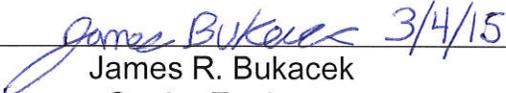


**38 kV Bay-O-Net**  
**Cartridge and Fuse Assemblies**  
**Certified Test Report**

# 38 kV Bay-O-Net Cartridge/Fuse Assemblies

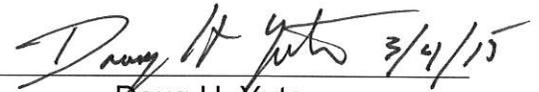
## CERTIFICATION

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

  
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## Introduction

Eaton designs its Cooper Power<sup>®</sup> series 38 kV Bay-O-Net fuse/cartridge assemblies to protect transformers and distribution systems at application voltages up to 38 kV. In this application, the 38 kV Bay-O-Net functions as a low current interrupting device, protecting against overloads and secondary faults up to its maximum interruption rating. The 38 kV Bay-O-Net should be applied in series with a backup current-limiting fuse. The combination provides “full range” protection.

This report details design tests conducted to verify performance of the new 38 kV Bay-O-Net fuse/cartridge assemblies. When applicable, testing was performed in both mineral oil and Envirotemp<sup>™</sup> FR3<sup>™</sup> fluid.

## Table of Contents

Interruption Tests.....	4
Load Switching Tests.....	5
Time-Current Tests.....	6
Mechanical Tests.....	7
Impulse Withstand Voltage (BIL).....	8
60 Hz Withstand.....	9

## **Interruption Tests**

### **Requirements**

The 38 kV Bay-O-Net fuse assembly is required to operate and isolate other pieces of equipment on the electrical distribution system when overcurrent conditions are present. Testing will establish the interrupting ratings for the 38 kV Bay-O-Net assembly when used with the 38 kV Bay-O-Net cartridge fuse links in mineral oil or Envirotemp™ FR3™ fluid.

### **Objective**

Verify the interrupting performance of the new 38 kV Bay-O-Net fuse assembly with the 38 kV Bay-O-Net cartridge fuse links.

### **Procedure**

38 kV Bay-O-Net fuse assemblies (4038380B03M) were mounted in an appropriate tank as detailed in instruction sheet MN132003EN. All testing was performed using the 38 kV Bay-O-Net cartridge fuse links (4000380C series). Circuits were created using IEEE Std C37.41™-2008 standard Table 17 as a guide. Testing was performed at rated voltage, with the current set at low (overload), several intermediate ranges, and at the rated maximum symmetric levels. Following interruption, voltage was maintained across the specimens for a minimum of three (3) minutes. Testing was repeated in both mineral oil and Envirotemp™ FR3™ fluid.

### **Results**

The 38 kV Bay-O-Net cartridge fuse links successfully interrupted each respective test current. The performance parameters are detailed in the Table below.

<b>38 kV Bay-O-Net Cartridge Fuse Ratings</b>			
Base Catalog #	Fuse Rating		Maximum Interrupting Rating (Amps symmetric)
	kV	Amp	
4000380C06CB	38.0	10	900
4000380C08CB	38.0	15	900
4000380C10CB	38.0	25	900
4000380C11CB	38.0	30	900
4000380C12CB	38.0	40	900
4000380C14CB	38.0	65	1,000

### **Conclusions**

The above test results verify the interruption ratings of the 38 kV Bay-O-Net fuse assembly and 38 kV Bay-O-Net cartridge fuse links.

## **Load Switching Tests**

### **Requirements**

Demonstrate that the 38 kV Bay-O-Net fuse assembly can be used to energize and de-energize load current without electrical or mechanical deterioration to the assembly.

### **Objective**

Verify that the 38 kV Bay-O-Net fuse assembly can meet the following switching current rating in both mineral oil and FR3 fluid:

- 50 operations at 38.0 kV, 50 amps.

One operation is defined as an insertion (make) and withdrawal (break) of the holder/cartridge assembly into the housing.

### **Procedure**

The test circuit used followed IEEE Std C37.41<sup>TM</sup>-2008 standard as a guide. The power factor of the circuit was 72% lagging. The series source impedance was 22% of the total circuit impedance. The X/R ratio of the series reactance to series resistance was 5.

Two 38 kV Bay-O-Net fuse assemblies were mounted in an appropriate tank and connected in series. Testing was initiated with one holder/cartridge assembly removed from the circuit, and a second already closed in. Using a pneumatic operator, the first holder/cartridge assembly was closed into the circuit, allowing current to flow. After approximately 150 milliseconds, the second holder/cartridge assembly was pulled out, interrupting the current. On the following operation, the order was reversed. This process was repeated until fifty (50) make/break operations were performed on each of the two assemblies. Subsequent to the switching tests, the assemblies were expected to withstand system voltage. Testing was repeated in both mineral oil and Envirotemp<sup>TM</sup> FR3<sup>TM</sup> fluid.

### **Results**

Samples tested successfully performed fifty (50) switching operations at the current and voltage detailed above. The housing, contacts, and cartridge assembly were in good condition following the above testing.

### **Conclusions**

The above test results verify the switching current rating of the 38 kV Bay-O-Net fuse assembly in both mineral oil and Envirotemp<sup>TM</sup> FR3<sup>TM</sup> fluid.

## **Time-Current Tests**

### ***Requirements***

Time-current characteristic (TCC) curves are primarily used for application, selection, and system coordination studies. The minimum-melt and total-clearing curves detail the operational performance for a particular fuse link.

### ***Objective***

Establish time-current characteristic curves for the 38 kV Bay-O-Net cartridge fuse links (4000380C series) in mineral oil.

### ***Procedure***

Minimum-melt and total-clearing time-current characteristic curves were developed using the methods described in IEEE Std C37.41™-2008 standard Clause 11 as a guideline. Testing was performed in an appropriate test tank filled with mineral oil. The fuse links were tested by applying current and measuring the time until the fuse links opened. The TCC curves were developed by utilizing curve-fitting techniques and applying the appropriate tolerances. An allowance for arcing time is also added to the total-clearing curve to determine the fuse link's total clearing characteristics. Testing was performed indoors at ambient temperatures.

### ***Results and Conclusions***

The minimum-melt and total-clearing TCC curves for the 38 kV Bay-O-Net cartridge fuse links were developed using the procedure described above and are detailed in product literature TC132001EN.

## **Mechanical Tests**

### ***Requirements***

Demonstrate that mechanical forces experienced during installation and cantilever forces developed during assembly, handling, and lead attachment will not damage the 38 kV Bay-O-Net housing or complete fuse assembly.

### ***Objective***

Verify that the 38 kV Bay-O-Net housing and complete fuse assembly are sufficiently robust to withstand the torque and cantilever forces experienced during assembly and handling.

### ***Procedure***

Five (5) samples were selected at random to perform the torque tests. Instruction sheet MN132003EN specifies that the 38 kV Bay-O-Net housing be attached to the tank wall by tightening the retaining nut to a level of 180-220 in-lbs to seat and compress the gasket for proper seal. Maximum torque levels were determined by placing the specimen into a fixture. The fastening nut was tightened to 220 in-lbs using a digital torque wrench. The specimens were examined for any damage. Torque was then increased at a steady rate until breakage occurred.

Cantilever testing was performed by placing the test specimens into a fixture as detailed in instruction sheet MN132003EN. Testing was performed on an Instron test machine. Cantilever force was applied to the housing by administering force to the lower contact with the unit held in the horizontal position. Force was applied until breakage occurred. Testing was then performed in a similar manner on the complete assembly while mounted in the same test fixture. A third test was performed similar to test number two, except with force applied at 90° to determine sideward strength.

### ***Results***

All five (5) test specimens exceeded a torque of 2x recommended maximum tightening level before breakage occurred.

Cantilever forces on the 38 kV Bay-O-Net housing caused breakage in excess of 50 ft-lbs. The complete fuse assembly exhibited breakage in excess of 150 ft-lbs.

### ***Conclusions***

The 38 kV Bay-O-Net housing and fuse assembly provide excellent strength required for handling, assembly, and lead attachment procedures.

### **Impulse Withstand Voltage (BIL)**

#### **Requirements**

Demonstrate that the 38 kV Bay-O-Net fuse assembly can meet a 1.2x50  $\mu$ s, 200 kV impulse at both polarities required to assure adequate ability to withstand lightning and other short duration high voltage surges.

#### **Objective**

Verify the basic insulation level (BIL) of the 38 kV Bay-O-Net fuse assembly as required in IEEE Std C37.42™-2009 standard.

#### **Procedure**

A 1.2x50  $\mu$ s impulse test was performed on three (3) 38 kV Bay-O-Net fuse assemblies in both mineral oil and Envirotemp™ FR3™ fluid. Testing was performed with both normal and blown fuse links. The assemblies were mounted in an appropriate tank as detailed in instruction sheet MN132003EN. The tank was grounded. Clearance from the bottom of the tank to the lower contact was three (3) inches. Voltage was applied to the lower contact. The upper contact was grounded only while testing with blown fuse links. Testing was conducted per IEEE Std C37.41™-2008 standard requirements.

#### **Results**

<b>Dielectric Fluid</b>	<b>Polarity</b>	<b>BIL (kV)</b>	<b>Fuse Element</b>	<b>Number of Shots</b>
Mineral Oil	Positive	200	Blown	3
Mineral Oil	Positive	200	Intact	3
Mineral Oil	Negative	200	Blown	3
Mineral Oil	Negative	200	Intact	3
Envirotemp™ FR3™	Positive	200	Blown	3
Envirotemp™ FR3™	Positive	200	Intact	3
Envirotemp™ FR3™	Negative	200	Blown	3
Envirotemp™ FR3™	Negative	200	Intact	3

#### **Conclusions**

The basic insulation level (BIL) of the 38 kV Bay-O-Net fuse assembly is adequate for use in 200 kV BIL equipment provided recommended dielectric clearances are maintained.

## **60 Hz Withstand**

### **Requirements**

Demonstrate that the 38 kV Bay-O-Net fuse assembly can meet a 70 kV, 60 Hz withstand per IEEE® standards.

### **Objective**

Verify 70 kV one minute hi-pot capability of the 38 kV Bay-O-Net fuse assembly as required by IEEE Std C37.42™-2009 standard.

### **Procedure**

38 kV Bay-O-Net fuse assemblies were mounted in an appropriate tank as detailed in instruction sheet MN132003EN. The tank was grounded. Clearance from the bottom of the tank to the lower contact was three inches. Voltage was applied to the lower contact. Testing was performed with both normal and blown fuse links. The upper contact was grounded only while testing with blown fuse links. Testing was conducted per IEEE Std C37.41™-2008 standard. Three (3) 38 kV Bay-O-Net fuse assemblies were tested in both mineral oil and Envirotemp™ FR3™ fluid.

### **Results**

The 38 kV Bay-O-Net fuse assembly successfully passed 70 kV, 60 Hz voltage withstand for a minimum of one minute in both mineral oil and Envirotemp™ FR3™ fluid.

### **Conclusions**

The 38 kV Bay-O-Net fuse assembly meets IEEE Std C37.42™-2009 standard requirements.



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Printed in USA  
Publication No. CT132001EN  
March 2015

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