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Brookhaven National Laboratory (BNL) Terminal Room Relay Fire

2011 DOE Facility Representatives Workshop

May 4-5, 2011

Patrick T. Sullivan

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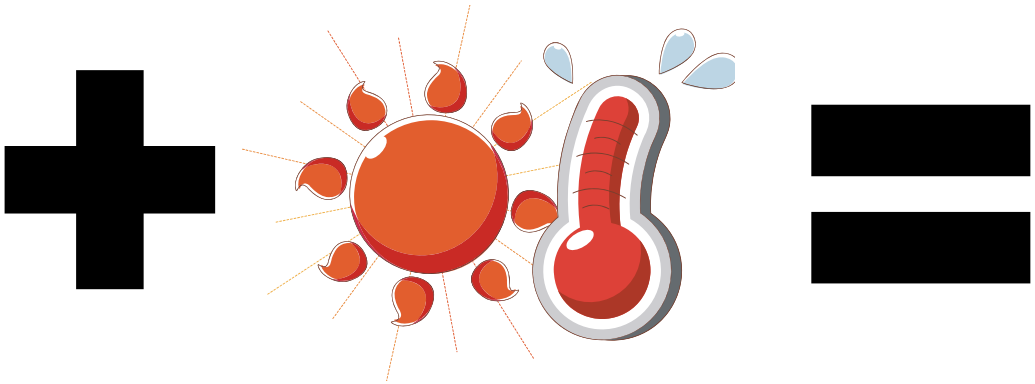
The Incident

Electromechanical Relay

Overheats



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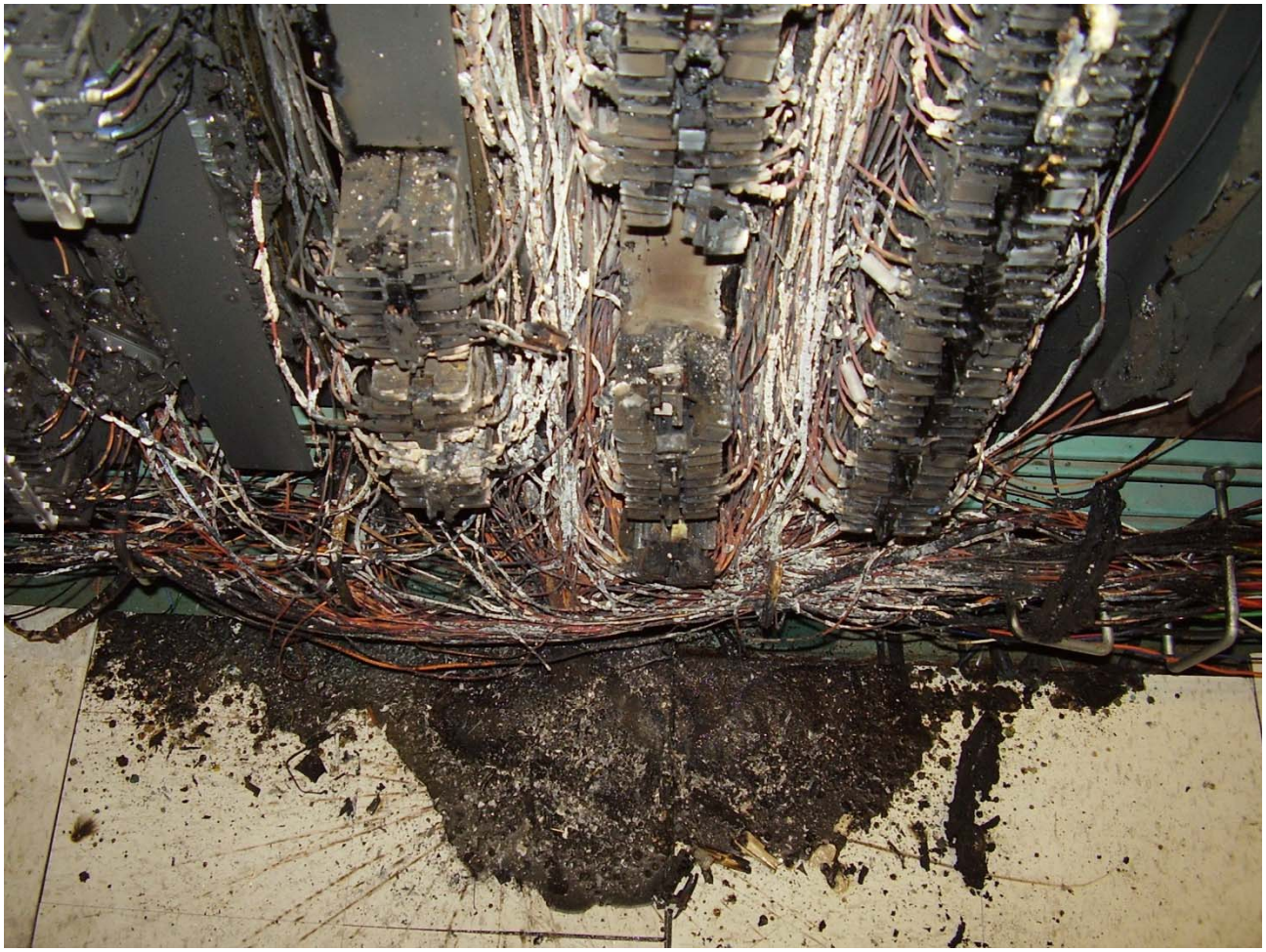
Terminal Room Fire



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Terminal Room Fire

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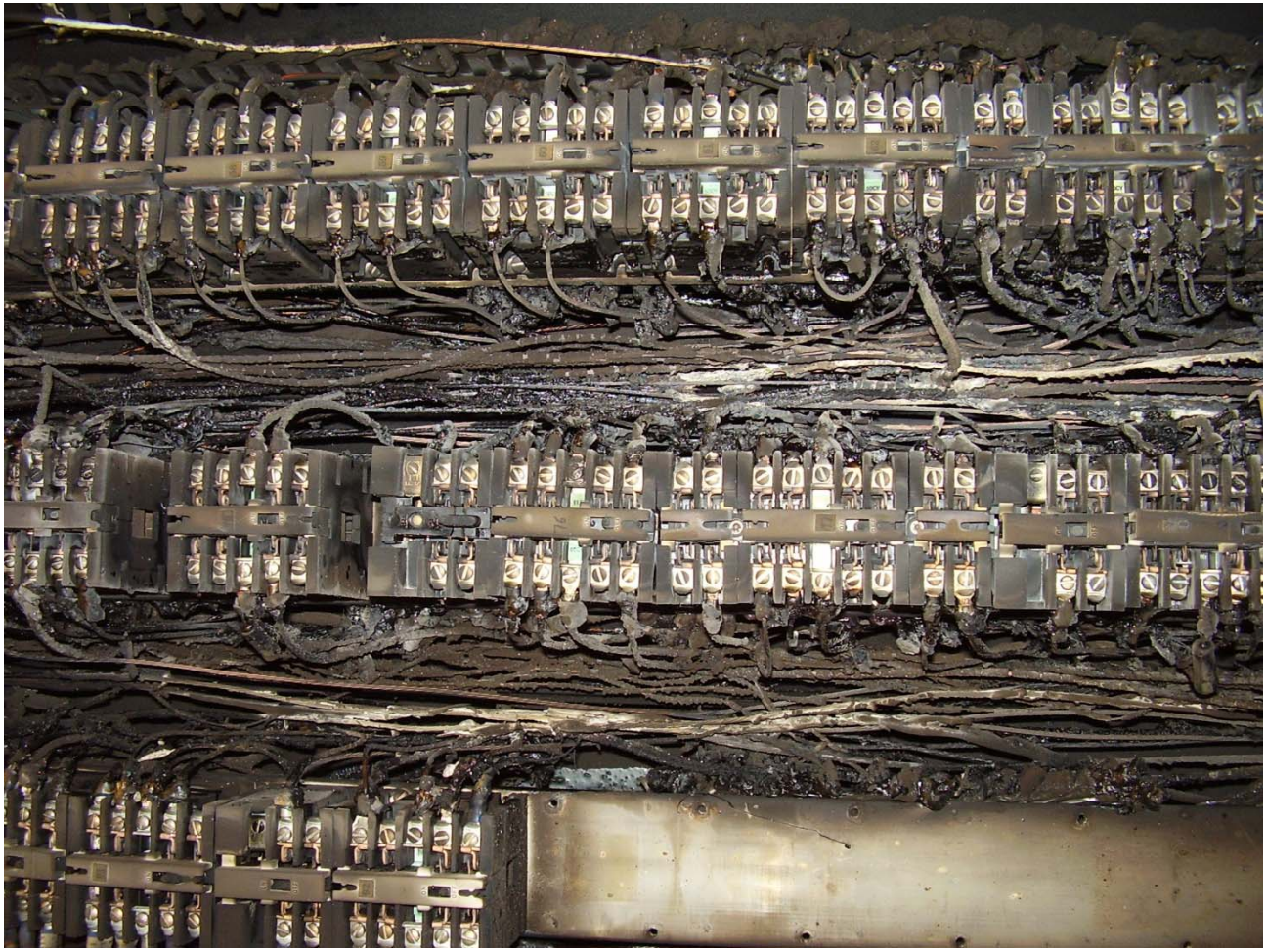
Terminal Room Fire



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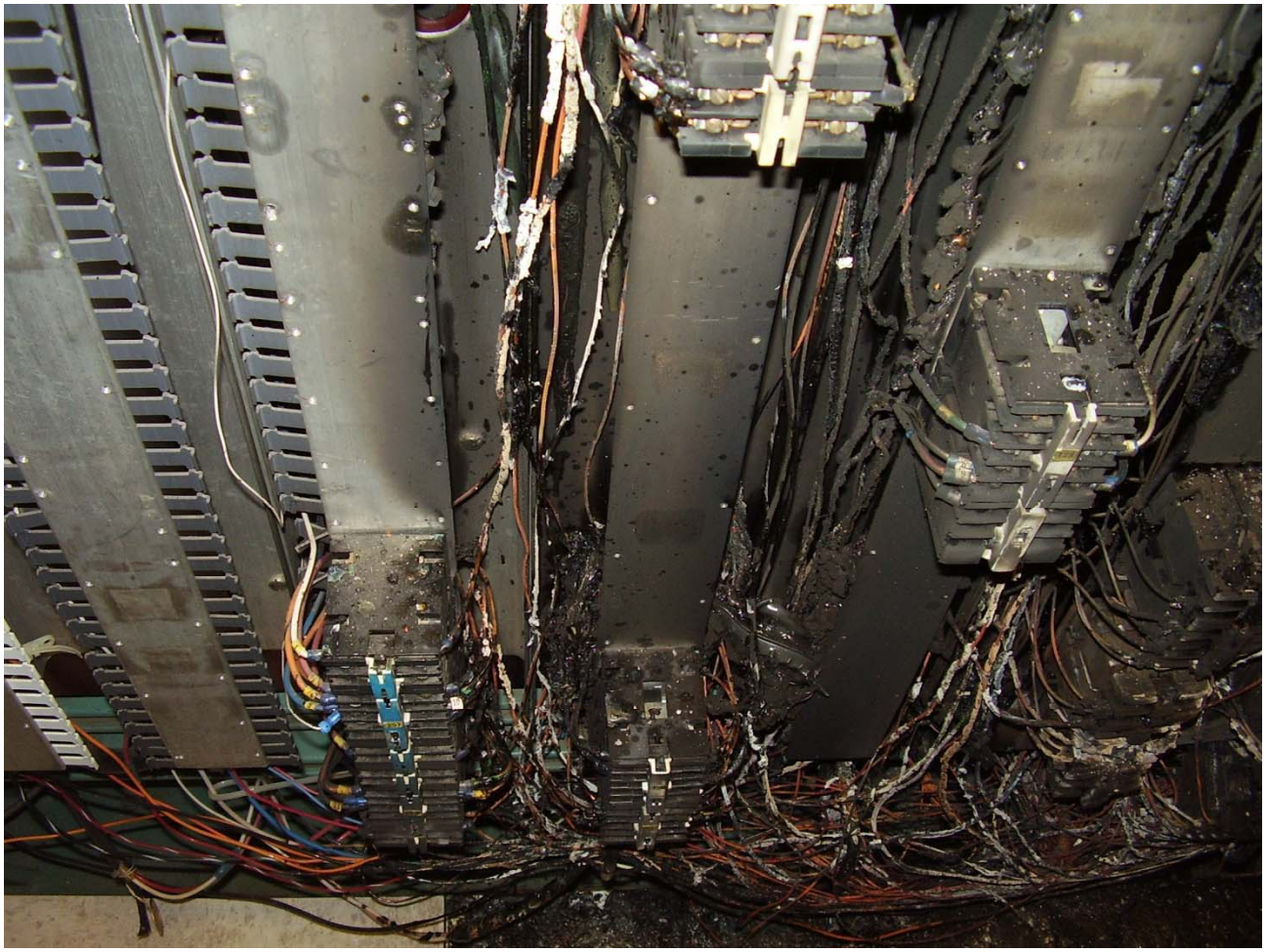
Terminal Room Fire



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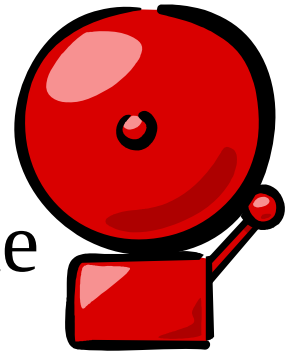
What Happened?

- On November 9, 2010 at approximately 1302, fire alarms sounded in and around the Collider Accelerator Departments (CAD) Main Control Room (MCR)
- For almost 20 minutes the exact location of the fire could not be determined
- After heat detectors tripped the Halon system in the MCR Terminal Room, the fire was located



RHIC
G-2
BOOSTER
LINAC
AGS
TANDEMS
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The "What" Continued

- Upon entering the Terminal Room, Fire Rescue personnel determined the fire was extinguished
- Extensive smoke in the building required the building to remain evacuated for 4 hours

- CAD accelerator operations were shutdown for 48 hours and in some areas longer

The Investigation

- With prompting from BNL's Associate Laboratory Director for ESH, the CAD Department Chair formed a committee to investigate the fire
- The committee was co-chaired by the CAD ESH manager and the BNL Electrical Safety Officer
- "Yours truly" was also a participant

The "What" Continued

- GE CR120A Electromechanical Relays are used extensively in older systems
- Used as part of the accelerator Access Controls System (ACS)
- Many systems were designed and have been in use since the early 60's
- Mechanical relay coils can overheat and fail

The “What” Continued

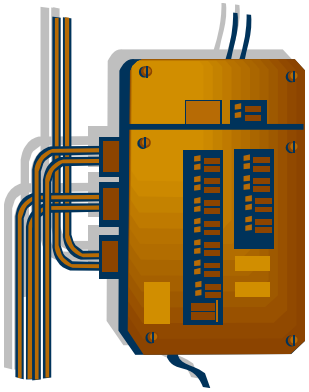
- Overheating was caused by a stuck armature in a relay, the heating led to expansion of and then flame from the coil with subsequent ignition of nearby flammables
- The nearby flammables turned out to be contact arm retainers and wiring

The “What” Continued

Failed Coil

The “What” Continued

- Compounding the problem, one breaker did not trip although it should have
- Insulation on a single wire from the relays to this breaker was melted along its length, about one hundred feet beyond the extent of the fire in the Terminal Room



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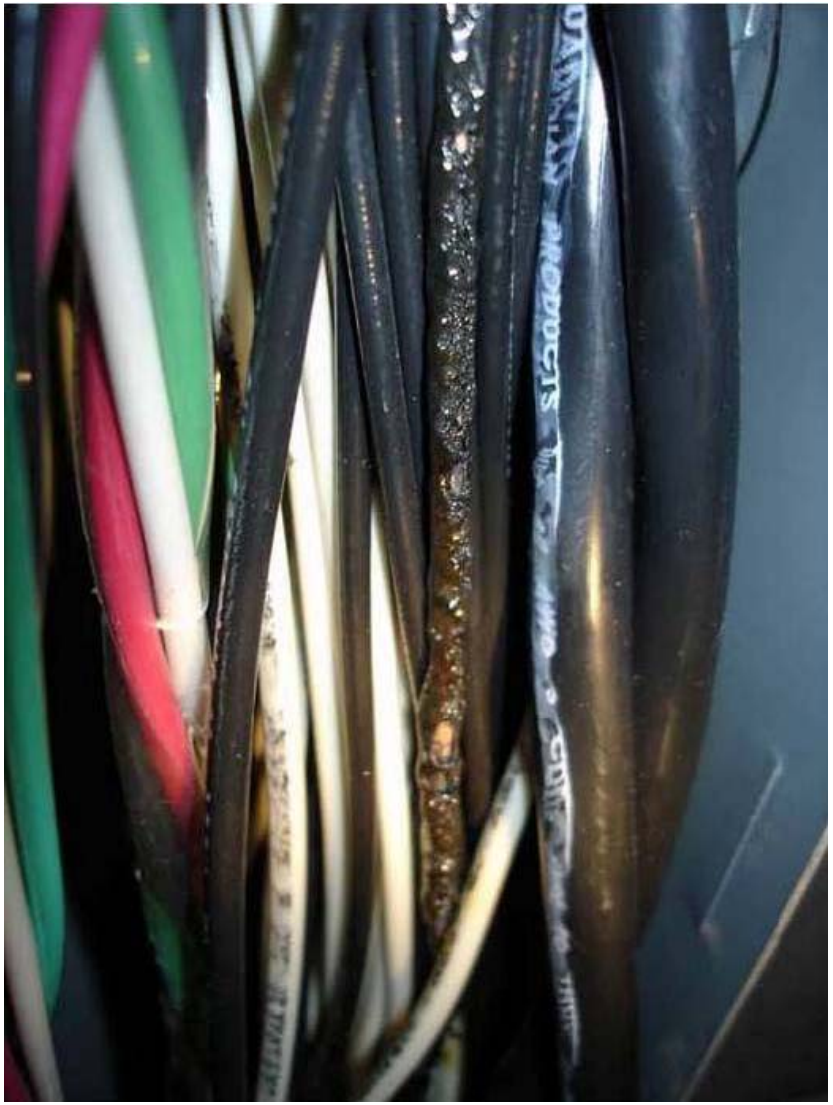
The “What” Continued

Melted wire from circuit breaker



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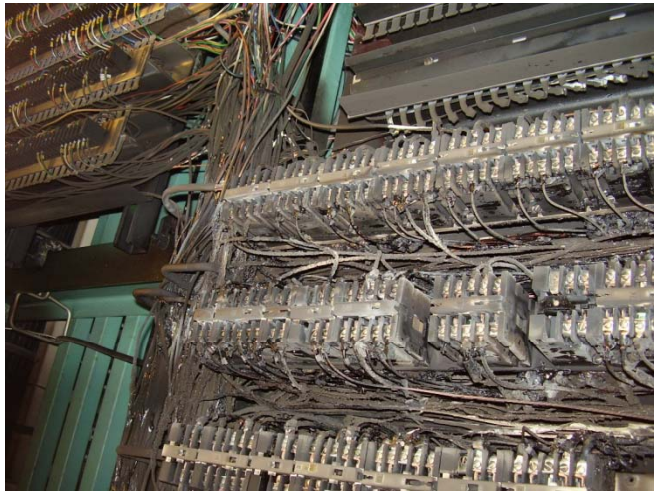
Can We Resume Operations?

- Extensive damage to Access Control System
- In the interest of science, can undamaged accelerators resume operations?
- Asking the hard question (DOE)
  - What assurance do we have that this won't happen again?

Why did it happen?

- A 1978 recall of flammable contact-arm retainers on GE CR120A Relays was not known to BNL
- Original wiring installed in the early 60's was of a flammable nature (not known to be flammable)

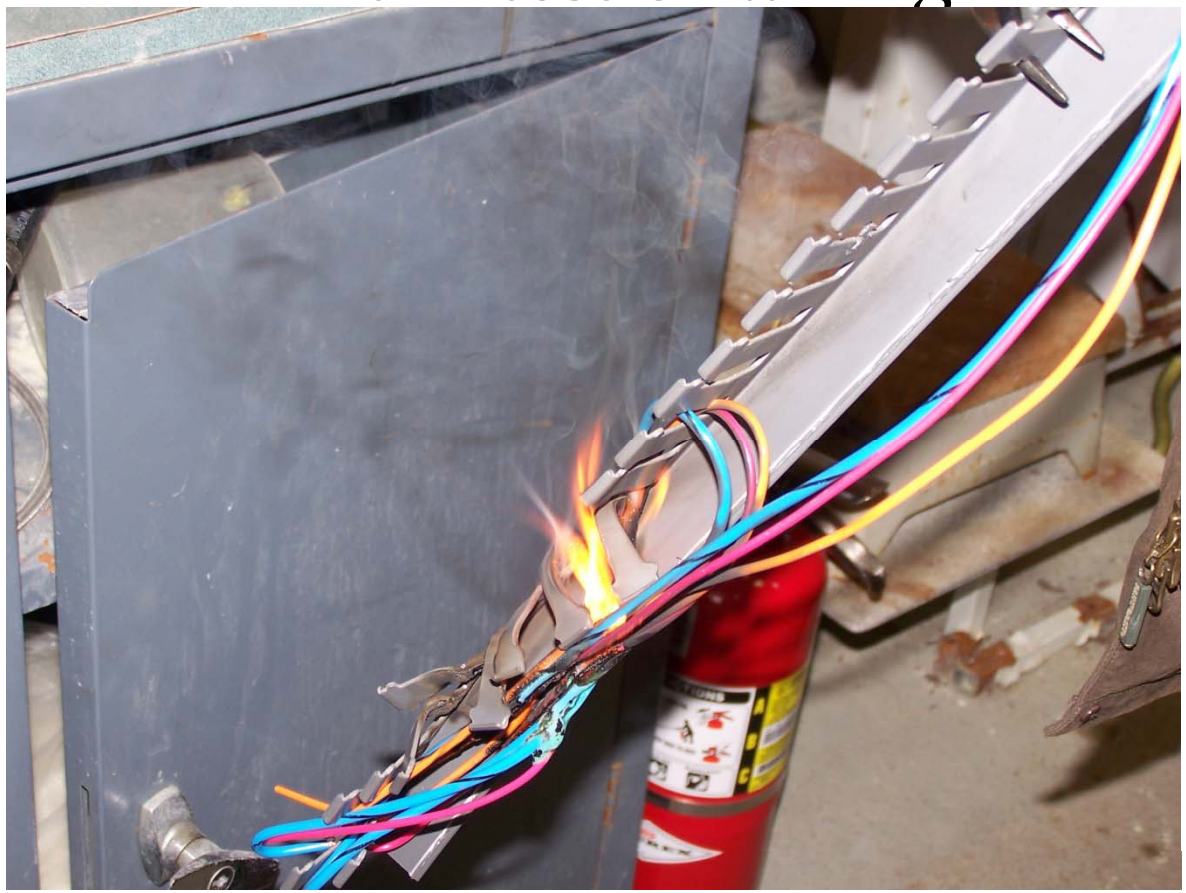


The “Why” Continued

Contact Arm Retainer Burn Test

The “Why” Continued

Burn test of wiring



The “Why” Continued

- Corrective maintenance for relays (replacement or repair) rather than well-defined preventive maintenance was practiced from 1960 to 2001. Many 120V relays in use today are 40 to 60 years old

The "Why" Continued

- Previous relay over-heating/fire investigations were not adequate for:

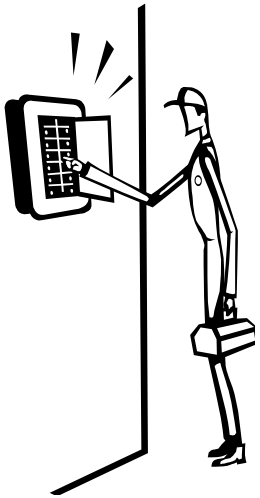
a) corrective action closure statements,
b) timely implementation of corrective actions; and
c) trending of lower level issues that could lead to bigger problems

The “Why” Continued

- High Sensitivity Smoke Detectors (HSSD) in the area were disabled that day for welding in an adjacent highbay
- Terminal Room does not meet current fire code requirements for separation from floor above and cable trays are open to outside air

The “Why” Continued

- Although not directly related to the fire, the failed circuit breaker continued to fail even during testing after the fire
- Exercising circuit breakers routinely is not done (NFPA 70E and Manufacturer requirements)



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Lessons Learned/Corrective Actions

- Develop an Institutional Recall Program
- Share the recall notice of the GE CR120A Electromechanical relays with the Lab and the DOE Complex
- Remove all recalled contact arm retainers and replace with non-flammable covers

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Lessons Learned/Corrective Actions

- Address legacy fire safety issues in the Terminal Room
- Install new relays and fuses on relay coils for Access Control System relays in Terminal Rooms
- Begin transitioning from electromechanical relays to Programmable Logic Controllers (PLC) as is done in newer areas

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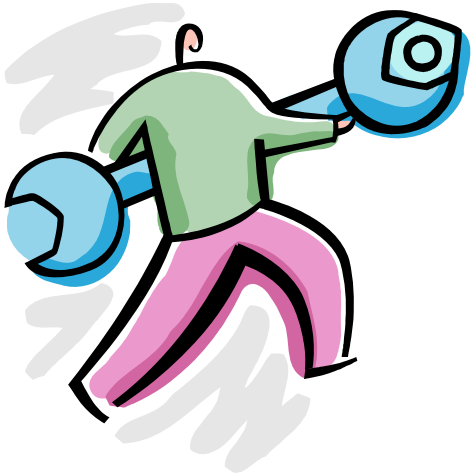
Lessons Learned/Corrective Actions

- Develop an improved procedure for surveillance, inspection and maintenance of CR120 relays; include thermal scanning (IR Camera), thermal tape readings, trending, trending criteria, visual inspection, and planned maintenance



Lessons Learned/Corrective Actions

- Establish a project with milestones to remove unused cable and all flammable wiring proximate to ignition sources in Terminal Rooms
- Establish a Laboratory Electrical Safety Committee approved program for inspection, testing and maintenance for circuit breakers

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Lessons Learned/Corrective Actions

- For events that do not trigger institutional investigation (e.g., as an ORPS would) develop a robust process for corrective action closure, objective evidence and trending
- FR LL, ask the hard question

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Resources

- Recall: GE Service Instruction Letter (SIL), SIL-NO-229 and NRC IE Bulletin 78-01, 1978
- Electric Power Research Institute (EPRI) Relay Study: Maintenance and Application Guide for Control Relays and Timers, EPRI TR102067s, 1993
- ORPS: SC--BHSO-BNL-AGS-2010-0003