KINECTRICS

MEDIUM VOLTAGE CABLE SPIKING TOOL

FUNCTIONAL TEST WITH FAULT CURRENT

K-352093-001- R00

Prepared for

SPIKE Tool INC.
2301-25 Broadway Avenue
Toronto, Ontario,
Canada, M4P 1T7

Issue Date

2018-August-15

Witnessed by: Ron Mock, Spike Tool Inc

Prepared by:	**Reviewed by:**	**Confirmed by:**	**Approved by:**
Claude Maurice 2018.08.27 09:09:15 -04'00'	Andrew Haines 2018.08.24 15:10:35 -04'00'	Digitally signed by Philip Skelding Date: 2018.08.27 10:25:19 -04'00'	Digitally signed by Zsolt Peter Date: 2018.08.27 10:56:32 -04'00'
Claude Maurice	Andrew Haines	Phil Skelding	Zsolt Peter
Associate	Supervising Technologist	Technologist	Department Manager
Transmission & Distribution Technologies	Transmission & Distribution Technologies	Transmission & Distribution Technologies	Transmission & Distribution Technologies

Revision History

Rev	Description:				
00	Original Issue				
	Issue Date: 2018-Aug-15	**Prepared by:** Claude Maurice	**Reviewed by:** Andrew Haines	**Confirmed by:** Phil Skelding	**Approved by:** Zsolt Peter

Table of Contents

List of Figures

1 Introduction

The SPIKE tool is a portable charge-actuated device which has been designed to push a metal nail (spike) into an electrical power cable. The nail pierces the cable through the neutral or sheath, insulation and the main conductor, and is designed to put a short across the cable. The purpose of spiking a cable is to provide further assurance that a cable is de-energized prior to cutting into the cable by piercing the dielectric of a single conductor cable.

When used correctly, spiking an energized cable will cause a severe arcing cable fault at the puncture location. For the safety of the operator, the SPIKE tool is operated by using a 10 m (30 ft) lanyard to remotely pull the safety pin and fire the charge.

The testing of this device was performed at the request of the manufacturer to demonstrate the operation of the tool under laboratory conditions. The testing does not address the safety considerations of using such a tool and the operation under all possible cable types and conditions.

The test was performed by personnel from Kinectrics Inc. at 800 Kipling Avenue, Toronto, Ontario, Canada, M8Z 5G5 on , 2018. The tests were performed under a signed service agreement dated June 14, 2018 and Kinectrics' ISO 9001 quality management program. A copy of Kinectrics' ISO 9001 certificate of registration is included in Appendix B.

2 Test Objective

The objective of this test was to observe the operation of the SPIKE tool at multiple fault current levels on different voltage class and size power cables. This will demonstrate the ability of the SPIKE tool to puncture different sizes of distribution cable.

Since the tool has a provision for an external cable connection for bonding a ground to the tool, the second objective was to verify the effect of the current path through the tool when the tool is solidly bonded to the power system ground.

The information will be used by SPIKE Tool Inc. to evaluate the performance of the different components in the assembly and the assigned rating.

3 Test Standard

No directly applicable test standard is available for this specialty product. The fault levels were agreed upon between Kinectrics and SPIKE Tool Inc. As a minimum, the fault current levels indicated in Ontario Energy Board (OEB) Transmission System Code Appendix 2, Ref 2 were used.

4 Acceptance Criteria

The acceptance criteria are based on the manufacturer's requirement for this tool to successfully puncture the cable and create a cable fault on an energized cable.

The tool does not provide a secure bolted connection for the fault current. If an energized cable is spiked, it is expected that the nail will instantly vaporize (less than 1 cycle) and an arcing fault will result. This will release a ball of vaporized gases, molten metal and thermal energy and create a hole blown into the cable. The tool may be severely damaged.

If the tool is used ungrounded, there is no definitive current limit imposed. The fault created by the tool results in fault current from the main conductor to the concentric neutral of the cable only. The tool will suffer collateral damage but is not part of the current carrying path.

When the tool is bonded to ground through either the split bolt or the 25 mm ball stud, the current path will be split between the concentric neutral and the tool ground path. In a worst case for the tool being used in an ungrounded cable, all the current will flow through the tool ground path. In the lab tests, the concentric neutral of the power cable was disconnected as to force all the current to flow through the tool. In such a case, the tool is expected to handle the fault current for the duration of the test.

5 Test Sample

A view of the SPIKE tool and accessories is shown in Figure 5-1.

Figure 5-1: View of cable SPIKE Tool kit (from website).

Test samples were received for testing at Kinectrics on June 15, 2018 in new condition. Based on the product literature, the tool can accommodate a cable up to approximately 90 mm (3½") and is supplied with three different cartridge power loads (colour coded with brown, green and yellow). A chart is provided for the user to select the correct cartridge for the size of cable being spiked. The tool is also provided with hardened 50 mm (2") nails. Photographs of the cartridge and nail are shown in Figure 5-2.

Figure 5-2: Cartridge and hardened nail supplied with SPIKE.

6 Test Conditions and Setup

The SPIKE tool was evaluated on all cable sizes listed below. In each instance the SPIKE tool was positioned and installed on the cable as normally used. The correct cartridge was selected based on the chart provided in the instruction. When correctly installed, the tool is self-centering on the cable and punctures the center of the cable with no adjustment required for the size of cable.

15 kV, TRXLPE, 500 kcmil copper conductor, 39 mm OD

15 kV, TRXLPE, 750 kcmil aluminum conductor, 44 mm OD

28 kV, TRXLPE, 1000 kcmil aluminum conductor, 55 mm OD

15 kV, TRXLPE, 2/0 AWG steel armoured cable, 47 mm OD

15 kV, TRXLPE, 1/0 AWG copper conductor, 27 mm OD

6.1 Operation on Non-Energized Cables

Tests were made on non-energized cables to demonstrate the functionality of the tool. This was to demonstrate the ability of the tool to fully puncture the insulation and conductor. With de-energized cable, the nail is expected to fully penetrate the cable and exit onto the striker plate of the tool.

6.2 Operation on Energized Cables

Tests were performed in a concrete vault where the cable could be safely energized and faulted. Each section of cable was terminated to allow a bolted connection to the test station at one end and open circuit at the other end to withstand the open circuit voltage.

Tests were performed at three fault current levels: nominal 14 kA, 20 kA and 27 kA with a duration of 15 cycles (0.25 seconds).

Tests were performed with the SPIKE tool under two scenarios;

1- Ungrounded having the fault current return trough the concentric neutral wires. Setup as shown in Figure 6-1.

2- -Bonded with additional ground cable connected to either the split bolt or the 25 mm ball stud with a grounding clamp. For these tests, the concentric neutral wires on the test cable were isolated allowing all the current to flow through the tool. In Figure 6-2, the grounding of the tool was made with 1/0 AWG copper flex conductor. This is the largest conductor that can be accommodated in the split-bolt mechanical lug supplied with the tool as currently sold. The split-bolt screws into the side of the SPIKE tool. Testing with the 1/0 AWG conductor with the split-bolt was limited to 14 kA.

The setup shown in Figure 6-3 used the new design which incorporates a 25 mm copper ball-stud for attaching a ground clamp. A number of different commercially available clamps are designed for use on a ball stud.

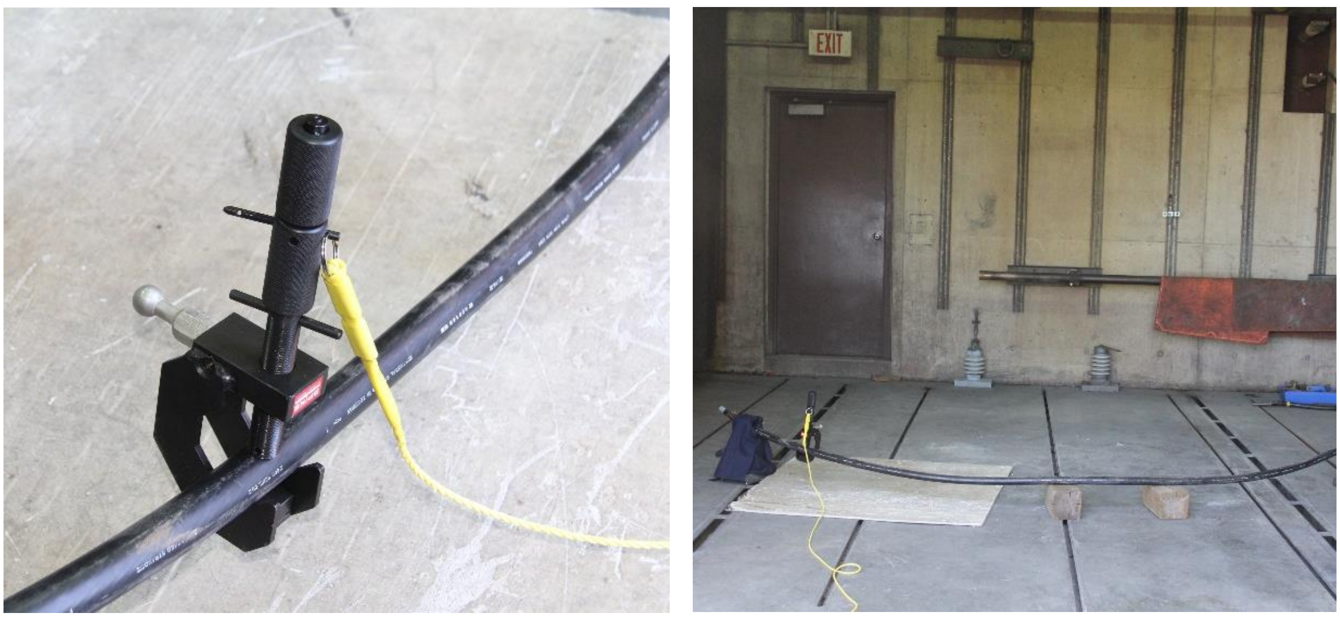


Figure 6-1: Setup of ungrounded SPIKE tool.

Figure 6-2: Setup of grounded SPIKE tool using split-bolt.

Figure 6-3: Setup of grounded SPIKE tool using 25 mm ball-stud.

7 Test Procedure

The test station was configured to provide the desired fault current and the station protection relay adjusted to allow 15 cycles of fault current. A waveform recorder was used to record the voltage and fault current. High speed video cameras were used to record the operation of the tool and initiation of the fault.

Under lab conditions, the tests were performed by first installing the tool onto the cable and withdrawing the operator to a safe distance. The station was energized and the lanyard was pulled to trigger the tool.

8 Results

8.1 Operation on Non-Energized Cables

The following cables were spiked using the recommended colour cartridge given in the instruction table.

15 kV, TRXLPE, 2/0 AWG steel armoured cable, 47 mm OD, cartridge used: Brown

With steel armoured cable, the tool barrel was positioned to be aligned with the nail over an armor shield wire as worst case scenario. In the tests performed, the nail always veered to one side or the other and fully pierced the cable and main conductor. See Figures 8-1 and 8-2.

Figure 8-1: SPIKE installed on steel armoured cable.

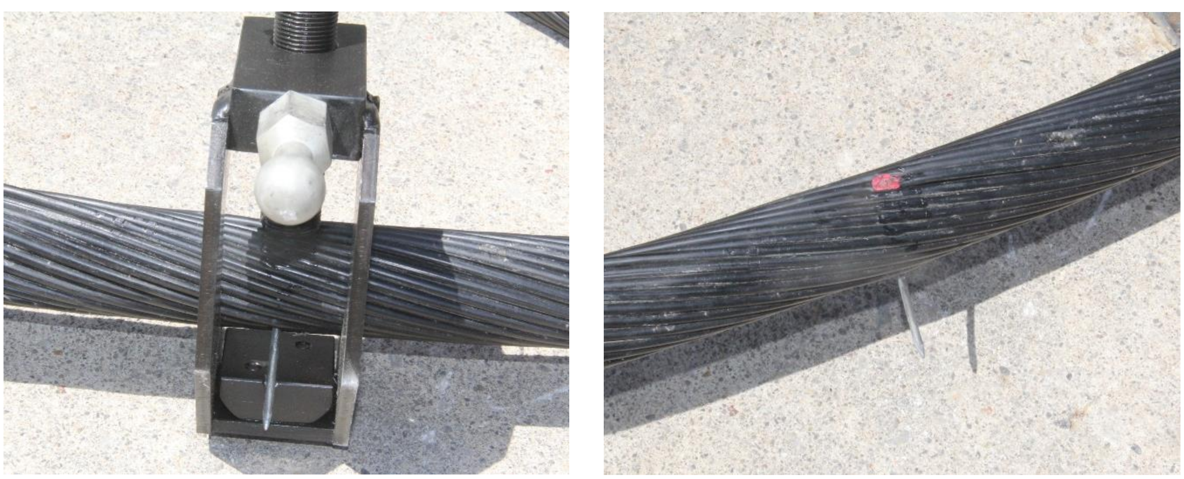


Figure 8-2: Nail punctured through on steel armoured cable.

15 kV, TRXLPE, 500 kcmil copper conductor, 39 mm OD, cartridge used: Brown & Green

Copper is a harder material than aluminum and requires more force to push the nail through to the other side. When using the brown cartridge, the nail penetrated through the insulation but only part way through the copper conductor. More than half the nail remained inside the barrel of the tool. It did not project out the opposite side.

A second spike was made using the next highest cartridge (green). In this case, the nail was inserted sufficiently to project out the opposite side and hit the striker plate of the tool. See Figure 8-3.

The table in the instruction manual does not make a distinction between aluminum and copper conductor when selecting the cartridge. This should be revised.

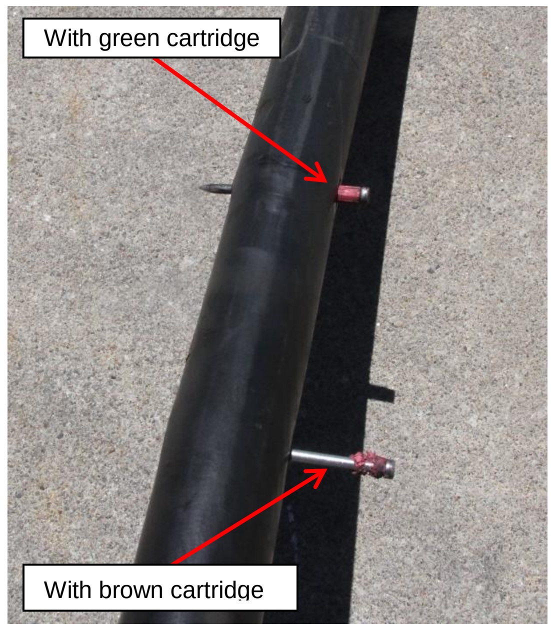


Figure 8-3: Nail punctured through on 15 kV, 500 kcmil copper conductor

[The remainder of this page is intentionally left blank.]

28 kV, TRXLPE, 1000 kcmil aluminum conductor, 55 mm OD, cartridge used: Green

This cable was the largest diameter cable that was available for evaluation. Using the green cartridge as indicated in the instruction manual, the nail fully penetrated the cable and projected out the other side and hit the striker plate. See Figure 8-4.

Figure 8-4: Nail punctured through on 28 kV, 1000 kcmil aluminum conductor

15 kV, TRXLPE, 1/0 AWG copper conductor, 27 mm OD, cartridge used: Brown

This cable was the smallest diameter cable and conductor size that was available for evaluation. Although there wasn't a question of the ability of the tool to puncture a small diameter cable, the tests were performed to check if the cable was pierced in the middle and able to puncture a small conductor. With the cable correctly installed in the "V" of the SPIKE tool, the nail was spiked directly in the middle of the cable.

Using the brown cartridge as indicated in the instruction manual, the nail fully penetrated the cable and projected out the other side and hit the plate. Since the cable diameter is small compared to the length of the nail, there is a long length of nail remaining in the barrel of the tool. The striker plate is a safety feature to stop the nail should it penetrate through the conductor as with small cables. The result is a depression in the steel plate. See Figure 8-5.

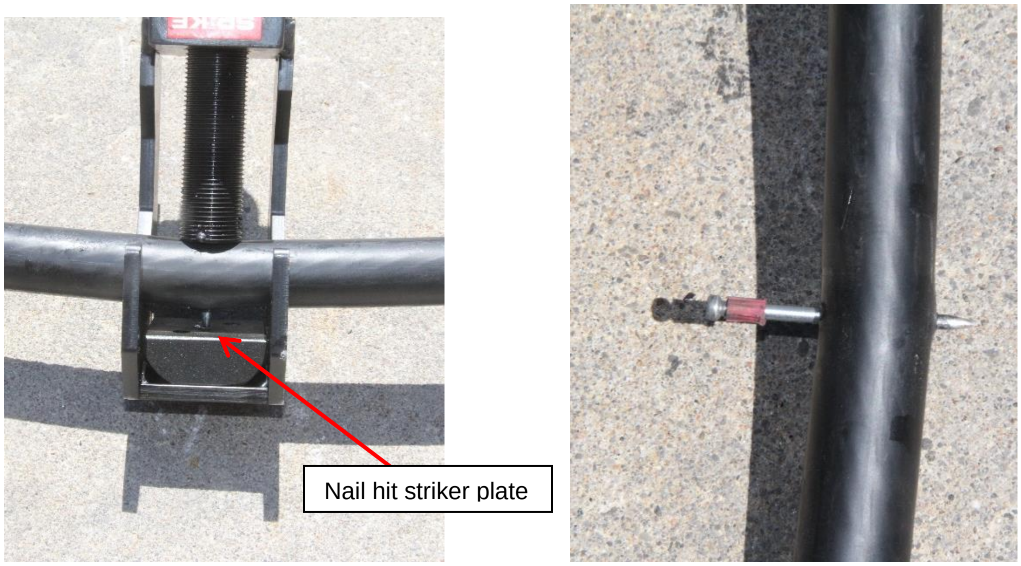


Figure 8-5: Nail punctured through on 15 kV, 1/0 AWG copper conductor

8.2 Operation on Energized Cables

Tests were performed to evaluate the performance of the tool with energized cables. The recorded data and test identification for the tests performed on energized cables is summarized in Table 8-1. The waveforms of the applied fault current were recorded and are provided in Appendix B.

Table 8-1: Results of Operation on Energized Cables

Test Number K-352093-	Test Current (kA)	I^2t (A^2s)	Arc Voltage (V)	Arc energy (kJ)	Test Duration (cycles)	Comment
3234	13.9	48 X 10^6	413	1310	15	Ungrounded tool 15 kV, TRXLPE, 500 kcmil, CU
3235	14.0	53 X 10^6	247	846	15	Grounded tool through split bolt and 1/0 AWG cable, 15 kV, TRXLPE, 500 kcmil, CU
3236	13.8	50 X 10^6	283	897	15	Grounded tool through 25 mm ball-stud and 4/0 AWG cable, 15 kV, TRXLPE, 750 kcmil, AL
3237	27.3	198 X 10^6	358	2320	15	Grounded tool through 25 mm ball-stud and 4/0 AWG cable, 15 kV, TRXLPE, 750 kcmil, AL
3238	19.3	99 X 10^6	291	1320	15	Grounded tool through 25 mm ball-stud and 4/0 AWG cable, 28 kV, TRXLPE, 1000 kcmil, AL

8.2.1 Faulting cable with an ungrounded tool

Test 3234 was performed with the tool installed on a 15 kV, 500 kcmil copper cable with the concentric neutral wires grounded, the SPIKE tool remained ungrounded, see Figure 6-1 for the installation. In this case, the tool pierces the cable and initiates the fault but does not carry any of the fault current. All current returns through the cable concentric neutral wires or shield.

Observation:

- The tool suffered damage to the barrel. The tip of the barrel is partially melted away.
- The nail did not penetrate though the cable. The nail was fused (melted) when reaching the conductor. Based on the waveform, the nail appears to fuse within ½ cycle. The remaining period is an arcing fault in air.
- The fault occurs upwards back toward the barrel of the tool where the nail punctured the cable. The concentric wires burn back and result in a large burn hole in the cable and thermal damage to the cable. See Figure 8-6.

Figure 8-6: Ungrounded SPIKE tool with 13.8 kA fault, 15 cycles.

8.2.2 Faulting cable with a grounded tool – split bolt lug

Test 3235 was performed with the tool installed on the same 15 kV, 500 kcmil copper cable but with the concentric neutral wires disconnected to have all the current flow through the tool. The SPIKE tool was bonded to a ground using the split-bolt provided in the kit. See Figure 6-2 for the installation. In this case, the tool pierces the cable and initiates the fault and carries all the fault current.

Observation:

- The tool had damage mostly to the bottom striker plate.
- The arcing fault did not appear to start until the nail projected through the cable and hit the grounded striker plate. This also occurred within ½ cycle.
- The fault occurs mostly downwards toward the bottom of the tool since the arc occurred to the striker plate. See Figure 8-7.
- Split-bolt mechanical lug held the 1/0 AWG flex cable.

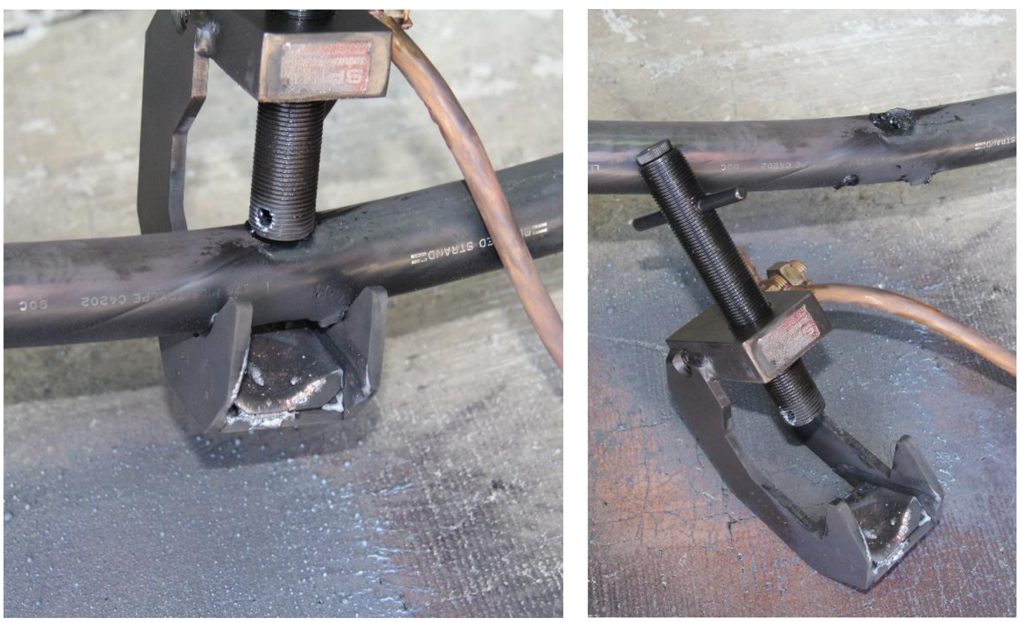


Figure 8-7: Grounded SPIKE tool with split-bolt lug at 13.8 kA fault, 15 cycles.

8.2.3 Faulting cable with a grounded tool – 25 mm ball stud

To adapt to modern clamps and provide a more secure ground connection, an alternate ground method was evaluated using a 25 mm ball stud threaded into the back of the tool. The ball stud is made of tinned copper and has a ½”-13 NC thread. The ball stud installed on the SPIKE tool was Maclean Power HC-30029-1 which is rated up to 43 kA (ASTM F855) which is much higher than the expected range on this tool. The SPIKE tool with the ball stud installed is shown in Figures 6-1 and 6-3 with a ground cable attached.

Three tests were performed with the SPIKE tool bonded to ground through the ball stud. The tool initiated the fault in all cases and withstood the fault current. There was no evidence of damage or overheating on the ball-stud and threaded connection. The tool sustained significant damage at the striker plate and “V” block. This should be expected as the tool is the arc electrode.

Figure 8-8: Test 3236: Grounded SPIKE tool with ball-stud at 13.8 kA fault, 15 cycles.

Figure 8-9: Test 3237: Grounded SPIKE tool with ball-stud at 27 kA fault, 15 cycles.

Figure 8-10: Test 3238: Grounded SPIKE tool with ball-stud at 19 kA fault, 15 cycles.

9 Summary

The operation of the SPIKE tool was observed on different non-energized and energized cables. Following the instructions of the manufacturer, the tool performed well as designed to rapidly push a nail into a cable to provide a shorting path from the main conductor to a neutral or ground.

Observations were made based on the tests performed on non-energized conductors and energized conductors which may be considered by the manufacturer to improve the application or design of the tool.

Based on the tests performed on non-energized cables, the cartridge selection chart appears satisfactory to pierce aluminum conductors. It was observed that better piercing depth could be obtained on the copper conductor by using the next higher capacity cartridge on the 500 kcmil conductor. This may apply for larger cables as well. Additional testing would be required to confirm if the present cartridge selection table is optimum for all copper conductor sizes. The tool performed well on small conductors such as 1/0 AWG in spiking the middle of the conductor.

Based on the tests performed on the energized conductors, all energized cables spiked resulted in clear detection and an arcing fault. In real field installations, the arc would continue until the station circuit breaker cleared the fault. In these laboratory conditions, the breaker was set to clear in 15 cycles. System protection that operate faster than this would result in less damage.

The SPIKE tool may be used un-grounded or bonded to ground with an external cable. The use of "floating" or grounding the tool is at the discretion of the end-user based on several factors such as having a suitable grounding point. Safety considerations and a hazard analysis should be performed by the system engineer.

Although the split-bolt lug was evaluated at 14 kA, based on historical test experience, the split-bolt mechanical lug which can accommodate a 1/0 AWG flex cable should not be used above 10 kA rms.

The use of a ball stud (20 or 25 mm) threaded into the body of the tool provides a more secure connection for higher fault currents. The tool was tested at a fault of 27 kA rms, 15 cycles. At this level the tool was severely damaged and very loose on the cable. The tool had less damage at 19 kA. It is recommended that it should not be used above a fault level of 20 kA, 15 cycles unless it's been verified that the fault clearing time is much shorter than 15 cycles.

In this testing, the tool was not evaluated on multi-conductor power cables or single core PILC armoured and un-armoured cables.

The safe and effective use of a spiking tool to provide assurance that a cable is de-energized requires a depth of knowledge about the system. Three phase ungrounded systems for example require special consideration. In such a case, multiple tools may be necessary which are bonded to one another and having all three cables spiked. The order of the spiking and installation of the three tools at once with the inter-bonding using the ball studs for examples should be done by trained personnel.

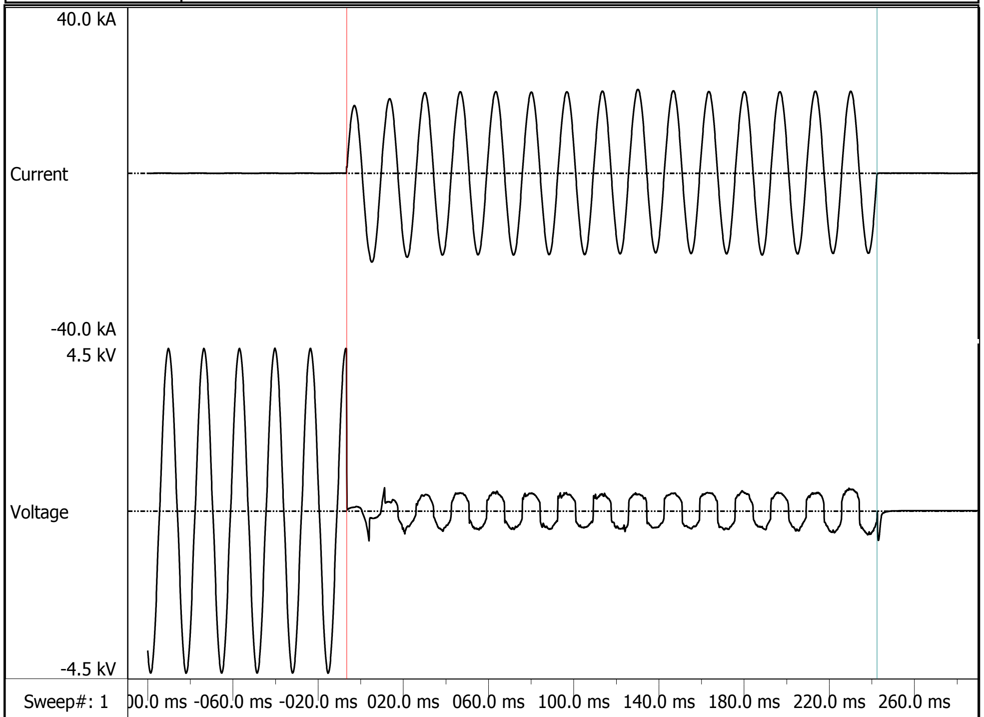
[The remainder of this page is intentionally left blank.]

Appendix A Waveforms

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

Record #	K-352093-3234_Copy
Project #	K-352093 Client: Spike Tool Inc.
Test Description:	Cable ID # 5
Item Description:	General Cable, 500 kcmil, Copper, 15 kV
Item Description:	Concentric grounded
Shot information:	Test # 2



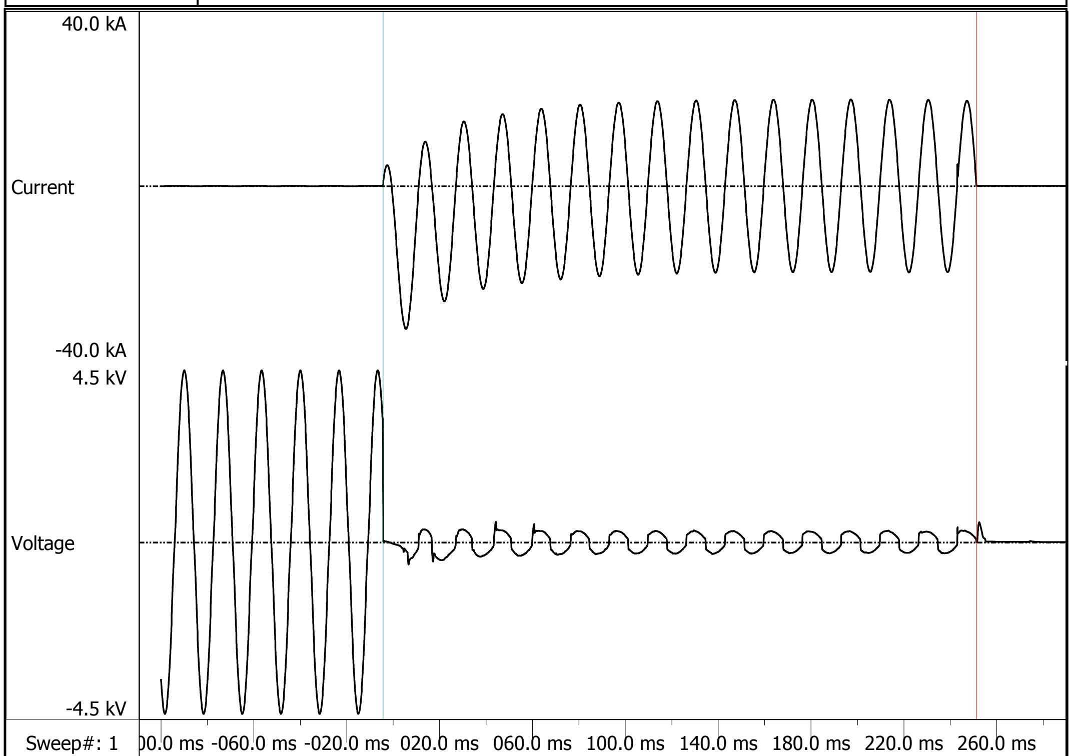
Calculated values between cursors			
Current Total RMS	13.87 kA	Integral I²t	4.79E+07 A²sec
Symetrical RMS	13.85 kA		
Current Peak	21.48 kA		
Terminal Voltage	404.6 V		
Loop Impedance	0.0292 Ohms		
Durationt(me)	249.0 ms	Test Date	15/06/2018

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

KINECTRICS

Record #	K-352093-3235	
Project #	K-352093	Client: Spike Tool Inc.
Test Description:	Cable ID # 5	
Item Description:	General Cable, 500 kcmil, Copper, 15 kV	
Item Description:	Grounded Spike Tool with U-bolt	
Shot information:	Test # 3	



Calculated values between cursors

Current Total RMS	14.47 kA	Integral I²t	5.35E+07 A²sec
Symetrical RMS	13.96 kA		
Current Peak	32.72 kA		
Terminal Voltage	246.7 V		
Loop Impedance	0.017 Ohms		
Durationt(me)	255.6 ms	Test Date	15/06/2018

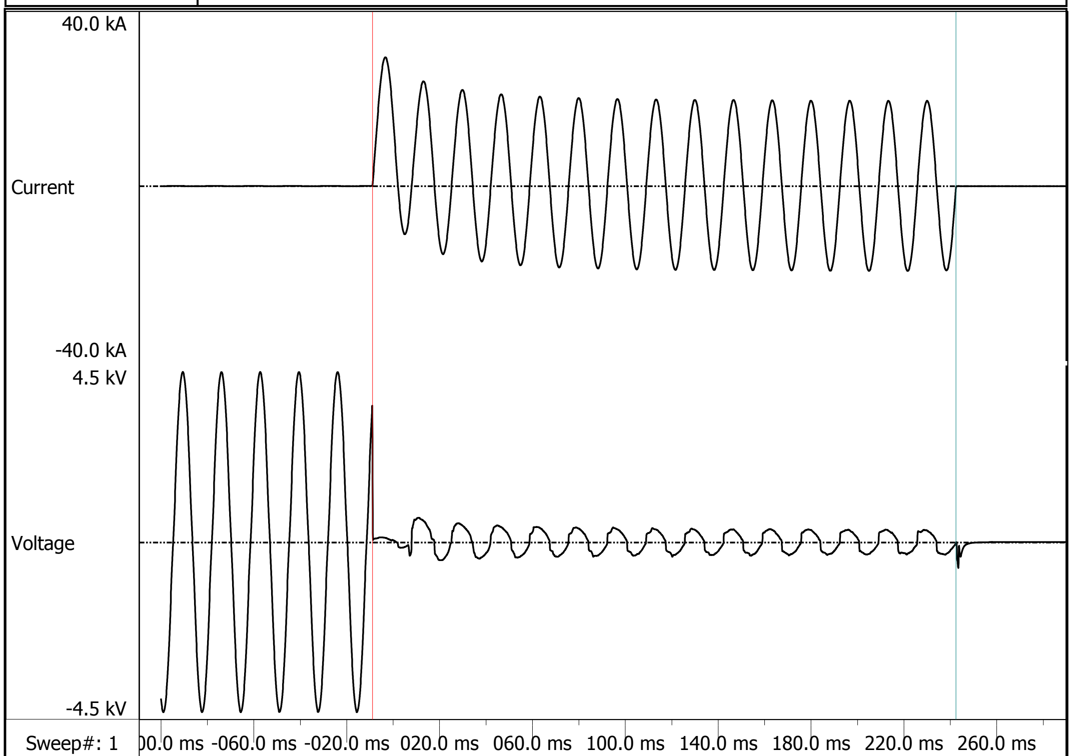
High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

KINECTRICS

Record #	K-352093-3236		
Project #	K-352093	Client:	Spike Tool Inc.

Test Description:	Cable ID # 6
Item Description:	Prysmian, 750 kcmil, Aluminum,15 kV
Item Description:	Grounded Spike Tool with ball stud
Shot information:	Test # 4

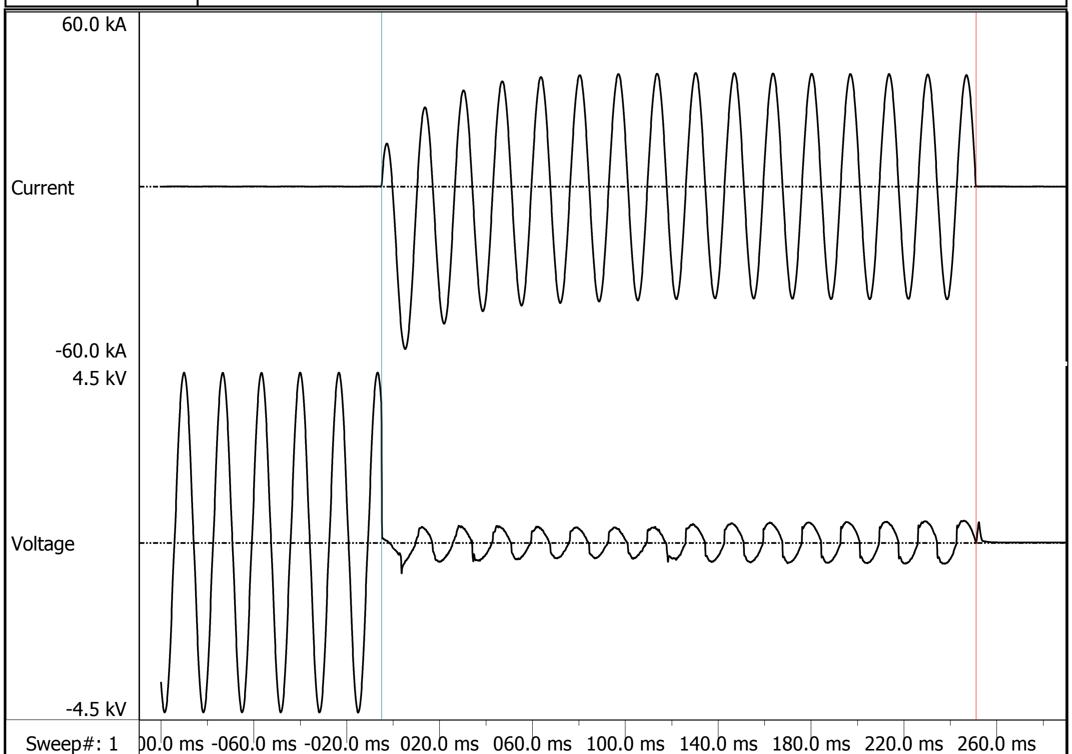


Calculated values between cursors			
Current Total RMS	14.13 kA	Integral I²t	5.02E+07 A²sec
Symetrical RMS	13.77 kA		
Current Peak	29.49 kA		
Terminal Voltage	283.2 V		
Loop Impedance	0.02 Ohms		
Durationt(me)	251.4 ms	Test Date	15/06/2018

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

Record #	K-352093-3237
Project #	K-352093 Client: Spike Tool Inc.
Test Description:	Cable ID # 6
Item Description:	Prysmian, 750 kcmil, Aluminum,15 kV
Item Description:	Grounded Spike Tool with ball stud
Shot information:	Test # 5



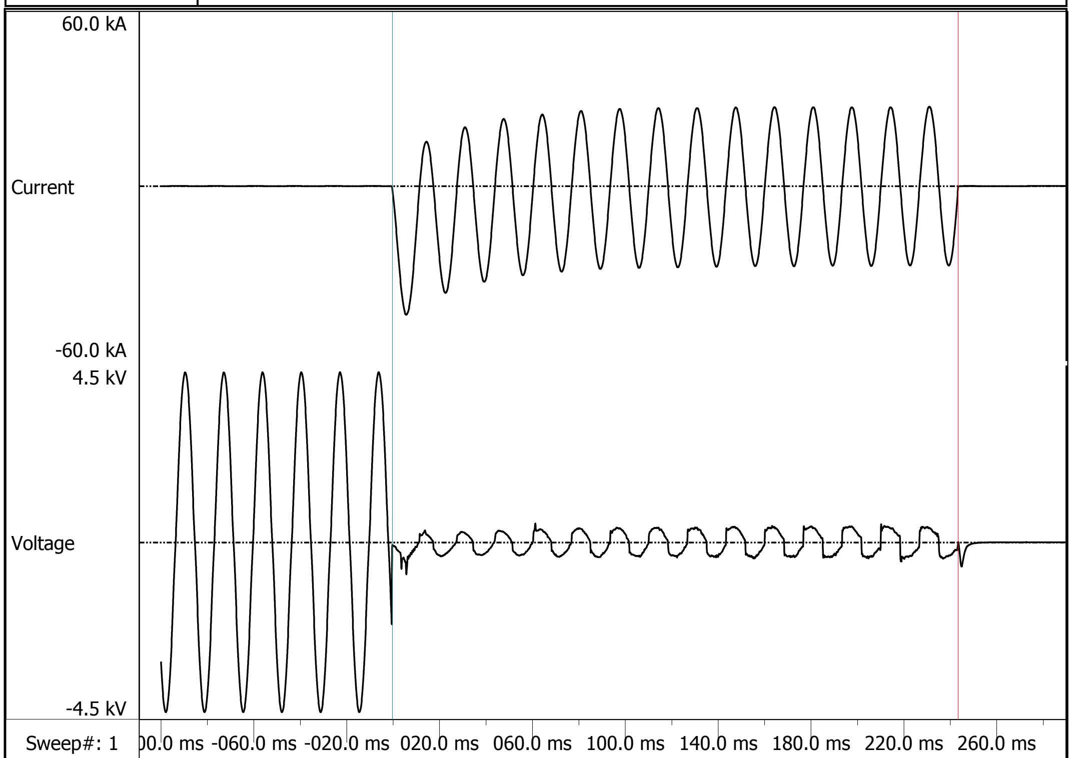
Calculated values between cursors			
Current Total RMS	27.78 kA	Integral I²t	1.98E+08 A²sec
Symetrical RMS	27.26 kA		
Current Peak	55.84 kA		
Terminal Voltage	361.0 V		
Loop Impedance	0.013 Ohms		
Durationt(me)	256.1 ms	Test Date	15/06/2018

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

Record #	K-352093-3238		
Project #	K-352093	Client:	Spike Tool Inc.

Test Description:	Cable ID # 7
Item Description:	General Cable, 1000 kcmil, Aluminum, 28 kV
Item Description:	Grounded Spike Tool with ball stud
Shot information:	Test # 6



Calculated values between cursors			
Current Total RMS	20.14 kA	Integral I²t	9.89E+07 A²sec
Symetrical RMS	19.27 kA		
Current Peak	44.25 kA		
Terminal Voltage	290.6 V		
Loop Impedance	0.0144 Ohms		
Duration(time)	243.7 ms	Test Date	15/06/2018

Appendix B Instrument Sheet

INSTRUMENTATION SHEET
Kinectrics
Testing Laboratories

Test Description: Medium Voltage Cable Spiking Tests

Test Dates: June 15, 2018

Item No.	Description	Asset #/sn	Stated Accuracy	Calibration date	Calibration due date	Test parameter
1	Nicolet Genesis Chassis IDH496	KIN-01709; Mod IDV0900810	±0.5%	Oct 18, 2017	Oct 18, 2018	Waveform Recorder for Arc Voltage & Current
2	Current transformer (CT1)	KIN-04507	±0.5%	Dec 1, 2017	Dec 1, 2020	Used with Genesis496 and Resistive Shunt to measure arc current
3	Resistive Instrumentation Shunt Panel	KIN-3460	±0.5%	May 31, 2017	May 31, 2018	Non inductive shunt, .5 ohms (on secondary of CT1)
4	2400V/120V Potential Transformer (PT6)	KIN-04505	±0.5%	Oct 27, 2015	Oct. 27, 2018	Potential Transformer for arc voltage on panel stand (ASTM F1959 only)
5	Isolation Amplifier	KIN-01706	±0.5%	Nov 23, 2017	Nov 23, 2018	Isolation and attenuator of PT6 and PT3 secondary
6						
7						
8						
9						

Test performed by: A. Haines, P. Skelding, E. Alhariri, C. Maurice
Project Number: K-352093

Appendix C Kinectrics ISO 9001 Certificate of Registration

CERTIFICATE OF REGISTRATION

This is to certify that

Kinectrics Inc.

800 Kipling Avenue Unit 2 Toronto, Ontario M8Z 5G5 Canada

Refer to Attachment to Certificate of Registration dated September 22, 2015 for additional certified sites

operates a

Quality Management System

which complies with the requirements of

ISO 9001:2008

for the following scope of registration

The registration covers the Quality Management System for consulting, scientific, and engineering services within our facilities and at field sites in the civil, chemical, electrical, environmental, mechanical, materials and metallurgical fields,safety and licensing, research, design and development and general project management for clients in the nuclear industry, electric power generation transmission & distribution, and related energy sectors. Within the nuclear industry services, life cycle management, safety assessment and analysis, probabilistic risk assessment regulatory affairs and licensing, fuel and fuel channel assessments, environment, waste management, decommissioning and health physics, and engineering and operations support.

Certificate No.:	CERT-0091424	Original Certification Date:	July 7, 1998
File No.:	006555	Current Certification Date:	October 26, 2015
Issue Date:	September 22, 2015	Certificate Expiry Date:	October 25, 2018

Heather Mahon
Acting Head of
Policy, Risk and Certification

Certified System ISO 9001

ANAB ACCREDITED ISO/IEC 17021 MANAGEMENT SYSTEMS CERTIFICATION BODY

SAI GLOBAL
INFORM. INSPIRE. IMPROVE.

ATTACHMENT TO
CERTIFICATE OF REGISTRATION

These sites are registered under Certificate No: CERT-0091424 issued on September 13, 2016

File No.		Effective Date
006555	**Kinectrics Inc.** **Kinectrics North America Inc., Kinectrics International Europe ApS or Kinectrics International Inc.** 800 Kipling Avenue Unit 2 Toronto, Ontario M8Z 5G5 Canada The registration covers the Quality Management System for the consulting, scientific, and engineering services within our facilities and at field sites in the civil, chemical, electrical, environmental, mechanical, materials and metallurgical fields, including manufacturing, testing, repair, calibration, training services, safety and licensing, research, design and development and general project management for clients in the nuclear industry, electric power generation transmission & distribution, and related energy sectors. Within the nuclear industry services particularly related to inspection, parts, life cycle management, safety assessment and analysis, regulatory affairs and licensing, fuel and fuel channel assessments, environment, waste management, decommissioning and health physics, and engineering and operations support.	October 26, 2015
1619845	**Candesco** **Division of Kinectrics Inc.** 26 Wellington Street East, 3rd Floor Toronto, Ontario M5E 1S2 Canada The registration covers the Quality Management System for the consulting, scientific, and engineering services within our facilities for clients in the nuclear industry and related energy sectors. Within the nuclear industry services particularly safety assessment and analysis, regulatory affairs and licensing, fuel and fuel channel assessments, environment, waste management, decommissioning and health physics, and engineering and operations support.	October 26, 2015
1641942	**Kinectrics Inc.** 940 Brock Road Unit 11 Pickering, Ontario L1W 2A1 Canada Consulting and engineering services within our facilities and at field sites in the safety and licensing fields within the nuclear industry services, analysis and probabilistic risk assessments are provided in relation to fire, seismic, internal flood, high winds, lightning and toxic gas impacts on nuclar utilities.	October 26, 2015

These registrations are dependent on Kinectrics Inc. Kinectrics North America Inc., Kinectrics International Europe ApS or Kinectrics International Inc. (File No. 006555) maintaining their scope of registration to ISO 9001:2008

SAI GLOBAL
INFORM. INSPIRE. IMPROVE.

Appendix D Distribution

Mr. Ron Mock	SPIKE Tool INC. 2301-25 Broadway Avenue Toronto, Ontario, Canada, M4P 1T7 Email:
Mr. Claude Maurice	Kinectrics Inc. 800 Kipling Ave, Unit #2 Toronto, Ontario, M8Z 5G5 Canada Email: claude.maurice@kinectrics.com

[The remainder of this page is intentionally left blank.]