CERTIFIED
TEST REPORT

Faulted Circuit Interrupting Tests on Type CMU Power Fuses

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Type CMU Power Fuses

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. The following report is a true and correct summary of data from tests performed by Powertech High Power Laboratory in Surrey, British Columbia Canada, from November 29 to December 2, 1999 and April 2, 2000. The tests demonstrate the capability of the Cooper Power Systems type CMU Power Fuses to safely interrupt circuits when applied within their assigned ratings.

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INTRODUCTION

The tests detailed in the following report were performed to present the

TESTS TO PROVE 10 kA (symmetrical), 16 kA (asymmetrical) – Dropout;
8.5 kA (symmetrical), 13.6 kA (asymmetrical) – Indoor;
INTERRUPTING CAPABILITY AT 38 kV
TO IEEE C37.40-1993, C37.41-1994, C37.46-1981 & C37.47-1981.

for

TYPE CMU 704003 to 704200, CMU 614003 to 614200 & CMU 714015 to 714200 POWER FUSES

Object

To prove the interrupting ability of Cooper Power Systems CMU 614003 - 614200, 704003 - 704200 & CMU 714015 – 714200 Power Fuses.

Maximum Interrupting Current	10 kA symmetrical, 16 kA asymmetrical (Dropout);
	8.5 kA symmetrical, 13.6 kA asymmetrical (Indoor)
Power Frequency Recovery Voltage	38 kV
Frequency	60 Hz

Equipment Tested

CMU 702006 Fuses

CMU 712065 Fuses

These fuses are the minimum and maximum ratings of a design family that covers the 3K to 80K, 5E to 80E, and 15SE to 65SE ratings.

CMU 612100 Fuses

CMU 712125 Fuses

These fuses are the minimum and maximum ratings of a design family that covers the 100K & 140K, 100E & 125E, and 80SE to 125SE.

CMU 612150 Fuses

This Fuse does not fit into any of the design families.

CMU 612175 Fuses

CMU 712200 Fuses

These fuses are the minimum and maximum ratings of a design family that covers the 200K,175E & 200E, and 150SE to 200SE ratings.

Test Arrangement

For 'dropout' tests, each fuse was equipped with a set of S&C end fittings, Cat. # 3095 (comprising one top end fitting and one bottom end fitting). The fuse was tested in a S&C drop-out mounting, Cat. # 92122R3.

For 'non-dropout' tests, each fuse was equipped with a set of S&C end fittings, Cat # 3097 (comprising one top fitting and one bottom end fitting and an S&C Silencer). The fuse was tested in a S&C pad mount mounting, Cat # 192322.

Test Conditions

Tests were carried out to the requirements of ANSI-IEEE Std C37.40-1993, and IEEE Std C37.41-1994, Tables 2, 3, and 4.

Series 1 tests were carried out 100% of rated maximum voltage, thus eliminating the need to carry out Series 2 tests.

The test circuit was arranged to monitor leakage current on tests on 'non-dropout' tests, and the circuit was opened after the leakage current had been less than 1 mA for 2 min.

Test Results

Table 1- Test Circuits

Test Series	Available Current Range (kA)	Actual (kA)	Test Voltage Minimum (kV)	Actual (kV)	Circuit X/R Ratio Min or Range	Actual	Transient Recovery Voltage Frequency Range	Actual	Peak Factor Range	Actual
1 (Dropout)	10.0 - 11.0	103 *1	33.1 - 36.4	>38.0	>=15	16	1.6 - 1.76	1.6	1.4 - 1.54	1.46
1 (Indoor)	8.5 - 9.35	8.74 *1	33.1 - 36.4	>38.0	>=15	16	1.6 - 1.76	1.6 (2.14) *2	1.4 - 1.54	1.4 (1.44) *2
2 (Dropout)	8.7 - 9.6		38 - 41.8		>=15		1.6 - 1.76		1.4 - 1.54	
2 (Indoor)	7.4 - 8.15		38 - 41.8		>=15		1.6 - 1.76		1.4 - 1.54	
3 (Dropout)	6.0 - 7.0	6.39	38 - 41.8	>38.0	>=15	15	1.6 - 1.76	1.66	1.4 - 1.54	1.4
3 (Indoor)	5.1 - 5.95	5.81	38 - 41.8	>38.0	>=15	15.1	1.6 - 1.76	1.65	1.4 - 1.54	1.42
4 (Dropout)	2.0 - 3.0	2.29	38 - 41.8	>38.0	>=15	16.7	1.6 - 1.76	1.66	1.4 - 1.54	1.43
4 (Indoor)	1.7 - 2.55									
5	0.4 - 0.5	.419	38 - 41.8	>38.7 *3	>=12	12.2	8.0 - 8.8	8.3	1.65 - 1.815	1.62 *3
6	.0162 - .0198	.0197	38 - 41.8	>38.0	0.75 - 1.3	0.83	Critically Damped			

*1 - The Series 1 tests were carried out at 100% of maximum rated voltage, which eliminated the need to carry out Series 2 tests. [See Note d, Table 2 of C37.41-1994.]

*2 - The values in parentheses were used for initial tests on 200SE fuses.

*3 - TRV Peak Factor of 1.62 was the maximum achievable by the test station. In order to fulfill the 1.65 minimum requirement of the standard, tests in Series #5 were performed at a voltage of 38.7 kV instead of 38 kV.

Table 2-i Test Results, Test Series 1 & 2 - Dropout

Test #	Fuse Cat. #	Test Series	Sample #	Silencer	Vapp kV	Ipros kA	Vrec kV	Ipk kA	Varc kV	Closing Angle	Melt Time msec.	Clear Time msec.	MW	Kj	Vrec Held sec.	Result
4-18	CMU 704006	1	4-18	N	38.1	10.3	38.1	25.7	63.4	0	.6	13.7	48.7	287	.5	Cleared
4-23	CMU 704006	1	4-23	N	38.1	10.3	38.1	14.0	74.2	90	.2	16.4	41.3	223	.5	Cleared
4-20	CMU 704006	1	4-20	N	38.1	10.3	38.1	23.4	68.9	145	.7	15.1	63.0	270	.5	Cleared
4-21	CMU 714040	1	4-21	N	38.1	10.3	38.1	25.8	61.0	0	3.3	13.9	39.4	227	.5	Cleared
4-22	CMU 714040	1	4-22	N	38.1	10.3	38.1	14.4	74.9	90	2.2	16.3	36.7	202	.5	Cleared
4-24	CMU 714040	1	4-24	N	38.1	10.3	38.1	23.4	64.6	140	4.6	15.4	27.9	156	.5	Cleared
4-6	CMU 704050	1	4-6	N	38.1	10.3	38.1	26.2	54.6	0	3.6	18.5	18.5	93	.5	Cleared
4-7	CMU 704050	1	4-7	N	38.1	10.3	38.1	14.6	71.6	90	2.6	24.4	52.3	336	.5	Cleared
4-15	CMU 704050	1	4-15	N	38.1	10.3	38.1	24.1	60.0	145	5.3	21.4	17.0	134	.5	Cleared
4-8	CMU 714125	1	4-8	N	38.1	10.3	38.1	26.2	67.0	0	4.9	18.9	12.2	62.4	.5	Cleared
4-9	CMU 714125	1	4-9	N	38.1	10.3	38.1	14.9	69.7	90	4.6	24.8	20.1	120	.5	Cleared
4-14	CMU 714125	1	4-14	N	38.1	10.3	38.1	23.0	73.7	140	4.3	31.4	121	505	.5	Cleared
4-4	CMU 614150	1	4-4	N	38.1	10.3	38.1	26.0	68.7	0	4.5	29.6	58.9	383	.5	Cleared
4-5	CMU 614150	1	4-5	N	38.1	10.3	38.1	14.8	71.7	90	4.1	32.8	50.4	365	.5	Cleared
4-16	CMU 614150	1	4-16	N	38.1	10.3	38.1	24.3	71.6	150	6.5	31.4	57.3	378	.5	Cleared
4-11	CMU 614175	1	4-11	N	38.1	10.3	38.1	26.2	66.7	0	4.5	29.6	47.7	278	.5	Cleared
4-12	CMU 614175	1	4-12	N	38.1	10.3	38.1	14.7	69.9	90	4.5	25.0	27.4	103	.5	Cleared
4-13	CMU 614175	1	4-13	N	38.1	10.3	38.1	23.4	67.9	150	6.2	38.4	44.3	442	.5	Cleared
4-2	CMU 714200	1	4-2	N	38.1	10.3	38.1	26.1	66.6	0	6.2	29.4	104	265	.5	Cleared
4-3	CMU 714200	1	4-3	N	38.1	10.3	38.1	14.9	71.8	90	11.0	49.9	61.2	443	.5	Cleared
4-10	CMU 714200	1	4-10	N	38.1	10.3	38.1	23.3	33.7	150	8.2	38.2	43.9	409	.5	Cleared

Table 2-ii Test Results, Test Series 1 & 2 - Indoor

Test #	Fuse Cat. #	Test Series	Sample #	Silencer	Vapp kV	Ipros kA	Vrec kV	Ipk kA	Varc kV	Closing Angle	Melt Time msec.	Clear Time msec.	MW	Kj	Vrec Held sec.	Result
6-16	CMU 704006	1	6-16	Y	38.1	8.74	38.1	22.0	59.2	0	.95	13.4	39.3	129	120	Cleared
6-17	CMU 704006	1	6-17	Y	38.1	8.74	38.1	12.8	70.4	90	.4	16.8	29.2	164	120	Cleared
6-18	CMU 704006	1	6-18	Y	38.1	8.74	38.1	20.3	64.0	145	1.0	15.4	38.5	222	120	Cleared
6-19	CMU 714040	1	6-19	Y	38.1	8.74	38.1	22.1	57.1	0	3.3	13.8	30.0	176	120	Cleared
6-20	CMU 714040	1	6-20	Y	38.1	8.74	38.1	12.5	69.9	90	2.2	16.4	24.3	133	120	Cleared
6-21	CMU 714040	1	6-21	Y	38.1	8.74	38.1	20.4	60.5	145	5.2	15.8	22.8	129	120	Cleared
6-12	CMU 704050	1	6-12	Y	38.1	8.74	38.1	22.1	53.4	0	3.6	18.8	9.24	55	120	Cleared
6-13	CMU 704050	1	6-13	Y	38.1	8.74	38.1	13.0	67.5	90	2.5	40.8	34.3	252	120	Cleared
6-14	CMU 704050	1	6-14	Y	38.1	8.74	38.1	20.5	57.0	145	5.3	31.2	70.8	445	120	Cleared
6-11	CMU 714125	1	6-11	Y	38.1	8.74	38.1	22.4	54.3	0	5.0	18.8	9.3	55	120	Cleared
6-10	CMU 714125	1	6-10	Y	38.1	8.74	38.1	13.0	67.6	90	7.7	40.8	34.3	252	120	Cleared
6-15	CMU 714125	1	6-15	Y	38.1	8.74	38.1	20.6	69.5	145	6.4	31.2	70.8	445	120	Cleared
6-5	CMU 614150	1	6-5	Y	38.1	8.74	38.1	22.4	65.5	0	4.6	29.4	45.8	300	120	Cleared
6-6	CMU 614150	1	6-6	Y	38.1	8.74	38.1	12.8	67.6	90	4.0	33.4	24.5	169	120	Cleared
6-7	CMU 614150	1	6-7	Y	38.1	8.74	38.1	20.1	67.3	145	6.4	31.6	42.7	279	120	Cleared
6-2	CMU 614175	1	6-2	Y	38.1	8.74	38.1	22.3	64.1	0	4.8	29.6	38.5	279	120	Cleared
6-4	CMU 614175	1	6-4	Y	38.1	8.74	38.1	12.7	67.8	90	4.4	41.8	51.6	398	120	Cleared
6-8	CMU 614175	1	6-8	Y	38.1	8.74	38.1	20.1	62.9	145	6.4	38.2	36.9	331	120	Cleared
5-4	CMU 714200	1	5-4	Y	38.1	8.74	38.1	22.3	61.7	0	4.8	35.6	30.8	319	120	Cleared
5-5	CMU 714200	1	5-5	Y	38.1	8.74	38.1	12.6	70.9	90	4.4	57.8	110	437	120	Cleared
6-1	CMU 714200	1	6-1	Y	38.1	8.74	38.1	20.6	62.7	145	6.4	31.5	20.7	143	120	Cleared

Table 2-iii Test Results, Test Series 3 - Dropout

Test #	Fuse Cat. #	Test Series	Sample #	Silencer	Vapp kV	Ipros kA	Vrec kV	Ipk kA	Varc kV	Closing Angle	Melt Time msec.	Clear Time msec.	MW	Kj	Vrec Held sec.	Result
8-19	CMU 704006	3	8-19	N	38.1	6.39	38.1	16.2	57.4	0	1.1	14.0	18.3	78	.5	Cleared
8-20	CMU 704006	3	8-20	N	38.1	6.39	38.1	9.37	74.1	90	.5	16.4	22.9	125	.5	Cleared
8-21	CMU 704006	3	8-21	N	38.1	6.39	38.1	15.0	63.0	145	1.3	15.3	22.9	125	.5	Cleared
8-16	CMU 714040	3	8-16	N	38.1	6.39	38.1	16.2	55.4	0	3.9	14.0	11.3	62	67	Cleared
8-17	CMU 714040	3	8-17	N	38.1	6.39	38.1	9.37	72.4	90	3.4	16.6	12.0	62	84	Cleared
8-18	CMU 714040	3	8-18	N	38.1	6.39	38.1	15.2	60.4	145	9.7	15.6	11.3	59	67	Cleared
8-1	CMU 704050	3	8-1	N	38.1	6.39	38.1	16.2	73.5	0	4.6	29.6	48.1	57	.5	Cleared
8-2	CMU 704050	3	8-2	N	38.1	6.39	38.1	9.39	71.4	90	3.8	24.8	19.9	131	.5	Cleared
8-3	CMU 704050	3	8-3	N	38.1	6.39	38.1	15.1	75.0	145	6.6	31.0	43.9	113	.5	Cleared
8-4	CMU 714125	3	8-4	N	38.1	6.39	38.1	16.3	71.1	0	5.9	29.8	39.9	259	.5	Cleared
8-5	CMU 714125	3	8-5	N	38.1	6.39	38.1	9.49	71.5	90	11.4	41.4	17.7	120	.5	Cleared
8-6	CMU 714125	3	8-6	N	38.1	6.39	38.1	15.2	71.3	150	7.1	31.2	30.5	115	.5	Cleared
8-7	CMU 614150	3	8-7	N	38.1	6.39	38.1	16.3	69.3	0	5.9	30.5	31.1	198	.5	Cleared
8-8	CMU 614150	3	8-8	N	38.1	6.39	38.1	9.54	72.3	90	10.6	41.4	22.1	133	.5	Cleared
8-9	CMU 614150	3	8-9	N	38.1	6.39	38.1	15.2	70.2	145	7.6	31.6	26.9	175	.5	Cleared
8-10	CMU 614175	3	8-10	N	38.1	6.39	38.1	16.3	67.2	0	6.0	30.2	19.7	136	.5	Cleared
8-11	CMU 614175	3	8-11	N	38.1	6.39	38.1	9.68	72.0	90	11.0	41.6	12.0	90	.5	Cleared
8-12	CMU 614175	3	8-12	N	38.1	6.39	38.1	15.1	69.0	145	7.7	31.6	17.7	107	.5	Cleared
8-13	CMU 714200	3	8-13	N	38.1	6.39	38.1	16.3	68.4	0	7.6	53.0	22.3	207	.5	Cleared
8-14	CMU 714200	3	8-14	N	38.1	6.39	38.1	9.6	73.6	90	26.1	50.2	38.5	324	.5	Cleared
8-15	CMU 714200	3	8-15	N	38.1	6.39	38.1	15.1	70.0	145	10.2	47.8	11.8	146	.5	Cleared

Table 2-iv Test Results, Test Series 3 - Indoor

Test #	Fuse Cat. #	Test Series	Sample #	Silencer	Vapp kV	Ipros kA	Vrec kV	Ipk kA	Varc kV	Closing Angle	Melt Time msec.	Clear Time msec.	MW	Kj	Vrec Held sec.	Result
9-21	CMU 704006	3	9-21	Y	38.1	5.81	38.1	14.7	58.0	0	1.1	13.8	15.2	84	120	Cleared
9-22	CMU 704006	3	9-22	Y	38.1	5.81	38.1	8.52	75.1	90	.6	16.7	15.3	87	120	Cleared
9-24	CMU 704006	3	9-24	Y	38.1	5.81	38.1	13.6	64.8	145	1.4	15.3	15.6	92	120	Cleared
9-18	CMU 714040	3	9-18	Y	38.1	5.81	38.1	14.8	57.3	0	4.0	14.3	11.6	62	120	Cleared
9-19	CMU 714040	3	9-19	Y	38.1	5.81	38.1	8.32	74.2	90	2.5	16.6	12.2	66	120	Cleared
9-20	CMU 714040	3	9-20	Y	38.1	5.81	38.1	13.6	63.1	145	5.7	20.8	8.6	73	120	Cleared
9-15	CMU 704050	3	9-15	Y	38.1	5.81	38.1	14.8	76.5	0	4.7	29.4	72.0	31	120	Cleared
9-16	CMU 704050	3	9-16	Y	38.1	5.81	38.1	8.59	74.2	90	4.0	49.2	76.1	27	120	Cleared
9-17	CMU 704050	3	9-17	Y	38.1	5.81	38.1	13.6	63.6	145	6.2	31.4	72.6	24	120	Cleared
9-9	CMU 714125	3	9-9	Y	38.1	5.81	38.1	14.8	72.0	0	6.0	30.1	22.3	140	120	Cleared
9-10	CMU 714125	3	9-10	Y	38.1	5.81	38.1	8.67	76.1	90	11.6	49.3	20.9	153	120	Cleared
9-11	CMU 714125	3	9-11	Y	38.1	5.81	38.1	13.8	72.6	145	7.8	38.0	15.5	129	120	Cleared
1-1	CMU 614150	3	1-1	Y	38.1	5.81	38.1	14.9	69.0	0	5.8	30.1	22.3	140	600	Cleared
1-2	CMU 614150	3	1-2	Y	38.1	5.81	38.1	8.55	73.2	90	10.6	49.3	20.9	153	600	Cleared
1-3	CMU 614150	3	1-3	Y	38.1	5.81	38.1	13.9	67.6	145	7.3	38.0	15.5	129	600	Cleared
9-4	CMU 614175	3	9-4	Y	38.1	5.81	38.1	14.9	67.2	0	6.1	36.0	17.7	179	120	Cleared
9-5	CMU 614175	3	9-5	Y	38.1	5.81	38.1	8.69	75.2	90	11.4	57.8	35.7	311	120	Cleared
9-6	CMU 614175	3	9-6	Y	38.1	5.81	38.1	13.8	76.7	145	5.2	47.4	35.3	301	120	Cleared
9-1	CMU 714200	3	9-1	Y	38.1	5.81	38.1	14.9	70.8	0	7.6	46.0	10.7	149	120	Cleared
9-2	CMU 714200	3	9-2	Y	38.1	5.81	38.1	8.69	75.8	90	24.7	91.4	37.1	293	120	Cleared
9-3	CMU 714200	3	9-3	Y	38.1	5.81	38.1	13.8	74.5	145	10.0	71.4	34.5	342	120	Cleared

Table 2-v Test Results, Test Series 4, 5 & 6

Test #	Fuse Cat. #	Test Series	Sample #	Silencer	Vapp kV	Ipros kA	Vrec kV	Ipk kA	Varc kV	Closing Angle	Melt Time msec.	Clear Time msec.	MW	Kj	Vrec Held sec.	Result
10-1	CMU 704006	4	10-1	N	38.1	2.29	38.1	3.38	73.9	90	1.0	25.0	7.5	49	.5	Cleared
10-7	CMU 704006	4	10-7	Y	38.1	2.29	38.1	3.42	74.9	90	1.1	24.4	7.6	52	120	Cleared
10-2	CMU 714040	4	10-2	N	38.1	2.29	38.1	3.37	74.2	90	13.0	32.9	5.7	35	.5	Cleared
10-10	CMU 714040	4	10-10	Y	38.1	2.29	38.1	3.39	74.3	90	12.4	33.0	4.3	28	120	Cleared
10-3	CMU 704050	4	10-3	N	38.1	2.29	38.1	3.41	74.6	90	19.6	41.0	7.7	52	.5	Cleared
10-9	CMU 704050	4	10-9	Y	38.1	2.29	38.1	3.39	74.4	90	19.4	41.0	6.3	46	120	Cleared
10-4	CMU 714125	4	10-4	N	38.1	2.29	38.1	3.37	73.8	90	55.6	176	6.6	35	.5	Cleared
10-11	CMU 714125	4	10-11	Y	38.1	2.29	38.1	3.42	72.5	90	56.0	174	8.5	64	120	Cleared
10-15	CMU 614150	4	10-15	N	38.1	2.29	38.1	3.35	72.9	90	46.4	158	8.8	66	.5	Cleared
10-16	CMU 614150	4	10-16	Y	38.1	2.29	38.1	3.44	67.0	90	46.6	159	8.5	72	120	Cleared
10-5	CMU 614175	4	10-5	N	38.1	2.29	38.1	3.42	72.5	90	54.0	192	11.2	123	.5	Cleared
10-12	CMU 614175	4	10-12	Y	38.1	2.29	38.1	3.39	71.7	90	53.6	183	11.1	115	120	Cleared
10-6	CMU 714200	4	10-6	N	38.1	2.29	38.1	3.42	75.4	90	144	409.2	11.7	120	.5	Cleared
10-13	CMU 714200	4	10-13	Y	38.1	2.29	38.1	3.41	70.1	90	141	408.3	8.6	89	120	Cleared
7-5	CMU 704006	5	7-5	N	38.7	.419	38.7	.644		90		49.4	3.0	21	.05	Cleared
7-8	CMU 704006	5	7-8	N	38.7	.419	38.7	.655		90		49.1	3.2	25	.5	Cleared
7-9	CMU 704006	5	7-9	Y	38.7	.419	38.7	.659		90		49.1	3.1	52	120	Cleared
7-10	CMU 704006	5	7-10	Y	38.7	.419	38.7	.668		90		49.3	3.1	24	120	Cleared
11-3	CMU 704006	6	11-3	N	38.1	.0197	38.1			90		2330	.1	7	.5	Cleared
11-4	CMU 704006	6	11-4	N	27.3	.0197	27.3			90		2240	.8	12	.5	Cleared
11-6	CMU 704006	6	11-6	Y	27.3	.0197	27.3			90		2170	.8	6	120	Cleared
11-7	CMU 704006	6	11-7	Y	27.2	.0197	27.2			90		2880	.01	5	120	Cleared

Conclusions

The above is a true and correct summary of data obtained from tests performed by:

Powertech High Power Laboratory in Surrey, British Columbia, Canada from April 3 to 7, 2000, and November 14 & 22, 2000. The tests demonstrate the capability of Cooper Power Systems type CMU Power Fuses to safely interrupt circuits when applied within their assigned ratings.

The fuses tested during this test sequence met the requirements of the referenced standards.

COOPER Power Systems

Quality from
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