Memorandum

U. S. Department
of Transportation
Pipeline and
Hazardous Materials
Safety Administration

Date: September 29, 2010

To: R.M. Seeley, Southwest Region Director

From: Kim Nguyen, General Engineer

Subject: Incident Report – Enterprise Products Operating LLC
Operator Number 31618, Unit Number 60534
Accident Location: Port Bolivar Galveston, TX
Date of Accident: December 23, 2009, NRC Number: 926954
SMART Activity # 128212 IO3

Summary:

On December 23, 2009, at approximately 7:15 am, the Galveston City Fire Department (GFD) was notified by a citizen of crude oil spraying up to 15 feet in the air at the Enterprise Products Operating LLC (Enterprise) Bolivar station in Bolivar, TX which is part of the Enterprise (EPCO) Cameron Highway Oil Pipeline System (CHOPS) crude oil transmission system. GFD arrived at the accident site at 7:30 am. The Galveston County Sheriff Department promptly notified Enterprise of the release at approximately 7:48 am. Enterprise instructed GFD not to close any valves. At approximately 8:10 am, Enterprise started shutting off crude oil from High Island A5 platform going to Bolivar station, and isolated the CHOPS system segment A5. There was no fire or explosion as a result of the accident, and an estimated 120 bbls crude oil were released to the environment (110 bbls crude oil were recovered via a vacuum truck). There was impact to the public as crude oil sheen was discovered on State Road (SR) 87 (adjacent to the Bolivar Station) causing traffic safety issues, and SR 87 was closed to the public by the Galveston County Sheriff Department (GCSD) from approximately 9:00 AM to 11:00 PM on December 23, 2009. There was impact to the environment as a result of the crude oil release, and crude oil recovery and soil remediation was completed on December 25, 2009. The nearest residential area to the accident site is ¼ mile away. The cause of the crude oil release was determined to be the failure of cap screws in a pressure switch, PSH-11003, due to hydrogen assisted cracking promoted by galvanic corrosion.

During Enterprise's response to the accident, three Enterprise field operation specialists from Sabine Pass, Port Arthur, and Texas City, TX were dispatched to the accident site on the morning of December 23, 2009. Upon arriving at approximately 9:00 AM, they closed ¾ inch (V-11003) Whitley ball valve, located on top of the 24-inch pipeline, that was used to isolate the failed pressure switch, and the release of crude oil into the environment was stopped. The release was estimated to have been active from approximately 7:00 AM to 9:00 AM on December 23, 2009. Enterprise established an on-site incident commander in coordination with GFD and GCSD, and T&T Marines Salvages was contracted to provide response clean-up and remediation services. The failed cap screws from the pressure switch and associated components were transported to the Stress Engineering Services Inc. (SES) laboratory for metallurgical analysis. The Bolivar station resumed operation at approximately 6:00 pm on December 24, 2009 without incident. T&T Marines Salvages completed crude oil recovery and soil remediation on December 25, 2009.

Background:

Over the last five years, Enterprise has experienced 1 accident (in 2008) on this PHMSA Inspection Unit 60534. The cause of this accident was due to Hurricane Ike storm surge causing a major washout of concrete supports under the pipeline resulting in a crack on a weld of a 2 inch pipe nipple which allowed crude oil to be released to the environment (2 bbls).

System Description:

PHMSA Inspection Unit 60534 includes the CHOPS offshore crude oil pipeline system which is designed for transportation of approximately 650,000 b/d of crude oil. CHOPS consists of approximately 237 miles of 30" offshore pipeline and approximately 138 miles of dual 24" pipeline. The 30" pipeline originates at the Ship Shoal (SS) 332B platform crosses Garden Banks (GB) 72 platform and terminates at the CHOPS High Island (HI) A5 platform. Departing the HI A5 platform are two 24" pipelines, with onshore destinations of Port Neches, TX and Texas City, TX respectively. The Port Neches 'leg' is approximately 68 miles in length, and the Texas City 'leg' is approximately 69 miles in length. CHOPS has a MOP of 2160 psig from SS332B to the onshore spec break platforms (HI A5), the MOP reduces to 1250 psig, the meters have a MOP of 275 psig. The Bolivar Station where the accident occurred is a midpoint meter station in the 24-inch pipeline as the crude oil is transported on shore and onto the Texas City terminus.

Findings:

The SES metallurgy evaluation report concluded that the cause of failed cap screws in the pressure switch was due to hydrogen assisted cracking. The high hardness (Rockwell C 43) of the steel that the failed cap screws were manufactured from probably played a significant role in the cracking process. The metallurgy laboratory analysis also indicated that the housing of the failed switch had been fabricated of type 316 stainless steel (16-18% Chromium, 10-14% Nickel), and the failed switch had been fabricated of stainless steel containing approximately 13% chromium.

Conclusions:

The metallurgy laboratory analysis also concluded that the presence of solutions containing zinc salts may have contributed to the observed cracking of the screws indirectly by promoting galvanic coupling between the screws and the more corrosion resistant type 316 stainless steel housing in which they were mounted. The origin of zinc salts are not identified during the investigation.

As a result of the accident investigation, EPCO implemented the following preventive measures on the CHOPS system:

- Replaced the failed pressure switch (ITT Neodyne, model 122P88CC6448) with a different pressure switch manufactured by Custom Control Sensors, model 646GZE. This model has been widely used at the facility and proven to be reliable. Enterprise has had no problems in the field with this model, to date.
- Installed excess flow valves between the ¾" Whitley isolation ball valve and PSL-11004 and PSH-11003 to prevent overflow

As a result of the accident investigation, EPCO implemented the following mitigative measures on the CHOPS system:

- Verified the Bolivar Station product containment alarm operated as designed
- Verified with the Liquid Control Center that the lightning and video cameras for the CHOPS system operated as designed
- Verified that the monitoring of pipeline pressures and pressure switches in the Liquid Control Center operated as designed
- Emphasized the importance of the monitoring system (video camera and ATMOS leak detection) with the onshore measurement technicians and the Liquid Control Center.

Appendices:

Appendix A – NRC # 926954
Appendix B – PHMSA 7000-1 Form
Appendix C– Enterprise Bolivar Station P&ID and Replaced Pressure Switch Specifications
Appendix D– Accident Time Line
Appendix E– Metallurgical Evaluation Report
Appendix F – Post-Accident Photos

Appendix A

NRC # 926954

NATIONAL RESPONSE CENTER 1-800-424-8802
*** For Public Use ***
Information released to a third party shall comply with any
applicable federal and/or state Freedom of Information and Privacy Laws

Incident Report # 926954

INCIDENT DESCRIPTION

*Report taken at 09:38 on 23-DEC-09
Incident Type: PIPELINE
Incident Cause: UNKNOWN
Affected Area:
The incident was discovered on 23-DEC-09 at 08:00 local time.
Affected Medium: LAND ONTO THE GROUND

SUSPECTED RESPONSIBLE PARTY

Organization: ENTERPRISE PRODUCTS
HOUSTON, TX 77002

Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

CAMERON HWY PIPELINE County: CHAMBERS
BOLIVAR PENINSULA
City: GALVESTON State: TX

RELEASED MATERIAL(S)

CHRIS Code: OIL Official Material Name: OIL: CRUDE
Also Known As:
Qty Released: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

CALLER STATED THERE IS A SPILL OF MATERIALS FROM A 24 INCH STEEL TRANSMISSION PIPELINE DUE TO UNKNOWN CAUSES. NO WATERWAYS IMPACTED BUT A HIGHWAY WAS CLOSED.

INCIDENT DETAILS

Pipeline Type: TRANSMISSION
DOT Regulated: YES
Pipeline Above/Below Ground: ABOVE
Exposed or Under Water: NO
Pipeline Covered: UNKNOWN

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN

INJURIES:	NO	Hospitalized:	Empl/Crew:	Passenger:
FATALITIES:	NO	Empl/Crew:	Passenger:	Occupant:
EVACUATIONS:	NO	Who Evacuated:	Radius/Area:	

Damages: NO

Closure Type		Description of Closure	Length of Closure	Direction of Closure	
Air:	N				
Road:	Y	HIGHWAY 87	.8	E/W	Major Artery: Y
Waterway:	N				
Track:	N				

Passengers Transferred: NO
Environmental Impact: UNKNOWN

Media Interest: NONE Community Impact due to Material:

REMEDIAL ACTIONS

CALLER STATED THEY HAVE TECHNICIANS EN ROUTE.
Release Secured: YES
Release Rate:
Estimated Release Duration:

WEATHER

Weather: OVERCAST, 55ºF

ADDITIONAL AGENCIES NOTIFIED

Federal: NONE
State/Local: TRRC
State/Local On Scene: COUNTY SHERIFF'S DEPT
State Agency Number: NONE

NOTIFICATIONS BY NRC

USCG ICC (ICC ONI)
23-DEC-09 09:47
DOT CRISIS MANAGEMENT CENTER (MAIN OFFICE)
23-DEC-09 09:47
U.S. EPA VI (MAIN OFFICE)
23-DEC-09 09:49
FLD INTEL SUPPORT TEAM PORT ARTHUR (FIST COMMAND CENTER)
23-DEC-09 09:47
FLD INTEL SUPPORT TEAM PORT ARTHUR (FIELD UNIT)
23-DEC-09 09:47
JFO-LA (COMMAND CENTER)
23-DEC-09 09:47
NATIONAL INFRASTRUCTURE COORD CTR (MAIN OFFICE)
23-DEC-09 09:47
NOAA RPTS FOR TX (MAIN OFFICE)
23-DEC-09 09:47
NATIONAL RESPONSE CENTER HQ (MAIN OFFICE)
23-DEC-09 09:48
HOMELAND SEC COORDINATION CENTER (MAIN OFFICE)
23-DEC-09 09:47
PIPELINE & HAZMAT SAFETY ADMIN (OFFICE OF PIPELINE SAFETY (AUTO))
23-DEC-09 09:47
SECTOR HOUSTON-GALVESTON (COMMAND CENTER)
23-DEC-09 09:50
TCEQ (MAIN OFFICE)
23-DEC-09 09:47
TX GENERAL LAND OFFICE (MAIN OFFICE)
23-DEC-09 09:47
TX GENERAL LAND OFFICE (TXGLO REGION 1)
23-DEC-09 09:47
TX GENERAL LAND OFFICE (TXGLO REGION 2)
23-DEC-09 09:47
TEXAS STATE OPERATIONS CENTER (COMMAND CENTER)
23-DEC-09 09:47

ADDITIONAL INFORMATION

CALLER DID NOT HAVE ANY ADDITIONAL INFORMATION.

*** END INCIDENT REPORT # 926954 ***

Appendix B

PHMSA 7000-1 Form

NOTICE: This report is required by 49 CFR Part 195. Failure to report can result in a civil penalty not to exceed $25,000 for each violation for each day that such violation persists except that the maximum civil penalty shall not exceed $500,000 as provided in 49 USC 60122

Form Approved OMB No. 2137-0047

Print

U.S. Department of Transportation
Research and Special Programs Administration

ACCIDENT REPORT – HAZARDOUS LIQUID PIPELINE SYSTEMS

Report Date jan 04,2010

No. 20090351 -- 12246
(DOT Use Only)

INSTRUCTIONS

Important: *Please read the separate instructions for completing this form before you begin. They clarify the information requested and provide specific examples. If you do not have a copy of the instructions, you can obtain one from the Office Of Pipeline Safety Web Page at http://ops.dot.gov.*

PART A – GENERAL REPORT INFORMATION

Check one or more boxes as appropriate:
☐ Original Report ☒ Supplemental Report ☒ Final Report

1. a. Operator's OPS 5-digit Identification Number (if known) / 31618 /
2. b. If Operator does not own the pipeline, enter Owner's OPS 5-digit Identification Number (if known) / /
   c. Name of Operator ENTERPRISE PRODUCTS OPERATING LLC
   d. Operator street address 1100 LOUISIANA STREET
   e. Operator address HOUSTON HARRIS TX 77002
   City, County, State and Zip Code

IMPORTANT: IF THE SPILL IS SMALL, THAT IS, THE AMOUNT IS AT LEAST 5 GALLONS BUT IS LESS THAN 5 BARRELS, COMPLETE THIS PAGE ONLY, UNLESS THE SPILL IS TO WATER AS DESCRIBED IN 49 CFR §195.52(A)(4) OR IS OTHERWISE REPORTABLE UNDER §195.50 AS REVISED IN CY 2001.

2. Time and date of the accident
   / 800 / hr. / 12 / month / 23 / day / 2009 / year

3. Location of accident
   (If offshore, do not complete a through d. See Part C.1)
   a. Latitude: 29.418782 Longitude: 94.704811
   (if not available, see instructions for how to provide specific location)
   b. PORT BOLIVAR GALVESTON
   City, and County or Parish
   c. TX 77650
   State and Zip Code
   d. Mile post/valve station ○ or survey station no. ○
   (whichever gives more accurate location)

4. Telephone report
   / 926954 / NRC Report Number / 12 / month / 23 / day / 2009 / year

5. Losses *(Estimated)*

Public/Community Losses reimbursed by operator:	
Public/private property damage	$ 2500
Cost of emergency response phase	$ 118433
Cost of environmental remediation	$ 60981
Other Costs	$ 0
(describe)	
Operator Losses:	
Value of product lost	$ 780
Value of operator property damage	$ 0
Other Costs	$ 0
(describe)	
Total Costs	$ 182694

6. Commodity Spilled ● Yes ○ No
(If Yes, complete Parts a through c where applicable)
   a. Name of commodity spilled CRUDE OIL
   b. Classification of commodity spilled:
   ○ HVLs /other flammable or toxic fluid which is a gas at ambient conditions
   ○ CO_2 or other non-flammable, non-toxic fluid which is a gas at ambient conditions
   ○ Gasoline, diesel, fuel oil or other petroleum product which is a liquid at ambient conditions
   ● Crude oil

c. Estimated amount of commodity involved :
● **Barrels**
○ **Gallons (check only if spill is less than one barrel)**

Amounts:
Spilled : 120
Recovered: 110

CAUSES FOR SMALL SPILLS ONLY (5 gallons to under 5 barrels) : ***(For large spills [5 barrels or greater] see Part H)***

○ **Corrosion** ○ **Natural Forces** ○ **Excavation Damage** ○ **Other Outside Force Damage**
○ **Material and/or Weld Failures** ○ **Equipment** ○ **Incorrect Operation** ○ **Other**

PART B – PREPARER AND AUTHORIZED SIGNATURE

NATHAN L. GRAY JR.
(type or print) Preparer's Name and Title

(985) 804-1376
Area Code and Telephone Number

NGRAY@EPROD.COM
Preparer's E-mail Address

Area Code and Facsimile Number

Authorized Signature (type or print) Name and Title Date Area Code and Telephone Number

PART C – ORIGIN OF THE ACCIDENT (Check all that apply)

1. Additional location information
   a. Line segment name or ID: CAMERON HIGHWAY
   b. Accident on Federal land other than Outer Continental Shelf ◡ Yes ● No
   c. Is pipeline interstate? ● Yes ◡ No

Offshore: ◡ Yes ● No *(complete d if offshore)*
d. Area _____ Block # _____
State /_____/ or Outer Continental Shelf ☐

2. Location of system involved (*check all that apply*)
   ☒ Operator's Property
   ☒ Pipeline Right of Way
   ☒ High Consequence Area (HCA)?
   Describe HCA: OTHER POPULATED AREA (OPA)

3. Part of system involved in accident
   ◡ Above Ground Storage Tank
   ◡ Cavern or other below ground storage facility
   ◡ Pump/meter station; terminal/tank farm piping and equipment, including sumps
   ◡ Other *Specify:* _____
   ● Onshore **pipeline**, including valve sites
   ◡ Offshore **pipeline**, including platforms

*If failure occurred on **Pipeline**, complete items a - g:*

4. Failure occurred on
   ◡ Body of Pipe ◡ Pipe Seam ◡ Scraper Trap
   ◡ Pump ◡ Sump ◡ Joint
   ● Component ◡ Valve ◡ Metering Facility
   ◡ Repair Sleeve ◡ Welded Fitting ◡ Bolted Fitting
   ◡ Girth Weld
   ◡ Other *(specify)* _____

Year the component that failed was installed: /2008/

5. Maximum operating pressure *(MOP)*
   a. Estimated pressure at point and time of accident: 693 *PSIG*
   b. MOP at time of accident: 1250 *PSIG*
   c. Did an overpressurization occur relating to the accident? ◡ Yes ● No

a. Type of leak or rupture
   ● Leak: ◡ Pinhole ● Connection Failure *(complete sec. H5)*
   ◡ Puncture, diameter *(inches)* _____
   ◡ Rupture: ◡ Circumferential – Separation
   ◡ Longitudinal – Tear/Crack, length *(inches)* _____
   Propagation Length, total, both sides *(feet)* _____
   ◡ N/A
   ◡ Other _____

b. Type of block valve used for isolation of immediate section:
Upstream: ☐ Manual ☐ Automatic ☒ Remote Control ☐ Check Valve
Downstream: ☐ Manual ☐ Automatic ☒ Remote Control ☐ Check Valve

c. Length of segment isolated 1 ft
d. Distance between valves 5 ft
e. Is segment configured for internal inspection tools? ● Yes ◡ No
f. Had there been an in-line inspection device run at the point of failure? ● Yes ◡ No ◡ Don't Know
   ◡ Not Possible due to physical constraints in the system
g. If *Yes*, type of device run (*check all that apply*)

☒	High Resolution Magnetic Flux tool	Year run: 2009
☐	Low Resolution Magnetic Flux tool	Year run:
☐	UT tool	Year run:
☒	Geometry tool	Year run: 2009
☐	Caliper tool	Year run:
☐	Crack tool	Year run:
☐	Hard Spot tool	Year run:
☐	Other tool	Year run:

PART D – MATERIAL SPECIFICATION

1. Nominal pipe size *(NPS)* /24/ in.
2. Wall thickness /.32/ in.
3. Specification API 5L SMYS /65000/
4. Seam type ERW
5. Valve type BALL VALVE
6. Manufactured by GROVE in year /2004/

PART E – ENVIRONMENT

1. Area of accident
   ◡ In open ditch
   ◡ Under pavement
   ● Above ground
   ◡ Underground
   ◡ Under water
   ◡ Inside/under building
   ◡ Other _____

2. Depth of cover: 0 inches

PART F – CONSEQUENCES

1. Consequences *(check and complete all that apply)*

a.	Fatalities	Injuries
Number of operator employees:	0	0
Contractor employees working for operator:	0	0
General public:	0	0
Totals:	0	0

b. Was pipeline/segment shutdown due to leak? ●Yes ◡No
If Yes, how long? 0 days 15 hours 0 minutes

c. Product ignited ◡ Yes ● No d. Explosion ◡ Yes ● No
e. ☐ Evacuation *(general public only)* /_____/ people
Reason for Evacuation:
◡ Precautionary by company
◡ Evacuation required or initiated by public official

f. Elapsed time until area was made safe:
/14/ hr. /30/ min.

2. Environmental Impact

a. Wildlife Impact: Fish/aquatic ◡Yes ● No; Birds ◡Yes ● No; Terrestrial ◡Yes ● No
b. Soil Contamination ● Yes ◡ No
If Yes, estimated number of cubic yards: 140
c. Long term impact assessment performed: ◡Yes ● No
d. Anticipated remediation ● Yes ◡ No
If Yes, check all that apply: ☐ Surface water ☐ Groundwater ☒ Soil ☐ Vegetation ☐ Wildlife

e. Water Contamination: ◡Yes ● No (*If Yes, provide the following*)
Amount in water _____ barrels
Ocean/Seawater ◡ No ◡ Yes
Surface ◡ No ◡ Yes
Groundwater ◡ No ◡ Yes
Drinking water ◡ No ◡ Yes (*If Yes, check below.*)
◡Private well ◡Public water intake

PART G – LEAK DETECTION INFORMATION

1. Computer based leak detection capability in place? ●Yes ○No

2. Was the release initially detected by? (check one):
- ○ CPM/SCADA-based system with leak detection
- ○ Static shut-in test or other pressure or leak test
- ○ Local operating personnel, procedures or equipment
- ○ Remote operating personnel, including controllers
- ○ Air patrol or ground surveillance
- ● A third party ○Other (specify) _____

3. Estimated leak duration days ____ hours 2

PART H – APPARENT CAUSE

Important: *There are 25 numbered causes in this Part H. Check the box corresponding to the primary cause of the accident. Check one circle in each of the supplemental categories corresponding to the cause you indicate. See the instructions for guidance.*

H1 – CORROSION

1. ○External Corrosion

2. ○Internal Corrosion

(Complete items a – e where applicable.)

a. Pipe Coating ○Bare ○Coated

b. Visual Examination ○Localized Pitting ○General Corrosion ○Other _____

c. Cause of Corrosion ○Galvanic ○Atmospheric ○Stray Current ○Microbiological ○Cathodic Protection Disrupted ○Stress Corrosion Cracking ○Selective Seam Corrosion ○Other _____

d. Was corroded part of pipeline considered to be under cathodic protection prior to discovering accident? ○No ○Yes, Year Protection Started: /_____/

e. Was pipe previously damaged in the area of corrosion? ○No ○Yes => Estimated time prior to accident: /_____/ *years* /_____/ *months* *Unknown* ☐

H2 – NATURAL FORCES

3. ○ Earth Movement => ○Earthquake ○ Subsidence ○ Landslide ○Other _____
4. ○ Lightning
5. ○ Heavy Rains/Floods => ○ Washouts ○ Flotation ○ Mudslide ○Scouring ○ Other _____
6. ○ Temperature => ○Thermal stress ○ Frost heave ○ Frozen components ○Other _____
7. ○ High Winds

H3 – EXCAVATION DAMAGE

8. ○ Operator Excavation Damage (including their contractors/Not Third Party)
9. ○ Third Party *(complete a-f)*

a. Excavator group ○ General Public ○ Government ○Excavator other than Operator/subcontractor

b. Type: ○Road Work ○Pipeline ○Water ○Electric ○Sewer ○Phone/Cable ○Landowner-not farming related ○Farming ○Railroad ○Other liquid or gas transmission pipeline operator or their contractor ○Nautical Operations ○Other _____

c. Excavation was: ○Open Trench ○ Sub-strata (boring, directional drilling, etc…)

d. Excavation was an ongoing activity (Month or longer) ○Yes ○No If Yes, Date of last contact /_____/

e. Did operator get prior notification of excavation activity?

○ Yes; Date received: /_____/ mo. /_____/ day /_____/ yr. ○No

Notification received from: ○One Call System ○ Excavator ○Contractor ○Landowner

f. Was pipeline marked as result of location request for excavation? ○ No ○Yes *(If Yes, check applicable items i - iv)*

i. Temporary markings: ○ Flags ○Stakes ○Paint

ii. Permanent markings: ○

iii. Marks were (check one) : ○ Accurate ○ Not Accurate

iv. Were marks made within required time? ○Yes ○No

H4 – OTHER OUTSIDE FORCE DAMAGE

10. ○ Fire/Explosion as primary cause of failure => Fire/Explosion cause: ○Man made ○Natural
11. ○ Car, truck or other vehicle not relating to excavation activity damaging pipe
12. ○ Rupture of Previously Damaged Pipe
13. ○ Vandalism

H5 – MATERIAL AND/OR WELD FAILURES

Material

14. ○ Body of Pipe => ○ Dent ○ Gouge ○ Bend ○ Arc Burn ○ Other _____

15. ● Component => ○ Valve ● Fitting ○ Vessel ○ Extruded Outlet ○ Other _____

16. ○ Joint => ○ Gasket ○ O-Ring ○ Threads ○ Other _____

Weld

17. ○ Butt => ○ Pipe ○ Fabrication ○ Other _____

18. ○ Fillet => ○ Branch ○ Hot Tap ○ Fitting ○ Repair Sleeve ○ Other _____

19. ○ Pipe Seam => ○ LF ERW ○ DSAW ○ Seamless ○ Flash Weld ○ HF ERW ○ SAW ○ Spiral ○ Other _____

*Complete a-g if you indicate **any** cause in part H5.*

a. Type of failure:
○ Construction Defect => ○ Poor Workmanship ○ Procedure not followed ○ Poor Construction Procedures
● Material Defect

b. Was failure due to pipe damage sustained in transportation to the construction or fabrication site? ○ Yes ● No

c. Was part which leaked pressure tested before accident occurred? ● Yes, *complete d-g* ○ No

d. Date of test: / 2004 / yr. / 5 / mo. / 29 / day

e. Test medium: ● Water ○ Inert Gas ○ Other _____

f. Time held at test pressure: / 4 / hr.

g. Estimated test pressure at point of accident: 1595 *PSIG*

H6 – EQUIPMENT

20. ○ Malfunction of Control/Relief Equipment => ○ Control valve ○ Instrumentation ○ SCADA ○ Communications ○ Block valve ○ Relief valve ○ Power failure ○ Other _____

21. ○ Threads Stripped, Broken Pipe Coupling => ○ Nipples ○ Valve Threads ○ Dresser Couplings ○ Other _____

22. ○ Seal Failure => ○ Gasket ○ O-Ring ○ Seal/Pump Packing ○ Other _____

H7 – INCORRECT OPERATION

23. ○ Incorrect Operation

a. Type: ○ Inadequate Procedures ○ Inadequate Safety Practices ○ Failure to Follow Procedures ○ Other _____

b. Number of employees involved who failed a post-accident test: drug test: /_____/ alcohol test /_____/

H8 – OTHER

24. ○ Miscellaneous, *describe:* _____

25. ○ Unknown
○ Investigation Complete ○ Still Under Investigation *(submit a supplemental report when investigation is complete)*

PART I – NARRATIVE DESCRIPTION OF FACTORS CONTRIBUTING TO THE EVENT *(Attach additional sheets as necessary)*

A PRESSURE SWITCH ON THE BOLIVAR VALVE STATION FAILED.

STRESS ENGINEERING REPORT SUGGESTS THAT FRACTURED SURFACES ON THE SCREWS CONFIRMED THAT THE FRACTURES HAD OCCURRED BY WAY OF HYDROGEN ASSISTED CRACKING. THE HIGH HARDNESS OF THE ATTACHMENT SCREWS PROBABLY PLAYS A SIGNIFICANT ROLE IN THE CRACKING PROCESS. ZINC RICH DEPOSITS FOUND ON SCREW #1 APPARENTLY DID NOT PRODUCE SIGNIFICANT WEIGHT LOSS CORROSION OF THE SCREW. THE PRESENCE OF SOLUTIONS CONTAINING ZINC SALTS MAY HAVE CONTRIBUTED TO THE OBSERVED CRACKING OF THE SCREWS INDIRECTLY BY PROMOTING GALVANIC COUPLING BETWEEN THE SCREWS AND THE MORE CORROSION RESISTANT STAINLESS STEEL HOUSING.

REPLACED FAILED SWITCH AND PUT PIPELINE BACK IN-SERVICE.

Appendix C

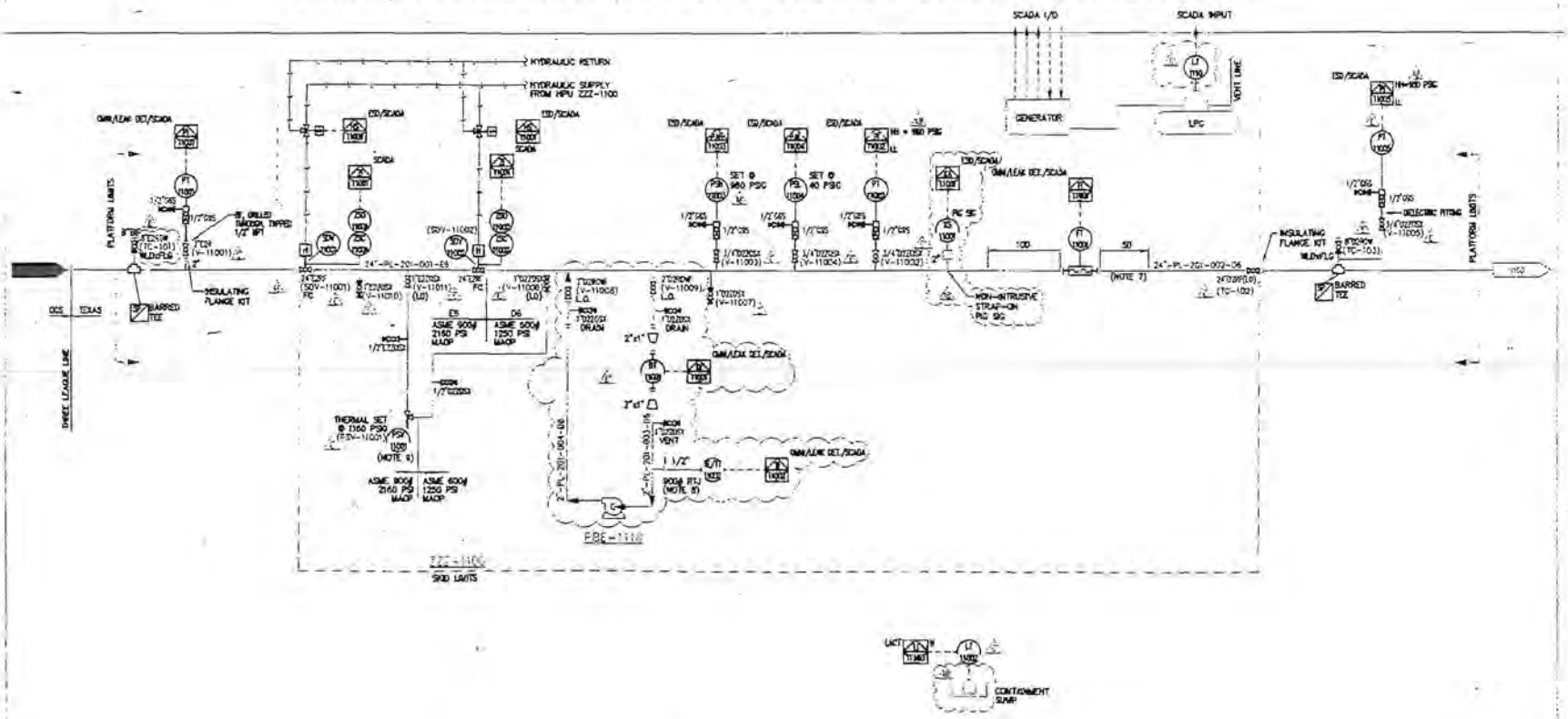
Port Bolivar Galveston station P&ID
&
Product Specification for the Pressure Switch that failed allowing crude oil to be released

PRESSURE BOUNDARY CHECK METER SKID AT SOLOMAR PIPELINE LANDING

SOLOMAR PIPELINE LANDING VALVE STATION

BOOSTER PUMP

HYDRAULIC POWER UNIT (FURNISHED WITH SDV-11001 & SDV-11002)



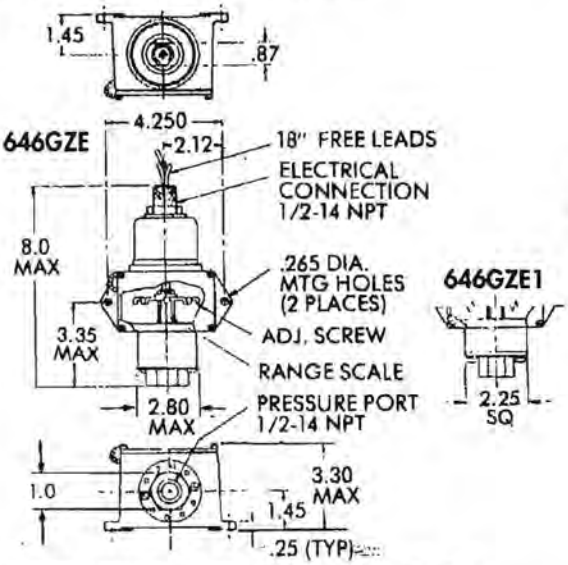
NOTES:
1. THE DESIGN CHARACTERISTICS OF THE PROPOSED PIPELINES EQUAL OR EXCEED THE REQUIREMENTS OF 49 CFR, PART 195. ALL OPERATED VALVES, INCLUDING CONTROL VALVES, RATE OF CLOSURE SET TO MITIGATE PIPELINE SURGE PRESSURES TO ALLOWABLE SYSTEM PRESSURE RATING.
2. THE PIPELINE MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) IS 2160 PSIG UPSTREAM OF AND INCLUDING THE 24" [illegible]
OF REMOTE SCADA INDICATION.
5. ALL INSTRUMENTS, AUTOMATED VALVES, FITTINGS, HARDWARE, AND ACCESSORIES SHALL BE SUITABLE FOR PERIODIC SEA WATER SUBMERGENCE WITHOUT COMPROMISING OPERATIONAL INTEGRITY. PLC INSTALLED IN LOCAL PANEL @ ELEVATED LOCATION ABOVE SUBMERGENCE ZONE. I/O UNITS INSTALLED ABOVE SUBMERGENCE ZONE.
6. 10 DIAMETERS UPSTREAM AND 5 DIAMETERS DOWNSTREAM UNOBSTRUCTED PIPE LENGTH

AS	AS BUILT	
C	RE-ISSUED FOR APPROVAL	
B		

Cameron Highway Oil Pipeline Company

PROJECT NO

INSTALLATION DRAWING



SHIPPING WT. APPROX. 56 OZ. (1587 GRAMS)

Press. **.4** to **5000** psi

Vac. **1.0** to **28.5"** Hg

SERIES: 646GZE 646GZE–7011 646VZE

Standard Features:

- **U.L. / CSA Explosion Proof: Div. 1, 2**
- **NEMA: 4, 7, 9, 13**
- **Fire Resistant Steel Body**

AMBIENT TEMP. RANGE
–30° to 160° F
–34° to 71° C

Options Code:
"F" Ethylene Propylene O–ring
"Y" EECS Certified to EXsIIT5
"7008" Gold Contacts
"7030" Gold Contacts w/SST Diaphragm
"7044" Monel Port and Diaphragm
"7045" Hastelloy Port and Diaphragm
"7065" Teflon Wire w/SST Diaphragm

OPERATING AND ORDERING DATA:

PRESSURE SWITCHES MODEL 646GZE • 1/2" STAINLESS STEEL PRESSURE PORT & POLYIMIDE DIAPHRAGM — Wetted Parts: 316 SST Polyimide Viton

Max Sys. Press. psi	Proof (Test) Press. psi	Adjustable Set-Point Range: On Incr. Press. psi	Adjustable Set-Point Range: On Decr. Press. psi	Approx. Dead–band psi	MODEL SPDT–Std.	MODEL DPDT "M"
500	750	1.2–16	.4–15.2	.8	646GZE1	646GZEM1
3000	5000	8–75	3–70	5	646GZE2	646GZEM2
3000	5000	20–150	8–138	12	646GZE11	646GZEM11
3000	5000	50–375	22–347	28	646GZE3	646GZEM3
3000	5000	330–1000	265–935	65	646GZE5	646GZEM5
3000	5000	950–2300	775–2125	175	646GZE7	646GZEM7

PRESSURE SWITCHES MODEL 646GZE–7011 • 1/2" STAINLESS STEEL PRESSURE PORT & DIAPHRAGM — Wetted Parts: 316 SST Viton

Max Sys. Press. psi	Proof (Test) Press. psi	Adjustable Set-Point Range: On Incr. Press. psi	Adjustable Set-Point Range: On Decr. Press. psi	Approx. Dead–band psi	MODEL SPDT–Std.	MODEL DPDT "M"
500	750	1.4–16	.4–15	1	646GZE1–7011	646GZEM1–7011
3000	5000	10–75	3–68	7	646GZE2–7011	646GZEM2–7011
3000	5000	20–150	6–136	14	646GZE11–7011	646GZEM11–7011
3000	5000	50–375	16–347	34	646GZE3–7011	646GZEM3–7011
3000	5000	330–1000	250–920	80	646GZE5–7011	646GZEM5–7011
3000	5000	950–2300	750–2100	200	646GZE7–7011	646GZEM7–7011
5000	7500	2100–3400	1820–3120	280	646GZE9–7011	646GZEM9–7011
5000	7500	3200–5000	2720–4520	480	646GZE10–701	646GZEM10–701

VACUUM SWITCHES MODEL 646VZE • 1/2" STAINLESS STEEL PRESSURE PORT & POLYIMIDE DIAPHRAGM — Wetted Parts: 316 SST Polyimide Viton

Max Sys. Press. psi	Proof (Test) Press. psi	Adjustable Set-Point Range: On Incr. Vacuum In. Hg	Adjustable Set-Point Range: On Decr. Vacuum In. Hg	Approx. Dead–band In. Hg	MODEL SPDT–Std.	MODEL DPDT "M"
150	250	3.5–28.5	1.0–26.0	2.5	646VZE1	646VZEM1

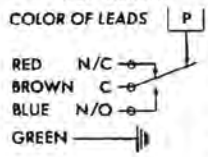
ELECTRICAL CHARACTERISTICS:

RATING OF SWITCH ELEMENT

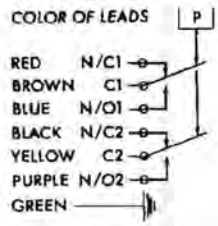
VOLTS	AMPERES SPDT Res.	AMPERES DPDT "M" Res.
125 AC – 50/60 Hz	15	5
250 AC – 50/60 Hz	15	5
480 AC – 50/60 Hz	15	—
125 DC	.4	.5

SCHEMATIC AND WIRING CODE:

SPDT–Standard



DPDT "M"



ENCLOSURE/CERTIFICATIONS:

Div. 1 explosion–proof and hermetically sealed electrical assembly Part No. 17–51 (17–73 for "M" model option), listed by both Underwriter's Laboratories, Inc. (File No. E32961) and CSA Testing Laboratories (File No. 22921) for hazardous locations, Class 1, Groups A, B, C, and D; Class 2 Groups E, F, and G.

Model 646GZEM1 has an approximate dead band of .9 psi.

HOW TO ORDER: **Specify model number, add desired "options" listing letter codes first followed by numbers:**

Custom Control Sensors, Inc. • 21111 Plummer Street, Chatsworth, CA 91311 • Tel: (818)341-4610 • Fax: (818)709-0426
e-mail: switchnet@ccsdualsnap.com • http://www.ccsdualsnap.com

Appendix D

Accident Time Line

Timeline Information for Enterprise Bolivar Station Crude Oil release on December 23, 2009 – NRC#926954

December 23, 2009

07:02 AM CST - Jeffrey Young (Enterprise Control Center) received Bolivar containment alarm from the Bolivar Station.

07:48 AM CST - Jeffrey Young (Enterprise Control Center) received a call from Lynette with Galveston Co. sheriff's department reporting a broken oil pipeline at Port Bolivar.

07:49 AM CST - Jeffrey Young (Enterprise Control Center) called Bruce Ousley (EPCO) and connected him to Lynette at Galveston Co. sheriff's department.

07:55 AM CST - Jeffrey Young (Enterprise Control Center) called Billy at Sunoco to see if they can take oil and notified Gilbert Rivera Jr.

08:00 AM CST - Jeffrey Young (Enterprise Control Center) requested Adam to head to Bolivar, he can make it quicker than Bruce.

08:05 AM CST - Jeffrey Young (Enterprise Control Center) verified oil mist at Bolivar on camera and spoke with Buster Bergeron.

08:07 AM CST - Philip (EPCO) notified Jeff Myers (as he responded).

0807 AM CST - TRRC Representative (Randy Vaughn) contacted John Jewett (EPCO) regarding a possible Crude Oil Leak on Bolivar Peninsula.

08:10 AM CST - Jeffrey Young (Enterprise Control Center) called John at A5 and requested he start shutting oil off going to Bolivar and stack back to GB72 and called Mike at SS332 to divert all he could away from CHOPS.

08:11 AM CST - Jeffrey Young (Enterprise Control Center) called Lucy at Shell control to get her to go to max rate on Seajack.

08:20 AM CST - Philip notified Greg Chapman (EPCO).

08:21 AM CST - Jeffrey Young (Enterprise Control Center) started BYPASSING CHOPS oil to Sunoco.

08:23 AM CST - A5 system blocked off to Bolivar Station.

08:28 AM CST - John Jewett with EPCO pipeline compliance called to verify leak and said they would make all agency notifications.

08:39 AM CST - Philip contacted the Galveston Co. on site command center (Herbert Franklin , Incident Commander), and it was verified the oil spray had stopped.

09:00 AM CST – Highway 87 (in front of Bolivar Station) is closed to the Public as a result of the crude oil release. Three EPCO Field Operation Specialists arrived at the Bolivar Station. They closed ¾ inch (V-11003) Whitney ball valve, located on top of the 24 inch-line, that is used to isolate the failed pressure switch PSH-11003 to stop the product release to the environment.

09:08 AM CST (and again at 09:14 AM CST) - Jeffrey Young (Enterprise Control Center) was contacted by Frank Groves – TRRC Oil & Gas Div., Region 3 regarding accident

09:18 AM CST - Jeffrey Young (Enterprise Control Center) was contacted by EPA representative – Mark Hays

09:23 AM CST – John Jewett contacted Victor Lopez – PHMSA SW Region, regarding accident

09:38 AM CST - NRC contacted, reference number 926954 at 09:38 a.m.

10:05 AM CST - Bruce Ousley reports TNT Marine is on the way to clean up released crude oil. Bruce reports all oil outside the containment area is from spray.
10:30 AM CST – TNT Marine arrives to clean up released crude oil, and following meeting initiate response at 12:30 PM CST. The clean-up response efforts will continue until the afternoon of December 25, 2009 when the spill response and clean-up efforts are declared to be finished.
11:00 AM CST – Kim Nguyen (PHMSA SW Region) contacts John Jewett regarding accident and establishes logistics for on-site investigation.
02:00 PM CST – Kim Nguyen (PHMSA SW Region) arrive on-site to initiate investigation.
11:00 PM CST – Highway 87 (in front of Bolivar Station) is re-opened to the Public.

December 24, 2009
05:00 PM CST – Coby Goos (EPCO) contacts Kim Nguyen to notify PHMSA that the Bolivar Station is being re-activated, and the CHOPS Crude Oil System is re-starting.

December 25, 2009
12:00 PM CST –The clean-up response efforts are declared to be finished.

Other Miscellaneous Notifications and Contacts
Jeffrey Young (Enterprise Control Center) contacted Texas emergency response center which covers TRRC, TGLO and TCEQ. Incident number is 20094041. John Jewett contacted Home Land Security this morning. NRC #926954.Talked to Kevin Lee

Appendix E

Metallurgical Evaluation Report

STRESS ENGINEERING SERVICES INC.
an employee-owned company

13800 Westfair East Drive, Houston, Texas 77041-1101
Phone: (281) 955-2900 Fax: (281) 955-2638
Website: www.stress.com

HOUSTON • CINCINNATI • NEW ORLEANS • BATON ROUGE

February 2, 2010

Mr. Joe Sobilo
Enterprise Products Company
1100 Louisiana
P.O. Box 4735
Houston, TX 77002

PN 1251102

Re: Failure of Cap Screws in Switch

Subject: Results of Metallurgical Evaluation

Introduction

Enterprise Products Company (EPCO) recently experienced a failure in an electrical switch on one of their offshore facilities in the Gulf of Mexico. Four small cap screws holding the top cover on the switch apparently failed during service, exposing the internals of the switch.

Following the failure, EPCO retained Stress Engineering Services (SES) to examine and test samples from the switch and to assist in determining the most likely cause(s) for the observed failure. The failed switch was thus shipped to the SES facility in Houston, Texas where the SES evaluation was performed.

Discussion

A view of the failed switch is presented in Photograph 1 (in Appendix A). A closer view of the cap that separated from the remainder of the switch is shown in Photograph 2. The end of one of the four screws that failed during the incident is just visible in Photograph 2 and is marked by the arrow in the photograph.

Closer views of the ends of the broken screws are presented in Photographs 3 and 4. The outer ends of all the broken screws were apparently lost during the incident.

The screw at the upper left in Photograph 4 was arbitrarily designated as screw # 1 by SES. Screw # 2 was at the upper right, screw # 3 was at the lower right and screw # 4 was at the lower left in the photograph.

Screw # 1 had what appeared to be a coating of a foreign substance on its fracture surface, while the fracture surfaces of the other three screws were very clean and appeared to be essentially identical. The ends of screws # 1 and # 3 were thus removed from the body of the switch for more detailed examination of their fracture surfaces. In view of their similarity to screw # 3, screws # 2 and # 4 were not examined in detail.

The compositions of the screws and the body of the switch into which they had been threaded were examined using the x-ray spectrometer (EDS) attachment of SES's scanning electron microscope (SEM). An SEM-EDS scan gives a semi-quantitative analysis of the chemical elements present in the small portion of the sample surface excited by the electron beam of the SEM.

The measured compositions of the screws # 1 and # 3 are presented in Scans I and II in Appendix B. The analyses indicated that the screws had been fabricated of stainless steel containing approximately 13 % chromium.

The composition of the housing in which the screws had been located during use is presented in Scan III. The analysis of the housing showed that it had apparently been fabricated of a Type 316, austenitic stainless steel.

Also presented in Appendix B (Scan IV) is the composition of the foreign substance found on the as-received fracture surface of screw # 1. As shown in scan IV, the foreign substance appeared to consist primarily of zinc, carbon, and oxygen. It thus appeared that the foreign substance may have consisted of zinc carbonate.

On the other hand, it should be noted that the foreign substance contained low concentrations of iron and chromium and thus did not appear to have been a corrosion product. Corrosion of the underlying screw would probably have produced a layer of mixed iron and chromium oxides on the screw surface.

Cross sections were taken through both of the screws for metallurgical structural evaluations. The structures of the screws are shown in Photographs 5 and 6. The structures appeared to consist of tempered martensite and the structures of the two screws were essentially identical.

The cross sections used to produce Photographs 5 and 6 were also used for hardness measurements. The hardness measurements showed that the screws were uniform in hardness across their cross sections. The measured hardness values ranged from Rockwell C 40.8 to Rockwell C 44.4. The average hardness of screw # 1 was Rockwell C 43.0 and the average hardness of screw # 3 was Rockwell C 42.7.

The fracture surfaces of screws # 1 and # 3 were also examined using the SEM. Prior to this examination, the foreign material on screw # 1 was removed ultrasonically using a non-corrosive commercially available cleaning solution. The as-received fracture surface on screw # 3 was clean and required no cleaning.

The fracture surfaces on screws # 1 and # 3 are shown in Photographs 7 and 8, respectively. As can be seen the fracture surfaces appeared to be identical. The fracture surfaces both had the "rock candy" texture that is typical of hydrogen stress cracking that has occurred along prior austenitic grain boundaries in a quenched and tempered steel structure.

The similarity of the clean fractures on screws # 2, # 3, and # 4 plus the similarity of the fracture surface structures shown in Photographs 7 and 8 indicate that all of the failed attachment screws apparently failed primarily due to hydrogen stress cracking. The lack of any significant corrosion damage on the cleaned face of screw # 1 indicates that corrosion due to the presence of the zinc carbonate deposit apparently played little, if any, direct role in the fracture of screw # 1.

Conclusions

Based upon the results of our testing and analysis, we have developed the following observations and/or conclusions:

1. SEM analysis of the fracture surfaces on the screws confirmed that the fractures had occurred by way of hydrogen assisted cracking.

2. The high hardness (Rockwell C 43) of the attachment screws probably played a significant role in the cracking process.

3. The zinc rich deposits found on screw # 1 apparently did not produce significant weight loss corrosion of the screw.

4. On the other hand, the presence of solutions containing zinc salts may have contributed to the observed cracking of the screws indirectly by promoting galvanic coupling between the screws and the more corrosion resistant Type 316 stainless steel housing in which they were mounted.

Thank you for allowing us to have been of assistance to you in performing this evaluation. If you have any questions concerning the test results or opinions presented in this report, please feel free to contact us at your earliest convenience.

Kenneth R. Riggs, Ph.D., P.E.
Staff Metallurgist
Stress Engineering Services, Inc.

Appendix A

Photographs

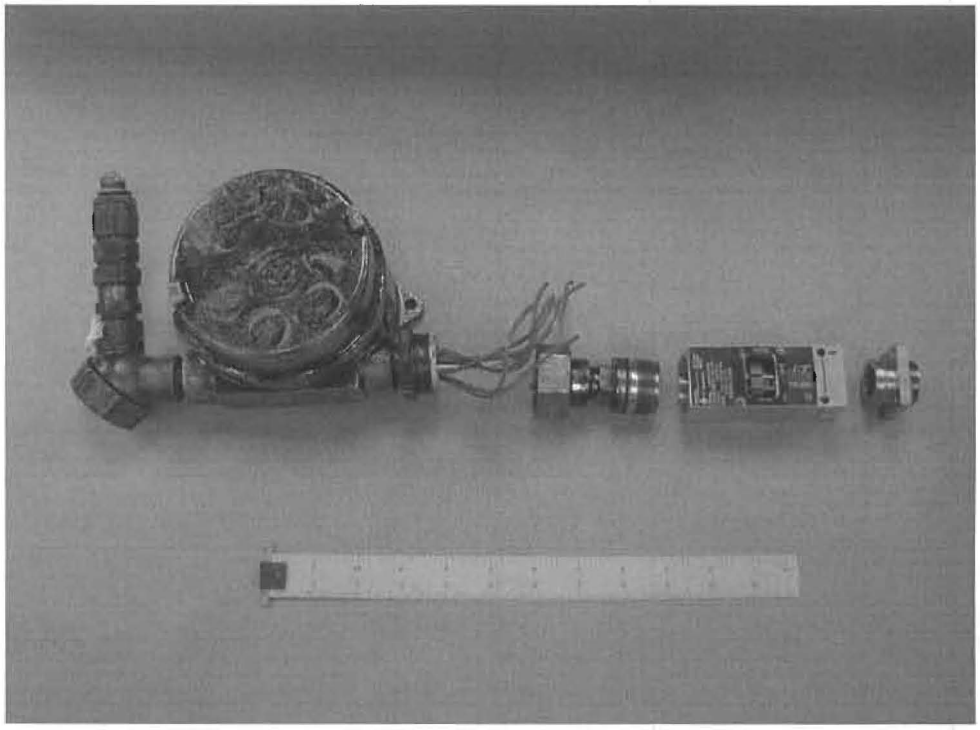


Photo 1: The failed switch supplied for this investigation. The failure occurred at the right end of the switch, as shown in this photograph.

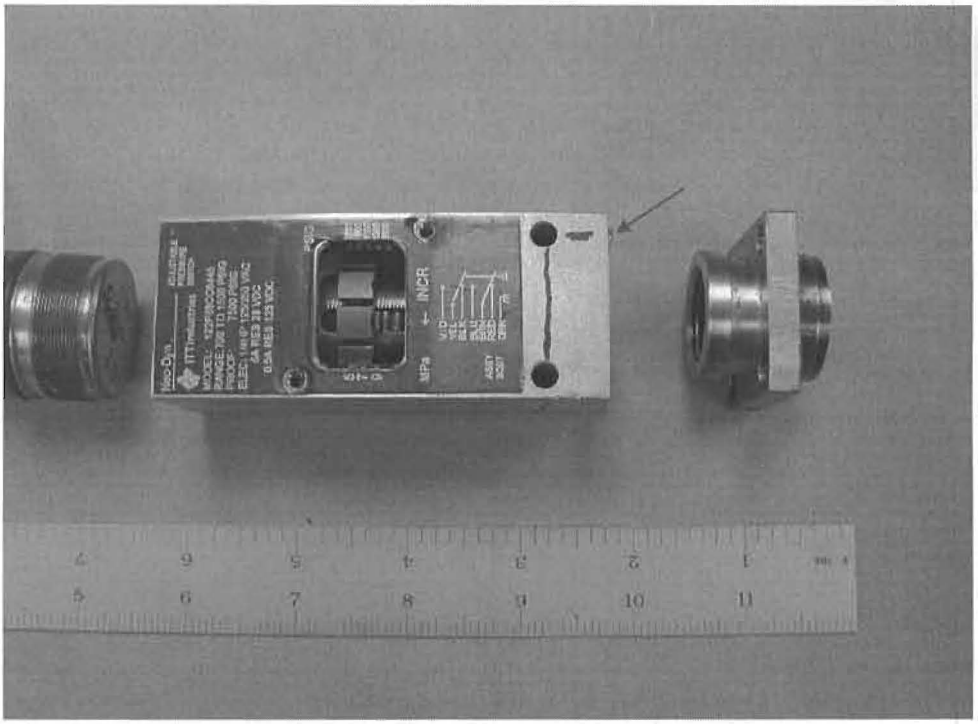


Photo 2: A closer view of the failure location. One of the failed screws is just visible in this view and is marked with the arrow.

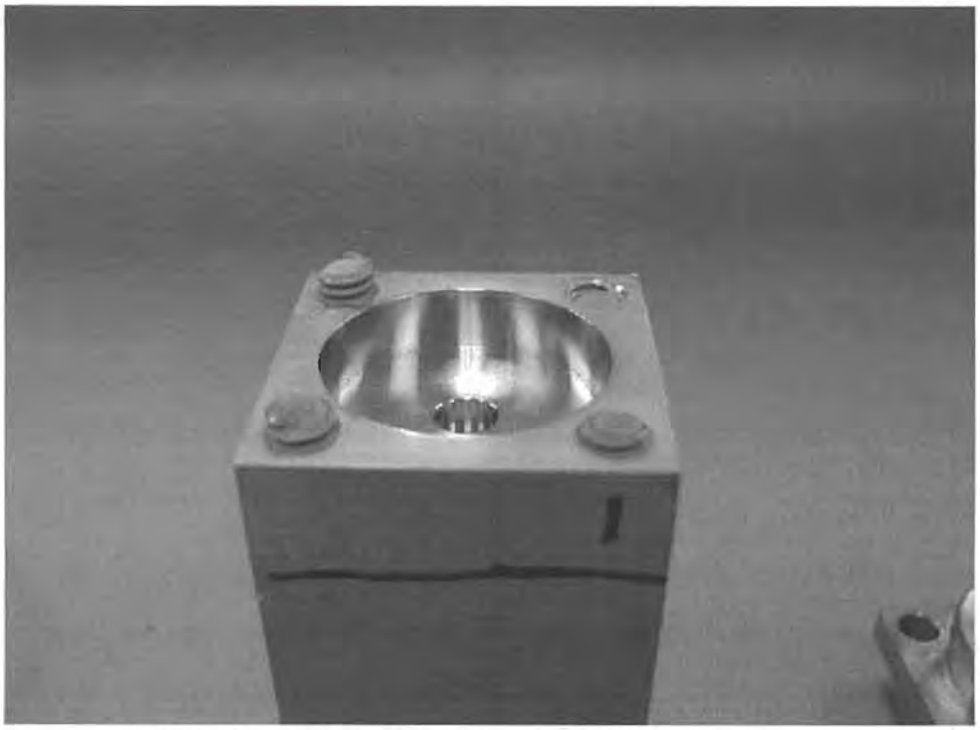


Photo 3: A view of the outer ends of all the failed screws.

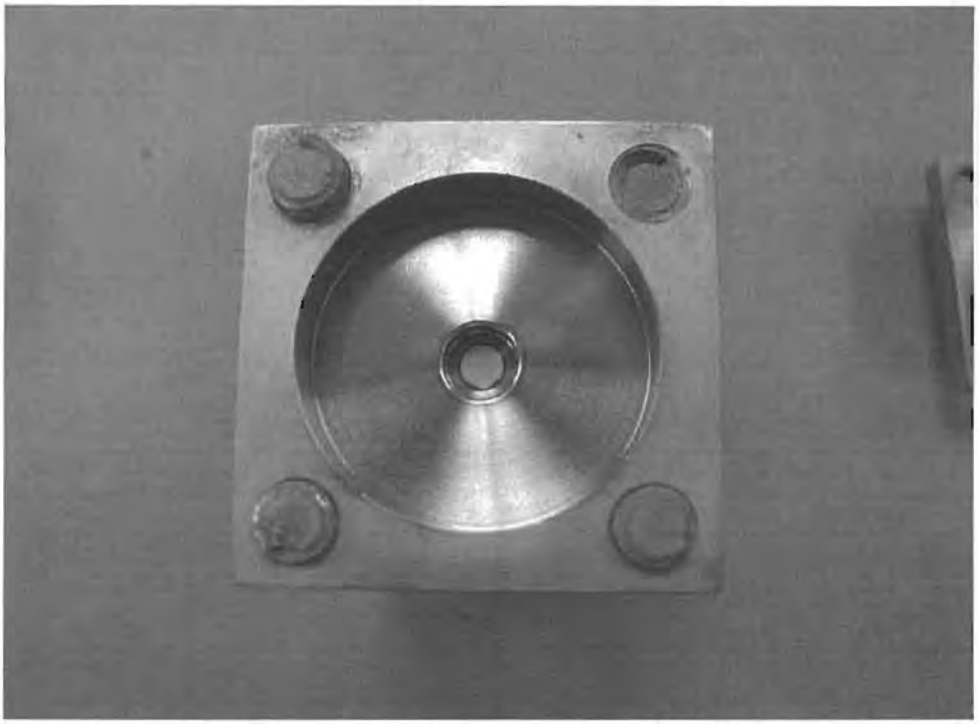


Photo 4: A closer view of the fracture faces on the screws. Screw # 1 is the upper left, screw # 2 is at the upper right, screw # 3 is at the lower right and screw # 4 is at the lower left in the photograph.

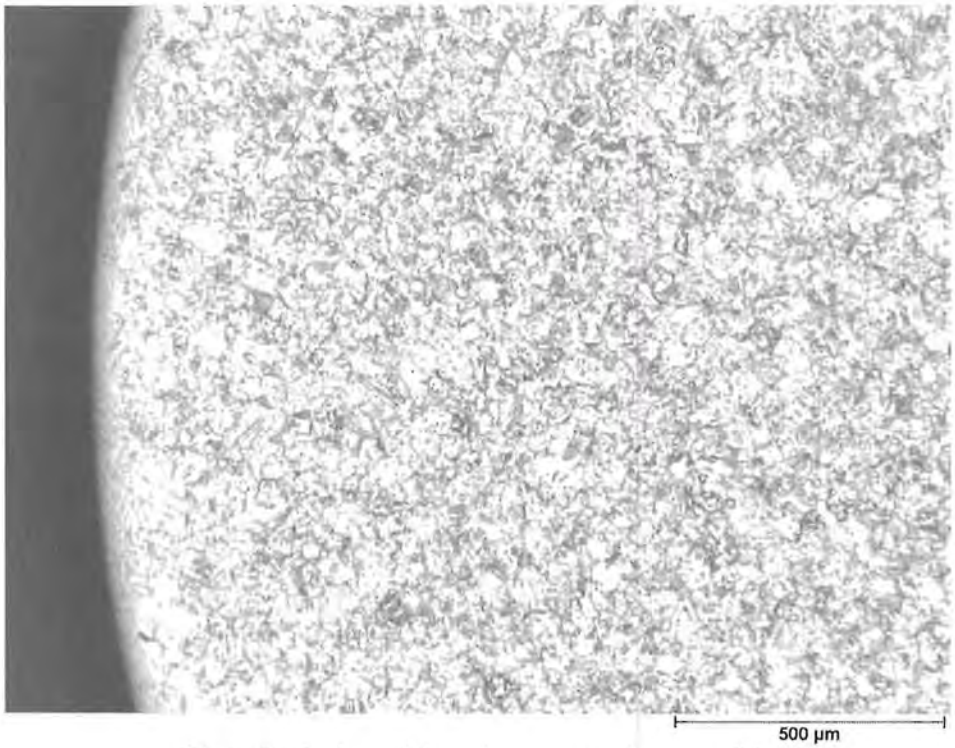


Photo 5: A view of the microstructure in screw # 1.

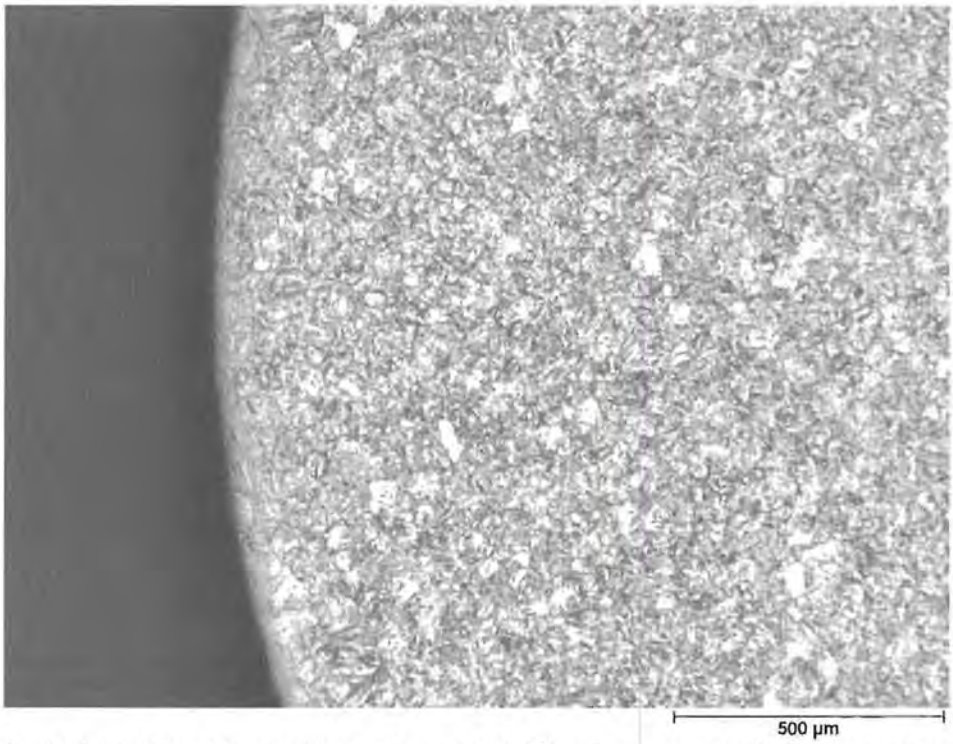


Photo 6: A view of the microstructure in screw # 3. The structures in both screws are essentially identical and appear typical of a quenched and tempered high alloy steel.

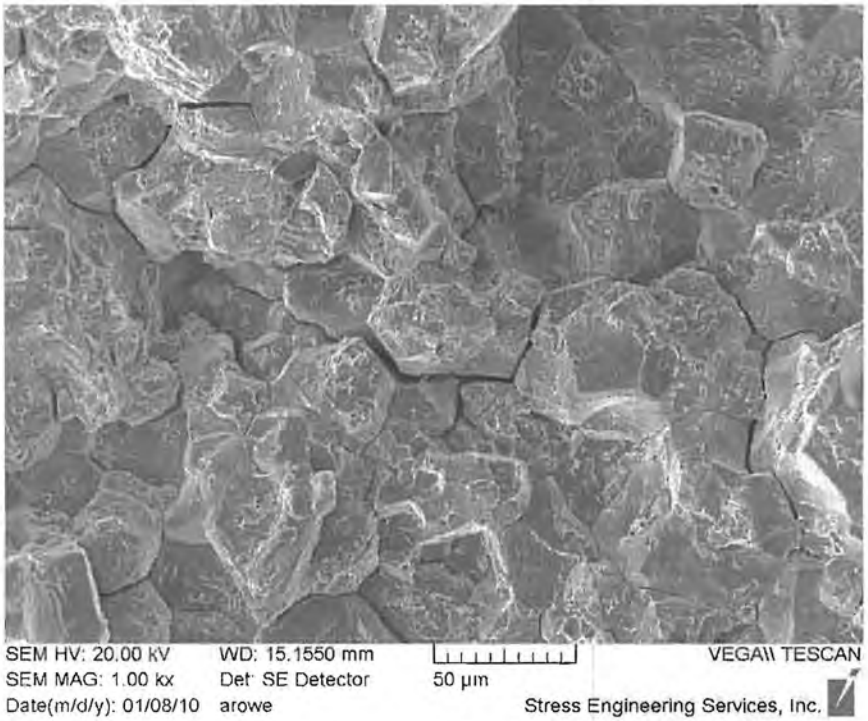


Photo 7: The fracture surface on screw #1 following ultrasonic cleaning. The fracture face appears typical of hydrogen stress cracking.

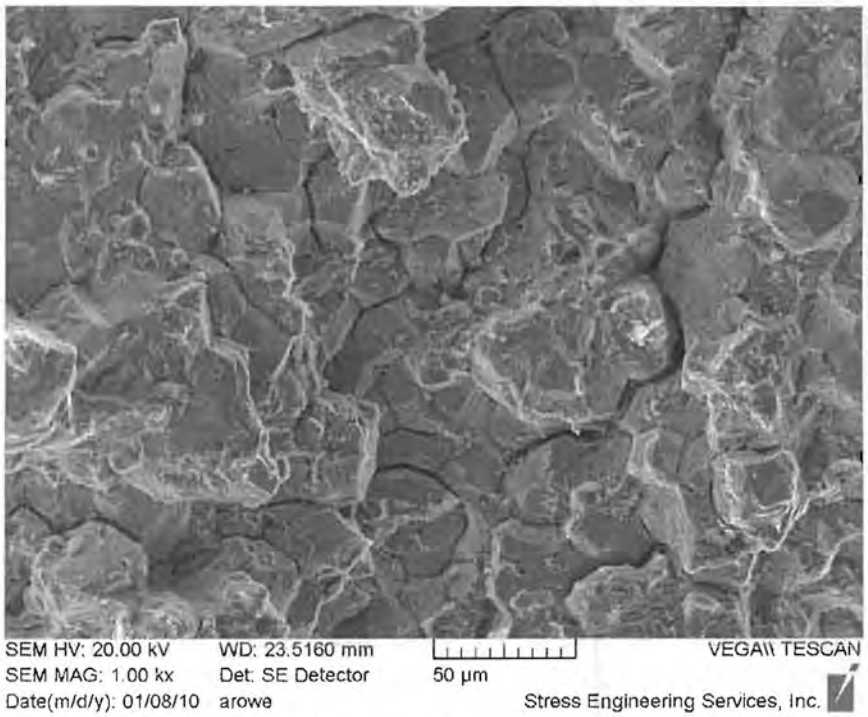


Photo 8: The fracture surface found on screw # 3. The structure is essentially identical to that shown in Photograph 7.

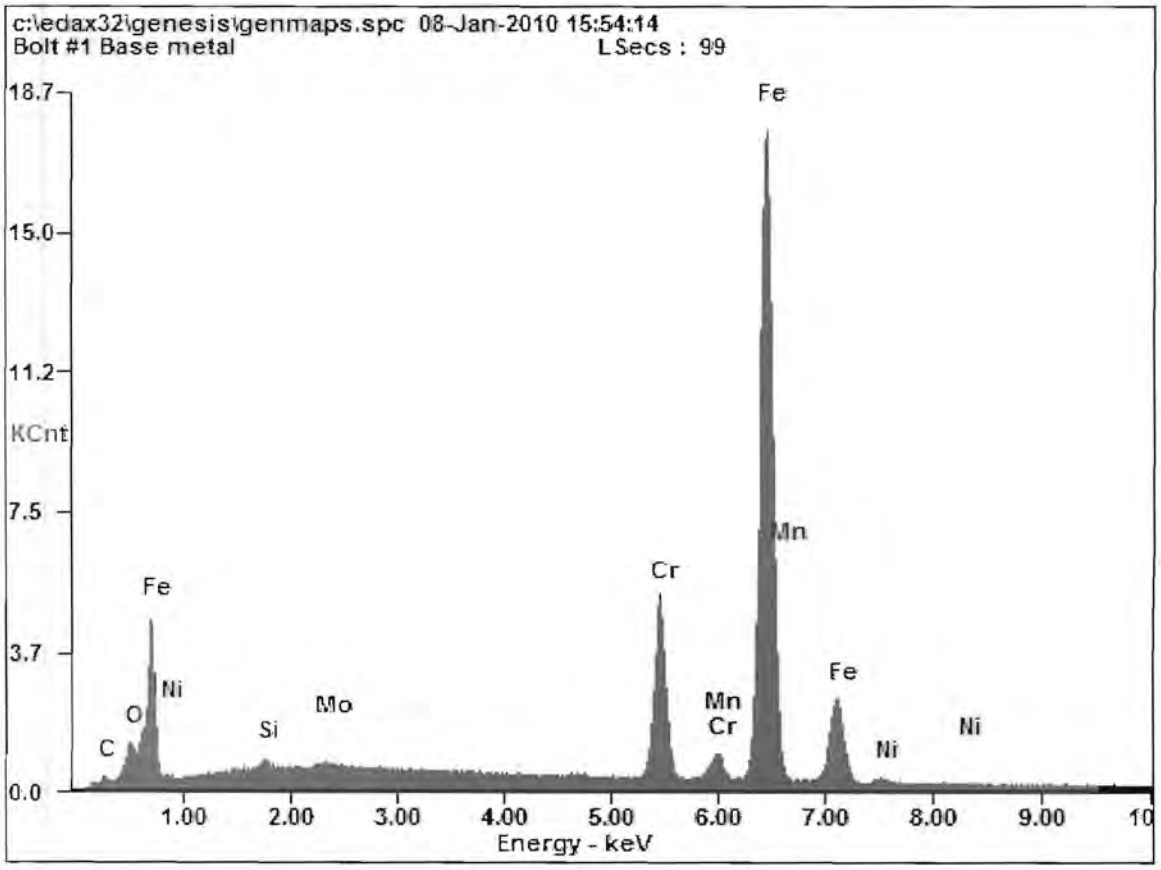
Appendix B

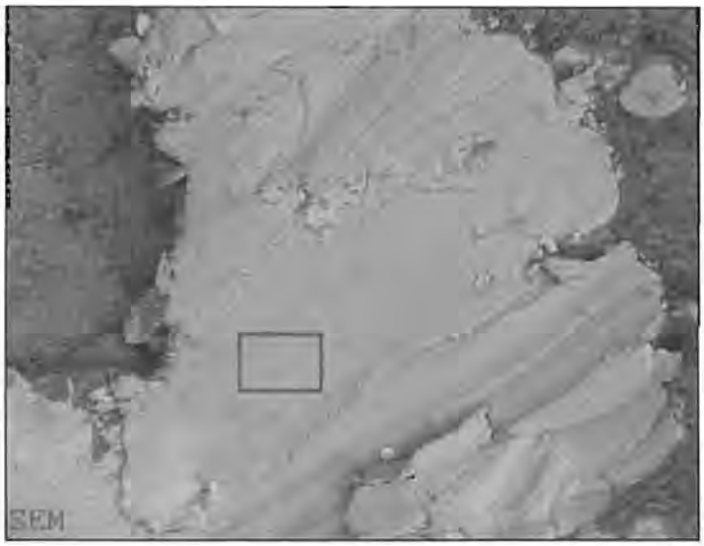
SEM-EDS Test Results

Energy Dispersive X-Ray Spectroscopy (EDS)

January 8, 2010

SCAN I



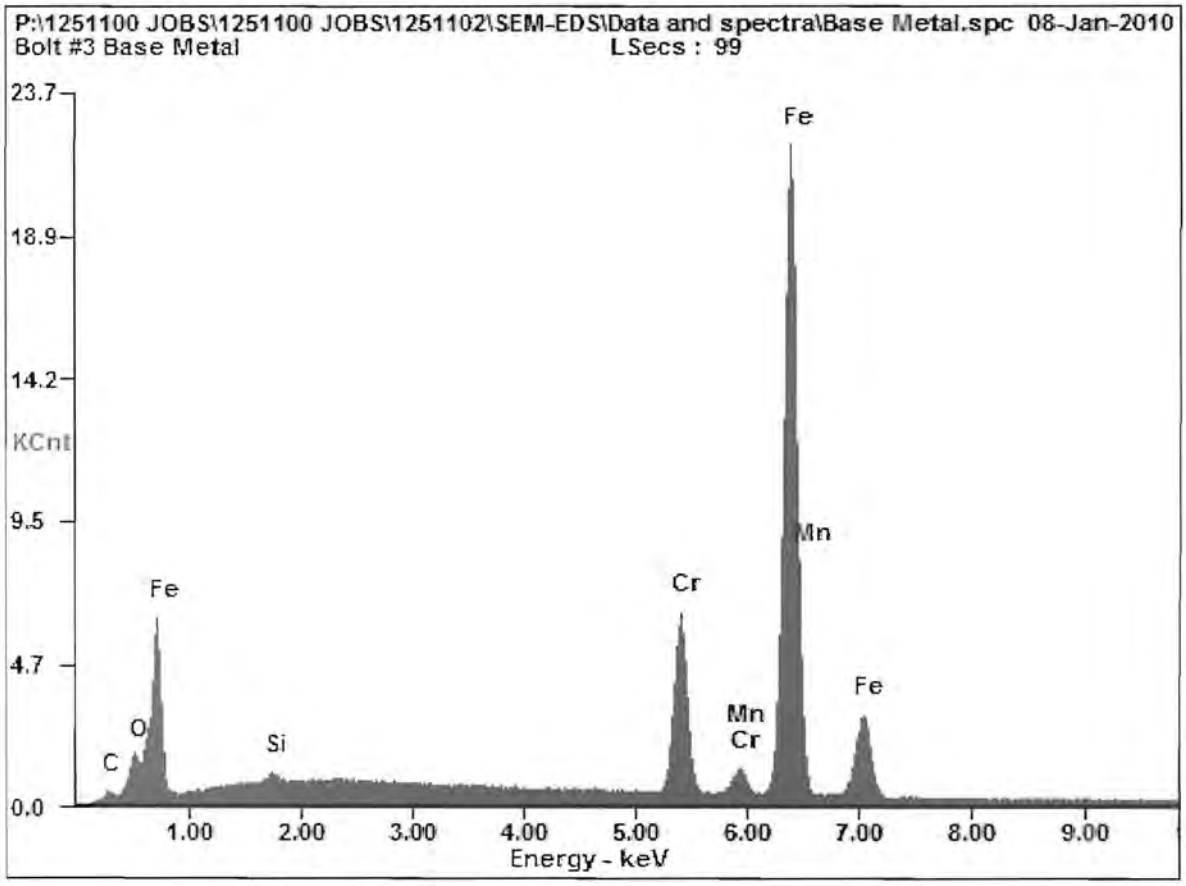


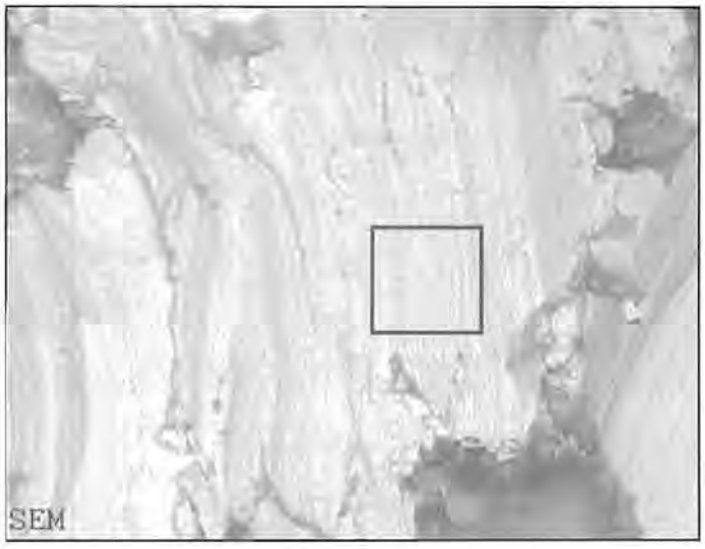
Element	*Wt%*	*At%*
SiK	00.36	00.70
MoL	00.58	00.34
CrK	13.12	13.95
MnK	00.44	00.44
FeK	84.44	83.57
NiK	01.06	01.00
Matrix	Correction	ZAF

Energy Dispersive X-Ray Spectroscopy (EDS)

January 8, 2010

SCAN II



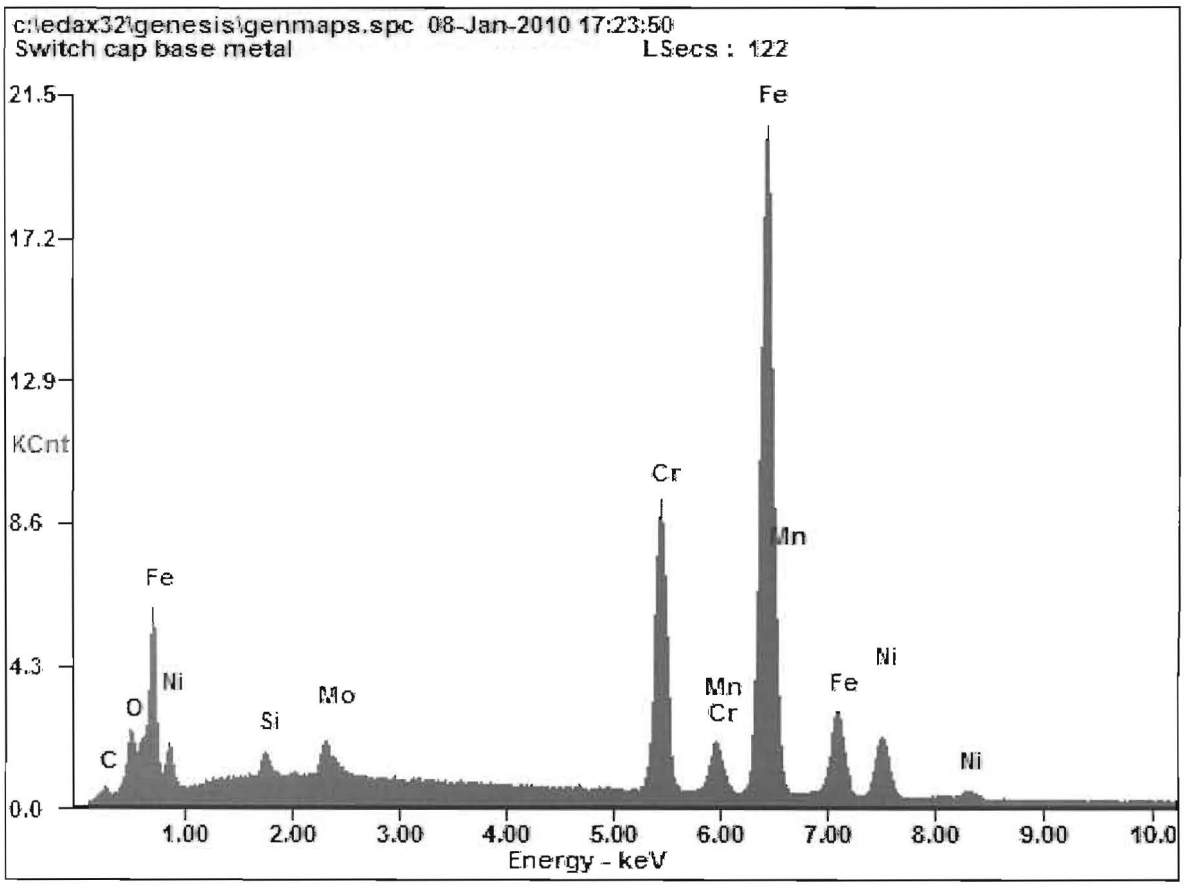


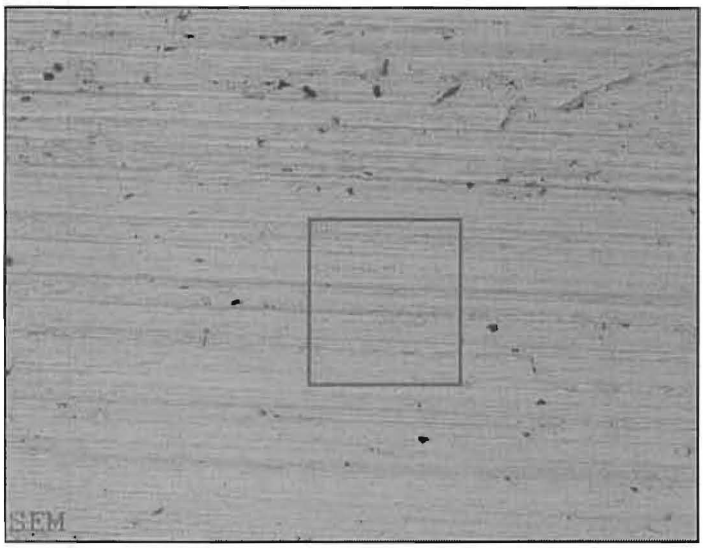
Element	*Wt%*	*At%*
SiK	00.47	00.92
CrK	13.36	14.14
MnK	00.38	00.38
FeK	85.79	84.56
Matrix	Correction	ZAF

Energy Dispersive X-Ray Spectroscopy (EDS)

January 8, 2010

SCAN III



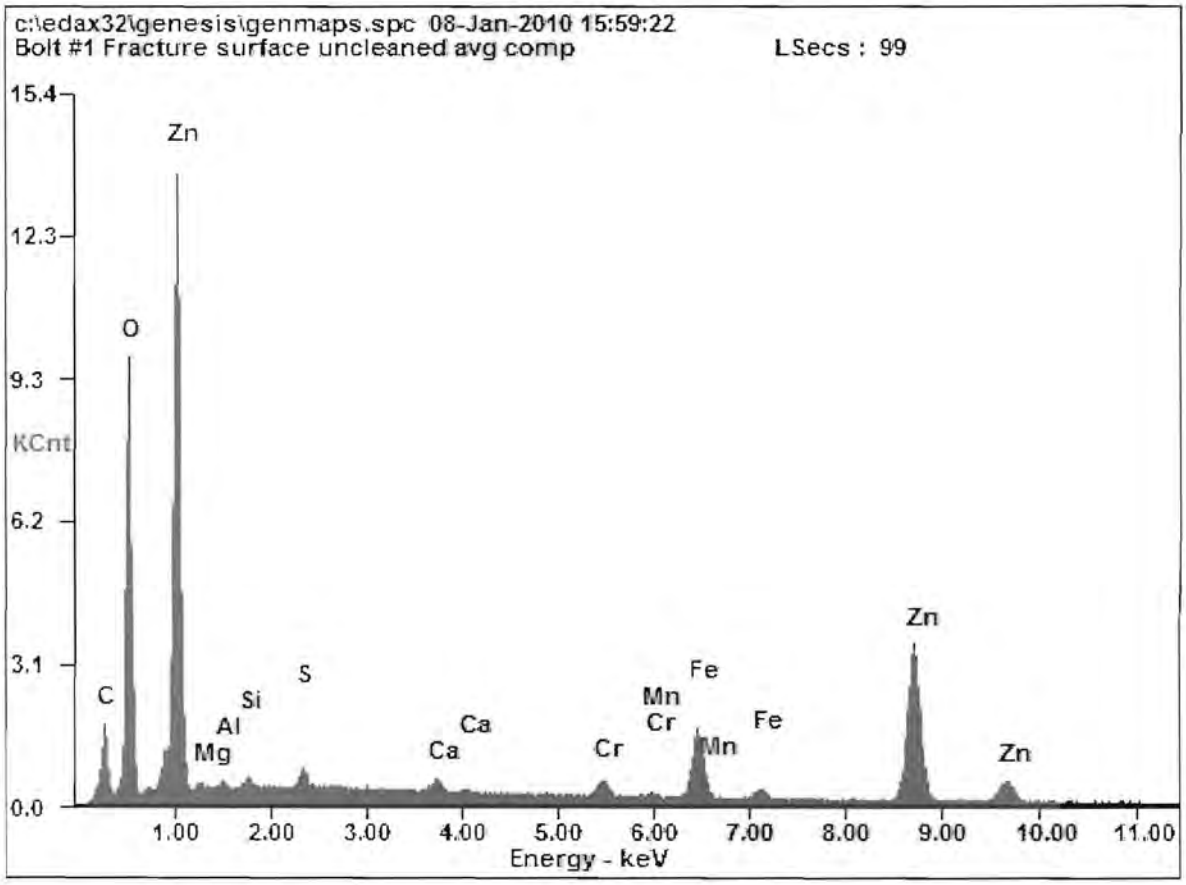


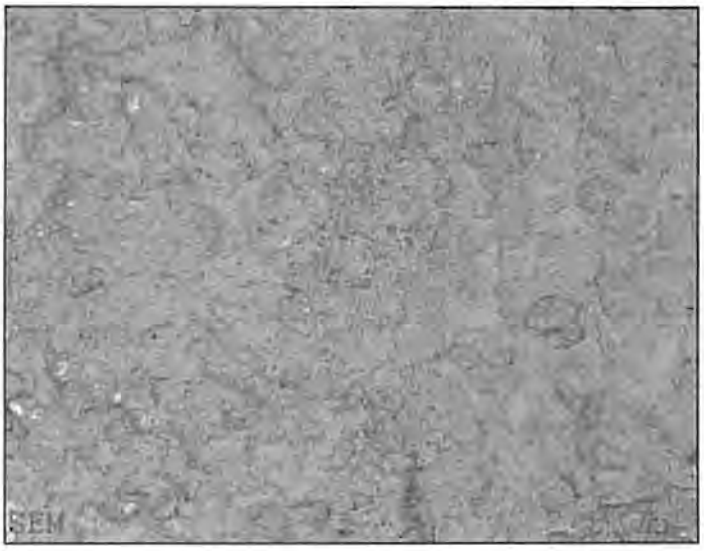
Element	*Wt%*	*At%*
SiK	01.05	02.07
MoL	02.69	01.55
CrK	17.44	18.60
MnK	01.46	01.47
FeK	67.43	66.93
NiK	09.93	09.38
Matrix	Correction	ZAF

Energy Dispersive X-Ray Spectroscopy (EDS)

January 8, 2010

SCAN IV





Element	*Wt%*	*At%*
CK	18.19	37.56
OK	25.40	39.37
MgK	00.42	00.43
AlK	00.30	00.27
SiK	00.35	00.31
SK	00.76	00.59
CaK	00.60	00.37
CrK	01.38	00.66
MnK	00.16	00.07
FeK	07.41	03.29
ZnK	45.03	17.08
Matrix	Correction	ZAF

Appendix F

Post-Accident Photos

Figure 1 – Photographs taken on December 23, 2009 showing aerial view and ground view of Enterprise Bolivar Station facility following release of crude oil. Highway 87 is shown in the aerial view, and it was the road closed as a result of the release.

Figure 2 – Photographs showing station piping where the failed pressure switch was located. The pressure had been removed prior to these photographs, and it is shown in the Metallurgical Report in Appendix E.