SUBJECT: Corrosion and abrasion tests on galvanized steel plate coated with Trenchcoat polymer

- corrosion tests with conventional salt spray in accordance with standard ASTM B117;
- abrasion tests with automated humid sandblast.

SAMPLES DESCRIPTION:

1. Galvanized steel plate coated with Trenchcoat.
2. Galvanized steel plate coated with Trenchcoat, including a welded joint covered with primer.
3. Galvanized steel plate coated with Trenchcoat, including a X-groove to the plain steel.
4. Aluminized steel plate.
5. Galvanized steel plate.

SALT SPRAY TESTS:

Work Procedure:

Five steel plates have been placed in a salt spray cabinet during 4,000 hours. They were removed at regular intervals, rinsed and cleaned with a soft brush. Pictures were taken at all breakpoints.

See Appendix A.

Observations were made at the following exposure steps:

- Before testing
- 250, 1000, 1700, 2200, 2700, 3000, 3500, 4000 hours

See Table 1.
Results:

1. Galvanized steel plate coated with Trenchcoat.

Loss of thickness almost null and no polymer coat delaminating after 4000 hours of exposure.

2. Galvanized steel plate coated with Trenchcoat, including a welded joint covered with repair paint.

The repair paint on the welded joint didn’t produce the expected results. The paint deteriorated after 1700 hours of exposure, leaving the door open to corrosion under the surface of the adjacent coating. Consequently, we must avoid welded joints in a galvanized steel pipe used as a culvert.

3. Galvanized steel plate coated with Trenchcoat, including a X-groove to the plain steel.

After 2200 hours, the salt started to filter under the polymer surface, causing its gradual delaminating until about 60% of the plate surface at 4000 hours of exposure.

In case of deterioration of the polymer during fabrication, handling or transportation, the repair method must be as sustainable as the polymer itself.

ABRASION TESTS:

Work Procedure:

Four steel plates were subjected to the abrasion test during four cycles. Pictures were taken at all breakpoints. See Appendix B.

Test parameters:
- 340 g/minute of abrasive, i.e. silica sand C-109 from Ottawa, Illinois, in accordance with standard ASTM C-778;
- pressure: 1200 kPa;
- duration: 51.5 min/cycle;
- effective area of the steel plates: 130 cm².
The steel plates were removed at the end each cycle, cleaned and their picture taken to measure the grade of abrasion.

Observations were made at the following cycles:

- Before testing
- Cycles 1, 2, 3 and 4

See Table 2.

Results:

1. **Galvanized steel plate coated with Trenchcoat**;

   Slight loss of thickness and no polymer coat delaminating at the surface after four abrasion cycles.

2. **Galvanized steel plate coated with Trenchcoat, including a welded joint covered with repair paint**.

   The welded joint’s repair didn’t produce the expected results. The paint used for the repair disappeared at the first abrasion cycle. However, the Trenchcoat product didn’t deteriorate during the other cycles. In case of deterioration of the polymer during fabrication, handling or transportation, the repair method must be as sustainable as the polymer itself.

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Addressee:

- Prepared by: Gaétan Rousseau, performance testing technician
- Verified by: Donald Villeneuve, P.Eng.
- Date: 2007-02-16
## SALT SPRAY TESTING (results summary) Table 1

**Report No.:** 04-014  
**Testing Start Date:** 2006-07-04  
**Testing End Date:** 2006-12-27

<table>
<thead>
<tr>
<th>Sample</th>
<th>250 hours</th>
<th>500 hours</th>
<th>1000 hours</th>
<th>1700 hours</th>
<th>2200 hours</th>
<th>2710 hours</th>
<th>3000 hours</th>
<th>3500 hours</th>
<th>4000 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Trenchcoat #1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No deterioration</td>
</tr>
<tr>
<td>Welded Joint covered with paint #2</td>
<td></td>
<td></td>
<td></td>
<td>Peeling of paint</td>
<td>Peeling of paint</td>
<td>Peeling of paint and lifting of Trenchcoat</td>
<td>Peeling of paint and lifting of Trenchcoat</td>
<td>Complete peeling of paint and 60% lifting of Trenchcoat</td>
<td></td>
</tr>
<tr>
<td>Trenchcoat (grooved) #3</td>
<td></td>
<td></td>
<td>Initial lifting of Trenchcoat at the points</td>
<td>Lifting of Trenchcoat</td>
<td>Lifting of Trenchcoat</td>
<td>Lifting of Trenchcoat</td>
<td>60% lifting of Trenchcoat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminized Steel #4</td>
<td></td>
<td>Initial corrosion</td>
<td>5% Corrosion</td>
<td>10% Corrosion</td>
<td>15% Corrosion</td>
<td>20% Corrosion</td>
<td>25% Corrosion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galvanized Steel #5</td>
<td>50% Corrosion</td>
<td>60% Corrosion</td>
<td>65% Corrosion</td>
<td>80% Corrosion</td>
<td>85% Corrosion</td>
<td>90% Corrosion</td>
<td>100% Corrosion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2007-02-15 Table 1 Final Results Summary
### TABLE 2 – ABRASION TEST WITH HUMID SANDBLAST

<table>
<thead>
<tr>
<th>Type</th>
<th>Weight (g)</th>
<th>Weight loss (g)</th>
<th>Computed Thickness Loss (µm)</th>
<th>1st cycle</th>
<th>2nd cycle</th>
<th>3rd cycle</th>
<th>4th cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thickness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(µm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galvanized Steel</td>
<td>424.12</td>
<td>0.89</td>
<td>10</td>
<td>0.038</td>
<td>38.6</td>
<td>4.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>2.18</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.58</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.68</td>
<td>Total loss of zinc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminized Steel</td>
<td>420.83</td>
<td>0.73</td>
<td>21</td>
<td>0.045</td>
<td>45</td>
<td>2.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>1.57</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.48</td>
<td>Total loss of aluminum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel + “Trenchcoat”</td>
<td>201.27</td>
<td>0.11</td>
<td>10</td>
<td>0.00386</td>
<td>0.038</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>0.29</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.48</td>
<td>Total loss of paint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel + Repair</td>
<td>353.06</td>
<td>0.60</td>
<td>Total loss of paint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paint on Joint</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thickness is measured before testing with an Elcometer 456 standard device and computed for cycles 1, 2, 3 and 4.

Estimated density: Zinc (7.14 g/cm³), Aluminum (2.70 g/cm³), Trenchcoat (0.95 g/cm³)

Computation examples:
- 7.14 g = 1cm³ thus a weight loss of 3.58 g = (3.58 gr/7.14g/cm³) = 0.50210 cm³ volume for a 130 cm² estimated area. Zinc thickness = 0.50210 cm³/130 cm² = 0.00386 cm = 0.038 mm = 38.6 µm
- Testing parameters: 340 g/min of abrasive (silica sand C-109 form Ottawa, Illinois, in accordance with standard ASTM C-778 Table 1) Graded sand
- Pressure: 1,200 kpa 51.5 min/cycle, Plates estimated area: 130 cm².

2007-02-15  TABLE 2 FINAL ABRASION
Trenchcoat

File Lab. 09-020-04-014

Salt spray testing (pictures)
APENDIX A

January 26, 2007

By: Gaétan Rousseau, Tech.
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel

250 hours
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel
Plate #1  
Trenchcoat

Plate #2  
Trenchcoat  
Welded Joint

Plate #3  
Trenchcoat  
X Groove

Plate #4  
Aluminized Steel

Plate #5  
Galvanized Steel

1000 hours
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel

1700 hours
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel

2200 hours
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel

2710 hours
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel

3500 hours
Plate #1 Trenchcoat
Plate #2 Trenchcoat Welded Joint
Plate #3 Trenchcoat X Groove
Plate #4 Aluminized Steel
Plate #5 Galvanized Steel
Plate #1
Trenchcoat

Plate #2
Trenchcoat
Welded Joint

Plate #3
Trenchcoat
X Groove

Plate #4
Aluminized Steel

Plate #5
Galvanized Steel
Trenchcoat coating for corrugated steel pipes

File Lab. 09-020-04-014

APPENDIX B

Abrasion Testing (pictures)

January 29, 2007

By: Gaétan Rousseau Tech.