

# ANSI 37 American High voltage fuses



# What is a high voltage fuse ?

High Voltage : 601-34500V

Our fuses: 2400-15500V

# Definitions

## Power fuse

Intended primarily for substation applications they are described in ANSI / IEEE C37.46.  
Examples E-Rated and R-Rated fuses.

## Distribution fuse

Intended primarily for distribution feeder circuit applications as described in ANSI / IEEE C37.47.  
C-Rated fuses are distribution fuses.

# Definitions

## « E-Rated »

Can interrupt all currents from maximum interrupting rating down to the current that causes the element to melt in no less than 1 hour

## « R-Rated »

Capable of interrupting all current from maximum interrupting rating down to minimum interrupting rating

## C37.41 Interrupting tests

### Current $I_1$ : maximum interrupting rating (breaking capacity)

Test voltage is 87% of fuse rated voltage for  $I_1$

Test voltage is 100% of fuse rated voltage for 87%  $I_1$

### Current $I_2$ : maximum energy test

Test voltage is 100% of fuse rated voltage

As for low voltage fuses current  $I_2$  will produce the maximum arc energy during interruption

## C37.41 Interrupting tests

### Current $I_3$ : minimum interrupting current

Test voltage = 100 % of fuse rated voltage.

- E-rated fuse : currents that cause the fuse to open in no less than 1hour, performed at fuse rated voltage. Fuses may experience damage due to overheating if subjected to currents that cause them to interrupt at times significantly more than 1hour.
- Full range: minimum continuous current that causes melting of the fuse elements with the fuse applied at the maximum ambient temperature specified by the manufacturer. In all cases the melt time shall be at least 1hour.
- Back up protection fuse or R-rated fuse: current at which fuse melts in 100s or more.

#### EXAMPLE

Minimum breaking capacity for 200E = 350A

Minimum breaking capacity for 9R (200A) = 740A

# Temperature rise test

Test run with 100% fuse rating at 40°C ambient or less

# Time current curve

## « E-rated » fuses

- 100E and below - must melt in 300 seconds at 200% to 240% of E-rating
- Above 100E - must melt in 600 seconds at 220% to 264% of E-rating
- Maximum melting current shall not exceed the minimum melting current by more than 20% at given time

Ratings available up to 900E



# Time current curve

## « R-rated » fuses

- Fuse must melt in 15-35 seconds when a current of 100 times R-rating is applied
  - Fuse shall open safely on a current that melts the fuse in 100 sec. Min
  - Maximum melting current shall not exceed the minimum melting current by more than 20% at given time
- « R-ratings » are not ampere ratings (see next slide)

## R-rated fuses for motor protection

« R-rating »	Continuous Ampere rating at 40°C (A)	Minimum Interrupting rating (RMS Amperes)
2R	70	190
3R	100	225
4R	130	330
5R	150	400
6R	170	500
9R	200	740
12R	230	955
18R	390	1440
24R	450	1910
36R	650	2810

# High voltage fuses

## « UL Listed » vs. « Component Recognized »

Both tested under ANSI / IEEE C37.41

UL Listed fuses are intended to provide overcurrent protection in accordance with the NEC.

« E-Rated »

UL Component Recognized fuses are intended to be used as a component in medium voltage motor controllers.

« R-Rated »

# Comparison: Expulsion fuses vs Limiting fuses

## Current-limiting fuse

- Limits both the magnitude and duration of fault currents
- Totally enclosed operation
- The sand filler absorbs the arc energy and dissipates it as a low energy

## Expulsion or solid material fuse

- Interrupts current with the aid de-ionizing gases released by the arc from the liner or boric acid filler
- The arc is blown out of the end of the fuse in a controlled manner
- May be renewed

## Comparison: Expulsion fuses vs Limiting fuses

	Current limiting	Expulsion
<b>Maxi I.R.</b>	High	Low
<b>Current limitation</b>	Yes	No
<b>Mounting restriction</b>	No	Yes
<b>Arc voltages</b>	Yes	Low
<b>Coordination</b>	Yes	?
<b>Current Ratings</b>	900E	1500E

Mersen do not manufacture expulsion fuses

# High Voltage Transformer protection

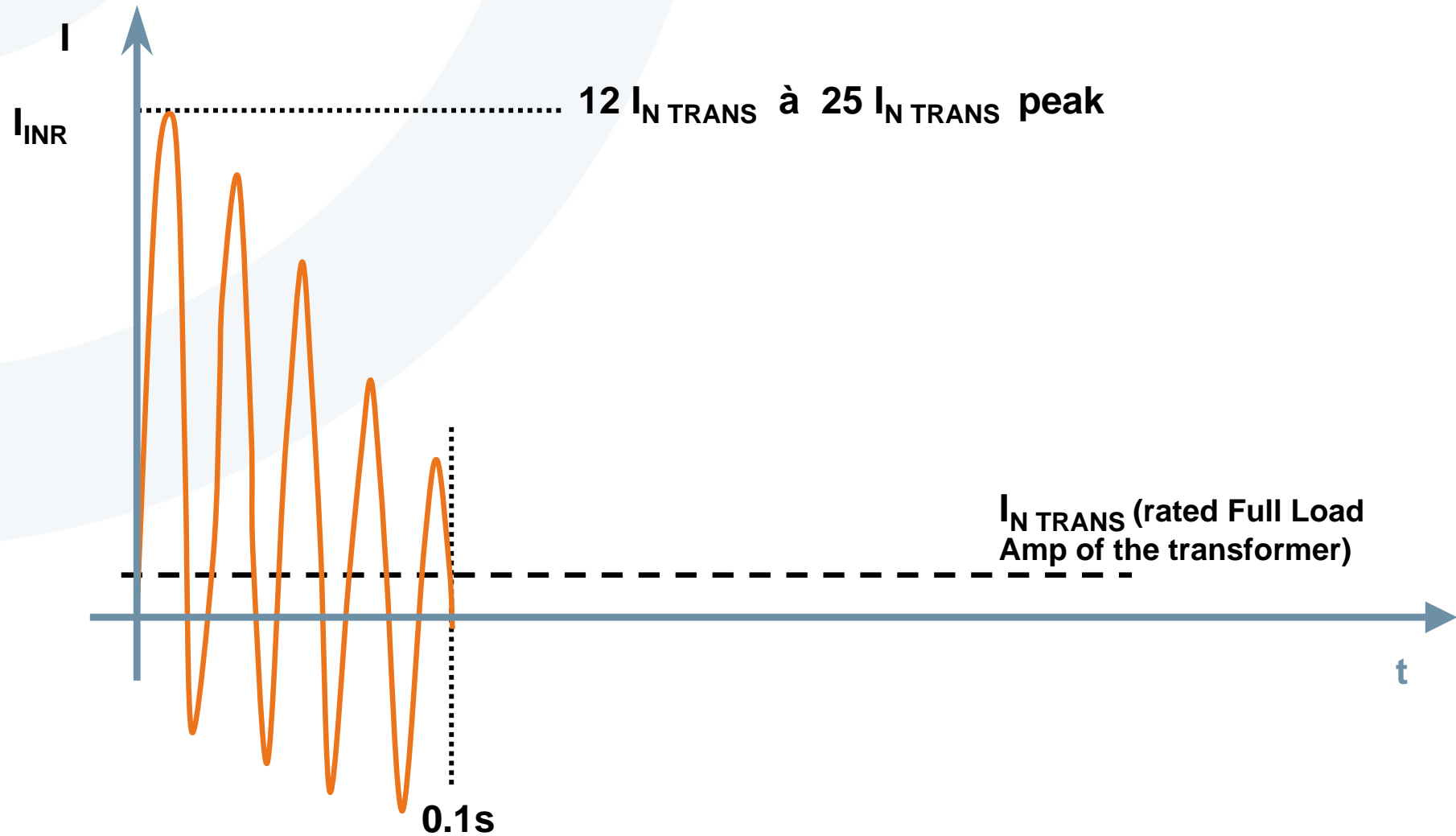
- Similar inrush characteristics to low voltage power transformers
- NEC requirements are different than low voltage transformers
- Fuse ratings are different than low voltage fuses

# Primary fuses

## Main objectives:

- Isolate faulted transformer
- Must hold transformer primary inrush
- Coordinate with secondary fuses

# Transformer inrush





# Primary fuse sizing recommendation

**Typical:** fuse sized at 133 to 150%

**Minimum:** fuse sized at 100 to 110%

Fuses must withstand the transformer inrush current :

Primary fuse is not for overload protection of transformer at currents less than 200% of fuse rating

# Transformer protection example

## Using tables of the catalog

Select a fuse to protect a 1500kVA – 14400/480V – 3-phase – transformer with 5.75% impedance

### Primary Fuse Ratings -13,800, 14,400 Volts

TRANSFORMER RATING KVA <sup>2</sup>	PRIMARY FUSE RATING <sup>1</sup>					
	13,800V (A155)			14,400V (A155)		
	FULL LOAD AMPERES	MIN.	133%	FULL LOAD AMPERES	MIN.	133%
112-1/2	4.7	10E	10E	4.5	10E	10E
150	6.2	10E	10E	6.0	10E	10E
225	9.4	15E	15E	9.0	10E	15E
300	12.6	15E	20E	12	15E	20E
500	21	25E	30E	20	25E	30E
750	32	40E	50E	30	40E	40E
1000	42	50E	65E	40	50E	65E
1500	63	80E	100E	60	65E	80E
2000	84	100E	125E	80	100E	125E
2500	105	125E	150E	100	125E	150E
3000	125	150E	200E	120	150E	200E

The table provides a very easy reading of the answer

Another way to find the solution is to use our software :

“Select-A-Fuse”



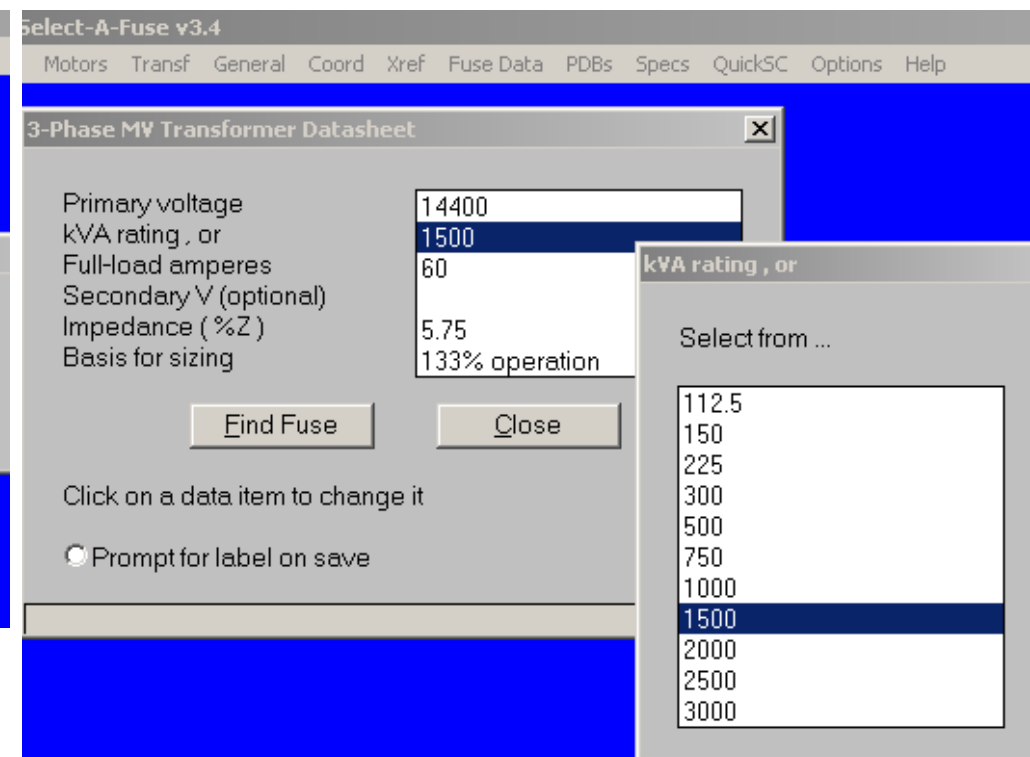
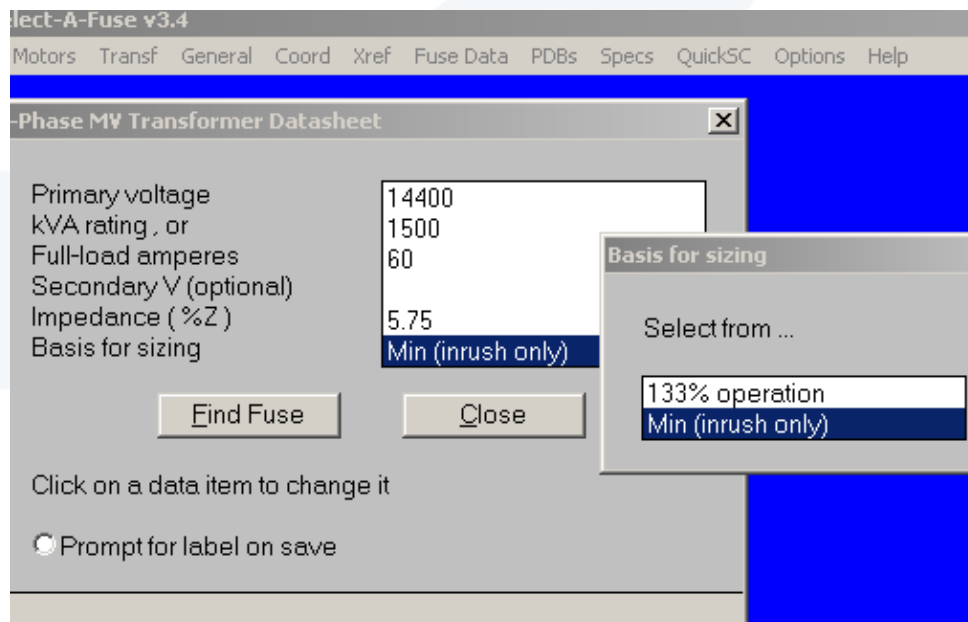
<sup>1</sup> Minimum fuse size shown will carry transformer magnetizing inrush current of 12 times full load amperes for .1 second. 133% fuse size permits continuous operation of transformer at 133% of its self cooled KVA rating.

# Transformer protection example

With « SAF » software

Calculation set up for minimum inrush

Calcul set up for 133% overload



# Transformer protection example

With « SAF » software

3-Phase MV Transformer Datasheet

Primary voltage: 14400  
 kVA rating, or: 1500  
 Full-load amperes: 60  
 Secondary V (optional):  
 Impedance (%Z): 5.75  
 Basis for sizing: Min (inrush only)

**Find Fuse**    Close

Click on a data item to change it

Prompt for label on save

**65E**

Recommended Primary Fuse(s)

Catalog#	Description	Barrels	Centres	Series
A155F2DORO-65E	Ferrules,	2x3"	15"	CS-3
A155F1DORO-65E	Ferrules,	1x3"	18"	CS-3
A155C1DORO-65E	ClipLock,	1x3"	21.25"	CL-14

Clips for 3" Ferrule types - cat# 228-700-530 (Qty 1)  
 Clips for ClipLock types - cat# 228-700-520 (Qty 1)

Save    Close

3-Phase MV Transformer Datasheet

Primary voltage: 14400  
 kVA rating, or: 1500  
 Full-load amperes: 60  
 Secondary V (optional):  
 Impedance (%Z): 5.75  
 Basis for sizing: 133% operation

Find Fuse    Close

Click on a data item to change it

Prompt for label on save

**80E**

Recommended Primary Fuse(s)

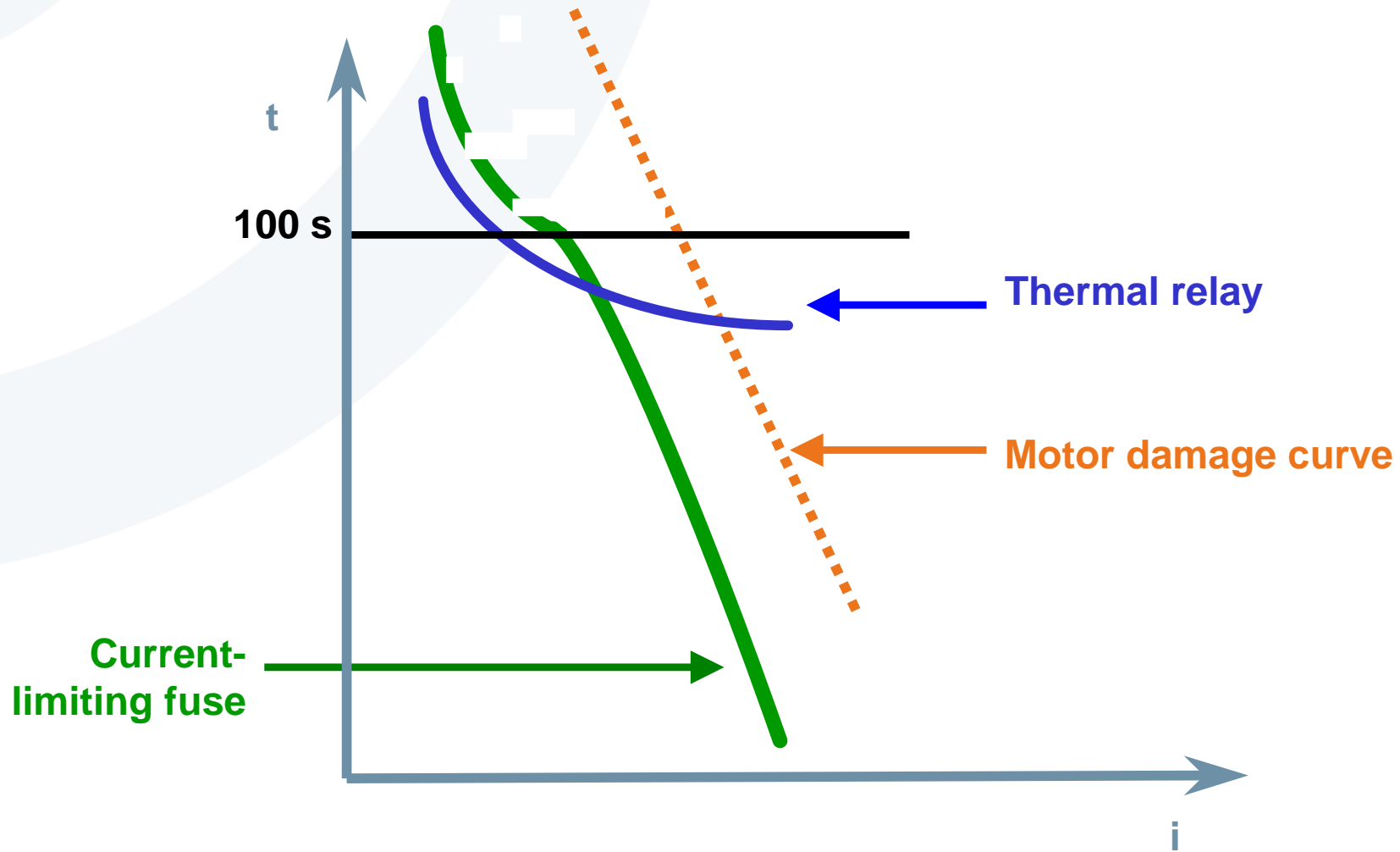
Catalog#	Description	Barrels	Centres	Series
A155F2DORO-80E	Ferrules,	2x3"	15"	CS-3
A155F1DORO-80E	Ferrules,	1x3"	18"	CS-3
A155C1DORO-80E	ClipLock,	1x3"	21.25"	CL-14

Clips for 3" Ferrule types - cat# 228-700-530 (Qty 1)  
 Clips for ClipLock types - cat# 228-700-520 (Qty 1)

Save    Close

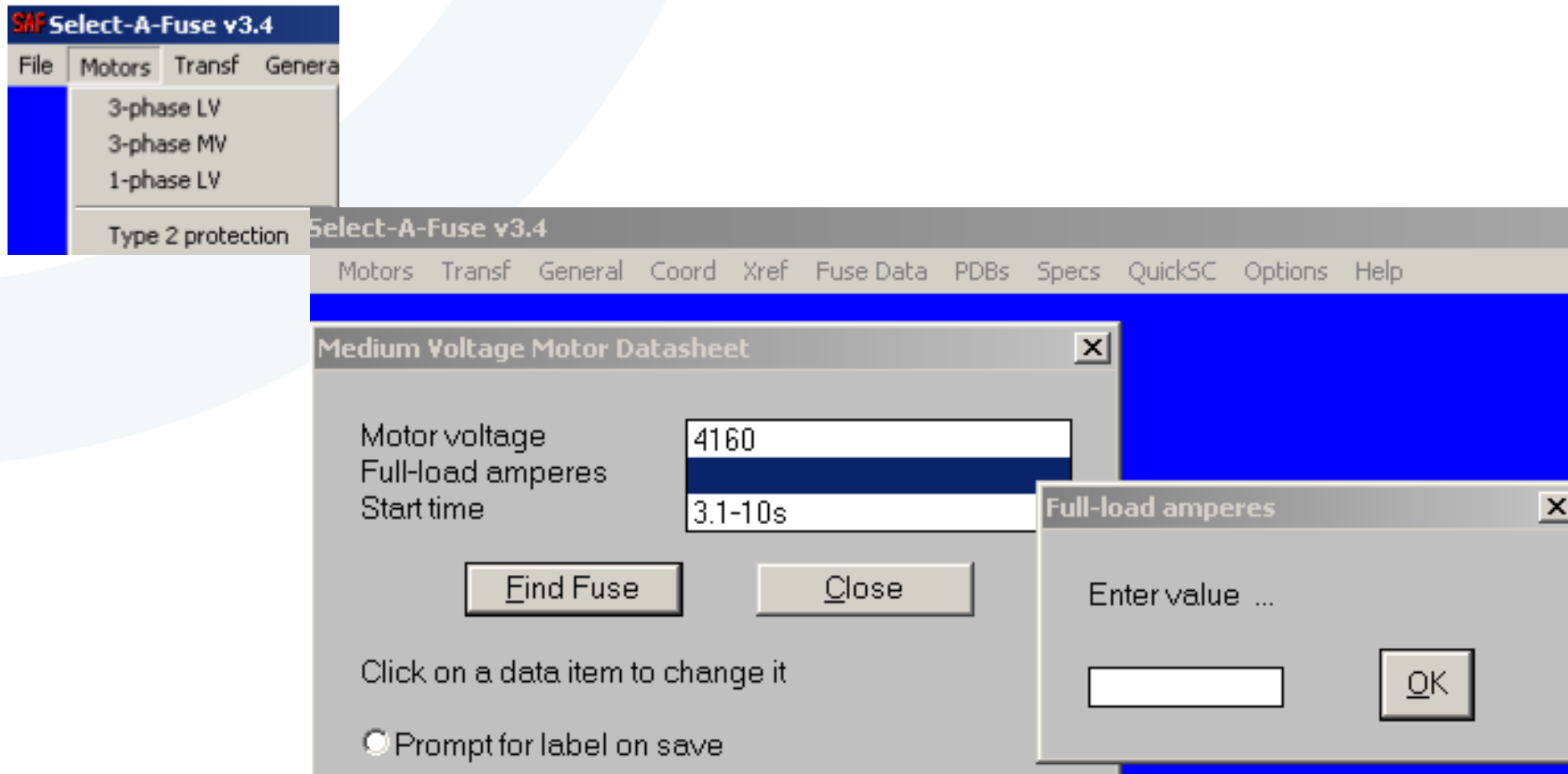
# R-rated fuses for motor protection

- R-rated fuses must be selected to coordinate with overload relay
- Starter/ Motor manufacturers will usually specify appropriate R-rating for their equipment

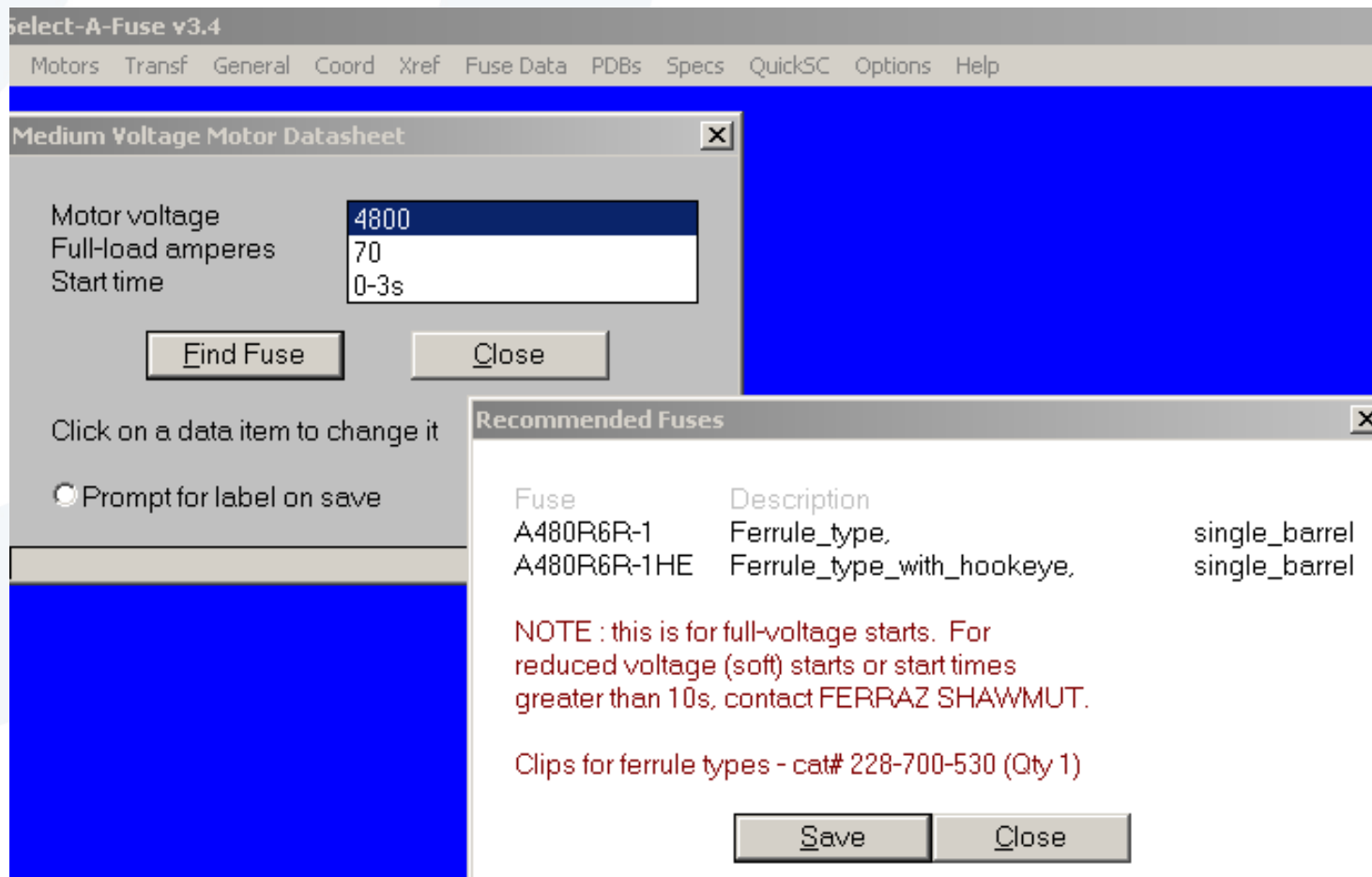


# Motor protection example

Select a fuse to protect a 4800V 3-phase motor that takes 3seconds to start and has a FLA = 70A



# Motor protection example



## Answer from Select-A-Fuse:

6R fuse

Catalog Number: A480R6R



# Potential transformer protection fuse

- Must hold high inrush current
- Size fuse at 200% minimum
- Secondary fuse must be used for overload protection

## Fuses available

- A240T 1/2E, 1E, 2E, 5E
- A480T 1/2E, 1E, 2E, 3E, 4E, 5E
- A500T 1/2E, 1E, 3E, 4E, 5E
- A720T 1/2E, 1E, 2E, 3

# Recommendation for the replacement of blown fuses

Circuit must be off-load

It is advisable to replace all three fuses unless it is definitively known that no overcurrent has passed through the unmelted fuses