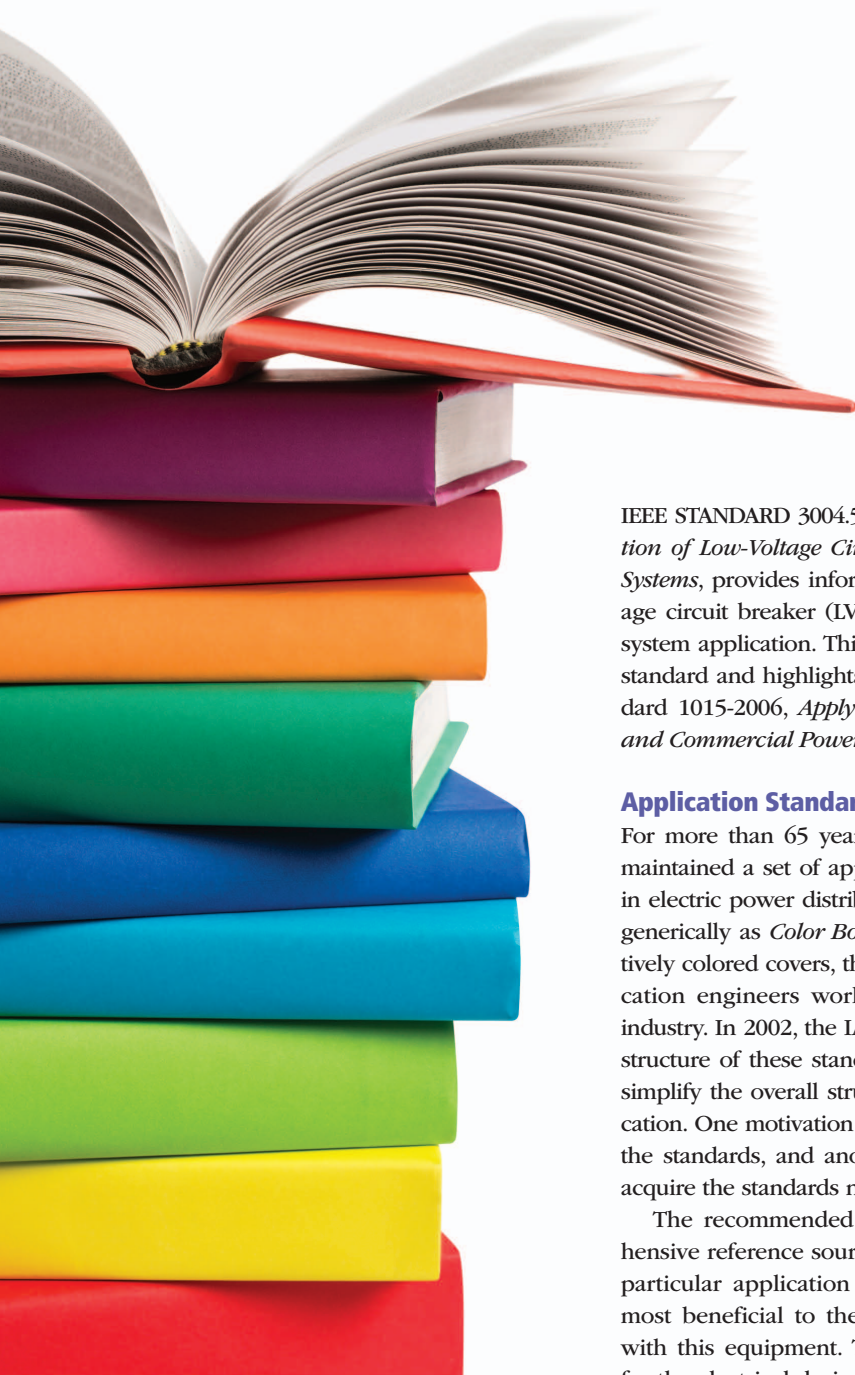


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Updating the *IEEE Color Books*

A REVIEW OF IEEE STANDARD 3004.5



IEEE STANDARD 3004.5, *IEEE RECOMMENDED PRACTICE FOR THE APPLICATION of Low-Voltage Circuit Breakers in Industrial and Commercial Power Systems*, provides information to help engineers select the proper low-voltage circuit breaker (LVCB) for a particular industrial or commercial power system application. This article provides an overview of what is in this new standard and highlights the new or revised content contained in IEEE Standard 1015-2006, *Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems* [2], also known as *The Blue Book*.

Application Standards

For more than 65 years, the IEEE Industry Applications Society (IAS) has maintained a set of application standards addressing the concerns involved in electric power distribution in industrial and commercial facilities. Known generically as *Color Books* because they were sizable volumes with distinctively colored covers, these standards have become reference texts for application engineers working in the field of electric power distribution in industry. In 2002, the IAS embarked on a program to dramatically revise the structure of these standards. The primary objective of this program was to simplify the overall structure of the standards by eliminating content duplication. One motivation for this was to reduce the effort required to maintain the standards, and another reason was to make it easier for end users to acquire the standards needed in their day-to-day work.

The recommended practice [1] provides an engineer with a comprehensive reference source to aid in deciding what type of LVCB to use for a particular application and how to apply the circuit breaker. It is likely most beneficial to the power-oriented engineer with limited experience with this equipment. The practice can also aid all engineers responsible for the electrical design of industrial and commercial power systems based on North American product standards. Similar related devices are covered by other standards, including the International Electrotechnical Commission standards, that are predominant in Europe and other regions. The

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recommended practice includes a comparison between the standards of low-voltage power circuit breakers (LVP-CBs) and molded-case circuit breakers (MCCBs) so that an engineer can make better, more informed choices. Pertinent tables have been extracted from other standards to provide the basis for the selection and application guidelines. In addition, specific application examples are provided. The material in IEEE Standard 3004.5 was originally published in the first edition of *The Blue Book* in 1997, and it is an update of the material in Chapters 1–4 and 6 of the 2006 edition of *The Blue Book*, IEEE Standard 1015-2006 [2]. It also encompasses the material in Chapter 7 of *The Buff Book*, IEEE Standard 242-2001 [3].

Scope

IEEE Standard 3004.5 covers the selection and application of LVCBs used in industrial and commercial power systems.

Definitions, Acronyms, and Abbreviations

Designers, engineers, installers, code enforcement officials, and end users apply a number of technical terms regarding the specification and applications of LVCBs. To ensure that the terms have a common meaning for all end users, it is important to establish clear communication or intent and minimize confusion among collaborators. Chapter 3 of IEEE Standard 3004.5 provides a clear description of the terms used to describe circuit breakers, such as MCCBs, LVPCBs, and other products that appear to be circuit breakers but do not have overcurrent protection. The definitions are used throughout the standard to assist the end user in the optimal selection and application of circuit breakers to provide the protection of equipment for industrial and commercial power systems.

In addition to describing the basic circuit breaker constructions, application terms are defined for the end user to specify the ratings and features of circuit breakers as well as systems considerations that are important for applications. These may include ampere ratings, short circuit ratings, continuous load currents, and protection functions for various products. The typical protection functions used today may include long-time, short-time, instantaneous, and ground-fault settings or delays. These settings are designed to assist with applications in which coordinated protection of a system's components and circuits is required.

The terms used in the recommended practice provide information from the standards and members of the end-user community, and they have been reviewed by the manufacturers for accuracy. The following terms are given as examples of what has been misunderstood by end users and members of industry. The terms provide a clear example of why IEEE Standard 3004.5 should be in your library.

- **Adjustable circuit breaker**—A circuit breaker that has adjustable time-current tripping characteristics, including inverse-time (e.g., continuous current, long time, and/or

short time), instantaneous, and ground-fault [adapted from Underwriters Laboratories (UL) Standard 489] [4].

- **Series rating**—The interrupting rating of a tested combination of a line-side (main) overcurrent protective device and a load-side (branch) circuit breaker in which the interrupting rating of the combination is greater than the interrupting rating of the branch circuit breaker. The interrupting rating of the series combination does not exceed the interrupting rating of the main overcurrent protective device. Syn is the series-connected rating. Series ratings are obtained through UL Standard 489 test protocols and are UL recognized.

What Are LVCBs?

Basic Circuit Breaker Selection Criteria

The selection of a circuit breaker must be based, at a minimum, on an assessment of its ability to perform the following basic functions:

- to carry the required current without overheating
- to switch and isolate or disconnect the load from the source
- to interrupt abnormally high operating current or short circuit currents
- to perform these functions over an acceptably long period of time under the operating and environmental conditions.

Additionally, regulatory or safety considerations may make these mandatory for meeting requirements related to, e.g., selective coordination and performance in arc flash reduction.

Circuit Breaker Classes and Types

For low-voltage circuit protection in North America, circuit-breaker designs and tests are based on the requirements of several standards organizations, including UL; the Canadian Standards Association (CSA); Asociación Nacional de Normalización y Certificación del Sector Eléctrico, A.C. (ANCE); the National Electrical Manufacturers Association (NEMA); and the IEEE. These organizations define the MCCB and LVPCB classes of circuit breakers. Due to the very large number of MCCBs produced for a great variety of applications, there are several types widely recognized within the industry. Two of the more popular MCCBs are insulated case circuit breakers (ICCBs) and miniature circuit breakers. These are discussed but are not separately defined within UL Standard 489.

These circuit breakers are characterized by the test and rating requirements of their applicable performance standards. MCCBs are tested and rated according to UL Standard 489, and their current-carrying parts, mechanisms, and trip devices are completely contained within a molded case of insulating material. ICCBs are also rated and tested according to UL Standard 489. However, they use characteristics of design from both the LVPCB and MCCB classes. LVPCBs are rated and tested to satisfy the applicable IEEE

C37 standard requirements and are used primarily in draw-out switchgear; they are generally characterized as being the largest in physical size. Depending on their design, LVPCBs may be partially or fully maintainable in the field.

LVCB time-current curves are drawn to represent the entire circuit breaker protection system and include the components that makeup system operation: 1) sensing variability, 2) algorithm or sensing mechanism operation, 3) mechanical operation time and variation, and 4) clearing time and variation.

The Role of Industry Standards and Safety Codes

A product standard is the primary vehicle for ensuring the same level of performance among circuit breakers of the same rating but produced by different manufacturers. Standards represent the consensus of manufacturers, testing organizations, end users, and others about what a given product should be able to do. Standards establish the design tests that each manufacturer must perform and pass to claim a rating and to be in compliance. The requirements for the different classes of circuit breakers establish a basis for minimum performance. Circuit breakers are defined by various other documents provided by NEMA, UL, CSA, ANCE, and the IEEE. This IEEE-recommended practice provides application guidance based on all of the applicable documents.

In North America, an important requirement is to meet all applicable regulatory and standard requirements. Some standards include requirements for periodic follow-up testing to sample the capabilities of newly manufactured circuit breakers. This testing assures the maintenance of the capabilities of product ratings. In addition to product performance standards, national safety and electrical construction code requirements have evolved in the United States and Canada. These codes reflect actual applications experiences over the years. Some examples are the regulations of the Occupational Safety and Health Administration, which is the primary legal safety code for workplaces in the United States, and the National Electrical Code (NEC) [5], which is the primary safety code for electrical installations for facilities owned or operated by entities other than electric utilities and railways. The NEC is a model code and, to be effective, must be adopted by an authority having jurisdiction either amended or unamended.

In Canada, the electrical installation code corresponding to the NEC is CSA Standard C22.1 [6], which

IEEE Standard 3004.5 provides information to help engineers select the proper low-voltage circuit breaker for a particular industrial or commercial power system application.

has been adopted by the provinces much like the NEC has been adopted by the states or local jurisdictions in the United States. Canada does not have a national health and safety act; rather, the individual provinces have their own laws, such as the Ontario Health and Safety Act and the Ontario Occupational Health and Safety Regulations for Industrial Establishments.

Circuit breaker performance is tested in laboratory conditions with test protocols that are expected to simulate or exceed real application situations. However, real applications may expose devices to conditions that are not explicitly tested under standard guidelines. When application conditions vary significantly

from those defined for the circuit breakers, the circuit breaker manufacturer should be consulted to determine suitability for the intended application and whether any specific performance deterioration or change needs to be considered. Readers of IEEE Standard 3004.5 should ensure that they are following the stipulations of the latest version of the referenced standards and codes enforced in the jurisdiction of interest.

Important Considerations

The ratings and test procedures for MCCBs and ICCBs are found in UL Standard 489, and those for LVPCBs used in enclosures are given in American National Standards Institute/NEMA Standard C37.50 [7]. LVPCBs are generally UL listed per UL Standard 1066 [8]. Within each of these standards, there are a variety of conditions and performance requirements that must be considered to verify that the circuit breaker complies with the standards. In some cases, the performance requirements between the classes of circuit breakers are very similar and overlap, and, in other cases, they are quite unique. The more common types of test considerations required by these various standards for LVPCBs are as follows:

- **Endurance**—The ability to check the mechanical and electrical performance for a number of OPEN and CLOSE cycles for a specified rate of time, with and without current.
- **Voltage ratings**—Verify performance at standard nominal system voltages such as 600 Vac, 480 Vac, and 240 Vac. Verify performance at additional slash voltages, such as 120 Vac, 120/240 Vac, 277 Vac, 347 Vac, 480 Y/277 Vac, and 600 Y/347 Vac. Verify performance at assigned maximum voltages, such as 254 Vac, 508 Vac, and 635 Vac.
- **Continuous ampere rating**—The ability of the internal components of the circuit breaker to handle factors such

as heat dissipation and mechanical stresses when applied continuously at currents such as 15–6,000 A for MCCBs per UL Standard 489 and 600–6,000 A for LVPCBs per IEEE Standard C37.16 [9].

- **Interrupting abilities**—Confirm the ability of the circuit breaker to successfully withstand various levels of short circuit current interruptions without electrical or mechanical breakdowns of the device.
- **Frequency rating**—Verify 60-Hz operation (typical for systems in North America). Verify frequencies above and below 60 Hz, including dc, for specific applications.
- **Operating temperature**—Verify the impact of both nominal and extreme cold and hot temperatures on the internal components of the circuit breaker, such as lubricants, dimensional changes, brittleness, and melting of materials.
- **Cable, wire, and conductor**—Confirm the ability of conductors connected to the circuit breaker to meet requirements per the NEC, such as load-current-carrying ability and heat sinking/dissipation abilities.
- **Enclosure type**—Determine the minimum-size enclosure that the circuit breaker may be installed in to satisfy 100% of rated performance or whether derating factors shall be applied.
- **Derating for ambient temperature**—For installations in ambient temperatures above the rated maximum of the circuit breaker, the current-carrying capacity must be derated. Determine how much derating is necessary for the various devices.
- **Humidity limitations**—Verify the impact of higher humidity (>50%) and lower temperatures (<40 °C) on the internal components of the circuit breaker, without the need of NEMA standardized enclosures being required. The recommended practice discussed higher than 50% humidity.
- **Altitude limitations**—As altitude increases, atmospheric pressure and air density decreases and temperatures go down. Determine the impact of the combination of these changes on the voltage withstand and current-carrying capacity of the circuit breaker.

The recommended practice includes a comparison between the standards of LVPCBs and MCCBs so that an engineer can make better, more informed choices.

anticipated. This recommended practice discusses several key conditions that should be considered.

First, the continuous current ratings required of circuit breakers can be affected by the characteristics of the loads being served. Harmonics are generated when a load draws a nonlinear current from a sinusoidal voltage. Harmonics in nonlinear loads and high, short-time inrush loads like those of tungsten filament lamps, resistance welding applications, and premium-efficiency motors and transformers at startup can affect the circuit breaker contacts and be interpreted by microprocessor-based, trip-circuit logic as overloads or faults.

Manufacturers generally provide derating guidelines for application on high harmonic circuits. At this time, there is no commonly accepted specification of a test waveform that microprocessor trip units should be able to sample and accurately quantify. However, circuit breaker manufacturers have done extensive development testing to provide assurance that their digital sampling algorithms will work to the degree that is specified in their technical literature.

Second, if loads are cycled on and off or up and down in level or if motor plugging is involved in an application, the current rating and the type of circuit breaker trip unit should be chosen carefully. A large inrush current with potentially high offset peaks and a longer duration of high continuous-current flows accompanies these operations, making them unlike a normal motor-starting duty. The response of the circuit breaker trip unit to these higher currents and offsets and their heating effect on the circuit breaker should be evaluated. Such effects are considered in circuit breaker overload testing.

Next, it is important to understand that LVPCBs in general are evaluated for short circuit interrupting capability on a first-half-cycle basis. If a circuit has a power factor (the X/R ratio) less than the value used for the proof testing required by the standard for a given circuit breaker, then no adjustment in that circuit breaker's interrupting rating is required. However, if the calculated value of the short circuit X/R ratio is greater than the value used to test the circuit breaker, then the interrupting duty requirement of that application has to be increased, resulting in a close re-evaluation of the true interrupting capability.

A final important consideration is the application of some ac-rated thermal-magnetic, MCCBs using their assigned UL Standard 489 dc ratings. Just as ac interrupting ratings differ with voltage ratings, different dc interrupting ratings apply at different dc voltage levels, and the dc interrupting ratings are subject to derating for application voltage as is done for ac circuit applications. Obviously, dc interruption is different from ac interruption. Alternating sinusoidal,

Application Schemes and Maintenance

Application Considerations

Beyond the satisfactory testing that shows compliance with applicable standards, circuit breakers must also operate in a variety of real-world conditions that are determined by their installed applications. It is very important to understand how these conditions can impact the performance of a circuit breaker so that the expected results can be

short circuit fault current usually passes through zero magnitude twice each cycle, whereas dc does not. To interrupt a dc, the circuit breaker must produce all of the physical effects required to reduce the dc to zero magnitude and thereafter maintain an open circuit. As a result, manufacturers typically recommend different configurations for applying these circuit breakers in ac versus dc applications.

Circuit Breaker Useful Life

LVCBs may be exposed to a wide range of overcurrent conditions and environmental factors during their installed lifetime. The conditions to which a circuit breaker may have been exposed make it difficult to determine its remaining useful life. As a result, for MCCBs, it is recommended that inspections be performed according to a plan developed to suit the application. NEMA Standard AB 4 [10] and IEEE Standard 1458 [14] should be referenced for MCCB and ICCB field inspection and maintenance. For LVPCBs, these devices can and should be inspected for wear and damage, and they should be refurbished or repaired as required after interrupting faults and before being restored to service. The fact that LVPCBs can even be maintained between tests emphasizes the maintainability feature of their design and further distinguishes them from MCCBs and ICCBs.

Specific Applications

IEEE Standard 3004.5 has a section devoted to standard circuit breaker applications and a section for fused and special circuit breaker applications. The scope of standard applications covers procedures for determining the type, rating, and protective characteristics of LVCB applied for specific purposes. Three specific types of LVCBs are addressed: LVPCBs, MCCBs, and a subset of the MCCBs referred to as ICCBs. The applications discussed in Chapter 5 are service entrance, main disconnect, and tie applications within the scope of normal power-distribution systems.

Important additional requirements, such as supply characteristics, known load requirements, expected growth, system reliability expectations, operating conditions and expectations, personnel safety consideration, equipment types, accessibility, and budgetary considerations, are discussed in the recommended practice.

Among the system considerations discussed are system voltage, system grounding, interrupting requirements, and system frequency. Circuit breakers must be properly rated for the various types of available systems. Not all circuit breakers are equally suitable for all possible variations in the system characteristics. The factors that affect which circuit breaker is the correct device for an application also include

- unusual load or system characteristics imposed by the source or by the loads
- requirements for system reliability or selectivity
- operating or environmental conditions
- safety considerations

- equipment in which the circuit breakers must be or can be installed
- protection requirements that guard against any possible arc flash for personnel or let-through fault current for downstream equipment.

Seemingly simple variations in system parameters can have significant effects on different circuit breakers. For example, differences in the fundamental frequency can greatly influence how trip systems using air-core sensors can interpret current measurements. Some trip systems may measure frequencies other than 60 Hz correctly, but the current-carrying parts of the circuit breaker must be derated due to skin effects or other considerations. At higher frequencies, the ability of a circuit breaker to interrupt may be significantly compromised, so interrupting ratings must also be derated. IEEE Standard 3004.5 discusses some of the more common kinds of considerations in some detail and provides guidance on when and how to discuss these subjects with manufacturers.

In addition, considerations for some specific applications of circuit breakers are also discussed.

- *Voltage and grounding*—Low-voltage power-distribution systems come in various voltages from 120 to 1,000 Vac. They may be solidly grounded, impedance grounded, or floating. The power source may be single phase, three-phase wye, or three-phase delta. Circuit breakers exist that may be connected to some of these systems but not others. Some circuit breakers are especially suited for application in some of these systems. The recommended practice covers this in some detail.
- *Power direction*—IEEE Standard 3004.5 discusses power direction and the suitability of circuit breakers for operating under forward- and reverse-power directions.
- *Series ratings*—Series ratings is a topic that has changed over the years and creates some controversy within the electrical power-distribution system design community. However, circuit breaker manufacturers are consistent on this topic. The proper uses as well as some common misconceptions regarding series ratings and engineered ratings are discussed. The differences between fully rated and series-rated systems are also described.
- *Fault types*—The arcing fault phenomena is discussed and contrasted with bolted fault characteristics. The implications of these for circuit breaker application are also described.
- *Accessories and common optional characteristics*—Most common accessories and commonly available optional characteristics that are traditionally associated with circuit breakers are discussed in some detail. Guidance is provided to readers on the differences between similar devices and application considerations for selection and ratings.
- *Normal versus abnormal considerations*—The standards describe what normal operating conditions are and how to handle a range of abnormal conditions. The

recommended practice discusses these conditions and how to account for them.

- *Main, tie, and feeder applications*—The guide discusses the various considerations to take into account when circuit breakers are implemented in these different circuit applications. Each has special needs for optimal system operation. Improper selection can impact system reliability, safety, maintainability, and cost.

Fused and Special-Purpose Circuit Breakers

This section of IEEE Standard 3004.5 discusses the following types of LVCBs:

- instantaneous-trip circuit breakers
- mine-duty circuit breakers
- current-limiting (CL) circuit breakers
- molded-case switches (MCSs)
- fused circuit breakers
- circuit breaker and ground-fault circuit interrupters (GFCIs)
- circuit breaker and arc-fault circuit interrupters (AFCIs)
- supplementary protectors.

These circuit breakers have just a subset of the full complement of features or capabilities ordinarily provided in an LVCB, exhibiting a special characteristic or specially designed for a specific application.

Instantaneous-Trip Circuit Breakers

This type of circuit breaker is not intended to be used by itself, and its most common use is for motor protection applications where it is combined in an assembly with an electro-magnetic contactor and separate overload protection. The instantaneous-trip circuit breaker contains an instant function to provide short circuit protection just to the motor circuit, and no time-overcurrent tripping is included. The instantaneous-trip circuit breaker has a continuous current rating. The instantaneous-trip setting is typically adjustable, and it is common for the adjustment to span a range of three to ten times the continuous current rating. The tripping mechanism may be in the form of a magnetic element, and digital trip types are also commonly available. When applied in motor starters, the instantaneous-trip circuit breaker also functions as the circuit disconnect, providing a means of isolating the circuit for the purposes of servicing and maintenance. When applied in a motor starter, the instantaneous-trip circuit breaker is commonly referred to as a motor circuit protector. Instantaneous-trip circuit breakers may have CL characteristics (see the “CL Circuit Breakers” section) either by inherent design or through the use of an add-on CL attachment that

Among the system considerations discussed are system voltage, system grounding, interrupting requirements, and system frequency.

connects to its load terminals. The CL attachment allows the instantaneous-trip circuit breaker to interrupt higher short circuit currents than it would otherwise be capable of interrupting without the attachment. The recommended practice includes information regarding NEC requirements pertaining to instantaneous-trip circuit breakers and recommendations on selecting the trip setting.

Mine-Duty Circuit Breakers

Mine-duty circuit breakers are designed to comply with the Mine Safety Health Administration (MSHA) requirements for protecting the electrical cables and equipment used in min-

ing operations where the equipment is movable and the power is conveyed over trailing cables. These breakers must also help safeguard against the special hazards created by the environmental conditions involved with mining. Mine-duty circuit breakers are available with voltage ratings up to 1,000 Vac and 300 Vdc, and they are designed to provide instantaneous settings that comply with MSHA Code of Federal Regulations Title 30 [11]. MSHA also stipulates the field testing and inspection of these circuit breakers [12]. Requirements for their location and applications regarding undervoltage releases, ground-fault tripping, and remote tripping are also discussed.

CL Circuit Breakers

The CL circuit breaker, as defined by UL Standard 489, will limit the let-through I^2t to a value that is less than the I^2t of a half-cycle wave of the prospective wave current and do so without incorporating any fusible elements. IEEE Standard 3004.5 describes the available continuous ratings and short circuit interrupting ratings of CL circuit breakers. Generally speaking, this encompasses the range of commonly available MCCBs. Interrupting ratings as high as 200 kA are available. The application of CL circuit breakers to take advantage of their limited let-through characteristics is discussed with particular attention to series-connected ratings of circuit breakers.

MCSs

The MCS is a subtype of MCCBs, where the device is intended for load-switching use only and not for overcurrent-protection use. A time-overcurrent trip is never provided. An instantaneous trip may or may not be included in the MCS. When provided, the instantaneous trip is there only to protect the MCS from damaging effects of high-level faults. The MCS will have a continuous current rating. It also has a short circuit withstand rating that is usually dependent on the type of overcurrent protection applied upstream.

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Fused Circuit Breakers

Fuses have been combined both with MCCBs and with LVPCBs to obtain higher interrupting ratings. These limiters, as they are also called, must be replaced after they have acted on a fault. The circuit breakers are designed to trip following the opening of a limiter, which reduces the risk of a motor overheating when single phased. In MCCBs, the limiters are mounted within the case. On LVPCBs rated 1,600 A and smaller, the fuses may be mounted on the circuit breaker stab assembly. Higher-rated circuit breakers typically require the fuses to be mounted on their own separate drawout truck. The fuses or limiters applied will

typically have a CL characteristic, and the recommended practice discusses those applications.

Circuit Breaker and GFCIs

GFCIs are designed to safeguard persons from sustained voltage shock using a technique that is sensitive to currents as small as 6 mA. The 6-mA value is below the current level at which a person would be unable to let go of a conducting part. It is also below the value at which ventricular fibrillation is likely for adults or children. The recommended practice identifies some of the locations where GFCIs should be applied. GFCIs can be packaged

within MCCBs where the GFCI function is combined with the other common functions of a circuit breaker.

Circuit Breaker and AFCIs

AFCIs are designed to detect and isolate arcing faults in 120-Vac circuits where the arcing current is too small for the overcurrent device to detect and quickly isolate the fault. AFCIs use detection methods for an undesirable arcing in the voltage or current waveforms, and they discriminate the undesirable arcing waveform from load waveforms with similar characteristics. The primary intent of the AFCI is to provide protection from arcing faults that may occur in the fixed wiring system; however, they are also capable of detecting faults in temporary wiring, such as extension cords. AFCIs can detect line-to-ground and line-to-line arcing faults. Another form called combination AFCI can also detect arcing currents caused by a break in a conductor (series fault). In much the same fashion as GFCIs, AFCIs and combination AFCIs can be packaged within an MCCB. The 2014 NEC requires AFCIs to be applied in residential occupancies and also in dormitories, guest rooms, and guest suites that are provided with permanent provisions for cooking.

Supplementary Protectors

Supplementary protectors are intended for a specific purpose or to provide protection to a particular type of equipment. They are used to supplement the protection provided by the branch-circuit overcurrent device that supplies power to the end-use equipment in which the supplementary protector is installed. The supplementary protector must meet the requirements of UL Standard 1077 [13] or CSA Standard C22.2 No. 235 [15] rather than UL Standard 489 or CSA Standard C22.2 No. 5. These devices are evaluated by the listing company as a recognized component. They are not listed other than as a component in a larger assembly, and they are listed per the standard of that end-use equipment. They cannot be applied as part of an electrical distribution system. Supplementary protectors share some of the functionality of circuit breakers. Much the same as circuit breakers, the supplementary protectors must open the circuit automatically in a predetermined time versus voltage or current, and they are manually resettable. They may provide a means for manually opening and closing the circuit, but it is not a feature that is required by the standard. While the device does not carry a short circuit rating, it must be subjected to a limited short circuit test at a maximum current of 5,000 A.

Conclusions

The standard introduced in this article is one of the latest of the IEEE 3000 standards collection to be approved by the IEEE Standards Association. It represents another step in the effort to reorganize and update the series of standards known as the *IEEE Color Books* that have been used and continue to be used as a reference for industry-recognized practices on various aspects of the design, operation, and

maintenance of industrial and commercial power-distribution systems. IEEE Standard 3004.5 provides key insights into the standards and tests that are used in the design and manufacturing of circuit breakers. Through a thorough understanding of these topics, the electrical system designer is capable of properly applying circuit breakers that should result in a safer and more reliable electrical system. For a list of the topics covered by the standard, see “The Table of Contents from IEEE Standard 3004.5.”

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