Written Testimony of

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"Caught by Surprise: Causes and Consequences of the

Helium-3 Supply Crisis"

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Mr. Chairman and members of the Subcommittee, my name is Tom Anderson and I am the Product Line Leader for GE Energy's Reuter Stokes Radiation Measurement Solutions. I appreciate the opportunity to testify before this Committee today.

I have been asked to speak about the impact the Helium-3 shortage has had on our business and our customers, and to share with the Committee our ideas on how to manage this problem in the future.

GE Energy's Reuter Stokes has over 50 years of experience supplying radiation detectors. We design and manufacture detectors for Boiling Water Reactors (BWR), neutron scattering instruments, oil and gas exploration, homeland security and nuclear safeguards systems. Our BWR in-core detectors monitor reactor power levels and provide signals to initiate protective actions in the event of an abnormal condition. Our

Helium-3 gas-filled neutron detectors are used to accurately account for nuclear materials during handling and processing. Over 35,000 GE Helium-3 detectors are installed in systems deployed around the world today to monitor for the illicit trafficking of smuggled nuclear materials. I look forward to providing you with GE's perspective on the consequences of the Helium-3 supply crisis.

According to information presented at the Helium-3 Workshop hosted by the American Association for the Advancement of Science on April 6, 2010, the Department of Energy's Helium-3 reserves have been depleted to approximately 50,000 liters, with future production rates expected to be less than 10,000 liters per year. With global demand now on the order of 70,000 liters per year, the total DOE reserve represents less than a one-year supply of Helium-3. As a consequence, GE is confronting the reality that Helium-3 for use in neutron detectors may soon no longer be available.

In my testimony, I will address two points. First, a drop-in replacement technology for Helium-3 does not exist today. Furthermore, as many as six different neutron detection technologies may be required to best address the performance requirements of the neutron detection applications GE has served historically with technology using Helium-3. Significant research is required immediately, and Federal funding is essential to accelerate development of new neutron detection technologies, and thereby preserve the remaining Helium-3 supply for other uses. Second, an adequate supply of Helium-3 must be made available by DOE and the Interagency Project Team (IPT) to support critical applications such as nuclear safeguards, homeland security and oil exploration while alternate technologies are developed.

Background

GE Energy's Reuter Stokes business is located in Twinsburg, Ohio. Beginning with our first gas-filled neutron detector in 1956, GE has become a global leader in designing and manufacturing gamma and neutron detection technologies for a wide variety of applications.

Many of the Boiling Water Reactors (BWR) in operation in the United States today rely on GE detectors to measure and monitor reactor power level. Several U.S. states, as well as South Korea and Taiwan, have installed networks of Environmental Radiation Monitors manufactured by GE to monitor low-level gamma radiation.

GE also manufactures a variety of products for use in the oil and gas drilling and logging industry. These include sophisticated instruments to navigate a drill string; gamma radiation detectors to determine the type of rock and formation density; resistivity tools to measure formation properties and Helium-3 neutron detectors to measure formation porosity. The data from this full suite of detectors is integrated to optimize oil exploration.

During its long history, GE has designed and manufactured an assortment of BF_3, Boron-10 lined, and Helium-3 gas-filled neutron detectors. Over 100,000 of our Helium-3 neutron detectors have been put in service during the past four decades. Our neutron detectors have been utilized in a wide variety of **neutron scattering research, nuclear safeguards, oil and gas, and homeland security** systems.

Recently in the media, there has been much excitement and speculation about the presence of water on the Moon and on Mars. Our Helium-3 detectors have been used for space exploration where the unique properties of Helium-3 support water exploration at temperatures approaching absolute zero.

GE purchases the majority of its Helium-3 gas from the Department of Energy. The Helium-3 is processed and then used to manufacture Helium-3 neutron detectors. Our company does not otherwise bottle or package Helium-3 for sale.

The following sections provide background on four of the larger applications that use Helium-3 neutron detectors.

Neutron Scattering Research

Neutron scattering facilities conduct fundamental science, materials, electromagnetics, food and medical research by directing a beam of conditioned neutrons at a test specimen and accurately measuring the position and timing of the scattered neutrons. GE is the industry leader in engineering and manufacturing Helium-3 gas-filled, position-sensitive neutron detectors for neutron scattering research facilities located around the globe. The three largest facilities in the United States are the Spallation Neutron Source (SNS) located at Oak Ridge National Laboratory, the National Institute of Standards and Technology (NIST) Center for Neutron Research (NCNR) in Gaithersburg, MD and the Los Alamos Neutron Science Center (LANSCE) located at Los Alamos National Laboratory (LANL). International facilities include the Japan Proton Accelerator Research Complex (JPARC), Rutherford Appleton Laboratory (UK), and Institut Laue-Langevin (France) as well as facilities located in Germany, South Korea, the Netherlands, Australia, and China. The research conducted at neutron scattering facilities has led to a long list of landmark discoveries including a better understanding of neurological and genetic diseases such as Huntington's disease, potential improvements in solar energy conversion, and advances in superconducting materials, to name but a few.[1]

Neutron scattering facilities represent a significant government research investment. The majority of the construction budget is used to build the neutron source, the accelerators and the infrastructure needed to support the scattering instruments. The construction cost for the SNS facility was $1.4 Billion.[2] The design and construction of

[1] Additional information is available on the Oak Ridge National Laboratory website: http://neutrons.ornl.gov/facilities/SNS/history/.
[2] *Id.*

the individual scattering instruments, including the Helium-3 detectors, is typically among the last tasks to be completed. The instrument arrays vary in size from tens of detectors to over 1,000 Helium-3 detectors per instrument. Instrument construction at many scattering facilities located outside the United States is currently on hold due to the lack of Helium-3.

Neutron scattering instruments require detectors with extremely fast response, high neutron sensitivity and excellent gamma discrimination. The detectors must provide accurate position and timing information for the scattered neutrons.

Nuclear Safeguards

The purpose of nuclear safeguards programs is to prevent diversion of nuclear materials for non-peaceful purposes. Nuclear safeguards systems are installed at facilities that process, handle, use and store plutonium, uranium, nuclear fuel, spent fuel or nuclear waste. Safeguards systems quantify and monitor nuclear material to enable facilities to precisely account for plutonium and uranium during all aspects of processing, storage and clean up. The International Atomic Energy Agency (IAEA) and the National Nuclear Security Administration (NNSA) via the National Laboratories sponsor a number of international safeguards programs such as the new reprocessing facility that is under construction at the Rokkasho Reprocessing Complex in Japan.

Nuclear safeguards systems are typically compact. The detectors must have high neutron sensitivity and excellent gamma discrimination to enable accurate neutron measurements. The extremely fast response of Helium-3 detectors makes certain measurements possible. Helium-3 detector performance can be further tailored to permit highly precise nuclear material assay. This is a key element in accurately accounting for nuclear materials.

Oil and Gas

Helium-3 neutron detectors are also widely used in oil and gas exploration. These detectors are used in conjunction with a neutron source to locate hydrogenous materials such as oil, natural gas, and water. Neutron measurements in conjunction with inputs from other drill string instruments are used to locate hydrocarbon reservoirs during drilling, and to further delineate the reservoirs during logging operations. The overwhelming majority of nuclear porosity tools used in the oil and gas industry today depend on the unique properties of Helium-3 neutron detectors.

Helium-3 neutron detectors have high neutron sensitivity, which enables them to be packaged to fit inside the tool string. The excellent gamma discrimination characteristic of Helium-3 means that background gamma radiation levels do not interfere with the accuracy of the neutron measurements. These detectors must also operate reliably and survive at temperatures up to 200^{o}C under severe vibration and shock levels up to 1,000 times the force of gravity. It is likely that without Helium-3, exploration for new reserves, development drilling of existing fields, and logging of both new and existing wells will be severely curtailed until an alternative technology is developed.

Homeland Security

The demand for Helium-3 neutron detectors has increased significantly since 9/11. Helium-3 is used as a neutron detector technology throughout the full spectrum of homeland security instruments, ranging from small 3/8" diameter detectors installed in pager-sized systems to six-foot long detectors installed in large area Radiation Portal Monitors (RPM). GE's Helium-3 detectors are widely used in radiation pagers, handheld instruments, fission meters, backpacks, mobile systems and RPMs that are deployed to search for and detect the illicit trafficking of fissile radioactive materials. Homeland security systems, particularly the RPMs, require a significant amount of Helium-3.

GE's Helium-3 neutron detectors are installed in systems supporting Customs and Border Protection (DHS), the Second Line of Defense (SLD)/Megaports Program (DOE) and the Advanced Spectroscopic Portal (ASP) Program (DHS). We have also manufactured thousands of Helium-3 detectors for other DHS, DOE (NNSA), Department of Defense (DoD), Department of Justice (DOJ), and other local and state security programs.

Helium-3 Supply Concerns

The Department of Energy has been selling isotopes for several years. In December 2003, the DOE auctioned 95,800 liters[3] of Helium-3. An additional 50,848 liters were auctioned between 2005 and 2006.[4] After the last auction sale of Helium-3 in July 2006, there were repeated delays in the periodic auction process. In May 2008, GE met with the DOE to request clarification on the next anticipated auction date. It was during this May 2008 meeting that GE first became aware of the potential shortage of Helium-3. In July 2008, the Department of Homeland Security's Domestic Nuclear Detection Office (DNDO) and the NNSA were briefed on the possibility that future supplies of Helium-3 might be inadequate to fully support their programs.

DOE suspended the anticipated 2008 auction and in December 2008 made a direct allocation of approximately 23,000 liters of Helium-3 to GE and Spectra Gases, Inc. Seventy percent of the Helium-3 sold to GE was controlled by NNSA for the Second Line of Defense (SLD) Program. There has been no additional Helium-3 auctioned by the DOE, and since 2008, all DOE gas supplied to GE has been allocated to specific projects or programs.

[3] Invitation for Bids to Purchase He-3 gas, Amendment 2, posted November 20, 2003.
[4] US DOE Helium-3 (He-3) Sales Solicitations (2005, 2006).

The impact of the Helium-3 shortage was immediate. GE was no longer able to supply products to many programs and customers. The neutron scattering community has been hardest hit, with programs in Japan and Germany having the most immediate need. The construction of several scattering instruments outside the United States will be delayed until a source of Helium-3 can be identified or an alternate technology is made available.

Upon learning of the Helium-3 shortage, GE designed and built equipment to more efficiently reclaim Helium-3 from unused detectors. Helium-3 is a stable gas, and therefore can be removed from old detectors, reprocessed and used to build new detectors. Recycled Helium-3 has been used over the past year to build neutron detectors for some systems.

Alternative Technologies

A drop-in replacement for Helium-3 does not exist today. Federal research funding is essential to supplement private sector efforts to accelerate development of replacement technologies. I have discussed four applications that currently rely on Helium-3 neutron detectors. I have also briefly described the detector performance attributes required in each. Many of the applications share similar attributes, yet each has its own subtle differences. Up to six different neutron detection technologies may be required to replace Helium-3 detectors in these four applications.

Three different technologies may be needed to support homeland security systems alone. The systems deployed for homeland security today range in size from large area portal systems and lightweight backpack instruments, to low-power pager-sized equipment. Neutron scattering detectors are even more complex due to the speed, timing and position measurement accuracies needed to support their research.

Alternate technologies for nuclear safeguards and the extremely harsh conditions encountered during oil exploration also present unique development challenges.

GE has been actively involved in developing alternate neutron detection technologies. GE's initial efforts have been focused on developing a replacement technology for portal monitors. RPMs have been the largest consumer of Helium-3 during the past seven years. GE recently completed development of a Boron-10 lined gas-filled neutron detection technology that meets the American National Standards Institute (ANSI), ANSI N42.35-2006 performance requirements for portals. This was an accelerated project, which from initial concept to first production is on track to be completed in 18 months. For this project, our Twinsburg team worked with scientists at the GE Global Research Center and leveraged production processes based on best practices from GE Consumer and Industrial businesses. GE is on schedule to begin production of Boron-10 lined neutron detection portal panels in July of this year.

The research and new product development programs for the four neutron detection applications described will be challenging. Each new technology must the reliable and consistently meet the performance requirements needed for accurate neutron measurements under all system operating conditions. The technology must be scalable to fit the instrument and have a reasonable service life. Finally, the technology must be practical to manufacture in sufficient quantities at a reasonable cost, with consistent quality and performance.

GE is well qualified to research and develop new neutron detection technologies. However, research and development programs of this scope are very expensive. DNDO has released Broad Agency Announcements (BAA) and a Request for Information (RFI) to seek information and provide funding for alternate neutron detection technologies for homeland security systems. I am not aware of similar programs at DOE. Nuclear safeguards, oil exploration, and neutron scattering facilities fall under different offices within DOE. Federal funding to support research in each of these areas is needed if replacement technologies are to be in place in time to avoid serious effects of the Helium-3 shortage.

Alternate Sources of Helium-3

Helium-3 is generated from the radioactive decay of tritium. During the Cold War, both the United States and Russia produced tritium to support nuclear weapons stockpiles. Most of the Helium-3 available today was harvested from the tritium produced for the weapons program.

Tritium is also produced as a byproduct of generating power in CANada Deuterium Uranium (CANDU) reactors. Four such reactors are located at Ontario Power Generation's (OPG) Darlington Generating Station in Ontario, Canada. GE has investigated the possibility of separating the Helium-3 from the tritium that is currently being stored at the Darlington facility. GE has been informed that the U.S. Government has initiated discussions with the Canadian government. If such discussions lead to an agreement, this might provide some additional Helium-3 to support critical applications while alternate technologies are developed.

Conclusion

We have come to rely on Helium-3 for cutting-edge research, medical lung imaging, cryogenic cooling, oil and gas exploration, and the radiation monitors that protect our borders. The Department of Energy's Helium-3 reserve is nearly depleted and there are no short-term solutions available to rectify the shortage. An Interagency Project Team has been established to manage the shortage and to make the difficult decisions to allocate the remaining limited supply of Helium-3.

DNDO has played a key role in addressing the shortage, however, there is much more to be done. It is critical that the federal government strengthen its support of research and development for alternate technologies. Specifically, DOE funding of research and development programs for oil and gas exploration, neutron scattering and nuclear safeguards is essential. Funding and collaboration with the National Laboratories could help accelerate technology development. Also, additional funding from DNDO would help accelerate development of technologies for homeland security. Finally, it is extremely important that the Interagency Project Team allocate adequate supplies of the remaining Helium-3 to support critical applications such as oil exploration and nuclear safeguards while alternate technologies are developed. Given the limited Helium-3 supply, the Federal government should consider moving forward on negotiations with the Canadian government so that Helium-3 can be produced from the tritium currently being stored at the CANDU Darlington facility. This is not a long-term solution, but it may help provide a supplemental supply of Helium-3 while alternative solutions are found.

Thank you for holding this hearing on this critical issue. I will be glad to answer any questions you may have.