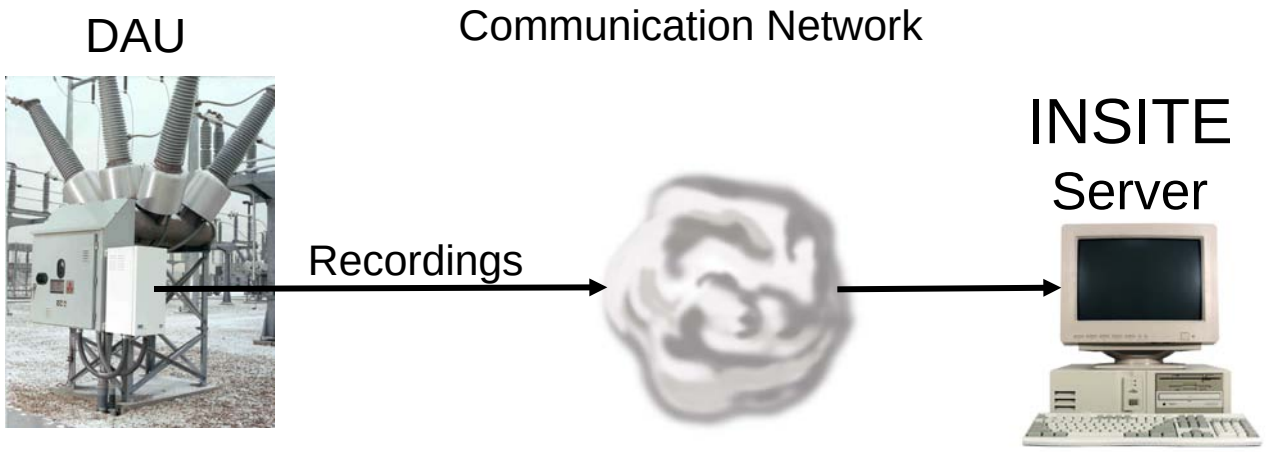
INSITE



Circuit Breakers Presentation
IEEE/PES Pittsburgh, PA
11/11/99
A. Wilson/Doble Engineering Company

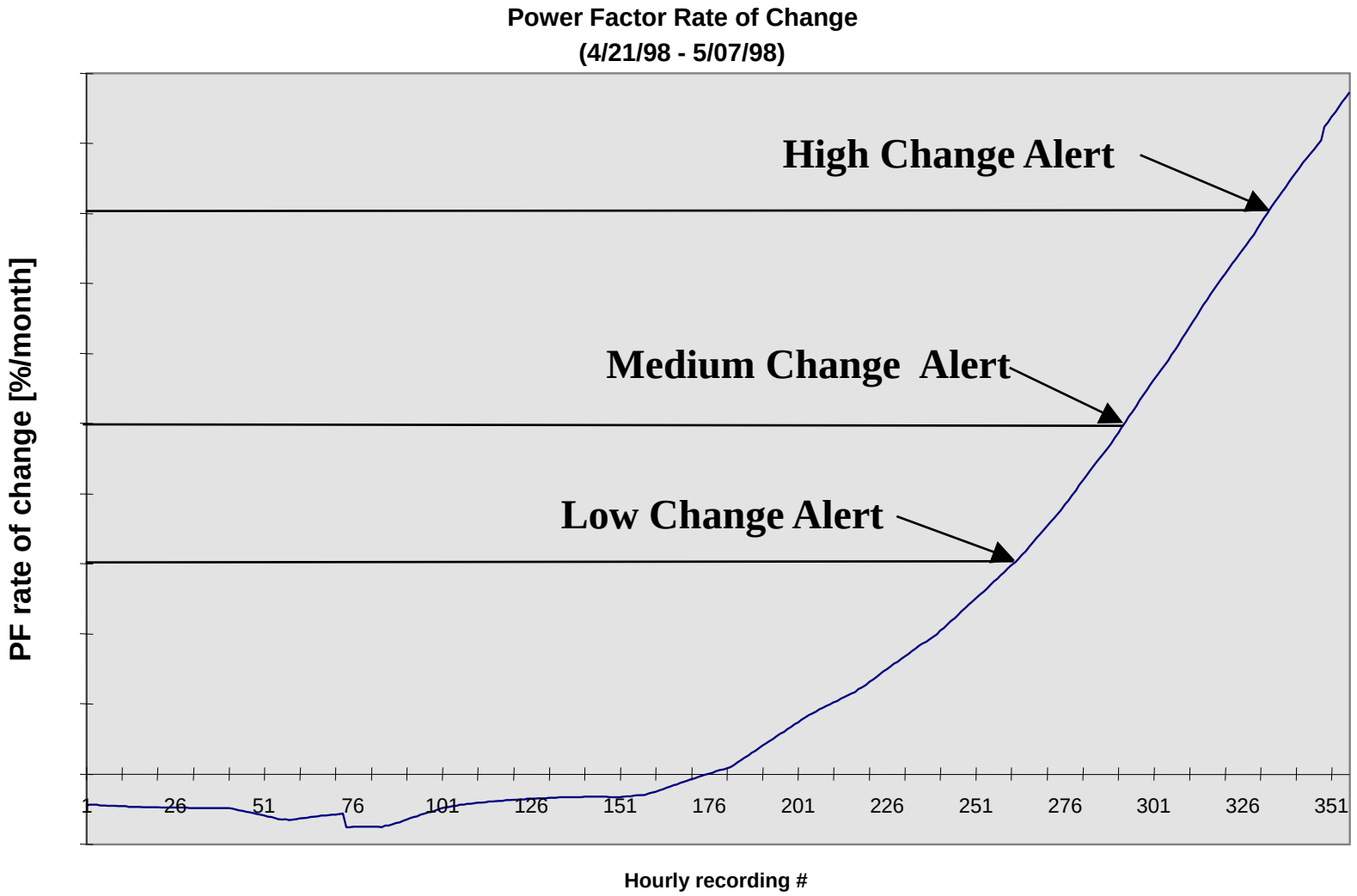
INSITE

Diagnostics For Substation Apparatus

- Circuit Breakers
- Transformers
- Bushings

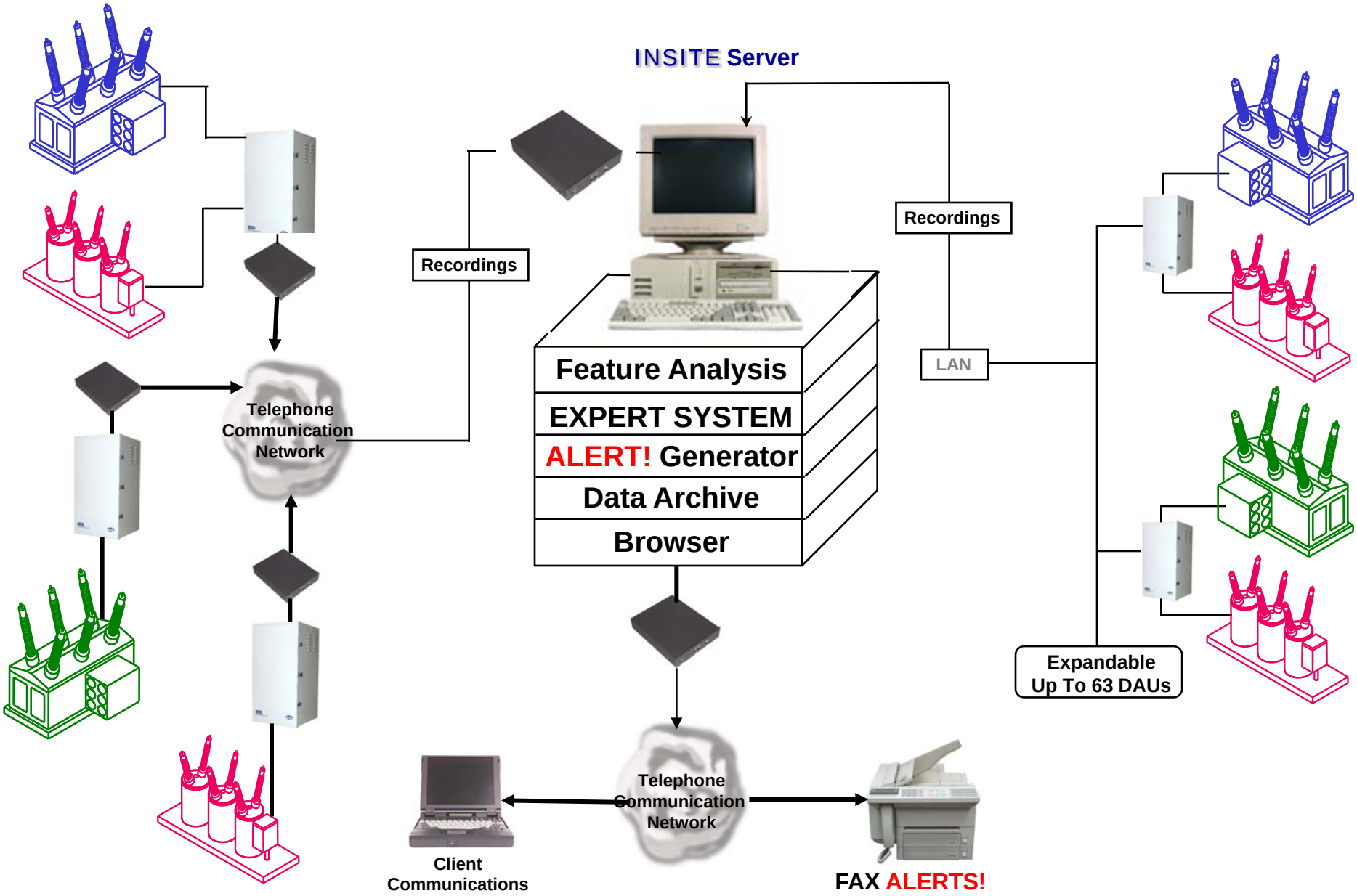
Diagnostics NOT Data

Power Factor Rate of Change



Multiple Locations-One Remote Server

One Substation-One Local Server



CIGRE Failure Analysis Study

- Control Circuits
  Major Failures - 30%
  Minor Failures - 20%
- Main Contacts
  Major Failures - 15%
  Minor Failures - 10%
- Motion
  Major Failures - 12%
  Minor Failures - 6%
- Ancillary Equipment
  Major Failures - 31%
  Minor Failures - 28%

Circuit Breaker Measurements

- Control Circuits
  52-A and 52-B Auxiliary Contact Status
  Trip and Close Coil Currents
- Main Contacts
  Trip and Close Coil Currents
  Phase Currents A,B, and C
- Insulation
  Bushings - PF and Capacitance
- Motion
  Breaker Mechanism-Total-Travel, Over-Travel, Rebound, and Velocity
- Ancillary Equipment
  Motor Current
  Pressure - SF6, Air Tank, or Hydraulic
  Heater Status
  Temperature - Ambient, SF6 Tank, or Cabinet

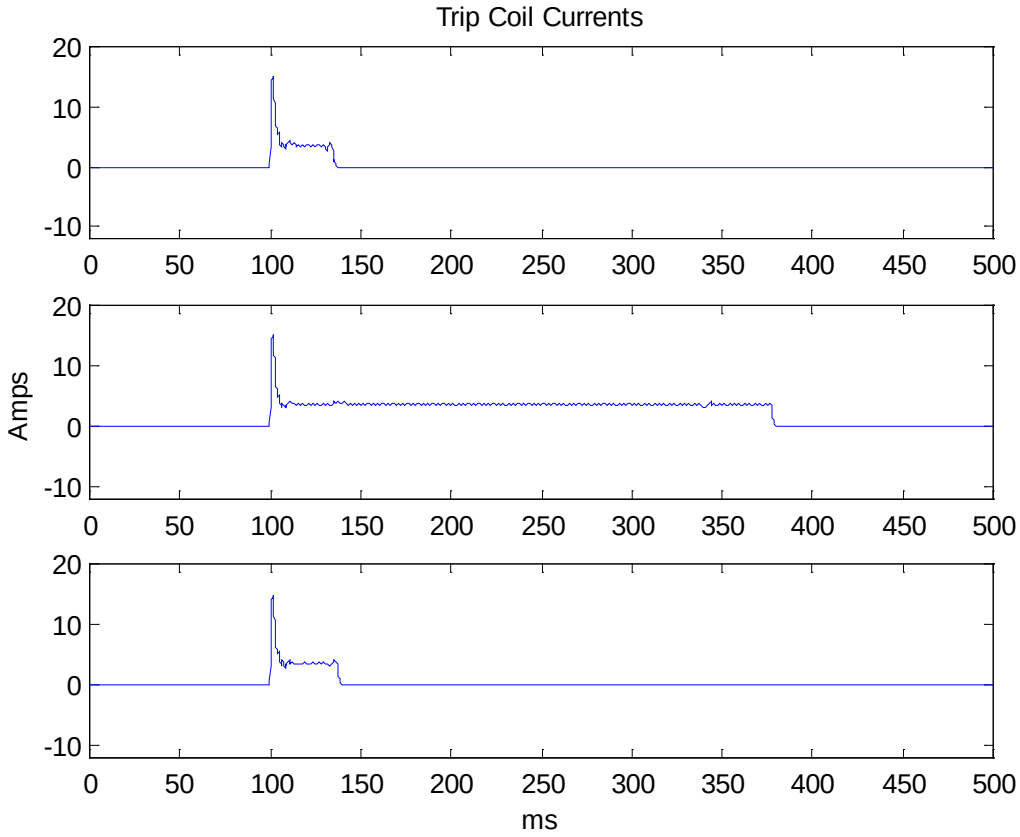
Identified Problems/Failures

- Control Circuits (2)
  Fails to Trip on Command
  Fails to Close on Command
  Control Circuit Performance
- Main Contacts
  Current Interruption/Initial Performance
  Contact Erosion
  Re-strike
- Insulation (3)
  Deteriorated Insulation
  Change in PF/Capacitance

- Motion (2)
  Mechanism Performance - Lubrication, Damping, and Binding
- Ancillary Equipment (15)
  Performance - Stored Energy, Pressure,Motor and Heaters

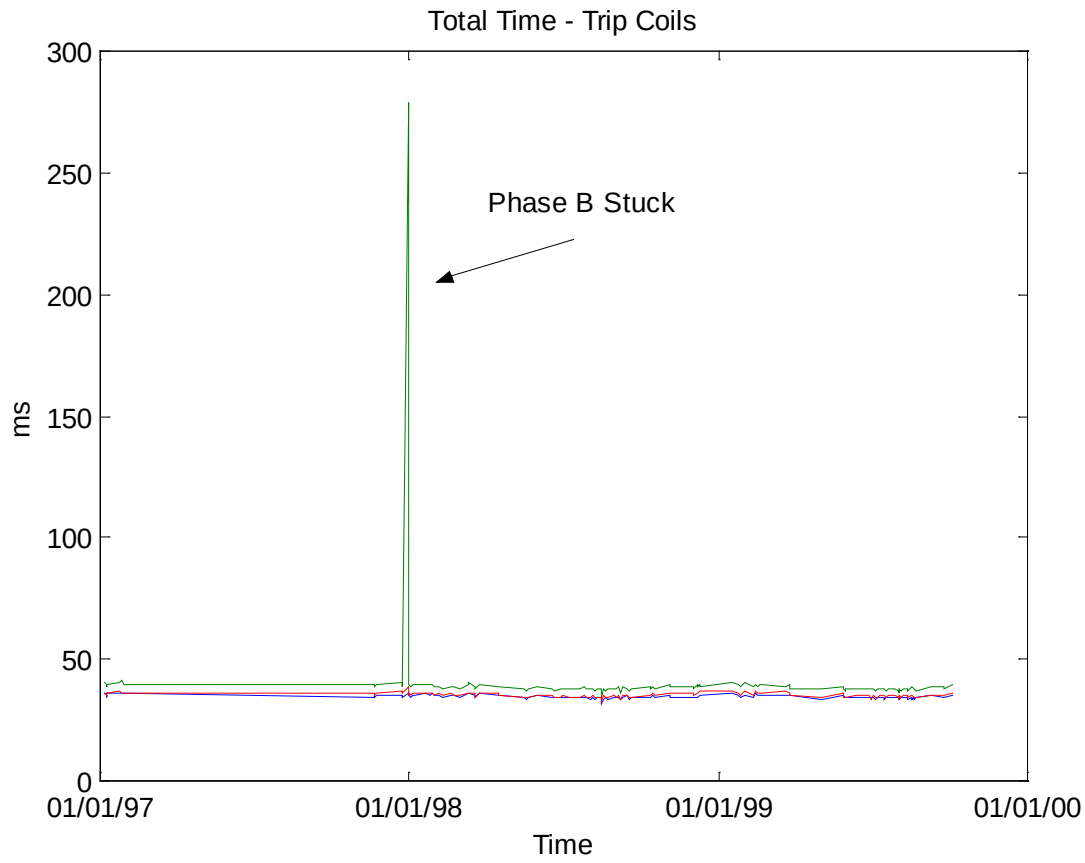
Contact Malfunction

- Breaker Type: Air-Blast Multi-Interrupter Breaker
- Four of the interrupting contacts along with the isolating contacts did not operate initially



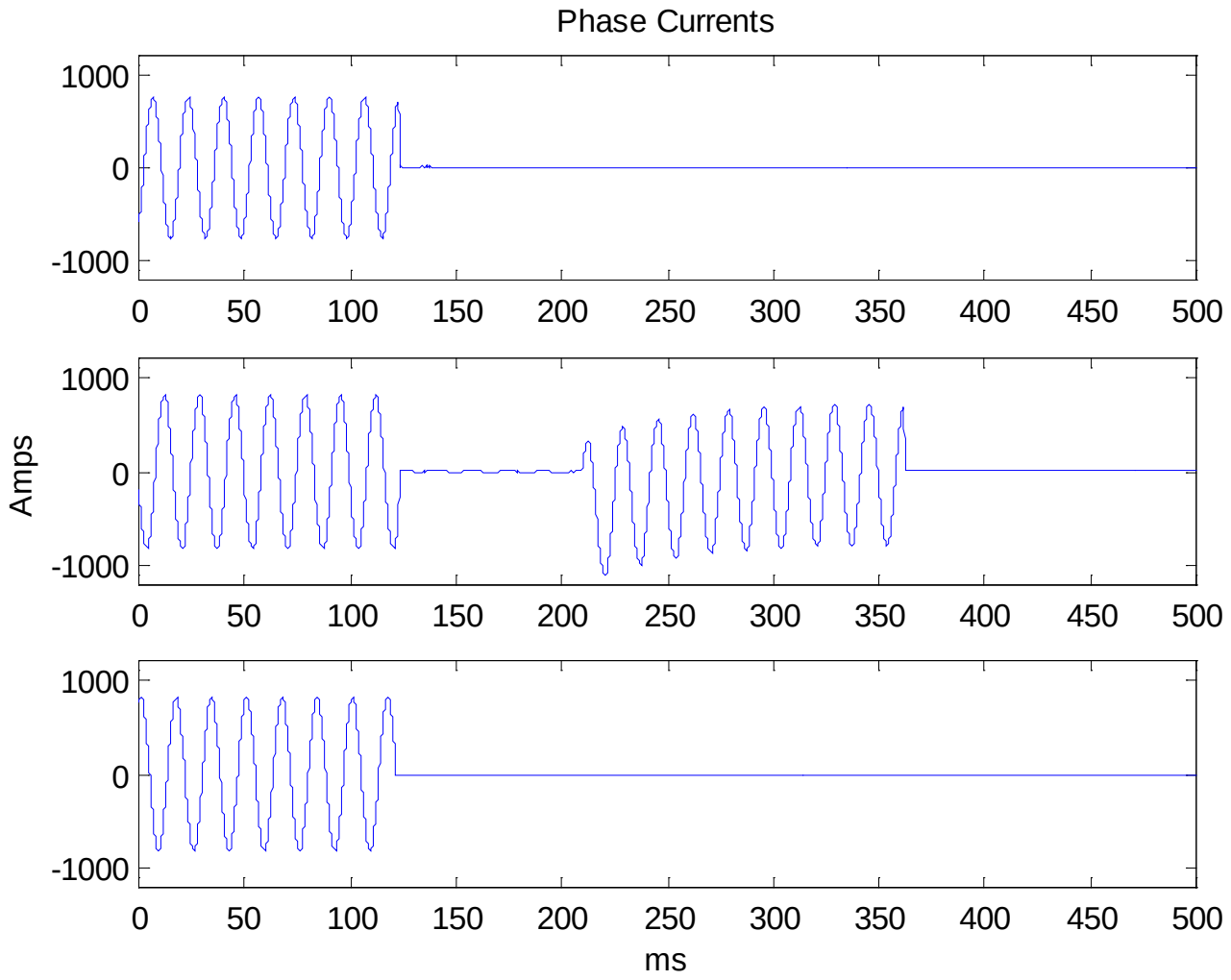
Contact Malfunction

- Total Trip Coil Time for each phase.
- 130+ operations in a 3 year period.
- The spike indicates the pole disagreement on Phase B.



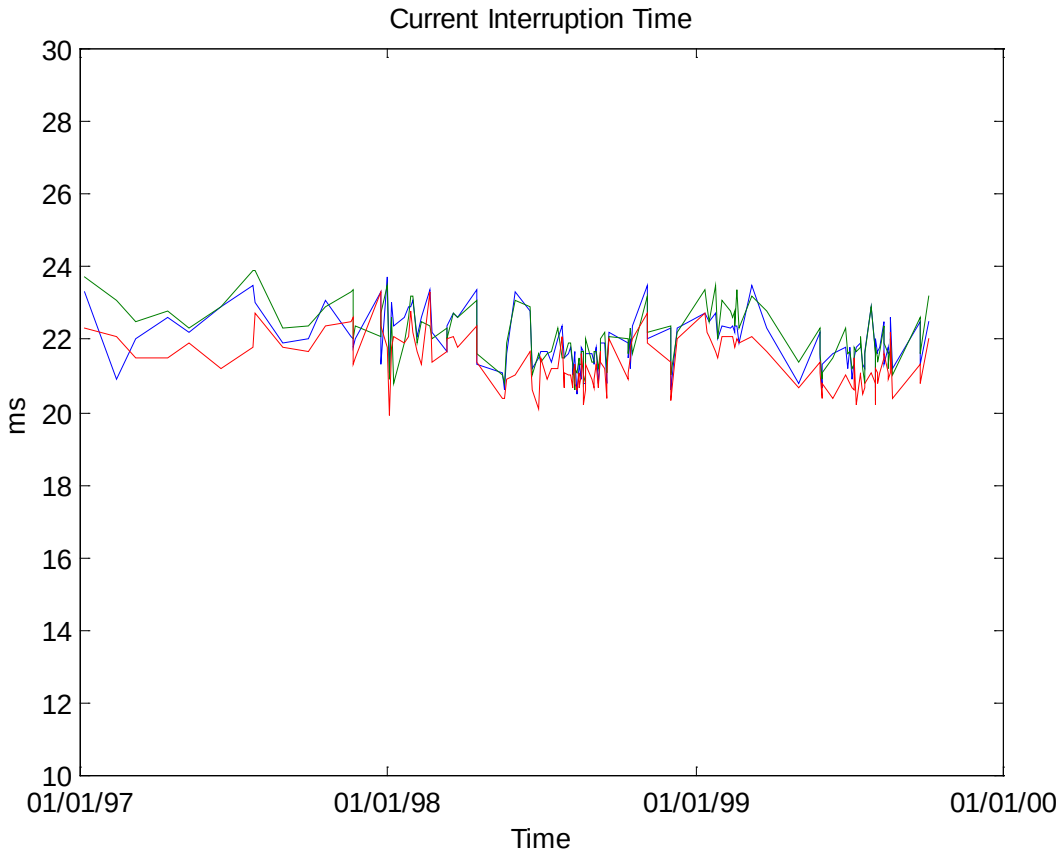
Contact Malfunction

- The trace of Phase B indicates re-ignition of current



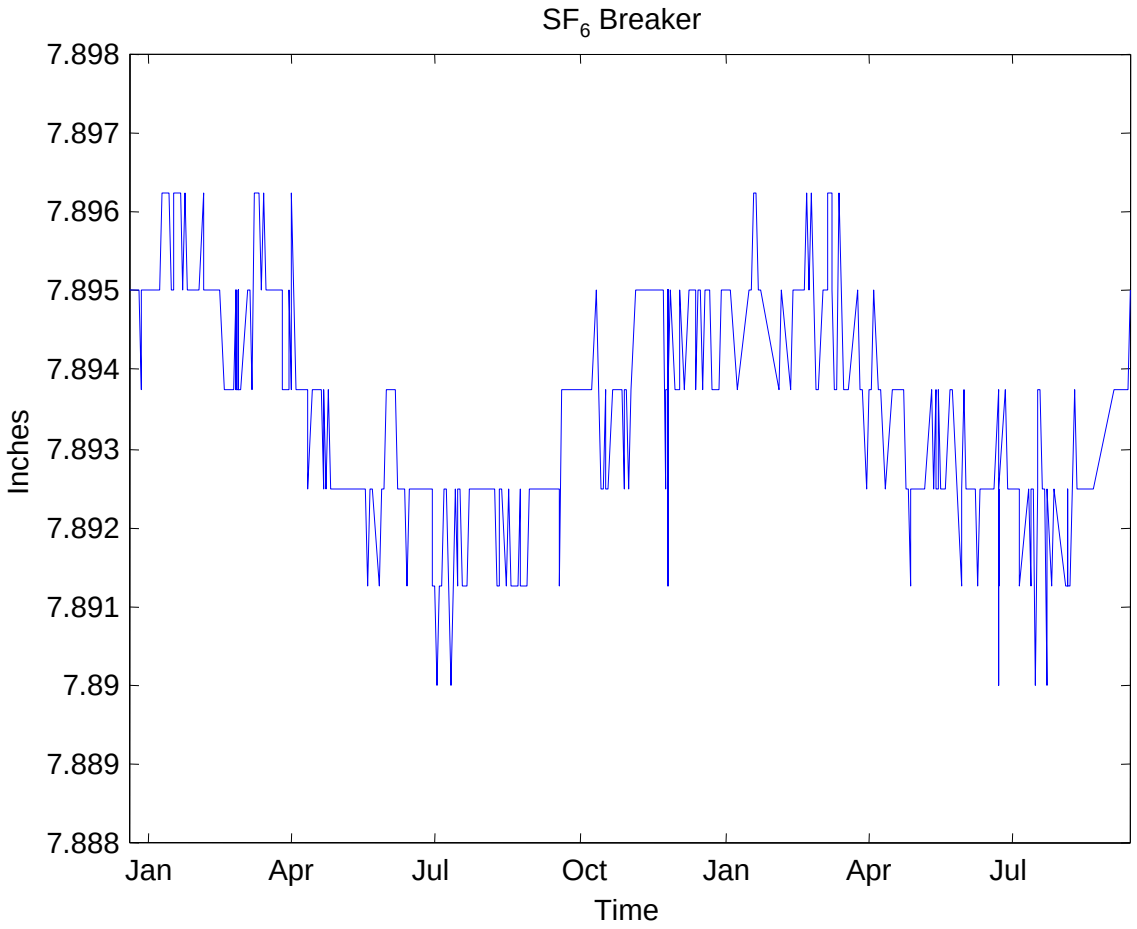
Interrupting Time of the Main Contacts

- Varies slightly with load current.
- Repeatable.
- The interrupting time did not indicate pole disagreement

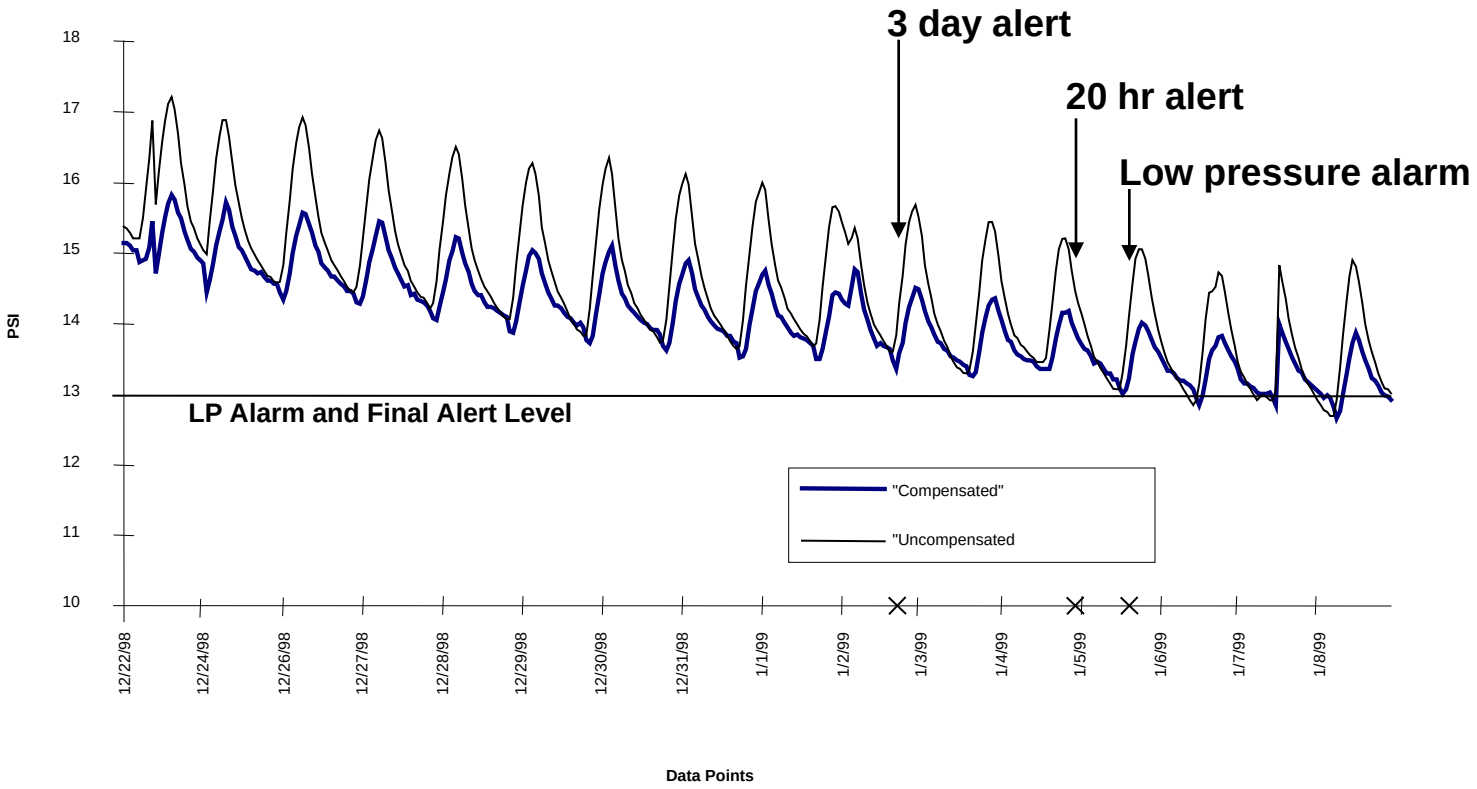


Motion

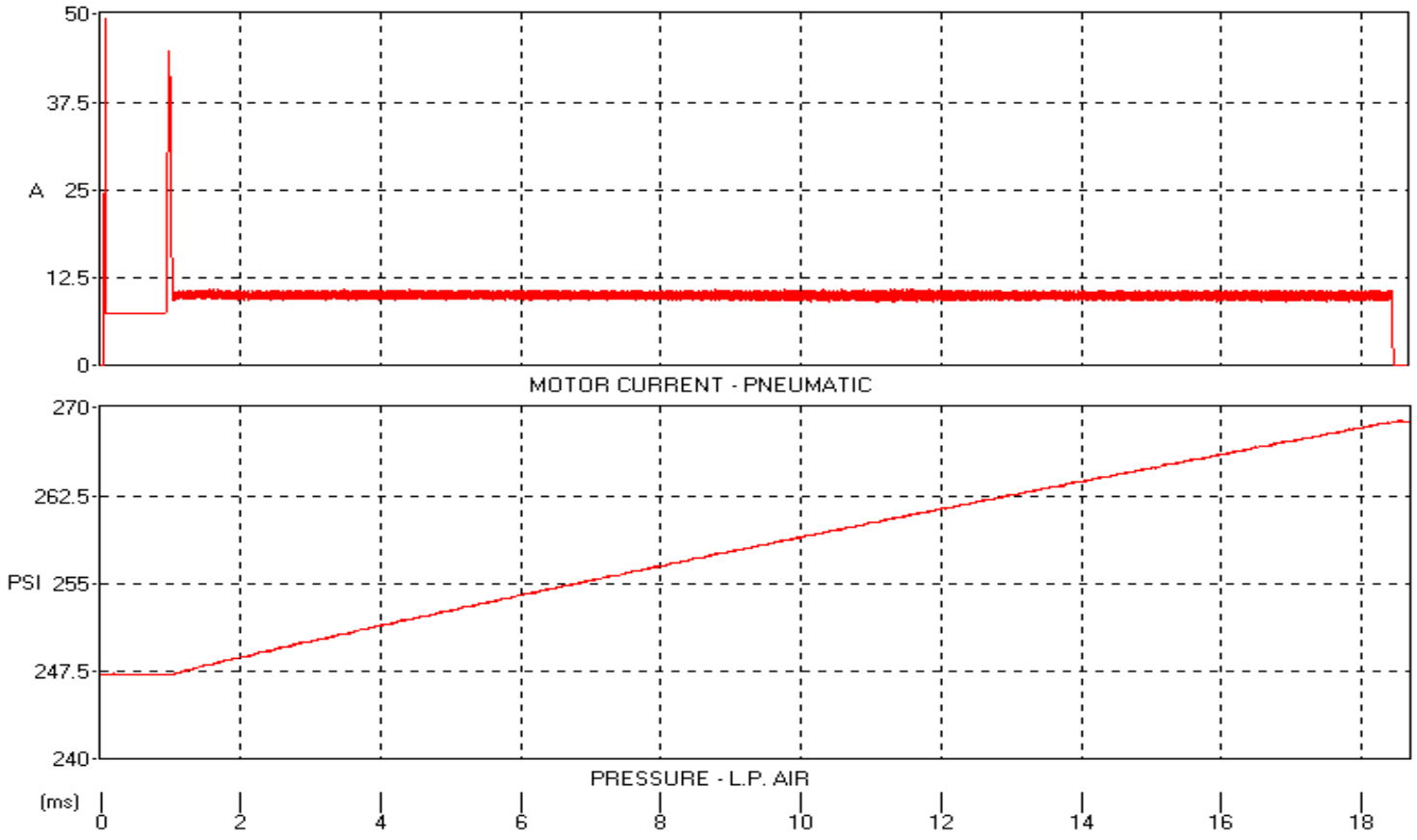
Future analysis may have to incorporate seasonal adjustments



SF6 Pressure (Hourly)



Motor Recording Belt Slipping



INSITE Diagnostics

- Linked To:
  Failure Statistics
  Reliability
  Maintenance
- Using:
  Statistics within Context of Limits
  Compensation for Operating Conditions
- To Give:
  Conditioned Based Maintenance

Conclusion

- Breakers have extremely repeatable functionality.
- INSITE sensors are robust and sensitive enough.
- Diagnostics must be focused