

**Low Voltage
Metal Enclosed Switchgear
Type LC**



Type LC Metal Enclosed Switchgear



INTRODUCTION

The increasing use of electrical energy in both industrial and commercial facilities places additional requirements on the power systems of these facilities. M&I Electric Industries, Inc. offers a wide variety of modern low voltage metal enclosed switchgear employing "iron-frame" power circuit breakers which are carefully designed and manufactured to meet the requirements of virtually all users and applications.

Today's business environment mandates that industrial and commercial facilities become both safer and more reliable than they already are, and that expansions and modifications to the electrical power systems and apparatus in these facilities be performed in less time, on ever tighter budgets.

M&I offers LC switchgear to meet these requirements. This modern equipment is available in all industry standard ratings to meet the vast majority of applications. Additionally, special ratings are available to meet virtually any unusual applications.

In addition to supplying affordable equipment for new construction, M&I has the experience and the technical qualifica-

tions needed to assist in a variety of switchgear expansion, modernization, extension, and upgrade projects. Whether the project requires new switchgear which can match and line up with existing apparatus, or simply requires that existing switchgear be remanufactured or updated to include circuit breaker elements with modern solid state trip units. M&I has the proven ability to complete the project on-time and within budget.

M&I is uniquely positioned to design, manufacture, install, test, and maintain a wide variety of electrical apparatus and systems, including low and medium voltage switchgear and its associated protection, monitoring, and control equipment. M&I can therefore become the ideal partner to organizations which purchase or utilize this type of equipment.

APPLICATION

Type LC Low voltage metal enclosed switchgear is used in electrical power distribution systems for the control and protection of circuit conductors and equipment. This equipment is commonly installed in industrial power distribution systems, generating stations, cogeneration facilities, peak shaving systems, auxiliary substations, unit substations, and in commercial buildings.



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Type LC Metal Enclosed Switchgear

Type LC switchgear is commonly applied in the following locations:

Industrial Plants - for service entrance equipment, bulk power distribution, and lighting network feeders, plus power generation and auxiliaries. Also to provide power for machine tools and material handling equipment drives.

Central Stations - to protect and distribute power to station auxiliaries - blowers, compressors, fans, pumps, motors.

Commercial Buildings - for power system protection and reliable distribution of power for lighting, elevators, air conditioning, plus blowers, fans, motors and pumps.

M&I metal enclosed switchgear is available in indoor type LC and outdoor type LCR construction. This apparatus is applied at system voltages of 600, 480, 240 and 208 volts.

The circuit breakers employed in type LC and LCR switchgear may be either manually or electrically operated, and are available either unfused or fused. Solid state trip devices are provided on all low voltage power circuit breakers.

DESIGN OVERVIEW

Among the design features of type LC switchgear are the following:

- Two design widths of vertical sections: 30 inch and 22 inch. All breaker sizes can be accommodated in a combination of units of the two widths.
- Flexible mounting arrangements: breakers from 800A through 2000A can be stacked four-high in a 22" wide section.
- Five circuit breaker frame sizes: 800, 1600, 2000, 3200 and 4000 amperes
- Expanded interrupting capacities optionally available.
- UL listing of circuit breakers is standard.
- UL listing for cubicles (UL 1558) optionally available.
- Cable compartment barriers between adjacent units.
- Fully insulated main bus optionally available.
- Metal barriers for incoming line, bus and cable compartments are optionally available.
- Secondary wire troughs, with optional covers.
- Closed door drawout of circuit breakers with separate connected, test and disconnected positions.

- Primary disconnect shutters - optionally available.
- Convenient inspection - with door open and the breaker fully withdrawn, key components can be inspected without removal from the rails.
- Coordinated Insulation System - high strength, track-resistant, flame retardant, fiberglass-reinforced polyester insulation, bus supports, and moldings provide high momentary short circuit strength. Bus bar arrangements which incorporate high creepage allowances resist dust buildup and the effects of contaminants.
- Solid state overcurrent tripping system assures years of trouble free, reliable service and provides optimum distribution system protection.
- Simple Breaker Rating Change - Changes in continuous current or pickup setting can be made without any special tools by merely adjusting the knob settings on the solid state trip units.

STANDARDS & RATINGS

M&I types LC and LCR metal-enclosed low voltage switchgear with drawout power circuit breaker is designed, tested, and constructed to comply with ANSI C37.20, Switchgear Assemblies, and other related ANSI standards, as well as the applicable standards of IEEE and NEMA, and meets the applicable requirements of the [600VAC Generator Control] National Electrical Code (NEC).

The drawout circuit breakers comply with ANSI C37.13, C37.16 and C37.17 for the frame sizes from 800 to 4000A, and they are individually UL labeled.

When the assembly is specified for applications as "Service (Entrance) Equipment", the additional features and modifications required by the NEC are incorporated into the equipment.

SPECIFICATIONS—CUBICLES

Framework and Compartments

The switchgear is totally metal-enclosed, employing a unit construction concept, where the switchgear structure is assembled from individual standardized compartments to form a single, compact switchgear assembly. Each vertical section consists of three or circuit breaker and/or auxiliary compartments, providing a uniform section height. All construction is a code of gauge (or better) cold rolled sheet steel.

A switchgear lineup is composed of as many vertical sections as required to provide the required circuit breakers and auxiliary devices. Normally, the end sections include provisions for the future installation of additional adjacent units

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Type LC low voltage metal-enclosed switchgear offers the inherent safety provided by closed-door drawout, dead-front construction, with totally metal enclosed circuit breakers, as well as metal enclosure of the top, rear, and ends of the switchgear lineup. The use of separate side sheets provides two metal thicknesses between vertical sections. This metal-enclosed design philosophy, combined with complete circuit breaker interlocking features, produces switchgear in accordance with ANSI C37.20-1974.

The base and top frame of type LC switchgear sections are welded subassemblies, composed of standard structural shapes carefully assembled to tight tolerances. The steel framework of the switchgear is then constructed of formed elements, fabricated from code gauge sheet steel, which are then bolted and/or welded together and reinforced with cross-member braces to form a rigid, self-supporting, compact assembly.

Compartments housing each low voltage power circuit breaker are steel sub assemblies mounted within the framework to form the complete switchgear section. The top, side, and rear sections are fitted with removable steel sheets securely bolted to the framework forming a rigid assembly. Where two vertical breaker sections are to be mounted together side by side, there are two thicknesses of code gauge steel between adjacent circuit breaker compartments.

The circuit breakers are barriered from the bus/cable compartment by the compartment housing the breaker.

The bus/cable compartment includes the main horizontal bus, riser bus, connections from the main bus to one set of primary disconnects, and load side "run-back bus". This equipment is arranged so that cable lugs for field connections are accessible without reaching over the main bus.

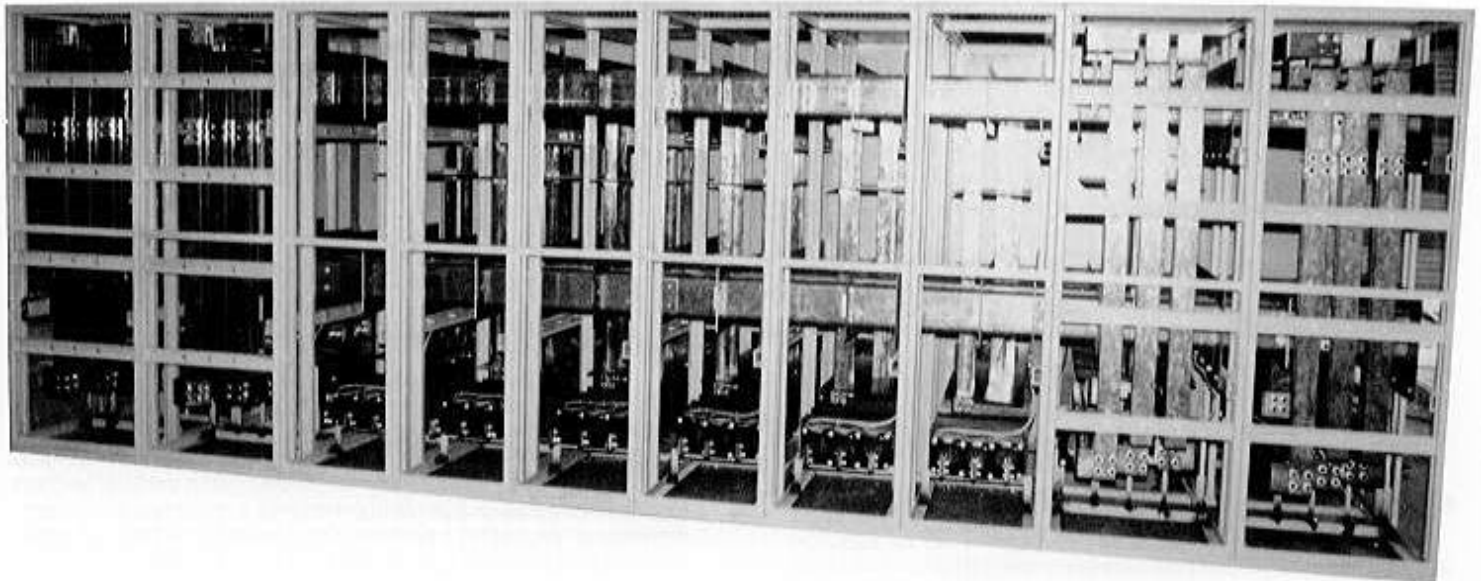
Main and Ground Bus

Rounded-edge silver-plated copper bus bars are standard. Main bus construction incorporates high pressure bolted bus joints. High strength Grade 5 steel hardware assures constant pressure and low resistance connections. Split lock washers are provided as a standard, with spring washers available as an option.

For normal applications, the main three phase horizontal bus is vertically arranged one phase above the other with edge-to-edge alignment providing a high short circuit strength system. Fully insulated bus is available as an extra cost option.

Normal main bus ratings are 1600, 2000, 3200, 4000, 5000, and 6000 amperes continuous, with even higher ratings available for special applications. Bus bracing is based on smallest breaker short circuit rating. Minimum bracings is 50,000 amperes RMS symmetrical. Other symmetrical bracings are 65,000, 85,000, 100,000, 130,000, 150,000, and 200,000 amperes.

A neutral bus is furnished when specified, and can be rated 1600, 2000, 3200, or 4000 amperes continuous, again with higher ratings available for special applications.



Type LC Switchgear with special 12,000 Ampere Main Bus



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A copper ground bus is furnished as standard. The ground bus extends through all vertical sections and is securely bolted to each vertical structure. Provision (in the form of two mechanical lugs per lineup) is made for connection to the owner's ground grid.

Optional barriers can be provided between the bus and cable areas, to isolate the cable area. Barriers are also available to isolate the incoming bus of main circuit breakers from the bus.

The assembly is designed for temperature limitations as defined by ANSI C37.20, paragraph 4.4.

The units are designed for a 50 degrees C maximum total temperature of parts handled by the operator. The bus is designed for 65 degrees C maximum rise above 40 degrees C ambient. Air surrounding the switchgear cable connection points is limited to 45 degrees C rise above 40 degrees C ambient. ANSI C37.20, paragraph 7 includes application requirements.

Insulation System

Track-resistant fiberglass-reinforced polyester insulation is used throughout in the coordinated insulation system, which is designed to provide liberal creepage allowances. This insulation has high impact strength, which eliminates risk of damage due to short circuit stress, and its design also assures low moisture absorption. Other advantages are: high flame retardance, long life - even at high temperatures, and high resistance to chemical fumes.

The primary disconnects are mounted on cast or molded fiberglass-reinforced polyester insulation elements in the cubicle. The high momentary strength provided by the edge-to-edge bus bar arrangement is coupled with high creepage distances insulation to provide the requisite bus bar bracing.

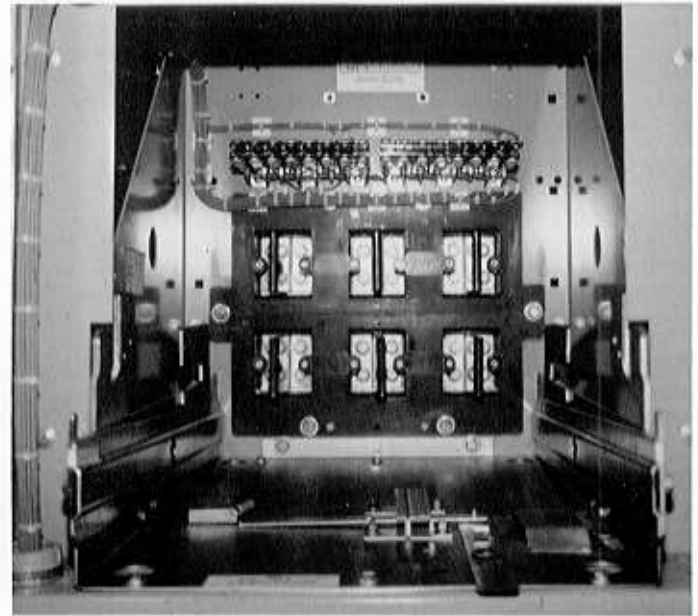
A completely insulated bus bar insulation system is optionally available for the main and vertical bus within the breaker units.

Circuit Breaker Compartments

Each circuit breaker compartment includes as standard the stationary primary disconnects, ground disconnects, and the drawout rails, plus the associated safety interlocks.

Circuit breakers can be fully withdrawn on compartment rails, which facilitate breaker handling, inspection, and maintenance.

Cells for electrically operated circuit breakers also include the necessary secondary disconnects, as well as control circuit fuse blocks. These fuse holders are of the dead front type, and are designed to allow the storage of the holder in the fuse block when the circuit is disconnected. This feature reduces the possibility of misplacing or interchanging fuses while performing maintenance on a breaker.



Circuit Breaker Compartment

Each circuit breaker cell includes provisions for mounting current transformers for metering or relaying.

Circuit Breaker Closed-Door Drawout

Racking the breaker in or out is accomplished by operating a separate racking handle. The handle operates the individual drawout mechanism within each circuit breaker compartment to move the circuit breaker from the CONNECTED position to the TEST and DISCONNECTED positions, respectively.

When the breaker is completely racked in, it is said to be in the CONNECTED position. This is the normal operating position. As it is drawn out, it passes into a TEST position where the primary disconnects no longer make contact, but the secondary circuits (if any) remain connected. In this position, the breaker may be opened and closed for testing without energizing the load. Beyond the test location the breaker is in the DISCONNECTED position where all contacts are parted. Racking of the breaker can be done while the compartment door is open or closed.

A position indicator is located on the front of the breaker mechanism cover. The breaker movement relative to the Connect, Test, and Disconnect positions may be observed while operating the racking handle.

Shutters

Shutters are optionally available to provide protection against accidental contact with energized primary disconnects when the breaker is withdrawn from its cell. These

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shutters are operated by the circuit breaker racking mechanism, and are designed to automatically close as the circuit breaker is withdrawn from the CONNECTED position toward the DISCONNECTED position. When the circuit breaker is subsequently withdrawn from its compartment, the primary disconnects will be fully installed.

Wire Trough Covers

Removable trough covers are available for enclosing secondary wiring within each vertical section in the primary bus and outgoing cable areas.

Hinged Rear Doors

Full height formed rear door with removable pin hinges are available in place of the standard split, bolted on plates. Doors may be secured by hex head hardware or by manual or tool operated latches.

METERING and CONTROL

A full spectrum of measurement, instrumentation, and control accessories are available as an integral part of an M&I type LC switchgear lineup. These compartments are mounted in metering and auxiliary compartments, and are interconnected with the remainder of the switchgear to provide an integrated control and protection package.

Metering and Auxiliary Compartments

Instruments, meters, and switches for main bus metering are normally grouped on a panel above the main breaker. This compartment also serves to enclose auxiliary devices, potential transformers, control power transformers, and the like.

Indicating Instruments

Standard indicating instruments are rectangular panel type with two percent (2%) accuracy, semi-flush mounted. Standard instrument transfer and breaker control switches are miniature rotary type.

Optional switchboard style indicating instruments are available, with one percent (1%) accuracy and 250 degree scales. Additionally, full size instrument transfer switches are available as an option, and are normally supplied when 1 percent switchboard instruments are specified. Watt-hour meters are switchboard type, and are provided with drawout cases which include built-in test facilities.

Primary fuses for potential transformers and control power transformers are installed in pull-out type fuse blocks. The secondary fuses may also be supplied in pull-out type fuse blocks as an option.

Potential Transformers

Potential transformers are mounted within separate metering compartments, and are protected by primary pull-out

type current limiting fuses. Secondary fuses are also provided.

Control Power Transformers

Control power transformers are normally mounted within the metering compartments, and are protected by primary pull-out type current limiting fuses. Secondary fuses are also provided. When their size prevents locating control power transformers in a metering compartment, they are located in a separate compartment.

Feeder Metering

Common instrumentation and control devices can be accommodated on feeder circuit breaker cell doors, including any (or all) of the following:

- Circuit breaker control switch, compact type
- Indicating lights, 1-red and 1-green
- Ammeter, 3 1/2" scale, 2% accuracy
- Ammeter transfer switch, compact type
- Current test block

Control Wiring

All secondary and control wiring in No. 14 AWG (minimum) extra flexible stranded copper wire rated 90 degrees C or better. Insulated barrel, crimp-type terminals are used for connection to screw-type terminations. Other termination types, such as locking fork, end sleeve, and tab disconnect types are employed, as applicable. A wide variety of optional

Protective Relaying

While the solid state trip units of the individual circuit breakers in type LC switchgear can provide overcurrent, short-circuit, and ground fault protection, additional protective relaying protection (differential, under/over voltage, over temperature, etc.) is available in virtually any conceivable protective scheme. Special application switchgear, such as generator control, cogeneration, and peak shaving systems, are also readily available from M&I.

Power Monitor and Control Systems

M&I type LC switchgear can be supplied with a variety of modern electronic power monitoring and/or control systems. These systems allow real-time central monitoring of operating conditions and event recording. Additionally, complete remote control of the switchgear is possible. These systems may be readily incorporated into existing DCS and other computer based control schemes, or they can form the basis for a central data collection and control system.

Mechanism Operated Cell (MOC) Switch

When required, a mechanism operated cell switch (MOC) can be mounted in the circuit breaker compartment. This device provides additional control or auxiliary contacts which are operated by the circuit breaker.



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Truck Operated Cell (TOC) Switch

When required, a truck operated cell switch (TOC) can be mounted in the circuit breaker compartment. This device provides control contacts to indicate the position of the circuit breaker within the compartment.

OUTDOOR SWITCHGEAR

General

Three principal types of outdoor housing (non-walk-in, walk-in, and power house) are available to meet almost any application.

For all types of outdoor construction, the underside of the base is coated with a coal tar emulsion (or equivalent). The switchgear is shipped in convenient groups for erection in the field. Shipping groups normally do not exceed 15 feet in length. All necessary erection hardware is furnished.

Non-Walk-In Design

The non-walk-in switchgear consists of indoor type vertical sections located in a steel housing of aisleless non-walk-in weatherproof construction. Each vertical section has a full height exterior front door with three point vault type hard-

ware and provisions for padlocking. Two removable rear panels or optional hinged doors are included for cable access to the cable termination area.

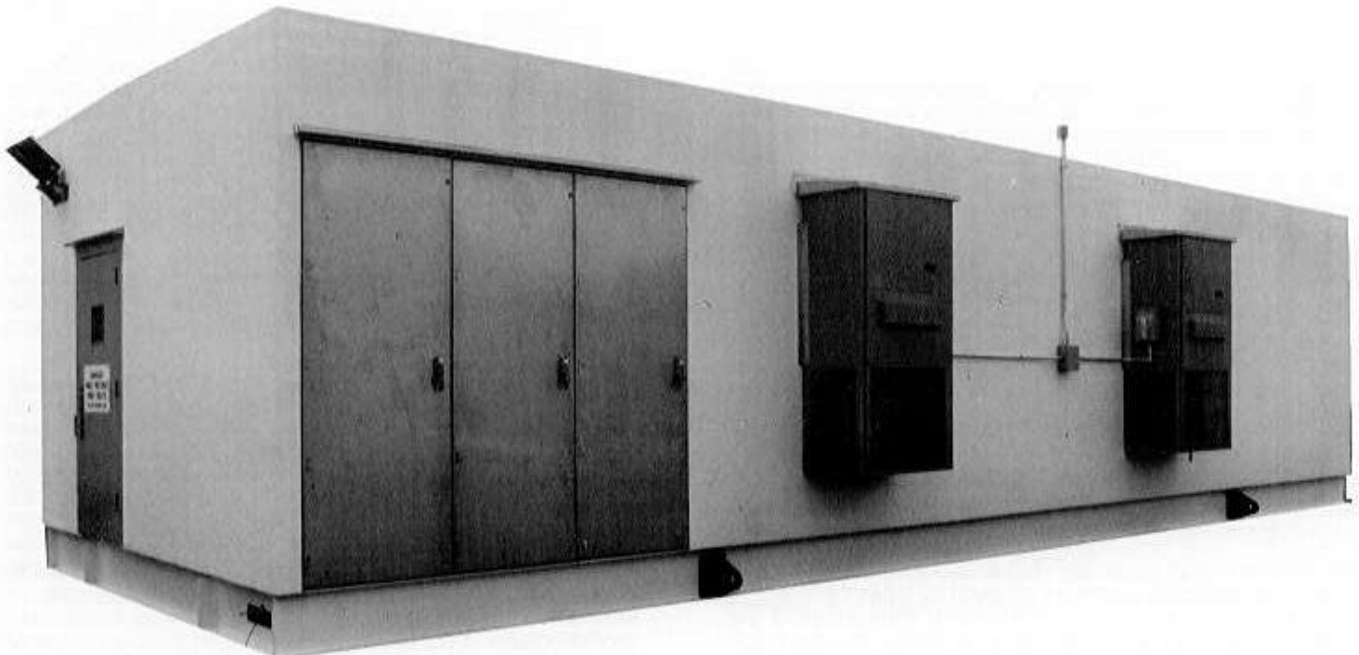
Each cubicle includes a switched lamp receptacle for proper illumination of the cubicle during maintenance and inspection, a duplex receptacle for use with electric tools, and necessary space heaters. A switch for all the space heaters is located in one cubicle.

Walk-In Design

Single Aisle

M&I single aisle outdoor walk-in switchgear consists of indoor type vertical sections located in a weatherproof steel housing having an operating aisle space of sufficient size to permit withdrawal of the circuit breakers for inspection, test, or maintenance. An access door is located at each end of the aisle, arranged so that the door can be opened from the inside regardless of whether or not it has been locked from the outside. The aisle space is provided with lighting which is controlled by means of a three-way switch at each access door.

Each cubicle includes necessary space heaters. Each lineup includes two utility duplex receptacles, one at each aisle access door, for use with electric tools.



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Common Aisle

Common aisle outdoor walk-in switchgear consists of two lineups of indoor type vertical sections located in a weather proof steel housing having a common operating aisle space of sufficient size to permit withdrawal of the circuit breakers for inspection, test, or maintenance. Otherwise the construction is as described for single aisle design.

Power Houses

M&I can offer a wide variety of power house designs and construction techniques, each of which is carefully tailored to the customer's application. In addition to type LC low voltage metal enclosed switchgear, all other types of medium and low voltage electrical power distribution apparatus and control equipment can be factory installed, wired, and fully factory tested in a virtually limitless number of schemes and arrangements.

As noted above, M&I power houses can be built using a variety of construction materials and techniques. Houses may be built using interlocking panels fabricated from galvanized steel, aluminum, and even stainless steel. Power houses may also be of the seal-welded type, again using a variety of ferrous or non-ferrous wall skin materials. Finally, power houses may be constructed with non-metallic wall systems, such as fiberglass.

Power houses are typically supplied with fluorescent and/or incandescent lighting systems designed to facilitate equipment operation and maintenance, convenience outlets for maintenance and test procedures, and emergency lighting systems.

M&I power houses are typically supplied with coordinated heating, ventilating, and air conditioning systems which are designed to both extend the life and reliability of the equipment installed in the power house and to provide a comfortable environment for operations and maintenance personnel.

A broad selection of special constructions and accessories are available upon request, including pressurization systems to allow power houses to be installed in Class I, Division 2 areas, and CO₂ or Halon fire protection systems.

Finish

The exterior panels and formed structural elements (except extruded structural shapes) of all outdoor equipment are fabricated from zinc plated steel sheets (Galvaneal or equivalent).

All unplated steel parts are degreased and exposed to a phosphate chemical treatment followed by a sealing solution. The phosphate bath effects a chemical conversion of the metallic surface to a non-metallic phosphate coating. Insoluble in water, this coating is effective in retarding corrosion and is an excellent undercoating for paint.

After cleaning and stabilization, primer and polyester urethane paint is applied to each part. Standard finish colors are:

Indoor - Light Gray (ANSI 61)

Outdoor - Dark Gray (ANSI 24) or Sky Gray (ANSI 70), as specified.

The underside of outdoor equipment is coated with a heavy coal tar emulsion (or equivalent) for added corrosion resistance.

ACCESSORIES

Standard Accessories:

- Handle for circuit breaker racking
- Lifting bar assembly for all circuit breaker types
- Manual spring charging handle if electrically operated circuit breaker are included
- Quart of touch-up paint

Partial list of optional accessories

- Inspection and test cabinet, indoor wall mounted with necessary controls and connectors for testing electrically operated breakers while the breaker is outside of unit.
- Breaker Lift Device - A hoist for ease of breaker handling, which is mounted on top of each switchgear group, and which travels along rails to positions above any vertical section. To remove a breaker it must first be drawn completely out of its compartment and the lifting bar attached, forming a two point lift. The hook from the crane is then connected to the bar, permitting the circuit breaker to be readily raised or lowered.

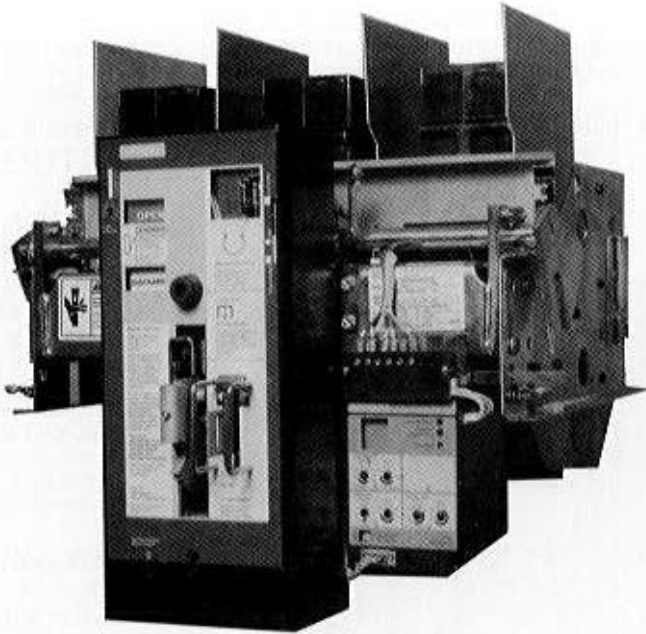
CIRCUIT BREAKERS

The circuit breakers employed in type LC and LCR switchgear are designed for 600-volt and below service with current carrying capacities up to 4000 amperes and interrupting capacities up to 200,000 amperes. These compact, fast operating, dead-front circuit breakers incorporate a stored energy operating mechanism for fast, positive closing.

These "iron frame" low voltage power circuit breakers include a stored energy operating mechanism (either manually or electrically operated), arc quenchers, main and arcing contact structures, inductive tripping sensors, static overcurrent trip devices, control wiring, auxiliary switches, interlocks, and position indicators.



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Typical type LC Circuit Breaker

Manually operated circuit breakers consist of a three pole single throw element which is mechanically trip free and which is complete with: a static overcurrent trip device, a manually charged stored-energy closing mechanism, inter-pole barriers, arc quenchers, mechanical close and trip controls, and a position indicator, all mounted to provide the closed door drawout features described previously.

Electrically operated circuit breakers consist of a three pole single throw element which is mechanically and electrically trip free, and which is complete with: a static overcurrent trip device, electrically charged stored-energy closing mechanism, inter-pole barriers, arc quenchers, electrically operated spring release solenoid, shunt trip device, mechanical close and trip controls, position indicator, and the required auxiliary switches, all mounted to provide the closed door drawout features described previously.

The stored energy operators used in type LC switchgear provide a quick-make/quick-break switching mechanism that assures high speed closing of breaker primary contacts, independent of the actions of the human operator. Positive, controlled closing prevents unnecessary arcing between the movable and stationary breaker contacts as would be the case with slow or hesitant manual closing, thereby lengthening contact with breaker life.

Manual operated stored energy breakers are charged by a manual handle, which when released returns to the normal position. Actuation of a manual closing control, located on

the front of the breaker, then releases the stored energy to close the breaker.

Electrically operated stored energy breakers are closed smoothly and positively by the action of springs which have been pre-charged by an electric motor. The springs remain charged indefinitely until the breaker is to be closed. When energy is released to close the breaker, the motor automatically recharges the springs for another closing operation. These breakers are therefore able to offer standard reclosing duty (Open-Close-Open) shortly after initially being closed.

Manual tripping of manual and electrically operated breakers is accomplished by operation of the manual trip control. The mechanical trip includes a provision for padlocking the breaker in the open position.

As an option, a manual spring charging handle (as furnished on manually operated breakers).

The design of the racking mechanism includes provisions for padlocking to prevent unauthorized racking of the circuit breakers. Please consult the M&I factory to determine the availability of the exact padlocking or other safety features required to meet your operating requirements.

Key interlocks are available as an option to regulate breaker position (CONNECTED, TEST, DISCONNECTED) and to regulate breaker operation. Again, please consult the M&I factory to determine the availability of the exact key interlocking system required to meet your operating requirements.

Primary Disconnects

Primary circuit connections between the removable circuit breaker and the switchgear assembly are made by sets of silver plated contacts on the circuit breaker with silver plated stationary contacts in the breaker compartment. The finger contacts are mounted on the studs of the circuit breaker, facilitating inspection and maintenance. The stationary contacts are mounted on a fabricated insulation sheet which is bolted to the rear wall of the breaker cubicle.

Primary disconnecting devices are arranged so that contact is made only when the removable circuit breaker is in the operating of CONNECTED position. In the TEST and DISCONNECTED positions, the primary contacts are separated by a safe distance.

Firm contact pressure is maintained by means of tempered back-up springs. As the circuit breaker is moved into the operating position, the wiping action of the self-aligning contact assures low contact resistance.

Secondary Disconnects

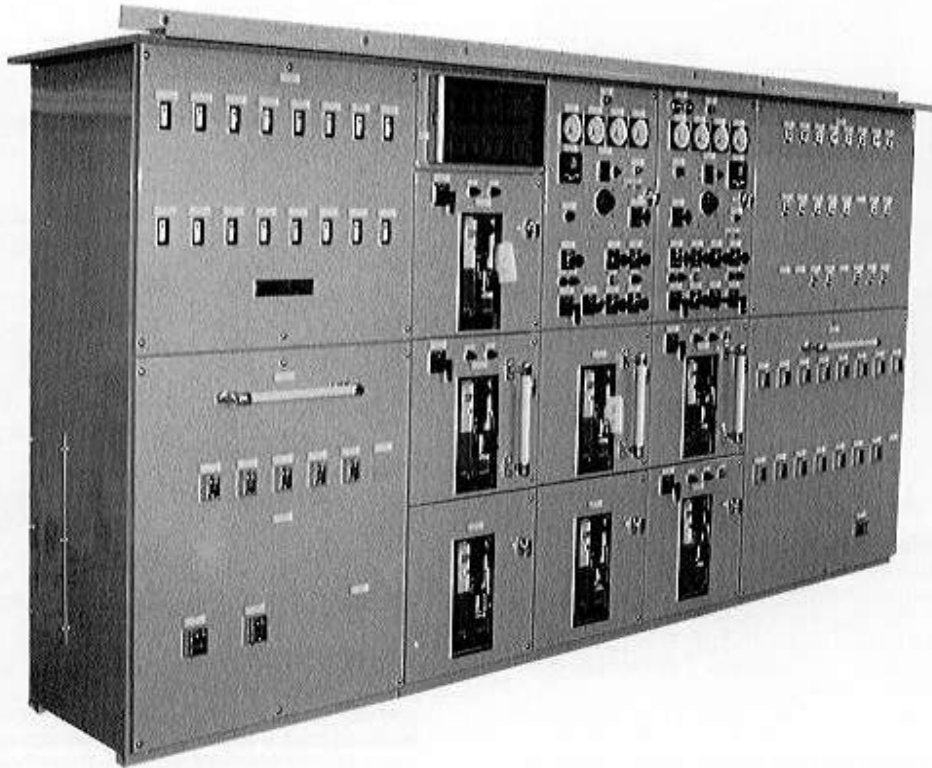
Secondary circuit connections between the circuit breaker and stationary switchgear structure are made by means of automatic, self-aligning, multi-contact, silver-plated, slide-type connectors.

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self-aligning, multi-contact, silver-plated, slide-type connectors.

The contact surfaces on the stationary element are heavily silver plated copper strips mounted on a molded base insulating material. The stationary contact surfaces are recessed to properly guide the movable fingers to prevent accidental short-circuiting of the control circuits.

- Rack the circuit breaker in or out of the cubicle compartment.
- Interlocking to prevent racking a closed circuit breaker into or out of the connected position.
- Interlocking to prevent closing a circuit breaker until it is fully racked to the connected position.



The movable secondary disconnect elements are located low on the side of the low voltage power circuit breaker, well below the arc quenching area, to avoid contamination from rapidly rising arc product gases.

The secondary connections automatically make contact when the breaker is in both the test and connected positions.

Ground Connection

A ground contact on the removable low voltage power circuit breaker engages with the ground circuit through a contact in the breaker compartment in both the test and connected positions.

Draw-Out Interlocks

Integral parts of the circuit breaker mechanism include provisions to:

- Interlocking to prevent withdrawing a circuit breaker from the cubicle while the closing springs are charged.

Fused Circuit Breakers

The 800, 1600, and 2000 ampere frame size circuit breakers are available with integrally mounted current limiting fuses, to increase their interrupting rating and/or limit the short circuit current to downstream equipment. The fuses are bolted in series with the upper set of primary disconnects. A blown fuse tripping device may be wired in parallel with the main fuses, to insure that the circuit breaker opens if a main fuse interrupts, thus preventing single phasing. This device also indicates which main fuse has interrupted.

The larger frame size circuit breakers, 3200 and 4000 ampere, are available with current limiting fuses mounted on a separate drawout truck, which is interlocked with the circuit breaker to prevent withdrawing the fuse truck unless the circuit breaker is racked to the disconnect position.



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The breakers have been qualified to all required standards and are UL list marked.

Fuses rated 600 amperes and below are Class J.

Fuses rated 800 amperes and above are Class L.

Circuit Breaker Accessories

A variety of accessories and auxiliary devices are available to aid the integration of type LC switchgear into the overall control system for a given facility. Among the accessories available for the breakers used in type LC switchgear are the following:

Shunt Trip

Provides a means to electrically trip the circuit breaker from a remote device, such as a pushbutton, switch, or relay for automatic tripping. It is standard on all electrically operated breakers and is optionally available on manually operated breakers.

Since the shunt trip coil is designed for a momentary duty cycle, an "a" auxiliary contact switch is used to interrupt its circuit immediately after the breaker is tripped. Energization of the coil causes the armature to pick up and actuate the trip latch to trip the breaker. A spring returns the armature to its normal position.

Undervoltage Trip Device (Option)

An undervoltage trip device provides protection against the effects of a drop in normal bus voltage and functions to directly trip the breaker. Pick-up is 85% or less of rated value, and drop-out is between 30% and 60% of the rated value. Pick-up and drop-out are individually adjustable. Either instantaneous or time-delay operation can be supplied.

Operation Counter

A mechanically operated non-resettable counter which is actuated from the breaker operating mechanism.

Automatic Trip Alarm Contact (Bell Alarm)

The bell alarm switch is initiated by the operation of the Static Trip Device, and functions to operate a switch. These contacts may be used for remote indication of an automatic trip. The switch operator must be reset either manually, or optionally by electrical reset. The contacts of the bell alarm switch can be connected in series with the breaker closing coil, to provide a lockout feature to prevent reclosing after a fault.

STATIC TRIP SYSTEMS

Static overcurrent tripping systems have been standard on the circuit breakers used in type LC switchgear for a number of years. These circuit breakers offer a variety of trip unit

types and characteristics, allowing LC switchgear to selectively and accurately protect virtually any low voltage circuit.

Standard solid state trip units offer a selection of long time, short time, instantaneous, and/or ground fault trip selections. These modern solid state trips allow circuit breakers to be zone interlocked with each other to assure coordination between upstream and downstream devices.

Among the features of modern solid state trip units are the following:

- Ease and accuracy in making field adjustments.
- Excellent repeatability.
- Negligible change in characteristics with normal temperature variations.
- Easy adjustment of pick-up point over a wide range.
- Integrated ground current tripping.
- Targets available to indicate the cause of tripping.
- Simple field testing without need of a primary current source - a portable test set is available as an option.
- Minimum maintenance.
- Simple breaker rating change.
- Flexibility - many combinations available including long time delay, short time delay, instantaneous and ground fault elements in the same device.

Trip Device Accessibility

The trip devices are readily accessible to the operator for simple adjustment of all settings.

Self Contained System

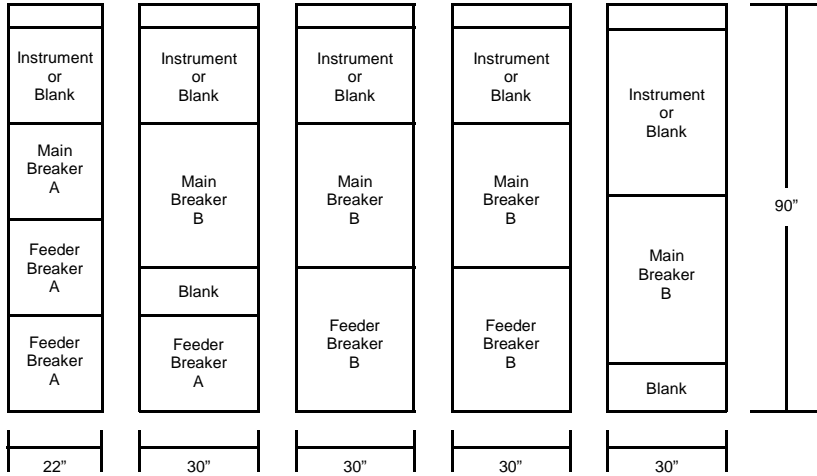
The tripping system is completely contained on the circuit breaker. The power for tripping the breaker and for operating the solid state circuitry in the static trip device is drawn from the primary current through tripping current transformers mounted on the breaker. Four-wire ground applications include a fourth transformer mounted in the cable compartment. A signal, proportional to primary current, is taken from the tripping current transformers. This signal is monitored by the static trip device, and upon current exceeding the points determined by the selected protection curve, the static trip device operates the tripping actuator to trip the breaker.

Tripping Actuator

Fast action tripping of the breaker is achieved with a low energy flux-shifting tripping actuator.

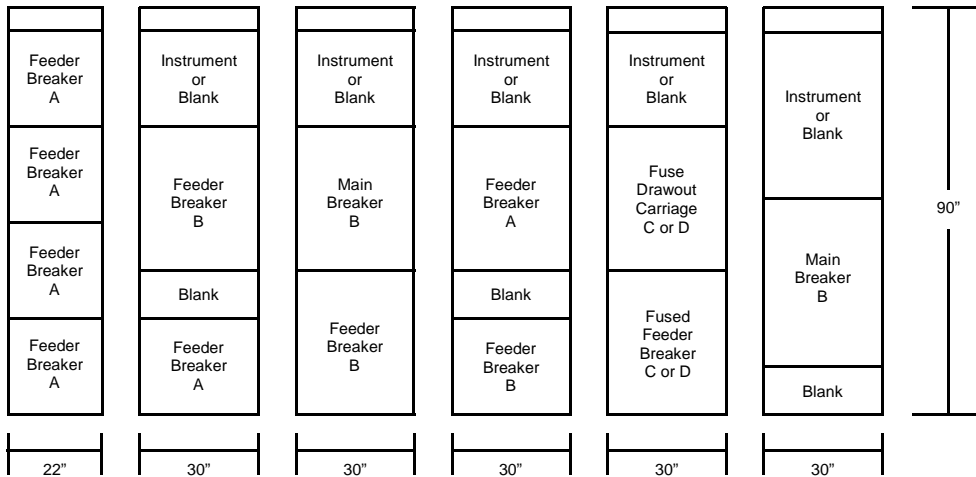
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Typical Section Arrangements



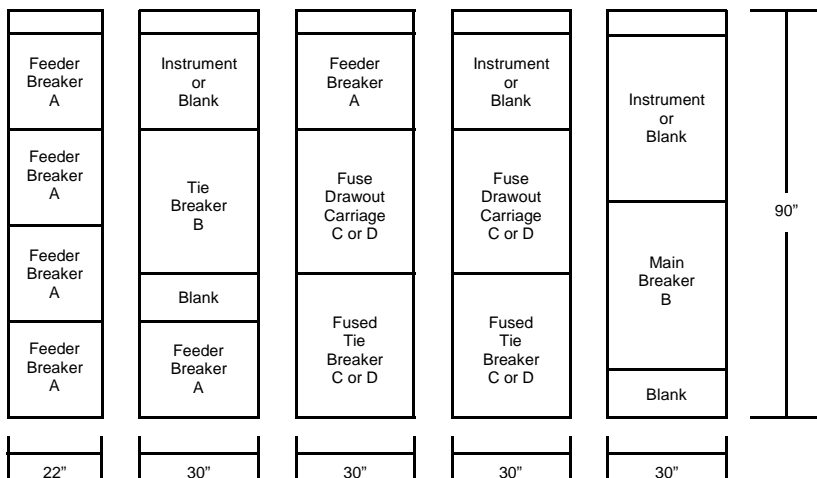
Main Breaker Sections
Breaker Identification Table

Breaker Code	Frame Size
A	800, 1600, 2000
B	3200
C	Fused 3200
D	4000
E	Fused 4000



Feeder Breaker Section
Metric Dimensions

English Dimensions	Metric Dimensions
22"	559 mm.
30"	762 mm.
90"	2286 mm.



Tie Breaker Sections
Vertical Section Weights

Section Type	Approx. Weights	
	22" Wide	30" Wide
Indoor	1400 lb.	1900 lb.
	635 kg.	862 kg.
Outdoor	2400 lb.	3100 lb.
	1088 kg.	1406 kg.



Circuit Breaker Ratings

Low Voltage Power Circuit Breaker Ratings at 50/60

Voltage Ratings		Frame Rating	50/60 Hertz Dielectric Rating Volts	Short Time Rating Amperes Sym.	Short Circuit Rating		Continuous Current Rating Amperes
Rated Volts	Rated Max.				With Instantaneous	Without Instantaneous Trip	
1	2	3	4	5	7	8	9
600	635	800 800 (H)	2,200 2,200	30,000 42,000	30,000 42,000	30,000 42,000	40 - 800 100 - 800
		1600 1600 (H)	2,200 2,200	50,000 65,000	50,000 65,000	50,000 65,000	100 - 1600 100 - 1600
		2000	2,200	65,000	65,000	65,000	100 - 1600
480	508	800 800 (H)	2,200 2,200	30,000 42,000	30,000 42,000	30,000 42,000	40 - 800 100 - 800
		1600 1600 (H)	2,200 2,200	50,000 65,000	50,000 65,000	50,000 65,000	100 - 1600 100 - 1600
		2000	2,200	65,000	65,000	65,000	100 - 1600
240 & 208	254	800 800 (H)	2,200 2,200	30,000 42,000	42,000 50,000	30,000 42,000	40 - 800 100 - 800
		1600 1600 (H)	2,200 2,200	50,000 65,000	65,000 65,000	50,000 65,000	100 - 1600 100 - 1600
		2000	2,200	65,000	65,000	65,000	100 - 1600
		3200 3200 (H)	2,200 2,200	65,000 85,000	65,000 130,000	65,000 85,000	1000 - 3200 2000 - 4000
		4000	2,200	85,000	130,000	85,000	2000 - 4000

Low Voltage Fused Power Circuit Breaker Ratings at 50/60 Hertz

Voltage Ratings		Frame Rating	50/60 Hertz Dielectric Rating Volts	Short Time Rating Amperes Sym.	Fuse Rating Range Amperes	Continuous Current Rating Amperes
Rated Volts	Rated Max. Volts					
1	2	3	4	5	7	9
208 To 600	600	800 1600 2000	2,200 2,200 2,200	200,000 200,000 200,000	250 - 1600 800 - 3000 4000	40 - 800 100 - 1600 100 - 2000
		3200	2,200	200,000	2000 - 5000	1000 - 3200
		4000	2,200	200,000	2000 - 6000	2000 - 4000

The ratings are typical, and are provided for reference only. Actual ratings depend upon the application. Contact the M&I factory for details.

Type LC Metal Enclosed Switchgear

SAMPLE SPECIFICATION

SCOPE

This specification covers the design, manufacture, testing and delivery of low voltage metal enclosed switchgear. The switchgear will be rated for operation at _____ (specify) Volts. The breakers are to be of closed door draw-out design, and shall utilize solid state trip units.

OWNER'S RESPONSIBILITY

Unloading and installation

Interconnecting control and power field wiring

Relay and trip unit coordination and settings, and short circuit study.

REFERENCED DOCUMENTS

The metal enclosed switchgear shall comply with the following standards:

- NEMA SG 5-1975 - Switchgear Assemblies
- ANSI C37.13 - Low Voltage Power Circuit Breakers
- ANSI C37.20 - Switchgear Assemblies

SERVICE CONDITIONS

The equipment shall be suitable for operation in an environment with a temperature range of _____ F in winter to _____ F in summer. The equipment shall operate in a relative humidity range of _____% to _____% (non condensing).

CONSTRUCTION

Indoor Applications

All equipment shall be constructed for indoor service. The switchgear cubicles shall be fabricated from cold rolled steel and formed steel members, reinforced as required to form a rigid self-supporting structure.

The rear of each circuit breaker enclosure shall include bolted panel(s)/hinged door(s) with padlocking provisions for gaining access to the cable termination area.

Each cubicle shall have edges formed by appropriate metal fabrication tooling. All exposed welded joints shall be ground smooth after welding.

Outdoor Applications

All equipment shall be constructed for outdoor service. The switchgear cubicles shall be fabricated from zinc coated cold rolled steel and formed steel members, reinforced as required to form a rigid self-supporting structure.

A weatherproof aisle shall be provided for each group of equipment large enough to permit interchange and maintenance of drawout circuit breaker elements. A weatherproof door with panic hardware at each end of the aisle shall be provided. The aisle and switchgear will be shipped totally assembled in one piece on a common base.

The rear of each circuit breaker vertical section shall include one or more (as required) [select] bolted panels / hinged doors with padlocking provisions for gaining access to the cable termination area.

Suitable openings shall be provided in each cubicle for owner's power and control cables to enter from the bottom of the associated cubicle.

All cubicles shall be provided with electrical space heaters to prevent condensation of moisture within the switchgear.

Each cubicle shall have edges formed by appropriate metal fabrication tooling. All exposed welded joints shall be of the continuous (seal) type, and shall be ground smooth and dye penetrate tested after welding.

The bottom of the switchgear and aisle shall be covered with a coal tar or equivalent undercoating compound to prevent corrosion.

PAINTING

All weld splatter, loose scale, and similar rough spots shall be removed by power tool or abrasive blast cleaning in accordance with SSPC recommendations (Steel Structures Painting Council) to present an acceptable appearance and to provide a surface to promote adhesion and application of primer coat.

The surface shall be free of any foreign materials (grease, oil, tar, etc.). These materials shall be removed by solvent cleaning per SSPC. The surfaces shall then be cleaned by steam or immersion in a cleaning and degreasing solution and shall be treated with an approved phosphating compound containing an etching agent.

After the surface has been properly cleaned and prepared, the work shall be coated with a zinc-rich chromate primer to a minimum thickness of .5 mils.

After the primer coat has been applied and properly dried, the surface shall be sprayed with a combination of primer and polyester urethane top coat for a total finish thickness of 2.0-3.0 mils.

The bottom of the switchgear and aisle shall be covered with a coal tar or equivalent undercoating compound to prevent corrosion.

One quart of the exterior finishing paint per lineup shall be included for field touch up.

CIRCUIT BREAKER COMPARTMENT

Each cubicle containing a circuit breaker shall be provided with a mechanism which will control the movement of the breaker between the operating, test, and disconnected positions. It shall not be necessary to open the breaker compartment door to operate the breaker racking mechanism. The mechanism shall be self-aligning and the circuit breaker shall be rigidly held in the operating position without the necessity of locking bars or bolts.

The stationary primary disconnecting contacts shall be constructed of silver plated copper. (OPTION: Grounded metal safety shutters shall be provided to isolate all primary connections in the circuit breaker compartment when the breaker is withdrawn from the connected position.)

CIRCUIT BREAKERS

The circuit breakers shall be rated at _____ (specify) Volts nominal, _____ (600, 800, 1,600, 2,000, 3,200, or 4,000) amperes continuous current carrying capacity, and _____ (specify) amperes short circuit interrupting capacity, as indicated on the contract drawings. The circuit breaker interrupter shall be 3-pole, and shall be mounted in a closed door drawout assembly.

The circuit breakers shall be operated either by a manually or motor-charged, mechanically and electrically trip-free, stored-energy spring driven operating mechanism.

Interlocks shall be provided to prevent moving the breaker to or from the operating position unless the breaker's contacts are in the open position. The operating springs shall be discharged automatically when the breaker is moved from one position to another, to assure operator safety.

The drawout breaker shall be furnished with reliable, robust secondary control power contacts or connections.

BUS COMPARTMENT

The main bus shall be rated for _____ (1,600, 2,000, 3,200, 4,000, 5,000, or 6,000) amperes continuous current carrying capacity, as indicated on the contract drawings. A main neutral bus _____ (shall/shall not) be provided, and shall be rated for _____ (1,600, 2,000, 3,200, or 4,000) amperes continuous current carrying capacity, as indicated on the contract drawings. Bus bars shall be high conductivity copper and shall have a continuous current rating in accordance with ANSI standards of temperature rise and documented by design tests. Bus work shall be braced to withstand the magnetic stresses developed by currents equal to the main circuit breaker's interrupting rating.



Type LC Metal Enclosed Switchgear

All bus shall be fully silver plated. All bus joints shall be constructed with at least two bolts per joint.

GROUND BUS

A continuous copper ground bus shall be furnished and secured to each unit. The ground bus shall extend the entire length of the switchgear and shall be equipped with a mechanical lug suitable for connecting the ground bus to the Owner's ground grid.

INSTRUMENT TRANSFORMERS

Current transformers shall have ratios in accordance with the contract drawings. The current transformers shall have a mechanical rating equal to the momentary rating of the circuit breakers and shall be insulated for the full voltage rating on the Switchgear.

Potential transformers shall meet ANSI standard accuracy ratings and shall include primary and secondary fusing.

CONTROL WIRING

All control wiring shall be installed and tested at the factory unless otherwise specified. All electrical conductors shall be Class B stranded copper #14 AWG or larger. All current transformer secondary wiring shall be #12 AWG. Wiring shall have thermosetting insulation rated 600 volts, designed for a conductor temperature of 90 degrees C (minimum).

Terminal blocks shall be provided for conductors requiring connection to circuits external to the specified equipment, for internal circuits crossing shipping splits, and where equipment paints, replacement and maintenance will be facilitated.

All terminal blocks shall be rated 600 volts minimum and shall have terminals which do not damage the individual strands of the control wire.

Shorting type terminal blocks shall be supplied for all current transformer connections.

Each terminal block, device, fuse block, and terminal shall be labeled to coincide with the identification shown on the drawings.

Sufficient clearance for field connections shall be provided for all leads. All leads for external circuit wiring shall be connected to grouped terminal blocks.

Splices will not be permitted in switchboard wiring.

DRAWINGS

Vendor drawings shall in sufficient detail to indicate the kind, size, arrangement, and weights of each major component, as well as the breakdown for shipping splits. Drawings shall also indicate the operation of component materials and devices, and the external connections, anchorages, and supports required for the switchgear. The drawings shall also indicate the installation, operating and maintenance clearance dimensions required.

Power diagrams and schematic diagrams shall be furnished in accordance with the functional requirements indicated on the Owner's one-line diagram.

The internal connection diagrams shall be drawn with all devices indicated in their relative physical locations.

EQUIPMENT SUBSTITUTION

The vendor shall indicate in their proposal the equipment (relay, switch, meter, transducer, etc.) included in the proposal.

The equipment being offered in the base bid shall be in strict accordance with the Owner's specification. Any alternate bids shall include a detailed description of the technical merits of the deviation to the specified require-

ments, and shall identify any cost savings or quality improvements offered to the Owner as a result of the deviation.

EQUIPMENT IDENTIFICATION

Equipment shall be tagged with Owner's tag numbers in accordance with the requirements of this specification. Tag numbers will be supplied to the Vendor by Owner.

TESTS AND INSPECTIONS

The Owner reserves the right to witness all test or to have his authorized representative present for such tests. The Owner shall be notified at least ten (10) working days prior to any test to be performed. In each case, notification shall include contract number, items involved, location of equipment to be tested, and the tests scheduled to be performed at the time.

Vendors shall be responsible for the proper protection of all instruments and devices that may be damaged by any test.

The complete sequence of production tests in accordance with ANSI C37 requirements shall be performed after manufacturing and assembly is completed. After these initial tests, and after all deficiencies and wiring errors have been corrected, the tests required to verify that all of the noted deficiencies have been completed shall be repeated.

Vendor shall provide a qualified service technician or engineer for the length of time required to inspect the switchgear at the factory after completion. This person shall assist in testing each switchgear metering, control, and alarm circuit during checkout by Owner. Any additional costs incurred for this services shall be included as part of the base bid.

An actual breaker of each rating being supplied with this equipment shall be used for testing purposes on this switchgear.

Any bus duct being supplied as part of this contract shall be physically connected to its associated switchgear lineup, to assure the mechanical fit of the sheet-metal flanges and bus bars. This arrangement shall be available for customer inspection.

Certified test reports of the production floor testing shall be supplied to the Owner at time of shipment.

All deficiencies in design, construction or equipment mounting and inadequately designed circuits or wiring error brought out during the testing at the Vendor's plant shall be corrected by the Vendor at no cost to the Owner. The equipment shall meet all requirements stated in this specification.

SHIPPING AND HANDLING

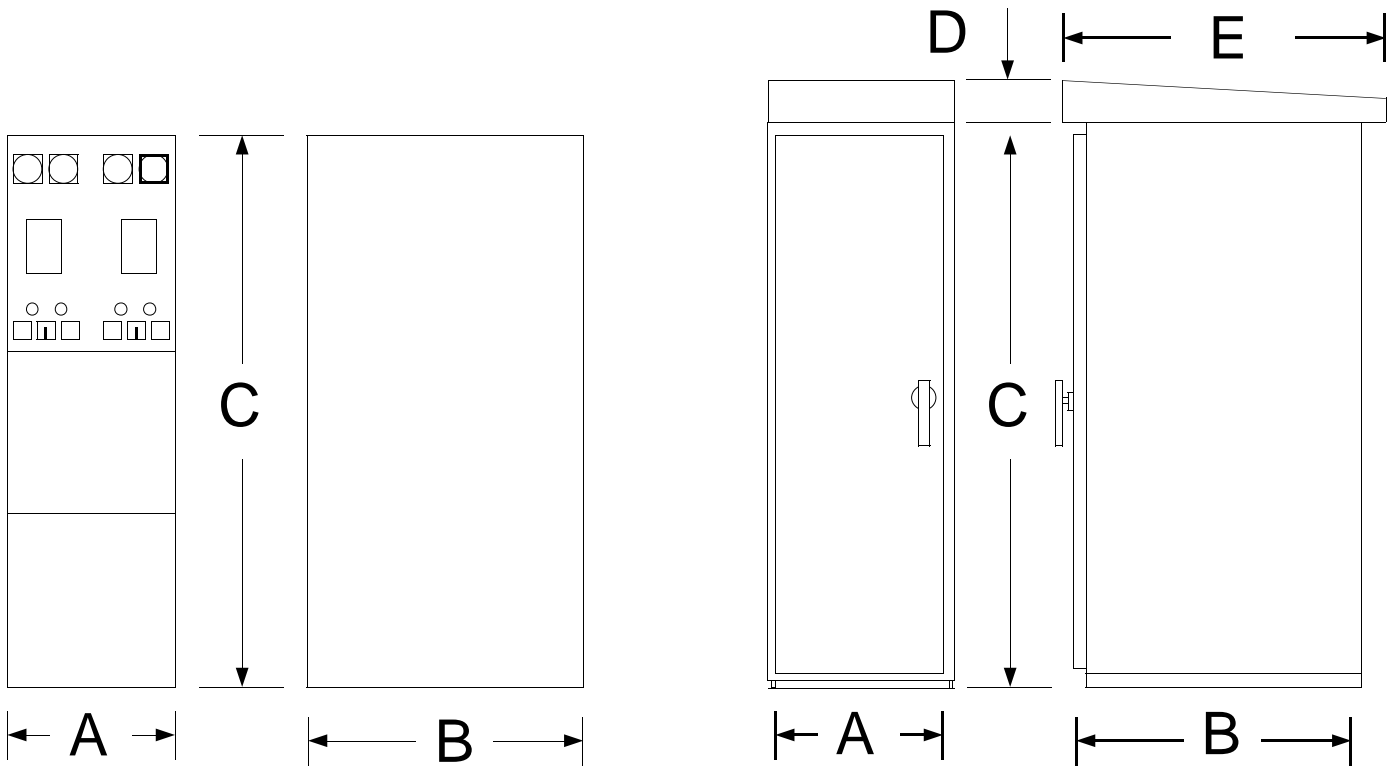
The method of preparation and packing shall protect the switchgear and associated equipment against corrosion, breakage, and vibration injury that might reasonably be encountered during transit and handling. If necessary, delicate instruments shall be disconnected, packed and separately shipped to the jobsite for mounting by the Owner. All accessories, mounted devices, instruction books, and parts list shall be packed and shipped with the switchgear.

Provisions shall be made for lifting and skidding. All lifting points shall be clearly marked. All temporary bracing shall be bolted to the switchgear so that no cutting torches will be required for installation. Disconnected shipping split wiring shall be properly tagged and supported. The switchgear shall be protected against reasonable environmental and mechanical damage during transit and storage, but the Owner shall be responsible to comply with the Vendor's instructions for handling and storage of the equipment at the destination.

SPECIFIC REQUIREMENTS

Owner or Engineer shall insert special requirements here, as required.

Specifications of equipment and the design thereof are subject to change without notice or obligation to incorporate same in existing equipment or in equipment under construction. The above sales information is for informational purposes only and there are NO WARRANTIES, EXPRESS OR IMPLIED, OF MERCHANTABILITY OR FITNESS FOR A SPECIFIC PURPOSE contained herein. For details of presently available equipment, designs, and specifications, please contact your local representative for M&I Electric Industries, Inc. to obtain specific application of M&I equipment and services to your needs.



Typical Dimensions

Unit Type	A	B	C	D	E
800 AF 1600 AF 2000 AF	22"	[1]	90"	7"	[2]
3200 AF 4000 AF	30"	[1]	93"	7"	[2]

Notes: 1. Depth depends upon application. Normal range is 48" to 67"
2. Depth depends upon application. Normal range is 66" to 78"

The above dimensions are typical, and are provided for reference only. Actual dimensions depend upon the application. Contact the M&I factory for details.



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