



# A Comparison of UL 60950 and GR-1089-CORE Safety Requirements

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# Presentation Overview

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- GR-1089-CORE Electrical Safety
- UL 60950 Electrical Safety
- Key Differences
- Wrap Up

# GR-1089-CORE Electrical Safety

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- Intended to protect “*Persons*” from harm, by:
  - Restricting access to various voltage levels
  - Limiting voltages and currents that are intentionally applied to communications circuits and to energized parts of network equipment
  - Controlling leakage currents that may be conducted from exposed surfaces of the equipment
  - Imposing an overall power limitation on sources that may be applied to communications wiring

# GR-1089-CORE Electrical Safety

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- “Persons” are:
  - General Public
    - Unfamiliar with electrical hazards
    - Not intended to have access to energized conductors or parts
    - May interface with network equipment on customer premises (NID, ONU, Cabinets)
  - Employees (work for phone company – *Administrative*)
    - Might interface with network equipment while performing administrative or service functions
  - Craftpersons (work for phone company – *Service*)
    - Trained to work with powered communication circuits
    - Access energized parts of network equipment

# GR-1089-CORE Electrical Safety

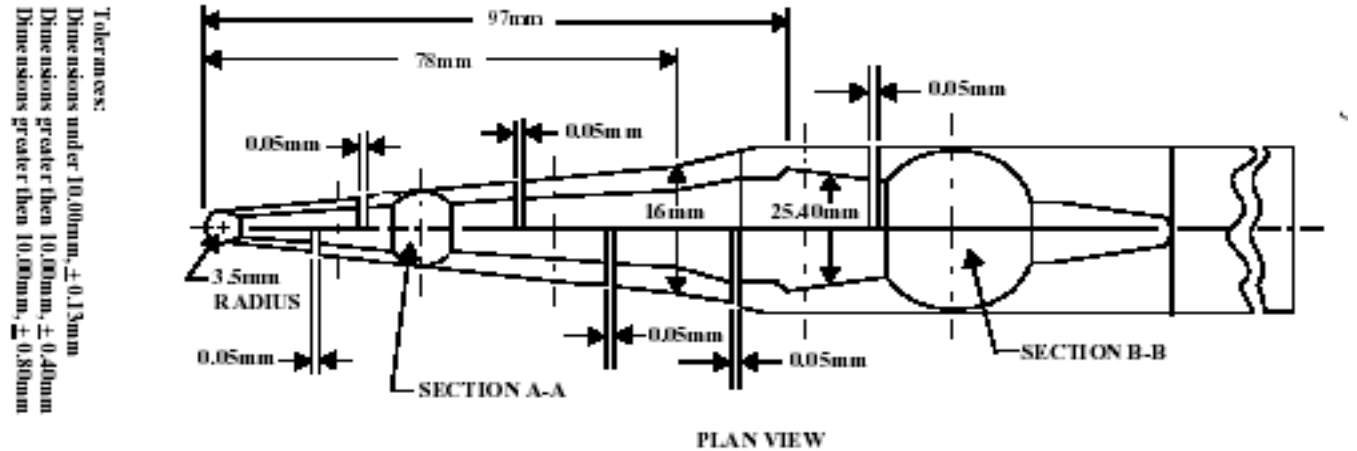
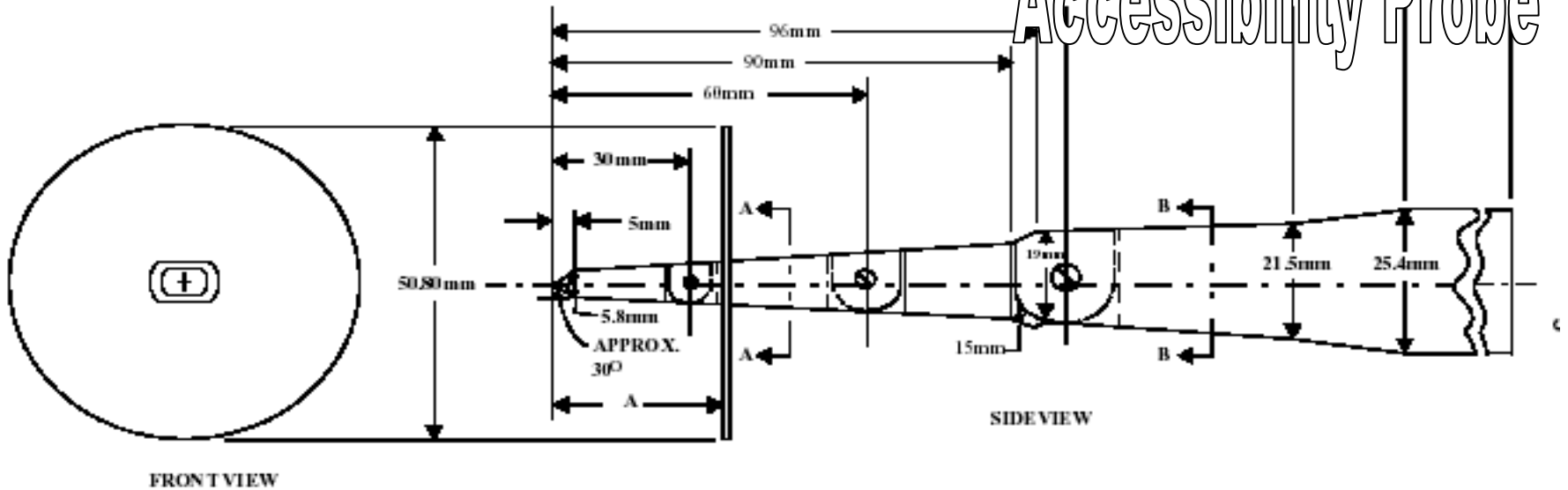
## *Restricting Access*

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- Three levels of diminishing accessibility determined by the use of the *Test Finger* or *Accessibility Probe*
  - Test Finger is from UL 60950, figure 2A modified by extending Part 3 by 10 mm; must use the 5.08 cm disk; preferable method and the only method allowed after January 1, 2005
  - Can use Accessibility Probe of UL 1459 if modified with the 5.08 cm disk; cannot use after January 1, 2005



# Accessibility Probe



Tolerances:  
Dimensions under 10.00mm, ± 0.13mm  
Dimensions greater than 10.00mm, ± 0.40mm  
Dimensions greater than 10.00mm, ± 0.80mm

Do not use after January 1, 2005

# GR-1089-CORE Electrical Safety

## *Restricting Access*

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- Three levels of diminishing accessibility
  - Exposed
    - If source can be contacted with Finger or Probe where dimension “A” is 3.5 cm
  - Restricted Access
    - If source is not Exposed, but may be contacted with Finger or Probe where dimension “A” is 9.0 cm
  - Inaccessible
    - If source cannot be contacted with Finger or Probe where dimension “A” is 9.0 cm



# GR-1089-CORE Electrical Safety

## *Restricting Access*

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<b>Voltage Class</b>	<b>General Public</b>	<b>Employees</b>	<b>Craftpersons</b>
A1	Restricted Access	Exposed	Exposed
A2	Inaccessible	Restricted Access	Exposed
A3	Inaccessible	Inaccessible	Restricted Access (Exceptions)

# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

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- Voltage and Current Classification
  - Voltage Source is classified as
    - Continuous or Duration-Limited
  - Continuous Source is defined as
    - One that is present for longer than 5 seconds
  - Duration-Limited Source falls into 2 categories
    - Interrupted/Tripped
      - Duration from 0.01 to 5 S (Ringing)
    - Transient
      - Duration of less than 0.01 S; Peak Voltage may exceed 200  $V_{\text{peak}}$ ; Source cannot deliver more than 2 joules into 500 ohm resistive load during the 0.01 S transient level

# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

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- Continuous Voltage and Current Limits
  - Apply between each terminal and ground with all other terminals connected as in normal service
  - Also apply between each terminal and ground with all other terminals open circuited
  - For paired-conductor sources, the limits also shall apply with all other terminals individually grounded
  - Divided into Classes A1, A2, and A3 (each may be contacted barehanded), Class AB, Class B, and Class C
  - NOTE – sources standardized by industry with voltages and currents known to be below Class A1 do not need to be tested (RS-232, V.35, 10BaseT, 100BaseT, X.25, DSX-1, DS3, USB)

# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

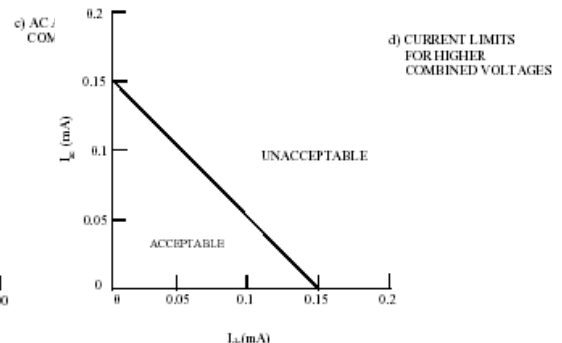
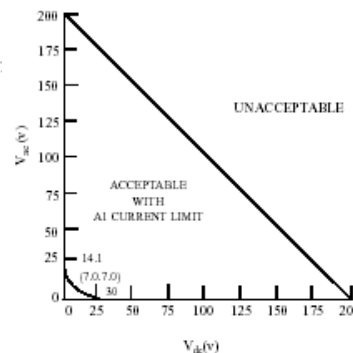
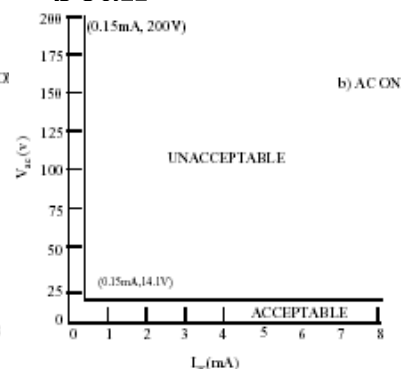
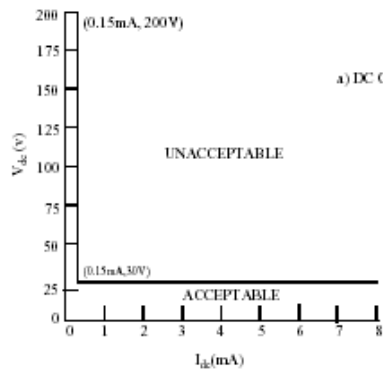
- Class A1

- $V_{dc}$  w.r.t. ground  $\leq 30$  V (any current)

- ( $30 < V_{dc} < 200$ , if  $I < 0.15$  mA<sub>dc</sub>)

- $V_{peak}$  w.r.t. ground  $\leq 14.1$  V<sub>peak</sub> (any current)

- ( $14.1 < V_{peak} < 200$ , if  $I < 0.15$  mA<sub>peak</sub>)



# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

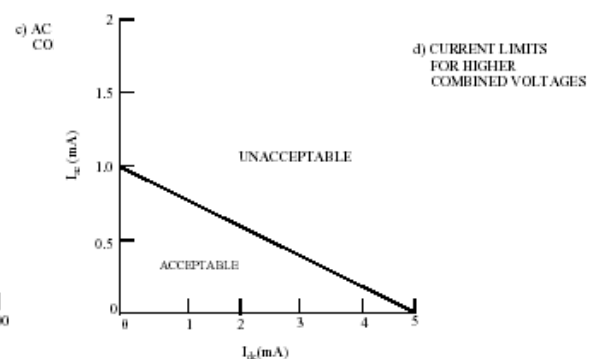
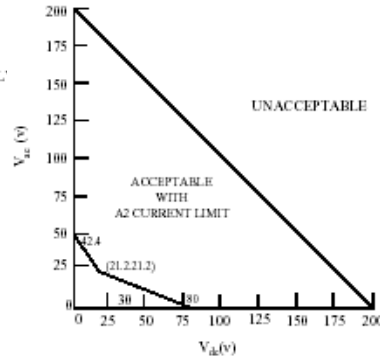
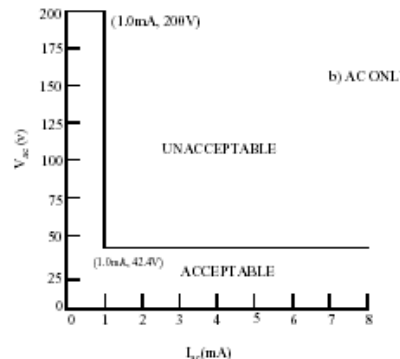
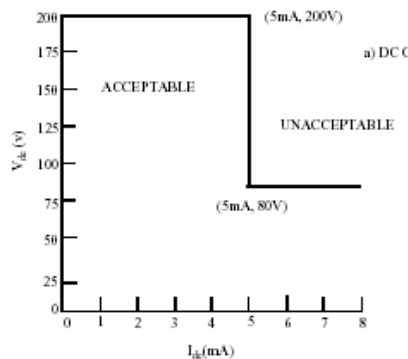
- Class A2

- $V_{dc}$  w.r.t. ground  $\leq 80$  V (any current)

- ( $80 < V_{dc} < 200$ , if  $I < 5.0$  mA<sub>dc</sub>)

- $V_{ac}$  w.r.t. ground  $\leq 42.4$  V<sub>peak</sub> (any current)

- ( $42.4 < V_{peak} < 200$ , if  $I < 1.0$  mA<sub>peak</sub>)



# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

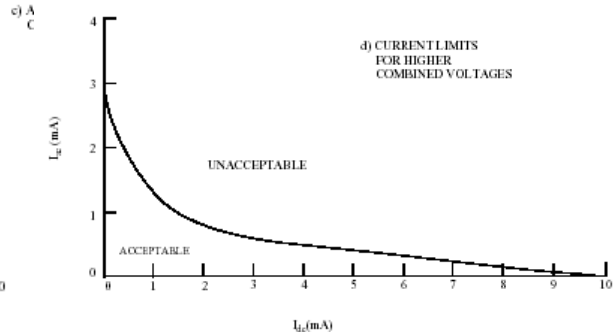
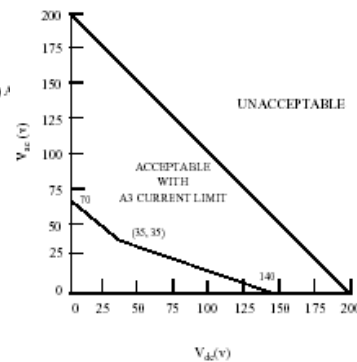
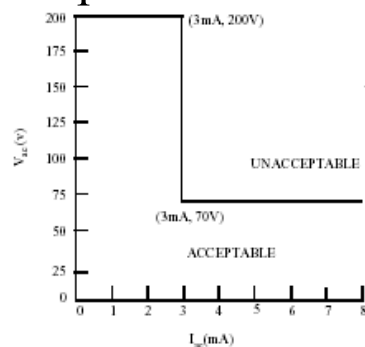
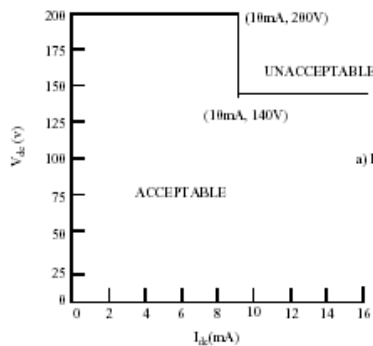
- Class A3

- $V_{dc}$  w.r.t. ground  $\leq 140$  V (any current)

- ( $140 < V_{dc} < 200$ , if  $I < 10.0$  mA<sub>dc</sub>)

- $V_{AC}$  w.r.t. ground  $\leq 70$  V<sub>peak</sub> (any current)

- ( $70 < V_{peak} < 200$ , if  $I < 3.0$  mA<sub>peak</sub>)



# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

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- Class AB
  - Exceed Class A3 limits
  - V w.r.t. ground  $< 90 V_{dc}$  or  $90 V_{ac rms}$ ,  $I \leq 15 A$
  - Power levels up to 1350 VA are permitted
  - Intended for OSP powering applications over COAX
- Class B
  - Exceed Class A3 limits;  $< 600 V_{dc} V_{ac rms}$  ; or  $1000 V_{ac}$  between metal parts
- Class C
  - Exceed Class B limits; beyond the scope of standard

# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

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- Duration-Limited Source
  - Interrupted/Tripped Sources
    - Apply to ringing and other sources used for network control or testing
    - Normally present over a small portion of a day (~10%)
    - Can be considered as Class A2 if the conditions of R7-17, R7-18, and R7-19 are met



# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

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- Interrupted/Tripped Sources (continued) considered as Class A2 if:
  - **R7-17** - Sources shall be  $< 300 V_{\text{peak-to-peak}}$  and  $< 200 V_{\text{peak-to-ground}}$  as measured across one megohm
  - **R7-18** - Voltage interrupted to create idle intervals of at least 1 S (continuous), each separated by no more than 5 S. During the idle intervals, the voltage to ground shall not exceed A2 voltage limits.
  - **R7-19** - Sources include a series current-sensitive tripping device in the current lead that will trip the voltage per Fig. 7-6 and/or provide a voltage to ground (“monitoring” voltage) on the tip or ring conductor with a magnitude of at least  $19 V_{\text{peak}}$  (but not exceed A2 voltage limits) when the interrupted voltage is not present (idle interval). Tripping devices and/or “monitoring” voltages shall be incorporated in the equipment, depending on the current flow through specified resistances connected between the interrupted/tripped source and ground as follows:

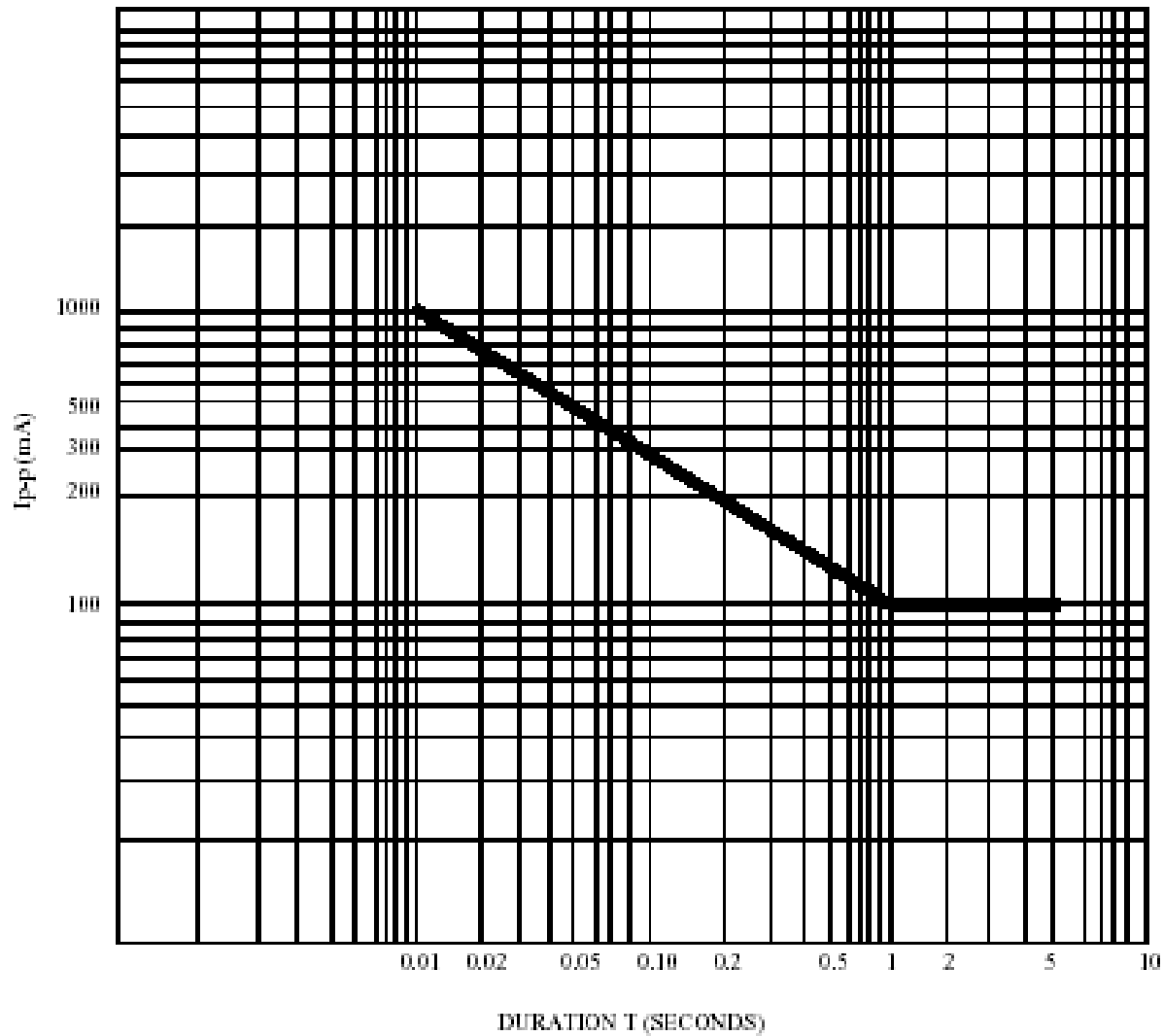
# GR-1089-CORE Electrical Safety

## *Limiting Voltages and Currents*

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- R7-19 (continued):
  - If the current through a 500-ohm and greater resistor does not exceed 100 mA peak-to-peak, neither a tripping device nor a “monitoring” voltage is required.
  - If the current through a 500-ohm and greater resistor exceeds 100 mA peak-to-peak but does not exceed this value of current with a 1500-ohm and greater resistor, the interrupted/tripped source shall include either a tripping device that meets the operating characteristics shown in Figure 7-6 for a resistance of 500 ohms and greater, or a “monitoring” voltage.
  - If the current through a 1500-ohm and greater resistor exceeds 100 mA peak-to-peak, the interrupted source shall include a tripping device. If the tripping device meets the operating characteristics shown in Figure 7-6 for a resistance of 500 ohms and greater, then no “monitoring” voltage is required. If the tripping device only meets the operating characteristics shown in Figure 7-6 for a resistor of 1500 ohms and greater, then the interrupted source shall also include a “monitoring” voltage.

Must run Ring Trip Test Procedure, 7.5.2, to prove compliance ...



<b>Voltage Class</b>	<b>General Public</b>	<b>Employees</b>	<b>Craftpersons</b>
A1	Restricted	Exposed	Exposed
A2	Inaccessible	Restricted	Exposed
A3	Inaccessible	Inaccessible	Restricted <i>See NOTES</i>
AB	Inaccessible	Inaccessible	Restricted <i>See NOTES</i>
B	Inaccessible	Inaccessible	Inaccessible <i>See NOTES</i>
C	Inaccessible	Inaccessible	Inaccessible

**A3 NOTES:** When an enclosure or baffle is removed, or energized electrical circuits are otherwise exposed for contact by Craftpersons, Class A3 sources shall be segregated from A1 and A2 sources by appropriate insulation, baffles, or location to prevent inadvertent contact. Class A3 voltage sources shall be labeled where Craftpersons are normally intended to contact them for service operation.

**AB NOTES:** Bare-handed contact with Class AB voltages shall not be permitted. Rubber gloves and eye protection shall be worn when working on conductors energized to Class AB voltages. Class AB voltage sources shall be labeled where Craftpersons are normally intended to access them for service operation.

**B NOTES:** Class B voltage sources shall be de-energized before contact is allowed. With normal equipment enclosures in place It shall not be possible to contact Class B sources with the test finger or the accessibility probe where dimension “A” is 9 cm. Protection covers carrying warning labels for Class B sources shall not be removable without the use of tools and/or a key. When an enclosure or baffle is removed to permit access to Class A1, A2, or A3 sources, Class B sources shall have restricted access for contact by Craftpersons.

# GR-1089-CORE Electrical Safety

## *Controlling Leakage Currents*

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- Surfaces of equipment and interconnecting cords and cables are considered “Exposed Surfaces”
- Exposed Surfaces must meet leakage current limits under normal operation
- Exception for portions of the electrical network accessible to personnel and trained personnel for normal operations such as, terminals, connectors, and conductors
- Grounding must be by design or it doesn't count
- Leakage currents are applicable to all modes of operation of the equipment

# GR-1089-CORE Electrical Safety

## *Controlling Leakage Currents*

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- Function of the surface area that may be contacted
  - Large Area Contact
    - The current from any 100 cm<sup>2</sup> (15.50 in<sup>2</sup>) area or the entire area, whichever is smaller, of exposed surface (excluding grounded metal surfaces) measured in a 1500-ohm resistor connected between the area and ground shall be less than 0.3 mA peak.
  - Small Area Contact
    - The current from any 1 cm<sup>2</sup> (0.16 in<sup>2</sup>) area of exposed surface (excluding grounded metal surfaces) measured in a 10,000-ohm resistor connected between the area and ground shall be less than 0.15 mA peak.
  - Between Surfaces of Equipment
    - The current measured in a 10,000-ohm resistor connected between any two areas of exposed surface (excluding grounded metal surfaces) of 1 cm<sup>2</sup> (0.16 in<sup>2</sup>) each shall be less than 0.15 mA peak.

# GR-1089-CORE Electrical Safety

## *Overall Power Limitation*

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- Sources applied to communication wiring shall be limited to 100 VA
  - Paralleling of power sources over multiple wires for the purpose of delivering more than 100 VA not permitted
  - Power limitation is not intended to apply to CO power and battery plant
  - Power limitation not intended to preclude using several individual 100 VA sources, each feeding a separate set of communications lines to a separate remote load
- Maximum continuous current from sources applied to communications wiring shall not exceed 1.3 A if the wire ampacity is not specified

# UL 60950 Electrical Safety

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- Intended to reduce risks of fire, electric shock or injury for the Operator, layman, and, where specifically stated, for Service Personnel, by:
  - Restricting access to various voltage levels - concept of SELV, Limited Current Circuit, and TNV
  - Limiting voltages and currents that are intentionally applied to communications circuits and to energized parts of network equipment and to Information Technology Equipment
  - Controlling leakage currents that may be conducted from exposed surfaces of the equipment – Touch Current



# UL 60950 Electrical Safety

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- Intended to reduce risks...electric shock ...by:
  - Imposing an overall power limitation on sources that may be applied to communications wiring
  - Provision and integrity of proper insulation between parts normally at a hazardous voltage and accessible conductive parts
  - Hazardous Energy Definition

# UL 60950 Electrical Safety

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- UL 60950 “Persons” are:
  - Service Personnel
    - Persons having appropriate technical training and experience necessary to be aware of hazards to which they may be exposed in performing a task and of measures to minimize the risks for themselves or other persons.
  - User or Operator
    - Other than Service Personnel

# UL 60950 Electrical Safety

## *Restricting Access*

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- Levels of accessibility (not explicitly called out by these terms in UL 60950; these are my definitions)
  - Exposed
    - Source can be contacted with Finger
  - Inaccessible
    - Source cannot be contacted with Finger
  - Service Accessible
    - Source can be contacted with Finger, but human contact is not permitted

# UL 60950 Electrical Safety

## *Limiting Voltages and Currents*

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- Safety Extra-Low Voltage (SELV)
  - A Secondary Circuit which is so designed and protected that its voltages do not exceed a safe value (Normal Operation:  $42.4 V_{\text{peak}}$  or  $60 V_{\text{dc}}$ ; Fault Condition: cannot exceed  $42,4 V_{\text{peak}}$ , or  $60 V_{\text{d.c.}}$ , for longer than  $0,2 s$ , a limit of  $71 V_{\text{peak}}$ , or  $120 V_{\text{d.c.}}$ , shall not be exceeded.
- Limited Current Circuit (LCC)
  - A circuit which is so designed and protected that, under both normal operating conditions and single fault conditions, the current which can be drawn is not hazardous.
- Extra-Low Voltage (ELV )
  - SELV minus the single fault condition and not a Limited Current Circuit

# UL 60950 Electrical Safety

## *Restricting Access*

<b>Voltage Class</b>	<b>User/Operator</b>	<b>Service Personnel</b>
SELV Circuit	Exposed	Exposed
Limited Current	Exposed	Exposed
ELV Circuit	Inaccessible	Exposed
Hazardous Energy	Inaccessible	Service Accessible
TNV-1	Inaccessible	Service Accessible
TNV-2	Inaccessible	Service Accessible
TNV-3	Inaccessible	Service Accessible
Hazardous Voltage	Inaccessible	Service Accessible

# UL 60950 Electrical Safety

## *Touch Current*

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- Touch Current
  - Electric current through a human body when it touches one or more accessible parts
  - Applies to and from Telecommunication Networks
    - To a Telecommunication Network
      - shall not exceed 0.25 mA r.m.s.
    - From a Telecommunication Network
      - Earthed Ports
        - » Can exceed 3.5 mA with conditions
      - Unearthed Ports
        - » Shall not exceed 0.25 mA or 3.5 mA if common connections

# UL 60950 Electrical Safety

## *Overall Power Limitation*

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- Protection of the telecommunication wiring system from overheating
  - Equipment intended to provide power over the telecommunication wiring system to remote equipment shall limit the output current to 1.3 A if such wiring is not specified.

# UL 60950 Electrical Safety

## *Provision of Proper Insulation*

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- Adequate isolation provided between hazardous circuits and SELV and/or LCC
  - Reinforced or Double Insulation
  - Creepage and Clearance distances
    - Check out [www.creepage.com](http://www.creepage.com) for more information
- Adequate isolation provided between other circuits



# Key Differences

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- Faults
  - UL 60950 considers likely fault conditions, consequential faults, foreseeable misuse, and external influences, i.e, temperature, altitude, pollution, moisture, overvoltages on mains and telecommunication lines. Two levels of protection for electric shock
  - GR-1089-CORE considers normal use for Electrical Safety. There are first and second-level overvoltage faults and short-circuit conditions on lines going to OSP; the Bonding and Grounding section also considers short-circuit w.r.t. fire hazard.
- Circuit Separation
  - UL does this by requiring specific insulation
  - GR-1089-CORE powers the CO network with batteries, -48 Vdc; no specific insulation requirements are called out

# Key Differences

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- **Restricted Access Locations (RAL)**
  - UL used to consider COs as RAL, now COs are considered Operator Access Areas per 4.4.3
  - GR-1089-CORE specifically covers COs and treats this environment as a RAL, however, Employees are instructed as to the hazards present and the General Public is very rarely invited into a CO.
- **Accessibility Levels**
  - UL protects User/Operator and Service Personnel
  - GR-1089-CORE protects General Public, Employees, and Craftpersons
- **Leakage Current/Touch Current**
  - UL concern about touch current to the network
  - GR-1089-CORE Leakage Current uses contact area

# Wrap Up

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- This presentation compares how UL 60950 and GR-1089-CORE address electrical safety, particularly, electric shock
- UL will use UL 60950 to List Network Equipment in the Central Office
- Network Equipment must comply with the electrical safety requirements of GR-1089-CORE, Section 7

# Wrap Up

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- Thank you for your participation
- References
  - Telcordia GR-1089-CORE “Electromagnetic Compatibility and Electrical Safety”, Issue 3, October 2002
  - UL 60950 “Safety of Information Technology Equipment”, Third Edition, March 15, 2002
- Resources:
  - [www.nebs-faq.com](http://www.nebs-faq.com)
  - [www.creepage.com](http://www.creepage.com)
  - [www.lorusso.com](http://www.lorusso.com) or call me at 512-695-5871