June 4, 2020
Email: *mmcgough@ncspa.org*

Mr. Michael McGough, P.E.
Director of Technical Services
National Corrugated Steel Pipe Association
14070 Proton Road, Suite 100
Dallas, TX 75244

**SUBJECT: Results of Freeze-Thaw Testing of Coated Steel Panels;**
**KTA-Tator, Inc. Project No. 390883**

Dear Mr. McGough:

In accordance with KTA-Tator, Inc. (KTA) Proposal No. PN1910661 and the subsequent signed Authorization to Proceed (ATP) form dated November 25, 2019, KTA has exposed twelve submitted coated steel panels in an alternating freeze-thaw (water soak) environment for 100 cycles. This report describes the testing procedures employed and contains the results of the visual evaluations performed. A link and password to access a protected folder on KTA's FileCloud server containing the digital photographs taken of the panels at various exposure intervals is also provided.

## SAMPLES

Twelve coated steel panels were received in the lab for this project on November 6, 2019. The description of the panels as received and their KTA designation are provided in Table 1 – "Samples". The faces of the panels were designated "A" for the front face, and "B" for the back face. At no time did KTA personnel witness the preparation or packaging of the samples.

**Table 1 - Samples**

| KTA ID | Sample Description | Client ID |
|---|---|---|
| 390883-1, 390883-2, 390883-3 | Three appx. 6 in. x 6 in. x 1/8 in. satin black coated steel panels with hole, coated both sides and all edges. 390883-1 and 390883-2 each have 1 small defect on side B. | Polyarmor G17 only |
| 390883-4, 390883-5, 390883-6 | Three appx. 6 in. x 6 in. x 1/8 in. gloss black coated steel panels with hole, coated both sides and all edges. 390883-4 very rough on side B, heavy pinholes. 390883-5 has few pinholes center left side A, top left side B, one small defect on side A. | Carboline 858 Zinc Primer Epoxy & Polyarmor G17 only |

| KTA ID | Sample Description | Client ID |
|---|---|---|
| | 390883-6 has pinholes center right side A, center left side B, one large defect each side. | |
| 390883-7 | One appx. 6 in. x 6 in. x 1/8 in. gloss grey coated steel panel with hole, coated both sides and all edges. 4 small defects on side A, 6 small defects on side B. | Valspar EEG 70% Zinc Primer Epoxy 7 TCI RAL 7037 Polyester |
| 390883-8 | One appx. 6 in. x 6 in. x 1/8 in. gloss green coated steel panel with hole, coated both sides and all edges. 4 defects and few pinholes (bottom left) on side A, 2 defects, 2 horizontal scratches, and many pinholes (upper half) on side B. | Carboline 858 Zinc Primer Epoxy & Pipe Clad 2000 Epoxy |
| 390883-9, 390883-10, 390883-11 | Three appx. 6 in. x 6 in. x 1/16 in. glossy black coated steel panels, coated both sides, not on edges.<br>390883-9 has large gouge side A center, 2 large defects side B (left center and right center).<br>390883-10 has many pockmarks (left of center) and 2 defects on side A, 2 large defects (top and bottom center) and "064" on side B.<br>390883-11 has many vertical scratches and several defects on both sides, two parallel large defects on side B (center left). | Trenchcoat over Galvanized Coil |
| 390883-12 | One appx. 8 1/2 in. x 6 in. x 1/16 in. glossy black coated steel panel, coated both sides, not on edges. Horizontal scratches on entire side A and long vertical scratch on left, horizontal scratches on side B (mostly on top quarter) with 3 large and 4 medium defects and the letters "TR". | Trenchcoat over Galvanized Coil |

## Panel Preparation and Conditioning

Panels 390833-1 through 390833-8 each had a hole drilled in the panel that was taped over using black vinyl electrical tape before conditioning to prevent corrosion at the hole during exposure. Panels 390833-9 through 390833-12 were not coated on the edges, thus the edges were taped using the same black vinyl electrical tape for the same reason.

All of the panels were placed into a room temperature water bath on November 22, 2019 to begin a pre-conditioning water soak for 2 weeks. Tap water was used to fill the bath and the temperature of the water was adjusted to approximately 25 ºC/77 ºF before the panels were introduced into the bath. The room was conditioned to maintain approximately 22 ºC/72 ºF to 25 ºC/77 º F during the pre-conditioning.

## Freeze-Thaw Exposure

Exposure of the panels to 100 freeze-thaw cycles began after the 2-week pre-conditioning water soak on December 9. 2019. Each cycle consisted of approximately 8 hours in a freezer set for approximately -18 ºC/0 ºF followed by approximately 16 hours (overnight) in the previously described room temperature water bath. Panels remained in the water bath over weekends, holidays, and other interruptions of the cycling procedure. The water in the water bath was changed approximately every two weeks, and the new water was adjusted to approximately 25 ºC/77 ºF each time. The panels were supported upright by plastic racks in both the freezer and the water bath. There was a brief interruption in the cycling on February 17-18, 2020 due to technician error. The cycling schedule was extended to ensure 100 freeze-thaw cycles were performed.

## Visual Evaluations

After 100 freeze-thaw cycles, the panels were taken out of the water bath and allowed to dry at room conditions. Before visual evaluation, the panels were wiped with a damp cotton cloth and again allowed to dry. Visual evaluations were performed with the unaided eye, noting areas of low gloss ("flat"), normal gloss, mottled appearance, and any rust spots that had developed.

Digital photographs of some of the panels were taken after 3, 30, and 65 cycles to show some changes in the panels during the exposure and when they were initially observed. The visual observation notes on these exposure intervals were performed using the digital photographs. Digital photographs of all the panels were taken after the end of the 100 cycles of exposure. All of the digital photographs are available for viewing and downloading at the following link:

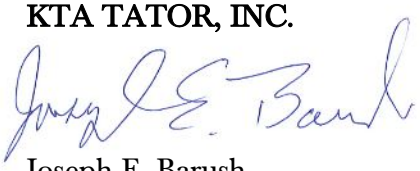
https://files.kta.com/url/nhp3vdybie9kpjwt. The password to access the photographs is: 390883

The results of the visual observations of the panels during and after exposure have been tabulated and appended to this report.

If you have any questions or comments regarding this report, please contact me by telephone at 412.788.1300, extension 194 or by e-mail at jbarush@kta.com.

Sincerely,

**KTA TATOR, INC.**



Joseph E. Barush
*Project Manager/Coatings Application Specialist*

Appendix – Visual Observations During and Following Freeze-Thaw Cycling

JEB/CSQ:edg

**NOTICE:** This report represents the opinion of KTA-TATOR, INC. This report is issued in conformance with generally accepted industry practices. While customary precautions were taken to verify the information gathered and presented is accurate, complete and technically correct, this report is based on the information, data, time, materials, and/or samples afforded. This report should not be reproduced except in full.

# *Appendix*

| KTA Panel ID | Panel Description | Coating System | Visual Observations (unaided) | | | |
|---|---|---|---|---|---|---|
| | | | 2 wk. water soak + 3 cycles FT Cycling | 2 wk. water soak + 30 cycles FT Cycling | 2 wk. water soak + 65 cycles FT Cycling | 2 wk. water soak + 100 cycles FT Cycling |
| 390883-1 | 6" x 6", satin black | Polyarmor G17 only | - | - | - | Moderate mottled flat appearance, both sides. Large flat area on right side of A. No rusting. |
| 390883-2 | 6" x 6", satin black | Polyarmor G17 only | - | - | - | Slightly mottled flat appearance, both sides. Large flat area on right side of A. No rusting. |
| 390883-3 | 6" x 6", satin black | Polyarmor G17 only | - | - | - | Slightly mottled flat appearance on side A, heavily mottled on side B. Large flat area on right side of A. No rusting. |
| 390883-4 | 6" x 6", gloss black | Carboline 858 Zinc Primer Epoxy & Polyarmor G17 only | - | - | - | Glossy, no rusting. |
| 390883-5 | 6" x 6", gloss black | Carboline 858 Zinc Primer Epoxy & Polyarmor G17 only | - | - | - | Glossy, no rusting. |
| 390883-6 | 6" x 6", gloss black | Carboline 858 Zinc Primer Epoxy & Polyarmor G17 only | - | - | - | Glossy, no rusting. |
| 390883-7 | 6" x 6", gloss grey | Valspar EEG 70% Zinc Primer Epoxy 7 TCI RAL 7037 Polyester | - | - | - | Glossy, one small rust spot on botton edge of panel. |
| 390883-8 | 6" x 6", gloss green | Carboline 858 Zinc Primer Epoxy & Pipe Clad 2000 Epoxy | - | - | - | Glossy, no rusting. |
| 390883-9 | 6" x 6", thin, gloss black | Trenchcoat over Galvanized Coil | Glossy, one small rust spot at left center of side A. | Glossy, one small rust spot at left center of side A. | - | Glossy, one small rust spot at left center of side A. |
| 390883-10 | 6" x 6", thin, gloss black | Trenchcoat over Galvanized Coil | - | - | - | Glossy, with some small flat areas. One small rust spot at top right corner of side B. |
| 390883-11 | 6" x 6", thin, gloss black | Trenchcoat over Galvanized Coil | Glossy, with some small flat areas. Four small rust spots at top half of side A. | Glossy, with some small flat areas. Four small rust spots at top half of side A. | Glossy, with some small flat areas. Four small rust spots at top half of side A. | Glossy, with some small flat areas. Four small rust spots at top half of side A. |
| 390883-12 | 8.5" x 6", thin, gloss black | Trenchcoat over Galvanized Coil | - | - | - | Glossy, with some small flat areas. No rusting. |