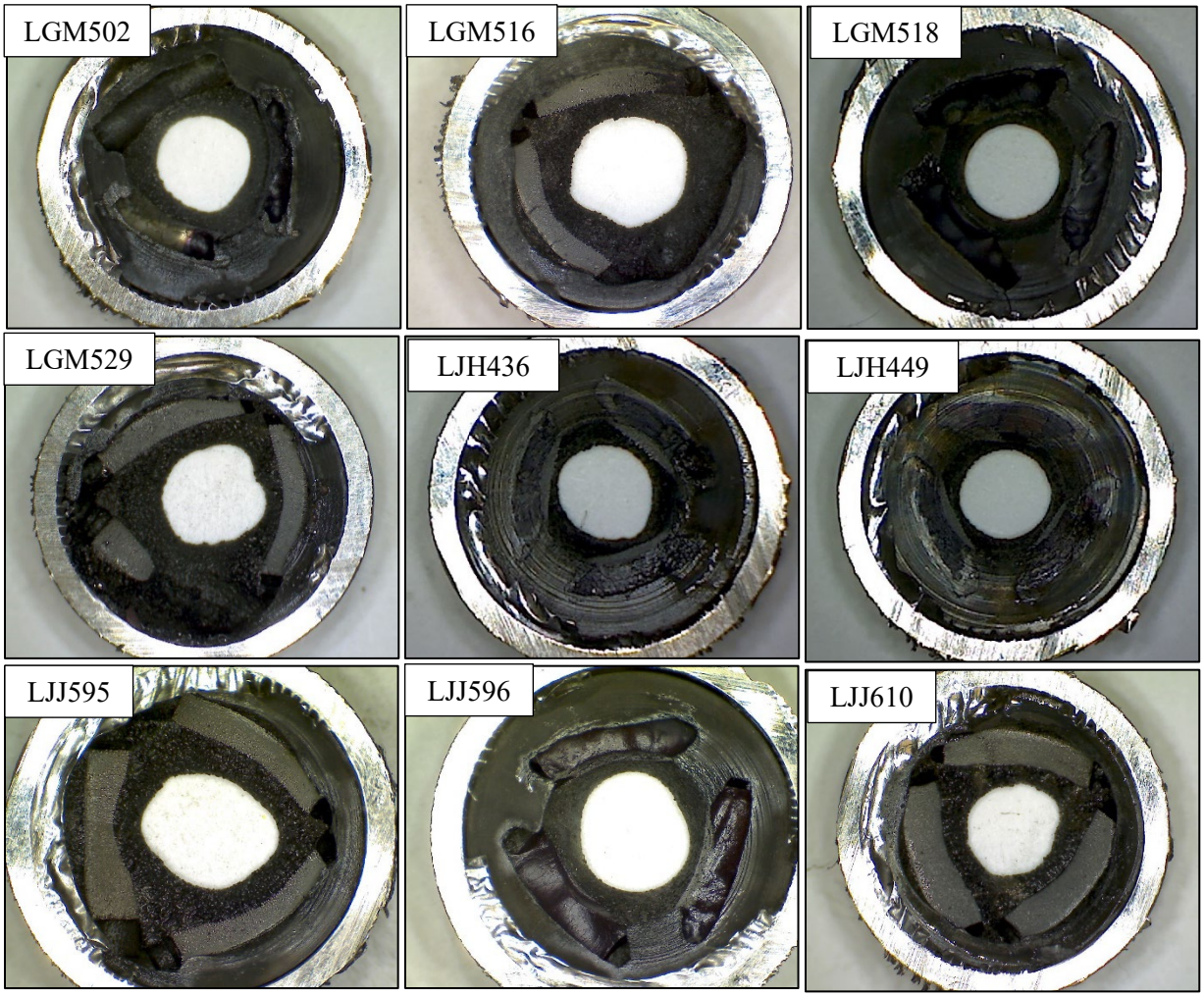
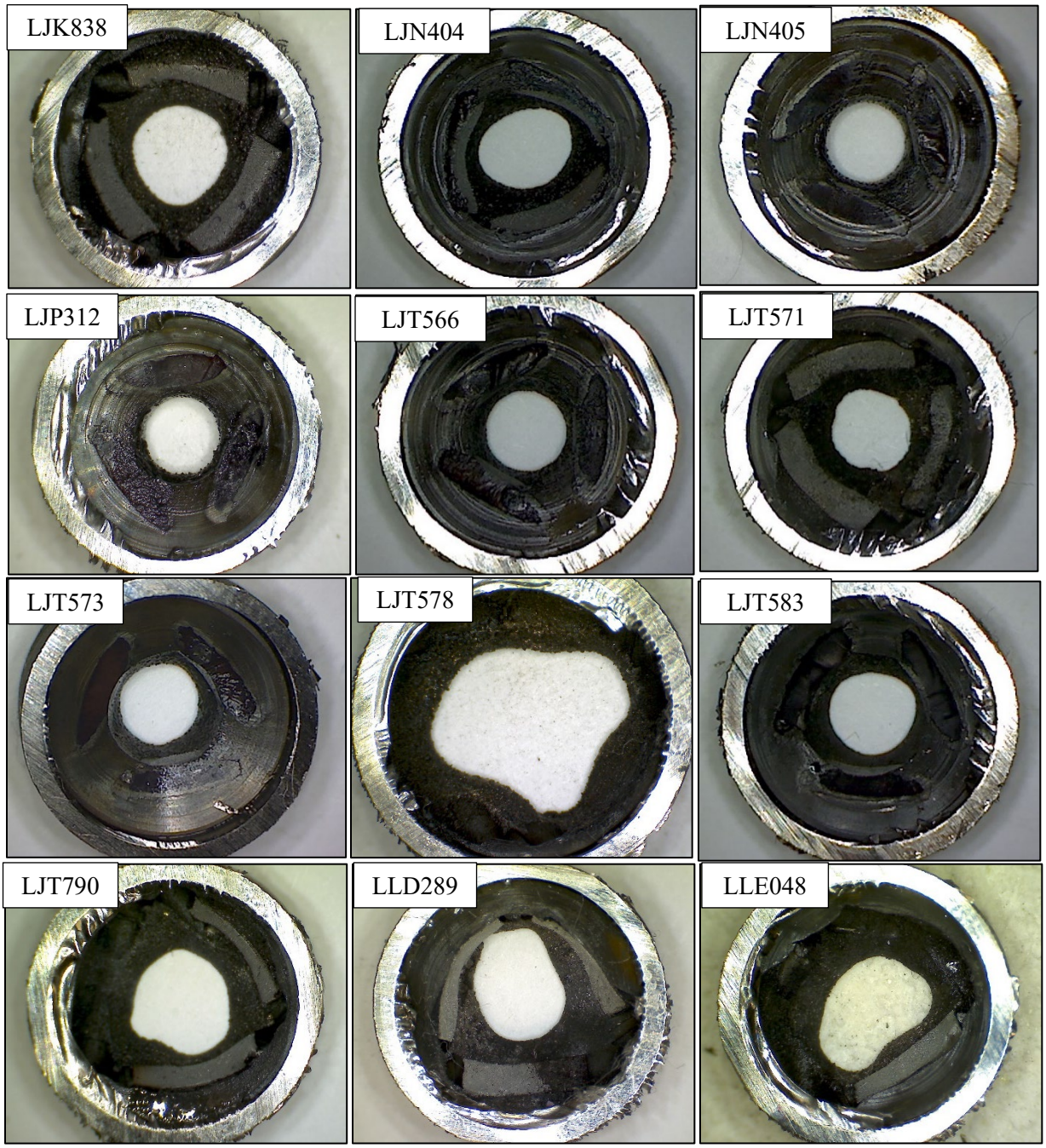
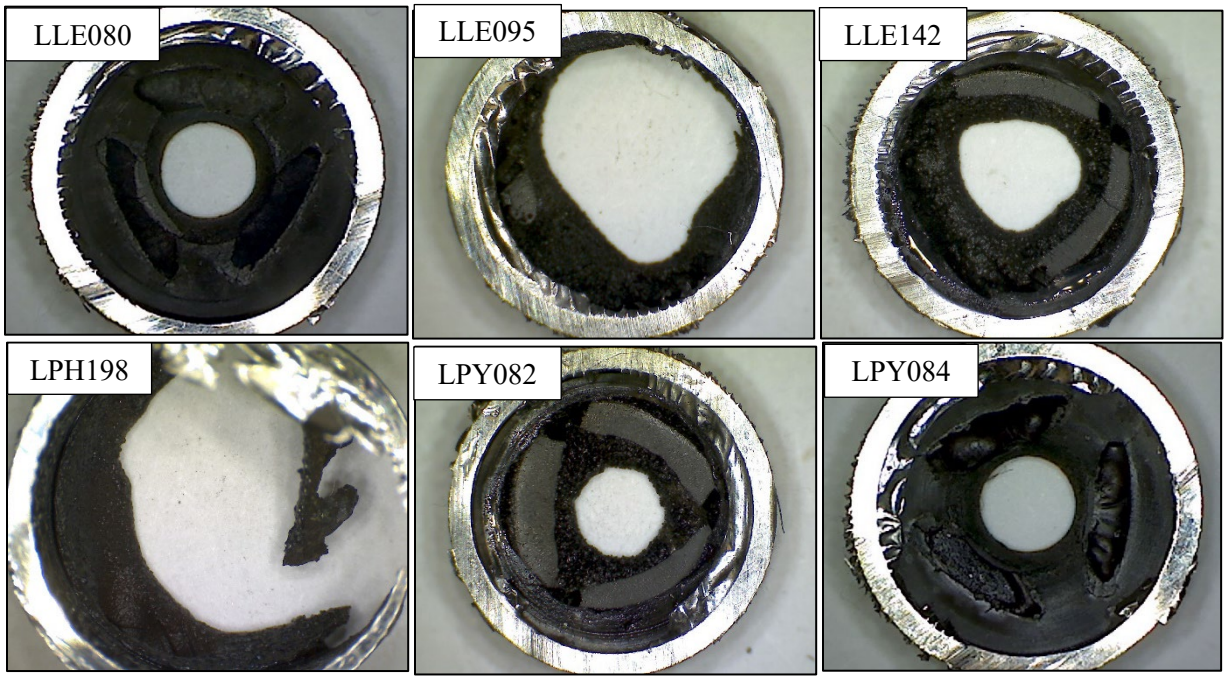


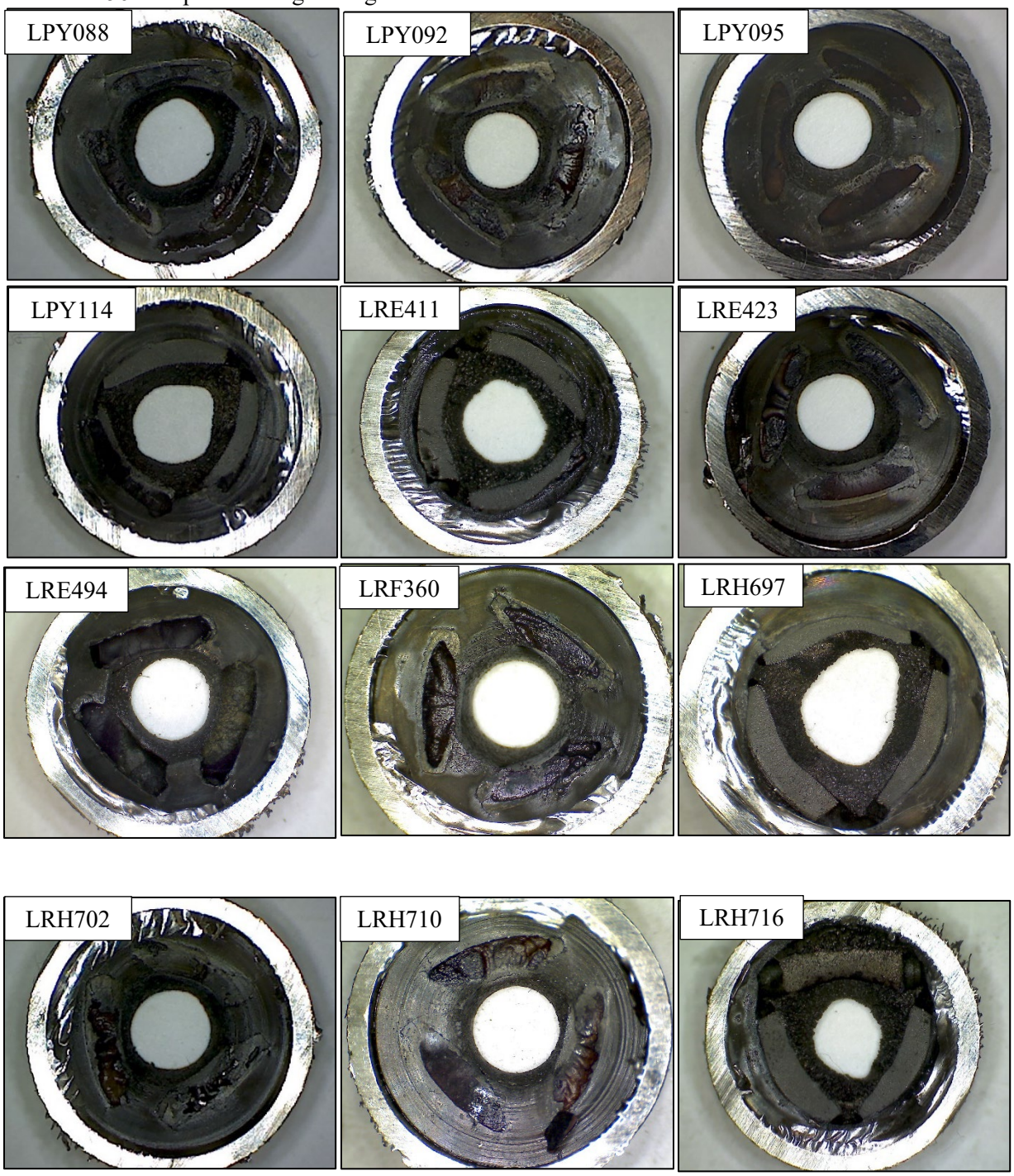
Figure 8: Champion and Competitor Long Life Igniter Geometry

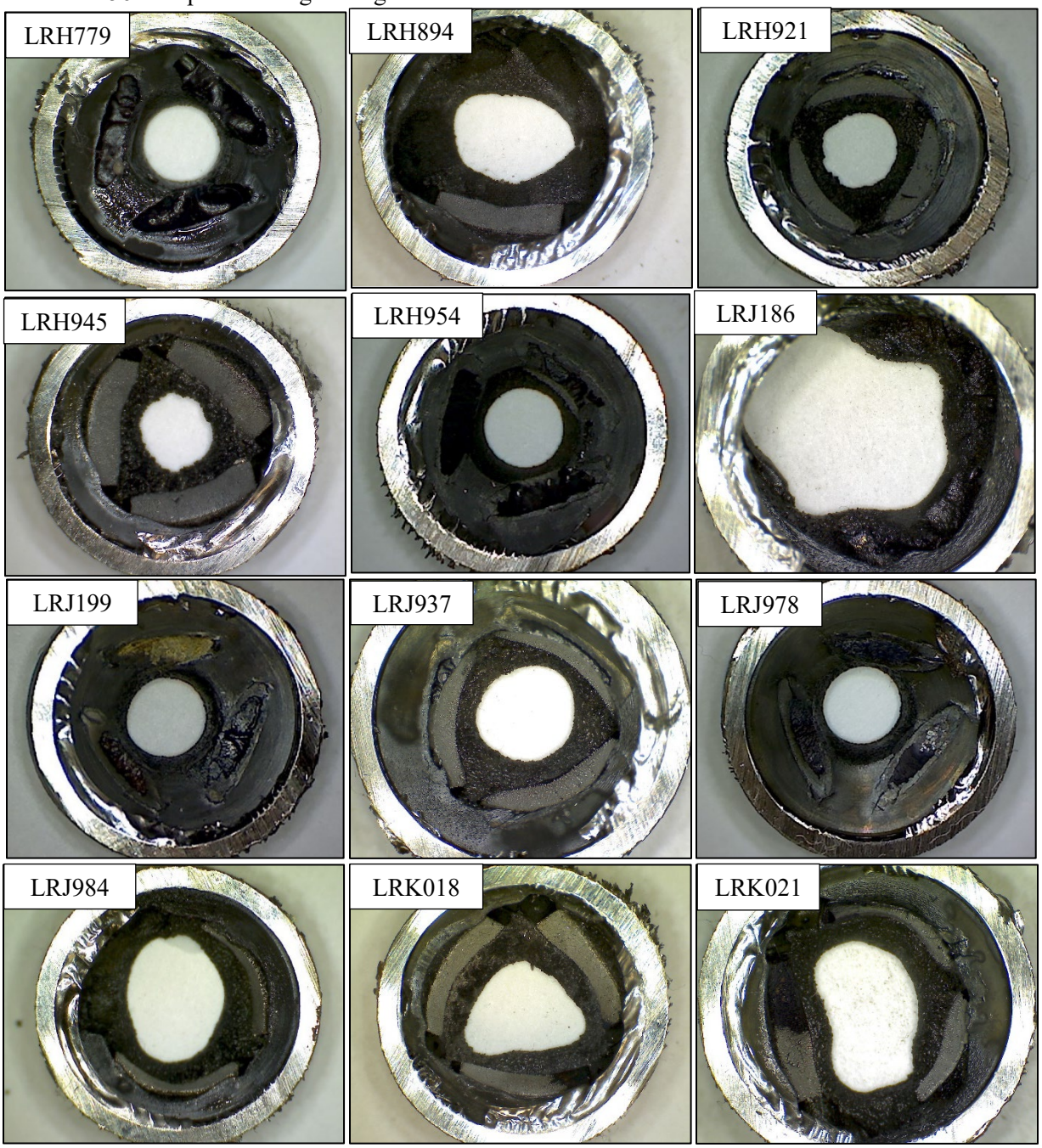
After evaluating the ninety-six (96) Competitor Long Life igniters returned, fifty-two (52) of the igniters appear to have all three ground pins remaining. However, the remaining forty-four (44) igniters appear to have portions of ground pins or entire ground pins missing with twelve (12) of these units appearing to have all their ground electrode material missing. The pin numbers for each individual igniter are included in **Table 2** above. Pictures of the ground pins are shown below in **Figure 9**.

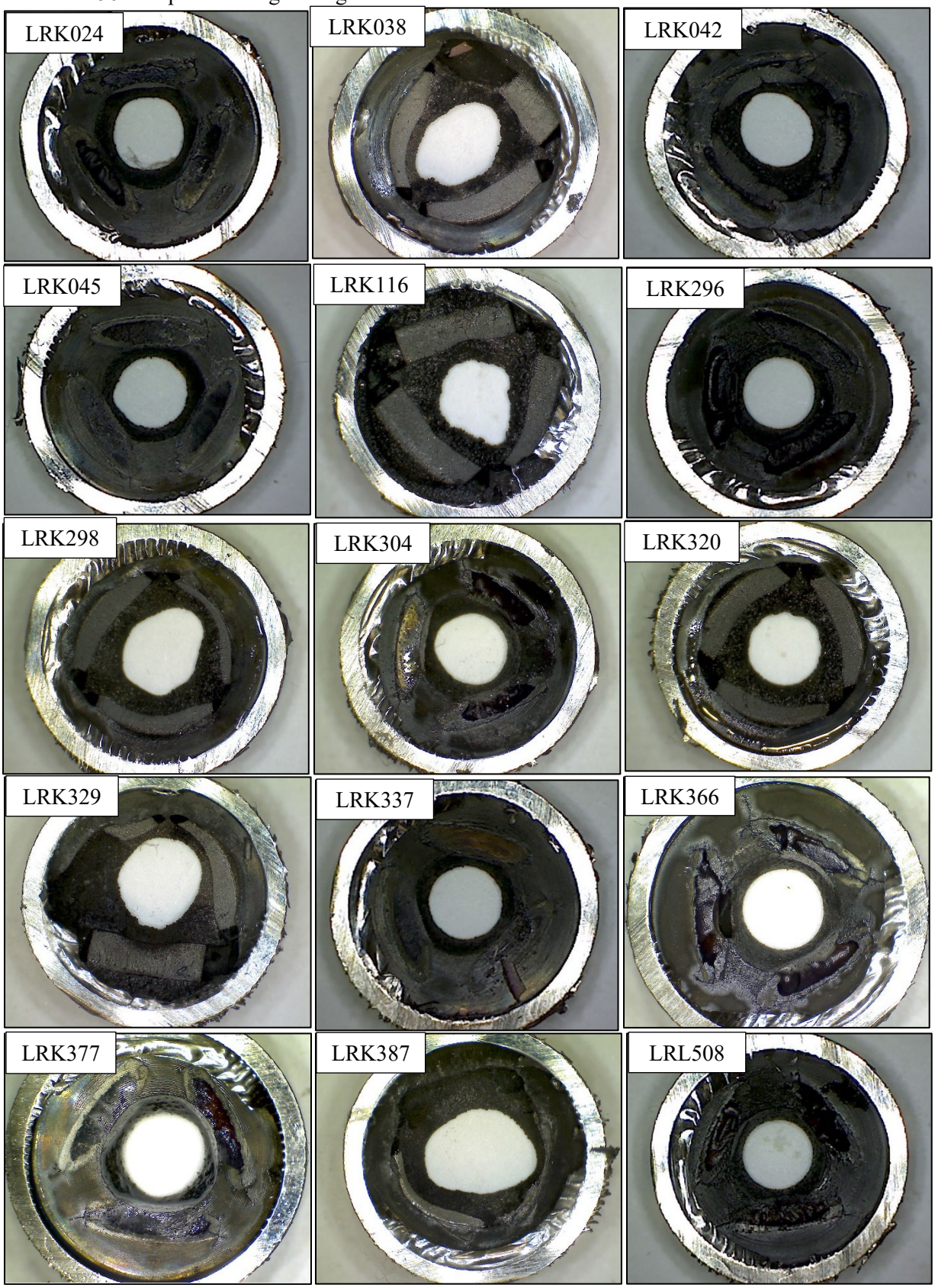


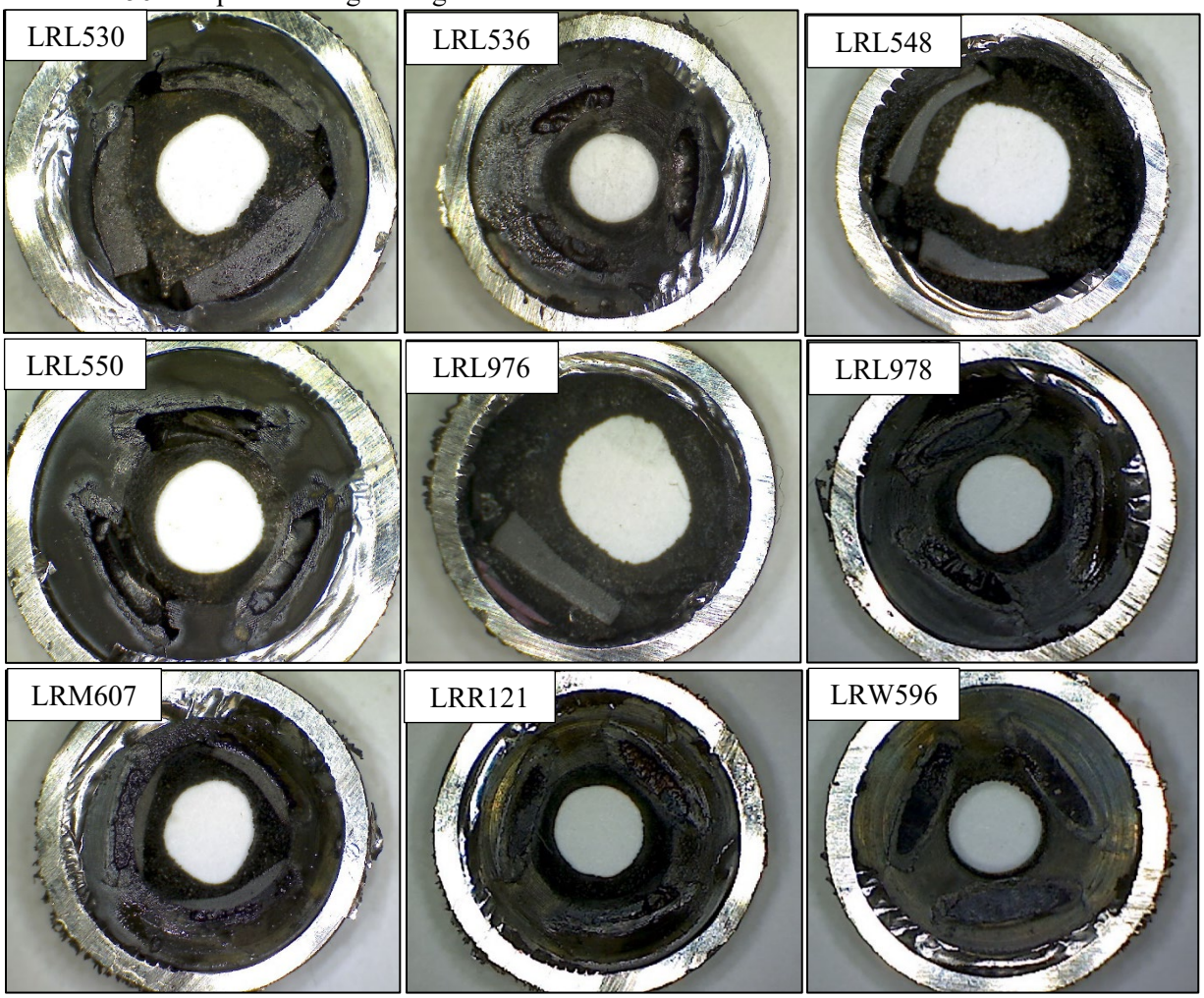


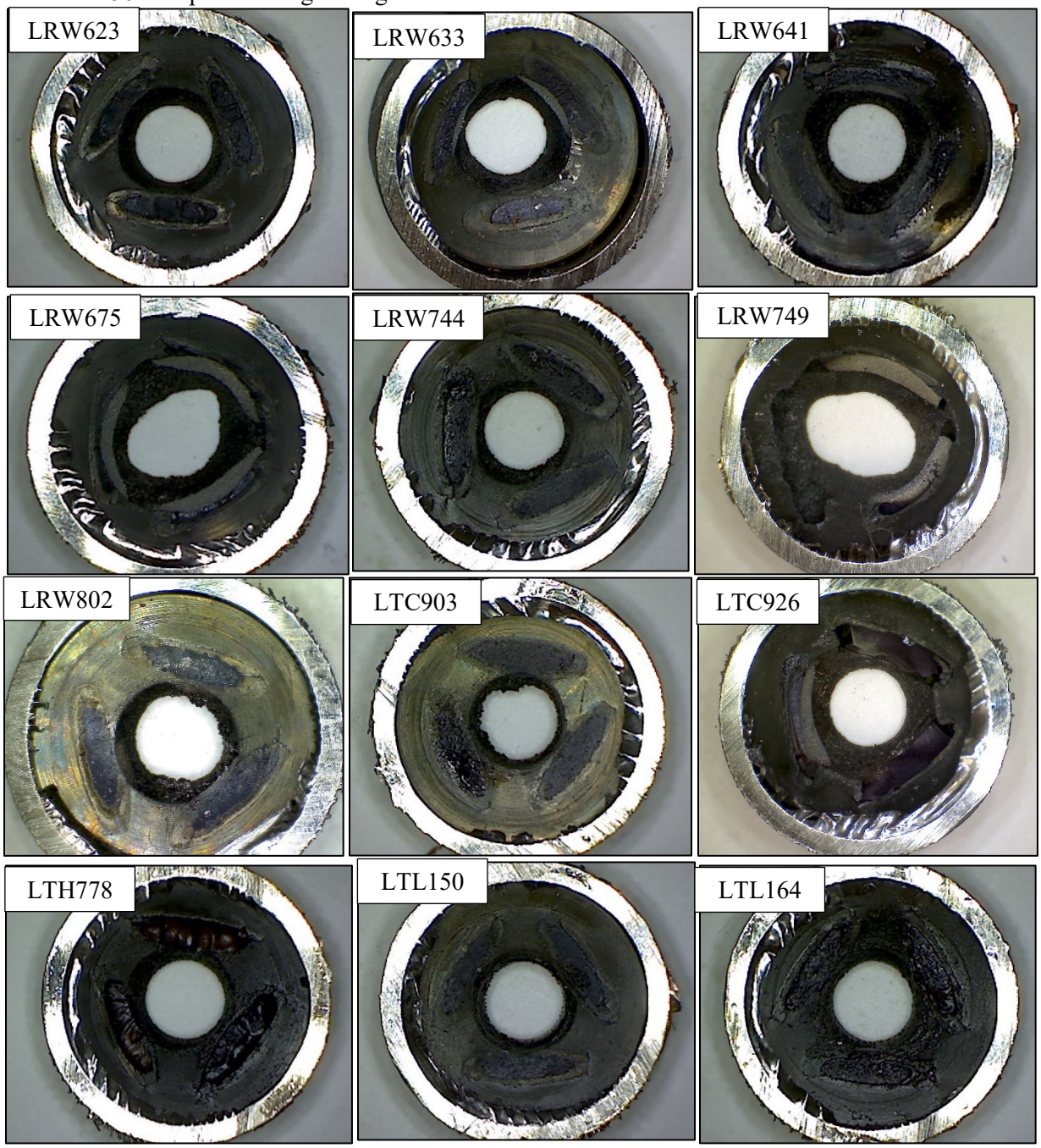












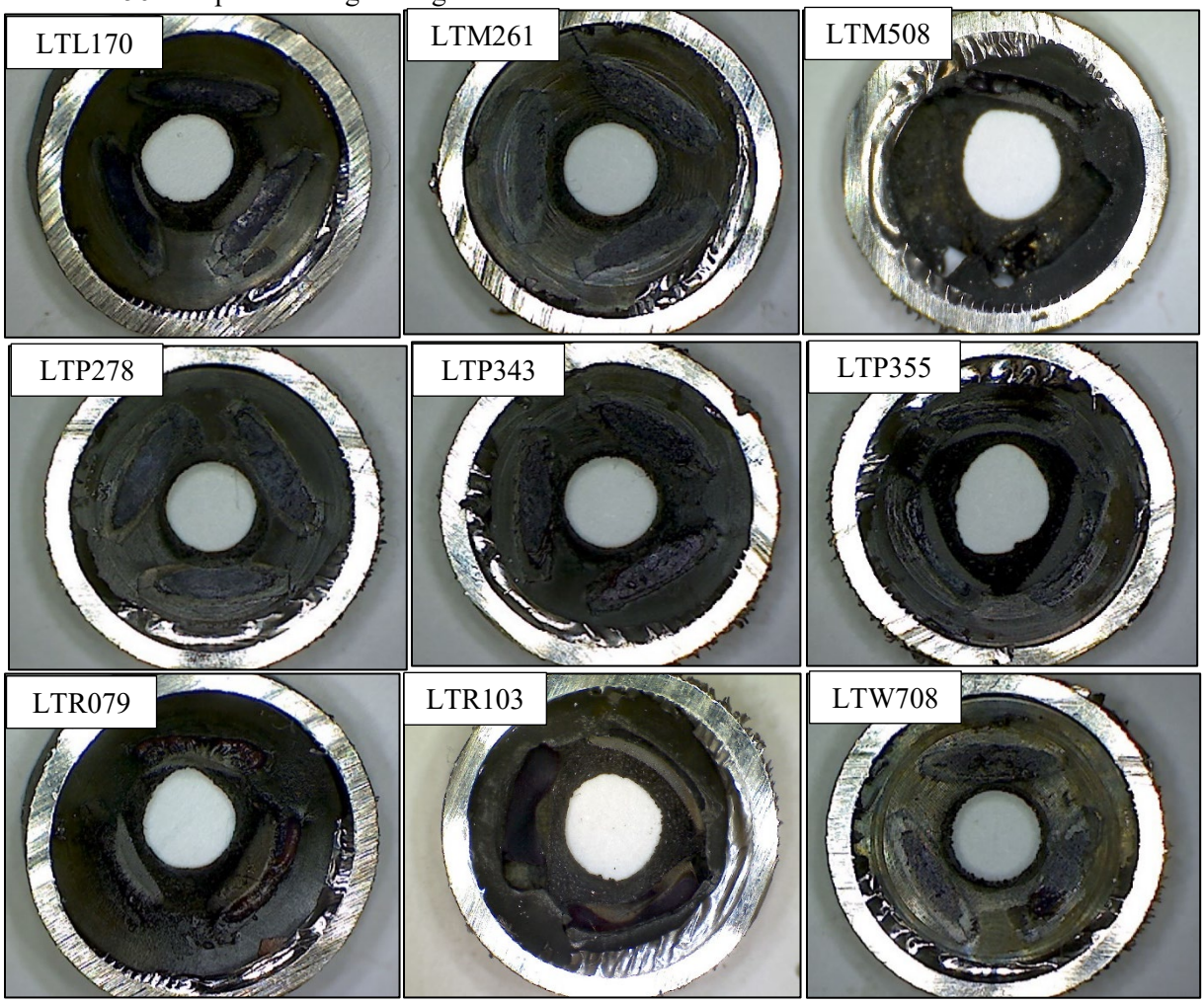


Figure 9: Competitor Long Life Igniter Pins

Upon further investigation of the removed shells, it was observed that some of the igniters also exhibited cracks in the cavity region housing the ground pin electrodes similar to **Figure 10**. This phenomenon has been witnessed before by Champion in previous competitive analysis, CH327.I.EER.004.

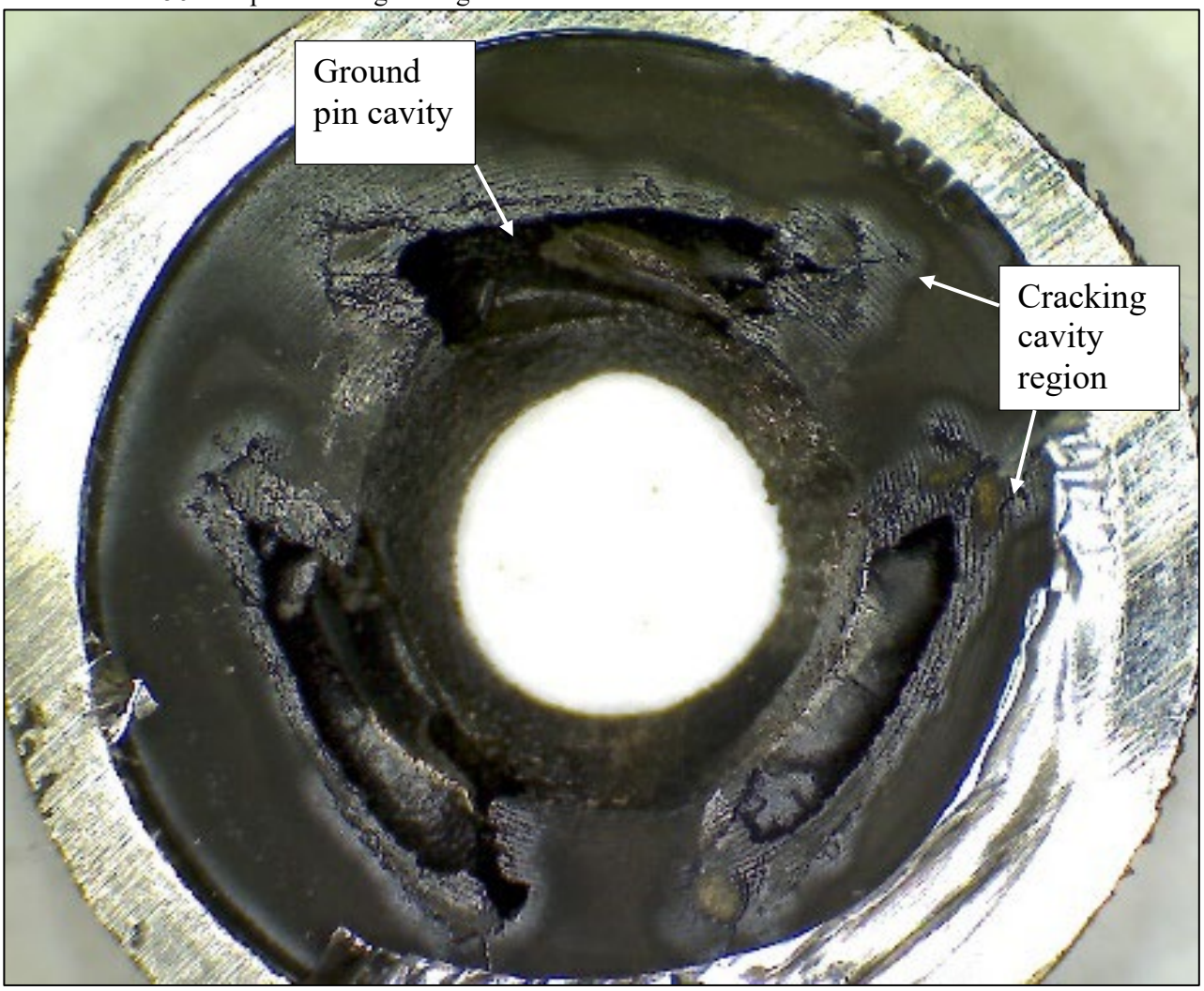


Figure 10: Igniter Tip Internal View

Conclusions:

1. From this analysis, it is seen that 39.6% of the returned Competitor Long Life igniters exhibit conditions that indicate at least one entire ground pin missing.
2. Because of the cracking and evidence of missing ground pin material, partial or full ground pin liberation into the combustor is likely to have occurred with the Competitor Long Life igniters missing ground pins.

Written by _____ 12-16-22
C. Meaders, Product Engineer

Approved by _____ 12-16-22
S. Thompson, Product Engineering Manager