



ANSI 37 - AMERICAN MEDIUM VOLTAGE FUSES

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1. INTRODUCTION

The medium voltage range is: 601 to 34500 V

The FERRAZ SHAWMUT fuses are available up to: 15 500 volts

As for low voltage fuses, medium voltage fuses have advantageous characteristics in the following points:

- **Safety**
- **Speed**
- **Breaking capacity**
- **Maintenance before a short-circuit**
- **Maintenance after a short-circuit**
- **Selectivity (or discrimination)**
- **Power quality**
- **Future system growth**
- **Universal**
- **Low power consumption**
- **Price**

2. ANSI / IEEE STANDARDS - MEDIUM VOLTAGE FUSES

2.1. Definitions of Fuse types and C37 standards

POWER FUSES: mainly for station and substation applications. They are described in ANSI / IEEE C37.46.
Examples: E-Rated and R-Rated fuses

DISTRIBUTION FUSES: mainly for distribution feeder circuit applications. They are described in ANSI / IEEE C37.47.

C-Rated fuses are distribution fuses.

C37.40 standard defines service conditions

C37.41 standard specifies testing required

C37.46 standard specifies fuse characteristics and ratings

2.2. C37.41 interrupting tests

- **Current I_1 : maximum interrupting rating (breaking capacity)**

The test voltage is 87% of fuse rated voltage for I_1 and 100 % of fuse rated voltage for 87% I_1

- **Current I_2 : maximum energy test**

The test voltage is 100 % of fuse rated voltage

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

- **Current I_3 : minimum interrupting current**

- General purpose fuse: currents that cause the fuse to open in no less than 1 hour, performed at fuse rated voltage. Fuses may experience damage due to overheating if subjected to currents that cause them to interrupt at times significantly longer than 1 hour. E-rated fuse: one hour melt.
- 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 1 hour
- Back up protection fuse or R-rated fuse: **current at which fuse melts in 100 sec or more**

EXAMPLE

Minimum breaking capacity for 200E = 350A

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

2.3. Temperature rise test

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

TABLE 1: maximum temperature rise and maximum temperatures

Fuse body material	BODY		CONTACTS	
	Maximum Temperature rise	Maximum temperature	Maximum Temperature rise	Maximum temperature
	(K)	(°C)	(K)	(°C)
Glass Melamine	110	150	65	105
Polyester	73	113	65	105

2.4. Time current curve

- **E - rated fuses**

- 100E and below : the fuse must melt in 300 seconds at 200% to 240% of E-rating
- Above 100E: the fuse 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 are available up to 900E

- **R - rated fuses**

R-RATINGS ARE NOT AMPERE RATINGS (Table 2)

TABLE 2

R-RATING	CONTINUOUS AMPERE RATING AT 40°C	MINIMUM INTERRUPTING RATING
	(A)	(A)
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

- 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.

TABLE 3

RATED VOLTAGE	R-RATINGS	MAX I.R.
(KV)		(KA)
2.4	2R – 36R	45
4.8	2R – 38R	63
7.2	2R – 24R	50

FERRAZ SHAWMUT R-RATED FUSES ARE UL COMPONENT RECOGNIZED AND MEET ANSI 37. 46

2.5. UL listed vs. Component Recognized medium voltage fuses

- UL Listed fuses are intended to provide overcurrent protection in accordance with the NEC. General purpose current limiting fuse like the E Rated fuses can interrupt all currents from maximum interrupting rating down to the current that causes the element to melt in no less than 1 hour.
E-Rated fuses are UL listed fuses
- UL Component Recognized fuses are intended to be used as a component in medium voltage motor controllers. Back up current limiting fuse like R-Rated fuses are capable of interrupting all current from maximum interrupting rating down to minimum interrupting rating, R-Rated are UL Recognized fuses

2.6. Arc voltage

TABLEAU 4

FUSE VOLTAGE RATING (KV)	FUSE CURRENT RATING	
	½ TO 12 A (KV)	OVER 12 A (KV)
2.8	12	9
5.8	23	18
8.3	38	26
15.5	70	49

The fuse arc voltage can be coordinated with the spark-over voltage of surge arrestors

3. EXPULSION FUSES VERSUS CURRENT 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 of 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

TABLE 5

	CURRENT LIMITING	EXPULSION
MAX INTERRUPTING RATING	HIGH	LOW
CURRENT LIMITATION	YES	NO
MOUNTING RESTRICTION	NO	YES
ARC VOLTAGES	YES	LOW
COORDINATION	YES	
CURRENT RATINGS	900E	1500E

FERRAZ SHAWMUT DO NOT MANUFACTURE EXPULSION FUSES

4. MEDIUM VOLTAGE TRANSFORMER PROTECTION

Notes:

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

4.1. primary fusing main objectives:

- isolate faulted transformer
- co-ordination
- conductor protection
- thru fault protection
- must hold transformer primary inrush
- coordinate with secondary fuses

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

4.2. Transformer inrush current

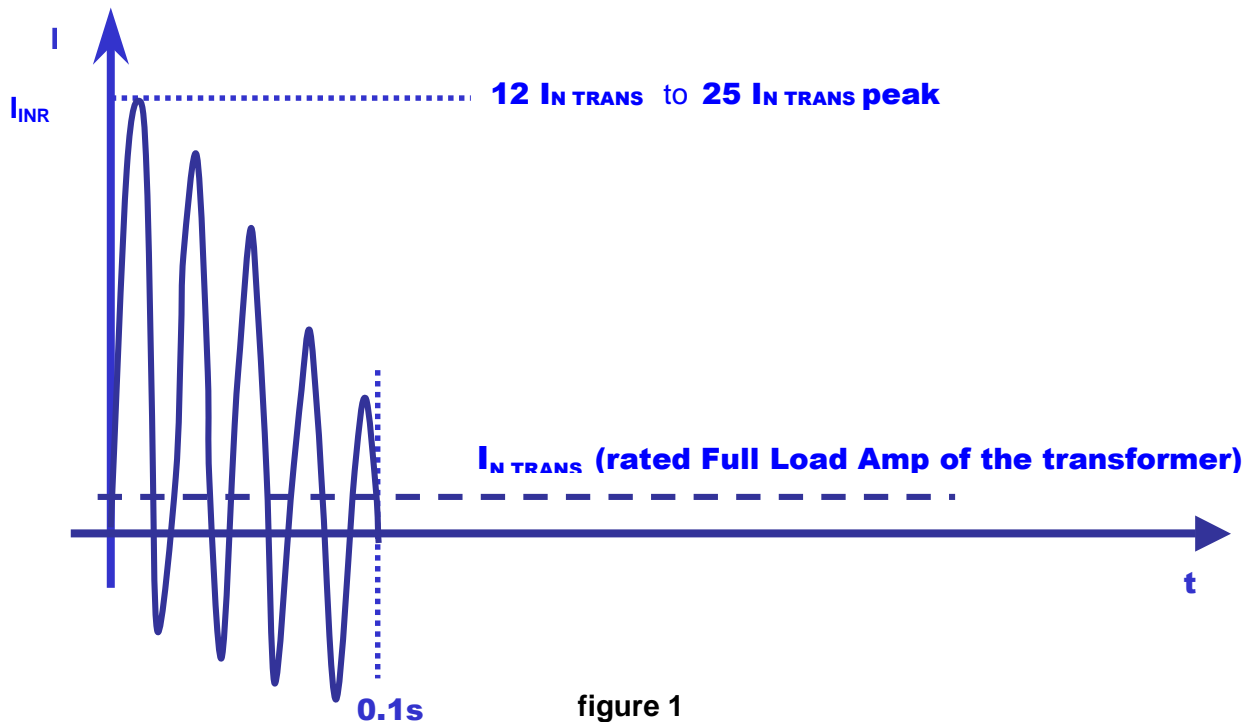


figure 1

4.3. Primary fusing sizing recommendation:

typical: fuse sized at 133 to 150%

minimum : fuse sized at 100 to 110%

fuses must withstand the transformer inrush current (figure 1) i.e. :

$$25 \times I_{N TRANS} \text{ peak for } .01 \text{ seconds}$$
$$12 \times I_{N TRANS} \text{ peak for } .1 \text{ seconds}$$

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

TABLE 6 shows the primary fuse selection for 4160 V / 480 V stepdown transformers. Footnotes for TABLE 6 are:

- 1- minimum fuse size shown will carry inrush current of 12 time $I_{N TRANS}$ for 0.1 seconds. 133% fuse size permits continuous operation of transformer at 133% of its self-cooled KVA rating
- 2- if two KVA ratings are given (self or forced air cooled) use the forced air cooled rating for fuse sizing.

TABLE 6

TENSION PRIMAIRE : 4160 V			
TRANSFORMATEUR		CALIBRE DU FUSIBLE AU PRIMAIRE	
		4160V (A055)	
PUISSANCE (KVA)	I _N TRANS (A)	MINIMUM E -rating	133 % E -rating
112.5	16	20 E	20 E
150	21	25 E	30 E
225	31	40 E	40 E
300	42	50 E	65 E
500	69	80 E	100 E
750	104	125 E	150 E
1000	139	150 E	200 E
1500	208	250 E	300 E
2000	278	300 E	400 E
2500	347	400 E	500 E
3000	416	450 E	600 E
3750	520	600 E	750 E
5000	694	700 E	

More tables for various voltages are published in the Application information inside the ADVISOR

4.4. Transformer protection example using tables of the catalogue

Select a fuse to protect a **1500KVA, 14400:480V, 3-PHASE**, transformer with 5.75% impedance
ANSWER from the Application Guide in the Advisor is:

MINIMUM rating: 65E (in the A155 series)
133% Typical : 80E in the A155 series

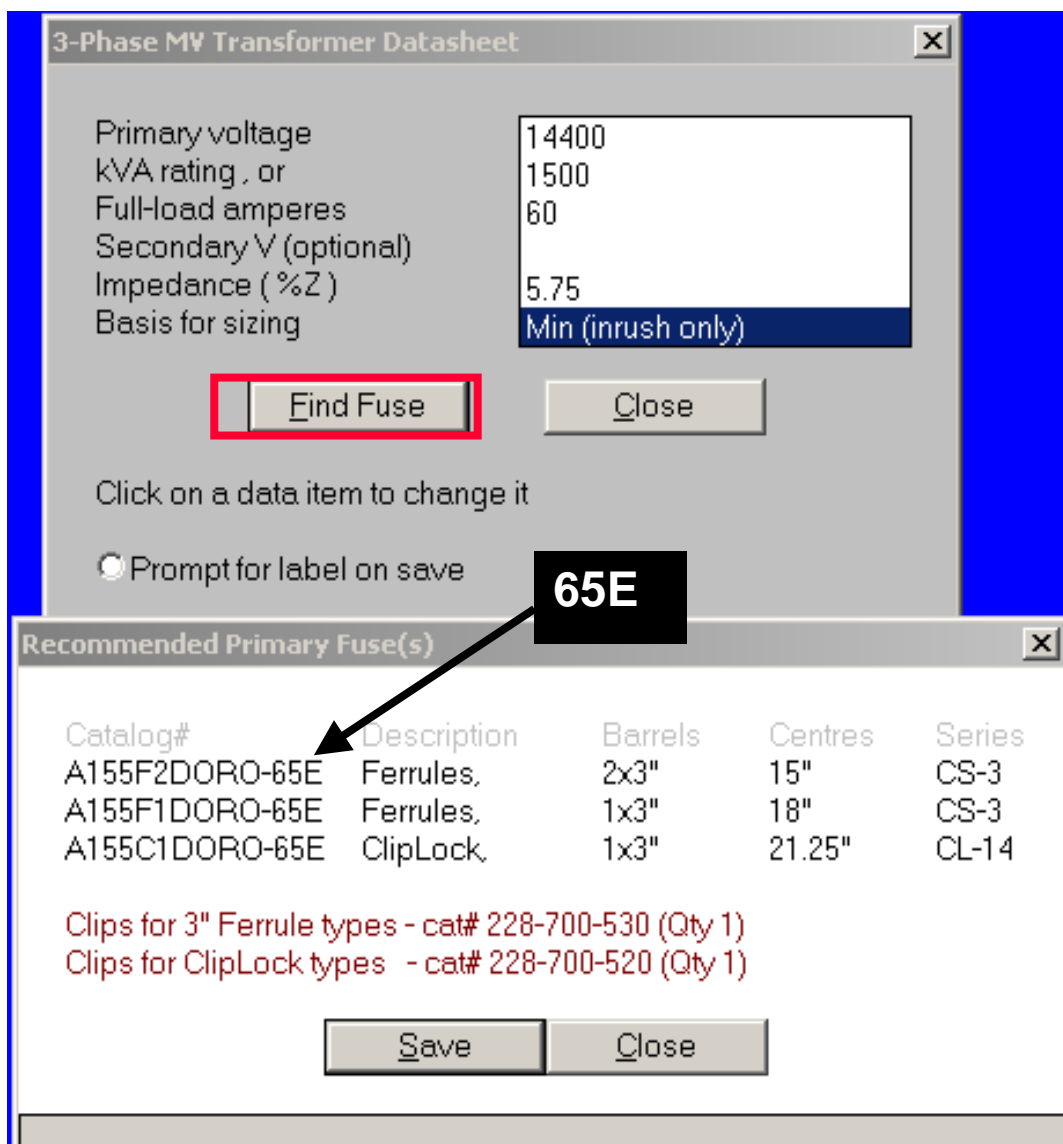
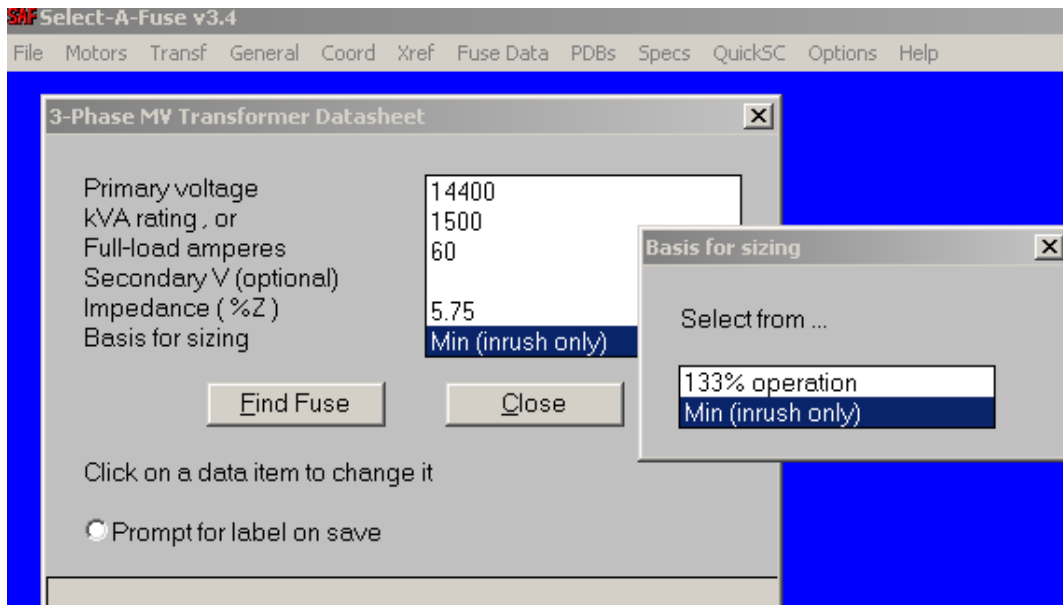
Primary Fuse Ratings -13,800, 14,400 Volts

TRANSFORMER RATING KVA ¹	PRIMARY FUSE RATING ¹					
	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

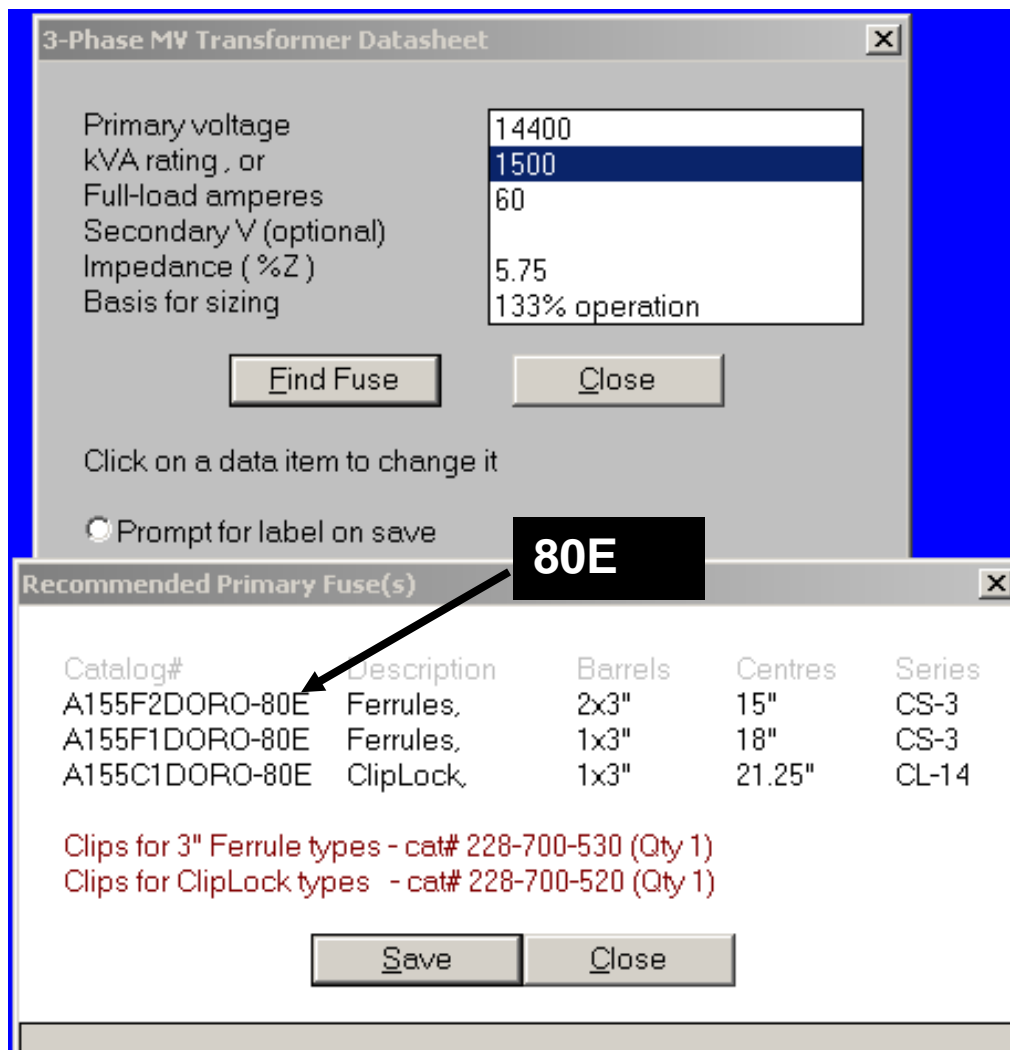
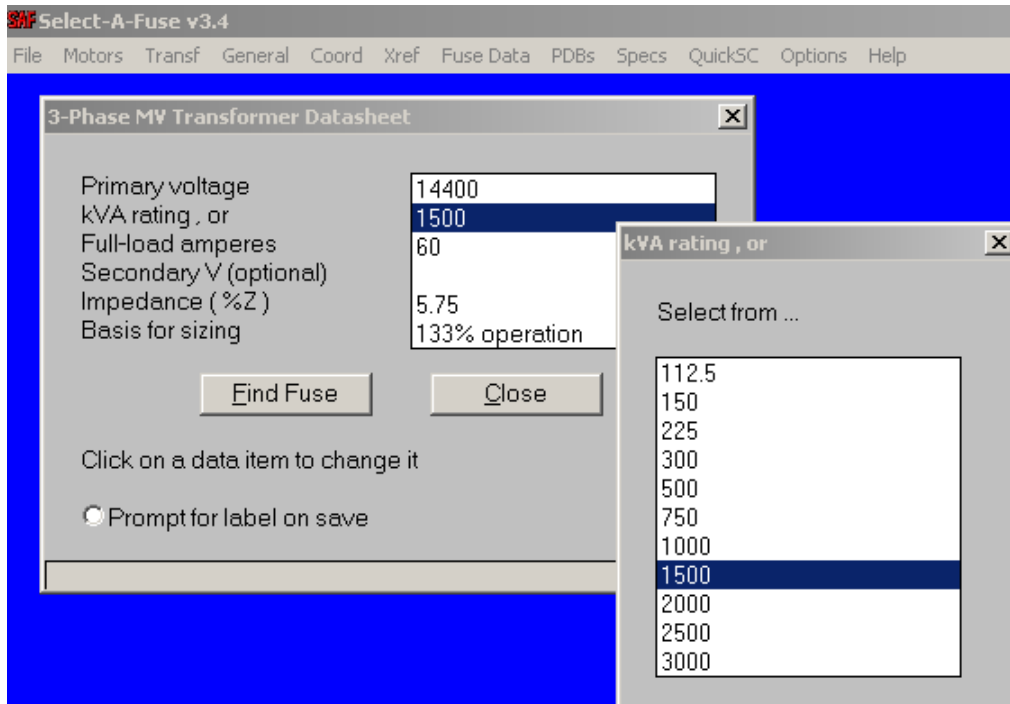
¹ Minimum fuse size shown will carry transformer magnetizing inrush current of 12 times full load amperes for .1 second.
 133% fuse size permits continuous operation of transformer at 133% of its self cooled KVA rating.

4.5. Transformer protection example using the SAF software

- Calculation set up for minimum inrush



- Calculation set up for 133% overload



5. MEDIUM VOLTAGE MOTOR PROTECTION

Comments:

Medium voltage motors have the same motor inrush characteristics as low voltage motors

R - rated fuses must be selected to coordinate with overload relay

Starter / motor manufacturers will usually specify appropriate R - rating for their equipment

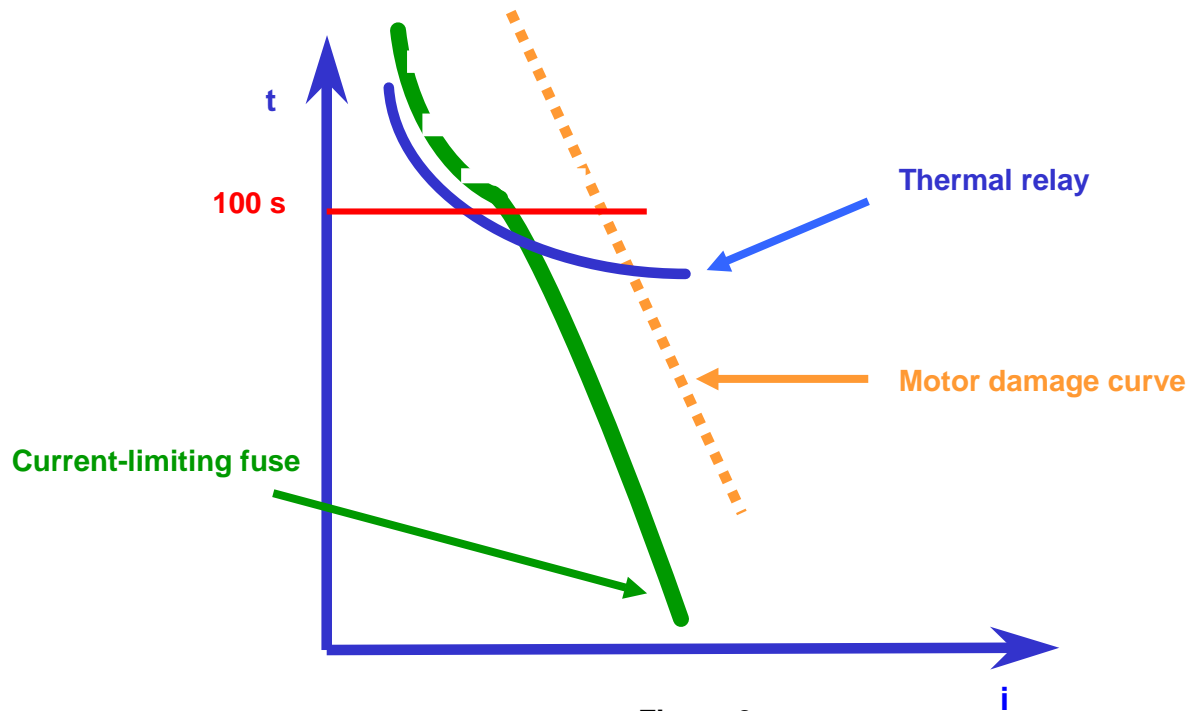


Figure 2

5.1. R - rated fuse selection table for full voltage start

TABLEAU 7

FUSE RATING	MAXIMUM FULL LOAD CURRENT FOR FULL VOLTAGE START AMPERE	
	10 SECONDS START	3 SECOND START
	(A)	(A)
2R	28	32
3R	40	45
4R	55	65
6R	80	95
9R	125	140
12R	165	190
18R	250	280
24R	330	360
36R	500	550

5.2. Motor protection application – example 1

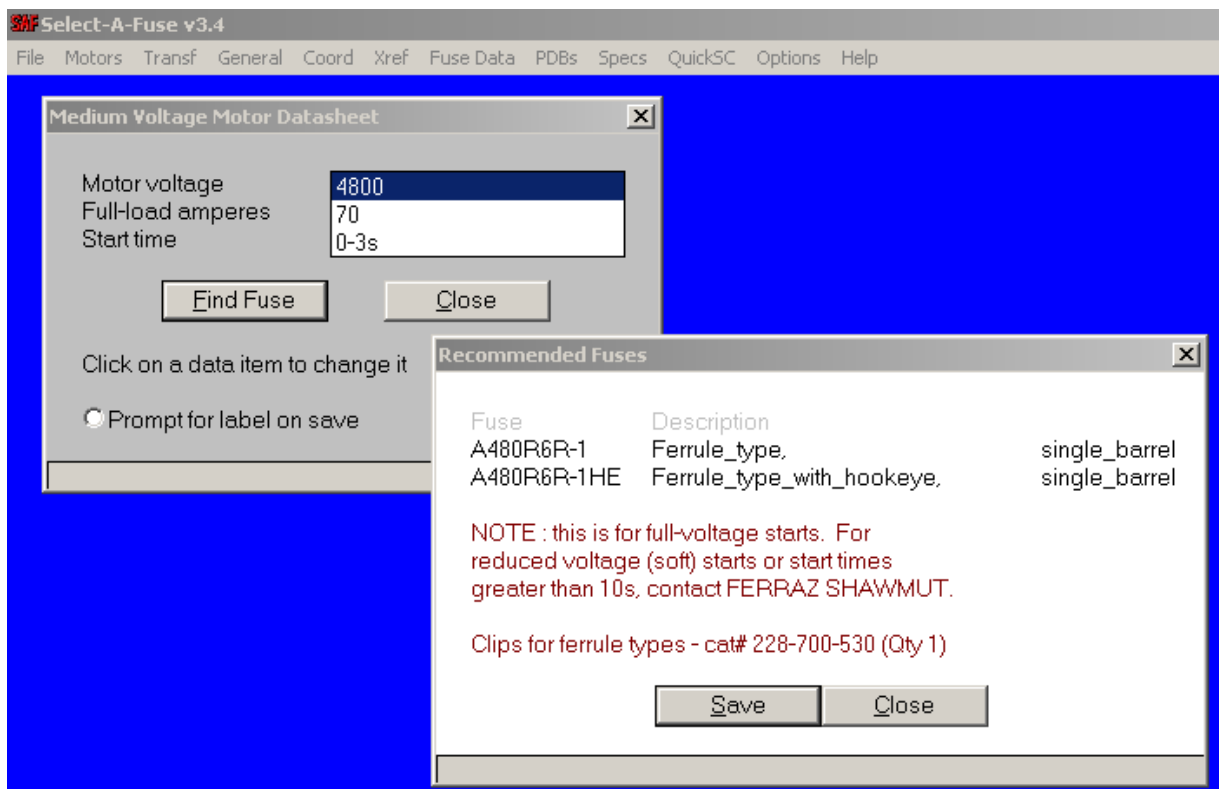
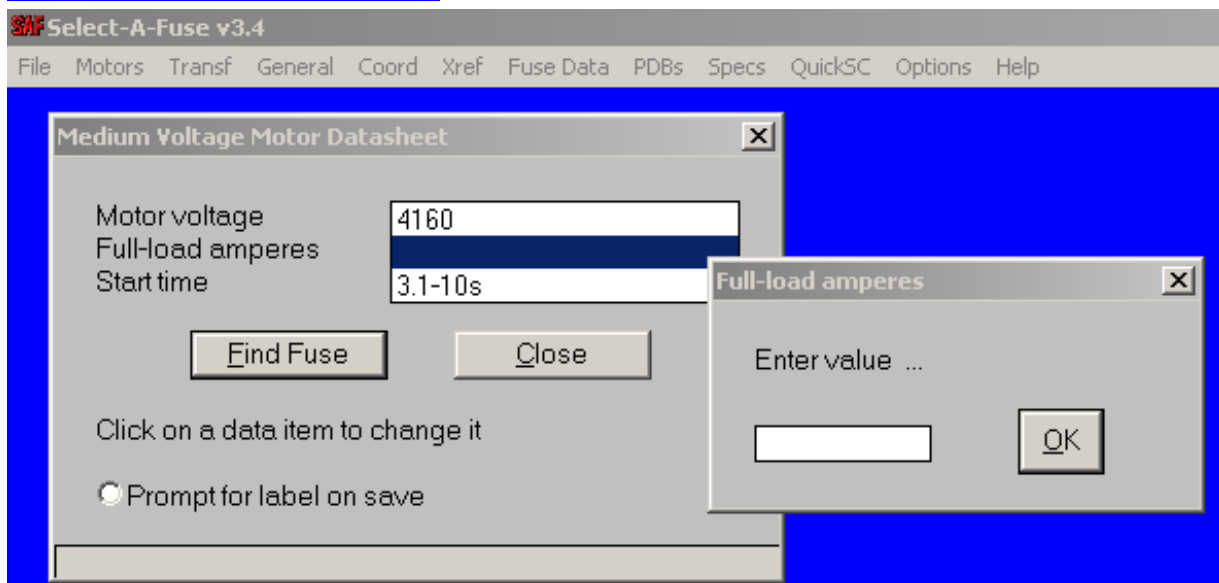
Select a fuse to protect a 4800 V motor that takes 3 seconds to start and has a FLA = 70 A.



ANSWER From Select – A - Fuse

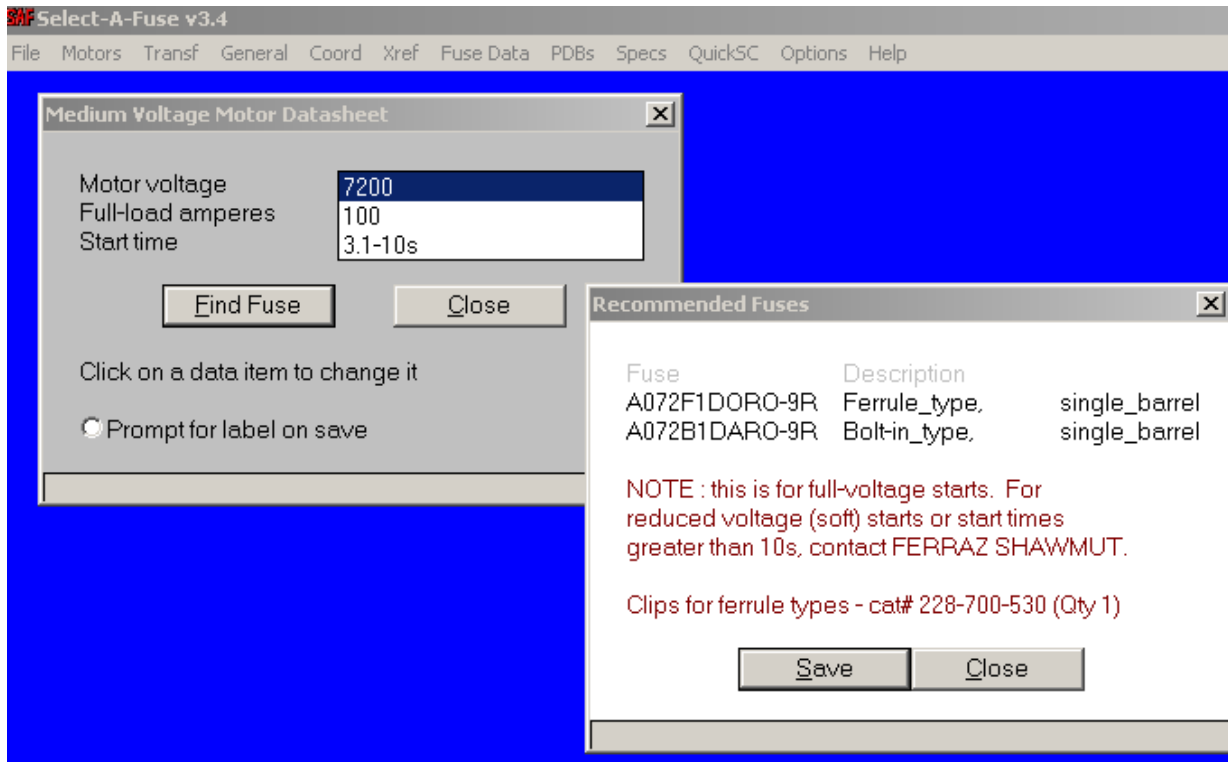
6R fuse

Cat. No. A480R6R



5.3. Motor protection application – example 2

Select a fuse to protect a 7200v motor that takes 8 seconds to start and has FLA = 100 A.



ANSWER from Select-A-Fuse :

9R fuse
A072F1DORO-9R
A072B1DARO-9R

b

6. POTENTIAL TRANSFORMER PROTECTION FUSES

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

7. REPLACEMENT OF 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.