To Fuse or Not to Fuse? That is the Question:

Codes, Science, and Case Studies to Support the Unfused Battery Bus in 48 Volt Dc Power Plants

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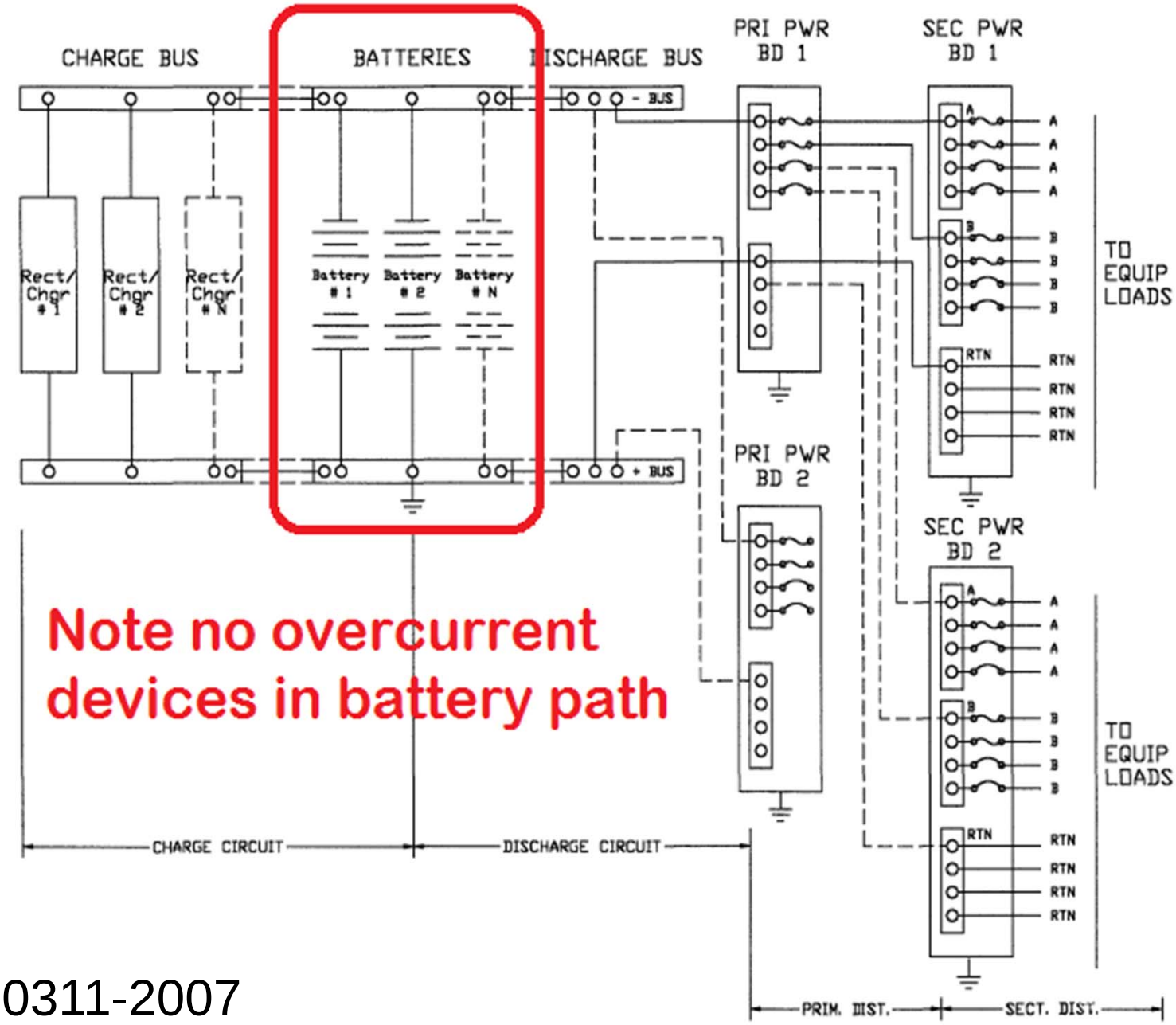
Issue

AHJs demanding Overcurrent & Disconnects on battery strings

Premise

- Overcurrent and disconnects are not a Code requirement for central offices
- Case studies show that they are unneeded
- Further, they are impractical
- It ain’t broke – don’t try to fix it!



ATIS 0600311-2007

Figure 1 – Typical DC Power System

Code basis for the AHJ misunderstanding

- NFPA 70, The National Electrical Code Chapter 2, Article 240.21(H) **Battery Conductors** Overcurrent protection shall be permitted to be installed as close as practicable to the storage battery terminals in an unclassified location. Installation of the overcurrent protection within a hazardous (classified) location shall also be permitted.

Code basis for the AHJ misunderstanding

- Chapter 4, Article 480.5 **Disconnecting Means** A disconnecting means shall be provided for all ungrounded conductors derived from a stationary battery system over 50 volts (nominal). A disconnecting means shall be readily accessible and located within sight of the battery system.


LEVEL
LEVEL
24
DANGER
C&D


8
9
10
11
MCT II
CD
BATTERY


DANGER
Replace lug cover after wiring.
MOLDED CASE SWITCH
400A
LHL36000M
Type LAL
Series 4
FOR 250V DC SERVICE
USE OUTSIDE POLES ONLY
CAUTION
PROVIDES NO OVERCURRENT PROTECTION
Switch suitable for use only on a circuit capable of delivering not more than
AIR
65kA 240 AC
35kA 480 AC
25kA 600 AC
10kA 250 DC
600 VAC 250 VDC
LUG: AL400LA
Cu/Al Wire Torque
1 Wire #1 AWG-600 kcmil 375 lb-in
2 Wires #1 AWG-250 kcmil 375 lb-in
Switch must be protected by a circuit breaker or fuse of equivalent rating. Switch may open at high fault levels.
LUG
Cu/Al Wire Torque
1 Wire 50-300 mm² 42 N·m
2 Wires 50-120 mm² 42 N·m
98342
ON
Molded Case Switch
LISTED 239G
3-pole Unit
Made in USA
SHUNT TRIP
(BLACK LEADS)
24 VDC 1500 mA
AUXILIARY SWITCH
When device closes:
"A" contact (yellow) closes
"B" contact (blue) opens
striped lead is common
1/4 HP 125-250V 50/60 Hz


STRING E
-48V
STRING C
-48V
-24

NFPA 70 (NEC)

- Article 90.2(B)4
-
- **(B) Not Covered.** This *Code* does not cover the following:
- (4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations
-

NEC

- **Article 100** defines ‘communications equipment:
- ‘Communications equipment is defined as, “The electronic equipment that performs the telecommunications operations for the transmission of audio, video, and data, and includes power equipment (e.g., dc converters, inverters, and batteries) and technical support equipment (e.g., computers).” ‘

NEC

- **Article 90.3** states, "Chapter 8 covers communications systems and is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8."

NEC

- Chapter 8- Communications Systems, Article 800 covers Communications Circuits. There are no references in Article 800 for the dc power plant.

NFPA 76 (Telecom Fire Standard)

- **1.2.1 “**This standard is intended to avoid requirements that could involve unnecessary complications for or interference with the normal use, occupancy, and operations of telecommunications facilities and equipment.”

NFPA 76

- **1.2.2 “**This standard provides a means by which the industry’s accepted fire safety methods are applied to continue the historically good fire safety record of these facilities.”

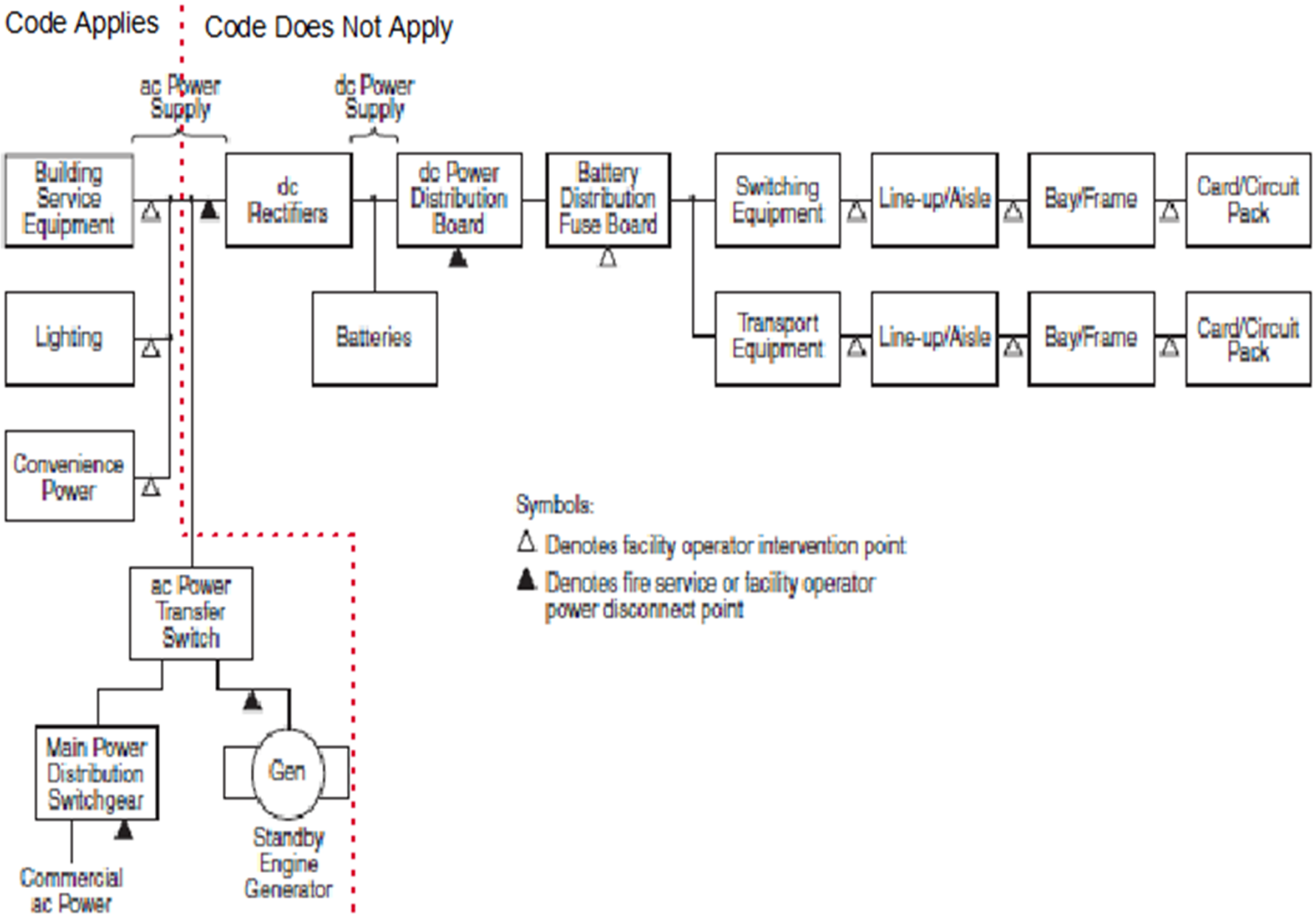
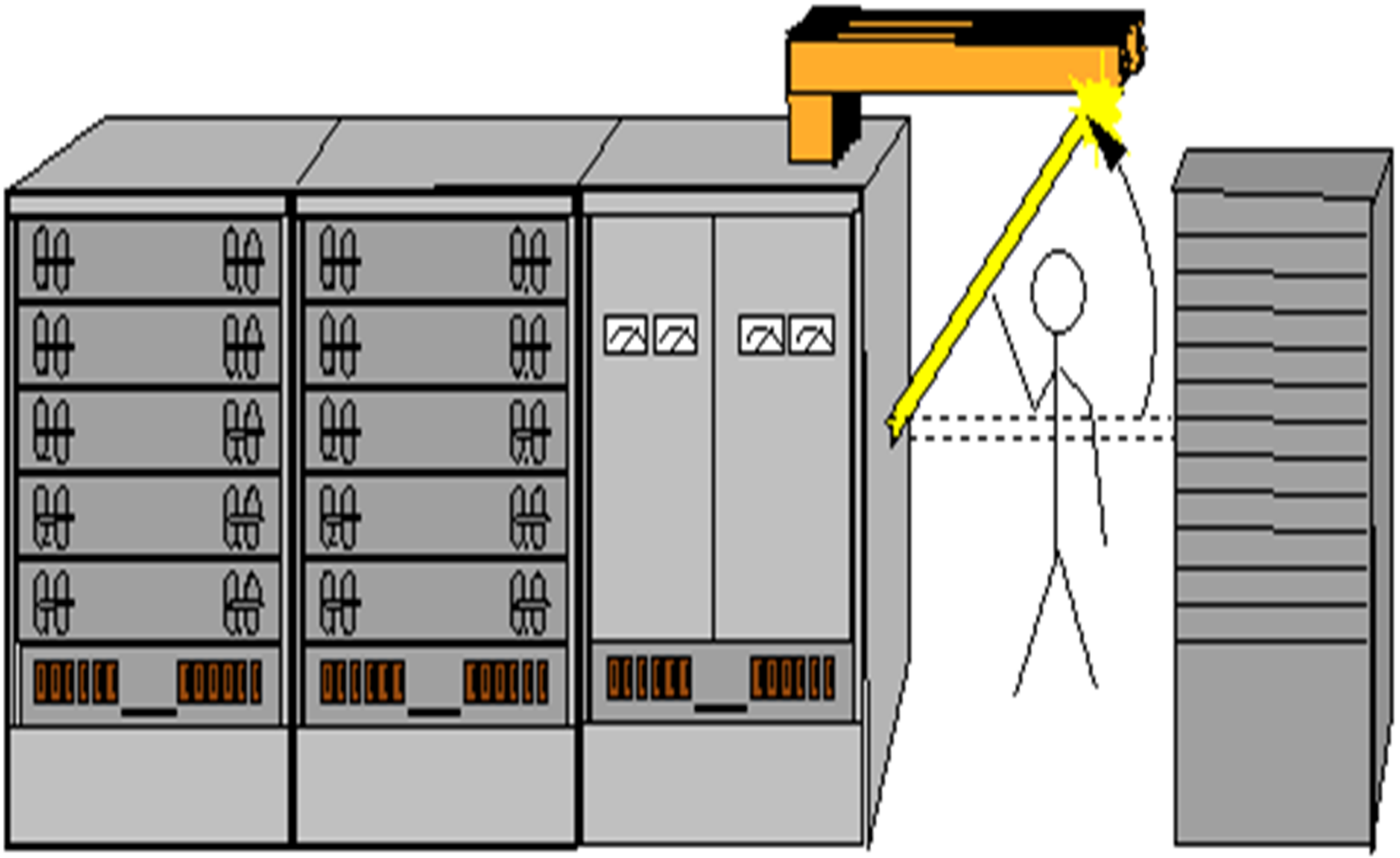
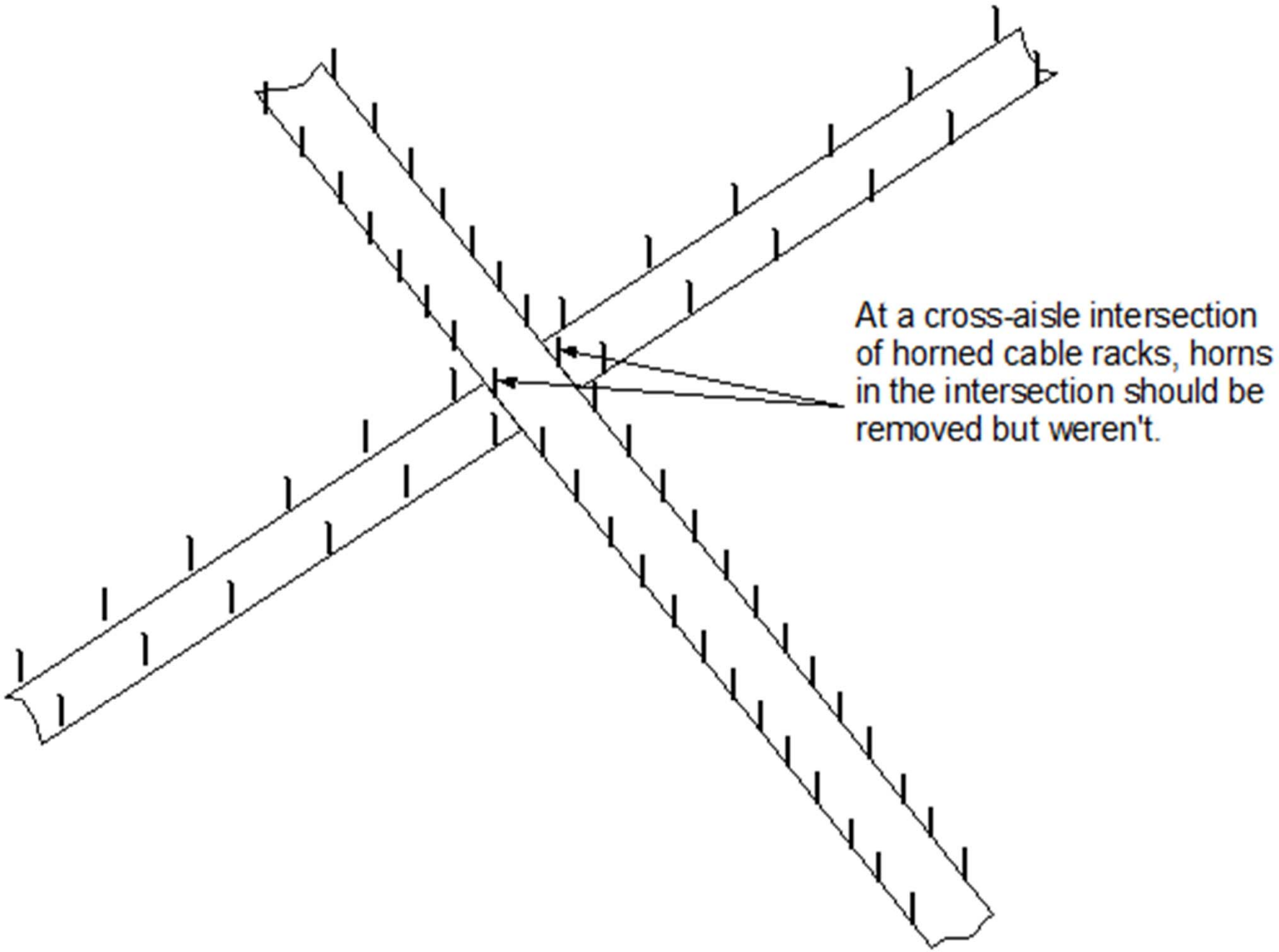
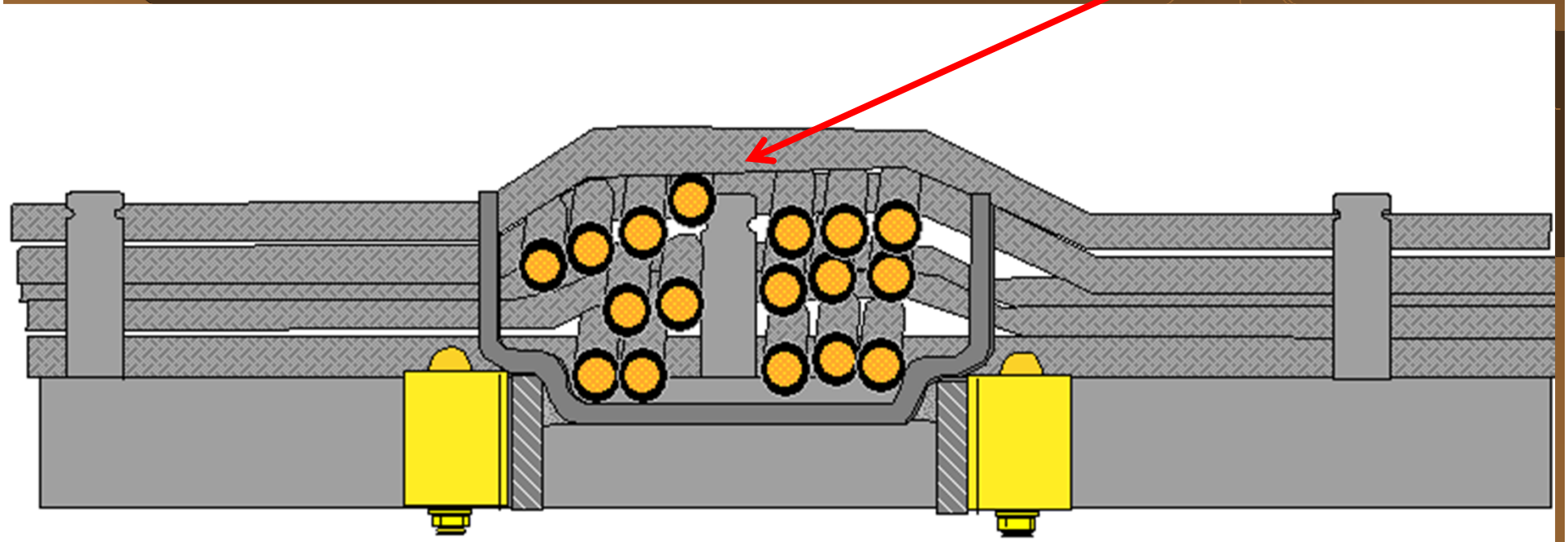
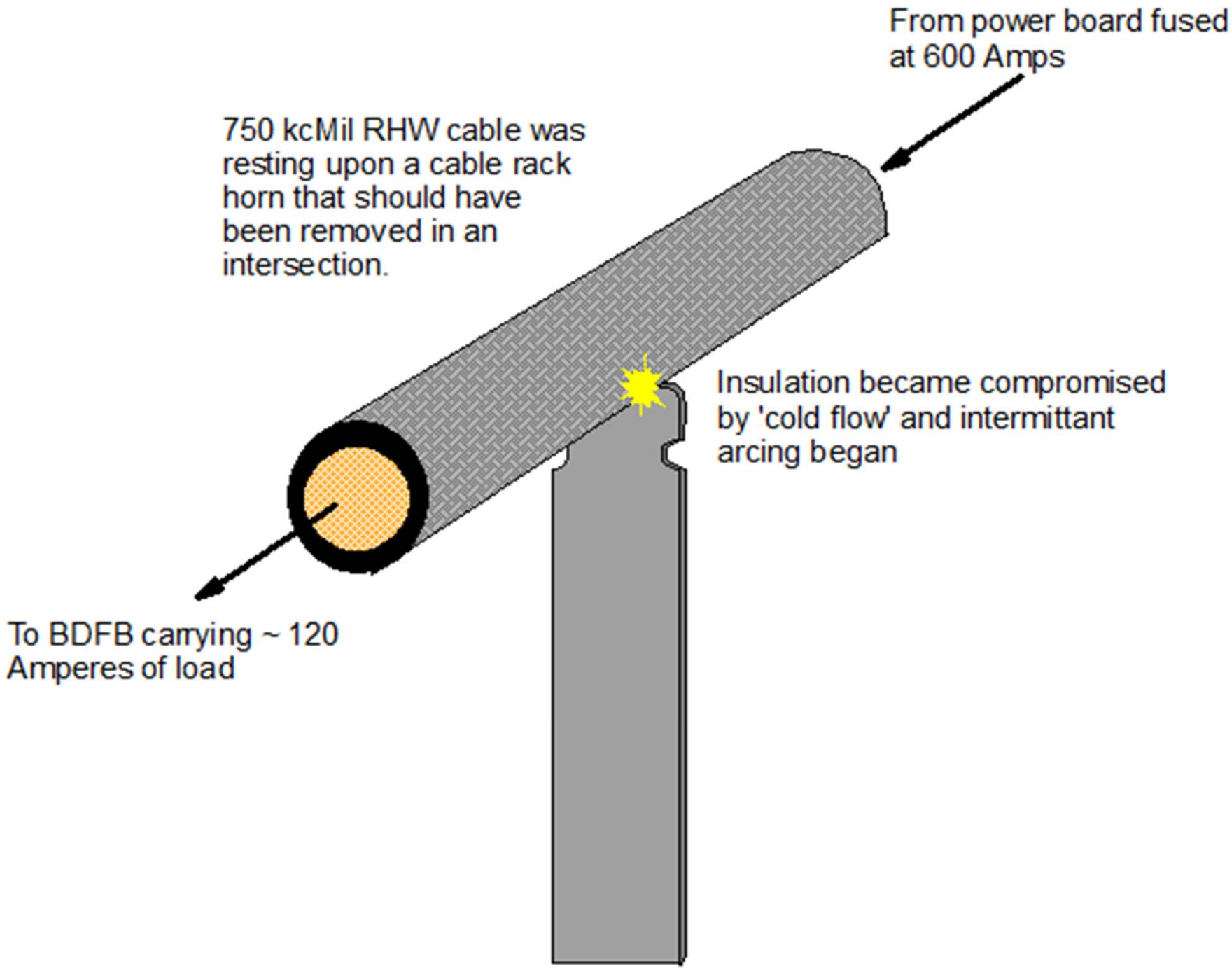


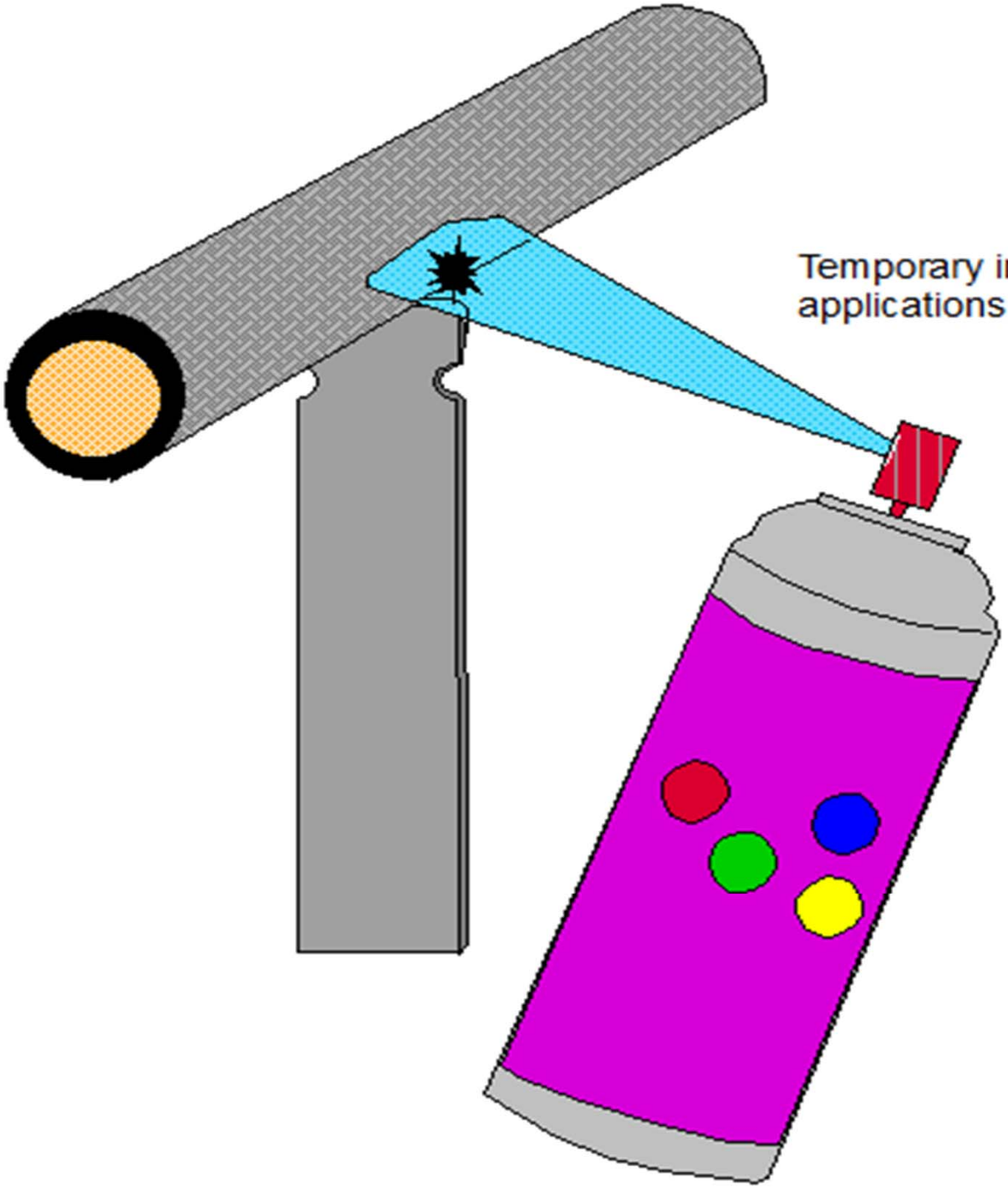
FIGURE A.6.5.2(a) Typical Telecommunications Facility Power Sources Indicating Selective Disconnect Points.



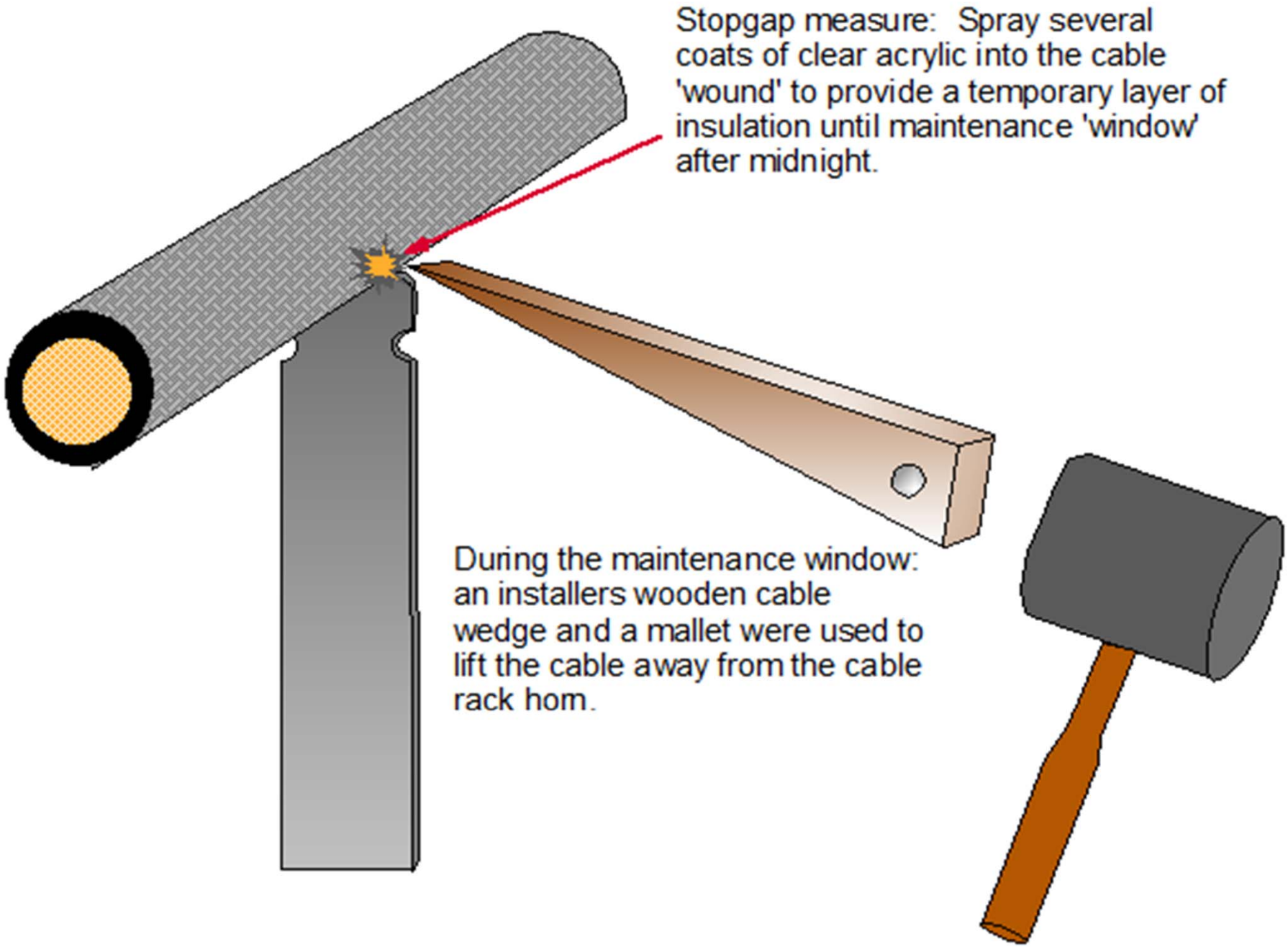

At a cross-aisle intersection of horned cable racks, horns in the intersection should be removed but weren't.

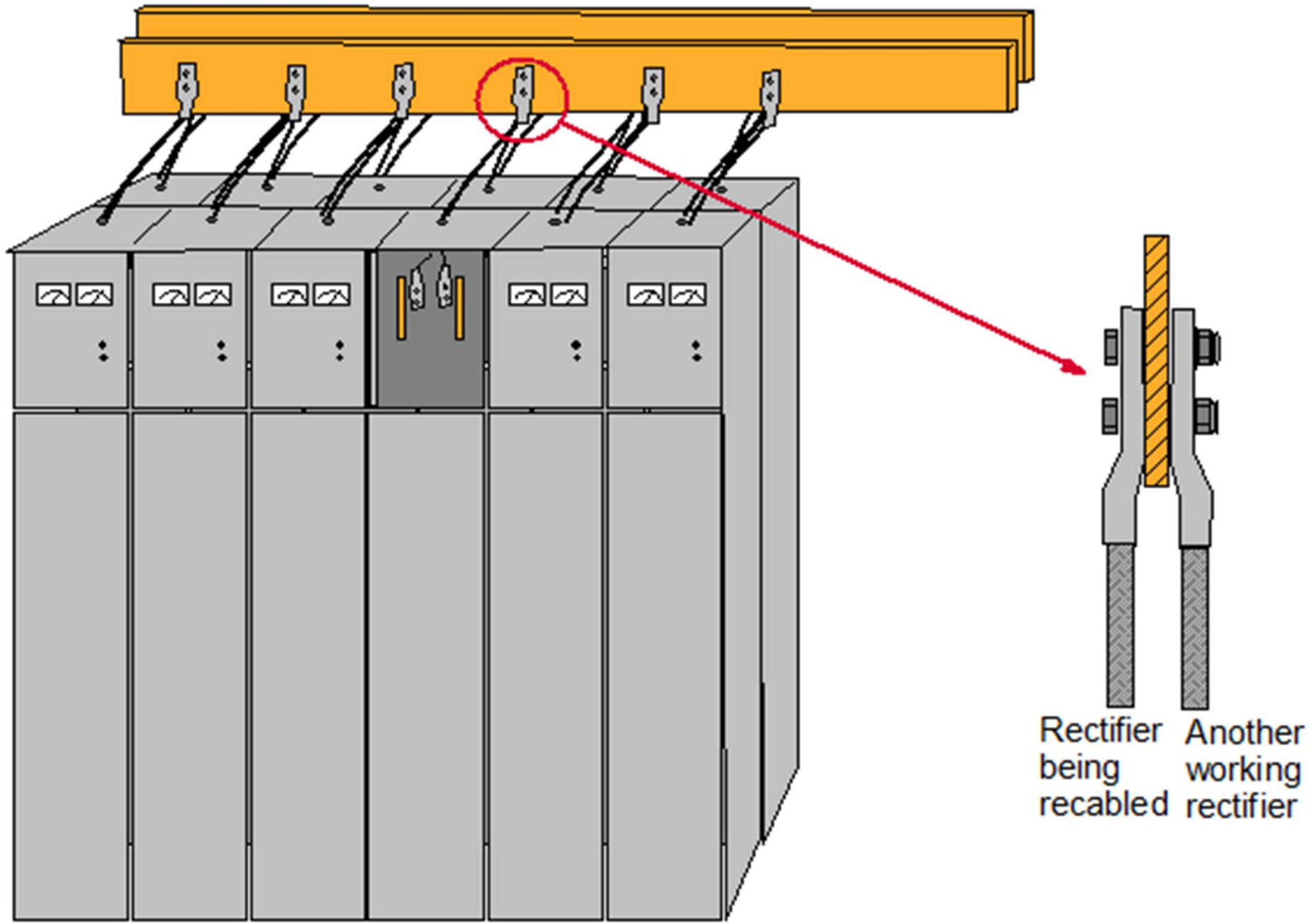



From power board fused at 600 Amps
750 kcMil RHW cable was resting upon a cable rack horn that should have been removed in an intersection.
Insulation became compromised by 'cold flow' and intermittant arcing began
To BDFB carrying ~ 120 Amperes of load

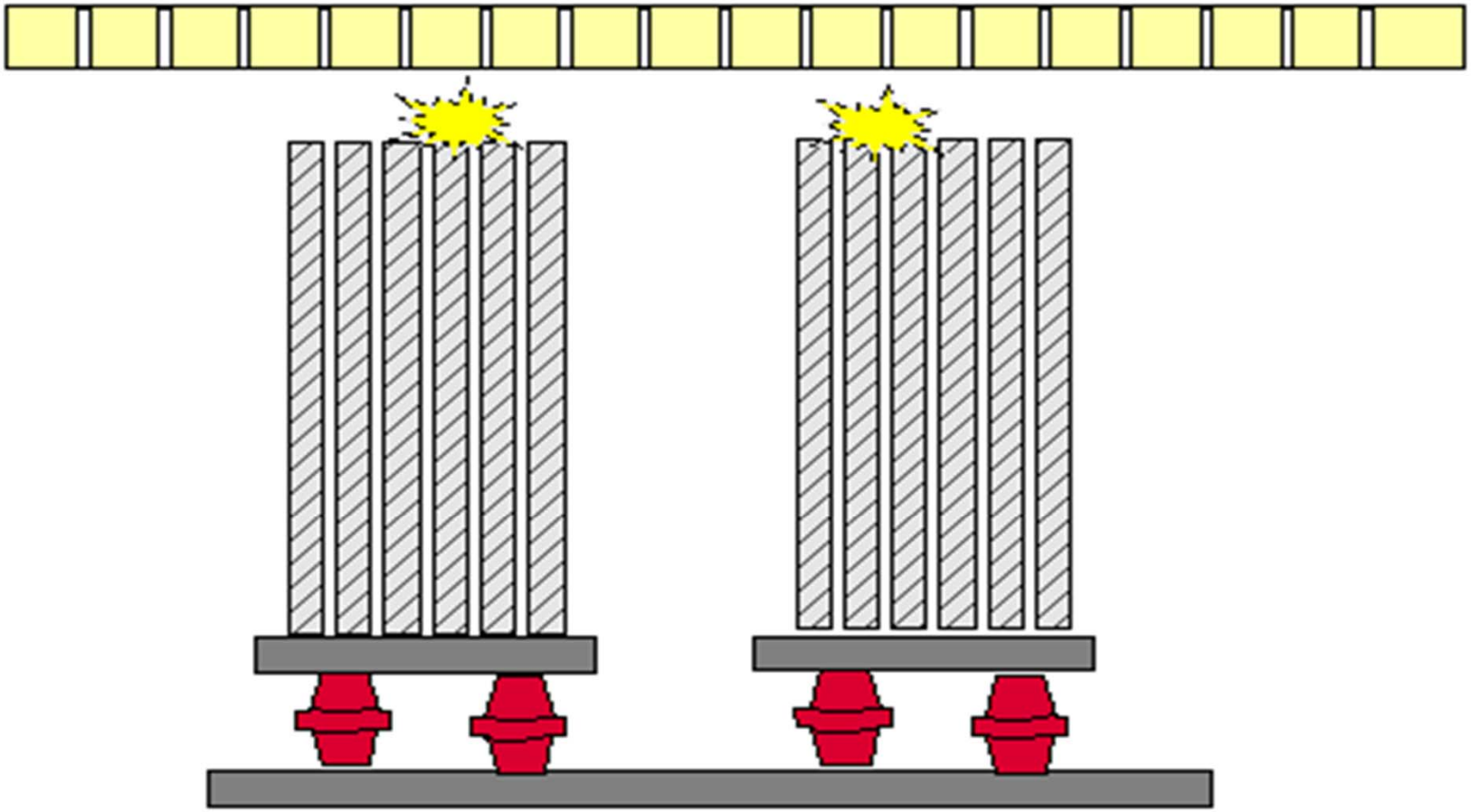


Temporary insulation from sprayed applications of clear acrylic

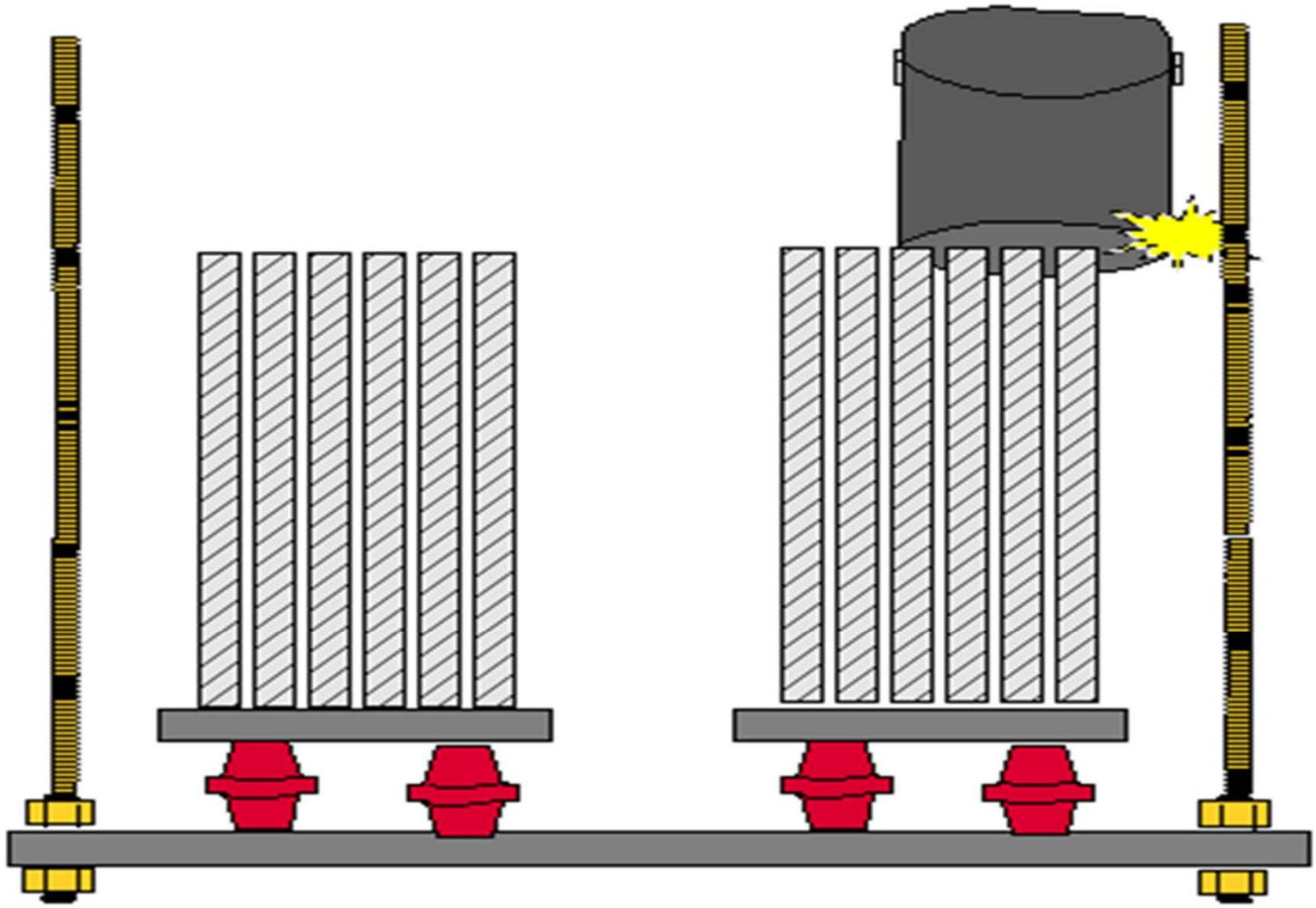

Stopgap measure: Spray several coats of clear acrylic into the cable 'wound' to provide a temporary layer of insulation until maintenance 'window' after midnight.
During the maintenance window: an installers wooden cable wedge and a mallet were used to lift the cable away from the cable rack hom.

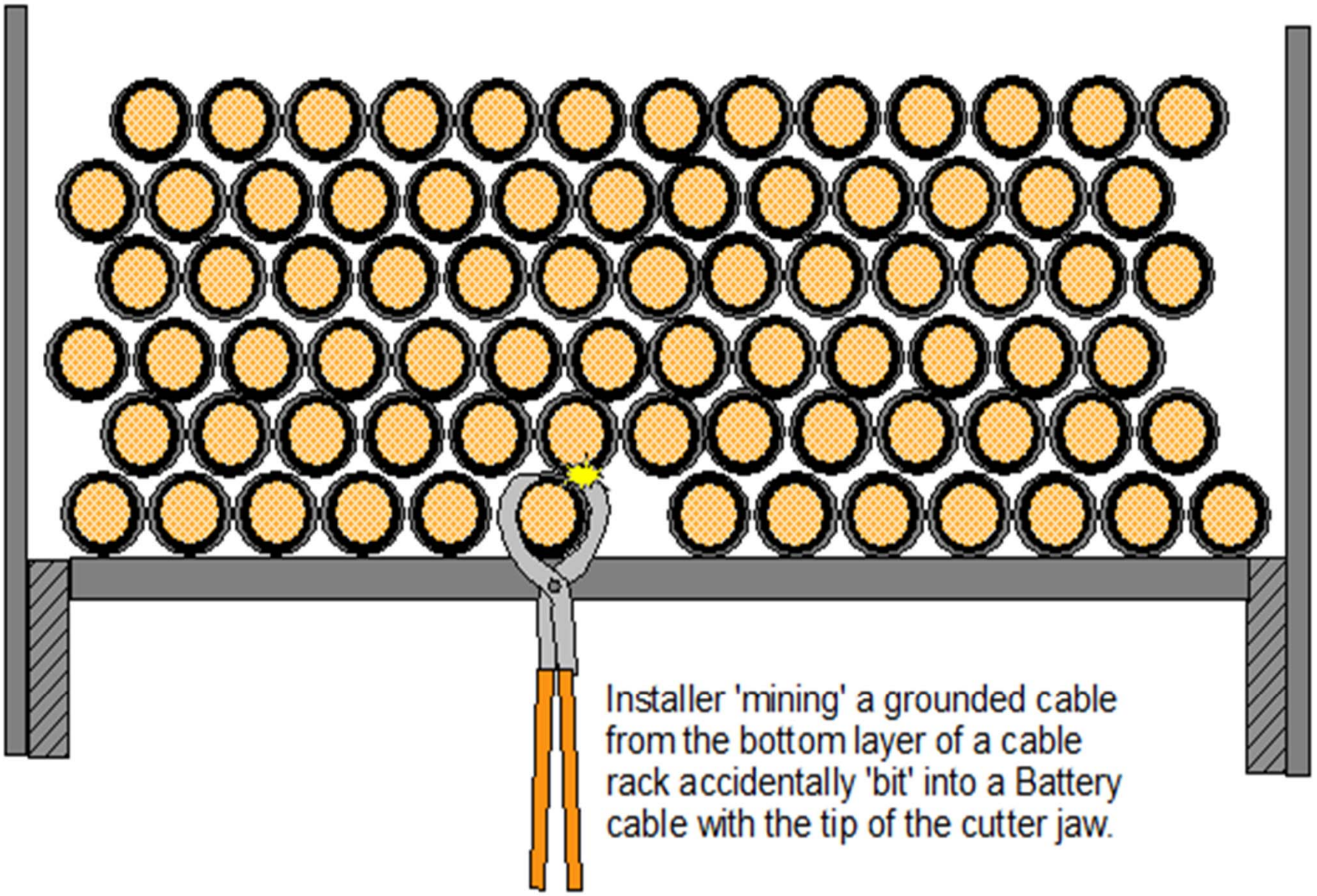

Rectifier being recabled
Another working rectifier

Janitor was cleaning and replacing tubes in a flourescent luminaire and mistook aluminum busbars in a 6,000 Ampere power plant for structural steel. He placed a steel diffuser from the light fixture across the busbars shorting the Battery side of the bus to Battery Return.

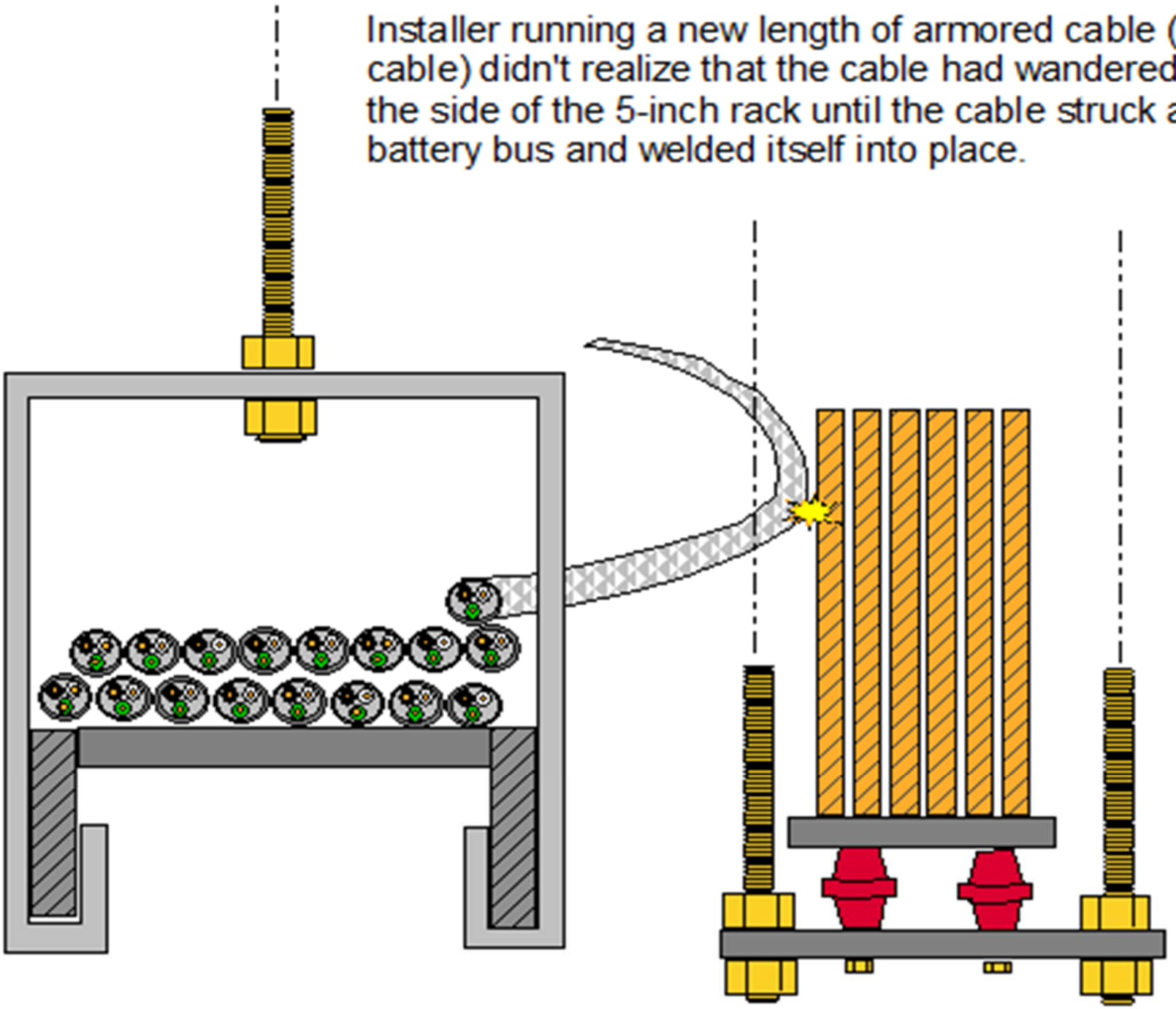


A painter mistook aluminum busbars in a 6,000 Ampere power plant for structural steel. He placed a 1 gallon paint can on the bus shorting the Battery side of the bus to grounded support items.




Installer 'mining' a grounded cable
from the bottom layer of a cable
rack accidentally 'bit' into a Battery
cable with the tip of the cutter jaw.

Installer running a new length of armored cable (MC cable) didn't realize that the cable had wandered off the side of the 5-inch rack until the cable struck a battery bus and welded itself into place.



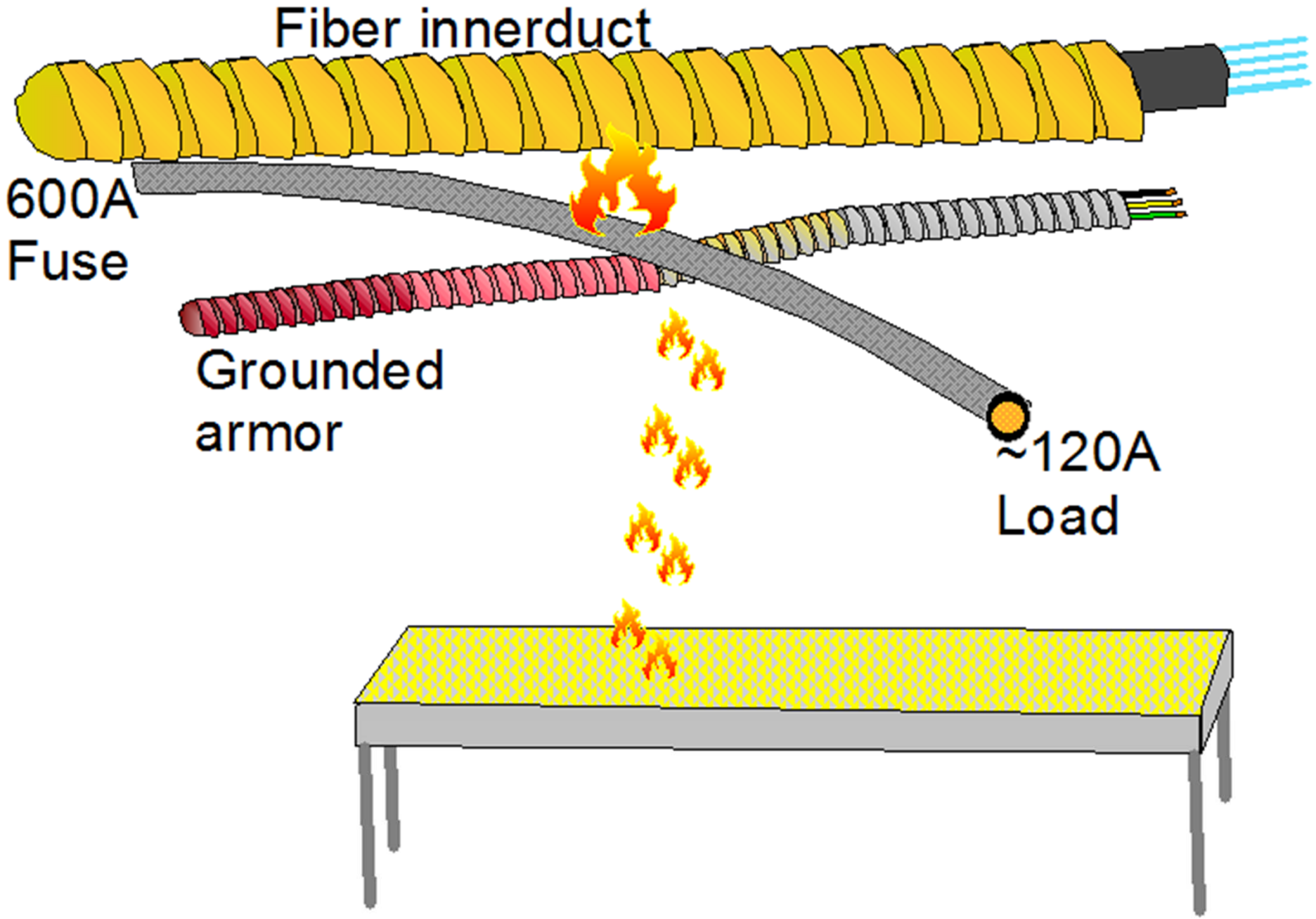
TELEPHONE EXCHANGE

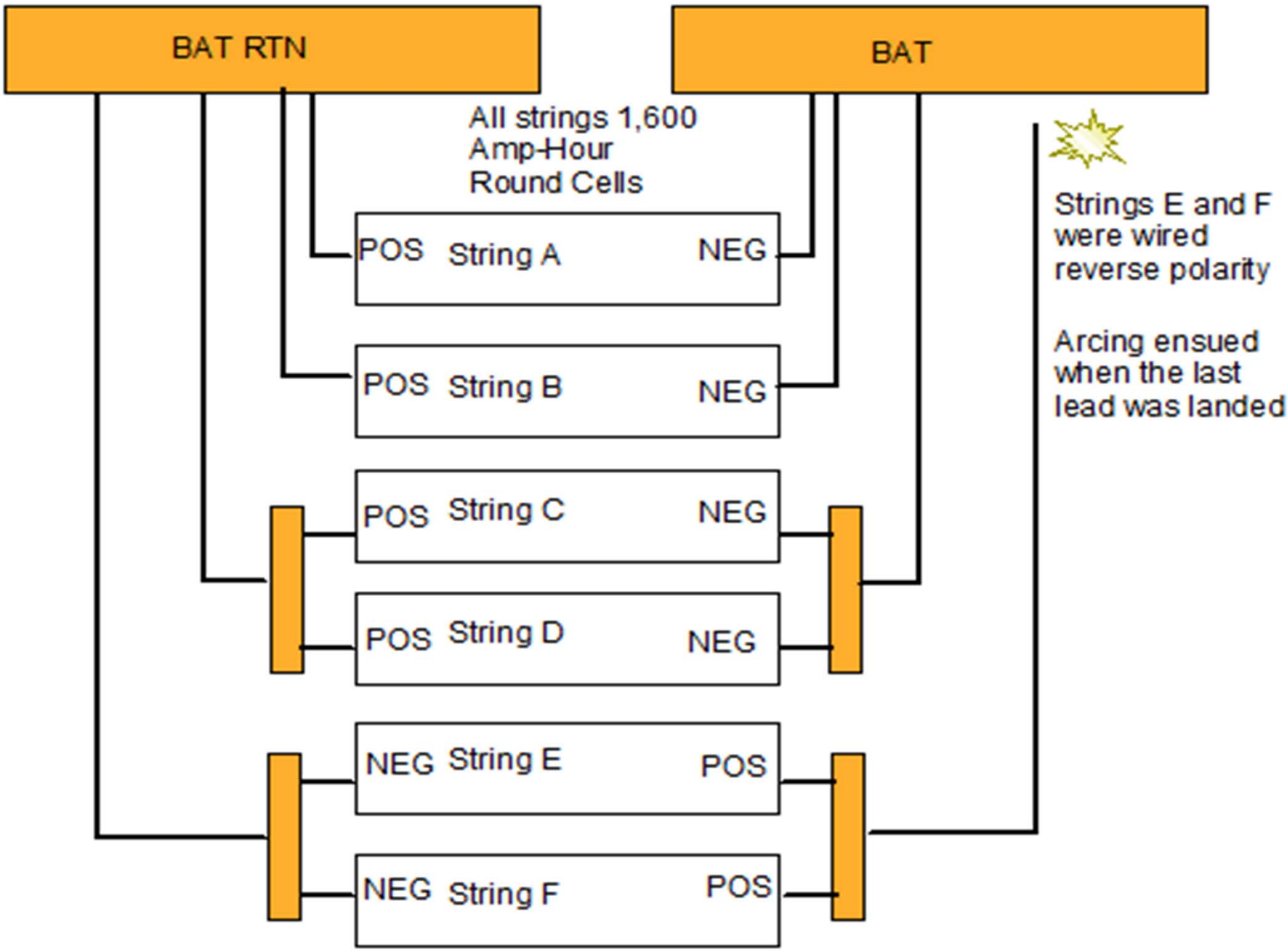
Hinsdale, Illinois
May 8, 1988

FIRE INVESTIGATIONS

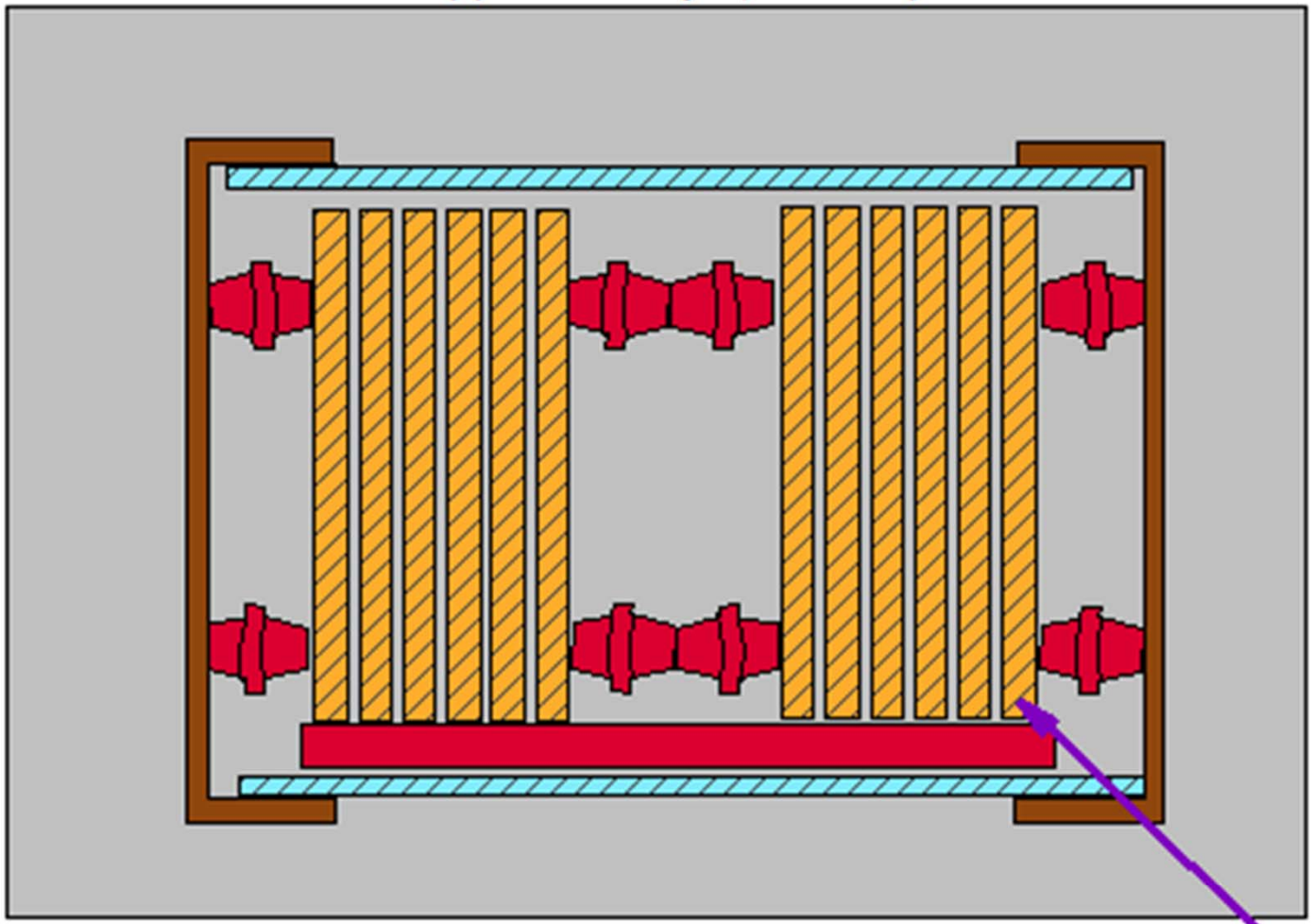
NATIONAL FIRE PROTECTION ASSOCIATION

1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101 USA
Telephone: 1-617-984-7263 E-mail: investigations@nfpa.org

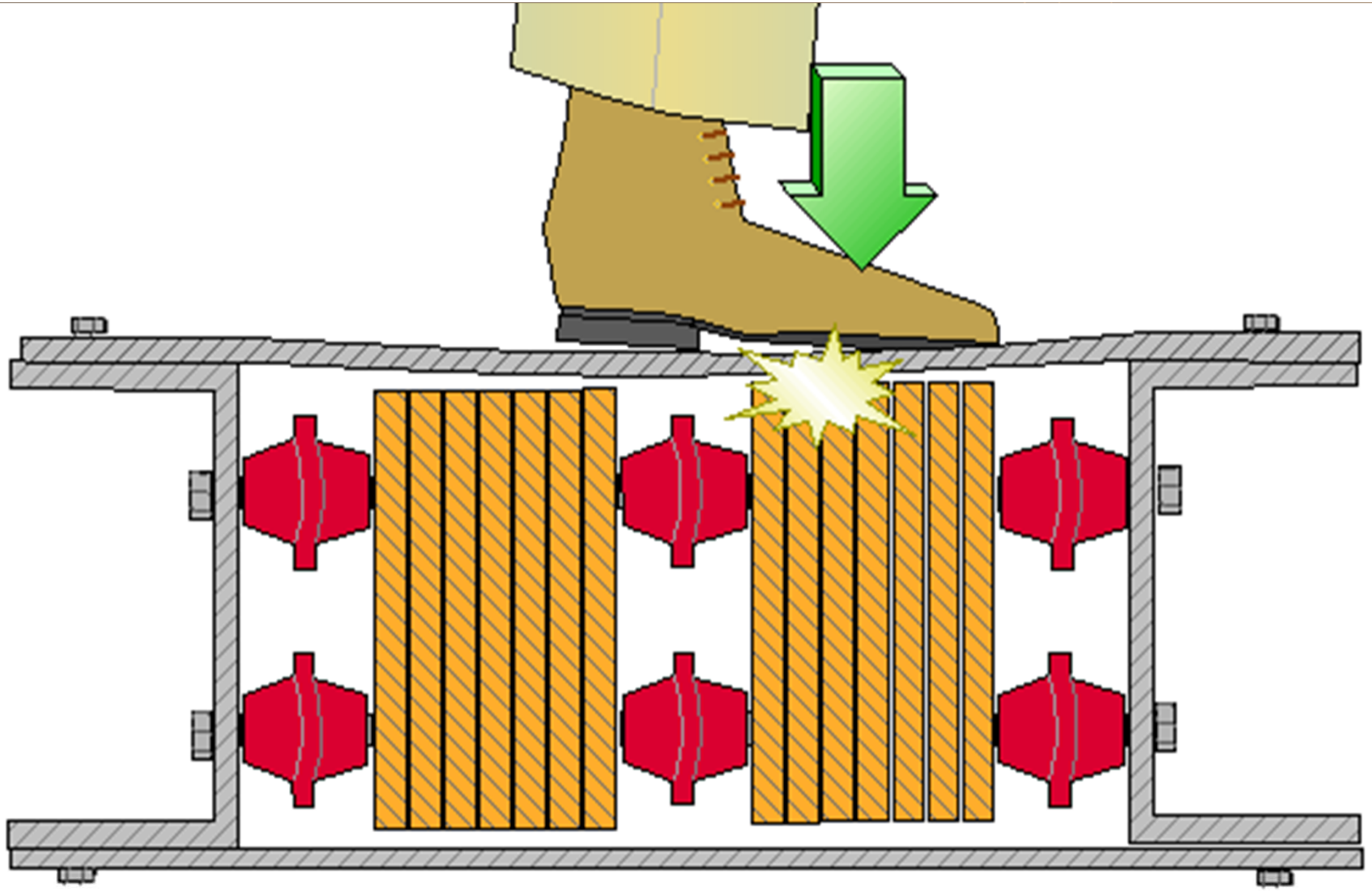

Fiber innerduct
600A
Fuse
Grounded
armor
~120A
Load


BAT RTN
BAT
All strings 1,600
Amp-Hour
Round Cells
POS String A NEG
POS String B NEG
POS String C NEG
POS String D NEG
NEG String E POS
NEG String F POS
Strings E and F
were wired
reverse polarity
Arcing ensued
when the last
lead was landed

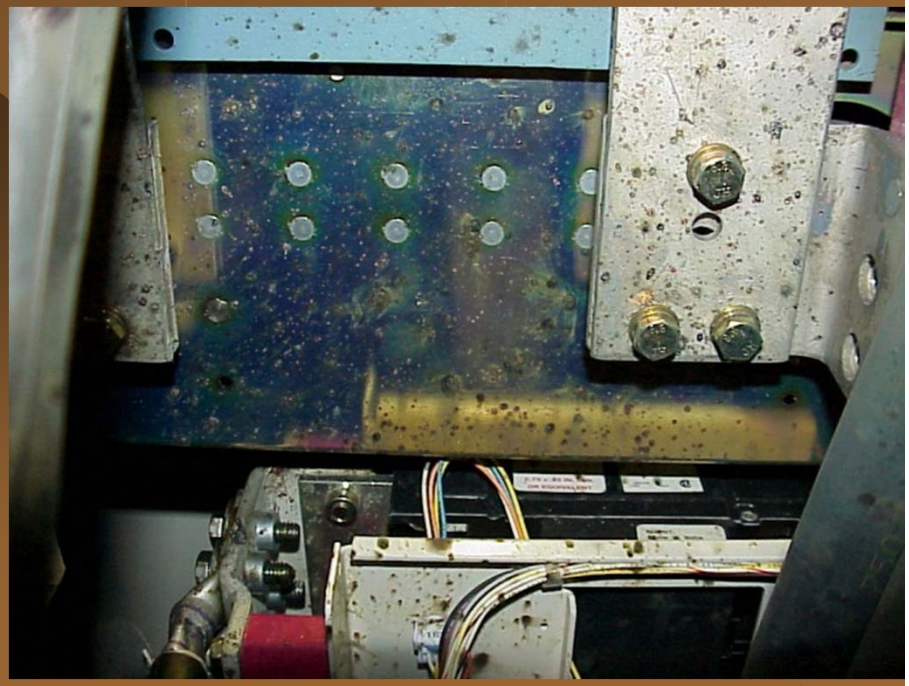
Busduct fused at 6,000 Amperes,
load approximately 1,200 Amperes

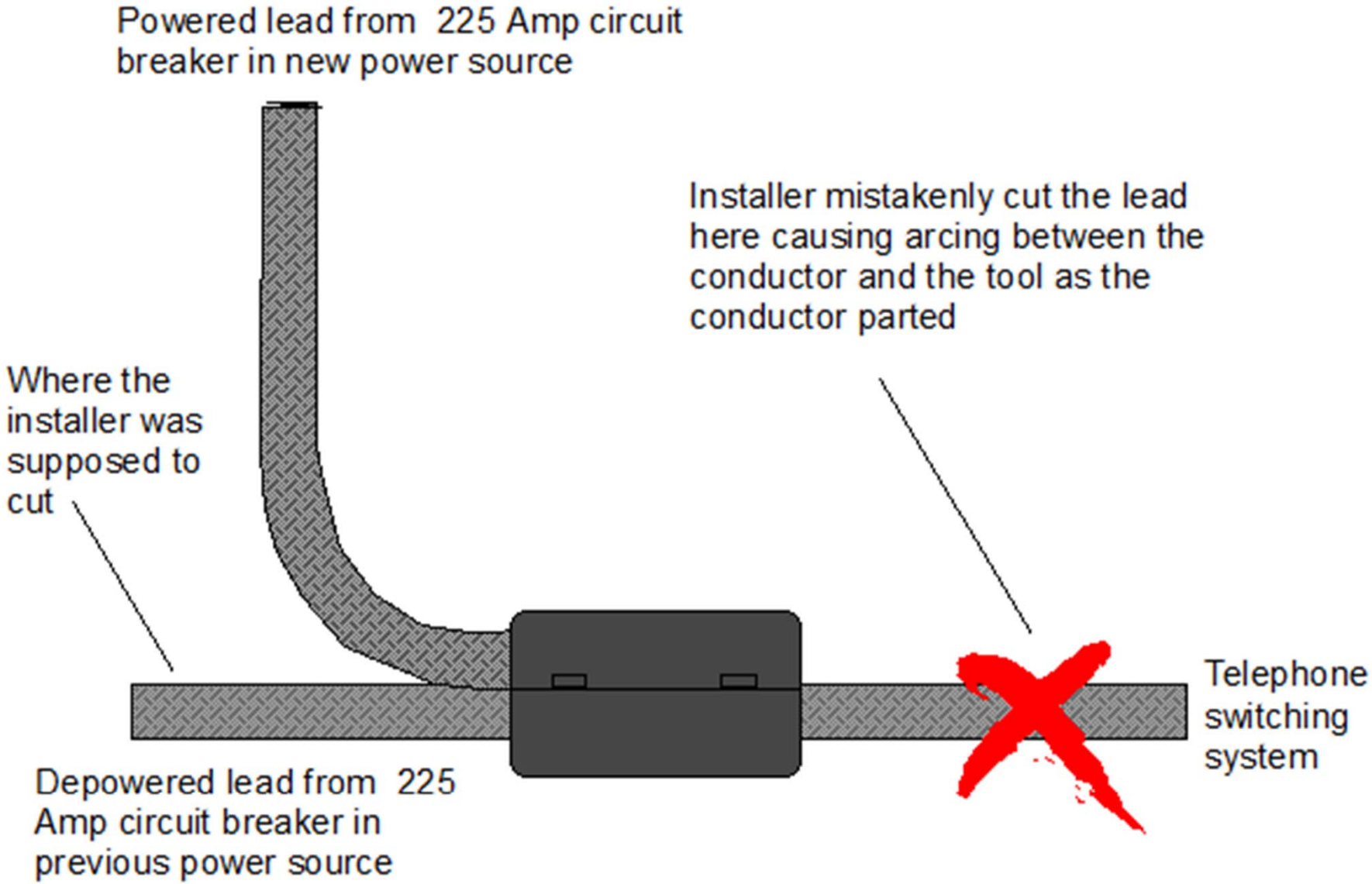


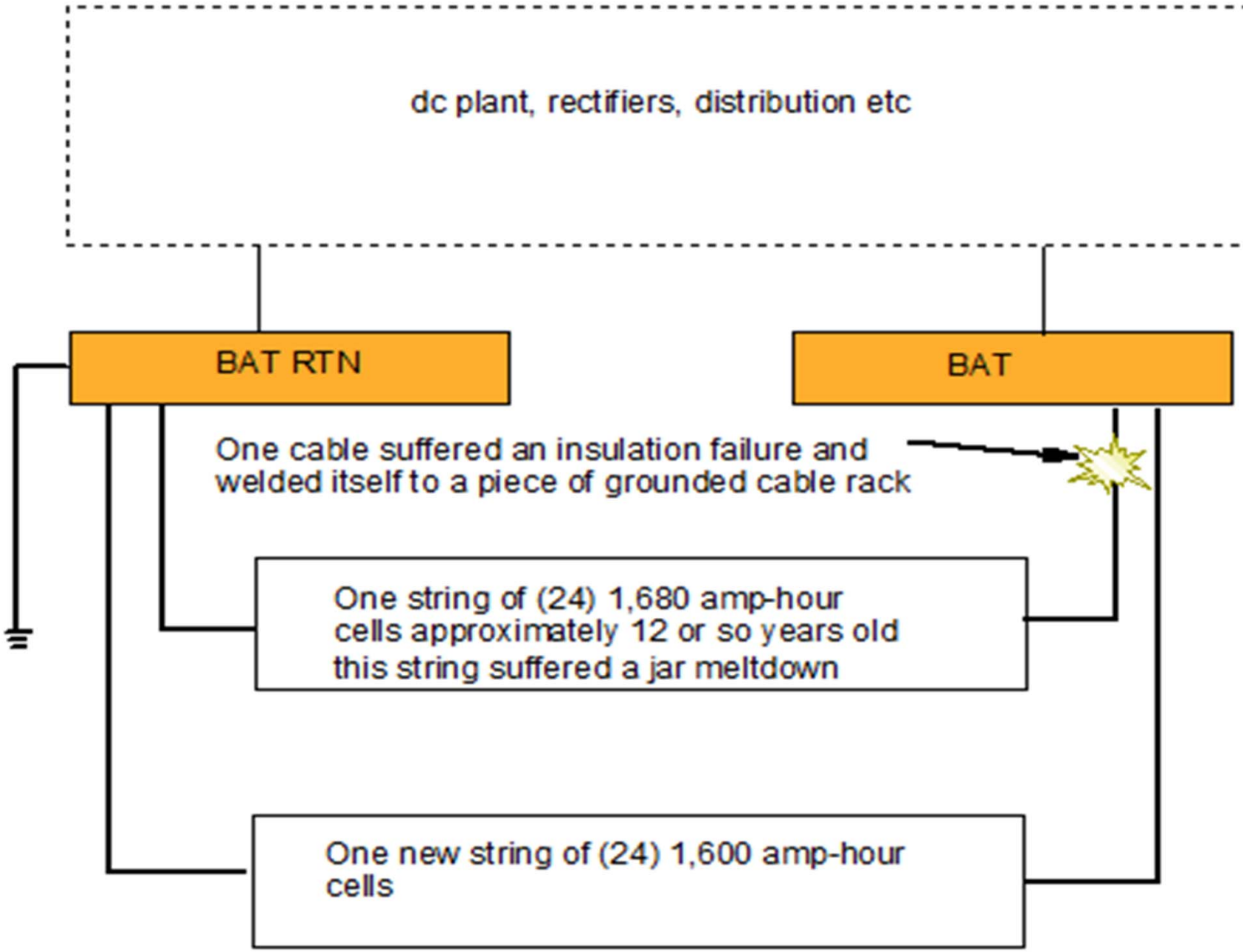
Installer closing the firestop at a wall penetration accidentally drilled into the bus, momentarilly shorting the Battery side of the bus to Ground

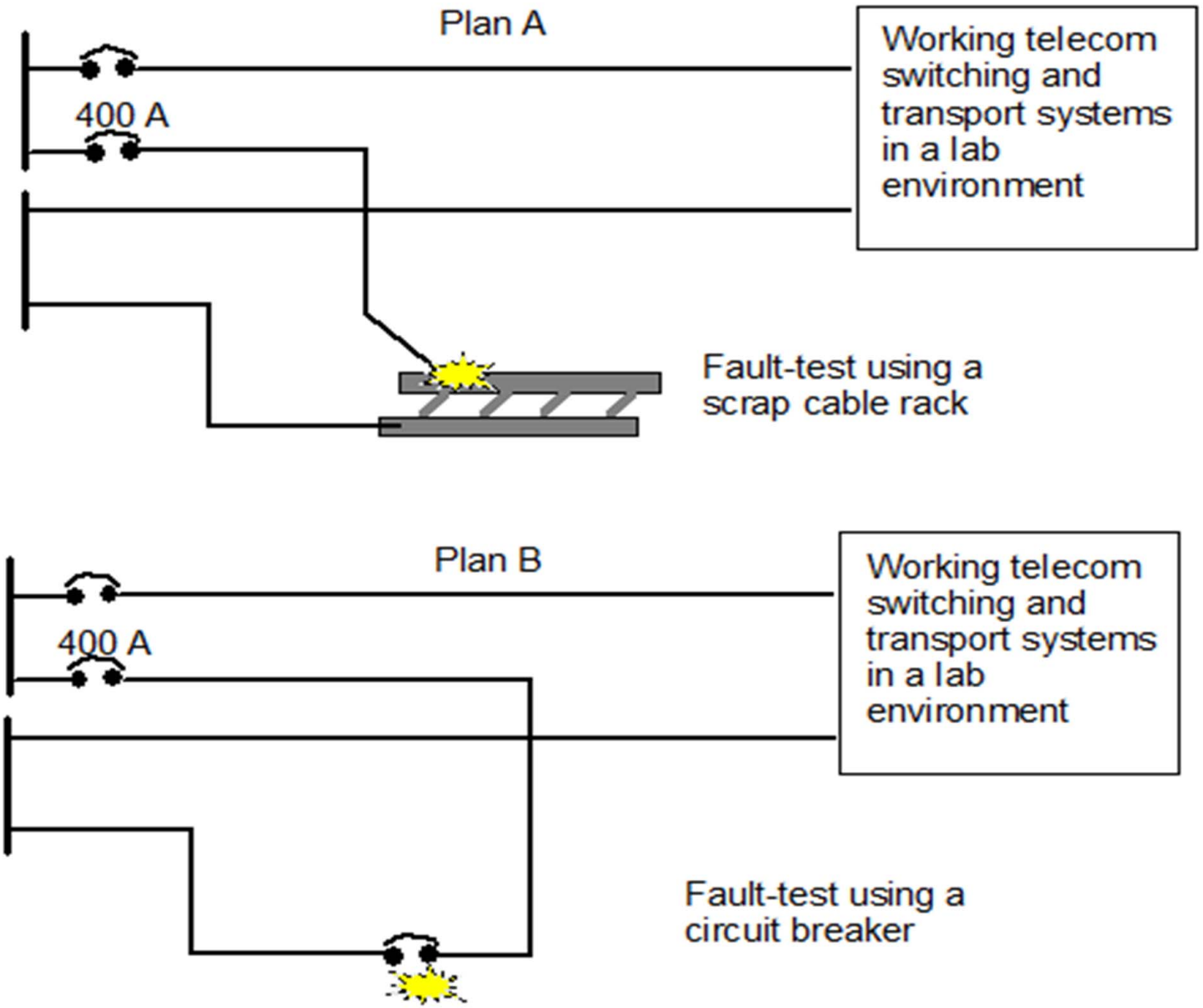


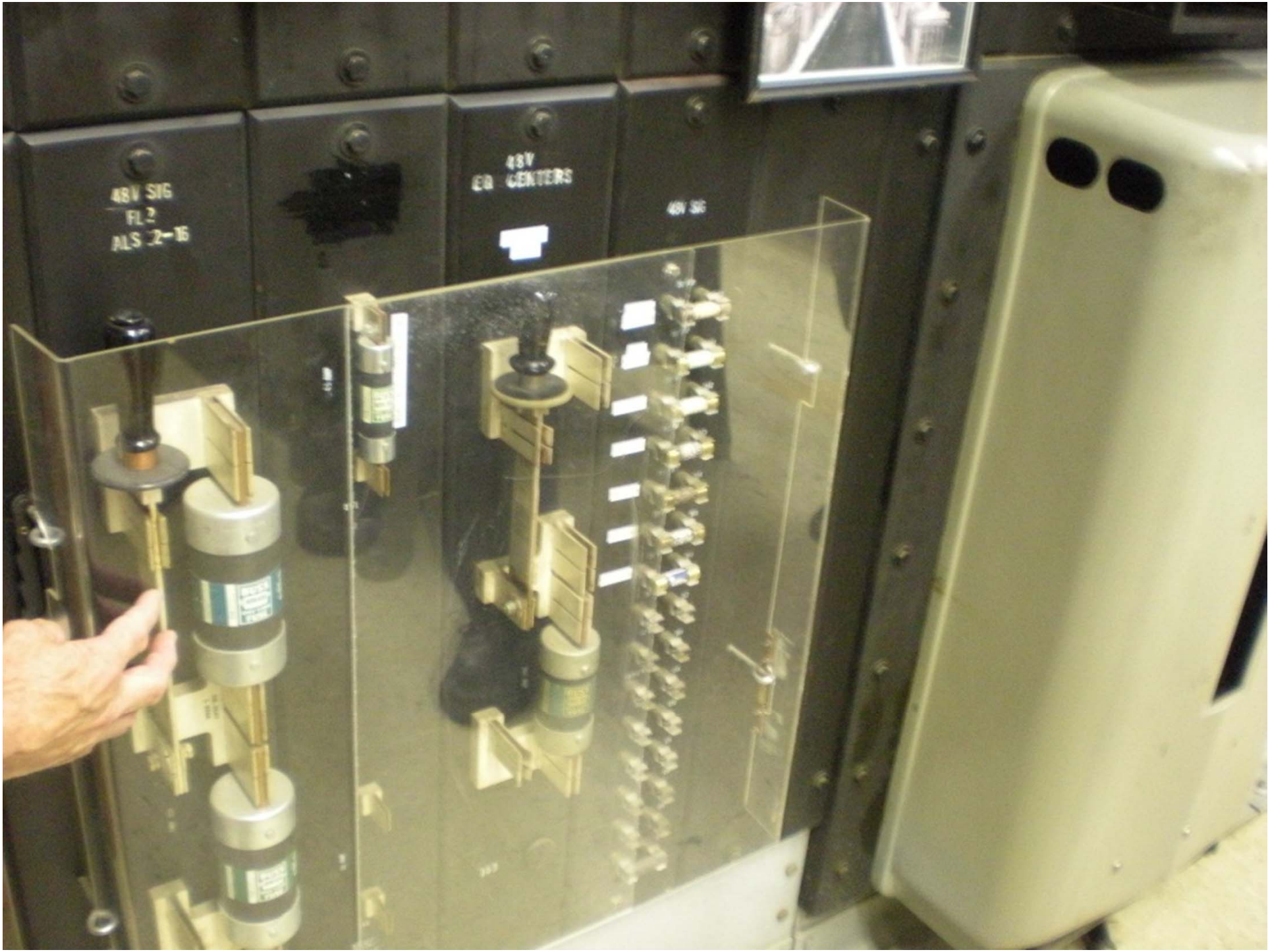
Installer drilling a concrete ceiling placed one foot onto the sheet steel cover of an enclosed dc busduct shorting the grounded cover into the battery bus of a 10,000 Ampere power system.

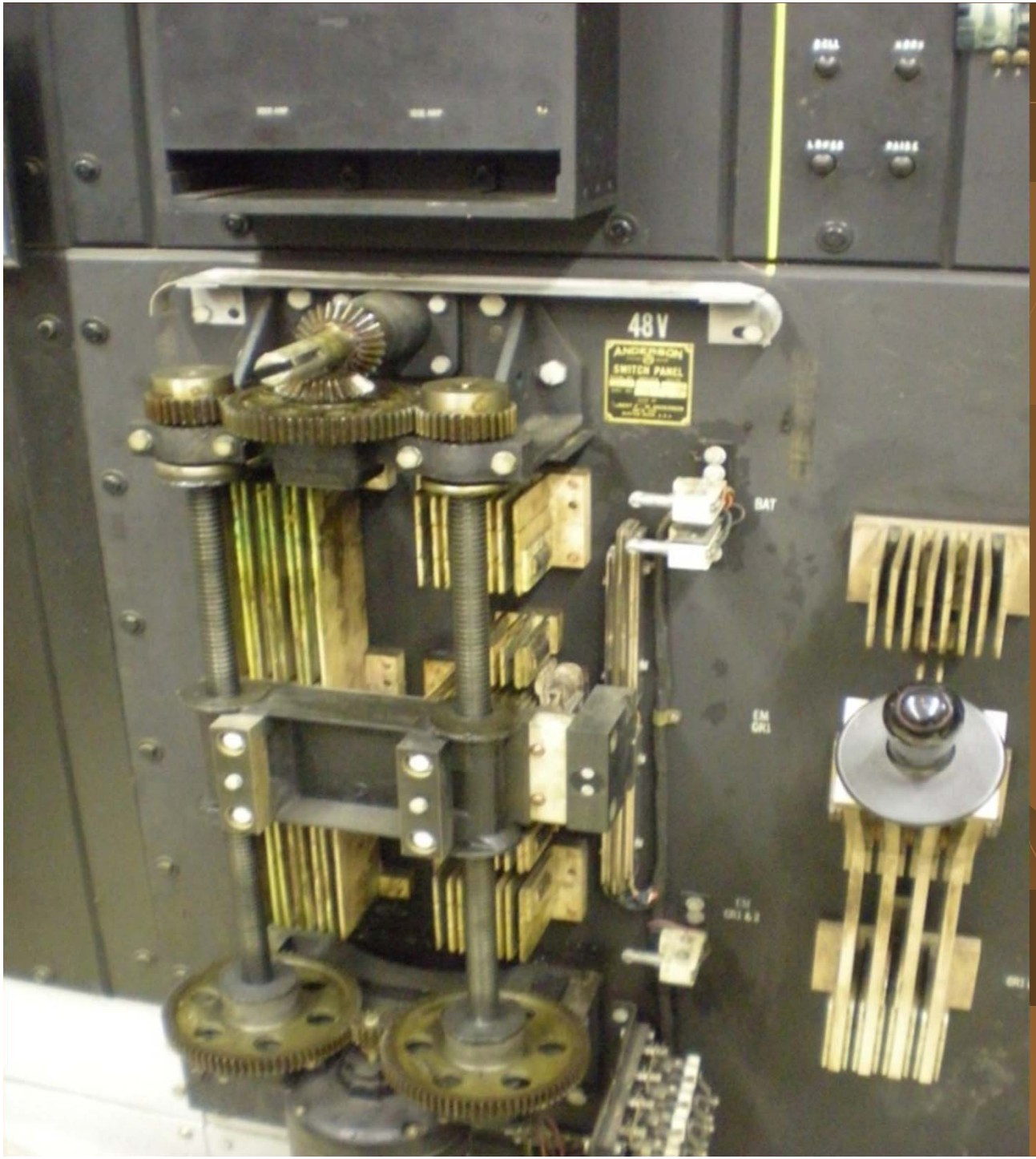


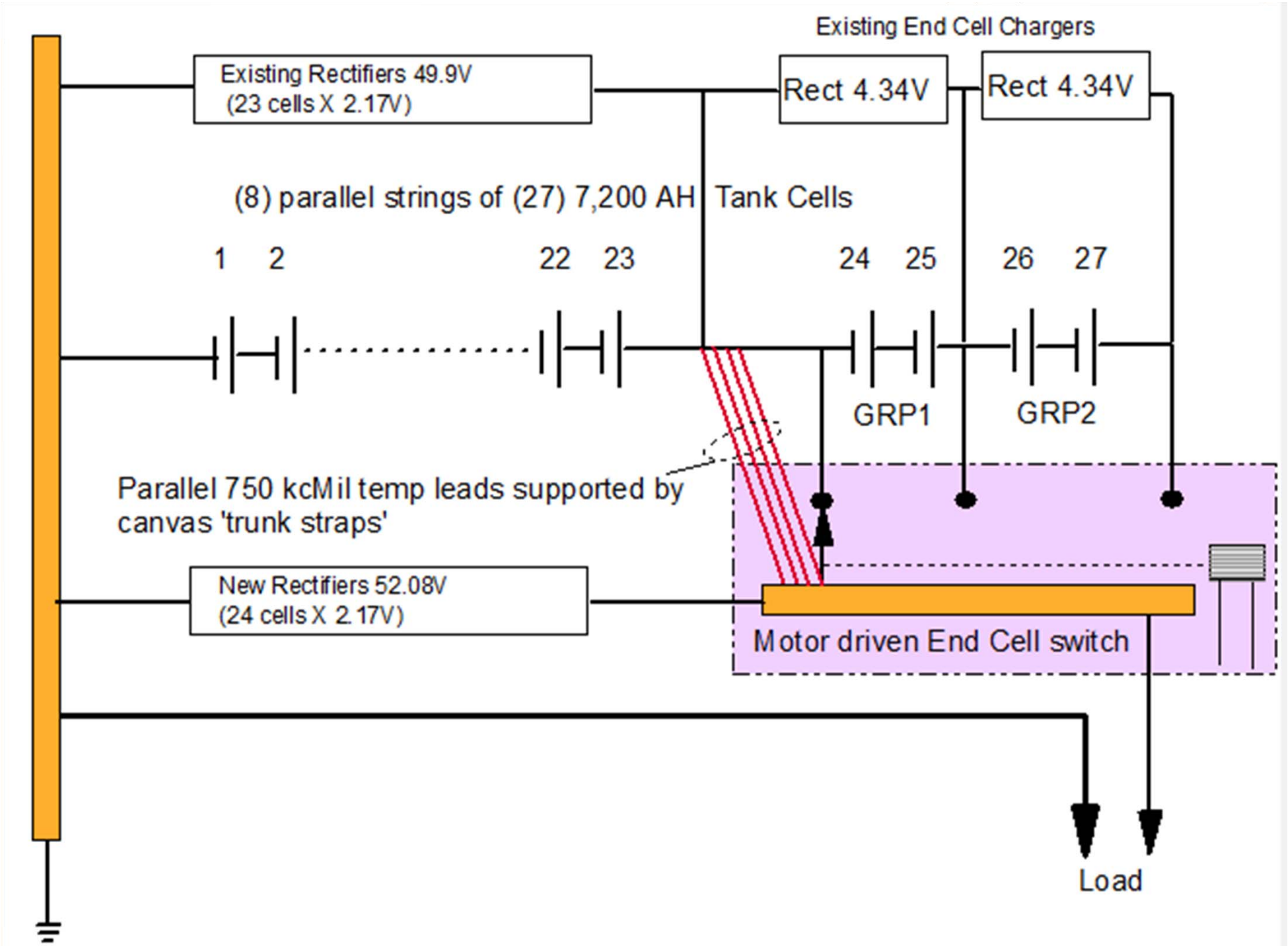

Powered lead from 225 Amp circuit breaker in new power source
Installer mistakenly cut the lead here causing arcing between the conductor and the tool as the conductor parted
Where the installer was supposed to cut
Telephone switching system
Depowered lead from 225 Amp circuit breaker in previous power source

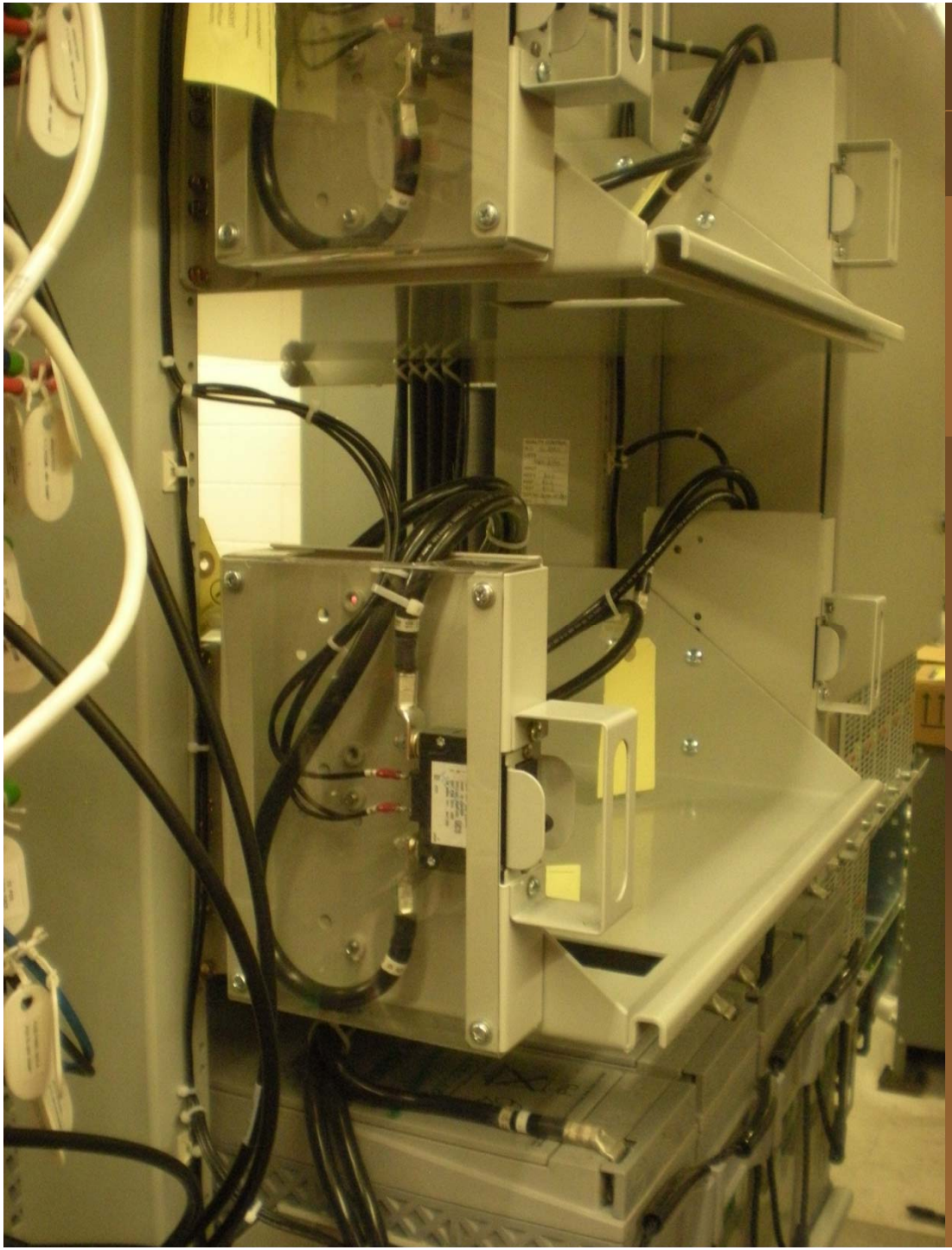

dc plant, rectifiers, distribution etc
BAT RTN
BAT
One cable suffered an insulation failure and welded itself to a piece of grounded cable rack
One string of (24) 1,680 amp-hour cells approximately 12 or so years old this string suffered a jar meltdown
One new string of (24) 1,600 amp-hour cells

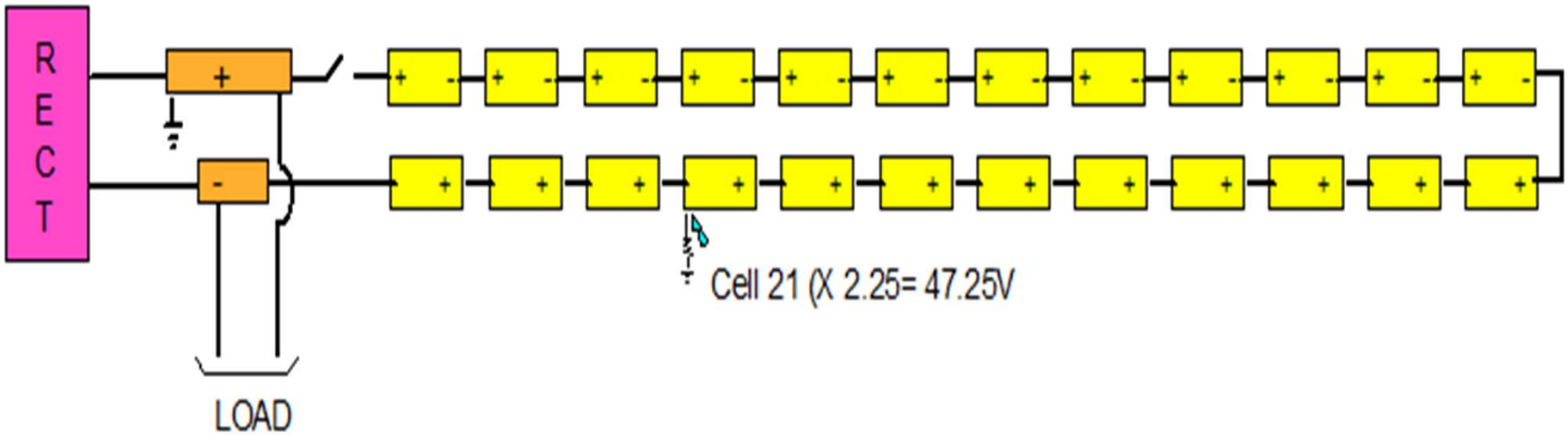

Plan A
400 A
Working telecom switching and transport systems in a lab environment
Fault-test using a scrap cable rack
Plan B
400 A
Working telecom switching and transport systems in a lab environment
Fault-test using a circuit breaker

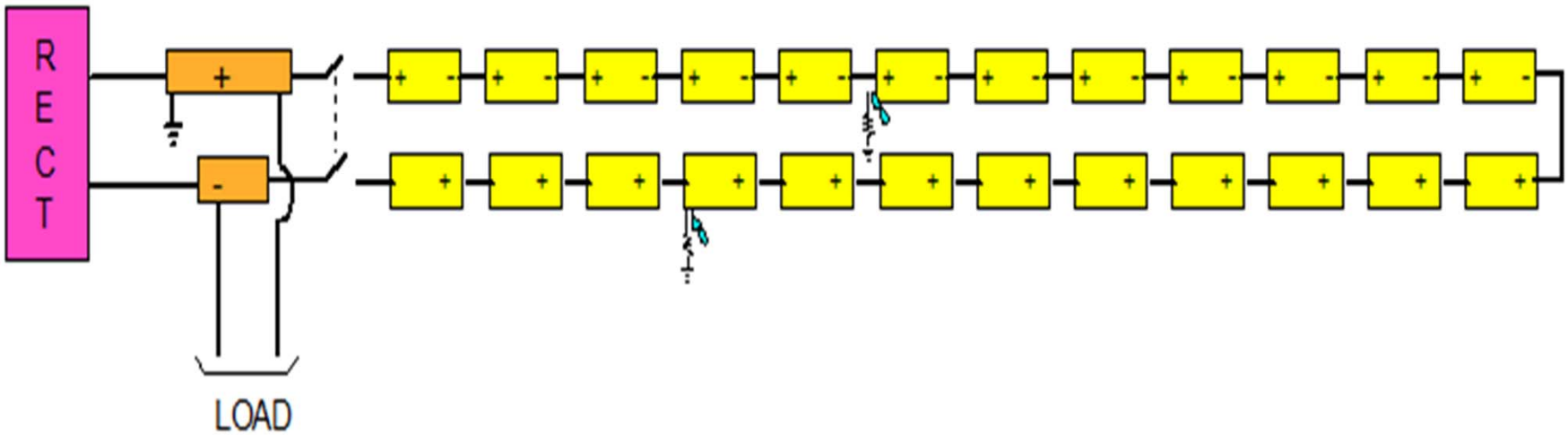

48V SIG
48V


48V
SWITCH PANEL
BAT


Existing End Cell Chargers
Existing Rectifiers 49.9V
(23 cells X 2.17V)
Rect 4.34V
Rect 4.34V
(8) parallel strings of (27) 7,200 AH Tank Cells
1
2
22
23
24
25
26
27
GRP1
GRP2
Parallel 750 kcMil temp leads supported by canvas 'trunk straps'
New Rectifiers 52.08V
(24 cells X 2.17V)
Motor driven End Cell switch
Load




RECT
+
-
Cell 21 (X 2.25= 47.25V
LOAD


RECT
+
-
LOAD

Conclusions

- Overcurrent is not a Code requirement for central office
- Disconnect not a Code requirement for central office

Thank you