Robert C. Duckworth

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EXPERIENCE

Group Leader & Senior R&D Staff: Fusion & Fission Energy and Science Directorate, Fusion Technology Group, Oak Ridge National Laboratory, 2001-present

- Leading design of superconducting magnet and cryogenic systems within a multi-disciplinary, multi-laboratory project team for Material Plasma Exposure eXperiment, a linear device tasked with exploring plasma/material interactions in fusion environments.
- Completed successful demonstration of a supercritical helium-cooled cryogenic viscous compressor prototype for the ITER Vacuum System utilizing
- Support DOE Light Water Reactor Sustainability effort in collaboration with EPRI, PNNL, and the NRC through accelerated aging and characterization of polymer jacket and insulation materials to determine key indications for their remaining useful life as part of nuclear plant relicensing efforts.
- Working with Analysis and Measurement Solutions Corporation on industry-focused DOE Gateway Accelerated Innovation in Nuclear program to monitor multiple prototype temperature and pressure sensors with irradiation in HFIR Gamma Irradiation Facility.
- Leveraged existing high voltage capability to new projects with University of Minnesota-Duluth on predictive model development of submerged degradation of cable insulations and with DOE Grid Modernization Lab Consortium on impact of short duration, fast rise (20 to 100 ns) high voltage (400kV) electromagnetic pulse for grid component performance characterization.
- Collaborated with HFIR Gamma Irradiation Facility and ORNL Co-60 irradiator to explore insulation properties of mineral insulated cables, harvested nuclear cable insulations, and radiation resistant nano-dielectrics for current and future nuclear fission and fusion devices.
- Implemented and carried out test plan for the qualification and performance characterization of two 25-m long, three-phase fault current limiting cable as part of multi-team effort in the Department of Homeland Security Project HYDRA with American Superconductor and Southwire for ConEd power grid.
- Advanced the understanding of high temperature superconducting wires in prototype devices to benefit collaboration with grid device developers such as Southwire and Waukesha Electric as part of DOE Superconductivity for Electric Power Systems.
- Mentored multiple high school and undergraduates to broaden their educational experience as part of ORNL programs to make meaningful contributions in the advancement of superconducting applications, vacuum life-time operations, and life-time issues in nuclear power cables.

Graduate Research Assistant, Department of Nuclear Engineering/Engineering Physics, Cryogenics Group/Applied Superconductivity Center. University of Wisconsin-Madison, 1996-2001

- Examined the role of normal zone formation in the operational dynamics of silver coated YBCO superconductors with respect to contact resistance, operating conditions, and silver thickness.
- Designed neon condensation-based cryostat for Fermi Lab to characterize high temperature superconducting magnets as a function of temperature and external applied magnetic field.
- Develop test assembly to explore accident scenarios in fusion reactors involving the interactions of super-heated steam and liquid nitrogen and helium

EDUCATION:

University of Wisconsin-Madison, Madison, Wisconsin, 1996-2001
Ph.D. in Nuclear Engineering and Engineering Physics, 2001
Thesis: "Contact Resistance and Normal Zone Formation in YBCO Coated Superconductors".
Advisor: Prof. John Pfotenhauer
M.S. in Nuclear Engineering and Engineering Physics, 1998

Butler University, Indianapolis, Indiana, 1992-1996
B.S. in Physics, cum laude

PROFESSIONAL MEMBERSHIPS, DEVELOPMENT, & COMMUNITY OUTREACH

- Cryogenic Society of America, 2009-present
- American Nuclear Society, Human Factors, Instrument and Controls Division & Fusion Energy Division, 2014-present; Fusion Energy Executive Committee 2019-2022
- Cryogenic Engineering Conference Board of Directors, 2019-present
- Mechanical team mentor for FIRST Robotics Team at L&N Stem Academy, 2013-present
- ORNL Nuclear Science and Engineering Directorate (NSED) Education / Outreach Committee, 2015-present
- League Director, Upward Basketball League, West Park Baptist Church, 2008-2012

PUBLICATIONS

- R.C. Duckworth, et. al., "Conceptual Design and Performance Considerations for Superconducting Magnets in the Material Plasma Exposure eXperiment," *IEEE Trans. Plasma Sci.*, 2020, doi: 10.1109/TPS.2020.2985948.
- G. Churu, J.A. Demko, A. Mole, R.C. Duckworth, H. Lu, S. Malakooti, and N. Leventis, "Thermal and Electrical Properties of Isocyanate Derived Organic Aerogels for Cryogenic Insulation Applications," 2020, 10.1088/1757-899X/756/1/012007.
- J.A. Demko, R.C. Duckworth, G. Churu, & W. Hassenzahl, "Analysis of Thermal Recovery of HTS Cables after an Overcurrent Fault," 2020, 10.1088/1757-899X/755/1/012137.
- R.C. Duckworth, M.K. Kidder, T.Aytug, L. S. Fifield, W. Glass III & S. Davis, "Mechanical and Chemical Properties of Harvested Hypalon Cable Jacket Subjected to Accelerated Thermal Aging," *Nuclear Technology*, 2018, doi: 10.1080/00295450.2017.1419783.
- R.C. Duckworth, T. Aytug, P. Paranthaman, G. Polizos, & K. Leonard, "Radiation-Resistant Electrical Insulation Materials for Nuclear Reactors: Final Report," United States: N. p., 2018, doi: 10.2172/1426574.
- R.C. Duckworth & S. Davis, "Consequence of Activation Energy and Mechanical Properties in Harvested I&C Cables," *Transactions of the American Nuclear Society*, vol. 117, p. 650-652 2017.
- R.C. Duckworth, M.K. Kidder, T. Aytug, L.S. Fifield, S.W. Glass, & S. Davis, "Accelerated Thermal Aging of Harvested Hypalon Jacket for Remaining Useful Life Determination and Diagnosis," *10th International Topical Meeting on Nuclear Plant Instrumentation, Control, and Human-Machine Interface Technologies, NPIC & HMIT 2017*, p. 821-830, 2017.
- R.C Duckworth, A. Ellis, B. Hinderliter, E. Hill, and M. Maurer-Jones, "Aqueous Degradation in Harvested Medium Voltage Cables in Nuclear Power Plants," *Environmental Degradation in Nuclear Power Systems – Nuclear Reactors*, The Minerals, Metals, & Material Series, 2017, doi:10.1007/978-3-319-68454.

- R. Duckworth, A. Lumsdaine, J. Rapp, T. Bjorholm, J. Demko, D. McGinnis, J. Caughman, & R. Goulding, "Progress in Magnet Design Activities for the Material Plasma Exposure Experiment," *Fusion Engineering and Design*, 2017, doi:10.1016/j.fusengdes.2017.05.137.
- R.C. Duckworth, E. Frame, L.S. Fifield, & S.W. Glass, "Benchmark Accelerated Aging of Harvested Hypalon/EPR and CSPE/XLPE Power and I&C Cables in Nuclear Power Plants," *Proceedings of 2014 24th International Conference on Nuclear Engineering,* doi:10.1115/ICONE24-60311, 2016.
- R.C. Duckworth, J.A. Demko, A. Lumsdaine, J. Rapp, T. Bjorholm, R.H. Goulding, J.B.O. Caughman, & W.D. McGinnis, "Cryogenic Considerations for Superconducting Magnet Design for the Material Plasma Exposure Experiment," *IOP Conference Series: Materials Science and Engineering, v 101, n 1* 2015, doi: 10.1088/1757-899X/101/1/012143.
- L.S. Fifield, R.C. Duckworth, & S.W. Glass, "Long Term Operational Issues for Electrical Cable Systems in Nuclear Power Plants," *Proceedings of 2014 24th International Conference on Nuclear Engineering,* 2016, doi:10.1115/ICONE24-60729.
- R.C. Duckworth, M. Parans Paranthaman, Tolga Aytug, Michelle K. Kidder, Georgios Polizos, and Keith J. Leonard, Cable Aging and Condition Monitoring of Radiation Resistant Nanodielectrics in Advanced Reactor Applications," *9th International Topical Meeting on Nuclear Plant Instrumentation, Control, and Human-Machine Interface Technologies, NPIC and HMIT 2015*, v 3, p 1875-1884.
- Robert C. Duckworth, Georgios Polyzos, Paranthaman, Parans, Tolga Aytug, Keith Leonard, and Isidor Sauers, "Radiation Resistance of XLPE Nano-Dielectrics for Advanced Reactor Applications," *Transactions of the American Nuclear Society,* vol. 110, p 937-941, 2014.
- R.C. Duckworth, L.R. Baylor, S.J. Meitner, S.K. Combs, T. Ha, M. Morrow, T. Biewer, D.A. Rasmussen, M.P. Hechler, R.J.H Pearce, M. Dremel, J.-C. Boisson, "Evaluation of Static Mixer Flow Enhancements for Cryogenic Viscous Compressor for ITER Vacuum System," *AIP Conference Proceedings*, vol. 1573, p.864-871, 2014.
- R.C. Duckworth, L.R. Baylor, S.J. Meitner, S.K. Combs, D.A. Rasmussen, M.P. Hechler, T.D. Edgemon, C.N. Barbier, R.J.H Pearce, R. Kersevan, M. Dremel, J.-C. Boisson, "Evaluation of Static Mixer Flow Enhancements for Cryogenic Viscous Compressor for ITER Vacuum System," *AIP Conference Proceedings*, vol. 1434, p.1234-42, 2012.
- Y. Zhang, R.C. Duckworth, T. Ha, M.J. Gouge, "Solderability Study of RABITS-based YBCO Coated Conductors," *Physica C*, vol. 471, n 15-16, p. 437-443, 2011.
- R.C. Duckworth, Y. Zhang, T. Ha, and M.J. Gouge, "Dynamic Resistance of YBCO-Coated Conductors in Applied AC Fields with DC Transport Currents and DC Background Fields," *IEEE Trans. Appl. Supercond.*, vol. 21, n. 3, p. 3251-3256, 2011.
- Y. Zhang, R.C. Duckworth, T. Ha, F.A. List, M.J. Gouge, Y. Chen, X. Xiong, and V. Selvamanickam, "AC loss Reduction in Filamentized YBCO Coated Conductors with Virtual Transverse Cross-Cuts," *IEEE Trans. Appl. Supercond.*, vol. 21, n. 3, p. 3301-3306, 2011.
- R.C. Duckworth, Y. Zhang, M.J. Gouge, C.M. Rey, D.C. van der Laan, and C. Clickner, "Voltage distribution and mechanical strength in splice joints made from as-manufactured YBCO coated conductors," *AIP Conference Proceedings*, vol. 1219, p.370-379, 2010.
- R.C. Duckworth, F.A. List, and Y. Zhang, "Effect of interfacial resistance on ac loss as a function of applied field in YBCO coated conductors," IEEE. Trans. Appl. Supercond., vol. 19, no. 3, p. 3327-3330, 2009.
- R.C. Duckworth, F.A. List, M.P. Paranthaman, M.W. Rupich, W. Zhang, Y.Y. Xie, and V. Selvamanickam, "Low ac loss geometries of YBCO coated conductors,' Physica C, vol. 463-465, p. 755-760, 2007.
- R.C. Duckworth, M.P. Paranthaman, M.S. Bhuiyan, F.A. List, M.J. Gouge, "AC losses in YBCO coated conductors with inkjet filaments," IEEE Trans. Appl. Supercond. vol. 17, n. 2, p. 3159-3162, 2007.

- M.J. Gouge, J.A. Demko, R.C. Duckworth, D.T.Lindsay, M.L. Roden, J.C. Tolbert, J.C., “Testing of an HTS Power Cable Made from YBCO Tapes,” IEEE Trans. Appl. Supercond., vol. 17, n. 2, p. 1708-1711, 2007.
- R.C. Duckworth, “"ac losses in RABiTS based conductors" as published in "Flux Pinning and ac Loss Studies on YBCO Coated Conductors" eds. M. Parans Paranthaman and Venkat Selvamanickam, Nova Science Publishers Inc, 2007.
- R.C. Duckworth, J.A Demko, M.J. Gouge, and J.A. Urbahn, “Measurement of the emissivity of clean and contaminated silver plated copper surfaces at cryogenic temperatures,” Adv. Cryo. Engr. Vol. 52A, p. 61-68, 2006.
- R.C. Duckworth, M.J. Gouge, J. Caughman, J.W. Lue, J.A. Demko, J. Tolbert, C.L.H. Thieme, and D.T. Verebelyi, “On the Effect of NiW on the Inductance and AC Loss of HTS Cables,” IEEE Trans. Appl. Supercond., vol. 15, n. 2, p. 1578-82, 2005.
- R.C. Duckworth, M.J. Gouge, J.W. Lue, C. Thieme, and D.T. Verebelyi, “Substrate and Stabilization Effects on the Transport AC Losses in YBCO Coated Conductors,” IEEE Trans. Appl. Supercond., vol. 15, n. 2, p. 1583-86, 2005.
- R.C. Duckworth, J.R. Thompson, M.J. Gouge, J.W. Lue, A. Ijaduola, D. Yu, and D.T. Verebelyi, “Transport AC loss studies of YBCO coated conductors with nickel alloy substrates,” Supercond. Sci. Tech., vol 16, p. 1294-1298, 2003.
- R.C. Duckworth, J.W. Lue, D.F. Lee, R. Grabovickic, M.J. Gouge, and Kroeger, D.M., “The Role of Nickel Substrates in the Quench Dynamics of Silver Coated YBCO Tapes,” IEEE. Trans. Appl. Supercond. , vol. 13 n 2, p. 1768-1771, 2003.
- R. Grabovickic, J.W. Lue, M.J. Gouge, J.A. Demko, and R.C. Duckworth,, “Measurement of Temperature Dependence of Stability and Quench Propagation of 20-cm-long RABiTS YBCO Tapes,” IEEE. Trans. Appl. Supercond. , vol. 13 n 2, p. 1726-1730, 2003.
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- Lue, J.W., Gouge, M.J., Duckworth, R.C., Lee, D.F., Kroeger, D.M., and Pfotenhauer, J.M., “Quench Tests of a 20-cm Long RABiTS YBCO Tape,” Adv. Cryo. Engr., vol. 48A, p. 321-328, 2001.
- R. Duckworth, J. Murphy, J. Pfotenhauer, and M. Corradini,, “Liquid Nitrogen – Water Interaction Experiments for Fusion Reactor Accident Scenarios,” Proceedings of ICONE-9, Nice, France, April 2001.
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- Duckworth, R.C., Pfotenhauer, J.M., and Corradini, M.L., “Liquid Helium-Water Interaction Experiments for Accident Scenarios in Fusion Reactors”, Proceedings of 2000 ASME National Heat Transfer Conference, v. 1, p. 11, 2000.