EPRI ELECTRIC POWER RESEARCH INSTITUTE

EPRI In a nutshell – and EPRI's new research into the area of Circuit Breakers

Luke van der Zel
EPRI – Power Delivery and Markets

Presentation Overview

- Thank you IEEE
- The 4 main ways EPRI operates
- EPRI's new Circuit Breaker research
  - How we started the program
  - Project 1: Refurbishment/Replacement Methodology
  - Project 2: Using protection for Circuit Breaker diagnostics
- EPRI and IEEE collaboration

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The 4 main ways EPRI operates

EPRI Facts

- Collaborative R&D
- Non-Profit
- 33-year history
- 450 participants in over 40 countries
- 66 technical programs
- 1600+ research and demonstration projects annually
- 10 to 1 average funding leverage

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Extensive Technology Portfolio




Generation & Distributed Resources

- Environmental Controls
- Major Component Reliability
- Combustion Turbines
- Maintenance, Operations and Workforce
- Advanced Coal Plant Portfolio
- Distributed and Renewable Generation Resources
- Generation Planning: Economics and Fuels

Nuclear Power

- Material Degradation/Aging
- High Performance Fuel
- Radioactive High-Level Waste & Spent Fuel Management
- NDE & Material Characterization
- Equipment Reliability
- Instrumentation & Control Hardware and Systems
- Nuclear Asset-Risk Management
- Safety/Risk Technology & Application
- New Nuclear Plant Deployment
- Environmental Benefits
- Low-Level Waste & Radiation Management

Power Delivery & Markets

- Strategic Initiatives
- Security
- Power Markets & Risk
- Assets, Planning & Operations
- Power Quality
- Transmission Reliability & Performance
- Distribution Reliability & Performance
- Electric Transportation and Energy Utilization
- Enterprise Asset Management

Environment

- Air Quality
- Global Climate Change
- Land & Groundwater
- Water and Ecosystems
- EMF Health Assessment and RF Safety
- Occupational Health and Safety

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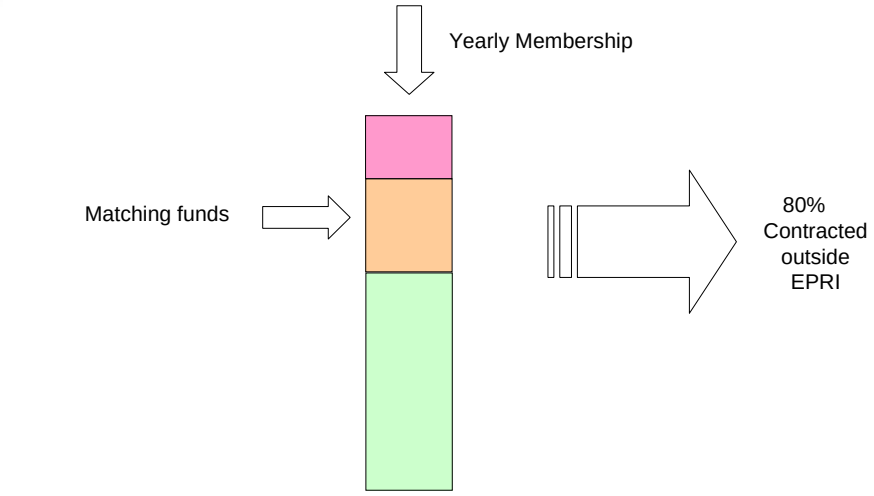
Funding Inputs into EPRI



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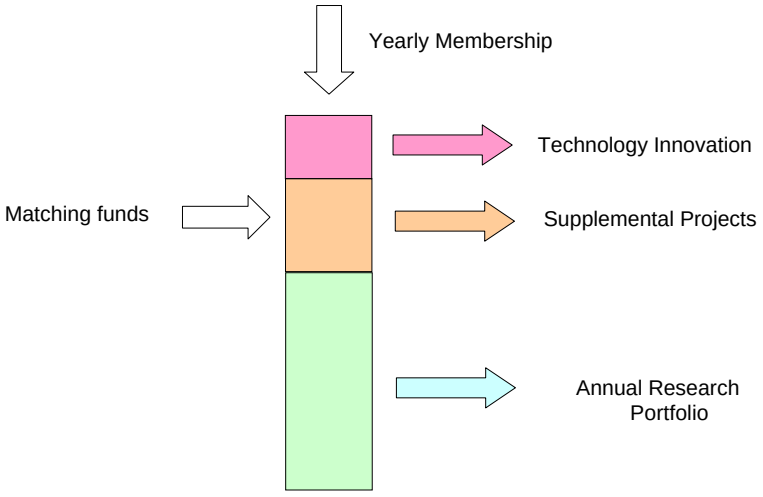
Research outputs from EPRI



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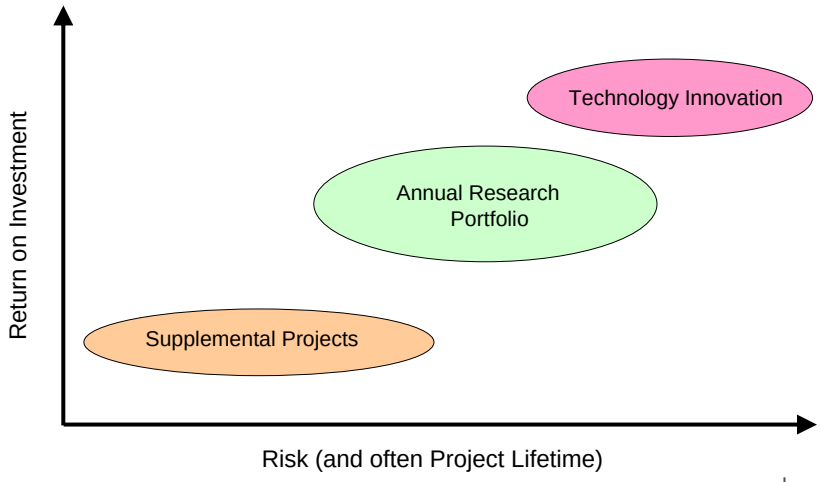
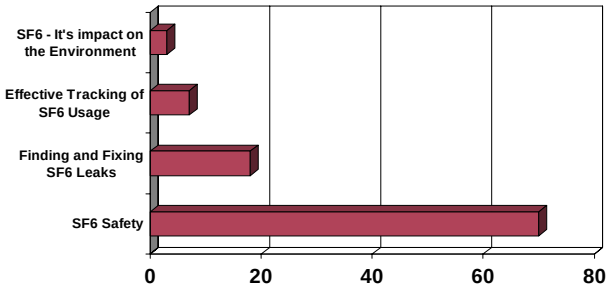
EPRI's Research Portfolio



Supplemental Example: SF_6 Training and Reference



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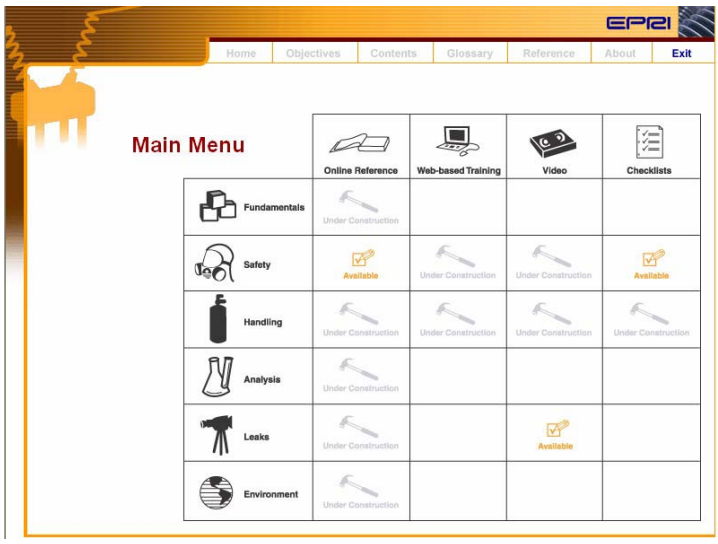

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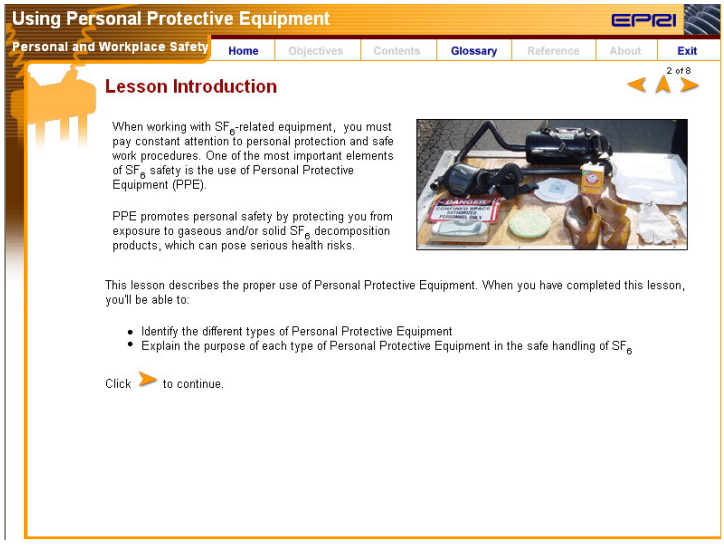

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Detecting Leaks with the SF_6 Camera

Detecting Leaks

Home | Objectives | Contents | Glossary | Reference | About | Exit

Detecting Leaks with the SF_6 Camera

1 of 2

The video at right demonstrates how a laser imaging system allows gases to be seen on a TV monitor.

Click the Play (right arrow) button above to view the video clip.

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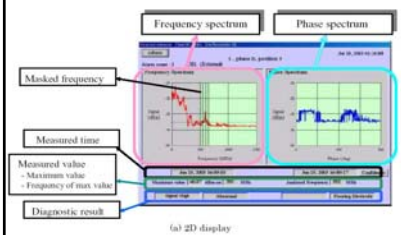
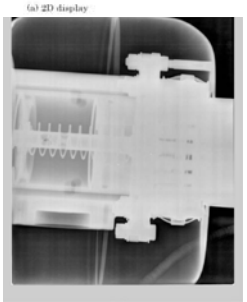
Supplemental Project example: GIS Monitoring tools and Techniques





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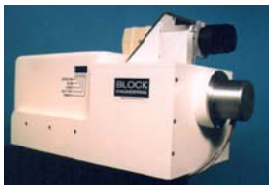
Supplemental Project example: GIS Monitoring tools and Techniques

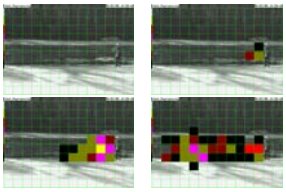


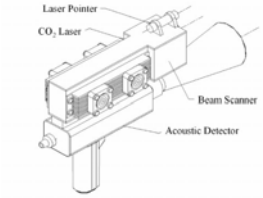


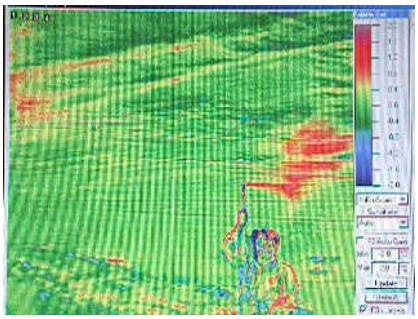
500
450
400
350
300
250
200
150
100
50
distance (m)
RCB
RD
CB1
CB2
CCB
antenna array

Annual Research Portfolio Example: SF_6 Research technolgies investigated









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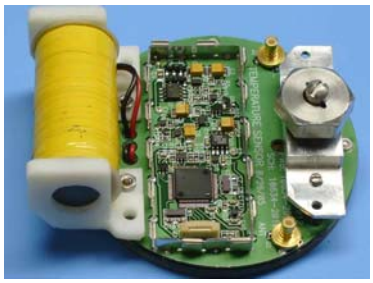
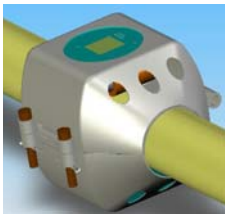
Technology Innovation Example: Wireless Battery-less sensor research





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EPRI's new Circuit Breaker research program

Starting a focused research area in Circuit Breakers

Group all CB research in EPRI

Funded a hard look at member needs

Execute the highest priority research needs

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Some snippets of past EPRI Circuit Breaker research

- 1980-Present: Life Extension Guidelines
- 2000- present: SSCL
- 2001: Reliability Centered Maintenance (RCM) Technical Reference for Power Delivery
- 2002-2005: Integrated Monitoring and Diagnostics: Maintenance Ranking and Diagnostic Algorithms for Circuit Breakers
- 2002: The Management of SF6 (Sulfur Hexafluoride) Leakage
- 2003: UHF and AE Condition monitoring tools for GIS (and possibly outdoor and Hybrid breakers)
- 2004: Oil Analysis as a Diagnostic Tool for Circuit Breakers

Ranking of candidate topics (Matched by voting by member dollars)

PROJECT	High	Medium	Low
Candidate 1 – End Of Life Model	7	1	
Candidate 2 - Risk-based Replacement Decision Support	7	1	
Candidate 3 - Health Index	6	2	
Candidate 4 - Establish Benefits of Using Available Data	3	4	
Candidate 5 - SF_6 Guidelines		1	7
Candidate 6 - RCM FMEA		2	6
Candidate 7 - Breaker Industry Database Model	2	4	3
Candidate 8 - Replacement Parts Methodology	2	1	6
Candidate 9 - Collect and Catalogue Best Practices		6	2

Ranking of candidate topics

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Candidate 1 – End Of Life Model	7	1	
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Candidate 7 - Breaker Industry Database Model	2	4	3
Candidate 8 - Replacement Parts Methodology	2	1	6
Candidate 9 - Collect and Catalogue Best Practices		6	2

Candidate 1- EOL Model

- **Objective:** Develop a practical and ***affordable*** circuit breaker end-of-life model, to support decisions related to circuit breaker replacement or refurbishment.
  - Identification of factors and information, which should be included in the decision support model.
  - Relate information available to appropriate EOL factors for circuit breakers, with the application of appropriate factor values and weightings.
  - Apply the model to sample groupings of representative circuit breaker populations and perform a sensitivity study
- Probability of technical success: **High**
- Number of utilities to which applicable: **High**
- Project length: **Estimated 9 - 12 months** (usable results)

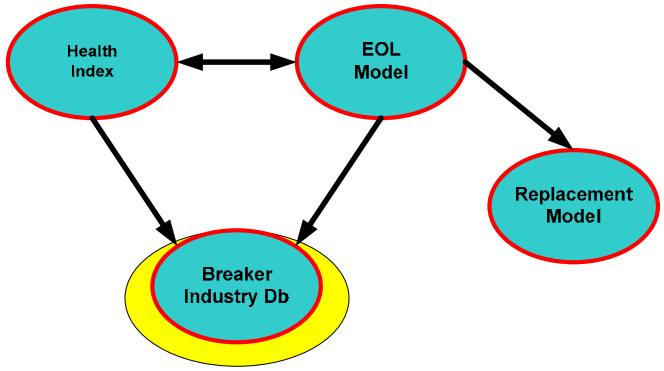
Candidate 2 – Risk-based Replacement Decision Support

- **Objective:** Compliment EOL model with a customizable risk-based business case analysis tool for circuit breaker replacement.
- Assist in risk-based analysis of various business scenarios and factors, taking into account safety, financial, reliability, business and regulatory drivers and factors.
  - Identify KPIs and measures,
  - Customize the weighing of each measure in accordance with utility's business, financial and regulatory drivers/environment
  - Identify the business cases to be considered
- Probability of technical success: **High**
- Number of utilities to which applicable: **Medium**
- Project length: **Estimated 9 - 12 months**

Candidate 3 - Health Index

- **Objective:** Develop a Circuit Breaker "Health" or "Action" Index
  - Develop a set of criteria which would contribute to a health index "score"
  - Establish appropriate weightings for each criterion, and establish which values would require action
  - Establish process for evaluation
- Probability of technical success: **High**
- Number of utilities to which applicable: **High**
- Project length: **Estimated 9 - 12 months**

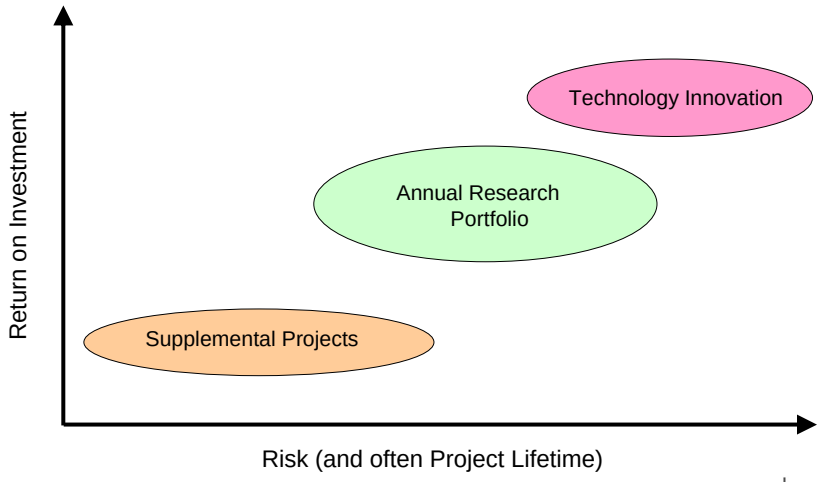
Project Synergies



Research and demonstration of the appropriate use of new microprocessor relays for circuit breaker monitoring

- Task 1: Literature Review
- Task 2: Member needs assessment
- Task 3: Detailed Research into the specific needs addressed by the members
- Task 4: Laboratory Demonstration
- Task 5: Identify data management issues
- Task 6: Task Force and Webcast participation
- Task 7: Final Report

What are we missing ?



Feedback from IEEE Monday presentation

1. Develop and document a practical methodology for circuit breaker replacement and refurbishment decisions
   - The work could provide a helpful summary of methodologies
   - The project could benefit from more input from field and equipment staff
2. Research and demonstration of the appropriate use of new microprocessor relays for circuit breaker monitoring
   - Breaker contact wear monitoring should be set as a low priority compared to mechanism issues
   - A simple timing limit to quantify a slow trip may be a valuable starting point
   - A number of members have gathered data from relays – but haven't seen the value yet. ***There is thus an important gap to bridge to determine how to convert the data into information***.