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September 22, 1982

2CANØ982Ø3

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Supporting Information for Technical Specification Change Request

Gentlemen:

The enclosed information is to support our August 23, 1982 Technical Specification Change Request (2CANØ882Ø8) regarding Surveillance Requirement 4.8.2.5. This material consists of manufacturer's recommendations for testing of the devices used at ANO-2 for containment penetration overcurrent protection. This material is being supplied at the request of Mr. Jim Lazevnick of NRC's Power Systems Branch.

Guidelines for testing are being forwarded for Westinghouse and Gould I-T-E molded case circuit breakers and for I-T-E air circuit breakers. These are considered representative of the 480 volt and under circuit breakers in service at ANO-2 for containment penetration overcurrent protection and these recommendations will be used in developing our test procedure.

Very truly yours,

John R. Marshall

John R. Marshall
Manager, Licensing

JRM/JK/rd

Enclosure

A001

J. Dobbs

See Pg. 16 for field testing of breakers

Westinghouse Electric Corporation
Low Voltage Breaker Division
Beaver, Pennsylvania 15009

May, 1976
Supersedes AD 29-160, pages 1-16 dated January, 1971; pages 16.1-16.2 dated October, 1971; and pages 16.3-16.4 dated February, 1973.
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Standard, SELTRONIC®, MARK 75®, and TRI-PAC® Designs

AB De-ION® Circuit Breakers

Index

Standard, SELTRONIC and MARK 75 Circuit Breakers

General Circuit Breaker Information

AB DE-ION molded case circuit breakers are designed to provide circuit protection for low voltage distribution systems. They are described by NEMA as, "...... a device for closing and interrupting a circuit between separable contacts under both normal and abnormal conditions," and further as,"...... a breaker assembled as an integral unit in a supporting and enclosing housing of insulating material". The N.E.C. describes them as, "A device designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating."

So designed, AB DE-ION circuit breakers protect conductors against overloads and conductors and connected apparatus, such as motors and motor starters, against short circuits.

All Westinghouse molded case circuit breakers are built to meet the requirements of NEMA Standard AB-1-1975.

Circuit Breaker Components and Their Functions

Being essentially a high interrupting capacity switch with repetitive elements, AB DE-ION circuit breakers are comprised of three main functional components. These are: trip elements, operating mechanism and arc extinguishers.

Trip Elements

The function of the trip element is to trip the operating mechanism in the event of a prolonged overload or short circuit current. To accomplish this, a thermal-magnetic trip action is provided.

Standard Breakers

Thermal trip action is achieved through the use of a bimetal heated by the load current. On a sustained overload, the bimetal will deflect, causing the operating mechanism to trip. Because bimetals are responsive to the heat emitted by the current flow, they allow a long time delay on light overloads, yet they have a fast response on heavier overloads.

Magnetic trip action is achieved through the use of an electro magnet in series with the load current. This provides an instantaneous tripping action when the current reaches a predetermined value. Front adjustable magnetic trip elements are supplied as standard on 225 amp frame breaker and above (except CA & DA) and on the 100 and 150 amp magnetic only breakers, all other thermal magnetic breakers have non-adjustable magnetic trip elements.

SELTRONIC Breakers

Both the thermal type trip action and the magnetic trip of SELTRONIC breakers are achieved by the use of current transformers and solid state circuitry that monitors the current and initiates tripping through a flux transfer shunt trip when an overload or short circuit is present.

All multiple pole circuit breakers have trip elements in each pole and a common trip bar. An abnormal circuit condition in any one pole will cause all poles to open simultaneously.

Operating Mechanism

The function of the operating mechanism is to provide a means of opening and closing the breaker contacts. All mechanisms are of the quick-make, quick-break type and are "trip free." "Trip free" mechanisms are designed so that the contacts cannot be held closed against an abnormal circuit condition and are sometimes referred to as an "over center toggle mechanism". In addition to indicating whether the breaker is "on" or "off", the operating mechanism handle indicates when the breaker is "tripped" by moving to a position midway between the extremes. This distinct trip point is particularly advantageous where breakers are grouped, as in panelboard applications, because it clearly indicates the faulty circuit.

Arc Extinguishers

The function of the DE-ION arc extinguisher is to confine, divide and extinguish the arc drawn between opening breaker contacts. It consists of specially shaped steel grids isolated from each other and supported by an insulating housing. When the contacts are opened, the arc drawn induces a magnetic field in the grids, which in turn draws the arc from the contacts and into the grids. The arc is thus split into a series of smaller arcs and the heat generated is quickly dissipated through the metal. These two actions result in a rapid removal of ions from the arc, which hastens dielectric build-up between the contacts and results in rapid extinction of the arc.

Westinghouse Family of Molded Case Circuit Breakers

In secondary distribution systems, there ae many varied applications of molded case circuit breakers. To better cover this wide range of applications, Westinghouse offers a family of DE-ION circuit breakers within a given frame size.

This family of breakers includes:
Thermal Magnetic (Std. and SELTRONIC)
Magnetic Only (Std. and SELTRONIC)
Ambient Compensating
Saf-T-Vue®
MARK 75 (Std. and SELTRONIC)
TRI-PAC

Thermal Magnetic Circuit Breakers

Thermal magnetic breakers are general purpose devices suitable for the majority of breaker applications and are considered the industry standard. Combining thermal and magnetic trip actions, they provide accurate overload and short circuit protection for conductors and connected apparatus.

Magnetic-Only Circuit Breakers

Magnetic-only breakers are similar to standard thermal magnetic breakers except that they do not have thermal trip elements. They are equipped with front-adjustable magnetic trip elements and are used where only short circuit protection is required. Because the adjustment feature allows closer short circuit protection, these breakers are commonly preferred for motors and resistance welder circuits.

Ambient Compensating Circuit Breakers (Standard Breakers Only)

Ambient compensating breakers are similar to standard thermal magnetic breakers in that they are thermal magnetic and provide overload and short circuit protection. The difference is that ambient compensating breakers automatically compensate for variations in ambient temperature. This provides a near-constant current rating over a wide range of temperatures. In effect, this breaker minimizes the need for derating in higher ambients, and uprating in lower ambients.

Because these breakers will carry their rated current in higher ambients, circuit conductors must be sized accordingly. Generally, standard thermal magnetic breakers, which derate in about the same ratio as the average conductor ratings, are best suited for conductor protection.

Typical applications of ambient compensating breakers include:

1. Conductors not subjected to same temperature changes as the breaker.

   a. Wiring located inside of a building having temperature control, but the protecting breaker mounted outside for convenience.

   b. Wiring buried underground, but breaker exposed such as in some outdoor pump controller applications.

2. Where overload protection of wiring is not of prime importance.

3. In portable engine generator sets, where varied climates and temperatures are encountered and the generator is designed to the anticipated temperature extremes.

Because the above applications are in the minority, ambient compensating is not supplied as standard

SELTRONIC breakers are insensitive to temperature changes. However, they include circuitry to protect the components from abnormally high temperatures.

Saf-T-Vue® Circuit Breakers

Saf-T-Vue breakers are similar to standard molded case breakers except that they are equipped with a window of transparent thermoplastic over the breaker contacts. This allows you to see whether the contacts are open or closed. These breakers fulfill the needs of industrial plants where safety codes require visible contacts as an additional safety precaution for maintenance personnel. They can be supplied with thermal magnetic, magnetic-only or ambient compensating trip elements to cover a wide scope of applications. They are not available in MARK 75 or TRI-PAC breakers.

MARK 75 Circuit Breakers

MARK 75 breakers are similar to standard molded case breakers. They are, however, designed with increased interrupting capacities – up to 75,000 amperes asymmetrical at 240 volts Ac. The improved performance makes these breakers ideally suited for use in network systems and other applications where unusually high fault currents exist. Standard MARK 75 breakers are equipped with thermal magnetic trip actions. Magnetic-only and ambient compensating① trip elements are also available. MARK 75 molded cases are of a gray polyester material which easily distinguishes them from standard breakers, which are black.

TRI-PAC Circuit Breakers

TRI-PAC circuit breakers offer an even higher interrupting capacity than MARK 75 breakers. They are similar to standard thermal magnetic breakers except that they incorporate a current limiting device. This enables them to be used in secondary distirbution systems where fault currents up to 200,000 symmetrical rms, amperes are available. Thus, as their name implies, they are a triple package of protection – (1) time delay thermal trip for overload protection, (2) instantaneous magnetic trip for normal fault current protection, and (3) current limiting action for higher fault current protection – combined and coordinated in a single compact and economical device. Because they limit current, TRI-PAC breakers can be used to protect smaller AB breakers and other connected apparatus in addition to protecting feeder and branch circuits. More specific information on TRI-PAC breakers is contained elsewhere in this publication.

Characteristic Trip Curves (Except TRI-PAC)

Characteristic trip curves are found in Application Data 29-161 A WE A which is available on request.

The band curves shown for each breaker type represent current tripping limits for the breaker and are within limits established by the Underwriters' Laboratories. For a given current, at rated ambient, a breaker will clear the circuit automatically at some total time within the two extreme values defined by "maximum" and "minimum" curves. For example, a 1 pole, 15 ampere Quicklag would trip in not less than 10 seconds and in not more than 150 seconds on a 30 ampere current. Because of this allowed spread, users should not specify exact tripping times.

The upper left portions of these curves show the inverse time delay tripping of the breakers due to thermal action. The lower right segments of these curves portray the magnetic tripping action of the breakers. In the case of the front adjustable thermal-magnetic breakers, the magnetic tripping elements may be adjusted to trip at values within a specific current range. This adjustment is shown on their respective characteristic tripping curves. When these breakers leave the factory their magnetic trip elements are set at the high side of their tripping range. Adjustment downward may be made to fit the requirements of the installation. Currents equal to or greater than these magnetic settings will cause instant tripping. Curves shown are family curves and are suitable for most applications; for more accurate application, a detailed curve of the particular type and ampere rating of the breaker should be requested.

The total time taken by a breaker to clear a fault consists of the mechanical operating time plus the time of actual current interruption. Characteristic family curves show total clearing times. Magnetic only breakers have no time delay in tripping. The tripping characteristics of these breakers are similar to the right hand portion of the standard breakers, except with the vertical lines extended to the top of the curve.

Circuit Breaker Ratings

A circuit breaker is rated in rms amperes, (at a specific ambient) voltage, frequency (usually 60 hertz), and interrupting capacity (in rms symmetrical and assymmetrical amperes). AB De-ion circuit breakers listed in the 29-000 section of the Westinghouse catalog are rated

① Except for SELTRONIC breakers.

a maximum of 3000 amperes continuous and 600 volts Ac, 250 volts Dc. For a summary list of ratings, voltages and interrupting capacities, see selection chart on page 4.

Circuit breakers are not horsepower rated.
Unlike switches, circuit breakers are not horsepower rated because they are able to safely interrupt currents far in excess of the locked rotor value for any motor with which they may be applied. This ability is recognized in the N.E.C. as stated in paragraph 430-109, and is proven by the Underwriters' tests described in U/L Bulletin number 489, "Standard for Branch Circuit and Service Circuit Breakers".

For example, a breaker must pass the U/L overload test consisting of breaking a current 600% of its ampere ratings. As motor branch circuit breaker ratings are usually 125% to 250% of motor full-load currents, this test establishes the ability of the breaker to more than interrupt locked rotor currents. Following the overload test and others, the breaker is called upon to successfully clear its rated short circuit current which is a minimum of 5000 amperes. This also is many times higher than motor locked rotor current. Because by definition a circuit breaker is required to "open under abnormal conditions...without injury to itself", the breaker must still be in operating condition after the test.

Underwriters' Laboratories Test Requirements

Standard Tests

1. The tripping mechanism shall be enclosed to prevent tampering.

2. The mechanism shall trip free of the handle on overload.

3. All breakers shall be calibrated to carry their continuous rating in an ambient temperature of 40°C.①

4. 200% calibration check.

5. 135% calibration check.

6. Overload tests at 600% normal current at rated voltage.

   Up to 1600 Amperes: 50 operations
   2000, 2500 Amperes: 25 operations
   3000, 4000 Amperes: Three operations at 600% followed by 25 operations at 200%

7. Temperature rise check at 100% rated load continuously without exceeding specified temperature limits.

8. Endurance test:

Ampere Rating	Operations Full Load	No Load	Per Minute
0 – 100	6000	4000	6
101 – 225	4000	4000	5
226 – 600	1000	5000	4
601 – 800	500	3000	1
801 – 2500	500	2000	1
2501 – 4000	400	1100	1

9. After endurance test, the breaker must again pass a calibration test at the 200% and 135% ratings.

10. It must next pass short circuit tests at its rated voltage at the value shown in the following chart.

Breaker Rating Volts	Amps	Test Circuit For Three Pole Breakers: Individual Poles Amps	Common Poles Amps	Total No. of Tests
250 & Below	100 & Below	4,330	5,000	7
Above 250	100 & Below	8,660	10,000	7
Any	101 – 800	8,660	10,000	7
Any	801 – 1200	12,120	14,000	7
Any	1201 – 1600	14,000	20,000	8
Any	1601 – 2000	14,000	25,000	8
Any	2001 – 2500	20,000	30,000	8
Any	2501 – 3000	25,000	35,000	8
Any	3001 – 4000	30,000	45,000	8

11. After the short circuit test, the breaker must again pass a calibration test at 200% of its rating.

12. Successful breakers passing all of the above tests must then pass a dielectric withstand for one minute without breakdown. The test consists of a 60 hertz potential of 1000 volts plus twice the rated voltage between line and load terminals with the breaker open and in the "tripped" position, between terminals of opposite polarity with the breaker closed and between live parts and the enclosure with the breaker open and closed.

13. A sample lot of breakers, as defined by U.L., INC., must pass the above sequence of tests without failure to achieve the initial standard U.L. listing. Once standard listing is achieved then higher interrupting ratings may be obtained by submitting sample lots of breakers to additional interrupting tests conducted for the particular rating desired. These additional tests will be conducted in accordance with the following sequence:

High Interrupting Capacity Tests

1. 200% Calibration Check.

2. Short circuit interruption. Two three-phase tests, one "open" followed by a "close-open" at the desired rating.

3. 250% Calibration check.

4. Finally, a dielectric withstand similiar to the one described above must be passed. The voltage for this test is twice rated but not less than 900 volts.

① Additional tests as an enclosed device required for listing as 100% application device.

AB DE-ION® Circuit Breaker Interrupting Ratings

Circuit Breaker Ratings: Type	Cont Amp. Rating	No. Poles	Volts Ac	Fed Spec. W-C-375a Class	U.L. Listed Interrupting Capacities—RMS Symmetrical Amps: Ac Rating Volts 120/240	240	277	480	600	Dc Rating Volts(5) 125	250
Lighting Circuit Breakers											
QC, HQP, BAB	10-70	1	120/240	1a	10,000	......	......	......	......	......	......
	15-125	2	120/240	1a	10,000	......	......	......	......	......	......
HQC, HQNP, BA	15-50	2	240	1b	......	10,000	......	......	......	......	......
	15-100	3	240	1b	......	10,000	......	......	......	......	......
BA	15-30	1	277	2a	......	......	10,000	......	......	......	......
QHP, QHC, HBA	15-30	1-2	120/240	⑦	65,000	......	......	......	......	......	......
	15-20	3	240		......	65,000	......	......	......	......	......
QPGF, QBGF	15-30	1-2	120/240	⑦	10,000	......	......	......	......	......	......
QPHGF, QBHGF	15-30	1	120/240	⑦	22,000	......	......	......	......	......	......
QPH, QCH, QBH	15-70	1	120/240		22,000	......	......	......	......	......	......
	15-100	2	120/240	⑦	22,000	......	......	......	......	......	......
	15-100	3	240		......	22,000	......	......	......	......	......
CA	125-225	2-3	240	⑦	......	10,000	......	......	......	......	......
CAH	125-225	2-3	240		......	22,000	......	......	......	......	......
DA	250-400	2-3	240	⑦	......	22,000	......	......	......	......	10,000(4)
Industrial Circuit Breakers											
EB Standard	15-100	1	120	2b	10,000(1)	......	......	......	......	5,000	......
	15-100	2-3	240	2c	......	10,000	......	......	......	......	5,000(2)
EHB Standard	15-100	1	277	2a	......	......	14,000	......	......	10,000	......
	15-100	2	480	2d	......	18,000	......	14,000	......	......	10,000
	15-100	3	480	2d	......	18,000	......	14,000	......	......	......
FB(3) Standard	15-150	2	600	2d	......	18,000	......	14,000	14,000	......	10,000
	15-150	3	600	2d	......	18,000	......	14,000	14,000	......	......
JB-KB Standard	70-250	2	600	3b	......	25,000	......	22,000	22,000	......	10,000
	70-250	3	600	3b	......	25,000	......	22,000	22,000	......	......
LB-LBB Standard	70-400	2	600	4b	......	42,000	......	30,000	22,000	......	10,000
	70-400	3	600	4b	......	42,000	......	30,000	22,000	......	......
LA Standard	250-600	2	600	4b	......	42,000	......	30,000	22,000	......	10,000
	250-600	3	600	4b	......	42,000	......	30,000	22,000	......	......
LC Seltronic	75-600	2-3	600	4b	......	42,000	......	30,000	22,000	......	......
MC Seltronic	400-800	2-3	600	5a	......	42,000	......	30,000	22,000	......	......
NC Seltronic	600-1200	2-3	600	5a	......	42,000	......	30,000	22,000	......	......
PC Seltronic	1000-3000	2-3	600	⑦	......	125,000	......	100,000	100,000	......	......
PCC(6) Seltronic	1000-3000	2-3	600	⑦	......	125,000	......	100,000	100,000	......	......
High Interrupting Capacity Circuit Breakers											
HFB Mark 75	15-30	1	277	⑦	......	......	65,000	......	......	10,000	......
	40-100	1	277	⑦	......	......	25,000	......	......	10,000	......
	15-150	2	600	2f	......	65,000	......	25,000	18,000	......	10,000
	15-150	3	600	2f	......	65,000	......	25,000	18,000	......	......
HKB Mark 75	70-250	2	600	⑦	......	65,000	......	25,000	22,000	......	10,000
	70-250	3	600	⑦	......	65,000	......	25,000	22,000	......	......
HLB Mark 75	125-400	2	600	4c	......	65,000	......	35,000	25,000	......	10,000
	125-400	3	600	4c	......	65,000	......	35,000	25,000	......	......
HLA Mark 75	250-600	2	600	4c	......	65,000	......	35,000	25,000	......	10,000
	250-600	3	600	4c	......	65,000	......	35,000	25,000	......	......
HLC Mark 75	75-600	2-3	600	4c	......	65,000	......	35,000	25,000	......	......
HMC Mark 75	400-800	2	600	5b	......	65,000	......	50,000	25,000	......	......
	400-800	3	600	5b	......	65,000	......	50,000	25,000	......	......
HNC Mark 75	600-1200	2-3	600	5b	......	65,000	......	50,000	25,000	......	......
FB Tri-Pac	15-100	2-3	600	2e	......	200,000	......	200,000	200,000	......	⑧
LA Tri-Pac	70-400	2-3	600	3c/4a	......	200,000	......	200,000	200,000	......	⑧
NB Tri-Pac	300-800	2-3	600	6	......	200,000	......	200,000	[illegible]	......	......
PB Tri-Pac	600-1600	2-3	600	⑦	......	200,000	......	200,000	200,000	......	......

① 120 volt only.
② 125/250 Volts Dc only.
③ Available in 4 pole version.
④ 2 pole only.
⑤ Higher NEMA ratings available.
⑥ U.L. listed at 100% rating.
⑦ Not defined in W-C-375a.
⑧ 100,000 based on NEMA test procedure.

Application Information

Selection of an AB breaker, with proper circuit protective characteristics, involves consideration of the following factors:

1. Circuit Voltage
2. Circuit Frequency
3. Continuous Current Rating
4. Unusual Operating Conditions
5. Available Short Circuit Current

The following discussion of these application considerations is based on National Electric Code and NEMA requirements.

1. Circuit Voltage

Molded case circuit breakers are rated by voltage class and should be applied only to system voltages within their rating.

Note: On all three phase Delta, grounded B phase applications, refer to Westinghouse.

2. Circuit Frequency

Most standard molded case circuit breakers up to 600 amps can be applied to frequencies from Dc up to 120 hertz without derating. On higher frequency applications, however, the increased effect of eddy currents and iron losses causes greater heating within the thermal trip elements necessitating that the breakers either be especially calibrated for the specific frequency or be derated accordingly. The amount of derating depends upon the frame size and ampere rating as well as the current frequency. In general, the higher the ampere rating in a given frame size, the greater the derating required.

Some 600 amp breakers and all higher ratings have a transformer-heated bimetal, and are suitable for 60 hertz Ac maximum, with special calibration available for 50 hertz Ac minimum.

In the smaller frames – Quicklags, BA, CA, EB, EHB and FB – higher frequencies require more current to trip the breakers magnetically. In the larger frames – JA and larger – magnetic trip elements constructed with laminated magnets have similar trip characteristics at frequencies of either 60 hertz or 400 hertz.

For specific derating information or information regarding application to frequencies higher than 400 cycles, consult factory. SELTRONIC breakers are suitable for 50/60 Hertz Ac circuits only.

3. Continuous Ampere Rating

Molded case circuit breakers are rated in r.m.s. amperes at a specific ambient. This ampere rating is the continuous current they will carry in the ambient temperature for which they are calibrated. Westinghouse thermal magnetic breakers are calibrated for an ambient temperature 40°C which is the average temperature within an enclosure; thus, they minimize the need for derating. If the enclosure ambient is known to exceed 40°C, the breaker used should either be especially calibrated for that ambient or be derated accordingly. (Refer to Item 4, Unusual Operating Conditions, for specific information).

The selection of a specific ampere rating for a given application is dependent upon the type of load and duty cycle, and is governed by the National Electric Code. In general, the N.E.C. requires overcurrent protection at the supply and at points where wire sizes are reduced. It further states that the conductors be protected in accordance with their current carrying capacity, but lists exceptions for applications such as motor circuits where a larger rating is often required to override motor inrush currents.

The following paragraphs outline pertinent information from the N.E.C. according to the type of load and duty cycle.

A. Service

A service includes the conductors and equipment for delivering electrical energy from the supply system to the wiring system of the premises served.

N.E.C. Article 230-1 through 230-98 contains the many requirements for services of 600 volts or less including the sizing, location and over-current protection of conductors, disconnect means, permissable number of disconnects, rating of disconnects, grounding of conductors and ground fault protection requirements of service equipment.

B. Feeder Circuits

A feeder is composed of the conductors of a wiring system between the service equipment or the generator switchboard of an isolated plant and the branch circuit over-current device.

N.E.C. Article 220-10 (b): Where a feeder supplies loads or any combination of continuous and noncontinuous load, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly including the overcurrent devices protecting the feeder(s) are listed for operation at 100 percent of their rating, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the sum of the continuous load plus the noncontinuous load.

Only breakers listed for 100% application, and so labeled, can be applied under the exception (for example, type PCC). Breakers without 100% application listing and label are applied under (b) above, or at 80% of rating.

N.E.C. Article 430-63: Breakers for feeders having mixed loads, i.e. heating (lighting and heat appliances) and motors, should have ratings suitable for carrying the heating loads plus the capacity required by the motor loads.

N.E.C. Article 430-62: Breakers for motor feeders shall have a rating not greater than the sum of the highest breaker rating of any of its branches and the full load currents of all other motors served by the feeder.

C. Branch Circuits

A branch circuit is the portion of a wiring system extending beyond the final overcurrent device protecting the circuit.

1. Lighting Circuits (N.E.C. Tables 310-16 through 19). These are protected in accordance with the conductor ratings as given. High wattage incandescent lamp loads may result in abnormally high inrush currents that must be taken into account to avoid nuisance tripping. The lamp manufacturer should be consulted for data relative to the inrush currents.

2. Motor Circuits (N.E.C. Article 430-51): Breakers are primarily intended for the protection of conductors, motor control apparatus and motors against short circuits and ground fault conditions.

On motor overloads, the motor overcurrent device will open the circuit before the correctly applied breaker. Currents higher than the locked rotor value will be interrupted by the breakers, protecting the circuit from these heavy fault currents. The breaker must not trip on normal motor starting.

While breakers may be applied for motor running overcurrent protection when the requirements of Article 430 of the N.E.C. are met, these applications are not recommended for Type AB breakers and, therefore, this discussion is confined to the use of a breaker as a circuit protector.

For many applications, particularly those where the starting behavior if the motor is unknown, the N.E.C. maximum rules are followed. Usually, lower rated breakers can be used successfully. This is further discussed under motor circuit application and motor application tables.

Motor Circuit Application (N.E.C. Article 430-110): The breaker must have a continuous rating of not less than 115% of the motor full load current. Before applying a breaker, one should check to determine the effect of any of the following conditions: High ambient temperature, heating within breaker enclosure due to grouping of current consuming devices, frequent motor starting, lengthy motor acceleration period.

Breaker Rating or Setting (N.E.C.) Article 430-52): The motor branch circuit over-current device shall be capable of carrying the starting current of the motor. The required protection shall be considered as being obtained when the overcurrent device has a rating or setting not exceeding the values given in Table A, page 9 (reference N.E.C. tables 430-152).

An instantaneous trip circuit breaker (without time delay) shall be used only if adjustable and if part of a combination controller having overcurrent protection in each conductor and the combination is especially approved for the purpose. In the event a breaker chosen on this basis still does not allow motor starting a higher rating is permitted by the code. See exceptions listed with Table A, page 9.

Due to the infinite number of motor-and-load combinations and because comparable breakers of different manufacture have different tripping characteristics, N.E.C. motor-circuit breaker rules are of a general nature and are set up as maximum boundaries. Protection is considered satisfactory if the breaker rating does not exceed the figure allowed by the N.E.C. requirements. Although Westinghouse breakers rated less than the N.E.C. maximum values may be applied in most cases. Many operating engineers select breakers on the basis of the N.E.C. maximum rules simply because consideration of other factors is not usually necessary, or to insure motor starting when the starting behavior of the motor is not known. Tables A and B, page 9, are adapted from Article 430-147 through 152 of N.E.C.

When a certain motor is standard for a given job, as on a volume produced machine tool, it is practical (and often more economical) to select a breaker for closer protection than one chosen on the basis of N.E.C. maximum rules.

D. Capacitor Protection (460-8 N.E.C.)
In normal applications, breakers rated about 150% of capacitor rated currents are recommended. This factor allows for switching surges, and possible overcurrent due to overvoltage and harmonic currents. Such selection fully meets the N.E.C. requirement in 460-8 for a conductor and disconnect to be rated not less than 135% capacitor rating. Where the operating currents exceed 135% of rated current due to harmonic components, service conditions may require the selection of a breaker with a higher current rating.

For application in ambients higher than the rated ambient of the breaker, the breaker derating table on page 11 should be checked to determine the rating of the breaker required to meet the minimum of 135% capacitor rating. In locations where temperatures vary greatly, ambient compensating breakers may be desireable.

For automatic switching, motor-operated AB breakers are economical devices.

E. Transformer Protection (450-3b N.E.C.)
(1) Primary. Each transformer 600 volts or less shall be protected by an individual overcurrent device on the primary side. Rated or set at not more than 125 percent of the rated primary current of the transformer.

Exception No. 1: Where the rated primary current of a transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, the next higher standard rating described in Section 240-6 shall be permitted. Where the rated primary current is less than 9 amperes, an overcurrent device rated or set at not more than 167 percent of the primary current shall be permitted.

Where the rated primary current is less than 2 amperes, an over-current device rated or set at not more than 300% shall be permitted.

Exception No. 2: An individual over-current device shall not be required where the primary circuit overcurrent device provides the protection specified in this Section.

Exception No. 3: As provided in (b) (2) below.

(2) Primary and Secondary. A transformer 600 volts or less having an over-current device on the secondary side rated or set at not more than 125 percent of the rated secondary current of the transformer shall not be required to have an individual overcurrent device on the primary side if the primary feeder overcurrent device is rated or set at a current value not more than 250 percent of the rated primary current of the transformer.

A transformer 600 volts or less, equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current, shall not be required to have an individual overcurrent device on the primary side if the primary feeder overcurrent device is rated or set at a current value not more than 6 times the rated current of the transformer for transformers having more than 6 percent impedance and not more than 4 times the rated current of the transformer for transformers having more than 6 but not more than 10 percent impedance.

Exception: Where the rated secondary current of a transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, the next higher standard rating described in Section 240-6 shall be permitted

Where the rated secondary current is less than 9 amperes, an overcurrent device rated or set at not more than 167 percent of the rated secondary current shall be permitted.

Closer protection can be provided by breakers having shunt trips actuated by a temperature sensing device imbedded in transformer windings.

4. Unusual Operating Conditions
A. High Ambient Temperatures
Because standard thermal magnetic breakers are temperature sensitive and are calibrated for a specific ambient of 40°C (average enclosure temperature), the presence of an ambient higher than 40°C will cause the breaker to carry less current than its nameplate rating, or in other words, will cause the breaker to "derate" (see Table D). Similarly, the safe current carrying capacity of a circuit conductor is based upon an ambient temperature of 30°C (average air temperature) and the presence of a higher ambient will reduce its safe current carrying capacity causing it to "derate" (see Table F). Thus, it can be seen from Tables D and F that in the presence of a fluctuating temperature, a thermal magnetic breaker will derate nearly parallel with its connected circuit conductors and maintain close circuit protection.

If the application temperature exceeds 40°C and is known, either a breaker especially calibrated for the higher ambients or one oversized according to Table D can be selected. It should be noted that in a case such as this, the circuit conductors should be oversized also according to the correction factors in Table F-1.

SELTRONIC breakers are insensitive to temperature changes. However, they do include circuitry to protect the components from abnormally high temperatures.

B. Moisture – Corrosion
For atmospheres having high moisture content and/or where fungus growth is prevalent, a special treatment of breakers to resist moisture and fungi is recommended.

Where the air is heavily laden with corrosive elements, breakers made with special corrosion-resistant finishes are recommended.

C. Altitude
At altitudes above 6,000 feet, breakers must be progressively derated for interrupting insulating (voltage), current-carrying ability and interrupting ability. (Refer to Westinghouse).

D. Shock
Where high shock is an anticipated condition, hi-shock Navy type breakers are recommended.

E. Maritime
ABS, USCG, CG-259, and IEEE-45 requirements for maritime breakers are met by using AB breakers similiar to standard except calibrated for 50°C ambients.

5. Available Short Circuit Current
A standard, MARK 75 or TRI-PAC circuit breaker should be applied only where their published interrupting capacity exceeds the available short circuit current (including motor contributions)at the point of application. Since there are many considerations involved in determining short circuit currents, a special brochure (✱B-8674, "How to Calculate Fault Currents") has been prepared to simplify this procedure (copies are available on request). It includes an explanation of the factors and circuit characteristics used to determine short-circuit values.

Current limiters in series with AB breakers: If the available short circuit current at the point of application exceeds the published interrupting capacity of the breaker, current limiting devices can be installed in the circuit in series with the breaker; however, before this solution is chosen, full consideration should be given to the use of TRI-PAC circuit breakers, or breakers with current limiter attachment.

Table E on page 12 lists the recommended current limiting fuse ratings to be used with thermal magnetic breakers in such applications.

TRI-PAC Breakers

General Information
The increase in demand for electrical power in modern commercial and industrial buildings has resulted in electrical services becoming substantially larger. In some low voltage distribution systems, available short circuit currents can exceed 100,000 symmetrical rms amperes. Fault currents of this intensity may exceed the interrupting ratings of molded case breakers. As a result, larger expensive circuit interrupting devices which could withstand the thermal and magnetic stresses associated with currents of this value have had to be used. High interrupting capacity current limiting devices have been developed which will restrict short circuit current. If applied correctly, they may be used in conjunction with the molded case circuit breakers to provide adequate and economical protection.

Because of this fact, Westinghouse developed the TRI-PAC breaker, so named because it affords TRIple-PACkage protection with (1) time delay thermal trip, (2) instantaneous magnetic trip and (3) current limiting protection, combined and coordinated in a compact and economical device. These protective actions are so coordinated that overcurrents and low magnitude faults are cleared by the thermal action; normal short circuits are cleared by the magnetic action; and abnormal short circuits, above an esbablished value, are cleared by the current limiting device. Thus, unless a severe short circuit occurs, the current limiter is unaffected and its replacement is held to a minimum.

Tripped status of the breaker is shown by the center handle "trip" position. In addition the cause of tripping is also indicated in the following ways:

1. If after tripping the breaker cannot be reset immediately, thermal tripping due to an overload or a high resistance fault is indicated.

2. If the breaker can be immediately reset a "normal" fault current has been interrupted by instantaneous magnetic action.

3. If the TRI-PAC cannot be reset, then fault current interruption by the current limiter has taken place.

In the latter case, one or more new limiters must be installed. Since these devices are especially designed for use with TRI-PAC breakers, they can be purchased only from Westinghouse.

TRI-PAC breakers are built to the same exacting design standards and methods as used with standard molded case breakers. They are available in ratings from 15 through 1600 amperes. TRI-PAC breakers have a U/L listed interrupting capacity of 200,000 amperes at up to 600 volts Ac, and based on NEMA test procedures, have an interrupting capacity of 100,000 amps. at up to 250 volts Dc. Basically, the circuit breaker portion of the TRI-PAC breaker is of the same design as a standard molded case breaker of comparative ampere rating, except to have specially designed current limiters located within an added housing separated from the sealed trip unit of the breaker for easy access.

An interlock is provided which insures the opening of the breaker contacts before the limiter housing can be removed. Each current limiting device is constructed with a spring loaded plunger which is ejected during the operation, initiating simultaneous opening of all poles of the breaker. Therefore, the possibility of single phasing is eliminated.

The TRI-PAC breaker has many advantages over other means of high current fault protection. To mention a few, the TRI-PAC breaker ...

1. Provides complete protection in one compact device.

2. Prevents the use of improper fuses.

3. Averts single phasing.

4. Saves space.

5. Installed cost is generally lower.

6. Gives an indication of the magnitude of the overcurrent.

7. Is thoroughly tested.

Thus, in the TRI-PAC breaker all the advantages of the economical molded case breaker and the current limiter are retained, while the disadvantages of separately mounted devices are eliminated.

Selection Guide
TRI-PAC breakers are compact, only a little larger than a standard molded case breaker. They can be applied as main breakers for the protection of branch and feeder circuits and connected apparatus. They are suitable for use in switchboards, control centers, panelboards, combination starters, bus duct plug-in devices and also as separately enclosed TRI-PAC breakers, when the calculated fault current exceeds the interrupting ratings of standard molded case breakers.

Since TRI-PAC breakers have thermal and magnetic trips similar to standard molded case breakers, they can be applied in much the same manner. TRI-PAC continuous current ratings are chosen in the same manner as standard molded case breakers.

In general, it is recommended that standard thermal magnetic breakers be considered fully before selecting TRI-PAC breakers. Attention should be given to the possibility of using larger frame size standard molded case breakers to obtain the required interrupting capacity. When standard molded case breakers or MARK 75 breakers do not have adequate ratings to handle the calculated fault currents, TRI-PAC breakers have many salient features which should receive next consideration.

The selection of TRI-PAC breakers should be made carefully. They should be applied in strict accordance with the general rules as described in the paragraphs under "basic application in distribution systems" and in accordance with the characteristic tripping curves.

Characteristic Trip Curves
TRI-PAC characteristic tripping curves in Application Data 29-162 A WE A present a complete picture of the breaker operation and point out the coordination between the thermal, magnetic, and current limiting actions. Percentage current curves such as those used for standard AB breakers are impractical in this case and therefore TRI-PAC curves are direct reading in amperes. Curves are presented showing maximum and minimum trip characteristic for each rating.

The upper segment of each curve represents the thermal (time delay) tripping of the breaker as a result of an overload condition.

The abrupt break and vertical segment of the curves represents the magnetic (instantaneous tripping of the breaker because of short circuit currents. The lower part of the TRI-PAC characteristic curve represents the maximum interrupting time of short circuit currents which exceed the magnitude of the magnetic trip setting. The point at which the current limiter curve crosses the lower portion of the breaker characteristic curve is called the "cross-over point" and the magnitude of the short circuit current at this point is called the "cross-over current". At values of current less than the cross-over current, the breaker will interrupt the fault without operation of the current limiter. At values of current greater than cross-over current, the current limiter and the breaker will clear the fault. The current limiters are not seriously affected by the breaker interrupting faults of lesser values than indicated by the cross-over currents.

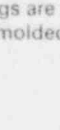
Basic Application in Distribution Systems

There are three basic applications for TRI-PAC circuit breakers. Certain procedures outlined in the following paragraphs must be followed in these applications to insure safe, well coordinated, and soundly engineered systems.

(1) Individual TRI-PAC Breakers in Distribution Systems

When a single TRI-PAC circuit breaker, in its own enclosure, is used to protect electrical equipment it is applied in the same manner as a standard molded case breaker. TRI-PAC can be connected directly to any low voltage distribution system where available fault currents may reach values as high as 200,000 symmetrical rms amperes. It has been proven by test that TRI-PAC will have adequate interrupting capacity.

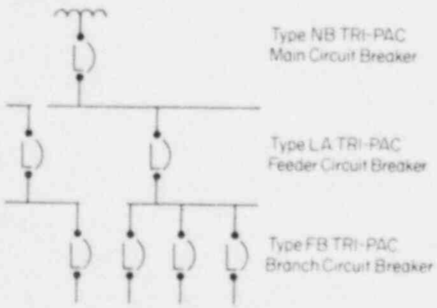
Figure 1



(II) Combination of TRI-PAC Circuit Breakers in Distribution Systems

If all the circuit breakers in the system are TRI-PAC breakers, no applications problem exists because all of the breakers are self-protecting. Current ratings are selected in the same manner as standard molded case breakers.

Figure 2



(III) TRI-PAC Main Breaker Feeding Standard Mclded Case Breakers in Distribution Systems

When a TRI-PAC circuit breaker is used for back up protection for standard molded case circuit breakers, see Figs. 3 and 4. They should be applied using the rules for protection and coordination of connected apparatus found with the Application Data for the specific TRI-PAC breaker involved.

Figure 3

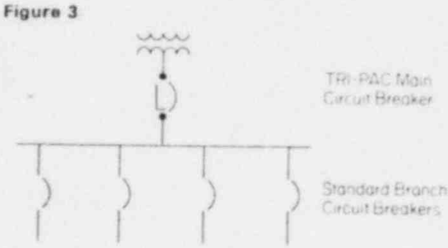
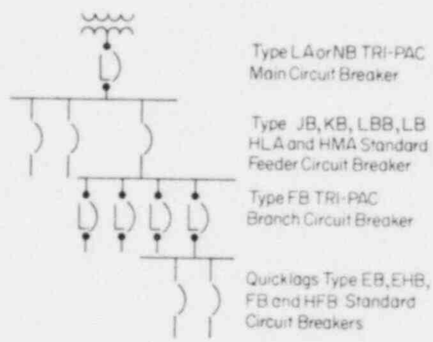


Figure 4



Panelboards

TRI-PAC breakers may be used in panelboards as branch and feeder circuit protection devices or as main breakers. Rules as outlined in paragraphs II and III apply. Figure 5 represents a panelboard made up of TRI-PAC breakers which presents no application problem. However, if the panelboard is made up of standard molded case breakers with a TRI-PAC main, as shown in Figure 6, the application should be made carefully as outlined in the rules of paragraph III.

Consideration should also be given to the matter of circuit continuity. For example in figure 6, a high fault could trip the main breaker interrupting power to all the circuits. When continuity of service is a prime requirement, it is recommended that each circuit be protected by TRI-PAC breakers as illustrated in Figure 5.

Figure 5

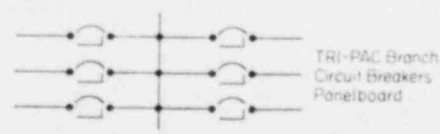
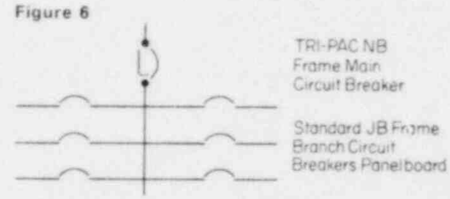


Figure 6



Switchboards or Substations

TRI-PAC breakers may be used in low voltage switchboards or substations where available currents do not exceed 200,000 symmetrical rms amperes. They may be connected directly to the secondary bus or grouped behind main low voltage circuit breakers. (Figures 7 and 8.)

Figure 7

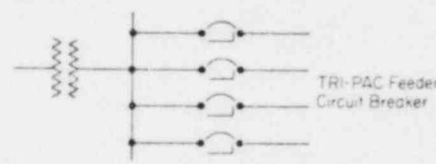
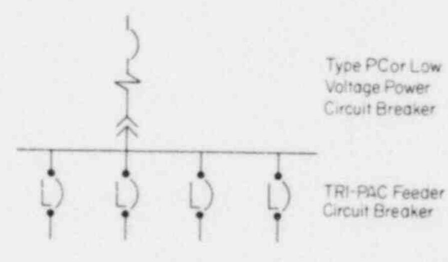


Figure 8



Control Centers

TRI-PAC breakers may be used in control centers as protection for main bus, as a main disconnect, and as branch protective devices. However, due to the special problems encountered in control centers, it is recommended that the application be referred to the control center manufacturer.

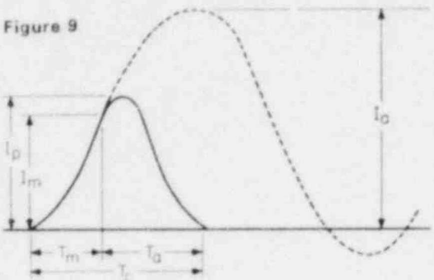
Bus Duct Distribution Systems

TRI-PAC breakers may be used in bus duct systems as a main protective device for low impedance and plug-in duct. They may also be used in the plug-in units feeding specific loads. Again, the previous rules as outlined in paragraphs II and III apply.

Protection of Connected Apparatus

Although greatly restraining the magnitude of fault currents, the current limiters must necessarily allow some current to pass for a short period of time in order to cause it to function. Figure 9 illustrates the operating characteristic of the current limiter used with TRI-PAC breaker.

Figure 9



Ia: Available Peak Current
Tm: Melting Time
Im: Current at Melting Time
Ip: Peak Let-thru Current
Ta: Arcing Time
Tc: Total Interrupting (clearing) Time

Operating Data

Tables have been prepared from actual test data of bolted faults on the load side of TRI-PAC breakers. These tables are found with the specific TRI-PAC involved. Installations made on basis of these tables allow a margin of safety because any other additional apparatus inserted into the distribution system further limits the short circuit current.

It can be seen from the tables that with a TRI-PAC breaker in the system, fault currents are limited before reaching possible peak currents. This action reduces the let-through currents and thus reduces substantially the thermal and magnetic stresses.

Under short circuit conditions any failure of apparatus will be due to excessive magnetic or thermal stresses. Magnetic stress is proportional to the product of the peak currents in two adjacent conductors. Thermal stress is proportional to the square of the rms let-through current multiplied by time (I^2t.) When the thermal and magnetic capabilities of the connected apparatus are known, then the data in the above mentioned tables can be used in designing complete systems.

Table A: AB Breaker Ratings for Motor Branch Circuits

Motor Type and Method of Starting	Maximum Rating② in % of Full Load Current	
	Thermal Magnetic Breakers (Time Limit Type)	Magnetic Only Breakers (Instantaneous Type)
For Motors Marked With a Code Letter		
All Ac single-phase and polyphase squirrel-cage and synchronous motors with full voltage, resistor, or reactor starting:		
Code letter A	150	700
Code letters B to E	200	700
Code letters F to V	250	700
All Ac squirrel-cage and synchronous motors with autotransformer starting:		
Code letter A	150	700
Code letters B to E	200	700
Code letters F to V	200	700
For Motors Not Marked With a Code Letter		
Single-phase, all types	250	700
Squirrel-cage and synchronous motors (full voltage, resistor and reactor starting)	250	700
Squirrel-cage and synchronous motors (autotransformer starting)	200	700
High reactance squirrel-cage:		
not more than 30 amperes	250	700
more than 30 amperes	200	700
Wound-rotor	150	700
Direct-current		
not more than 50 HP	150	250
more than 50 HP	150	175

② Exception: Where the overcurrent protection specified in tables is not sufficient for starting current of motor:
a. The rating or setting of a time limit circuit breaker may be increased but shall in no case exceed (1) 400% of the full load currents of 100 amps or less, and (2) 300% for full load currents greater than 100 amps.
b. The setting of an instantaneous trip circuit breaker (without time delay) may be increased over 700 per cent but shall in no case exceed 1300 per cent of the motor full load current.

Table B: Motor Terminal Amperes At Full Load①

Average Values For All Speeds and Frequencies

HP	Single Phase Ac		Polyphase Ac (Induction Type) Squirrel-Cage and Wound-Rotor								Direct-Current	
	115 Volts	230⑤ Volts	115 Volts 3-Ph	115 Volts 2-Ph④ 4-Wire	230 Volts⑤ 3-Ph	230 Volts⑤ 2-Ph④ 4-Wire	460 Volts 3-Ph	460 Volts 2-Ph④ 4-Wire	575 Volts 3-Ph	575 Volts 2-Ph④ 4-Wire	120 Volts	240 Volts
⅙	4.4	2.2	...	...	...	...	...	...	...	...	...	...
¼	5.8	2.9	...	...	...	...	...	...	...	...	3.1	1.6
⅓	7.2	3.6	...	...	...	...	...	...	...	...	4.1	2.0
½	9.8	4.9	4	4	2	2	1	1	.8	.8	5.4	2.7
¾	13.8	6.9	5.6	4.8	2.8	2.4	1.4	1.2	1.1	1	7.6	3.8
1	16	8	7.2	6.4	3.6	3.2	1.8	1.6	1.4	1.3	9.5	4.7
1½	20	10	10.4	9.0	5.2	4.5	2.6	2.3	2.1	1.8	13.2	6.6
2	24	12	6	11.8	6.8	5.9	3.4	3	2.7	2.4	17	8.5
3	34	17	...	...	9.6	8.3	4.8	4.2	3.9	3.3	25	12.2
5	56	28	...	...	15.2	13.2	7.6	6.6	6.1	5.3	40	20
7½	80	40	...	...	22	19	11	9	9	8	58	29
10	100	50	...	...	28	24	14	12	11	10	76	38
15	...	...	...	...	42	36	21	18	17	14	...	55
20	...	...	...	...	54	47	27	23	22	19	...	72
25	...	...	...	...	68	59	34	29	27	24	...	89
30	...	...	...	...	80	69	40	35	32	28	...	106
40	...	...	...	...	104	90	52	45	41	36	...	140
50	...	...	...	...	130	113	65	56	52	45	...	173
60	...	...	...	...	154	133	77	67	62	53	...	206
75	...	...	...	...	192	166	96	83	77	66	...	255

① These values of full load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high-torques may require more running current in which case the nameplate current rating should be used.
④ Current in common conductor of 2-phase, 3-wire systems will be 1.41 times value given.
⑤ For full load currents of 208 and 200-volt motors, increase the corresponding 230-volt motor full load current by 10 and 15% respectively.

Motor Application for Front-Adjustable Magnetic-Only Circuit Breaker
Table C: Standard Breakers

Hp Rating 230 Volt 3 Phase	Hp Rating 460 Volt 3 Phase	Motor Full Load Amps	Breaker Type	Continuous Rating Amps	Magnetic Trip Range/Adjustment Positions Low to High: Low	1	2	3	4	5	6	7	8	9	10	11	12	High
....	½, ¾, 1	.54-1.8	FB	3	**7**	8	8.5	9	10	11	12	13	15	16	18	19	20	**22**
½, ¾	¾, 1, 1½, 2	1.2-3.7	FB	5	**15**	17	18	20	22	24	26	28	30	33	36	39	42	**45**
¾, 1, 1½, 2	2, 3, 5	2.7-8.6①	FB	10	**35**	40	45	50	55	60	65	70	80	85	90	100	105	**110**
¾, 1, 1½	1½, 2, 3	2.5-6.6	FB	25	**32**	35	39	43	47	50	54	58	62	65	69	73	76	**80**
1½, 2, 3, 5	5, 7½, 10	5.1-15.7	FB	25	**66**	75	80	85	90	100	110	120	130	140	150	165	175	**190**
1½, 2, 3	3, 5, 7½	3.9-12.4	FB	30	**50**	56	65	72	80	90	96	105	110	120	125	135	140	**150**
3, 5, 7½	5, 7½, 10, 15	7.0-22.2	FB	30	**90**	100	110	115	125	140	155	170	185	200	215	230	250	**270**
1½, 2, 3, 5	5, 7½, 10	5.1-15.7	FB	50	**66**	75	80	85	90	100	110	120	130	140	150	165	175	**190**
5, 7½, 10	10, 15, 20, 25	12.3-39.6	FB	50	**150**	180	195	210	230	250	285	320	350	380	405	430	455	**480**
2, 3, 5, 7½	5, 7½, 10, 15	7.7-22.3	FB	70	**100**	110	125	140	150	165	175	190	205	215	230	245	255	**270**
5, 7½, 10	10, 15, 20, 25	11.6-39.6	FB	100	**150**	170	190	205	225	250	285	320	350	380	405	430	455	**480**
15, 20, 25, 30	30, 40, 50, 60	34.7-87①	FB	100	**450**	500	540	580	625	670	750	825	900	1000	1125②	1250	1400	**1550**
20, 25, 30, 40, 50	40, 50, 60, 75, 100	44.3-130①	FB	150	**575**	650	700	750	825	900	1050	1200	1300	1400	1500	1600	1700②	**1800**
10, 15, 20	20, 25, 30, 40	27-61	JB-KB	250	**350**	400	440	480	525	560	610	660	....	....	....	....	....	**700**
20, 25, 30, 40	40, 50, 60, 75	49-108	JB-KB	250	**625**	700	780	860	940	1020	1050	1170	....	....	....	....	....	**1250**
25, 30, 40	50, 60, 75, 100	58-130	JB-KB	250	**750**	850	930	1030	1125	1210	1300	1400	....	....	....	....	....	**1500**
25, 30, 40, 50	60, 75, 100	68-151	JB-KB	250	**875**	980	1100	1200	1300	1400	1500	1640	....	....	....	....	....	**1750**
40, 50, 60, 75	75, 100, 125, 150	87-195	JB-KB	250	**1125**	1290	1425	1560	1700	1840	1980	2115	....	....	....	....	....	**2250**
40, 50, 60, 75	100, 125, 150	97-216①	JB-KB	250	**1250**	1400	1560	1720	1880	2040	2100	2340	....	....	....	....	....	**2500**
10, 15, 20	20, 25, 30, 40	27-61	LBB-LB	400	**350**	400	440	480	525	560	610	660	....	....	....	....	....	**700**
20, 25, 30, 40	40, 50, 60, 75	49-108	LBB-LB	400	**625**	700	780	860	940	1020	1050	1170	....	....	....	....	....	**1250**
25, 30, 40	50, 60, 75, 100	58-130	LBB-LB	400	**750**	850	930	1030	1125	1210	1300	1400	....	....	....	....	....	**1500**
25, 30, 40, 50	60, 75, 100	68-151	LBB-LB	400	**875**	980	1100	1200	1300	1400	1500	1640	....	....	....	....	....	**1750**
40, 50, 60, 75	75, 100, 125, 150	87-195	LBB-LB	400	**1125**	1290	1425	1560	1700	1840	1980	2115	....	....	....	....	....	**2250**
50, 60, 75, 100	100, 125, 150, 200	115-260	LBB-LB	400	**1500**	1690	1875	2065	2250	2440	2630	2815	....	....	....	....	....	**3000**
60, 75, 100, 125	125, 150, 200, 250	154-346①	LBB-LB	400	**2000**	2250	2500	2750	3000	3250	3500	3750	....	....	....	....	....	**4000**
40, 50, 60, 75	75, 100, 125, 150	87-195	LA	600	**1125**	1265	1405	1555	1690	1830	1970	2110	....	....	....	....	....	**2250**
50, 60, 75, 100	100, 125, 150, 200	115-260	LA	600	**1500**	1685	1875	2060	2250	2435	2625	2810	....	....	....	....	....	**3000**
60, 75, 100, 125	125, 150, 200, 250	154-346	LA	600	**2000**	2250	2500	2750	3000	3250	3500	3750	....	....	....	....	....	**4000**
75, 100, 125, 150	200, 250, 300, 350	193-433	LA	600	**2500**	2815	3125	3440	3750	4065	4375	4690	....	....	....	....	....	**5000**
100, 125, 150, 200	200, 250, 300, 350, 400	231-520①	LA	600	**3000**	3375	3750	4125	4500	4875	5250	5625	....	....	....	....	....	**6000**

On combination starters or special control panels where the circuit breaker is mounted in close proximity to the starter unit, it may be advisable to use a magnetic-only circuit breaker. This is true for two reasons: 1) the overload relays on the starter or control panel will supply the circuit overload protection needed and 2) since it is adjustable, the magnetic-only circuit breaker can provide closer short circuit protection, thus preventing some heater burnouts.

Tables C and C-1 assume the following conditions:

1. The first ½ cycle asymmetrical inrush current is not more than 11 times motor full load current. This is true for most motors.

2. A continuous rating of the breaker should not be less than 115% of the motor FLC.

When magnetic only circuit breakers are used in motor circuits, they should be set to trip just above the current inrush. The first half-cycle inrush will vary with the motor characteristics. Motors with locked rotor currents of six times motor full load amperes will usually require an instantaneous magnetic setting of 10 to 11 times motor full load amperes to prevent tripping when starting. To obtain the best protection, the magnetic trip should be adjusted downward until the breaker trips in starting and then adjusted upward one setting position. This will insure that the circuit will open instantly on any current above the motor inrush.

Many factors can influence the trip point of magnetic-only breakers. See Field Testing, page 16.

① Maximum motor full load current based on use of 75°C rated conductors and ambients inside enclosures not exceeding 60°C.
② Maximum trip position setting permissable without exceeding 13 times maximum motor full load current.

Motor Application for Front-Adjustable Magnetic Only Breakers, *Continued*

Table C-1: SELTRONIC Breakers (Magnetic-only)

Hp Rating 230 Volt 3 Phase	Hp Rating 460 Volt 3 Phase	Motor Full Load Amps	Breaker Type	Continuous Rating Amps	Magnetic Trip Range Continuously Adjustable Low	Magnetic Trip Range Continuously Adjustable High
15, 20	25, 30, 40, 50	29-65	LC	600	375	750
15, 20, 25	30, 40, 50, 60	35-78	LC	600	450	900
15, 20, 25, 30	30, 40, 50, 60	39-87	LC	600	500	1000
20, 25, 30, 40	40, 50, 60, 75	49-108	LC	600	625	1250
25, 30, 40, 50	50, 60, 75, 100	58-130	LC	600	750	1500
25, 30, 40, 50	60, 75, 100	68-151	LC	600	875	1750
30, 40, 50, 60	60, 75, 100, 125	77-173	LC	600	1000	2000
40, 50, 60, 75	100, 125, 150	97-216	LC	600	1250	2500
50, 60, 75	100, 125, 150	106-238	LC	600	1375	2750
50, 60, 75, 100	100, 125, 150, 200	116-260	LC	600	1500	3000
60, 75, 100	125, 150, 200	135-303	LC	600	1750	3500
60, 75, 100, 125	125, 150, 200, 250	154-346	LC	600	2000	4000
75, 100, 125, 150	150, 200, 250, 300	174-390	LC	600	2250	4500
100, 125, 150	200, 250, 300, 350	193-433	LC	600	2500	5000
100, 125, 150, 200	200, 250, 300, 350, 400	231-520①	LC	600	3000	6000
60, 75, 100, 125	125, 150, 200, 250	154-346	MC	800	2000	4000
100, 125, 150	200, 250, 300, 350	193-433	MC	800	2500	5000
100, 125, 150, 200	200, 250, 300, 350, 400	231-520	MC	800	3000	6000
125, 150, 200	200, 250, 300, 350, 400	270-606	MC	800	3500	7000
		308-693①	MC	800	4000	8000
75, 100, 125, 150	200, 250, 300	185-416	NC	1200	2400	4800
100, 125, 150, 200	200, 250, 300, 350, 400	216-485	NC	1200	2800	5600
100, 125, 150, 200	250, 300, 350, 400, 450	247-554	NC	1200	3200	6400
125, 150, 200, 250	250, 300, 350, 400, 450, 500	277-623	NC	1200	3600	7200
		308-693	NC	1200	4000	8000
		370-831	NC	1200	4800	9600
		231-520	PC	2000	3000	6000
		277-623	PC	2000	3600	7200
		324-779	PC	2000	4200	8400
		370-831	PC	2000	4800	9600
		416-935	PC	2000	5400	10800
		462-1040	PC	2000	6000	12000
		270-606	PC	2500	3500	7000
		308-693	PC	2500	4000	8000
		347-779	PC	2500	4500	9000
		385-866	PC	2500	5000	10000
		481-1082	PC	2500	6250	12500
		247-554	PC	3000	3200	6400
		277-623	PC	3000	3600	7200
		308-693	PC	3000	4000	8000
		385-866	PC	3000	5000	10000
		462-1040	PC	3000	6000	12000

① Maximum motor full load current based on use of 75°C rated conductors and ambients inside enclosures not exceeding 60°C.

Table D: Derating Chart for Non-Compensated Thermal Magnetic Breakers Calibrated for 40°C

Breaker Ampere Rating at 40° C	Ampere Rating At 25° C (77° F)	50° C (122° F)	60° C (140° F)
Type EB			
15	17	13	11
20	22	18	16
25	28	23	21
30	33	28	26
35	39	30	25
40	44	37	34
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
Type EHB			
15	17	13	11
20	22	18	16
25	28	23	21
30	33	28	26
35	39	30	25
40	44	37	34
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
Type FB			
15	17	13	11
20	22	18	16
25	28	23	21
30	33	28	26
35	39	30	25
40	44	37	34
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
125	137	116	105
150	165	138	125
Type CA			
125	137	114	100
150	165	136	120
175	192	159	140
200	220	182	160
225	247	205	180
Type JB, KB			
70	79	63	55
90	102	81	71
100	115	89	76
125	140	114	102
150	171	134	116
175	200	156	134
200	230	178	153
225	252	205	183
250	281	227	201
Type DA			
250	275	235	220
300	330	276	252
350	385	325	301
400	440	372	340
Type LBB, LB			
70	85	63	55
90	107	82	73
100	121	90	79
125	145	116	106
150	188	132	111
175	210	159	141
200	243	180	157
225	255	212	198
250	294	230	208
300	364	270	236
350	412	322	291
400	471	368	333

Breaker Ampere Rating at 40° C	Ampere Rating At 25° C (77° F)	50° C (122° F)	60° C (140° F)
Type LA 600 Amp Frame			
250	275	235	220
300	330	276	252
350	385	325	301
400	440	372	340
500	550	468	435
600	660	564	525
Type MA			
125	138	115	103
150	165	139	128
175	192	163	151
200	220	186	170
225	247	210	195
250	275	232	213
300	332	277	252
350	388	322	292
400	444	368	334
450	495	418	383
500	550	468	435
600	660	564	525
700	770	658	613
800	880	754	704
Type NB			
700	770	658	613
800	880	754	704
900	990	828	749
1000	1100	900	825
1200	1320	1090	1000
Type PB			
600	660	540	474
700	770	630	554
800	880	728	632
900	990	820	720
1000	1100	920	800
1100	1210	1010	891
1200	1320	1115	972
1400	1540	1304	1148
1600	1760	1500	1320
1800	1980	1690	1485
2000	2200	1880	1650
2500	2750	2350	2060
3000	3300	2820	2470

SELTRONIC Breakers

SELTRONIC breakers are insensitive to changes in ambient temperature. However they include circuitry to protect the components from abnormally high temperatures.

Table E: Current Limiting Fuse Ratings (See page 14 for "How to Use Table E")

In series with standard and MARK 75® thermal magnetic circuit breakers.

Circuit Breaker Ampere Rating	Current Limiting Fuse Rating, Amperes: Min. Fuse	Max. Fuse Load Side	Max. Fuse Line Side
Quicklag P, B, C and Type BA Breakers①			
15	50	...	200
20	50	...	200
30	100	...	200
40	100	...	200
50	100	...	200
70	150	...	250
90	150	...	250
100	150	...	250
EB Breakers			
15	70	200	250
20	100	200	250
30	100	200	250
40	100	200	250
50	100	200	250
70	200	200	300
90	200	200	300
100	200	200	300
EHB Breakers			
15	70	200	300
20	70	200	300
30	100	200	300
40	100	200	300
50	100	200	300
70	200	200	600
90	200	200	600
100	200	200	600
FB, HFB Breakers			
15	70	200	300
20	70	200	300
30	100	200	300
40	100	200	300
50	100	200	300
70	200	200	600
90	200	200	600
100	200	200	600
125	200	200	600
150	200	200	600
CA, CAH Breakers			
125	400	600	600
150	400	600	600
175	400	600	600
200	600	600	600
225	600	600	600
DA Breakers			
250	600	800	1000
300	600	800	1000
350	600	800	1000
400	600	800	1000

Circuit Breaker Ampere Rating	Current Limiting Fuse Rating, Amperes: Min. Fuse Inst. Trip Lo	Min. Fuse Inst. Trip Hi	Max. Fuse Load Side	Max. Fuse Line Side
JA, KA, HKA, JB, KB, HKB, Breakers				
70	200	400	600	600
90	200	400	600	600
100	300	400	600	600
125	300	400	600	800
150	300	400	600	800
175	300	400	800	800
200	400	600	800	800
225	400	600	800	800
250②	400	600	800	800
LAB, LA, HLA, LB, LBB, HLB Breakers				
70	200	400	600	600
90	200	400	600	600
100	300	400	600	600
125	300	400	600	800
150	300	400	600	800
175	300	400	800	800
200	400	600	800	1000
225	400	600	800	1000
250	400	600	800	1000
300	400	600	800	1000
350	400	600	800	1000
400	400	600	800	1000
500	800	800	1000	1000
600	800	800	1000	1000
MA, HMA Breakers				
125	300	400	600	800
150	300	400	600	800
175	300	400	800	800
200	400	600	800	1000
225	400	600	800	1000
250	400	600	800	1000
300	400	600	800	1000
350	600	600	800	1000
400	600	800	1000	1200
500	800	800	1000	1200
600	800	800	1000	1200
700	1000	1000	1000	1200
800	1000	1000	1000	1200
NB, HNB Breakers				
700	1000	1200	1600	1600
800	1000	1200	1600	1600
900	1200	1400	1600	1600
1000	1200	1400	1600	1600
1200	1400	1600	1600	1600
PB Breakers				
600	1000	1200	3000	3000
700	1000	1200	3000	3000
800	1000	1200	3000	3000
900	1200	1400	3000	3000
1000	1200	1400	3000	3000
1200	1400	1600	3000	3000
1400	1600	1800	3000	3000
1600	1800	2000	3000	3000
1800	2000	2500	3000	3000
2000	2500	3000	3000	3000
2500	3000	3000	3000	3000
3000	3000	3000	3000	3000

Circuit Breaker Ampere Rating	Current Limiting Fuse Rating, Amperes: Min. Fuse Inst. Trip Lo	Min. Fuse Inst. Trip Hi	Max. Fuse Load Side	Max. Fuse Line Side
LC, HLC SELTRONIC Breakers				
75	150	300	1200	1200
90	250	600	1200	1200
100	250	600	1200	1200
125	300	600	1200	1200
150	300	600	1200	1200
175	600	800	1200	1200
200	600	800	1200	1200
225	600	800	1200	1200
250	600	800	1200	1200
300	600	800	1200	1200
350	800	1000	1200	1200
400	800	1000	1200	1200
500	800	1200	1200	1200
600	800	1200	1200	1200
MC, HMC SELTRONIC Breakers				
400	800	1200	1600	1600
500	800	1200	1600	1600
600	1000	1200	1600	1600
700	1200	1600	1600	1600
800	1200	1600	1600	1600
NC, HNC SELTRONIC Breakers				
600	1200	1600	1600	1600
700	1200	1600	1600	1600
800	1200	1600	1600	1600
900	1200	1600	1600	1600
1000	1400	1600	1600	1600
1200	1600	1600	1600	1600
PC, PCC SELTRONIC Breakers				
1000	1400	1800	3000	3000
1200	1600	2000	3000	3000
1400	1800	2500	3000	3000
1600	1800	3000	3000	3000
1800	2000	3000	3000	3000
2000	2000	3000	3000	3000
2500	2500	3000	3000	3000
3000	3000	3000	3000	3000

① Also applies to MARK 75 Types HP, HC and HBA.
② JB, KB, HKB only.

How to Use Table E (Page 13)
Table E is based on the following type fuses:

240 volts: Class K1

600 Volts: Class J, K1 or L

The ratings listed are for applications up to 200,000 amps sym. available faults.

When applying 480 or 600 volt breakers on 240 volt (or less) circuits, the maximum line side fuse rating may be increased as follows:

Breaker Rated 480 or 600 Volts Ac	Increase Using	
	600 Volt Fuses	250 Volt Fuses
EHB, FB	20%	25%
JA, KA, JB, KB	20%	50%
LA, LAB, LB, LBB, LC	20%	50%
MA, MC	20%	50%
NB, NC	20%	50%
PB, PC, PCC	20%	25%

Minimum Current Limiting Fuse Rating
The columns headed "Min. Fuse" show the minimum fuse rating whose characteristic curve will not cross the thermal portion of the breaker characteristic curve. Thus, the fuse will not blow unless the short circuit current exceeds the instantaneous trip setting of the circuit breaker.

The magnetic trip setting of the Quicklags, Types CA, DA, EB, EHB, and FB thermal magnetic circuit breakers is non-adjustable. The instantaneous trip settings of the types JA, KA, HKA, JB, KB, HKB, LA, LAB, HLA, LB, LBB, HLB, MA, HMA, MC, HMC, NB, HNB, NC, HNC, PB, PC, and PCC, are adjustable so that two columns, headed "Min. Fuse Inst. Trip LO" and "Min. Fuse Inst. Trip HI" are provided to show the minimum fuse ratings at the low and high position of the magnetic trip setting. Other fuse ratings may be used between those shown for the LO and HI positions of the adjustable instantaneous trip, provided the magnetic trip adjustment is correctly set.

Maximum Current Limiting Fuse Rating on Load Side of Breakers
The columns headed "Max. Fuse Load Side" show the maximum fuse rating which may be used on the load side of the breaker. It should be noted that the ratings given are less than the ratings which may be used on the line side. The lower ratings are used because of the arc voltage created by the fuses during interruption. These voltages will be impressed across the poles of a 2 or 3 pole breaker when the fuses are applied on the load side. At the same time, ionized gases are generated. If fuses of higher rating than those shown in the table are used on the load side, the arc voltage and the ionized gases may cause flash-over between the poles of the breaker. This condition is not present if the fuses are used on the line side.

Maximum Current Limiting Fuse Rating on Line Side of Breaker
The columns headed "Max. Fuse Line Side" show the maximum fuse rating for each circuit breaker ampere rating which may be used in series with, and on the line side of the breaker. These are the maximum fuse ratings which will limit the short circuit current to within the capacity of the breaker and also protect the thermal elements. When these ratings are used, the fuses will not blow unless the short circuit approaches the maximum interrupting rating of the breaker. Applied in this manner, nuisance fuse blowing is minimized.

General Application Rules
1. In an application involving several different frame sizes or ampere ratings of circuit breakers, the maximum fuse rating is that one which will protect the smallest breaker in the system. The minimum fuse rating should be no less than the minimum rating shown for the largest breaker in the system.

2. If the application in question will not conform to the above requirement, the application is not in accordance with sound engineering practice.

Current Limiter Selectivity
Within an electrical distribution system, it is economically advantageous to provide selectivity whenever possible. Selectivity defines the interrelated performance of protective devices. The following is a tabulation of information necessary to apply Tri-Pac breakers and MCP's or FB breakers, with current limiter attachments in various arrangements, to provide coordination of limiters such that serious damage will not occur to the upstream limiter should the downstream limiter melt, regardless of the fault current within the maximum rating of the devices.

This does not imply that there will be any selectivity between tripping of the breakers involved but applies only to the current limiters as follows:

Tri-Pac's used with Tri-Pac's
Tri-Pac's used with breaker and current limiter attachment
Breaker and limiter attachment used with breaker and limiter attachment.

This is based on the I^2t values of the limiters. To insure selectivity, I^2t value of the upstream limiter must be at least three times that of the downstream limiter. Example: EL3030R will coordinate with 200LAP08.

Limiter	$I^2t \times 10^6$
FB Current Limiters	
LFB3070R	.35
LFB3150R	.7
LFB3003MR	.002
LFB3005MR	.004
LFB3010MR	.006
LFB3025MR	.03
LFB3030MR	.03
LFB3050MR	.15
LFB3070MR	.35
LFB3100MR	.415
LFB3150MR	.7
MCP Current Limiters	
EL3003R	.002
EL3007R	.004
EL3015R	.02
EL3030R	.03
EL3050R	.15
EL3100R	.415
EL3150R	.7
Tri-Pac Current Limiters	
100FBP06	.40
200LAP08	1.30
400LAP10	4.0
500LAP15	5.0
500NBP12	8.0
800NBP20	13.0
1000PBPR20	20.0
1600PBPR30	29.0

Table F: Allowable Ampacities of Insulated Copper Conductors③⑦

Not more than three conductors in raceway or cable or direct burial (Based on ambient temperature of 30°C. 86°F.)①

Wire Size AWG MCM	60°C 140°F	75°C 167°F	85°C 185°F	90°C 194°F	110°C 230°F	125°C 257°F	200°C 392°F	250°C 482°F
	Temperature Rating of Conductor (See Table F-1)							
	Types RUW (14-2), T, TW, UF	Types RH, RHW RUH (14-2) THW THWN XHHW USE	Types V, MI	Types TA, TBS, SA, AVB, SIS, FEP, FEPB, RHH, THHN, XHHW②	Types AVA, AVL	Types AI (14-8), AIA	Types A (14-8), AA, FEP⑥ FEPB⑥	Type TFE Nickel or nickel coated copper only
18	...	...	...	21	...	...	...	...
16	...	...	22	22	...	...	...	...
14	15	15	25	25④	30	30	30	40
12	20	20	30	30④	35	40	40	55
10	30	30	40	40④	45	50	55	75
8	40	45	50	50	60	65	70	95
6	55	65	70	70	80	85	95	120
4	70	85	90	90	105	115	120	145
3	80	100	105	105	120	130	145	170
2	95	115	120	120	135	145	165	195
1	110	130	140	140	160	170	190	220
1/0	125	150	155	155	190	200	225	250
2/0	145	175	185	185	215	230	250	280
3/0	165	200	210	210	245	265	285	315
4/0	195	230	235	235	275	310	340	370
250	215	255	270	270	315	335	...	...
300	240	285	300	300	345	380	...	...
350	260	310	325	325	390	420	...	...
400	280	335	360	360	420	450	...	...
500	320	380	405	405	470	500	...	...
600	355	420	455	455	525	545	...	...
700	385	460	490	490	560	600	...	...
750	400	475	500	500	580	620	...	...
800	410	490	515	515	600	640	...	...
900	435	520	555	555	...	...	...	...
1000	455	545	585	585	680	730	...	...
1250	495	590	645	645	...	...	...	...
1500	520	625	700	700	785	...	...	...
1750	545	650	735	735	...	...	...	...
2000	560	665	775	775	840	...	...	...

Table F-1: Correction Factors – Ambient Temps. Over 30 C. 86 F.

C.°	F.°	60°C 140°F	75°C 167°F	85°C 185°F	90°C 194°F	110°C 230°F	125°C 257°F	200°C 392°F	250°C 482°F
40	104	.82	.88	.90	.91	.94	.95	..	..
45	113	.71	.82	.85	.87	.90	.92	..	..
50	122	.58	.75	.80	.82	.87	.89	..	..
55	131	.41	.67	.74	.76	.83	.86	..	..
60	140	..	.58	.67	.71	.79	.83	.91	.95
70	158	..	.35	.52	.58	.71	.76	.87	.91
75	167	..	..	.43	.50	.66	.72	.86	.89
80	176	..	..	.30	.41	.61	.69	.87	.87
90	194	..	..	..	..	.50	.61	.80	.83
100	212	..	..	..	..	..	.51	.77	.80
120	248	..	..	..	..	..	..	.69	.72
140	284	..	..	..	..	..	..	.59	.59
160	320	..	..	..	..	..	..	..	.54
180	356	..	..	..	..	..	..	..	.50
200	392	..	..	..	..	..	..	..	.43
225	437	..	..	..	..	..	..	..	.30

① For ambient temperatures over 30°C, see Table F-1, Correction Factors.
② For dry locations only. See Table 310-13 of N.E.C.
③ These ampacities relate only to conductors described in Table 310-13.
④ Ampacities for Types FEP, FEPB, RHH, THHN and XHHW conductors for sizes 14, 12 and 10 shall be the same as designated for 75°C conductors in this table.
⑤ Ampacities for Types RHH, THHN and XHHW conductors for sizes 12 and 10 shall be the same as designated for 75°C conductors in this table.
⑥ Special use only. See Table 310-13.

Table G: Allowable Ampacities of Insulated Aluminum and Copper-Clad Aluminum Conductors③⑧

Not more than three conductors in raceway or cable or direct burial (Based on ambient temperature of 30°C. 86°F.)①

Wire Size AWG MCM	60°C 140°F	75°C 167°F	85°C 185°F	90°C 194°F	110°C 230°F	125°C 257°F	200°C 302°F
	Temperature Rating of Conductor (See Table F-1)						
	Types RUW (12-2), T, TW, UF	Types RH, RHW, RUH (12-2), THW, THWN, XHHW, USE	Types V, MI	Types TA, TBS, SA, AVB, SIS, RHH, THHN, XHHW②	Types AVA, AVL	Types AI, (12-8), AIA	Types A (12-8), AA
12	15	15	25	25⑤	25	30	30
10	25	25	30	30⑤	35	40	45
8	30	40	40	40	45	50	55
6	4	50	55	55	60	65	75
4	[illegible]	65	70	70	80	90	95
3	65	75	80	80	95	100	115
2	75	90	95	95	105	115	130
1	85	100	110	110	125	135	150
1/0	100	120	125	125	150	160	180
2/0	115	135	145	145	170	180	200
3/0	130	155	165	165	195	210	225
4/0	155	180	185	185	215	245	270
250	170	205	215	215	250	270	...
300	190	230	240	240	275	305	...
350	210	250	260	260	310	335	...
400	225	270	290	290	335	360	...
500	260	310	330	330	380	405	...
600	285	340	370	370	425	440	...
700	310	375	395	395	455	485	...
750	320	385	405	405	470	500	...
800	330	395	415	415	485	520	...
900	355	425	455	455	...	...	...
1000	375	445	480	480	560	600	...
1250	405	485	530	530	...	...	...
1500	435	520	580	580	650	...	...
1750	455	545	615	615	...	...	...
2000	470	560	650	650	705	...	...

Caution

Molded case circuit breakers are listed with UL, Inc. using 60°C rated conductor for ratings up to 100 amperes and 75°C rated conductor for all higher ratings. The use of smaller conductor with a higher temperature insulation rating will cause the breaker to operate hot and result in premature tripping and/or damage to the breaker.

⑦ Taken from N.E.C. Table 310-16. For information on aluminum conductors, refer to Table G.
⑧ Taken from N.E.C. Table 310-18. For information on copper conductors, see Table F.

Field Testing of Molded Case Circuit Breakers

Data obtained from field tests of molded case breakers often differs from published information, resulting in confusion on the part of the user as to which is correct.

Factory calibration and testing, on which published information is based, nearly duplicates actual operating conditions, i.e., 40°C ambient temperature, with poles in series in case of two and three pole breakers. Field testing, on the other hand, is usually done at room temperature (25°C) on individual poles.

Field testing should be performed by qualified individuals using the proper equipment and procedure. Such a service is available through the Westinghouse Electric Service Division. However, as a guide to those users who desire to do their own testing, the following procedure is offered:

Test Procedure

Any deviation from this procedure will result in time values different from those in Table 2, requiring interpretation of those values to adjust for the difference.

1. Connect breakers as instructed in Table 1, one pole at a time, using four feet of wire or cable as specified.
2. Conduct test at 300% of breaker rating in an ambient temperature of 25°C (77°F).
3. Resulting trip time should agree with trip times in Table 2.
4. Allow at least five (5) minutes cooling time between tests of adjacent poles.

① If copper bus is used in lieu of cable, on these ratings, base size on 1000 amps. per sq. inch.

② TRI-PAC breakers must be tested using dummy fuses or shorting the fuse terminal with a copper strap, or results will not be accurate and unnecessary blowing of fuses may result.

Table 1

Four feet of copper wire or cable, sized as indicated below, should be used for each pole.

Breaker Amp. Rating	Wire Size	No. of Cables Per Pole	Breaker Amp. Rating	Wire Size	No. of Cables Per Pole
15	#14	1	400	#000	2
20	#12	1	500	250 MCM	2
30	#10	1	600	350 MCM	2
40	#8	1	700	500 MCM	2
50	#6	1	800①	300 MCM	3
70	#4	1	900①	350 MCM	3
90	#2	1	1000①	400 MCM	3
100, 125	#1	1	1100①	300 MCM	4
150	#0	1	1200①	350 MCM	4
175	#00	1	1300①	400 MCM	4
200	#000	1	1400①	500 MCM	4
225	#0000	1	1500①	350 MCM	5
250	250 MCM	1	1600①	400 MCM	5
300	350 MCM	1	1700-2000①	500 MCM	5
350	500 MCM	1	2500①	500 MCM	6
			3000①	600 MCM	7

Table II

Test values are based on 300% of breaker rating on individual poles at 25°C.

Type Breaker	No. of Poles	Amp. Rating	Trip Time in Seconds Minimum	Trip Time in Seconds Maximum
Standard Breakers				
Quicklag B, C, P, HC, HP; Types BA, BAB, HBA	1	15-40	5	35
Quicklag B, C, P, HC, HP; Types BA, BAB, HBA	1	50-70	6	40
Quicklag B, C, P, HC, HP; Types BA, BAB, HBA	2,3	15-40	4	45
Quicklag B, C, P, HC, HP; Types BA, BAB, HBA	2,3	50-100	6	70
BA 277 Volt	1	15-30	12	35
CA, CAH	2,3	125-225	15	140
DA	2,3	250-400	65	250
EB, EHB, HFB	1	15-40	8	35
EB, EHB, HFB	1	50-100	22	75
EB, EHB, FB, HFB	2,3	15-40	9	45
EB, EHB, FB, HFB	2,3	50-150	23	110
JA, KA, HKA	2,3	70-100	65	150
JA, KA, HKA	2,3	125-225	65	200
JB, KB, HKB	2,3	70-100	5	150
JB, KB, HKB	2,3	125-225	10	200
JB, KB, HKB	2,3	250	25	250
LB, LBB, HLB	2,3	70-100	65	150
LB, LBB, HLB	2,3	125-400	50	250
LA, HLA (400 amp. frame)	2,3	125-400	50	250
LA, HLA (600 amp. frame)	2,3	250-600	50	250
MA, HMA	2,3	125-600	35	225
MA, HMA	2,3	700-800	100	450
NB, HNB	2,3	700-1200	120	450
PB	2,3	600-1600	150	575
PB	2,3	1800-3000	135	600
TRI-PAC Breakers②				
FB TRI-PAC	2,3	15-40	9	45
FB TRI-PAC	2,3	50-100	23	110
LA TRI-PAC	2,3	70-300	70	170
LA TRI-PAC	2,3	350, 400	115	230
NB TRI-PAC	2,3	300-400	180	480
NB TRI-PAC	2,3	500-800	210	540
PB TRI-PAC	2,3	600-1600	150	575
SELTRONIC Breakers				
LC, HLC	2,3	75-600	25	150
MC, HMC	2,3	400-800	25	150
NC, HNC	2,3	600-1200	25	300
PC, PCC	2,3	1000-3000	25	450
Magnetic Only Breakers				

Due to the many possible outside influencing factors, it may be very difficult to duplicate the factory calibration of magnetic only breakers or the instantaneous portion of standard thermal magnetic breakers. Such factors as the presence of steel, its thickness and proximity to the breaker, if the breaker is front or rear connected, the type of enclosure in which the breaker is mounted, current waveshape, current rate of rise, and power supply capacity all exert varying degrees of influence on the magnetic trip response of a breaker.

Molded Case Breakers for Application on Resistance Welding Circuits

Short circuit protection for resistance welding devices can be obtained by properly applying instantaneous trip molded case circuit breakers. These breakers permit normally high welding currents, but trip instantaneously if a short circuit develops.

These breakers include standard molded case circuit breaker features such as trip-free operation, dead front and single phase protection. Because the breakers are resettable after tripping, replacement costs and downtime are minimized.

The proper breaker can be selected by using the curve on page 19, and the instantaneous Trip Range tables at right using the "during-weld" amperes and % duty cycle.

Duty cycle is based on the one minute averaging time of the breaker, and can be determined as follows:

$$\% \text{ Duty Cycle} = \frac{\text{Weld Time} \times 100}{\text{Weld Time} + \text{Off Time}}$$

"During-weld" amperes can be obtained from the welder manufacturer, or as follows:

$$\text{During-weld Amperes} = \frac{\text{During-weld KVA} \times 1000}{\text{Voltage}}$$

Interrupting capacity of the breaker should be within the maximum available at the point of application.

For additional information on complete breakers listed in the tables, refer as follows:

Prices: Price List 29-020 P WE A
Ordering Information, etc:
Tech. Data 29-120 T WE A
Dimensions: Dimension Sheet 29-170
Application: Application Data 29-160

% Duty Cycle	100 A Frame		150 A Frame		225 A Frame		250 A Frame	
	Weld Current Amps	Inst. Calib. Amps	Weld Current Amps	Inst. Calib. Amps	Weld Current Amps	Inst. Calib. Amps	Weld Current Amps	Inst. Calib. Amps
1	1000	575-1800 FB; 450-1550 FB	1500	1250-2500 KB, LB; 575-1800 FB	2250	1500-3000 LA, LB	2500	2000-4000 LA, LB
2	707		1060		1592	1250-2500 KB, LB	1767	
3	577		866		1300		1443	1250-2500 KB, LB
4	500		750		1125		1250	
5	447		671		1007		1118	
6	408		612		919		1020	
7	378		568		851		945	
8	353		530	350-700 KB, KA	795		883	
9	333	160-480 FB	500		750		833	
10	316		474		711	500-1000 KB, KA	790	
15	258		387		604		645	500-1000 KB, KA
20	224		336		505		560	
25	200		300		450		500	
30	183		275		412		458	
35	168		252		378		420	
40	158		237		356		395	
45	149		224		336		373	
50	141		212		318		353	
55	135		203		304		338	
60	129		194		290		323	
65	124		186		279		310	
70	120		180		270		300	
75	116		174		261		290	
80	112		168		252		280	
85	109		164		246		272	
90	105		158		236		263	
95	103		155		232		257	
100	100		150		225		250	

% Duty Cycle	400 A Frame		600 A Frame		800 A Frame		1200 A Frame	
	Weld Current Amps	Inst. Calib. Amps	Weld Current Amps	Inst. Calib. Amps	Weld Current Amps	Inst. Calib. Amps	Weld Current Amps	Inst. Calib. Amps
1	4000	3000-6000 LA, LC; 2000-4000 LA, LB	6000	4000-8000 MA, MC, Spec. LA	8000	6000-12000 NB, MA Spec.	12000	8000-16000①
2	2828		4250	3000-6000 LA, LC	5656		8500	6000-12000 NB, PC
3	2310		3450		4620		6900	
4	2000		3000		4000	3000-6000 MA, MC	6000	
5	1790		2785		3580		5570	
6	1635		2450		3270		4900	
7	1512		2270		3024		4540	
8	1412		2120		2824		4240	3000-6000 NB, 3200-6400 NC
9	1332		2000		2664		4000	
10	1264		1896	1250-2500 LA, LC	2528		3792	
15	1032	750-1500 LA, LB	1550		2064	1500-3000 MA, MC	3100	
20	896		1345		1792		2690	
25	800		1200		1600		2400	
30	731		1100		1462		2200	
35	672		1010		1344		2020	
40	632		950		1264		1900	
45	596		895		1192		1790	
50	564		846		1128		1692	
55	540		811		1080		1622	
60	516		775		1032		1550	
65	496		745		992		1490	
70	480		720		960		1440	
75	464		696		928		1392	
80	448		672		896		1344	
85	436		655		872		1310	
90	420		631		840		1262	
95	411		618		822		1236	
100	400		600		800		1200	

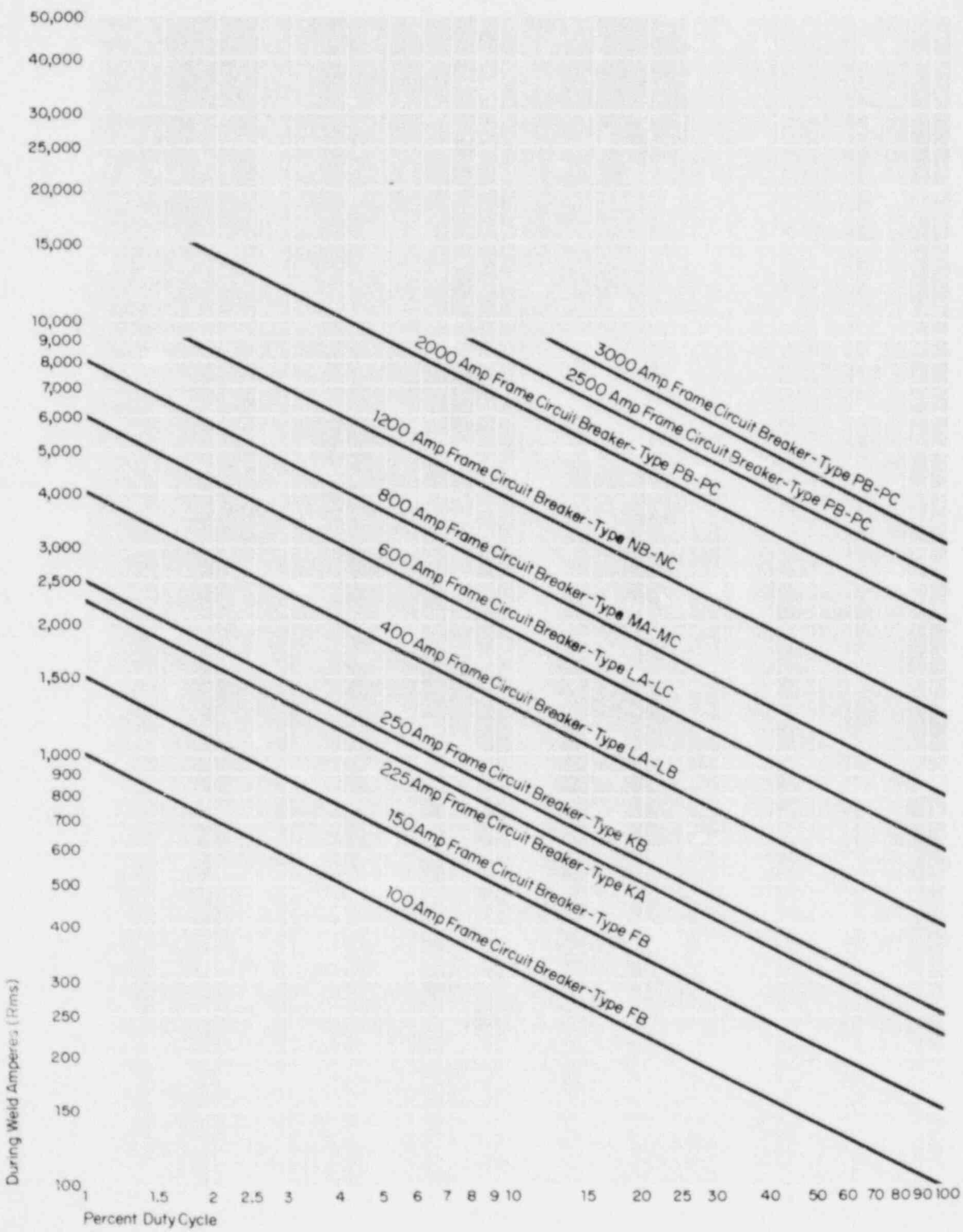
① Breaker not available in AB molded case design.

Molded Case Breakers for Application on Resistance Welding Circuits, *Continued*

% Duty Cycle	2000 A Frame Weld Current Amps.	2000 A Frame Inst. Calib. Amps.	2500 A Frame Weld Current Amps.	2500 A Frame Inst. Calib. Amps.	3000 A Frame Weld Current Amps.	3000 A Frame Inst. Calib. Amps.
1	20000	↑ 10000-30000①	25000	↑ 12000-30000①	30000	↑ 16000-48000①
2	14140	↑ 2000-20000 SCB-2000	17680		21250	
3	11550		14420		17250	
4	10000		12500		15000	
5	8950	↑ 4000-12000 PB	11280		13925	
6	8175		10200		12250	
7	7560		9450		11350	
8	7060		8830	↑ 4000-12000 PB	10600	
9	6660		8330		10000	
10	6320		7900		9480	↓ (16000-48000①)
15	5160	↓ (10000-30000①)	6450	↓ (12000-30000①)	7750	↑ 4000-12000 PB
20	4480	↑ 3000-8000 PB	5600	↑ 3000-8000 PB	6725	
25	4000		5000		6000	↑ 3000-8000 PB
30	3655		4580		5500	
35	3360		4200		5050	
40	3160		3950		4750	
45	2980		3725		4475	
50	2820		3525		4230	
55	2700		3395		4055	
60	2580		3225		3875	
65	2480		3100		3725	
70	2400		3000		3600	
75	2320		2900		3480	
80	2240		2800		3360	
85	2180		2725		3275	
90	2100		2625		3155	
95	2050		2580		3090	
100	2000	↓ (2000-20000 SCB-2000; 4000-12000 PB; 3000-8000 PB)	2500	↓ (4000-12000 PB; 3000-8000 PB)	3000	↓ (4000-12000 PB; 3000-8000 PB)

① Breaker not available in AB molded case design.

% Duty Cycle Vs. During-Weld Amperes



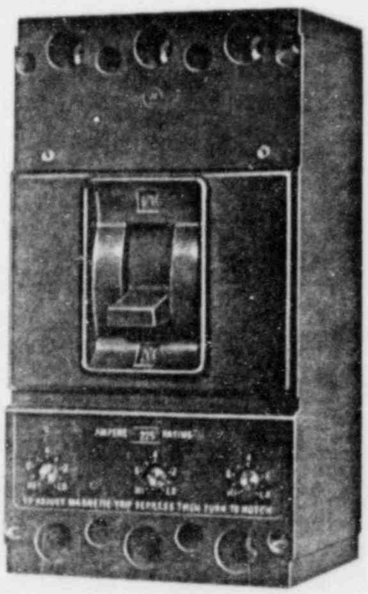
Westinghouse Electric Corporation
Low Voltage Breaker Division
Beaver, Pennsylvania 15009

September, 1976
Supersedes Application Data
29-160 all previous issues.
Mailed to: E, D, C/1901, 1928/DB

WE HAVE

Standard Types JA, KA, and MARK 75®
Type HKA
70-225 Amperes, 600 Volts Ac, 250 Volts Dc,
2 and 3 Poles

AB DE-ION® Circuit Breakers



Continuous Ampere Ratings
Underwriters' Laboratories, Inc. Listed
70, 90, 100, 125, 150, 175, 200, 225

Interrupting Ratings, Amperes
Underwriters' Laboratories, Inc. Listed

Types JA and KA
240 Volts Ac: 30,000 Asym., 25,000 Sym.
480 Volts Ac: 25,000 Asym., 22,000 Sym.
600 Volts Ac: 25,000 Asym., 22,000 Sym.
250 Volts Dc: 10,000

Mark 75 Type HKA
240 Volts Ac: 75,000 Asym., 65,000 Sym.
480 Volts Ac: 40,000 Asym., 35,000 Sym.
600 Volts Ac: 30,000 Asym., 25,000 Sym.
250 Volts Dc: 20,000⑤

Application
These breakers are designed for the protection of branch and feeder circuits. Being of compact size, they are ideally suited for use in control panels, panelboards, switchboards or separate enclosures where a 225 ampere frame size breaker is required.

MARK 75 Type HKA Breakers, because of their higher interrupting capacity, are ideally suited for use in network systems where unusually high fault currents are available.

Listed with Underwriters' Laboratories, Inc.

On all three phase Delta, grounded B phase applications, refer to Westinghouse.

Construction
These breakers have all the standard AB breaker features. Two and three pole breakers are supplied in one frame size; the current carrying parts being omitted from the center pole for two pole breakers. In addition, the MARK 75 Type HKA molded case is a higher strength glass polyester material with greater resistance to tracking. Type JA breakers have non-interchangeable trip units. Types KA and HKA have interchangeable trips.

Federal Specification W-C-375b
See tabulation on page 20.1.

Terminals
Two terminals required per pole. Terminals are Underwriters' Laboratories, Inc. listed for wire type and range listed below. When used with aluminum conductors, use joint compound.

Terminal arrangement permits ready use of other circuit connecting means, such as rear-connecting studs, panelboard connectors and plug-in adaptor kits.

Max. Breaker Amps	Catalog Number	Wire Range, Type No. of Cables
Standard Pressure Terminals (Copper Only)		
225	T225LA	1 #6-350 MCM
Optional Al/Cu Pressure Terminals		
225	TA225LA1	1 #6-350 MCM Cu, or 1 #4-350 MCM Al

Operation
When the breaker contacts are open the handle is in either the mid or OFF position. If in the mid-position the breaker has been tripped automatically. The latch must be reset by moving the operating handle to the extreme OFF position before attempting to restore service. Contacts may be closed, after resetting the latch, by moving the handle to the ON position. JA breakers may be mounted in an inverted position and are approved for reverse feed.④ Types KA and HKA may be mounted in an inverted position, but are not approved for reverse feed. The toggle handle operates with the following forces in pounds from the end of the handle: ON – 24 lbs; OFF – 10 lbs; reset – 15 lbs.

Thermal Magnetic Breakers
These breakers are equipped with thermal, front-adjustable magnetic trip elements. Thermal trip elements are of an indirectly heated bimetallic type having a long time delay well suited for starting motors having high inrush currents of long duration. Instantaneous magnetic trip settings may be adjusted between established limits to take care of circuit surge conditions. Trip units are non-interchangeable on JA breakers, and interchangeable on Type KA and HKA.

Magnetic Trip Setting and Range②

Ampere Rating	70	90	100	125	150	175	200	225
High	700	900	1000	1250	1500	1750	2000	2250
Low	350	450	500	625	750	875	1000	1125

Magnetic Only Circuit Interrupters③
These are breakers with adjustable magnetic trip elements only, for applications where short circuit protection only is required. Magnetic trip ranges are the same as those listed for thermal-magnetic breakers, but the continuous current ratings in all cases are 225 amperes.

Ambient Compensating Breakers③
Have thermal and magnetic trip elements. They are thermal compensating to carry full load at 50°C while also meeting U/L trip requirements at 25°C. Can be applied where a wide range of ambients is experienced.

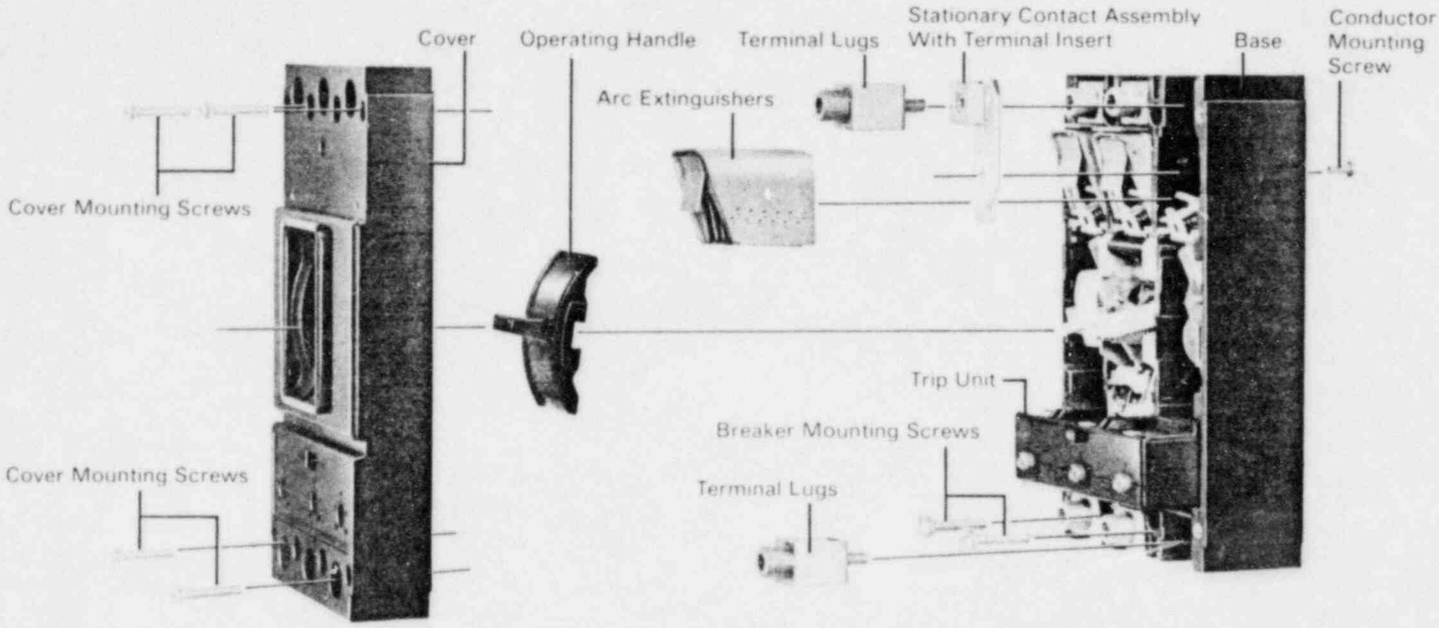
Saf-T-Vue Breakers (JA, KA Only)③
Saf-T-Vue breakers are similar to standard breakers except that they have a transparent window located over the breaker contacts. Saf-T-Vue breakers are commonly used in steel mill applications where sight of contacts is required. Can be supplied in all standard ratings.

Molded Case Switches (JA, KA Only)
(Non-Auto Interrupters)
Breakers with non-automatic details (latch bracket and bridging strap) can be installed where a heavy-duty, high-capacity disconnect switch without overcurrent protection is required. Accessories, such as shunt trip, undervoltage release, etc., cannot be field mounted in molded case switches as a dummy trip is required for mounting. Accessories can be mounted if specified when breaker is ordered.

Mining Service Breakers③
A special version of KA and HKA breakers is available to meet Bureau of Mines requirements for trailing cable applications. Refer to Technical Data 29-128 T WE A.

② All adjustable magnetic trips are set in high position at factory; may be adjusted down to required limit in the field.
③ Not Underwriters' Laboratories, Inc. listed.
④ Except when used with an auxiliary switch having 2A-2B contacts.
⑤ Ratings above 10,000 amps are not UL Listed.

Typical Exploded View



Circuit Breaker Removal
Before inspecting, installing, or removing from a circuit, the circuit breaker should be in the OFF position, and if practicable the circuit should be de-energized. If the circuit cannot be de-energized insulated tools, rubber gloves and a rubber floor mat should be used.

To remove a rear-connected circuit breaker from its mounting, remove terminal stud locknuts and pull circuit breaker forward.

To remove a front-connected circuit breaker from its mounting, loosen screws in terminal lugs and remove cables from terminals. Remove circuit breaker mounting screws and pull circuit breaker forward.

To remove a circuit breaker equipped with plug-in mounting blocks from its mounting, remove breaker mounting screws and pull circuit breaker forward.

Inspection and Maintenance
Good maintenance procedure calls for periodic inspection of all electrical apparatus including molded case circuit breakers. Terminal lugs and trip units must be tight to prevent overheating. Due to the inherent wiping action built into the moving contacts of all Westinghouse circuit breakers, operating the breaker several times under load will remove any high resistance film that may have formed. Under normal conditions, additional cleaning of contacts is not required. However, should operating and/or atmospheric conditions make it desirable to clean the contacts further, the following procedure is recommended.

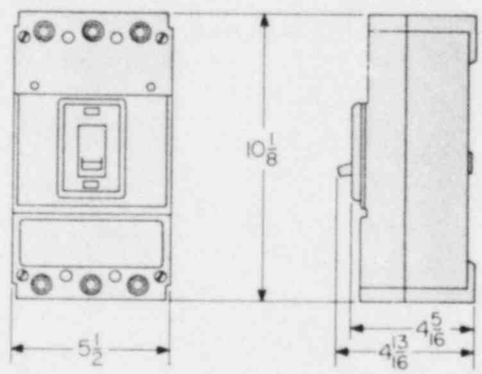
1. Remove cover, arc extinguishers and stationary contact assemblies.
2. Wipe contact surfaces with a clean cloth dipped in a chlorinated solvent. If surfaces are excessively oxidized or corroded, scrape lightly with a fine file before wiping.

It should be noted that removing the sealed cover of the type JA breaker voids the Underwriters' Laboratories, Inc., label.

Replacing Interchangeable Trip Unit, Types KA and HKA
1. Remove circuit breaker from its mounting per instructions under "circuit breaker removal".
2. Remove cover by removing four screws.
3. Remove screws from the outer poles of the line side of the trip unit and loosen the screw in the center pole of the same side of the trip unit.
4. Lift trip unit from frame after removing the operating handle from its mounting.
5. Install new trip unit by reversing above procedure.
6. Before replacing frame cover and mounting circuit breaker, check for proper latching and closing. Perform latching and closing operations per instructions under "operation". Open and close breaker several times to make certain proper latching has been achieved.
7. Replace frame cover and mount circuit breaker.

Accessories and Modifications
Accessories and modifications available include: alarm switch, auxiliary switch, shunt trip, undervoltage release, line terminal shields, plug-in adaptor kits, rear-connecting studs, center studs, mechanical interlocks, panelboard connectors, paralleling straps, motor operators, handle locking devices, moisture and fungus treatment.

Dimensions, Inches②
Not to be used for construction purposes. See Dimension Sheet 29-170 for detailed dimensions.



② 2-pole breakers supplied in 3-pole frames with center pole parts omitted.

Further Information
Prices: Price List 29-020 P WE A
Ordering Data: Tech. Data 29-120 T WE A
Dimensions: Dimension Sheet 29-170
Trip Curves: App. Data 29-161 A WE A

Printed in U.S.A.

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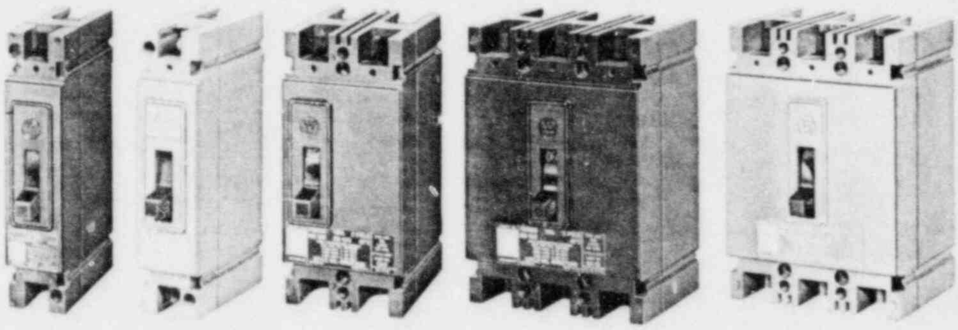
Low Voltage Breaker Division
Beaver, Pennsylvania 15009

September, 1976
Supersedes Application Data
29-160 all previous issues.
Mailed to: E, D, C/1901, 1928/DB

Standard Types EB, EHB, FB, and MARK 75®
Type HFB
15-100 Amperes, 1, 2, 3 Poles; 15-150
Amperes 2, 3, 4 Poles

AB DE-ION® Circuit Breakers



EB 1 Pole | HFB 1 Pole | EHB 2 Poles | FB 3 Poles | HFB 3 Poles

Continuous Ampere Ratings

Underwriters' Laboratories, Inc. Listed

Type EB
1 Pole, 120 Volts Ac, 125 Volts Dc: 15-100
2, 3 Poles, 240 Volts Ac, 125/250 Volts Dc: 15-100

Type EHB
1 Pole, 277 Volts Ac, 125 Volts Dc: 15-100
2 Poles, 480 Volts Ac, 250 Volts Dc: 15-100
3 Poles, 480 Volts Ac: 15-100

Type FB
2 Poles, 600 Volts Ac, 250 Volts Dc: 15-150
3, 4 Poles, 600 Volts Ac: 15-150

MARK 75 Type HFB
1 Pole, 277 Volts Ac, 125 Volts Dc: 15-100
2 Poles, 600 Volts Ac, 250 Volts Dc: 15-150
3 Poles, 600 Volts Ac: 15-150

Interrupting Ratings, Amperes

Underwriters' Laboratories, Inc. Listed

Type EB:
120, 240 Volts Ac: 10,000 (Asym. and Sym.)
120/250 Volts Dc: 5,000

Type EHB:
240 Volts Ac: 20,000 Asym., 18,000 Sym.
277 Volts Ac: 15,000 Asym., 14 000 Sym.
480 Volts Ac: 15,000 Asym., 14,000 Sym.
250 Volts Dc: 10,000

Type FB:
240 Volts Ac: 20,000 Asym., 18,000 Sym.
480 Volts Ac: [illegible]000 Asym., 14,000 Sym.
600 Volts Ac: 1[illegible],000 Asym., 14,000 Sym.
250 Volts Dc: 10,000

MARK 75 Type HFB
240 Volts Ac: 75,000 Asym., 65,000 Sym.②
480 Volts Ac: 30,000 Asym., 25,000 Sym.
600 Volts Ac: 20,000 Asym., 18,000 Sym.
250 Volts Dc: 20,000④

Application

These breakers are designed for use in control panels, convertible power panelboards, switchboards, motor control centers, lighting panels, bus duct plug-ins, individual enclosures and machine tool control panels. This breaker is used most frequently on motor branch circuits because its ratings cover most protective requirements. These breakers are listed with the Underwriters' Laboratories, Inc.

On all three phase Delta, grounded B phase applications, refer to Westinghouse.

Construction

These breakers have all the standard AB breaker features. The HFB breaker molded material is a high impact, high tensile, flame resistant glass polyester, six times stronger and 21 times more resistant to tracking than the standard black moldarta.

Federal Specification W-C-375b

See tabulation on page 20.1.

Terminals

Thermal magnetic breakers include load terminals only, Underwriters' Laboratories, Inc. listed for wire sizes and ranges listed below. Line terminals are available if required. When used with aluminum conductors, use joint compound.

Max. Breaker Amps.	Wire Type	Wire Range
Standard Pressure Terminals		
20 (EB, EHB)	Al/Cu	#14-#10
100	Al/Cu	#14-1/0
150	Al/Cu	#4-4/0
Optional Al/Cu Pressure Terminals		
50	Al/Cu	#14-#4
100	Al/Cu	#4-4/0

Removable terminal collar permits ready use of rear connected studs, plug-in adapter kits, or panelboard connector straps.

Operation

When the breaker contacts are open, the handle is in either the mid or OFF position.

If in mid-position, the breaker has been tripped automatically and the latch must be reset by moving the operating handle to the extreme OFF position before attempting to restore to service. Contacts may be closed, after resetting the latch, by moving the handle to the ON position.

Pounds of force required to operate toggle handle:

Breaker Amps.	On	Off	Relatch
Up to 100	15.5	3.75	6.5
125, 150	25.5	6.5	9.5

Thermal Magnetic Breakers

EB, EHB, FB and HFB frame breakers are equipped with cooperative thermal magnetic trip elements. On low overloads, the bimetal initiates tripping action. On short circuits, the magnetic element instantly opens the circuit. On high overloads, the bimetal, gradually bending, assists magnetic tripping by shortening the air gap. After calibration, breaker cases are sealed to prevent tampering; thus trip elements are not adjustable and are not interchangeable.

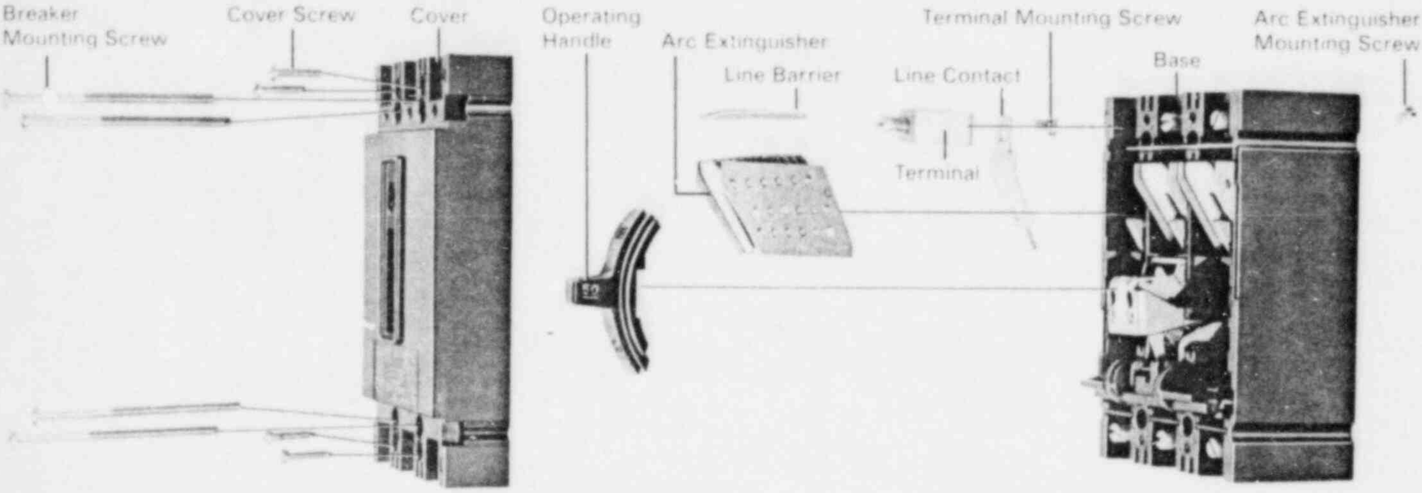
Magnetic Only Breakers (FB, HFB)③

Front adjustable magnetic only circuit breakers are instantaneous trip devices providing short circuit protection only. They are normally used in conjunction with additional overcurrent protection.

Trip units are calibrated and set at the factory on the high value of the trip range, but may be field-adjusted to the low value. The trip setting may be changed by turning the

② 1 pole breakers are rated at 277 volts Ac with an interrupting rating of 75,000 amps. Asym., 65,000 amps. Sym. for 15-30 amps. and 30,000 amps. Asym., 25,000 amps. Sym. for 40-100 amps.
③ Not UL Inc. Listed.
④ Ratings above 10,000 amps not UL Listed.

Exploded View, Ther**mal Magnetic Breaker**



adjusting knob in the front cover of the breaker. The adjustment is designed to follow a linear scale, so that each of the settings provided has a definite ampere significance within calibration tolerances.

Magnetic Trip Range and Settings

Setting	Continuous Ampere Rating						
	3	5	10	25	25	30	30
Low	7	15	35	32	66	50	90
High	22	45	110	80	190	150	270

Setting	Continuous Ampere Rating					
	50	50	70	100	100	150
Low	66	160	100	150	450	575
High	190	480	270	480	1550	1800

Saf-T-Vue Breakers (Except HFB)②

Saf-T-Vue breakers are similar to standard breakers except that the cover is fitted with a transparent window located over the breaker contacts. They are commonly used in steel mill applications where sight of contacts is required. Can be supplied in all standard ratings.

Molded Case Switches (Except HFB) (Non-Auto Interrupters)

These are breakers without overload or short circuit tripping elements and can be installed where a compact high capacity disconnect switch is required without overcurrent protection.

Mining Service Breakers②

A special version of FB and HFB breakers is available to meet Bureau of Mines requirements for trailing cable applications. Refer to Technical Data 29-128 T WE A.

Breaker Mounting

Breakers are approved for either upside down mounting or reverse feed.④

Circuit Breaker Removal

Before inspecting, installing, or removing from a circuit, the circuit breaker should be in the OFF position, and if practical, the circuit should be de-energized. If the circuit cannot be de-energized, insulated tools, rubber gloves, and a rubber floor mat should be used.

To remove a rear-connected circuit breaker from its mounting, remove terminal stud locknuts and pull circuit breaker forward.

To remove a front-connected circuit breaker from its mounting, loosen terminal screws and remove cables from terminals. Remove circuit breaker mounting screws and pull circuit breaker forward.

To remove a circuit breaker equipped with support blocks from its mounting, remove support block breaker mounting screws and pull circuit breaker forward. When the optional bolt-on support block feature is used, the screws mounting the stabs to the breaker conductor must also be removed.

Inspection and Maintenance

Good maintenance procedure calls for periodic inspection of all electrical apparatus including molded case circuit breakers. Terminal lugs must be tight to prevent overheating. Due to the inherent wiping action built into the moving contacts of all Westinghouse circuit breakers, operating the breaker several times under load will remove any high resistance film that may have formed.

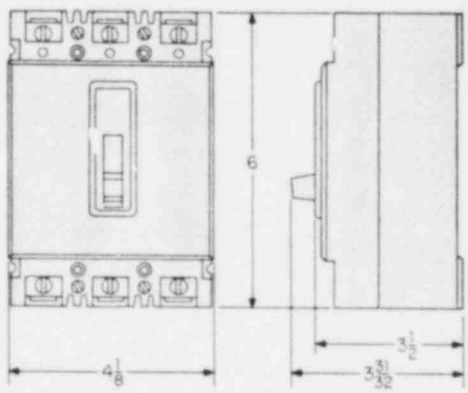
② Not Underwriters' Laboratories, Inc. listed.
③ 1 pole breakers are $1\frac{3}{8}$" wide, 2 pole breakers are $2\frac{3}{4}$" wide, except 2 pole FB magnetic only, and all 2 pole HFB which are the same as 3 pole. 4 pole FB breakers are $5\frac{1}{2}$" wide; other dimensions are same as 3 pole.
④ Breakers with internal attachments are not suitable for reverse feed.

Accessories, Modifications

Accessories and modifications are available as follows: See PL 29-120 or DB 29-150 for description. Line terminal shields, rear connecting studs, plug-in adapter kits, panelboard connectors, center studs, handle locking devices, parallel connectors, moisture and fungus treatment, shunt trip, undervoltage release, auxiliary switch, alarm switch, mechanical interlocks, and motor operator.

Dimensions, Inches③

Not to be used for construction purposes. See Dimension Sheet 29-170 for detailed dimensions.



Further Information

Prices: Price List 29-020 P WE A
Ordering Data: Tech Data 29-120 T WE A
Dimensions: Dimension Sheet 29-170
Trip Curves: Application Data 29-161 A WE A

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