INSPECTION OF CHAMPION DEFENDER BUS :

DRIVER SIDEWALL, FRAME (PART # 0414250)

PASSENGER SIDEWALL, FRAME (PART #0414249)

BACKWALL, FRAME (PART #0406365)

CONTENTS

February 17, 2017

E. Todd Tracy
The Tracy Firm
5473 Blair Road
Dallas, Texas 75235

Re: Champion Defender bus accident, Davis, Oklahoma

Dear Mr. Tracy:

You asked that I review and, if proper, address the welding and structural opinions of Kim Ewing as it relates to the subject Champion Defender bus. I reviewed the bus design drawings, the Florida State rollover test paper, the deposition of Michael Neuville, the reports of Stephen Syson and Kim Ewing and inspected the subject bus. To ensure that the Champion welders' fabricated the subject bus properly, I requested that the passenger side exterior panel be removed so that I could evaluate the welds and structure on the non-impact side.

I have the following qualifications and certifications that permit me to address the sufficiency of the welding and structure on the subject Champion Defender bus.

I have been in the welding industry for over 18 years, with combined experience in the welding, construction and inspection fields. My experience combines both codebook and hands-on experience in the position of a Certified Welder, Certified Welding Inspector and Certified Welding Educator. I possess knowledge of management techniques, code compliance and research as well as strict adherence to safety policies. I have owned NIA Consulting & Welding Inspection, LLC for 7 years and specialize in correcting welder techniques to lower a welder's percentage of discontinuities and improving welder efficiency, certifying welders to meet the required codes and specifications, consulting to increase a company's productivity, code compliance assessments and welding procedure analysis and development.

In my position as Lead Consultant at NIA Consulting, I routinely determine if a weldment meets the accepted criteria of a specified code, standard or other documents; teach and evaluate the fundamentals of the following welding processes (SMAW, SAW, OFW, GTAW, FCAW, GMAW, PAW.) and mechanical and thermal cutting, brazing as well as welding metallurgy; teach and evaluate the fundamentals of quality testing procedures (VT, MT, UT, PT, RT) and the audit or surveillance of these procedures; teach and evaluate how to interpret welding symbols, drawings, and welding procedure specifications (WPS's); verify compliance of materials, equipment, records and welding procedures (including production welds); witness and verify welder performance qualifications; develop, coordinate and perform visual inspection activities; provide NDE inspection planning and scheduling; verify compliance with safety requirements; Perform audits and surveillance for quality assurance; develop and verify implementation of visual inspection training; review contract requirements and vendor proposal compliance.

I serve as President of Viking Vessel Services, LLC, and hold a fifty per cent share of this company. Viking is a mechanical contractor certified to ASME and the National Board holding its U Stamp for New Construction of Pressure Vessels, S Stamp for the Construction of Power Boilers and Power Piping and R Stamp for the Repair and Alteration of Pressure Retaining Items. Within this company, I have designed and built the framework for Viking to be certified by the above-identified certification bodies and have passed audits through the State of Texas Boiler Commission Board and ASME. These certification bodies require a highly rigid, documented quality system due to the nature of high heat and exceedingly high pressure applications of products that Viking manufactures or repairs.

I have specific experience as a pressure vessel welder (welding under ASME), and as a structural steel welder (welding under D1.1 D1.5), and in-depth knowledge of those codes.

I can weld under the following codes: ASME Sect. IX, AWS D1.1, API 1104. Welder Performance Qualifications with Filler Metal Cert (FMC): **GTAW** 6G (FMC ER90S-B9 and 9ER70S-2), 4G (FMC ER70S-2). **SMAW** 6G (FMC E9015-B9), 2G and 3G (FMC E308-15 and E7018-A1), 4G (FMC E7018-A1), 5G (FMC E6010 AND E6011). **FCAW** 6G (FMC E71T-1). **GMAW** 6G (FMC ER70S-2) and have extensive experience in working with the following metals and alloys: Aluminum, Copper Nickel, Stainless Steel, Chromium, Carbon.

Applying my education, training and experience as well as the practices of an AWS (American Welding Society) Certified Welding Inspector (CWI), along with the specifications such as AWS D8.8M: 2014, I have reached the following welding and structure opinions that are based upon a reasonable degree of probability.

Drawings

1. No design drawings with calculations of welding joint efficiency and weld deposit sizing.
2. Incomplete AWS standard welding symbols on manufacturing drawings.
3. Deviations in structure not documented in drawing revisions.

Quality Documentation

4. No documented quality system to ensure proper receiving of materials and processing of MTR's (Material Test Records)
5. No documented In-house welding inspection procedure and certified inspector.
6. No Procedure Qualification Records (PQR's): mockup test assemblies which are produced by the manufacturer where they witness, documents and mechanically test the soundness of the weld.
7. No Welding Procedure Specification (WPS) to ensure welding parameters are vetted, documented and controlled.
8. No Welder Performance Qualification Records (WPQR's). Without these the welder cannot demonstrate how to perform a sound weld in utilizing the set parameters of the WPS, they are not 'certified' or deemed they can make a sound weld.
9. Undocumented Welder traceability management system (for the purpose of Weld Mapping, to locate individual welder's weldments).

Weld Quality

10. Missing Welds
11. Incomplete welds
12. Numerous weld discontinuities such as Porosity, Cracks, Craters, Overlap, Incomplete Fusion, Weld Reinforcement, Notching and insufficient Weld Sizing.
13. The welds and structure on this bus are consistent with the weld descriptions contained within the Florida State test where Champion Bus failed to properly weld structure, missed welds, changed the design and forgot to install designed for structure.

Because of the 13 items listed above, the subject Champion Defender bus contains numerous manufacturing defects that rendered the bus defective and in my professional opinion unreasonably dangerous and unsuitable for service. These manufacturing defects are a direct result of a lack of manufacturing controls to ensure quality welds that would enhance the vehicle's potential for safety and roadworthiness as well as provide meaningful protection in the event of an accident.

When a manufacturer is operating without set welding controls and procedures in place, the weld quality is compromised. With this particular bus, the failure to utilize quality control plans and procedures, the lack of weld drawings and failure to utilize quality weld assurance, certification and testing systems, resulted in a bus being manufactured that violated welding industry standards, welding standards and guidelines, and ISO standards. The Champion Defender Bus was deficient in the following areas:

- Failed to utilize certified welders (a certified welder would have utilized WPS's for control measures in deposited weld, and would have knowledge for visual inspection to ensure their welds were sound and satisfied standards).
- Failed to vet and certify welding processes to control welding parameters
- No weld testing standards
- No engineering calculations to control weld deposit size and placement
- Extreme deviations from manufacturing drawings, such as not installing structural members
- Inadequate descriptions on BOM (Bill of Materials)
- Poor drafting and engineering controls that detail the location, size and type of weld to be used
- Splice connections that are not detailed in the drawings
- Significant loss of HSS sections in prime structural members
- Long, uneven hand cut windows for easy access to run electrical wires drastically compromising HSS structural integrity resulting in shearing
- The hacking out of 95% of the structural CAP over rear fender wells, structural members over fenders being shown on drawing or BOM but not being placed on side wall
- Numerous weld discontinuities leading to a weakened structure

All of these deficiencies reinforce my opinion that the welds that are missing in the driver's side area of the bus were of the same poor quality as those that have been inspected within the passenger side and other undamaged areas of the bus. Further, with all of these weld and structure deficiencies, there is no way that the subject buses' welding complied with AWS Specifications such as AWS D8.8M/2014 Specification for Automotive Welding Quality- Arc Welding of Steel (An American Welding Society and American National Standard Institution), quality or certification standards, guidelines or recommended practices.

Whenever manufacturing defects exist such as weld discontinuities, the weld efficiency and thus structural capability is drastically reduced and can result in catastrophic failure under its designed tensile load. The structural harm caused by deficient welds and inadequate welding procedures have been known for decades. There is no utility to a bus that fails to have rigorous manufacturing oversight. There is no utility to a bus that lacks welds, that contains inadequate welds or has missing structure. There is no utility to any bus where the fabricator has no weld map, organized protocol or procedures in place to ensure the structure is compliant with industry standards. Due to these manufacturing defects, it is my opinion that there was a high probability that the structure would fail during an impact and designed tensile load and yield. There are international, industry and national welding, quality and certification standards, guidelines and recommended practices that exist to ensure that vehicles are manufactured properly. The welds on the subject bus failed to meet AWS D8.8M/2014 Specification for Automotive Welding Quality- Arc Welding of Steel, guidelines or recommended practices.

When welds are deficient or are missing, the structural strength is decreased, by a reduction in tensile value/yield strength of the effective welds, resulting in a lower overall joint efficiency. When entire sections of structure are missing, this will add significantly to the structural failure. Sadly, the subject bus had all of these deficiencies.

The following is my specific rebuttal for Ms. Ewing's report:

Ms. Ewing indicates that there were no "bad" or "improper" welds present on the subject bus. She is mistaken however. Upon inspection of all exposed/visible welds on the passenger side, driver side and back side of the subject bus, there are numerous "bad" and "improper" welds, or welds that would not satisfy American Welding Society standards. There are numerous welds in the impact zone that have failed due to poor/incomplete fusion. Clear examples are 2-A and 7-B, both located on the impact side in figures (1) and (2). Non fusion will drastically affect the joint efficiency and could result in catastrophic weld failure.

Figure (1) Incomplete Fusion of Joint 2-A

Figure (2) Incomplete Fusion of Joint 7-B

Numerous other discontinuities were discovered which would be classified as unsatisfactory to AWS specifications. In many of the welds, combinations of discontinuities existed. i.e Craters, Overlap, Weld Reinforcement, Surface Porosity, Inadequate Fillet Weld Sizes, Notching and Cracks, all of which singularly can contribute to catastrophic weld failure, let alone in combination.

Ms. Ewing also stated that "the collision was so severe and violent that there was even base metal tearing in the tube itself." Ms. Ewing's conclusion is misleading because it omits the fact that the majority of tubular tearing occurred in the Heat Affected Zone (HAZ) of the base metal, and the weld interface. Common fatigue spots when welding processes are not proofed, documented and controlled. See Figure (3). AWS requires that all welding be controlled by a WPS (Welding Procedure Specification), which will control the amount of Joules heat input ingested into the base metal, changing the molecular structure, and resulting in a change in the mechanical properties of the parent metal. Manufacturers are required to proof their processes and demonstrate weld soundness by methods of destructive and non-destructive examination to ensure sound weld quality. Ms. Ewing mentioned visual inspection and macro-etch testing – these are two ways to test the soundness of a weld and should be applied prior to fabrication. No such test results have been furnished.

Figure (3) Tearing in the Heat Affected Zone

Ms. Ewing claimed that "The side structure on the 2008 Champion Defender Bus did not collapse. Its network of tubular and open section structural members provided a cage structure that resisted intrusion and impact by the tractor trailer which had a velocity of 70 mph at initial contact with the bus. The crash overwhelms any **reasonable** bus structure." Upon investigation, I discovered that items 'R' and 'T', Channel Sidewall 16GA x 33.5 (Part CUT FR 0350769), as shown in Figures (4) and (5), were never placed into the Side Wall frame of the Champion Defender bus in question. At first glance, looking at the impact side, one might incorrectly assume like Ms. Ewing did that item 'R' was missing because the structure was torn away in the accident. To verify the design drawings and verify that the welds were compliant to AWS standards, I requested the passenger side and rear skin be removed. Upon removal (see Figure 5), it was discovered that Champion Bus failed to install section 'T' in this side also. Champion Bus had also failed to follow design drawings in the Florida State rollover testing. Not only did removing the skin on the passenger side reveal this missing structural item in the epicenter of the collision, but item L (see Figure 5), 14GA CAP, was found to have been butchered to fit the contour of a tire. This was not denoted in the design drawings.

Much like Champion Bus had done on the Florida State test, they failed to build the subject bus to the design drawings, forgot to install critical structure, changed the design drawings and did a poor job of welding. These changes and deficiencies had the same result in this tragic accident as they did in the simulated rollover test: the structure failed.

[Manufacturer Drawing Redacted]

Figure (4) Manufacturer Drawing Driver's Side – Red Arrow Missing Member, Green Arrow C Channel Splice

Figure (5) Missing structural members missing and cut

Ms. Ewing also claims that "Welds separated and tubular members separated from adjacent members due to the high crash forces which exceeded the load-carrying capacity of the welded joints." Ms. Ewing failed to factor joint efficiency on welds that are improperly fused or possess surface discontinuities such as Craters, Overlap, Weld Reinforcement, Surface Porosity, Inadequate Fillet Weld Sizes, Notching and Cracks.

Ms. Ewing stated that "The FSU report did not call out "bad welds" in the modified 2005 Challenger bus. The report used the term "incomplete" to describe missing welds on the modified bus, and not lack of penetration, or non-compliant welds as compared to an in-house or American Welding Society arc weld quality specification." The comparison of 'incomplete' welds to defective welds with a 'lack of penetration, or non-compliant' is irrelevant. They are both prone to failure when force is applied to the structure. The fact that Ms. Ewing directly calls out the 'American Welding Society Arc Weld Quality Specification' affirms the fact AWS D8.8M:2014 Specification for Automotive Welding Quality/Arc Welding of Steel is of critical importance to the weld issues in this bus. I used this same standard as my acceptance criteria for visual inspection of the weldments on the Champion Defender Bus. The majority of the welds on the Champion Defender Bus did not meet the requirements of this specification and therefore would be deemed as "bad welds" under AWS Specifications.

Ms. Ewing states "Whether a weld is "bad" or "discrepant" rests on a proper metallographic examination of the weld bead." This is incorrect. Metallographic examination, the proof of welding process and sound metal deposit involving macro-etching the cross sectional weld deposit is a destructive examination and would cause any product to be discarded. Visual examination is the most readily used NDE (Non Destructive Examination) in a variety of industries, and is a reliable method of inspecting to Visual Acceptance Criteria to determine the weld soundness to meet AWS Specification.

Ms. Ewing also states "Plaintiff expert has not identified the location of these so-called "bad" welds, nor explained how they affected the side structure deformation in more detail than simply stating that the structure "collapsed"." A structure with welds that have a substantial amount of surface discontinuities and do not meet the acceptance criteria of an AWS Specification cannot hold to yield load calculations prescribed for the design and application of the Champion Defender Bus. Furthermore altered designs and missing parts, with undocumented deviations, compounded with numerous weld discontinuities, can drastically weaken any structure, making it prone to failure, regardless of applied loads. Ms. Ewing also failed to address the fact that the pillar joints were 'inadequately welded'. Instead, Ms. Ewing focused on the 'add-on design changes' to suggest that they could 'not alter the outcome of this specific crash'. Upon inspection, the majority of the Pillar Joints were found to have Incomplete Fusion, creating a weakened structure, regardless of whether they were reinforced or not. I have provided a drawing that identifies the non-compliant ('bad welds') as defined by AWS. I have also labelled, photographed and explained why the welds were bad in accordance to the AWS standards.

Ms. Ewing stated "The tractor trailer side swiped the side frame, deformed rear sections of the lower longitudinal rail and as a consequence, the bolts holding the outboard seat anchor to this rail pulled apart." The left side seating mounts did detach from the lower longitudinal rail. However, what Ms. Ewing failed to address is that the channel seat track back (as seen in Figures 3 and 6) was spliced. This splice was not detailed in the drawings, nor mentioned in Ms. Ewing's report. The plate that was used to join the spliced sections is not listed, dimensioned or specified on the Champion Defender Bus manufacturing drawings. As is seen in Figure 8, the lack of fusion rendered these spliced sections unsatisfactory to an AWS Acceptance Criteria. When welding non-coated, versus coated, material (this Channel is Zinc coated or 'galvanized'), D8.8M/2014 specification requires that "the filler metal shall conform to the requirements of the appropriate AWS filler metal specifications. Filler metals used to weld zinc coated steel shall be evaluated for their compatibility with zinc coatings."

Figure (6) Spliced C Channel Seat Track Back Weld Failure

Lastly, Ms. Ewing concluded that the "The structural design and welding of the subject 2008 Champion bus were not defective and unreasonably dangerous." Having inspected both sides of the bus, as well as the rear of the 2008 Champion Bus, I have found the majority of visible welds to be non-compliant to AWS Welding standards, thus rendering them defective for service. Also, finding lack of engineering controls, such as: undocumented deviations from design i.e. structural members missing from as-built; structural members being drastically modified and not documented in a revision of drawings; and crucial structural members (such as C channel holding the seats stable) having undocumented splices and unspecified materials placed in crucial structural members, are deviations from design demonstrate that the subject bus was defective and unsuitable for service due to its welds and structure.

The manufacturer did not follow any set specifications or guidelines to ensure the quality of the subject Champion Defender bus. If specifications and guidelines exist, there still has been a massive deviation, resulting in multiple areas of undocumented, uncontrolled manufacturing. As an AWS Certified Welding

Inspector and with numerous years of experience, I am lead to believe the Champion Bus involved in this accident was not properly vetted for design yield capacity. As such, a defectively manufactured bus was permitted to leave Champion's production facility and put into service.

Ms. Ewing also concludes that the "subject bus contained galvanized steel and also galvanized steel over luan." Ms Ewing is mistaken. We tested the structural tubing and the structural C-Channel and it is not galvanized steel. The 'seat track black' is galvanized steel. Ms. Ewing also refers to tubular diagonal structural members. Again she is mistaken because this material was non-galvanized C-Channel. Ms. Ewing also states in her report 'outboard seat anchors are bolted to the full length lower longitudinal rail', as you can see if Figure 5 which she refers to in her report, she points to the galvanized C Channel (description per Champion Bus BOM 'seat track black'). She is mistaken, this lower longitudinal rail is not 'full length', as I have noted in the report this has been spliced in several locations and is not in a continuous run. The plate placed on the C Channel to splice is an unidentified part, not listed on the Champion Defender Bus BOM. Furthermore Ms. Ewing states that 'longitudinal tubes were arc welded to adjacent vertical tubes to form a continuous longitudinal rail at the lower edge of window openings' she is again mistaken, the longitudinal rail in sections L1, L2, L3 and L6 are C Channel, not HSS tubing.

The manufacturing defects could have been avoided:

- had Champion Bus complied with AWS industry and ISO standards;
- had Champion Bus utilized quality assurance protocols and procedures;
- had Champion Bus followed its own design drawings;
- had Champion Bus tested and visually inspected each weld;
- had Champion Bus ensured that no structure was missing, butchered or spliced together;
- had Champion Bus proofed their design with structural calculations and testing.

My opinions are based on the information I have at the present time. I will supplement this report once laboratory test results are received. I have also requested Mr. Tracy to request ISO and QVM audits as well as base metal and filler metal specifications which may need to be addressed further.

Yours Sincerely,

John.D.Null

AWS®
John D Null
CWI 09110811
QC1 EXP. 11/1/2018

INSPECTION OF CHAMPION DEFENDER BUS:

DRIVER SIDEWALL, FRAME (PART # 0414250)

PASSENGER SIDEWALL, FRAME (PART #0414249)

BACKWALL, FRAME (PART #0406365)

CODE BODIES: AWS (American Welding Society)

SPECIFICATIONS UTILIZED:

AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

AWS A2.4: 2012 Standard Symbols for Welding, Brazing, and Nondestructive Examination

WIT-T:2008 Welding Inspection Technology

AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel is the prime specification adopted by NIA Consulting & Welding Inspection, LLC for the inspection of the Champion Bus case (Richardson V Champion Bus).

The drawings in the file do not have any direction to a particular welding specification, but by best practice a manufacturers responsibility is to provide safe products for public consumption. A code such as AWS 8.8M is produced for structuring and guidance to assist manufacturers with weld quality.

As stated in the Foreword of AWS D8.8M:2007 'Recent changes in automotive design, caused by the desire to reduce fuel consumption and improve crash performance, have resulted in automotive structures being made of thinner and higher strength metal parts. This specification was undertaken to prepare minimum quality standards for arc welding of various types of components. One objective of the subcommittee was to prepare a specification that would be useful for the OEMs and Tier suppliers of automotive components who may not have quality standards of their own. Another objective is to get as many of the OEMs and Tier suppliers to use and specify this document so there is greater consistency'.

AWS D8.8 General Provisions

4.1.1 This specification provides the minimum acceptable quality requirements for Arc and hybrid arc welding of coated and uncoated materials for various types of automotive and light truck components.

4.1.2 The post weld acceptance requirements contained in this document and mandatory when this specification is referenced on a product drawing or in a contract. A product not conforming to the acceptance criteria contained in this specification shall be reworked, scrapped, or accepted by concession.

4.2.1 Welding Procedures list those variable (and their limits) which influence the quality of the weld. The welding process and welding procedure shall be developed and documented to demonstrate the capabilities to reliably produce welds on production parts over a specified range of variables. Information pertaining to welding procedure qualification may be found in AWS B2.1/B2.1M Specification for Welding Procedures and Performance Qualification, other AWS application codes , and OEM (Original Equipment Manufacturer) standards.

4.2 Filler Metals shall conform to the requirements of the appropriate AWS filler metal specification. Filler metal used to weld zinc coated steel shall be evaluated for their compatibility with zinc coatings.

Photographic Report

The following are detailed photographic reports of the welds located on the Driver Side Wall, Passenger Side Wall, and Backwall of the Champion Bus. Each window frame section is segregated alphabetically and each weld deposit is numerically docketed within each frame section. Please refer to Weld Maps in Annex E, F & G.

Not all welds were able to be visually inspected due to inaccessibility or the loss of section located in impact zone.

All welds in the following detailed photographic report are considered DEFECTIVE unless otherwise stated. Based on AWS D8.8M:2014 each discontinuity observed and documented will have a sub-clause detailing the discontinuity (please refer to Annex B).

As stated in 5.1.12 of AWS D8.8M:2014 Specification for Automotive Weld Quality, a Combination of Discontinuities (more than one of the listed discontinuities) is not permitted and therefore makes the weld automatically rejectable.

Annex C depicts common manufacturing controls and the cause and effect of discontinuities catalogued in Annex B.

Annex D is an example of an acceptable T-joint fillet weld profile

Drawing Deviations

Driver Side: Item R, Part # 0400131 Qty 1, Channel , Sidewall 16GA x 33.50: This has not been located. This item is missing on both Driver and Passenger Sides. No welds are apparent on the metal in this region over the fender well on the impact driver's side. This constitutes an undocumented revision and deviation from manufacturing drawings.

Driver Side: Section L5 Items C & F, Z Channel, Seat track Black 10' and Channel, Seat track Black 61.00: a ¼" 2" x 2.5" plate of unidentified material has been placed on 10' spliced connections on Z side wall channel. This deviation is not noted in manufacturing drawings, nor is the unidentified plate placed in the BOM (Bill of Material). Same condition exists on passenger side.

Driver & Passenger Side: Rear window sections L6 and L6(P) diagonal supports are not specified on the BOM (Bill of Material) to be broken. In the drawing they are shown as one piece. Horizontal tube in this section (which splits the diagonal support in two is also not specified in the drawing BOM (Bill of Material).

Passenger Side: Section L2(P) Item D & E, Z sidewall 16GA x 96.00 and Z sidewall 16GA x 74.00 vertical section of joint not welded (Figure 1)

Figure (1)

AWS D8.8 General Provisions

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PHOTOGRAPHIC REPORT –CHAMPION DEFENDER - DRIVER SIDE

5.1.12 Combination of Discontinuities[3] - Applies to all welds with more than one discontinuity.

1-A: 5.1.2 Craters[1] 1/16”, 5.1.10 Overlap[2], Incomplete fusion to corner- - Ref Table 1: Common Types of Discontinuities[4].

2-A: 24/32” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], clause 4.5

Numbers 1 to 12 refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

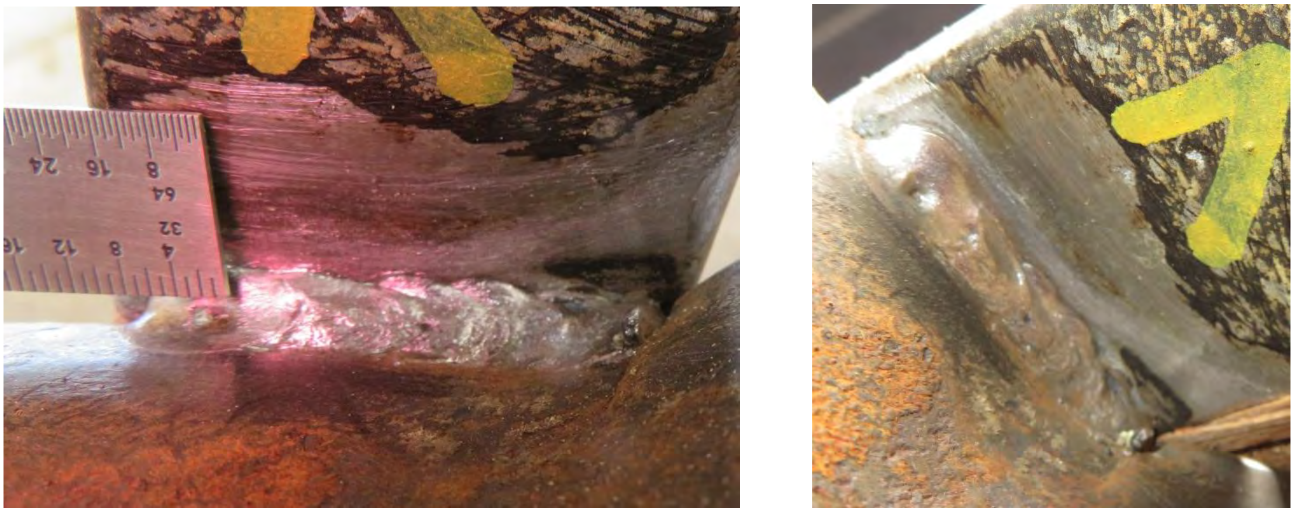
3-A: Sheared at Heat Affected Zone (HAZ), above the top weld toe. (not a rejectable discontinuity)

4-A: 4.17 Table 1 Weld Reinforcement^5, 5.1.10 Overlap$_2$, Incomplete fusion to corner- Ref Table 1: Common Types of Discontinuities$_4$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

5-A: 1/8” Incomplete fusion - Ref Table 1: Common Types of Discontinuities$_4$.

6-A: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$. Incomplete fusion - Ref Table 1: Common Types of Discontinuities$_4$.



7-A: 1/8” 5.1.2 Craters$_1$, 1/8”, Incomplete fusion - Ref Table 1: Common Types of Discontinuities$_4$.

8-A: 12/32” Incomplete fusion (top weld) & ¾” Incomplete fusion (bottom weld) - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

9-A: Incomplete fusion (bottom weld) - Ref Table 1: Common Types of Discontinuities[4], poor weld placement

10-A: Cumulative 33/64" Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.10 Overlap[2], 5.1.2 Craters[1].

11-A: Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1].

12-A: Incomplete fusion of the root - Ref Table 1: Common Types of Discontinuities[4], ¼” no weld deposit.

13-A: ¼” Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1] , 5.1.10 Overlap[2].

Numbers [1] to [12] refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

14-A: 5.1.2 Craters[1]

1-B: Top weld = inaccessible, bottom weld: ¼” Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4],

5.1.2 Craters[1]

2-B: ¼” Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.10 Overlap[2], 5.1.2 Craters[1], no weld deposited ¼”.

3-B: 5.1.2 Craters[1],

Numbers [1] to [12] refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

4-B: 5.1.13: 5.1.2 Craters$_1$, Incomplete fusion - Ref Table 1: Common Types of Discontinuities$_4$,

5-B: Rear weld 1/8” no weld, 5.1.10 Overlap$_2$. Front weld : 5.1.2 Craters$_1$,

6-B: Botton weld ½” Incomplete fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$, Top weld 3/32” no weld deposit.

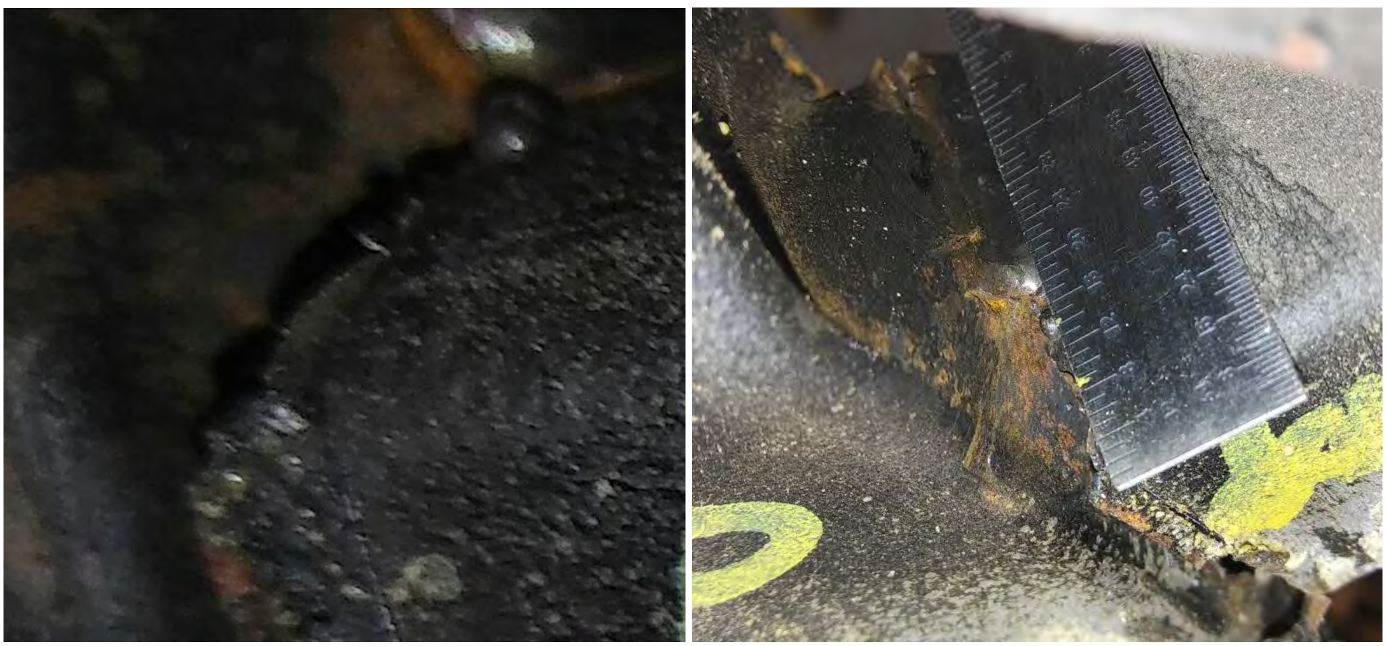
Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

7-B: Top Weld ¼" Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], Bottom weld 48/64 Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4].

8-B: non weld deposit of 3/32”, 5.1.2 Craters$_1$.

1-C: 16/32” suspicion of non-fusion, 5.1.2 Craters$_1$.

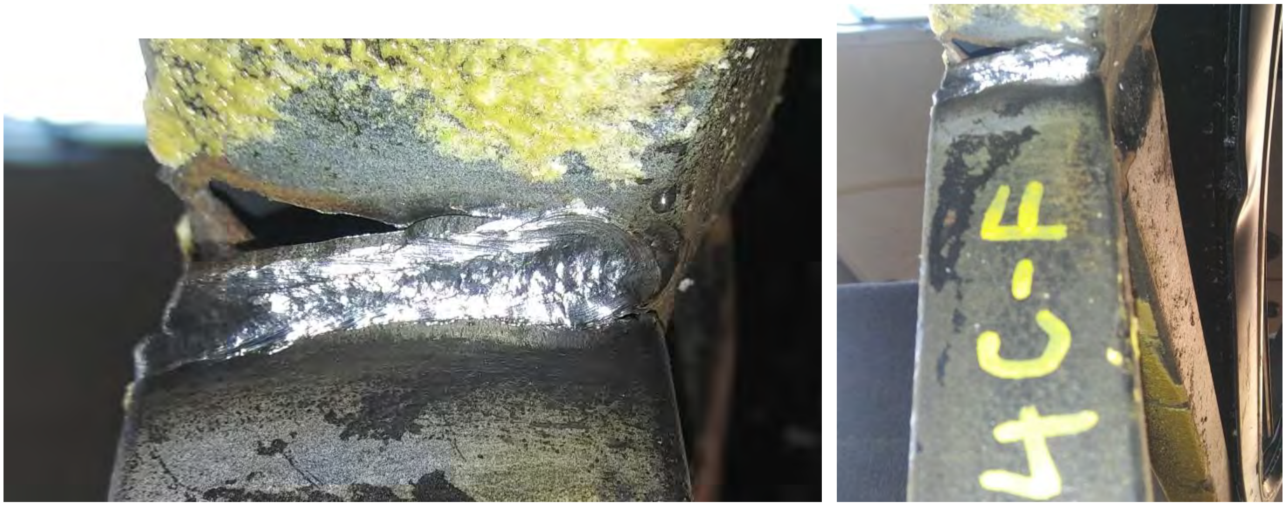
2-C: Bottom weld - 5.1.2 Craters$_1$.end of weld not fused 3/32”.



2-C Top weld – ½” no weld deposit

3-C: 5.1.2 Craters$_1$.

4-C: Rear weld: 2/32” no weld deposit, 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.



4-C: Front weld: base metal sheared in Heat Affected Zone (HAZ), fillet weld toe. (not a rejectable discontinuity)

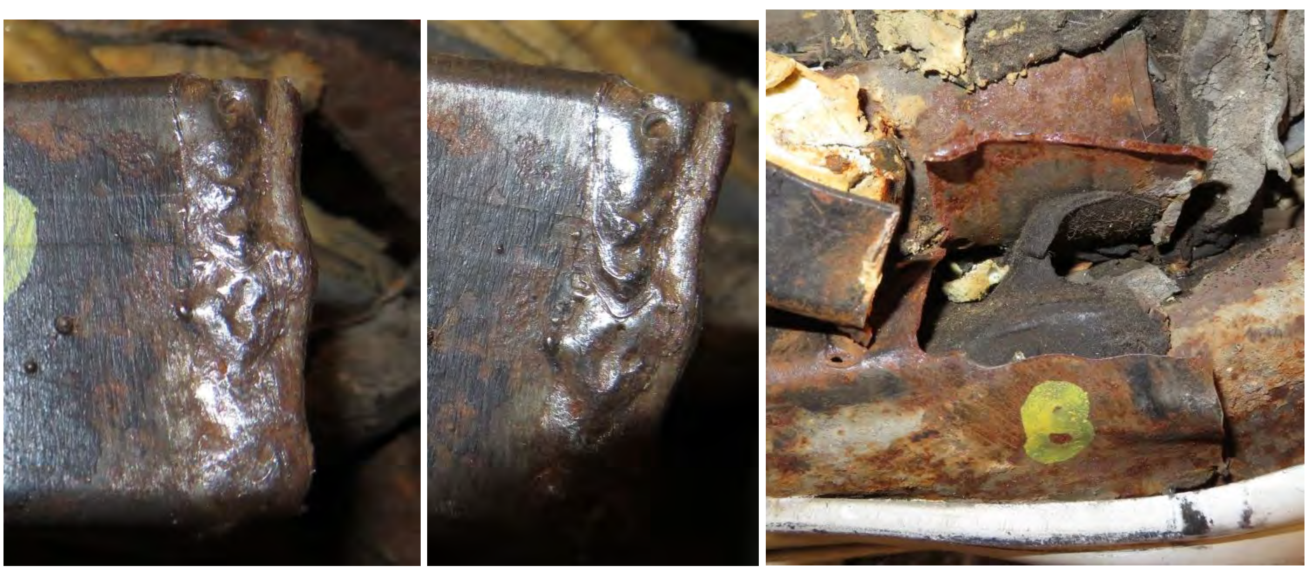
5-C: 5.1.2 Craters[1], 4.5.4.1 Surface Porosity[6]

Numbers [1] to [12] refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

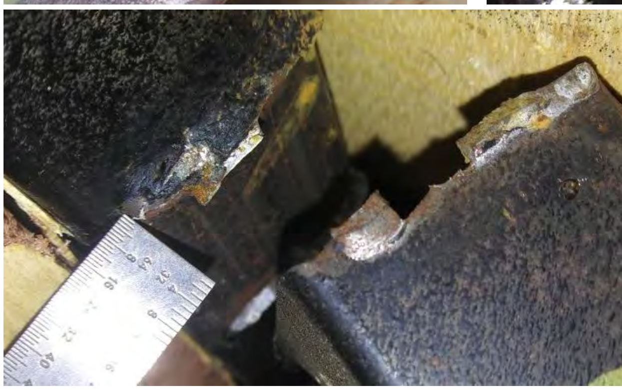
6-C: ¼” non weld deposit.

7-C: Tubing ripped away from weld toes

8-CA: Failure in the overlap region of the weld.

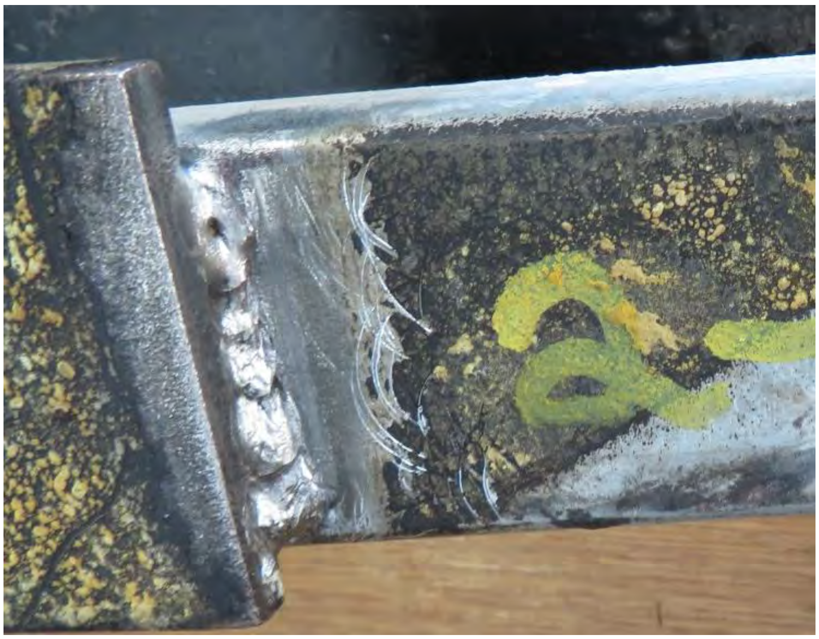


8-CB: 5.1.2 Craters$_1$, possible failure in HAZ (Heat Affected Zone)



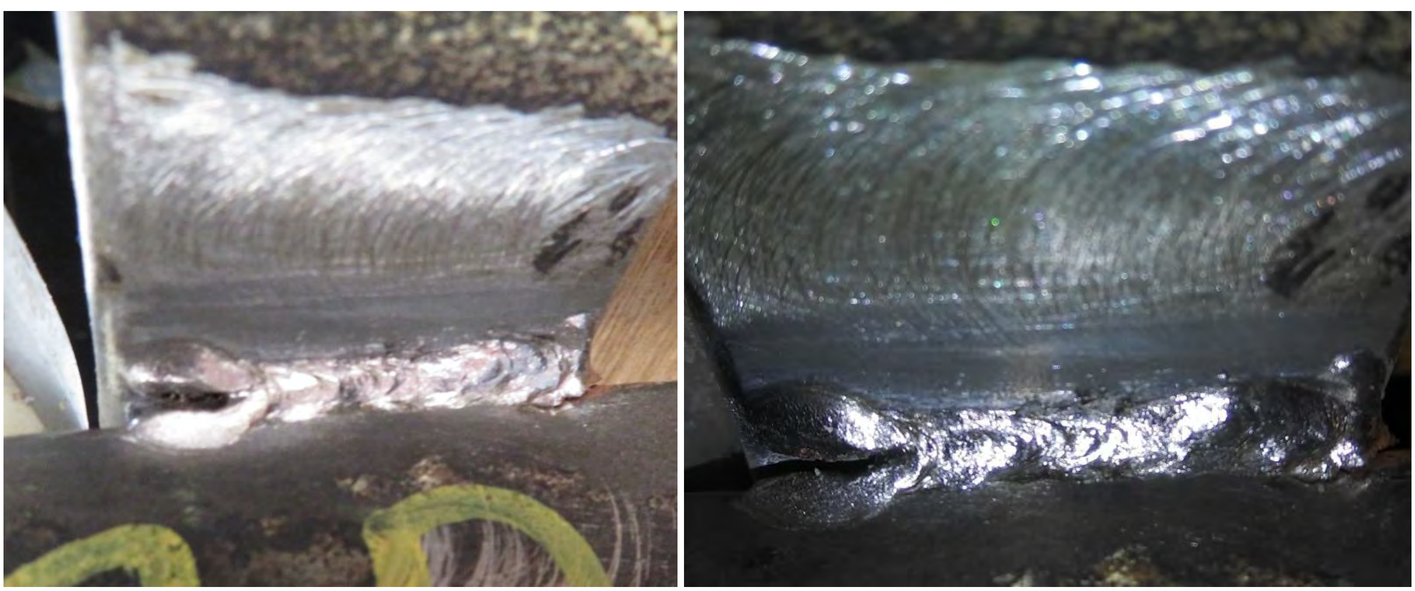
1-D: Top Weld: ½" in center of weld deposit plus combined on each corner of 1/4:" of Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4],

1-D Bottom Weld: Limited visual access, suspected incomplete fusion, Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4],

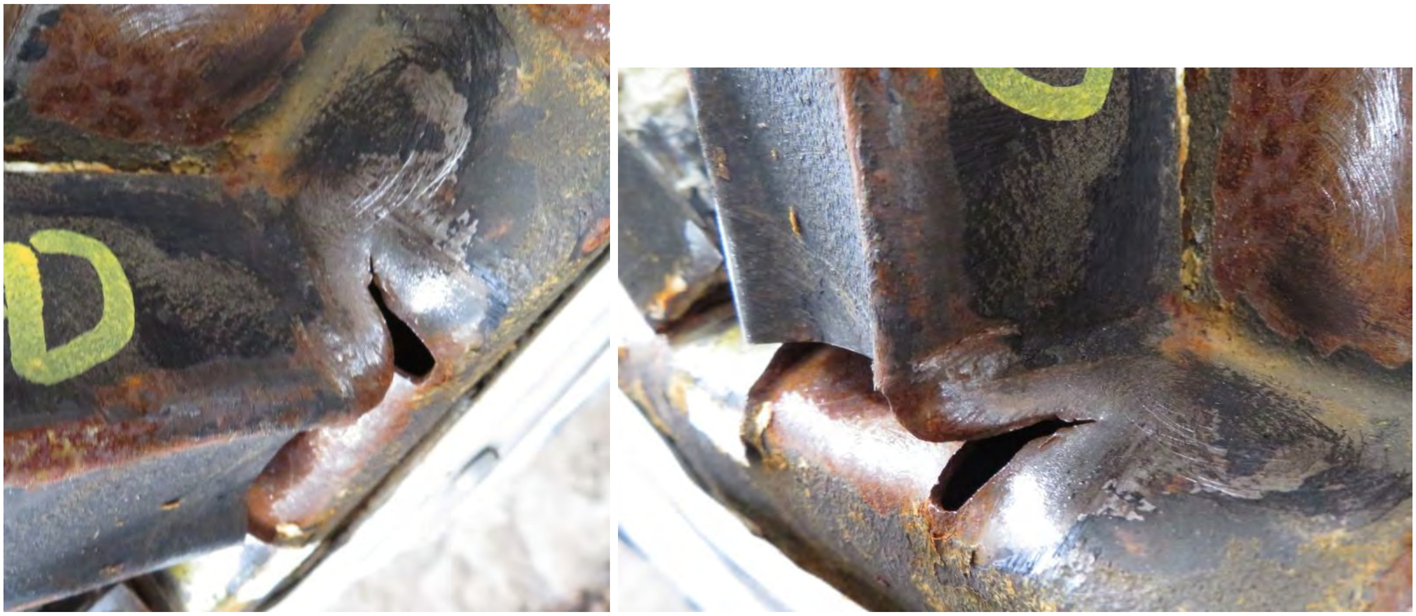


2-D Rear weld: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

2-D Front weld: Poor placement of weld deposit creating dissimilar legs on 15/64" thick splice plate. 5.3.1 Fillet Welds[7] - Fillet weld leg fusion attached to splice plate exhibits only 2/32" (1/16") of fusion.



3-D: Root Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.9 Notching[8].



4-D: Tear in Heat Affected Zone (HAZ) (not a rejectable discontinuity)

5-D: Missing C channel. No weld to inspect.

6-D: Missing C channel, no weld to inspect.

7-D: Metal tearing originating in toe of weld, 5.1.10 Overlap$_2$ on edge of weld.

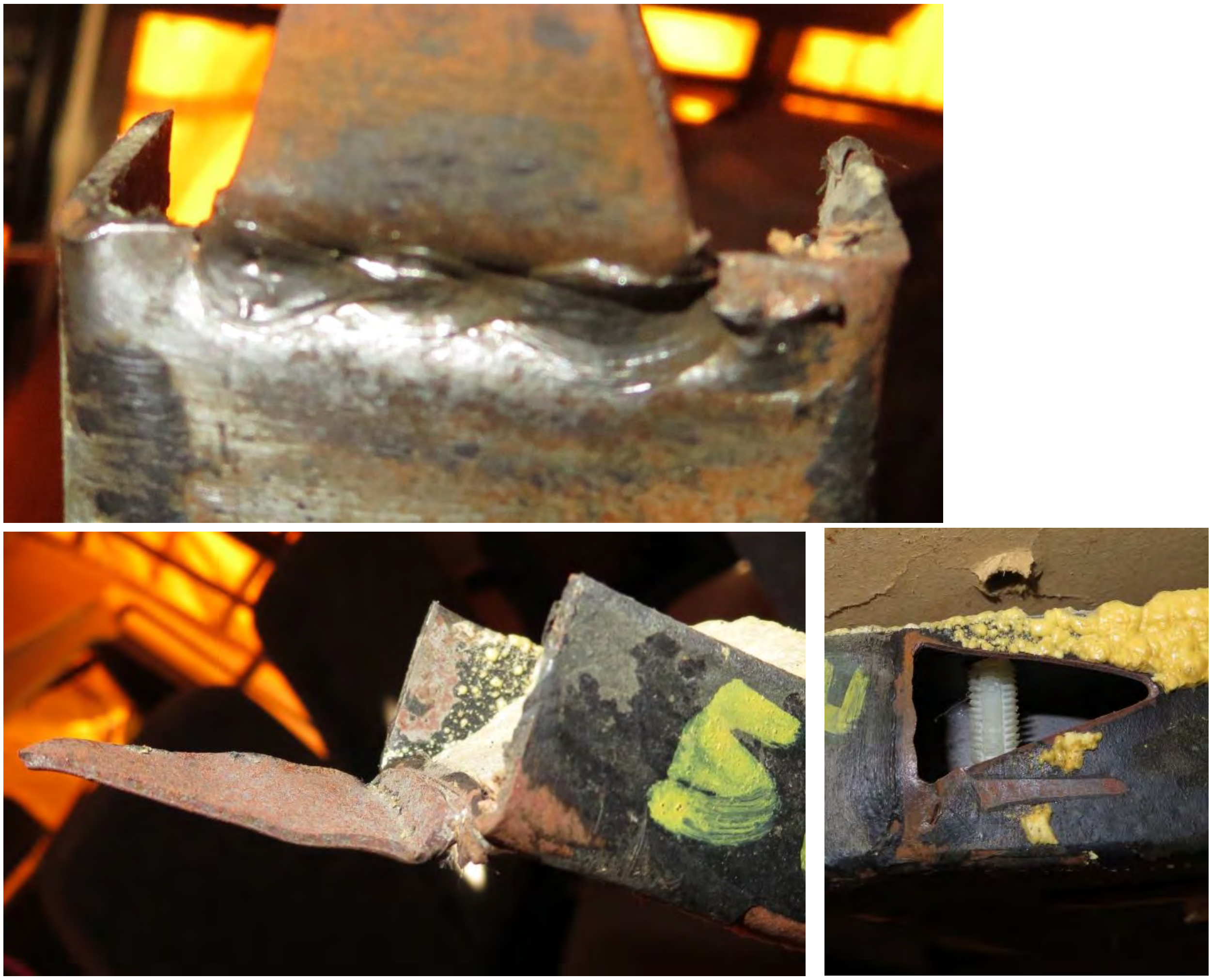
1-E: 5.1.10 Overlap[2], ½” Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4].

2-E: 5.1.10 Overlap[2]. 5.1.2 Craters[1]

Numbers [1] to [12] refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

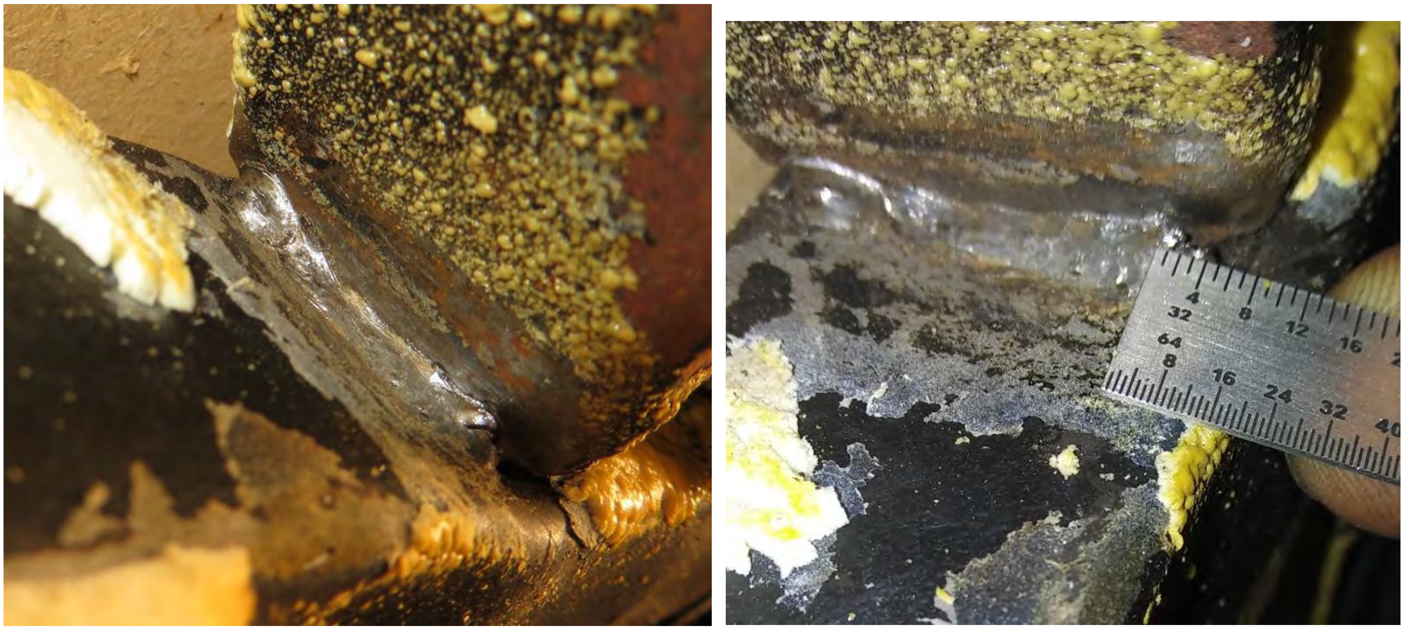
3-E: Loss of HSS due to suspect corrosion -Height 11/64”, width 45/64”, 5.1.2 Craters[1],

4-E: Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1], 5.1.10 Overlap[2], 5.1.3 Cracks[9]

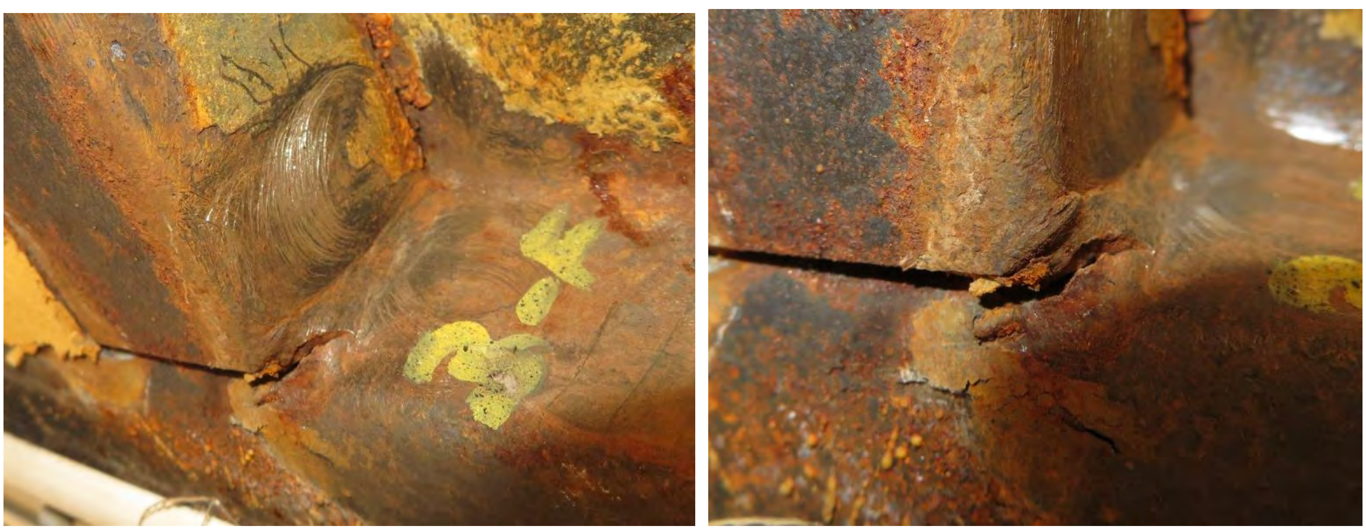


5-E: Incomplete fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1]

1-F: Surface exhibits no discontinuities.



2-F: 5/32” Incomplete fusion - Ref Table 1: Common Types of Discontinuities$_{4}$, 5.1.2 Craters$_{1}$,



3-F: 5.1.3 Cracks$_{9}$ - crack is located in Crater (5.1.2 Craters$_{1}$), 5.1.10 Overlap$_{2}$, 5.1.12 Combination of Discontinuities$_{3}$ applies but is over-ruled due to sub-clause 5.1.3 Cracks.

Numbers $_{1}$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

4-F: Surface Porosity$_6$ in the linear length 9/32”, widest point 10/64, 5.1.10 Overlap$_2$,

5-F: Further lab examination required

PHOTOGRAPHIC REPORT – CHAMPION DEFENDER - PASSENGER SIDE

5.1.12 Combination of Discontinuities$_3$ - Applies to all welds with more than one discontinuity.

G-1A: 8/64” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.10 Overlap$_2$.

G1-B: 5.1.1 Undercut$_{10}$ T = 0.065”. 0.2T =0.013” (= permissible depth of undercut in this weld). Actual depth of undercut in this weld is 0.031 (1/32”). Length of undercut is 24/64”, this is also outside the permissible length of cumulative 1/8 of specified weld.

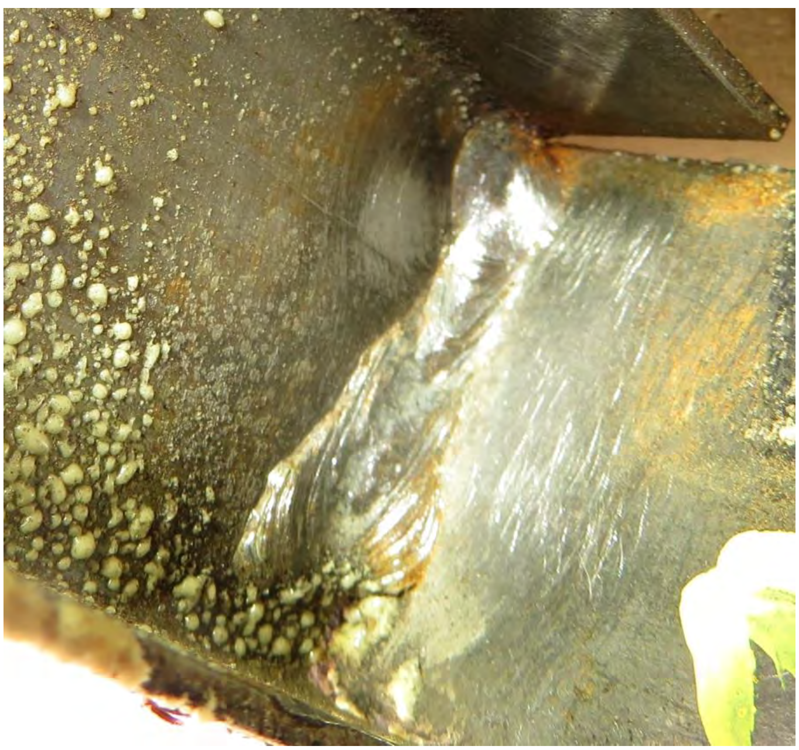
G-2A: 5.1.2 Craters$_1$

G-3A: 5.1.2 Craters$_1$

G-3B: 5.1.10 Overlap$_2$, 5.1.2 Craters$_1$

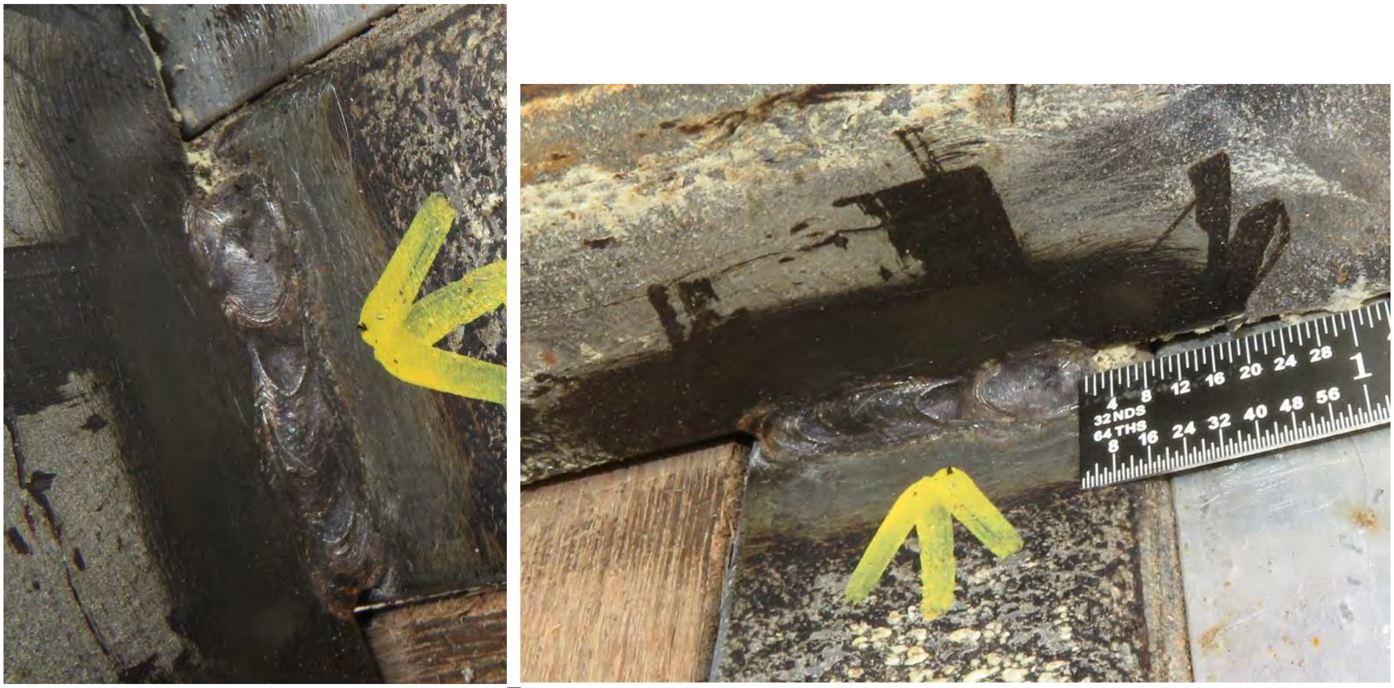


G-4A: 2 x 5.1.2 Craters$_1$, 5.1.3 Cracks$_9$ - crack is located in Crater.



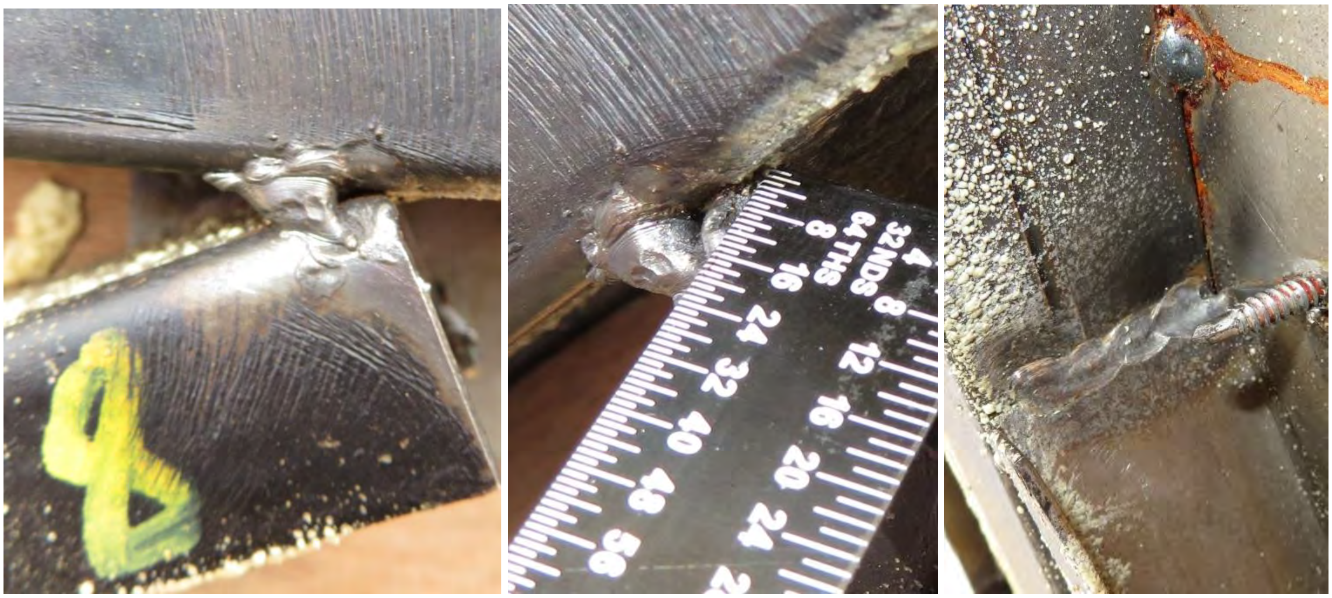
G-5: 5.1.10 Overlap$_2$, 5.1.2 Craters$_1$, Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)



G-6: 7/32” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 2 x 5.1.2 Craters$_1$.

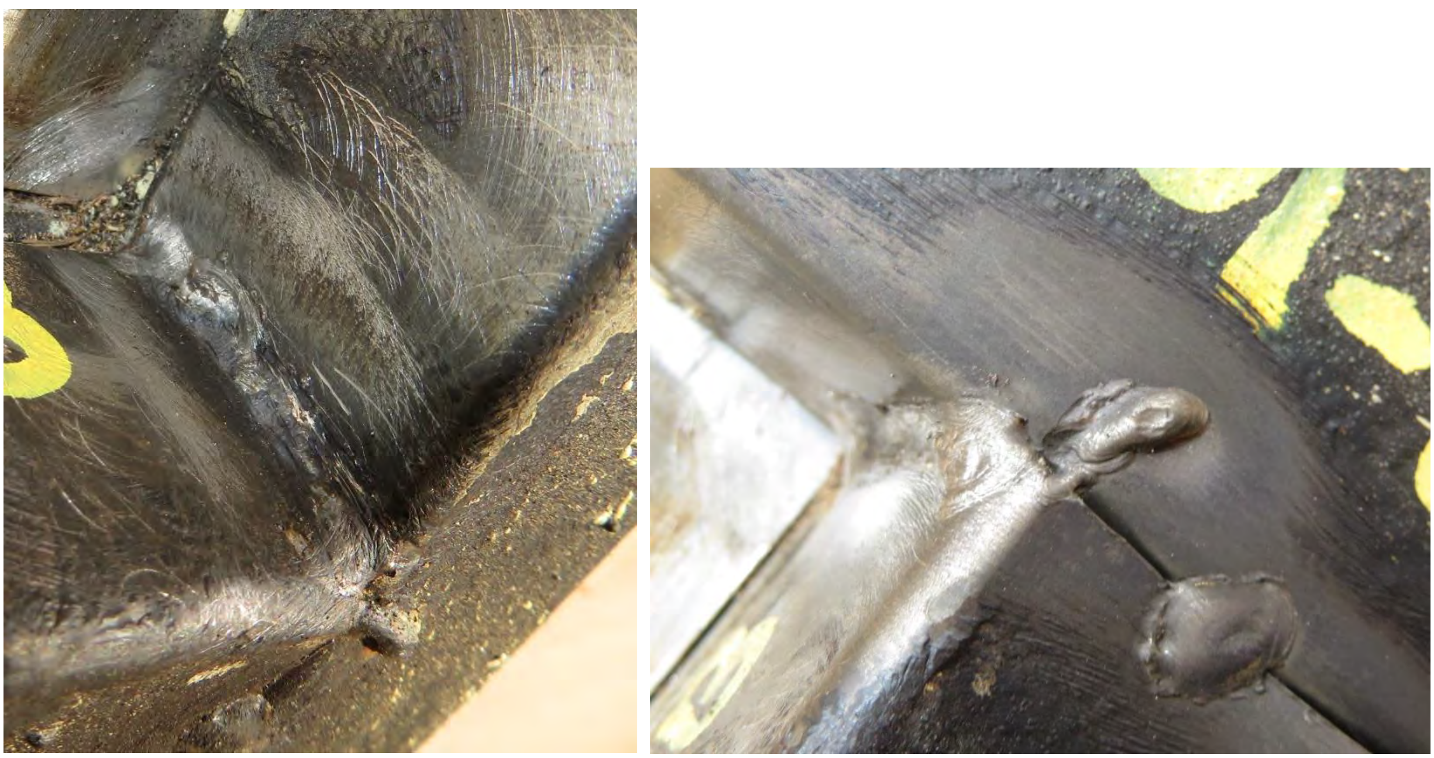
G-7: 5.1.2 Craters$_1$., Zinc plated C-channel spliced with unknown plate.



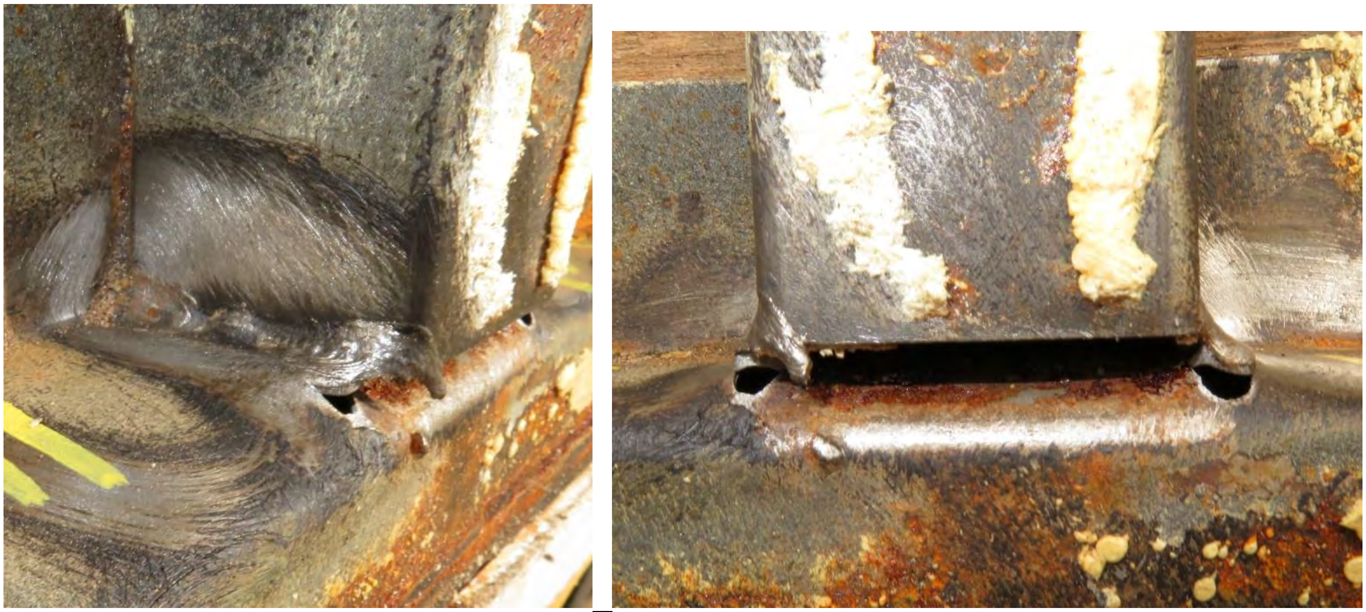
G-8: 1/8" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 2 x 5.1.2 Craters[1].

G-9: ¾" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4].

G-10A: 5.1.10 Overlap[2], 5.1.2 Craters[1].



G-10B: Excessive arc strike (5.1.10 Overlap[2]), 5.1.2 Craters[1].



G-11: 5.1.2 Craters[1], HAZ (Heat Affected Zone) / toe of weld tearing 6/32”

G-12: ¼”Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.10 Overlap[2].

G-13: ¼” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.10 Overlap[2], 5.1.2 Craters[1].

H-1: 5.1.2 Craters[1], HAZ (Heat Affected Zone)/ toe of weld tearing 1/8”

H-2: 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4].

Numbers 1 to 12 refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

H-3: Excessive arc strike (5.1.10 Overlap$_2$), 5.1.2 Craters$_1$.

H-4: Excessive arc strike (5.1.10 Overlap$_2$), 5.1.2 Craters$_1$.

H-5: 5.1.2 Craters$_1$.

H-6: 5.1.2 Craters$_1$.

H-7: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

H-8: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$, 5.1.7 Meltback$_{11}$.

H-9: 5.1.2 Craters$_1$, 5.1.7 Meltback$_{11}$., 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

H-10: 5.1.2 Craters₁, 5.1.10 Overlap₂.

H-11: 5.1.2 Craters₁

H-12A: 5.1.10 Overlap$_2$, 5.1.2 Craters$_1$, HAZ (Heat Affected Zone) / toe of weld tearing 1/16”

H-12B: Limited accessibility for cleaning & visual inspection, HAZ (Heat Affected Zone) / toe of weld tearing 1/16”

H-13A: 5.1.2 Craters[1].

H-13B: 1/4” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], : 5.1.2 Craters[1].

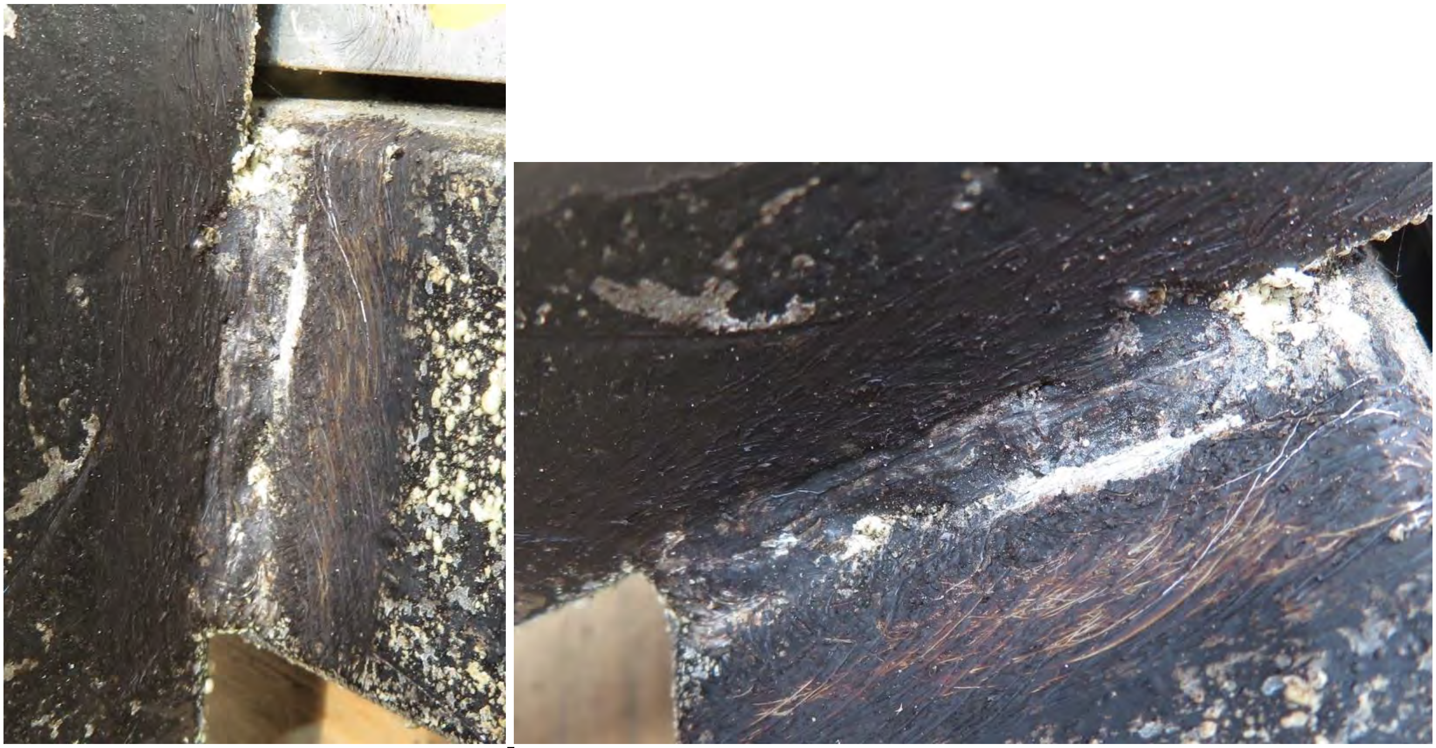
H-14A: Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1], 5.1.10 Overlap[2].

H-14B: Inaccessible for cleaning and visual inspection

H-15: 5.1.2 Craters[1], Excessive arc strike (5.1.10 Overlap[2]).

H-16: Undersized weld (5.3.2.2 Welds in Butt & Groove Joints[12]), 5.1.2 Craters[1],

I-1: 5.1.2 Craters[1],



I-2: 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.1 Undercut[10] T = 0.0625”. 0.2T =0.0125” (= permissible depth of undercut in this weld). Actual depth of undercut in this weld is 0.031 (1/32”). Length of undercut is 3/16”.

I-3A: OK

I-3B: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

I-4A: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

I-4B: 5.1.2 Craters[1].

I-5A: 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.10 Overlap[2].

I-5B: ¼” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$.

I-6A : 5.1.2 Craters$_1$. I-6B: Inaccessible for cleaning & visual inspection

I-7: ½" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4],

I-8: 5.1.2 Craters[1].

I-9: 1/4" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1].

I-10A: 5.1.2 Craters[1], 5.1.10 Overlap[2].

I-10B: Inaccessible for full inspection due to cleaning, 5.1.10 Overlap$_2$.

I-11: 1/8" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$,

J-1: 5.1.10 Overlap$_2$, 5.1.2 Craters$_1$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

J-2: 5.1.10 Overlap$_2$, 5.1.2 Craters$_1$.

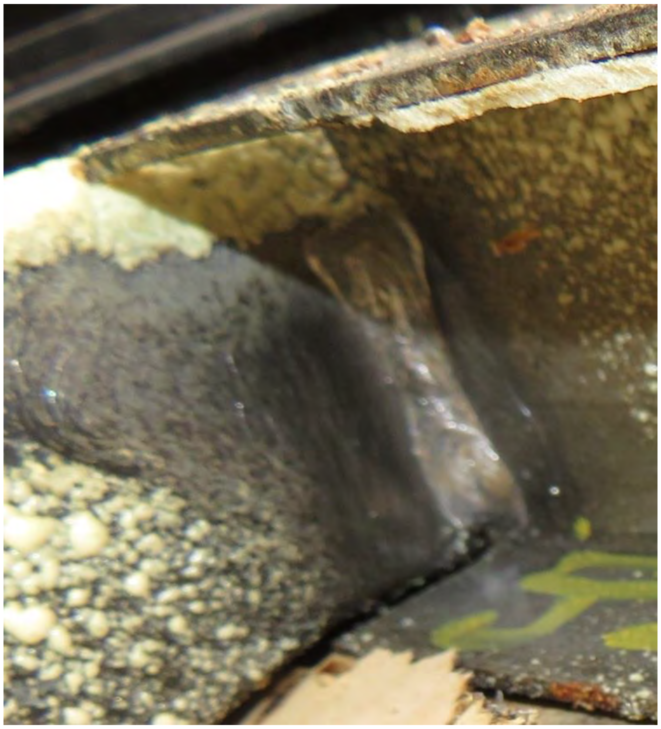
J-3A & B: Refer to Macro-etch Report

J-4: 3/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_{4}$,

J-5: 5.1.2 Craters$_{1}$, HAZ (Heat Affected Zone) / toe of weld tearing 1/16”

J-6: 5/32” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$.

J-7: 3/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, (cumulative for both sides).



J-8: 1/4” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1].

K-1: HAZ (Heat Affected Zone) / toe of weld tearing 1/4”

K-2: 1” cumulative Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4].

K-3: HAZ (Heat Affected Zone) / toe of weld tearing 1/4”, 5.1.2 Craters$_1$.

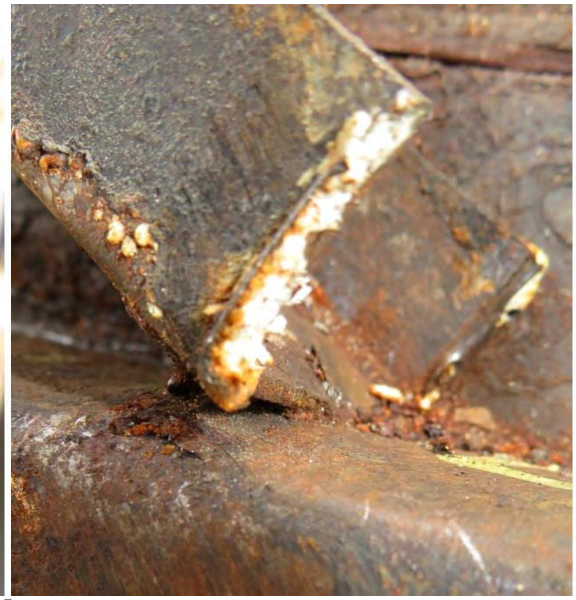
K-4: 5.1.2 Craters$_1$,5.1.10 Overlap$_2$.

K-5: 3/8" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$.

K-6: 3/8" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$.

K-7: 5.1.2 Craters[1].

L-1: 1/2” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4].

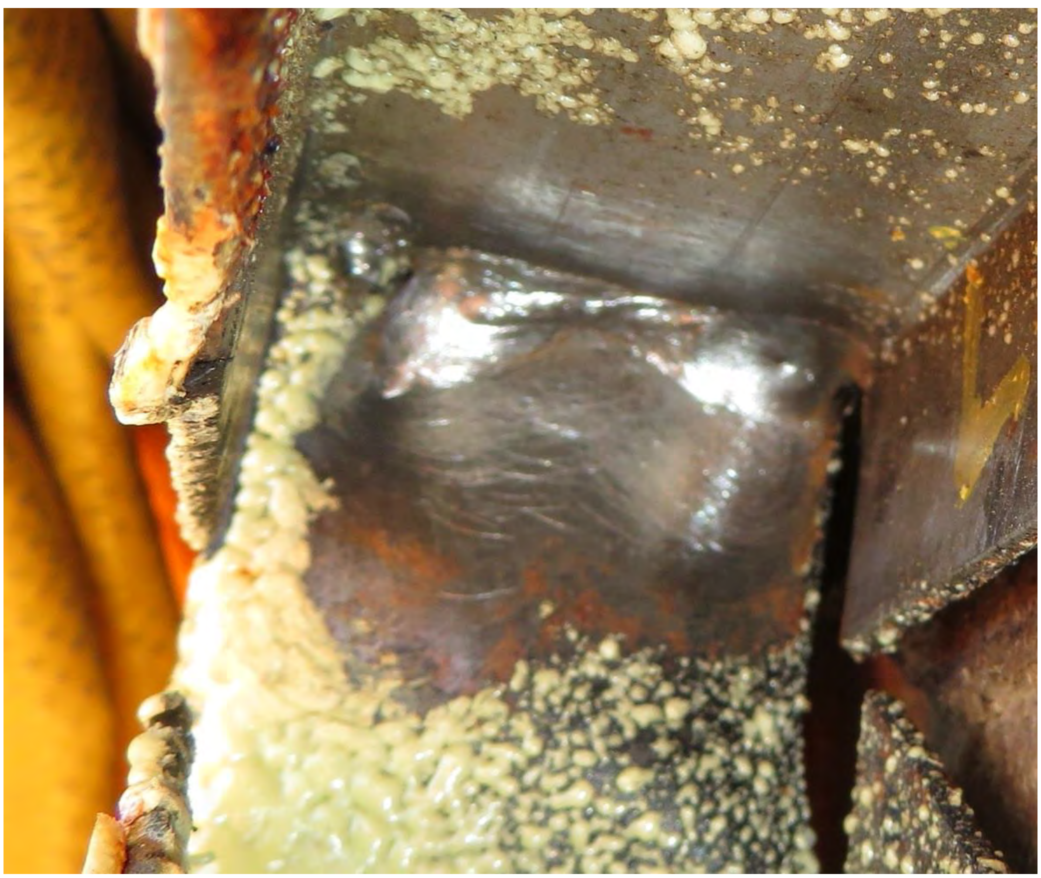
L-2: 1/4” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4].


L-3: HAZ (Heat Affected Zone) / toe of weld tearing 1/4”, 5.1.2 Craters[1].

L-4: 3/16” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1].

L-5: 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1].

L-6: 5/32" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4],



L-7: 3/8" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1], 5.1.10 Overlap[2].

L-8: 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1], 5.1.10 Overlap[2].

M-1: 5/64” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], 5.1.2 Craters[1], 5.1.10 Overlap[2].

M-2A: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

M-2B: 1/16” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$, 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

Numbers $_{1}$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

N1-43: Intermittant welds: 5.1.7 Meltback$_{11}$.

PHOTOGRAPHIC REPORT – CHAMPION DEFENDER - REAR SIDE

5.1.12 Combination of Discontinuities$_{3}$ - Applies to all welds with more than one discontinuity.

X-1: 5.1.2 Craters$_{1}$,

X-2: 5.1.2 Craters$_{1}$, 5.1.10 Overlap$_{2}$.

Numbers $_{1}$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

X-3: Oxidised overlay, 5.1.2 Craters$_1$.

X-4: Oxidised overlay, 5.1.2 Craters$_1$, Underfill, 1/8” Incomplete Fusion - Ref Table 1: Common Types of Discontinuities$_4$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

X-5: Weld became detached in 5.1.2 Craters$_1$ and 5.1.10 Overlap$_2$.

X-6: Pulled apart from weld toes

X-7: 3/16" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], HAZ (Heat Affected Zone) / toe of weld tearing.

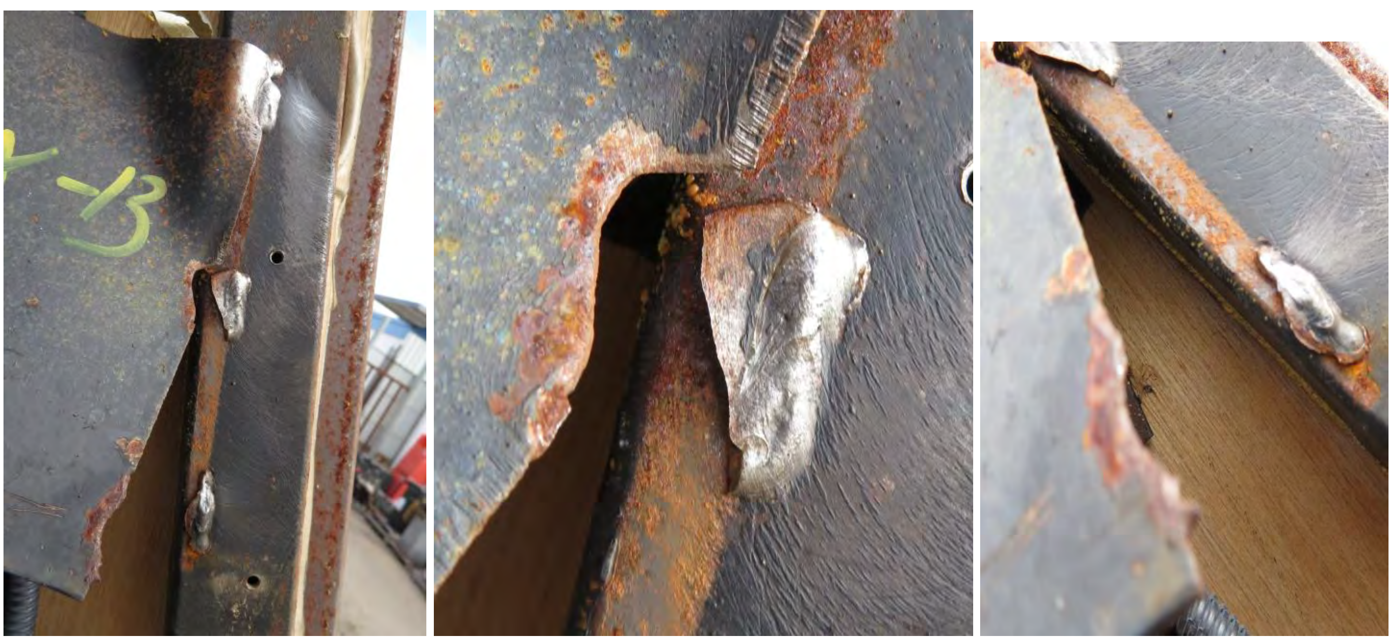
X-8: 1/8" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], most of weld inaccessible for cleaning & visual inspection.

X-9: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

X-10: 5.1.2 Craters$_1$,

X-11: 5.1.2 Craters$_1$ x 2, $_1$, 5.1.10 Overlap$_2$.

X-12: 5/16” 5.1.3 Cracks$_9$ due to porosity in weld overlap$_2$ 5.1.0 & 5.1.2 Craters$_1$

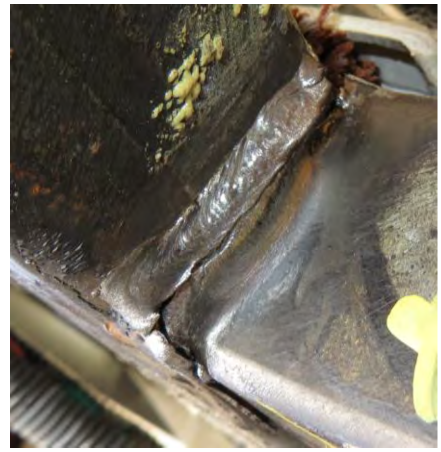


X-13: Pull away in toes and HAZ (Heat Affected Zone)., 5.1.2 Craters$_1$.

Numbers $_1$ to $_{12}$ refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

X-14A: 5.1.2 Craters[1] 5.1.10 Overlap[2].

X-14B: 5.1.2 Craters[1] 5.1.10 Overlap[2], Pull away in toes and HAZ (Heat Affected Zone).

X-15A: 5.1.2 Craters[1], Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4], shear in HAZ &

B: 5.1.2 Craters[1], 5.1.10 Overlap[2].


X-16A: 5.1.2 Craters[1].

16-B: Unable to clean, no visual inspection

Numbers [1] to [12] refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

X-17A: 5.1.2 Craters[1], 5.1.10 Overlap[2].; A&B: 1/8"Incomplete Fusion - Ref Table 1: Common Types of Discontinuities[4]; B: 5.1.2 Craters[1]; B&C: 5.1.2 Craters[1] on corner; C: 5.1.10 Overlap[2].; D: No weld

X-18A: OK

Numbers [1] to [12] refer to Annex B: Weld Discontinuities (refer to Annex C for a further explanation of common causes of these discontinuities)

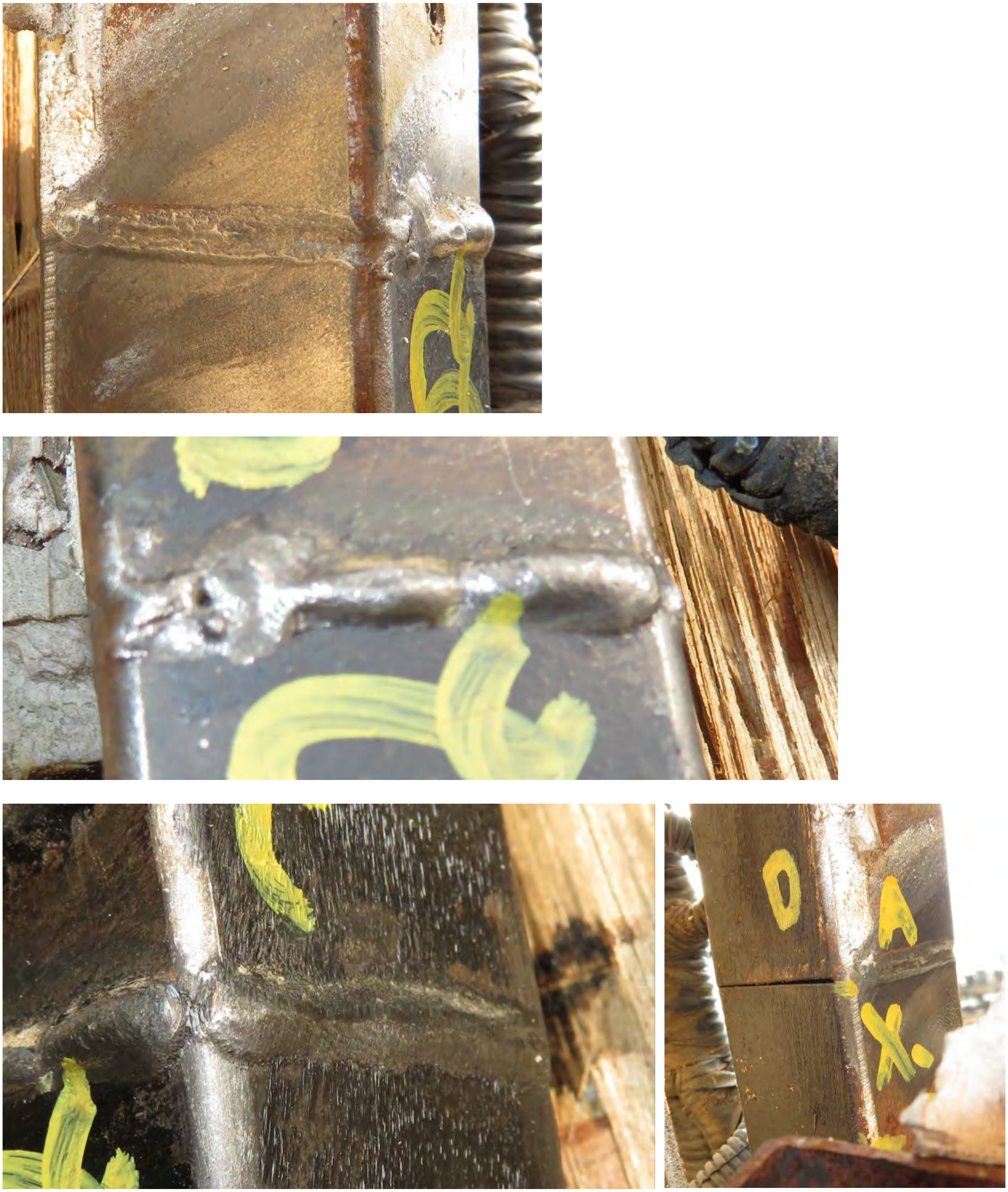
X-18B: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$.

X-19A: OK

X-19B: OK

X-20B: OK

X-21: 5.1.2 Craters$_1$, 5.1.10 Overlap$_2$, Undersized weld (5.3.2.2 Welds in Butt & Groove Joints$_{12}$).



X-22 A: Undersized weld (5.3.2.2 Welds in Butt & Groove Joints$_{12}$);

B: 5.1.2 Craters$_{1}$, 5.1.10 Overlap$_{2}$;

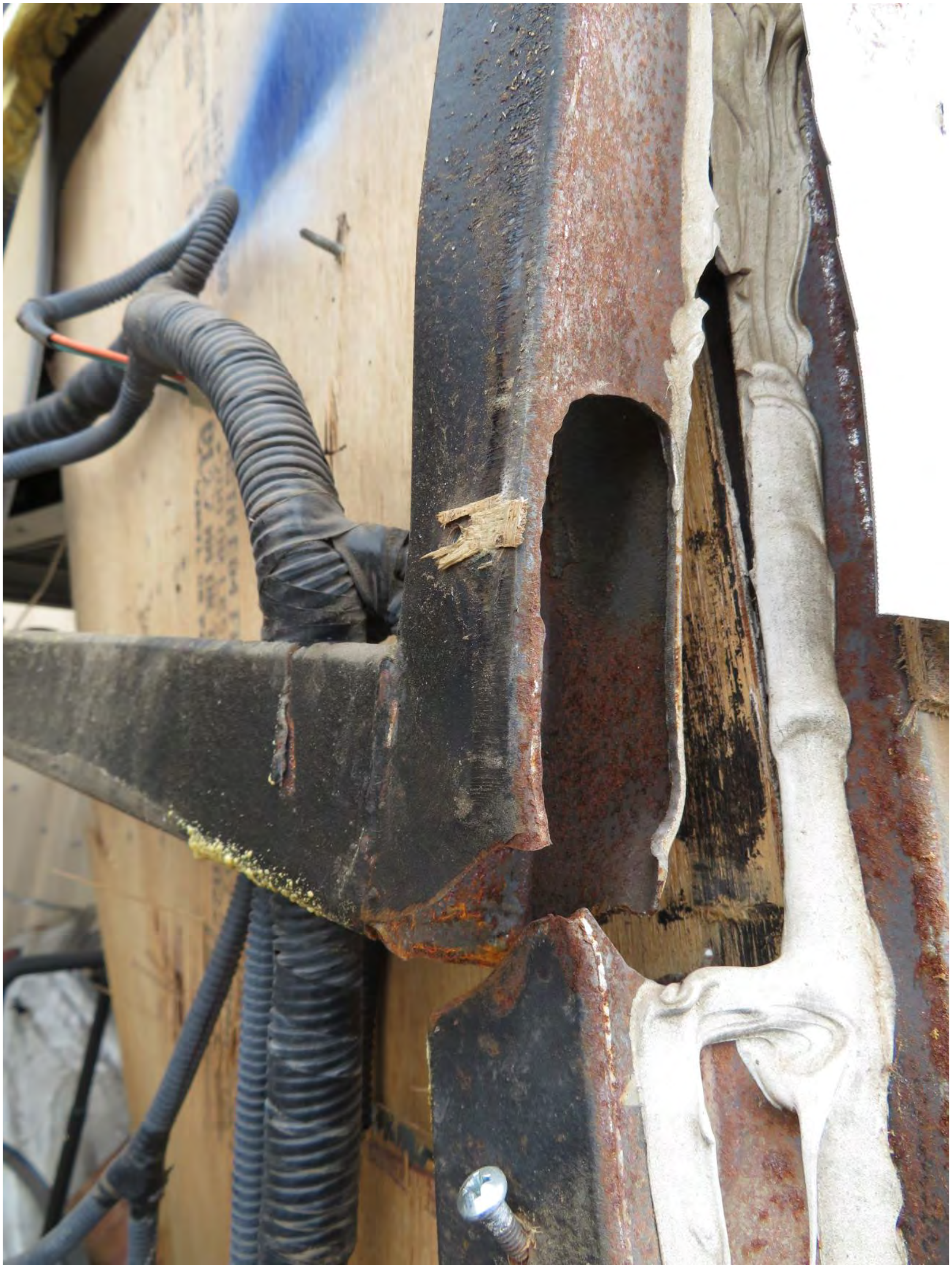
C: Undersized weld (5.3.2.2 Welds in Butt & Groove Joints$_{12}$);

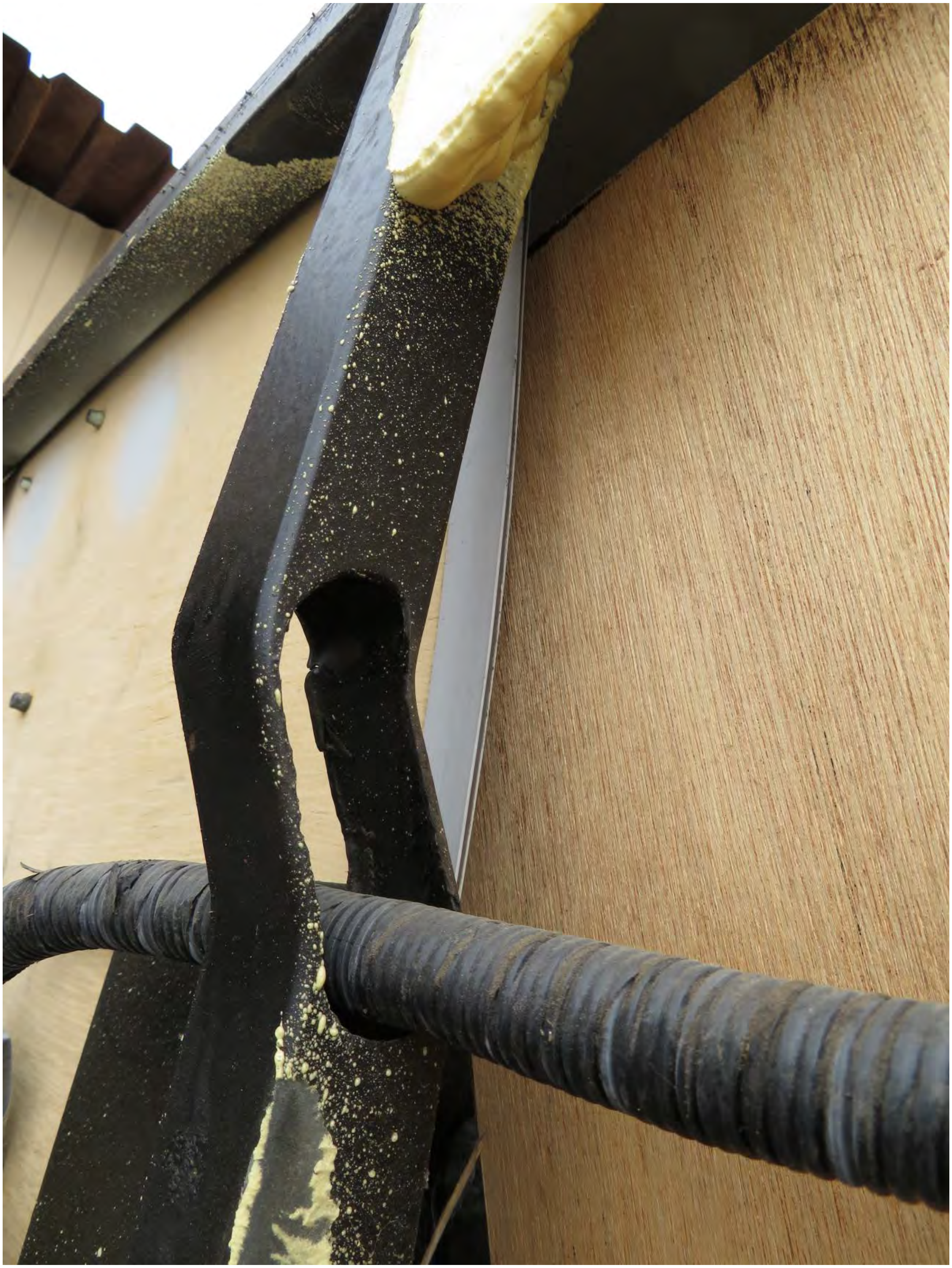
D: No weld

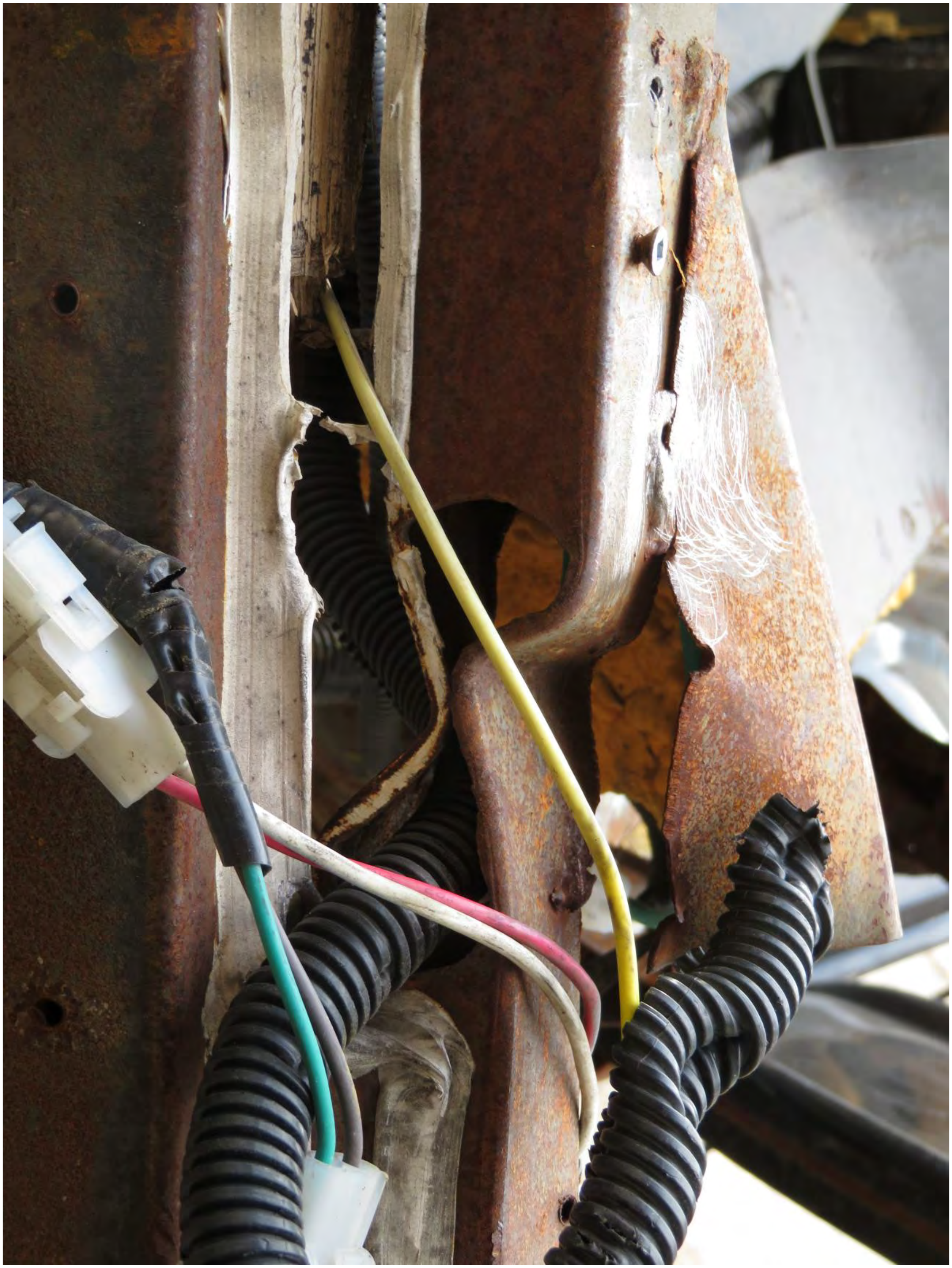
X-23A: 5.1.2 Craters₁, 5.1.10 Overlap₂; B: 5.1.2 Craters₁,

X-24: B: 5.1.2 Craters₁, 1/16" Incomplete Fusion - Ref Table 1: Common Types of Discontinuities₄.

STRUCTURAL CUT-OUT EXHIBITS








X-14

Statement on the Use of American Welding Society Standards

All standards (codes, specifications, recommended practices, methods, classifications, and guides) of the American Welding Society (AWS) are voluntary consensus standards that have been developed in accordance with the rules of the American National Standards Institute (ANSI). When AWS American National Standards are either incorporated in, or made part of, documents that are included in federal or state laws and regulations, or the regulations of other governmental bodies, their provisions carry the full legal authority of the statute. In such cases, any changes in those AWS standards must be approved by the governmental body having statutory jurisdiction before they can become a part of those laws and regulations. In all cases, these standards carry the full legal authority of the contract or other document that invokes the AWS standards. Where this contractual relationship exists, changes in or deviations from requirements of an AWS standard must be by agreement between the contracting parties.

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ANNEX B

Weld Discontinuities

1. 5.1.2 Craters[a]

Weld craters shall not be considered part of the effective weld length unless they are filled and meet all the requirements of this specification.

2. 5.1.10 Overlap[a]

The protrusion of weld metal beyond the weld toe is not allowed.

4.9 Overlap[b]

Overlap is the protrusion of unfused weld metal beyond the weld toe or weld root. Overlap is a surface discontinuity which forms a mechanical notch and is nearly always considered rejectable. Two common causes of overlap may be insignificant travel speed for the given electrode parameters and improper penetration of the base metal.

3. 5.1.12 Combination of Discontinuities[a]

The presence of more than one of the above discontinuities in any weld shall not be permitted if any one of the evaluated discontinuities (inclusions, undercut, porosity, or melt-back) is at the maximum permissible limit.

4. Incomplete Fusion Ref Table 1: Common Types of Discontinuities$_2$, clause 4.5[b]

Incomplete Fusion is a weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads. It is the result improper welding technique, improper preparation of the base metal, or improper joint design.

[a] AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

[b]AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

5. <u>4.17 Table 1 Weld Reinforcement[b]</u>

In Groove welds, weld reinforcement is weld metal in excess of the quantity required to fill a joint. Weld reinforcement may be located at either the root or face of a groove weld. Weld reinforcement is undesirable when it creates high stress concentrations at the weld toe or weld root similar to convexity. It tends to establish notches that create stress concentrations. This condition may result from improper welding technique or insufficient welding current.

6. <u>4.5.4.1 Surface Porosity[a]</u>

Individuals pores, separated by at least their own diameter, and other scattered surface porosity shall be permitted. The total length of porosity (sum of diameters) shall not exceed 15/64” in any 63/64”of weld. The maximum pore dimension shall not exceed 1/16”

7. <u>5.3.1 Fillet Welds[a] (5.3 Weld Size)</u>

5.3.1.1 Figures 5(A) and 5(B) identify the nomenclature which describes the cross section of a Fillet welded T-joint. Figure 6 illustrates both convex and concave Fillet welds in lap and T-joints.

5.3.1.2 The length of the legs of a Fillet weld on each side of the joint determines the Fillet size. For purposes of determining the Fillet leg size, only the fused portion of the leg (see Figure 7) shall be included and shall conform to the following dimensions:

(1) The minimum leg size shall be equal to 90% of the thickness of the thinner material being welded.

(2) When gaps are present, the leg where the gap appears must be increased by the amount of the gap (see Figure 1).

5.3.1.3 The weld throat thickness shall conform to the following:

(1) The minimum theoretical throat thickness shall not be less than 60% of the thinner metal being welded (see Figure 6).

(2) There shall be no maximum convexity or concavity requirement, provided all other requirements of this specification are in compliance.

[a] AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

[b]AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

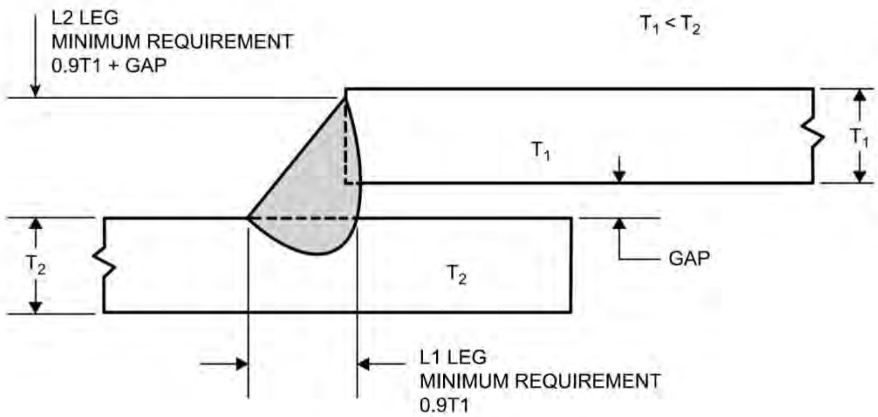


Figure 1—Fillet Weld

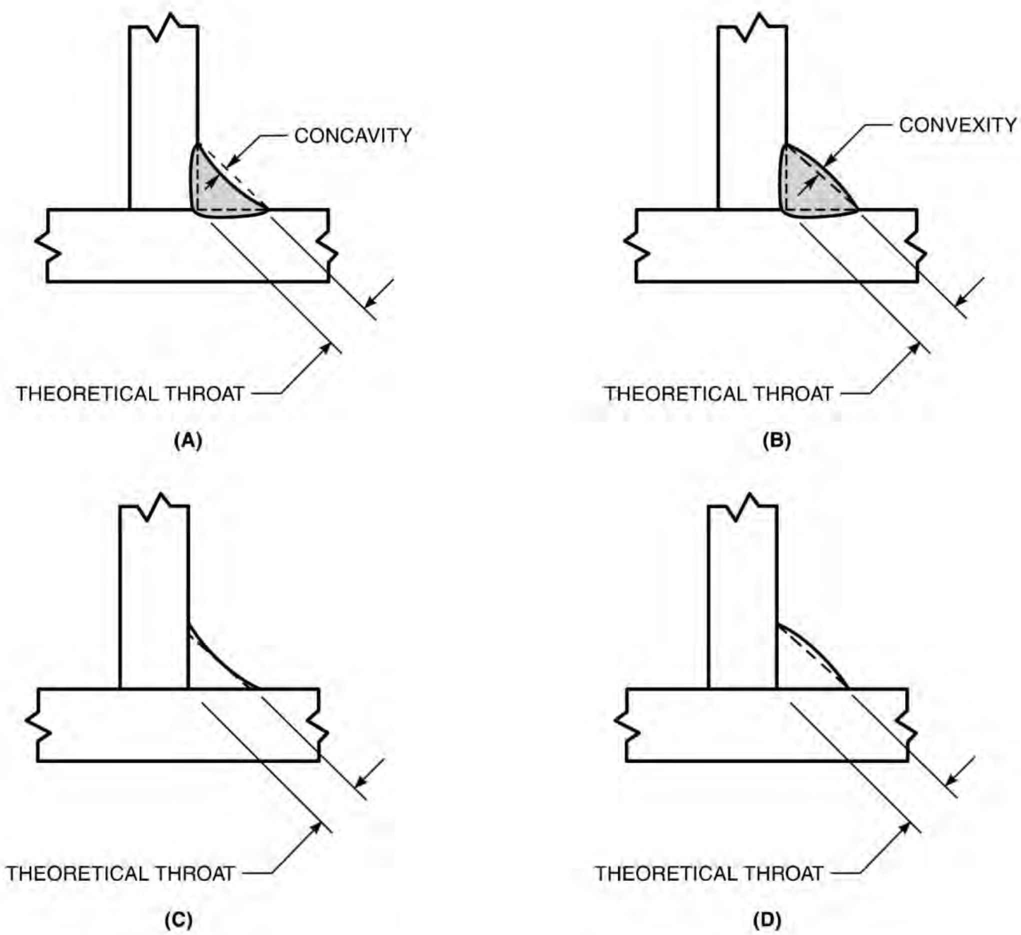


Figure 6—Illustration of Fillet Welds—Concavity and Convexity

[a] AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

[b]AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

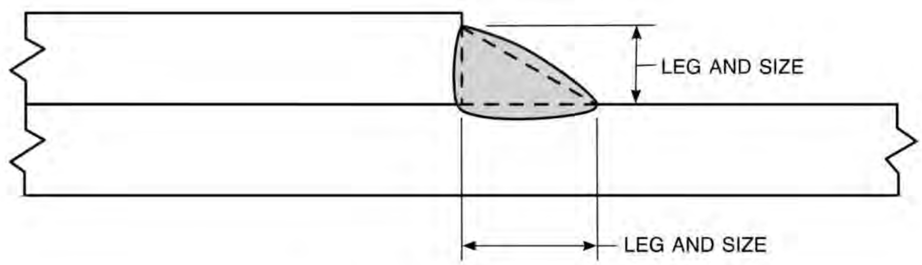


Figure 7—Leg Length of a Lap Fillet Weld

8. 5.1.9 Notching[a]

Notching or gouging of the base metal at the ends or at the edge of the joint shall not be permitted (see Figure 3).

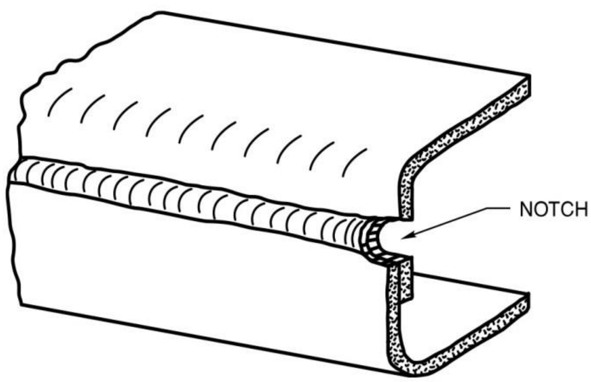


Figure 3—Example of Notching at End of Weld

9. 5.1.3 Cracks[a]

Cracks shall not be permitted.

10. 5.1.1 Undercut[a]

Undercut shall not be permitted within 0.51" of the start or end of the weld. Undercut is permitted to range from 0-0.2T (T = thickness of steel) over a maximum cumulative length of 1/8 the specidfied weld length when material thickness exceeds 0.039".

11. 5.1.7 Meltback[a]

[a] AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

[b]AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

Meltback in lap fillet welds shall not exceed the stock thickness in depth for plate edges at top of meltback and shall decrease to zero at the root of the joint (see Figure 2). Complete fusion shall be obtained in the root of the joint. Meltback shall be limited to 15% of the weld length.

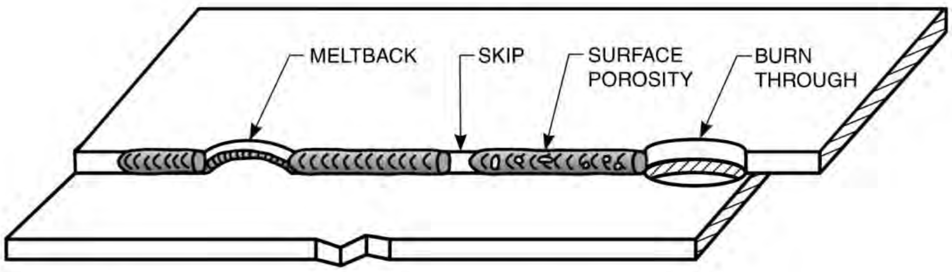


Figure 2—Examples of Discontinuities Found in Arc Welds

12. <u>5.3.2.2 Welds in Butt & Groove Joints</u>[a]

The effctive weld size shall be equal to the thickness of the thinner material being joined or the portion within the limits of the thickness of the thinnest sheet.

[a] AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

[b]AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

ANNEX C

Common Causes of Weld Discontinuities

Discontinuities may be found in the weld metal, heat-affected, and base metal zones of weldments .

The effect of all the following discontinuities can be weld failure.

1. Craters

Common Causes of Craters by Welding Operators for GMAW (short circuit) fillet weld and single flare groove welds: Inadequate termination of arc. The solution can be to minimize or prevent crater by filling the crater to a slightly convex shape prior to terminating the arc.

2. Overlap

Overlap is a surface discontinuity and forms a mechanical notch and is normally always considered rejectable.

Common Causes of Overlap by Welding Operators for GMAW (short circuit) fillet weld and single flare groove welds: Two common causes of overlap may be insignificant travel speed for the given electrode parameters and improper preparation of the base metal.

3. Incomplete Fusion

The result of improper welding technique, improper penetration of the base metal, or improper joint design.

Common Causes of Incomplete Fusion by Welding Operators for GMAW (short circuit) fillet weld and single flare groove welds: Incorrect electrode angle, incorrect weld direction, incorrect welding parameters eg. Amps (wire feed speed), volts, travel speed, shielding gas, filler metal electrode size.

4. Weld Reinforcement

This condition may result from improper welding technique or insufficient welding current.

Common Causes of Excess Weld Reinforcement by Welding Operator s for GMAW (short circuit) fillet weld and single flare groove welds: Incorrect Travel speed, filler metal electrode size. An insufficient welding current can deposit a shallow weld deposit which results weld reinforcement reduction.

5. Surface Porosity

Common Causes of Porosity by Welding Operators for GMAW (short circuit) fillet weld and single flare groove welds: Improper preparation of base metal prior to weld deposit resulting in weld deposit impregnated with foreign contaminants. As contaminants rise to the surface of the molten weld puddle they create an oxidized opening or pores (porosity). Another common cause of porosity is improper flow rate or displacement of shielding gas/gases , which can result in atmosheric oxidation, allowing the molten weld puddle to be contaminated with ambient atmosphere (oxygen/hydrogen) thus creating porous cavities in weld deposit.

6. Fillet Welds[a] (5.3 Weld Size)

Can be caused by inadequate weld detailing on manufacturing drawings. Poor quality control.

Common Causes of Oversizing/Undersizing Fillet Welds by Welding Operators for GMAW (short circuit) fillet weld and single flare groove welds: Incorrect travel speed, incorrect electrode size and angle.

7. Notching

Common Causes of Notching by Welding Operators for GMAW (short circuit) fillet weld and single flare groove welds: Commonly caused by not reducing current or utilizing non consumabe backer.

8. Cracks

Hot Cracks: Usually occurs as the metal solidifies, at some elevated temperature. The propogation of these cracks is considered to be intergranular; that is, the cracks occuring between individual grains . If we observe the fractured surface of a hot crack we may see various 'temper' colors on the fractured face indicating the presence of that crack at an elevated temperature.

Cold cracks: occur after the metal has cooled to ambient temperature. Those cracks resulting from service conditions would be considered cold cracks. Delayed, or underbead, cracks resulting from entrapped hydrogen would also be categorized as cold cracks. The propogation of cold cracks can be either intergranular or transgranular; that is, either between or through the individual grains, respectively.

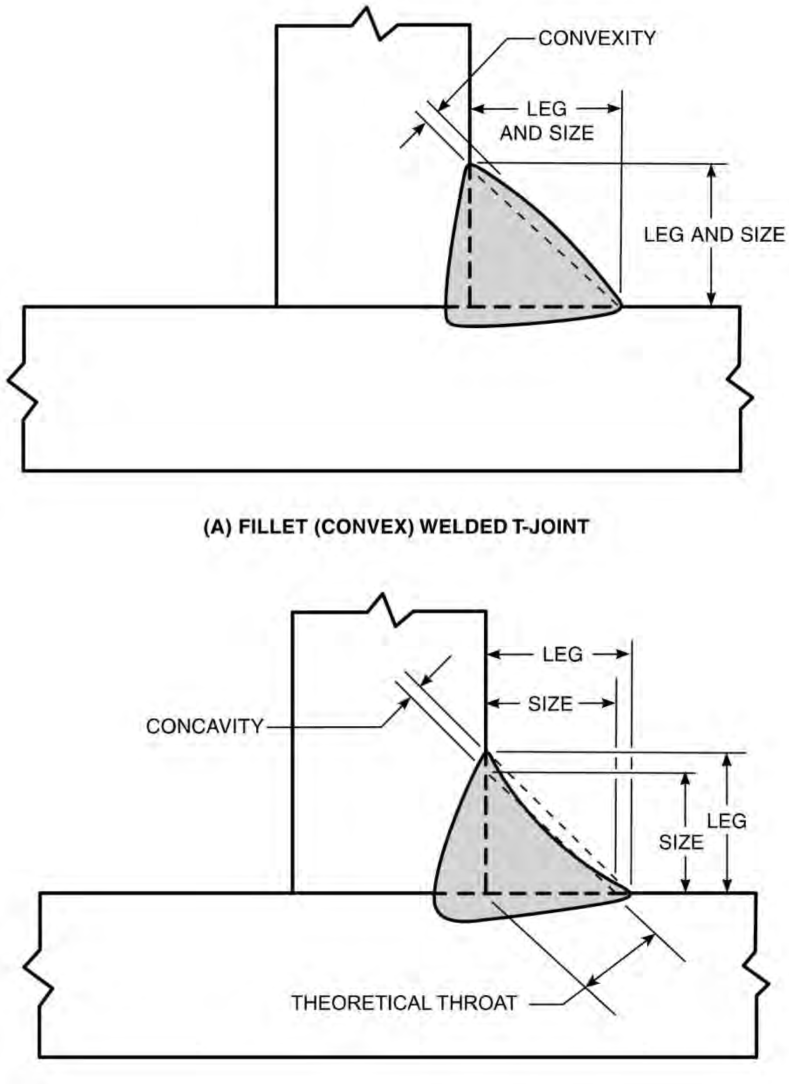
Transverse cracks are generally caused by the longitudinal shrinkage stress of welding acting on welds or base metal of low ductility.

Cracks may be limited in size and contained completely within the weld metal or they may propogate from the weld metal into the adjacent heat-affected zone and further into the base metal. In some weldments, transverse cracks will form in the heat-affected zone and not in the weld.

Crater cracks are caused when the weld is improperly terminated. They are sometimes referred to as star cracks, though they may have other configurations. Crater cracks are hot cracks usually forming a pronged star-like network. Crater cracks are found most frequently in materials with high coefficients of thermal expansion. For example, austenitic stainless steel and aluminum. However, the occurance of any such cracks can be minimized or prevented by filling the crater to slightly convex shape prior to terminating the arc.

Common Causes of Cracks by Welding Operator for GMAW (short circuit) fillet weld and single flare groove welds: Joint misalignment, travel speed, volts & amps (wire feed speed), inadequate root penetration.

ANNEX D



(A) FILLET (CONVEX) WELDED T-JOINT

(B) FILLET (CONCAVE) WELDED T-JOINT

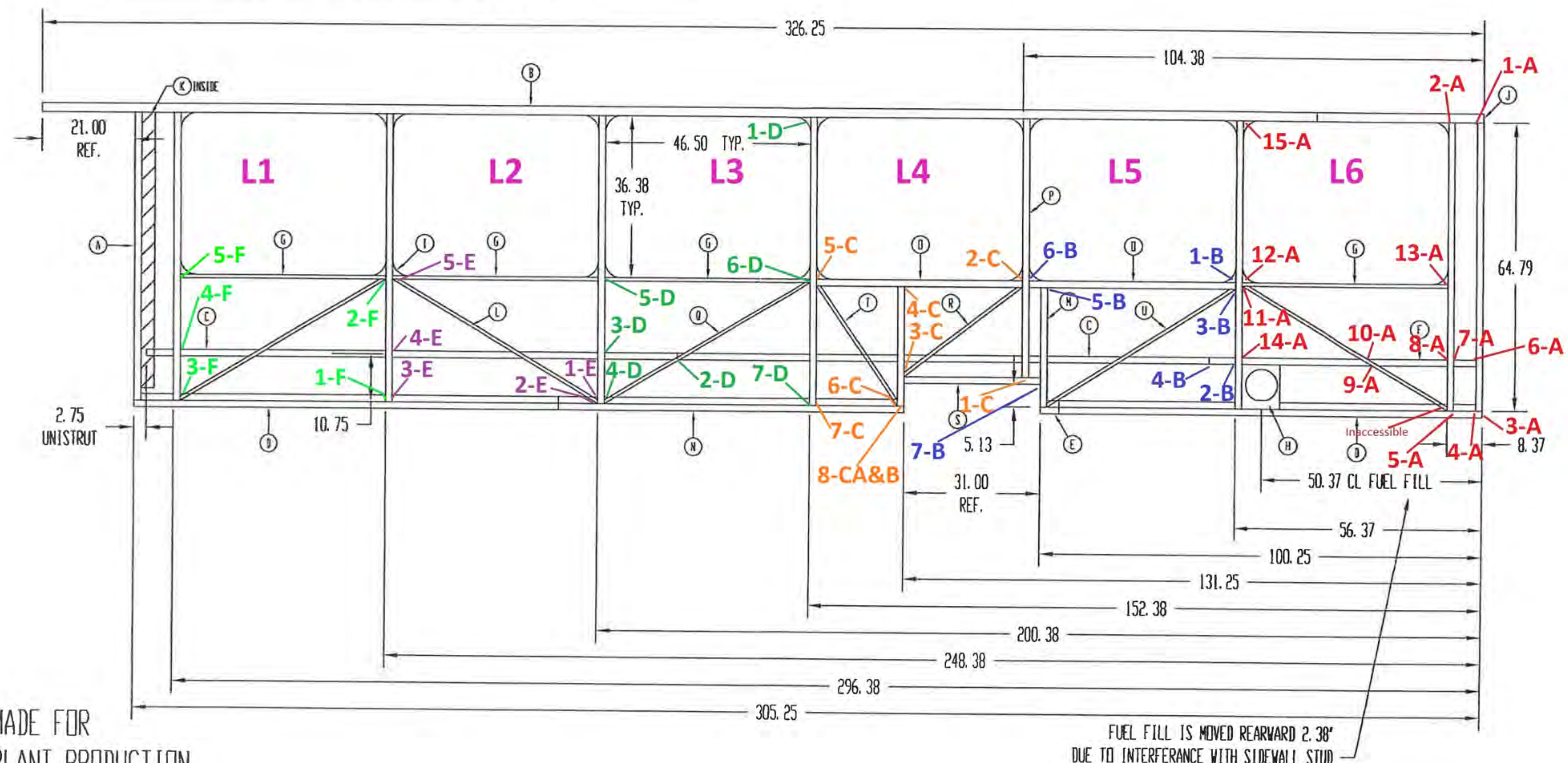
Figure 5—Fillet Welded T-Joints

A proper fillet weld will need to exhibit root penetration, fusion of toes, similar leg lengths and a sufficient throat. Convexity shall not become excessive and such that it creates cold fusion/overlap of fillet toe. Excessive concavity can result in an inefficient throat size and undercut on toe of fillet weld.

SYB.	QTY.	DESCRIPTION	PART #	SYB.	QTY.	DESCRIPTION	PART #	SYB.	QTY.	DESCRIPTION	PART #
A	8	STUD, SIDEWALL 1.5 X 64.79" 4 DEGREE	0376015	K	1	STEEL, FLAT 16 GA. X 3 X 62.00	CUT FR 0342428	U	1	CHANNEL, SIDEWALL 16 GA. X 50.50	CUT FR 0350769
B	1	TUBE, 14 GA. 2 X 1.5 X 288.00	0342212	L	2	CHANNEL, SIDEWALL 16 GA. X 54.50	CUT FR 0350769	V			
C	2	CHANNEL, SEAT TRACK BLACK 10"	0377052	M	2	TUBE, 16 GA. 1.5 X 26.88	CUT FR 0340992				
D	2	Z, SIDEWALL 16 GA. X 96.0	0376885	N	1	Z, SIDEWALL 16 GA. X 78.00	CUT FR 0376885				
E	1	Z, SIDEWALL 16 GA. X 4.25	CUT FR 0376885	O	2	TUBE, 16 GA. 1.5 X 46.50	CUT FR 0340992				
F	1	CHANNEL, SEAT TRACK BLACK 61.00	CUT FR 0377052	P	1	STUD, SIDEWALL 1.5 X 58.13"	CUT FR 0376015				
G	4	CHANNEL, SIDEWALL 16 GA. X 46.50	0376458	Q	1	CHANNEL, SIDEWALL 16 GA. X 53.50	CUT FR 0350769				
H	1	BACKER, GAS FILL FORD	0400131	R	1	CHANNEL, SIDEWALL 16 GA. X 33.50	CUT FR 0350769				
I	24	CORNER, WINDOW RADIUS	0345280	S	1	TUBE, 16 GA. 1.5 X 31.00	CUT FR 0340992				
J	1	TUBE, 14 GA. 2 X 1.5 X 38.25	CUT FR 0342212	T	1	CHANNEL, SIDEWALL 16 GA. X 32.25	CUT FR 0350769				

ANNEX E

WELD MAP - DRIVER SIDE



NOTE: MADE FOR NORTH PLANT PRODUCTION SIDEWALLS SIT ON TOP OF FLOOR PLYWOOD (NOT CAP)

DFGT GMT 560

PART NO. 0414250

CHAMPION BUS INC. — a THOR company —

ECN # 55-7209 DO NOT

MATERIAL: AS SHOWN

TOLERANCES UNLESS OTHERWISE NOTED
.XX = .03
.XXX = .020
X° = 1°

SCALE:

DRAWN BY: P RUHALA DATE: 5/18/05

CHK. DATE:

APP'D DATE:

PURCH./MFG.: MFG.

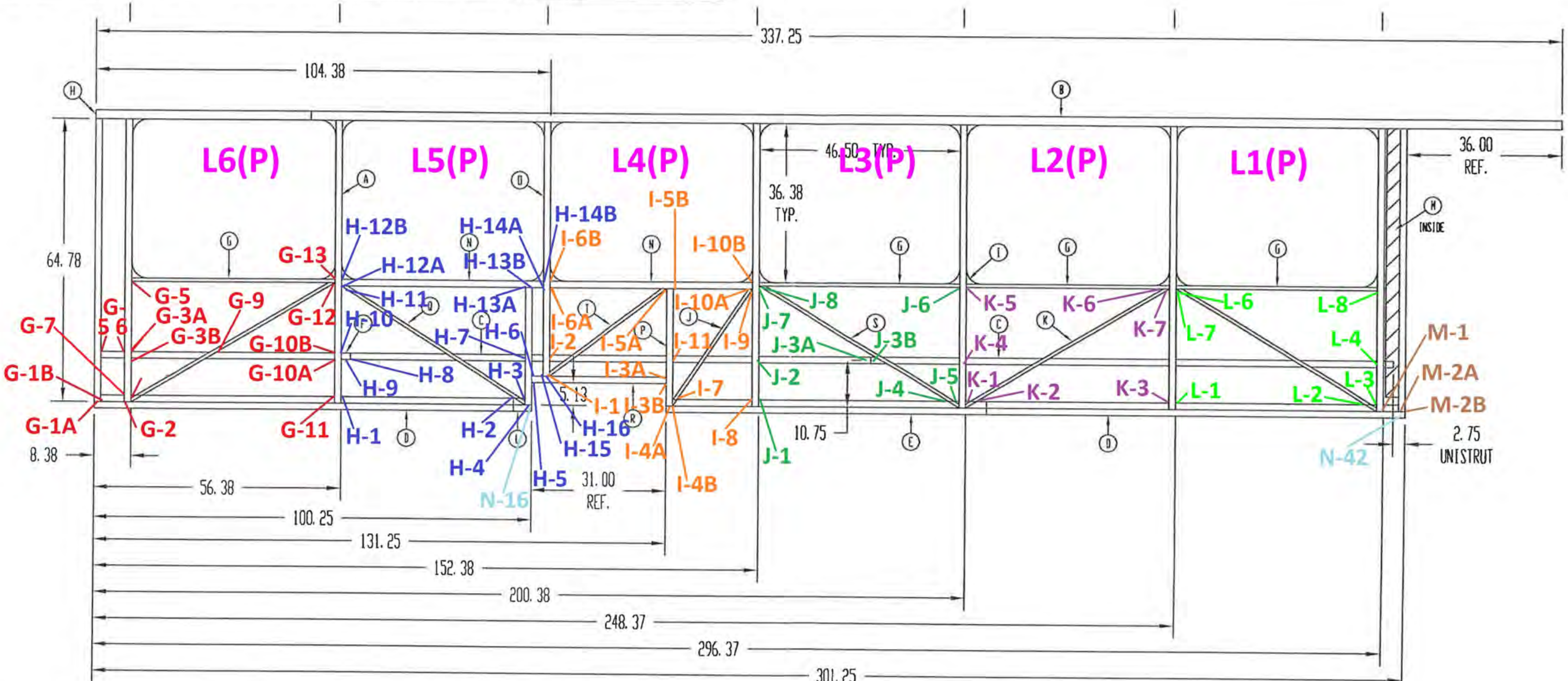
TITLE: SIDEWALL, FRAME R/S DFGT-350 259.00' W/B (311' FLOOR LENGTH) 4 DEG. W/A

REV DATE ECN

ANNEX F

WELD MAP - PASSENGER SIDE

SYB.	QTY.	DESCRIPTION	PART #	SYB.	QTY.	DESCRIPTION	PART #
A	8	STUD, SIDEWALL 1.5 X 64.79 4 DEGREE	0376015	K	3	CHANNEL, SIDEWALL 16 GA. X 54.00	CUT FR 0350769
B	1	TUBE, 14 GA. 2 X 1.5 X 288.00	0342212	L	1	Z, SIDEWALL 16 GA. X 4.25	CUT FR 0376885
C	2	CHANNEL, SEAT TRACK BLACK 10'	0377052	M	1	STEEL, FLAT 16 GA. X 3 X 62.00	CUT FR 0364836
D	2	Z, SIDEWALL 16 GA. X 96.00	0376885	N	2	TUBE, 16 GA. 1.5 X 46.50	CUT FR 0340992
E	1	Z, SIDEWALL 16 GA. X 74.00	CUT FR 0376885	O	1	STUD, SIDEWALL 1.5 X 58.13"	CUT FR 0376015
F	1	CHANNEL, SEAT TRACK BLACK 57.00	CUT FR 0377052	P	2	TUBE, 16 GA. 1.5 X 26.88	CUT FR 0340992
G	4	CHANNEL, SIDEWALL 16 GA. X 46.50	0376458	Q	1	CHANNEL, SIDEWALL 16 GA. X 50.50	CUT FR 0350769
H	1	TUBE, 14 GA. 2 X 1.5 X 49.25	CUT FR 0342212	R	1	TUBE, 16 GA. 1.5 X 31.00	CUT FR 0340992
I	24	CORNER, WINDOW RADIUS	0345280	S	1	CHANNEL, SIDEWALL 16 GA. X 53.50	CUT FR 0350769
J	1	CHANNEL, SIDEWALL 16 GA. X 32.50	CUT FR 0350769	T	1	CHANNEL, SIDEWALL 16 GA. X 33.50	CUT FR 0350769



NOTE: MADE FOR
NORTH PLANT PRODUCTION
SIDEWALLS SIT ON TOP OF
FLOOR PLYWOOD (NOT CAP)

DFGT GMT 560

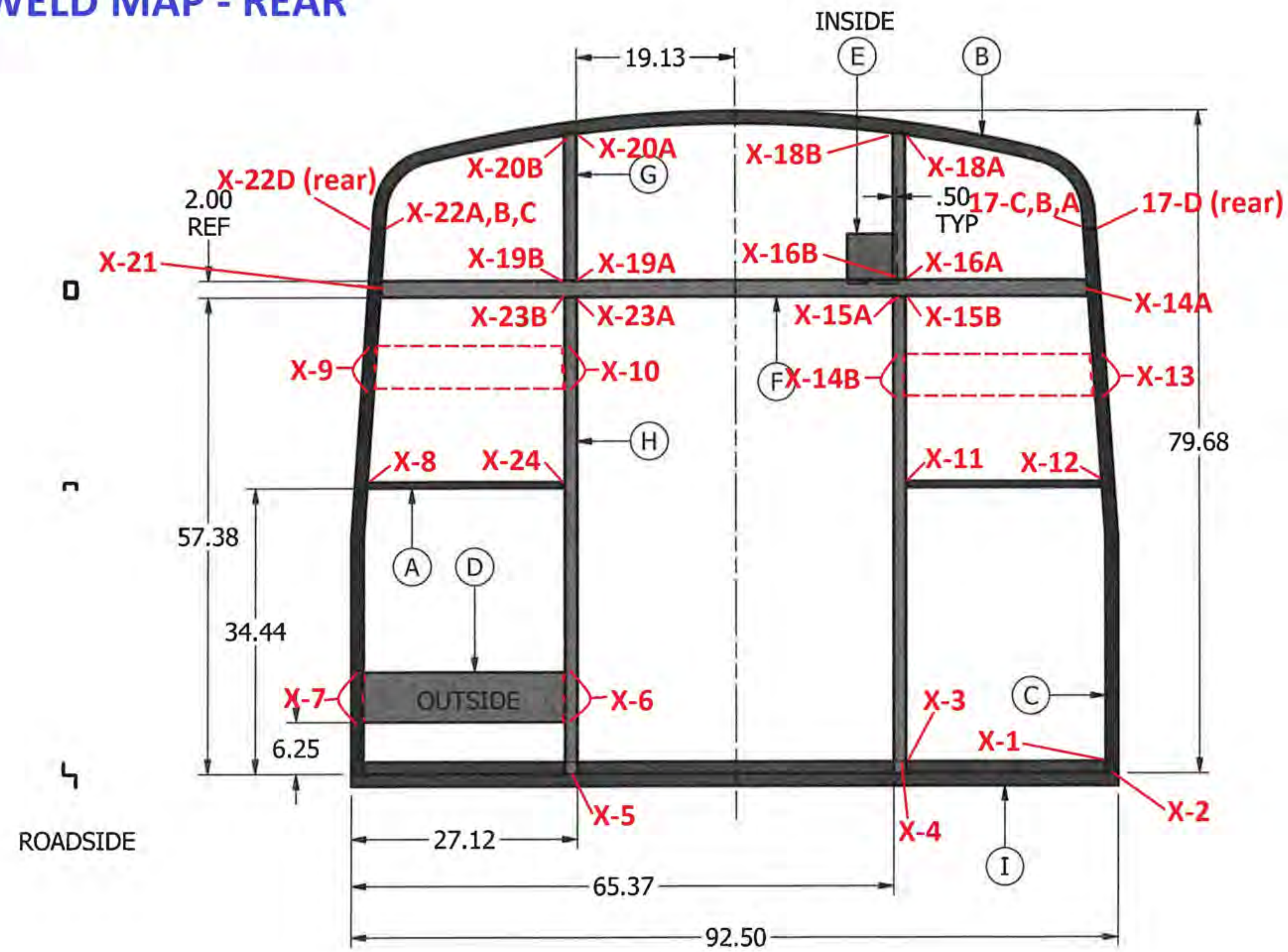
PART NO. 0414249	MATERIAL: AS SHOWN			PURCH./MFG.: MFG.
CHAMPION BUS INC. — a THOR company —	TOLERANCES UNLESS OTHERWISE NOTED .XX = .03 .XXX = .020 X° = 1°	DRAWN BY P RUHALA	DATE: 5/17/05	TITLE: SIDEWALL, FRAME C/S DFGT-350 259.00" W/B (311" FLOOR LENGTH) 4 DEG. W/A
		CHK.	DATE:	
ECN # 55-7209 / DO NOT	SCALE:	APP'D	DATE:	

REV | DATE | ECN

Richardson v Champion Bus
Champion 1464

ANNEX G

WELD MAP - REAR



ITEM	QTY	DESCRIPTION	STOCK NUMBER
A	2	CHANNEL, STRAIGHT 16GA. x 23.63	CUT FR 0350769
B	1	RAFTER, REAR 94" 4 DEGREE	0376444
C	2	SIDEWALL, STUD 1.5 x 65.54" 4 DEGREE	0376930
D	1	STEEL, FLAT 16GA. x 6.0 x 24.13	CUT FR 0342428
E	1	STEEL, FLAT 16GA. x 6.0 x 6.00	CUT FR 0342428
F	1	TUBE, 11GA. x 2.0 x 1.5 x 85.18	CUT FR 0374950
G	2	TUBE, 16GA. x 1.5 x 17.58	CUT FR 0340992
H	2	TUBE, 16GA. x 1.5 x 57.38	CUT FR 0340992
I	1	Z, SIDEWALL 1.5 x 1.5 x 1.5 x 92.50	CUT FR 0376885

Richardson v Champion Bus
Champion 1466

REVISION HISTORY

REV	DATE	REV ERN	DESCRIPTION	REV BY	APPR
K	10/28/16	002-584	DELETED 45.5" CUT FR 0350769, 103.13" CUT FR 0342428 DUE TO FIBERGLASS CAP. DELETED NOTES FOR OPTIONAL GRAB HANDLE & EXTRA STEEL FOR SIDEWALL SKIN.	PR	
J	12/9/10	55-11124	"F" WAS 85.50 "H" WAS 17.625	SAS	
I	3/3/10	55-10565	REMOVED ITEM "L"	BD	

PART NO. 0406365-INV

CHAMPION REV GROUP

ECN# 55-3713

DO NOT SCALE

MATERIAL: AS SHOWN

FINISH:

TOLERANCES UNLESS OTHERWISE NOTED
ANGLES: ± 1°
.X ± .125
.XX ± .063
.XXX ± .010

DRAWN BY: M MOSHER

DATE: 4/26/99

CHK.:

DATE:

PURCH./MFG.: MFG

TITLE: BACKWALL, FRAME 37 X 56 DOOR 94" NORTH 4 DEG ASSY

MODEL: 94" NORTH 4 DEG ASSY

REFERENCES

a. AWS D8.8M:2014 Specification for Automotive Weld Quality – Arc Welding of Steel

b. AWS B1.10M/B1.10:2009 Guide for the Nondestructive Examination of Welds

c. AWS A2.4: 2012 Standard Symbols for Welding, Brazing, and Nondestructive Examination

d. WIT-T:2008 Welding Inspection Technology