BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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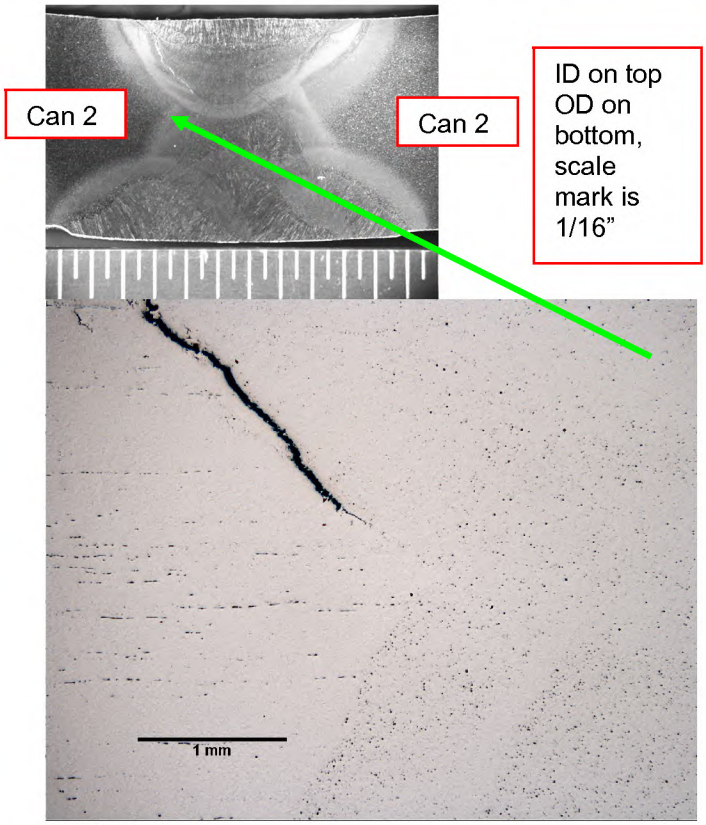
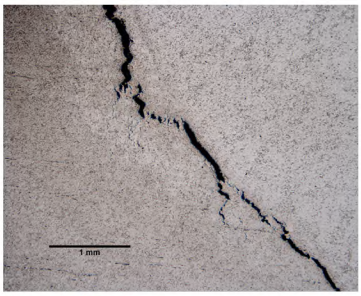
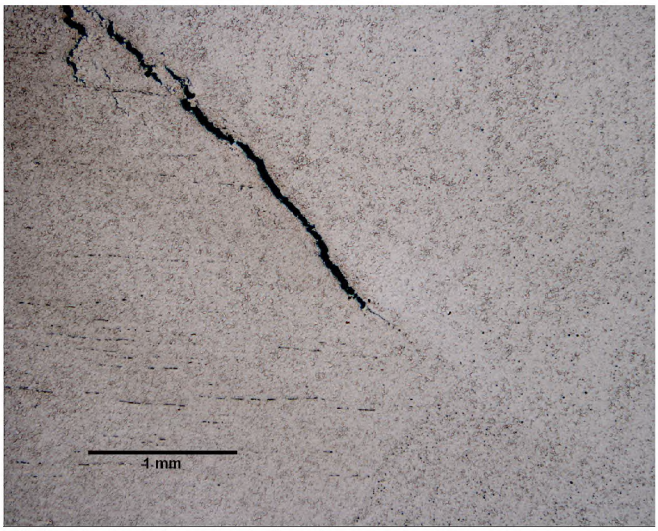
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS





Un-etched at major crack tip at cusp



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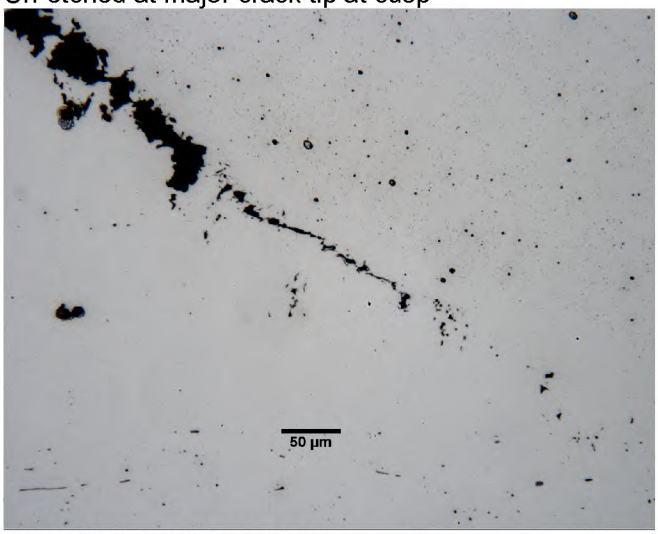
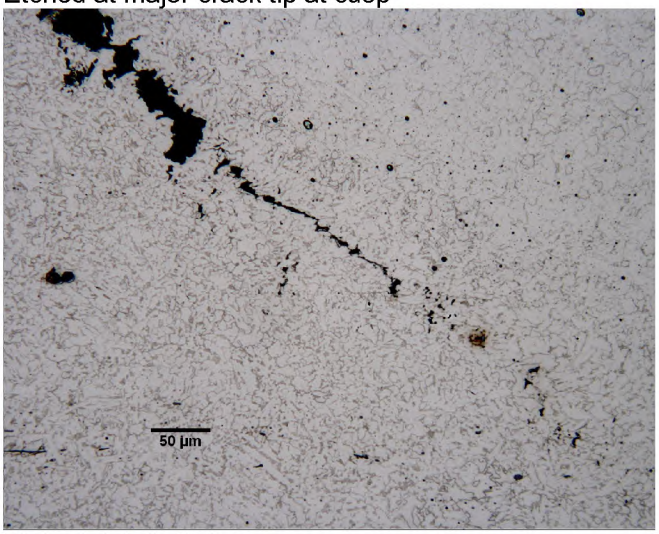


Un-etched detail from above



Etched detail of above

FIGURE 17 Photomicrographs of Mount T2L at ID left side

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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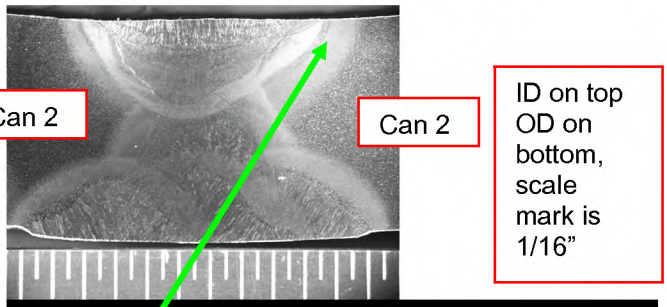
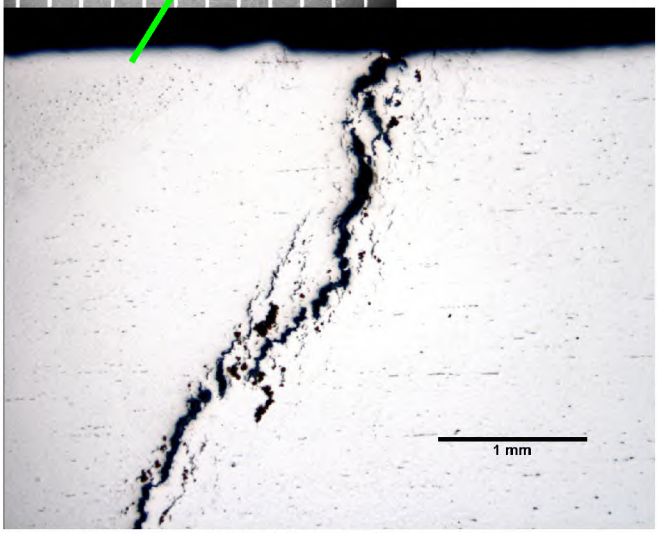
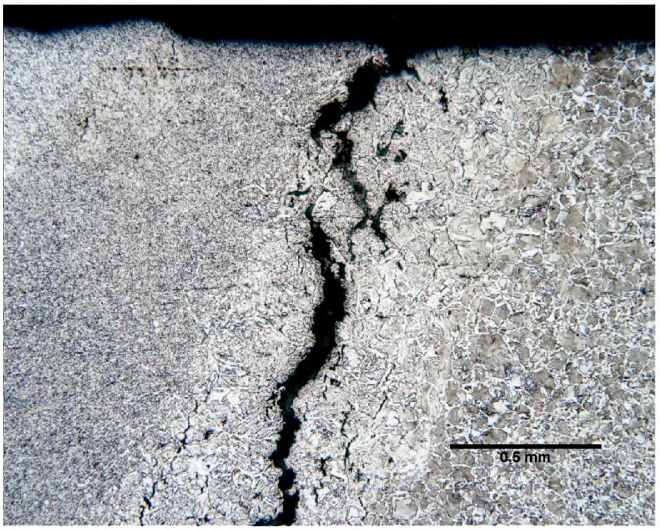
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS

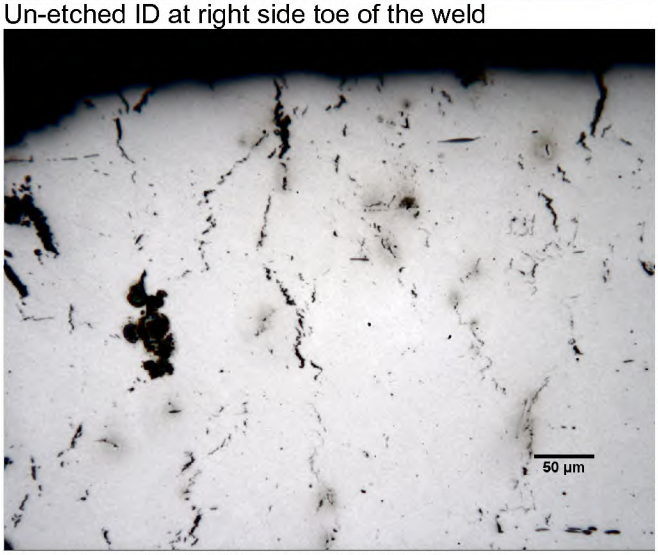




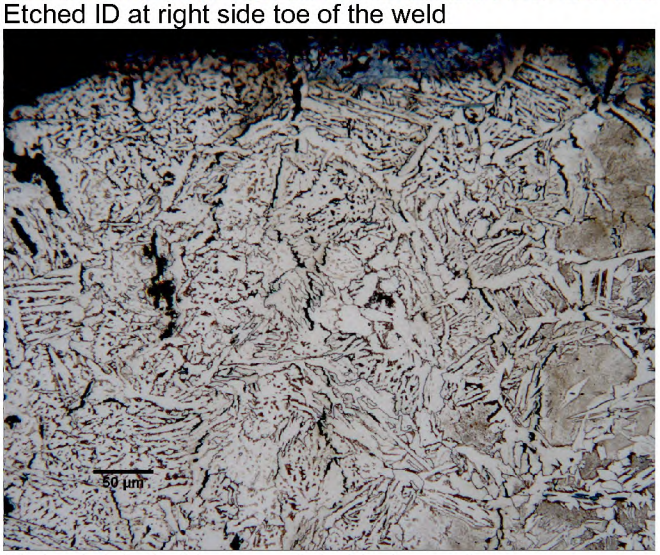
Un-etched ID at right side toe of the weld



Etched ID at right side toe of the weld



Un-etched detail of base metal side from above



Etched detail of base metal side from above

FIGURE 18 Photomicrographs of Mount T2L at right side

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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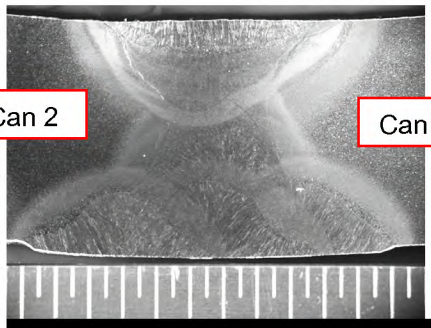
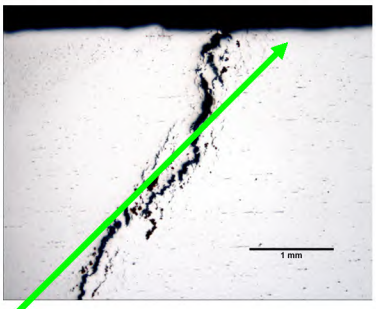
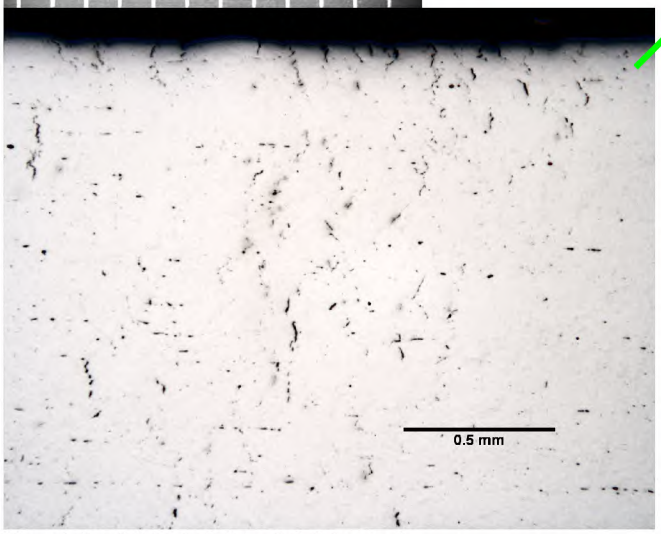
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS

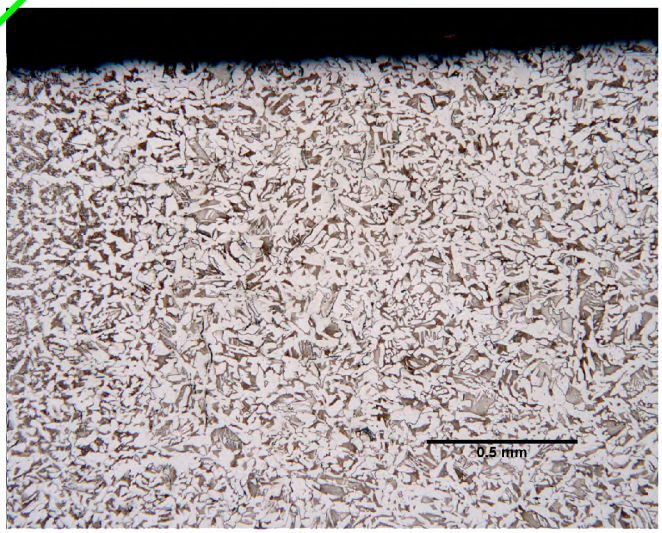


ID on top OD on bottom, scale mark is 1/16”

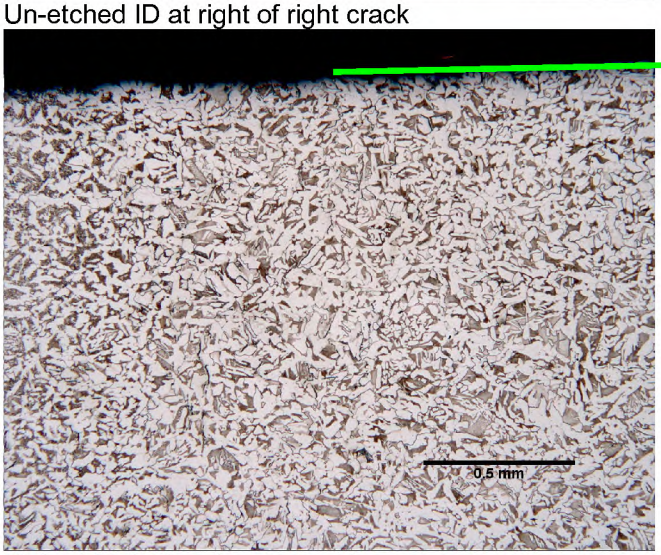




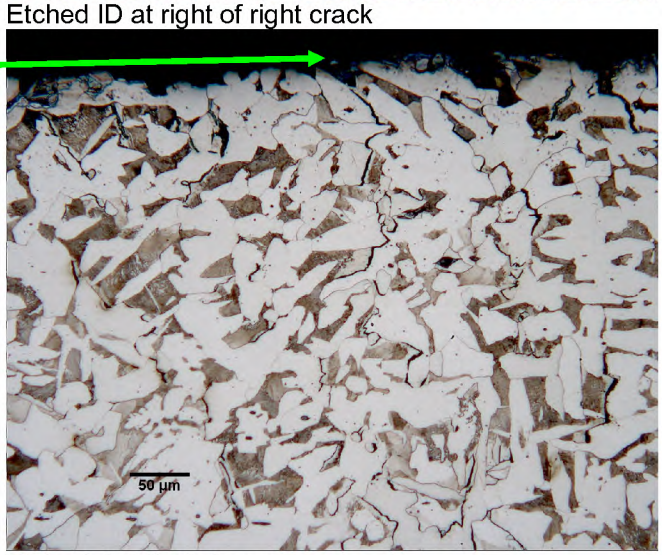
Un-etched ID at right of right crack



Etched ID at right of right crack



Etched ID further from area above



Etched detail of above

FIGURE 19 Photomicrographs of Mount T2L at right side Base Metal side of crack

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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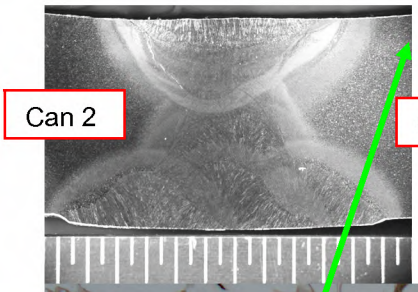
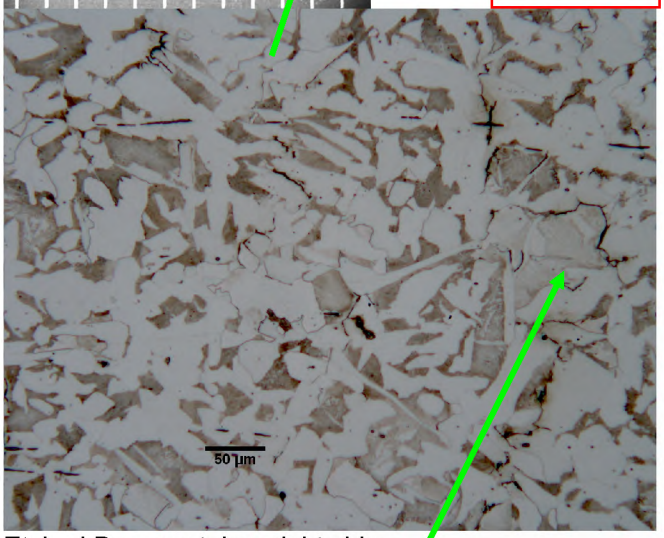
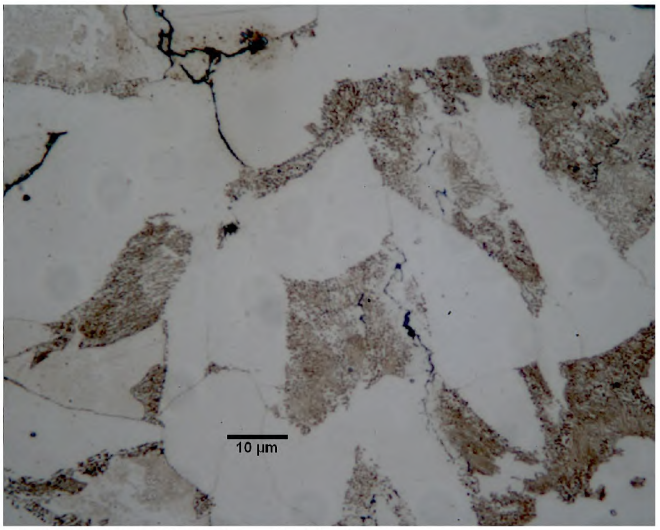
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS

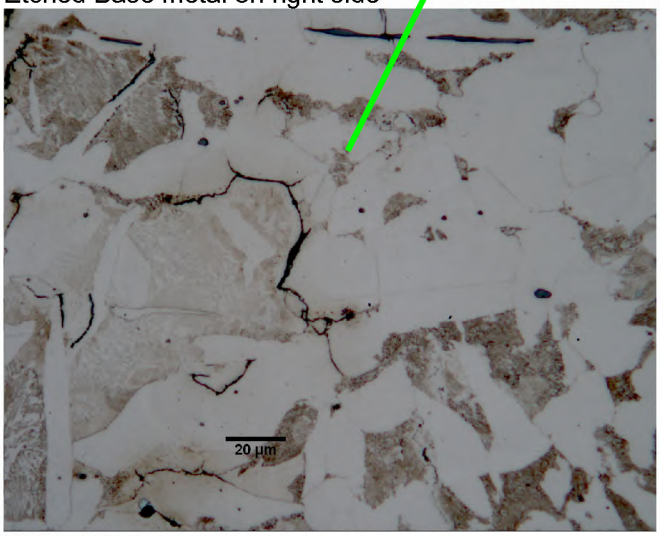




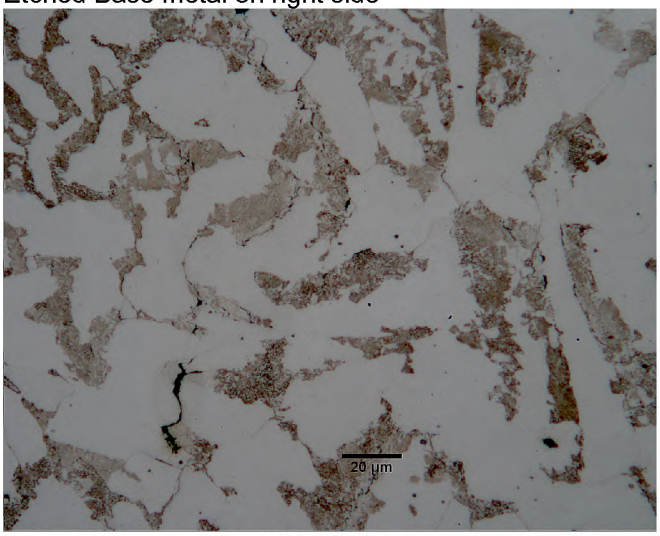
Etched Base metal on right side



Etched Base metal on right side



Etched Base metal on right side detail of above



Etched Base metal on right side

FIGURE 20 Photomicrographs of Mount T2L at ID left side

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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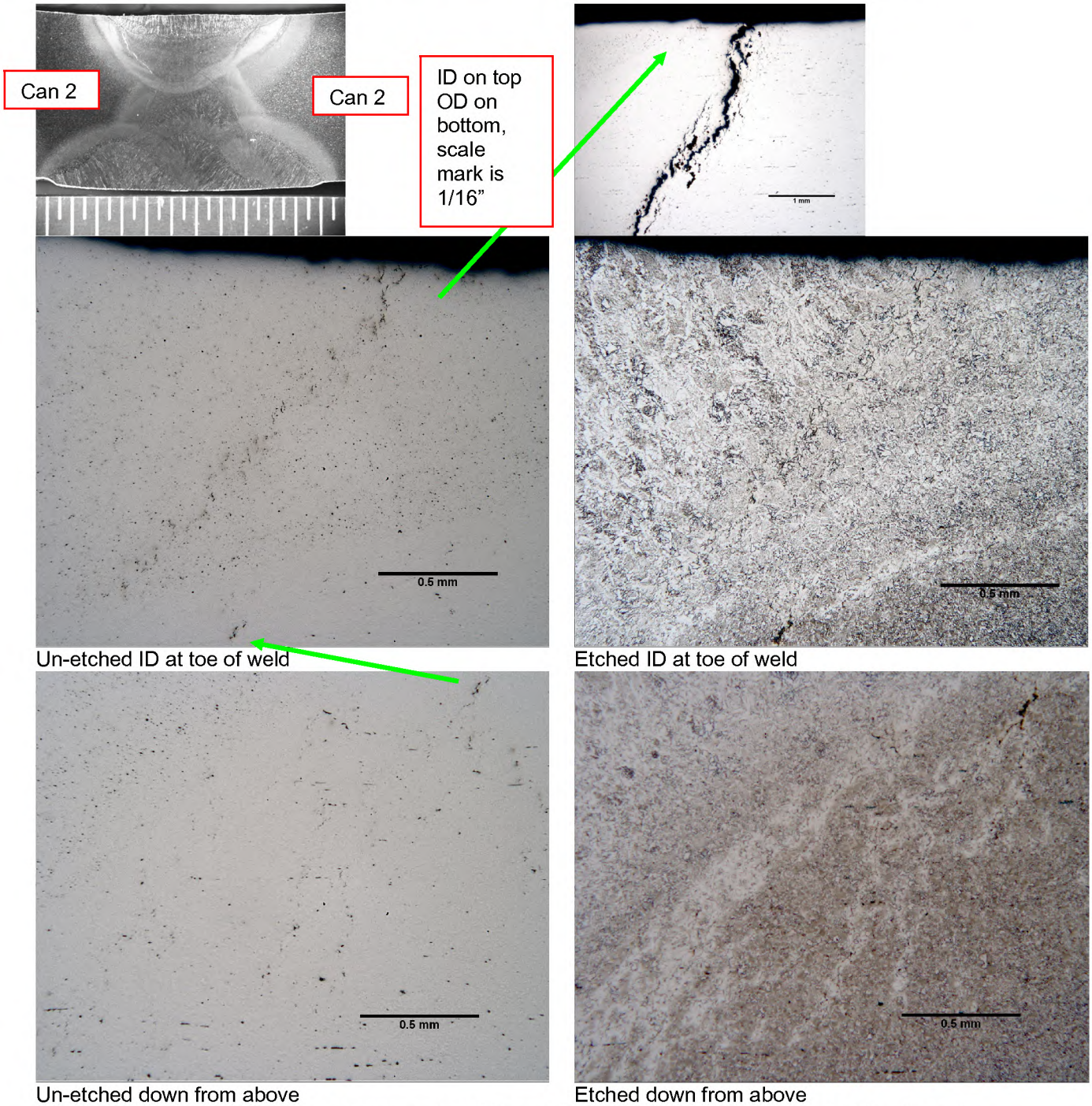
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS



Un-etched ID at toe of weld

Etched ID at toe of weld

Un-etched down from above

Etched down from above

FIGURE 21 Photomicrographs of Mount T2L at right side Weld Metal side of crack

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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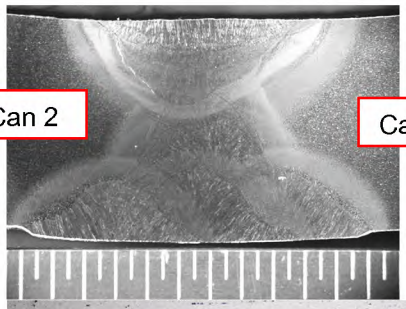
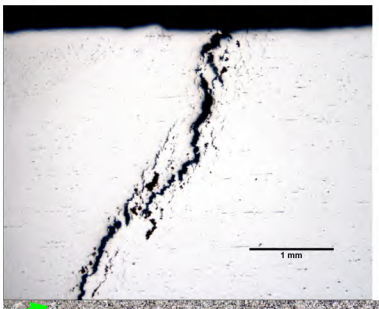
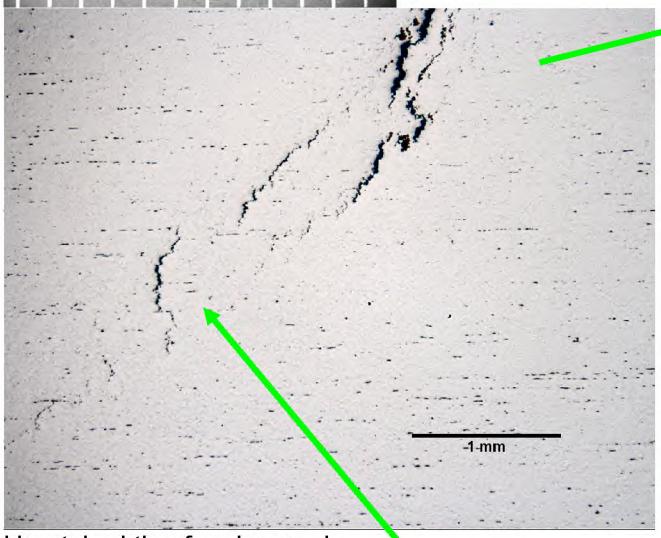
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS

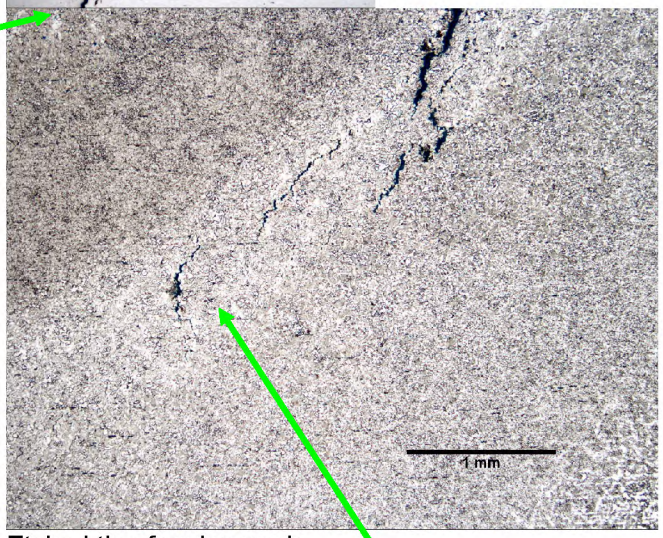


ID on top OD on bottom, scale mark is 1/16”

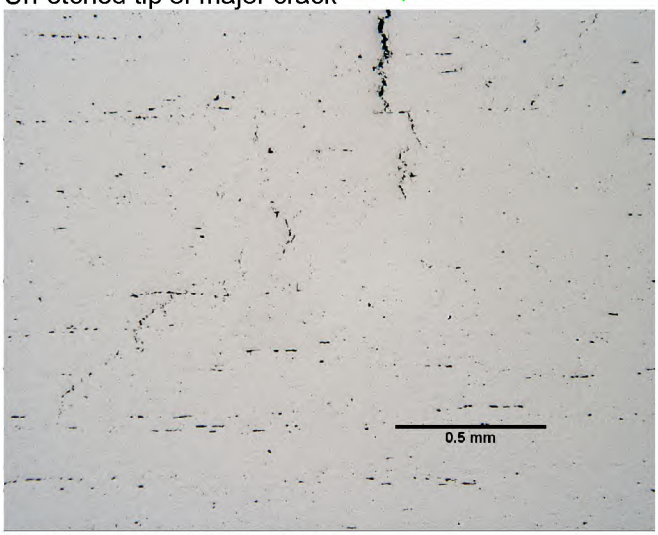




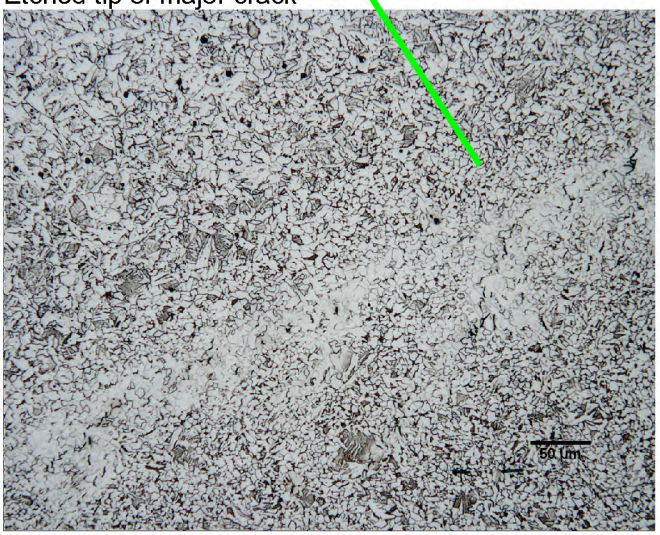
Un-etched tip of major crack



Etched tip of major crack



Un-etched detail from above



Etched detail from above

FIGURE 22 Photomicrographs of Mount T2L at right side Weld Metal side of crack tip

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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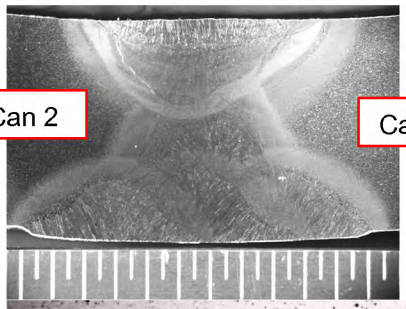
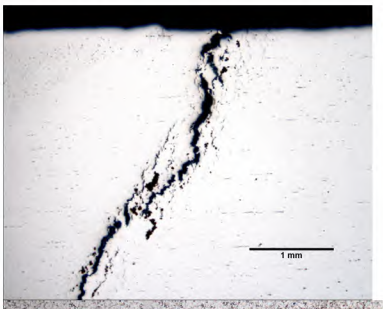
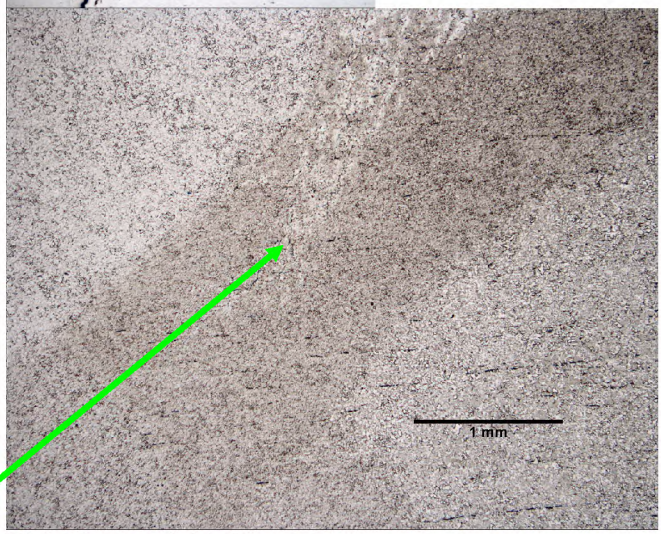


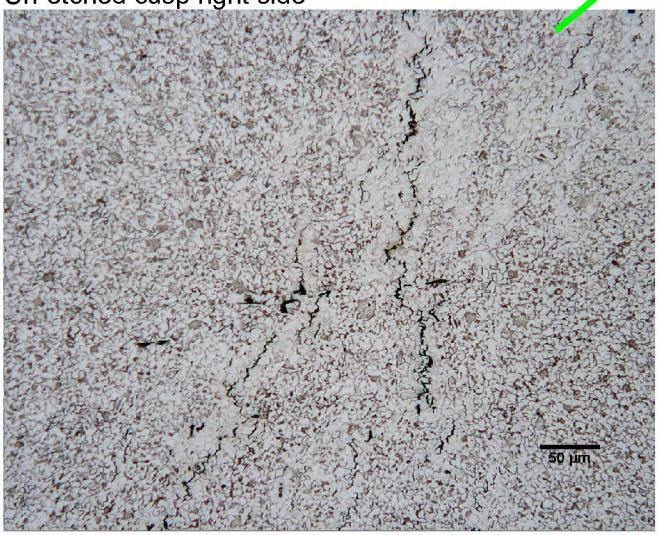
ID on top OD on bottom, scale mark is 1/16”



Un-etched cusp right side



Etched cusp right side



Un-etched detail from above

FIGURE 23 Photomicrographs of Mount T2L at right side Weld Metal side of crack tip

BETA LAB NO.M10198- LS2-CS3 TEE INDICATIONS	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
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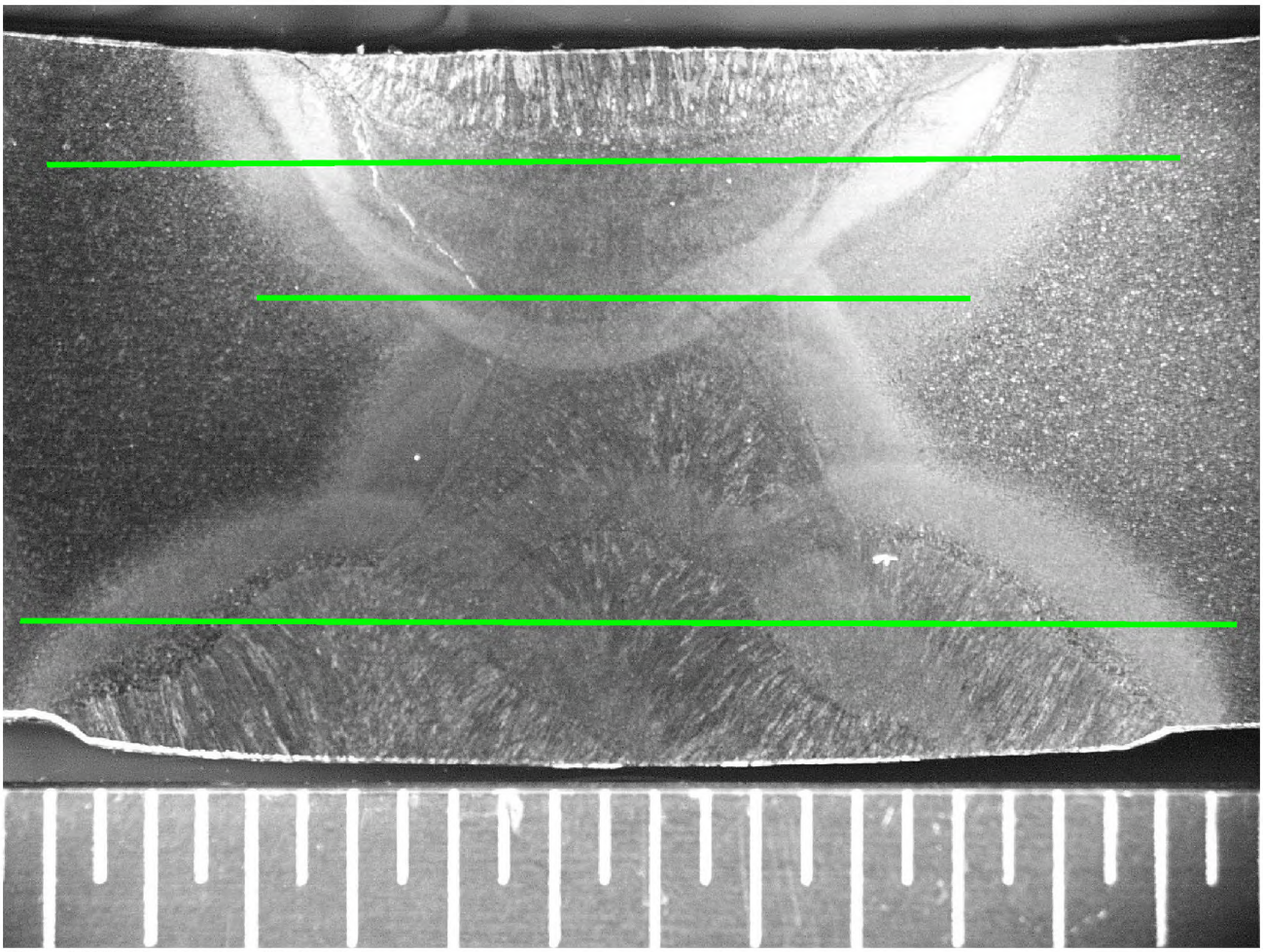
LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS



Mount T2L transverse through -

FIGURE 24 Photo macrographs with green lines where the micro-hardness traverses were made. Hardness values are given in Table 4 & 5. The scale marks are 1/16inch.

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LABORATORY REPORT- LS2-CS3 TEE INDICATIONS FINDINGS

ATTACHMENT 1 TEST PROTOCOL AND ADDENDUM

Tesoro Exchanger E Failure Examination Protocol

Part 1. Field Visual and Nondestructive Examination

Part 1 of this protocol identifies visual and non-destructive testing that is approved to be conducted on the shell of exchanger 6600-E by a contractor acceptable to the parties to this agreement. Prior to performing any visual inspection or non-destructive testing, 3 business days notice must be provided to all parties to the agreement to allow the opportunity to observe. Parties to this agreement may elect not to perform aspects of the visual inspection or non-destructive testing described in this protocol. Should parties identify the need to conduct additional inspection or non-destructive testing not described in Part 1 of this protocol, 2 days notice must be provided to all parties to this agreement in order to register any objections.

Detailed visual inspection and testing will not be permitted until the equipment is placed in the secure evidence storage location.

All field visual and nondestructive tests shall be appropriately documented indicating examinations performed, scope of examinations, test equipment used in examinations, results of testing and the qualifications of the examiner as appropriate. All reports will be signed and dated by the examiner(s). Data reports shall be distributed within 48 hours of examinations by the third party conducting these examinations to all parties simultaneously. No party shall have the opportunity to review any data results in advance of the other parties. Any part requesting clarification or correction of anything in the report shall submit their request to all parties.

Data generated as a result of the execution of this protocol will be shared with all parties to the agreement simultaneously. Visual inspection reports, analysis or conclusion will not be shared.

Each party conducting field visual and nondestructive examination shall be assigned a unique set of alpha-numeric sets of markings. The format of the markings shall be AXXX, BXXX, CXXX, etc. The markings shall be applied to the external surfaces of the shell only and shall be permanent in nature (etch, stamp, etc.). Any markings shall be applied at least two (2) inches from any fracture surface. The markings shall be used for purposes described in Part 1 of this protocol and may also be used to identify locations of specific areas of interest determined by any examination conducted in Part 1. Each party using the markings shall supply a drawing identifying unique markings used and locations of these markings on the shell for information to all parties.

Field Visual Examination

1. Photographically document the heat exchanger in the "as-found" condition before initiating the metallurgical analysis. Documentation should include the following:
   - Any reference points needed
   - Fracture area and surface
   - Seams

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Tesoro Exchanger E Failure Examination Protocol

- Welds
- Anomalies (dents, cracks, appurtenance)
- Manufacturing flaws or defects
- Pitting and/or evidence of corrosion on internal and external surfaces

2. Videotape the failed heat exchanger and surrounding heat exchangers and piping in the "as-found" condition. The videotape should similarly scan all items listed in (1) above. One scan should also offer a panoramic view of all affected surrounding equipment shot from a location immediately adjacent to the point of failure on the failed exchanger.

3. Perform an initial field visual examination of the internal and external surfaces in the "as-found" condition, and document any anomalies that may be present such as the following:
   - Cracks
   - Crevices
   - Dents
   - Gouges
   - Manufacturing defects
   - Pitting and/or evidence of corrosion on internal and external surfaces
   - Presence of corrosion products and/or deposits
   - Examine the surface for evidence of cracks
   - Examine for evidence of arc burns, grinding around the surface area near the fracture

   Additional considerations

   a. Fracture Surfaces: All fracture surfaces should be reviewed and photographed to check for:
      - thinning due to apparent corrosion
      - thinning due to necking
      - scaling (indicating an older crack)
      - beach or ratchet (chevron) marks pointing to the initiation site
      - proximity to welds and whether the crack propagates through weld metal, base metals or HAZs (Heat Affected Zones).
      - proximity to the end of the cladding
      - geometrical anomalies – e.g. gouges, sharp weld corners, mismatch, incomplete penetration of welds, etc

   b. Characterization of Internal Corrosion: Visible thinning or pitting on shell, tubes and baffles. Record description of all visible areas, with:
      - locations of corrosion on shell with length from outlet tubesheet and height from the bottom of the exchanger),
      - appearance of corrosion type on shell – thinning , pitting, etc
      - descriptions of scales
      - estimates of depths of observable corrosion and scales.

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c. Characterization of Fouling or Other Deposits:
- Describe by color, volume, location, density, tenacity of adhering to surface, whether initiating on tubes or shell.
- Use initial photos for comparison to see if fouling has been affected by atmospheric and weather exposure in the last few weeks.
- Report any areas near fracture surface where the fouling seems to be removed due to the flow escaping from the fracture (to help define initial leak point).

d. Characterization of Distortion – Possible Pre- or Post-Explosion:
- Look for tube distortion such as pulling out of tubesheet or breaking behind tubesheet or baffles, or having contact with shell.
- Look for bundle distortion which may be an affect of the explosion, and may indicate the initial leak point.

e. Tracing Initial Leak Point by Surrounding Impingement or Damage:
- Inspect adjacent equipment in the direction of the rupture and cracking, and report any signs of flow impingement, high temperature exposures, explosion pressure-wave, etc.

Field Visual and Nondestructive Examination

1. Positive Materials Identification (PMI)

Perform PMI testing on all shell components and full penetration welds within two feet of the fracture surfaces using portable x-ray emission analyzers.
- Conduct all tests on external surfaces at least 6 inches away from all fracture surfaces.
- Conduct one test per weld located in the areas of interest on an external surface at least one foot away from all fracture surfaces.
- Unique numeric markings for identification purposes shall be made on the external surfaces of the shell where any PMI test was conducted.

2. Deposit Collection

Deposits from the lower section of the bundle and representative deposits found adhered to the shell shall be collected and stored in clean glass covered jars for subsequent laboratory analysis. Unique numeric markings for identification purposes shall be made on the external surfaces of the shell and on the surface of the bundle where the deposits were collected. Photographs should be taken of locations where deposits are to be removed prior to removal.

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