

ATTACHMENTS

**KASGRO REPORT 1
METALLURGICAL REPORT**

Miller, Bret A. 2022. Metallurgical Evaluation of a Welded Steel Plate. Report No. 20221788. IMR Test Labs, Louisville, KY. Proprietary Report.

KASGRO REPORT 3 METALS INVESTIGATION REPORT



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Customer Claim - Triad Metals Investigation

Background

Triad Metals submitted a specimen to the Burns Harbor Plate Mill Metallurgical Laboratory for evaluation due to cracking near the weld of the fabricated sample. The plate grade is ASTM A572-15 GR 60 with two possible serials H023195 or J020022 shown in table 1. Both possible serials were rolled and shipped from Burns Harbor in early 2018.

The provided plate was torch cut in two locations as seen in Figure 1. The specimens extracted from the two locations were given the following I.D.s "BI" (S000001) and "BR" (S000002). Samples from both locations were prepared for chemical analysis, tensile and V-Notch Charpy impacts tests. The results of these tests are found in tables 2, 3, and 4.

Dye penetrant and ultrasonic evaluation was conducted on the BR side of the sample to determine the presence of cracks or any other imperfection in the material and the weld.

Table 1. Possible serial numbers of the provided plate.

SM Grade	Serial Number	Heat Number	Ship Manifest	Ship Date
A257	H023195	812z36570	803-29091	01/26/2018
A257	J020022	812z36480	803-29364	02/09/2018



Figure 1. Cut procedure on the provided plate with labeled I.D.s.

Non-Destructive Testing

Dye penetrant testing was performed on the BR side of the sample. Multiple small crack indications were found along the weld in the Heat Affected Zone (HAZ). Refer to the arrows in Figure 2 and Figure 3.

An Ultrasonic evaluation was conducted on the sample, two ultrasonic indications were found on the BR side of the sample. These indications were found roughly one inch into the sample and did not propagate to the surface or edge of the material. These indications lined up with the location of the support beams on the bottom of the part, as shown in Figure 3.

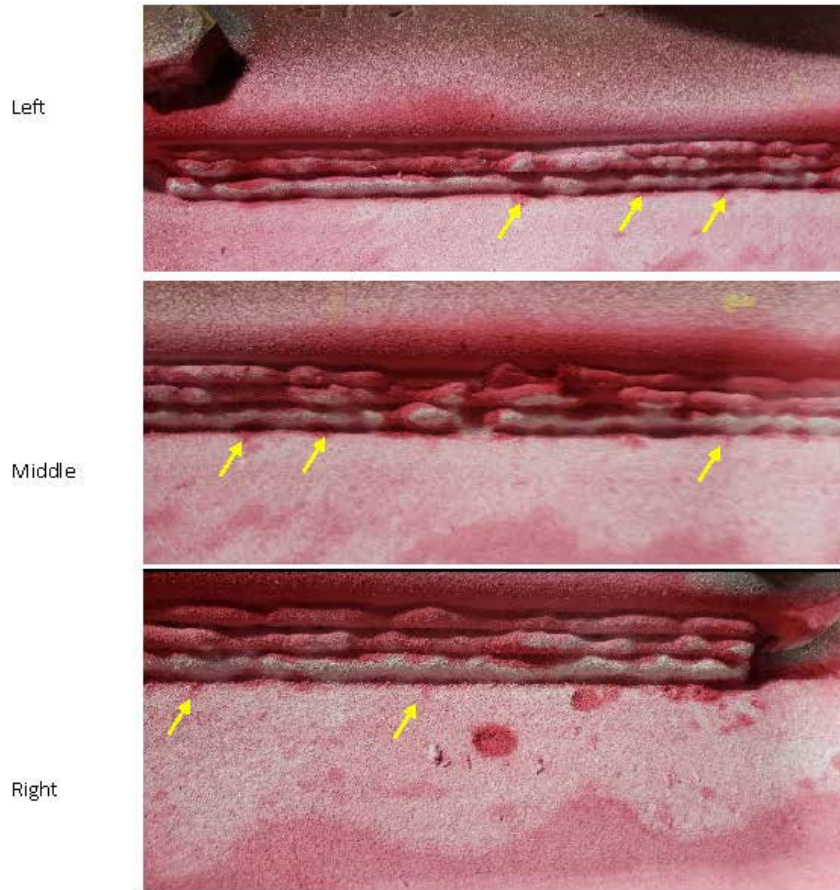
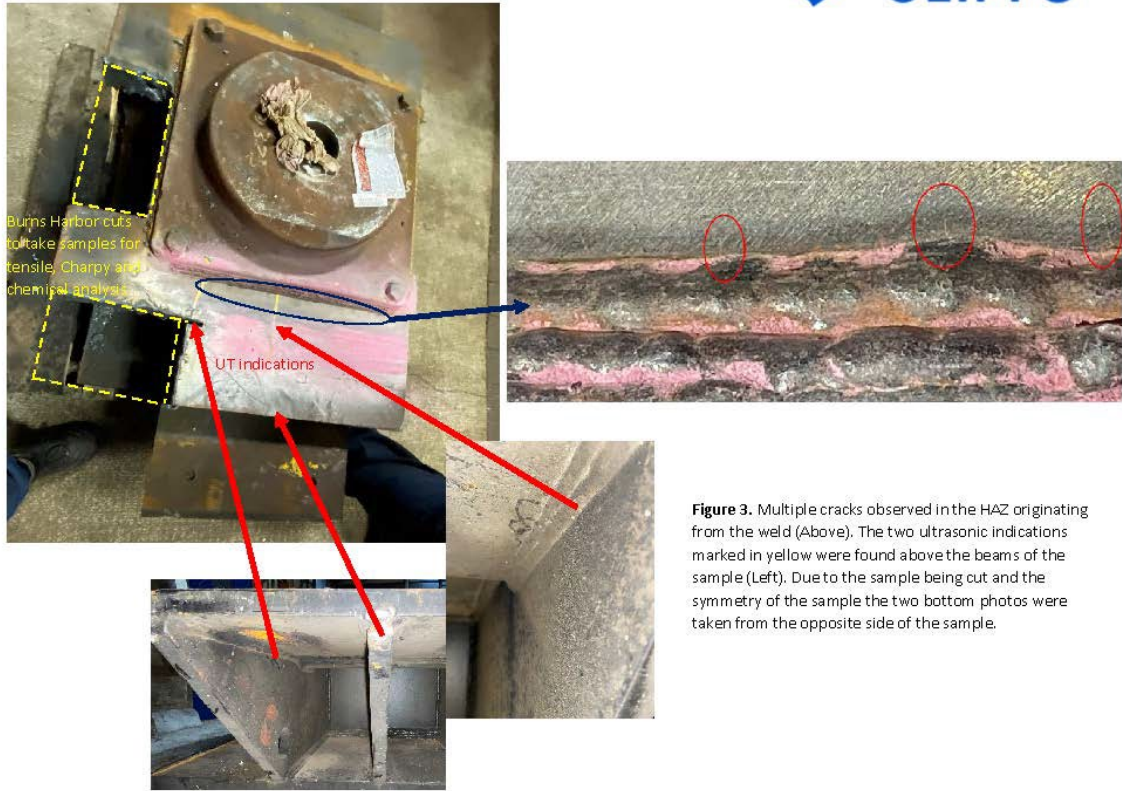


Figure 2. Multiple small cracks in the HAZ detected by Dye Penetrant inspection in the BR side of the sample received for investigation.





Tensile Tests Results

Tensile properties were found to be acceptable and consistent with the properties reported in the Plate Material Test Results (MTR).

Table 2. Tensile results

I.D. Number	Sample	Location	Yield (ksi)	Tensile (ksi)	Elongation (%)
SS00001	BI	Top	78.3	94.6	25
SS00001	BI	Bottom	78.3	94.6	25
SS00002	BR	Top	78.6	94.4	27
SS00002	BR	Bottom	78.6	94.4	27
H023195 [^]	-	-	76	94.1	28
J020022 [^]	-	-	80.8	96.6	34

[^] indicates certified test results from shipped plate

Charpy V-Notch Impact Tests Results

Charpy tests were conducted at 0 °F. All impact tests results met specifications and are consistent with the properties reported in the MTR.

Table 3. Impact results

I.D. Number	Sample		Energy (FT.LBS)		Average (FT.LBS)
SS00001	BI	83	107	129	106
SS00002	BR	106	91	106	101
H023195 [^]	-	107	63	87	86
J020022 [^]	-	89	80	74	81

[^] indicates certified test results from shipped plate



Chemical Composition Results

The chemical analysis conducted on the sample returned from the customer is consistent with the heat analysis as reported on MTR.

Table 4. Chemical composition results

Element Symbol	Composition		
	BR (wt%)	H023195 (wt%) [^]	J020022 (wt%) [^]
C	0.171	0.17	0.18
Mn	1.24	1.18	1.19
P	0.011	0.011	0.012
S	0.003	0.003	0.004
Si	0.281	0.265	0.275
Cu	0.017	0.018	0.021
Ni	0.01	0.01	0.01
Cr	0.03	0.03	0.03
Sn	0.002	0.002	0.002
Mo	0.005	0.003	0.007
V	0.089	0.083	0.088
Al	0.35	0.033	0.03
Cb	0.002	0.002	0.002
B	0.0003	0.0002	0.0002
Ti	0.002	0.002	0.002
Ca	0.0022	0.0024	0.0023

[^] indicates certified test results from shipped plate

Conclusions

The chemical composition and mechanical tests results obtained from the sample received for investigation meet the requirements of the ASTM A572-15 GR 60.

These results are consistent with MTR of the possible Plate Serials and match the chemistry of the plates sent to the customer.

Based on the results from the sample received from the investigation there is no evidence that point out issues related to the material. The multiple cracks that were observed are most probably related to the welding practice used during the fabrication of the part.