

A photograph of a male technician in a light blue shirt and khaki pants, kneeling and working on a large industrial electrical cabinet. He is pointing at a component inside the cabinet. The cabinet is filled with various electrical components, including circuit breakers and wiring.

Protection Against Electric Shock

- Protection against direct contact
- Protection against electric shock in case of indirect contact (fault case)
- Protection through protective extra-low voltage (PELV)
- Protection against residual voltages

Protection Against Direct Contact

General:

Energized parts must be protected against direct contact when:

- AC: $U \geq 50 \text{ V}$
- DC: $U \geq 60\text{V}$

Measures:

- (1) Insulation
- (2) Enclosure
- (3) Interlocking of enclosures
- (4) Restricted access to the enclosure

Protection Against Direct Contact

(1) Insulation

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Energized parts must meet the following conditions:

- Complete insulation (only removable through disassembly!)
- Mechanical, chemical, electrical and thermal resistance
- Paints, varnishes and coatings do not offer sufficient protection against electric shock

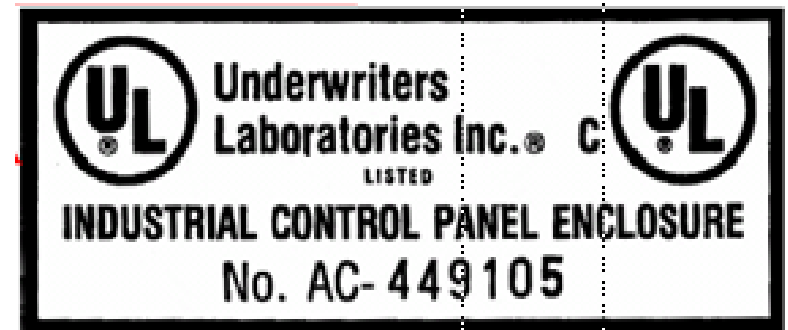
Protection Against Direct Contact

(2) Enclosures

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Enclosures and enclosure openings must comply with the requirements according to:

- **UL508**
- **UL508A**
- **UL50** or **NEMA 250**.

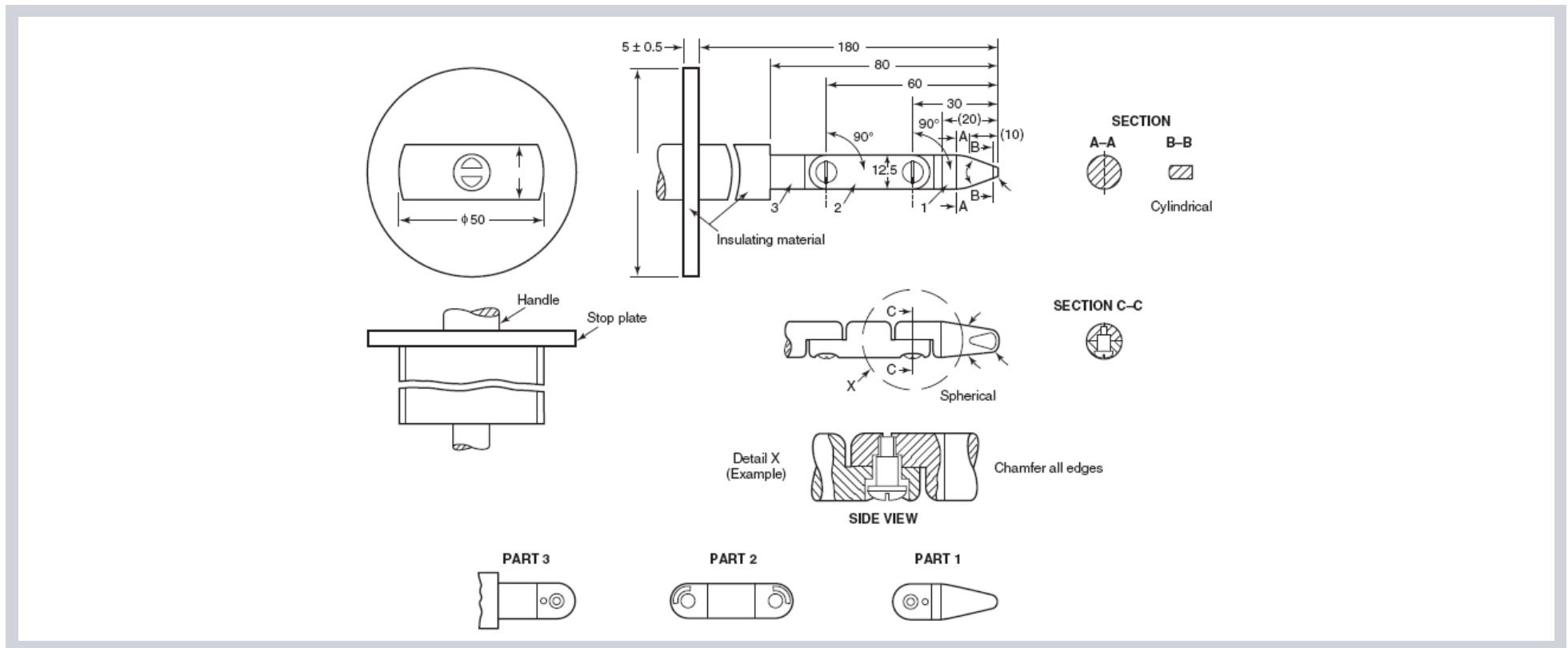


Exception:

Unapproved enclosures can be checked by means of a **test finger**; checking of all openings after disassembly of all parts removable without tools

→ *Touching of energized parts with the test finger must **not** be possible*

Test Finger – NFPA79 6.2.2.1



Protection Against Direct Contact

(3) Interlocking of Enclosures

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General: Main disconnecting means of enclosures / industrial control panels must be interlocked with the door when energized parts are contained with

- AC \geq 50 V
- DC \geq 60 V

Exceptions:

1. Main disconnecting means for industrial control panel lighting inside the industrial control panel
2. Main disconnecting means for memory elements for the retention of information

Note:

Qualified persons may implement measures for defeating the interlocking (see NFPA 70E "Standard for Electrical Safety in Workplaces")

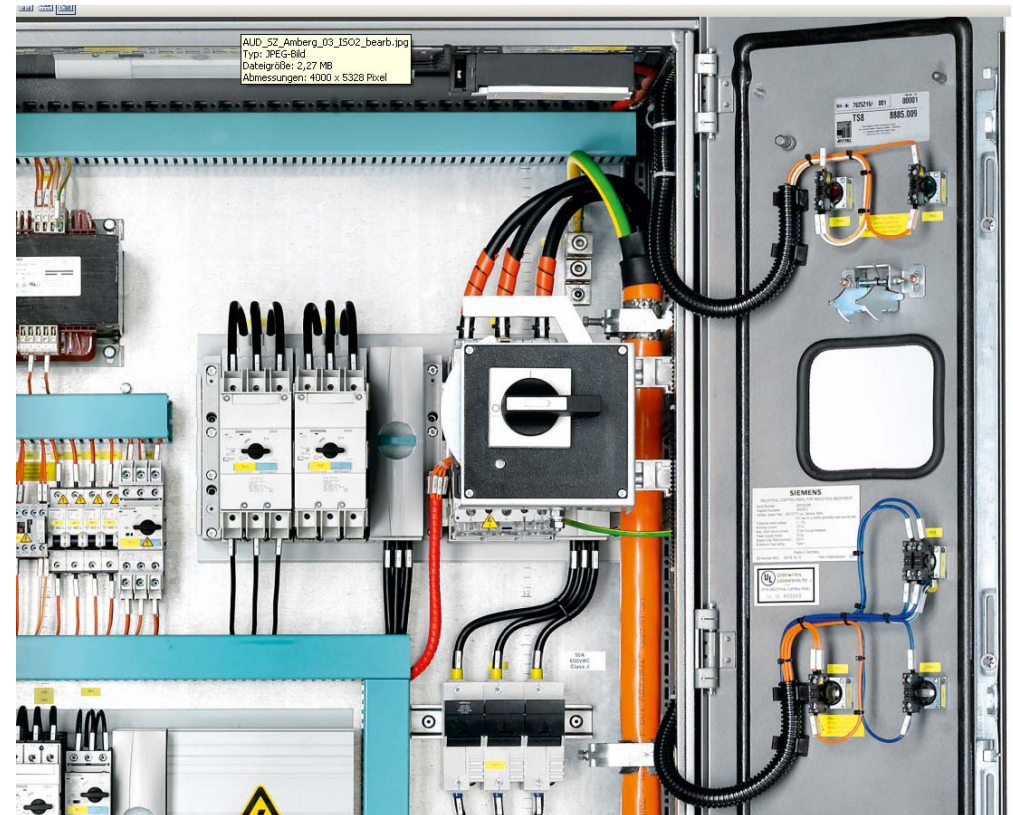
Protection Against Direct Contact

(3) Interlocking of Enclosures – Conditions

- The interlocking must be defeatable by means of a tool
- With the door open and the "ON" position, the interlocking must be enabled upon closing
- With the door is open, switch-on must be mechanically blocked; defeat must be possible without tools ("deliberate action")

Caution:

Devices on the inside of industrial control panels must be protected against unintended contact when $U \geq 50 \text{ V}$; either by means of *device characteristics* or through *barriers in a range of 50 mm (2 inches)*



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Protection Against Direct Contact
(3) Interlocking of Enclosures – Solutions

UL Guideline, Chapter 6.1.4

Mechanical solutions:

UL-compliant with **UL508A**, **NFPA 79**, **JIC** and **NEC**

Max-flex drive

Enclosure type: 1, 3R, 12



Interlocking module 8UC

Enclosure type: 1



Standard references:

UL508A: 30.4 / 66.1.5 / 66.6.3

NFPA79: 5.3.3 / 6.2.3 / 6.2.5

Protection Against Direct Contact (3) Interlocking of Enclosures – mechanical solutions

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Examples for mechanical interlocking solutions provided by Siemens

Protection Against Direct Contact

(3) Interlocking of Enclosures – Solutions

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UL Guideline, Chapter 6.1.4

Electrical solutions:

- 1 key switch for defeat
- 1 timing relay
- 1 undervoltage release per main disconnecting means
- Diverse auxiliary relays
- 1 limit switch per door, preferably with tumbler
- Motorized operating mechanism

Note:

The electrical interlocking must meet the same conditions as the mechanical interlocking!

Protection Against Direct Contact

(4) Access to Industrial Control Panels

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When **qualified skilled persons** with respective experience open an industrial control panel without main disconnecting means, the following conditions must apply:

- the door can be opened by means of a key or tool,

or

- the door can be opened without defeat, key or tool when all energized parts are covered or encapsulated in a finger-safe manner

Protection Against Indirect Contact (Fault Case)

NFPA79 §6.3

General:

Protection against indirect contact is to prevent hazardous states in *case of faults* (e.g. due to insulation faults between energized and exposed parts)

Measures:

- (1) Protection through double insulation
- (2) Protection through automatic supply disconnection

Protection Against Indirect Contact

(1) Double Insulation

- Double insulation is to prevent the occurrence of hazardous touch voltages due to faults in the basic insulation
- Operating equipment must be *respectively marked*
- Operating equipment either must be *listed or tested in a comparable manner*



**“Double insulation” symbol
(protection class 2)**

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Industry Sector

Protection Against Indirect Contact

(2) Protection Through Automatic Supply Disconnection

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General:

Protection through automatic supply disconnection of affected circuits by means of the respective overcurrent protective device in case of faults

Prerequisites for the safety measure:

1. Exposed, conductive parts must be grounded
2. Application of overcurrent protective devices for automatic disconnection

Protection Through Protective Extra-Low Voltage – PELV

General:

Operator protection for indirect and direct contact in restricted work areas!

PELV circuits must meet the following conditions:

1. Rated voltage
 - a) 30 V AC (RMS) or 60 V DC (ripple-free) with dry locations and when no large contact surfaces for the body are given
 - b) 6 V AC (RMS) or 15 V DC (ripple-free) when a.) is not applicable
2. One side of the circuit or one point of the supply must be grounded
3. Energized parts of PELV circuits must be isolated from other energized parts; distance \geq distance between the primary and secondary side of safety transformers
4. Wires must be routed separately from other circuits as far as possible;
option: the dielectric strength of all wires must be given
5. Connectors and receptacles must be coded for PELV circuits

Possible devices for infeed:

- Safety transformer
- Current source with identical degree of protection as safety transformer, e.g. motor generator with insulated windings
- Electrochemical supply (e.g. battery)
- Supply via sources which are independent of circuits with higher voltages (diesel-driven generators)
- Electronic power supply unit with protected outputs; internal fault does not lead to voltage overshoot according to the PELV standard voltages

Protection Through Protective Extra-Low Voltage PELV – Electronic Power Supply Unit with Protected Outputs

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SITOP Select
6EP1961-2BA00,
setting range 2...10 A
UL, cUL
CCN: NMTR
E197259



Selectivity module SITOP PSE200U
6EP1961-2BA10, setting range 0.5...3 A
6EP1961-2BA20, setting range 3...10 A
UL, cUL
CCN: NMTR
E197259

Protection Against Residual Voltages

NFPA79 §6.5

Note: Residual voltages ≥ 60 V with energized parts must be reduced to $U \leq 60$ V within $t \leq 5$ sec. after disconnection

Exceptions:

- Components with a stored charge $Q \leq 60 \mu\text{C}$
- In case of faults regarding operational functionality; permanent marking on the enclosure with reference to the risk of electric shock and indication of the delay

Note: If the unplugging of connectors leads to exposed conductors (e.g. pins), the discharge time must amount to $t \leq 1$ sec.

Exceptions:

- Components with a stored charge $Q \leq 60 \mu\text{C}$
- Conductors which are protected against direct contact

Questions?



Note / disclaimer

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