



Update on IEEE/NFPA Collaboration on Arc Flash Research and Testing

Presenters

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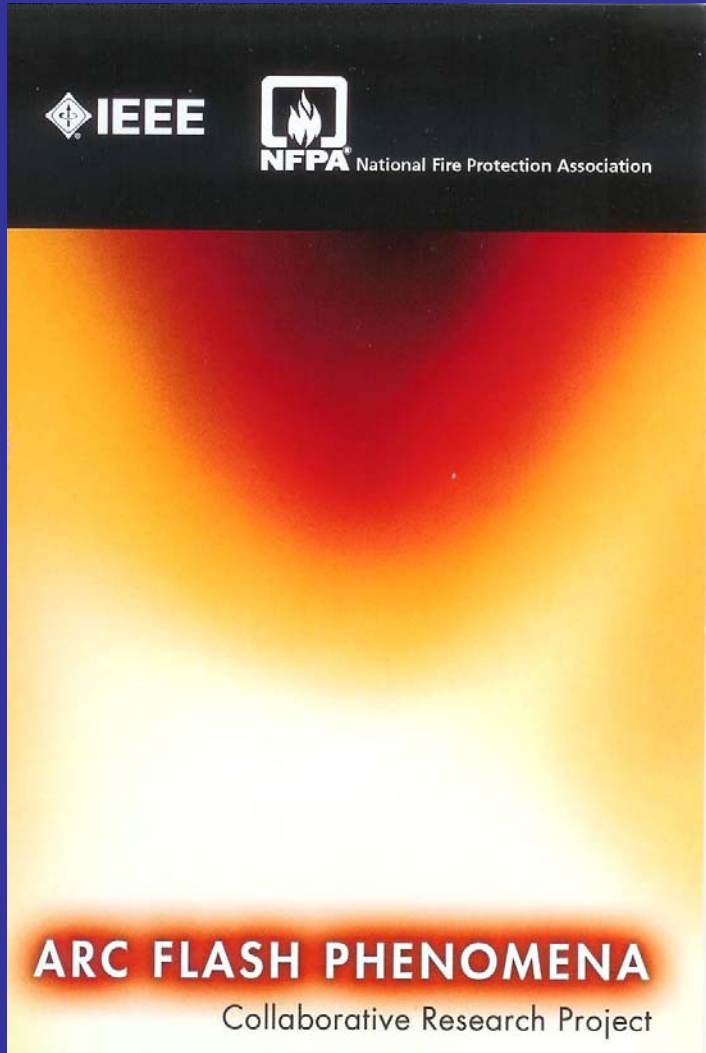
Colorado School of Mines



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Introduction



- This Collaborative Initiative supports Research and Testing to increase the understanding of various aspects of Arc Flash Phenomena.
- The effort brings together two organizations (IEEE and NFPA) that have been instrumental in the advancement of the Electrical Safety culture.

Introduction



- Research Areas
 - Heat and Thermal Effects
 - Blast Pressure
 - Sound
 - Toxicity
 - Electromagnetic Radiation

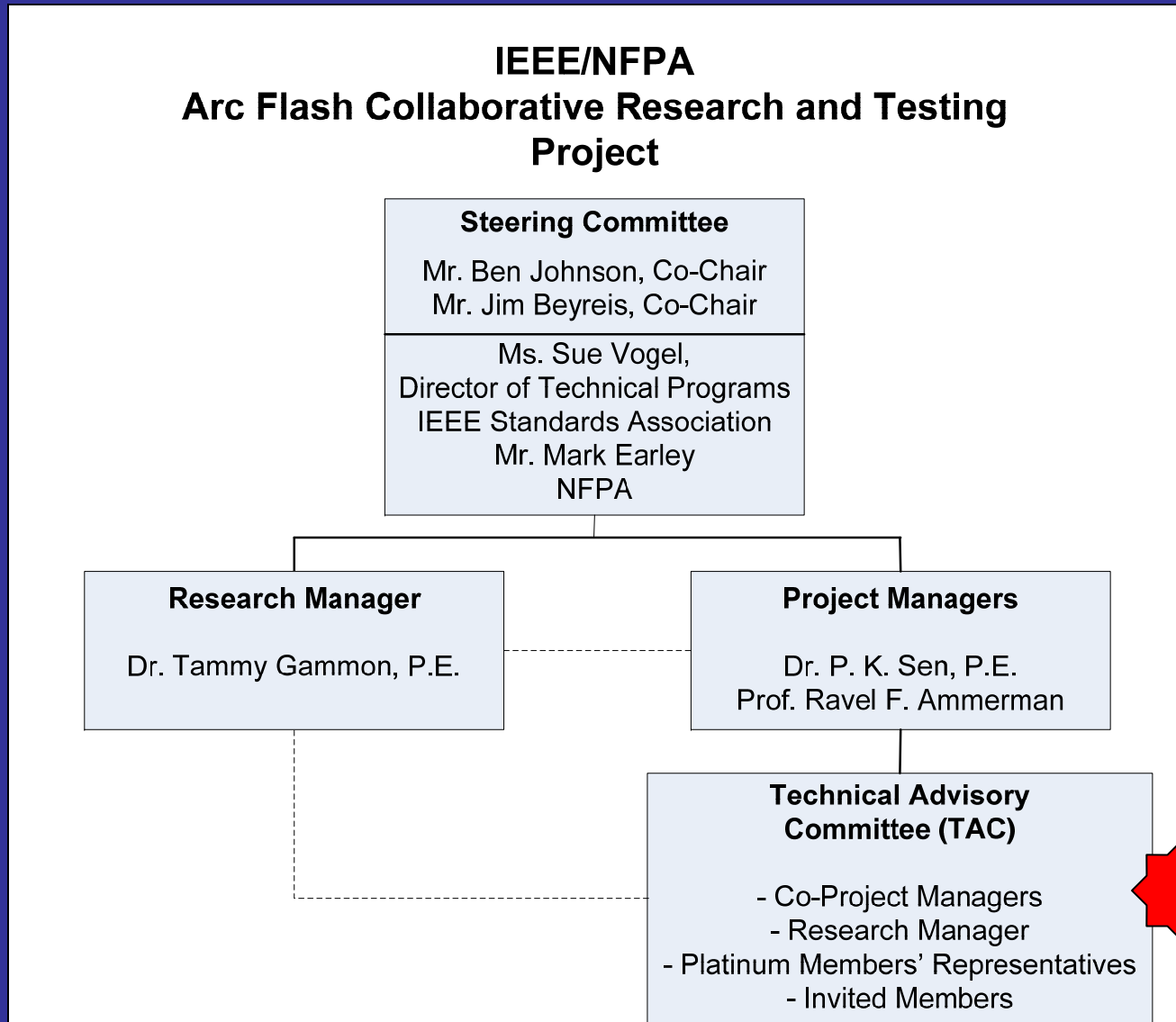


Present Research Project Goals

- Because of the complexity of the arc flash phenomena and the number of variables and unknowns involved in testing, one of the major goals of the present research effort is to properly design the experiments and clearly define the test protocols for uniformity and future reference.
- The other major goal is to develop engineering and/or physics based models which verify the experimental test results.



Project Organizational Structure



Technical Advisory Committee (TAC) – Qualifications and Roles

- Provide Guidance in defining the research goals, testing program protocols, validation of the theoretical and/or empirical or semi-empirical models
- Advisor (and not decision makers) to the Project Manager(s)
- Two (2) years (renewable) appointments

Technical Advisory Committee (TAC) – Qualifications and Roles

- Fundamental Understanding of Arc Physics, Heat Transfer and Gas Dynamics, Statistical Analyses and Modeling, etc.
- Experience in Safe Electrical Practices, Engineering Design, Industrial Applications, etc.
- Practical Knowledge of Third party Laboratory Testing Practices Including Instrumentations and Measurements
- Extensive Knowledge of Codes, Standards and Regulations

Technical Advisory Committee (TAC) Platinum Members' Representatives

- All Platinum Members “Representatives” serve on the Technical Advisory Committee.
- Bring Yrs. of Experience and Knowledge in Research, Design, Testing, Applications, Codes & Regulations.

Technical Advisory Committee Invited Members

- The following world-renowned individuals (from Four Continents and Five Countries) have accepted TAC Memberships by Invitation from the IEEE/NFPA Collaborative Research Team.
 - Mr. Bruce Land, III (USA)
 - Dr. Holger Schau (Germany)
 - Dr. David Sweeting (Australia)
 - Dr. Bob Wilkins (UK)
 - Dr. Huaren Wu (China)

Mr. Bruce Land, III



Mr. H. Bruce Land, III is a member of the Principal Professional Staff in the Milton S. Eisenhower Research and Technology Development Center of the Johns Hopkins University Applied Physics Laboratory. He received a BEE from the Johns Hopkins Whiting School of Engineering in 1984. Mr. Land is recognized by the US Navy as an expert in electrical fire forensics and has investigated numerous electrical fires. He has one issued patent in arc fault protection and twelve patents are pending.

Dr. Holger Schau



Dr. Holger Schau studied Electrical Engineering at the Ilmenau Technical University from 1975 to 1979 and received his Dr.-Ing. degree (PhD) from there in 1984. His main research interests include short circuit and arc-fault protection as well as power quality in electric power systems. He has been involved with arcing fault and the corresponding hazard related activities and protection for many years.

Dr. David Sweeting



Dr. David Sweeting graduated from Sydney University with a Bachelor of Science, Bachelor of Engineering and Doctor of Philosophy in Engineering. Dr. Sweeting is currently the Chairman of Standards Australia Committee EL/7/04 and a member of the IEC working group on short circuit currents and the Chairman of a recently formed Standards Australia Committee on arcing faults.

Dr. Bob Wilkins



Dr. Robert Wilkins graduated from the University of Manchester Institute of Science and Technology (UMIST), England with a B.Sc. (Tech) in 1962, and a Ph.D. in 1968. From 1985 to 2006 he worked as an electrical power engineering consultant, specializing in the design, application and modeling of circuit protection devices, including the representation of arcing faults. He has published over 60 technical papers and holds 2 US patents.

Dr. Huaren Wu

Dr. Huaren Wu received his Ph.D. from the Department of Electrical Engineering and Information Technology at Ilmenau Technical University in Germany. His research interests include:

- Arcing faults- testing and modeling
- Calculation of arcing currents in power systems

Since July 2004 Dr. Wu has been working in Department of Electrical Engineering at Nanjing Normal University, China as an Associate Professor.



Project Management Activities

- Dr. P.K. Sen, P.E. and Prof. Ravel F. Ammerman, the Co-Project Managers, oversee all the day-to-day activities.

Project Management Activities

Major milestones (Completed Tasks) include:

- Formation of the Technical Advisory Committee (TAC)
- Issued "Requirements for Qualification for Test Laboratories" and Performed Evaluation
- Made Site Visits to "Test Laboratories" and Qualified them for Future Testing
- Prepared the "Test Protocols for First Phase of Testing"
- Working very closely with the Research Manager to Develop the Engineering/Physics Based Models
- Progress Reports, Schedule and Project Status

Further Testing Needs and Requirements for Qualification

- A “Requirements for Qualification” package was issued to twenty (20) high-power, high-current test facilities worldwide inviting the Testing Laboratories to submit a Statement of Qualifications (for performing future testing) to the IEEE/NFPA Project Managers.

Three (3) laboratories submitted the complete Qualification Statement.

Selection of Test Facilities

- The Project Managers were authorized by the Steering Committee to conduct (Test Laboratory/Facility) site visits to evaluate the capabilities of these facilities.
- These extended site visits took place during July and August, 2007.
- A final recommendation was sent to the Steering Committee in September, 2007.

Research Activities

- Dr. Tammy Gammon, P.E., the Research Manager, has been performing research on the broad topics of Arc Physics and Modeling along with the Project Managers.

Research Activities

Major Milestones (Completed / Ongoing Tasks) include:

- Thorough and Extensive Literature Review
- Arcing Faults in AC Low-Voltage (below 1kV) Power Systems
- Arcing Faults in Medium- and High-Voltage Power Systems
- Additional research is being performed on DC Arc Models and other energy release mechanisms related to a high-energy arcing fault, namely pressure, sound, shrapnel, electromagnetic radiation, and toxicity
- Number of Technical Papers

Papers & Update

- 2008 IEEE IAS Electrical Safety Workshop, Dallas, March 18-21, 2008, **Update on IEEE/NFPA Collaboration on Arc Flash Research and Testing**,
- 2007 IEEE PCIC Conference Paper (Not Sponsored by the Collaborative Research) - **Arc Flash Hazard Incident Energy Calculations a Historical Perspective and Comparative Study of the Standards: IEEE 1584 and NFPA 70E**
- 2008 IEEE PCIC Conference Paper (Accepted for Presentation – Not Sponsored by the Collaborative Research) **Comparative Study of Arc Modeling and Arc Flash Incident Energy Exposures**
- Unpublished Paper (Not Sponsored by the Collaborative Research) – **Estimation of the Arc Energy Using Static Volt-Ampere Characteristics of Electrical Arc**

DC Arc Flash Testing: Update

- Bruce Power (Ontario, Canada and a Platinum Member of the Research Project) contracted Kinectrics, Inc. (formerly Ontario Hydro Technologies) to perform some DC Arc Testing. Bruce Power has agreed to share the results of the study and has authorized the IEEE/NFPA Research Team to oversee all the activities and get any additional information required.
- The Collaborative Research Team Members is currently reviewing the Test Results and will report to the Steering Committee their findings.

Future Test Proposal

- The next phase of the project will deal with defining a well-defined test protocol to be utilized for all future standard testing.
- An initial round of “scouting” tests, primarily focused on Thermal Energy testing, is being designed at this time to check the instrumentation functionality, sensitivity of number of variables and repeatability of test results based on the defined test protocol.
- Once these preliminary results have been verified for accuracy and conformity, an expanded set of general tests is planned which focus on quantifying the significance of many of the variables that influence an arcing fault event.

Other Developments

- As the project moves forward, the Collaborative Research Team is planning to utilize the heat energy evaluation testing as an opportunity to collect some additional exploratory data and high-speed video recording pertaining to the other hazards.
- The experience gained during these tests should be instrumental in developing a more thorough understanding of the future testing needs and define protocols for such testing.

Commitments for Support

- Platinum
 - Underwriters Laboratories
 - Bruce Power
 - Ferraz Shawmut
 - Square D / Schneider-Electric
 - Eaton Corporation
- Gold
 - Hydro One Networks, Inc.
 - Procter & Gamble, Inc.
- Silver
 - Inter-National Electrical Testing Association (NETA)
 - Duke Energy Foundation
 - Salisbury
 - NFPA
- General
 - SKM Systems Analysis, Inc.
 - Cadick Corporation
 - Powell Electric

Contributions to Date

- **Total to Date: \$3.7 million**
- **Total Needed: \$6.5 million**

Fund Raising

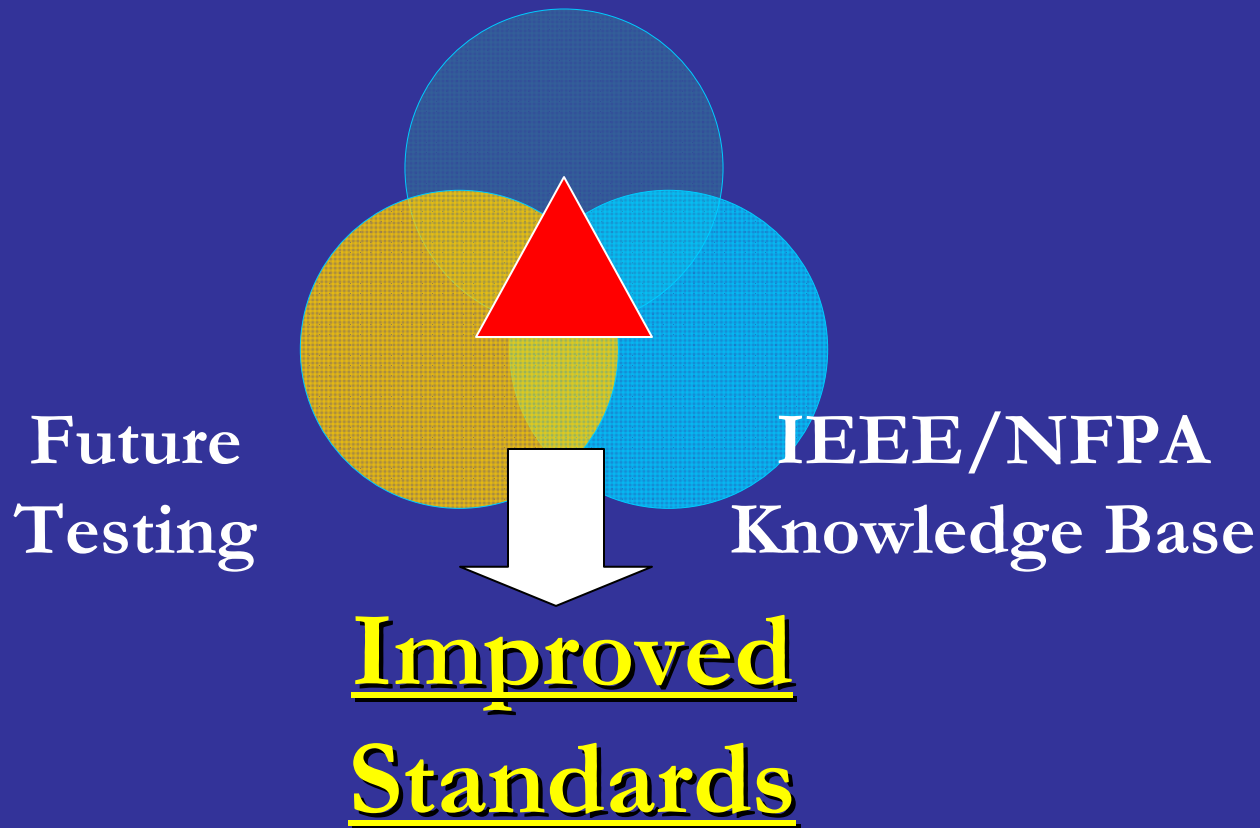
- **Fund raising activities will continue. For additional information, please contact Ben Johnson (Thermon), James Beyreis (UL), Mark Earley (NFPA), or Sue Vogel (IEEE).**

Conclusions

- The main objective of the IEEE/NFPA Collaborative Arc Flash Research and Testing Project is to develop a deeper understanding of the energy transfer mechanisms present during high-energy arcing faults.
- Results from this project will provide more detailed information relevant to all aspects of electrical arcing phenomena, which may help the electrical safety community more accurately predict the dangers associated with the arc flash hazard.

Conclusions

Arc Models



Questions

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