Cryogenic Dielectric Roundtable Session
(just after the 2006 DOE Peer Review)
Crystal City, VA
July 27, 2006

Summary

An open discussion was held among a cross section of representatives from industry, government, and universities. This discussion was lead by Dr. Mike Gouge from Oak Ridge National Laboratory and the potential objectives of a Cryogenic Dielectric Initiative (CDI) were used as a starting point. There were two fundamental questions to start the session:

- What is the best method to perform dielectrics research?
- Should there be a base program on cryogenic dielectrics that is similar to the superconducting materials program?

These two questions stimulated discussion across several issues. With respect to the structure of the program, the consensus was that the CDI needs to encompass both fundamental dielectric research and application-driven issues. It was proposed that universities and national laboratories would be best suited to address fundamental research with respect to materials, geometries, and phenomenon, while HTS equipment manufacturers should be allowed to pursue their specific issues. While this could be done independently, there have been great potential collaborations shown between the SPI projects and national laboratories and universities.

With respect to specific areas of mutual interest, several ideas were mentioned.

- Fundamental characterization of liquid nitrogen with respect to large volumes and breakdown geometry is sorely needed.
- Geometry effects on breakdown need to be better understood.
- The ability to quantify aging of cryogenic dielectrics was important to assure success with utility applications. The connection of partial discharge and aging although proven in some cases was considered an open question.
- All high voltage testing needs to be done at liquid nitrogen temperatures or below.
- A database needs to be compiled to list previous dielectrics work that was done especially during the 70's and early 80s, which may not be widely known.
- Standards for HTS applications need to be established. Should they match with conventional equivalents given that there is really no good way to test life-cycle issues?

Despite the agreement for this research, several questions were brought up about the CDI and were not resolved by the participants.

- How should the dielectrics/epoxy manufacturers be engaged?
- Are there metrics to quantify progress in dielectric strength that have been used to drive the performance of YBCO coated conductor development?
- Who should give technical direction to CDI? Manufacturers? End users? National Laboratories? Universities?

- Should some effort be given to DC cable dynamics which are different than conventional ac equipment?

Recommendations/Action Items:

- Strategy to engage dielectric industry needs to be established and pursued.
- Issues of fundamental nature should be compiled to define basic research scope.
- Working group comprised of industry, national laboratories, and universities need to be established to organize effort to maintain relevance of both fundamental and application dielectric issues
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Attendees:

Jeon Wook Cho, KERI
Dave Christen, Oak Ridge National Laboratory
Steiner Dale, Center for Advanced Power System – Florida State University
Jim Daley, DOE OE
Robert Duckworth, Oak Ridge National Laboratory
Michael Gouge, Oak Ridge National Laboratory
Ed Hahn, NYPA
Bill Hassenzahl, Advanced Energy Analysis
Yong Sik Jo, KERI
Swarn Kalsi, American Superconductor
Dominic Lee, Oak Ridge National Laboratory
David Lindsay, Ultera (Southwire)
Jim Maguire, American Superconductor
Sam Mehta, SPX/Waukesha Electric Systems
Sastry Pamidi, Center for Advanced Power System – Florida State University
Dean Peterson, LANL
Ed Pleva, SPX/Waukesha Electric Systems
Horatio Rodrigo, Center for Advanced Power System – Florida State University
Isidor Sauers, Oak Ridge National Laboratory
Frank Schmidt, Nexans
Selva, SuperPower
Alan Wolsky, Argonne National Laboratory

Actual comments from participants

Swarn: During the 70s, there used a person at MIT had proposed had a lot of data with liquid hydrogen. Worked with viton, liquid hydrogen and liquid nitrogen. Centralized testing of high voltage, but these can be application specific and may be better.

Dale: Materials and application have more of an impact on the high voltage dielectrics. It is driven more by geometry than material. How does field scale in these geometries as they scale?

Sam: Approach should be two-fold: materials-based and application-based SPI. The junctions and interface really should be considered as an entire dielectric system.

Dale: Aging mechanism – do these tests need to be done at liquid nitrogen temperatures only?

Isidor: Big question is the whether aging and partial discharge are truly related?

Horatio: Standard – These are established over years and years on continually study.

Sam: Existing device standards are considered a starting point. Transformer, 5-10 MVA, microcracks from thermal cycles. A requirement that may be added to standards.

Mike Gouge: Are better design rules needed instead of materials? Do we just need to be smarter?

Frank: It is sufficient, but there can be head room in new materials. Size is not important. Pure LN2 data with large volumes was very hard to come by.

Alan Wolsky: Recall from the October 2005 workshop:

- Cable, not the termination, was under control.
- FCL and transformers felt different.
- Other colleagues in other countries feel the same way about the lack of information about cryogenic dielectrics. Wanted to be part of an information sharing between the two programs. The problems are widespread.

Bill Hassezahl: International cooperation would be appropriate. Standards are used to determine rule of thumbs. This is done when the situation is well understood in other technologies. Transformer, FCL, and terminations all possess a certain amount of materials and scaled tests are needed in order to determine because this is a specialized field.

Jim Daley : How high in voltage do we go?

Sam Mehta: Higher voltage at 138 kV should be the starting point for good market penetration for HTS applications.

Bill Hassenzahl: DC cables have a different response with respect to the application of voltage. You just don’t change the voltage of operation with change in operation.

Steinar Dale: What functionality does the dielectric need to do? The voltage only works for a given application. Voltage is not a generic. This is very design specific.

Generic understanding is definitely needed.

Question: Who should wag the dog? Industry directing the areas of interest or are independent.

Swarn Kalsi: Standards are device specific. With respect to the chemicals, there are standard. How you measure the standards is just as important?

Sam Mehta: There some materials standard with respect to dielectric strength

Dean Peterson: Were not SPI readiness reviews here to address these concerns?

Jim Maguire: Aging is the next barrier to the utility customer.

Swarn Kalsi: We should use at a minimum of the high voltage specifications for current dielectrics in conventional equipment.

Industrial participation: How can dielectric industry contribute to this initiative? Should we go to epoxy information to engage them?

Swarn Kalsi: They is interest in applying to their materials and would be interested but it needs to be built from a few materials. There needs to be outreach to the communities.

LN2 – short cable testes need to be done to understand and thermal cycles. Is thermal cycles equivalent with lifetime testing?

Mike Gouge – are diagnostics okay? Are there any other materials?

Tests that need to done on existing materials:
Liquid nitrogen in large volume
Surface creepage of solid materials with respect to thickness
G10 manufacturer can be interested
Partial discharge

Selva: Are there numbers out there we can reach for? Base programs are driven by goals.