Composite Wrap Repairs: Quality Assurance & Control

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Composite Repair Users Group Workshop
Houston, TX
September 26, 2013
Outline

- Motivation
- Case Studies
- Chevron Documents
  - Data Sheet
  - Install Checklist
- Qualification
- Manufacturing Traceability
- Training
- Installation
- Documentation
- NDE
Motivation for Composites

- **Advantages:**
  - Composites fulfill a need
  - Decreased Repair Costs
  - Decreased Lost Production

- **Challenges:**
  - Safety – Willingness to Say ‘No’
  - Consistency
  - Traceability
  - Documentation
Basic Requirements for Composites

- **Industry Requirements**
  - Full Documentation Required by Regulators
  - Records are how operators document safe & controlled operation
  - For Operators, PCC-2 alone is not enough

- **Chevron Requirements**
  - System Qualified to PCC-2
  - Chemical Compatibility with Process
  - SP-10 Surface Prep & No Steam Out
  - For Permanent Repairs:
    - 60C Maximum
    - 10,000 hour ASTM D2992 testing
Recent Case Study A:

- **Case A: Internal Corrosion Leak Repair**
  - Emergency repair of sulfuric acid line, no surface preparation or engineered design – leaked within 24 hours
  - Repair was re-wrapped shortly thereafter, but leaked again
  - No documentation or report of installation details (i.e. how many layers)
  - Remediation required much larger repair and eventual cutout

- **What Should Have Happened: Written procedure followed and performance of each step documented**
  - Review and written approval of design and install method documents
  - Documents available for lessons learned and followup decision making should incident occur
Recent Case Study B:

- Case B: Large group of installations on buried pipe
  - Record keeping documents reviewed and approved beforehand
  - After installation, multiple documents were found incomplete:
    - No lead installer name recorded
    - Curing temperature different than that used in qualification
    - Identity of fiber/resin combination not recorded
    - No signatures present in provided signature boxes
  - No failures or technical problems reported, but documentation had to be retroactively corrected

- Key Takeaway: Documenting installation achieves two goals:
  - Record of install remains for customer
  - Ensures the job is done right the first time
  - Safety depends on quality control – analogy to welding
Common Factors

1. Installer deviated from written procedure.

2. Operator accepted deviation.
Recent Case Study C:

- **Case C: Contractor Deviated from Materials List**
  - During installation, contractor used a different bonding material than specified by operator and manufacturer
  - Operator’s representative (third party observer) noticed the mistake and re-wrap was performed
  - Review of documentation indicated that bonding material was not recorded. If engineer had not noticed the difference, deviation would not have been captured

- **Successful Instance of Quality Control**
  - Engineer noticed deviation
  - Success occurred at the **individual**, not at a **system**, level
Goal of data sheets:
- Standardize communication with manufacturers and installers
- Improve consistency of design reviews within Chevron

Goal of install checklist:
- Ensure repeatable quality of installs
- Build a system for traceability of composite wrap repairs

Working Together to Ensure Safe and Traceable Repairs
## DATA SHEET FOR COMPOSITE WRAP REPAIR

*(To Be Completed By Chevron Representative)*

### 1. GENERAL INFORMATION

<table>
<thead>
<tr>
<th>LOCATION:</th>
<th>LINE/EQUIPMENT NO:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td></td>
</tr>
<tr>
<td>DESIGN BASIS:</td>
<td>ASME B31.1, B31.3, B31.4, B31.8, BPVC Section VIII, Div 1</td>
</tr>
</tbody>
</table>

### 2. EQUIPMENT DESCRIPTION

<table>
<thead>
<tr>
<th>MAX. DESIGN TEMPERATURE:</th>
<th>MIN. DESIGN TEMPERATURE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F or °C</td>
<td>°F or °C</td>
</tr>
<tr>
<td>DESIGN PRESSURE:</td>
<td>psi or bar</td>
</tr>
<tr>
<td>NOMINAL DIAMETER:</td>
<td>inches or mm</td>
</tr>
<tr>
<td>NOMINAL WT:</td>
<td>inches or mm</td>
</tr>
<tr>
<td>CORROSION ALLOWANCE:</td>
<td>inches or mm</td>
</tr>
<tr>
<td>MATERIAL AND GRADE:</td>
<td></td>
</tr>
<tr>
<td>ATTACH DRAWINGS IF AVAILABLE</td>
<td></td>
</tr>
</tbody>
</table>

| NORMAL OPERATING CONDITIONS: | | |
|------------------------------|-------------------------------|
| °F or °C (MIN) TO °F or °C (MAX) | psi or bar |
| SEALLESS | WELDED |
| BURIED | HEAT TRACED | EXPOSED TO SUNLIGHT |
| COATED (DESCRIBE): | |
| EXPOSED TO IMMERSION CONDITIONS | |

### 3. DEFECT DESCRIPTION

<table>
<thead>
<tr>
<th>DEFECT TYPE:</th>
<th>ILI LOG DISTANCE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTERNAL CORROSION</td>
<td></td>
</tr>
<tr>
<td>DEFECT AXIAL EXTENT:</td>
<td></td>
</tr>
<tr>
<td>DEFECT CIRCUMFERENTIAL EXTENT:</td>
<td></td>
</tr>
<tr>
<td>DEFECT DEPTH:</td>
<td></td>
</tr>
<tr>
<td>DISTANCE TO BEND, FITTING, OR SUPPORT: ft or m</td>
<td></td>
</tr>
<tr>
<td>LOWEST ST REMAINING WALL THICKNESS:</td>
<td></td>
</tr>
<tr>
<td>LIMITED ACCESS TO DEFECT</td>
<td></td>
</tr>
<tr>
<td>CLAMPS OR PLUGS PRESENT</td>
<td></td>
</tr>
<tr>
<td>LOCATED AT/NEAR COMPLEX GEOMETRY (ATTACH PHOTOS)</td>
<td></td>
</tr>
<tr>
<td>ANTICIPATE HOLE THROUGH BEFORE PERMANENT REPAIR (Contact ETC Materials Team)</td>
<td></td>
</tr>
</tbody>
</table>
### 4. SERVICE DESCRIPTION

**DESCRIPTION OF OCCASIONAL EXCURSION CONDITIONS:**
- **STEAM OUT (CONTACT ETC)**
- **CRYOGENIC CONDITIONS (CONTACT ETC)**

**EXTERNAL LOADS (CONTACT ETC IF ANY APPLY):**
- BENDING MOMENT
- CYCLIC LOADING
- AXIAL LOADING
- VIBRATION
- EXTERNAL WEIGHT
- **HIGH ΔT** (Max-Min Temperature Range >70°F or 39°C)

**EXTERNAL LOAD DETAILS:**

**PROCESS HAZARDS:**
- SOUR SERVICE
- FIRE PROTECTION REQUIRED
- ASPHYXIA HAZARD

**PROCESS COMPOSITION NOTES:**

<table>
<thead>
<tr>
<th>5. REPAIR REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REPAIR SHALL BE FOR DESIGN PRESSURE AND TEMPERATURE OF EQUIPMENT</strong></td>
</tr>
<tr>
<td>DESIRED REPAIR LIFETIME:</td>
</tr>
<tr>
<td>PCC-2 RISK LEVEL:</td>
</tr>
<tr>
<td>PCC-2 REPAIR TYPE:</td>
</tr>
<tr>
<td>ISO REPAIR CLASS:</td>
</tr>
<tr>
<td>POST-REPAIR HYDROTEST:</td>
</tr>
<tr>
<td>SP-10 SURFACE PREPARATION REQUIRED (CONTACT ETC IF NOT POSSIBLE)</td>
</tr>
</tbody>
</table>

**EXPECTED CONDITIONS AT TIME OF INSTALL:**
- % REL. HUMIDITY:  |
- SURFACE: | DRY | WET (Contact ETC) |
- AMBIENT TEMPERATURE: |  |
- OPERATING DURING INSTALL? | Y | N |
- CONTENTS EVACUATED BEFORE INSTALL? | Y | N |
- PROCESS TEMP. DURING INSTALL: |  |
- PROCESS PRESS. DURING INSTALL: |  |

**HOLD: CHEVRON ENGINEER TO APPROVE AND SIGN BEFORE INSTALL**

**SIGNATURE REQUIRED:**

**PRINT NAME:**

**DATE:**

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### Chevron Installation Worksheet for Composite Wraps

#### 1. GENERAL INFORMATION
- **INSTALLED DATE:**
- **LOCATION/DESCRIPTION:**
- **LINE/EQUIPMENT NO.:**
- **ILI LOG DISTANCE:**
- **VENDOR NAME AND CONTACT INFORMATION:**
- **REPAIR PRODUCT NAME:**
- **CVI REPRESENTATIVE CONTACT INFORMATION:**
- **UNIQUE REPAIR IDENTIFIER:**

#### 2. DESIGN DETAILS
- **DESIGN DOCUMENT ATTACHED:**
- **DO NOT USE:**
- **REPAIR DESIGN PRESSURE:** psi or bar
- **REPAIR DESIGN TEMPERATURE:** °F or °C
- **HARDNESS REMOVED DURING QUALIFICATION:**

#### 3. PRE-INSTALL CHECKLIST
- **HOLD: CHEVRON ENGINEER TO APPROVE DESIGN AND METHOD STATEMENT DOCUMENTS BEFORE INSTALL SIGNATURE REQUIRED:**
- **PRINT NAME:**
- **DATE:**
- **HOLD: CHEVRON REPRESENTATIVE TO VERIFY MATERIALS EXPIRATION AND SURFACE PREP BEFORE INSTALL SIGNATURE REQUIRED:**
- **PRINT NAME:**
- **DATE:**
- **ON-SITE SAFETY DISCUSSION (TAILGATE OR JSA) CONDUCTED BEFORE INSTALL? Y N:**

#### 4. INSTALLATION REPORT
- **LEAD INSTALLER NAME:**
- **CERTIFIED INSTALLER NAME:**
- **EXP. DATE:**
- **CERTIFICATION NO.:**
- **SURFACE PREPARATION METHOD:**
- **CONFIRM: DEFECT DIMENSIONS MATCH DESIGN DOC.**
- **MATERIALS BATCH NUMBER:**

#### INSTALLATION CONDITIONS:
- **TIME/DATE OF SURFACE PREPARATION:**
- **TIME/DATE WRAP INSTALLATION BEGAN:**
- **TIME/DATE INSTALL COMPLETED:**
- **AMBIENT TEMPERATURE:**
- **HUMIDITY:**
- **PIPE TEMPERATURE DURING INSTALL:**
- **PRESSURE DURING INSTALL:**

#### POST INSTALL QA/QC
- **MEASURED WRAP THICKNESS:**
- **TOTAL CIRCUMFERENCE:**
- **HARDNESS MEASURED AFTER INSTALLATION:** Shore D or D or Barcol
- **HARDNESS MEASURED IS AT LEAST 90% OF HARDNESS QUALIFIED (COMPARE TO SECTION 2)**
- **REPAIR COATED:**
- **REPAIR FIRE-PROOFED:**
- **REPAIR MARKED WITH UNIQUE IDENTIFIER:**
- **IDENTIFIER DESCRIPTION:**
- **POST-REPAIR HYDROTEST PERFORMED:** psi or bar
- **HOLD: CHEVRON REPRESENTATIVE TO VERIFY POST-INSTALL HARDNESS AND REPAIR DIMENSIONS SIGNATURE REQUIRED:**
- **PRINT NAME:**
- **DATE:**

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## INSTALLATION WORKSHEET FOR COMPOSITE WRAP REPAIR
(TO BE COMPLETED BY LEAD INSTALLER)

### 1. GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Installed Date:</th>
<th>Vendor Name and Contact Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location/Description:</td>
<td>Repair Product Name:</td>
</tr>
<tr>
<td>Line/Equipment No.:</td>
<td>CVR Representative Contact Information:</td>
</tr>
<tr>
<td>ILI Log Distance:</td>
<td>Unique Repair Identifier:</td>
</tr>
</tbody>
</table>

### 2. DESIGN DETAILS

<table>
<thead>
<tr>
<th>Design Document Attached?</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair Design Pressure:</td>
<td></td>
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</tr>
<tr>
<td>Repair Design Temperature:</td>
<td></td>
<td>°F or °C</td>
</tr>
<tr>
<td>Hardness Recorded During Qualification:</td>
<td></td>
<td></td>
</tr>
<tr>
<td># of Layers:</td>
<td>Design Repair Thickness:</td>
<td></td>
</tr>
<tr>
<td>Axial Length of Composite:</td>
<td>Design Life:</td>
<td></td>
</tr>
<tr>
<td>Defect Length and Depth Used in Design:</td>
<td></td>
<td></td>
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### 3. PRE-INSTALL CHECKLIST

| Hold: Chevron Engineer to Approve Design and Method Statement Documents Before Install |
| Signature Required: | Print Name: | Date: |

| Hold: Chevron Representative to Verify Materials Expiration and Surface Prep Before Install |
| Signature Required: | Print Name: | Date: |

| On-Site Safety Discussion (Tailgate or JSA) Conducted Before Install? | Y | N |
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**HOLD:** CHEVRON REPRESENTATIVE TO VERIFY POST-INSTALL HARDNESS AND REPAIR DIMENSIONS

**SIGNATURE REQUIRED:** __________________________  **PRINT NAME:** __________________________  **DATE:** __________
Personnel Training

- **Installer**
  - Trained within past year, with documentation
  - Follows written procedure and records steps taken

- **Supervisor**
  - Experienced installer with 12+ previous installs performed
  - Documented training and installation record available for review
  - Signs off on work procedure and checklists

- **Owner Representative**
  - Aware of company and industry requirements for composites
  - Observes work site, confirms traceability of raw materials
  - Verifies final state of repair in writing
Traceability

- Manufacturer
  - Batch Numbers
  - Expiration Dates
  - Storage Instructions

- End User
  - Record Keeping
  - Marking
  - Tracking & Replacement
**Conclusions**

- **Reviewed Case Studies**
  - Case A, B: Leak & delays were experienced because of quality control issues on installer and operator’s side
  - Case C: Example of a good ‘catch’ for a quality issue
  - Conclusion: Need to focus on *system-level solutions*

- **Previewed Data Sheets**
  - Internal data sheets assist individual operators
  - Industry standard reporting and documentation will be better

- **Moving Forward:**
  - Training
  - Materials traceability