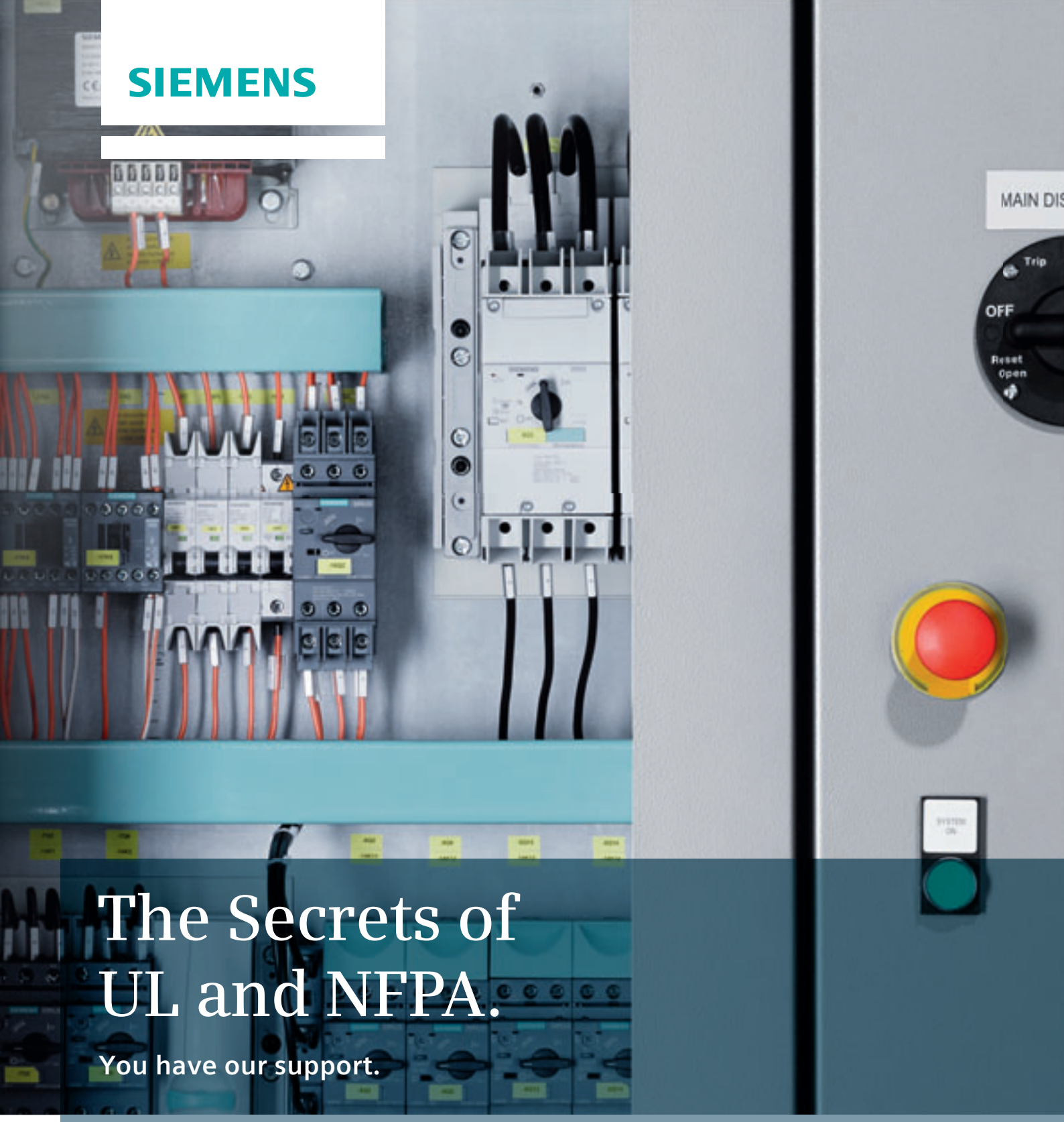
SIEMENS



The Secrets of UL and NFPA.

You have our support.

siemens.com/applicationconsulting/ul

Answers for industry.

Exporting Successfully to the USA with a Sound Knowledge of Applicable Standards

Product liability laws in the USA are significantly stricter than in Europe. Products to be exported to North America are required to be certified by the Underwriters Laboratory (UL), particularly when it comes to industrial control equipment. This brochure aims to explain the meaning of UL certification and to describe the corresponding aspects to be considered. As well as information on how you can leverage Siemens' comprehensive know-how on this topic to your advantage and broad portfolio of UL-certified low-voltage controls and distribution products.

UL and IEC differ fundamentally. The IEC standards merely specify the minimum safety requirements of a device or system. Technical details of the safety requirements' constructional implementation are up to the manufacturers. In contrast, the standards for the American market are far more detailed. Depending on the standard, the required process may be monitored from product design to product production down to application, mounting and operation.

Benefiting all along the line – with the UL know-how by Siemens

- You can depend on our strong and reliable product and system portfolio, which have been designed with consideration to the UL standards right from the development phase.
- Save commissioning time with expert UL consulting services and training courses.
- Obtain assistance from our UL-certified manufacturer in Chemnitz in relation to configuration, production and delivery of complete control panels.

You can rely on cost-effectiveness during production and operation of control panels for North America.

- Stay flexible for a highly diverse range of solutions and add-ons with our comprehensive and matched product portfolio: from the supply of the industrial control panel to the machine's smallest actuator.
- Benefit from efficient stock keeping thanks to the universal applicability of the products (IEC-UL/CSA).
- Implement a uniform operation and maintenance concept through our standard system.
- Save space and costs through integrated product interfaces and compact designs.
- Experience convenient, efficient on-site operation thanks to easy-to-use systems.

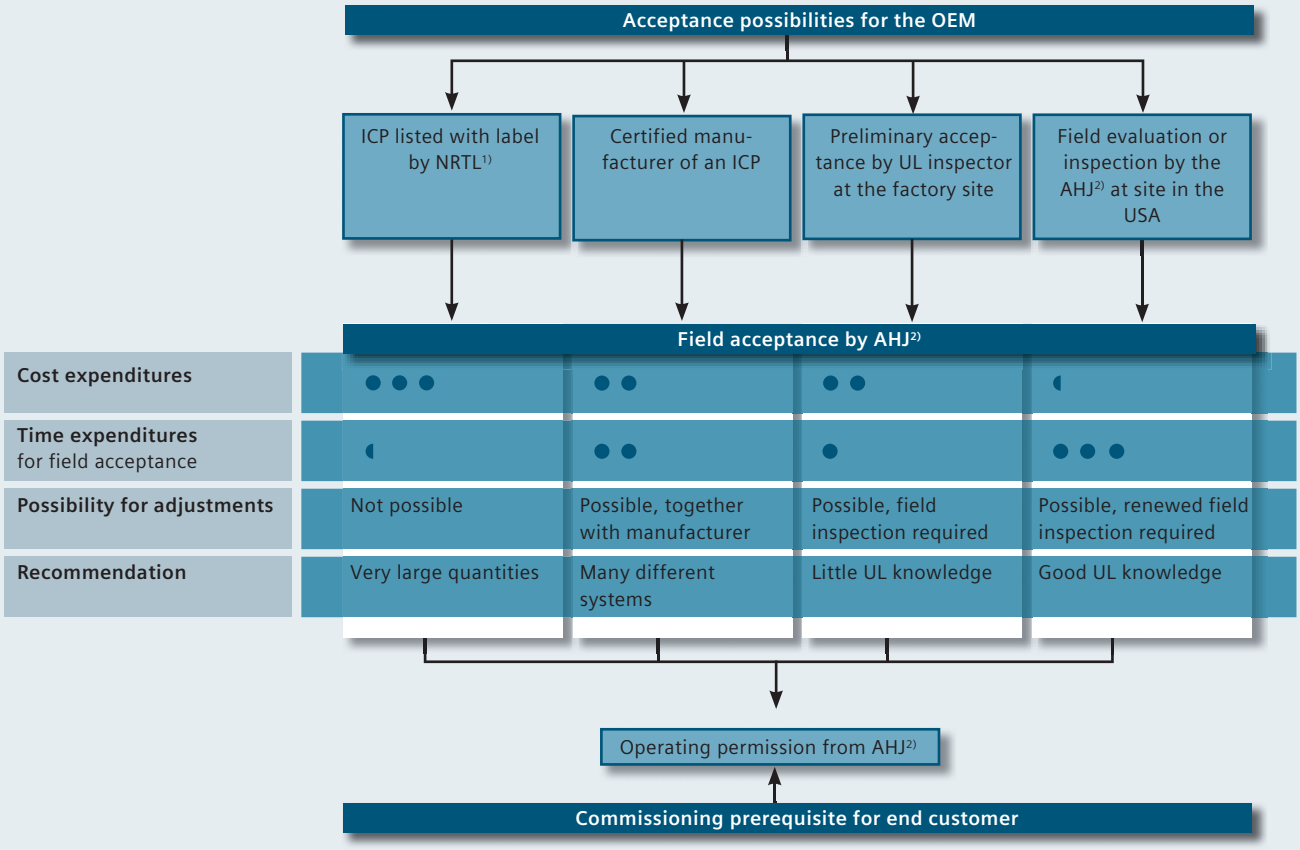
IEC and UL markets at a glance

Siemens production facility Amberg – UL partner since 1969

To avoid unnecessary trouble and save time- and cost-intensive expenditures, it is recommendable to rely on a competent partner like Siemens. Since 1969, our production facility Amberg, where the complete diversity of our low-voltage controls and distribution portfolio is developed and produced, has been closely cooperating with the Underwriters Laboratories Inc. We therefore offer comprehensive know-how on the subject of UL certification, ranging from production down to control panel wiring according to UL standards. Our portfolio of low-voltage controls and distribution products ensures your being on the safer side in terms of UL and facilitates the easy and fast assembly of control panels according to UL.

Contents

Field Inspection and Acceptance



[1)] Nationally Recognized Testing Laboratories
[2)] Authority Having Jurisdiction

Every electrical machine or system in the USA is investigated by an inspector, the so-called Authority Having Jurisdiction (AHJ) prior to commissioning. The National Electrical Code (NEC), also known as NFPA 70 respective application-specific standards such as NFPA 79 as well as local standards and specifications form the basis for acceptance.

Acceptance is required by law in the USA. Operators failing to have their machines or systems inspected by an AHJ risk both loss of insurance as well as power supply. For successful field acceptance, a correct configuration according to the applicable standards is of the essence. The illustration above shows four possible acceptance methods.

Conclusion

For manufacturing UL-compliant industrial control panels, the employment of UL-certified products alone is not sufficient. The interaction of devices in accordance with the respective application standards as well as the acceptance of the industrial control panel in its actual application environment are critical.

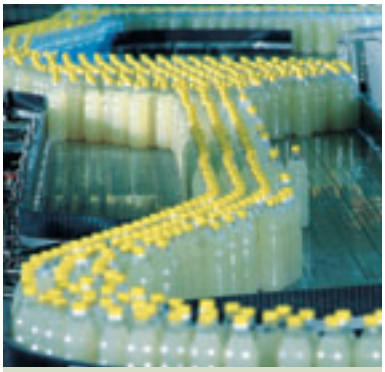
Overview of the Most Important US Standards

There is a whole series of organizations in the USA that are dedicated to promoting technical safety. Which standards and directives are relevant in the individual case can only be safely determined in conjunction with the respective application.

The following directives/standards are of essential importance to mechanical engineers and panel builders:

- **UL508A** for industrial control panels
- **NFPA 79** (Electrical Standard for Industrial Machinery) for industrial machines and
- **NEC** (National Electrical Code, NFPA 70) for electrical on-site installation.

Local conditions also have to be considered. These are specified by the Occupational Safety and Health Administration (OSHA), one of the most important organizations for the enforcement of safety requirements. It ensures safe and healthy occupational conditions and the protection of persons at their workplace by law, which became effective in 1970. In this context, OSHA also publishes various standards on safety technology pertaining to machines and systems, which are to be considered for the respective application case.



Here are two examples: When it comes to the equipment of a liquid filling system, the FDA (Food and Drug Administration) has to be consulted when it is for foodstuff. Additionally, the conditions for hazardous locations may be observed if there is alcohol processed (danger of inflammable liquids or explosive gases).

Who or what is NFPA?

NFPA (National Fire Protection Association) is an organization in the USA that publishes a comprehensive set of regulations for fire protection, electrical safety and construction safety. It was founded in 1896 and has published over 300 standards to date. NFPA does not certify products. It limits itself exclusively to drawing up standards, such as the NEC and NFPA 79 standards relevant to control panel production. NEC is considered state-of-the-art by the US legal system. You will find further information at **www.NFPA.org**

Who or what is UL?

Underwriters Laboratories Inc.® (UL) is one of the world's leading organizations for testing and certification in the field of product safety. This independent, non-profit US organization was founded in 1894 at the request of American fire insurance companies to analyze the fire hazards posed by electrically operated devices. Today, UL tests and certifies a wide range of materials, components and end products for their operational safety, particularly with regard to potential personal injury and fire formation. The organization maintains subsidiaries in numerous European countries. Detailed information on the US organization as well as contact details for the various European subsidiaries are available on UL's website at **www.ul.com**

US standard			Approximate IEC standard[1)]
General installation standards			
NEC (NFPA 70)	National Electrical Code (NEC)	Installation standard for the USA. All electrical installations shall comply with this code. The NEC is generally applied by local inspectors (Authority Having Jurisdiction – AHJ) and revised every 3 years.	IEC 60364-1
Application standards			
NFPA 79	Electrical Standard for Industrial Machinery	The "Electrical standard for industrial machinery" is mainly applied in the automotive and machine tool industry.	IEC 60204-1
UL 508A	Industrial Control Panels	Standard for industrial control panels	IEC 61439-1
UL 1741	Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources	Standard for installation of converters and their protection and control devices. It is particularly applicable to the testing of systems that serve the energy supply to the public network (grid connection), e.g. wind power, photovoltaics, etc.	IEC 60364-7-712
Product standards			
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures	Standard for power distribution equipment, e.g. molded-case circuit breakers (MCCB), miniature circuit breakers (MCB), molded-case switches and instantaneous trip circuit breakers	IEC 60947-2
UL 508	Industrial Control Equipment	Standard for industrial control equipment, e.g. contactors, overload relays, PLCs, etc.	IEC 60947-2, IEC 60947-4-1
UL 508C	Power Conversion Equipment	Standard for power conversion equipment, e.g. converters	IEC 61800-5-1
UL 98	Enclosed and Dead Front Switches	Standard for enclosed and dead-front switches, e.g. disconnectors, main switches	IEC 60947-3
UL 1077	Supplementary Protectors for use in electrical equipment	Standard for miniature circuit breakers (MCBs) not covered by UL 489; application as "supplementary protectors"	IEC 60947-2, IEC 60934
UL 248	Low-Voltage Fuses	Standard for fuses with fuse holder UL 512	
UL XXX	Further codes for devices used can be found under www.ul.com		IEC XXXXX

[1)] The IEC standards stated here serve as orientation. A one-to-one comparison of IEC and UL standards is not possible.

Seeing Clearly through the Jungle of Standards

In the USA, the National Electrical Code (NEC), which also deals with the topics of "Industrial Control Panels (Article 409)" and "Industrial Machinery (Article 670)", must generally be complied with when it comes to setting up electrical equipment. In these sections, reference is also made to the UL 508A for Industrial Control Panels and the NFPA 79 for Industrial Machinery standards, among others.

In the case of industrial machinery and plant, a distinction is generally made between factory wiring (sometimes also called internal wiring) and field wiring. Factory wiring is understood to be wiring that is laid and connected only in the control panel (i.e. under supervision), while field wiring is wiring that is connected by an electrician "in the field".

Application range of UL 508A

UL 508A, the relevant standard for the control panel (factory wiring), covers control panels with a voltage up to 600 V for normal ambient conditions. It applies between the electrical infeed and the outgoing feeder terminals to the field. On the topic of field wiring, only the interfaces (e.g. outgoing feeder terminals) to the field are dealt with. According to NEC Article 409, an industrial control panel is understood to be an arrangement of two or more components in the main circuit, the control circuit or hybrid circuits.

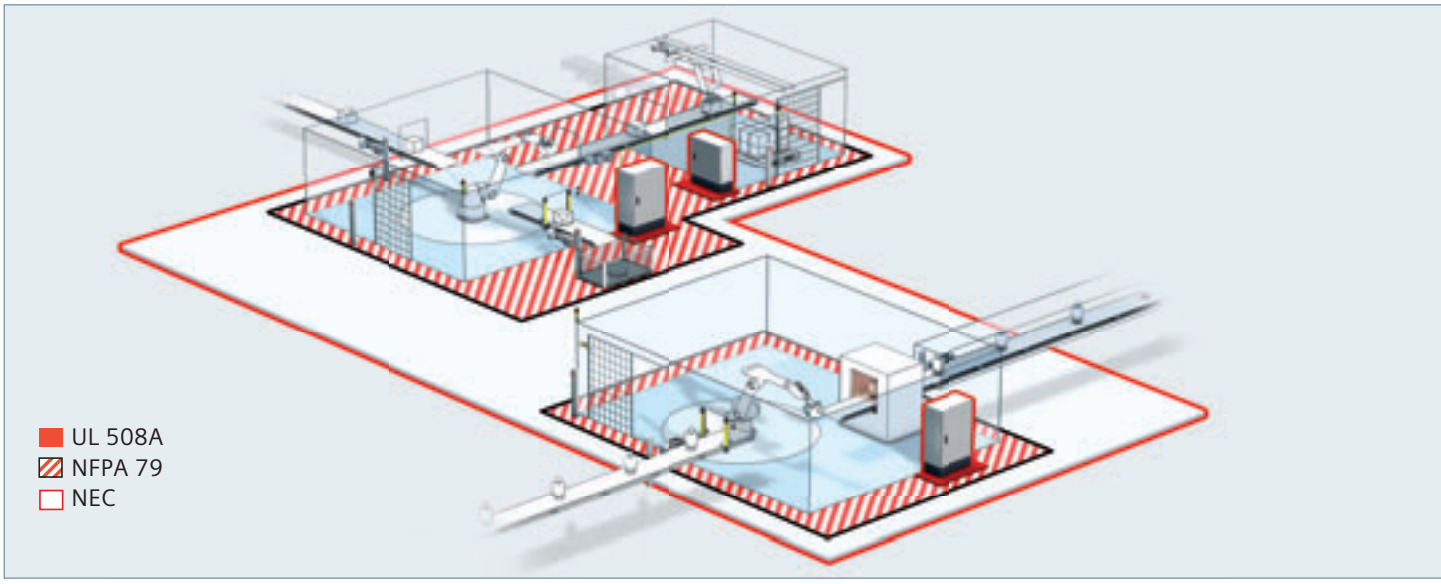
Application range of NFPA 79

NFPA 79 is the relevant standard for electronic components of industrial machinery up to 600 V for normal ambient conditions. It applies from the electrical infeed to the individual machine assemblies. This standard is aimed at protecting persons and plants.

Which standard applies?

Before configuration, it is necessary to clarify which standard is applied in which application cases. When to use UL 508A? When to use NFPA 79? When to use both? The requirements and interfaces of both standards are clearly set out with regard to most points. If requirements overlap, however, the standard with the higher requirements in relation to the respective point must be applied.

An example to improve understanding: UL 508A does not clearly define the maximum filling of cable ducts. Thus, it could be assumed that filling is 100%. In NFPA 79, though, it is limited to a maximum of 50%. This is why NFPA 79 must be applied in this case. Both standards are highly important for the manufacturer of industrial machinery.



Relevant Contents of UL 508A

Overcurrent protection according to system type

UL 508A distinguishes between straight rating and slash rating. Which of these two ratings applies depends on the existing system type.

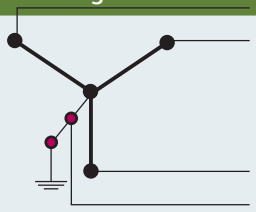
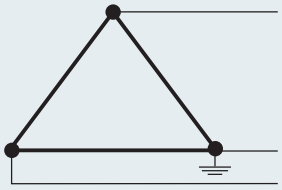
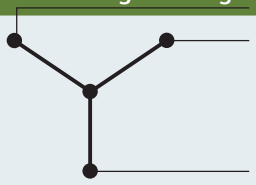
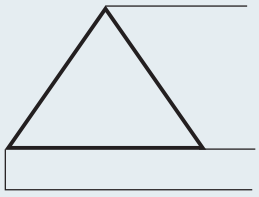
Slash rating

There are two voltages (phase – phase / phase – ground) in a solidly grounded wye network. These two voltages are also specified along with the rating, e.g. 480 Y/277 V. The rating for such a network is called the slash rating.

Straight rating

In the common industrial networks (see table) there is only one voltage. Such networks are called “straight networks.”

When choosing short-circuit protection devices, attention must be paid to whether devices are approved for straight or slash rating.

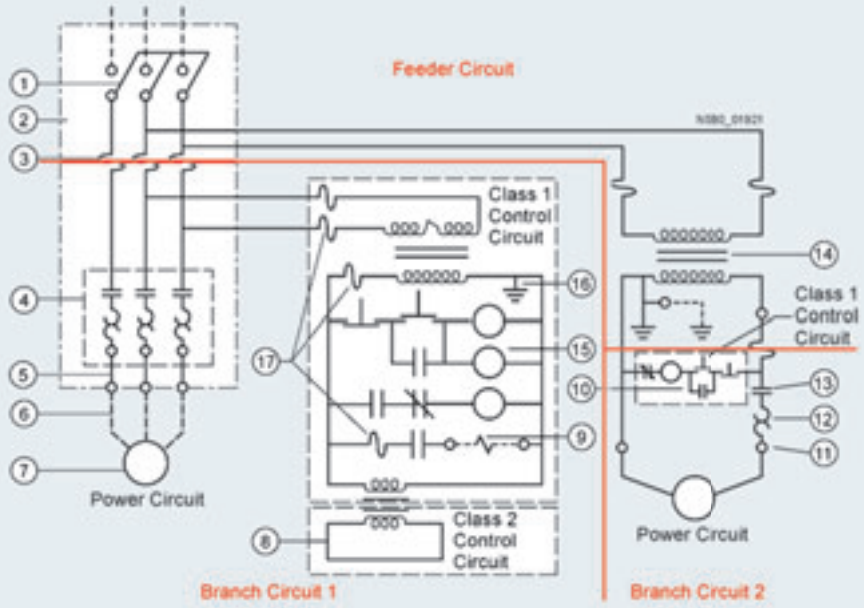
Industrial networks in the USA (industry and commercial)			
Slash rating	**Straight rating**		
			
3 phases, 4 wires Solidly grounded wye, 3-phase, 4-wire	**3 phases, 3 wires** Corner grounded delta, 3-phase, 3-wire	**3 phases, 3 wires** Ungrounded wye, 3-phase, 3-wire	**3 phases, 3 wires** Ungrounded delta, 3-phase, 3-wire
Note: the PE must not carry any current. There is no PEN conductor -> N = grounded conductor (white or gray); separate conductors must be used for PE and N.			
Usable line voltages			
600Y / 347 V[1)]	600 V		
480Y / 277 V[1)]	480 V		
240Y / 131 V[1)]	240 V		
208Y / 120 V[1)]			

[1)] Y describes the solidly grounded circuit. The value “Y” indicates the voltage between the phases (e.g. 480 V), and the value behind the slash indicates the voltage between the phase and the grounding or the neutral conductor (e.g. 277 V with 480 V voltage between the phases).

Overcurrent protection

The term “overcurrent” refers to the overload, short circuit and ground-fault current. Overcurrent protection is understood to be a device designed to open a circuit when the rated current is exceeded. The ampere rating of the device is selected for a circuit to terminate a condition where the current exceeds the rating of conductors and equipment due to overloads, short circuits and faults to ground.

Circuit and Switching Elements of an Industrial Control Panel



1	Fused disconnect switch acc. to UL 98, circuit breaker acc. to UL 489 or miniature circuit breaker acc. to UL 489
2	Combination Motor Controller
3	Branch Circuit Protection *[1]
4	Starter
5	Power Circuit Internal Wiring / Factory Wiring *[2]
6	Field Wiring *[3]
7	Load (provided in field)
8	Class 2 Circuit
9	Solenoid or other Control Devices (provided in field)
10	Control Circuit / Class 1 Circuit / Common Control Circuit
11	Field Wiring Terminals
12	Overload Relay
13	Contactor / Controller
14	Power Transformer – for Motor Load and Control Circuit
15	Control Circuit Devices and Wiring / Class 1 Circuit / Isolated Secondary Circuit
16	Control Transformer Ground (for 1000 VA Max Control Transformer)
17	Supplementary protection (miniature circuit breaker acc. to UL 1077)

[1] **Branch circuit protection: Overcurrent protection** with an ampere rating selected to protect the branch circuit (devices and cables). For a motor branch circuit, the overcurrent protection is required for overcurrents due to short circuits and faults to ground only.
[2] **Power circuit internal wiring/factory wiring:** The devices may only be connected by the factory, e.g. if soldered or crimped connections are required.
[3] **Field wiring:** Field wiring is mostly done by an electrician without specially prepared conductors.

Power circuit according to UL 508A

Short-circuit current rating of the control panel power circuit

An industrial control panel must be marked with a so-called Short-Circuit Current Rating (SCCR). With IEC, this approximately corresponds to the I_{cw} value of the switchboard. The NEC 2011 Article 409 describes the specifications of short-circuit current rating marks on industrial control panels (with reference to UL 508A, SB4). For short-circuit rating, not only the short-circuit breaking capacity, e.g. of the circuit breaker, but also the short-circuit rating of every individual device in the power circuit is relevant.

The SCCR-relevant components in the power circuit include circuit breakers, contactors, overload relays, solid-state switching devices, terminals, busbars, the line side of control transformers and frequency converters, however, no internal wiring of the industrial control panel. The lowest value is applicable to the entire industrial control panel. A transformer with a higher short-circuit current must not be connected to the industrial control panel.

Infeed

The specifications for the infeed to the industrial control panel also differ from the IEC standards. For example, only certain devices are permitted as main switches, e.g. circuit breakers according to UL 489.

Distinction between branch and feeder circuits in the power circuit

The distinction between branch and feeder circuits applies only to the power circuit. The control circuit is not a branch circuit and it does not belong to the feeder circuit either. Other rules apply here, which are considered in the section on control circuits.

- **Feeder circuit**
  The conductors and circuitry on the supply side of the branch circuit overcurrent protective device.
- **Branch circuit**
  The conductors and components following the last branch circuit overcurrent protective device protecting the load.

Protecting other loads

Non-motor loads must be protected as specified in the manufacturer's UL report. One essential difference with respect to the IEC world is that circuit breakers according to UL 489 or fuses according to UL 248-4...12 must be used in both cases.

Combination Motor Controller Examples

Assembly options of motor branch circuits

The assembly options of combination motor controllers within IEC greatly differ from those for the UL market. Combination motor controllers according to IEC may cause UL inspectors or the AHJ to impose the so-called "red flag," which means that the machine can only be put into operation after a significant change.

Motor branch functions:

- Disconnect
- Short-circuit protection / branch circuit protection
- Motor overload protection
- Motor control

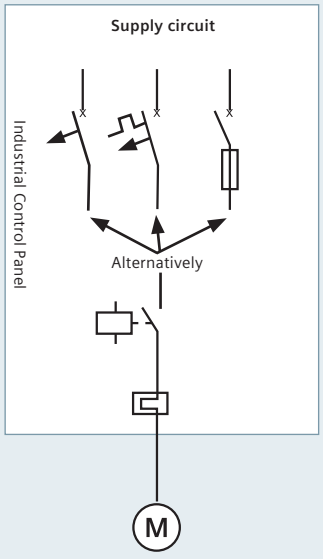
Motor branch configuration types:

- Motor feeder protection types A to D
- Manual self-protected combination motor controller type E
- Self-protected combination motor controller type F
- Motor feeder protection types A to D in a group installation
- Manual motor controller in group installation suitable for tap conductor protection

Motor feeder protection types A, B, C, D

Application:
- With decentrally installed single motors (e.g. fans in factory hall)
- For few motors in the machine
- Motor branches for high voltages

Assembly:
- 1 short-circuit protective device
- 1 magnetic motor controller (contactor for remote motor switching)
- 1 overload relay



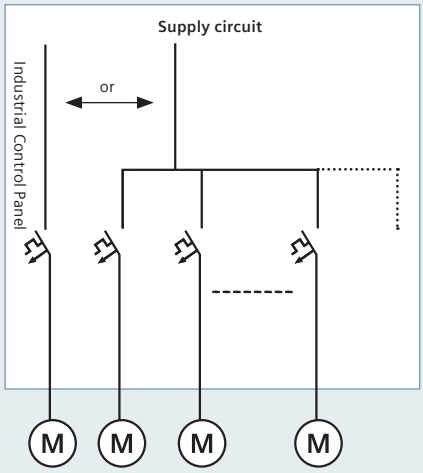
Devices	UL standard	Device functions			
		Disconnect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch/ fuses	UL 489 UL 98 / UL 248	● ●	● ●		
Magnetic motor controller	UL 508			●	
Overload relay	UL 508				●

Manual self-protected combination motor controller type E

Application:
- For systems comprising one or several motors
- Can only be used for slash rating

Assembly:
- 1 manual self-protected combination motor controller type E per motor

Note:
- Upstream circuit breakers or fuses are not required
- Smaller cross sections for motor supply line permitted than with group installation
- Type E controllers are only certified for motor protection
- Type E controllers require 1 inch through air and 2 inches over surface on the line side to comply with UL



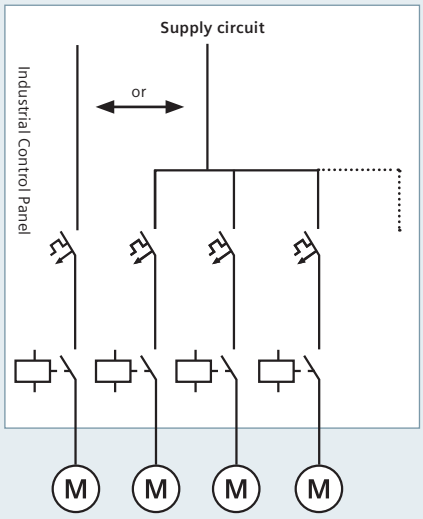
Devices	UL standard	Device functions			
		Dis-connect	Short-circuit protection	Motor control	Overload protection
Manual self-protected combination motor controller	UL 508	●	●	●	●

Self-protected combination motor controller type F

Application:
- For systems comprising one or several motors
- Can only be used for slash rating

Assembly:
- 1 manual self-protected combination motor controller per motor
- 1 magnetic motor controller per motor

Note:
- Upstream circuit breakers or fuses are not required
- Smaller cross sections for motor supply line permitted than with group installation
- Type F controllers are only certified for motor protection
- Type F controllers require 1 inch through air and 2 inches over surface on the line side to comply with UL



Devices	UL standard	Device functions			
		Disconnect	Short-circuit protection	Motor control	Overload protection
Manual self-protected combination motor controller	UL 508	●	●		●
Contactor	UL 508			●	

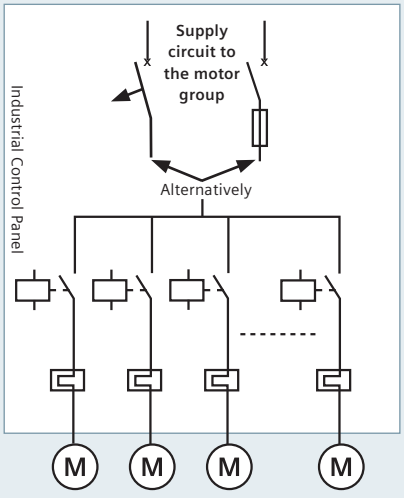
Motor feeder protection types A, B, C or D in a group installation

Application:
- For systems comprising several motors

Assembly:
- 1 short-circuit protective device as group protection
- 1 magnetic motor controller per motor (contactor for remote motor switching)
- 1 overload relay per motor

or
- 1 short-circuit protective device as group protection
- 1 manual motor controller per motor (motor controller for manual motor switching)
- Optional: 1 control device per motor (contactor for remote motor switching)

Note:
- Conventional assembly type if no certification as "type E" or "suitable for tap conductor protection in group installation" is available
- Often inefficient in practical applications due to the cable / wire size dimensioning rule



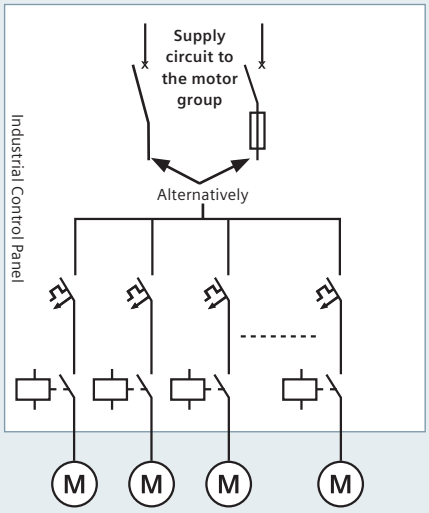
Devices	UL standard	Device functions			
		Disconnect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch/ fuses	UL 489 UL 98 / UL 248	● ●	● ●		
Magnetic motor controller	UL 508			●	
Overload relay	UL 508				●

Manual motor controller in group installation suitable for tap conductor protection

Application:
- For systems comprising several motors

Assembly:
- 1 short-circuit protective device as group protection
- 1 manual motor controller per motor with certification "suitable for tap conductor protection in group installation" (motor controller for manual motor switching)
- Optional: 1 control device (contactor for remote motor switching) per motor

Note:
- Smaller line cross sections permitted than with standard group installation
- No adapter required as opposed to type E
- As opposed to manual motor controllers in group installation, line protection is not realized by the upstream short-circuit protective device here, but by the devices themselves



Devices	UL standard	Device functions			
		Disconnect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch/ fuses	UL 489 UL 98 / UL 248	● ●	● ●		
Manual motor controller	UL 508	●	●	●	●
Contactor (optional)	UL 508			●	

Control circuits according to UL 508A

Control circuit
A circuit that carries the electric signals directing the performance of a controller, and which does not carry the main power circuit. Control circuits are, in most cases, limited to 15 A. There are various ways of realizing control circuits:

- Direct tap-off upstream of the branch circuit protective device. Here, respective protective devices are to be used, e.g. circuit breakers according to UL 489.
- Direct tap-off downstream of the branch circuit protective device. Here, also so-called supplementary protectors can be used, e.g. miniature circuit breakers according to UL 1077.
- Via control transformers or DC power supply units. Caution: Various protective devices may not be approved for this application.

Low-voltage limited energy circuit
A circuit with 30 V_{rms} (root mean square value) or 42.4 V_{peak} or 42.4 V_{peak} or DC voltage. Power is limited to 100 VA, and current to 5 A. An example of such a control circuit would be 24 V, fused with 4 A.

Class 2 control circuit
A control circuit supplied from a source having limited voltage (30 V_{rms} or less) and current capacity, such as from the secondary of a Class 2 transformer and rated for use with Class 2 remote-control or signaling circuits.

Class 1 common control circuit (acc. to UL 508A)
A control circuit on the load side of an overcurrent protective device where the voltage does not exceed 600 volts, and where the power available is not limited, or a control circuit on the load side of a power limiting supply, such as a transformer.

Enclosure types according to UL
In the USA, the enclosure type refers to the degree of protection (comparable to the IP degree of protection in Europe). The UL system works differently to the IEC system, e.g. a higher digit is not equivalent to higher protection, but different protection. There are also rules for mounting components onto the enclosure or through the enclosure plate.

UL mark
According to UL 508A, the control panel must be marked in detail. From the rating plate to the wire end identification, extensive rules must be complied with.

The UL Marks in Detail

For the marking of UL-certified products, a general differentiation is made between listed devices and recognized components. Further variants exist for the Canadian market.

UL Listing Mark: This is one of the most common UL marks. If a product carries this mark, it means UL found that representative samples of this product met UL's safety requirements. These requirements are primarily based on UL's own published standards for safety. This type of mark is seen commonly on appliances and computer equipment, furnaces and heaters, fuses, electrical panelboards, smoke and carbon monoxide detectors, fire extinguishers and sprinkler systems, personal flotation devices like life jackets and life preservers, bullet-resistant glass, and thousands of other products. Our own portfolio, for example, offers contactors in accordance with UL 508 or circuit breakers in accordance with UL 489.

C-UL Listing Mark: This mark is applied to products for the Canadian market. The products with this type of mark have been evaluated to Canadian safety requirements, which may be somewhat different from U.S. safety requirements. You will see this type of mark on appliances and computer equipment, vending machines, household burglar alarm systems, lighting fixtures, and many other types of products.

C-UL Listing Mark: UL introduced this new Listing Mark in early 1998. It indicates compliance with both Canadian and U.S. requirements. The Canada / U.S. UL mark is optional. UL encourages those manufacturers with products certified for both countries to use this new, combined mark, but they may continue using separate UL marks for the United States and Canada.

Recognized Component Mark: This mark consumers rarely see because it is specifically used on component parts that are part of a larger product or system. These components may have restrictions on their performance or may be incomplete in construction. The Component Recognition mark is found on a wide range of products, including some switches, power supplies, printed wiring boards, some kinds of industrial control equipment and thousands of other products. They shall only be installed by experts of the manufacturer according to the so-called "Conditions of Acceptability (CoA)" that apply to these devices. Amongst others, our portfolio contains the following products with the UR mark: miniature circuit breakers according to UL 1077, time switches according to UL 917, and SITOR fuses.

Canadian Recognized Component Mark (similar to Recognized Component Mark – see above): Products intended for Canada carry the Recognized Component Mark "C."

Recognized Component Mark for Canada and the United States: This new UL Recognized Component Mark, which became effective in 1998, may be used on components certified by UL to both Canadian and U.S. requirements. Although UL had not originally planned to introduce a combined Recognized Component Mark, the popularity of the Canada/U.S. Listing and Classification Marks among clients with UL certifications for both Canada and the United States has led to the new Mark.

Certifications such as  and  are issued by the so-called NRTLs (Nationally Recognized Testing Laboratories) after successful testing. The OSHA (Occupational Safety and Health Administration) has accredited Underwriters Laboratories Inc. as an NRTL.

Relevant Contents of NFPA 79

NFPA 79 deals with electrical safety for an entire machine, both inside and outside the control panel. Above all, the following contents and stipulations of NFPA 79 must be observed in relation to machine and control panel production.

Cables outside the control panel (field wiring)
NFPA 79 stipulates which cables are permitted from the control panel to the load, how they are to be designed and how they have to be laid.

Motors in the field
NFPA 79 describes the dimensions and selection criteria for electrical motors.

Identifications, safety information and technical documentation
The standard stipulates in detail which identifications, safety information and technical documentation are required to be available.

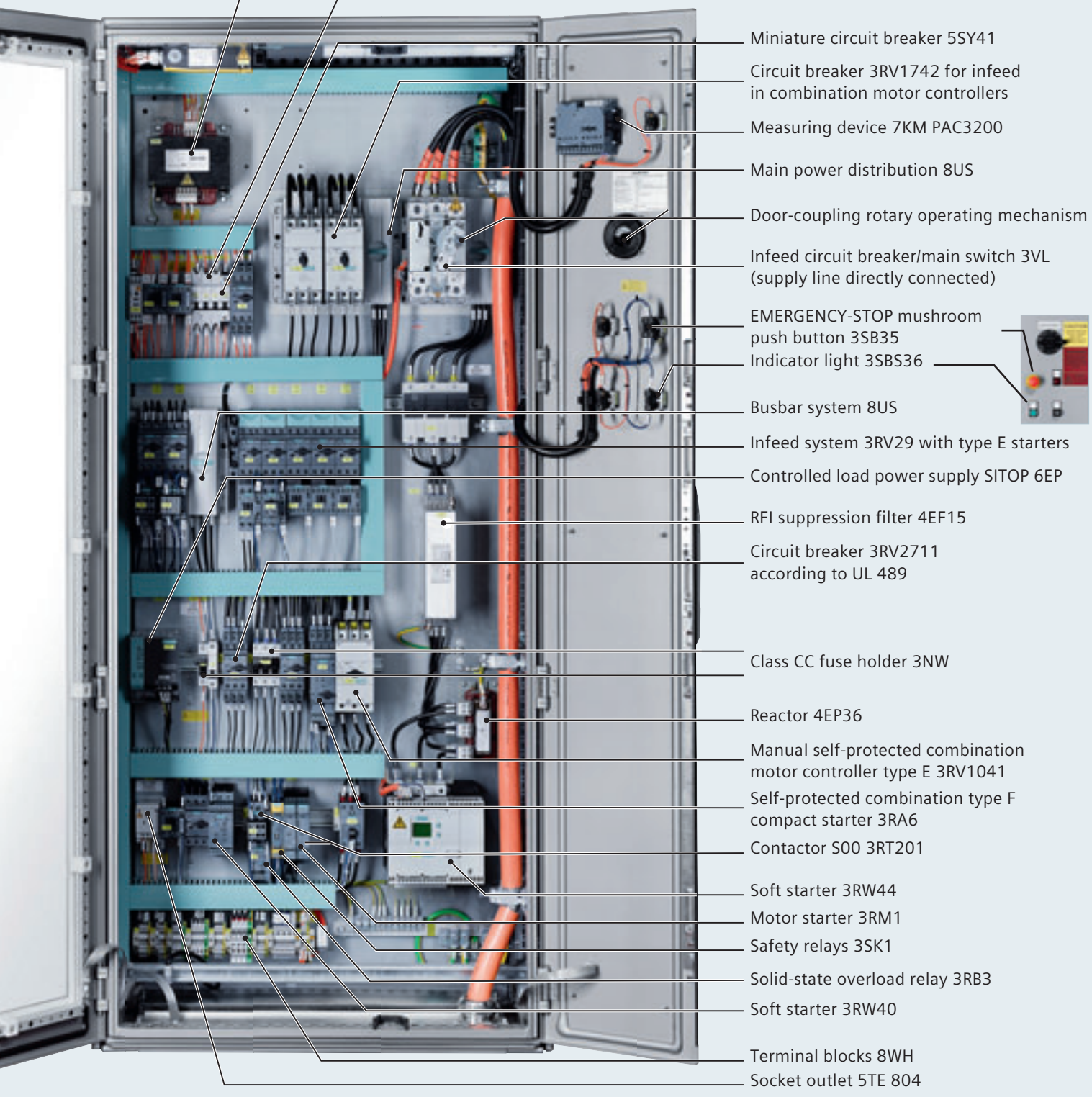
Machine safety
NFPA 79 deals with the subject of machine safety only in part. The standard essentially refers to other standards, e.g. to IEC and ANSI standards when it comes to the risk analysis.

Tests and verifications
According to NFPA 79, diverse tests and verifications have to be carried out in contrast to UL 508A, for example checking the continuity of PE conductors, voltage testing, and much more.

Stipulations for control equipment
NFPA 79 contains detailed specifications for control equipment (such as push buttons, Emergency Stop) as well as its installation location, mounting and distances in the operating range.

Other NFPA 79 topics
- It includes specifications for Emergency Stop and emergency shutdown (e.g. stop categories).
- Control panel topics such as infeed and the main switch, system protection, protection against electrical hazards, motor protection, accessories and lighting.

A Small Selection from our Large UL Portfolio



Our Portfolio for Industrial Control Panels

	Product	Order No. body	UL standard	Explanation
	Circuit breakers acc. to UL 489			
	**SENTRON air circuit breakers (ACB)**	3WL5	UL 489	Thanks to their modular design and UL 489 as well as IEC 60947 approvals, the 3WL air circuit breakers facilitate global applicability. With only three sizes, they cover a power range from 630 A to 5,000 A. This makes them universally applicable and they also offer unique planning certainty. As lubrication of mechanical parts is not necessary and the main contacts can be replaced locally, they are extraordinarily maintenance-friendly.
	**SENTRON molded-case circuit breakers (MCCB)**	3VL	UL 489	Covering the range from 16 A to 1,600 A, the 3VL molded-case circuit breakers ensure overload and short-circuit protection. In new installations, the 3VL molded-case circuit breakers with integrated communication are a good solution. Acquisition of measured values is an integral component of the circuit breaker.
	**SIRIUS circuit breakers**	3RV17, 3RV18 3RV27, 3RV28	UL 489	The circuit breakers SIRIUS 3RV17/18/27/28 are compact circuit breakers with 100% rating. They guarantee secure disconnection in case of a short circuit and protect consumers and the system against overload.
	**SENTRON miniature circuit breakers (MCB)**	5SJ4...-.HG	UL 489	Miniature circuit breakers 5SJ according to UL 489 can be used as an all-round solution as "branch circuit protector" for protection in branches, distributors, switchgear panels and control systems in accordance with UL 508A. They are also approved for circuit protection in heating, air-conditioning and ventilation systems (HACR) and for DC applications up to 60 V/125 V. All additional components 5ST3 ...-.HG can be combined with miniature circuit breakers 5SJ4 ...-.HG in accordance with the assembly concept.

You will find extensive accessories such as door-coupling rotary operating mechanisms and door locks in the product catalogs IC 10 and LV 10.1, and in the UL catalog LV 16.

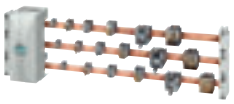
	Circuit breakers acc. to UL 1077			
	**SENTRON miniature circuit breakers** Supplementary protectors	5SY4, 5SY6, 5SY7, 5SY8, 5SP4, 5ST30	UL 1077	Within the scope of the UL 1077 standard, we offer you a whole series of miniature circuit breakers with accessories as supplementary protectors.
	Fuses			
	**SITOR semiconductor fuses and fuse holders**	3NE, 3NC3 3NC1 0, 3NC1 4, 3NC2 2	UL 512, UL 248-13	The semiconductor fuses SITOR protect power semiconductors against short-circuit faults. They protect high-quality equipment and system parts, like converters with fuses in the entry and in the DC link, UPS systems and soft starters for motors.
	**SENTRON LV HRC fuse bases**	3NH3, 3NH4	UL 512 only downstream of the branch protection	In combination with the SITOR fuse link, the LV HRC fuse bases 3NH3, 3NH4 of the BETA low-voltage circuit protection portfolio ensure the reliable protection of power semiconductors.
	**SENTRON LV HRC fuse switch disconnectors**	3NP1	UL 512	The LV HRC fuse switch disconnector 3NP1 can be used to protect and switch a highly diverse range of electric loads. It can be additionally equipped with electromechanical or electronic fuse monitoring that detects, displays and signals fault states.
	**SENTRON cylindric fuse holders and Class CC fuse holders** **SENTRON class CC fuse links**	3NW7 0, 3NW7 1, 3NW7 5.3-0HG 3NW1 ...-0HG, 3NW2 ...-0HG, 3NW3 ...-0HG	UL 512 UL 248-4	The Class CC fuse system in compliance with the UL standard is used for branch circuit protection. The encapsulated fuse holders are designed and tested in compliance with US NEC 210.20(A) National Electrical Code.

	Product	Order No. body	UL standard	Explanation
	Industrial control equipment in compliance with UL 508			
	**SIRIUS contactors** Contactors / magnetic motor controllers	3RT, 3RH	UL 508	No matter which load you want to switch, you'll find the right solution among the SIRIUS contactors. With high contact reliability and a compact, modular design, and also particular robustness and longevity, as part of the SIRIUS modular system they are the ideal partner for operational switching.
	**SIRIUS function modules** for mounting on 3RT2 contactors	3RA28	UL 508	To reduce control circuit wiring when assembling direct-on-line, reversing and wye-delta starters, function modules are available that can simply be plugged onto the new-generation 3RT2 contactors in sizes S00 and S0. Thus, this size of contactor assemblies can be realized fast, easily and above all fault-free. The function modules with starter functions are also available with interfaces for AS-Interface or for IO-Link. Thus, in addition to saving on wiring within the feeders, interfacing to higher-level control systems can also be substantially simplified.
	**SIRIUS solid-state switching devices**	3RF2, 3RF3	UL 508	The SIRIUS 3RF solid-state switching devices are used when frequent switching of motors, small drives and valves is required. They do not feature any mechanically moved parts and therefore facilitate noise-free, wear-free and almost unlimited switching. Their compact design enables space-saving assembly in the control panel.
	**SIRIUS motor starter protectors** Manual self-protected combination motor controllers / manual motor controllers	3RV10, 3RV20	UL 508	The manual motor controllers SIRIUS 3RV10/20 are compact switching devices. Depending on the application (and on the UL approval), they guarantee secure disconnection in case of a short circuit and protect motors against overload.
	**Motor and maintenance switches** Manual motor disconnect	3LD2	UL 508	The particularly compact manual motor disconnect units SENTRON 3LD2 are employed for the switching of power and auxiliary circuits as well as for three-phase motors and other consumers for maintenance and repair cases. Amongst others, they facilitate the cable bending radius specified by UL.
	**SENTRON switch disconnectors** Manual motor controllers	3KA	UL 508	The switch disconnectors 3KA and 3KL in three-pole design assume the tasks of "disconnecting" and "switching under load" for the stated rated current and guarantee safety disconnection in all low-voltage networks. They are thus predestined for use as EMERGENCY-STOP, repair or load transfer switch. (According to UL, only applicable with SITOR fuses – special-purpose fuse.)
	**SENTRON switch disconnectors with fuses** Fused manual motor controllers	3KL	UL 508	
	**SENTRON switch disconnectors**	5TE1	UL 508	The switch disconnectors 5TE1 from 100 A to 200 A in 3- and 4-pole design can be employed as motor disconnect switch, repair switch, outgoing isolator and emergency disconnector unit.
	**SIRIUS fuseless load feeders**	3RA	UL 508	The fuseless load feeders SIRIUS 3RA are assembled from 3RV self-protected combination motor controllers and 3RT contactors. Thanks to their integrated prewiring, the fuseless load feeders can be rapidly and easily mounted. They are the optimum solution particularly for distributed and wide-spread system structures.

	Product	Order No. body	UL standard	Explanation
	Industrial control equipment in compliance with UL 508			
	**SIRIUS compact starter** Self-protected combination motor controller Type F, motor controller/group application, suitable for tap conductor protection	3RA6	UL 508	Using a compact design, the universal motor feeder according to UL 508 Type E combines the functions of circuit breaker / MSP, solid-state overload relay and contactor. The compact starter SIRIUS can be used as direct-on-line and reversing starter for three-phase standard motors up to 32 A (approx. 15 kW/400 V). Advantage: weld-free contacts.
	**SIRIUS motor starters**	3RM1	UL 508	Thanks to its compact design, the SIRIUS 3RM1 motor starter is particularly suitable for constricted space conditions in the control panel. Thus, the motor starter complements the SIRIUS control panel portfolio precisely when there is not much space in the control panel. The motor starter protects motors against overload and switches small motors up to 3 kW, optionally as a direct-on-line or reversing starter.
	**SIRIUS motor starters**	3RK	UL 508	Whether central or distributed assembly in the industrial control panel or in high degree of protection in the field – motor starters SIRIUS are always an optimum and easy solution. The motor starters of the ET 200S system are, for example, suitable for central assembly in the control panel or for distributed solutions directly in the field. The distributed I/O system SIMATIC ET 200pro is ideal for complete solutions in particularly high degree of protection thanks to its modular design.
	**SIRIUS Soft starters**	3RW	UL 508	The soft starters SIRIUS ensure a longer useful life of system components and a current saving because they reduce mechanical and electrical loads that occur when starting and stopping three-phase motors. Three variants in terms of function and performance (3RW30, 3RW40 and 3RW44) make soft starting practicable for a large number of applications. Compact design and innovative technology enable cost-effective application and space-saving installation.
	**SIRIUS thermal overload relays** **SIRIUS solid-state overload relays**	3RU 3RB	UL 508 UL 508	SIRIUS overload relays with screw-type, spring-loaded or ring cable lug connections reliably protect loads as well as other switching and protective devices in the respective load feeder against overload, phase asymmetry and phase failure. The overload relays can easily be used with the contactors of the SIRIUS modular system.
	**SIRIUS coupling relays**	3TX70, 3RS18	UL 508	The very narrow SIRIUS 3TX70 coupling relays allow for particularly space-saving assemblies in the control panel and offer a large range of input and output coupling links. In addition to combined-voltage devices, the SIRIUS 3RS18 coupling relay range also comprises wide-voltage versions. All 3RS18 versions are consistently available with screw-type or spring-loaded connection system. The optional hard gold-plated contacts ensure maximum contact reliability even with low currents.
	**SIRIUS interface converters**	3RS17	UL 508	The interface converters SIRIUS 3RS17 assume the coupling function for analog signals, both on the input and the output sides. They are indispensable for the processing of analog values with electronic controls.

	Product	Order No. body	UL standard	Explanation
	Industrial control equipment in compliance with UL 508			
	**SIRIUS plug-in relays**	LZX	UL 508	The plug-in relays SIRIUS LZX are available both as complete units and as individual modules for self-assembly or spare parts requirements. They are employed as coupling relays for coupling between the inputs and outputs of electronic controls, for contact multiplication, for switching of small loads, and as measuring transducers.
	**SIRIUS power relays**	3TG10	UL 508	With a width of only 36 mm, the compact power relays/small contactors SIRIUS 3TG10 are particularly suitable for applications in minimum space, e.g. for air-conditioning units, heaters, pumps, fans – as well as generally for simple electric controls. Thanks to their hum-free operation, they are also ideally suited for application in household appliances or power distributions in office and residential buildings.
	**SIRIUS timing relays**	3RP15, 3RP20, 7PV15	UL 508	The electronic timing relays SIRIUS 3RP15, 3RP20 and 7PV15 are employed for all time-delayed switching operations in control, start-up, protection and regulation circuits. They ensure a high functionality as well as a high repeat accuracy of the set operating time.
	**SIRIUS pushbutton units and indicator lights**	3SB	UL 508	The pushbuttons and indicator lights SIRIUS are characterized by maximum functionality, their modern and flat design as well as particular ease of mounting.
	**SIRIUS signaling columns**	8WD4	UL 508	The signaling columns SIRIUS 8WD4 are employed for checking complex machine functions or in automated processes and serve as visual or audible warning devices.
	**SIRIUS position and safety switches**	3SE5	UL 508	SIRIUS position and safety switches detect mechanical movements, e.g. of moving machine parts or protective equipment. They are available for both standard and safety applications. There are mechanical and no-contact variants.
	**SIRIUS magnetically operated switches**	3SE6	UL 508	The magnetically operated switches SIRIUS 3SE6 are designed for attachment to mobile protective devices. Evaluation is realized via a safety relay or connection to a bus system. The touch-free, magnetically operated 3SE6 safety switches are characterized by their closed design and high degree of protection IP67.
	**SIRIUS cable-operated switches**	3SE7	UL 508	The cable-operated switches SIRIUS are employed for monitoring applications or as EMERGENCY-STOP devices in particularly hazardous system components.

	Product	Order No. body	UL standard	Explanation
	Industrial control equipment in compliance with UL 508			
	**SIRIUS safety relays**	3SK1	UL 508	The slimline and clearly arranged product portfolio offers the ideal solutions for locally limited and simple safety applications. Typical applications are EMERGENCY-STOP, protective door and two-hand operator panel applications, for example. Safety relays SIRIUS 3SK1 quickly make a system safe. The safety relays keep you flexible at all times because the system is modular and therefore adaptation to new requirements is possible at all times.
	**Modular safety systems (MSS)**	3RK	UL 508	The 3RK3 (MSS) modular safety system is a freely parameterizable and modular safety relay. Depending on the external circuitry, safety-related applications up to Performance Level e in accordance with ISO 13849-1 or SIL 3 in accordance with IEC 62061 can be realized. The modular safety relay supports the interconnection of multiple safety applications. The comprehensive fault and status diagnostics allows for trouble-shooting in the system and for the localization of sensor signals, resulting in reduced system downtimes.
	**SIMOCODE pro motor management and control devices**	3UF7	UL 508	SIMOCODE pro is a flexible and modular motor management system for motors with constant speeds in the low-voltage range. SIMOCODE pro supports optimum process control and thus facilitates efficient operations control.
	**SIRIUS monitoring relays**	3UG4	UL 508	The monitoring relays 3UG4 provide a maximum degree of protection for machines and systems. Line and voltage faults, for example, can be detected and rectified early on before leading to more substantial damage. The following variables can be monitored with the monitoring relays 3UG: line, voltage and current monitoring, cos phi and active current monitoring, fault current monitoring, insulation monitoring, level monitoring, speed monitoring.
	**SIRIUS monitoring relays** for mounting on 3RT2 contactors	3RR2	UL 508	The monitoring relay SIRIUS 3RR2, which is mounted on a contactor, monitors the entire application rather than just the single motor. Especially in assembly, its use produces a crucial advantage, because wiring is reduced enormously thanks to integration in the load feeder.
	**SIRIUS temperature monitoring relays**	3RS10, 3RS11	UL 508	Temperature monitoring relays 3RS specialize in measurement of temperatures in solid, liquid and gaseous media. The temperature is measured using a sensor that is placed in the medium, evaluated by the device, and monitored to determine whether it is within the upper and lower temperature limits. Depending on the function that has been parameterized, the output relay either switches on or off at these threshold values.
	**SIRIUS thermistor motor protection**	3RN1	UL 508	The thermistor motor protection devices SIRIUS 3RN1 offer a professional and reliable temperature-dependent overload protection of three-phase motors.

	Product	Order No. body	UL standard	Explanation
	Miscellaneous devices and accessories			
	**SIRIUS transformers**	4AJ, 4AM, 4AP, 4AW, 4AT, 4BT, 4AP, 4AU, 4BU	UL 506 UL 1561	The transformers SIRIUS offer optimum protection through high permissible ambient temperatures up to 40 °C or 55 °C (104 °F or 131 °F), high short-time rating with control transformers, fuseless design and their "safety inside" standard in accordance with IEC 61558. They are employed for the voltage and power supply of systems, controls and series products (medical engineering, machine tool construction, robots and compressors).
	SIRIUS power supplies	4AV	UL 1012	The power supplies SIRIUS are reliable, rugged, compact and comply with the latest standards.
	**SITOP power supplies**	6EP		The technology power supply in the SITOP modular product line fulfills the highest demands on functionality, e.g. for use in complex plants and machinery. The wide-range input enables connection to any power system in the world and ensures high safety even in the event of extreme voltage fluctuations. The Power Boost function briefly supplies up to three times the rated current. In the event of an overload, the choice is yours: constant current with automatic restart or latching shutdown.
	**SIDAC reactors**	4EM, 4ET, 4EP, 4EU, 4EV	UL 1561 UL 506	The reactors and filters SIDAC can be used as options for variable-speed drives in all industries and applications. They improve the line quality and efficiency of systems by reducing harmonics, increase the reliability of applications and thus enhance the availability of installations and systems. The portfolio comprises line, commutation, smoothing, output and filter reactors as well as radio interference suppression, dv/dt and sinewave filters.
	SIDAC filters	4EF11 4EF15	UL 508 UL 1283	
	**SENTRON busbar system / fast bus**	8US1	UL 508	The 60 mm busbar system is preferably used in control panel production, motor control centers and in power distribution systems for the medium (630 A) and high power ranges (1,600 A). The busbars are available in cross sections of 12 x 5 mm to 30 x 10 mm and as special profiles.
	**Busbar system infeed 8US**	8US19		The terminal to the infeed for busbar systems is available in a 3-pole design, including a cover.
	**SIRIUS infeed systems** Setting up self combination motor controllers type E, self-protected combination motor controllers type F	3RV19, 3RV29		The infeed systems are a convenient means of energy supply and distribution for a group of several motor starter protectors or complete load feeders with a screw or spring-type connection up to size S0.
	**ALPHA FIX terminal blocks**	8WA, 8WH	UL 1059 (completely or partially)	A complete range of terminal blocks is available in all conventional connection technologies for the secure connection of wires, conductors and lines.

	Product	Order No. body	UL standard	Explanation
	Miscellaneous devices and accessories			
	**SENTRON overvoltage protection devices**	5SD7 424-1 5SD7 423-1 5SD7 422-1 5SD7 444-1 5SD7 443-1 5SD7 442-1 5SD7 414-1 5SD7 413-1	UL 1449	Besides the energy supply, other circuits containing devices and systems that require protection, in particular in instrumentation and control and also data processing and telecommunications, are reliably protected against malfunctions and destruction. Surge arresters 5SD7 protect low-voltage systems against overvoltages and high currents that can be triggered by direct lightning strikes.
	**SENTRON measuring devices 7KM PAC3100, 7KM PAC3200, 7KM PAC4200**	7KM	UL 61010-1 UL 50, enclosure type 5	The innovative measuring devices 7KM PAC facilitate precise energy consumption detection. The devices provide measured values for assessment of the system state and line quality. These values are displayed on the device or centrally evaluated with a power management software tool such as SENTRON powermanager or alternatively SIMATIC WinCC powerrate.

For further UL-approved devices, such as the ALPHA 8HP molded-plastic distribution system or Insta contactors 5TT5 7 from the SENTRON portfolio, refer to www.siemens.com/lowvoltage/ul-europe or our UL catalog LV16 "Controls and Components for Applications according to UL."

Test Privileges of the Production Facility Amberg

In 1995, the production facility Amberg was granted the authorization of implementing certifications in accordance with the Client Test Data Program (CTDP). As a CTDP customer of UL, the production facility is entitled to carry out tests and independently prepare test as well as UL reports that contain the product description. UL merely verifies the compliance of the test and UL reports with UL standards. This way, the production facility Amberg has acquired a way higher degree of autonomy for the testing and certification process.

To ensure the products' compliance with the UL standards, UL inspectors regularly audit our factory within the so-called follow-up service. Follow-up service means that one or several devices are compared with the UL-certified documents, which are described in detail in a report. UL inspectors regularly visit the production plants to verify that the product is produced as described (example: SIRIUS contactors). With some devices, repeat tests are additionally implemented at regular intervals.

Application example

Mechanical engineering

Circuit breakers and contactors with UL certification in tunnel boring machines

Requirements

Herrenknecht AG, leading manufacturer of tunnel boring machines, was looking for a new supplier for its switching and protection technology. The project comprised the equipment of two so-called hydro-shields, which were to bore a wastewater tunnel spanning a length of 10 km and a diameter of 5.33 m in Seattle, USA.
Project name: Brightwater Conveyance System

The most important requirements included:

- UL-certified low-voltage protection and switching devices for the 480 V on-board power supply system with 60 Hz and a max. short-circuit current of 65 kA
- Switching devices for wye-delta starter
- Protective devices for protection of the entire tunnel boring machine
- High supply and product quality, comprehensive consulting services and documentation

© Herrenknecht AG

Solution

- All pumps and drive motors are protected with molded-case circuit breakers 3VL; they facilitate extended distances through air and over surface, are available for nominal currents from 150 A to 1,600 A with thermal-magnetic or electronic trip units and feature a switching capacity of up to 100 kA at 480 V AC
- UL-certified contactors SIRIUS 3RT realize wye-delta starter
- Protection of the entire hydro-shield is ensured by air circuit breakers SENTRON 3WL (3,000 A) with approval according to UL 489
- As manual self-protected combination motor controller type E, motor controllers SIRIUS 3RV, integrated disconnect, overload protection and short-circuit protection as well as extended distances through air and over surface are employed in the terminal area

Added value

- Structured device documentation which considerably eased UL-compliant dimensioning compared with the previous competitor product
- Reliable UL conformity: the order specifications were accurately complied with
- Comprehensive consulting services: Siemens provided its broad expertise for dimensioning according to all relevant UL standards
- Easy retrofitting of circuit breakers with electronic trip units or communication module for direct PROFIBUS connection
- Uniform design through identical construction of IEC/UL devices

Systems Engineering Plant Chemnitz – an Experienced Partner in Control Panel Production

The Systems Engineering Plant Chemnitz (WKC) is the European market leader in control panel and controller production for machine tools and production machines. On an area of about 14,000 m², 850 employees develop, configure and manufacture more than 30,000 control panels every year, both standard products and tailored one-off models for large customers, small and medium businesses and small companies.

The portfolio comprises the complete process from the specification through engineering and material procurement to the complete electrical equipment "ready to plug in." Every customer individually decides what services the WKC provides.

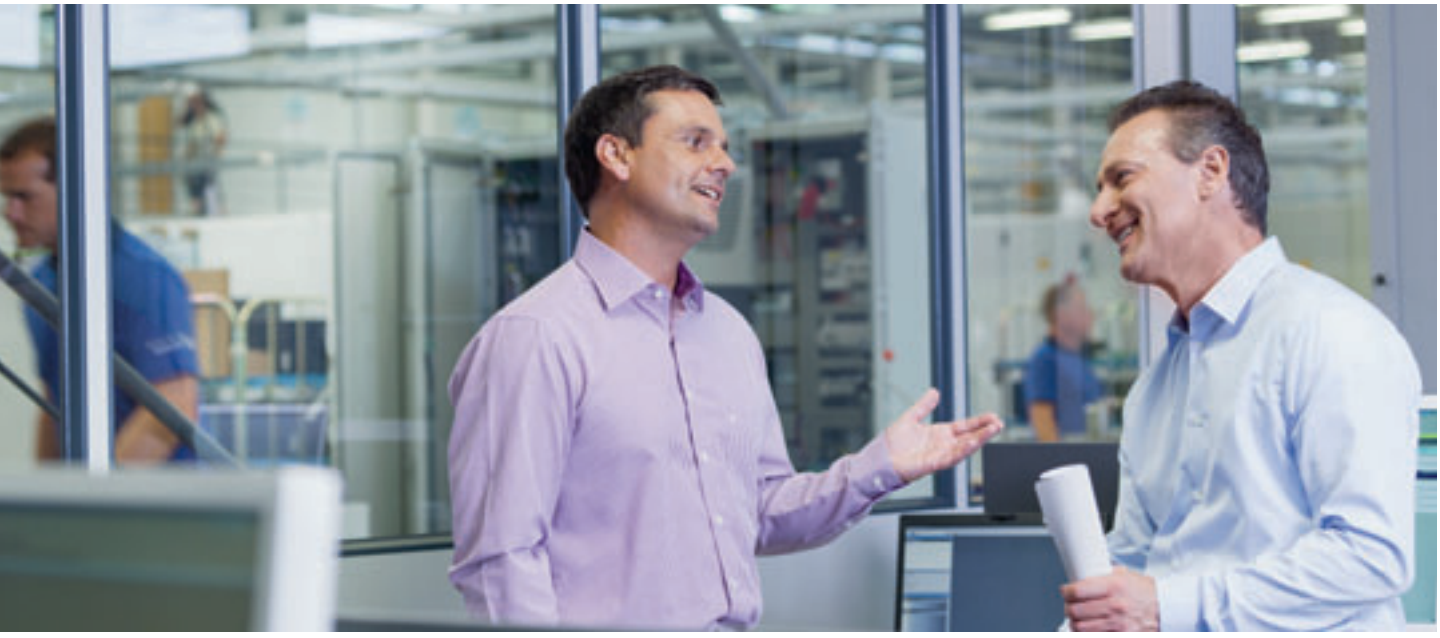
Control panel production with UL label

WKC will also support your exports to North America with its complete service spectrum. These include feasibility tests in advance as well as reconfigurations of IEC equipment. As a panel builder with UL certification, WKC offers complete control panels with a UL label that are tailored to customer specifications and are certified. Customers benefit from tried-and-tested products and combinations from Siemens.

Your advantage:

- Rely on flexible customer solutions from a single source, from the idea to the complete delivery.
- Trust in documented quality and more than 50 years of experience in control system production.
- Make use of the procurement, cost and productivity advantages of a strong partner.

Competitive Advantages through more Know-How



As your partner, we will help you to fulfill the many strict rules and guidelines that apply to assembly and exporting of machinery and plants for North America. To this end, we offer workshops to deliver answers to the most urgent questions, namely: How do I configure my control panel? What cable certifications, protective measures, risk analyses, documentation, identifications, etc. do I have to observe? This knowledge will pave the way for you to orientate your business and achieve success in the North American market.

Our application consulting services have a lot more to offer:

We support you with comprehensive know-how in control panel construction, machine manufacture, and plant building. We are specialized in efficient configuring with CAE/CAD data, in applying the relevant European directives and North American export legislation, as well as in standard-compliant control panel engineering.

Our offer:

- **CAx application consulting**
  Our CAx application consulting will advise you on questions dealing with how to handle your CAE and CAD systems and also in targeted data management in your engineering process.
- **Switchgear and control panels in line with European directives and IEC standards**
  The IEC standards are the most widely used in the world for low-voltage controls and distribution. But staying up to date with the abundance of relevant standards and guidelines is a considerable challenge. Siemens can assist you with a wide range of information, training and consulting services.
- **Industrial control panels for North America**

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