CERTIFIED TEST REPORT

ELF™ Current-Limiting Dropout Fuse

June 1999 • Replaces Rev. 1 dated 12/19/96 •

Design Tests for the ELF Current-Limiting Dropout Fuse
per the following ANSI/IEEE Requirements:
C37.40
C37.41
C37.47

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.

Frank J. Muench
Engineering Manager

Tomas I. Babic
Project Leader
Olean, NY

Stephen P. Hassler
Project Leader
Franksville, WI

INTRODUCTION

The **Cooper Power Systems' ELF Fuse** has been developed to provide a full range, energy-limiting, silver-sand dropout fuse for use in an industry standard interchangeable cutout.

This report details testing conducted to verify fuse performance and to verify that the fuse meets the requirements specified in the following ANSI/IEEE standards:

C37.40
C37.41
C37.47

Interruption Testing

- Minimum Current
- Critical Current
- Maximum Interrupting Level - (Refer to Table 1)

Temperature Rise Characteristics & Long-Term Current Carrying Capacity

Time-Current Characteristics

Mechanical Testing

INTERRUPTION TESTS

REQUIREMENT

Current-limiting fuses are required to operate and isolate other pieces of equipment on the electrical distribution system when overload and fault current conditions are present. In the case of high available fault currents, the fuse must limit the current magnitude and energy to the protected equipment.

OBJECTIVE

The objective of these tests were to verify the interrupting performance of the ELF fuse for use in applications up to the fuse's respective voltage rating, by testing according to the requirements specified in ANSI C37.41 and C37.47.

PROCEDURE

Tests were run on production fuses which were assembled using established methods and procedures. Testing was conducted per ANSI C37.41.6. Samples were mounted in standard interchangeable cutout mountings and testing was conducted at room temperature.

TEST RESULTS

The 8.3 kV, 15.0 kV, 23.0 kV, and 24.0 kV ELF fuse ratings successfully interrupted each respective test current. Fuse performance parameters derived from these tests are detailed in Table 1 and on pages 9 and 10.

CONCLUSION

The ELF fuses, forming a homogeneous series, successfully passed all interruption tests per ANSI C37.41 and C37.47 requirements.

Table 1: Performance Ratings

Fuse Ratings		Cutout Ratings		Continuous Current Rating[a] (Amps)			Interruption Test Results		
Voltage Rating (kV)	Current Rating (A)	Voltage Rating (kV)	BIL (kV)	25°C	40°C	55°C	Minimum Melt I^2t (A^2 x s)	Maximum Let-Through I^2t (A^2 x s)	Maximum Interrupting Current (A rms symmetrical)
8.3	6	15	95/110	8	7	6	520	4550	31000
8.3	8	15	95/110	12	11	11	1150	6500	31000
8.3	12	15	95/110	18	17	16	1150	7000	31000
8.3	18	15	95/110	25	24	23	1350	8600	31000
8.3	20	15	95/110	27	26	25	2000	11700	31000
8.3	25	15	95/110	34	33	31	2900	17000	31000
8.3	30	15	95/110	43	41	39	4000	20000	31000
8.3	40	15	95/110	50	48	46	8000	39000	31000
8.3	50*	15	95/110	68	65	62	16000	65000	31000
8.3	65*	15	95/110	78	75	71	20000	100000	31000
8.3	80*	15	95/110	95	91	87	32000	150000	31000
8.3	100*	15	95/110	120	114	109	46000	215000	31000
15.0	6	15	95/110	8	7	6	520	4550	20000
15.0	8	15	95/110	12	11	11	1150	6500	20000
15.0	12	15	95/110	18	17	16	1150	7000	20000
15.0	18	15	95/110	25	24	23	1350	8600	20000
15.0	20	15	95/110	27	26	25	2000	11700	20000
8.3	6	27	125/150	8	7	6	520	4550	31000
8.3	8	27	125/150	12	11	11	1150	6500	31000
8.3	12	27	125/150	18	17	16	1150	7000	31000
8.3	18	27	125/150	25	24	23	1350	8600	31000
8.3	20	27	125/150	27	26	25	2000	11700	31000
8.3	25	27	125/150	34	33	31	2900	17000	31000
8.3	30	27	125/150	43	41	39	4000	20000	31000
8.3	40	27	125/150	50	48	46	8000	39000	31000
8.3	50*	27	125/150	68	65	62	16000	65000	31000
8.3	65*	27	125/150	78	75	71	20000	100000	31000
8.3	80*	27	125/150	95	91	87	32000	150000	31000
8.3	100*	27	125/150	120	114	109	46000	215000	31000
15.0**	6	27	125/150	8	7	6	520	4550	43000
15.0**	8	27	125/150	12	11	11	1150	6500	43000
15.0**	12	27	125/150	18	17	16	1150	7000	43000
15.0**	18	27	125/150	25	24	23	1350	8600	43000
15.0**	20	27	125/150	27	26	25	2000	11700	43000
15.0**	25	27	125/150	34	33	31	2900	17000	43000
15.0	30	27	125/150	43	41	39	5100	25000	20000
15.0**	30*	27	125/150	43	41	39	5100	25000	43000
15.0**	40*	27	125/150	50	48	46	8000	39000	43000
15.0**	50*	27	125/150	68	65	62	16000	65000	43000
23.0	6	27	125/150	8	7	6	520	5200	31000
23.0	8	27	125/150	12	11	11	1150	7000	31000
23.0	12	27	125/150	18	17	16	1150	8000	31000
23.0	18	27	125/150	25	24	23	1350	10000	31000
23.0	20	27	125/150	27	26	25	2000	14000	31000
23.0	25*	27	125/150	34	33	31	2900	20000	31000
23.0	30*	27	125/150	43	41	39	5100	30000	31000
24.0	6	27	170	8	7	6	520	5200	13000
24.0	8	27	170	12	11	11	1150	7000	13000
24.0	12	27	170	18	17	16	1150	8000	13000
24.0	18	27	170	25	24	23	1350	10000	13000
24.0	20	27	170	27	26	25	2000	14000	13000

a For temperatures other than listed, a deration factor of 0.26% per °C can be applied.
* Multi-barrel design
** 15 kV, 125/150 kV BIL, 6 through 25 A (single barrel part numbers FAK44W6 through FAK44W25) and 30 through 50 A (double barrel part numbers FAK44W30P, FAK44W40, and FAK44W50) have been tested and approved for 17.2 kV application.

TEMPERATURE RISE CHARACTERISTICS & LONG-TERM CURRENT CARRYING CAPACITY

REQUIREMENT

ELF current-limiting fuses are required to carry any system steady state current up to the fuse's continuous current capacity without incurring temperature rises that would be detrimental to any of the fuse parts. The fuse's continuous current capacity is the maximum current level which the device can carry, when operating at a specific ambient temperature, without melting open. At this current level, the fuse must not exceed the allowable temperature levels as detailed in standards.

OBJECTIVE

The objectives of these tests are to verify that the temperature rise of the fuse parts do not exceed the maximum allowable values specified in ANSI C37.40.3, Table 2 and also to determine the continuous current capacity of each of the ELF fuse ratings.

PROCEDURE

Tests were run on ELF fuses which were assembled using established methods and procedures. The samples were mounted in standard interchangeable cutout mountings and tested per the requirements specified in ANSI C37.41. Current was supplied by a regulated current source. Temperature levels of the various current carrying parts were recorded throughout the duration of the test.

RESULTS

Temperature rises were below levels allowed in standards. The continuous current capacity for each respective ELF fuse rating is specified in the performance characteristics table located on page 5 of this report.

CONCLUSION

The ELF fuse met the temperature rise requirements of ANSI C37.40, Table 2 and provides long-term continuous current ratings specified on page 5 of this report.

TIME CURRENT CHARACTERISTICS TESTS

REQUIREMENT

Time-current characteristic curves are used primarily for application selections and system coordination studies. These curves, minimum melt and total clear detail the performance data of a particular fuse design.

OBJECTIVE

The objective of these tests were to establish time-current characteristic curves for the following ELF fuse ratings:

8.3 kV	—	6, 8, 12, 18, 20, 25, 30, 40, 50, 65, 80 and 100 A
15.0 kV	—	6, 8, 12, 18, 20, 25, 30, 40 and 50 A
23.0 kV and 24.0 kV	—	6, 8, 12, 18, 20, 25* and 30* A

Note *: 23kV fuse only

PROCEDURE

Tests were run on ELF fuses that were assembled using established methods and procedures.

"Minimum melt" time-current curves were developed using ANSI C37.41, section 12 requirements as a guideline. Testing was performed with the fuses in standard interchangeable cutout mountings to simulate actual field application. Testing was performed at room temperature.

"Maximum clear" time current characteristic curves were developed using ANSI C37.41, section 12 requirements as a guideline. For longer times, the fuse's melt time current characteristic, with an adjustment for production tolerances, were used to determine the fuse's maximum clearing characteristic. For shorter times, where arcing times are significant, high voltage interrupting tests were used to determine the fuse's maximum clearing time.

RESULTS

The attached minimum melt TCC curves on pages 11, 13 and 15 and the maximum clear TCC curves on pages 12, 14 and 16 were developed from the above testing.

CONCLUSION

The minimum melt and maximum clear time-current characteristics are on pages 11-16 of this report.

MECHANICAL TESTS

REQUIREMENT

The ELF fuse is required to withstand 200 open/close operations per ANSI/IEEE C37.41.

OBJECTIVE

The objective of this test is to verify the mechanical performance of the ELF fuse.

PROCEDURE

Production fuses were assembled using established methods and procedures. Testing was conducted per ANSI/IEEE C37.41. The tests were run by first closing the ELF fuse into an interchangeable cutout mounting and then opening the ELF fuse from the same mounting. This was done the required number of times using normal operating procedures.

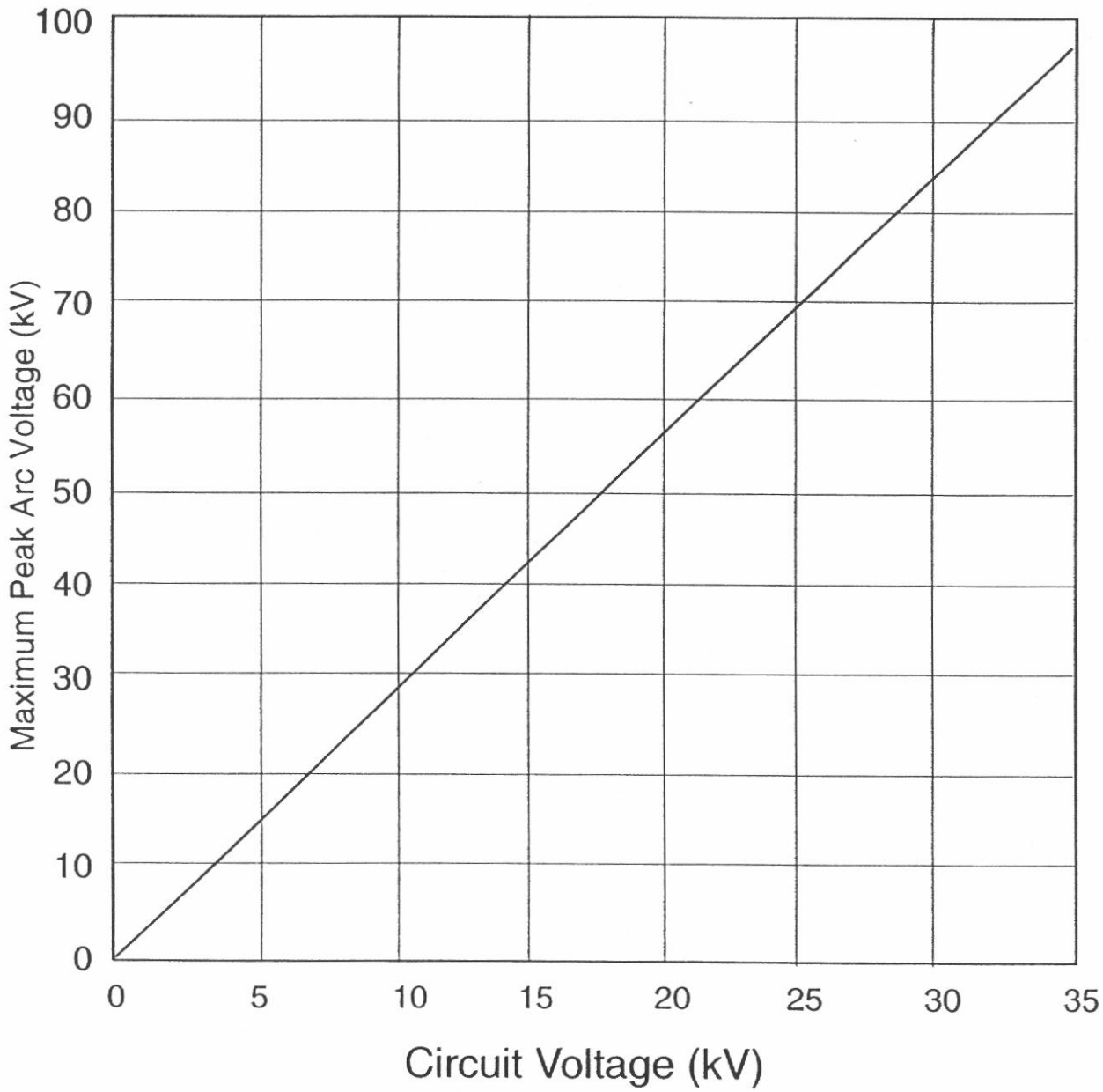
RESULTS

The ELF fuses passed all mechanical tests with no evidence of damage.

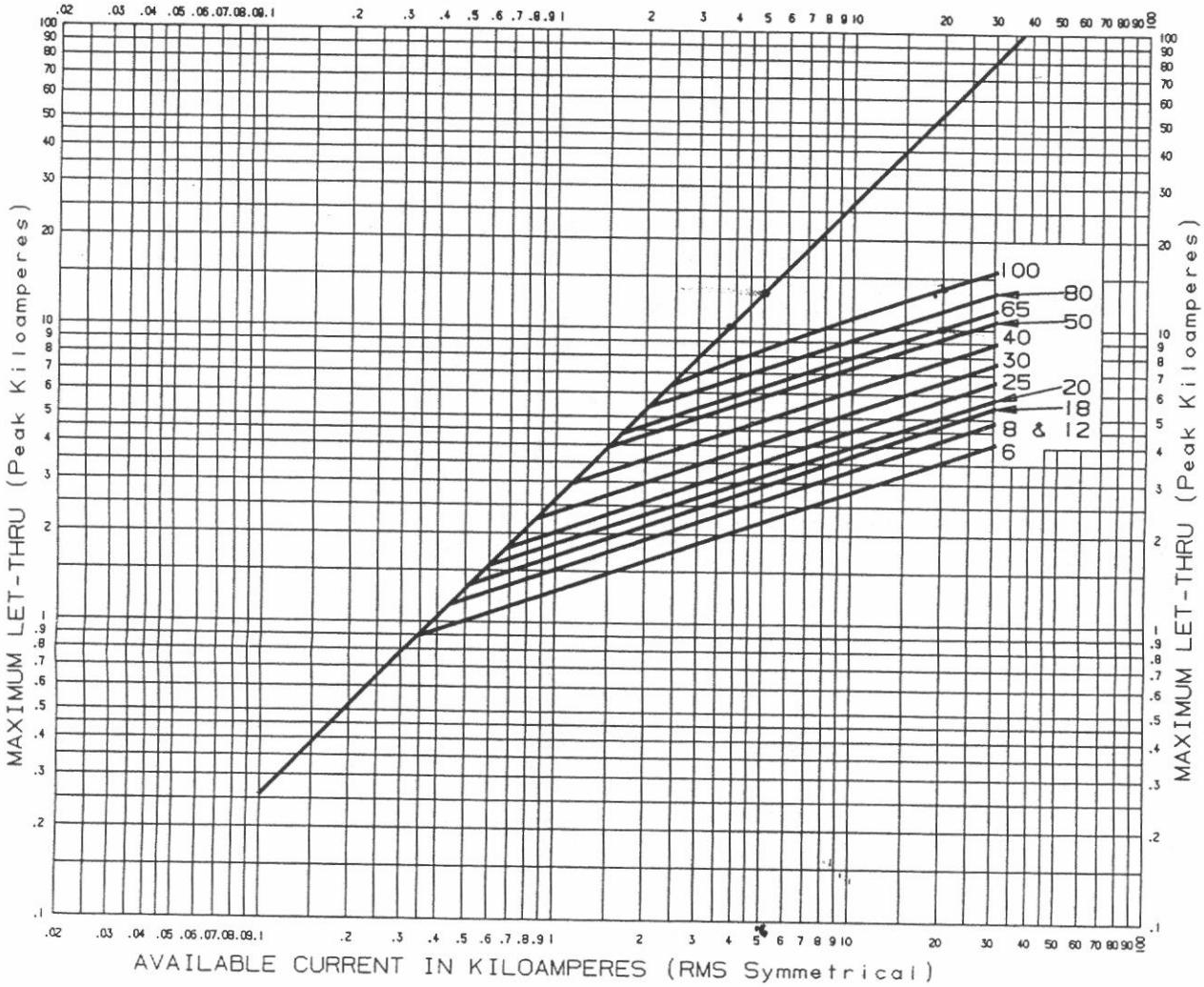
CONCLUSION

The ELF fuse meets the mechanical requirements as specified in ANSI/IEEE C37.41.

MAXIMUM PEAK ARC VOLTAGE
for
8.3kV rated fuses 6 amps and above
15.0kV rated fuses 6 amps and above
23.0 & 24.0 rated fuses 6 amps and above



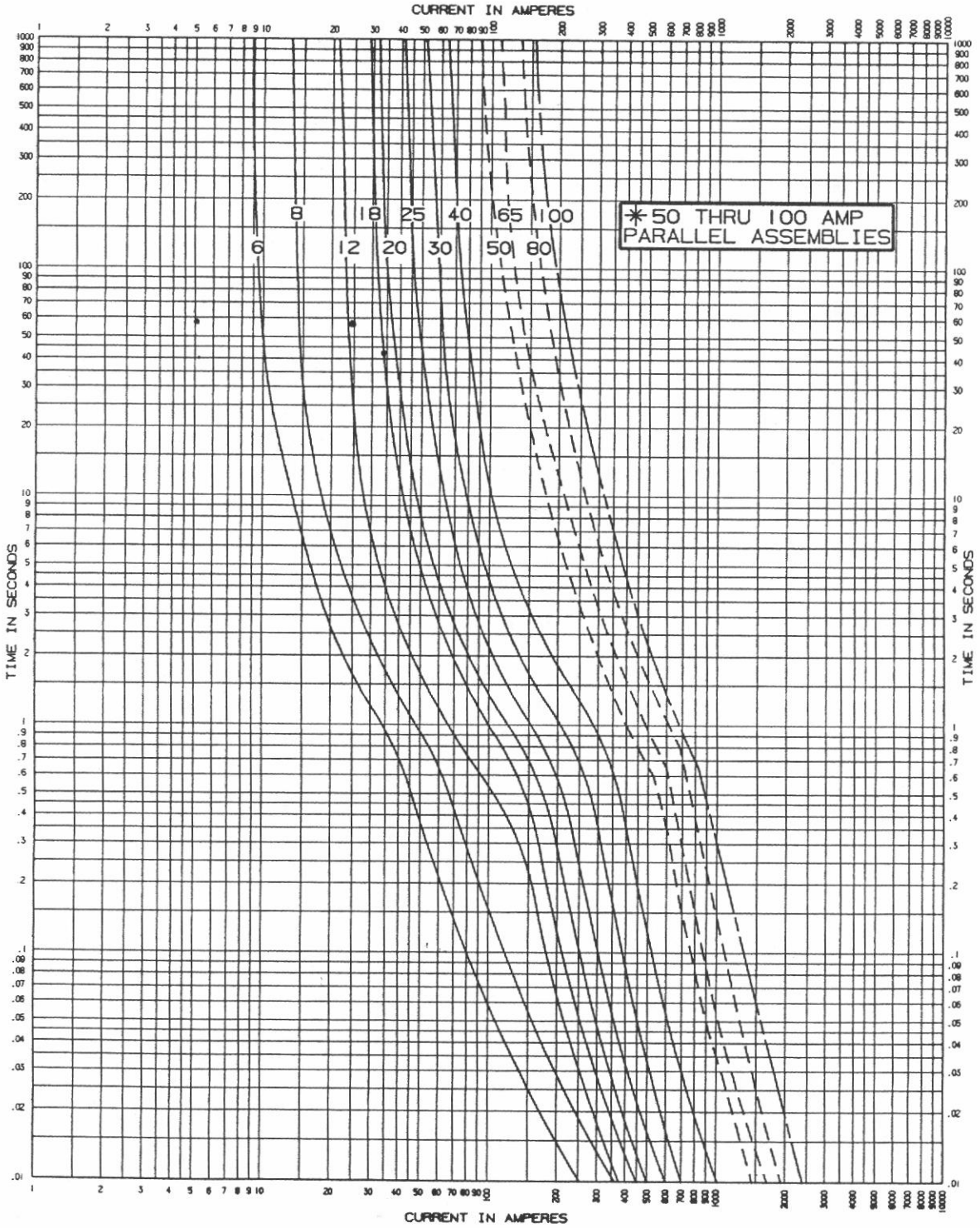
MAXIMUM LET-THROUGH CURRENT
for
ELF Fuse



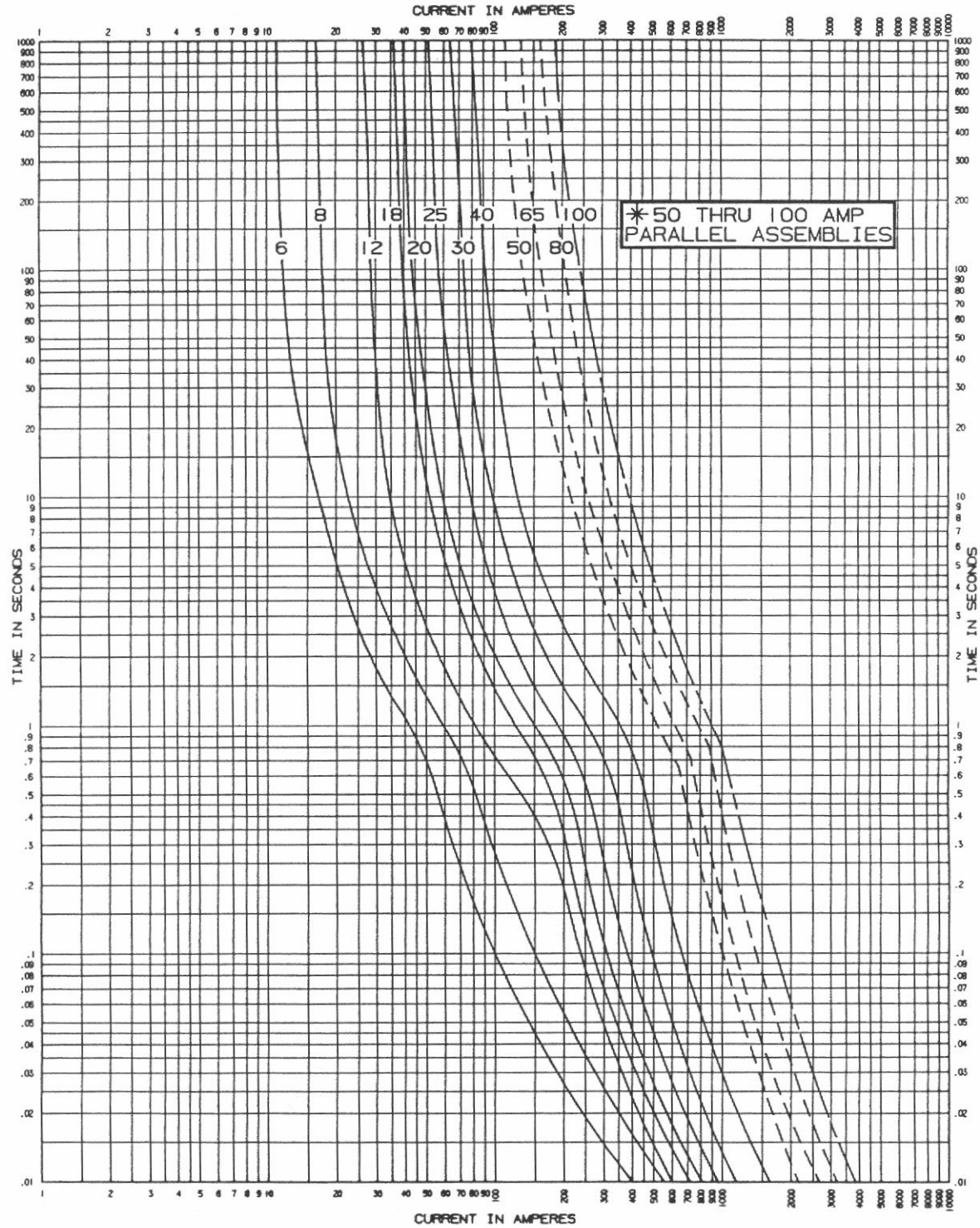
3KA

4-5KA

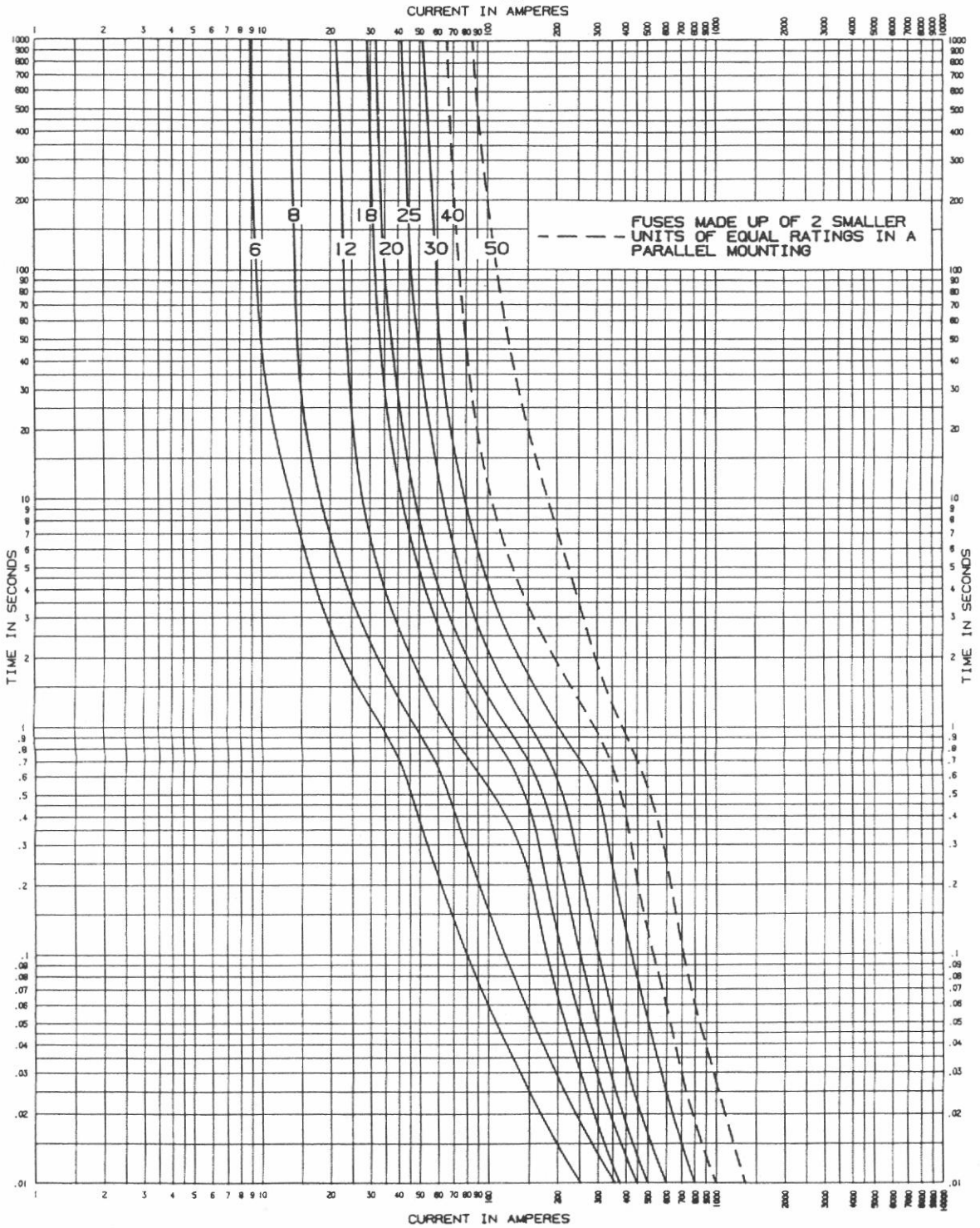
MINIMUM MELT
Time Current Characteristic Curves for 8.3kV ELF Fuse



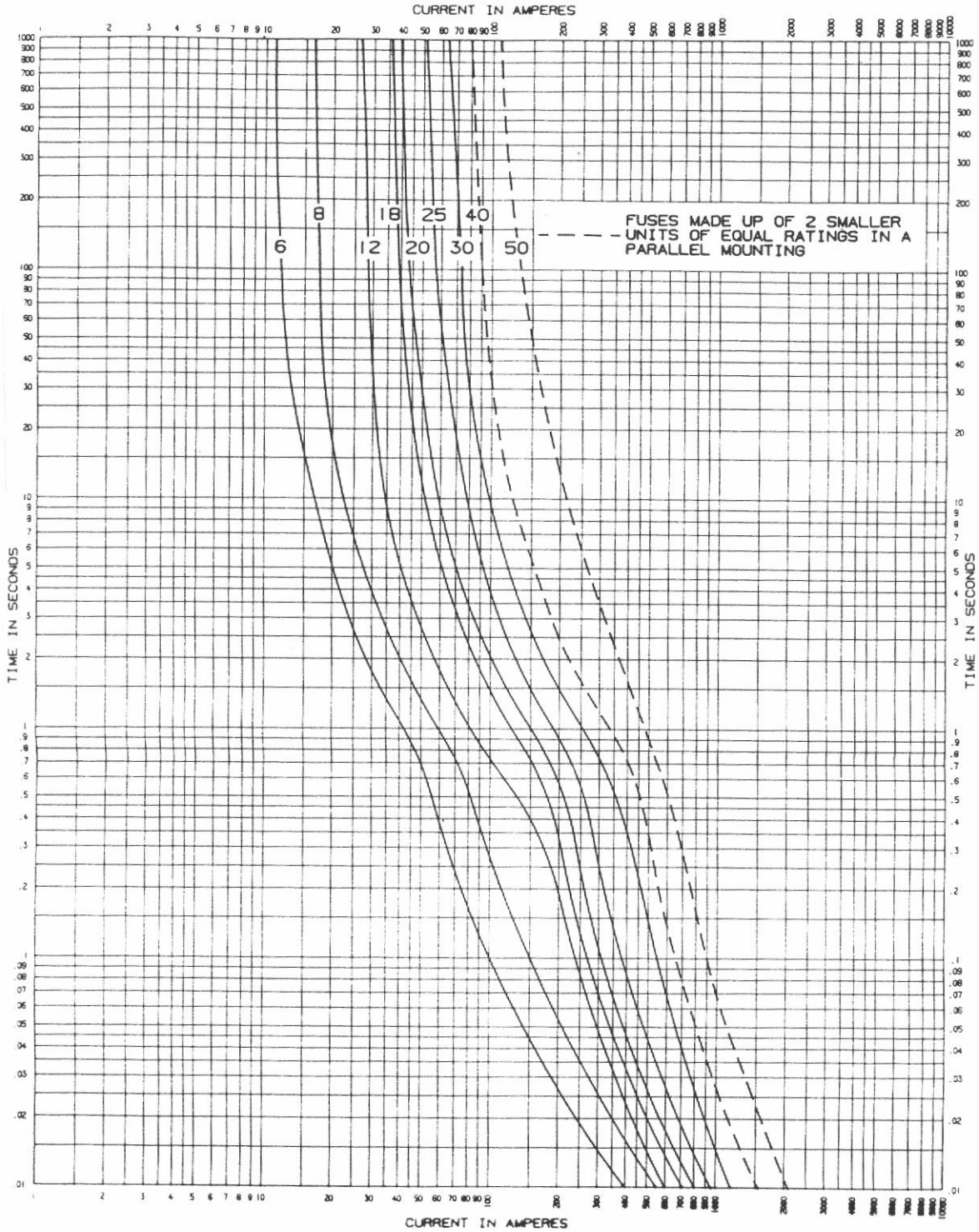
MAXIMUM CLEAR
Time Current Characteristic Curves for 8.3kV ELF Fuse



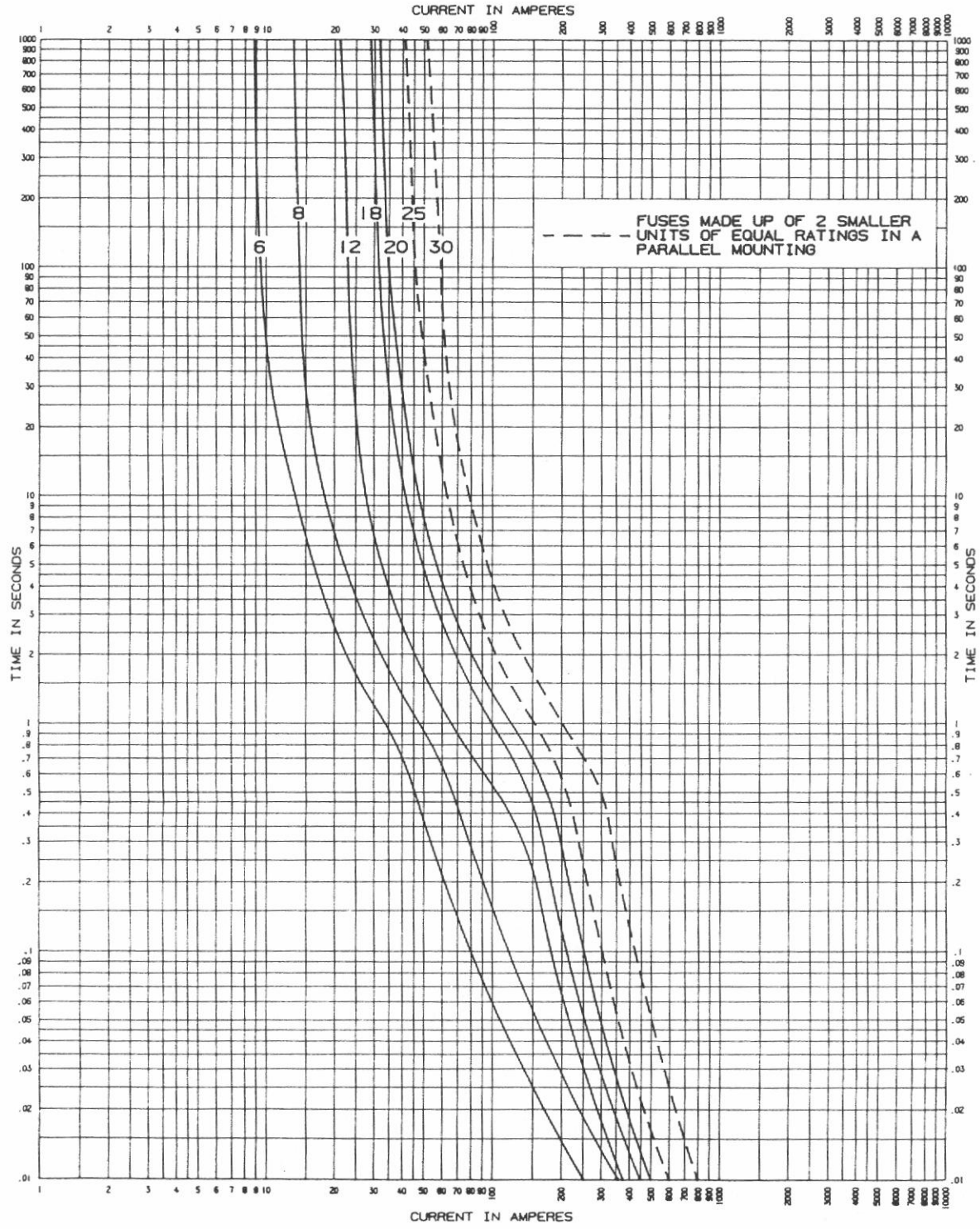
MINIMUM MELT
Time Current Characteristic Curves for 15.0kV ELF Fuse



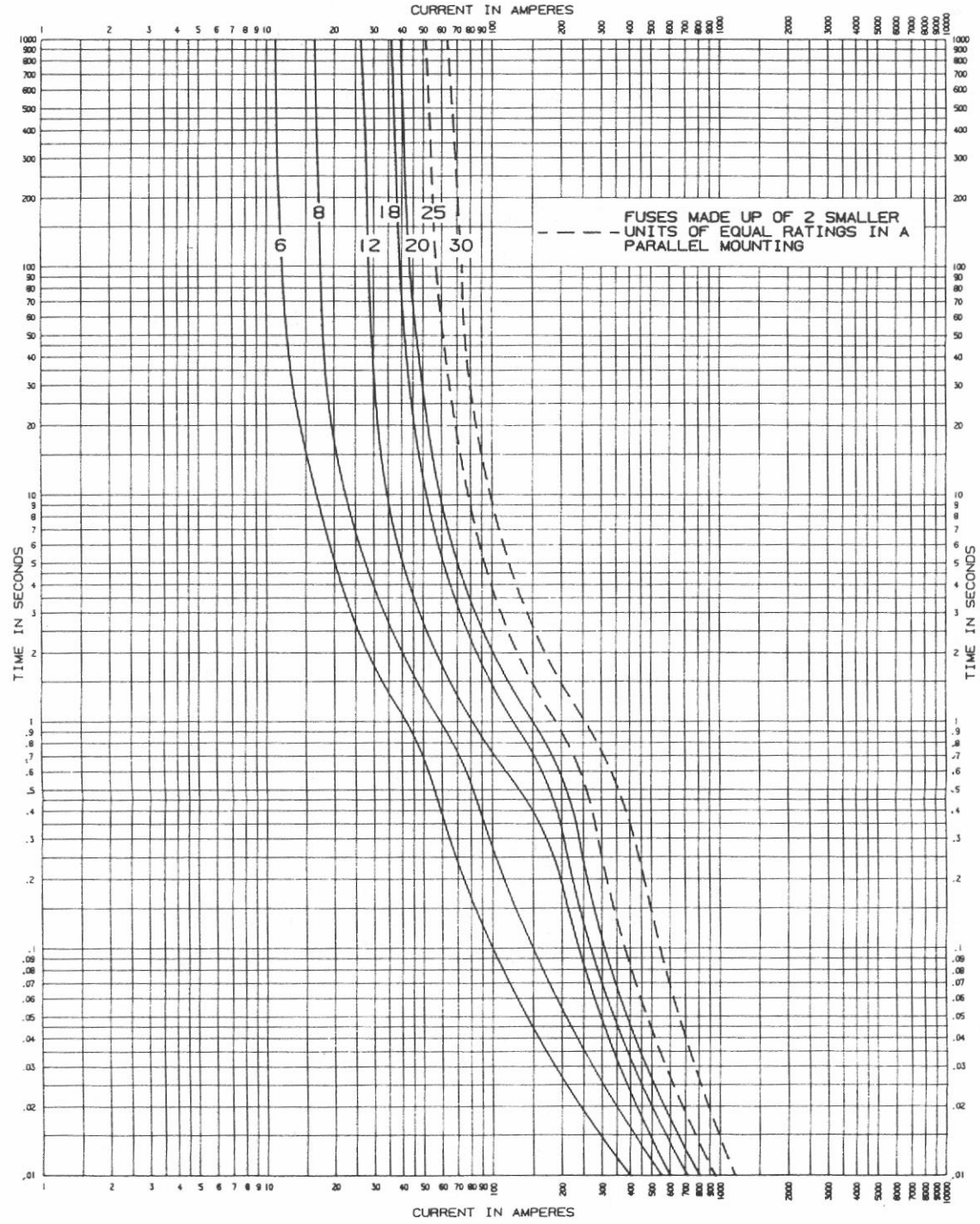
MAXIMUM CLEAR
Time Current Characteristic Curves for 15.0kV ELF Fuse



MINIMUM MELT
Time Current Characteristic Curves for 23.0kV ELF Fuse



MAXIMUM CLEAR
Time Current Characteristic Curves for 23.0kV ELF Fuse



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Quality from Cooper Industries

P.O. Box 1640, Waukesha, WI 53187