TEST REPORT

REPORT NUMBER: 101754207COQ-001
ORIGINAL ISSUE DATE: October 28, 2014

EVALUATION CENTER

INTERTEK TESTING SERVICES NA LTD.
1500 BRIGANTINE DRIVE
COQUITLAM, BC V3K 7C1

RENDERED TO

STEEL TUBE INSTITUTE
SUITE 172 - 2516 WAUKEGAN ROAD
GLENVIEW, IL 33134

PRODUCT EVALUATED: Electrical Metallic Tubing and Metal-Clad Cables
EVALUATION PROPERTY: Impact and Crush Resistance

Report of Electrical Metallic Tubing and Metal-Clad Cables tested in accordance with selected sections of the standard as referenced below:

- **UL 1569, *Standard for Safety: Metal-Clad Cables***
  - **Section 24, *Impact Test***
  - **Section 25, *Crushing Test – All Cable***

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2 Introduction

Intertek Testing Services NA Ltd. (Intertek) has conducted physical testing on two Trade Sizes of Electrical Metallic Tubing (EMT) and several sizes of Metal-Clad (MC) Cable for Steel Tube Institute. The testing was carried out in accordance with selected sections of the standard as referenced below:

- UL 1569, Standard for Safety: Metal-Clad Cables
  - Section 24, *Impact Test*
  - Section 25, *Crushing Test – All Cable*

This evaluation was completed during the months of August and September 2014.

3 Test Samples

3.1. SAMPLE SELECTION

The client supplied eleven (11) different product types to the Evaluation Center on July 16 and September 3, 2014. Samples were not independently selected for testing and cannot be used for Intertek Certification. Samples were identified with Coquitlam ID#'s VAN1408130748-001 and VAN1409100904-001.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

The products were identified as Electrical Metallic Tubing (EMT) and Metal-Clad (MC) Cables, and were submitted in the following configurations:

- Sample 1: 1/2" EMT with 2 conductors of 14 gauge THHN (0.70 inch O.D.)
- Sample 2: 1/2" EMT with 3 conductors of 14 gauge THHN (0.69 inch O.D.)
- Sample 3: 3/4" EMT with 2 conductors of 12 gauge THHN (0.92 inch O.D.)
- Sample 4: 3/4" EMT with 3 conductors of 12 gauge THHN (0.92 inch O.D.)
- Sample 5: 14 /2 with green grounding conductor Aluminum MC cable (0.47 inch O.D.)
- Sample 6: 14 /3 with green grounding conductor Steel MC cable (0.50 inch O.D.)
- Sample 7: 14 /3 with green grounding conductor Aluminum MC cable (0.47 inch O.D.)
- Sample8: 12 /2 with green grounding conductor Steel MC cable (0.49 inch O.D.)
- Sample 9: 12 /2 with green grounding conductor Aluminum MC cable (0.49 inch O.D.)
- Sample 10: 12 /3 with green grounding conductor Aluminum MC cable (0.51 inch O.D.)
- Sample 11: 12 /3 with green grounding conductor Steel MC cable (0.49 inch O.D.)

4 Testing and Evaluation Methods

4.1. CONDITIONING

Unless otherwise stated, the sample materials were maintained in standard laboratory conditions for a minimum of 24 hours at a temperature of 73 ± 4°F (23 ± 2°C) and relative humidity of 50 ± 5%.

4.2. IMPACT TEST

The Impact Test was conducted in accordance with Section 24, *Impact Test* of UL 1569. For each product type, three (3) samples, each measuring 3 ft. long, were used for testing. Test

samples were placed into an impact test apparatus and laid over a ¾ in. diameter steel rod as shown in Figures 1-2 below.

Figure 1. Impact Test Apparatus

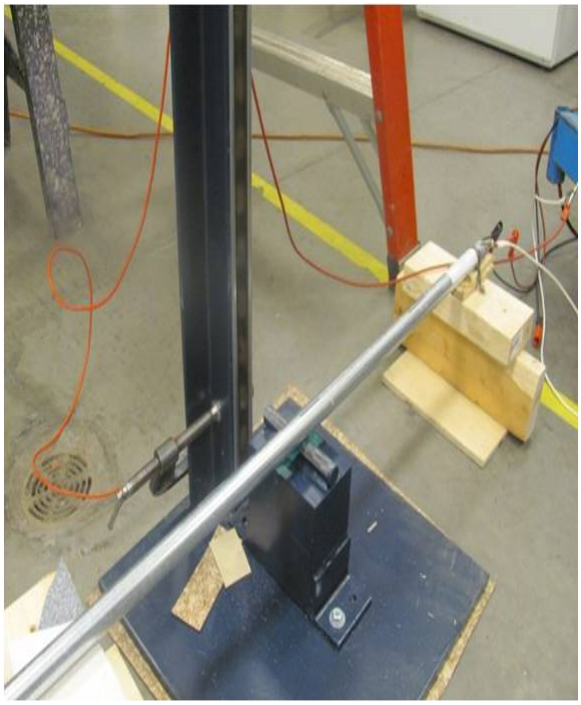


Figure 2. Impact Test Apparatus

Each of the insulated circuit conductors in the length of EMT or MC Cable being tested were connected in series with a 3-W 120-V neon lamp to one of the energized conductors of a 208-V 48 – 62 Hz 4-wire grounded-wye a-c supply circuit. The bare or insulated grounding conductor in the test length of the tubing or cable was connected to the armor, to all parts of the impact apparatus, to earth ground, and to the grounded supply wire.

Each test sample was impacted at the center of each 3 ft. section using an impact weight of 10 lb. The impact weight was a solid rectangular block of steel with the impact face measuring 2 in. x 6 in. The impact weight was raised to the required drop height as specified by the client. A release mechanism allowed the impact weight to fall freely in the guides of the impact apparatus and strike the sample. Upon impact, the neon lamps were observed to see if they lit, indicating momentary or other contact between the circuit conductors or between one or both of the circuit conductors and the grounding conductor, the armor, or both. The maximum impact height was reported for three consecutive failures. Refer to Appendix B for after test photos of the test samples.

4.2.1. Deviations from Standard Test Method

Per the client's request, a total of three (3) impact drops were conducted on 3 ft. long sections of EMT or MC Cable instead of the required ten (10) impacts over a single continuous length of at least 11 ft. Additionally, instead of the 1.5 ft. drop height as specified in the standard, the maximum failure height of each sample was determined and reported.

4.3. CRUSHING TEST

The Crushing Test was conducted in accordance with Section 25, *Crushing Test – All Cable* of UL 1569. For each product type, three (3) samples, each measuring 3 ft. long, were used for testing. Each test sample was placed into an Instron universal testing machine and laid over a ¾ in. diameter steel rod. The top compression plate was a flat platen that measured 2 in. wide.

Each of the insulated circuit conductors in the length of EMT or MC Cable being tested were connected in series with a buzzer and its supply circuit, one leg of which was earth-grounded. All grounding conductors in the test length were connected to the armor, to all metal parts of the compression apparatus, to earth ground, and to the grounded supply wire.

Each sample was tested at a compression rate of 0.50 ± 0.05 in./min until one or more of the indicators signaled that contact occurred between the circuit conductors or between one or more of the circuit conductors and any grounding conductor, the armor, or both. The maximum load obtained at the moment of contact was recorded. The three test results were averaged and reported. Refer to Appendix B for after test photos of the samples.

4.3.1. Deviations from Standard Test Method

Per the client's request, a total of three (3) crush tests were conducted on 3 ft. long sections of EMT or MC Cable instead of the required ten (10) crush tests over a single continuous length of at least 100 in.

5 Testing and Evaluation Results

The test results for the Steel Tube Institute supplied EMT and MC Cables are shown in Table 1 below. A copy of the data sheets can be found in the Appendices.

Table 1. Test Results

Description	Impact Test	Crushing Test
	Average Failure Height (in)	Average Load (lb)
Sample 1	Sample reached the limits of the testing apparatus (96”) without a failure	1809
Sample 2	Sample reached the limits of the testing apparatus (96”) without a failure	1845
Sample 3	Sample reached the limits of the testing apparatus (96”) without a failure	2155
Sample 4	Sample reached the limits of the testing apparatus (96”) without a failure	2016
Sample 5	24	1011
Sample 6	30	808
Sample 7	24	834
Sample 8	30	848
Sample 9	24	792
Sample 10	24	895
Sample 11	26	720

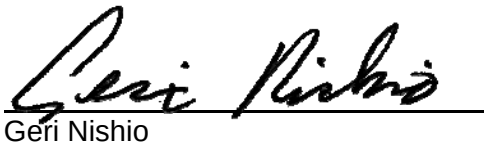
6 Conclusion

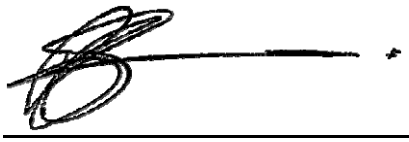
The Steel Tube Institute supplied Electrical Metallic Tubing and Metal-Clad Cables identified and evaluated in this report have been tested in accordance with selected sections of the following with deviations:

- UL 1569, Standard for Safety: Metal-Clad Cables
  - Section 24, *Impact Test*
  - Section 25, *Crushing Test – All Cable*

The product test results are presented in Section 5 of this report.

INTERTEK TESTING SERVICES NA LTD.

Reported by: 
Geri Nishio
Senior Technician, Building Products

Reviewed by: 
Baldeep Sandhu
Lab Supervisor, Building Products

APPENDIX A: Test Data (3 pages)

Company	Steel Tube Institute	Technician(s)	Geri Nishio
Project No.	G101754207	Reviewer	Baldeep Sandhu
Models	Various Electrical Metallic Tubing and Metal Clad Cables	Start/End Date	August - September, 2014
Product Name	Same as above	Sample ID	VAN1408130748-001 & VAN1409100904-001
Standard	**UL 1569, Metal-Clad Cables, Section 24 and 25**		

Test Data Package

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Impact Test	2
Crushing Test	3

Test:	**Impact Test**	Project #:	G101754207
Date:	August 5 and September 5, 2014	Eng/Tech:	Geri Nishio
Client:	Steel Tube Institute	Reviewer:	Baldeep Sandhu
Product:	**See below for Sample Descriptions**		
Method:	UL 1569, *Metal-Clad Cables,* Section 24 Impact Test		
Conditioning:	Minimum 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%		
Equipment:	Fluke 87V Multimeter (Intertek ID# P60158, cal due Feb 2015)		
	Fluke 87V Multimeter (Intertek ID# P50361, cal due June 2015)		
	Fluke 289 Multimeter (Intertek ID# P60089, cal due October 2014)		
	Fluke 289 Multimeter (Intertek ID# P60090, cal due October 2014)		
Time/Temp/RH:	8:30AM / 22.3°C / 47.0%		

Sample	Description	Specimen	Drop Height (in.)	Observations
1	**1/2" EMT with 2 conductors of 14 gauge THHN**	A	96	**No short; wires were able to move freely**
		B	96	**No short; wires were able to move freely**
		C	96	**No short; wires were able to move freely**
2	**1/2" EMT with 3 conductors of 14 gauge THHN**	A	96	**No short; wires were able to move freely**
		B	96	**No short; wires were able to move freely**
		C	96	**No short; wires were able to move freely**
3	**3/4" EMT with 2 conductors of 12 gauge THHN**	A	96	**No short; wires were able to move freely**
		B	96	**No short; wires were able to move freely**
		C	96	**No short; wires were able to move freely**
4	**3/4" EMT with 3 conductors of 12 gauge THHN**	A	96	**No short; wires were able to move freely**
		B	96	**No short; wires were able to move freely**
		C	96	**No short; wires were able to move freely**

Sample	Description	Specimen	Drop Height (in.)	Observations
5	**14 /2 with green grounding conductor Aluminum MC cable**	A	24	**Wires were pinched**
		B	24	**Wires were pinched**
		C	24	**Wires were pinched**
6	**14 /3 with green grounding conductor Steel MC cable**	A	30	**Wires were pinched**
		B	30	**Wires were pinched**
		C	30	**Wires were pinched**
7	**14 /3 with green grounding conductor Aluminum MC cable**	A	24	**Wires were pinched**
		B	24	**Wires were pinched**
		C	24	**Wires were pinched**
8	**12 /2 with green grounding conductor Steel MC cable**	A	30	**Wires were pinched**
		B	30	**Wires were pinched**
		C	30	**Wires were pinched**
9	**12 /2 with green grounding conductor Aluminum MC cable**	A	24	**Wires were pinched**
		B	24	**Wires were pinched**
		C	24	**Wires were pinched**
10	**12 /3 with green grounding conductor Aluminum MC cable**	A	24	**Wires were pinched**
		B	24	**Wires were pinched**
		C	24	**Wires were pinched**
11	**12 /3 with green grounding conductor Steel MC cable**	A	26	**Wires were pinched**
		B	26	**Wires were pinched**
		C	26	**Wires were pinched**

Test:	**Crushing Test**	Project #:	G101754207
Date:	August 5 and September 5, 2014	Eng/Tech:	Geri Nishio
Client:	Steel Tube Institute	Reviewer:	Baldeep Sandhu
Product:	**See below for Sample Descriptions**		
Method:	UL 1569, *Metal-Clad Cables,* Section 25 Crushing Test		
Conditioning:	Minimum 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%		
Equipment:	Instron 3382 Universal Testing Apparatus (Intertek ID# P60553, cal due July 2015)		
	Fluke 87V Multimeter (Intertek ID# P60158, cal due Feb 2015)		
	Fluke 87V Multimeter (Intertek ID# P50361, cal due June 2015)		
	Fluke 289 Multimeter (Intertek ID# P60089, cal due October 2014)		
	Fluke 289 Multimeter (Intertek ID# P60090, cal due October 2014)		
Time/Temp/RH:	8:00AM / 22.7°C / 49.0%		

Sample	Description	Specimen	Maximum Load (lbf)	Average Load (lbf)
1	**1/2" EMT with 2 conductors of 14 gauge THHN**	A	1971	**1809**
		B	1779	
		C	1676	
2	**1/2" EMT with 3 conductors of 14 gauge THHN**	A	1608	**1845**
		B	1976	
		C	1951	
3	**3/4" EMT with 2 conductors of 12 gauge THHN**	A	2116	**2155**
		B	2664	
		C	1685	
4	**3/4" EMT with 3 conductors of 12 gauge THHN**	A	1884	**2016**
		B	2289	
		C	1876	

Sample	Description	Specimen	Maximum Load (lbf)	Average Load (lbf)
5	**14 /2 with green grounding conductor Aluminum MC cable**	A	1163	**1011**
		B	925	
		C	946	
6	**14 /3 with green grounding conductor Steel MC cable**	A	1383	**808**
		B	452	
		C	589	
7	**14 /3 with green grounding conductor Aluminum MC cable**	A	745	**834**
		B	907	
		C	850	
8	**12 /2 with green grounding conductor Steel MC cable**	A	1121	**848**
		B	439	
		C	985	
9	**12 /2 with green grounding conductor Aluminum MC cable**	A	588	**792**
		B	808	
		C	981	
10	**12 /3 with green grounding conductor Aluminum MC cable**	A	591	**895**
		B	688	
		C	1406	
11	**12 /3 with green grounding conductor Steel MC cable**	A	808	**720**
		B	457	
		C	896	

APPENDIX B: Photos (7 pages)

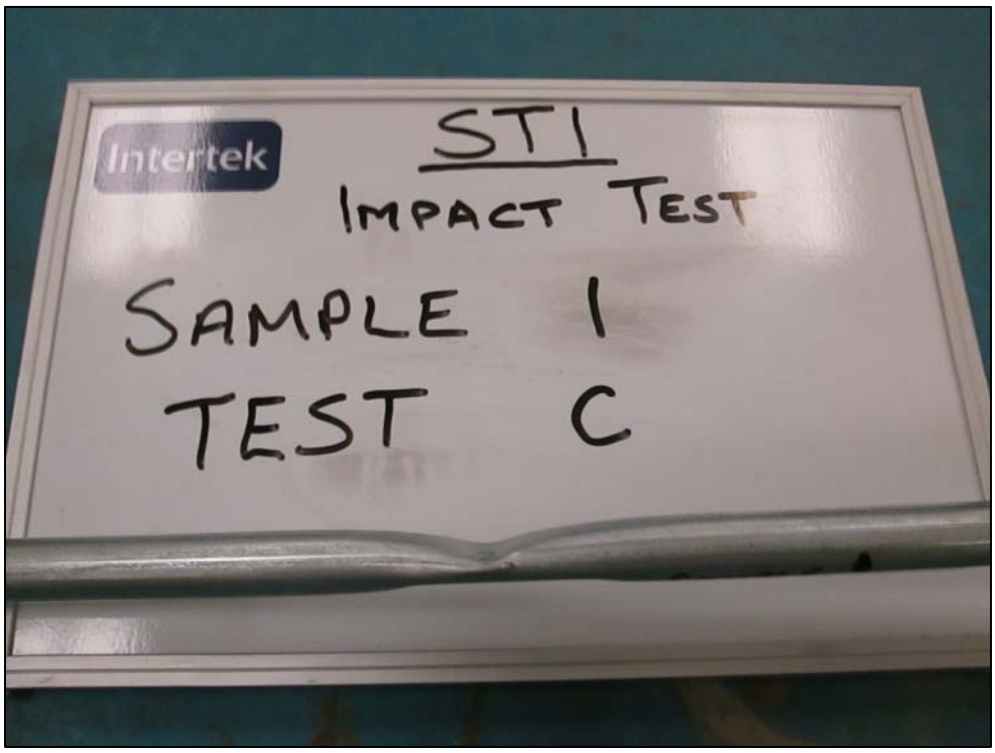

Figure 1. After Impact Test

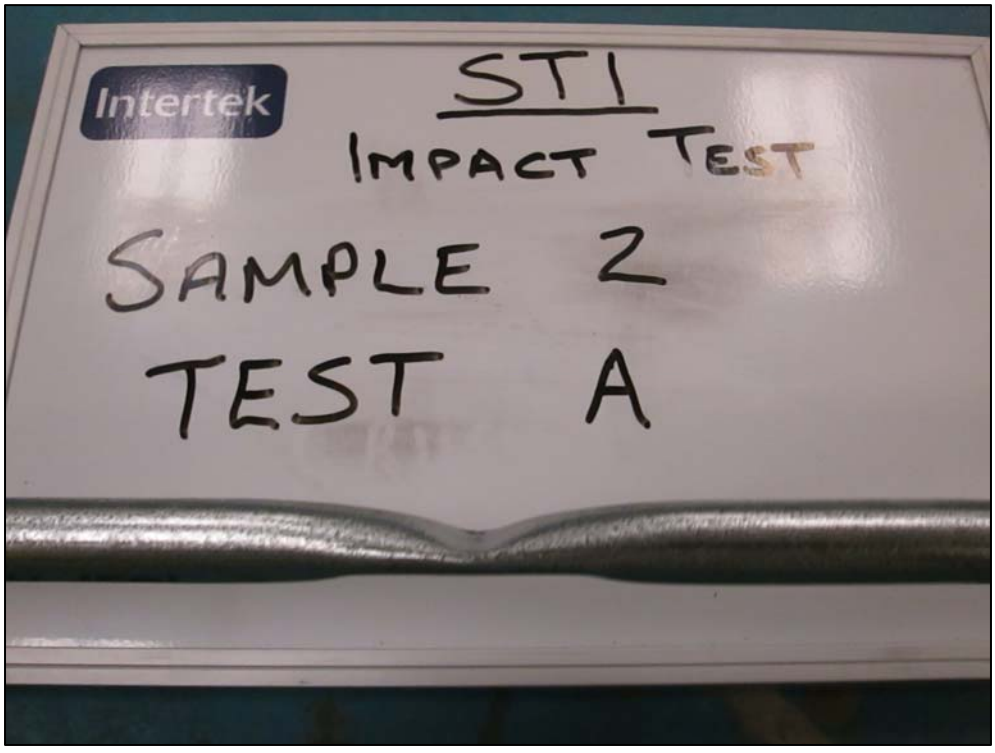

Figure 2. After Impact Test

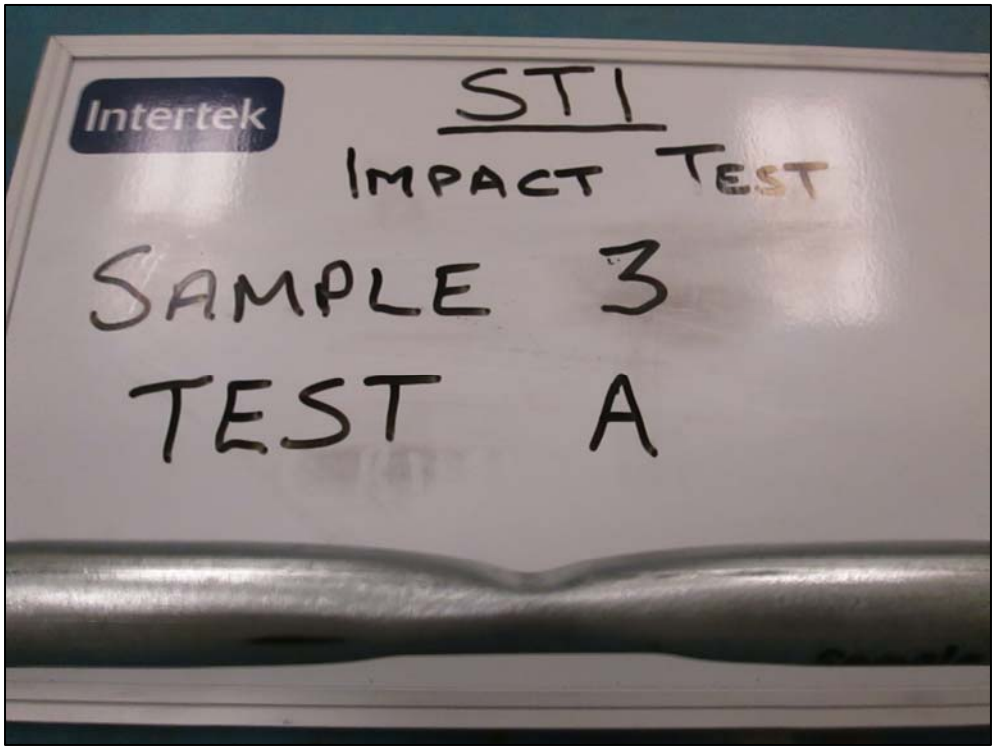

Figure 3. After Impact Test

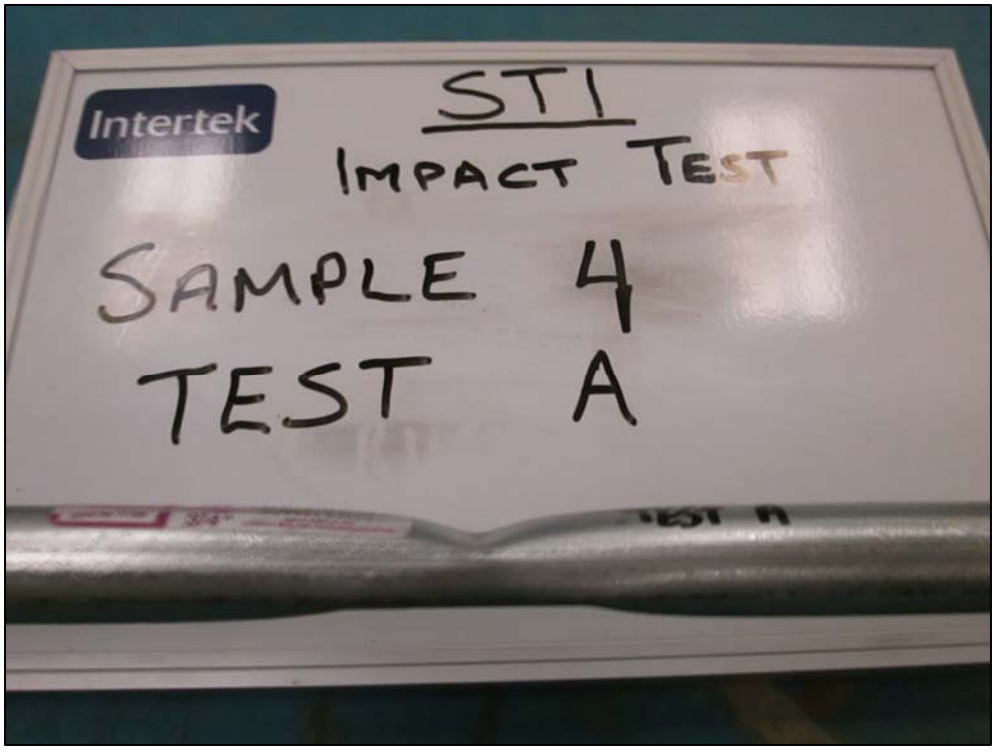

Figure 4. After Impact Test

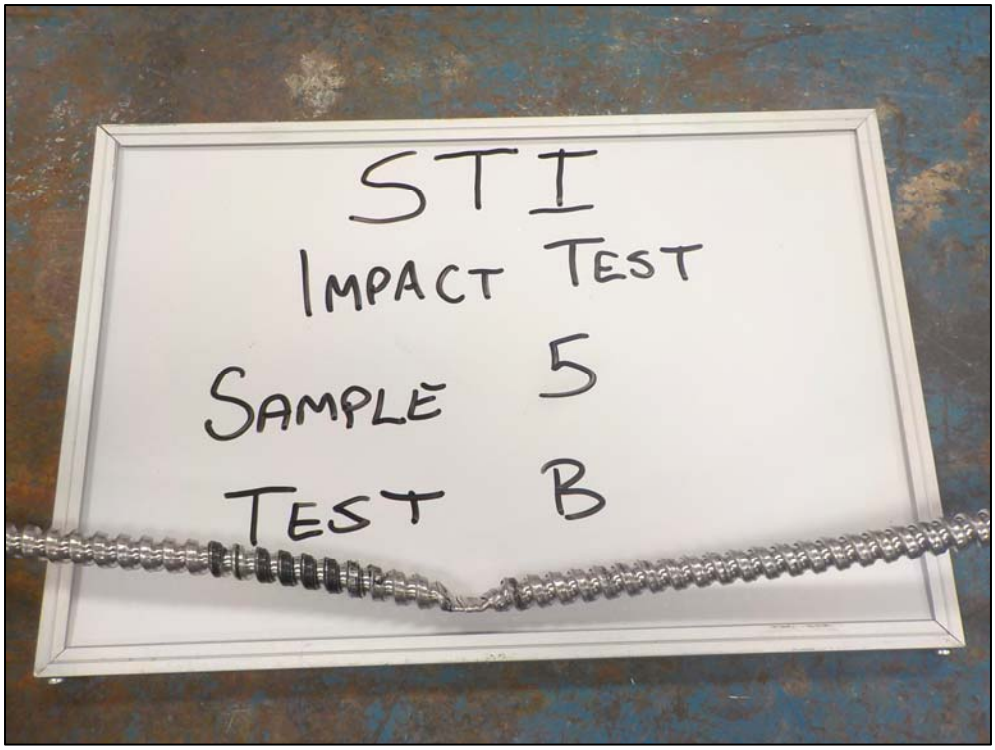

Figure 5. After Impact Test

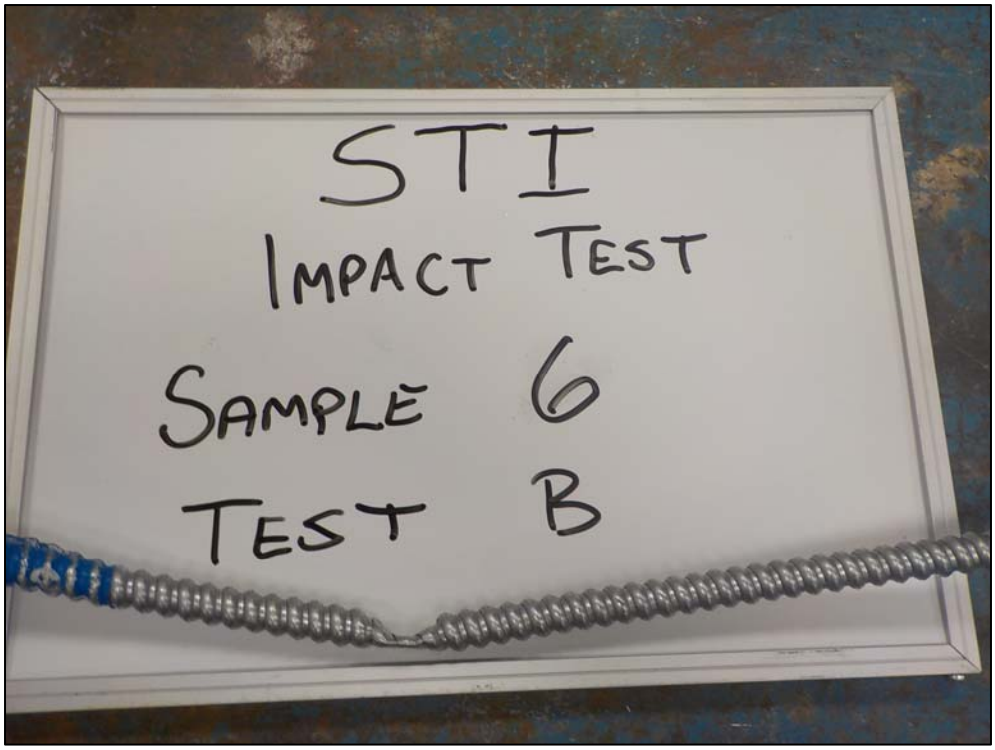

Figure 6. After Impact Test

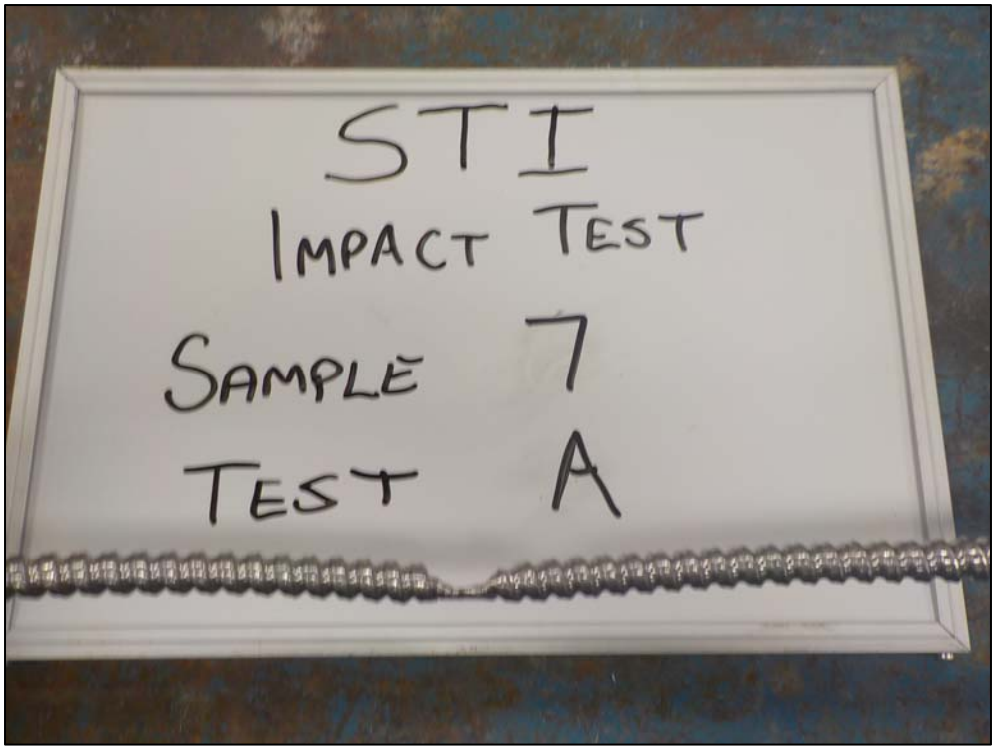

Figure 7. After Impact Test

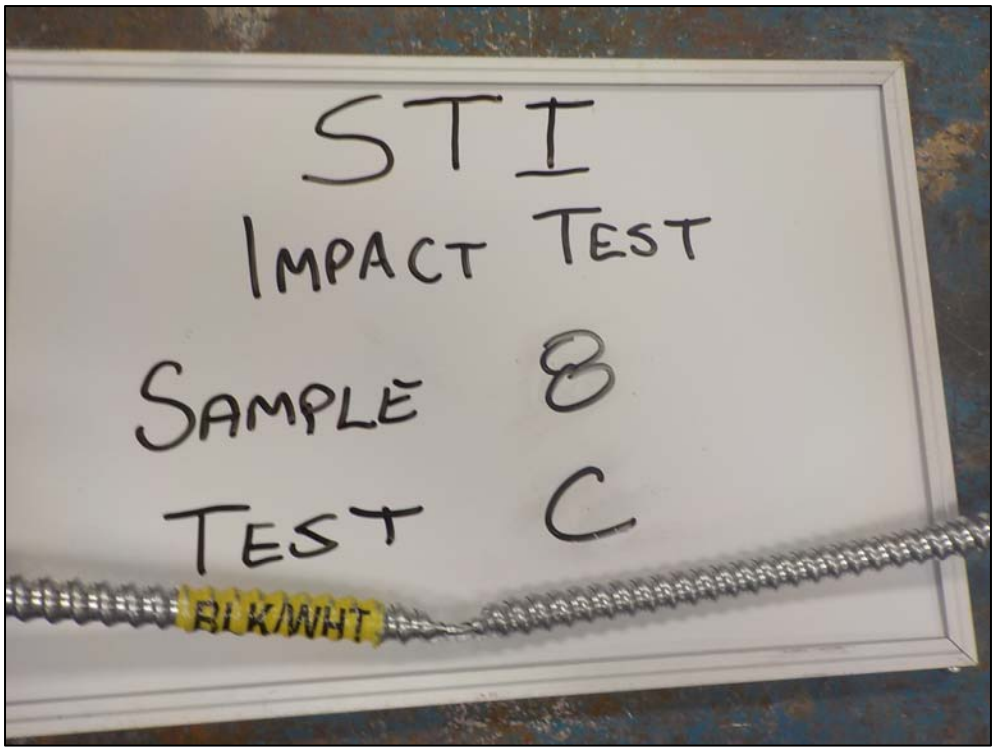

Figure 8. After Impact Test

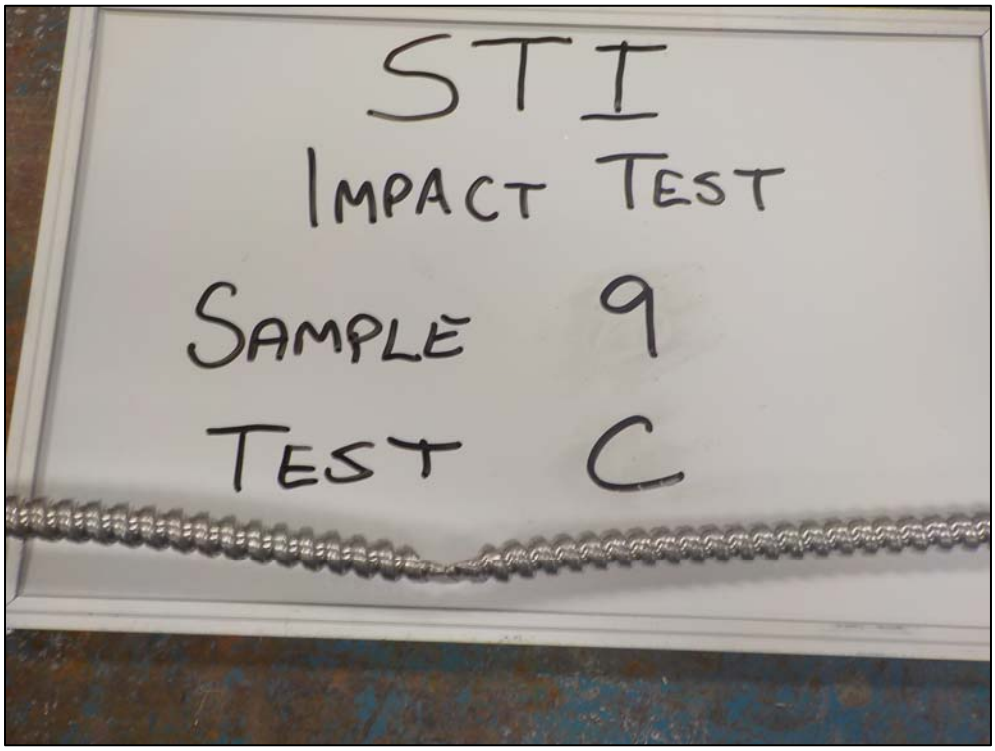

Figure 9. After Impact Test

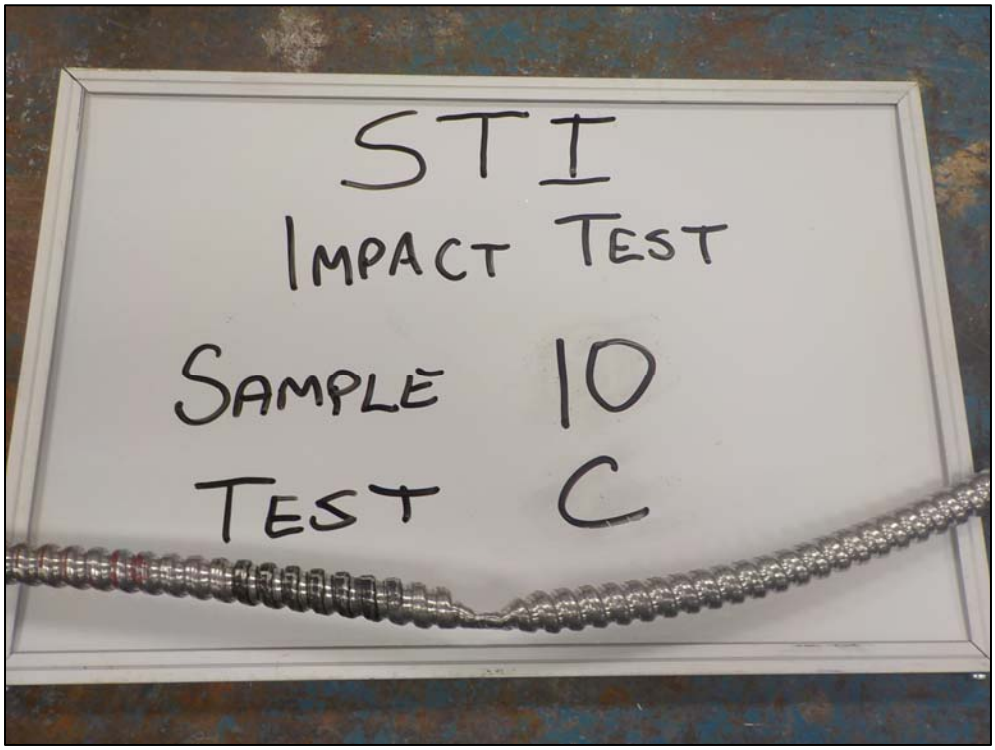

Figure 10. After Impact Test

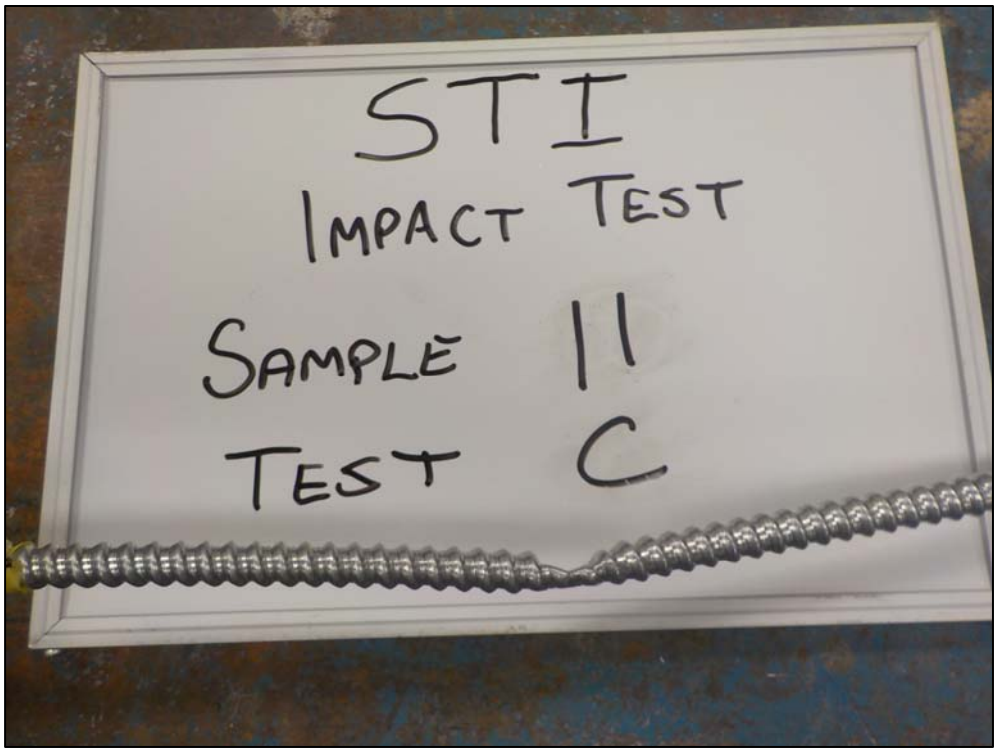

Figure 11. After Impact Test

Figure 12. After Crushing Test

Figure 13. After Crushing Test

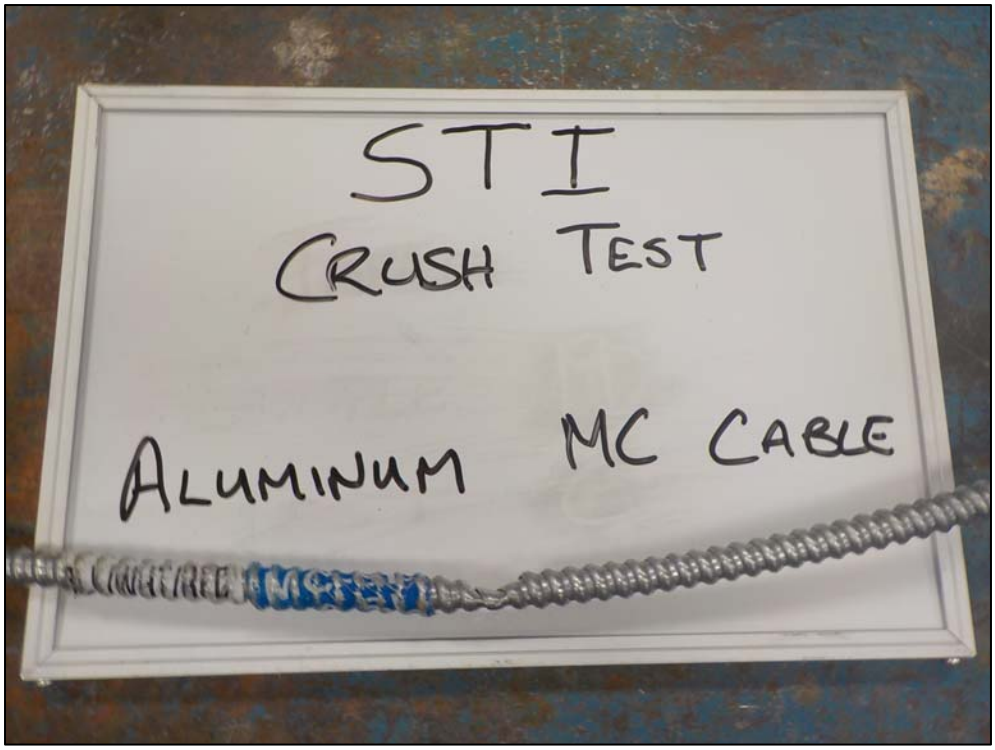

Figure 14. After Crushing Test