STATEMENT OF

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Thank you Mr. Chairman, Ranking Member Broun, and Members of the Committee. I appreciate the opportunity to appear before you to provide testimony on the DOE's role and reaction to the national Helium-3 (^{3}He) shortage. Both the National Nuclear Security Administration (NNSA), and the DOE Isotope Development and Production for Research and Applications Program (Isotope Program) recently transferred to the Office of Science in the FY 2009 Appropriation, play a role in Helium-3 production and distribution. I have served as the Director of the Office of Science since June 2009, and I am pleased to share with you my perspectives on the role of the DOE Isotope Program in ^{3}He production and distribution.

Overview of the Role of DOE in Helium-3 Production and Distribution

The DOE has supplied isotopes and isotope-related services to the Nation and to foreign countries for more than 50 years. Since its transfer to the Office of Science in 2009, the Isotope Program has continued to produce a suite of isotopes for research and applications that are in short supply, as well as technical services such as target development, chemical conversions, and other isotope associated activities. As part of this mission, the Isotope Program is responsible for the sale and distribution of ^{3}He on behalf of DOE, but not for the production of ^{3}He. ^{3}He is a rare, non-radioactive and non-hazardous isotope of helium. Due to its low natural abundance, recovery from natural deposits has not been economically viable thus far. Instead, the sole production of ^{3}He in the United States results from the refurbishment and dismantlement of nuclear weapons. The natural radioactive decay of tritium used in these weapons creates ^{3}He, which is separated and stored during processing at the NNSA Savannah River Site (SRS) in South Carolina. To date, the only other commercial source of ^{3}He has been from the decay of tritium that was produced within the former Soviet Union for its nuclear weapons program. Because the primary, current source of ^{3}He is the decay of tritium, current supplies of this important gas are limited by the quantities of tritium on hand and being produced. Without development of alternative sources for ^{3}He, use of this gas will be constrained seriously in the foreseeable future as accumulated stockpiles are drawn down.

The U.S. distribution of ^{3}He for commercial consumption started in 1980. ^{3}He production for commercial use, has never been a mission of the DOE. However, DOE made this byproduct of its operations available to scientific and industrial users at a price designed to recover extraction, purification, and administrative costs. Currently, the need for ^3He in the United States is outpacing production.

The major application of ^3He is for neutron detection, principally for national security purposes, nuclear safeguards measurements, oil and gas exploration, and in scientific experimentation. It is the preferred detector material for these applications because it is non-reactive/non-corrosive and it has the highest intrinsic efficiency for neutron detection. It is also important in low-temperature physics research and increasingly in medical diagnostics. A major use of ^3He in U.S. research is for neutron detection in the Spallation Neutron Source (SNS), a one-of-a-kind, accelerator-based neutron source that provides intense pulsed neutron beams for scientific research, materials research, and industrial development. ^3He is also used in dilution refrigeration in low-temperature physics experiments; there is no known alternative for this use.

The U.S. Government ceased reactor-based production of tritium for the nuclear weapons stockpile in 1988. Due to the downsizing of the world's nuclear stockpiles and the increase in the demand for ^3He, we have reached a critical shortage in the global supply of ^3He.

Realization of ^3He Shortage

From 1980 to 1995, ^3He collected by the NNSA at the Savannah River Site (SRS) was purified at the Mound Laboratory along with other stable isotope gases for distribution by the Isotope Program. NNSA ceased operations at Mound, a laboratory used primarily for weapons research during the Cold War, in 1995. Between 1980 and 2003, the SRS had accumulated about 260,000 liters of unprocessed ^3He. For security purposes, this total was closely held, and not known widely beyond DOE. Sales of this raw ^3He by SRS began in 2003 as a remediation test project with the commercial firm, Spectra Gases (now named Linde LLC); Linde invested in excess of $4,000,000 to establish purification capability of ^3He. In August of 2003, NNSA and the DOE Office of Nuclear Energy, in which the Isotope Program resided at that time, entered into a Memorandum of Understanding for the sales of raw ^3He derived from tritium processing. On October 2, 2003, the first invitation to bid on the sale of ^3He was published in a FEDBIZOPS notice. There were three competitive auctions from 2003 until 2006. Some of the 2006 shipment occurred in 2007 and 2008. There were a total of 146,000 liters supplied primarily to two vendors. During this time period, the Isotope Program advised both vendors that the supply was limited to about 10,000 liters annually by NNSA. Between 2004 - 2008, an average of 25,000 liters of Russian ^3He was entering the U.S. market annually. Since 2003, DOE has sold over 200,000 liters of ^3He, drawing down a significant portion of the Department's inventory. In addition, allocations totaling 58,000 liters were provided to SNS directly from NNSA in 2001 and 2008 in support of the high priority neutron scattering basic research program.

In March 2006, Isotope Program was briefed by Systems Development and Acquisition, Domestic Nuclear Detection Office (DNDO) on the development and acquisition of the deployment of their domestic detection system. The goal was to award contracts by July

2006. There was discussion that additional ^{3}He would be required by DNDO, but final quantities could not be provided at that time. Some quantities were discussed prior to the meeting, particularly taking into account the availability at the time of additional supply from Russia. In the fall of 2007, vendors expressed interest to the Office of Nuclear Energy Isotope Program about the timing of the next bid of ^{3}He and the probability of increased needs, but actual quantities were not known. While it was becoming apparent that a gap between supply and demand was emerging the magnitude of the projected demand was still unknown, as was the future availability of ^{3}He gas from Russia. A combination of ^{3}He loading enhancements at SRS in 2007, which delayed ^{3}He distribution capabilities, and a lack of detailed information on demand caused the planned 2007 bid to be delayed.

In 2008, concerned that the overall demand would surpass the available supply, even though the U.S. was not the sole source at the time, the Isotope Program delayed all further bid sales until additional information could be obtained. The Office of Nuclear Physics, in anticipation of the transfer of the Isotope Program from the Office of Nuclear Energy to the Office of Science, organized a workshop on the Nation's needs for isotopes for research and applications. This August 2008 workshop was attended by national laboratories, universities, industry, and federal agencies, including the Department of Homeland Security, and NNSA. At the workshop, the community discussed a demand for ^{3}He approaching 70,000 liters annually'. The projected U.S. supply in the out years was estimated, at that time, to be about 8,000 liters annually. The results of the workshop were subsequently released in a report to the interagency community. During the same time period, Russia ceased offering ^{3}He to the commercial market, informing U.S. vendors that it was reserving its supplies for domestic use.

DOE Response to ^{3}He Shortage

With the estimated magnitude of the shortage becoming clear in August 2008, the Isotope Program coordinated sales in 2008 among the Department of Homeland Security (DHS), the NNSA Second Line of Defense (SLD) program, and industry, and did not distribute ^{3}He through an open bid process. A briefing by the Isotope Program was held at DHS, with attendance by Department of Defense, DHS and NNSA, to discuss the projected ^{3}He shortage. The DOE was instrumental in the development of the self-formed interagency group that was established in March 2009, with the objective of identifying the ^{3}He demand and supply and R&D efforts on alternative technologies.

DOE quickly implemented a number of actions. NNSA and Office of Science agreed that no further ^{3}He allocations would be made without interagency agreement. Together with DHS, they decided not to provide additional gas for portal monitor systems, which accounted for up to 80 percent of projected future demand. DOE accelerated plans for the development and deployment of alternative neutron detection technology to reduce demand, with the aim to begin implementation within the next few years. DOE started investigating the identification of new sources of ^{3}He from other countries, including Canada, which could increase the domestic supply starting in two to three years. Together with DHS, DOE also started examining additional new ^{3}He production from either natural gas distillation or new reactor-based irradiation. These options were seen as a long-term and expensive, but potentially necessary if demand continues to outpace supply in the future.

A targeted public outreach campaign was instituted to help ensure that the ^{3}He user community was made aware of the current shortage. The DOE Isotope Program published the Workshop Report, which articulated the ^{3}He shortage, and broadly disseminated the report to stakeholders and interested parties in December 2008. Both NNSA and the Office of Science made a formal inquiry in July 2009 to national laboratories and universities supported by their programs, explaining the shortage and asking for input on use, demand and alternatives. The public outreach campaign included letters to scientific associations involved in cryogenics, nuclear detection, medicine, and basic research, alerting them and their members of the shortage. Dedicated ^{3}He sessions at technical association meetings such as the American Association for the Advancement of Science, National Academy of Sciences, American Nuclear Society, Institute of Nuclear Materials Management and Institute of Electrical and Electronics Engineers were arranged. The Isotope Program posted a fact sheet on the ^{3}He shortage on both the Office of Nuclear Physics Website and the Isotope Business Office website in August 2009, notifying stakeholders of the shortage and informing them of the interagency efforts.

In July 2009, the White House National Security Staff (NSS) formed an Interagency Policy Committee (IPC), with broad federal representation, to investigate strategies to decrease overall demand for ^{3}He, increase supply, and make recommendations to optimally allocate existing supplies. Both NNSA and the Office of Science are members of the IPC and the working groups that subsequently have been formed. The DOE, through its Isotope Program, presently is distributing the 2010 allocations of ^{3}He to federal and non-federal entities, based on the recommendation of the IPC. The allocation process gives priority to scientific uses dependent on unique physical properties of ^{3}He and to maintaining continuity of activities with significant sunk costs. It also provides some supply for non-government sponsored uses, principally oil and gas exploration. The Isotope Program is working closely with ^{3}He industrial distributors to ensure that the available ^{3}He is being distributed in accordance with the Interagency Working Group decisions.

Preliminary results obtained by the interagency group, projected FY 2010 U.S. demand to be 76,330 liters, far outpacing the total available supply of 47,600 liters or projected annual production of 8,000 liters. Based on guidance developed by the group, agencies have reduced their projected needs to 16,549 liters. A second review produced further reductions to 14,557 liters for FY 2010. At a December 10, 2009 meeting, the task force agreed to allocate a portion of this revised amount.

To achieve this reduction in demand, DHS and DOE have agreed to make no new allocations of ^{3}He for use in portal monitors, which employ the largest quantities of this material in the allocation process. The NNSA Second Line of Defense program will continue carrying out its mission to deploy portal monitors, by using past allotments that provide sufficient ^{3}He to support SLD activities through early FY 2011.

Impact of ^{3}He Shortage

International Safeguards

The current shortage has had the most severe impact on U.S. international safeguards efforts. Historically, due to the low cost of ^{3}He, the U.S. has been the major supplier of ^{3}He in support of International Atomic Energy Agency (IAEA) safeguards efforts. ^{3}He is the neutron detector material in systems used for nuclear material accountancy measurements that help assure that nuclear materials have not been diverted. Except for the U.S. mixed oxide fuel (MOX) facility, which received its full request, all other U.S. international safeguards support is currently on hold as a result of the ^{3}He supply shortage. Concern about undermining the U.S. Government international safeguards efforts at the Japan MOX (JMOX) facility resulted in further investigation of international options for ^{3}He supply and verification of the operational timeline for JMOX. The IAEA is currently reaching out to Member States requesting they support JMOX by making ^{3}He available. The U.S. has offered to work with potential ^{3}He suppliers on extraction processes. NNSA's Office of Nonproliferation and International Security also has been working with Japan on an updated operational timeline. The original 2,800 liter request for FY 2010 has been scaled back to 1,000 liters and approved.

In the case of international safeguards, it is DOE's view that the shortage should not be viewed as just a U.S. problem, but rather one that will require international cooperation to solve. The U. S. has met with IAEA representatives, including Director General Amano, and has obtained full and active IAEA support for outreach to potential international suppliers. DOE also suggested that Russia provide ^{3}He from its reserves in support of these international safeguards efforts. The safeguards community both in the U. S. and internationally has reexamined its ^{3}He needs and the timing of those needs, with a view to phasing in installation of detectors that use non-^{3}He technology, without negative impact to safeguards requirements.

Second Line of Defense (SLD)

Portal monitors have been the largest use of ^{3}He in the past few years, accounting for about one-third of the total annual use. Given that most of the alternative development work is focused portal monitors, the IPC allocation process eliminated ^{3}He allocations for this use. Past FY 2011, this decision could potentially impact the SLD program.

SLD has a sufficient number of ^{3}He-loaded detection tubes to complete its planned deployments through FY 2011. After that, SLD would be dependent on alternative technology for neutron detection. However, boron tri-fluoride (BF3), the neutron detection technology in use before ^{3}He became the preferred alternative, is toxic when exposed to air, leading to difficulties with handling, international shipping, and deployment of monitors in foreign locations. Several new neutron detection technologies are currently being tested by DHS and DOE. However, these need to be brought to full deployment readiness, married with portal technology, and formally tested by SLD for detection capability and robustness, in accordance with the SLD mission and standards. It is estimated that two to three more years of development will be required before detection systems based on these technologies will be available for deployment.

Other users

^3He is used in support of lung imaging research. Constraining allocations or increased gas costs may have an impact on future pulmonary research efforts, particularly long term studies that use and provide historical data. For FY 2010, the medical community received 1,800 liters of gas which supports current activities. The medical research community is working with industry to recapture, recover and recycle ^3He used for pulmonary research.

^3He is used as the refrigerant for ultra-low-temperature coolers for physics research, such as nanoscience and the emerging field of quantum computing. ^3He is unique in that there are no materials other than helium that remain liquid at temperatures closely approaching absolute zero, and ^3He's nuclear properties provide a handle to do cooling that ^4He doesn't provide, allowing for cooling down to the milli-Kelvin level. In FY 2010, the full U.S. cryogenics request for 1,000 liters was approved. The true impacts to both R&D and operational programs will be better quantified in the upcoming months, as users with small volume requirements place orders for their projects.

^3He is a component of ring laser gyros, used in guidance and navigation equipment utilized by the DoD for strategic and tactical programs. These systems are utilized in guidance for smart munitions and missiles and in military aircraft and surface vehicle and navigation systems. They are also used in space guidance and navigation systems. ^3He is required until current testing and qualification tests to assess an alternative gas are completed.

^3He plays an important role in basic research. Neutron scattering provides unique information about the structure and dynamics at the atomic and molecular level for a wide variety of different materials. Neutron scattering instruments have the requirements of high efficiency, very good signal-to-background ratio, and high stability of signal and background. Many neutron instruments depend on the use of ^3He detectors because of their insensitivity to gamma rays, which permits measurements spanning very large dynamic ranges. They have high efficiency (>50%) for thermal neutrons, and their high stability permits precise measurements over long periods of time or with different sample conditions. No other detector technology currently comes close to matching these capabilities. A number of the neutron scattering instruments at the Office of Science High Flux Isotope Reactor (HFIR) and the SNS at ORNL already use ^3He-based detectors. The shortage has not yet impacted the U.S. neutron scattering research community. It is projected that their ^3He allocation will support experiments through FY 2014.

In addition, the international neutron scattering community is developing and installing new facilities that are projected to require approximately 120,000 liters of new ^3He over the course of this decade. The U.S. neutron scattering community has been actively engaged with their international counterparts in investigating ways to reduce the total demand, make better use of available supply, and develop alternative technologies. The U.S. has insisted that international partners take responsibility for securing new sources of ^3He, that the U.S. can no longer be the major supplier satisfying these needs.

Alternative Sources of ^3He

The DOE is pursuing multiple approaches to identify alternative sources of ^3He.

Reuse and recycle
In the medium term (1-3 years), the focus is on investigating ways to increase and/or improve use of ^3He supplies. DOE programs, such as the Emergency Response Program which uses backpack-sized ^3He-based detection equipment for their nuclear search mission, and the international safeguards program have instituted recycle and recovery efforts. These efforts, have led to reductions in their overall demands for new ^3He by about 10 percent. Other programs, such as SLD, have been able to reduce the total amount of ^3He required in each system and still meet required specifications. The Office of Science also has been developing recycling approaches for its uses of ^3He.

To help identify stray inventories of ^3He, DOE/NNSA and Office of Science have issued a call to the laboratories and plants, directing that they inventory unused/excess bulk ^3He quantities and equipment containing ^3He. This could be used in the preparation of a DOE/NNSA recycling program that could be expanded to other government agencies. The DOE laboratories are analyzing the extraction process used to remove ^3He from tritium to determine if it can be further optimized. Savannah River National Laboratory is developing a process to extract ^3He from retired tritium equipment that otherwise would have been discarded. The process may provide as much as an additional 10,000 liters of ^3He.

New supply
Tritium is produced by neutron capture in heavy-water-moderated reactors, such as those used in Canada, Argentina and other countries. Because tritium is radioactive, utilities using these types of reactors often need to separate and store tritium in sealed containers, where it decays to produce ^3He. Typically these containers have been designed to support permanent storage, not future extraction. DOE/NNSA is discussing with these countries how much, if any, ^3He they have in storage and how best to secure and make available. Investigations into possible ways to secure that material include transporting the storage containers to the U.S. for extraction in the U.S. or licensing the U.S. extraction process at the foreign facility. These are on-going negotiations; additional details can be provided once agreements have been reached with potential partners. Based on preliminary estimates, DOE/NNSA believes it would be possible to extract approximately 100,000 liters of ^3He over a 7-year period. The results of technical feasibility and cost studies are expected to be available by early FY 2011 as a basis for decisions by DOE and other interested agencies.

Over the longer term, it may be possible to produce ^3He rather than derive it as a byproduct of other activities. DOE/NNSA is currently examining the feasibility of two possible pathways. However, both of these options would require capital investment by DOE or another agency, and would likely involve a substantial increase in the cost of ^3He to the end user.

First, it may be possible to extract ^{3}He from natural gas. A 1990 Department of Interior (DOI) Study entitled, "Method and Apparatus for Direct Determination of ^{3}He in Natural Gas and Helium" found wide variations in the amount of ^{3}He at various drilling sites, ranging from less than 1 part per billion to over 200 parts per billion.

Secondly, the NNA Office of Defense Programs is evaluating the cost and feasibility of conducting reactor-based irradiations to produce tritium for the primary purpose of subsequent ^{3}He harvesting. This approach would utilize the facilities currently employed to generate tritium for the nuclear weapons stockpile. Although the necessary infrastructure currently is in place, additional costs would be incurred for target fabrication and subsequent processing. Because of the 12.3-year half life of tritium, there would be a delay of a number of years before any new ^{3}He would become available.

Non ^{3}He based detectors
In FY 2009, NNSA initiated a program to address the shortage of ^{3}He that focuses on non-^{3}He replacement technologies for neutron detectors in portal monitors deployed by the SLD Program. The NNSA Office of Nonproliferation and Verification Research and Development has, for many years, been developing alternative neutron detection technologies, but these efforts were not focused on portal monitoring applications that require large-area detectors. Since FY 2009, this application has become the principal focus of this neutron detection R&D program. Several promising technologies are being investigated that could supplement the use of the older BF_3 technology as substitutes for ^{3}He neutron detectors.

Current Actions and Allocation Process for Helium-3

The NSS IPC met in September 2009 and concurred on a strategy that decreases overall demand for ^{3}He, including conservation and alternative technologies, increases supply through exploring foreign supplies/inventories and recycling, and optimally allocates existing supplies. Furthermore, the IPC agreed to defer all further allocation of ^{3}He for portal monitors, beginning in FY 2010, and would not support allocating ^{3}He for new initiatives that would result in an expanding ^{3}He infrastructure. The IPC stipulated that ^{3}He requests should be ranked according to the following priorities:

1. programs requiring the unique physical properties of ^{3}He have first priority.
2. programs that secure the threat furthest away from US territory and interests have second priority.
3. programs for which substantial costs have been incurred will have third priority.

Adoption of this approach for managing the U.S. ^{3}He inventory produces allocations for Fiscal Years 2010 through 2017 that can be met by projected reserves. This is in contrast to the original allocation approach, which would have resulted in large and increasing shortages over the same period of time.

For FY 2010, allocations were as follows:

a. DOE (Safeguards)	800 liters (+1000 liters)*
b. DOE (Detection)	1,520 liters

c. DOE (Emergency Response) 1,750 liters
d. DOE (NIF/NNSA) 80 liters
e. DOE-Science 341 liters
f. NIST 832 liters
g. Oil and Gas 1,000 liters
h. NIH (Med Imaging) 1,800 liters
i. Cryogenics 1,800 liters
j. NASA 80 liters
k. Environ Management 0 liters
l. IC 0 liters
m. DoD 882 liters (+648 liters)**
n. DHS 772 liters
o. DOS 100 liters

*DOE requested and was approved for an additional 1000 liters for the JMOX facility in FY10.
**DoD requested and was approved for an additional 648 liters in FY10. 325 liters will be used for the guidance and navigation systems, and 323 liters will be used by the DoD laboratories for cryogenic dilution refrigeration.

Concluding Remarks

The DOE is committed to working with other agencies, the community and the White House in reducing the demand of ^{3}He, increasing the supply of ^{3}He, and distributing ^{3}He in accordance to the Nation's highest priorities.

Thank you, Mr. Chairman and Members of the Committee, for providing this opportunity to discuss the national ^{3}He shortage and DOE's roles and reaction to the shortage. I'm happy to answer any questions you may have.