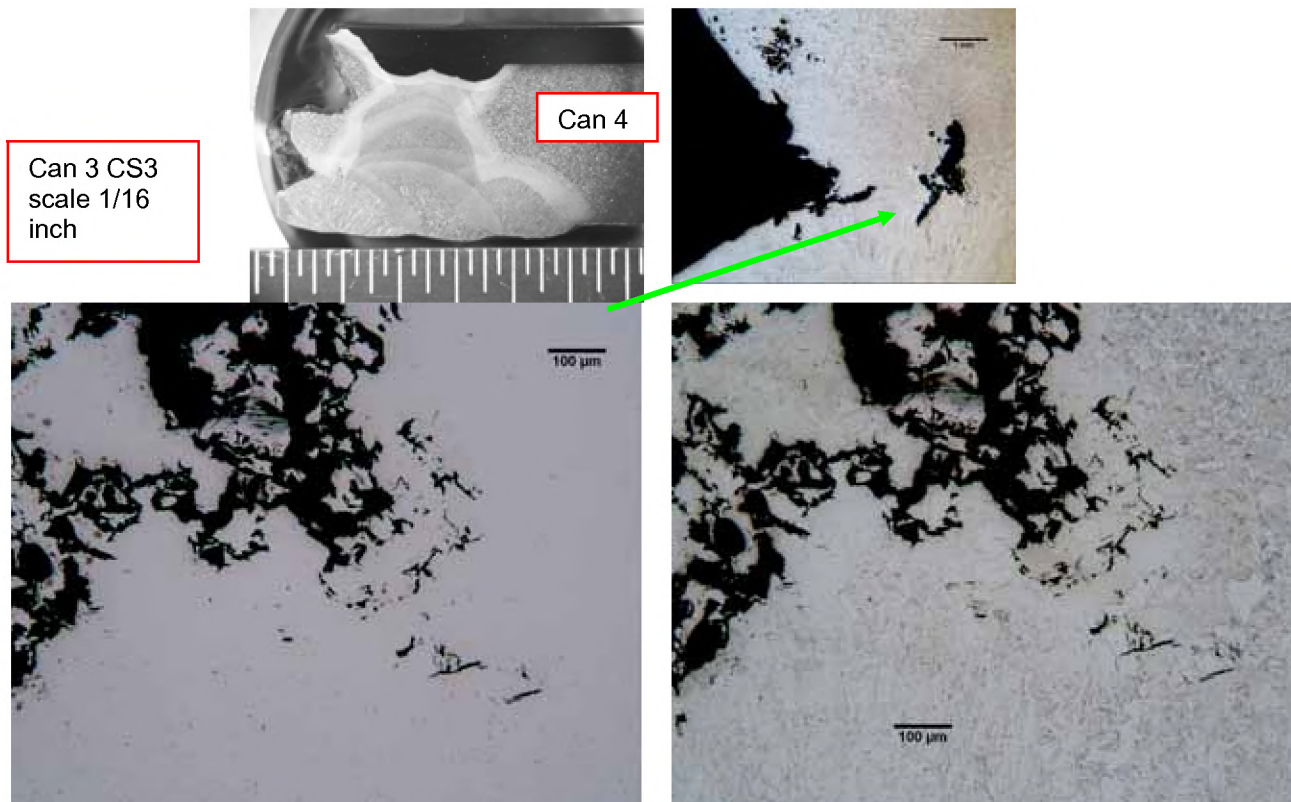


BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
PAGE 29 OF 57		

LABORATORY REPORT-CS4



Un-etched detail near OD under OD cap

Etched detail near OD under OD cap

FIGURE 20 Un-etched and etched details of are in Figure 18 for mount M1

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PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
PAGE 30 OF 57		

LABORATORY REPORT-CS4

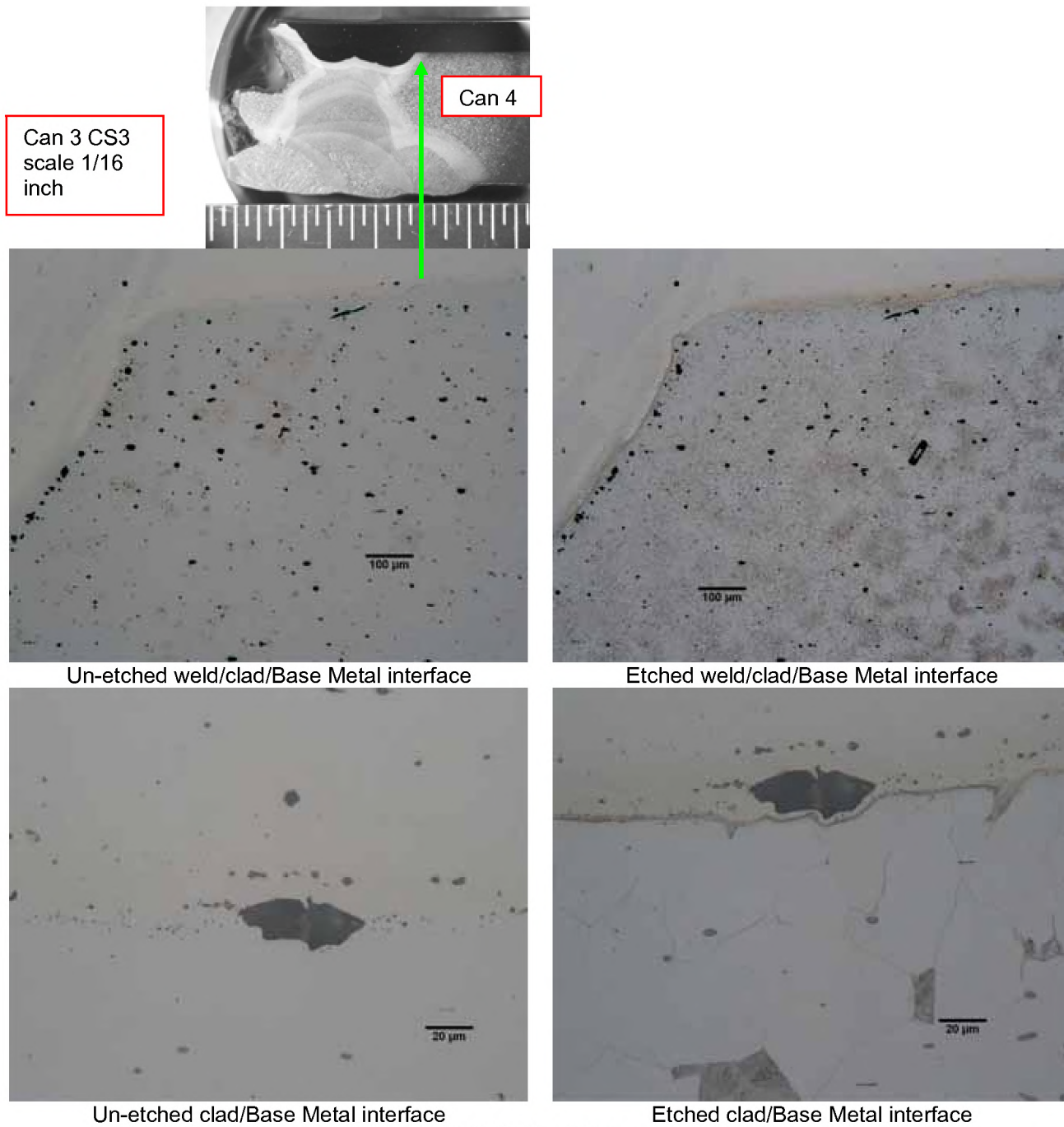
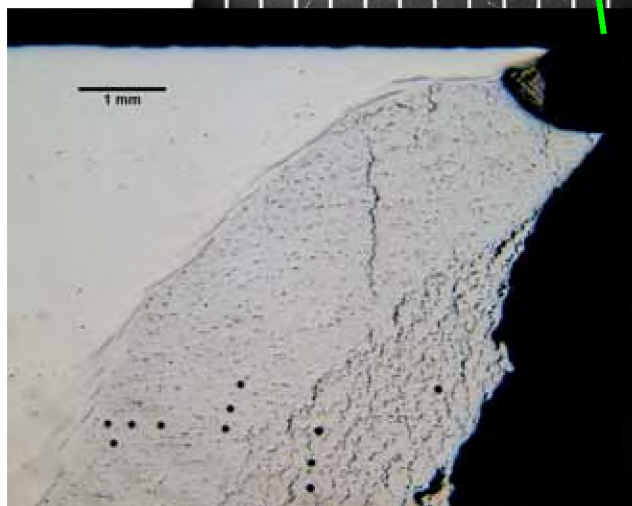
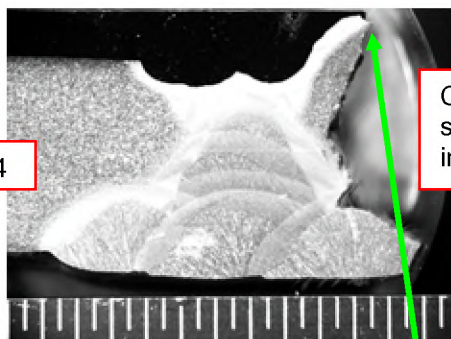


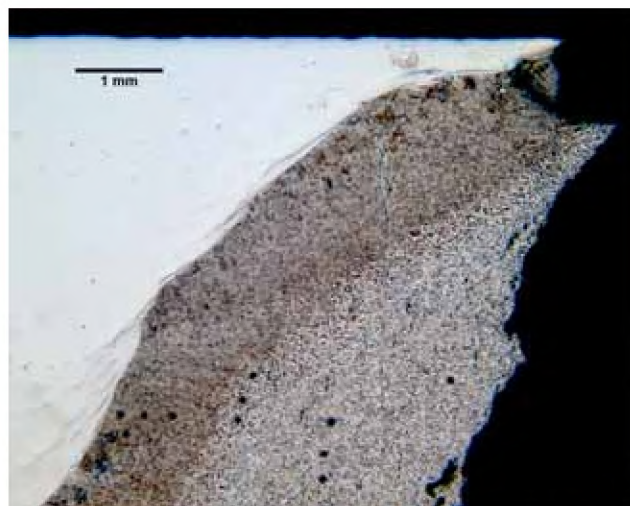
FIGURE 21 Un-etched and etched clad/weld/base metal interface for mount M1

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 31 OF 57

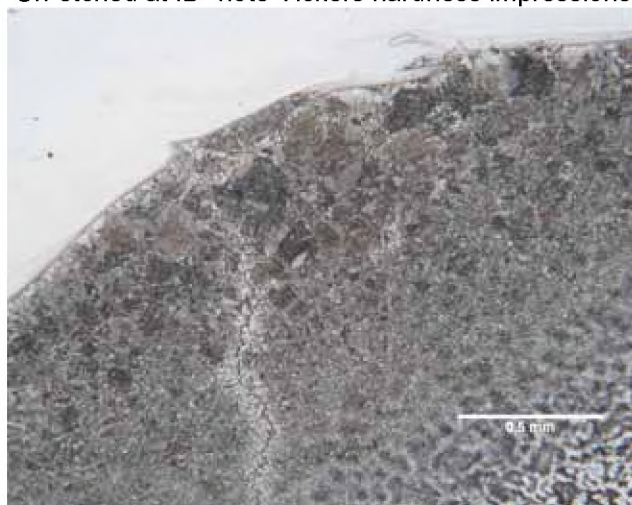
LABORATORY REPORT-CS4



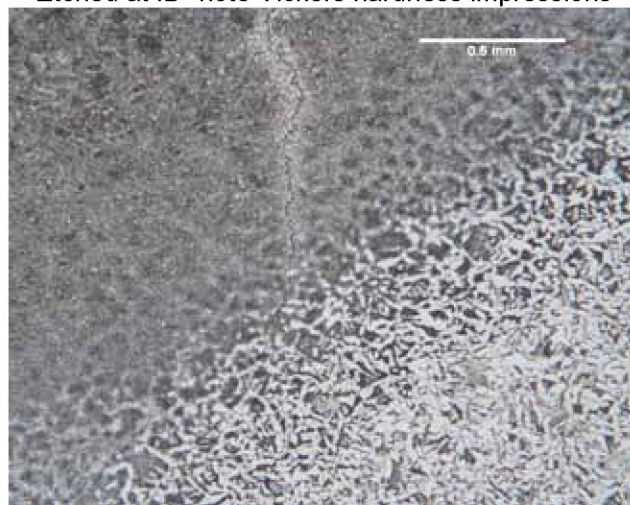
Un-etched at ID- note Vickers hardness impressions



Etched at ID- note Vickers hardness impressions



Etched under stainless steel weld from above

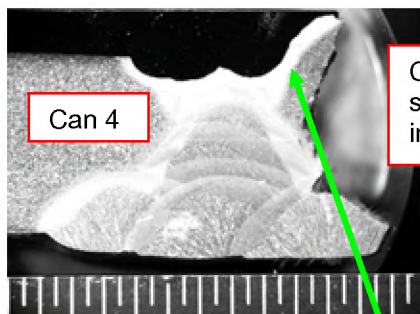


Etched under stainless steel weld at tip from above

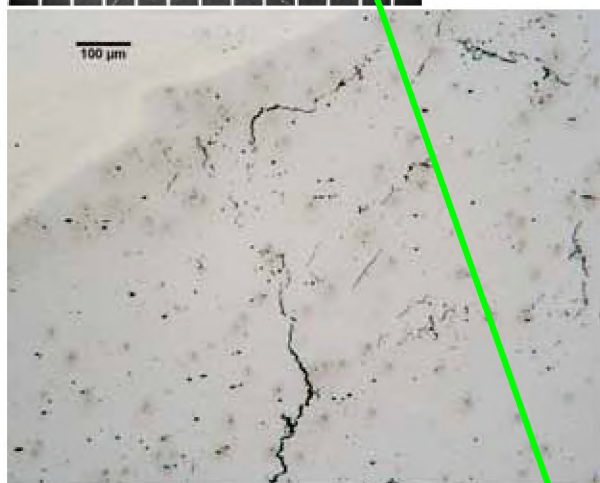
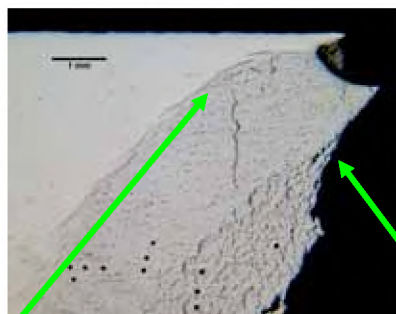
FIGURE 22 Un-etched and etched ID for mount M2

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 32 OF 57

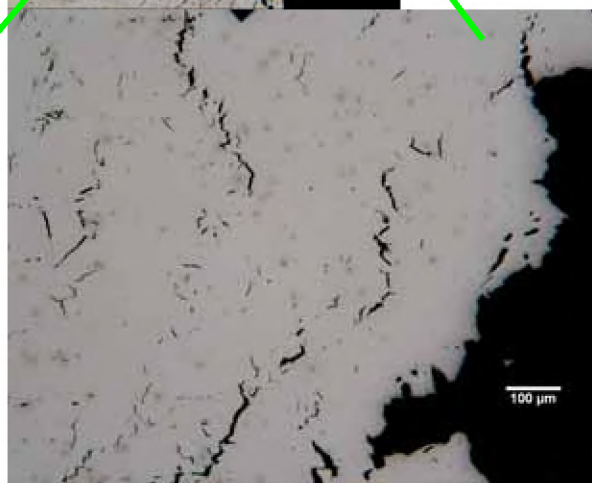
LABORATORY REPORT-CS4



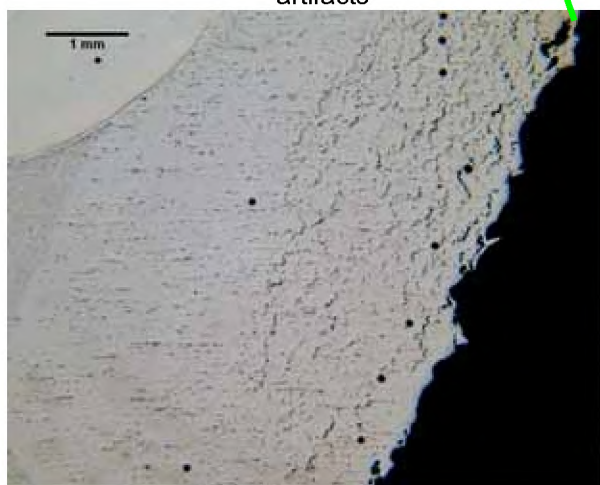
Can 3 CS3 scale 1/16 inch



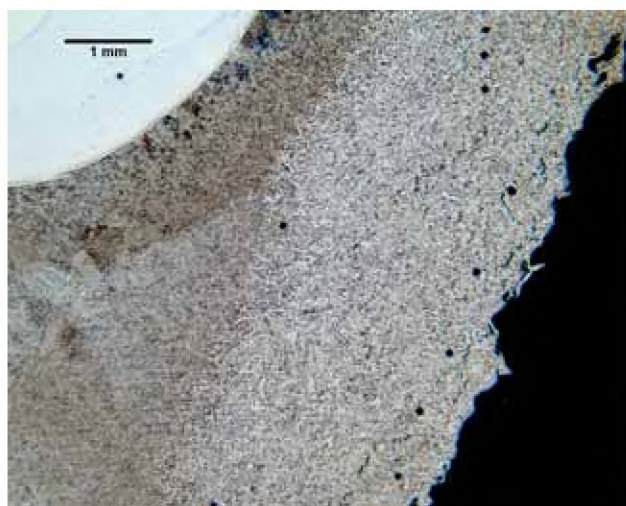
Un-etched under stainless weld metal-brown are artifacts



Un-etched along fracture edge



Un-etched further along the fracture edge-note Vickers hardness impressions

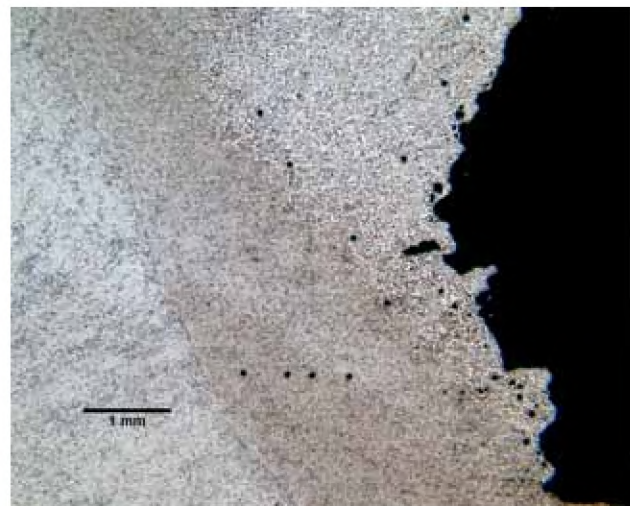
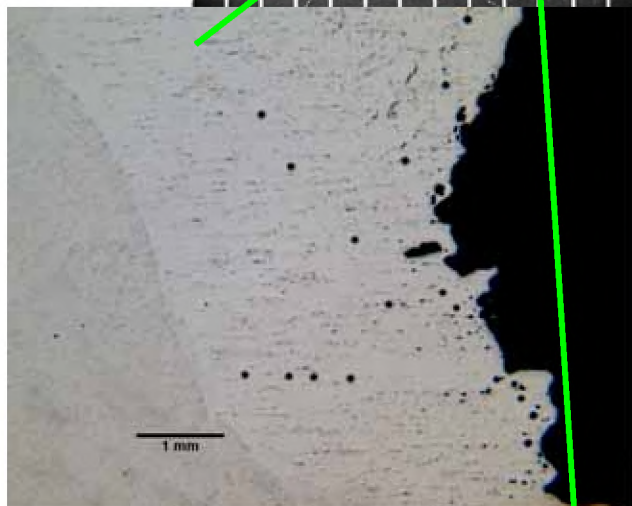
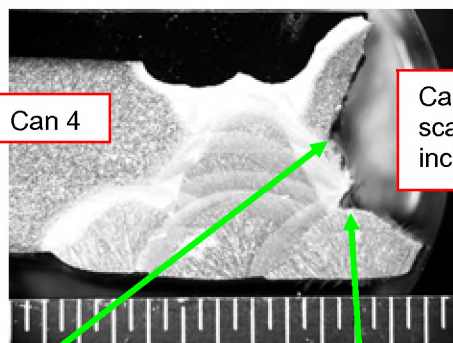


Etched area at left

FIGURE 23 Un-etched and etched fracture edge progressing from ID toward the OD for mount M2

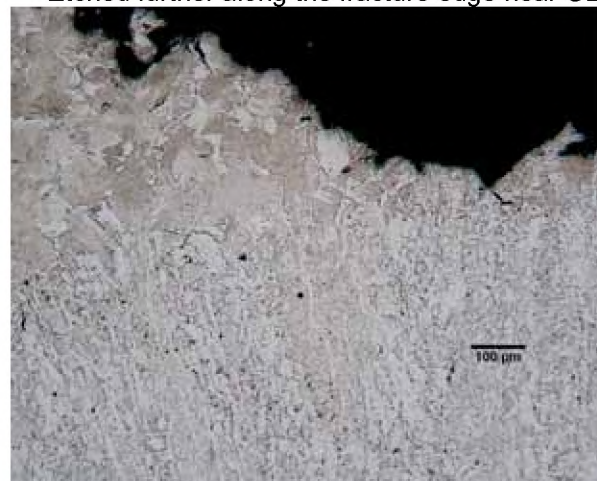
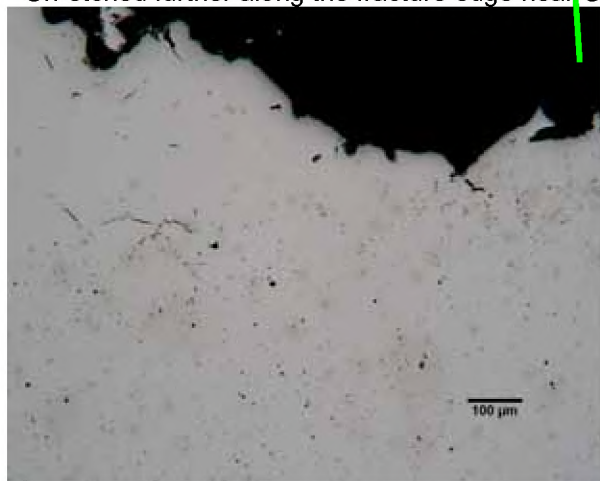
BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 33 OF 57

LABORATORY REPORT-CS4



Un-etched further along the fracture edge near OD

Etched further along the fracture edge near OD



Un-etched under OD cap pass

Etched under OD cap pass

FIGURE 24 Un-etched and etched fracture edge towards OD for mount M2

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 34 OF 57

LABORATORY REPORT-CS4

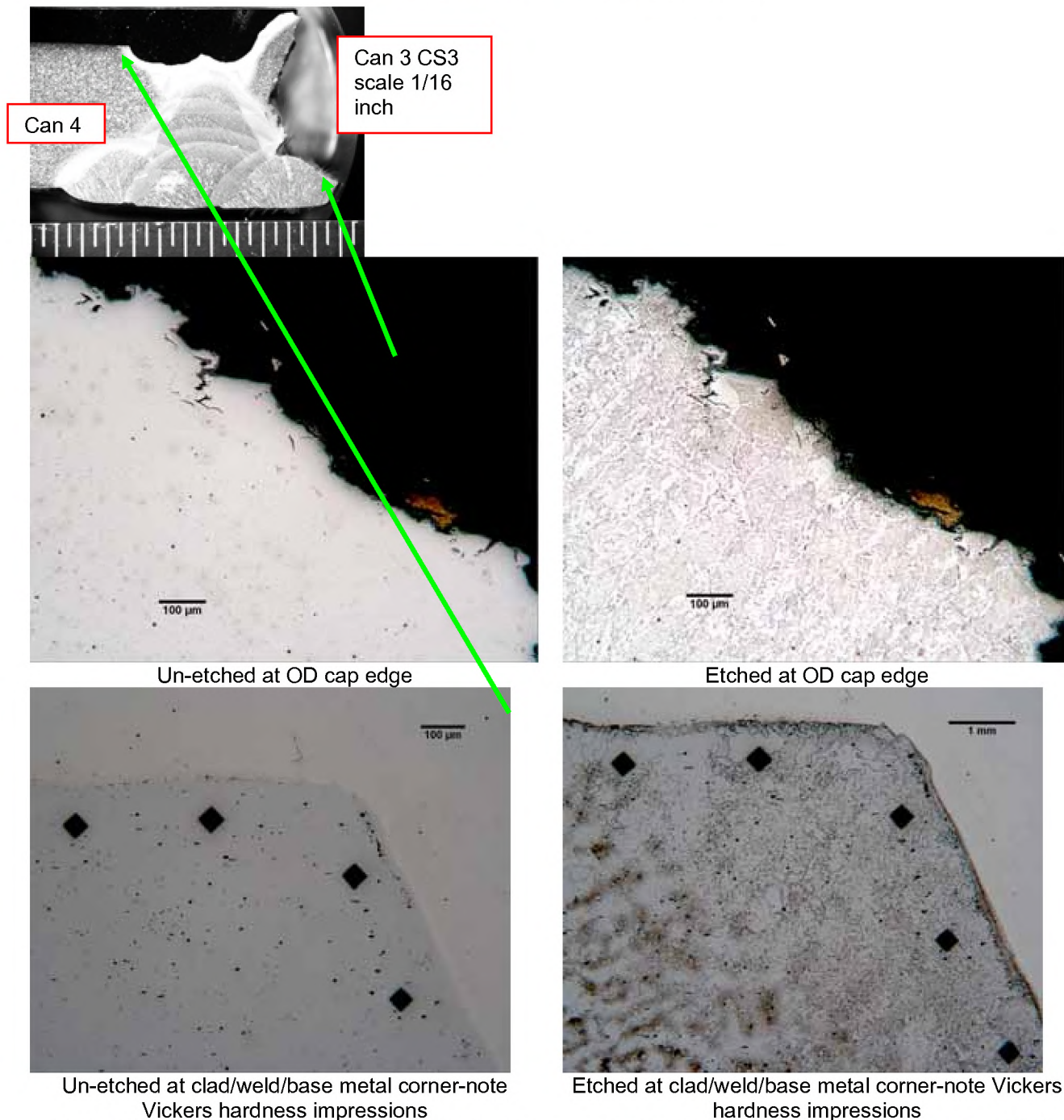
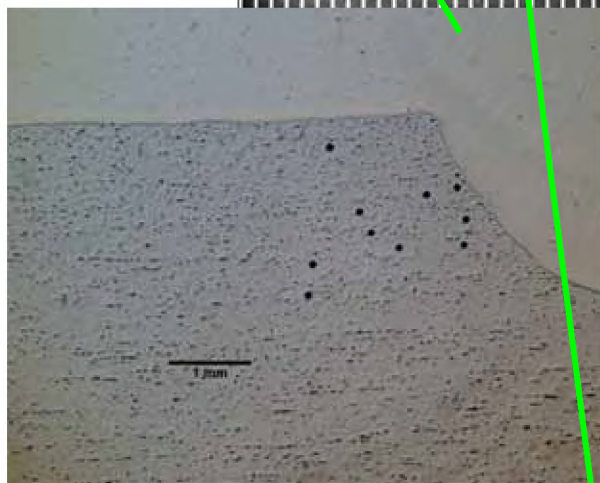
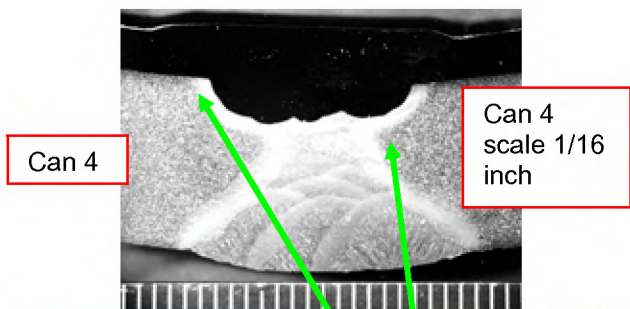


FIGURE 25 Un-etched and etched fracture edge progressing from ID toward the OD for mount M2

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
PAGE 35 OF 57		

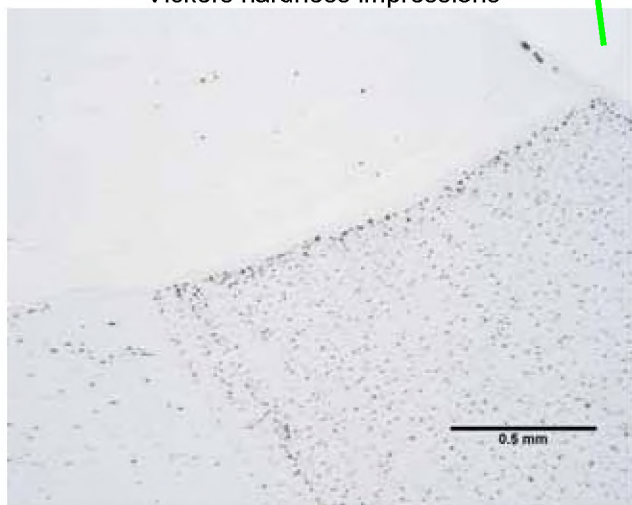
LABORATORY REPORT-CS4



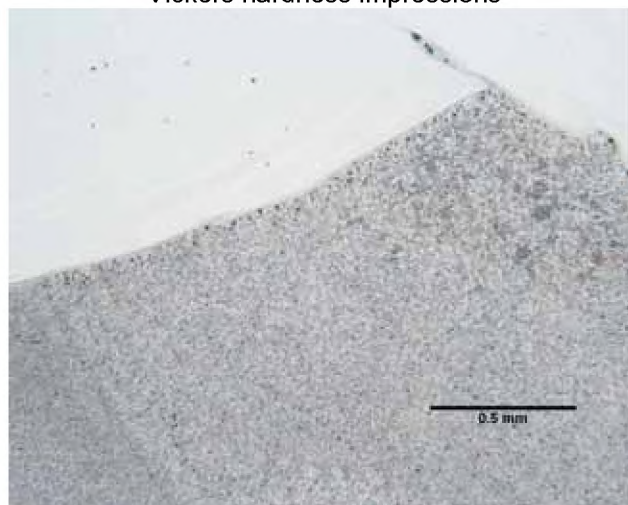
Un-etched at weld/clad/base metal interface- note Vickers hardness impressions



Etched at weld/clad/base metal interface- note Vickers hardness impressions



Un-etched at weld/base metal interface

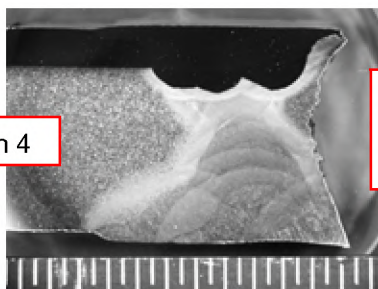


Etched at weld/base metal interface

FIGURE 26 Un-etched and etched weld and clad interfaces for mount M3

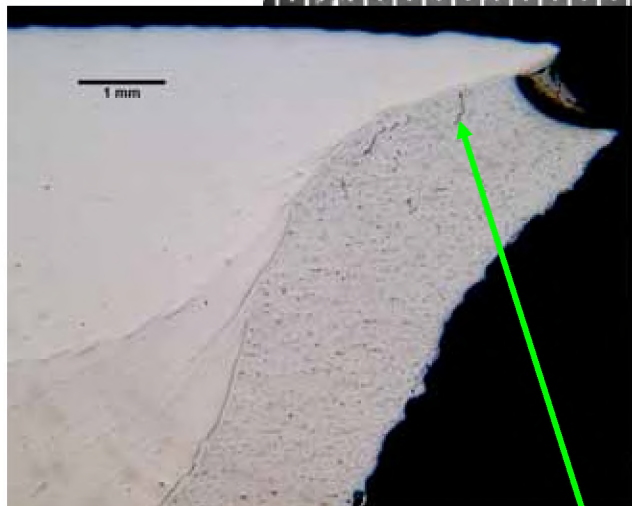
BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 36 OF 57

LABORATORY REPORT-CS4

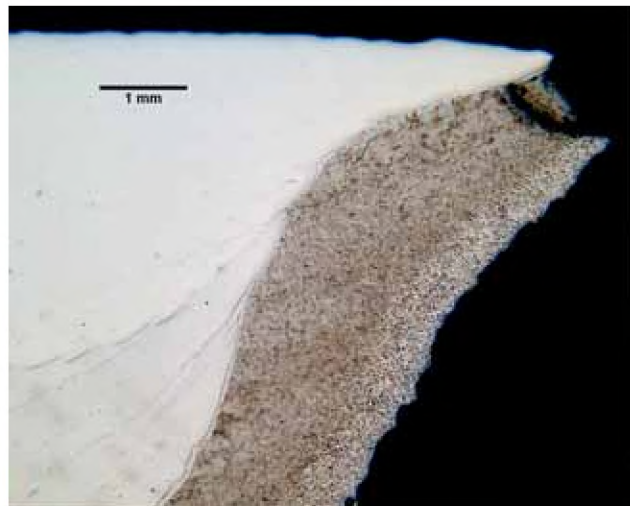


Can 4

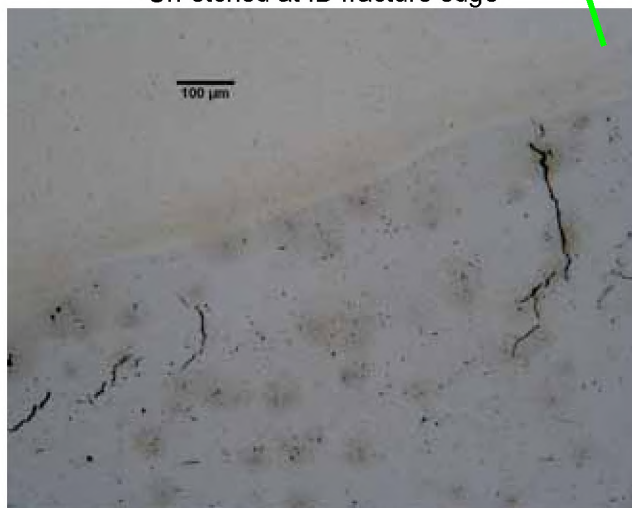
Can 3 CS3
scale 1/16
inch



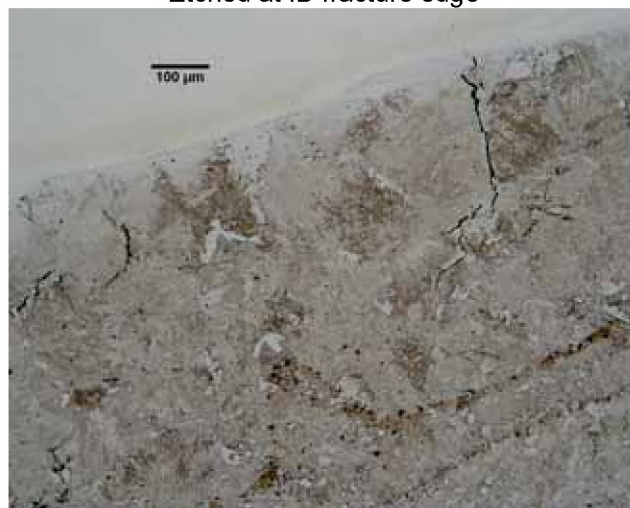
Un-etched at ID fracture edge



Etched at ID fracture edge



Un-etched under weld near ID-brown are artifacts



Etched under weld near ID

FIGURE 27 Un-etched and etched at ID and along the fracture edge for mount M4

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 37 OF 57

LABORATORY REPORT-CS4

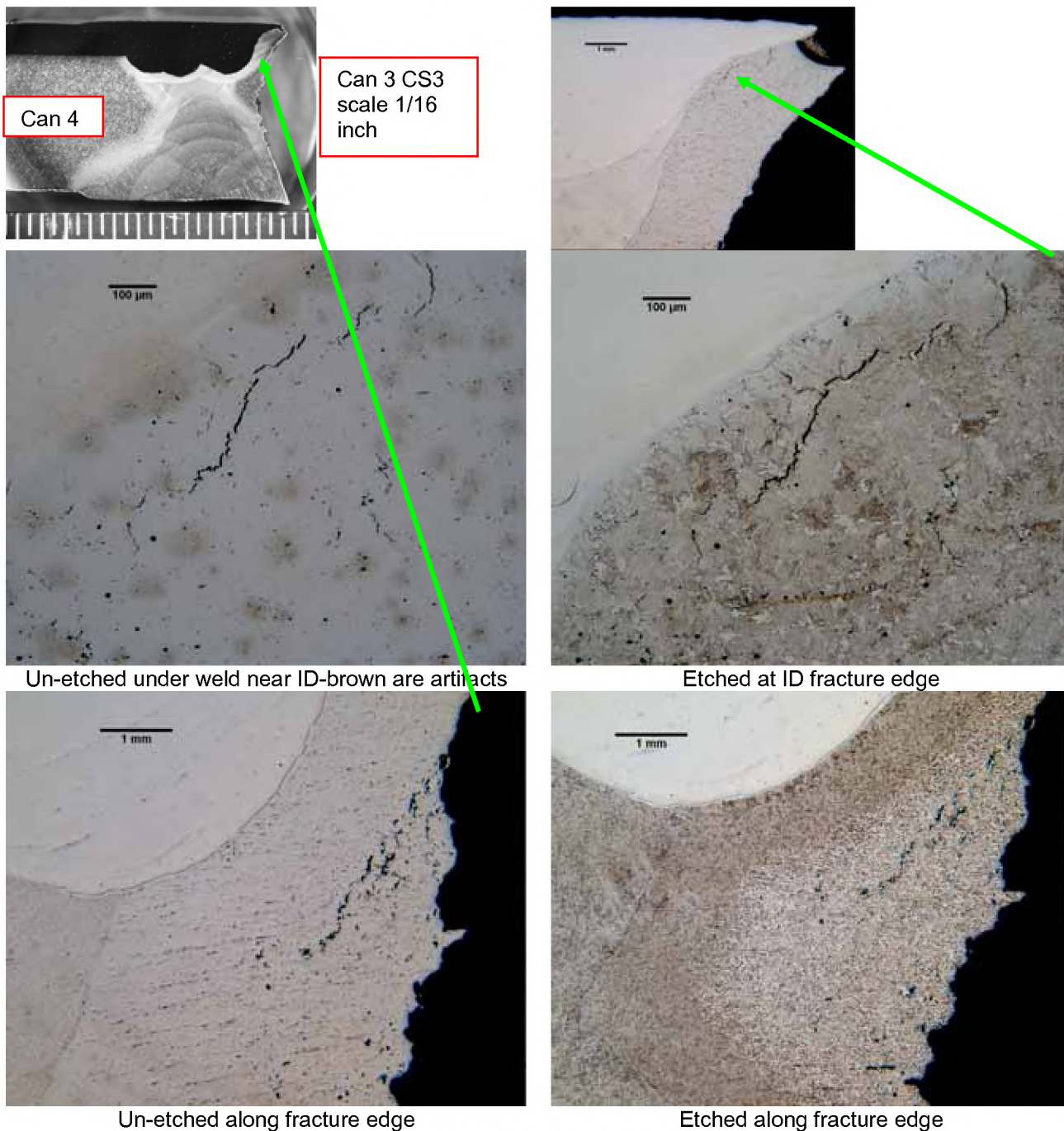
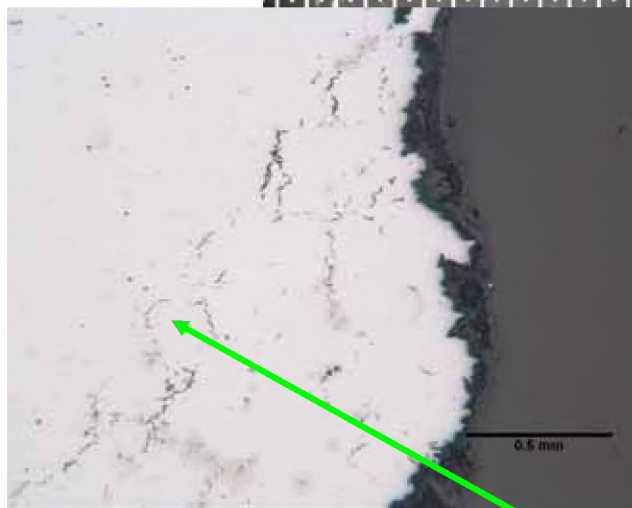
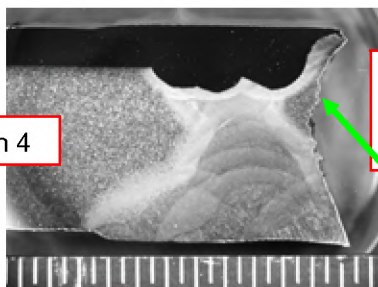


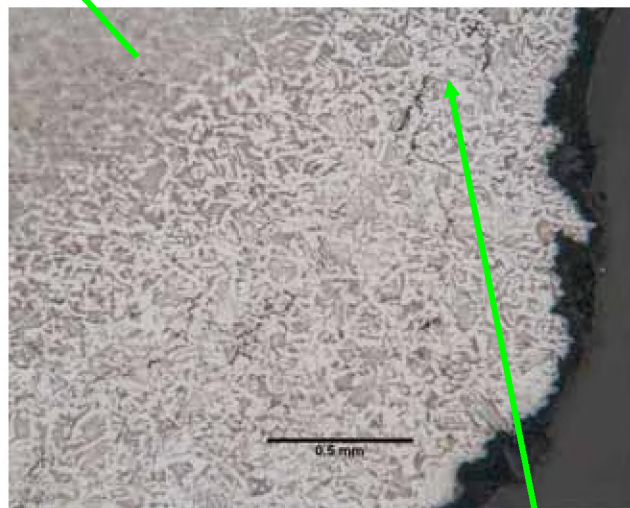
FIGURE 28 Un-etched and etched under weld near ID mount M4

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 38 OF 57

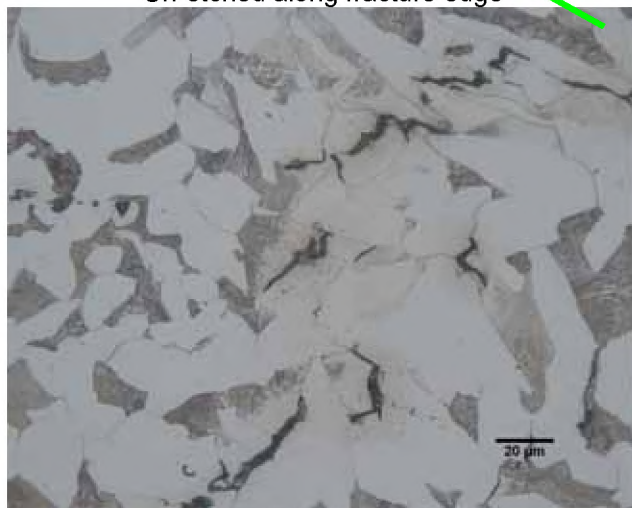
LABORATORY REPORT-CS4



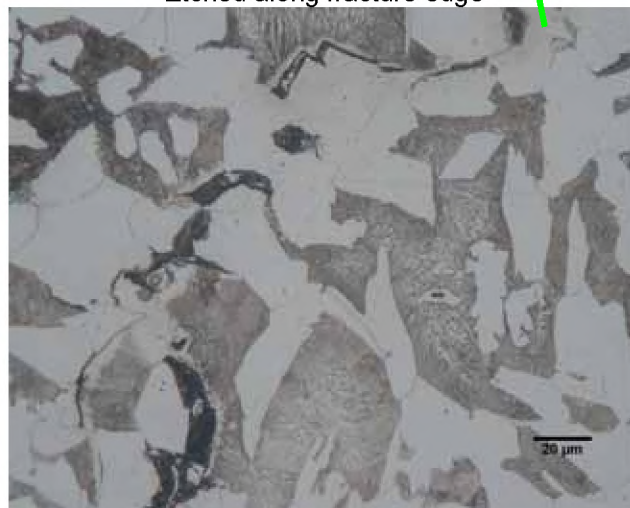
Un-etched along fracture edge



Etched along fracture edge



Etched detail of above

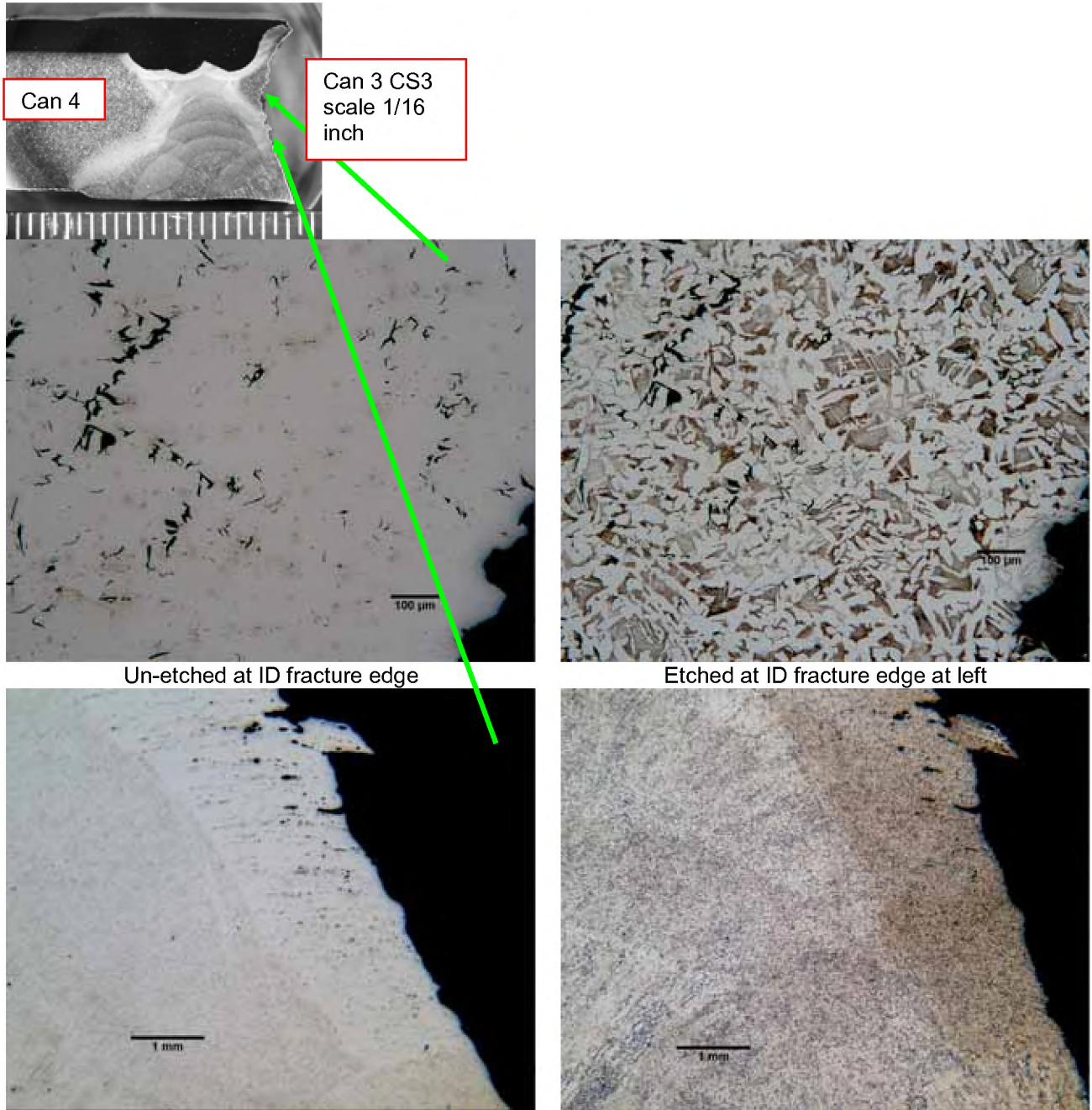


Etched detail of above

FIGURE 29 Un-etched and etched at ID and along the fracture edge for mount M4

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
PAGE 39 OF 57		

LABORATORY REPORT-CS4



Un-etched at ID fracture edge

Etched at ID fracture edge at left

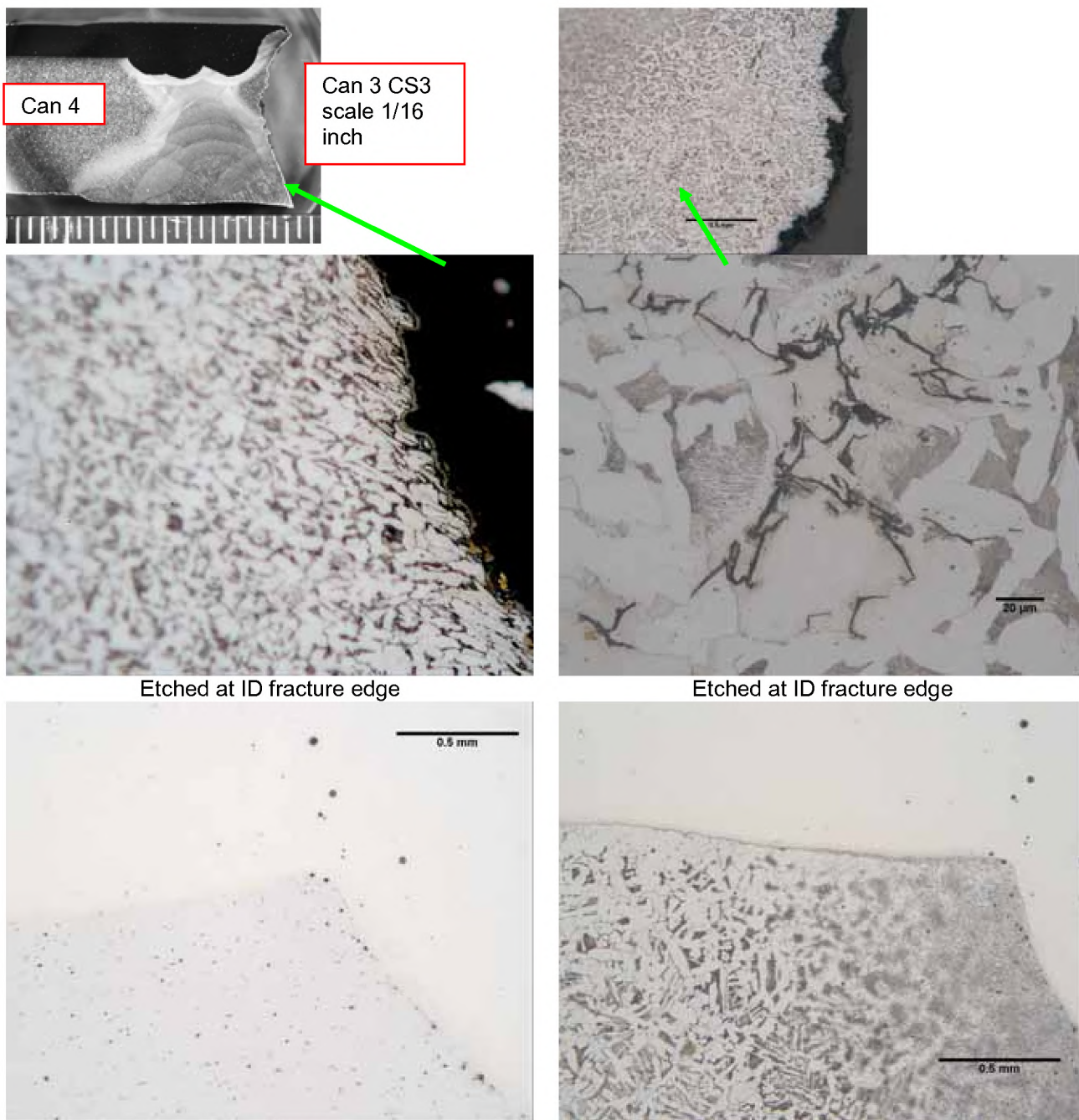
Un-etched along fracture edge

Etched along fracture edge

FIGURE 30 Un-etched and etched along fracture edge for mount M4

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
		PAGE 40 OF 57

LABORATORY REPORT-CS4



Etched at ID fracture edge

Etched at ID fracture edge

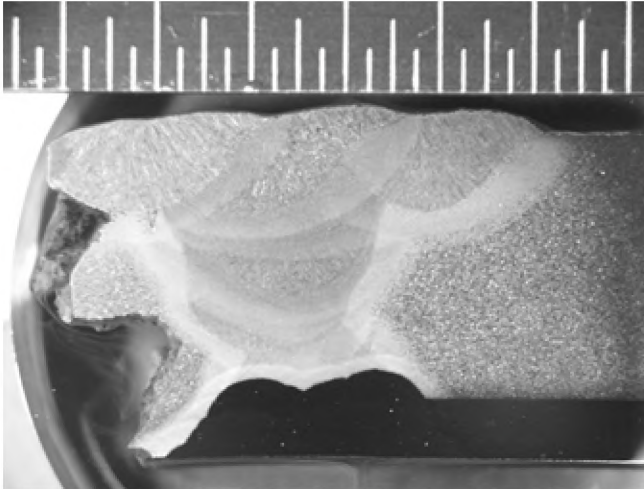
Un-etched at clad/weld/base metal interface

Etched at clad/weld/base metal interface

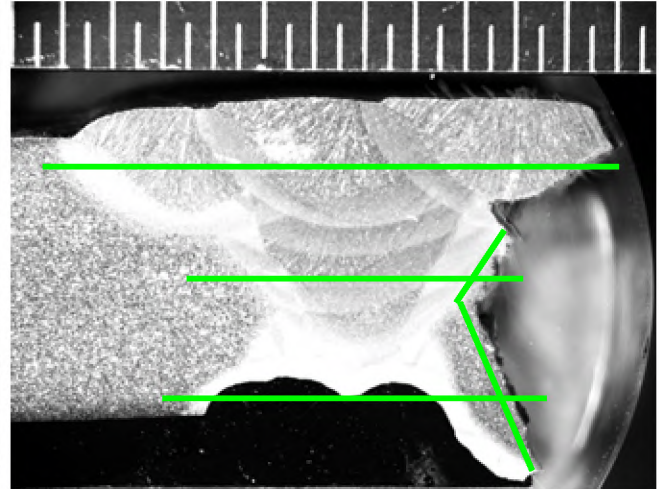
FIGURE 31 Un-etched and etched along fracture edge for mount M4

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
PAGE 41 OF 57		

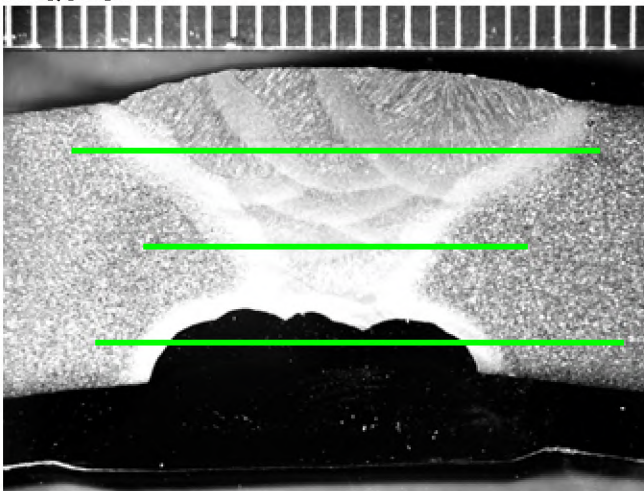
LABORATORY REPORT-CS4



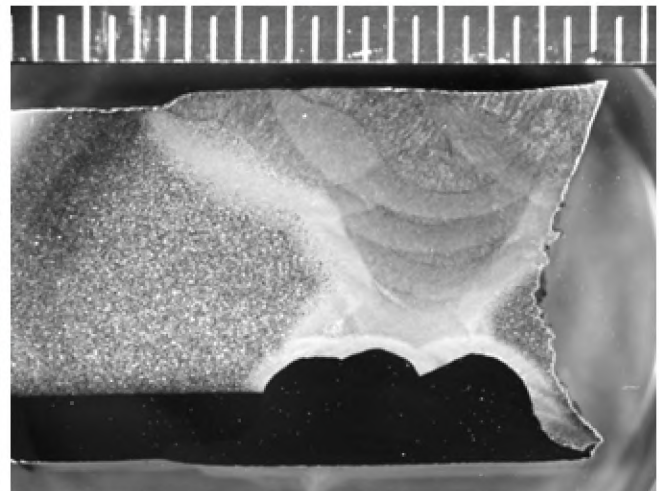
Mount M1 transverse through CS4 can 3 fracture on left and can 4 on right – ID on bottom- Black is clad and stainless steel weld- NO HARDNESS TESTS REQUESTED



Mount M2 transverse through CS4 can 4 on left and can 3 fracture on right- ID on bottom- Black is clad and stainless steel weld-



Mount M3 transverse through LS4 can 4 on both sides – ID on bottom- Black is clad and stainless steel weld

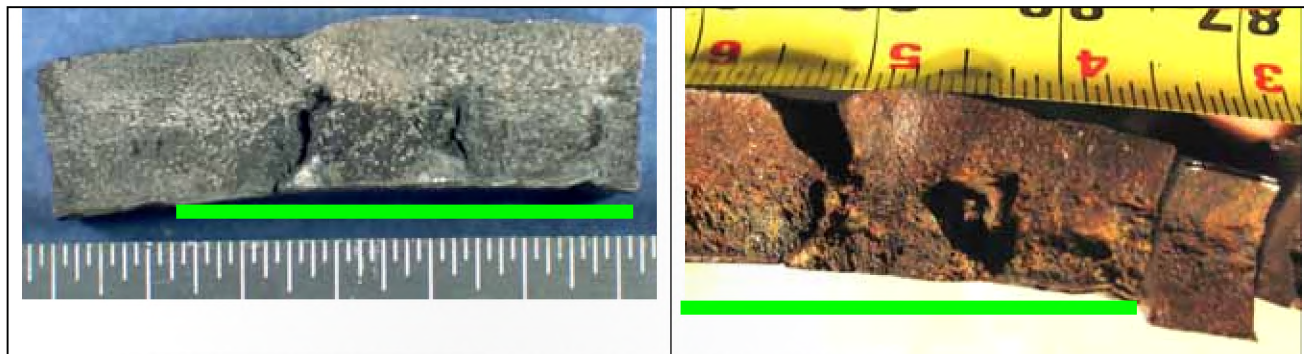


Mount M4 transverse through CS4 can 3 fracture on right and can 4 on left – ID on bottom- Black is clad and stainless steel weld- NO HARDNESS TESTS REQUESTED

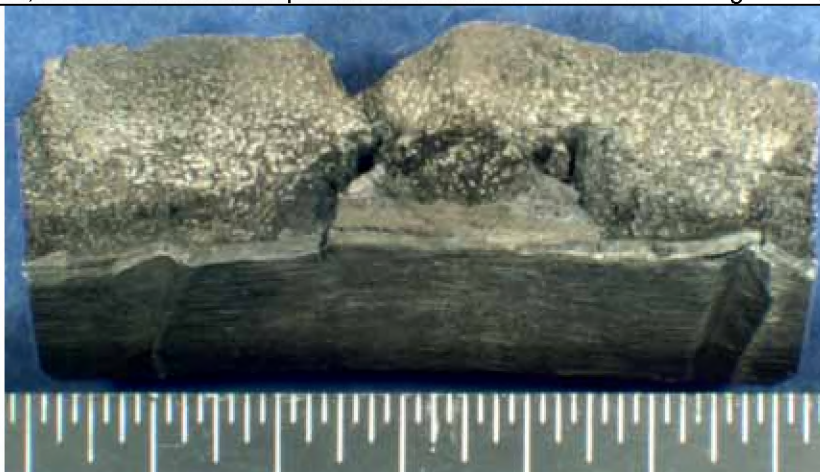
FIGURE 32 Photo macrographs with green lines where the micro-hardness traverses were made. hardness values are given in Table 5-7

BETA LAB NO.M10198- CS4-02	TESORO REFINING AND MARKETING COMPANY ANACORTES REFINERY 10200 W. MARCH POINT ROAD T91WA4428 ANACORTES, WA 98221	CUSTOMER P.O. NO.: 4501667904
PART: 6600-E HEAT EXCHANGER CS4 PART 19 & 20		DATE: AUGUST 5, 2010
PAGE 42 OF 57		

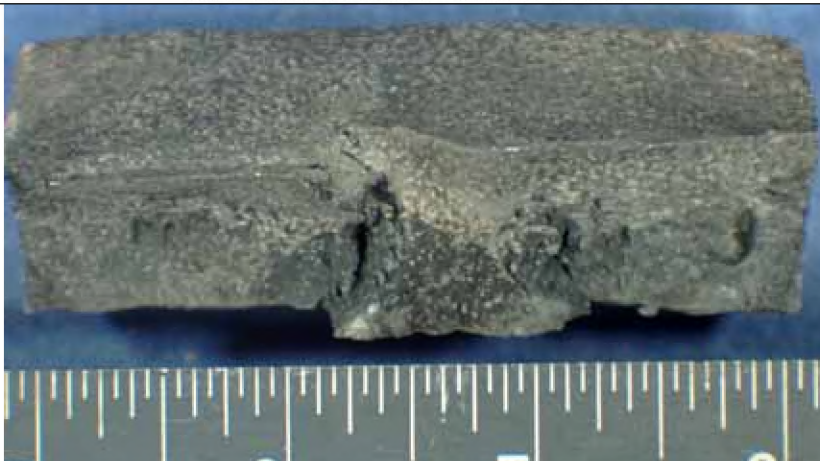
LABORATORY REPORT-CS4



Straight down photo, ID bottom and OD top-scale is 1/16 inch—left after cleaning and right before cleaning



Tilt to show ID corner- scale is 1/16 inch



Tilt to show OD corner- scale is 1/16 inch

FIGURE 33 Photo of SEM 1 sample before and after cleaning