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TEST CERTIFICATE – EAR-CONTROLLED DATA

Date: January 5, 2018
 P.O. No.: 2017PO1009_01
 Report No.: ENB023380P

Subject: Cyclic Corrosion per SAE J2334

Summary of Sample Identification

Sample ID:	EP	9 Coated Panels
	WP	9 Coated Panels
Test Specifications:	SAE J2334	

Summary of Testing and Results

Selected panels per coating group were subjected to gravel impact and scribed prior to placement into the cyclic corrosion chamber. Images of the samples as received and prepared for testing can be found in Figures 1 through 6.

Test Method	EP	WP	Figures
Unbreached Coating (Control)	3 Coated Panels	3 Coated Panels	1 & 2
	Panel ID: 1, 2 & 3	Panel ID: 1, 2 & 3	
ASTM D3170 (Gravelometer Impact)	3 Coated Panels	3 Coated Panels	3 & 4
	Panel ID: 4, 5 & 6	Panel ID: 4, 5 & 6	
ASTM D1654, Procedure A	3 Coated Panels	3 Coated Panels	5 & 6
	Panel ID: 7, 8 & 9	Panel ID: 7, 8 & 9	

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Signed:

Michael Miljan
 Project Manager

Panel samples were subjected to Gravelometer impact per the requirements of ASTM D3170. Testing consisted of the impact of one pint of gravel per sample at a 90° orientation at a temperature of 23 °C.

Selected samples were also scribed in accordance with ASTM D1654 Procedure A. The scribe was a minimum of 4” long and performed vertically on the panels.

The panels were evaluated following cyclic corrosion exposure per the requirements of SAE J2334 for 60 cycles (1440 hours), using a salt solution per SAE J2721 corrosion test solution No. 6, Solution B for Chassis and wheel-end testing. The samples were orientated at 15 to 30 degrees from vertical during exposure. The test was conducted in a Q-Fog Cyclic Corrosion Tester, Serial No. 95-1286-19-CCT600, in accordance with SAE J2334, which specifies one cycle consisting of a 6-hour humidity exposure at 50 °C and 100% humidity, 15-minute salt mist at ambient temperature, followed by a 17-hour and 45-minute dry off phase at 60 °C and 50% relative humidity. The application of the salt solution was performed through an air atomized fog method.

Following 60 cycles the samples were rinsed with DI water and allowed to air dry. The specimens were visually evaluated for blistering and corrosion.

Following corrosion exposure the scribe lines were scraped in accordance with ASTM D1654, Method 2. A rating number was determined after identifying the maximum amount of creepage (or loss of paint after scraping) in millimeters from 3 readings along the scribe line on each evaluated sample. Observations and test results can be found in Tables 3 through 8.

Corrosion coupon mass loss data can be found in Table 1. Conductivity and pH of the salt solution was conducted initially and at the conclusion of 60 cycles as shown in Table 2. Images of the specimens following exposure can be found in Figures 7 through 9.

Table 1 – Corrosion Coupon Mass Loss Data

Coupon #	Cycles	Initial (g)	Final (g)	Mass Loss (g)
E621	20	29.8039	26.9845	2.8194
E622	40	29.7168	24.0808	5.6360
E626	60	29.8241	21.3630	8.4611
E632	80	29.8236	18.5436	11.2800
E633	100	29.8174	16.6090	13.2084
E636	120	29.8378	15.1780	14.6598

Table 2 - Salt Solution Evaluation

Evaluation Method	Initial	Final
pH at 25 °C.	7.01	7.15
Conductivity (mS) at 25 °C.	10.17	10.01

Table 3 – Unbreached Coating (Control) Observations Following Cyclic Corrosion

Sample ID		Blisters	Corrosion	Figure
EP	1	No blisters observed	Red rust corrosion observed on panels edges only	7
	2	No blisters observed	Red rust corrosion observed on panels edges only	
	3	No blisters observed	Red rust corrosion observed on panels edges only	
WP	1	No blisters observed	Red rust corrosion observed on panels edges only	
	2	No blisters observed	Red rust corrosion observed on panels edges only	
	3	No blisters observed	Red rust corrosion observed on panels edges only	

Table 4 – Unbreached Coating (Control) Test Results Following Cyclic Corrosion

Sample ID		Area Failed, %	Rating Number
EP	1	No Failure (No corrosion on significant surface)	10
	2	No Failure (No corrosion on significant surface)	10
	3	No Failure (No corrosion on significant surface)	10
WP	1	No Failure (No corrosion on significant surface)	10
	2	No Failure (No corrosion on significant surface)	10
	3	No Failure (No corrosion on significant surface)	10

ASTM D1654, Procedure B, Rating of Unscribed Areas

Table 5 – ASTM D3170 (Gravelometer Impact) Observations Following Cyclic Corrosion

Sample ID		Blisters	Corrosion	Figure
EP	4	Severe blistering originating from gravel impact locations	Red rust originating from gravel impact locations	8
	5	Severe blistering originating from gravel impact locations	Red rust originating from gravel impact locations	
	6	Severe blistering originating from gravel impact locations	Red rust originating from gravel impact locations	
WP	4	Severe blistering originating from gravel impact locations	Red rust originating from gravel impact locations	
	5	Severe blistering originating from gravel impact locations	Red rust originating from gravel impact locations	
	6	Severe blistering originating from gravel impact locations	Red rust originating from gravel impact locations	

Table 6 – ASTM D3170 (Gravelometer Impact) Test Results Following Cyclic Corrosion

Sample ID	No. of Chips	Rating Number	Size of Chips	Rating Letter	
EP	4	25-49	5	1-3 mm	B
	5	50-74	4	1-3 mm	B
	6	75-99	3	1-3 mm	B
WP	4	25-49	5	1-3 mm	B
	5	25-49	5	1-3 mm	B
	6	25-49	5	1-3 mm	B

Table 7 – ASTM D1654, Procedure A Observations Following Cyclic Corrosion

Sample ID	Blisters		Figure
EP	7	Severe blistering originating from scribe line	9
	8	Severe blistering originating from scribe line	
	9	Severe blistering originating from scribe line	
WP	7	Severe blistering originating from scribe line	
	8	Severe blistering originating from scribe line	
	9	Severe blistering originating from scribe line	

Table 8 – ASTM D1654, Test Results Following Cyclic Corrosion

Sample ID	Mean Creepage from Scribe, mm	Rating Number	Area Failed, %	Rating Number	
EP	7	12	2	No Failure (No corrosion on significant surface)	10
	8	0	10	No Failure (No corrosion on significant surface)	10
	9	7	4	No Failure (No corrosion on significant surface)	10
WP	7	8	3	No Failure (No corrosion on significant surface)	10
	8	0	10	No Failure (No corrosion on significant surface)	10
	9	0	10	No Failure (No corrosion on significant surface)	10

ASTM D1654, Procedure A, Method 2 (Scraping of scribe line)
ASTM D1654, Procedure B, Rating of Unscribed Areas

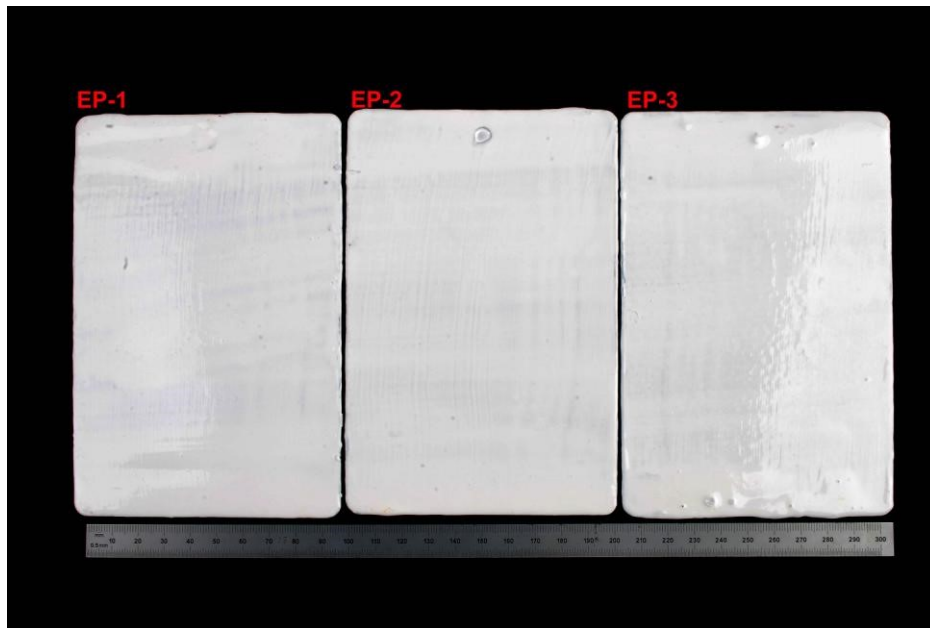


Fig. 1 The “EP” Unbreached Coating (Control) panels are shown as received.

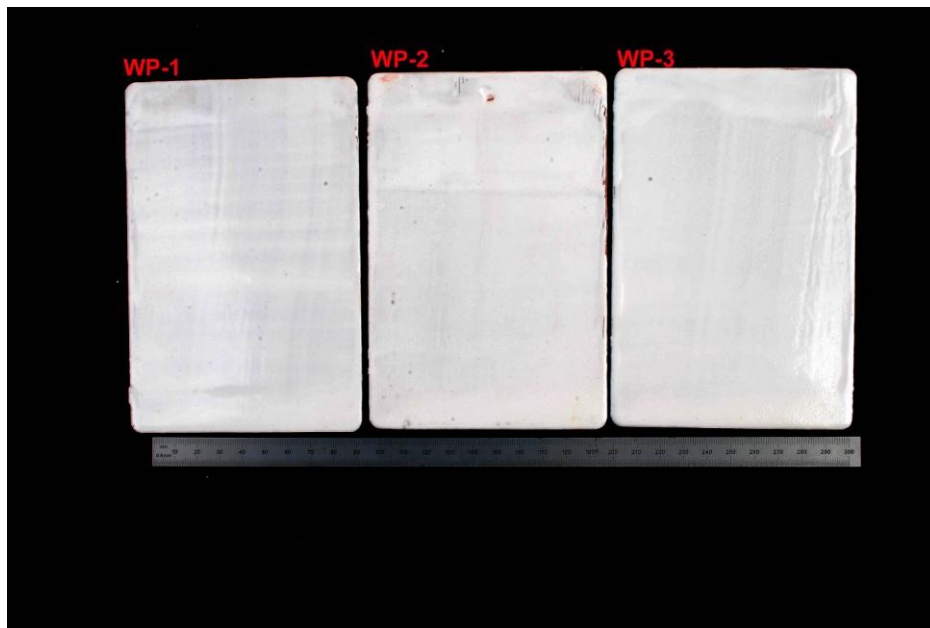


Fig. 2 The “WP” Unbreached Coating (Control) panels are shown as received.

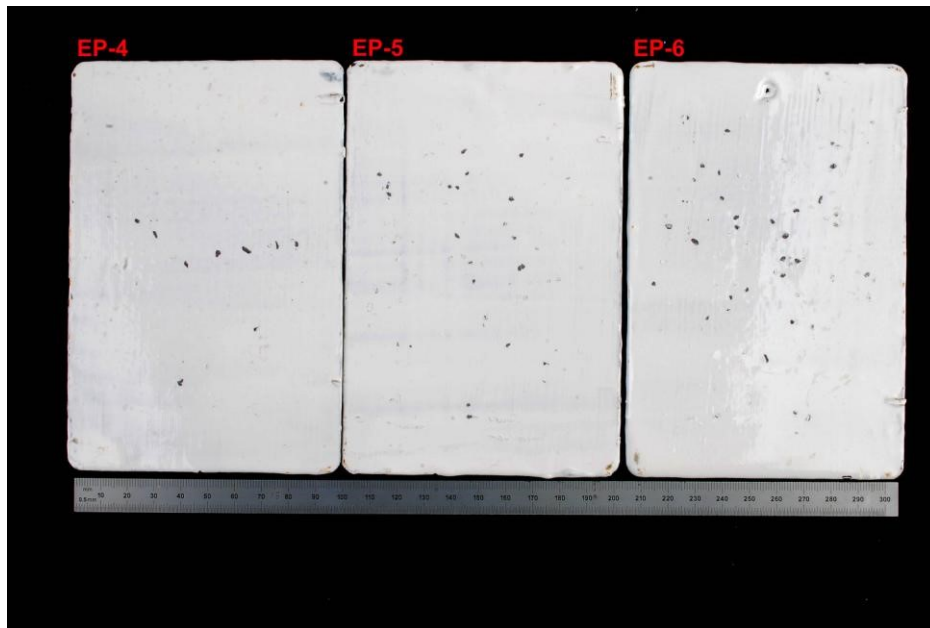


Fig. 3 The “EP” panels are show following Gravelometer impact.

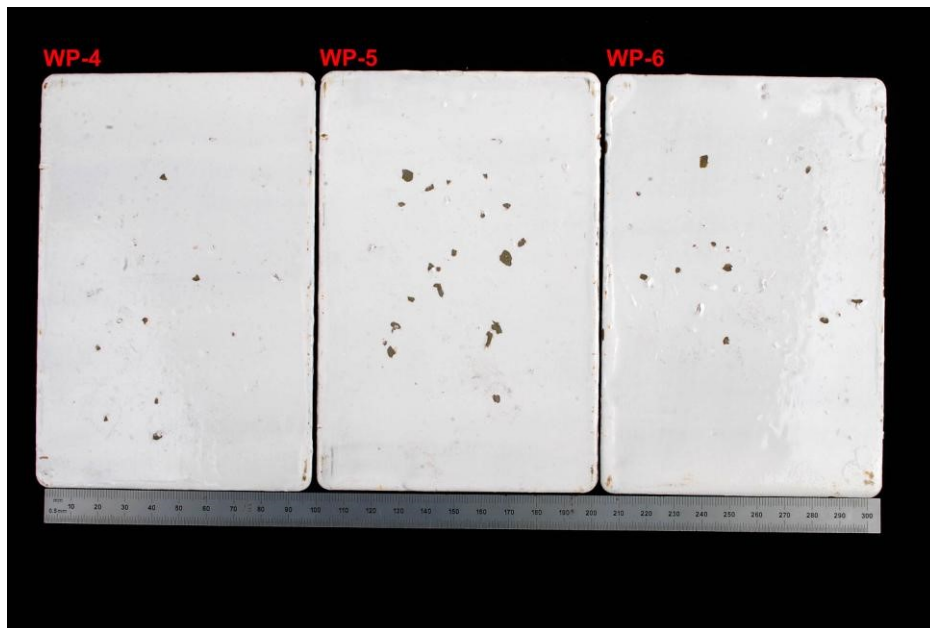


Fig. 4 The “WP” panels are show following Gravelometer impact.

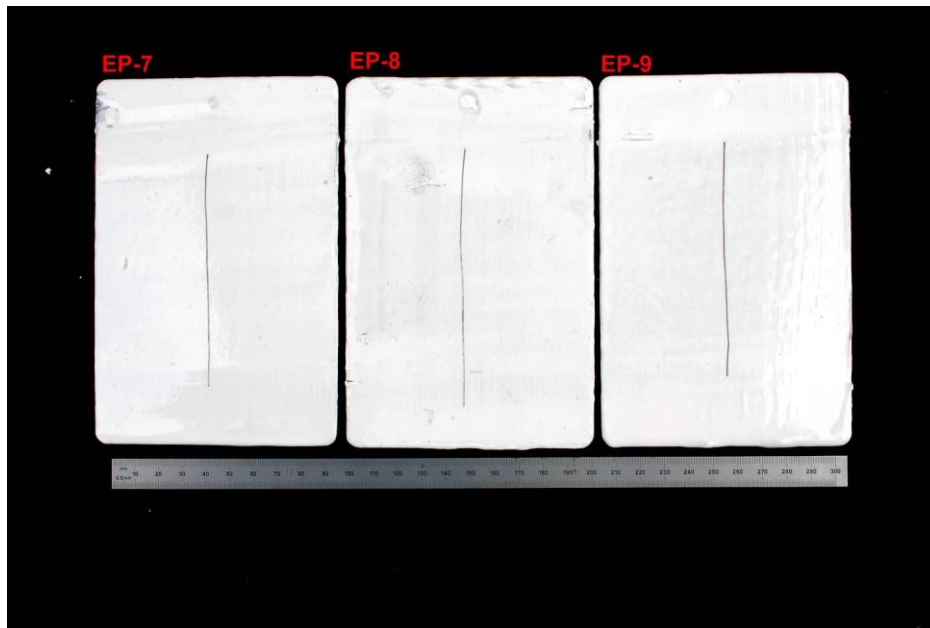


Fig. 5 The “EP” panels are show following ASTM D1654 scribe procedure.

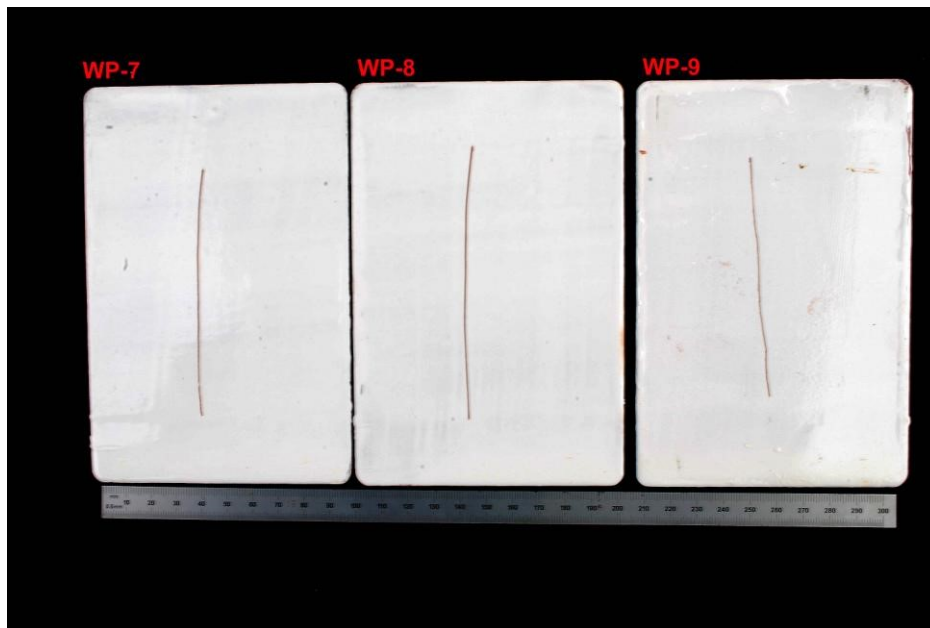


Fig. 6 The “WP” panels are show following ASTM D1654 scribe procedure.



Fig. 7 The “EP and WP” Unbreached Coating (Control) panels are shown following cyclic corrosion.

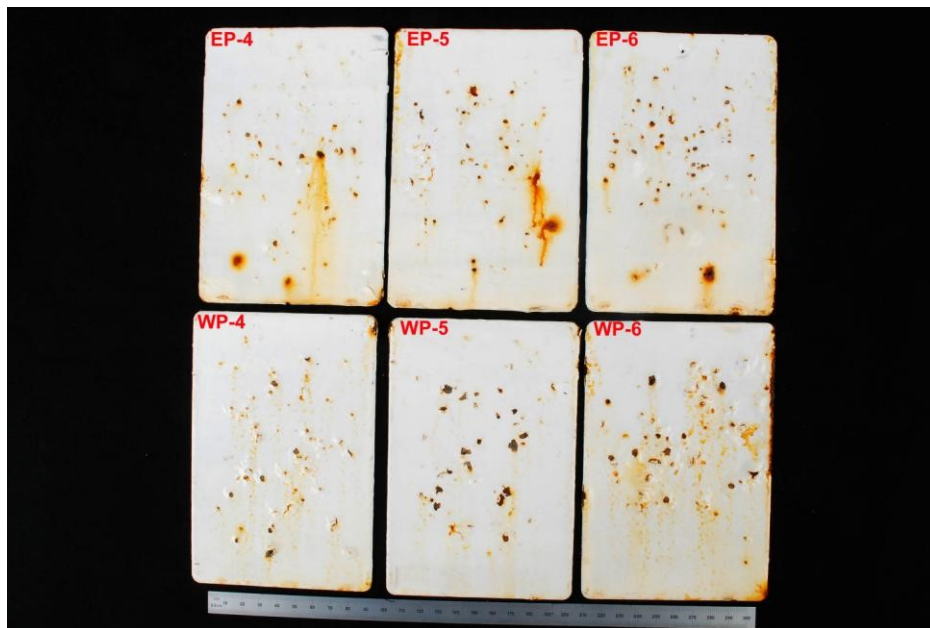


Fig. 8 The “EP and WP” Gravelometer impacted panels are shown following cyclic corrosion.

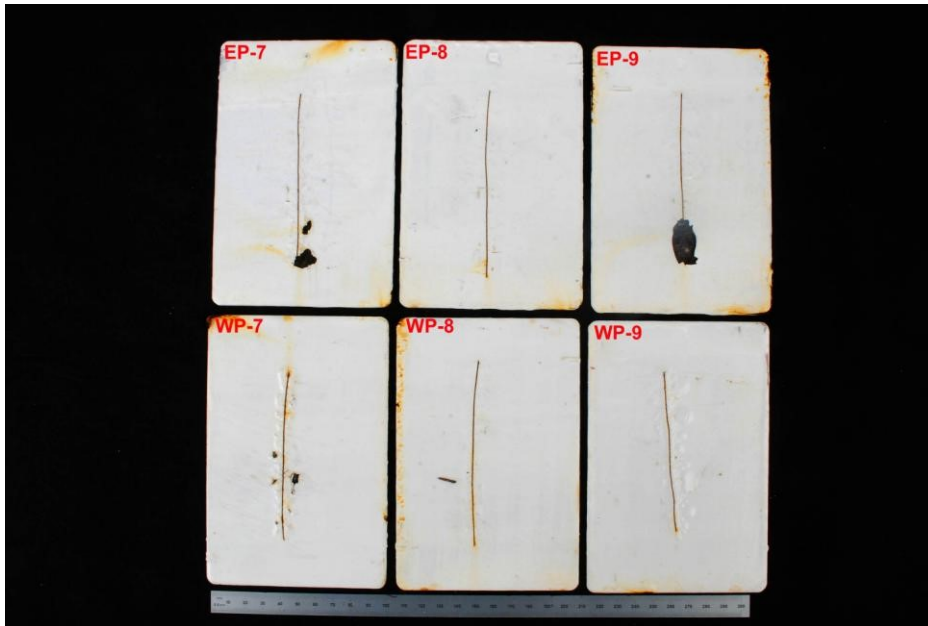


Fig. 9 The “EP and WP” ASTM D1654 scribed panels are shown following cyclic corrosion and Procedure A, Method 2 (Scraping of scribe line).