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COOPER POWER
SERIES

Test Report for SideBuster® Type M-Force™ Sidebreak Switch

Powering Business Worldwide

Design Tests for the M-Force Sidebreak Switch
Per the following IEEE Standards
IEEE Std C37.34™-1994, and
IEEE Std 1247™-2005 standards

M-Force Sidebreak Switch

Part No: M3R11TR3 – 38 kV M-Force, Polymer insulator

Part No: M3R00SC3 – 38 kV M-Force, Epoxy insulator

Part No: M2R11TR2 – 27 kV M-Force, Polymer insulator

Part No: M2H03SC2 – 27 kV M-Force, Epoxy insulator

Part No: M1R11TR2 – 15.5 kV M-Force, Polymer insulator

Part No: M1H03SC2 – 15.5 kV M-Force, Epoxy insulator

M-Force Sidebreak Single Phase Switch

Part No.: 7A1342-1P2RAC – 15.5 V M-Force Single Phase Switch

CERTIFICATION

Statements made and data shown are, to the best of our knowledge and belief, correct and within the usual limits of commercial testing practice.

9/21/15

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Introduction

Eaton's Cooper Power series M-Force™ Sidebreak switch with silicone insulators has been developed for 15.5kV through 38kV applications.

The test details and data to verify performance in meeting the applicable IEEE® standards are available upon request.

Contents

Load Switching Test

27 kV and 38kV M-Force Sidebreak switches were tested per IEEE Std 1247™-2005, Clause 8. Table 1 shows 27kV M-Force test and Table 2 shows 38kV M-Force test.

Table 1. 27kV M-Force Switch test.

	Test Voltage kV (rms)	Test current A (rms)	No. of Operations
Line Load Switching	27	600	50
Line Load Switching	27	900	10
Loop Switching	5.4	900	10
No Load Transformer Switching	27	31.5	20
Line Charging	27	10	20
Cable Charging	25	20	20

Table 2. 38kV M-Force Switch test.

	Test Voltage kV (rms)	Maximum current A (rms)	No. of Operations
Line Load Switching	38	900	15
Loop Switching	7.6	900	10
No Load Transformer Switching	38	31.5	20
Line Charging	27	10	20
Cable Charging	27	20	20

All switches successfully passed number of operations at the above conditions.

Voltage Withstand Test

15.5kV M-Force Sidebreak Switch

Power frequency and lightening-impulse dry withstand testing was performed on a 15.5 kV M-Force Sidebreak switch. Test was in accordance with IEEE Std 1247™-2005, clause 8.1.

Table 3. Points of application to 15.5 kV Switch for power frequency withstand test

Test Condition	Phase A Source Ternimal	Phase A Load Terminal	Phase B Source Terminal	Phase B Load Terminal	Phase C Source Terminal	Phase C Load Terminal
Switch Closed	Energized	Energized	Energized	Energized	Energized	Energized
Switch Open	Grounded	Grounded	Grounded	Energized	Grounded	Grounded
Switch Open	Grounded	Grounded	Energized	Grounded	Grounded	Grounded
Switch Closed	Grounded	Grounded	Energized	Energized	Grounded	Grounded
Note: Frame grounded for all tests.						

At least 50 kV rms, corrected for atmospheric conditions, was applied to the test specimen for each condition in Table 3 without incurring a dielectric breakdown or puncture. The test specimen successfully met the requirements of the power frequency dry withstand test.

Table 4. Points of application to 15.5 kV Switch for impulse withstand test

Test Condition	Phase A Source Ternimal	Phase A Load Terminal	Phase B Source Terminal	Phase B Load Terminal	Phase C Source Terminal	Phase C Load Terminal
Switch Closed	Energized	Energized	Energized	Energized	Energized	Energized
Switch Open	Grounded	Grounded	Grounded	Energized	Grounded	Grounded
Switch Open	Grounded	Grounded	Energized	Grounded	Grounded	Grounded
Note: Frame grounded for all tests.						

IEEE Std C37.34™-1994, clause 4.2.7 specifies that the switch shall be considered to have passed the test if it withstands three consecutive impulses for each test condition at the defined test voltage. The test specimen was subjected to three positive and three negative impulses of at least 110 kV for all conditions defined in Table 4 without incurring a dielectric breakdown or puncture. The test specimen successfully met the requirements of the lightning-impulse dry withstand test.

27 kV M-Force Sidebreak Switch

Power frequency and lightening-impulse dry withstand testing was performed on a 27 kV M-Force Sidebreak switch. Test was in accordance with IEEE Std 1247™-2005, clause 8.1.

Table 5. Points of application to 27 kV Switch for power frequency withstand test

Test Condition	Phase A Source Ternimal	Phase A Load Terminal	Phase B Source Terminal	Phase B Load Terminal	Phase C Source Terminal	Phase C Load Terminal
Switch Closed	Energized	Energized	Energized	Energized	Energized	Energized
Switch Open	Grounded	Grounded	Grounded	Energized	Grounded	Grounded
Switch Open	Grounded	Grounded	Energized	Grounded	Grounded	Grounded
Switch Closed	Grounded	Grounded	Energized	Energized	Grounded	Grounded
Note: Frame grounded for all tests.						

At least 70 kV rms, corrected for atmospheric conditions, was applied to the test specimen for each condition in Table 5 without incurring a dielectric breakdown or puncture. The test specimen successfully met the requirements of the power frequency dry withstand test.

Table 6. Points of application to 27 kV voltage for impulse withstand test

Test Condition	Phase A Source Ternimal	Phase A Load Terminal	Phase B Source Terminal	Phase B Load Terminal	Phase C Source Terminal	Phase C Load Terminal
Switch Closed	Energized	Energized	Energized	Energized	Energized	Energized
Switch Open	Grounded	Grounded	Grounded	Energized	Grounded	Grounded
Switch Open	Grounded	Grounded	Energized	Grounded	Grounded	Grounded
Note: Frame grounded for all tests.						

IEEE Std C37.34™-1994, clause 4.2.7 specifies that the switch shall be considered to pass the test if it withstands three consecutive impulses for each test condition at the defined test voltage. The test specimen was subjected to three positive and three negative impulses of at least 150 kV for all conditions defined in Table 6 without incurring a dielectric breakdown or puncture. The test specimen successfully met the requirements of the lightning-impulse dry withstand test.

38 kV M-Force Sidebreak Switch

Power frequency and lightening-impulse dry withstand testing was performed on a 38 kV M-Force Sidebreak switch. Test was in accordance with IEEE Std 1247™-2005 standard, clause 8.1.

Table 7. Points of application to 38 kV Switch for power frequency withstand test

Test Condition	Phase A Source Ternimal	Phase A Load Terminal	Phase B Source Terminal	Phase B Load Terminal	Phase C Source Terminal	Phase C Load Terminal
Switch Closed	Energized	Energized	Energized	Energized	Energized	Energized
Switch Open	Grounded	Grounded	Grounded	Energized	Grounded	Grounded
Switch Open	Grounded	Grounded	Energized	Grounded	Grounded	Grounded
Switch Closed	Grounded	Grounded	Energized	Energized	Grounded	Grounded
Note: Frame grounded for all tests.						

At least 95 kV rms, corrected for atmospheric conditions, was applied to the test specimen for each condition in Table 7 without incurring a dielectric breakdown or puncture. The test specimen successfully met the requirements of the power frequency dry withstand test.

Table 8. Points of application of rated 38 kV voltage for impulse withstand test

Test Condition	Phase A Source Ternimal	Phase A Load Terminal	Phase B Source Terminal	Phase B Load Terminal	Phase C Source Terminal	Phase C Load Terminal
Switch Closed	Energized	Energized	Energized	Energized	Energized	Energized
Switch Open	Grounded	Grounded	Grounded	Energized	Grounded	Grounded
Switch Open	Grounded	Grounded	Energized	Grounded	Grounded	Grounded
Note: Frame grounded for all tests.						

IEEE Std C37.34™-1994, clause 4.2.7 specifies that the switch shall be considered to pass the test if it withstands three consecutive impulses for each test condition at the defined test voltage. The test specimen was subjected to three positive and three negative impulses of at least 200 kV for all conditions defined in Table 8 without incurreing a dielectric breakdown or puncture. The test specimen successfully met the requirements of the lightning-impulse dry withstand test.

Table 9. Voltage withstand test summary

Test unit	60 Hz Power Frequency Test	Full wave Lightning Impulse Test
M-Force Sidebreak, 15.5 kV	50 kV, 1 minute duration	110 kV BIL
M-Force Sidebreak, 27 kV	70 kV, 1 minute duration	150 kV BIL
M-Force Sidebreak, 38 kV	95 kV, 1 minute duration	200 kV BIL

Short-Time Withstand Current Test

M-Force Sidebreak switches were tested for short-time current withstand per IEEE Std C37.34™-1994 and IEEE Std 1247™-1998, Clause 8.4.

Table 10. Short-Time Withstand Current Test

Rated Voltage, kV	Test	Test Current Obtained		
		Asymmetric (kA rms)	Symmetric (kA rms)	Duration (Seconds)
15.5/27	10 cycles	40.68	26.5	0.179
15.5/27	3 Second		26.1	3.1
38	10 cycles	41.5	26.3	0.174
38	3 Second		27.2	3.1

The test specimen successfully met the requirements of the Short-Time Withstand Current test at the above conditions.

Fault Close Test

M-Force Sidebreak switches were tested for Fault Close Test per IEEE Std C37.34™-1994 standard and IEEE Std 1247™-1998 standard, Clause 8.5.

Table 11. Fault Close Test

Rated Voltage, kV	Respective Current kA, peak	Duration, millisecond	Number of Operations
15.5	>29 kA peak	>180	2
27	>25 kA peak	>180	3

The test specimen successfully met the requirements of the Fault Close test at the above conditions.

Continuous Current Test

Continuous current testing was performed on Eaton's Cooper Power series 15.5/27/38kV, 900A M-Force single-phase switch.

Testing of the device was in accordance with IEEE Std 1247™-2005, clause 8.2.

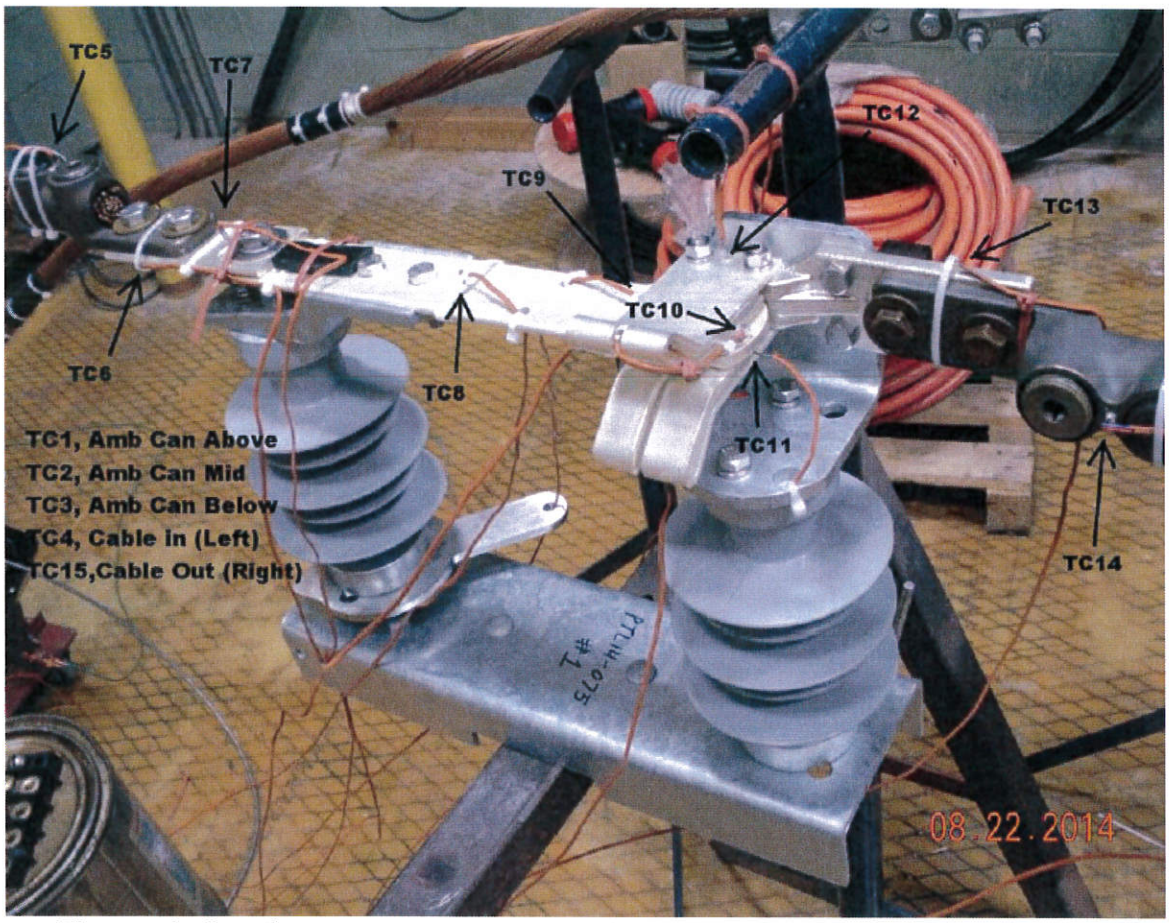

Figure 1: Continuous current test unit Metering thermocouple locations are shown.

Table 12. Temperature rise values at each thermocouple location

Position No.	Thermocouple Location	Temperature Rise, °C	Standard Allowance, °C
TC1	Amb Can Above	-	-
TC2	Amb Can Mid	-	-
TC3	Amb Can Below	-	-
TC4	Cable in (Left)	47.1	-
TC5	Cable joint(Left)	45.1	65
TC6	Terminal pad (Left)	46.1	50
TC7	Terminal pad (Left)	44.1	50
TC8	Blade	44.0	65
TC9	Blade	42.1	65
TC10	Contact Joint	43.2	65
TC11	Contact Joint	40.8	65
TC12	Contact Joint	39.3	65
TC13	Terminal pad(Right)	43.5	50
TC14	Cable joint (Right)	41.4	65
TC15	Cable out (Right)	49.4	-

Ambient temperature was 23.6°C.

The test specimen successfully met the requirements of the Continuous Current test at the above conditions.

Mechanical Test

Mechanical Endurance Test was performed on Eaton's Cooper Power series 38 kV, 900 A M-Force three-phase switch, assembly No. M3R00SC3-X161.

The test unit completed 3,000 operations. Afterward, all fasteners were tight. Minimal mechanical abrasion was observed on moving parts. There was practically no change in contact resistance.

Table 13. Test Unit Resistance Values

Phase	Phase A	Phase B	Phase C
Terminal to Terminal before testing	47.3 μΩ	46.8 μΩ	40.8 μΩ
Terminal to Terminal after testing	46.2 μΩ	48.9 μΩ	45.5 μΩ

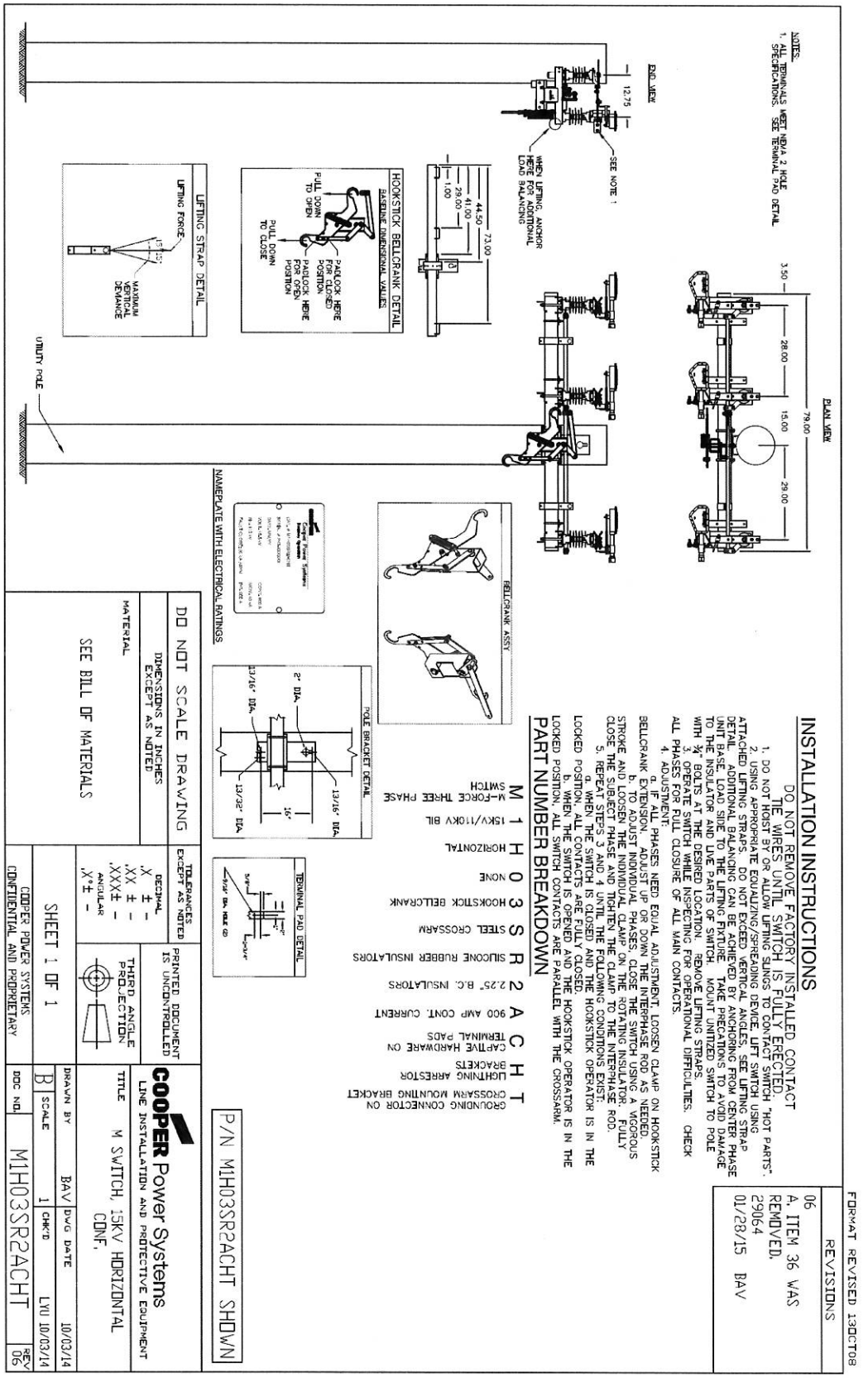

Figure 2: Example- M-Force, 15.5 kV horizontal switch configuration

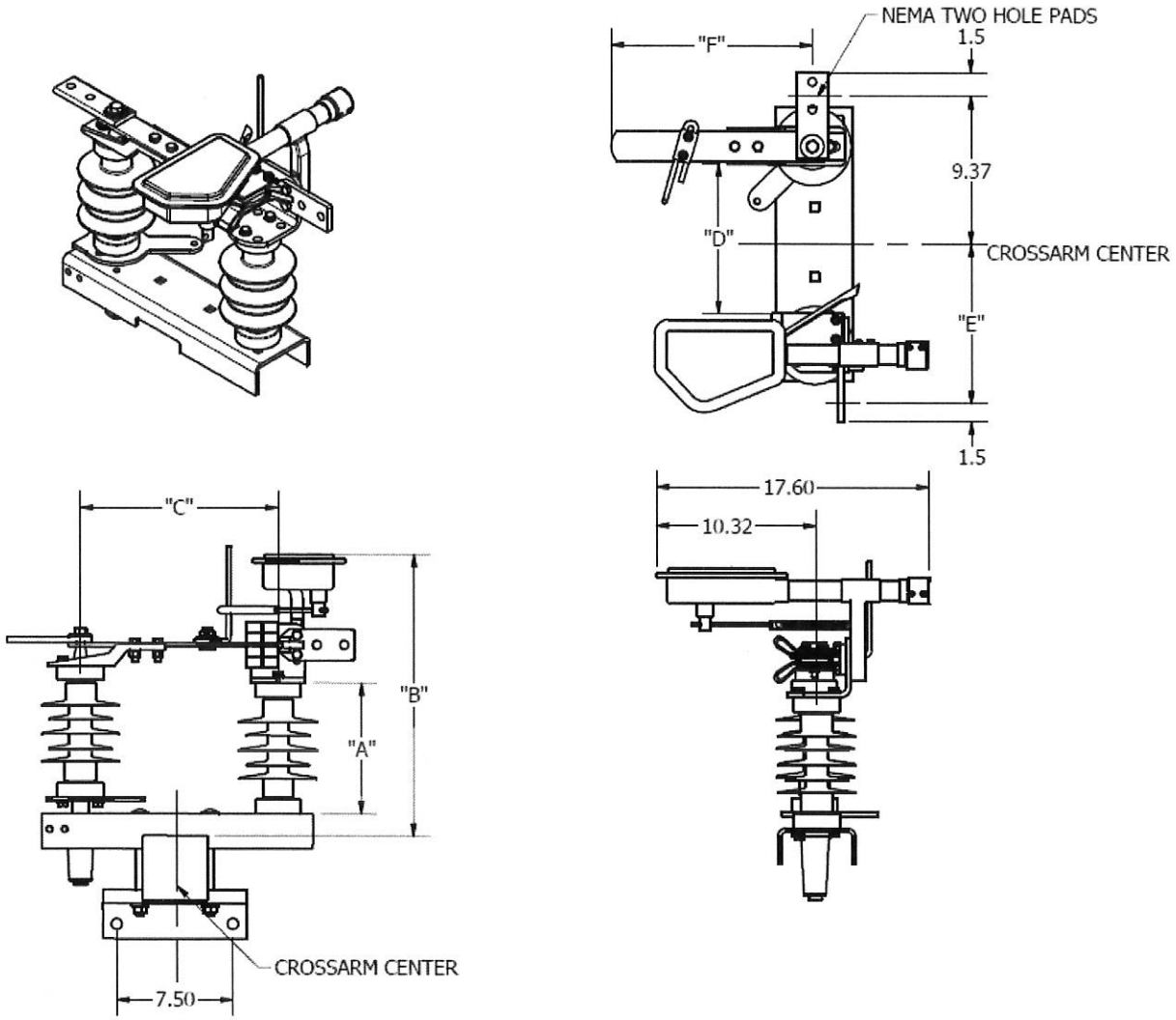

Figure 3: Example- M-Force 15.5 kV single-phase switch
Dimensions A through F are different depending on rated voltage and mounting configuration.

Revisions

Revision No.	Date	What was added/changed:
00	6/11/15	Initial test report
01	7/21/15	Added 27kV, 900A line load switching in table 1

Reference: Test Number / Test Report

1. Test Report No. PTL15-029 for 38kV M-Force Line Load Test
2. Test Report No. PTL14-308 for 38kV M-Force Loop Switching, No Load Transformer Switching, and Line and Cable Charging Switching Tests
3. Test Report No. PTL15-007 for 27kV M-Force Line Load Switching, Loop Switching, No Load Transformer Switching, and Line and Cable Charging Switching Tests.
4. Test Report No. PTL14-258-A for 15.5kV M-Force Dielectric Test
5. Test Report No. PTL14-258-B for 27kV M-Force Dielectric Test
6. Test Report No. PTL14-258-C for 38kV M-Force Dielectric Test
7. Test Report No. KCP-0001 Rev.4 for M-Force Short Time and Peak Current Withstand Test
8. Test Report No. 15713-26 for M-Force Fault Closing Test
9. Test Report No. PTL14-75 Ver.1 for M-Force Continuous Current Test
10. Test Report No. AEA14 001 4D for M-Force Mechanical Test
11. Test Report No. PTL15-133 for 27kV M-Force Additional Line Load Switching Test

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