Fusion Technology, Wolves, Wanderings and Thoughts on Your Future

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Fusion reactor components will face an extreme environment. The ones near the plasma will glow white hot and must survive very high heat loads and damage from energetic ions and neutrons. Others will breed tritium from lithium and pass hot coolant through the cryostats that keep superconducting magnets cold. Richard has spent four decades developing advanced materials and fusion components at four national labs, UCLA and the Dept. of Energy. He received a BS from MIT and PhD from Northwestern, both in Material Science.

Richard's current interests include the path forward in fusion, developing its new leaders, and opportunities such as Transformative Enabling Capabilities (TEC) that can simplify how you (future fusion scientists and engineers) will design and build a fusion power plant. One example of TEC is Advanced Manufacturing (AM+), including 3-D Printing. AM+ is transforming products worldwide and introducing new materials and novel complex multi-material structures, such as bio-active interfaces for medicine and lightweight aerospace parts. AM+ may be the only way to make novel materials architectures for high-performance heat sinks in fusion systems.

In this talk, Richard describes fusion systems and his thoughts about the attraction and opportunities of working in the multi-disciplinary world-wide network of fusion development. This is an interesting time for fusion with large private venture investments and studies by the National Academies of Science noting the need for much more R&D on fusion nuclear science and technology (FNST). Maybe we are finally nearing the tipping point where such research will ramp up. Richard will present information on the declining US expertise in FNST. Replenishing this resource and reinvigorating FNST is both a challenge and an opportunity.

The APS Division of Plasma Physics is coordinating a (fusion) Community Planning Process to develop a consensus vision from on our path forward. On their Program Committee, Richard represents the crosscutting area of Enabling Technology in the Materials and Technology.

In this talk, Richard mixes information on fusion with his own brand of humor and photos from his wilderness treks. He has always sought wilderness accessible from his many work sites and travels and has hiked in the Sierra, Cascades, Rockies and southwest canyons. He once spent a month solo on a 400-mile journey downriver in the Alaskan arctic.

Some recent publications are listed below.

RE Nygren, et al., Power Deposition on a Tungsten Leading Edge in a DIII-D He Plasma, Nucl. Mater. & Energy 2019, accepted for pub.

RE Nygren, et al., Post-test examination of a Li-Ta heat pipe exposed to H plasma in Magnum PSI, accepted for pub. Fus. Eng. & Des. 2019

R Nygren, et al., Advanced Manufacturing – A Transformative Enabling Capability for Fusion, (invited, 13th Int. Symp. on Fus. Nuc. Tech. 2017 Kyoto) Fus. Eng. & Des. 2018 **136B** p1007-11

RE Nygren, et al., Thermal Management of Tungsten Leading Edges in DIII-D and ITER, (SOFT2016) *Fus. Eng. & Design* 2017 4/29

K Holtrop K., ... R Nygren, et al. The Study of Fusion Plasma Material Interactions using Tungsten Coated TZM Molybdenum Tile Inserts on the DIII-D Tokamak, Fus. Sci. & Tech. 2017 **72/4** p634-9

RE Nygren, DL Youchison, BD Wirth, LL Snead, A new vision of plasma facing components, (invited, 12th Int. Symp. on Fusion Nucl. Tech., Jeju Island, Korea) *Fusion Eng. & Design* **109-111 A** (2016) 192

[1]Sandia National Laboratories is a multi-mission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. This work was also part-funded by the RCUK Energy Programme under grant EP/I501045

RE Nygren, Integration of liquid surface PFCs into DEMO or FNSF, *Physica Scripta* **T167** 2016 014063.
RE Nygren, P Tabares, Liquid surfaces for fusion plasma facing components: A critical review – Physics and PSI , *Nuclear Materials and Energy* **9** (2016) 6