IEEE Switchgear Committee Meeting
Pittsburgh, PA

Monitoring and Diagnostics for High Voltage Circuit Breakers: The Condition Monitoring Unit (CMU)

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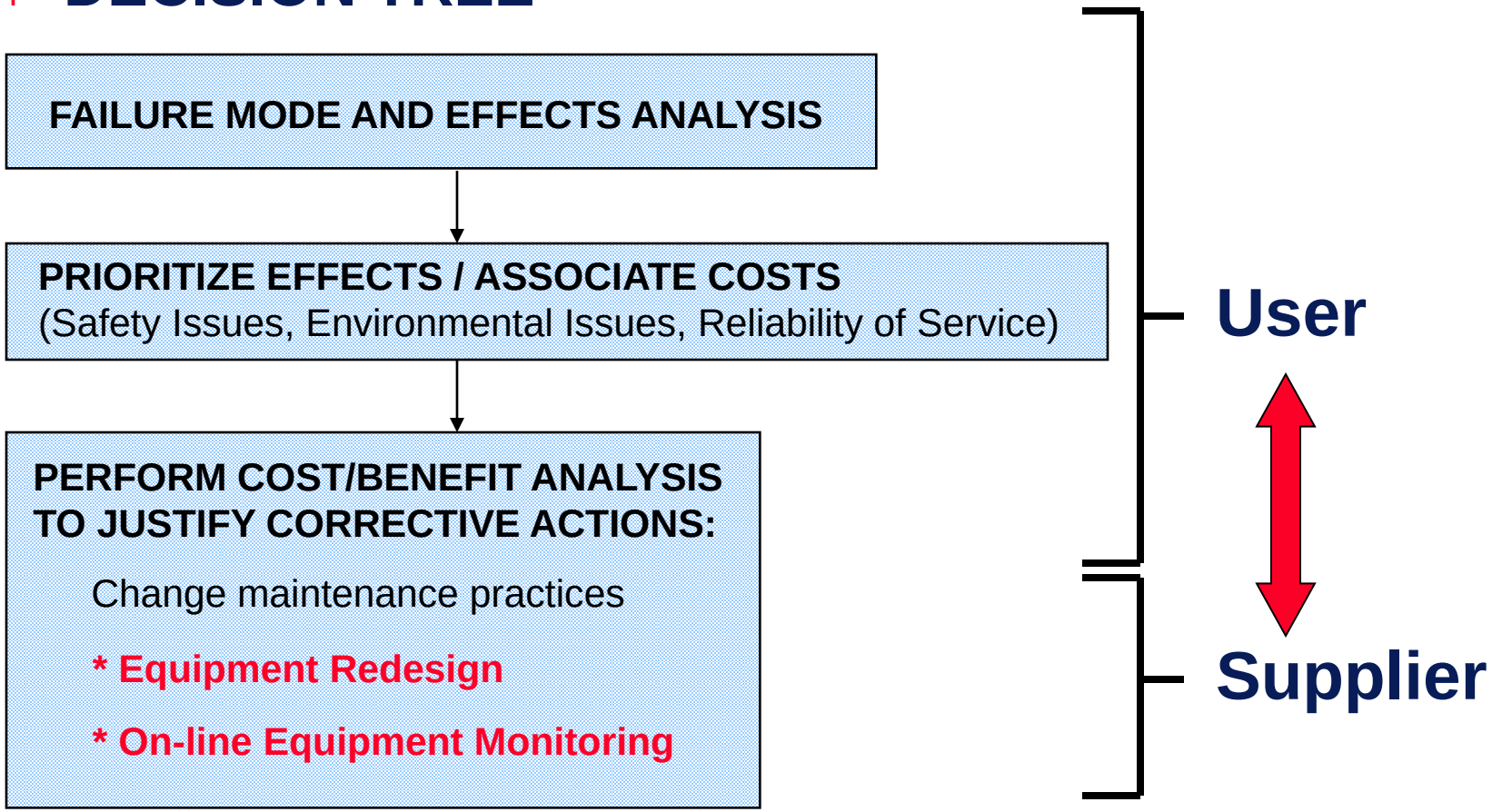
Greensburg, PA

Reliability Centered Maintenance

- Example: Commercial Aircraft Industry
  - DC 8 required 339 overhaul items, DC 10 required 7.
  - Greater than 50% reduction in spare parts inventory
  - **Cost reductions achieved with *no reduction in reliability***

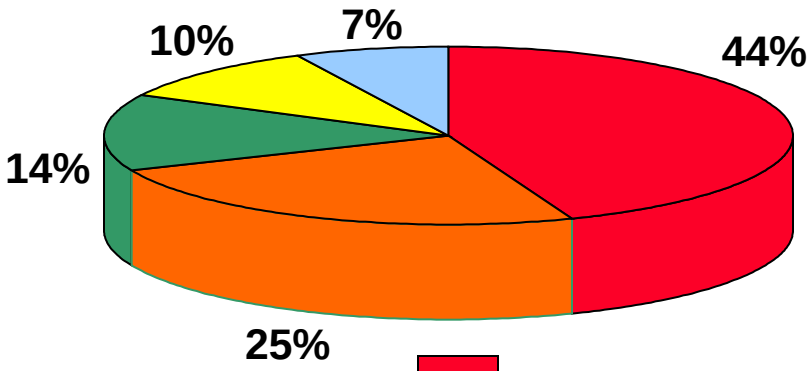
Reliability Centered Maintenance

- **DECISION TREE**

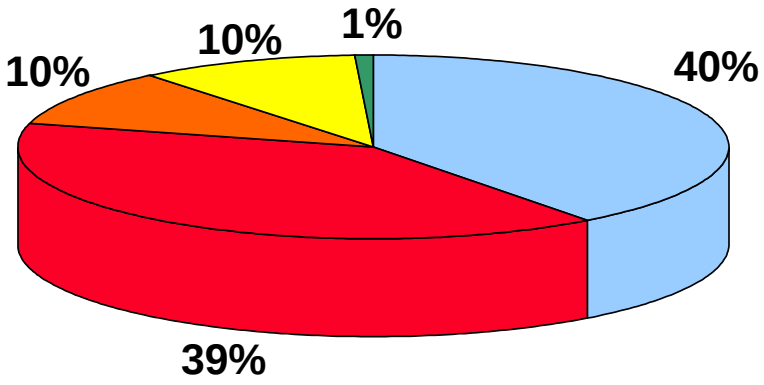


Circuit Breaker Failures

MAJOR FAILURES*



MINOR FAILURES*



Mechanical - Operating Mechanism

Mechanical - Other

Tightness of SF6 gas

Electrical - Control and aux. circuits

Electrical - Interrupter / HV insulation

*** 1994 CIGRE WG13.06 Study of HV Single Pressure SF6 Circuit Breakers**

Objectives of Monitoring

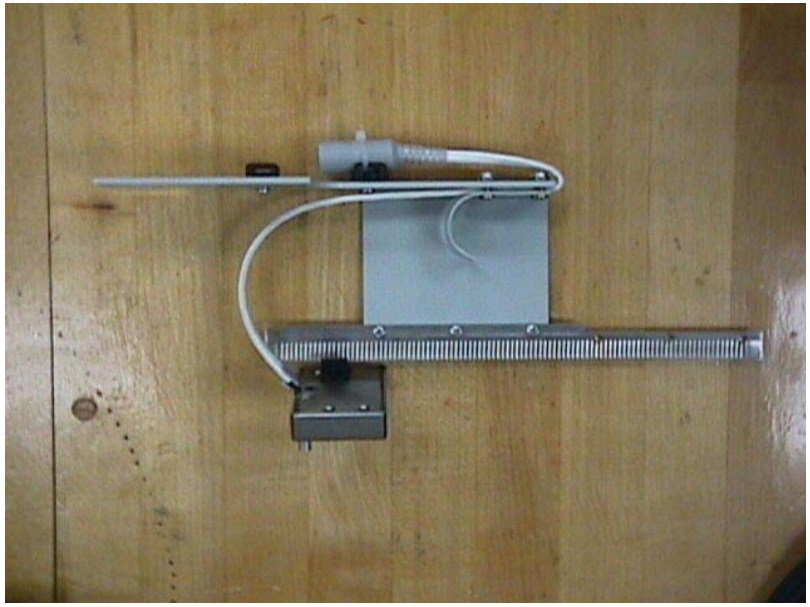
- Utilize Design Know-How To:
  - Identify impending failures (direct & indirect impacts)
  - Reduce routine maintenance
- Reduce Total Cost of Ownership

Condition Monitoring Unit

Diagnostic Feature	**Sensors (monitored quantity)**
Mechanical System Condition (operating mechanism)	Optical Travel Transducer (Operating Time, Speeds), Shunts (Charging Motor Current & Voltage)
Interrupter Condition	Secondary CT's (interrupted current, arcing time)
SF_6 Gas System Condition	Pressure sensor, Temperature sensor (SF_6 Gas Density)
Control Circuit Condition	Trip & Close Coil Availability, Heater Current Monitoring

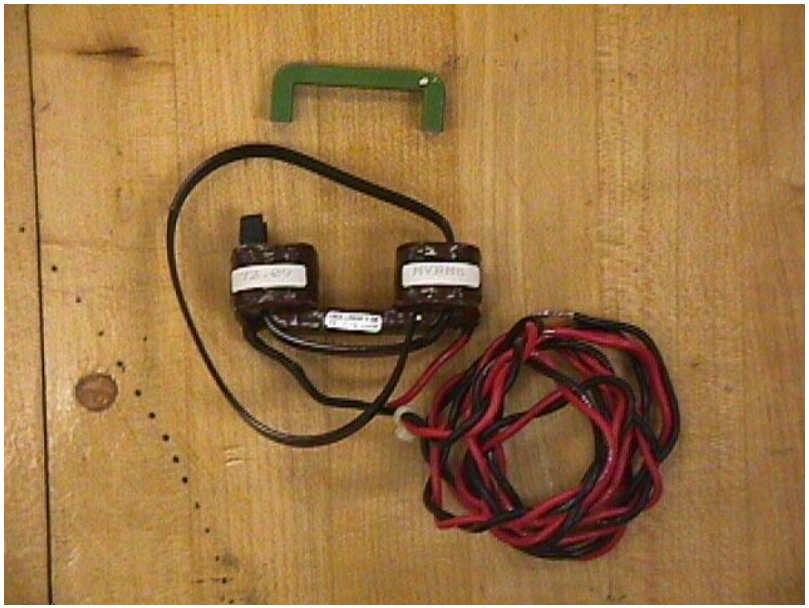
Travel Sensors

- ***Optical Sensors with Metal Comb***



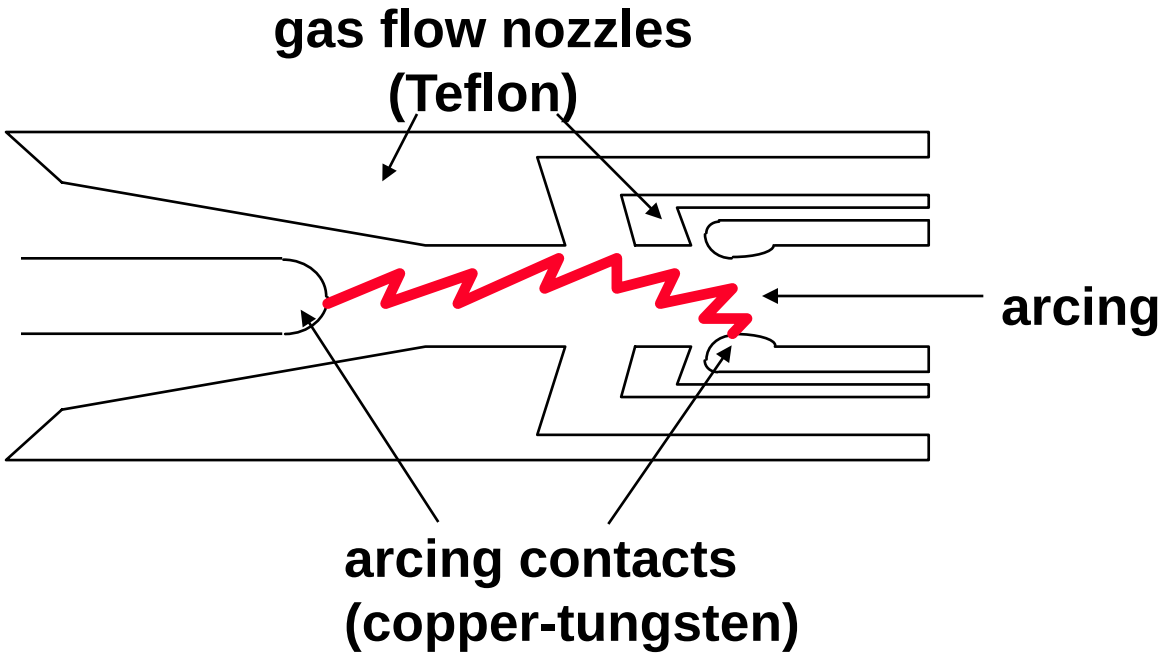
Current Sensors

- ***Split-Core: Phase Currents***
- ***Doughnut: Heater Currents***



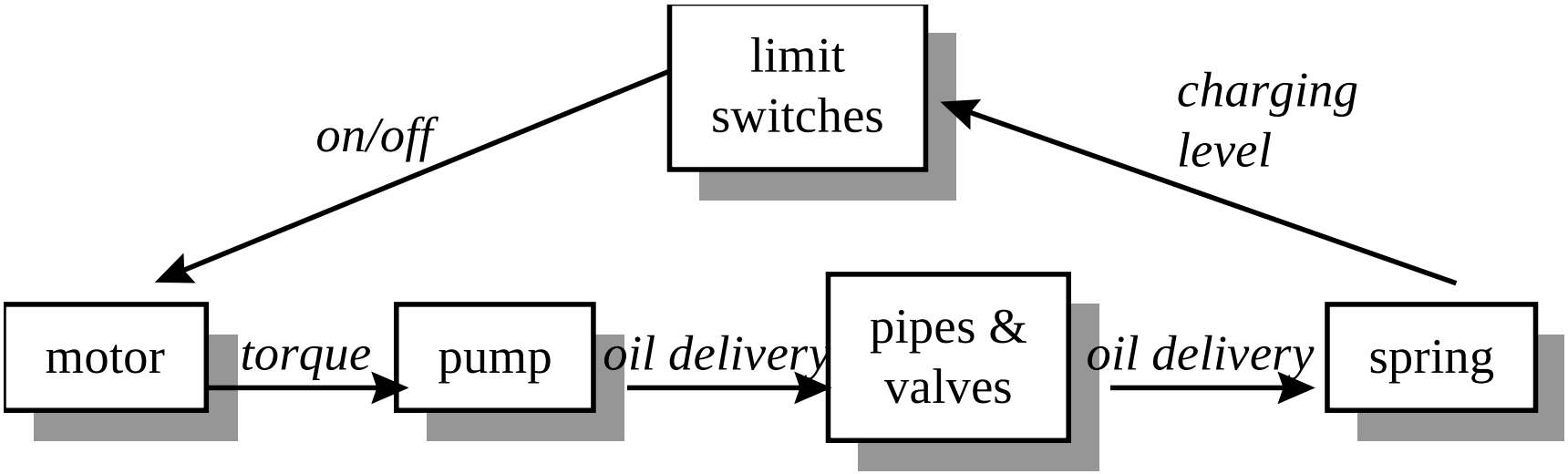
Diagnostics Approach

- ***On-line*** vs. off-line monitoring
- ***Data analysis*** vs. data collection
  - e.g. interrupter wear calculation

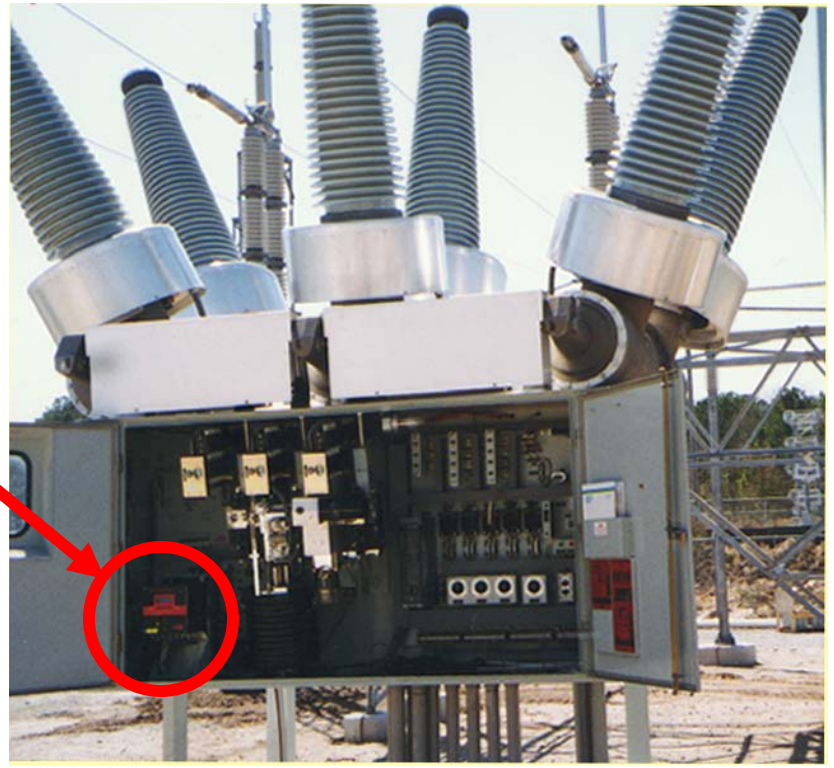


Diagnostics Approach (cont.)

- e.g. Operating mechanism charging system



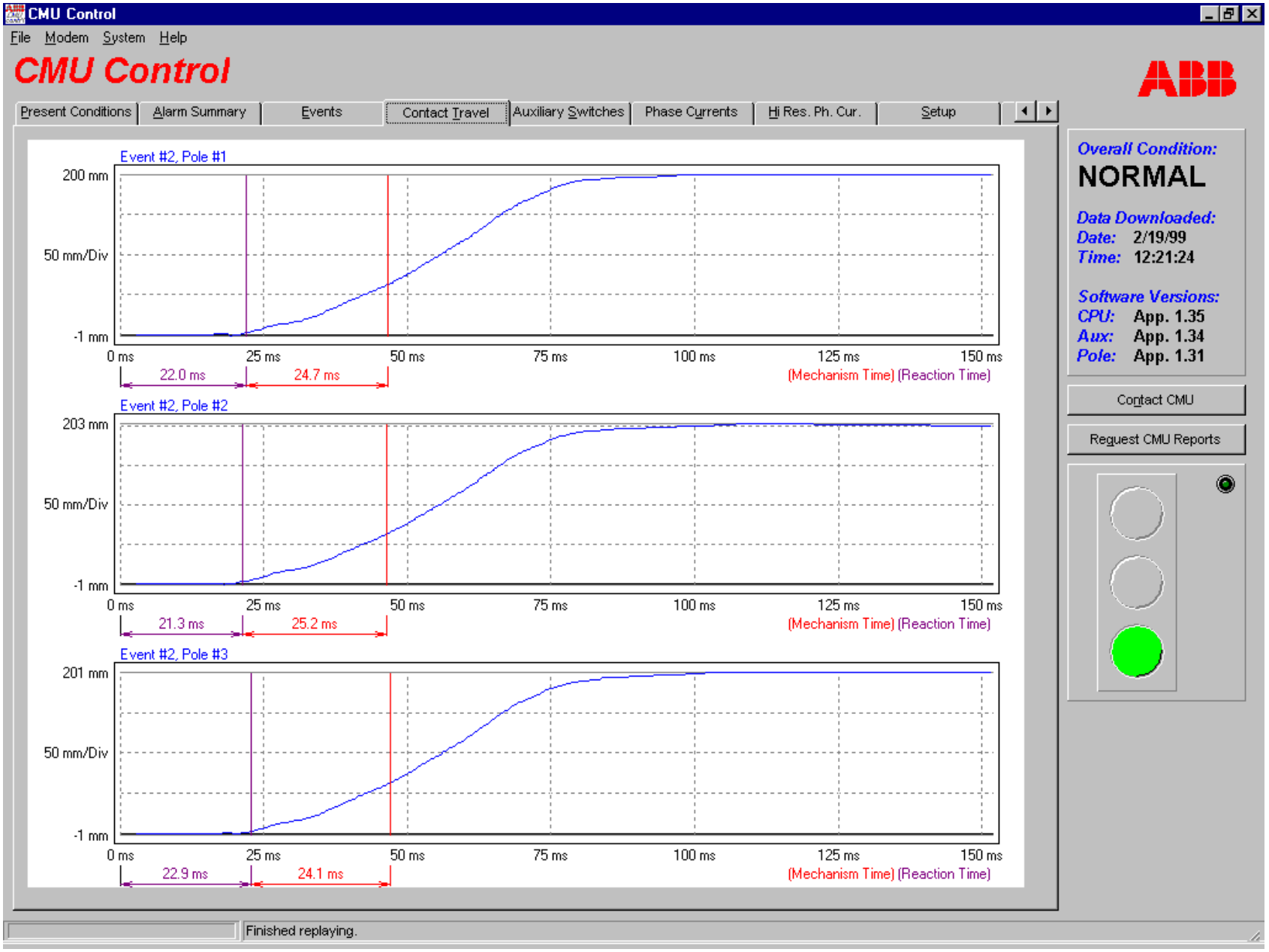
CMU Installation (<242 kV)



CMU Installation (362-550 kV)

CMUControl Software

- Graphical display of CMU data
- Modem dial-up capabilities (MODBUS for network connections)
- Automatic setpoint creation for commissioning tests
- Loading and updating CMU software


CMU Control
File Modem System Help
CMU Control
ABB
Present Conditions
Alarm Summary
Events
Contact Travel
Auxiliary Switches
Phase Currents
Hi Res. Ph. Cur.
Setup
Event #2, Pole #1
200 mm
50 mm/Div
-1 mm
0 ms
25 ms
50 ms
75 ms
100 ms
125 ms
150 ms
22.0 ms
24.7 ms
(Mechanism Time) (Reaction Time)
Event #2, Pole #2
203 mm
50 mm/Div
-1 mm
21.3 ms
25.2 ms
(Mechanism Time) (Reaction Time)
Event #2, Pole #3
201 mm
50 mm/Div
-1 mm
22.9 ms
24.1 ms
(Mechanism Time) (Reaction Time)
Overall Condition:
NORMAL
Data Downloaded:
Date: 2/19/99
Time: 12:21:24
Software Versions:
CPU: App. 1.35
Aux: App. 1.34
Pole: App. 1.31
Contact CMU
Request CMU Reports
Finished replaying.

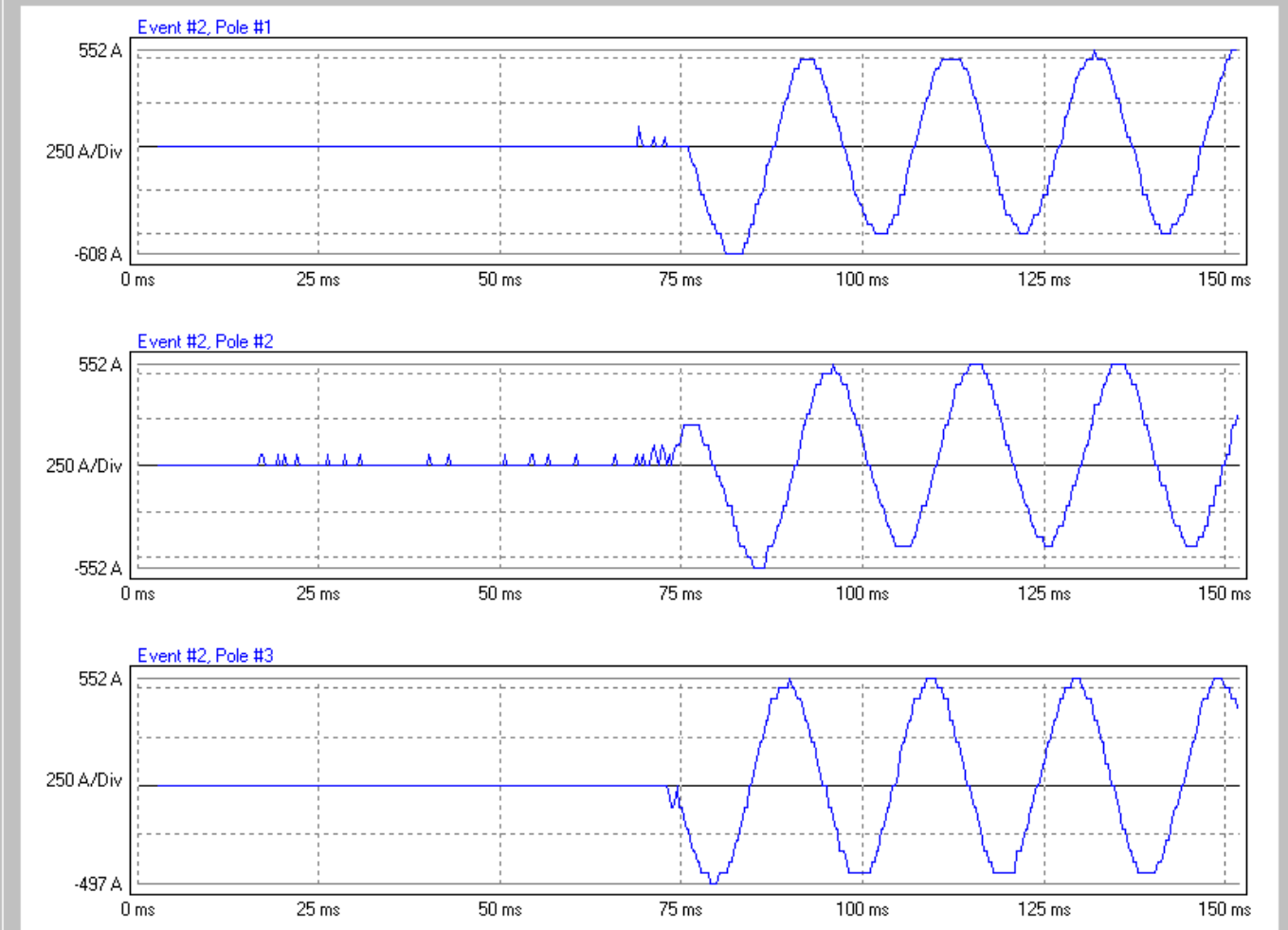
CMU Control

File Modem System Help

CMU Control

ABB

Present Conditions | Alarm Summary | Events | Contact Travel | Auxiliary Switches | Phase Currents | Hi Res. Ph. Cur. | Setup



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CMU Control

File Modem System Help

CMU Control

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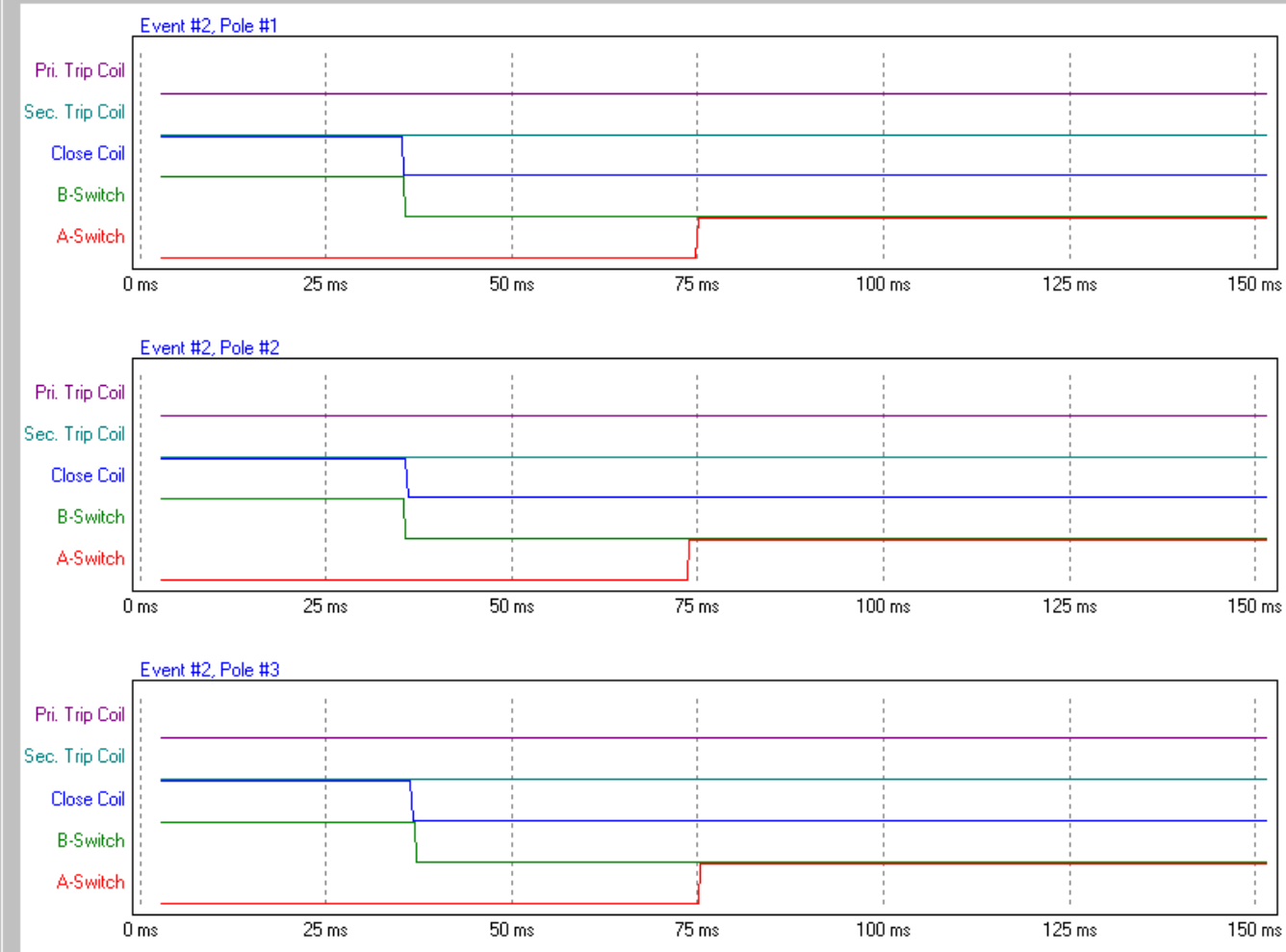

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