November 1, 2019

The SAE Product Specification Manual – ConduDisc® Version 1.5 contains specifications, drawings and test reports for the design and construction of the SAE ConduDisc®.

The SAE ConduDisc® is designed and manufactured to comply with CSA Standards C22.2 No. 41-13 Section 6.10.4.1 and No. 65-13 Section 9.1.10.2 and as such meets the ESA Technical Guideline for Section 6 "Approval of Electrical Equipment" with regards to Ontario Regulation 22/04.

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CONDUDISC®

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PRODUCT SPECIFICATION MANUAL – CONDUDISC® VERSION 1.5

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Contents

Standards Met by Encapsulated Galvanized Steel Grounding Plate

ASTM Standards

1) ASTM A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
    - This specification covers the standard requirements for hot-dip galvanized zinc coatings on iron and steel products made from rolled pressed and forged shapes, castings, plates, bars, and strips. This specification deals with both unfabricated products and fabricated products, for example, assembled steel products, structural steel fabrications, large tubes already bent or welded before galvanizing, and wire work fabricated from uncoated steel wire. Also covered here are steel forgings and iron castings incorporated into pieces fabricated before galvanizing or those too large to be centrifuged (or otherwise handled to remove excess galvanizing bath metal).

2) ASTM A153/A153M: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
    - This specification covers standards for zinc coatings applied through hot-drip process on iron and steel hardware. The hot-dip galvanizing process shall form layers of Zn/Fe alloy adhering to the steel surface. This specification is applicable to steel hardware items of Classes A, B, C, and D. The thickness or weight/mass of zinc coating shall conform to specified values for various classes of materials. The coated articles shall be free from uncoated areas, blisters, flux deposits, dross inclusions, and other defects. The coating shall be smooth and reasonable uniform in thickness. Tests shall be performed to determine the minimum coating weight or minimum coating thickness, finish and appearance, embrittlement, adherence, average weight/mass of coating, and average thickness of coating. Guidelines are also given for inspection, rejection and retest, packaging, and certification procedures.

CSA Standards

Galvanized Steel Plate components and assembly procedures follow strict CSA Standards as outlined in CAN/CSA-C22.2 No. 65-13 Section 9.1.10.2 and CAN/CSA-C22.2 No. 41-13 Section 6.10.4.1.

No. 65-13 Section 9.1.10.2 The following hardware shall be used to make the connections mentioned in 9.1.10.1; once the initial assembly is completed, there shall be no subsequent retightening:

a) A bolt shall be plated steel, SAE Grade 2, UNC thread having a maximum standard diameter compatible with the hole or holes in the connector tang and a minimum standard length allowing at least a 2-thread projection through the nut, and the projection shall not exceed 6.4 mm (1/4 in.) after assembly.

b) A single flat washer shall be used on each side of the tang-to-tang or tang-to-bus connection. These washers shall be plated steel having an SAE configuration compatible with the diameter of the bolt.

c) A nut shall be plated steel, and shall have a Class 2B, UNC and a hexagonal configuration.

d) Clean, dry, nonlubricated screws and bolts and nuts shall be used.

e) The assembled hardware shall be torqued to the values in Table 24. (8 N·m for a ¼" screw or bolt)

No. 41-13 Section 6.10.4.1 A plate electrode shall

a) be not less than 6.4 mm (1/4 in) in thickness if of iron or steel, or 1.5 mm (0.06 in) if of nonferrous metal, other than aluminum;

b) have a total surface area of not less than 0.186 m^2 (2 ft^2);

c) if provided with a means of connection to the system grounding conductor, have connections that comply with the requirements of Clauses 6.1.3, 7.1, and 7.5; and

d) shall be marked in accordance with Clause 10.10.

Specifications

ConduDisc®

Physical	Typical Value	Unit	Test Method
Physical State	Black solid		
Odor	None		
Water Permeability	1.72 x 10^{-7}	cm/s	ASTM D5084 (2.6 psi)
Flammability	No ignition		Exposed to a propane torch (~2000 ^{o}C) for 60 seconds
Electrolytic corrosion resistance			
Steel	98.09	%	SAE Inc. Standard 100
Galvanized Steel	99.91	%	
Copper	100	%	
Environmental Impact	Neutral		Ontario Regulation 558/00
Freeze-Thaw Withstand	30	years	SAE Inc. Standard 102

Mechanical	Typical Value	Unit	Test Method
Elastic Compression			
7000 kg	2.2 (4.3)	mm (%)	
12 000 kg	2.6 (5.1)	mm (%)	SAE Inc. Standard 103
14 500 kg	3.0 (5.9)	mm (%)	
16 771 kg	3.1 (6.1)	mm (%)	
Maximum Load Applied	16 771	kg	SAE Inc. Standard 103

Electrical	Typical Value	Unit	Test Method
Electrical Resistivity	30.39	ohm·cm	SAE Inc. Standard 105
Electrical Resistance	0.031	ohms	SAE Inc. Standard 105

Fault Current Withstand

RMS Current (A)	RMS Voltage (kV)	Resistance Before Test (mΩ)	Resistance After Test (mΩ)	Approximate Temperature Rise (^{o}C)	Test Duration (milliseconds)
1040	19.5	30.6	20.3	1	508
2520	124.0	55.5	20.2	2	508
3730	239.0	44.9	46.0	13	234
4990	176.0	34.6	7.28	1	508

ConduDisc® Freeze-Thaw Testing: Results and Analysis

Contents

1.0 Abstract

The behaviour of the ConduDisc® material under freeze-thaw conditions is analyzed in this report. Due to the uniqueness of the material, a combination of studies and standards for similar materials were used to develop an appropriate test procedure. The test procedure involved the rapid freezing and thawing of samples with varying water and salt-water exposure. The samples were studied over 90 freeze-thaw cycles, which is equivalent to 30 years of freeze-thaw withstand.

The mass results of the 90 freeze-thaw cycles for the ConduDisc® indicate that physically none of the samples were adversely affected by freezing. The dry samples and the wet samples all experienced minor fluctuations in their masses during the 90 freeze-thaw cycles however, these were determined not to be a cause for concern since the samples are all within 6 g of the initial mass conditions. The freshwater submerged samples and the saltwater submerged samples all experienced a relatively steady increase in mass as the samples absorbed water. This increase in mass of the submerged samples does not indicate that the samples were adversely affected by the freeze-thaw testing since the samples followed the same trend with no major deviations.

The resistance results of the ConduDisc® agree with the mass results that no degradation of the samples occurred. All of the samples either returned to their initial resistance values or became more conductive over the 90 freeze/thaw cycles. Any spikes in the resistance of the dry and soaked/wet samples was during freeze measurements and the resistance always dropped during the subsequent thaw measurement. An increase in the conductivity of the ConduDisc® samples after freeze-thaw testing is a very positive outcome and indicates that ConduDisc® surround material improves as freeze-thaw cycling occurs.

Both the mass and resistance results strongly indicate that the ConduDisc® will continue to perform in situ for at least 30 years with no degradation due to freezing and thawing experienced during winter conditions.

2.0 Test Method

2.1 Background and Development

The freeze-thaw stability testing of any product is a topic of great debate, resulting in varying standards and practices even for commonly tested materials such as concrete. Due to its composition and properties the ConduDisc® cannot be closely compared with other materials that are tested for freeze-thaw stability or withstand. This study aims to estimate the material's freeze-thaw behaviour.

Most existing test methods for building materials were deemed not entirely appropriate for the testing of the ConduDisc® material. "Masonry: Research, Application, and Problems" (Grogan and Conway) was used as a starting point for the development of the freeze-thaw testing of the ConduDisc® material. According to Grogan and Conway, a realistic freeze-thaw test method includes subjecting samples to 90 freeze-thaw cycles, which equates to 30 years of exposure to an extreme environment. It is also suggested in the same literature that three freeze-thaw cycles is to be the equivalent of one year of natural weathering.

2.2 Experimental Design

The largest factors in freeze-thaw behaviour include freeze-thaw rate and exposure to water. To account for the most extreme cases, samples were frozen and thawed as quickly as possible. The exposure to water was also varied. The conditions for each sample are summarized in Table 2.2.1.

Table 2.2.1: Test Conditions for ConduDisc® Samples

Sample	Condition
1, 2	Dry
3, 4	Soaked in water, removed prior to freeze cycle
5, 6	Completely submerged in freshwater
7, 8	Completely submerged in saltwater

One freeze-thaw cycle in this study was defined as a freeze period for 16 hours +/- 2 hours, a thaw period for 24 hours +/- 2 hours, then samples 3 and 4 were soaked in water for 5 – 7 hours and a new cycle began with the freeze period. Testing of these samples continued until 90 freeze-thaw cycles had been completed, roughly equating to 30 years of exposure to an extreme environment.

3.0 Results

3.1 Test Conditions

The ConduDisc® is expected to face significant exposure to water in-situ. Thus, emphasis is placed on the material's ability to withstand freezing and thawing conditions in water.

Samples 1 through 8 were half-disc samples of the ConduDisc® material, with approximately 2.0'' radius and 1.0'' thickness. The initial measurements of each sample are listed in Table 3.1.1.

Table 3.1.1: Initial Measurements of ConduDisc® Samples

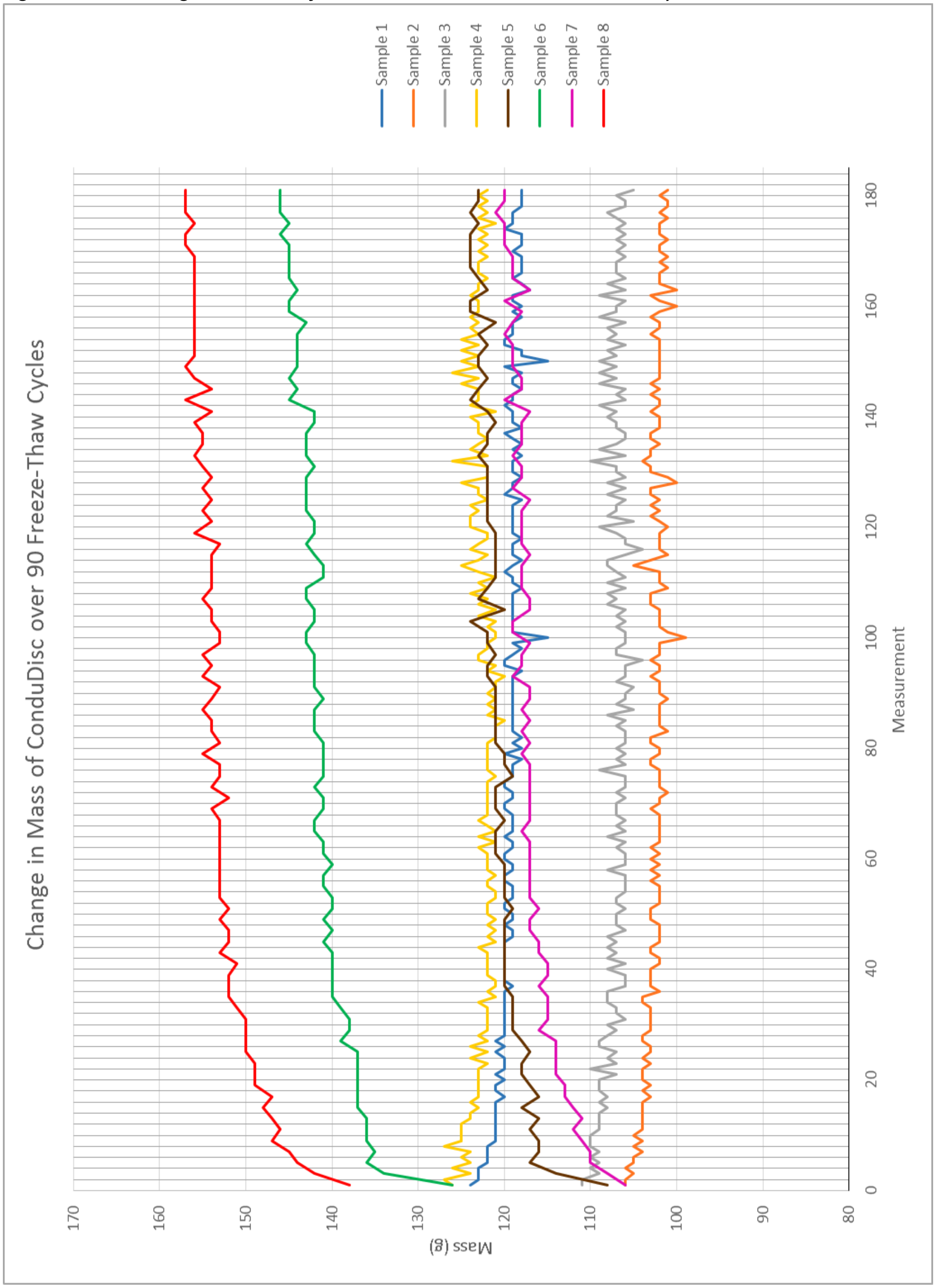
Sample	Date	Temperature (°C)	Resistance (Ω)	Mass (g)	System mass* (g)
1	Oct. 16/2017	15.4	6.0	124	-
2	Oct. 16/2017	15.4	5.7	106	-
3	Oct. 16/2017	15.2	6.0	111	-
4	Oct. 16/2017	15.1	6.1	126	-
5	Oct. 16/2017	15.1	6.0	108	1058
6	Oct. 16/2017	14.4	5.5	126	1058
7	Oct. 16/2017	14.3	5.7	106	1069
8	Oct. 16/2017	14.3	5.4	138	1069

**System mass is defined as the combined mass of the samples, water, and container.*

The test procedure was followed immediately after initial measurements were taken. The measurements were taken during each freeze or thaw period and the results were analyzed at the 90-cycle mark.

3.2 Changes in Mass over 90 Freeze-Thaw Cycles

Figure 3.2.1: Changes in Mass of ConduDisc® over 90 Freeze-Thaw Cycles



Analysis:

The physical condition of the sample serves as the best indicator of freeze-thaw stability. Ideally, no changes to the appearance of the material should be observed. Cracking and other physical damage should not be observed. The mass of the samples may be used as another indicator of freeze-thaw stability; large deviations from the original mass of the sample signal material instability. Finally, the samples should not experience extreme deviations in resistance readings. Note that the vertical lines in Figure 3.2.1 above indicate data obtained during a freeze period, and the spaces between the vertical lines indicate thaw periods.

For the dry samples (1 and 2), the mass did fluctuate on occasion, however these fluctuations were small and were likely due to the inherent scale error, it is accurate to +/- 1 g. The data for these samples indicates that both samples lost a small amount of mass over the 90 cycles, however this loss in mass was only 6 g or 4.8% for sample 1 and 5 g or 4.7% for sample 2 and does not indicate that the samples were adversely affected by freezing.

For the wet samples (3 and 4), the mass generally increased when measured after a freeze cycle, since these samples were soaked in water prior to freezing, this indicates that some water is absorbed. The samples expelled the water and returned to approximately their initial mass or lower during thaw periods. There were periods when both samples experienced no change in mass between freeze and thaw cycles which indicated that no water was absorbed or expelled by the samples at this time.

The two samples submerged in freshwater (5 and 6), demonstrate a relatively steady increase in mass as the samples absorbed water for the first 15 cycles. During the remaining 75 cycles the samples still demonstrated an increase in mass as the samples absorbed water however the rate of water absorption had significantly decreased, the samples appeared to be approaching constant mass. These samples can only be measured during thaw cycles since they are frozen in their containers during freeze cycles. The increase in the mass of the submerged samples does not indicate that the samples were adversely affected by the freeze-thaw testing since there were no significant deviations from the trend. Both of the samples had absorbed a similar amount of water after the 90 cycles. Sample 5 had increased in mass by 15 g or 13.9% and sample 6 had increased in mass by 20 g or 15.9%.

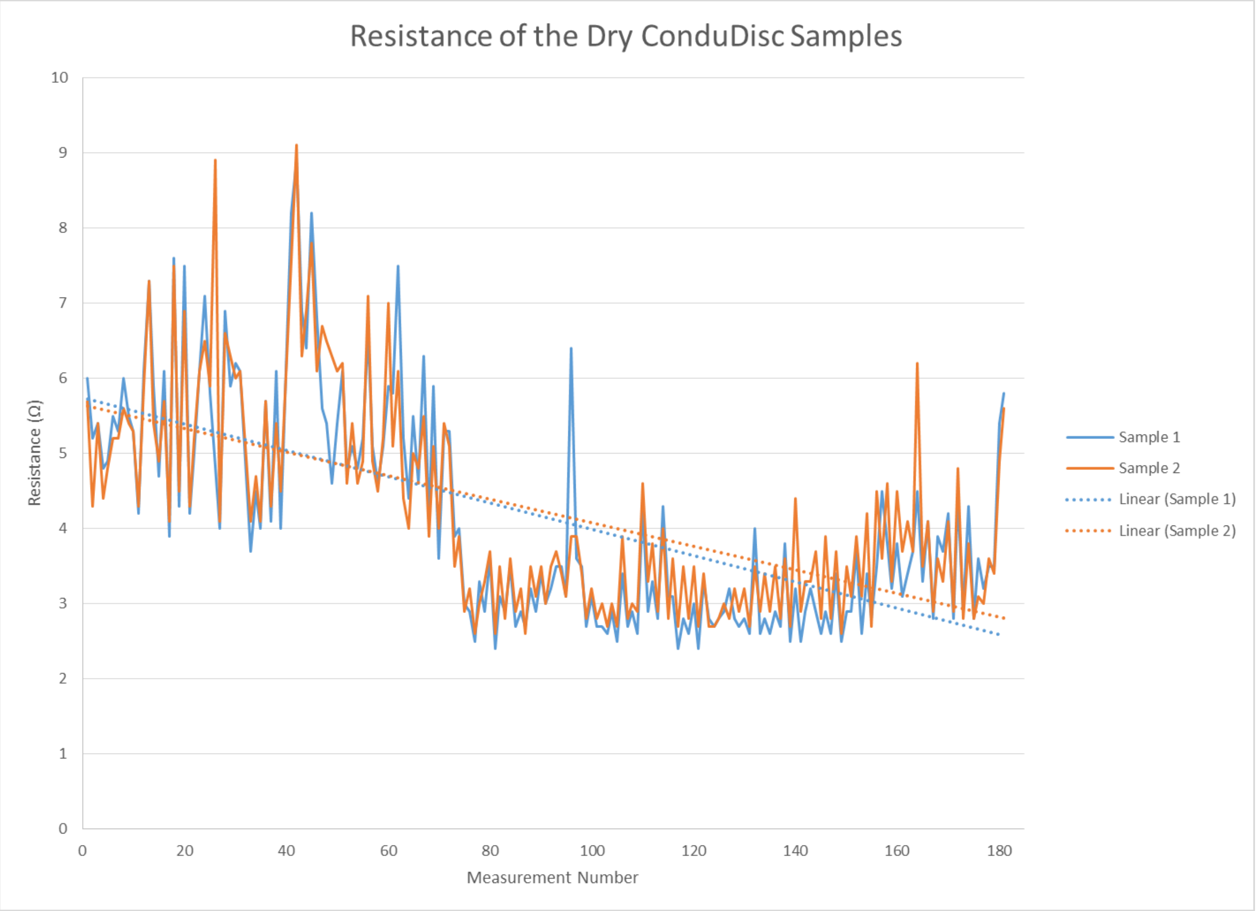
The two samples submerged in saltwater (7 and 8), also demonstrate a relatively steady increase in mass as the samples absorbed water for the first 15 cycles. During the remaining 75 cycles the samples still demonstrated an increase in mass as the samples absorbed water however the rate of water absorption had significantly decreased, the samples appeared to be approaching constant mass. These samples were also only measured during thaw cycles since they were frozen in their containers during freeze cycles. The increase in mass of the samples does not indicate that the samples were adversely affect by the freeze-thaw testing since there were no significant deviations from the trend. Both of the samples had absorbed a similar amount of water after the 90 cycles. Sample 7 had increased in mass by 14 g or 13.2% and sample 8 had increased in mass by 19 g or 13.8%.

None of the samples in this study experienced any change in the appearance of the material after 90 freeze-thaw cycles. No cracking or other physical damage to the samples was observed.

One month after testing of the ConduDisc® samples was completed the samples were analyzed. The dry samples, 1 and 2, had not changed from the final reading after 90 cycles and had lost 6 g (4.8%) and 5 g (4.7%) respectively from their initial mass. The wet samples, 3 and 4, had also only experienced a small change in mass from their initial values. Sample 3 was still the same value as the final reading after 90 cycles and had lost 6 g (5.4%) from its initial mass. Sample 4 had lost 2 g of water mass since the final reading after 90 cycles and had lost a total of 6 g (4.8%) from its initial value. All of the submerged samples, freshwater and saltwater, had lost all of the water mass they absorbed during the testing and were slightly lower than their initial mass. Sample 5 was 6 g (5.6%) lower than its initial mass, sample 6 was 6 g (4.8%) lower than its initial mass. Sample 7 was 6 g (5.7%) lower than its initial mass, sample 8 was 7 g (5.1%) lower than its initial mass.

3.3 Resistance Measurements over 90 Freeze-Thaw Cycles

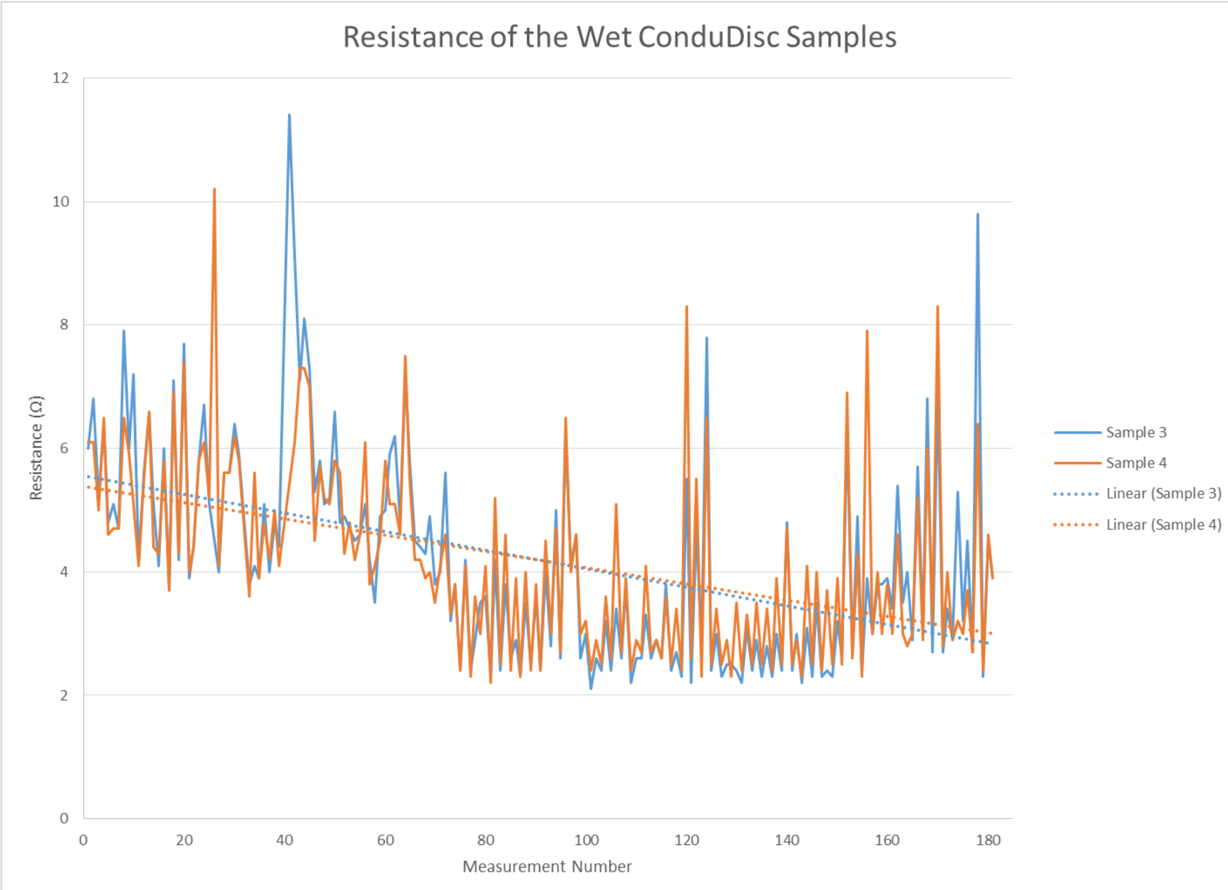
Figure 3.3.1: Resistance Trends of the Dry ConduDisc® Samples



Analysis:

Both dry ConduDisc® samples demonstrated very similar resistance trends. There were fluctuations between the resistances of the samples when measured during a freeze cycle or a thaw cycle. In general, both dry ConduDisc® samples were more resistive when frozen and less resistive when thawed. After 90 cycles the resistance of both dry ConduDisc® samples was slightly lower than their initial values, sample 1 had decreased in resistance by 0.2 ohms (3.3%), and sample 2 had decreased in resistance by 0.1 ohms (1.8%). One month after testing of the samples was complete the resistance was checked. The samples had decreased in resistance significantly, sample 1 was 3.4 ohms (56.7%) lower than the initial resistance and sample 2 was 2.9 ohms (50.9%) lower than the initial resistance. This is a very positive result, indicating that the performance of the samples is not negatively affected, and actually improves when subjected to the freeze-thaw conditions. The less resistive the samples are, the easier the flow of electrons through the material to ground.

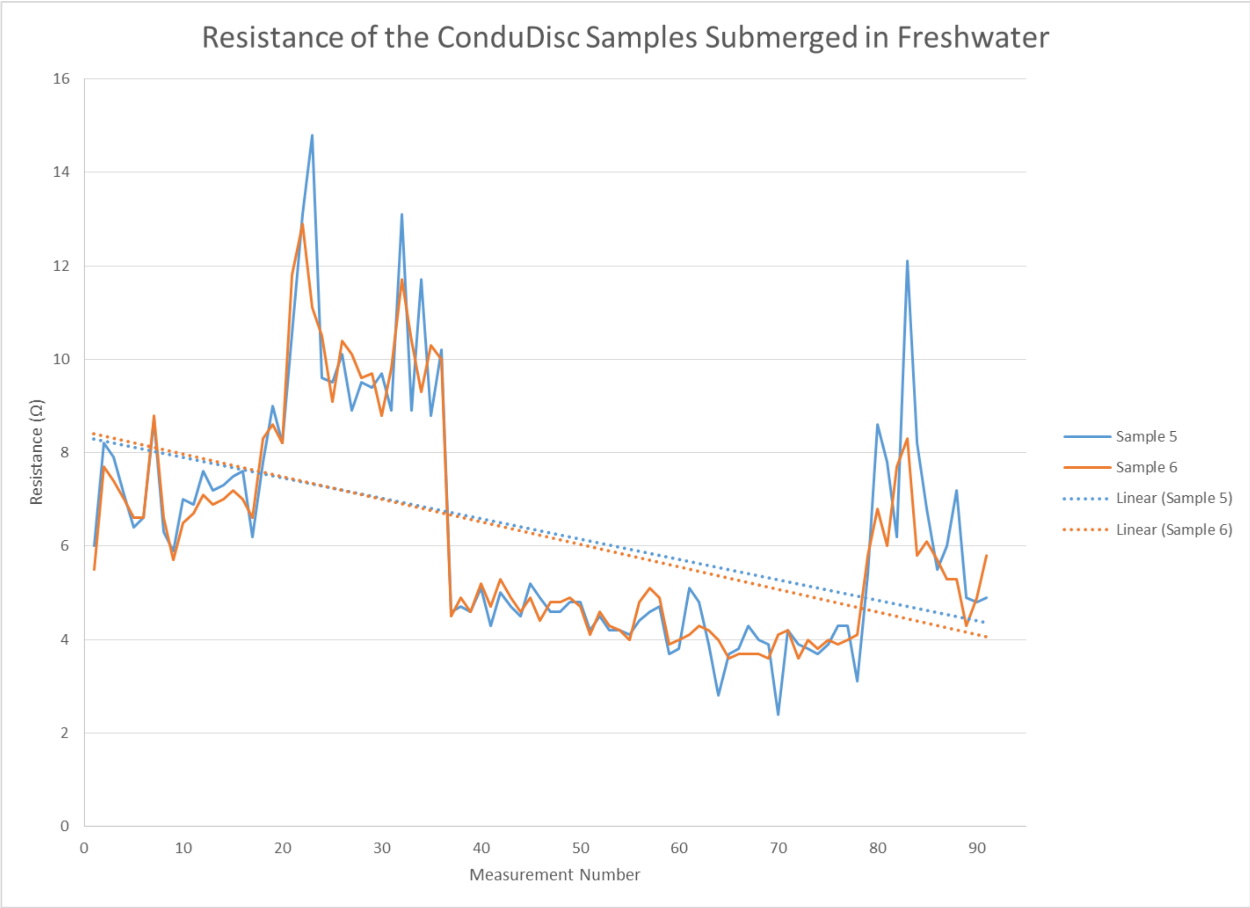
Figure 3.3.2: Resistance Trends of the Wet ConduDisc® Samples



__Analysis:__

Both wet ConduDisc® samples demonstrated very similar resistance trends. There were fluctuations between the resistances of the samples when measured during a freeze cycle or a thaw cycle. In general, both wet ConduDisc® samples were more resistive when frozen and less resistive when thawed. After 90 cycles the resistance of both wet ConduDisc® samples had decreased by approximately 2.1 ohms (35%). One month after testing of the samples was complete the resistance was checked. The samples further decreased in resistance from their initial values, sample 3 was 3.8 ohms (63.3%) lower than the initial resistance and sample 4 was 4.0 ohms (65.6%) lower than the initial resistance. This is a very positive result, indicating that the performance of the samples improved when subjected to the freeze-thaw conditions. The more conductive the samples are, the easier the electrons flow through the material to ground.

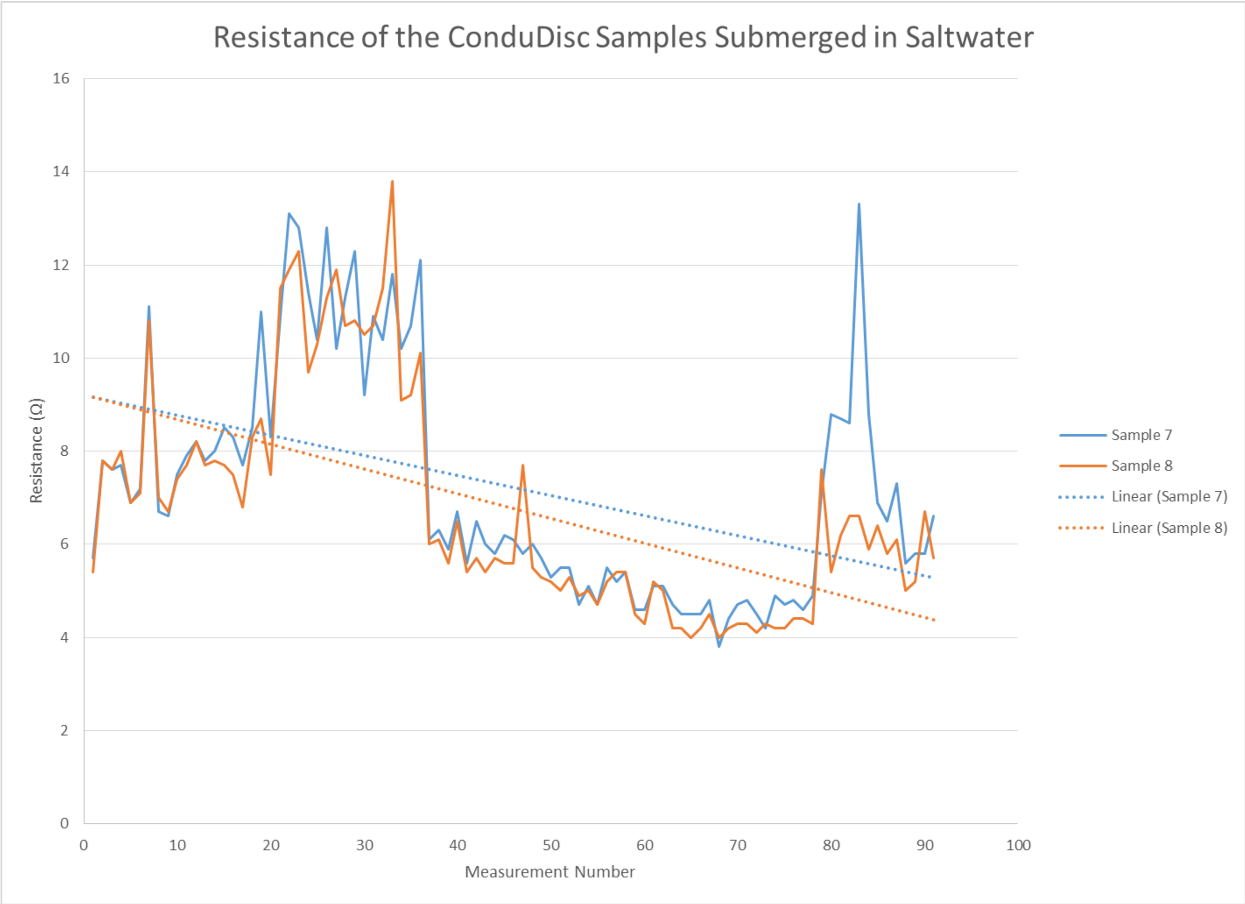
Figure 3.3.3: Resistance Trends of the Submerged Freshwater ConduDisc® Samples



Analysis:

Both ConduDisc® samples submerged in freshwater demonstrated fairly similar resistance trends. The values shown in Figure 3.3.3 above are the resistance readings taken during the thaw cycles, the samples were frozen in their containers during the freeze cycles and the resistances could not be measured. There were fluctuations in the resistances of the samples however all of the measured values are within +/- 9 ohms of the initial resistance value. After 90 cycles the resistance of ConduDisc® sample 5 submerged in freshwater had decreased by 1.1 ohms (18%) and the resistance of sample 6 submerged in freshwater returned to approximately the original value, it increased by only 0.3 ohms (5.4%), which can be attributed to the method used to measure the resistance. One month after testing of the samples was complete the resistance was checked. The samples further decreased in resistance from their initial values, sample 5 was 4.2 ohms (70.0%) lower than the initial resistance and sample 6 was 3.8 ohms (69.1%) lower than the initial resistance. This is a very positive result, indicating that the performance of the samples improved when subjected to the freeze-thaw conditions. The more conductive the samples are, the easier the electrons flow through the material to ground.

Figure 3.3.4: Resistance Trends of the Submerged Saltwater ConduDisc® Samples



Analysis:

Both ConduDisc® samples submerged in saltwater demonstrated fairly similar resistance trends. The values shown in Figure 3.3.4 above are the resistance readings taken during the thaw cycles, the samples were frozen in their containers during the freeze cycles and the resistances could not be measured. There were fluctuations in the resistances of the samples however all of the measured values are within +/- 8 ohms of the initial resistance value. After 90 cycles the resistance of both ConduDisc® samples submerged in saltwater had returned to roughly the initial resistance value, the small increases in the resistance can be attributed to the method for measuring the resistance. One month after testing of the samples was complete the resistance was checked. The samples had decreased in resistance significantly, sample 7 was 3.9 ohms (68.4%) lower than the initial resistance and sample 8 was 3.6 ohms (66.7%) lower than the initial resistance. This is a positive result, indicating that the performance of the samples improved when subjected to the freeze-thaw conditions. The more conductive the samples are, the easier the electrons flow through the material to ground

4.0 Conclusions

The results of the 90 freeze-thaw cycles when analyzing the changes in mass of the samples indicate that none of the samples were adversely affected by freezing. The dry samples and the wet samples all experienced minor fluctuations in their masses during the 90 freeze-thaw cycles however, these were determined not to be a cause for concern since the samples are all within 6 g of the initial mass conditions. The freshwater submerged samples and the saltwater submerged samples all experienced a relatively steady increase in mass as the samples absorbed water. This increase in mass of the submerged samples does not indicate that the samples were adversely affected by the freeze-thaw testing since the samples followed the same trend with no major deviations. Also none of the samples experienced any physical deterioration in the form of cracking, or other physical damage.

The resistance results agree with the mass results that no degradation of the samples occurred. All of the samples became more conductive or returned to their initial resistance values over the 90 freeze/thaw cycles which is a very positive result. One month after the completion of the testing all of the samples were significantly more conductive than their initial resistance values. This indicates that the performance of the ConduDisc® will improve when subjected to freeze-thaw conditions.

The results of this study strongly indicate that the ConduDisc® will perform in situ for at least 30 years with no significant degradation due to freezing and thawing experienced during winter conditions.

This report is a summary of results generated from testing conducted by SAE Inc. at their Midhurst, ON and Barrie, ON locations. Testing was performed by Chris Allison, R&D Assistant; David Sisti, R&D Assistant; and Caitlin Hughes, R&D Coordinator, from October 16, 2017 to September 28, 2018.

Resistance of Bare and Galvanized Steel Encased in ConduDisc® Surround to Electrolytic Corrosion

Contents

1.0 Introduction

SAE Inc. has developed the ConduDisc®; a conductive grounding plate that dramatically enhances the performance and longevity of utility pole grounding systems. The ConduDisc® grounding plate virtually eliminates electrode corrosion and lasts the life of a utility pole.

In order to determine the effectiveness of the ConduDisc®, the following experiment measuring the electrolytic corrosion resistance of steel and galvanized steel when encased in ConduDisc® surround was conducted.

2.0 Procedure

Four rectangular pieces of steel (approximately 2” x ¾”) were cut using an angle grinder and weighed using an electronic balance. A ¼” hole was drilled into one end of each sample. Two coats of Rustoleum Cold Galvanizing Compound were applied to two of the samples, numbered 7 and 8. These samples were Hot Dip Galvanized at Supreme Galvanizing in Burlington so Rustoleum Cold Galvanizing Compound was only applied to the edges of the samples that had been cut with the angle grinder. Samples 1 and 2 were left ungalvanized.

Lengths of Dual Insulated Wire (HMWPE and Kynar) were attached to each sample by soldering the wire to the steel samples. Rectifier leads were soldered to the end of the samples with no surround material, numbered 1 and 7. Samples 1 and 7 were left bare in the soil, while samples 2 and 8 were encased in ConduDisc® surround. The samples were allowed to cure for 4 weeks prior to the start of the experiment.

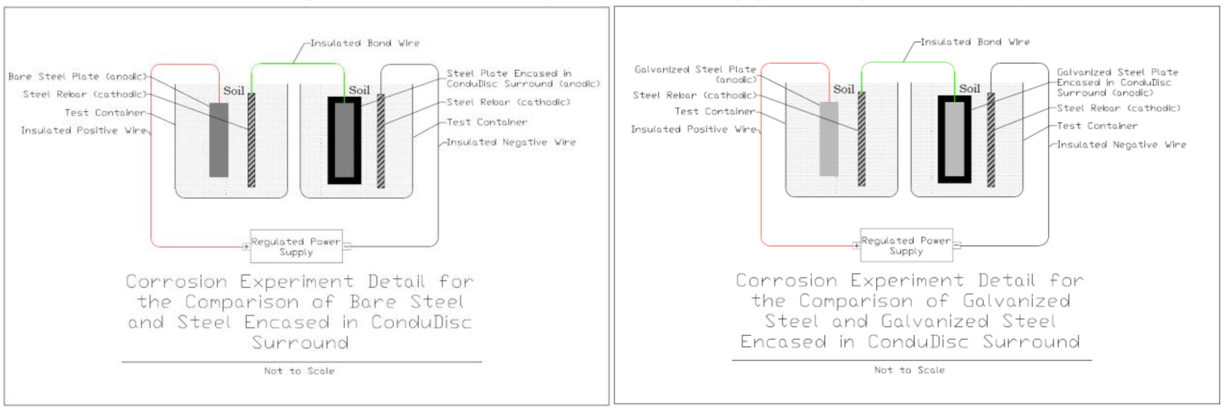
Each of the samples were placed in pails and surrounded with a mixture of top soil and sand. A length of steel rebar was placed in each container approximately six inches from the anode. One liter of water and twenty grams of sodium sulfate was added to each container. Each pair of samples was connected in a series circuit to an individual channel of a 30 V rectifier, to ensure an equal current load.

Figure 1: Sample 1 (left), bare steel, and Sample 7 (right), galvanized steel, prior to Experiment

As seen in Figure 1, sample 1 had begun to corrode prior to the start of the experiment simply due to exposure to the air.

The power source was set to provide 3 mA of current throughout the duration of the test. A schematic of the layouts can be seen below in Figure 2. Two hundred and fifty milliliters of water was added to each pail twice a week to ensure that the soil remained moist. Resistance readings were taken throughout the experiment. All samples were removed from the soil after thirty days, cleaned, and weighed using an electronic balance.

Figure 2: Schematics of the Circuit Configuration for Each Sample



3.0 Results and Analysis

The resistance data for each system was recorded throughout the experiment and can be seen below in Tables 1 and 2.

Table 1: Resistance Data for the Galvanized Steel Samples

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
16-Oct-18	42.79	0.001	42790.00
17-Oct-18	6.428	0.003	2142.67
18-Oct-18	7.714	0.003	2571.33
19-Oct-18	8.248	0.003	2749.33
22-Oct-18	8.602	0.003	2867.33
24-Oct-18	8.701	0.003	2900.33
25-Oct-18	8.823	0.003	2941.00
26-Oct-18	8.879	0.003	2959.67
29-Oct-18	9.000	0.003	3000.00
30-Oct-18	8.795	0.003	2931.67
31-Oct-18	8.825	0.003	2941.67
1-Nov-18	8.865	0.003	2955.00
2-Nov-18	8.989	0.003	2996.33
5-Nov-18	8.992	0.003	2997.33
6-Nov-18	8.561	0.003	2853.67
7-Nov-18	8.617	0.003	2872.33
8-Nov-18	8.752	0.003	2917.33
9-Nov-18	8.877	0.003	2959.00
12-Nov-18	7.909	0.003	2636.33
13-Nov-18	8.654	0.003	2884.67
14-Nov-18	8.911	0.003	2970.33
15-Nov-18	9.093	0.003	3031.00

Table 2: Resistance Data for the Bare Steel Samples

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
16-Oct-18	12.69	0.003	4230.00
17-Oct-18	10.99	0.003	3663.33
18-Oct-18	10.76	0.003	3586.67
19-Oct-18	10.51	0.003	3503.33
22-Oct-18	9.10	0.003	3003.33
24-Oct-18	8.57	0.003	2856.67
25-Oct-18	8.57	0.003	2856.67
26-Oct-18	8.75	0.003	2916.67
29-Oct-18	8.59	0.003	2863.33
30-Oct-18	8.68	0.003	2893.33
31-Oct-18	8.62	0.003	2873.33
1-Nov-18	8.58	0.003	2860.00
2-Nov-18	8.41	0.003	2803.33
5-Nov-18	7.98	0.003	2660.00
6-Nov-18	7.73	0.003	2576.67
7-Nov-18	7.65	0.003	2550.00
8-Nov-18	7.56	0.003	2520.00
9-Nov-18	7.61	0.003	2536.67
12-Nov-18	6.47	0.003	2156.67
13-Nov-18	7.23	0.003	2410.00
14-Nov-18	7.33	0.003	2443.33
15-Nov-18	7.42	0.003	2473.33

After thirty days the experiment was completed and the samples were removed from the soil for analysis. The samples were cleaned and weighed using an electronic balance. As shown in Table 3 and Figure 3 both the bare steel sample in soil, sample #1, and the galvanized steel sample in soil, sample #7, had experienced significant corrosion and consumption of steel. The galvanized steel sample in soil, sample #7, had actually corroded almost twice as much as the bare steel sample #1. This is potentially due to the rapid consumption of the zinc layer as it sacrificed itself to protect the steel underneath. In comparison as show in Table 3 and Figure 4 the bare steel and galvanized steel samples encased in ConduDisc® surround, samples #2 and #8 respectively, experienced minimal changes in mass and there was no visible corrosion on the samples.

Table 3: Percentage of Mass Consumed from Each Sample

Sample	Initial Mass (g)	Final Mass (g)	Mass Difference (g)	Percentage Loss (%)
Bare Steel #1 (Soil)	20.67	19.07	- 1.60	- 7.74
Bare Steel #2 (ConduDisc®)	22.98	22.54	- 0.44	- 1.91
Galvanized Steel #7 (Soil)	24.99	21.02	- 3.97	- 15.89
Galvanized Steel #8 (ConduDisc®)	22.76	22.74	- 0.02	- 0.09

Figure 3: Uncoated Samples, Bare Steel #1 (left) and Galvanized Steel #7 (right), after Experiment

Figure 4: Sample encased in ConduDisc® surround, Bare Steel #2 (left) and Galvanized Steel #8 (right), after Experiment

4.0 Conclusions

This experiment compared the consumption rates of bare and galvanized steel in damp soil at low current to the consumption rates of bare and galvanized steel encased in ConduDisc® surround in damp soil at low current. The bare and galvanized steel samples that were in direct contact with the damp soil both experienced a fairly significant loss in mass at the completion of the test. The bare steel in direct contact with the damp soil had 7.74% of the sample consumed and the galvanized steel in direct contact with the damp soil had 15.89% of the sample consumed after thirty days. In comparison the bare and galvanized steel samples encased in ConduDisc® surround both experienced minimal loss of mass at the completion of the test. The bare steel encased in ConduDisc® surround had 1.91% of the sample consumed and the galvanized steel encased in ConduDisc® surround had 0.09% of the sample consumed after thirty days. Therefore, this experiment demonstrates that applying the ConduDisc® surround significantly and effectively reduces the rate of corrosion of both bare and galvanized steel in buried grounding applications.

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Long Term Resistance of Galvanized Steel Encased in ConduDisc® Surround to Electrolytic Corrosion

Contents

1.0 Introduction

SAE Inc. has developed the ConduDisc®; a conductive grounding plate that dramatically enhances the performance and longevity of utility pole grounding systems. The ConduDisc® grounding plate virtually eliminates electrode corrosion and lasts the life of a utility pole.

In order to determine the effectiveness of the ConduDisc® surround material at preventing corrosion, the following experiment comparing the electrolytic corrosion resistance of galvanized steel when in direct contact with wet, salty soil and when encased in ConduDisc® surround then buried in wet, salty soil was conducted.

2.0 Procedure

Two rectangular pieces of ¼” thick galvanized steel (approximately 3” x ¾”) were cut using an angle grinder. A ¼” hole was drilled into one end of each sample. Two coats of Rustoleum Cold Galvanizing Compound were applied to both of the samples, numbered 5 and 6. These samples were Hot Dip Galvanized at Supreme Galvanizing in Burlington so Rustoleum Cold Galvanizing Compound was only applied to the edges of the samples that had been cut with the angle grinder.

The samples were then weighed using an electronic balance to determine their pre-test weights. Lengths of Dual Insulated Wire (HMWPE and Kynar) were attached to both samples by soldering the wire to the steel samples. A rectifier lead was connected to the end of the sample 5, which had no surround material and was left bare in the soil. Sample 6 was encased in ConduDisc® surround material and allowed to cure for 4 weeks prior to the start of the experiment.

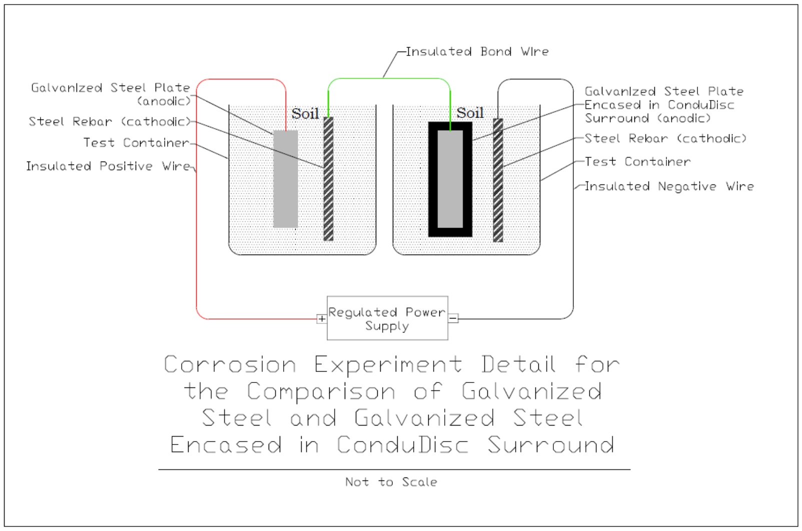
Both of the samples were placed in pails and surrounded with top soil. A length of steel rebar was placed in each container approximately six inches from the galvanized steel samples. One liter of water and twenty grams of sodium sulfate was added to each container. The samples were connected in a series circuit to an individual channel of a 30 V rectifier, to ensure an equal current load.

The power source was set to provide 3 mA of current throughout the duration of the test. A schematic of the layouts can be seen below in Figure 3. Two hundred and fifty milliliters of water was added to each pail twice a week to ensure that the soil remained moist. Resistance readings were taken throughout the experiment. Both samples were removed from the soil after six months, cleaned, and weighed using an electronic balance.

Figure 2: Sample 5 prior to the Experiment

Figure 2: Sample 6 prior to the Experiment

Figure 3: Schematic of the Circuit Configuration



3.0 Results and Analysis

The resistance data for each system was recorded throughout the experiment and can be seen below in Table 1.

Table 2: Resistance Data for the Galvanized Steel Samples

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
29-Apr-19	0.41	0.004	102.50
30-Apr-19	1.04	0.004	260.00
1-May-19	1.25	0.004	312.50
2-May-19	1.50	0.004	375.00
3-May-19	1.66	0.004	415.00
6-May-19	1.85	0.004	462.50
7-May-19	1.84	0.004	460.00
8-May-19	1.88	0.004	470.00
9-May-19	1.91	0.004	477.50
10-May-19	1.91	0.004	477.50
13-May-19	1.95	0.004	487.50
14-May-19	1.91	0.004	477.50
15-May-19	1.92	0.004	480.00
16-May-19	1.92	0.004	480.00
17-May-19	1.95	0.004	487.50
21-May-19	2.00	0.004	500.00
22-May-19	1.98	0.004	495.00
23-May-19	1.99	0.004	497.50
24-May-19	2.00	0.004	500.00
27-May-19	2.00	0.004	500.00

28-May-19	1.99	0.004	497.50
29-May-19	2.01	0.004	502.50
30-May-19	2.02	0.004	505.00
3-Jun-19	2.09	0.004	522.50
4-Jun-19	2.08	0.004	520.00
5-Jun-19	2.09	0.004	522.50
6-Jun-19	2.08	0.004	520.00
7-Jun-19	2.07	0.004	517.50
10-Jun-19	2.05	0.004	512.50
11-Jun-19	2.04	0.004	510.00
12-Jun-19	2.06	0.004	515.00
13-Jun-19	2.06	0.004	515.00
14-Jun-19	2.09	0.004	522.50
17-Jun-19	2.09	0.004	522.50
18-Jun-19	2.05	0.004	512.50
19-Jun-19	2.05	0.004	512.50
20-Jun-19	2.04	0.004	510.00
21-Jun-19	2.07	0.004	517.50
24-Jun-19	2.08	0.004	520.00
25-Jun-19	2.06	0.004	515.00
26-Jun-19	2.06	0.004	515.00
27-Jun-19	2.06	0.004	515.00
15-Jul-19	1.28	0.004	320.00
16-Jul-19	2.07	0.004	517.50
17-Jul-19	2.10	0.004	525.00
18-Jul-19	2.10	0.004	525.00
19-Jul-19	2.11	0.004	527.50
22-Jul-19	2.13	0.004	532.50
23-Jul-19	2.14	0.004	535.00
24-Jul-19	2.18	0.004	545.00
25-Jul-19	2.17	0.004	542.50
26-Jul-19	2.16	0.004	540.00
29-Jul-19	2.17	0.004	542.50
30-Jul-19	2.16	0.004	540.00
31-Jul-19	2.18	0.004	545.00
1-Aug-19	2.20	0.004	550.00
2-Aug-19	2.20	0.004	550.00
6-Aug-19	2.22	0.004	555.00
7-Aug-19	2.23	0.004	557.50
8-Aug-19	2.24	0.004	560.00
9-Aug-19	2.26	0.004	565.00
12-Aug-19	2.20	0.004	550.00

13-Aug-19	2.26	0.004	565.00
14-Aug-19	2.27	0.004	567.50
15-Aug-19	2.28	0.004	570.00
16-Aug-19	2.30	0.004	575.00
19-Aug-19	2.20	0.004	550.00
20-Aug-19	2.33	0.004	582.50
21-Aug-19	2.32	0.004	580.00
22-Aug-19	2.32	0.004	580.00
23-Aug-19	2.35	0.004	587.50
26-Aug-19	2.38	0.004	595.00
27-Aug-19	2.38	0.004	595.00
28-Aug-19	2.38	0.004	595.00
29-Aug-19	2.41	0.004	602.50
30-Aug-19	2.40	0.004	600.00
3-Sep-19	2.46	0.004	615.00
4-Sep-19	2.35	0.004	587.50
5-Sep-19	2.49	0.004	622.50
6-Sep-19	2.49	0.004	622.50
9-Sep-19	2.57	0.004	642.50
10-Sep-19	2.57	0.004	642.50
11-Sep-19	2.55	0.004	637.50
12-Sep-19	2.53	0.004	632.50
13-Sep-19	2.57	0.004	642.50
16-Sep-19	2.54	0.004	635.00
17-Sep-19	2.60	0.004	650.00
18-Sep-19	2.61	0.004	652.50
19-Sep-19	2.60	0.004	650.00
23-Sep-19	2.61	0.004	652.50
24-Sep-19	2.64	0.004	660.00
25-Sep-19	2.68	0.004	670.00
26-Sep-19	2.67	0.004	667.50
27-Sep-19	2.71	0.004	677.50
30-Sep-19	2.75	0.004	687.50
1-Oct-19	2.71	0.004	677.50
2-Oct-19	2.68	0.004	670.00
3-Oct-19	2.74	0.004	685.00
4-Oct-19	2.77	0.004	692.50
7-Oct-19	2.67	0.004	667.50
8-Oct-19	2.73	0.004	682.50
9-Oct-19	2.74	0.004	685.00
10-Oct-19	2.72	0.004	680.00
11-Oct-19	2.71	0.004	677.50
15-Oct-19	2.74	0.004	685.00

16-Oct-19	2.69	0.004	672.50
17-Oct-19	2.67	0.004	667.50
18-Oct-19	2.68	0.004	670.00
21-Oct-19	2.67	0.004	667.50
22-Oct-19	2.74	0.004	685.00
23-Oct-19	2.75	0.004	687.50
24-Oct-19	2.70	0.004	675.00
25-Oct-19	2.68	0.004	670.00
28-Oct-19	2.70	0.004	675.00
29-Oct-19	2.76	0.004	690.00

After six months the experiment was completed and the samples were removed from the soil for analysis. The samples were cleaned and weighed using an electronic balance. As shown in Table 2 and Figures 4 and 5 the galvanized steel sample in direct contact with wet, salty soil, sample #5, had experienced significant corrosion and consumption of steel. In comparison as show in Table 2 and Figures 6, 7, and 8 the galvanized steel sample encased in ConduDisc® surround, sample #6, experienced only a minimal loss of mass and there was no visible corrosion on the sample.

Most of the loss of mass of sample #6 is likely due to the fact that the Rustoleum Cold Galvanizing Spray that was applied to the edges of the sample bonded to the ConduDisc® surround and peeled off of the steel when the sample was removed from the surround after the experiment was completed. Therefore this loss of mass does not indicate that the galvanized steel sample encased in ConduDisc® surround experienced any corrosion.

Table 2: Percentage of Mass Consumed from Each Sample

Sample	Initial Mass (g)	Final Mass (g)	Mass Difference (g)	Percentage Loss (%)
Galvanized Steel #5 (Soil)	65.48	54.53	- 10.95	- 16.72
Galvanized Steel #6 (ConduDisc®)	62.89	62.44	- 0.45	- 0.72

Figure 4: Uncoated Galvanized Steel Sample #5, after Experiment

Figure 5: Uncoated Galvanized Steel Sample #5 with Loose Rust Scraped off, after Experiment

Figure 6: Galvanized Steel Sample #6 Encased in ConduDisc® Surround Material, after Experiment

Figure 7: Rustoleum Cold Galvanizing Stuck to the ConduDisc® Surround Material, after Experiment

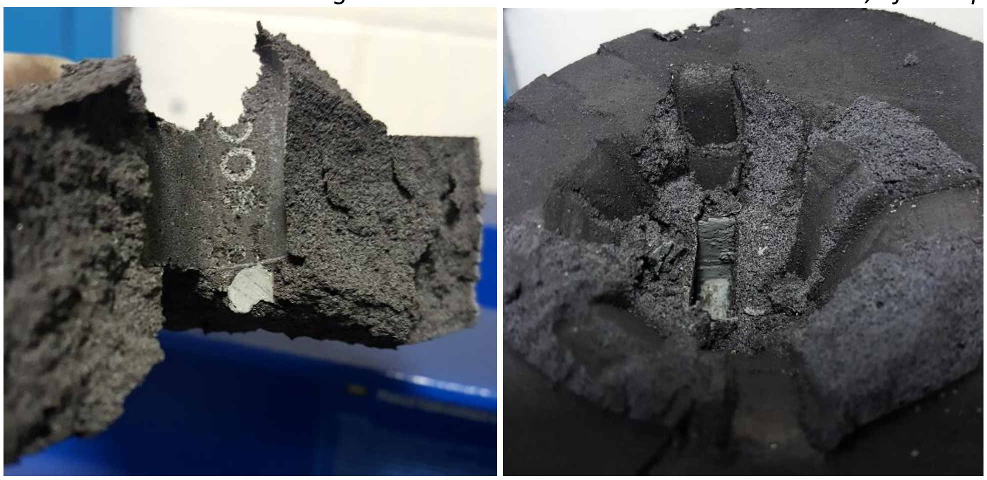


Figure 8: Galvanized Steel Sample #6 with loose rust/build up scraped off, after Experiment

4.0 Conclusions

This experiment compared the long term consumption rate galvanized steel in damp, salty soil at low current to the long term consumption rate of galvanized steel encased in ConduDisc® surround in damp, salty soil at low current. The galvanized steel sample that was in direct contact with the damp, salty soil experienced a fairly significant loss in mass at the completion of the test. The galvanized steel in direct contact with the damp soil had 16.72% of the sample consumed after six months. Previous testing demonstrated that a galvanized steel sample in direct contact with damp, salty soil had 15.89% of the sample consumed after thirty days. This appears to indicate that most of the corrosion of the sample occurred rapidly in the first month of the experiment.

In comparison the galvanized steel sample encased in ConduDisc® surround experienced minimal loss of mass at the completion of the test. The galvanized steel encased in ConduDisc® surround had 0.72% of the sample consumed after six months. Most of that consumption can likely be attributed to the fact that the Rustoleum Cold Galvanizing Spray that had been applied to the edges bonded to the ConduDisc® surround and peeled off of the steel when the sample was removed from the surround at the end of the experiment. Previous testing demonstrated that a galvanized steel sample encased in ConduDisc® surround and buried in damp, salty soil had 0.09% of the sample consumed. In that case the cold galvanizing spray did not adhere to the ConduDisc® surround which would explain the difference between the two values.

Therefore, this experiment demonstrates that applying the ConduDisc® surround significantly and effectively reduces the rate of corrosion of galvanized steel over extended periods of time for buried grounding applications even in harsh conditions.

This report is the summary of results generated from testing conducted by SAE Inc. at their Barrie, ON location. Testing was performed by Caitlin Hughes, R&D Coordinator from April 29, 2019 to October 29, 2019.

Compression Testing of the ConduDisc®

In order to determine how the ConduDisc® will perform when attached to the bottom of a utility pole in situ, varying loads were applied to full sized ConduDisc® samples using an Instron. Our research found that the heaviest wooden utility poles are 125 ft. class H-6 Douglas Fir Poles which weigh 15 480 lbs., or 7022 kg, and the heaviest spun concrete utility poles are 118 ft. class K poles which weigh 24 088 lbs., or 10 926 kg. This does not include the weight of the wires, transformers, and any additional equipment attached to the pole after installation. Table 1 below outlines how much the ConduDisc® compressed when subjected to varying loads.

Table 1: ConduDisc® Compression Testing

Applied Load (kg)		Applied Pressure		Compression of ConduDisc®	
kg	**lbs.**	**MPa**	**psi**	**mm**	**%**
7000	15 432	0.693	100.51	2.2	4.3
12 000	26 456	1.185	171.91	2.6	5.1
14 500	31 967	1.436	208.27	3.0	5.9
16 771	36 975	1.677	241.43	3.1	6.1

As shown in Table 1 the ConduDisc® only experienced minimal compression even when subjected to a load over two times the weight of the heaviest wooden utility poles. The compression of the ConduDisc® was elastic compression, as once the load was released the samples returned to their original thickness with no deterioration of the sample. None of the ConduDisc® samples in this experiment experienced cracking or deterioration of the surround material at any of the loads applied.

These results are the summary of results generated from testing conducted by SAE Inc. at Georgian College's technology laboratory located in Barrie, ON. Testing was performed by Tim Sirola and Duncan Wishart, R&D Assistants, on July 26, 2017.

Permeability Testing

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 – Constant Volume

Sample Type: Tube	Permeant Fluid: De-aired Distilled water
Orientation: Vertical	
Sample Preparation: Placed into permeameter at as-received density and moisture content.	
Assumed Specific Gravity: 1.18	

Parameter	Initial	Final
Height, in	7.13	7.095
Diameter, in	3.96	3.96
Area, in^2	12.34	12.34
Volume, in^3	87.95	87.65
Mass, g	1639	1672
Bulk Density, pcf	70.8	72.55
Moisture Content, %	3.8	6
Dry Density, pcf	68.25	68.55
Degree of Saturation, %	58	97

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	89.99	Increased Cell Pressure, psi:	94.96	Cell Pressure Increment, psi:	4.97
Sample Pressure, psi:	87.38	Corresponding Sample Pressure, psi:	92.16	Sample Pressure Increment, psi:	4.78
				B Coefficient:	0.96

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, Sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °c, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
8-May-17	1	90	87.4	23.75	23.5	0.25	43	16.6	1.70E-07	19.5	1.013	1.70E-07
8-May-17	2	90	87.4	23.75	23.5	0.25	45	16.6	1.83E-07	19.5	1.013	1.84E-07
8-May-17	3	90	87.4	23.75	23.5	0.25	49	16.6	1.59E-07	19.5	1.013	1.60E-07
8-May-17	4	90	87.4	23.75	23.5	0.25	51	16.6	1.58E-07	19.5	1.013	1.63E-07

PERMEABILITY AT 20° C: 1.72 x 10^{-7} cm/sec (@2.6 psi effective stress)

These results are the summary of results generated from testing conducted by GeoTesting Express located in Acton, MA. Testing was performed by Ethan Marro, Assistant Laboratory Manager, from May 5, 2017 to May 9, 2017.

Leachate Data

The ConduDisc® is environmentally neutral. It is provided as a solid that does not leach, dissolve or migrate into the soil or water. A table of toxicity characteristic leaching procedure (TCLP) results for ConduDisc® surround material is included below. The ConduDisc® surround material was tested to EPA Standard SW846-6020A. TCLP is a soil sample extraction method for chemical analysis employed as an analytical method to simulate leaching through a landfill. Because the testing methodology is used to determine if a waste is characteristically hazardous, similar conditions are not expected in a typical groundwater environment, and the results overestimate the amount of leaching that would occur.

The TCLP results are compared to the Maximum Contaminant Level (MCL) established by the U.S. Environmental Protection Agency (USEPA) for each constituent in the table below. The MCL is the highest level of a contaminant that is allowed in drinking water. For those constituents detected in the leachate, none exceeded USEPA regulatory standards for drinking water. Additionally, because of TCLP conditions, these constituents would not be expected to present a risk for migration in a typical groundwater environment.

Table 1: TCLP Results for ConduDisc®

Constituent	ConduDisc® TCLP Concentration (mg/L)	USEPA Maximum Contaminant Level (mg/L)
Arsenic	< 0.010	0.010
Barium	1.490	2.000
Boron	1.067	2.000ƚ
Chromium	0.026	0.100
Mercury	< 0.001	0.002
Selenium	0.013	0.050
Silver	< 0.010	0.100*
Uranium	< 0.010	0.030
Fluoride	0.190	2.000*
Nitrate (as Nitrogen)	< 0.10	10.000
Nitrite (as Nitrogen)	< 0.050	1.000
Cyanide	< 0.050	0.200

ƚ No MCL established; value shown is USEPA's Lifetime Drinking Water Health Advisory.
* No MCL established; value shown is USEPA's secondary drinking water standard.
Note: < denotes less than method detection limit (MDL).

These results are the summary of results generated from testing conducted by Testmark Laboratories Ltd. located in Kirkland Lake, ON. Testing was performed by Brad Woodward, Laboratory Director, from October 12, 2017 to October 18, 2017.

Fault Current Withstand

Contents

Powertech

REPORT OF PERFORMANCE

CLIENT / MANUFACTURER	SAE Inc. 19 Churchill Drive Barrie, ON, L4N 8Z5, Canada
TEST OBJECT	ConduDisc Serial number/identification: N/A Description, Condition: Design Investigation
TESTED BY	Powertech Labs Inc. 12388 - 88th Ave, Surrey, BC Canada V3W 7R7 www.powertechlabs.com
TEST DATE	2017-11-27
TEST SPECIFICATION	Client Specifications

Powertech Labs Inc. does not accept any liability for any damages resulting from the use of this report. The results relate only to the item tested, and it is the responsibility of the manufacturer to maintain conformity of any object having the same designations. Information regarding the estimated measurement uncertainty is available upon request. The test report shall not be reproduced except in full, without written approval of Powertech Labs Inc.

Prepared by:

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Powertech Labs Inc.

Reviewed by:

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BRITISH COLUMBIA
ENGINEER
2018-01-05

Chris Morton, P.Eng.
Specialist Engineer, Substations
Technology and Testing, High Power Lab
Powertech Labs Inc.

1.0 Introduction

Four ConduDisc® samples, manufactured by SAE, Inc., were subjected to short-circuit tests at the High Power Laboratory of Powertech Labs, Inc. The tests were performed for investigative preliminary fault current testing in accordance with the client's requirements.

2.0 Test Object Information

The ConduDisc® test objects were identified by the client with the following information:

- Labelled as sample Numbers 1 through 4
- Samples were made using formulation #1117
- Surround encapsulated a 1/8" thick galvanized steel plate
- Lead wire was #2 copper clad steel equivalent to #4 AWG all copper wire

3.0 General Information

3.1 Purpose

The purpose of the test was to determine the amount of fault current that the ConduDisc® samples can withstand within a 500 millisecond test duration.

3.2 Test Standards/Specifications

There were no specific standards to guide the testing. The tests performed were directed by the client as follows:

- Fault current at levels specified by the client.
- Fault duration of up to 500 milliseconds.

4.0 Fault Current Testing

General Information:
Standard: None
Test Date: November 27, 2017

Environmental Conditions:
Ambient temperature: 6 – 10 ^{o}C

Test Conditions:
Test Voltage: 3.7 kV_{rms} phase-to-ground
Test Current Levels: 1.04 kA_{rms} to 4.99 kA_{rms}
Phases: 1
Test Frequency: 60 Hz

The samples were tested using a single-phase circuit as shown in Figure 1. The current level in the tested sample was controlled by adjusting the current-limiting source reactance of the circuit.

Test Setup:
The testing was performed in the High Power Lab test cell with the following configurations:

Tests on Sample Number 1-2, sample setup #1

The test sample assembly consisted of:
- A ½" aluminum plate which acted as a lower grounded electrode
- The ConduDisc® placed on top of the electrode
- A fiberglass board placed on top of the ConduDisc®
- 2-4 concrete blocks weighing approximately 70-140 lbs. placed on top of the fiberglass board to hold the ConduDisc® against the lower electrode
- The assembly was placed on an insulated table for the tests

Current was applied to the ConduDisc® through a 43.5 inch long #2 copper-clad steel ground wire which was embedded in the ConduDisc®. The configuration of the typical test sample set-up is shown in Figure 2.

Tests on Sample Number 3, sample setup #2

It was found during testing that the #2 copper-clad steel ground wire was insufficient to carry higher fault current levels, and it fused during some of the tests. The test sample assembly was therefore modified to consist of:
- A ½" aluminum plate which acted as a lower grounded electrode
- The ConduDisc® placed on top of the electrode
- A second ½" aluminum plate which acted as an upper energized electrode placed on top of the ConduDisc®
- 4 concrete blocks weighing approximately 140 lbs. placed on top of the upper electrode to hold the ConduDisc® against the electrodes
- The assembly was placed on an insulated table for the tests

The configuration of the test set-up is shown in Figure 3.

Tests on Sample Number 4, sample setup #3

The test sample assembly consisted of:
- A ½" aluminum plate which acted as a lower grounded electrode
- The ConduDisc® placed on top of the electrode
- A second ½" aluminum plate which acted as an upper energized electrode placed on top of the ConduDisc®
- A large concrete block weighing approximately 2000 lbs. placed on top of the upper electrode to hold the ConduDisc® against the electrodes
- The assembly was placed on an insulated fiberglass board which was placed directly on the concrete floor of the test cell for the tests.

The configuration of the test set-up is shown in Figure 4.

Requirements:
Test samples are required to withstand the applied current for up to 500 milliseconds.

Results:
The following table shows the test data for the tests performed on the tested objects.

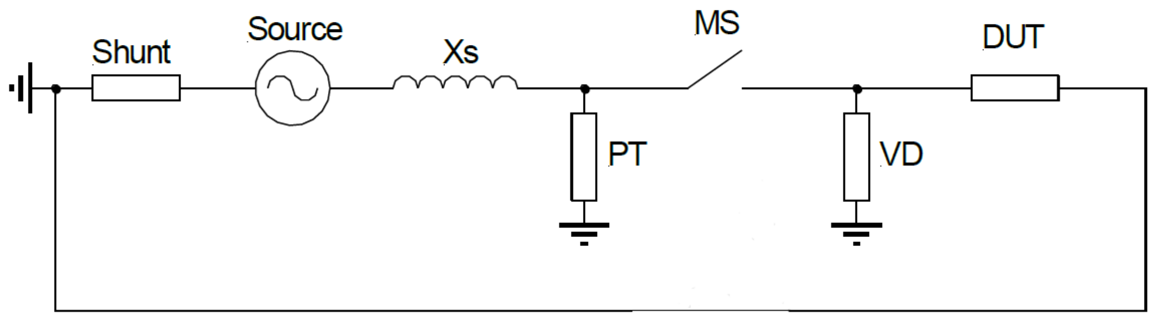
Table 1: ConduDisc® Fault Current Test Data

Test No.	Test Setup No.	RMS Current (A)	RMS Voltage (kV)	Resistance Before Test (mΩ)	Resistance After Test (mΩ)	Approximate Temperature Rise (^oC)	Test Duration (milliseconds)
Sample #1, Test #2	#1	1040	19.5	30.6	20.3	1	508
Sample #2, Test #1	#1	2520	124	55.5	20.2	2	508
Sample #3, Test #2	#2	3730	239	44.9	46.0	13	234
Sample #4, Test #1	#3	4990	176	34.6	7.28	1	508

The above report is the summary of results generated from testing conducted by Powertech Labs Inc. in Surrey, British Columbia.

Appendix A – Test Circuit

Figure 1: Test circuit schematic



Notes:

1. *Shunt – Current measurement*
2. *X_s – Source reactance*
3. *PT – Source voltage measurement*
4. *MS – Make switch*
5. *VD – DUT voltage measurement*
6. *DUT – Device under test*

Appendix B – Diagrams and Photographs of the Tests

Figure 2: ConduDisc®, Test Setup #1

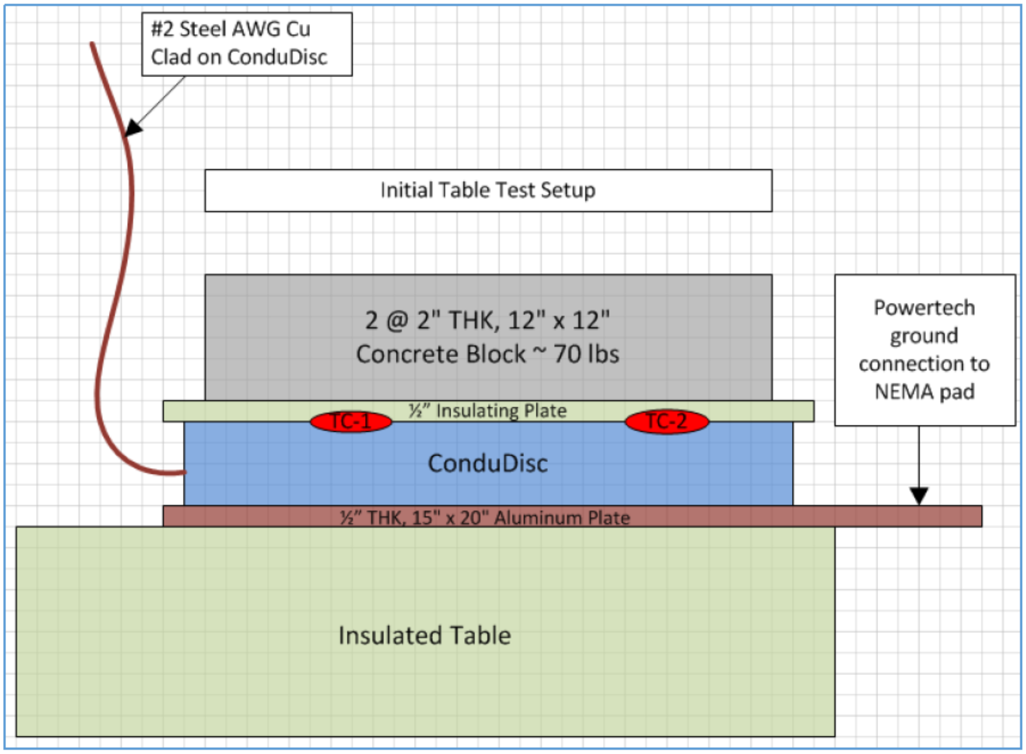
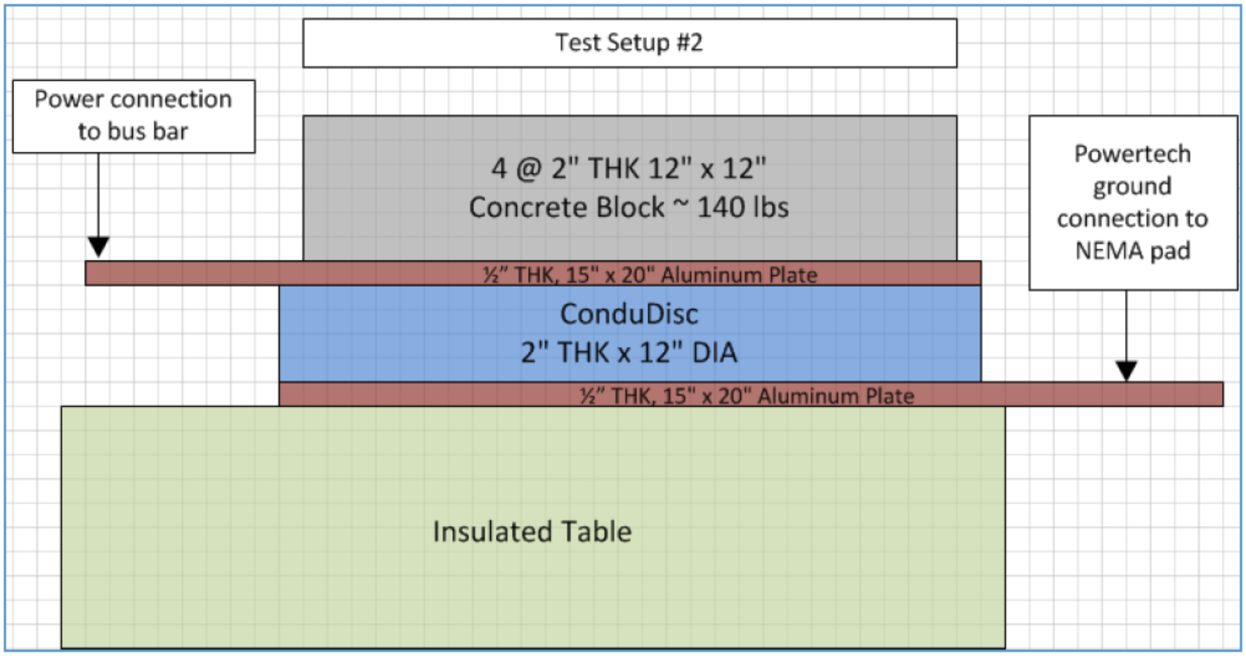


Figure #3: ConduDisc®, Test Setup #2



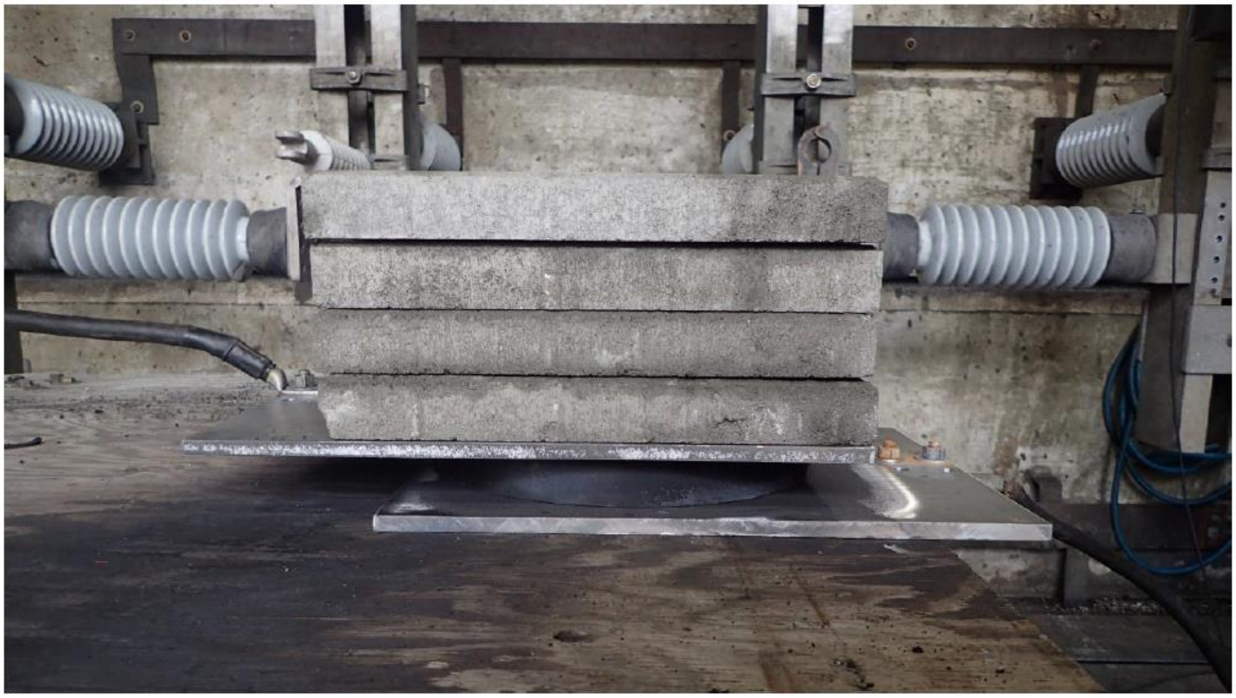
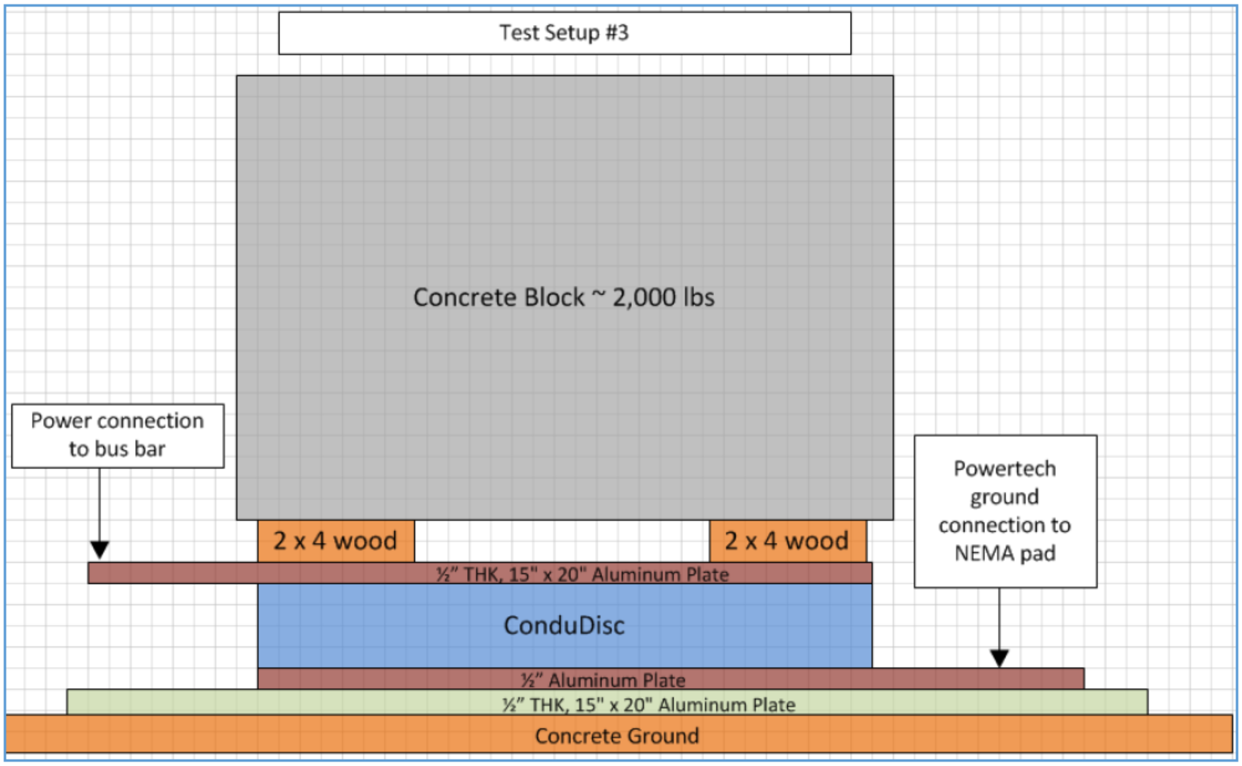
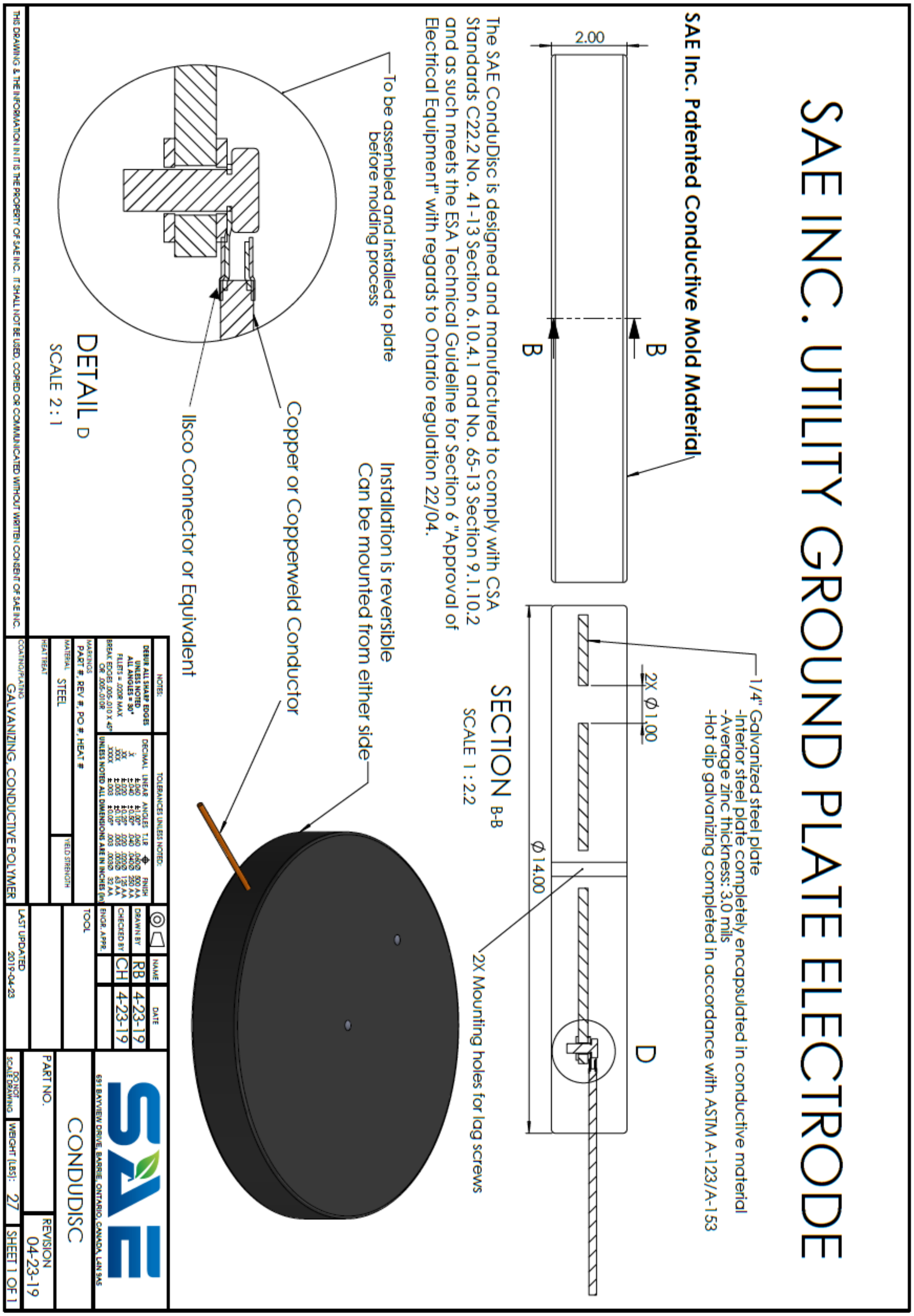
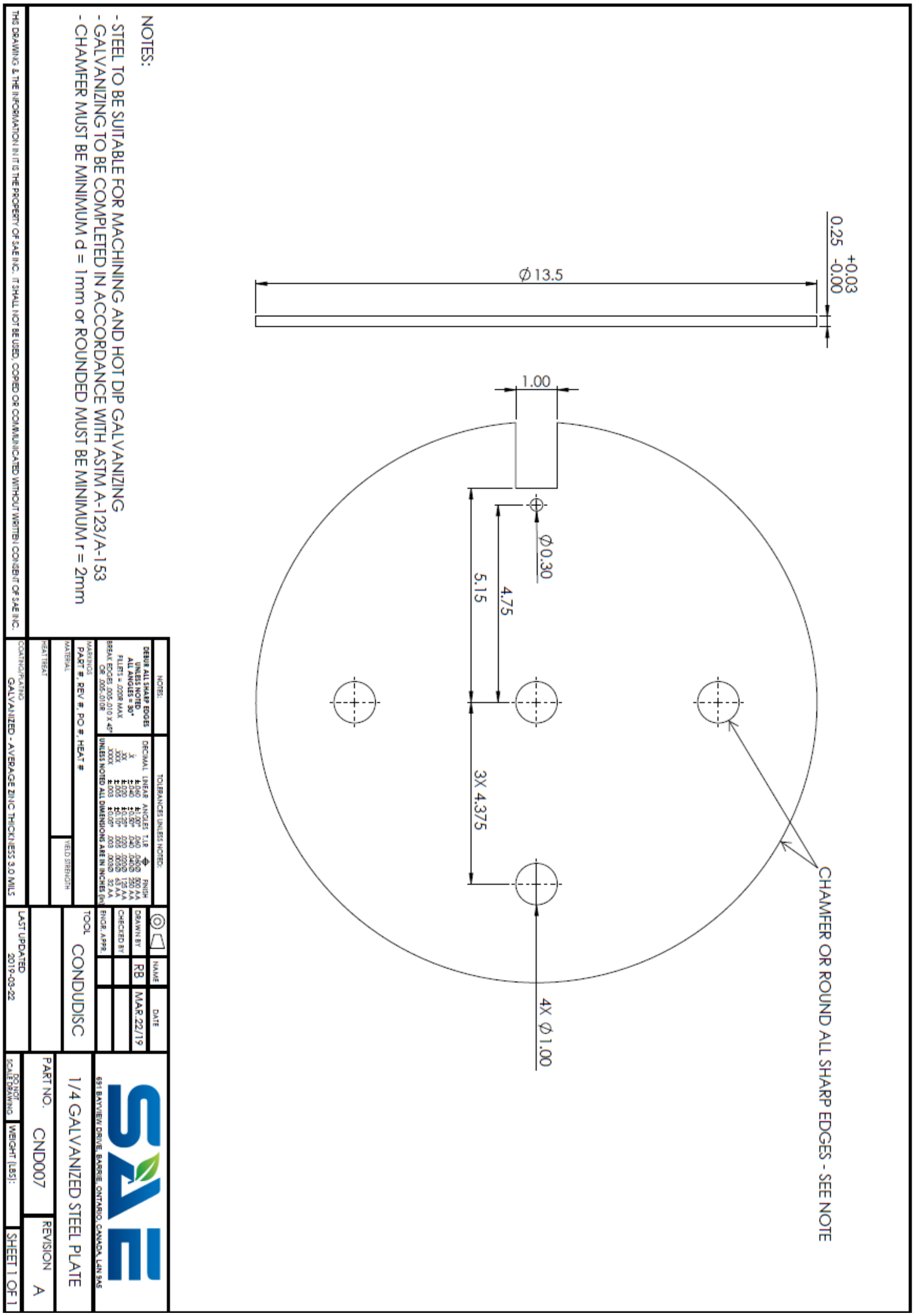


Figure #4: ConduDisc®, Test Setup #3



Engineering Drawings


SAE INC. UTILITY GROUND PLATE ELECTRODE
SAE Inc. Patented Conductive Mold Material
1/4" Galvanized steel plate
-Interior steel plate completely encapsulated in conductive material
-Average zinc thickness: 3.0 mils
-Hot dip galvanizing completed in accordance with ASTM A-123/A-153
2.00
B
B
2X Ø1.00
D
Ø14.00
SECTION B-B
SCALE 1 : 2.2
2X Mounting holes for lag screws
The SAE ConduDisc is designed and manufactured to comply with CSA Standards C22.2 No. 41-13 Section 6.10.4.1 and No. 65-13 Section 9.1.10.2 and as such meets the ESA Technical Guideline for Section 6 "Approval of Electrical Equipment" with regards to Ontario regulation 22/04.
To be assembled and installed to plate before molding process
Installation is reversible
Can be mounted from either side
Copper or Copperweld Conductor
Ilsco Connector or Equivalent
DETAIL D
SCALE 2 : 1
NOTES:
DEBUR ALL SHARP EDGES UNLESS NOTED
ALL ANGLES = 30°
FILLETS = .020R MAX
BREAK EDGES .005-.010 X 45° OR .005-.010R
TOLERANCES UNLESS NOTED:
UNLESS NOTED ALL DIMENSIONS ARE IN INCHES (in)
NAME
DATE
DRAWN BY RB 4-23-19
CHECKED BY CH 4-23-19
ENGR. APPR.
SAE
691 BAYVIEW DRIVE, BARRIE, ONTARIO, CANADA, L4N 9A5
MARKINGS
PART #, REV #, PO #, HEAT #
MATERIAL STEEL
YIELD STRENGTH
HEAT TREAT
TOOL
CONDUDISC
PART NO.
REVISION 04-23-19
COATING/PLATING GALVANIZING, CONDUCTIVE POLYMER
LAST UPDATED 2019-04-23
DO NOT SCALE DRAWING
WEIGHT (LBS): 27
SHEET 1 OF 1
THIS DRAWING & THE INFORMATION IN IT IS THE PROPERTY OF SAE INC. IT SHALL NOT BE USED, COPIED OR COMMUNICATED WITHOUT WRITTEN CONSENT OF SAE INC.



NOTES:
- STEEL TO BE SUITABLE FOR MACHINING AND HOT DIP GALVANIZING
- GALVANIZING TO BE COMPLETED IN ACCORDANCE WITH ASTM A-123/A-153
- CHAMFER MUST BE MINIMUM d = 1mm or ROUNDED MUST BE MINIMUM r = 2mm
THIS DRAWING & THE INFORMATION IN IT IS THE PROPERTY OF SAE INC. IT SHALL NOT BE USED, COPIED OR COMMUNICATED WITHOUT WRITTEN CONSENT OF SAE INC.
Ø13.5
0.25 +0.03 -0.00
1.00
Ø0.30
5.15
4.75
3X 4.375
4X Ø1.00
CHAMFER OR ROUND ALL SHARP EDGES - SEE NOTE
NOTES:
DEBUR ALL SHARP EDGES
UNLESS NOTED
ALL ANGLES = 90°
FILLETS = .020R MAX
BREAK EDGES .005-.010 X 45° OR .005-.010R
TOLERANCES UNLESS NOTED:
UNLESS NOTED ALL DIMENSIONS ARE IN INCHES (in)
MARKINGS
PART #, REV #, PO #, HEAT #
MATERIAL
YIELD STRENGTH
HEAT TREAT
COATING/PLATING
GALVANIZED - AVERAGE ZINC THICKNESS 3.0 MILS
DRAWN BY
CHECKED BY
ENGR. APPR.
NAME
DATE
RB
MAR.22/19
TOOL
CONDUDISC
LAST UPDATED
2019-03-22
SAE
691 BAYVIEW DRIVE, BARRIE, ONTARIO, CANADA, L4N 9A5
1/4 GALVANIZED STEEL PLATE
PART NO.
CND007
REVISION
A
DO NOT SCALE DRAWING
WEIGHT (LBS):
SHEET 1 OF 1

Safety Data Sheet

SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT:

Product Identifier: ConduDisc®
Product Description; Utility Pole Ground Plate
Recommended Use: Electrical Grounding

COMPANY IDENTIFICATION:

SUPPLIER

SAE Inc.
691 BAYVIEW DRIVE
BARRIE, ONTARIO, CANADA L4N 9A5
+1 (705) 733-3307
www.saeinc.com

SECTION 2 HAZARDS IDENTIFICATION

CLASSIFICATION of the Substance or Mixture:

Not classified for physical or health hazards under GHS.

LABELLING:

SYMBOLS: None	
Signal Word: None	
Hazard Statements: • **Not applicable**	***Precautionary Statements:*** • **Observe good industrial hygiene practices** • **This product is considered inert and is not hazardous**
Trade Secret: A trade secret is being claimed for a specific chemical identity and exact percentages.	

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS No.	Wt. %
Calcined Petroleum Coke	64743-05-1	40 – 80
Proprietary Styrene Butadiene Polymer	00000-00-0	1 – 15
Portland Cement	65997-15-1	1 – 5
Deionized Water	7732-18-5	1 – 15
Non-Hazardous Components are Proprietary		

SECTION 4 FIRST AID MEASURES

EYE: Rinse or flush exposed eye gently using water. Remove contact lenses, if present, while rinsing. If irritation persists or you are concerned seek medical attention.

SKIN: Not applicable.

INHALATION: Not applicable.

INGESTION: Rinse mouth. Do NOT induce vomiting. Do not give anything by mouth to an unconscious person. Seek medical attention if irritation persists or if concerned.

Most Important Symptoms and Effects, both Acute and Delayed:
Not applicable.

Indication of any Immediate Medical Attention and Special Treatment Needed:
If seeking medical attention provide SDS document to physician. Physician should treat symptomatically.

SECTION 5	FIRE FIGHTING MEASURES
FLASH POINT:	Carbonic matter: May burn if exposed to temperatures above 1290 ºF (700 ºC).
EXTINGUISHING MEDIA:	Use extinguishing media appropriate to the surrounding fire conditions. Water Fog, Dry Chemical, Foam, or Carbon Dioxide.
SPECIAL HAZARDS:	Products of combustion may contain carbon monoxide, carbon dioxide and sulfur dioxide. Fire fighters should wear self-contained breathing apparatus and full protective clothing as normal.
EXPLOSION DATA:	Not applicable.

SECTION 6	ACCIDENTAL RELEASE MEASURES
PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURES:	Not applicable.
ENVIRONMENTAL PRECAUTIONS:	Not applicable.
METHODS AND MATERIAL FOR CONTAINMENT AND CLEANING UP:	Use normal housekeeping procedures. Material can be picked up by sweeping, shoveling, or vacuuming.
REFERENCE TO OTHER SECTIONS:	See Section 8 for information on selection of personal protective equipment.

SECTION 7	HANDLING AND STORAGE
PRECAUTIONS FOR SAFE HANDLING:	The ConduDisc® may be damaged by rough handling.
CONDITIONS FOR SAFE STORAGE:	Store in a dry, well-ventilated area, out of the elements. Protect from physical damage or significant water exposure.

SECTION 8	EXPOSURE CONTROLS / PERSONAL PROTECTION
CONTROL PARAMETERS:	No applicable occupational exposure limits.
EXPOSURE CONTROLS:	
Engineering Controls:	Handle in accordance with good industrial hygiene and safety practices.
Personal Protection:	Workers must comply with the Personal Protective Equipment requirements of the workplace in which this product is handled.
Eye/Face Protection:	Not required under normal conditions of use. When installing the ConduDisc® wear approved safety glasses.
Skin Protection:	Not required under normal conditions of use.
Respiratory Protection:	Not required under normal conditions of use.
Other Protection:	Perform routine housekeeping. Do not eat, drink or smoke where this material is handled, stored and processed. Wash hands thoroughly before eating, drinking and smoking.

SECTION 9	PHYSICAL/CHEMICAL PROPERTIES

INFORMATION ON BASIC PHYSICAL AND CHEMICAL PROPERTIES:

Appearance:	Solid; black
Odour:	Odourless
Odour Threshold:	Not applicable
pH:	Not applicable
Melting point/Freezing point:	Not applicable
Initial Boiling Point and boiling range:	Not applicable
Flash point:	Not applicable
Flammability:	Not flammable or combustible
Auto-ignition temperature:	>1290 ºF, >700 ºC
Upper/lower flammability or explosive limits:	Not applicable
Explosive properties:	Not applicable
Oxidizing properties:	Not applicable
Sensitivity to mechanical impact:	Not applicable
Sensitivity to static discharge:	Not applicable
Vapour pressure:	Not applicable
Vapour density:	Not applicable
Density:	111 lbs./ft^3, 1778 kg/m^3
Solubility:	Not applicable
Partition coefficient (n-octanol/water):	Not applicable
Decomposition temperature:	>2400 ºF, >1316 ºC
Viscosity:	Not applicable

SECTION 10	STABILITY AND RELIABILITY

REACTIVITY:	Non-reactive under normal conditions.
CHEMICAL STABILITY:	Stable under normal conditions.
POSSIBILITY OF HAZARDOUS REACTIONS:	None known.
CONDITIONS TO AVOID:	Avoid contact with incompatible materials.
INCOMPATIBLE MATERIALS:	Oxidants – Incompatible with strong oxidizing agents.
HAZARDOUS DECOMPOSITION PRODUCTS:	In normal combustion, carbon oxides and sulfur oxides will be released.

SECTION 11	TOXICOLOGICAL INFORMATION

LIKELY ROUTES OF EXPOSURE:	The ConduDisc® is inert and insoluble, and is not expected to present an ingestion hazard, or other toxicity hazard.
ACUTE TOXICITY DATA:	Not classified.
CHRONIC TOXICITY:	Not applicable
Respiratory and/or Skin Sensitization:	Not known to be a respiratory or skin sensitizer.
Germ Cell Mutagenicity:	Not available.
Reproductive Effects:	Not available.
Developmental Effects:	Not available.
Carcinogenicity:	Not available.
Interactions with Other Chemicals:	Not available.

SECTION 12	ECOLOGICAL INFORMATION

TOXICITY The ConduDisc® is inert and insoluble. It does not present any environmental hazards and is not a hazard to aquatic organisms.

PERSISTENCE AND DEGRADABILITY: Non-biodegradable. The ConduDisc® is stable, unreactive in water under ambient conditions, and is insoluble.

BIOACCUMULATION POTENTIAL: Low bioaccumulation potential as negligible water solubility restricts route of exposure to the aquatic environment.

MOBILITY IN SOIL: Mobility is insignificant due to negligible water solubility and vapour pressure. May incorporate within soil for extended periods of time.

OTHER ADVERSE EFFECTS: Not available

SECTION 13	DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Reuse or recycle packaging whenever possible to minimize the generation of waste. All Federal, Provincial, and Local regulations regarding health and pollution must be followed for disposal.

SECTION 14	TRANSPORT INFORMATION

This product is not classified as a Hazardous Material under U.S. DOT or Canadian TDG regulations. This material is not classified as dangerous under ADR, RID, ADNR, IMDG and IATA regulations.

SECTION 15	REGULATORY INFORMATION

SAFETY, HEALTH AND ENVIRONMENTAL REGULATIONS/LEGISLATION SPECIFIC FOR THE SUBSTANCE OR MIXTURE:

USA
TSCA STATUS: Substances are listed on the TSCA inventory or are exempt.

CANADA
This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations* and the SDS contains all the information required by the *Controlled Products Regulations*.

NSNR Status: Substances are listed on the DSL or are exempt.

RCRA: If discarded in its purchased form, this product would not be a hazardous waste either by listing or characteristic. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as hazardous waste.

SECTION 16	OTHER INFORMATION

Revision Date: July 31, 2019.

Additional Information: This safety data sheet is believed to provide a useful summary of the hazards of ConduDisc® as it is commonly used, but cannot anticipate and provide all of the information that might be needed in every situation.
The information provided herein was believed by SAE Inc. to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information to comply with all laws and procedures applicable to the safe handling and use of product and to determine the suitability of the product for its intended use.