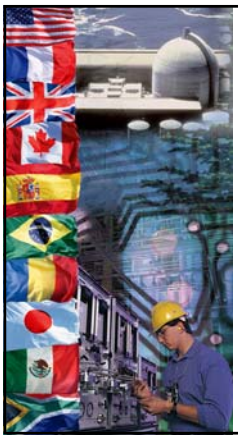


EPRI ELECTRIC POWER RESEARCH INSTITUTE

Industry Circuit Breaker Maintenance Guidance and Users Groups Activities

NRC Regulatory Information Conference
March 12, 2008
Jim Sharkey
Senior Project Manager

Presentation Overview

- History
- Industry Documents
- Failure Causes
- Good Practices
- EPRI Guidance
- The Users Groups
- How do industry groups help ensure reliability?
- Questions?
- Supplemental Material

Background - History

- 1991-1995: EPRI initial maintenance guides issued
- 1994-1996: Industry Users Groups formed around manufacturers and models with significant breaker populations
- 1996 -2001: EPRI 'supplemental' circuit breaker maintenance guides issued
- 1997
  - NEI Circuit Breaker Task Force formed
  - NRC began attending users group meetings

Background - History

- 1998; NRC Temporary Instruction (TI Inspections)
- 1998; SOER 98-02 Issued and subsequent inspections
- Nov.1998: NEI Circuit Breaker Task Force meeting
- 1999: NRC Information Notice 99-13, *Insights from NRC Circuit Breaker Maintenance Program Inspections*

Background - History

- 2000: EPRI publishes 1000014, *Circuit Breaker Maintenance Programmatic Considerations*
- 2004, NEIL Loss Control Standard: Breaker programs for critical breakers.
- 2000-2008 Users Groups continue to review OE, identify issues, and modify programs
- Breaker replacements: Ongoing

Critical Industry Documents Relating to Circuit Breaker Maintenance

- INPO SOER 98-02
  - Circuit Breaker Reliability, September 18, 1998 – Provides recommendations for maintenance programs and reliability
- NRC IN 99-13
  - Insights from NRC Inspections of Low and Medium Voltage Circuit Breaker Maintenance Programs, June 9, 1999
- EPRI 1000014
  - Circuit Breaker Maintenance Programmatic Considerations, December, 2000 – Provides programmatic and technical guidance for maintenance programs
- EPRI Circuit Breaker Guides
  - Preventive maintenance and overhaul guidance documents on model-specific circuit breakers and switchgear. (See list included)

SOER 98-02; Primary Causes for Circuit Breaker Failures

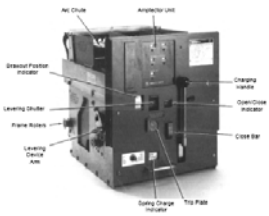
- Inadequate lubrication
- Inadequate receipt inspections
- Program deficiencies (inadequate maintenance frequencies)
- Inadequate procedures
- Ineffective monitoring of maintenance history
- Weaknesses in personnel knowledge of maintenance

Good Practices and Program Characteristics Common to NRC, INPO, and EPRI Documents

- Vendor recommendations and industry guidance considered in program / procedures
- Vendor information and communication current and included in program
- Maintenance frequencies justified if substantially different from manufacturer.
- Industry/plant OE considered in program/procedures.
- Maintenance tracked by unique identifier
- Training for operators and maintenance personnel
- Receipt inspections and root cause analysis performed
- Maintenance history monitoring

Contents of Initial EPRI Circuit Breaker Maintenance Guidelines

- Description
- Historical Performance (NPRDS; LERs)
- Maintenance Recommendations
- Routine Preventive Maintenance
- Overhaul Maintenance
- Replacement parts

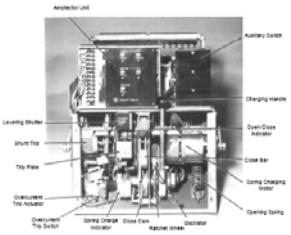


Supplemental Guidance

- Initial guidelines
  - Prescriptive, procedural-type guidance
  - Maintenance interval recommendations too prescriptive
- Supplemental guides – Less prescriptive. Provided information on **WHAT** to do, not **HOW** to do it or in what **ORDER** to do it
- Maintenance guidance in supplemental guides supersedes initial guidance

Contents of Supplemental Guidelines

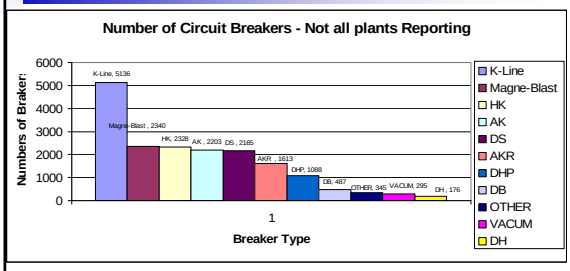
- PM and overhaul intervals
- Lubrication
- Preventive maintenance and overhaul tasks



The Circuit Breaker Users Groups

- General Electric
  - AK (Low voltage)
  - AKR (Low voltage)
  - Magne-Blast (4-15 KV)
- ABB (ITE - Gould)
  - K-Line (Low voltage)
  - HK (4-15 KV)
- Siemens
  - Wyle-Siemens Vacuum (4-15 KV)
- Westinghouse / Cutler-Hammer
  - DB (Low voltage)
  - DS (Low voltage)
  - DHP (4-15 KV)
- Square D
  - Masterpact (Low voltage)

Circuit Breakers in Service – 2002 Survey



Approximately 20,000 Circuit Breakers

Users Groups Activities

- Meetings
  - Topical presentations and maintenance program presentations
  - Operating experience review
  - Roundtable discussions
  - Discussions with the OEM / Service providers
- Workshops (TechXpert forums)
- Outside meetings
  - Website
  - E-mail network and contact list
    - Technical issue resolution
    - Benchmarking method for programs and practices

How do industry groups help ensure circuit breaker reliability?

- Overview:
  - OE Review
    - Micro-switch
    - HK Primary stabs
  - Vendor interface
  - Replacement Lessons learned - Example
  - Info network - Website

Operating Experience (OE) Review

- OE reviewed during meetings to identify potential issues and solutions
  - OE discussed typically by individual most familiar with event.
  - Problems or adverse trends can be identified.
  - Plant personnel use information to modify maintenance programs as necessary
  - Significant failures or OE is presented.
  - Vendors provide technical input or answer questions.

New Micro-switch for Magne-Blast Breakers

- Cause for various OE reports
- Identified as problem area
- Owners requested solution
- New switches designed and tested by GE

- Switches
  - Close Latch monitoring switch
  - Latch checking switch
  - Interlock Switch

ABB HK Arcing on Primary Stabs

- OE15980; Degradation of 4160 Volt Bus Work due to Inadequate PM

- Identified as problem area

- Inspection / solutions discussed in meetings and distributed via
  - E-mail
  - Newsletters
  - CD-ROM
- Information provided to INPO

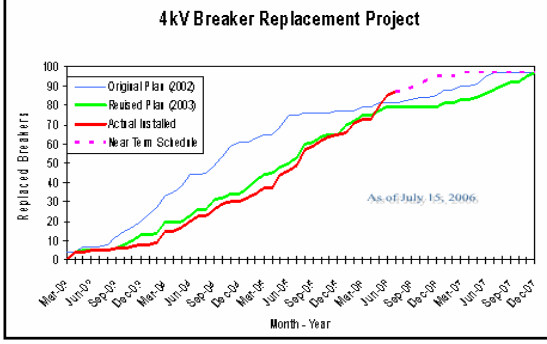
Vendor Interface

- Meetings provide the opportunity of face-to-face meetings with vendors and service providers.
  - Vendors and service providers can discuss items of interest, recent failures, or root cause evaluations, etc.
  - Vendors provide immediate responses to industry operating experience and questions posed by utility personnel.
  - Utility personnel utilize their collective leverage to discuss and resolve issues with the vendors
  - Vendors update plants on important changes in their equipment, processes and within their organizations.

Replacement Breaker Lessons-Learned

- Utility lessons-learned on replacing circuit breakers are often shared via presentations during users group meetings.
  - Specific problems with breaker-to-cubicle interfaces are identified and discussed.
  - As more and more utilities replace their breakers, there is a larger and larger body of experience and knowledge to tap into and learn from.

Example Slide from Meeting Presentation on Plant Circuit Breaker Replacement Project



Information Network

- Disseminates information and helps resolve questions
- E-mail Network:
  - Resolves technical questions
  - Resolves programmatic issues
  - Benchmarking

Circuit Breaker Users Groups Website

- Contents
  - Documents
  - Lists
  - Drawings
  - Reports
  - Issue Resolution
  - Meeting Minutes

Supplemental Material Included at End of Presentation

- SOER 98-02; Recommendations for circuit breaker reliability
- NRC IN 99-13; Insights from NRC inspections
- EPRI 1000014; Program and technical guidance
- EPRI-NMAC Initial circuit breaker documents
- EPRI-NMAC Supplemental guidance documents
- Other circuit breaker guidance produced
- Maintenance interval guidance
- Example Users Groups Activities
  - Drawings Developed
  - HK Switchgear Replacement Parts Lists

Questions ?

SOER 98-02; Recommendations for Maintaining Circuit Breaker Reliability

- Perform receipt inspections
- Verify maintenance program considers vendor recommendations, industry guidance, and OE
  - Inspection frequency
  - Station and industry OE
- Verify procedures provide adequate guidance
  - Vendor communications
  - Periodic contact with vendors – Technical info
  - Worker feedback

SOER 98-02; Recommendations for Maintaining Circuit Breaker Reliability

- Monitor maintenance history
  - Review failures
  - As-found data
  - Track maintenance with unique identifiers
  - Review history for trends
  - Perform root cause analysis
- Provide training
  - Operators
  - Technician training
  - Procedure, technical info, and OE training
  - Review training records of vendor personnel

NRC IN 99-13; Insights from NRC Inspections

- Programmatic issues
  - Vendor recommendations and OE
  - Control of lubricants
  - Maintenance tracking with unique identifiers
  - Operator training
- Preventive maintenance
  - Justification for maintenance frequency
  - Include OE in maintenance program

NRC IN 99-13; Insights from NRC Inspections

- Licensee / Vendor interface
  - Vendor contact and information current (GL 90-03); Need for substantial involvement by technically knowledgeable personnel
- Control voltage calculations
  - Calculations based on as-built
- Operating experience review
  - Rigorous OE review process performed by knowledgeable personnel.

EPRI 1000014; Program / Technical Guidance

- Considerations when developing a maintenance program
- Program documentation and oversight
- Procedures
- Receipt inspections
- Industry experience (OE)
- In-house overhaul programs
- Maintenance intervals

EPRI 1000014; Program / Technical Guidance

- Lubrication
- Training
- Quarantine procedures and root cause analysis
- Information on timing, travel, and reduced control voltage testing
- Self assessments

EPRI-NMAC Initial Circuit Breaker Documents

- NP-7410-V1-P1; ABB K-Line (ITE; Gould)
- NP-7410-V1-P2; GE AK Circuit Breakers
- NP-7410-V1-P3; Westinghouse DB
- NP-7410-V1-P4; Westinghouse DS

- NP-7410-V2-P1; ABB HK
- NP-7410-V2-P2; GE Magne-Blast
- NP-7410-V2-P3; Westinghouse DH and DHP

- NP-7410-V3; Molded Case Circuit Breakers (Superseded)

EPRI-NMAC Supplemental Guidelines

- TR-113736; ABB K-Line Routine PM
- 1000013; ABB K-Line Overhaul
- TR-109642; ABB HK Routine PM
- 1003086; GE AK / AKR Routine PM
- 1002759; GE AK 15/25 Overhaul
- TR-109641; GE Magne-Blast Routine PM
- 1000011; GE Magne-Blast Overhaul
- 1000246; Westinghouse DS Routine PM
- 1002758; Westinghouse DHP Routine PM, Rev1
- 1009832; Molded Case Circuit Breakers, Rev 2

Other Circuit Breaker Guidance Produced

- 1000014; Circuit Breaker Maintenance Programmatic Considerations
- TR-112783; Timing and Travel Analysis
- TR-112814; Reduced Control Voltage Testing of Low and Medium Voltage Circuit Breakers
- 1007912; Replacement of Medium Voltage Breakers Using Vacuum or SF6

Other Circuit Breaker Guidance Produced

- TR-104513; Field Testing of Overcurrent Trip Units used in DC Applications
- 1013457; Switchgear and Bus Maintenance Guide
- 1010984; DHP Switchgear Maintenance
- 1003089; Magne-Blast Switchgear maintenance
- 1012004; Evaluation of Cracks in ABB Arc Chutes
- 1003087; Evaluation and Testing of ABB Breakers with Mobilegrease 28

Maintenance Intervals

- Maintenance intervals should be determined on a plant-by-plant basis.
- Justification documented in plant's maintenance program.
- Manufacturers typically provide guidance on maintenance task intervals. By their own admission, this guidance represents their best generalized advice, and may include conservative (to liberal) assumptions about the circuit breaker's environment, lubrication, previous maintenance, and operational history.
- Manufacturers encourage plants to identify plant-specific considerations and modify their maintenance intervals as needed.

Maintenance Intervals

Manufacturer's manuals support this position:

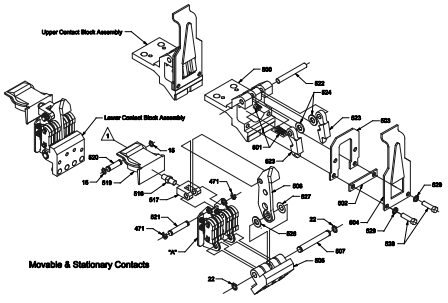
- ABB's Maintenance and Surveillance (MS) 3.2.1-9-1D states "*Suggested time frames in the program are not absolute, they represent the best generalized advice of the manufacturer . . .* "
- Westinghouse's Instruction Bulletin (I.B.) 32-253-4B states "*Because these breakers are applied in a broad variety of applications under unique combinations of environmental conditions, each having operating duty requirements that can vary widely, it is virtually impossible to outline a specific maintenance schedule which would be universally appropriate for all rating of circuit breakers in all types of applications*."

Breaker Maintenance Interval Considerations

Time-Based Maintenance

- Circuit Breakers are typically complex, electromechanical devices.
- Circuit breaker maintenance continues to be primarily time-based.
- Thermography has been used effectively on switchgear to detect hot spots, primarily on buss work, motor control centers, and panel boards.

K-Line, HK, and AKR Drawings Developed



HK Switchgear Replacement Parts List

- HK Switchgear Replacement Parts List and recommendations