Fusing Equipment
Catalog Data
CA132048EN

Effective November 2016
Supersedes December 2015

COOPER POWER SERIES

NX® current-limiting fault guard tool

General

Eaton's Cooper Power™ series NX® fault guard tool can be applied anywhere that it is desirable to provide temporary current limitation when energizing a load. One application is to connect an overhead transformer through the NX fault guard tool to the line. If a fault is present, the non-expulsion, current-limiting fuse in the tool will operate harmlessly and limit the energy that gets through to protected equipment.

Other applications include minimizing the expulsion blast on any fuse cutout application, limiting catastrophic transformer failures, hot-line testing for a shorted surge arrester.

In performing these functions, the tool utilizes a fuse unit borrowed from the NXD line of outdoor, current-limiting fuses.

The fault guard tool with the self-extracting electrical cable is for use with distribution transformers protected by open-fuse cutouts.

The complete tool consists of the fuse unit (sold separately), an upper end fitting for clamping the tool to the line, a lower end fitting for retaining the indicating squib parts during operation, a self-retracting electrical cable extendable up to 10 feet for flexibility, and a pigtail-shaped switchstick head. The switchstick is for lifting the tool, making contact with the pull ring and closing the cutout.

The companion model, equipped with a metal stirrup, is for use with self-protected transformers.

Shown above on the left is the NX fault guard tool for use with self-protected transformers and on the right is the NX fault guard tool for use with open-fuse protected transformers.

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Features and detailed description

The fault guard tool, catalog number FA21M1, is intended for use with self-protected transformers. An aluminum rod (stirrup) attached to the lower-end fitting equips the tool to accept the hot-line clamp on a transformer bushing lead. "Fuzzing" at the clamp/rod connection and non-operation of the tool's fuse indicate that no fault is present and the circuit may be safely energized. In the event of a fault, operation of the fuse is reported by a loud "pop" from the squib-actuator. Squib operation can also be verified visually. After repair of the fault and replacement of the tool's fuse, which can be done in seconds with an ordinary screwdriver, the circuit can be retested.

The other fault guard tool model, catalog number FA18M1, is designed for use with distribution transformers protected by open-fuse cutouts. Like its companion tool, the complete device consists of an NXD fuse unit (sold separately) an upper-end fitting for clamping the tool to the line, a lower-end fitting for retaining the indicating squib parts during operation. In place of the aluminum stirrup, this tool has a self-retracting electrical cable, extendable up to ten (10) feet, and a pigtail-shaped switchstick head for lifting, making contact with the cutout pullring and closing the cutout. "Fuzzing" at the pigtail/pullring and nonoperation of the tool's fuse indicate that the cutout can be safely closed.

Correctly applied, the NX fault guard tool will limit the energy available to a faulted load to a level that will prevent double-vented cutouts from blowing the expendable caps Experiments indicate that the maximum probable duty levels shown in the coordination tables are within this limit. It is recommended that the tool be used only with cutouts having ungrounded-hangers. Where hangers are grounded, the tool should be used only with cutouts having spring-loaded leader ejectors.

Tables 1 and 2 show recommended fuses for use in the NX fault guard tool for single-phase applications. These recommendations are based on information taken from Reference Data, R240-30-1 (for delta connected primaries, 200-300 percent protection, EEI-NEMA K or T links). Duty levels specified in these tables are the maximum levels likely to occur. The probability of occurrence of theoretically possible higher levels is considered to be less than one percent.

The operation of the NX fault guard tool in combination with an expulsion fuse cutout will occur in one of three modes:

1. Exuplsion fuse operates, tool fuse does not

2. Expulsion fuse does not operate, tool fuse does

3. Both fuses operate

Mode 1 will occur in the case of low faults where the minimum melt of the expulsion fuse is less than the minimum melt of the NX fuse. Mode 2 will occur in the case of high faults of a level that the let-through I^2t is less than the minimum melt I^2t of the expulsion fuse. Mode 3 will occur in the case of high faults of a level that the let-through I^2t is greater than the minimum melt I^2t of the expulsion fuse, or low current faults where both fuses melt at approximately the same time. Non-operation of either fuse indicates that no fault is present. An open circuit in the load or an open fuse can be detected by fuzzing the switchstick head along the cutout pullring. If the circuit is open, no fuzzing will be detectable.

Table 1. Fusing Schedule for NX Fault Guard Tool at 14.4 kV (With 15.5 kV NXD Fuse Unit)

			Scheme 1					Scheme 2				
			Sized for Minimum No. of Fuse Sizes					Sized for Minimum Expulsion Duty				
				K Link		T Link			K Link		T Link	
Transformer kVA	Link Size K or T	Min. Tool Fuse Size*	15.5 kV Tool Fuse Size	Max. Expect Duty	Max. Low I Duty	Max. Expect Duty	Tool Low I Duty	15.5 kV Max. Fuse Size	Max. Expect Duty	Max;. Low I Duty	Max. Expect Duty	Max. Low I Duty
667												
500	40	40	40C	496	490	–	300	40C	496	490	–	300
333	30	30	40C	1410	610	–	370	30C	–	350	–	230
300	25	30	40C	1745	800	–	450	30C	1210	410	–	280
250	20	20	20C	595	170	–	120	20C	595	170	–	120
200	15	18	20C	844	210	–	140	20C	844	210	–	140
167	12	18	20C	1040	300	187	155	20C	1040	300	187	155
150	12	18	20C	1040	300	187	155	20C	1040	300	187	155
100	8	10	20C	1160	450	1035	270	10C	666	45	420	38
75	6	10	20C	1188	450	1120	450	10C	720	230	600	35
50	6	6	20C	1188	450	1120	450	10C	720	230	600	35
37.5	6	6	20C	1188	450	1120	450	10C	720	230	600	35
25	6	6	20C	1188	450	1120	450	10C	720	230	600	35
15	6	6	20C	1188	450	1120	450	10C	720	230	600	35
10	6	6	20C	1188	450	1120	450	10C	720	230	600	35
5	6	6	20C	1188	450	1120	450	10C	720	230	600	35
3	1H	6	20C	1220	450	1220	450	10C	768	230	768	230

* Minimum size for the tool fuse (C-rated) is based on the multiple of 25 times inrush current.

Table 2. Fusing Schedule for NX Fault Guard Tool at 19.9 kV (With 23 kV NXD Fuse Unit)

			Scheme 1					Scheme 2				
			Sized for Minimum No. of Fuse Sizes					Sized for Minimum Expulsion Duty				
				K Link		T Link			K Link		T Link	
Transformer kVA	Link Size K or T	Min. Tool Fuse Size*	23 kV Tool Fuse Size	Max. Expect Duty	Max. Low I Duty	Max. Expect Duty	Tool Low I Duty	23 kV Max. Fuse Size	Max. Expect Duty	Max;. Low I Duty	Max. Expect Duty	Max. Low I Duty
667	40	40	40C	406	480	-	320	40C	406	480	-	320
500	30	30	40C	1380	600	-	380	30C	-	340	–	240
333	20	20	20C	540	170	-	120	20C	540	170	-	120
300	20	18	20C	540	170	-	120	20C	540	170	-	120
250	15	18	20C	806	210	-	140	20C	807	210	-	140
200	12	12	20C	1010	255	-	160	12C	814	55	-	50
167	10	12	20C	1086	460	858	200	12C	908	85	615	53
150	8	12	20C	1128	460	1005	260	12C	960	350	807	60
100	6	10	20C	1160	460	1090	450	12C	996	350	915	95
75	8	10	20C	1160	460	1090	450	12C	996	350	915	95
50	8	10	20C	1160	460	1090	450	12C	996	350	915	95
37.5	8	10	20C	1160	460	1090	450	12C	996	350	915	95
25	8	10	20C	1160	460	1090	450	12C	996	350	915	95
15	8	10	20C	1160	460	1090	450	12C	996	350	915	95
10	8	10	20C	1160	460	1090	450	12C	996	350	915	95
5	8	10	20C	1160	460	1090	450	12C	996	350	915	95
3	1H	10	20C	1194	460	1194	450	12C	1035	360	1035	360

* Minimum size for the tool fuse (C-rated) is based on the multiple of 25 times inrush current.

Interpreting the tables

The interpretation of Tables 1 and 2 can best be explained by example. With a 100 kVA transformer fused by an eight amp K- or T-rated link on a 15.5 kV system, the minimum fuse size that should be used in the NX fault guard tool is ten (10) amps (Table 1). This size will assure that transformer inrush current will not cause fuse operation. Satisfactory operation of the tool, however, can be achieved by using a fuse rated as high as 20 amps. For Scheme 1 (mimimum number of fuse sized required), the 20C fuse used in this example will allow a maximum expected expulsion duty of 1160 amps on a mode 3 operation, and a maximum low current duty of 450 amps on a mode 1 operation where the cutout is fused with an eight-amp K-rated link. The maximum high and low fault duties for T-rated links are also listed. Scheme 2 is offered with fuses selected so that minimum expulsion duty is allowed. This portion of the table can be interpreted similar to Scheme 1. Dashes in the tables indicate that duty of the expulsion fuse is not expected.

it is important to note that the duties specified in the tables are expected-worst-case duties. These levels re well within the design goal.

The following information will aid in determining proper fuse sizes for use in the NX fault guard tool where transformer fuse combinations other than those covered in Tables 1 and 2 are used. The selected fuse must lie within a range defined by a minimum rating determined by transformer inrush current, a maximum rating, determined by comparing maximum expected let-through of the tool fuse to average melt of the expulsion fuse. Minimum size to prevent fuse damage from transformer inrush current can be selected from the tables.

Maximum fuse size should be selected so that the combinations of NX fuse and expulsion fuse result in a maximum expected expulsion duty of no more than 1800 amps. Calculate maximum expected expulsion duty using the following procedure.

Step 1

Look up the following values

1. Minimum melt I^2t of the NX fuse, NX_{min}. This value can be found in the appropriate bar graph of Reference Data R240-60-5.
2. Maximum total I^2t of the NX fuse, NX_{max}. This value can also be found on the respective gar graph of Reference Data R240-60-5.
3. Minimum melt current for link at 0.01 second, I_L. This value can be found from the minimum melt TCC curves published by the manufacturer of the link.

Step 2

Calculate the following values

1. Average melt I^2t for the link, P_L; $P_L = (1.1\ I_L)^2 \times 0.01$
2. $(\text{Arcing } I^2t)_1$ for NX fuse, A_1: $A_1 = (0.85\ NX_{max} - 1.1\ NX_{min})$
3. $(\text{Arcing } I^2t)_2$ for NX fuse, A_2;

$$A_2 = A_1\left[\frac{V_S}{V_R}\right]^2$$

where:

V_S = system voltage

V_R = rated voltage of fuse cartridge

Step 3

Calculate max expected let-through I^2t, X

$X = A_2 + 1.1\ NX_{min}$

Step 4

Convert X to half-wave current

$\sqrt{\frac{X\text{-}P_L}{0.00833}}$ = Max expected expulsion duty in amps rms

Where the maximum let-through I^2t of the NX fuse is less than the minimum melt I^2t of the link, operation of the link will be prevented. Where some duty of the link is considered acceptable, maximum let-through of the NX fuse can be slightly higher (no more than 1800 amps) than the minimum melt I^2t of the link. Once the maximum and minimum fuse sizes have been selected, the fuse unit of the appropriate size can be selected from Table 3.

For efficient field operation, it is recommended that a schedule relating transformer kVA and NX fault guard tool fuse rating be prepared which considers the particular fusing practices of the using organization.

Information on the manner in which current is limited by the NX fuse is published in *Catalog Data CA132049EN NX Indoor Current-Limiting Fuse*.

Table 3. NX Fault Guard Tool Fuse Replacement Units (Current-Limiting, Outdoor, Interrupting Capacity 50,000 Amps Symmetrical)

Voltage Rating (kV)	Continuous Current (Amps)	Replacement Catalog Number*	A Dimension (in.)
15.5	6	FAG4A6R	17-3/8
	8	FAG4A8R	
	10	FAG4A10R	
	12	FAG4A12R	
	18	FAG4A18R	
	20	FAG4A20R	
	25	FAG4A25R	
	30	FAG4A30R	
	40	FAG4A40R	
23	6	FAG5A6R	20-1/4
	8	FAG5A8R	
	10	FAG5A10R	
	12	FAG5A12R	
	18	FAG5A18R	
	20	FAG5A20R	
	25	FAG5A25R	
	30	FAG5A30R	
	40	FAG5A40R	

Dimensions

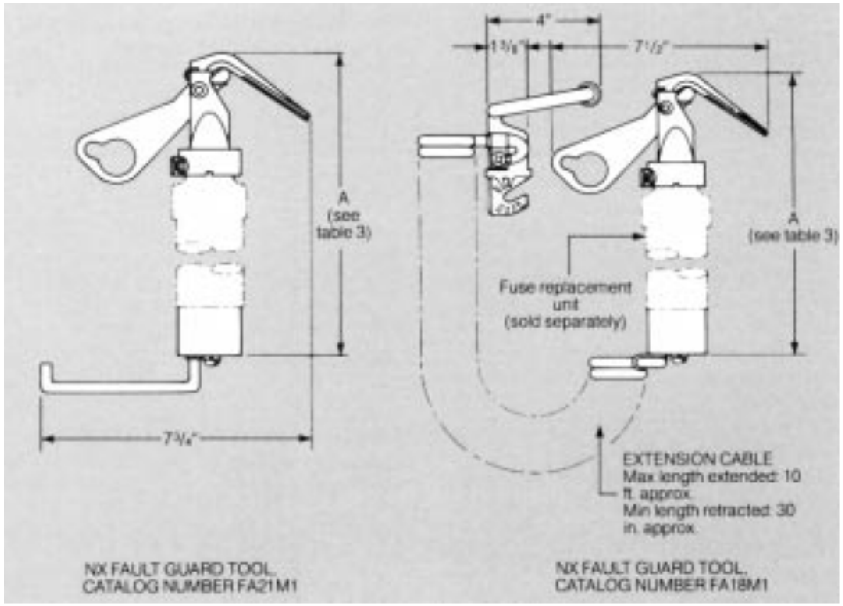

Figure 1. NX Fault Guard FA21M1 and FA18M1.

Ordering information

The NX fault guard tool accepts 15.5 and 23 kV NX fuse replacement units with current ratings from 6 to 40 amps. Fuse units for use with the tool are sold separately and can be selected from Table 3.

Fault Guard Tool	Catalog Number
With metal stirrup	FA21M1
With electrical cable	FA18M1

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Printed in USA
Publication No. CA132048EN

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