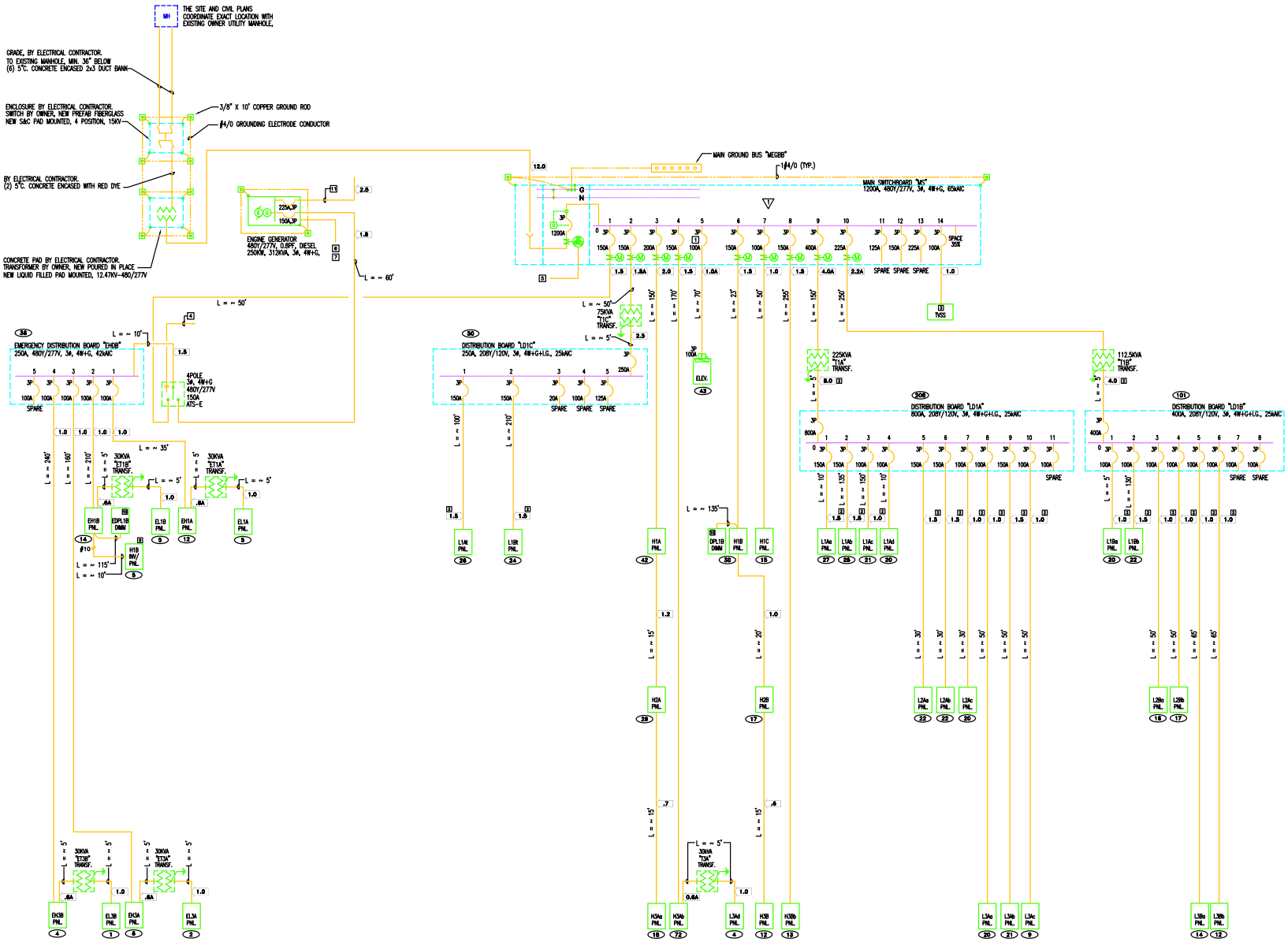
APPENDIX E

Electrical System Single Line Diagram

Overcurrent Protection Study

Overcurrent Protection Device Specifications



UCSB Student Resource Building

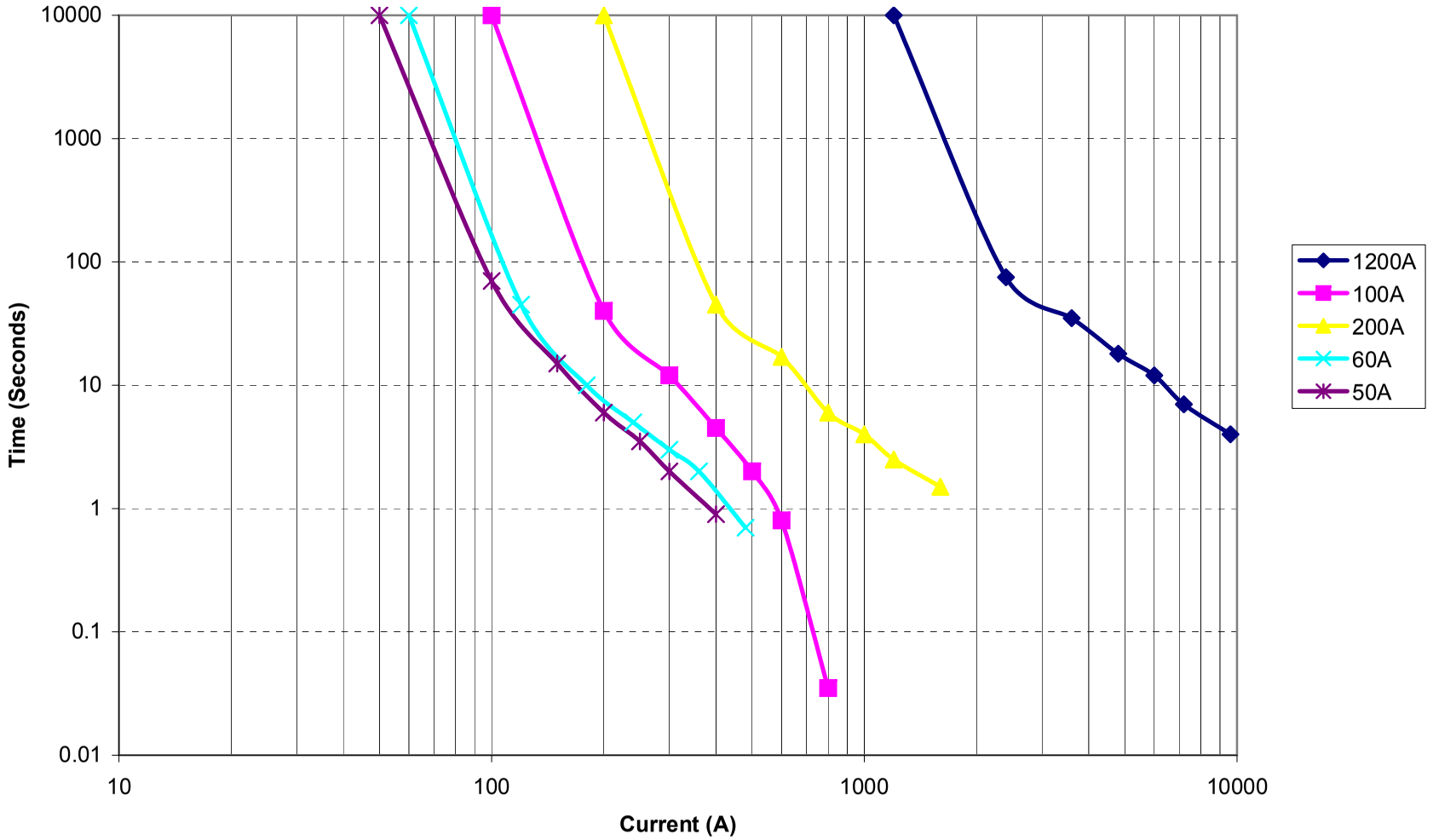
Single Line Diagram
Scale: NTS

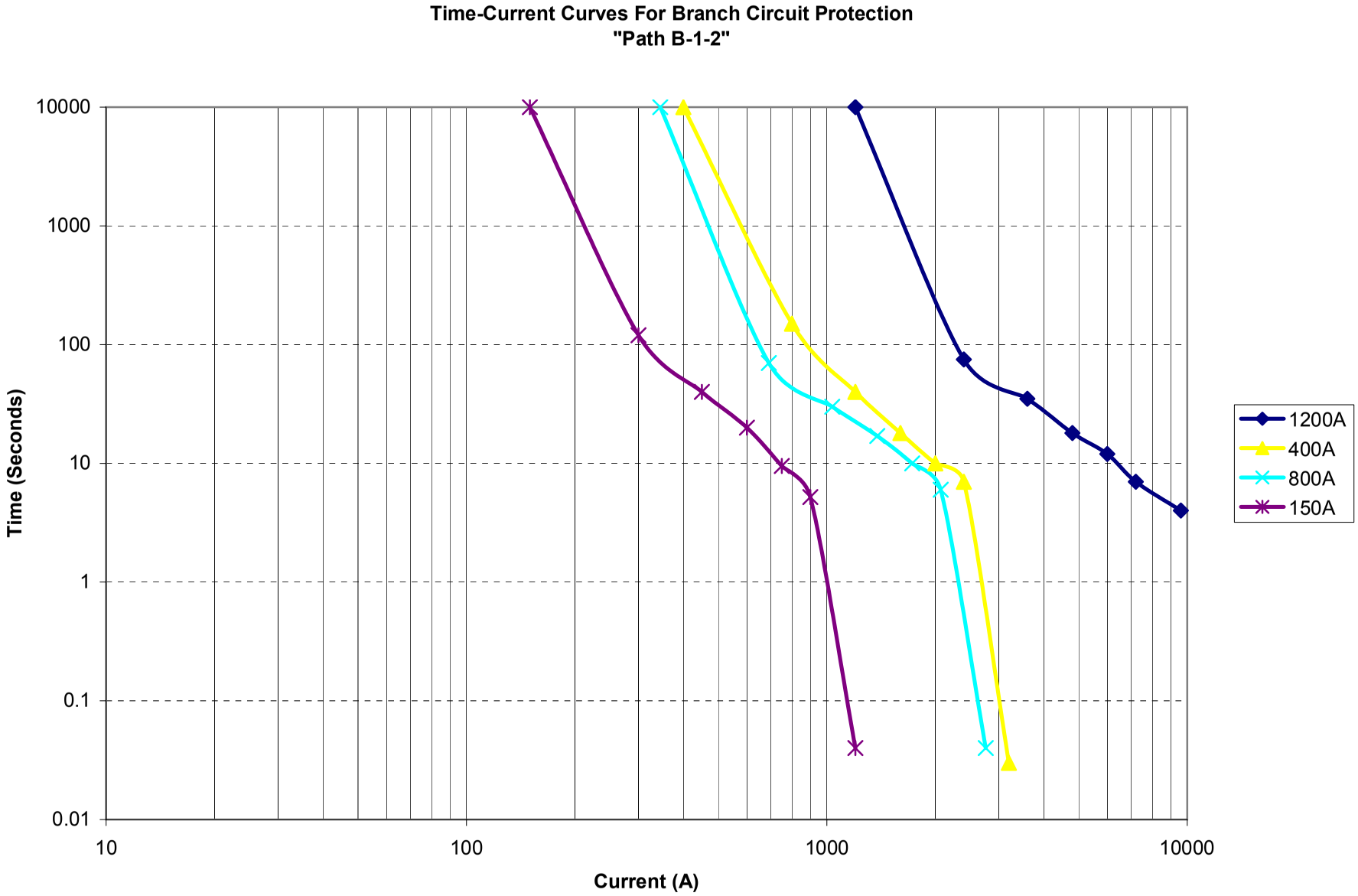
Overcurrent Protection and Coordination

	Main Switchboard (MS)		Panel H3Aa		Panel H2A		Panel H1A		Feeder to H1A	
Breaker Rating (A)	**1200**		**50**		**60**		**100**		**200**	
% of Rated Current	**Actual Current (A)**	**Time(s)**	**Actual Current (A)**	**Time(s)**	**Actual Current (A)**	**Time(s)**	**Actual Current (A)**	**Time(s)**	**Actual Current (A)**	**Time(s)**
100	1200	10000	50	10000	60	10000	100	10000	200	10000
200	2400	75	100	70	120	45	200	40	400	45
300	3600	35	150	15	180	10	300	12	600	17
400	4800	18	200	6	240	5	400	4.5	800	6
500	6000	12	250	3.5	300	3	500	2	1000	4
600	7200	7	300	2	360	2	600	0.8	1200	2.5
800	9600	4	400	0.9	480	0.7	800	0.035	1600	1.5

	Transformer T1A (primary)		Transformer T1A (secondary)		Feeder to Panel L1Aa	
Breaker Rating (A)	**400**		**800**		**150**	
% of Rated Current	Actual Current (A)	Time(s)	Actual Current (A)	Time(s)	Actual Current (A)	Time(s)
100	400	10000	345	10000	150	10000
200	800	150	690	70	300	120
300	1200	40	1035	30	450	40
400	1600	18	1380	17	600	20
500	2000	10	1725	10	750	9.5
600	2400	7	2070	6	900	5.2
800	3200	0.03	2760	0.04	1200	0.04

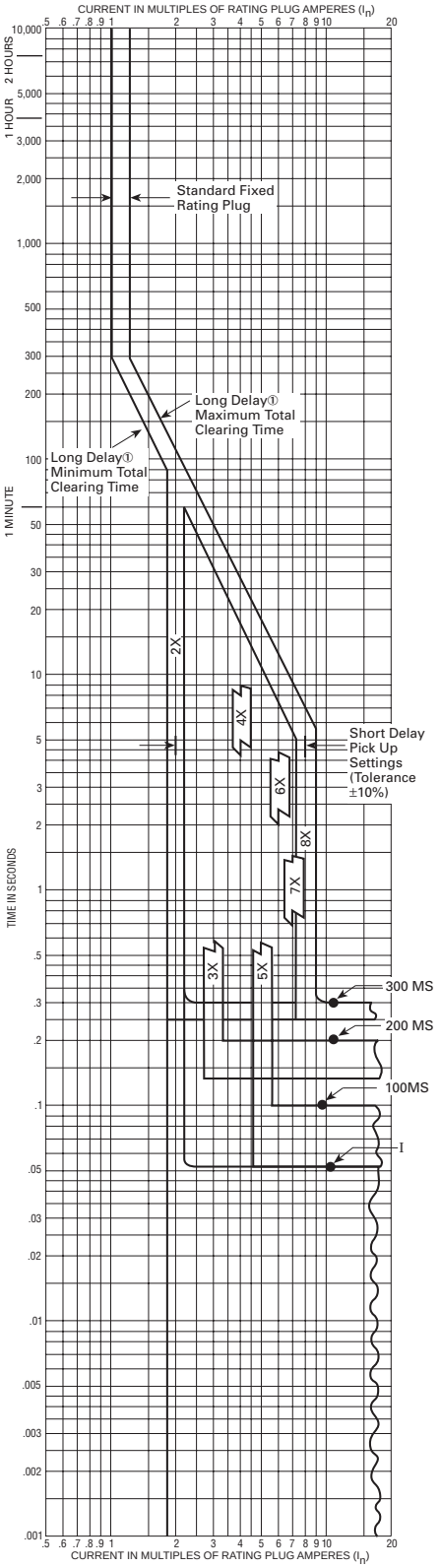
Time-Current Curves For Branch Circuit Protection
"Path B-C-D-E"




Time-Current Curves For Branch Circuit Protection
"Path B-1-2"
Time (Seconds)
10000
1000
100
10
1
0.1
0.01
10
100
1000
10000
Current (A)
1200A
400A
800A
150A

AB DE-ION Circuit Breakers

Types ND, CND, HND, CHND, NDC, CNDC Equipped With Type NES Digitrip RMS 310 Trip Units With Adjustable Short Time Delay (Phase Protection)



Circuit Breaker Time/Current Curves (Phase Current)
Series C® N-Frame Circuit Breakers
Equipped With Type NES Digitrip RMS 310 Trip Units

The NES Digitrip RMS 310 Trip Units are AC only devices that employ microprocessor based technology that provides true RMS current sensing means for proper correlation with thermal characteristics of conductors and equipment. They are used with Circuit Breaker Types ND, CND, HND, CHND, NDC, and CNDC.

Adjustable Short Time Delay **Typical Trip Unit Nameplate**

Available Rating Plugs

Frame Rating Amperes (Max.)	Ampere Rating (I_n)	Type	Catalog Number	Short Delay Pickup Range Amperes
800	800	Fixed	8NES800T	1600-6400
	700	Fixed	8NES700T	1400-5600
	630	Fixed	8NES630T④	1260-5040
	600	Fixed	8NES600T	1200-4800
	550	Fixed	8NES550T	1100-4400
	500	Fixed	8NES500T	1000-4000
	450	Fixed	8NES450T	900-3600
	400	Fixed	8NES400T	800-3200
	400, 500, 600, 800	Adj.	A8NES800T1	800-6400
	400, 500, 630, 800	Adj.	A8NES800T2④	800-6400
1200	1200	Fixed	12NES1200T	2400-9600
	1000	Fixed	12NES1000T	2000-8000
	900	Fixed	12NES900T④	1800-7200
	800	Fixed	12NES800T	1600-6400
	700	Fixed	12NES700T	1400-5600
	630	Fixed	12NES630T④	1260-5040
	600	Fixed	12NES600T	1200-4800
	600, 800, 1000, 1200	Adj.	A12NES1200T1	1200-9600

Interrupting Ratings – 50/60 Hz
RMS Sym. Amperes (kA)

Breaker Type	UL/CSA 240V	UL/CSA 480V	UL/CSA 600V	IEC 947-2 220-240V	IEC 947-2 380-415V
ND, CND	65	50	25	65	50
HND, CHND	100	65	35	100	65
NDC, CNDC	200	100	50	200	100

I_{CS} = .25 I_{CU}
I_{CW} = 15 kA @ .5S
U_{imp} = 8kV

Notes

Curve accuracy applies from -20°C to +55°C ambient. For possible ampere derating for ambient above 40°C, refer to Cutler-Hammer.

Digitrip RMS 300 trip units are suitable for functional field testing with test kit Cat. No. STK2. For field testing using primary injection methods, follow NEMA publication AB-4-1991.

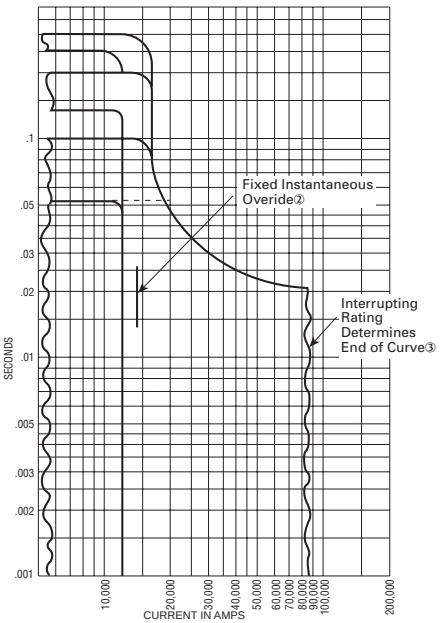
For ground fault time-current curves see SC-5377-92A.

① There is a memory effect that can act to shorten the long delay. The memory effect comes into play if a current above the long delay pick up value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately five minutes is required between overloads to completely reset the memory.

② For high fault current levels a fixed instantaneous override is provided at 14000A (Tolerance ±15%).

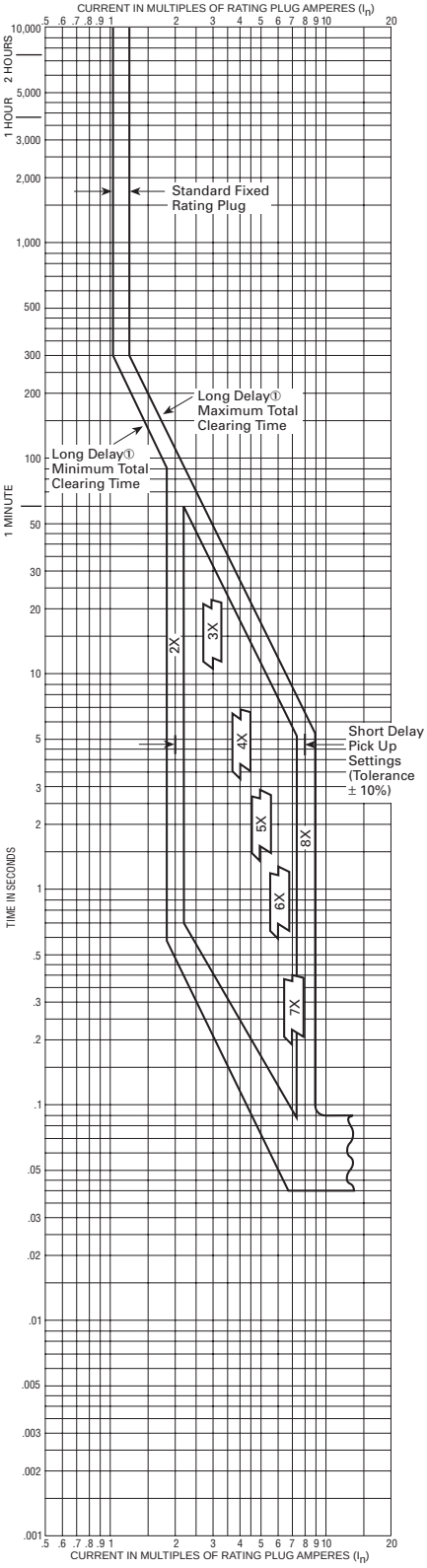
③ The end of the curve is determined by the interrupting rating of the circuit breaker. See above tabulation.

④ Not UL/CSA Listed.



AB DE-ION Circuit Breakers

Types ND, CND, HND, CHND, NDC, CNDC Equipped With Type NES Digitrip RMS 310 Trip Units With I²t Ramp Short Time Delay (Phase Protection)

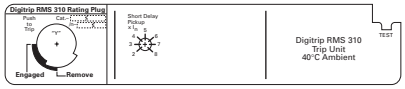


Circuit Breaker Time/Current Curves (Phase Current)
Series C® N-Frame Circuit Breakers
Equipped With Type NES Digitrip RMS 310 Trip Units

The NES Digitrip RMS 310 Trip Units are AC only devices that employ microprocessor based technology that provides true RMS current sensing means for proper correlation with thermal characteristics of conductors and equipment. They are used with Circuit Breaker Types ND, CND, HND, CHND, NDC, and CNDC.

I²t Ramp Short Time Delay

Typical Trip Unit Nameplate



Frame Rating Amperes (Max.)	Available Rating Plugs Ampere Rating (I_n)	Type	Catalog Number	Short Delay Pickup Range Amperes
800	800	Fixed	8NES800T	1600-6400
	700	Fixed	8NES700T	1400-5600
	630	Fixed	8NES630T④	1260-5040
	600	Fixed	8NES600T	1200-4800
	550	Fixed	8NES550T	1100-4400
	500	Fixed	8NES500T	1000-4000
	450	Fixed	8NES450T	900-3600
	400	Fixed	8NES400T	800-3200
	400, 500, 600, 800	Adj.	A8NES800T1	800-6400
	400, 500, 630, 800	Adj.	A8NES800T2④	800-6400
1200	1200	Fixed	12NES1200T	2400-9600
	1000	Fixed	12NES1000T	2000-8000
	900	Fixed	12NES900T④	1800-7200
	800	Fixed	12NES800T	1600-6400
	700	Fixed	12NES700T	1400-5600
	630	Fixed	12NES630T④	1260-5040
	600	Fixed	12NES600T	1200-4800
	600, 800, 1000, 1200	Adj.	A12NES1200T1	1200-9600

Interrupting Ratings – 50/60 Hz
RMS Sym. Amperes (kA)

Breaker Type	UL/CSA 240V	UL/CSA 480V	UL/CSA 600V	IEC 947-2 220-240V	IEC 947-2 380-415V
ND, CND	65	50	25	65	50
HND, CHND	100	65	35	100	65
NDC, CNDC	200	100	50	200	100

I_{CS} = .25 I_{CU}
I_{CW} = 15 kA @ .5S
U_{imp} = 8kV

Notes

Curve accuracy applies from -20°C to +55°C ambient. For possible ampere derating for ambient above 40°C, refer to Cutler-Hammer.

Digitrip RMS 300 trip units are suitable for functional field testing with test kit Cat. No. STK2. For field testing using primary injection methods, follow NEMA publication AB-4-1991.

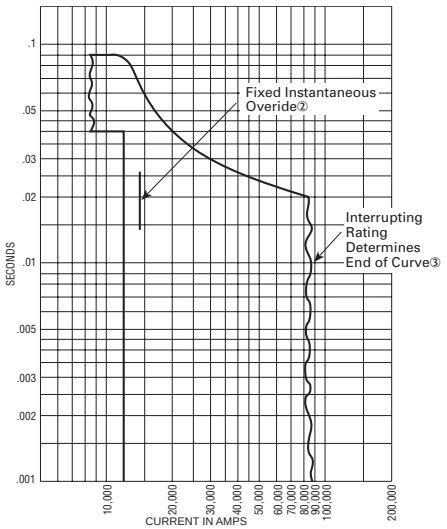
For ground fault time-current curves see SC-5377-92A.

① There is a memory effect that can act to shorten the long delay. The memory effect comes into play if a current above the long delay pick up value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately five minutes is required between overloads to completely reset the memory.

② For high fault current levels a fixed instantaneous override is provided at 14000A (Tolerance ±15%).

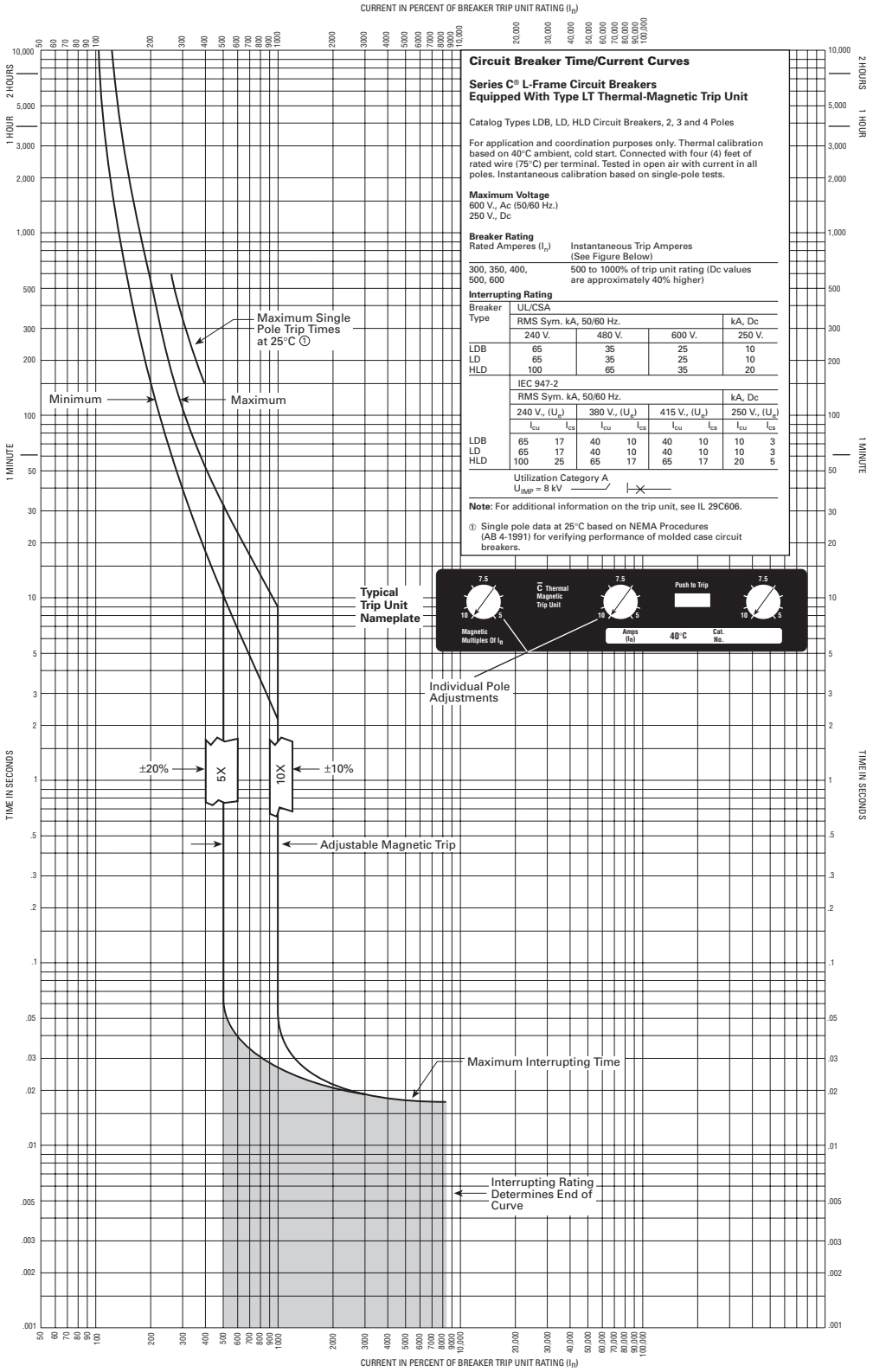
③ The end of the curve is determined by the interrupting rating of the circuit breaker. See above tabulation.

④ Not UL/CSA Listed.



AB DE-ION Circuit Breakers

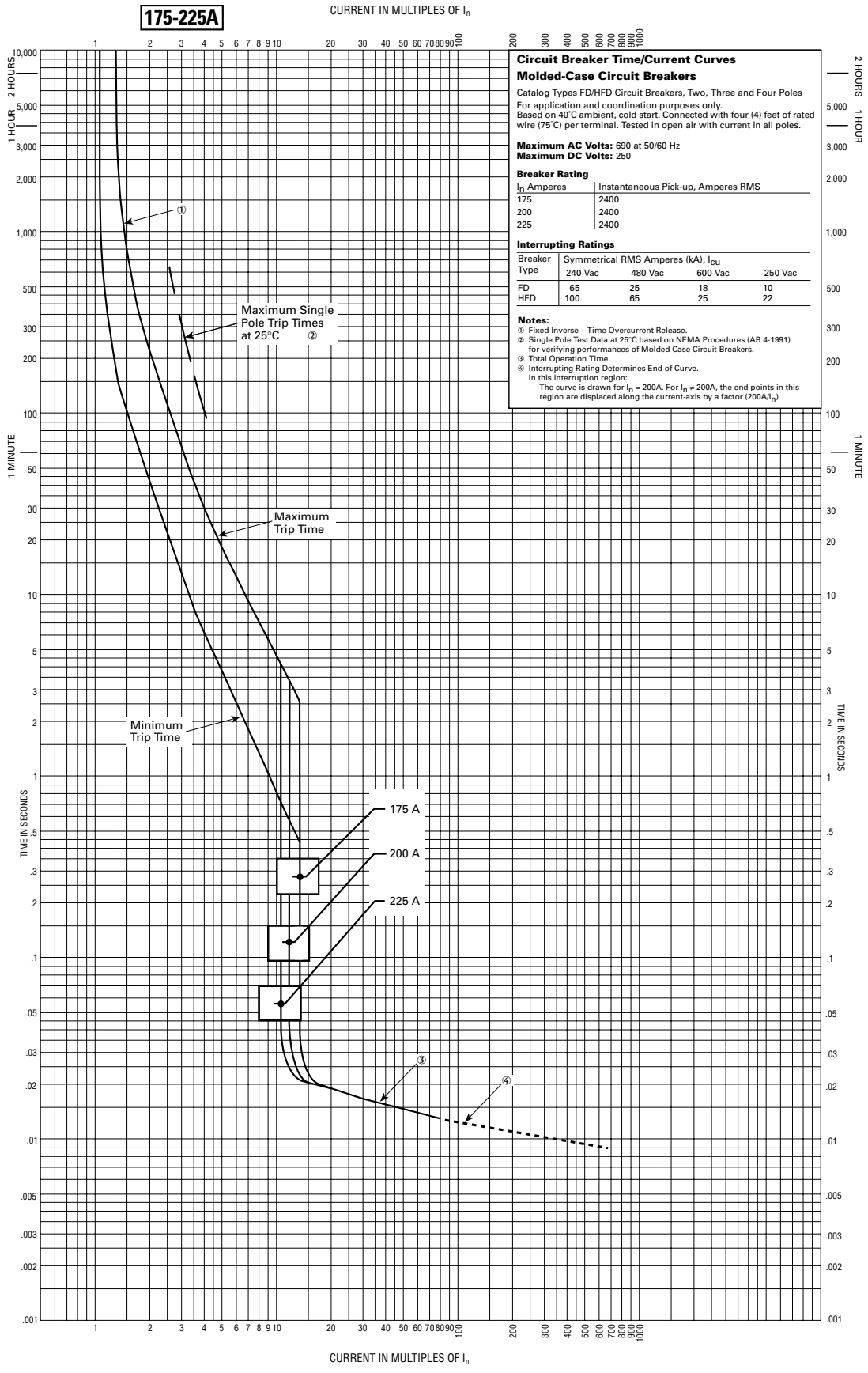
Types LDB, LD, HLD Equipped With Type LT Thermal-Magnetic Trip Unit



Curve No. SC-4547-89B

October 1997

175-225A



Circuit Breaker Time/Current Curves

Molded-Case Circuit Breakers

Catalog Types FD/HFD Circuit Breakers, Two, Three and Four Poles

For application and coordination purposes only.
Based on 40˚C ambient, cold start. Connected with four (4) feet of rated wire (75˚C) per terminal. Tested in open air with current in all poles.

Maximum AC Volts: 690 at 50/60 Hz
Maximum DC Volts: 250

Breaker Rating

I_n Amperes	Instantaneous Pick-up, Amperes RMS
175	2400
200	2400
225	2400

Interrupting Ratings

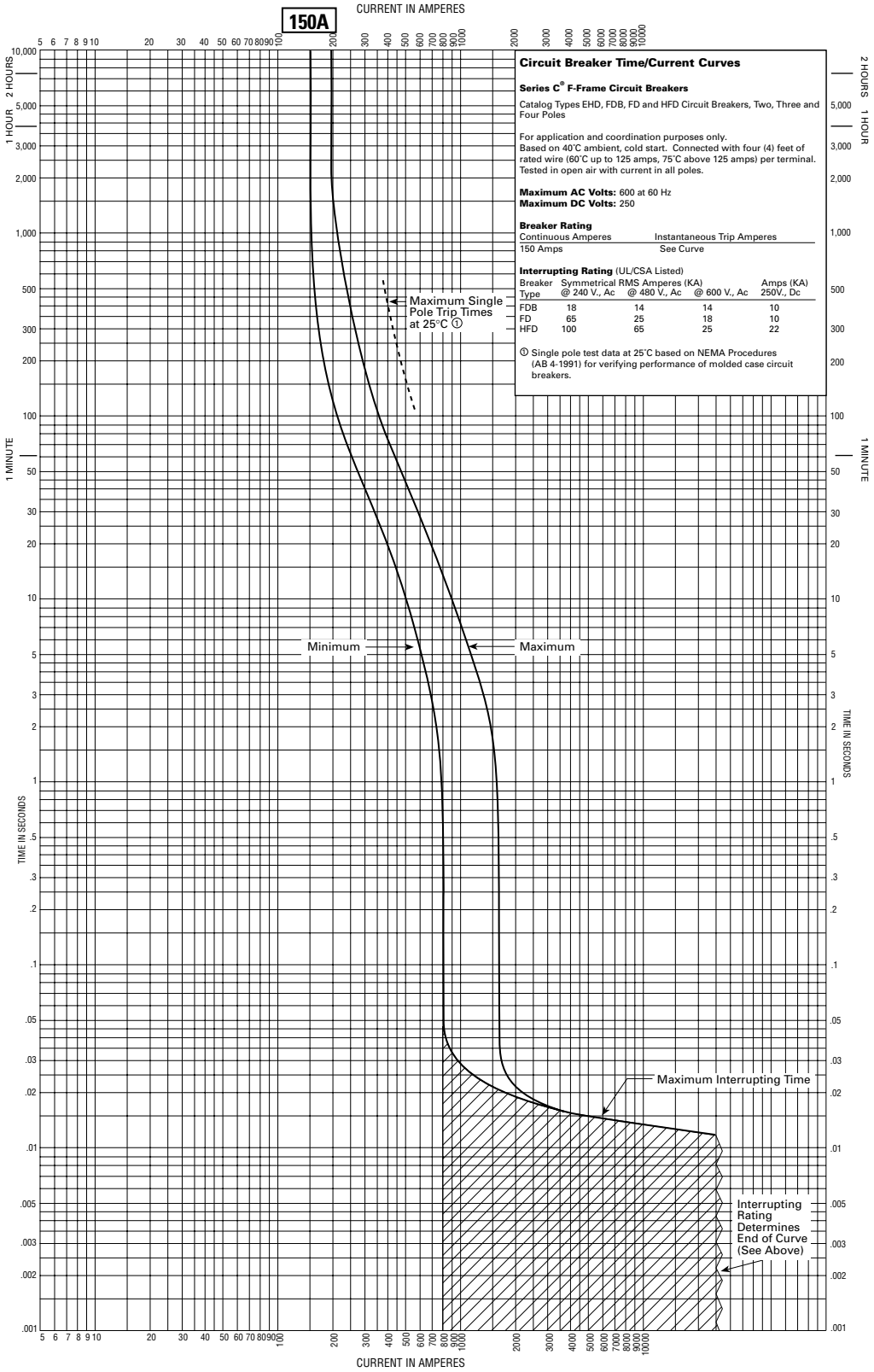
Breaker Type	Symmetrical RMS Amperes (kA), I_{cu}			
	240 Vac	480 Vac	600 Vac	250 Vac
FD	65	25	18	10
HFD	100	65	25	22

Notes:
① Fixed Inverse – Time Overcurrent Release.
② Single Pole Test Data at 25˚C based on NEMA Procedures (AB 4-1991) for verifying performances of Molded Case Circuit Breakers.
③ Total Operation Time.
④ Interrupting Rating Determines End of Curve.
In this interruption region:
The curve is drawn for I_n = 200A. For $I_n \neq$ 200A, the end points in this region are displaced along the current-axis by a factor (200A/I_n)

Curve No. SC-6970-98A

AB DE-ION Circuit Breakers

Types FDB, FD and HFD 150 Amperes

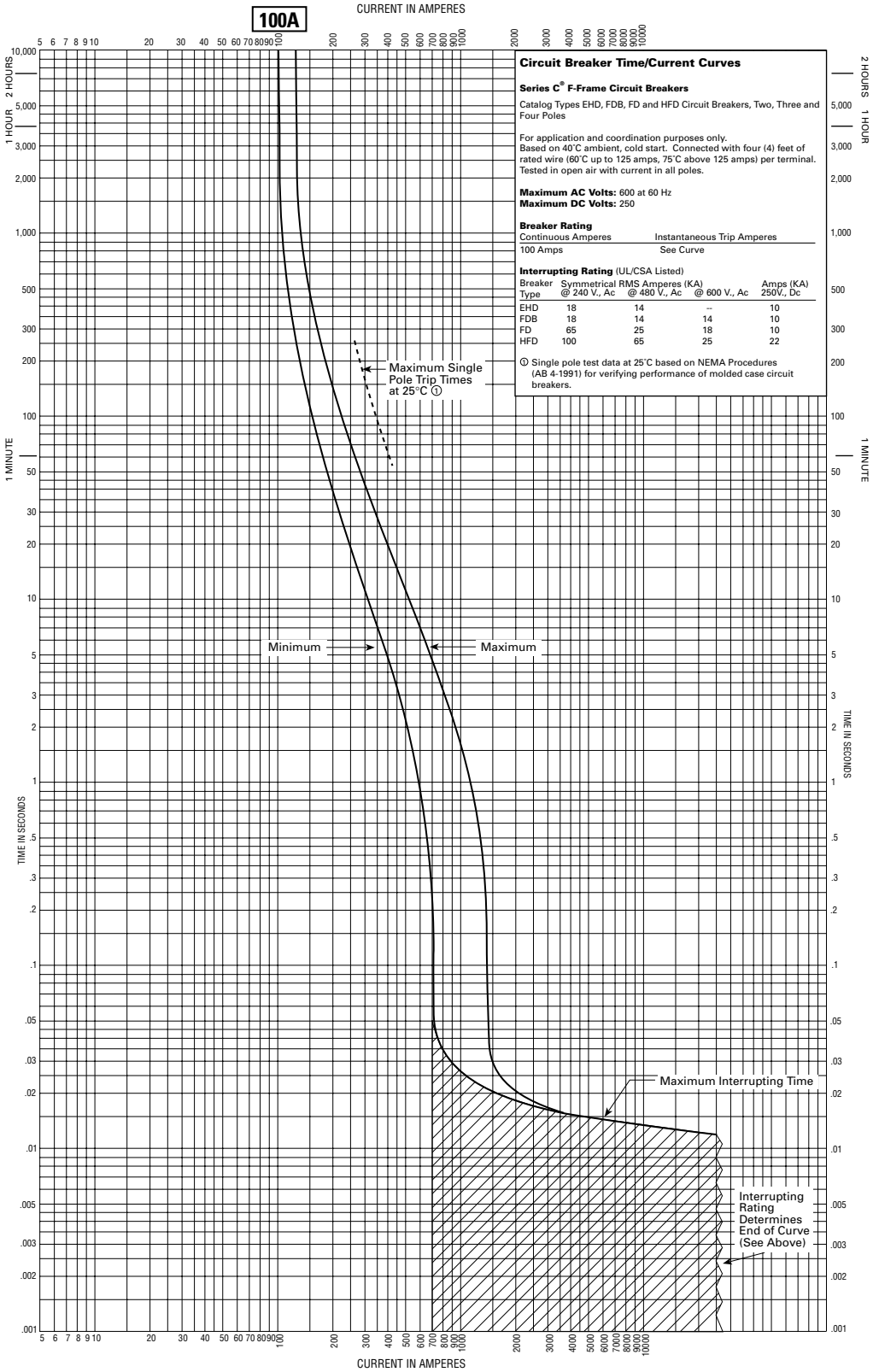


Curve No. SC-4149-87B

October 1997

AB DE-ION Circuit Breakers

Types EHD, FDB, FD and HFD 100 Amperes



Circuit Breaker Time/Current Curves

Series C® F-Frame Circuit Breakers

Catalog Types EHD, FDB, FD and HFD Circuit Breakers, Two, Three and Four Poles

For application and coordination purposes only.
Based on 40˚C ambient, cold start. Connected with four (4) feet of rated wire (60˚C up to 125 amps, 75˚C above 125 amps) per terminal. Tested in open air with current in all poles.

Maximum AC Volts: 600 at 60 Hz
Maximum DC Volts: 250

Breaker Rating

Continuous Amperes	Instantaneous Trip Amperes
100 Amps	See Curve

Interrupting Rating (UL/CSA Listed)

Breaker Type	Symmetrical RMS Amperes (KA) @ 240 V., Ac	@ 480 V., Ac	@ 600 V., Ac	Amps (KA) 250V., Dc
EHD	18	14	--	10
FDB	18	14	14	10
FD	65	25	18	10
HFD	100	65	25	22

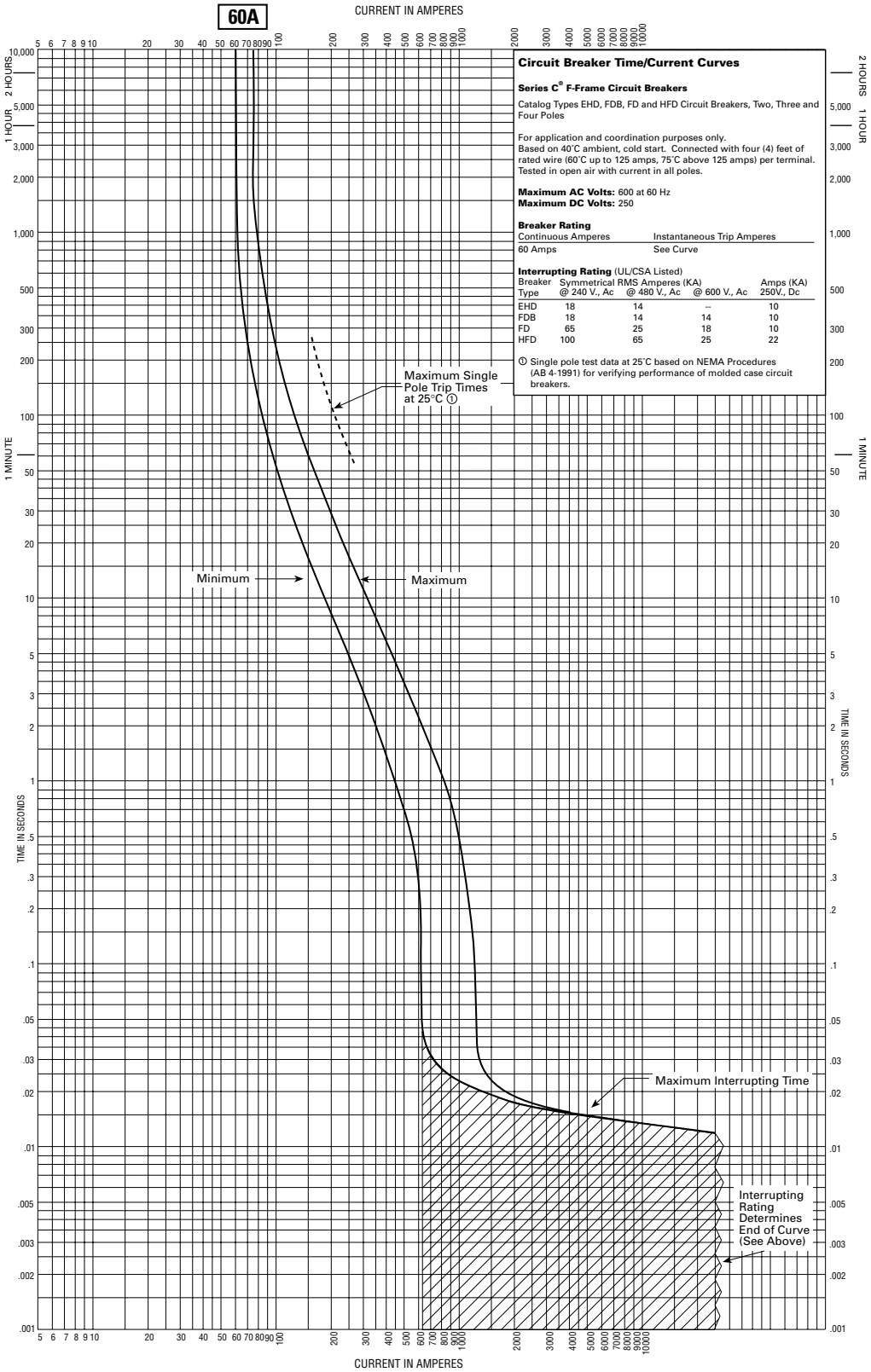
① Single pole test data at 25˚C based on NEMA Procedures (AB 4-1991) for verifying performance of molded case circuit breakers.

Curve No. SC-4146-87B

October 1997

AB DE-ION Circuit Breakers

Types EHD, FDB, FD and HFD 60 Amperes



Circuit Breaker Time/Current Curves

Series C® F-Frame Circuit Breakers

Catalog Types EHD, FDB, FD and HFD Circuit Breakers, Two, Three and Four Poles

For application and coordination purposes only.
Based on 40˚C ambient, cold start. Connected with four (4) feet of rated wire (60˚C up to 125 amps, 75˚C above 125 amps) per terminal. Tested in open air with current in all poles.

Maximum AC Volts: 600 at 60 Hz
Maximum DC Volts: 250

Breaker Rating

Continuous Amperes	Instantaneous Trip Amperes
60 Amps	See Curve

Interrupting Rating (UL/CSA Listed)

Breaker Type	Symmetrical RMS Amperes (KA) @ 240 V., Ac	@ 480 V., Ac	@ 600 V., Ac	Amps (KA) 250V., Dc
EHD	18	14	--	10
FDB	18	14	14	10
FD	65	25	18	10
HFD	100	65	25	22

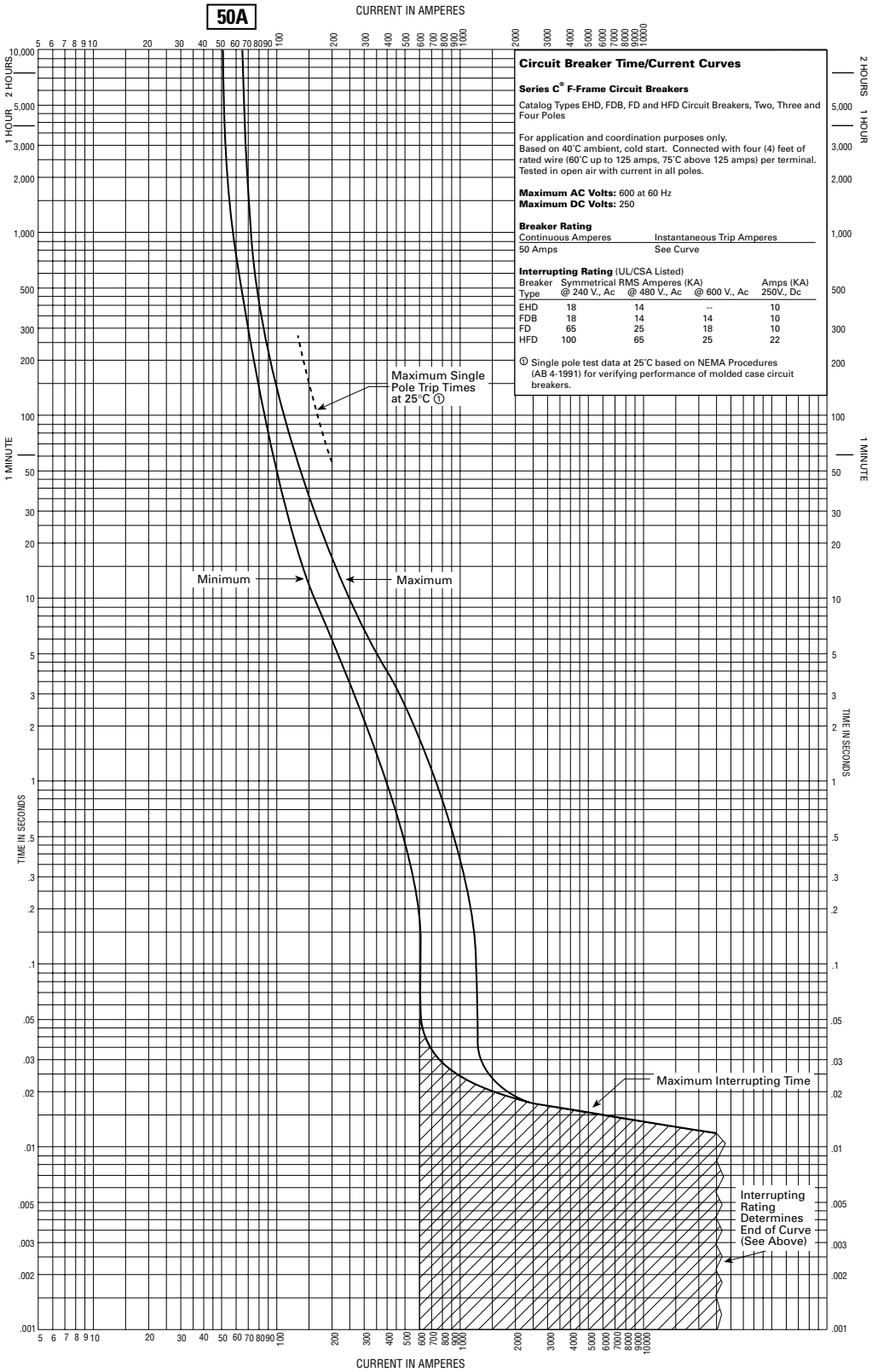
① Single pole test data at 25˚C based on NEMA Procedures (AB 4-1991) for verifying performance of molded case circuit breakers.

Curve No. SC-4142-87B

October 1997

AB DE-ION Circuit Breakers

Types EHD, FDB, FD and HFD 50 Amperes



Circuit Breaker Time/Current Curves

Series C® F-Frame Circuit Breakers

Catalog Types EHD, FDB, FD and HFD Circuit Breakers, Two, Three and Four Poles

For application and coordination purposes only.
Based on 40°C ambient, cold start. Connected with four (4) feet of rated wire (60°C up to 125 amps, 75°C above 125 amps) per terminal. Tested in open air with current in all poles.

Maximum AC Volts: 600 at 60 Hz
Maximum DC Volts: 250

Breaker Rating

Continuous Amperes	Instantaneous Trip Amperes
50 Amps	See Curve

Interrupting Rating (UL/CSA Listed)

Breaker Type	Symmetrical RMS Amperes (KA) @ 240 V., Ac	@ 480 V., Ac	@ 600 V., Ac	Amps (KA) 250V., Dc
EHD	18	14	--	10
FDB	18	14	14	10
FD	65	25	18	10
HFD	100	65	25	22

① Single pole test data at 25°C based on NEMA Procedures (AB 4-1991) for verifying performance of molded case circuit breakers.

Curve No. SC-4141-87B