CAUGHT BY SURPRISE: CAUSES AND CONSEQUENCES OF THE HELIUM-3 SUPPLY CRISIS

HEARING

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

APRIL 22, 2010

Serial No. 111–92

Printed for the use of the Committee on Science and Technology

CAUGHT BY SURPRISE: CAUSES AND CONSEQUENCES OF THE HELIUM-3 SUPPLY CRISIS

CAUGHT BY SURPRISE: CAUSES AND CONSEQUENCES OF THE HELIUM-3 SUPPLY CRISIS

HEARING

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

APRIL 22, 2010

Serial No. 111–92

Printed for the use of the Committee on Science and Technology

Available via the World Wide Web: http://www.science.house.gov

U.S. GOVERNMENT PRINTING OFFICE

57–170PDF WASHINGTON : 2010

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON SCIENCE AND TECHNOLOGY

HON. BART GORDON, Tennessee, *Chair*

JERRY F. COSTELLO, Illinois
EDDIE BERNICE JOHNSON, Texas
LYNN C. WOOLSEY, California
DAVID WU, Oregon
BRIAN BAIRD, Washington
BRAD MILLER, North Carolina
DANIEL LIPINSKI, Illinois
GABRIELLE GIFFORDS, Arizona
DONNA F. EDWARDS, Maryland
MARCIA L. FUDGE, Ohio
BEN R. LUJÁN, New Mexico
PAUL D. TONKO, New York
STEVEN R. ROTHMAN, New Jersey
JIM MATHESON, Utah
LINCOLN DAVIS, Tennessee
BEN CHANDLER, Kentucky
RUSS CARNAHAN, Missouri
BARON P. HILL, Indiana
HARRY E. MITCHELL, Arizona
CHARLES A. WILSON, Ohio
KATHLEEN DAHLKEMPER, Pennsylvania
ALAN GRAYSON, Florida
SUZANNE M. KOSMAS, Florida
GARY C. PETERS, Michigan
JOHN GARAMENDI, California
VACANCY

RALPH M. HALL, Texas
F. JAMES SENSENBRENNER JR., Wisconsin
LAMAR S. SMITH, Texas
DANA ROHRABACHER, California
ROSCOE G. BARTLETT, Maryland
VERNON J. EHLERS, Michigan
FRANK D. LUCAS, Oklahoma
JUDY BIGGERT, Illinois
W. TODD AKIN, Missouri
RANDY NEUGEBAUER, Texas
BOB INGLIS, South Carolina
MICHAEL T. MCCAUL, Texas
MARIO DIAZ-BALART, Florida
BRIAN P. BILBRAY, California
ADRIAN SMITH, Nebraska
PAUL C. BROUN, Georgia
PETE OLSON, Texas

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

HON. BRAD MILLER, North Carolina, *Chairman*

STEVEN R. ROTHMAN, New Jersey
LINCOLN DAVIS, Tennessee
CHARLES A. WILSON, Ohio
KATHY DAHLKEMPER, Pennsylvania
ALAN GRAYSON, Florida
BART GORDON, Tennessee

PAUL C. BROUN, Georgia
BRIAN P. BILBRAY, California
VACANCY
RALPH M. HALL, Texas

DAN PEARSON *Subcommittee Staff Director*
EDITH HOLLEMAN *Subcommittee Counsel*
JAMES PAUL *Democratic Professional Staff Member*
DOUGLAS S. PASTERNAK *Democratic Professional Staff Member*
KEN JACOBSON *Democratic Professional Staff Member*
TOM HAMMOND *Republican Professional Staff Member*

C O N T E N T S

April 22, 2010

Opening Statements

Panel I:

Panel II:

CAUGHT BY SURPRISE: CAUSES AND CONSEQUENCES OF THE HELIUM-3 SUPPLY CRISIS

THURSDAY, APRIL 22, 2010

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brad Miller [Chairman of the Subcommittee] presiding.

Subcommittee on Investigations and Oversight

Hearing on

Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis

Thursday, April 22, 2010
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Panel I

Dr. William Hagan
Acting Director
Domestic Nuclear Detection Office (DNDO), Department of Homeland Security (DHS)

Dr. William Brinkman
Director
Office of Science, Department of Energy

Panel II

Mr. Tom Anderson
Product Manager
Reuter-Stokes Radiation Measurement Solutions, GE Energy

Mr. Richard Arsenault
Director
Health, Safety, Security, and Environment, ThruBit LLC

Dr. William Halperin
John Evans Professor of Physics
Northwestern University

Dr. Jason Woods
Assistant Professor
Northwestern University

HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
U.S. HOUSE OF REPRESENTATIVES

Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis

THURSDAY, APRIL 22, 2010
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

The Subcommittee on Investigations and Oversight meets on April 22, 2010, to examine the causes and consequences of the Helium-3 supply crisis. Helium-3 (He-3) is a rare, non-radioactive gas that has been produced in both the United States and Russia as a by-product of nuclear weapons development. Tritium, which helps boost the yield of nuclear weapons, decays into Helium-3 gas after approximately 12 1/2 years. The gas was produced as a consequence of tritium production by the defense programs of the Department of Energy (DOE). As a valuable commodity, it was packaged, managed and sold through DOE's Isotope Program in the Office of Nuclear Energy (though the Isotope program was moved to the Office of Science in a reorganization during FY2009).

Background

Helium-3 has wide-ranging applications as a neutron detector for nuclear safeguards, nonproliferation and homeland security purposes because it is able to detect neutron-emitting radioactive isotopes, such as plutonium, a key ingredient in certain types of nuclear weapons. Currently, almost 80 percent of its use is for safeguards and security purposes worldwide. It is also broadly used in cryogenics, including low-temperature physics; quantum computing; neutron scattering facilities; oil and gas exploration; lasers; gyroscopes; and medical lung imaging research.

During the Cold War, the U.S. had a steady supply of He-3 gas resulting from weapons production, but tritium production was halted in 1988. In the wake of the 9/11 terrorist attacks, however, the desire for radiation portal monitors and other nuclear detection equipment exploded. The Department of Homeland Security, for example, initiated a program to install more than 1,400 radiation portal monitors at ports and border crossings and also to supply smaller detectors to state and local governments. This enormous new demand came just as the available supply of Helium-3 was diminishing because of a reduction in nuclear weapons production. By early 2009, the total demand for helium was over 213,000 liters, and the supply was 45,000 liters.

The Department of Energy is the sole U.S. supplier of He-3 as part of its management of the nuclear weapons stockpile. They are also a key consumer of the gas because of their nuclear weapons detection program (the DOE Megaports and Second Line of Defense programs distribute PVT radiation portal monitors and other smaller detectors to nations around the world) and because of their support for spallation neutron sources. As the key supplier of He-3, as well as a consumer of the gas and a partner with agencies such as DHS and DOD in nuclear security, DOE was in a position to see the disconnect between an expanding demand and a declining supply. However, DOE failed to see the problem until the He-3 stockpile was nearly expended. This guaranteed that the He-3 shortage would become a crisis, rather than a smoothly managed transition to conserving and allocating supply to the highest use and obtaining alternative technologies.

It wasn't until late in 2008 that the Helium-3 supply shortage began to be identified as an issue by DOE when DNDO suppliers of He3 and other non-safeguards users could not obtain enough He-3 for their work. The last major allocation of He-3 had occurred in 2008 when DOE set aside 35,000 liters for the Spallation Neutron

Source, an advanced neutron science research center at DOE's Oak Ridge National Laboratory in Tennessee which the Department spent over $1 billion to construct.

By January of 2009, an inter-agency phone conference between DNDO and DOE occurred in which DOE established restrictions on the use of He-3. DNDO agreed to develop priorities for He-3 use and initiate a working group on the issue; DOE said it would start investigating alternatives. In the wake of that meeting, an inter-agency task force developed with participation by DNDO, DOE and the Department of Defense. That task force first met in March 2009. In the discussion that ensued, total annual government and non-governmental demand for FY2009 was projected as in excess of 213,000 liters. The total available stockpile was, at that time, just 45,000 liters. Out years show similar levels of demand while annual production was projected at 8,000 liters. As an appreciation of the scope of the problem developed among the key participants, other agencies were invited to participate. Work quickly began on allocation of He-3 for FY 09 and 10, research on alternatives and investigation of possible sources of additional He-3, such as obtaining tritium from Candu reactors in Canada, Argentina and other countries to harvest He-3 and recycling and re-use of existing He-3. The entire process was "elevated" to the National Security Council when the DOD staffer heading up their He-3 effort was detailed to the NSC.

This process continued under the new Interagency Policy Committee (IPC), chaired by staff at the NSC. The Subcommittee has been told that allocation decisions for 2010 have been completed; the gas is now being processed and will soon be provided to those who have been approved to receive it.

Impact of the Shortage

The domestic and global impact has been profound. The per-liter He-3 have skyrocketed from $200 to in excess of $2,000 per liter. (The Subcommittee has been told of one sale of Russian He-3 to a German firm at a price of $5,700 a liter.) The U.S. has essentially halted all exports of Helium-3 gas, and recently told the International Atomic Energy Agency (IAEA) that they will no longer be able to rely solely on the U.S. to provide them with He-3 gas for use in non-proliferation enforcement and verification actions. The Canadian government had to receive special permission from the U.S. prior to the Vancouver Olympics to permit the export of a He-3 mobile neutron detector for use at the Olympic Games.

For neutron scattering facilities that require tremendous amounts of Helium-3 gas, the situation is very grim. At least 15 of these multi-billion dollar research facilities are being or have been built in at least eight countries, including the U.S., United Kingdom, France, Germany, Switzerland, Japan, South Korea and China. By 2015, these facilities will require over 100,000 liters of He-3 gas, according to estimates provided to the Subcommittee. Most of those needs are unlikely to be met. There have been several international meetings of scientists discussing possible alternatives to He-3 for spallation neutron detection, but the research is in the very early stages.

Within the U.S. government, no program appears to have been more significantly affected than the Domestic Nuclear Detection Office's (DNDO's) Advanced Spectroscopic Portal (ASP) radiation monitor program, which relies on He-3 as its neutron detection source. The scale and scope of the Helium-3 crisis, however, and its impact on the ASP program in particular was not clearly known outside the government until the Investigations & Oversight Subcommittee held its second hearing on the ASP program on November 17, 2009. During that hearing, Dr. William Hagan, acting director of DNDO, testified that the Interagency Policy Committee had decided in September 2009 that He-3 would not be used radiation portal monitors. This was the first time the Subcommittee and the public were informed of the extent of the Helium-3 crisis. Surprisingly, even Raytheon, DNDO's prime contractor on the ASP program, did not become aware that a decision had been made to halt the supply of Helium-3 gas for their radiation portal monitors until they heard Dr. Hagan's testimony.

Summary

The shortage of He-3 was an inevitable consequence of a declining source from the U.S. nuclear weapons enterprise and a growing demand. However, the crisis and its jarring impacts were avoidable. With foresight on the part of DOE, the kinds of prioritization efforts now happening through the IPC could have started years ago. Research into alternatives to He-3 could have been well along to success, with some areas (such as portal monitor systems) lending themselves to alternatives more readily than others (cryogenics). In short, the stockpile could have been managed in a way that allowed for non-disruptive impacts to industry, researchers and the national security community. Instead, everyone is surprised and scrambling to identify alternatives, suspending their research and their production lines while hoping that a breakthrough in sources of He-3 or alternatives to He-3 happens very, very rapidly. The failure to manage the stockpile with an eye to demand, supply and future needs has had real consequences for many, many fields. Once the shortage became clear to all the key agencies, an interagency process that has laid out a rational guide to allocation and policies has emerged very quickly and appears to be well managed.

Witnesses

Panel I

Dr. William Hagan, *Acting Director, Domestic Nuclear Detection Office (DNDO), Department of Homeland Security (DHS)*

Dr. William Brinkman, *Director of the Office of Science, Department of Energy (DOE)*
(Dr. Brinkman will be accompanied by **Dr. Steven Aoki**, *Deputy Undersecretary of Energy for Counterterrorism and a Member of the White House He-3 Interagency Policy Committee (IPC) Steering Committee*.)

Panel II

Mr. Tom Anderson, *Product Manager, Reuter-Stokes Radiation Measurement Solutions, GE Energy*

Mr. Richard L. Arsenault, *Director of Health, Safety, Security and Environment, ThruBit LLC*

Dr. William Halperin, *John Evans Professor of Physics, Department of Physics, Northwestern University*

Dr. Jason C. Woods, *Assistant Professor, Radiology, Mallinckrodt Institute of Radiology, Biomedical MR Laboratory, Washington University in St. Louis and Program Director, Hyperpolarized Media MR Study Group, International Society for Magnetic Resonance in Medicine (ISMRM)*

Chairman MILLER. Good morning. This hearing will now come to order.

Welcome to today's hearing called "Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis."

Five months ago, this Committee held a hearing that examined technical problems in the development of the Domestic Nuclear Detection Office's (DNDO's) new generation of radiation portal monitors called Advanced Spectroscopic Portals, or mercifully, ASPs. Among the issues that the Subcommittee had expressed an interest in or we had heard about as a potential problem was the effect of a reported shortage of helium-3 and whether that was affecting the ASP program, or might affect it, and at that hearing, Dr. Bill Hagan, the Acting Director of DNDO, who is with us again, testified that because of the shortage of helium-3, that the White House two months earlier had had barred DNDO from using helium-3 in radiation portal monitors. We would have liked to have known that before the hearing but we found out about it in the testimony at the hearing, not the prepared testimony submitted in advance but actually in the oral testimony at the hearing. It was a surprise to us. Also, the principal contractor, Raytheon, had a witness here who also was wondering about it in the oral testimony at the hearing.

We have since learned that both the Department of Energy and the Department of Homeland Security should have known several years ago that it would be a disaster to rely on radiation-based equipment that used helium-3 technology. Helium-3 is a byproduct of tritium, and tritium's only purpose is to enhance the capability of nuclear weapons. Until recently, no tritium had been produced in this country since 1988, and the reduction in our stockpile of nuclear weapons guaranteed a reduction in the stockpile of tritium and therefore helium-3.

At the same time, or after 9/11, the demand for helium-3 grew exponentially because of the use in radiation detection devices. DOE not only produces and sells helium-3, but is one of its largest consumers through the Megaports and Second Line of Defense programs and the Spallation Neutron Source at Oak Ridge. DOE never warned anyone that there was no long-term supply for all of these uses and everyone who used or counted on helium-3 should begin to make other plans, look for alternatives. In 2006, there was only 150,000 liters left in the stockpile and DOE told Homeland Security that there was enough for 120,000 liters then estimated for the first phase of the ASP program. The result was that in mid-2008 when commercial vendors began to warn of a helium-3 shortage, DHS didn't appear to take it seriously. It took several more months before there was a government-wide acknowledgement of the severity of the problem.

The effects of the helium-3 shortage are real and painful and not just for radiation detection. Helium-3 also plays a crucial role in oil and gas exploration and in cryogenics including low-temperature physics, quantum computing, neutron scattering facilities and medical lung imaging research. Important science is on hold in a wide range of fields and commercial opportunities for American firms have been lost. Over the past year the cost of obtaining helium-3 has risen from around $200 per liter to more than $2,000 per liter.

For many applications there are potential alternatives for some work, particularly the cryogenics. There is no known alternative for helium-3, so today we will examine the causes and the consequences of the helium-3 supply crisis with an eye to learn lessons to guide future resource management. We also want to hear about what we are now doing to manage the limited supply of helium-3, to set priorities for access to that stockpile and the search for alternative sources and alternative gases. I understand the allocations for 2010 have been determined, the gas is being processed and it will soon be distributed.

Looking back, it is clear that the shortage was inevitable. If DOE had noticed the disconnect between supply and demand, they could have managed the stockpile with clear priorities that would have allocated it to the most important, most essential uses and led to an aggressive and timely search for alternatives. That might have helped avoid the crisis or mitigated the crisis.

Why did DOE not see this coming? And also, why did DNDO not validate, ascertain that there was enough helium-3 for the ASP program? A cautious and reasonable analysis should have sought a complete accounting from DOE before wagering years of effort of research and hundreds of millions of dollars into a technology that depended upon a gas that would not be available.

The current efforts of DNDO, DOE and DOD and other agencies working with the National Security Council staff do appear to be very well organized. Although there are many failures to get to this point, it does appear that all the relevant agencies are doing well now. They are identifying alternatives. They are trying to identify other sources, international sources of helium-3, and it really is a model, as I understand it, for interagency crisis management but the best crisis management is not to have a crisis, and I hope that DOE has learned and other agencies will learn from this and lead to wiser management of the unique isotopes they control and distribute.

Finally, obviously we were mildly annoyed to learn that the technology that we had been investigating for some time was not going to be used, to learn that in oral testimony. We are also at least mildly annoyed that we had not gotten the documents that we have asked for. The agencies appear to be going through some extraordinary courtesies to each other of letting everybody review everybody's else's documents and there is no legal basis for that, and it may be a courtesy by each agency to the other but it is discourteous to us and makes it very difficult for us to do our job. We are not as well prepared today for this hearing as we would like to be and should have been had the documents that we requested in a timely way been provided in a timely way, and I certainly took the last Administration to task for their failures in that area and I intend to take this Administration to task as well.

We are leaving—in consultation with Dr. Broun, we are leaving the record of this hearing open today to add additional documents that we receive, tardy production of documents, and it is very possible that there are questions that we should have asked had we had those documents that there will be another hearing. I know it is not convenient for us either.

[The prepared statement of Chairman Miller follows:]

PREPARED STATEMENT OF CHAIRMAN BRAD MILLER

Five months ago, the Subcommittee held a hearing titled: *The Science of Security: Lessons Learned in Developing, Testing and Operating Advanced Radiation Monitors*. That hearing examined technical problems in the development of the Domestic Nuclear Detection Office's (DNDO's) new generation of radiation portal monitors called Advanced Spectroscopic Portals or ASPs. Among the issues the Subcommittee had expressed an interest in was the impact a reported shortage of Helium-3 was having on the ASP program.

At that hearing, Dr. Bill Hagan, the Acting Director of DNDO, (who joins us again today) testified that the shortage of Helium-3 was so severe that two months earlier a White House Interagency Policy Committee (IPC) had barred DNDO from using Helium-3 in radiation portal monitors. Since the Department had not informed the Subcommittee of this situation, and the written testimony submitted to the Subcommittee also failed to make reference to the decision, we were surprised by the testimony. We were not the only ones to be surprised, among others taken by surprise was DNDO's the main ASP contractor, Raytheon.

What we have learned since is that both the Department of Energy and the Department of Homeland Security should have known several years ago that it would be a disaster to base radiation-detecting equipment on helium-3 technology. Helium-3 is a byproduct of tritium, and tritium's only purpose is to enhance the capability of nuclear weapons. Until recently, no tritium had been produced in this country since 1988, and the reduction in the nation's stockpile of nuclear weapons guaranteed a reduction in the stockpile of tritium—and helium-3.

After 9/11—at the same time the supply was significantly decreasing—the demand for helium-3 grew exponentially for use in radiation detection devices. It was also expanding for spallation neutron facilities worldwide, cyrogenic and medical research, and oil and gas exploration. The Department of Energy, which not only produces and sells helium-3, but is one of its largest consumers through the Megaports and Second Line of Defense programs and the Spallation Neutron Source at Oak Ridge, never—not once—warned anyone that there was no long-term supply for all of these uses, and they should begin looking for alternatives. In fact, in 2006, when there was only 150,000 liters left in the stockpile and many other users lined up, DOE told the Department of Homeland Security that there was enough for the 120,000 liters then estimated for the first phase of the ASP program. The result was that in mid-2008 when commercial vendors began to warn of a He-3 shortage, DHS didn't appear to have taken them seriously. It took several more months before there was government-wide acknowledgement of the severity of the problem.

The impacts of the helium-3 shortage are real and painful and extend well beyond Megaports, the Second Line of Defense and the ASP programs. Because of its unique physical properties, helium-3 plays a crucial role in oil and gas exploration, cryogenics (including low-temperature physics), quantum computing, neutron scattering facilities and medical lung imaging research. Important science is on hold in a wide range of fields and commercial opportunities for American firms that sell products using helium-3 have been lost. Over the past year the cost of obtaining Helium-3 has risen from around $200 per liter to more than $2,000 per liter.

The ongoing crisis has drastically delayed the ability of researchers and others to obtain helium-3 and prevented many firms and researchers from acquiring helium-3 at all, at any price. For many applications there are potential He-3 alternatives including boron-10 and lithium. For some work, particularly cryogenics-related applications, however, there are no known alternatives to using Helium-3 and these industries will need to continue to be supplied with He-3 if these industries and their scientific research programs are to continue.

Today, we will examine the causes and consequences of the Helium-3 supply crisis with a desire to learn lessons to guide future resource management. We also want to hear about the processes that are now in place to manage the limited supply of helium-3, to set priorities for access to that stockpile and the search for alternative sources and alternative gases. It is my understanding that allocations for 2010 have been determined, the gas is being processed and it will soon be distributed.

Looking back, it is clear that the shortage was inevitable. Helium-3 has been captured by the Department of Energy from the decay of tritium. With the end of the Cold War and the arms reduction agreements going back all the way to the Reagan Administration, the stockpile of tritium was not growing and so the production of Helium-3 would inevitably decline. Since 1991, DOE has allocated over 300,000 liters of helium-3, drawing the reserve down to a very low level by 2009. The annual production of Helium-3 from the U.S. tritium stockpile is now in the range of 8,000 liters per year and demand is orders of magnitude higher.

At the same time that production was declining, the demand for Helium-3 has been increasing since 9–11. Helium-3 has been a critical component in the portal radiation monitor programs at DHS and approximately 60,000 liters have been used in the current PVT systems alone. The ASP systems that Raytheon designed would have required, if a full acquisition had gone forward, approximately 200,000 liters of helium-3. The Department of Energy has its own radiation detection program in mega-ports with additional liters of helium-3 used in that program. Handheld and backpack radiation detection systems at DHS, DOE and also DOD are another ongoing source of expanded demand since 9–11.

In addition to this new security-related source of demand, the Spallation Neutron Source project, also a DOE program was moving towards conclusion, with its main detector requiring an additional 17,000 liters. With countries around the world all pushing to get into SNS-style research, the global demand in coming years for Helium-3 from these detectors alone is expected to exceed 100,000 liters.

Since the shortage was inevitable, does it matter that DOE failed to see that their stockpile was evaporating? Yes, it absolutely does matter. If DOE had noticed the disconnect between growing demand and declining supply, they could have managed the stockpile with clear prioritization for highest use, and led an aggressive and timely search for alternatives to helium-3. These actions would have helped us avoid this crisis. It is astonishing that DOE did not see this coming.

It also astonishes me that DNDO did not validate that sufficient resources of helium-3 were available for the ASP program. A cautious and reasonable analyst would have sought a complete accounting from DOE before wagering years of effort and hundreds of millions of dollars.

Good crisis management is an inspiring thing to see in the government and I have to say that the current efforts of DNDO, DOE, DOD and other agencies under the orchestration of the National Security Council staff appears to be very well organized. They have set out to do a thorough survey of demand and have attempted to identify all outlying sources of supply. They are identifying alternative gases and locating international opportunities to temporarily expand the supply of Helium-3. All of this is laudatory, and can serve as a nice model for future interagency management of crises, but even better is to avoid a situation requiring crisis management in the first place. I hope that DOE has learned a lesson with Helium-3 that will lead to wiser management of the unique isotopes they control and distribute.

The final lesson I hope the agencies and the White House learn is that when a Subcommittee asks for your documents, you have to produce them or explain why you cannot. The Subcommittee wrote to both the Department of Energy and the Department of Homeland Security on March 8 requesting materials by March 29. Neither agency responded in a timely fashion. Neither agency has produced all of their materials, nor offered anything approaching a comprehensible explanation of the situation. Allegedly, some small set of documents were originally produced by White House staff and distributed to the agencies, and I have been surprised at the difficulty of getting the White House and the agencies to simply do the reviews that the precedents of legislative-executive relations suggest should properly occur for these documents, which do not appear to rise to the level of an executive privilege claim. I am hopeful that we will break this impasse soon.

The implications of the situation are that the Subcommittee is not as prepared for this hearing as we should properly be. The agencies have gone through elaborate fictional inter-agency courtesies allowing for duplicative, time-consuming reviews. There is no legal basis for these reviews. This has not only wasted time but is discourteous to the Committee. As a result, it is my intention to leave the hearing record open and, in consultation with my Ranking Member, Dr. Broun, to include in the record relevant materials that are responsive to my original letter. I will not rule out a second hearing on this subject if the documentary record contradicts testimony we receive today nor would I rule out taking any other steps necessary to compel production of agency records. I hope it won't come to that, but I had enough of stonewalling and slow rolls by the last Administration to have much patience with it from this Administration.

Chairman MILLER. I am attaching for the record two letters sent to the Subcommittee on the subject. One is from an oil and gas industry representative and one is from a researcher at the Lawrence Livermore National Lab.

[The information follows:]

April 19, 2009

Mr. Brad Miller, Chairman
Subcommittee on Investigations & Oversight
Committee on Science & Technology
U.S. House of Representatives
Washington DC

Subject: Helium 3 (He-3) shortage and petroleum industry

Dear Honorable Chairman Miller,

I am greatly honored to provide this input to you, the Ranking Minority Member and the Subcommittee on this important matter. While the petroleum industry utilizes only a small volume (2.5%) of the total He-3 volume used worldwide, it is a critical component of a key technology utilized in this industry. Thus, its shortage is likely to have a major economic impact unless it is mitigated by availability of additional supplies or alternative technologies.

I am grateful to Mr. Doug Pasternak, the Subcommittee Staff Professional Staff Member, for inviting the input. I am an oil industry nuclear scientist working in R&D at a major oil company technology organization and also the Coordinator of an oil industry technology group, Nuclear Logging Special Interest Group (SIG), which despite its rather charged name is actually the oil industry technical group of nuclear experts who deal with technical issues only. All major nuclear experts in the industry participate in it. Like technical SIG's in other petrophysics-related disciplines, the Nuclear SIG functions under the umbrella of the Society of Petrophysicists and Well Log Analysts (SPWLA).

In order to address the invitation, I canvassed my colleagues in the Nuclear SIG and received input from several of them. I particularly thank Drs. Dale Fitz (ExxonMobil), John Nieto (Canbriam Energy), Brad Roscoe and Chris Stoller (Schlumberger), Jerome Truax (Halliburton) and Ward Schultz (Smith-Pathfinder) for the input and discussion. In this letter, I collect their thoughts and combine them with my own. While the letter reflects the wisdom of several industry nuclear logging experts, the letter's composition and hence any errors or omissions, are entirely mine, and are inadvertent.

In the letter, I first briefly describe the importance of He-3 to the petroleum industry and then discuss how its shortage has begun to impact the industry, the likely future impact, possible alternatives, challenges in developing alternatives and what the industry is doing to address the challenge posed by the shortage. Several of the oil service companies learned of the shortage through supply problems going back to July 2009 and then the fall of 2009. Two industry experts attended the recent AAAS Forum held in Washington DC on this topic.

A. Application of He-3 in Oil Industry

He-3 is an inert, non-hazardous gas used in the so-called proportional counters to detect neutrons. As is well-known, it comes from the decay of tritium primarily from the nuclear weapons stockpile which is dwindling. In the petroleum industry, He-3 is used in detectors in neutron porosity tools, one of the key instruments used to locate hydrocarbons, estimate petroleum reserves, and make production decisions. The neutron device is particularly used to establish the rock and fluid parameters which help determine these properties. Thus, uncertainties in these parameters can have a large impact. For example, a seemingly small uncertainty in the reservoir porosity (the fraction of the geological formation that is porous) can result in uncertainties in reserves in the tens to hundreds of millions of barrels oil-equivalent, depending on the size and quality of the reservoir. These are discussed in **Attachment A** in greater detail.

As discussed in Attachment A, neutron instruments (using He-3 detectors) play a central role in detecting gas and quantifying gas volumes. Thus, with both clean-gas and shale-gas reservoirs becoming key sources of US and world energy supply, an accurate neutron measurement is critically important.

B. Impact of He-3 shortage to date

Since July 2009, the He-3 shortage has affected the cost and availability of new detectors for most service companies. In some cases, additional premiums have been required to assure supply in the near future. For others, the shortage has led to reduced spare parts and delayed production of new tools. One vendor redesigned one of their key neutron instruments to reduce the He-3 volume which increased the statistical error of the instrument by over 20%.

C. Potential long term Impact of He-3 shortage

We noted previously that neutron measurements are critical in detecting gas and quantifying the gas volume. Thus, with both clean-gas and shale-gas reservoirs becoming key sources of US and world energy supply, any increase in the uncertainty in the neutron response caused by a degraded detection system, either due to redesign to reduce the amount of He-3 in the detector or due to the necessity to use a lower performing alternative, will have a significant economic impact. We noted previously the 20% increase in the statistical uncertainty of the measurement from instrument redesign to reduce He-3 inventory in the detector by one tool designer.

We will see later that none of the alternatives to He-3 being considered perform at the level of He-3 at this time. One user of the technology estimates that alternatives to He-3 could add 10% uncertainty to reserves estimates for clean gas reservoirs and could add 15-20% uncertainty to overall reserves estimates when density-neutron approaches are used to quantify shale volume.

Even if alternatives were to become technically feasible, we would need a sufficient supply of He-3 gas until we can roll out new technology that is independent of He-3 gas. The next one- to ten-year time-frame will be critical for us since we do not currently have alternatives and it will take time to develop and implement them.

D. He-3 vs. potential alternatives

The characteristics important in detectors used in the petroleum industry are efficiency, statistical precision, gamma-neutron response separation (to avoid interference from gamma rays), deployment robustness such as temperature and pressure tolerance, cost, and commercial availability. To date He-3 has had the best combination of these characteristics to detect neutrons, although the current shortage is making He-3 more expensive and its availability is now in question. We briefly review the characteristics of He-3 and those of major alternatives under consideration.

He-3 detectors are able to operate at temperatures up to 500 F (260 C); they survive under high mechanical shocks and vibrations which especially arise in logging-while-drilling; they have a high neutron detection efficiency, which is very important because of space limitations inside well logging instruments; and they have a very low detection background from gamma rays.

The major alternatives considered are 1) BF-3 counters, 2) boron-lined counters, 3) lithium-6 glass scintillators, and 4) optical fibers coated with scintillator and lithium. All are deficient in one or more of the characteristics desired for detectors. For example, the BF-3 proportional counters which could be a direct physical replacement of He-3 counters have only 1/5 the sensitivity to neutrons as He-3, although their neutron-gamma separation is as good. In addition, BF-3 is toxic and corrosive. The sensitivity of Boron-lined tubes (these are non-toxic) is even lower (1/7 of He-3). The sensitivity of lithium-glass scintillator is similar to that of He-3 but these tubes have high interference from background gamma-ray induced signals ; the separation is only 1/10 of that of He-3. Only coated fiber has comparable neutron sensitivity and neutron-gamma separation but it has not been produced on a large scale and thus is expensive. While research is underway to eliminate these deficiencies, physics limitations may prevent that and it may take three to ten years before suitable alternative can be found.

As we drill deeper and in hotter environments, the industry is searching for more reliable technologies than current detection systems and the impact of He-3 shortage will be even greater because, some of the alternative technologies would take us in the wrong direction. For example, in hot wells, the reliability and life-time of detection system will be severely degraded if a lithium-glass-and-PMT-pulse-discrimination system replaces the current system which itself is prone to failures in such wells.

E. Industry steps to address the problem

The major service companies have either undertaken steps to address the issue or are contemplating them. These include assuring supply by paying a premium, reusing He-3 from aging detectors, and looking at alternative detector technologies. Here are a couple examples:

Schlumberger have initiated a process to reduce, reuse, and recycle He-3 detectors and/or the He-3 gas. They have already started a recycling program of tubes and He-3 gas from old or broken tools. In addition, they are looking at ways to reduce the usage of gas in existing tools (if it does not affect the response) and of new tools under development. In addition, they have reallocated company resources to look at neutron detector technologies that might work in oil industry environments within the constraints that industry imposes on them.

Other service companies, such as Halliburton and Pathfinder, have either initiated R&D on replacements or will do so if reduced availability of the He-3 becomes a challenge despite the payment of a premium.

It should be noted that unlike the major service companies which can commit significant resources to R&D of alternatives, small mom-and-pop service companies, often with no large R&D capability, will be devastated without He-3 and without R&D support from the government on alternatives.

F. Length of time and cost to switch to He-3 free technology

Since currently there is nothing off-the-shelf that would work reliably in the harsh environment logging tools operate and at the same time, supply the required performance in terms of detection efficiency, count-rate capability, and neutron-gamma discrimination, it would take a significant effort to develop alternatives. There are three key steps in the process: 1) developing and qualifying a replacement technology, 2) rolling out of this technology out into fully engineered and characterized commercial tools for use/field trials by oil companies, and 3) getting acceptance of the quality of resultant measurements by the users.

Schlumberger: In their input to me on this question, Schlumberger "hoped" that they can develop a qualified replacement technology within 3 years. Once they have a qualified technology, they need to engineer it into a down-hole logging tool. This step would involve, 1) optimizing the response to compensate for undesirable sensitivities (such as salinity or stand-off), 2) fully characterizing the response, and 3) the new technology, which is likely to introduce some differences in tool response, being accepted by the clients as giving the response they desire and can use. They noted that a normal design cycle for this phase is likely to be 5-7 years.

Since there are several tool configurations for the many different environments and applications, several iterations would be required through this second step. Since one can't work on all the issues simultaneously, it will take additional time to change or replace the entire fleet of neutron tools with a new technology. Thus, my Schlumberger colleagues estimate that this would take at least 12 years from the time that they have a new neutron detector technology and it would cost in excess of $100 Million.

Halliburton. They estimate that replacement with different technologies for new equipment would require about a $1.5 Million investment for the first re-engineering and perhaps $800K for each instance thereafter. In Halliburton, with nine instances, this would amount to $8 Million. Industry-wide, using Halliburton's market share numbers , a total re-engineering cost of $50 Million is postulated by my Halliburton colleagues.

They further estimate that the incremental cost of each unit produced would be about $60K for LWD and about $30K in wireline for an additional cost to Halliburton of $12 Million annually for new production. Converting industry-wide, using the market-share numbers, gives about $60 Million incremental cost per year for new builds.

From the above discussion it is clear that shortage of He-3 will have a severe impact on the petroleum industry and thus on the US and world economy. The timing of the occurrence of this shortage is particularly unfortunate as shale-gas reservoirs are becoming a key part of world's reduced carbon energy sources and neutron detection is the most reliable way to detect gas and quantify gas volumes. Consequently, without the He-3 detection system, the uncertainty in reserves and resources of oil companies could increase significantly and oil-service companies will be unable to provide quality measurements in a timely manner. Small service companies and operating companies will be particularly affected.

The industry is looking at alternatives to He-3, but all current potential alternatives would require R&D to reduce or eliminate their limitations. This will require a one to ten year window to develop and implement alternatives at a cost of $50 million to $100 million. The smaller vendors are unlikely to be able afford such costs. I believe that industry-government collaboration will be needed to address the impact of He-3 shortage.

My colleagues and I thank you, Mr. Chairman and the Subcommittee for the opportunity for providing input on a key issue to the industry with the potential to adversely affect the economy unless it is addressed appropriately and in a timely manner. We will be happy to further address technical questions based on the input in this letter.

Best regards,

Ahmed Badruzzaman, Ph. D; Fellow of Am. Nucl. Soc.
Coordinator, SPWLA Nuclear SIG
306 Shavano Way
San Ramon, CA 94583

Tel: (925) 842-1043 (Work)
(925) 828-3342 (Home)

Ahmed Badruzzaman is a Senior Staff Research Scientist and the Nuclear R&D Leader at Chevron Energy Technology Co, San Ramon, CA. He has also taught, part-time, a graduate course, *Subsurface Nuclear Technology*, at the Department of Nuclear Engineering at University of California, Berkeley, CA, since 2001. He is a Fellow of American Nuclear Society and was a Distinguished Lecturer of the Society of Petroleum Engineers (2006-2007) and Distinguished Speaker of the SPWLA (2002-2003). He earned a Ph. D in Nuclear Engineering and Science from Rensselaer Polytechnic Institute, Troy, NY, in 1979.

Disclaimer: This letter is based technical input collected by Dr. Badruzzaman from his colleagues in the SPWLA Nuclear SIG and his own views, all as individual experts. Its contents are not intended to reflect those of their employers, organizations they are affiliated with or of the SPWLA.

April 19, 2009

Attachment A to Letter by A. Badruzzaman to House Subcommittee on Investigations & Oversight Committee on Science & Technology

Nuclear tools are compact devices used to interrogate the subsurface media, along with other subsurface devices (electrical, sonic, magnetic resonance, etc), to locate hydrocarbons, estimate petroleum reserves, and make production decisions. Two major types of nuclear instruments are used to probe the subsurface for fluid and rock properties during exploration and development of a field. One uses a photon source and measures formation density from which one computes the porosity, the formation volume that is porous and thus can hold a fluid. The other nuclear tool uses a neutron source to estimate a "neutron porosity" which indicates both the presence of hydrocarbon fluids and of the 'shaliness' of the rock that impacts flow behavior and the estimation of the porosity.

Neutron-density measurements are coupled to indicate gas; in fact the neutron measurement is the best gas indicator. For lower quality reservoirs, a sonic- neutron overlay is essential. The (thermal) neutron measurement is about twice as sensitive to gas at reservoir condition as the companion formation density measurement. Thus, the neutron measurement is central in estimating the total porosity in gas-bearing formations.

Uncertainty in petrophysical parameters can result in large uncertainties in the reserves estimate and producibility of a reservoir. For example, an error of one porosity unit in a 15 porosity unit reservoir (i.e., a reservoir with 15% of its volume being porous) with a nominal oil reserve of 1 billion barrels, will introduce an uncertainty of 67 million barrels.

Lawrence Livermore National Laboratory

Darin Kinion, PhD
LLNL MS L-50
Livermore, CA 94550
April 16, 2010

Mr. Brad Miller
Chairman, Subcommittee on Investigations & Oversight,
Committee on Science & Technology
U.S. House of Representatives

Dear Chairman Miller:

I am writing to you to describe the impact of the Helium-3 shortage on my research program at Lawrence Livermore National Laboratory. I am in the middle of a program sponsored by IARPA to develop superconducting materials and readout for Quantum Computing applications. The overall aim of the program is to develop new, powerful types of computers which have significant applications to national security. These computers rely on Quantum Mechanics, and must operate at temperatures within a few thousandths of a degree from absolute zero. To reach these temperatures requires an instrument called a dilution refrigerator which uses a mixture of Helium-3 and Helium-4 gases to reach ultra-low temperatures.

As part of my research program I placed an order with Janis Instruments to purchase a dilution refrigerator. This in turn required a subcontract with Spectra Gases to supply the required 23 liters of He-3 gas. In early October 2009, a request for approval to release the gas was submitted. With no response to the first request, a second request was submitted in November 2009. As of today, there is still no response from either request, and no He-3 has been supplied. Janis Instruments was kind enough to loan me some gas for testing, but my program is dependent on receiving the He-3 for continuation. It is not reasonable for me to consider a loan of He-3 gas a solution to my problem. Given the size of the research program I am part of, the stockpile at Janis would be completely depleted in a short period of time if other groups were forced to rely on a similar loan. There is no doubt that the shortage is real, and that all users of Helium-3 can expect some impact in terms of cost and delivery schedule. A major problem right now is a lack of information regarding the process and guidelines to be followed. An approval process was seemingly in place, but six months have passed with no feedback. In a four year research program, this is a major burden. Working on a intelligence backed activity at a National Laboratory, I am a bit surprised at the trouble I am facing from the Department of Energy.

As part of a detector group at LLNL which works on the detection of special nuclear materials, I am aware of the desirability of Helium-3 for these applications. However,

Mr. Brad Miller
April 16, 2010
Page 2

there is one point that I specifically want to get across to the committee: there are potential alternatives for the SNM detectors, but there is **NO** alternative for dilution refrigerators. The mixture of Helium-3 and Helium-4 is unique, and no other method is available for reaching ultra-low temperatures.

I would also like to pass along a couple of thoughts related to my experiences in low-temperature physics. First, I hope that recycling efforts are part of either this hearing or one in the near future. I have seen a number of retired instruments around, and with the current shortage it could easily be worth the time and effort to retrieve the He-3 gas. I would be very interested to know the amount of gas that is sitting in storage vessels in the corners of laboratories around the country. The second thought is that by necessity, dilution refrigerators are built to be extremely leak-tight, and the amount of He-3 gas is constantly monitored. The loss rate is very low. With new applications, it should be very important that all users treat the gas as a precious resource.

Thank you for the opportunity to explain my situation, I regret that I could not be there in person for this important discussion. I would like to stress the need for a process to be in place that allows scientists to better estimate costs and delivery times when He-3 gas is involved before embarking on a major research endeavor. I will conclude by again stating that Helium-3 gas is a precious resource and there is no alternative for scientists who require ultra-low temperatures and the businesses that build the instruments. Please feel free to contact me if you need any assistance regarding this issue.

Sincerely,

Darin Kinion
Physicist, Science & Technology Directorate
LLNL
(925) 422-8798
kinion1@llnl.gov

Chairman MILLER. The Chair now recognizes our Ranking Member from Georgia, Dr. Broun, for his opening statement.

Mr. BROUN. Thank you, Mr. Chairman.

Let me welcome our witnesses here today and thank you all for attending. I wish I could say that I was glad that we are holding this hearing, but unfortunately, I am not.

During a hearing last fall, as the Chairman has already mentioned, the hearing was on the Domestic Nuclear Detection Office's ASP program, Advanced Spectroscopic Portal program. This Subcommittee was notified of the state of the Nation's helium-3 supply and the shortfall's effects on our national security, particularly in nuclear detection. This by itself was a troubling revelation, but the impact of insufficient helium-3 supplies is not limited to the national security sector. Medical treatments, oil and gas exploration, cryogenics and other research endeavors have all come to depend upon helium-3 because of its historical abundance as a byproduct of our nuclear weapons program.

For years helium-3 was a cheap and plentiful resource that was ideal for many applications because of its intrinsic properties. Until only recently the United States was continually building up its stockpile but a number of issues combined to change that trend. The breakdown of our Nation's nuclear weapon stockpile after the Cold War, the increased priority on domestic nuclear detection brought about by September 11, 2001, the demand created by neutron scattering facilities and Russia's decision to cease exports all combined to create the perfect storm for helium-3. DHS, DOE, DOD initiated processes to limit demand, ration existing supplies and find alternatives but these actions were after the fact. As this Committee has seen before with rare earth elements, medical isotopes and plutonium-238, mitigation efforts were taken after the crisis has already emerged.

In the future, the Federal Government needs to do a better job of projecting both the demand for isotopes in its control and its own needs of those isotopes and elements that are not. This becomes even more important with the President's recent nuclear arms reduction pact with Russia.

I look forward to working with the Chairman to ensure that the Federal Government does a better job of predicting and mitigating these supply shortages. I congratulate the Chairman on his efforts to help do just that.

To this end, I hope that the agencies assist this Committee in meeting its oversight responsibilities in a more cooperative fashion. To date, the documents provided to this Committee in response to the Chairman's request contained unexplained redactions. It is also my understanding that not all documents have been provided. In order for this Committee to do its work, the agencies and the Administration need to either provide the documents requested or claim a legally recognized privilege so that we can move forward. I hope we will see some radical changes on that issue.

Thank you, Mr. Chairman, and I yield back the balance of my time.

[The prepared statement of Mr. Broun follows:]

PREPARED STATEMENT OF REPRESENTATIVE PAUL C. BROUN

Let me welcome our witnesses here today and thank them for appearing. I wish I could say that I was glad we were holding this hearing, but unfortunately I'm not.

During a hearing last fall on the Domestic Nuclear Detection Office's (DNDO's) Advance Spectroscopic Portal Program (ASP), this subcommittee was notified of the state of the Nation's helium-3 supply and the shortfall's effect on national security—particularly nuclear detection. This by itself was a troubling revelation, but the impact of insufficient helium-3 supplies is not limited to the national security sector. Medical treatments, oil and gas exploration, cryogenics, and other research endeavors have all come to depend on helium-3 because of its historical abundance as a byproduct of our nuclear weapons program.

For years, helium-3 was a cheap and plentiful resource that was ideal for many applications because of its intrinsic properties. Until only recently, the U.S. was continually building up its stockpile, but a number of issues combined to change that trend. The drawdown of our nation's nuclear weapons stockpile after the cold war; the increased priority on domestic nuclear detection brought about by September

11th, 2001; the demand created by neutron scattering facilities; and Russia's decision to cease exports all combined to create the perfect storm for helium-3.

DHS, DOE, and DOD initiated processes to limit demand, ration existing supplies, and find alternatives, but these actions were after the fact. As this committee has seen before with rare earth elements, medical isotopes, and plutonium-238, mitigation efforts are taken after the crisis has already emerged. In the future, the federal government needs to do a better job of projecting both the demand for isotopes in its control, and its own needs of those isotopes and elements that are not. This becomes even more important with the President's recent nuclear arms reduction pact with Russia.

I look forward to working with the Chairman to ensure that the federal government does a better job of predicting and mitigating these supply shortages. To this end, I hope that the agencies assist this committee in meeting its oversight responsibilities in a more cooperative fashion. To date, the documents provided to the committee in response to the Chairman's requests contain unexplained redactions. It is also my understanding that not all documents have been provided. In order for this committee to do its work, the agencies and the Administration need to either provide the documents requested, or claim a legally recognized privilege so that we can move forward.

Thank you, I yield back the balance of my time.

Chairman MILLER. Thank you, Dr. Broun.

All additional opening statements or any additional opening statements submitted by Members will be included in the record. Without objection now, I would enter a packet of documents into the record.[1] The majority of those materials were drawn from the documents produced by the Department of Homeland Security and the Department of Energy in response to the request, the Subcommittee's request on March 8, 2010. As is our common practice, those materials were shared between the majority and minority staffs before the hearing.

Panel I:

Chairman MILLER. I am now pleased to introduce our witnesses today. Dr. William Hagan is currently the Acting Director of the Domestic Nuclear Detection Office, DNDO, the Department of Homeland Security. Dr. William Brinkman is the Director of the Office of Science at the Department of Energy and has been in his position at DOE since 2009.

As our witnesses should know, you each will have five minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you have all completed your spoken testimony, we will begin with questions and each member will have five minutes to question the panel.

It is our practice to receive testimony under oath. Do any of you have any objection to taking an oath? The record should reflect that all the witnesses nodded their head that they did not. You also have the right to be represented by counsel. Do any of you have counsel here? And the record should reflect that all the witnesses nodded their head that they did not have counsel present. If you would all please now stand and raise your right hand? Do you swear to tell the truth and nothing but the truth?

Dr. Brinkman, would you introduce Dr. Aoki just quickly?

Dr. BRINKMAN. This is Dr. Steven Aoki, who is from the NNSA, part of the DOE, and I want him to be here to represent his half if you have questions.

[1] Please see Appendix 2: Additional Material for the Record.

Chairman MILLER. Okay. Well, he has just taken the oath, so not only will what you tell us be under oath but what he tells you will be under oath as well. You should do that with your staff all the time. I should try it with mine.

Mr. BROUN. Mr. Chairman, I ask unanimous consent that we allow Mr. Rohrabacher to sit in on this hearing.

Chairman MILLER. Without objection.

Okay. The record should reflect that all the witnesses and the witnesses' helpers have taken the oath, and we will start with Dr. Hagan. Dr. Hagan, you are recognized for five minutes.

STATEMENT OF DR. WILLIAM HAGAN, ACTING DIRECTOR, DOMESTIC NUCLEAR DETECTION OFFICE, DEPARTMENT OF HOMELAND SECURITY

Dr. HAGAN. Good morning, Chairman Miller, Ranking Member Broun and distinguished Members of the Subcommittee. On behalf of DNDO, I would like to thank the Committee for the opportunity to discuss the helium-3 supply. My testimony today will address the following points: what was done at the beginning of the Advanced Spectroscopic Portal program to ensure there was adequate supply of helium-3, how we became aware of the shortage of helium-3, how we responded to it, the impact of the shortage on DNDO's programs and the status of the work to identify alternative neutron detection technologies.

In the past, helium-3 was a relatively low-cost commodity and its use has increased greatly in recent years. Its increased demand was driven largely by the expanded use of large radiation portal monitors that are being deployed around the world. An RPM consists of a neutron detector using helium-3 gas in tubes and a gamma detector using a plastic scintillator. In addition, helium-3 is used in scientific research and medical and industrial applications.

Unfortunately, as the demand was rising, the supply was declining. The current and future helium-3 supply will fail to satisfy the demand of interagency partners and the commercial sector.

In February 2006, as DNDO was planning for the Advanced Spectroscopic Portal program, program staff contacted DOE to ensure adequate supplies of helium-3 for up to 1,500 systems over five years. At that time there was no indication that the supply of helium-3 would be problematic. Similarly, vendor responses to the ASP request for proposals showed no concerns over the availability of helium-3 to meet manufacturing needs.

DNDO first became aware of the potential problem with helium-3 supply in the summer of 2008. However, it was unclear whether the problem was a result of delays in the supply chain or an actual shortage of helium-3. In the fall of 2008, DOE issued a report verifying existence and seriousness of the overall supply shortfall.

In February of 2009, DNDO took the lead in forming an interagency helium-3 Integrated Product Team, or IPT, with participation of major users of helium-3 for neutron detection applications. The IPT aimed to assess the true impact of the shortage and to ensure that the most crucial government and commercial programs would receive helium-3. DNDO had simultaneously begun negotiations in January 2009 to secure helium-3 for its programs. The sale was finalized in June, but one month later DNDO ceded control of the helium-3 to be allocated in accordance with interagency determinations.

Further, in September, DNDO ceased to make any new allocations of helium-3 for RPMs. Based on current funding and guidance, however, the helium-3 shortage has had no appreciable short-term impact on the deployment of RPMs. The program has a sufficient inventory of systems to support deployments through 2011. Additionally, a number of technical and management solutions are further reducing potential impacts. For instance, if ASP units are certified, the helium-3 from the existing RPMs that are being replaced can be reused in the ASP units.

Devices that utilize smaller volumes of helium-3 such as handhelds and backpacks may also be impacted by this shortage. To mitigate the impact, industry has been purchasing helium-3 from other sources and recycling gas from obsolete equipment. However, a redesign of current equipment to utilize new neutron technologies will eventually be necessary, and DNDO plans to work with industry to catalyze this development. DNDO will also request modest allocations from the government stockpile to continue deployment of these systems until alternatives are available.

DNDO has been funding programs to identify alternative neutron detection technologies for several years. However, because helium-3 was widely available until only recently, alternatives are still somewhat early in their development. DNDO is working with the commercial sector to identify technologies that have potential for near-term commercialization and recently tested several available alternatives. DNDO has also accelerated exploratory research projects to identify other potential materials suitable for neutron detection. I brought a few examples here on the table today if you would like to discuss later.

My testimony has outlined the course of action DNDO took to initially ensure the availability of helium-3 when we became aware of the shortage, the steps we took in response, the impacts of the shortage and the alternative technologies under development. Chairman Miller, Ranking Member Broun and Members of the Subcommittee, I thank you for your attention and we will be happy to answer your questions.

[The prepared statement of Dr. Hagan follows:]

PREPARED STATEMENT OF WILLIAM K. HAGAN

Introduction:

Good morning Chairman Miller, Ranking Member Broun, and distinguished members of the Subcommittee. As Acting Director of the Domestic Nuclear Detection Office (DNDO) at the Department of Homeland Security (DHS), I would like to thank the Committee for the opportunity to discuss the helium-3 (He-3) supply.

As requested, my testimony today will address the following points:

- How we became aware of the shortage of He-3;
- How we responded to it;
- What was done at the beginning of the Advanced Spectroscopic Portal (ASP) program to ensure there was an adequate supply of He-3 to meet the program's needs;
- The impact of the shortage on DNDO's radiological and nuclear detection programs; and

- The status of the work we are doing to identify alternative technologies to replace He-3 as a neutron detector.

Since National Security Staff has recently briefed the Committee staff regarding the He-3 shortage, I have limited my remarks today to DNDO actions related to He-3.

Helium-3 Supply

The United States' supply of He-3 has traditionally come from the decay of tritium, which the nation previously produced in large quantities as part of the U.S. nuclear weapons enterprise. The suspension of U.S. production of tritium in the late 1980s, however, resulted in a reduction in the amount of He-3 available for harvest. Currently, a significant portion of He-3 is used for neutron detection to aid in the prevention of nuclear terrorism. He-3 has become the overwhelmingly predominant technology used for this purpose; the Departments of Homeland Security, Defense (DoD), and Energy (DOE) each have nuclear detection programs that use He-3-based sensors. Additionally, He-3 is finding increasingly widespread use in areas beyond homeland security, including scientific research, medical, and industrial applications. Some of these applications may require relatively large volumes of He-3 for which there may be no known alternative. In the past, He-3 was a relatively low-cost commodity, and its use increased particularly with the advent of large radiation portal monitors both domestically and abroad. The limited supply of He-3, which is based on the nation's current stores of tritium, has been overwhelmed by this increase in demand. The current and future He-3 supply will fail to satisfy the demand of interagency partners and the commercial sector. Only approximately one tenth of the current demand for He-3 will be available from DOE/National Nuclear Security Administration (NNSA) for the foreseeable future, and neutron detectors using He-3 are already becoming difficult to procure.

Since the inception of DHS in 2003, the majority of He-3 used was for the Radiation Portal Monitor (RPM) program. An RPM consists of a neutron detector, using He-3 gas in tubes, and a gamma detector, using large slabs of plastic scintillator. When DNDO was established in 2005, the RPM program was transferred from U.S. Customs and Border Protection (CBP). In FY 2006, when preparing to start a program for an advanced portal system, called the Advanced Spectroscopic Portal (ASP), DNDO met with DOE to discuss strategic resources that would be required for the ASP. DOE gave no indication that the supply of He-3 would be problematic, even with the amount of units we were envisioning.

Until recently, DHS acquired systems using He-3 by publishing an RFP and then reviewing responses to select a vendor or vendors. The bidders, in preparing their responses, would check the resources required to fulfill the order, including He-3. When this process was used at the beginning of the ASP program, none of the proposals indicated any issue with He-3 supply.

In the summer of 2008, DNDO first became aware of a potential problem with the He-3 supply through an email from a neutron detector tube manufacturer. Although DNDO investigated this issue, it was initially unclear whether the problem was a result of delays in the supply chain or an actual shortage of He-3. DOE, which traditionally has been responsible for managing and allocating the supply of He-3, issued a report verifying the existence and seriousness of the overall supply shortfall in the fall of 2008.

In February 2009, DNDO took the lead in forming the He-3 Interagency Integrated Product Team (IPT), with participation of DOE/NNSA and DoD, to assess the true impact of the shortage and to ensure that the most critical government and commercial programs would preferentially receive He-3. The IPT also began exploring opportunities to manage the existing He-3 stockpile; increase the supply of He-3; account for the entire demand for He-3; investigate alternative technologies to replace He-3 for neutron detection; adapt old technologies for retrofit into existing equipment; and examine policy issues that may impact the use, distribution, or production of He-3.

The IPT took steps to secure the He-3 necessary for high-priority programs, which included the RPM Program. DNDO also began negotiations in late January 2009 to secure He-3 for the ASP and other DNDO programs. This He-3 sale, which would have covered initial deployments of ASP, was finalized in June 2009. In July 2009, DNDO ceded control of this He-3 purchase to the National Security Staff Interagency Policy Committee to be allocated in accordance with interagency determinations in order to optimally satisfy the competing needs of He-3 users. As the He-3 is allocated to other agencies and departments, DNDO will be financially reimbursed. DNDO has continued to coordinate with interagency efforts to manage the

He-3 shortage and actively participates in interagency working groups to address He-3 supply, demand, alternative technologies, and policy.

Impact of the Helium-3 Shortage

Because of the volume of He-3 required in the construction of RPMs and the desire to make sure that He-3 was being used for the highest interagency priorities, DNDO ceased to allocate any additional He-3 for RPMs in September 2009. Based on current funding and guidance for the RPM Program, the He-3 shortage has had no appreciable impact on the deployment of systems in FY 2010. The program has a sufficient inventory of RPM systems with He-3 tubes available to support deployments through FY 2011. Additionally, a number of solutions—including both the identification of new detector materials and management solutions to most effectively utilize existing supplies—are yielding results. If ASP units are certified for secondary scanning applications, DHS can reuse the He-3 from the existing RPMs that are being replaced and use it for the ASP units. Simultaneously, DNDO is leading interagency efforts to identify alternative neutron detectors that may eventually replace He-3 in these applications.

While other devices (for example, handheld radioisotope identification devices and backpack detectors used by the U.S. Coast Guard, CBP and the Transportation Security Administration) use smaller volumes of He-3, they are also impacted by this shortage. To mitigate the shortage and ensure supply to government customers, industry has been purchasing He-3 from other sources, such as private companies that have stored He-3, and recycling gas from obsolete equipment. This has offset some of the shortfall in the near-term, but a redesign of current equipment will be necessary over the next several years, once new neutron detection technologies have been identified. As such, DNDO plans to work with the device manufacturers to develop new technologies, integrate them into systems, and test them for suitability in the field. In the meantime, DNDO will also request modest allocations from the government stockpile to continue deployment of current human portable systems until alternatives are available.

Alternative Neutron Detection Technologies

As I mentioned earlier, the U.S. government is also exploring options to resolve this situation through the development of new types of neutron detectors. DNDO is at the forefront of these efforts and had been funding programs to address alternative neutron detection technologies as part of their mandate, prior to any knowledge of the He-3 shortage. We are also working with the interagency to engage the technical, commercial, and international communities to solicit ideas to address alternative materials for neutron detection. We are confident that the government, private industry, and international stakeholders are making progress on a prudent path forward. At present, we are working with the commercial sector to identify alternative detection products that have potential for near-term commercialization. Our DNDO Exploratory Research projects that address other detection materials with neutron capabilities have also been accelerated.

DNDO recently tested many known commercial off-the-shelf (COTS) and near-COTS alternatives for neutron detection and remains committed to working with the interagency to identify potential solutions. For RPMs that require large volumes of He-3, four technologies have been identified as being potentially viable candidates. Boron Trifluoride (BF_3)-filled proportional counters were widely used for neutron detection before He-3-based detectors were available. DNDO conducted testing at a national laboratory to compare the performance of BF_3 with the performance of He-3; while this testing validated the neutron detection capabilities of BF_3 as a low cost replacement technology, we continue to seek additional alternatives because the hazardous material classification of BF_3 makes it less attractive for end users.

Other promising technologies under development include Boron-lined proportional counters; Lithium-loaded glass fibers; coated non-scintillating plastic fibers; and a new scintillating crystal composed of Cesium-Lithium-Yttrium-Chloride, (Cs_2LiYCl_6) or CLYC, commonly pronounced “click”, that has both neutron and gamma detection capabilities. Some of these new technologies may have neutron detection capabilities that meet or even exceed the abilities of current He-3-based detectors. Before any alternative is commercialized, we will check the availability of the key components to avoid another shortage issue.

Since He-3 was widely available and relatively inexpensive until only recently, alternatives are still somewhat early in their development, although these development efforts have been accelerated in the last year or so. DNDO will continue funding of exploratory research and early development, testing of new COTS and near-

COTS alternatives, and acquisition of samples of promising technologies for more extensive testing and evaluation.

Chairman Miller, Ranking Member Broun, and Members of the Subcommittee, I thank you for your attention and will be happy to answer your questions.

BIOGRAPHY FOR WILLIAM K. HAGAN

Dr. William Hagan is the Acting Director of the Domestic Nuclear Detection Office (DNDO), a position he has held since December 2009. Prior to this position, Dr. Hagan served as the Acting Deputy Director from January through December 2009. Dr. Hagan was initially appointed to the Senior Executive Service and joined DNDO in 2006 as the Assistant Director for Transformational Research and Development (R&D), where he was responsible for long-term R&D, seeking technologies that can make a significant or dramatic positive impact on the performance, cost, or operational burden of detection components and systems.

Prior to DNDO, Dr. Hagan had a long career with Science Applications International Corporation (SAIC), where he worked from 1977 through 2006. He served in many positions during his tenure with SAIC, culminating with a position as the Senior Vice President and Deputy Business Unit Manager for Operations of the Security and Transportation Technology Business Unit (STTBU). Specifically, STTBU focused on securing the supply chain by applying technologies such as neutron interrogation, gamma- and x-ray imaging, passive radiation detection, ultrasound, radio frequency resonance, and chemical agent detection using data fusion of ion mobility spectrometry and surface acoustic waves. The radiation portal monitors that are currently used to screen 99% of all cargo entering the country were built by STTBU, using technology from a company whose acquisition was led by Dr. Hagan in 2003.

Previous positions with SAIC included work as a senior scientist, operations manager, Group Manager of the Technology Development Group (TDG) of the SAIC's Commercial Business Sector, and Senior Vice President for Technology Commercialization and acting Chief Technical Officer for SAIC's Venture Capital Corporation.

Dr. Hagan earned a Bachelor of Science in Engineering Physics in 1974, Master of Science in Physics in 1975, and Master of Science in Nuclear Engineering in 1977 from the University of Illinois at Urbana. He received his Ph.D. in Physics from the University of California–San Diego in 1986. He holds three patents.

Chairman MILLER. Thank you.

Dr. Brinkman, you are now recognized for five minutes.

STATEMENT OF DR. WILLIAM BRINKMAN, DIRECTOR OF THE OFFICE OF SCIENCE, DEPARTMENT OF ENERGY

Dr. BRINKMAN. Thank you. Thank you, Chairman Miller, Ranking Member Broun and Members of the Committee. I appreciate the opportunity to come before you and provide testimony on DOE's action in response to the national helium-3 shortage.

Within the DOE, both NNSA and the Office of Science play a role in helium-3 production. NNSA provides the helium-3 supply and the Isotope program now within the Office of Science distributes helium-3 from NNSA to the marketplace. Even before the DOE Office of Science assumed responsibility for the Isotope program in fiscal year 2009, we undertook measures to educate the various communities of users including national security, medical, industrial and research communities of isotope shortages in general.

Our Office of Nuclear Physics within the Office of Science organized a major workshop in August 2008. The purpose of this workshop was to identify critical isotopes for the Nation that are in short supply. Following this workshop, the community of users became aware of the imminent shortage of helium-3 and the DOE began coordinating future allocations of helium-3 with other agencies. We and others in the government have reinforced this message through presentations at major scientific societies including the American Association for the Advancement of Science, for example.

Since assuming responsibility for the Isotope program one year ago, the Office of Science has worked very closely with NNSA and other federal agencies to develop a coordinated response. In March 2009, we joined NNSA, DOD and DHS to form an interagency group with the purpose of identifying demand, supply and R&D options for the future. Since July 2009, this interagency effort has been under the auspices of an official Interagency Policy Committee formed by the White House national security staff.

Our approach has been straightforward. We have reached out to the various communities that use helium-3 and asked them to refine their needs in light of the shortage so that we can allocate resources as rationally as possible across various sectors. We also identified portal monitors as a vital but disproportionate source of demand for helium-3 and recognized the need for alternative detection technologies. These alternative detectors, although not quite as good as helium-3, will enable us to support these applications without the use of helium-3 and will provide our country with a strong nuclear detection program. We are cautiously optimistic that alternative detection approaches can be evaluated and put into production in the next few years, avoiding major disruption of planned deployment of portal monitors as seen by the evidence on the table here.

We worked hard to develop accurate needs for other communities that use helium-3, cryogenic research, lung imaging and other communities, and found that with recycling the helium-3 we could further reduce the demand. The guidance developed by the IPC for allocation of available helium-3 supply assigns high priority to scientific applications that depend on the unique physical properties of the isotope.

Working on the supply side, we have developed a plan that will allow us to keep in balance the supply and demand for the next five to six years. To do this, we need to increase our supply by one of two approaches. The first would be to use helium-3 that results from heavy-water reactors that exist around the world but particularly in Canada. The second would be to produce commercial tritium using the current infrastructure but separately from the weapons program and harvest the helium-3 from tritium decay. We are currently getting cost estimates, et cetera, for these two approaches. If we can capture the helium-3 from Canada, we believe that we have a balanced program over the next five to six years.

Another possibility is extracting helium-3 from helium sources such as natural gas deposits. Since the fraction of helium-3 captured from natural gas wells is only 200 parts per billion, further study is needed to determine whether this approach can be cost competitive. We believe we have organized a well-defined proactive interagency approach to meeting this challenge and mitigating its impact to the extent possible. Thank you.

[The prepared statement of Dr. Brinkman follows:]

PREPARED STATEMENT OF WILLIAM F. BRINKMAN

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 ^{3}He in the United States is outpacing production.

The major application of ^{3}He 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 ^{3}He 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. ^{3}He 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 ^{3}He, we have reached a critical shortage in the global supply of ^{3}He.

Realization of ^{3}He Shortage

From 1980 to 1995, ^{3}He 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 ^{3}He. For security purposes, this total was closely held, and not known widely beyond DOE. Sales of this raw ^{3}He 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 ^{3}He. 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 ^{3}He derived from tritium processing. On October 2, 2003, the first invitation to bid on the sale of ^{3}He 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 ^{3}He was entering the U.S. market annually. Since 2003, DOE has sold over 200,000 liters of ^{3}He, 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 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 ^3He 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 ^{3}He.

To help identify stray inventories of ^{3}He, DOE/NNSA and Office of Science have issued a call to the laboratories and plants, directing that they inventory unused/ excess bulk ^{3}He quantities and equipment containing ^{3}He. 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 ^{3}He from tritium to determine if it can be further optimized. Savannah River National Laboratory is developing a process to extract ^{3}He from retired tritium equipment that otherwise would have been discarded. The process may provide as much as an additional 10,000 liters of ^{3}He.

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 ^{3}He. Typically these containers have been designed to support permanent storage, not future extraction. DOE/ NNSA is discussing with these countries how much, if any, ^{3}He 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 ^{3}He 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 ^{3}He 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 ^{3}He 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 ^3He 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. ^3He 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 ^3He, increasing the supply of ^3He, and distributing ^3He 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 ^3He shortage and DOE's roles and reaction to the shortage. I'm happy to answer any questions you may have.

BIOGRAPHY FOR WILLIAM F. BRINKMAN

Dr. William F. Brinkman was confirmed by the Senate on June 19, 2009 and sworn in on June 30, 2009 as the Director of the Office of Science in the U.S. Department of Energy. He joins the Office of Science at a crucial point in the Nation's history as the country strives toward energy security—a key mission area of the Department of Energy.

Dr. Brinkman said during his confirmation hearing that he looked forward to working "tirelessly to advance the revolution in energy technologies, to understand nuclear technologies and to continue basic research in the 21st century."

Dr. Brinkman brings decades of experience in managing scientific research in government, academia, and the private sector to the post. He leaves a position as Senior Research Physicist in the Physics Department at Princeton University where he played an important role in organizing and guiding the physics department's condensed matter group for the past eight years.

He joined Bell Laboratories in 1966 and after a brief sojourn as the Vice President of Research at DOE's Sandia National Laboratories, where he oversaw the expansion of its computer science efforts, Dr. Brinkman returned to Bell Laboratories in 1987 to become the executive director of its physics research division. Dr. Brinkman returned to Bell Laboratories in 1987 to become the executive director of its physics research division. He advanced to the Vice President of Research in Bell Laboratories in 2000, where he directed research to enable the advancement of the technology underlying Lucent Technologies' products. Brinkman led a research organization that developed many of the components and systems used in communications today, including advanced optical and wireless technologies.

He was born in Washington, Missouri and received his BS and Ph.D. in Physics from the University of Missouri in 1960 and 1965, respectively. Since this time, he has served as a leader of the physics community. He has spent one year as a National Science Foundation postdoctoral fellow at Oxford University. He has served as president of the American Physical Society and on a number of national committees, including chairmanship of the National Academy of Sciences Physics Survey and their Solid-State Sciences Committee. He is a member of the American Philosophical Society, National Academy of Sciences, and the American Academy of Arts and Sciences.

He has worked on theories of condensed matter and his early work also involved the theory of spin fluctuations in metals and other highly correlated Fermi liquids. This work resulted in a new approach to highly correlated liquids in terms of almost localized liquids. The explanation of the superfluid phases of one of the isotopes of helium and many properties of these exotic states of matter was a major contribution in the middle seventies. The theoretical explanation of the existence of electron-hole liquids in semiconductors was another important contribution of Brinkman and his colleagues in this period. Subsequent theoretical work on liquid crystals and incommensurate systems are additional important contributions to the theoretical understanding of condensed matter.

Chairman MILLER. Thank you, Dr. Brinkman.

We will now begin with our first round of questions and the Chair now recognizes himself for five minutes.

Dr. Brinkman, I know that you joined in DOE in 2009 so the obvious criticisms don't apply to you personally. I know that you probably don't want to be harshly critical, publicly of the people who now work for you but it does seem obvious with benefit of hindsight that this was coming and that DOE not only as the only domestic source for helium-3 but is a major consumer of helium-3 should obviously have known what the demand was and what the supply was and seen this coming, and even apparently DHS, we might fault them for not being more aggressive about assuring that there was a sufficient supply, apparently did inquire and DOE said no problem. How did that happen?

Dr. BRINKMAN. As you point out, I wasn't around to witness that. The only thing I can say is that at the time the Russians were putting a lot of helium-3 onto the market as well as the DOE and I think that confused the picture somewhat as to what was actually going on in the marketplace and it was only around 2008 when people started to really realize what was happening and then the Russian source dried up and so there was a sequence of events that happened there that—look, I don't want to defend the situation because it is unfortunate that this wasn't recognized earlier but there was a sequence of events there that led to some confusion.

Chairman MILLER. You mentioned earlier that you have now had a conference on isotopes, rare isotopes. Although I know that helium-3 was discussed at that, it doesn't appear that the participants in the conference came away with an oh, crap kind of feeling about it. There was an understanding that there was, you know, some shortage but not quite a crisis. What are you all doing now to identify whether there are other isotopes that may have a supply or demand that greatly exceeds the supply and that we aren't developing technologies that will depend upon a material that is not there?

Dr. BRINKMAN. Well, first of all, the program has been moved to the nuclear physics office rather than the nuclear energy office. The nuclear energy organization is really interested in reactors, not isotopes. However, the nuclear physics organization is an organization which is very much interested in isotopes, rare isotopes of various types to learn more about nuclear physics and nuclear structure, and so it has a much bigger presence in isotope development and now of course manages all of our isotope development that we do internally. So it is responsible for exactly what you are asking for, where things will go wrong.

We of course, have had another crisis as you know in moly 99, and it was ameliorated again by an interagency office, and we are working at looking very carefully for future ways of generating that particular isotope and have made progress on how to do that commercially.

Chairman MILLER. The Chair now recognizes Dr. Broun for five minutes.

Mr. BROUN. Thank you, Mr. Chairman.

Coming back to Dr. Brinkman, you mentioned moly 99 as a problem. Helium-3 obviously from this hearing is a problem. How about other isotopes? Have you identified other isotopes that are susceptible to similar shortages, and if so, what other technologies should we be utilizing to seek alternatives to those isotopes?

Dr. BRINKMAN. Those are the only two known to me that we have to worry about, but we have a workshop report in which we have gone through all the different isotopes that are used commercially and looked to see whether they are in short supply and what we need to supply them. So we have a full report on that, and we have gone through all of them. These two are the ones that I know have created recent crises, anyway. I don't believe we are in trouble on any others.

Mr. BROUN. Are you continuing an inventory on an ongoing basis of those just to make sure that we do not have a repeat of what we are having on helium-3?

Dr. BRINKMAN. We sure try to.

Mr. BROUN. I certainly hope so.

Dr. Brinkman, part of the reason we found ourselves in the current situation is the drawdown of nuclear weapons after the Cold War. What impact will the recently signed nuclear agreement with Russia have on helium-3 supplies?

Dr. BRINKMAN. It is bound to reduce them further because the weapons program will eventually draw down the tritium supply that they need and so we really will have to find alternative sources, and that is what we are working on right now.

Mr. BROUN. What other isotopes are potentially impacted by that?

Dr. BRINKMAN. I don't think there are any other isotopes impacted by the production of tritium, which is what you have to produce to make helium-3.

Mr. BROUN. All right, sir. Are we the only nation that provides helium-3 for IAEA monitors?

Dr. BRINKMAN. Primarily, that is true.

Mr. BROUN. Is the United States bound by international agreements to supply helium-3 to the IAEA?

Dr. BRINKMAN. You will have to answer that.

Dr. AOKI. Well, the United States is not bound by international agreement but traditionally we have been the primary source of supply for the IAEA nuclear safeguards program. One of the things that we have done as the magnitude of the problem have become clear, we have encouraged the IAEA to actually pursue supplies from other countries. In particular, Russia would be one place they could go look, possibly some other countries, but we have really made sure that the IAEA is aware that we are probably not going to be in a position that we have been in the past to be the primary source of supply or sole source of supply for the material.

Mr. BROUN. Very good.

Dr. Hagan, after helium-3 alternatives are developed for neutron detection, do you believe that further testing will need to be done at the Nevada test site?

Dr. HAGAN. You are talking about alternatives to helium-3?

Mr. BROUN. Yes, sir.

Dr. HAGAN. Yes. I would think that we would do that. We are testing a lot of—we tested some systems already at Los Alamos using relevant sources. With the type of—some of these detectors you can test them without having to actually use special nuclear material. You can use other sources of neutron. So it kind of depends on the particular technology. But if it is appropriate, we would certainly do that.

Mr. BROUN. And that will be an ongoing basis?

Dr. HAGAN. Oh, yes.

Mr. BROUN. How about the cost and schedule and impacts on them?

Dr. HAGAN. The cost of testing or cost of development of——

Mr. BROUN. All of it.

Dr. HAGAN. Well, I have got 47 seconds.

Mr. BROUN. No, I have 47 seconds, so you can take what you need.

Dr. HAGAN. Good point. All right. The costing varies of course with each technology so we have some that are more near term than others, some are longer term, and so I can't really give you an answer for all that we have approximately within DNDO, and there are other projects going on elsewhere in the government. But within DNDO, we have some two dozen projects to develop alternatives. On the average, I would say those are probably a million dollars now a—no, that is probably too high, half a million dollars a year, in that range, for that development. The testing, as I said, would depend on what type of sources we would need. If we could get by with so-called californium source to test for thermal neutron detectors, that could be done relatively cheaply and quickly. If we have to go to NTS or places where there is special nuclear material, that is very expensive. That is multimillions of dollars and many months.

Mr. BROUN. Okay. Thank you.

Thank you, Mr. Chairman. I yield back.

Chairman MILLER. Thank you, Dr. Broun.

The Chair recognizes Mrs. Dahlkemper for five minutes.

Mrs. DAHLKEMPER. Thank you, Mr. Chairman.

Dr. Brinkman, how much money is the DOE spending to support the work being done by DNDO for looking at substitutes or other areas of research?

Dr. BRINKMAN. I don't know that we are spending so much money on this. We are of course interested in alternative detectors too and we have this Second Line of Defense but I don't know the amount the Second Life of Defense program is spending on alternative detectors at this time. I just don't know that number. But that is one of the places where we are spending money. In addition, you know, one of the major users of helium-3 has been our neutron scattering and neutron experimental program at SNS at Oak Ridge. There we see some very big numbers that are needed but there is now an international community of people to do those kind of experiments and they are looking at alternative detectors too. So there is a fair bit of activity on the alternative detectors and a very broad base of work.

Mrs. DAHLKEMPER. So you don't have any idea what you are spending? I mean, can you get back to me on that?

Dr. BRINKMAN. We can get back to you on that, but I think Steve will have to an answer to that.

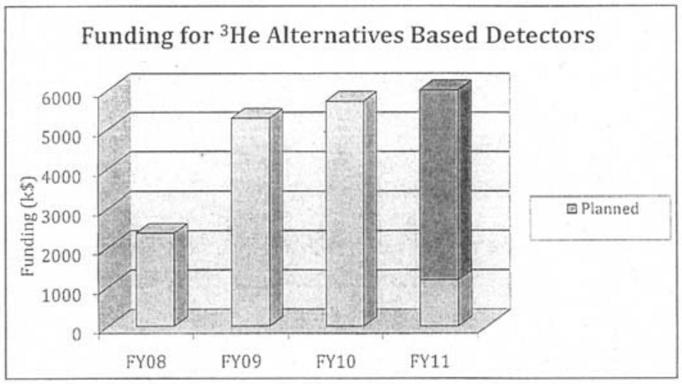
Mrs. DAHLKEMPER. Mr. Aoki?

Dr. AOKI. There is a research and development program within the National Nuclear Security Administration that includes funding for nuclear detector development which is now prioritized, the identification of new neutron detection technologies that would provide a substitute for helium-3, and I think I was told this morning that it is something like $7 million a year but I would want to confirm that and get back to you.

Mrs. DAHLKEMPER. If you could confirm that and get back to me, I would appreciate it.

[The information follows:]

There has been an ongoing research effort investigating non-He3 based detectors (prior to the issue's being raised in 2008–2009). The level of funding in 2009 was increased to accelerate existing efforts, address the problem of large-area detectors, and fund a more serious look at possible longer term solutions. At this point, the researchers believe that increases in research funds beyond what is planned would experience diminishing returns on investment. Attached is a chart outlining the funding. The funds directed towards non-He3-based detectors were redirected from longer-term research and development efforts addressing other nonproliferation technologies such as fast-neutron detectors and systems for active interrogation.



Mrs. DAHLKEMPER. And so as you make that a priority, what happens to the funding for other pieces within that?

Dr. AOKI. Well, you know, clearly one has to make some choices, and right now because of the time urgency, I think there has been a decision by that office to try to accelerate the work on the neutron detectors. Obviously there are possibly other detection systems that may therefore receive some lower priority.

Mrs. DAHLKEMPER. And do you see that as being any kind of an issue going down the road similar to where we are at right now with the helium-3 issue?

Dr. AOKI. I think, you know, clearly if one had no budget constraints, it would be nice to do all these.

Mrs. DAHLKEMPER. Well, we do have budget constraints.

Dr. AOKI. But since we do have budget constraints, we have to make these choices and this is one choice we have made in response to the current situation.

Mrs. DAHLKEMPER. Dr. Hagan, I was interested in your statement that DNDO is funding programs to look at alternative neutron detection technology prior to even knowing of the helium-3 shortage. I didn't see any—I guess there was no evidence of this in the documents that we received here in the Subcommittee. I am just wondering what funding of alternative detection technologies you were engaged in prior to 2008, and if you can tell me about those efforts, their purpose and the amount that was being spent?

Dr. HAGAN. I would have to get back to you on exact numbers. I wouldn't want to—but it is on the order of a few million dollars starting in probably 2007, 2008 time frame.

Mrs. DAHLKEMPER. Okay.

Dr. HAGAN. And the research was being done because it was—you are always looking for better detectors and so even though helium-3 was not thought to be in short supply, we tend to do R&D to always make things better, or if not better, cheaper, and so that was sort of the thrust of the early research, and basically there are two ways—two common alternatives to detecting thermal neutrons. Instead of using helium-3, you can usually talk about using lithium-6 or boron-10 and so most of the work that was funded early on—not all of it, there are some other techniques.

Mrs. DAHLKEMPER. Where was that funding coming from, I guess is what I am more trying to get at here?

Dr. HAGAN. It was form our transformational and applied research directorate. We had total funding for that effort back in 2006, I believe, was around $70 million and today is up around 109. So it has grown with time. And back in——

Mrs. DAHLKEMPER. Where was this research being done at?

Dr. HAGAN. Oh, I see. Various places, universities, companies and laboratories, national laboratories, Los Alamos, Livermore. I don't know the—I have got the stuff here but I don't remember exactly.

Mrs. DAHLKEMPER. If you could get back to me on that, that would be great. I would appreciate that. I know it is probably more information than you can really—any of us could keep in your heads. I appreciate that.

I yield back. Thank you.

Chairman MILLER. Thank you, Mrs. Dahlkemper.

The Chair recognizes Mr. Bilbray for five minutes.

Mr. BILBRAY. Mr. Chairman, with your pleasure, I would like to yield to the senior member of this panel, Mr. Rohrabacher, from the great city of Huntington Beach.

Chairman MILLER. Actually, Mr. Rohrabacher is not on this panel but he is recognized, I think without objection.

Mr. ROHRABACHER. He meant the senior member of the surfing caucus, is what he really meant.

Chairman MILLER. I think he just meant the oldest.

Mr. ROHRABACHER. That is good.

Mr. BILBRAY. To be blunt, I want to be nice to him while he is still around.

Mr. ROHRABACHER. The demand that we are talking about for helium-3 is how much per year now?

Dr. BRINKMAN. Demand seems to be around 20,000 liters.

Mr. ROHRABACHER. Twenty thousand liters, and is that just the United States or that worldwide?

Dr. BRINKMAN. That is the United States—well, pretty much worldwide. It involves cryogenics internationally.

Mr. ROHRABACHER. The entire demand for helium-3 worldwide is 20,000 liters. Is that what I'm getting here?

Dr. BRINKMAN. That is roughly right.

Mr. ROHRABACHER. Okay. And what is the price per liter?

Dr. BRINKMAN. Well, that is very variable. We think it is around between $350 and $400 a liter, but some of my friends out in the world claim that it is higher than that.

Mr. ROHRABACHER. Okay. So——

Dr. BRINKMAN. But it is certainly not more than $1,000 at this point.

Mr. ROHRABACHER. Not more than $1,000, not less than $300?

Dr. BRINKMAN. That is right.

Mr. ROHRABACHER. All right. And how much does a liter of helium-3 weigh?

Dr. BRINKMAN. A liter is roughly one-twentieth of a mole, so it probably weighs three grams divided by 20, so what is that, .06 grams or something like that.

Mr. ROHRABACHER. Tell me in pounds. I am sorry.

Dr. BRINKMAN. Pounds? Oh, my goodness. It weighs less than an ounce.

Mr. ROHRABACHER. Less than an ounce?

Dr. BRINKMAN. Yes.

Mr. ROHRABACHER. Way less than an ounce? Does anyone here have a more accurate figure on that in terms of the weight?

Dr. AOKI. A gram of helium-3 is seven liters.

Dr. BRINKMAN. A gram of helium-3, but he wants it in ounces.

Mr. ROHRABACHER. Is what now?

Dr. BRINKMAN. A gram is—an ounce is several grams, so it is very small.

Mr. ROHRABACHER. When you say less than an ounce per liter——

Dr. BRINKMAN. It is a gas after all.

Mr. ROHRABACHER. A half an ounce or closer to——

Dr. BRINKMAN. It is probably less than a tenth.

Mr. ROHRABACHER. A tenth of an ounce?

Dr. BRINKMAN. I am thinking in my head.

Mr. ROHRABACHER. Okay. So I am trying to get a grip on——

Dr. BRINKMAN. Yes, it is very small, but, you know, it is——

Mr. ROHRABACHER. So a tenth of an ounce would be $1,000?

Dr. BRINKMAN. You are right. It is expensive.

Mr. ROHRABACHER. Now, the reason why I am trying to get to this is that we do know—and by the way, I have appreciated the testimony talking about the alternatives that we have and recycling and alternative approaches and et cetera, and also the concept of maybe getting this out of natural gas and seeing if we can explore that avenue, but one thing that we haven't talked about today is the possibility of helium-3 from the moon, which is something that has not escaped our international competitors. Now, if we are talking about $1,000 for a tenth of an ounce, and this is in what form at that point? Is it liquid or is gas at that point?

Dr. BRINKMAN. At room temperature, it is obviously a gas. It is only a liquid at extreme low temperatures of a few Kelvin.

Mr. ROHRABACHER. So it would be in gas form, so if we actually had some type of system on the moon, you could actually put this into a tank and then transport it. Is that correct?

Dr. BRINKMAN. You have to remember though, a tank is 20,000 liters, so it is a fairly big tank, and it is a long way to the moon.

Mr. ROHRABACHER. Right, but I am not thinking about necessarily having the entire supply of helium-3 for the world transported in one moon mission, just like you wouldn't have one coal train providing all of the coal for the United States. It would seem to me that what you have told me would be—we right now have a group of entrepreneurs who are trying to decide what space programs, projects they will invest in that would have a future profit. It sounds like to me that that might be penciled out.

Dr. BRINKMAN. Well, you could try that. You know, my own guess would be that I would rather generate tritium at some nuclear reactor and convert it into helium-3 than try to go all the way to the moon to get it.

Mr. ROHRABACHER. Okay. Let me ask you this. What would the cost of that be?

Dr. BRINKMAN. We don't really have an accurate number for that yet. That is where we are.

Mr. ROHRABACHER. Could that also be up to $1,000——

Dr. BRINKMAN. A liter?

Mr. ROHRABACHER. A liter.

Dr. BRINKMAN. It could well be.

Mr. ROHRABACHER. Mr. Chairman, I would just suggest that in the world that we live in today, considering that we did go to the moon all those many decades ago that we might actually have a reason to go back to the moon if this can be done successfully.

Dr. BRINKMAN. Well, let us be a little careful here. Remember that $1,000 a liter, that is only $20 million a year for the business, so that is not very big business.

Mr. BROUN. Mr. Chairman, I think we ought to have a CODEL to go check that out, and I want to sign up.

Chairman MILLER. And none of us weigh as much as what you would be bringing back.

Mr. ROHRABACHER. So you would say that the demand is actually—when you were looking at the scenario that I am creating here, that the demand is too low to actually justify some kind of a mission that would cost——

Dr. BRINKMAN. My general impression, the mission is a billion dollars, at least, right? I mean, probably more. A billion dollars is one shuttle flight. And so if you——

Mr. ROHRABACHER. Well, that is when the government is doing it. The Administration is trying to privatize this now.

Dr. BRINKMAN. More power to them.

Chairman MILLER. Mr. Rohrabacher's time is expired.

Mr. ROHRABACHER. Thank you very much.

Chairman MILLER. The Chair recognizes Mr. Davis for five minutes.

Mr. DAVIS. We have one of the folks who will testify later that I really wanted to introduce, so for that reason, I will hang around but I would like to yield my time back to you or any other member on the majority side.

Chairman MILLER. I will accept that time just to ask one question of Dr. Brinkman. You said that the whole supply of helium was complicated by the fact that some was coming from Russia. It seems odd, although we are now trying to develop a better relationship than we had with the Soviet Union, a subject near and dear to Mr. Rohrabacher's heart, they are still not exactly our BFF. We are kind of natural competitors with Russia, not best friends forever, and it seems odd that we would rely upon Russian supply for something so obviously critical to our national security needs.

Dr. BRINKMAN. I think they—I am sorry. I am not familiar with all this but I believe they dumped their helium-3 onto the market not through their government.

Chairman MILLER. And did you have any idea of how much more there was, how much more helium-3 there might be coming from that source? I mean, obviously there was a mistake in not seeing this coming, but it is odd that the supply from Russia did in fact complicate the ability to see this coming quite so much, particularly for something so obviously critical to national security needs.

Dr. BRINKMAN. It is just one of the things. I would not want to claim that that was the only driving factor in this crisis at all, but it was certainly—it has played a role. Let us put it that way.

Chairman MILLER. Actually Mr. Rohrabacher used up Mr. Bilbray's time and now you——

Mr. ROHRABACHER. I will yield to Mr. Bilbray.

Chairman MILLER. All right.

Mr. BILBRAY. Thank you, Mr. Chairman.

I would solicit comment from any one of the doctors for this. I have been in government since I was 25 years old. I was elected April of 1976, before Jimmy Carter. That is how long I have been hanging around. And the one thing that has become very obvious to me is, those of us in government in our quest to try to stop people from doing wrong, we have legislated ourselves into a position where so often we stop people from doing good and correcting. My question to you is that, you talk about this ability to somewhere in the future build and operate a facility that can then provide the service after—remember, we have 12 years we have to wait for a certain natural process to occur. Do we have any plans? Have we sited? Do we permit? What do we have online right now, Doctor, to be able to move the agenda to build the facility to produce the components that we need to keep the supply flowing?

Dr. BRINKMAN. Well, presently we still have the processing capability that was part of the weapons program and probably you could use that for the private purpose of creating helium-3. The issue is where do you get the tritium that you could use in that process. The process is available to us and so the big issue is what the source is, and even in the case of the source, we could go back to irradiating samples in reactors in this country. That is the way it was done in the weapons program, and create the tritium and let it decay and——

Mr. BILBRAY. My question is, we could go back, but where and has it been permitted? Is it legal for these facilities to go back and do that now? Does the regulatory process allow them to go back and are we—have we sited this? Because it is one thing to say we need to do this or we should do it. It is another thing when we sit there and say yeah, we ought to do it and come the 11th hour we block it from getting a permit to go into operation. We have seen that with this issue for the last 30 years.

Dr. BRINKMAN. I do not know of any legal blocking of this. The issue we are—the main issue with this approach is just how much it is going to cost because it looks like it is expensive.

Mr. BILBRAY. How many facilities do we have in the country that make it?

Dr. BRINKMAN. The way the process used to work, we used various reactors to expose—to create the tritium and then everything moved—was moved to Savannah River and Savannah River did the processing.

Chairman MILLER. The gentleman's time has expired. We do have a second panel and we probably have votes at 11:30 or so.

Dr. Hagan, there seems to be something you were burning to say.

Dr. HAGAN. Thank you. I appreciate that. I just wanted to comment that in addition to going back and making more helium-3 through other means, I also wanted to answer a question from my own Congressman. I live in your district. I wanted to be able to say that. But these other technologies in the past may not have been as viable because of the cost but as the cost of helium-3 rises, they become more and more viable, so I think it may be quite likely in my mind that the future will lie with these kinds of things, not going back and having to sort of resurrect the helium-3 production through tritium decay. Thank you.

Chairman MILLER. Thank you. We will now take a short break and have our second panel, and I want to obviously thank this panel for your testimony today. Thank you.

[Recess.]

Panel II:

Chairman MILLER. We are back. It is now time to introduce our second panel, and I will begin by recognizing Mr. Davis to recognize or introduce Dr. Woods.

Mr. DAVIS. Mr. Chairman, thank you very much. Our good friend, John Tanner from West Tennessee, had other meetings and could not stay to make the introduction. We certainly welcome you here today and look forward to your testimony and look at the work you have performed and your impact. Thank you for being here and thank you for agreeing to join us today with your testimony. Welcome.

Chairman MILLER. Okay. I am now pleased to introduce the balance of our panel. Mr. Tom Anderson is the Production Manager at Reuter-Stokes Radiation Measurement Solutions at GE Energy. Mr. Richard Arsenault is Director of Health, Safety, Security and Environment at ThruBit LLC. And Dr. William Halperin is the John Evans Professor of Physics at Northwestern University of Illinois.

As all of you should know from having been here before, we do allow five minutes for spoken testimony. Your written testimony will be included in the record. After your spoken testimony, each member will have five minutes to question the panel.

It is our practice to take testimony under oath. Do any of you have any objection to taking an oath? The record should reflect that all of the witnesses shook their head to indicate they had no objection to taking an oath. You also have the right to be represented by counsel. Do any of you have counsel here? And the record should reflect that all the witnesses shook their heads that they did not have counsel here. If you would now please now stand and raise your right hand, and if anyone in the audience wishes to be sworn in, you may stand as well. Do you swear to tell the truth and nothing but the truth?

The record should reflect that all the witnesses have now taken the oath. We will start with Mr. Tom Anderson. Mr. Anderson, you are recognized for five minutes.

STATEMENT OF TOM ANDERSON, PRODUCT MANAGER, REUTER-STOKES RADIATION MEASUREMENT SOLUTIONS, GE ENERGY

Mr. ANDERSON. Mr. Chairman, 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 provide my perspective on the helium-3 shortage.

GE Energy's Reuter-Stokes legacy dates back to the early years of the nuclear industry. We manufacture in-core sensors and accurately measure neutron power levels under the extreme temperature and radiation conditions prevalent in boiling-water reactors. We also design and manufacture a variety of products that are used in oil and gas exploration including helium-3 neutron detectors, gamma sensors and systems to navigate and locate oil and gas reservoirs thousands of feet under the earth's surface. We also use helium-3 to manufacture neutron detectors for homeland security, nuclear safeguards and neutron scattering research facilities.

GE Energy's Reuter-Stokes facility in Twinsburg, Ohio, is the largest manufacturer of helium-3 neutron detectors in the world. In my written testimony, I described in detail the important systems and applications that have come to rely on GE's helium-3 neutron detectors. This morning I want to emphasize two points. First, an adequate supply of helium-3 must be made available to support critical applications such as nuclear safeguards and oil exploration while replacement technologies are developed. Second, federal funding is essential to accelerate development of alternate neutron detection technologies.

The need to act is critical. The Department of Energy's helium-3 reserves have been depleted to approximately 50,000 liters. To put this in perspective, GE has purchased over 100,000 liters of helium-3 from the DOE since 2003. Since 9/11, GE has manufactured over 40,000 helium-3 detectors which support homeland security and nuclear safeguards programs.

DNDO and the Integrated Project Team have played a key role in responding to the helium-3 shortage. I believe DNDO is exploring the most practical options available to produce helium-3. Short of planning a trip to the moon, as was discussed this morning, to mine helium-3, the most promising near-term prospect is to accelerate work with the Canadian government to harvest the helium-3 from the tritium storage beds at Ontario Power Generation. Expeditious recovery and processing of this gas could be used to sustain helium-3 detectors for applications such as oil exploration and nuclear safeguards while replacement technologies are developed.

As we look for additional supplies, it is critical that the Federal Government strengthen its support of research and development for alternative technologies. There is currently no drop-in replacement technology and as many as six different technologies may be required to support the neutron detection needs in the various applications I just described. GE is well on the way to completing development of a boron-10 neutron detection panel for radiation portals used in homeland security. This required considerable investment by GE and will involve significant facility and process modifications.

I have personally been involved in over 10 new technology and product development programs during my time at GE. Not all have been successful. If I leave you with one thought today, it would be this: It is one thing to invent a technology to solve our problem, but it is an entirely separate set of challenges that industry faces to then take that science, craft it into a product that is scalable in form, fit and function that can operate over the full range of environmental extremes, a product that is reliable with relatively long service life and minimal maintenance requirements, a product which thousands or even tens of thousands could be manufactured at a reasonable cost with quality and consistent performance.

The magnitude of these challenges illustrates the need for federal investment. We must develop new technologies and maximize available helium-3 supplies to avoid being caught again by surprise.

Thank you for inviting me to testify today. I look forward to your questions.

[The prepared statement of Mr. Anderson follows:]

PREPARED STATEMENT OF THOMAS R. ANDERSON

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 Helium3. 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 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

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

[2] *Id.*

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°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.

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,

[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).

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.

BIOGRAPHY FOR THOMAS R. ANDERSON

Tom Anderson is the Product Line Leader for GE Energy's Reuter Stokes Radiation Measurement Solutions. In this capacity, he is responsible for new product development, product quality, and all aspects of engineering and manufacturing for neutron detection products used in security and research applications. He reports to the General Manager of GE Energy's Reuter Stokes.

From December 2000 until his current assignment in 2003, Tom served as Product Line Leader for GE Reuter Stokes Harley Electrical Equipment Group and GE's Silicon Carbide Gas Turbine Flame Sensor products.

Prior to joining GE, Tom served in the U.S. Navy. He retired as a Commander in 2000. Tom served as Executive Office on the submarine USS Benjamin Franklin (SSBN 640) (GOLD) and submarine tender USS L.Y. SPEAR (AS 36). His shore assignments included a tour of duty at the On-Site Inspection Agency where he led weapons inspection teams into the former Soviet Union in support of the Intermediate Nuclear Forces (INF) and the Strategic Arms Reduction Treaties (START). Tom's naval career culminated with his assignment as the Deputy Assistant Chief of Staff for the Nuclear Weapons Inspection Center on the staff of Commander Submarine Forces, U.S. Atlantic Fleet. In this capacity, Tom was responsible for submarine force nuclear weapons policy, safety and security.

Tom graduated from the U.S. Naval Academy in 1976 with a Bachelor of Science in Electrical Engineering. He later studied at the Naval Postgraduate School in Monterey, California where he earned a Master of Science in Electrical Engineering. Tom is also a 1997 graduate of the U.S. Army War College.

Chairman MILLER. Thank you.

Mr. Arsenault is recognized for five minutes.

STATEMENT OF RICHARD ARSENAULT, DIRECTOR, HEALTH, SAFETY, SECURITY AND ENVIRONMENT, THRUBIT LLC

Mr. ARSENAULT. Chairman Miller, Ranking Member Broun and members of the Committee, my name is Richard Arsenault. I am the Director of Health, Safety, Security and Environment along with being the Corporate Radiation Safety Officer of ThruBit LLC, which is a Shell Technology Ventures Fund I portfolio company formed in 2005. Today we offer logging solutions based on a unique patented through-the-bit deployment technique that provides significant advantage in many applications. We are a small company taking this new technology from proof of concept to commercial introduction with aspirations to grow into a much larger company. I have been involved in the oil well logging industry since 1979 starting out as an open hole wireline engineer in West Texas and later got involved in the early stages of logging while drilling in 1982.

Neutron logging: Wells can be logged by wireline logging or LWD logging, known as logging while drilling. There are a number of formation measurements that are taken when a well is logged. Neutron logging is one of the primary measurements taken when a well is logged. The neutron measurement provides the hydrogen located in the pore space of the formation and the porosity is determined from neutron count rates in the detectors within the logging tool. The neutron measurement is a primary gas indicator which helps delineate gas and oil producing zones along with providing the porosity of the formation.

Both wireline and LWD tools will in most cases have a long space and short space helium-3 detector which are located at different distances from the radioactive sources mounted in the logging tool. The helium-3 detectors are used with either americium–241 beryllium or californium–252 radioactive sources.

The importance of helium-3 supply to the oil industry is critical and crosses into numerous sectors of the industry. Helium-3 is used in almost the entire neutron detectors incorporated into downhole tools in our industry. The neutron count rate measurement, from which the porosity measurement is derived, is used in oil and gas reservoir evaluations. Even small errors in the neutron measurement can make the difference in whether a reservoir is commercially viable or not.

Oil and gas exploration within the United States is a vital part of our national security and lessens our dependence on foreign oil and gas. The shortage of helium-3 is starting to impact our entire industry. As rig counts increase and the request for well logging increases it will require more tools to be in service ready to go. Large companies can take stockpiles of tools not in service during the slowdown in the last two years and put them back in service. Smaller companies which have less of a stockpile of tools not in service to pull from are unable to do so. With small companies such as ThruBit trying to increase our market penetration, it creates an extra hardship limiting our ability to grow and bring our new technology to the marketplace. Large companies have financial and human resources to pursue extensive research and development in looking for potential alternatives in detector technologies. Smaller companies are not as fortunate. They cannot afford extensive research and development. Their commercial viability comes into question along with their ability to sustain their business. These smaller companies are also in a situation where they cannot afford the extensive research and development of looking at alternatives to their current supply of tools.

I want to personally thank you for the opportunity to discuss this important issue involving the oil and gas well services industry today.

[The prepared statement of Mr. Arsenault follows:]

PREPARED STATEMENT OF RICHARD L. ARSENAULT

Introduction

Chairman Miller, Ranking member Broun, and members of the Committee, my name is Richard Arsenault and I am the Director of Health, Safety, Security and Environment along with being the Corporate Radiation Safety Officer for ThruBit LLC (ThruBit Logging Solutions) which is a Shell Technology Ventures Fund 1 BV Portfolio company formed in 2005. Today we offer complete logging solutions based on a unique patented "through the bit" deployment technique that provides significant advantages in many applications. We are a small company taking this new technology from proof of concept to commercial introduction with aspirations to grow into a much larger company. I have been involved in the Oil Well Logging industry since 1979 starting out as an Open Hole Wireline Engineer in West Texas and later got involved in the early stages of Logging While Drilling in 1982.

Well Logging

Every well requires formation evaluation; well logging is a key part of this evaluation. The quality and accuracy of data is key to decide and ascertain if the well is a producer or dry hole. This evaluation supports and drives:

- Production Estimations,
- Well Economics,
- Reserve calculations
- Corporate and Government Energy Assets,
- Overall market fundamentals

It supports ability to commit to long term projects with less than certain payback. Provides support for filing Company's statement of reserves. Helps value royalty payments back to state and federal government and drives legislation.

The US is most affected:

- 1/2 of worlds activity
- 1/4 of world consumption
- < 5% of world reserves
- Greatest need for immediate continuity of supply

Neutron Logging

Wells can be logged by Wireline Logging or Logging-While-Drilling (LWD). There are a number of formation measurements that are taken when a well is logged. Neutron logging is one of the primary measurements taken when a well is logged. The neutron measurement provides the hydrogen located in the pore space of the formation and the porosity is determined from neutron counting rates in the detectors within the logging tool. The neutron measurement is a primary gas indicator which helps delineate gas and oil producing zones along with providing the porosity of the formation.

Both Wireline and LWD tools will in most cases have a "Long Space" and "Short Space" Helium-3 Detector which are located at different distances from the radioactive sources mounted in the logging tool. The Helium-3 detectors are used with either an Americum-241 Beryllium or Californium-252 radioactive source.

The importance of Helium-3 supply to the oil and gas industry is critical and crosses into numerous sectors of the industry. Helium-3 gas is used in almost the entire neutron detectors incorporated into downhole tools in our industry. The neutron count rate measurement, from which the porosity measurement is derived, is used in all oil and gas reservoir evaluations. Even small errors in the neutron measurement can make the difference in whether a reservoir is commercially viable or not.

It is difficult for our industry to determine the number of neutron detectors used in our course of business, especially since the neutron detector is used in open and cased hole compensated neutrons, single detector neutrons and other devices in our industry. There are numerous large well logging companies in the U.S. that also operate internationally along with medium to small size companies throughout the U.S. Each of these companies incorporates the use of He-3 neutron detectors in their tools. With the downturn in our industry over the last two years, most existing companies have been able to utilize existing tool stocks for replacement detectors and spare parts, which have lessened the impact over these years, but will eventually deplete the stock within those companies. They will be forced to buy additional detectors as the industry expands, for both new tools and for replacements in older tools. The detectors do have a limited life expectancy on the average of about 5 years depending on the downhole conditions they are exposed. So they do need to be replaced periodically to keep the tools working correctly. Companies introducing new technologies for logging wells, such as ThruBit, are limited to what is already available in house to build tools and what they can find available by the detectors suppliers with long leads time and a substantially higher price.

Pricing and Availability of He-3 Detectors

We have personally seen almost a 3 times price increase and a quoted lead time of almost 6 months for delivery in an order recently placed this year. I have also received reports from others in the industry of pricing increases reported on neutron detectors in the 3 to 10 times range due to the Helium-3 shortage. Pricing is not the only issue, but availability is also key. Lead times of 6–8 months have been reported. There have been reports of some detectors not being available due to the lack of Helium-3.

There is a big difference in application of detector technology to applications that are located on surface, exposed to ambient temperatures and pressures and are not moved or exposed to conditions involving shock and vibration. Detector technology used in down hole tools used for well logging are subjected to more stringent requirements just to survive the environment and meet the engineering requirements of the design.

Wireline Tools are operated at high temperature, have limited internal geometry to mount the detectors and experience medium shock and vibration. In the case of LWD tools they have all the same factors, but the shock and vibration is a lot higher. As result of the limited internal geometry small reliable detector packages are a must. In our particular case we have the smallest well logging tools in the industry with a 2-1/8″ diameter tool. Any type of alternative technology would require the same or smaller foot print inside the tool. We could not go larger since we limited to our 2-1/8″ diameter specification. We do not have the resources for an R&D effort to pursue another tool design with potential alternative detector technology.

Impact

Being a small company bringing new technology to market is a challenge. We are in transition from a commercial introduction phase to commercialization with an aggressive plan to be a full blown viable and sustainable Formation Evaluation Service Company. The Helium-3 detectors are all we have to put in our Neutron Porosity tools. We do not have a substitute detector for use in these well logging tools. It would take substantial development time (years) to pursue a substitute. We have neither the financial resources or R&D staff to pursue this effort. An extreme shortage or unavailability would be extremely detrimental in our ability to provide formation evaluation services and increase our tool fleet size allowing our company to grow. Other medium and small companies are in the same situation with a finite amount resources to pursue a pure R&D effort on alternatives. Some larger companies are looking at alternatives, but are finding the Boron Trifluoride with 1/7 the sensitivity of the Helium-3 type detectors will require increasing the activity of the Californium-252 or Americium-241 Beryllium source strengths.

Alternative to Helium-3

The substitute for Helium-3 detectors, Boron Trifluoride (BF3), however it is much less sensitive to the thermal neutron detector as required by our industry. The majority of the sources used with neutron tools are Americium-241 Beryllium (Am-241Be), however, most recently due to Americium supplies being limited; more companies are utilizing Califorium-252 (Cf-252) in its place. Most all of these sources are in the 5 Curie (with some older 3 Curie sources used in cased hole operations) up to 20 Curies. With the decreased sensitivity of Boron Trifluoride, the strength of these neutron sources would have to be increased to achieve the statistical results needed for industry.

There are other concerns with Boron Trifluoride. The USDOT has classified this gas has a hazardous material and cannot be shipped without a US DOT special permit. Shipping by air in the US also requires classifying it as Toxic Inhalation Class 2.3. For international shipment it is restricted to Cargo Only Aircraft and classified as Toxic Inhalation Hazard Class 2.3 and Corrosive Class 8. This provides for some packaging and logistic challenges moving tools with detectors with this type of gas in the detector. Not a good solution with the mobility required for well logging tools.

Conclusion

Oil and gas exploration within the U.S. is a vital part of our national security and lessens our dependence on foreign oil and gas. The shortage of Helium-3 is starting to impact our entire industry. As rig counts increase and the request for well logging increases it will require more tools to be in service ready to go. Large companies can take stock piles of tools not in service during the slowdown in the last 2 years and put them back in service. Smaller companies will have less of a stock pile of tools not in service to pull from. With small companies such as ThruBit trying to increase our market penetration it creates an extra hardship limiting our ability to grow and bring our new technology to the market place.

Larger companies have the financial and human resources to pursue extensive research and development to look at potential alternatives in detector technologies. Smaller companies are not as fortunate—they cannot afford extensive research and development. Their commercial viability comes into question along with their ability to sustain their business. These smaller companies are also in a situation where they cannot afford the extensive research and development of looking at alternatives to their current supply of tools.

I want to personally thank you for the opportunity to discuss this important issue involving the Oil & Gas Well Services Industry today.

BIOGRAPHY FOR RICHARD L. ARSENAULT

Richard L. Arsenault, CSP is the Director of Health, Safety, Security and Environment and Corporate Radiation Safety Officer for ThruBit LLC (ThruBit Logging Solutions). ThruBit Logging Solutions is an STV (Shell Technology Ventures) Fund 1 BV Portfolio company formed in 2005. Our innovative logging technology was developed in 1998 to provide market access to the benefits of Shell Oil Company proprietary drill bit advances. Today we offer complete logging solutions based on a unique "through the bit" deployment technique that provides significant advantages in many applications.

Mr. Arsenault has been involved in the Oil & Gas Well Logging Industry since March of 1979 as a Dresser Atlas Open Wireline Engineer in West Texas and then got involved in May of 1982 with the Testing, Development and Commercialization of the first generation of Sperry-Sun Drilling Services Logging While Drilling (LWD) Tools. In addition led the Field Testing effort and Commercialization of the first generation Neutron Porosity and Density Porosity LWD Tools. Has also held Technical Support, Regulatory Compliance, HSE and Corporate Radiation Safety Officer Roles up to the fall of 1998. With the merger of Dresser Industries and Halliburton he was appointed as the Global Radiation and Explosive Safety Manager for Halliburton.

He holds a Masters in Business Administration from the University of Houston and Bachelors Degree in Electrical and Electronic Engineering from the University of South Florida. He is a Certified Safety Professional holding a CSP Registration.

He has been involved in the following industry related activities over the years:

- Established in April 2003 and chaired the Oilfield Services Industry Forum for Radiation and Security. This now resides in the Association of Energy Services Companies (AESC).
- Established in June 2005 and chaired the Oilfield Services Subcommittee in the Institute of Makers of Explosives (IME).
- Established a partnership between DOE (PNWL) and Oilfield Services Industry to establish a baseline with the ultimate goal of establishing a recommended practice for the security of radioactive material. This was recommendation was published by the DOE in 2008.

Chairman MILLER. Thank you, Mr. Arsenault.

Dr. Halperin is recognized for five minutes.

STATEMENT OF DR. WILLIAM HALPERIN, JOHN EVANS PROFESSOR OF PHYSICS, NORTHWESTERN UNIVERSITY

Dr. HALPERIN. Mr. Chairman and Members of the Committee, thank you for the opportunity to testify about the negative impact on scientific research caused by the shortage of helium-3.

I am a physics professor at Northwestern and I rely heavily on helium-3 to carry out scientific research at low temperatures. I have been involved in this kind of work since 1970. Low-temperature research is essential for studying properties of materials such as superconductivity, magnetism and developing various advanced materials. Low-temperature research is also critical to future improvements in metrology and high-speed computation including quantum information technology. Shortages of helium-3 driven by increased homeland security demands and decreased production capability are already creating major difficulties in these areas of research.

Let me briefly summarize the salient points. From 2001 to the present, the stocks of about 230,000 liters have been drawn down at a rate far in excess of today's global production estimated to be approximately 20,000 liters per year. The use of helium-3 as a detector of radioactive materials at airports and border crossings combined with the growth of medical, commercial and scientific applications is responsible for this extraordinary increase in demand.

Now, absent new production sources, it is now impossible to serve the estimated need of 70,000 liters per year. It may be possible to find alternatives to the use of helium-3 for some applications but for others the unique physical properties of helium-3 are essential. Scientific research at low temperatures is the signature example of an area in which helium-3 is irreplaceable. Without adequate supplies, such research will cease entirely. To put the matter into context, I note that eight Nobel laureates in physics in the past 25 years owe their accomplishments in some important measure to the availability of helium-3. Cases in which substitutes might be found for helium-3 include neutron detection at facilities such as the Spallation Neutron Source at Oak Ridge National Laboratory, oil and gas well evaluation, building construction technology and the improvement of lasers.

The issue perhaps is best illustrated by a personal experience in October of 2008. I sought information about availability and pricing from six well-known distributors of helium-3 gas. Only Chemgas and Spectra Gas had any supply but their prices were extraordinarily high, on the order of $2,000 a liter, five to 10 times higher than I had expected, and well outside of my research budget.

The following summer I received more bad news. Oxford Instruments, the largest supplier of low-temperature refrigerators, contacted me to say that the company could not obtain any helium-3 from their supplier, Spectra Gas. Discussions among attendees at a subsequent international low-temperature physics conference revealed that this shortage was global. Although the shortage took many of us by surprise, I later learned that some government officials had been aware of this problem for some time but had not shared that information.

In the fall of 2009, Nobel laureates Doug Osheroff and Bob Richardson, on behalf of a low-temperature working group of which I was a member, wrote to Bill Brinkman, Director of the Department of Energy's Office of Science, to express concern about the shortage of helium-3 for low-temperature research. Conversations with DOE ensued but to date, requests by scientists and refrigerator companies often go unanswered or unmet, and young scientists are especially vulnerable.

Many of us are concerned that cryogenic instrumentation companies may soon be forced out of business. Janis Research is an example. Janis has been guaranteed an allocation but helium has not been delivered and sales interruptions place the company at risk. Should Janis and other companies stop providing refrigerators, low-temperature science will end.

Dr. Brinkman requested that our working group assess the critical needs of low-temperature science, so I conducted a survey with the following principal findings. In a ten-year interval from 1999 to 2009, the purchase of helium-3 for low-temperature science averaged 3,500 liters per year and was growing at approximately 12 percent per year worldwide. The details are in my written testimony.

Now, on a personal note, I have an immediate need in my laboratory for 20 liters of helium-3. Spectra Gas, the sole provider of helium-3 released by the Department of Energy, has not responded in the five months since I made my request and my National Science Foundation support is now in jeopardy.

In conclusion, we must recognize the diversity of needs for helium-3 and adopt the following strategies: Explore alternative technologies, establish effective communication among all the stakeholders, implement recycling and conservation, redesign critical need instrumentation to be more efficient, and finally, develop new sources of helium-3.

I would be pleased to answer your questions.

[The prepared statement of Dr. Halperin follows:]

PREPARED STATEMENT OF WILLIAM P. HALPERIN

Mr. Chairman and members of the committee, thank you for the opportunity to testify about the negative impact on scientific research caused by the shortage of helium-three. I am a physics professor at Northwestern University, and I rely heavily on helium-three to carry out scientific research at low temperatures and have been involved in this work since 1970. Low-temperature research is essential for studying properties of materials, such as superconductivity, and magnetism, and for developing various advanced materials. Low-temperature research is also critical to future improvements in metrology and high-speed computation, including quantum information technology. Shortages of helium-three, driven by increased homeland security demands and decreased production capability, are already creating major difficulties in these areas of research.

Let me briefly review the salient points. Helium-three is a gas and a byproduct of the radioactive decay of tritium, an essential element of nuclear weapons. Following the Second World War, as the nuclear stockpile grew, stocks of helium-three grew commensurately, reaching about 230,000 liters by the year 2000. From 2001 to the present, these stocks have been drawn down at a rate far in excess of today's global production, estimated to be approximately 20,000 liters/year. The use of helium-three as a detector of radioactive materials at ports, airports and border crossings, combined with the growth of medical, commercial and scientific applications, is responsible for the extraordinary increase in demand.

Absent new production sources, it is now impossible to serve the estimated need of 70,000 liters/year. It may be possible to find alternatives to the use of helium-three for some applications, but for others the unique physical properties of helium-three are essential.

Scientific research at low temperatures is the signature example of an area in which helium-three is irreplaceable. Without adequate supplies, such research will cease entirely. To put the importance of such research in context, I note parenthetically that twelve Nobel Laureates in physics in the past 25 years owe their accomplishments in some important measure to the availability of helium-three. Cases in which substitutes might be found for helium-three include neutron detection at facilities such as at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, oil and gas well evaluation, building construction technology and the improvement of lasers.

The issue perhaps is best illustrated by a personal experience. In October 2008 I sought information about availability and pricing from several well-known distributors of helium-three gas. I spoke with representatives of Sigma Isotec, Cambridge Isotope Labs, Icon Isotope Services, Isoflex USA, Chemgas, and Spectra gas (now Linde Electronics and Speciality Gases) and learned that only the latter two had any supply, but their prices were extraordinarily high: $800 to $2,000/liter. It was 5 to 10 times higher than I had expected and well outside of my research budget plan.

The following summer I received more bad news. Oxford Instruments, the largest supplier of low temperature refrigerators, contacted me, to say that the company could not obtain any helium-three from their supplier, Spectra Gas. Discussions among attendees at a subsequent international low-temperature physics conference revealed that the shortage was global. Although the shortage took many of us by surprise, I later learned that some government officials had been aware of the problem for some time but had not shared this information.

In the fall of 2009, Nobel Laureates Doug Osheroff and Bob Richardson, on behalf of a low-temperature working group of which I was a member, wrote to Bill Brinkman, Director of the Department of Energy's Office of Science, to express concern about the shortage of helium-three for low temperature research. Conversations with DOE ensued, but to date requests by scientists and refrigerator companies often go unanswered or unmet. Young scientists, especially, find themselves without access to this essential resource.

Many of us are also concerned that without adequate access to helium-three, instrumentation companies may soon be forced out of business. Janis Research is an example. Janis has been guaranteed an allocation, but the helium has not been delivered and the sales interruptions place the company at risk. Should Janis and other companies stop providing refrigerators, low-temperature science will end.

Dr. Brinkman requested that our working group assess the critical needs in low temperature science. The principal finding of our recently completed survey is the following: In a ten year interval, from 1999 to 2009, the purchase of helium-three for low temperature science averaged 3,500 liters/year and was growing at approximately 12%/year world-wide. (Survey details are posted at *http://www.qfs2009.northwestern.edu/survey/* and attached to my written testimony.)

On a personal note, I have an immediate need in my laboratory for 20 liters of helium-three. Spectra Gas, the sole provider of helium-three released by the Department of Energy, has not responded in the five months since I made my request, and my National Science Foundation supported research is now in jeopardy.

In conclusion, we must recognize the diversity of needs for helium-three and adopt the following strategies: explore alternative techn6logies; establish effective communication among all stake holders; implement recycling and conservation; redesign critical-need instrumentation to be more efficient; and develop new sources of helium-three.

I would be pleased to answer your questions.

Survey of Critical Use of ^{3}He for Cryogenic Purposes

Results of the Survey

Northwestern University
January 21 to February 5, 2010

You may also download the results as a PDF.

The rare isotope of helium, ^{3}He, has critical strategic importance. One of it's applications is to achieve low temperatures through refrigeration and measuring devices, mostly in the pursuit of fundamental knowledge, providing the essential building blocks for engineering and technology for our future. Cryogenic use of ^{3}He is critical in that there is no alternative to reaching a range of more than 4 orders of magnitude of temperature from 1 K to as low as 10-4 K. Here basic scientific investigations require ^{3}He for the study of quantum systems, including information technology, magnetism, and superconductivity. Its recent short supply and extraordinary high price has posed serious problems for the scientific community. The purpose of this survey was to document as accurately as possible world-wide use of ^{3}He in the past ten years as a framework for future cryogenic allocations and to evaluate the impact of research that uses ^{3}He.

The survey is restricted to senior or principal scientific investigators, who are representatives of their respective research groups. The survey solicitation was sent to the e-mail list serves of the International Conference on Low Temperature Physics, LT25; the International Symposium on Quantum Fluids and Solids, QFS2009; a list of principal investigators using cryogenic ^{3}He in their research grants from the National Science Foundation, the Program in Condensed Matter Physics; a list of principal investigators using cryogenic ^{3}He in their research grants from the Department of Energy, the Program in Basic Energy Sciences. These totaled approximately 2,300 including members of the communities including students, research associates, postdoctoral fellows, scientists, and finally, the principal or senior investigators who were asked, on behalf of their groups, to respond to the survey.

This survey and a copy of the results were posted at: http://www.qfs2009.northwestern.edu/survey/

Survey Results:

Number of senior investigator respondents:	206
USA respondents:	98
Total ^{3}He purchases, yearly average over ten years:	3,469 L/year
maintenance and samples gas from research groups:	1,141 L/year
new instruments (mostly refrigerators) from companies:	2,328 L/year
^{3}He for cryogenic purposes purchase last year (2009):	3,828 L
Price of ^{3}He last year, average (2009):	930 $/L

Scientific programs requiring cryogenic ^{3}He (fraction of total):

Quantum Fluids and Solids	8 %
Superconductivity	24 %
Quantum Information	7 %

Mesoscopic Physics	12 %
Magnetism	12 %
Electronic Materials	10 %
Quantum Resonators	3 %
Quantum Transport	12 %
Refrigeration Instrumentation	8 %
Detector Instrumentation	3 %
Other	2 %
Graduate student training using cryogenic ^3He, graduated in ten years:	3,349 students
Postdocs hired in ten years using cryogenic ^3He:	2,322 postdocs
Research funding in ten years requiring cryogenic ^3He:	2.65 billion $

Comments on growth in the cryogenic use of ^3He:
Sufficient information in the responses was given to determine the following growth in requirements for cryogenic use of ^3He. Yearly increases in purchases for cryogenic ^3He are 12% per year on average. The increase in cost in the past three years has been approximately a factor of 4 to 5 on average.

2005	23 %
2006	- 1 %
2007	30 %
2008	- 20 %
2009	26 %
yearly average	12 %

Comments on impact from research that uses cryogenic ^3He:
The significant impact of research that uses cryogenic ^3He includes 335 graduate student PhD's awarded per year and 232 postdoctoral fellows hired per year (numbers adjusted for response rates determined as described in b) below averaged over the past ten years). Additionally, all theoretical work related to experimental research that uses cryogenic ^3He would not have taken place without this range of temperature for quantum condensed systems, substantially increasing the student, staff, and funding impacts beyond that shown in this survey.

Reporting methodology:
a) The following nine companies provide cryogenic ^3He instrumentation and reported their sales of ^3He, presented above in aggregate form: Bluefors, Chase Research Cryogenics, Cryomagnetics (including Cryoconcepts), Janis Research, Lakeshore Cryotronics, Leiden Cryogenics, Oxford Instruments, Quantum Design.
b) Purchases of ^3He, not as a part of commercial instrumentation, made by individual research groups, reported above, were adjusted by a survey response fraction of 51%. This fraction is defined by the USA pool and was assuned to be valid elsewhere in the world. The fraction is defined as the number of USA principal investigators responding to the survey divided by the total number of funded USA principal investigators identified by program mangers from the NSF/CMP and the DOE/BES. Error in corrections for survey response rate is relatively small since 2/3 of the cryogenic ^3He is purchased by the instrumentation companies for which we have an accurate total response.
c) The responses were examined one-by-one to avoid duplication and improper submission and to be sure that each submission represented only one research group.

Click here to view an archived copy of the survey.

BIOGRAPHY FOR WILLIAM P. HALPERIN

BIOGRAPHICAL SKETCH

Personal Data: William P. Halperin

Address: Dept. Physics, Northwestern University, Evanston IL 60208
e-mail w-halperin@northwestern.edu

a) Professional Preparation

Bachelor of Science,	B.Sc.,1967	Queen's University, Kingston, Ontario
Master of Science,	M.Sc., 1968	University of Toronto, Ontario
Doctor of Philosophy,	Ph.D.,1975	Cornell University, Ithaca, NY
Postdoctoral Fellow	(1974-75)	Cornell University, Ithaca, NY

b) Appointments and Honors:

Science Advisory Board, Center of Excellence, Low Temp. and Quantum Devices, Helsinki Univ. of Tech. 2009-
International Advisory Committee, High Magnetic Field Laboratory, Chinese Academy of Sciences, Hefei 2009-
Fellow, The Institute of Physics, (2004-)
Editorial Board, Journal of Low Temperature Physics, Springer, (2004-)
Chair, External Advisory Committee, National High Magnetic Field Laboratory (2004-)
Regional Editor for North America, New Journal of Physics, Inst. of Phys. (2002-)
John Evans Professor of Physics (2001-)
Director, Interdisciplinary Science Program, Northwestern University (1999-)
Chairman, Department of Physics and Astronomy (1990-1995)
Fellow, American Physical Society (1995)
Editor, Progress in Low Temperature Physics, Elsevier (1995-)
Professor, Northwestern University (1986-present)
Associate Professor, Northwestern University (1981-86)
Alfred P. Sloan Fellow (1977-81)
Assistant Professor, Northwestern University (1975-81)
Resident Associate, Argonne National Laboratory (1979-85)

c) Publications (10 selected from 201):

Spatially Resolved Electronic Structure Inside and Outside the Vortex Core of a High Temperature Superconductor, V. F. Mitrovic, E. E. Sigmund, M. Eschrig, H. N. Bachman, W.P. Halperin, A.P. Reyes, P. Kuhns, W.G. Moulton, Nature **413**, 501 (2001).
Two-dimensional Superconductivity, B. Chen, W.P. Halperin, P. Guptasarma, D.G. Hinks, V.F. Mitrovic, A.P. Reyes, and P. Kuhns, Nature Physics **3**, 239 (2007).
Discovery of an Excited Cooper Pair State in Superfluid ^{3}He, J.P. Davis. J. Pollanen, H. Choi, J.A. Sauls, and W.P. Halperin, Nature Physics, **4**, 571 (2008).
Evidence for Complex Superconducting Order Parameter Symmetry in the Low Temperature Phase of UPt_3 from Josephson Interferometry, J.D. Strand, D.J. Van Harlingen, J.B. Kycia, and W.P. Halperin, Phys. Rev. Lett., **103**, 197002 (2009)
Magnetic Impurities in the Pnictide Superconductor $Ba_{1-x}K_xFe_2As_2$, S. Mukhopadhyay, S. Oh, A.M. Mounce, M. Lee, W.P. Halperin, N. Ni, S.L. Bud'ko, P.C. Canfield, A.P. Reyes, and P.L. Kuhns, New J. Phys. **11**, 055002 (2009).
Quantum Size Effects in Metallic Powders, W.P. Halperin, Rev. Mod. Phys. **58**, 533 (1986).
Discovery of the Acoustic Faraday Effect in Superfluid ^{3}He-B, Y.Lee, T. Haard, W. P. Halperin, and J.A. Sauls, Nature, **400**, 431 (1999).
Antiferromagnetism in the Vortex Cores of $YBa_2Cu_3O_{7-d}$, V. F. Mitrovic, E. E. Sigmund, W.P. Halperin, A.P. Reyes, P. Kuhns, W.G. Moulton, Phys. Rev B. Rapid **67**, 220503 (2003).
Surface Specific Heat and Andreev Bound States, H. Choi, J.P. Davis, J. Pollanen, and W.P. Halperin, Phys. Rev. Lett. **96**, 125301 (2006).
Intrinsic Impurity in the High Temperature Superconductor $Bi_2Sr_2CaCu_2O_{8+d}$, Bo Chen, Sutirtha Mukhopadhyay, W.P. Halperin, Prasenjit Guptasarma, and D.G. Hinks, Phys. Rev. B **77**, 052508 (2008).

Chairman MILLER. Thank you, Dr. Halperin.
Dr. Woods for five minutes.

STATEMENT OF DR. JASON WOODS, ASSISTANT PROFESSOR, WASHINGTON UNIVERSITY

Dr. WOODS. Chairman Miller, Ranking Member Broun, Members of the Subcommittee, I am honored to be asked to testify today. My name is Dr. Jason Woods. I am Assistant Professor of Radiology, Physics and Molecular Biophysics at Washington University, where I am also Assistant Dean of Arts and Sciences, and within the International Society for Magnetic Resonance in Medicine, I am the Program Director for our Hyperpolarized Media Study Group. I have been involved with helium-3 magnetic resonance imaging since 1997. My education and background are in nuclear-spin physics, helium-3 MRI, and the use of imaging for pulmonary physiology and pathophysiology. My research is focused on the use of helium-3 as a diagnostic imaging tool to precisely quantify lung ventilation, lung microstructure, and to guide new interventions that are being developed. In my testimony, I attempt to represent the field of helium-3 MRI and the impact of the shortage on our field.

Now, if we ask seasoned pulmonologists how much their field has changed in 25 years, responses will be that largely not much has changed. There are the same technologies for measuring pulmonary function. There are largely the same treatments. There are a few new drugs available but not much has changed, and these people see a large number of patients. Approximately 35 million Americans suffer from obstructive lung disease. That is asthma and COPD [Chronic Obstructive Pulmonary Disease] together. And taken together, this is 35 million Americans. COPD alone is the fourth leading cause of death and the only major leading cause of death in the United States and in the world that is significantly rising.

Helium-3 MRI is beginning to emerge as a new gold standard biomarker for measuring pulmonary function and structure. Its high signal creates extraordinarily detailed images of lung ventilation, which I have shown you right here, a healthy patient and a couple of volunteers with asthma and COPD.

[The information follows:]

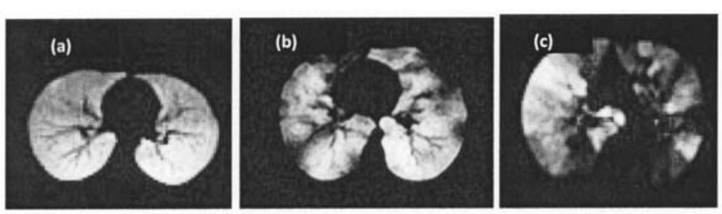


Figure 2: High-resolution transverse ventilation images of (a) a healthy volunteer and patients with (b) asthma and (c) COPD. This type of ventilation imaging represented a huge leap forward in our ability to visualize and quantify regional ventilation distribution and dynamics.

And its physical properties allow the determination of microstructure at the alveolar level. So here I have shown you a couple of images which are maps of lung microstructure, again at the alveolar level.

[The information follows:]

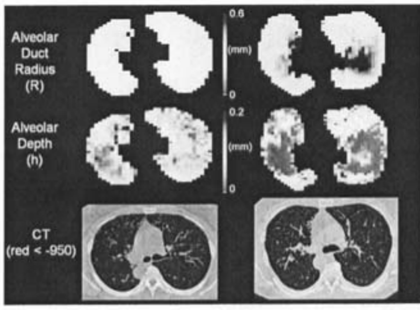
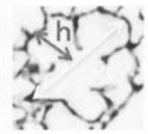


Figure 4: Maps of lung microstructure (color) obtained from gas diffusion imaging, in two volunteers with normal lung function and normal CT, yet the patient on the right is a current smoker and has a greatly reduced alveolar depth. *R* and *h* are depicted below within an individual alveolar duct (perpendicular to the page).



So this kind of sensitivity to lung structure and function and the ability to get regional maps of lung microstructure are allowing us to basically lead a renaissance in pulmonary medicine, and I think that in the next ten years we are going to see significant advances within this field. A lack of helium-3 gas will stifle these advances.

Now, to be clear, the shortage affects my research acutely and without any gas, my research as a young professor would be completely shut down and I would likely join the ranks of the unemployed. But I think the larger impact of helium-3 MRI is on much easier determination of the effectiveness of new drugs and devices and in guiding new minimally invasive interventions, which is my most recent work.

The lack of big leaps forward in drugs and devices in pulmonary medicine over the last 10 and 20 years is largely due to the combination of two things: the exceptional cost to bring a drug or device to market and the lack of a precise biomarker to determine changes in lung function and structure, and one recent example illustrates this well.

In 2007, GlaxoSmithKline released results of a study entitled "Toward a Revolution in COPD Health," or TORCH. The total cost of the study was $500 million for 6,000 patients with moderate and severe COPD, and in this case the endpoint was final: It was death from all causes. It ranged from a high of 16 percent to a low of 12.6 percent, and they wanted to answer the question. Does Advair reduce mortality by as much as 20 percent? And unfortunately for GSK, the question remains entirely unanswered because there was a 5.2 percent chance that the difference between the groups occurred randomly and the maximum accepted value is five percent. So by my calculation, if we had used helium-3 diffusion MRI that our group has developed as a biomarker and as an endpoint, then 6,000 patients would have turned into approximately 500 patients and the $500 million study would have turned into a $50 million study, saving $450 million and the question of efficacy would likely have been answered. This is just one example of the significant impact that I think that helium-3 MRI will have.

I firmly believe the helium that we use is 100 percent recyclable and we can begin to do this in the next few years with a commercially viable recycling scheme. From my perspective, the most important thing that I want to communicate to you today is that without approximately 2,000 liters of helium-3 for our imaging community per year, we will basically curtail this revolution in pulmonary medicine which is currently in progress.

[The prepared statement of Dr. Woods follows:]

PREPARED STATEMENT OF JASON C. WOODS

Chairman Miller, Ranking Member Broun, Members of the Subcommittee, I'm honored to be asked to testify today. My name is Dr. Jason Woods; I am an Assistant Professor of Radiology, Physics, and Molecular Biophysics and Assistant Dean of Arts & Sciences at Washington University and an the Program Director for the Hyperpolarized Media Study group of the International Society for Magnetic Resonance in Medicine. I have been involved with medical imaging—specifically hyperpolarized ^{3}He MRI—since 1997. My education and background are in nuclear-spin physics, ^{3}He MRI, and the use of MR imaging for pulmonary physiology and pathophysiology. My research has focused on the use of ^{3}He as a diagnostic imaging tool to understand regional lung ventilation, to precisely quantify lung microstructure and acinar connectivity, and to use imaging to guide new minimally-invasive interventions. In my testimony I attempt to represent the field of ^{3}He MRI and the impact of the shortage on this field. I focus on the revolutionary way that ^{3}He MRI has illuminated pulmonary ventilation and microstructure, how its physical properties make it unique and irreplaceable in many instances, its potential for guiding interventions and drug development, and how a developing recycling technology can allow significant, sustained research into the future with approximately 2000 liters per year. In so doing I specifically address the questions outlined in your letter to me dated April 9, 2010.

SUMMARY

If we ask seasoned pulmonologists today how much the practice of pulmonary medicine has changed in the last 25 years, responses will largely be that very little has changed—a few new drugs are available, but there is largely the same technology for measuring lung function and for treatment. ^{3}He MRI, however, is beginning to emerge as a new "gold standard" and revolutionary biomarker for measuring pulmonary function and structure. Its high signal creates detailed images of lung ventilation and dynamics, and its physical properties allow precise measurement of alveolar size, microstructure, and regional lung function. This makes ^{3}He MRI particularly sensitive to changes in both global and regional lung function and structure. We are at the cusp of leading pulmonary medicine to a renaissance of new drug development and image-guidance of surgical interventions for various lung diseases, such as asthma, fibrosis, and COPD, which currently affect 11% of the US population. This imaging technology, as I speak, is currently serving as a catalyst for pulmonology to see significant advances in the next 10 years. A lack of supply of ^{3}He gas will stifle these advances.

This ^{3}He shortage affects my research acutely; it affects my employees and collaborators, and the research and livelihood of MRI groups in at least 11 US universities and at least that many universities abroad. For me personally, a lack of gas will likely mean that my research is shut down, and I would join the ranks of the unemployed. To be clear, however, I think the larger impact of this technology is not on my research group but in drug development, in much easier determination of the effectiveness of new pharmacologic agents, and in guiding new minimally-invasive interventions (my most recent work). The lack of big leaps forward in drugs to treat lung diseases—asthma, COPD, pulmonary fibrosis—has largely been due to the combination of the exceptional cost to bring drugs to market and the lack of a precise biomarker to determine changes in the lung. Pulmonary function tests, the decades-old standard in pulmonary medicine, have notoriously high measurement errors. Obstructive lung diseases (asthma and COPD), taken together, afflict approximately 35 million Americans; COPD alone is the 4th leading cause of death and is the only major cause of death that is steadily increasing [1, 2]. The financial and human impacts of the shortage are significant.

One recent example of drug efficacy testing illustrates the lack of a precise biomarker and its impact: in 2007 GlaxoSmithKline released results of an Advair study, entitled "Toward a revolution in COPD health (TORCH)." The total cost was estimated at $500 million dollars for this study in over 6,000 moderate and severe COPD patients. The study endpoint was death from all causes, which ranged from a high of 16% to a low of 12.6% for those on Advair. The key question was "Does Advair reduce mortality by as much as 20%?" Unfortunately for GSK, the question remained unanswered, because the statistical p-value of the difference was 0.052. This means the difference in mortality had a 5.2% chance of occurring randomly, whereas the generally accepted limit is 5%. This $500M thus was largely wasted; the company couldn't answer the question about benefit, and patients and society received no benefit or increased understanding from the study. If the ^{3}He diffusion MRI techniques that our group has developed, for example, were used as a biomarker and endpoint (not possible when the study began), 6,000 patients could have turned into fewer than 500 patients, saving around 90% of the cost of the study, or $450M. And the question about efficacy would likely have been answered. This is only one example of the type of significant impact that I think ^{3}He MRI is going to have on pulmonary medicine.

There has been some discussion in the scientific literature about using hyperpolarized ^{129}Xe instead of ^{3}He gas for specific future studies, and for some studies this may be a viable alternative within the next 5–10 years [3], though the intrinsic physical properties of ^{129}Xe reduce the signal by a factor or 3–5 compared to ^{3}He. Some damage to the field could be tempered by outside assistance in developing this infrastructure and technology. However, many studies, like my NIH-funded research, rely upon ^{3}He's large diffusion coefficient for large-distance measurements, and for this xenon will not be an alternative [4]. On the bright side, the ^{3}He that we use is nearly 100% recyclable, but we do not yet have the recycling technology in place to begin to do this. I believe firmly that the development of efficient and commercially viable recycling schemes will allow this important work to continue, with a total allotment of around 2,000 Liters STP per year.

Lastly, I note that in 2009 an allocation of ^{3}He was made specifically for the NIH-funded medical imaging community. This was offered through Spectra Gases (now Linde Gas) at $600/L STP—an approximately 500% increase over previous years. Because the price of ^{3}He increased so quickly and by so much, research groups (who have strict budgets from federal or private grants) were not able to plan for the cost increase and are now scrambling for supplementary funding sources. This is the reason why all of the ^{3}He recently set aside for various medical imaging groups has not been instantly purchased.

BACKGROUND

Conventional MRI relies upon a large magnetic field to generate a net alignment of nuclear spins (generally within the hydrogen atoms of water molecules), which can be manipulated to create images with high contrast. The technology allows images to answer specific questions about structure and function of the brain, joints, or other parts of the body [5, 6]. MRI of gas is not generally used, since the density of a gas is about 1000 times less than tissues, and there is not enough signal to generate an image. The unique properties of the ^{3}He atom allow us to align a large fraction of its nuclear spins via a laser polarization technique with a magnetic field; this is often called "hyperpolarization" [7, 8]. Hyperpolarized ^{3}He gas has signals enhanced by a factor of 100,000 or more—allowing detailed images of the gas itself to be generated in an MRI scanner. Since helium gas (either ^{4}He or ^{3}He) has a solubility of essentially zero and is arguably the most inert substance in the universe, inhaled hyperpolarized ^{3}He allows the generation of exceptional quality, gas-MR images of ventilated lung airspaces with no ionizing radiation or radioactivity [9]. Further, traditional technologies for measuring pulmonary function (*e.g*., pulmonary function tests or nuclear ventilation scans) have either high errors on reproducibility or low content of regional information. While x-ray CT has some potential for quantifying lung structure (not function), its large amount of ionizing radiation raises cancer risks and prevents it from being used in longitudinal studies for drug development or in vulnerable populations, such as children [10, 11]. ^{3}He is inert and has proven to be very safe in studies to date (helium-oxygen mixtures[12] are used routinely in pulmonary and critical care); it is, however, currently regulated as an investigational drug by the US FDA.

THE REVOLUTION OF ^{3}HE MRI ON PULMONARY IMAGING

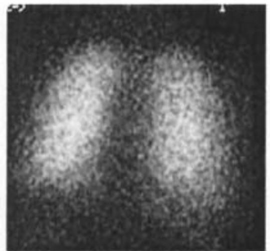


Figure 1: Nuclear ventilation scan

Ventilation

Previous technologies for imaging pulmonary ventilation generally involved the inhalation of radioactive gas over a period of one to several minutes, and then detecting what parts of the chest emitted the most radioactivity over several minutes. This technology (nuclear ventilation scans) had low spatial and temporal resolution (Figure 1). ^{3}He ventilation MRI represented a clear step forward in depicting not only precise, 3–D regional ventilation, but also in beginning to understand the regional dynamics of human ventilation in health and disease.

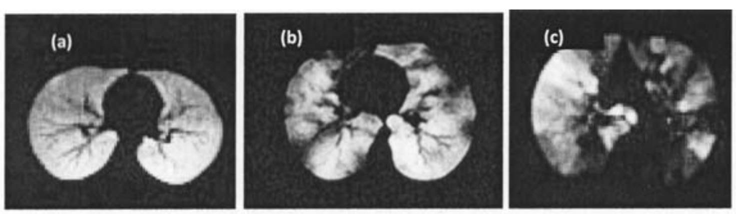


Figure 2: High-resolution transverse ventilation images of (a) a healthy volunteer and patients with (b) asthma and (c) COPD. This type of ventilation imaging represented a huge leap forward in our ability to visualize and quantify regional ventilation distribution and dynamics.

At present, ^{3}He ventilation imaging is being used in a wide variety of studies and holds high promise in increasing our understanding of the regional effects of asthma and its treatment [13–16], in addition to COPD, and various types of lung fibrosis [17, 18]. For example, it was recently found (Figure 2) that many ventilation defects persisted over time, opening the door to new regional treatments for asthma—an idea not previously pursued [19]. Because asthma is the most prevalent pulmonary disease in the US, improved medical and interventional therapies, facilitated by ^{3}He MRI, can significantly improve care and lower health care costs.

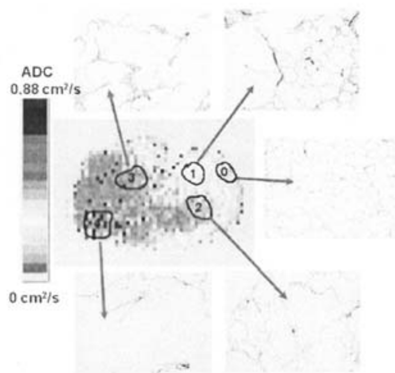


Figure 3: ^{3}He diffusion image (color) of a human lung with heterogeneous COPD, demonstrating the ability of the ^{3}He ADC to predict morphometry.

Diffusion and In-vivo Morphometry

Three unique physical properties of ^{3}He make it particularly well suited for measuring lung airspace size, geometry, and connectivity, by quantifying its restriction to thermal diffusion in the lung. These properties are 1) its small size (and thus large thermal diffusion coefficient), 2) its lack of solubility in tissue, and 3) its long relaxation time, T_1. Since ^{3}He is insoluble and has a large diffusion coefficient, collisions with airway and alveolar walls restrict the movement of the gas. This restriction can be measured and quantified using diffusion MRI. In fact, our group in particular has had a focus on ^{3}He diffusion MRI; we have shown that the technique is extraordinarily sensitive to airspace enlargement and has better discrimination than quantitative histology—the gold standard for airspace quantification in lung parenchyma (Figure 3). We have recently shown that the technique can be used to measure the size and geometry of alveolar ducts—allowing regional morphometry of the human lung, in vivo (Figure 4). These types of measurements are not available by any other noninvasive technique and represent a leap forward in our understanding of lung microstructure and our ability to quantify early disease.

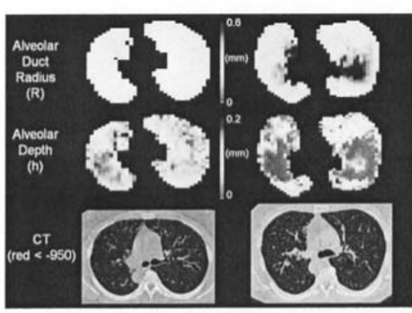


Figure 4: Maps of lung microstructure (color) obtained from gas diffusion imaging, in two volunteers with normal lung function and normal CT, yet the patient on the right is a current smoker and has a greatly reduced alveolar depth. *R* and *h* are depicted below within an individual alveolar duct (perpendicular to the page).

Airspace enlargement (emphysema) is a significant component of chronic obstructive pulmonary disease (COPD)—the only leading cause of mortality with dramatic *increases* in the US and the world [2]. Quantifying this airspace enlargement in a reliable and precise way, as ^{3}He MRI easily can, has enormous potential therapeutic benefit for patients with COPD. No other measurement modality has such potential to detect early disease, disease progression, or to quantify microstructural parameters in the ^{3}He MRI can. Figure 4 demonstrates this in two volunteers with normal lung function by pulmonary function test and with normal CT scans; ^{3}He MRI, however, can distinguish early lung disease in the smoker at right. This extraordinary sensitivity to early disease makes it a prime biomarker for use in drug development and efficacy testing.

One particularly unique quality of ^{3}He comes from the combination of its large gas diffusion coefficient and insolubility in tissue. This allows us to the diffusion of the gas over very long distances (2–5 cm) and has been called "long-range diffusion". Because these distances are larger than any acinar dimension, the technique is sensitive to the extent of "collateral" or short-circuits pathways other than the airway tree in the lung. These collateral pathways are essential to quantify for two minimally-invasive interventions that are being developed for end-stage COPD: transbronchial stents (Broncus Technologies, Inc.; Mountain View, CA) and one-way exit valves in segmental bronchi (Spiration, Inc.; Redmond, WA). My most recent NIH-funded research involves the use of long-range ^{3}He diffusion to guide and predict the efficacy of these minimally-invasive interventions under development. Early results are quite promising, and demonstrate that the imaging will do quite well at guiding the therapy, but the shortage of ^{3}He has had a negative impact on the study.

Regional Pulmonary Oxygen Monitoring

The long relaxation time T_1 of ^{3}He and its sensitive dependence on oxygen concentration allow us to measure the regional partial pressure of oxygen in the lung. Maps of this partial pressure (pAO_2) in the lung can be used to understand regional pulmonary blood flow and diffusion of oxygen into capillaries—the essential purpose of the organ. Not only can pAO_2 be used to measure deficiencies in the partial pressure of oxygen, but it can be employed to understand the regional relationship between structure and function in the lung, at its most fundamental level (oxygen and CO_2 transfer). Again, this is a technique only possible via ^{3}He MRI.

Partial List of Currently Funded ^{3}He Imaging Projects in North America

The following list of current ^{3}He MRI research projects is far from complete but represents the broad range of lung diseases studied and research funded by both the NIH and by US-based private industry:

Assessing drugs for treatment of cystic fibrosis: University of Massachusetts (Dr. Albert, *et al.*)

Detecting early and preclinical COPD: Washington University (Dr. Yablonskiy, *et al.*)

Detection of pulmonary metastases with ^{3}He: Duke University (Dr. Driehuys, *et al.*)

Detecting and treating pulmonary embolism: University of Massachusetts (Dr. Albert, *et al.*)

Diffusion kurtosis imaging in asthma, COPD and in the lungs of 9/11 NYC firefighters: New York University (Dr. Johnson, *et al.*)

Drug Efficacy in preclinical models of asthma and COPD: Duke University (Dr Driehuys, *et al.*)

Early detection of bronchiolitis obliterans syndrome in lung transplant recipients: Washington University (Dr. Woods, *et al.*)

Evaluation of endobronchial interventions for COPD: Washington University (Dr. Woods, *et al.*), Robarts Imaging Institute (Dr. Parraga, *et al.*, University of Virginia (Dr. Altes, *et al.*)

Evaluation of a novel treatment for asthma: University of Virginia (Dr. Altes, *et al.*)

Evaluation of a novel treatment for cystic fibrosis: University of Virginia (Dr. Mugler, *et al.*)

Imaging of small-animal models of diseases: Duke University (Dr. Johnson *et al.*), Washington University (Dr. Woods, *et al.*)

In-vivo morphometry with ^{3}He diffusion MRI: Washington University (Dr. Yablonskiy, *et al.*)

***Measuring regional pulmonary oxygen pressure by* ^{3}He MRI:** University of Pennsylvania (Dr. Rizi, *et al*)

Monitoring Progression of COPD: Duke University (Dr Driehuys, *et al.*), Robarts Imaging Institute (Dr. Parraga, *et al.*), University of Virginia (Dr. Mugler, *et al.*), Washington University (Dr. Yablonskiy, *et al.*)

Neonatal ventilation and dynamics under mechanical ventilation: Harvard University (Dr. Patz *et al.*), University of Virginia (Dr. Miller, *et al.*)

Noninvasive methods for measuring alveolar surface area: Harvard University (Dr. Patz, *et al.*), Washington University (Dr. Yablonskiy, *et al.*)

Persistence of Ventilation Defects in patients with asthma: University of Virginia (Dr. Altes, *et al.*), University of Massachusetts (Dr. Albert, *et al.*)

Predicting ventilation changes caused by radiation therapy: Robarts Imaging Institute (Dr. Parraga, *et al.*), University of Virginia (Dr. Mugler, *et al.*)

Probing the fundamental limits of MRI resolution by diffusion: Duke University (Dr. Johnson, *et al.*)

Pulmonary Gas flow Measurements and Dynamic ^{3}He MRI of the Lungs: New York University (Dr. Johnson, *et al.*)

A Specialized Clinically Oriented Center of Research for COPD: (Dr. Holtzman and Dr. Woods, *et al.*)

THE ^{3}HE SHORTAGE AND ITS EFFECTS

Timeline

Late in 2008 our research group and others became aware that there was a supply issue with ^{3}He gas, through conversations with Spectra Gases, Inc. We immediately purchased some gas to continue imaging studies in COPD patients. In March, 2009, we were told there was no gas available for medical applications and that the price of non-medical ^{3}He had risen to near $400/L STP. Conversations with colleagues at the University of Virginia, Harvard University, and the University of Pennsylvania confirmed that others were also unable to purchase ^{3}He gas. In April–June of 2009, we worked with Spectra Gases and other universities to state our ^{3}He requirements to continue NIH- and NSF-funded research in 2009; Spectra Gases then met with the Department of Energy (DOE) in July and August to make clear that US Government-funded research was being affected. In August 2009, Spectra approached me and the other officers of the Hyperpolarized Media Study Group of the International Society for Magnetic Resonance in Medicine (the primary professional organization for ^{3}He MRI researchers) to write a letter to the Isotope Work Group of the DOE, stating how ^{3}He is unique in medical imaging and that a significant amount of NIH-funded research would be effectively shot down without access to the small amount of gas that our community uses (2000 L STP/year, approximately). Dr. William Hersman and I drafted this letter, dated September 4, 2009; it is attached to the end of this written testimony. In October 2009 we were notified by Spectra Gases that an algorithm for obtaining a small amount of ^{3}He gas for NIH-funded studies had been achieved. In order to obtain any gas, we were to list each federally-funded grant's title and number, and for each a requested amount of gas for the subsequent 6 months of usage. ^{3}He was offered to our group for $600/L STP, an approximately 500% increase from previous years. I also drafted a letter in support of Spectra's modification of their permit for 3H (tritium) limits with ^{3}He, in addition to letters of support for allocation of ^{3}He to two non-US researchers who do important work; these are also attached to this testimony. At a recent AAAS meeting (April, 2010), it was made clear that the White House Office of Science and Technology Policy (OSTP) had been diligently and actively pursuing a solution to this shortage by facilitating discussions between DOE and DHS. My understanding is that OSTP was helpful in (perhaps in large part responsible for) the 2009 and 2010 allocation of ^{3}He gas to NIH-funded projects.

Impact of the Shortage upon Medical Imaging Research

While I have stated that I think the biggest impact of ^{3}He MRI *technology* is in drug development, efficacy monitoring, and in guiding new minimally-invasive interventions, the impact of the shortage was most keenly felt by those of us in the middle of performing NIH- and industry-funded research studies. Some of us (like our group at Washington University) were able to continue to perform studies at a lower rate and were able to purchase gas at $600/L STP, once it became available. Other groups, such as the Robarts Imaging Institute, have not been able to continue ^{3}He studies, even if these studies were funded by US companies. Even for US, NIH-funded researchers, however, the price of ^{3}He increased so quickly and by so much that research groups were not able to plan for the cost increase and are now scrambling for supplementary funding sources. This is the reason why all of the ^{3}He recently set aside for various medical imaging groups has not been instantly purchased. The shortage has had a significant negative impact on the continued productivity of our research community and on the probability of future research. Importantly, if sufficient ^{3}He is not allocated to medical imaging at reasonable cost, this will likely curtail the revolution in pulmonary medicine currently in progress.

Financial and Scientific Impact

It is difficult to gauge the precise financial impact of the ^{3}He shortage on the field of hyperpolarized-gas MRI. It is clear that fewer studies are being conducted and planned as a result of this shortage. It is probably safe to say that all studies mentioned previously have been scaled back by a factor of 2 or more. By my count, the National Institutes of Health are currently supporting at least 25 active projects requiring ^{3}He, with over $4M allocated for FY2010. If we assume similar funding for the past 8 years, with less funding before that, this represents an investment of over $32M via NIH funding alone. When added to the significant (but more difficult to quantify) investment from the NSF, private and public universities, and private industry, the total investment in ^{3}He MRI is likely between $60M and $100M over the past 10 years.

While the above numbers represent an enormous investment in ^{3}He polarization and MRI infrastructure, it is my opinion that the biggest financial impact of the shortage is on future drug development, efficacy monitoring, and in guiding new surgical and minimally-invasive interventions. Through the use of more precise biomarkers, such as we have developed via ^{3}He MRI, the number of patients required to determine the true efficacy of a drug or device can be reduced by large fractions (up to 90% by a recent calculation from our techniques), which would translate directly into proportionate cost savings. The GSK example of the TORCH study mentioned in the Summary is illustrative. The key question was "Does Advair reduce mortality by as much as 20%?" Unfortunately for GSK, the question remained unanswered after studying 6000 patients and expending $500M, because the statistical significance was not high enough to determine an answer to the vital question. If the ^{3}He diffusion MRI techniques that have been discussed here were used as a biomarker and endpoint (not possible when the study began), 6,000 patients could have turned into fewer than 500 patients, saving around 90% of the cost of the study, or $450M. The question about efficacy would likely have been answered, and the company could have devoted its efforts to the marketplace, if successful, or to newer and more innovative solutions, if unsuccessful.

The scientific impact of the shortage is serious. Scientific studies and investigations into lung physiology and pathophysiology and new treatments are being scaled back; without a clear solution in place, the revolution in pulmonary medicine will be at least partially curtailed. In one case that I'm very familiar with, research has ceased entirely because of a lack of ^{3}He gas. The Robarts Research Institute in London, Canada was established in part with capital funding provided by and research partnerships with Merck Research Laboratories (Imaging, Westpoint PA USA) and General Electric Health Care (GEHC, Milwaukee WI). They have been performing ^{3}He MRI studies in animal models of respiratory disease, in healthy volunteers, and patients with lung disease (COPD, asthma, cystic fibrosis, radiation-induced lung injury). Their human studies are funded by Merck, GEHC, the Canadian Lung Association and Canadian Institutes of Health Research. Without a small allocation of ^{3}He to this institution, their entire pulmonary MRI operation will be shut down, and further investment by US companies will be lost.

POTENTIAL ALTERNATIVES TO ^{3}HE

Two noble gas isotopes (^{3}He and ^{129}Xe) were originally identified as having potential for use in pulmonary MRI, since they could be hyperpolarized to 10% or more with sufficient laser power (originally very expensive and technically complex). Other gases (e.g. ^{83}Kr, ^{21}Ne) have potential for low levels of hyperpolarization, but their nuclear and physical properties will prevent high polarizations in bulk gas or their widespread use in human MRI. When high-power, low-cost diode laser technology became available in the 1990s, these lasers were used to produce macroscopic quantities of ^{3}He at high polarization (~50–60%), and ^{129}Xe at much lower polarization ($\leq$ 10%). The comparative physical properties of the gases and early hyperpolarization technology led to near-universal adoption of ^{3}He as the gas of necessity for pulmonary gas MRI. These properties are outlined below.

1. The magnetic moment of ^{129}Xe is only about 1/3 that of ^{3}He; this is directly related to the signal strength in MRI. Further, the natural abundance of ^{129}Xe is only 26%; both of these reduce the available signal in the hyperpolarized gas intrinsically by a factor of 6. Enrichment of the isotope (at significant cost, since ^{129}Xe is close in weight to the abundant isotopes of Xe) can reduce this intrinsic signal reduction to a factor of 3 below ^{3}He. The achievable polarization with xenon has also been historically lower than with ^{3}He, and the delivered dose of xenon gas is limited

by its anesthetic activity. In short, hyperpolarized xenon does not yield the high signal-to-noise that ^{3}He does, which means that xenon delivers poorer quality images and less physiological information. The sum of the effects of lower magnetic moment (gyromagnetic ratio), lower abundance, lower polarization, and lower dose add up to an approximate reduction in signal by a factor of 50. The efforts of Dr. William Hersman (XeMed, LLC) have helped to increase ^{129}Xe polarizations, but this new technology requires new, significant capital investment by each hyperpolarized group wishing to switch to ^{129}Xe. Even with "perfect" new technology which achieves comparable polarization and with isotopically enriched gas, the signal reduction is still intrinsically limited by the magnetic moment and limited dose—a factor of 3–5—and many experiments and clinical trials are not possible with ^{129}Xe. This is particularly true for measurements of lung morphometry and connectivity.

2. The free diffusivity of ^{3}He is extremely large, because of its low mass and small collisional cross-section. This property is crucial to measurements of long-range diffusivity in lungs, which have been shown to be more sensitive to emphysema than short-range diffusivity. By comparison, the much lower free diffusivity of xenon greatly reduces the distances that can be explored with the long-range technique. To our knowledge, no one has even reported long-range diffusion measurements in lungs with hyperpolarized xenon for this reason. Several of our NIH-funded projects rely upon a measurement of long-range ^{3}He diffusion and would not be completed without the ^{3}He isotope. Further, larger field gradients are required even for short-range diffusion experiments; this may require further capital costs.

3. The long T_1 of ^{3}He allows it to be shipped by air freight. This has been demonstrated in Europe and the Mayo Clinic (in addition to a current proposal by Dr. Hoffman's group at the University of Iowa) as a feasible business-model for polarized gas use in hospitals, removing the necessity of each hospital having its own dedicated polarizer (a requirement that has so far limited the clinical utilization of polarized gas). By comparison, the T_1 of xenon is shorter (of order 2 hours), making air shipment virtually impossible to orchestrate.

^{3}He will remain a necessity for MRI researchers because of the physical properties mentioned above (specifically its high diffusion coefficient). The intrinsic properties of ^{129}Xe will necessarily limit the images to have a factor of 3 reduction in signal compared to ^{3}He images. The polarization of ^{129}Xe has seen significant improvement in the past 3–4 years, however, and some recent images of ventilation have had acceptable contrast, even though the signals were not as high as for ^{3}He. And while the relatively large solubility in tissue has an anesthetic effect on animals and humans, this property can be capitalized upon in an attempt to quantify diffusion across gas-tissue barriers. There is thus a potential role for t29Xe in perhaps half of the future hyperpolarized-gas MRI studies.

RECYCLING ^{3}HE

Since helium is not soluble in the tissues of the body, it can be very highly recoverable, yet most research groups do not have systems currently in place to recapture and compress exhaled gas. The hyperpolarized helium research community has demonstrated in the past that inexpensive technologies can be assembled for easily solvable problems within the field, and the technology for recycling of ^{3}He is straightforward. (For example, since ^{3}He is a liquid at 4 K [4 degrees above absolute zero], all other gases, particulate and biological matter can be frozen out by passing through a liquid ^{4}He bath at 4 K.) Both Washington University (Dr. Woods, et al.) and the University of Virginia (Dr. Miller, et al.) are currently collaborating with Walter Whitlock, of Conservation Design Services, Inc., in North Carolina, to develop commercially-viable recycling for wide use in the ^{3}He MRI community. This recycling collaboration is not yet funded but is currently underway. I believe that the important and significant scientific research outlined in this testimony can be sustained and performed with around 2,000 total STP liters of ^{3}He per year, after development of good recovery/recycling systems for ^{3}He.

REFERENCES

1. Bednarek, M., et al., *Prevalence, severity and underdiagnosis of COPD in the primary care setting*. Thorax, 2008. **63**(5): p. 402–7.
2. Mannino, D.M. and A.S. Buist, *Global burden of COPD: risk factors, prevalence, and future trends*. Lancet, 2007. **370**(9589): p. 765–73.
3. Hersman, F.W., et al., *Large production system for hyperpolarized 129Xe for human lung imaging studies*. Acad Radiol, 2008. **15**(6): p. 683–92.

4. Woods, J.C., et al., *Long-range diffusion of hyperpolarized ^{3}He in explanted normal and emphysematous human lungs via magnetization tagging*. J Appl Physiol, 2005. **99**(5): p. 1992–7.

5. Callaghan, P.T., *Principles of nuclear magnetic resonance microscopy*. 1991, Oxford [England]; New York: Clarendon Press; Oxford University Press. xvii, 492 p.

6. Talagala, S.L. and I.J. Lowe, *Introduction to magnetic resonance imaging*. Concepts Magn Reson, 1991. **3**: p. 145–159.

7. Gamblin, R.L. and T.R. Carver, *Polarization and relaxation processes in 3He gas*. Phys Rev 1965. **138**: p. 946–960.

8. Walker, T.G. and W. Happer, *Spin exchange optical pumping of noble-gas nuclei*. Rev Mod Phys, 1997. **69**: p. 629–642.

9. Lutey, B.A., et al., *Hyperpolarized ^{3}He MR imaging: physiologic monitoring observations and safety considerations in 100 consecutive subjects*. Radiology, 2008. **248**(2): p. 655–61.

10. Berrington de González, A., et al., *Projected Cancer Risks from Computed Tomographic Scans Performed in the United States in 2007*. Arch Intern Med, 2009. **169**(22): p. 2078–2086.

11. Smith-Bindman, R., et al., *Radiation Dose Associated With Common Computed Tomography Examinations and the Associated Lifetime Attributable Risk of Cancer*. Arch Intern Med, 2009. 169(22): p. 2078–2086.

12. Frazier, M.D. and I.M. Cheifetz, *The role of heliox in paediatric respiratory disease*. Paediatr Respir Rev. **11**(1): p. 46–53; quiz 53.

13. Wang, C., et al., *Assessment of the lung microstructure in patients with asthma using hyperpolarized ^{3}He diffusion MRI at two time scales: comparison with healthy subjects and patients with COPD*. J Magn Reson Imaging, 2008. **28**(1): p. 80–8.

14. de Lange, E.E., et al., *Evaluation of asthma with hyperpolarized helium-3 MRI: correlation with clinical severity and spirometry*. Chest, 2006. **130**(4): p. 1055–62.

15. Fain, S.B., et al., *Evaluation of structure function relationships in asthma using multidetector CT and hyperpolarized He-3 MRI*. Acad Radiol, 2008. **15**(6): p. 753–62.

16. Altes, T.A. and E.E. de Lange, *Applications of hyperpolarized helium-3 gas magnetic resonance imaging in pediatric lung disease*. Top Magn Reson Imaging, 2003. **14**(3): p. 231–6.

17. Woods, J.C., et al., *Hyperpolarized 3He diffusion MRI and histology in pulmonary emphysema*. Magn Reson Med, 2006. **56**(6): p. 1293–300.

18. van Beek, E.J., et al., *Assessment of lung disease in children with cystic fibrosis using hyperpolarized 3-Helium MRI: comparison with Shwachman score, Chrispin-Norman score and spirometry*. Eur Radiol, 2007. **17**(4): p. 1018–24.

19. de Lange, E.E., et al., *Changes in regional airflow obstruction over time in the lungs of patients with asthma: evaluation with 3He MR imaging*. Radiology, 2009. **250**(2): p. 567–75.

Washington University in St.Louis
SCHOOL OF MEDICINE

Jason C. Woods, Ph.D.
Assistant Professor of Radiology, Physics, & Molecular Biophysics
Assistant Dean of Arts & Sciences
Director, MARC uSTAR Program

Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission

Cc: Spectra Gases, Inc. (Jack Faught, Keith Darabos)
3434 Route 22 West
Branchburg, NJ 08876

September 4, 2009

RE: ^{3}He is unique and irreplaceable - Letter to the Isotope Work Group of the US Government in relation to release of ^{3}He for medical imaging.

Dear Keith,

Our understanding is that the US government's "isotope work group" may benefit from some additional information and a statement from the hyperpolarized-gas community concerning the necessity of ^{3}He as the hyperpolarized isotope of choice for our pulmonary imaging studies and clinical trials. ^{3}He has emerged as a new and unique standard for pulmonary imaging, both for its high signal, physical properties (specifically, a high diffusion coefficient, allowing morphometric measurements of alveolar spaces), developed infrastructure, and mature polarization technology. There has been some discussion in the literature about using hyperpolarized xenon instead of ^{3}He gas for specific future studies, but it is clear to us that hyperpolarized xenon is simply not suitable to replace ^{3}He at this point, both for scientific and practical reasons. We outline these reasons below. In the long run, we believe that significant scientific research can be performed with around 1000-2000 STP liters of ^{3}He after development of good recovery/recycling systems for ^{3}He.

1. The magnetic moment of ^{129}Xe (the spin ½ stable isotope) is only about 1/3 that of ^{3}He, and the natural abundance of ^{129}Xe is only 26%; both of these reduce the available signal in the hyperpolarized gas. The achievable polarization with xenon has also been historically lower than with ^{3}He, and the delivered dose of xenon gas is limited by its anesthetic activity. In short, hyperpolarized xenon does not yield the high signal-to-noise that ^{3}He does at this point in time, which means that xenon delivers poorer quality images and less physiological information. The sum of the effects of lower gyromagnetic ratio, lower abundance, lower polarization, and lower dose add up to an approximate reduction in signal by a factor of 50. In the future, the achievable

Mallinckrodt Institute of Radiology
510 South Kingshighway • St Louis, MO 63110 • 314-362-9187 • Fax 314-935-6219 • jason.woods@wustl.edu

polarizations of xenon are expected to improve, though we do not view this as a viable replacement for ^{3}He for the reasons stated herein. The efforts of Dr. Bill Hersman (XeMed, LLC) have helped to increase ^{129}Xe polarizations, but this new technology requires new, significant capital investment by each hyperpolarized group wishing to switch to ^{129}Xe. Even with "perfect" new technology which achieves comparable polarization and with isotopically enriched gas, the signal reduction is still limited by the gyromagnetic ratio and limited dose—a factor of 3-5—and many experiments and clinical trials are not possible with ^{129}Xe.

2. Different physical properties of Xe and He lead to differences in the investigations that can be performed with the two gases. One big difference is the self diffusion coefficient; the free diffusivity of ^{3}He is extremely large, because of its low mass and small collisional cross-section. This property is crucial to measurements of long-range diffusivity in lungs, which have been shown to be more sensitive to emphysema than short-range diffusivity. By comparison, the much lower free diffusivity of xenon (neat, or mixed with air or nitrogen) greatly reduces the distances that can be explored with the long-range technique. To our knowledge, no one has even reported long-range diffusion measurements in lungs with hyperpolarized xenon for this reason. Several of our NIH-funded projects rely upon a measurement of long-range ^{3}He diffusion and would not be completed without the ^{3}He isotope.

3. The long T_1 of ^{3}He allows it to be shipped by air freight. This has been demonstrated in Europe and the Mayo Clinic (in addition to a current proposal by the Iowa group) as a feasible business-model for polarized gas use in hospitals, removing the necessity of each hospital having its own dedicated polarizer (a requirement that has so far limited the clinical utilization of polarized gas). By comparison, the T_1 of xenon is shorter (of order 2 hours), making air shipment virtually impossible to orchestrate. Further, the hyperpolarized helium research community has demonstrated that inexpensive technologies can be assembled for recapturing and recycling of the ^{3}He gas used for medical imaging. Since helium is not soluble in the tissues of the body, it can be very highly recoverable.

4. Many groups in the field using hyperpolarized ^{3}He have existing, funded grants, most of which are from the National Institutes of Health, representing a $100 million investment over the past decade in infrastructure and expertise. A substantial decrease in availability or increase in price of ^{3}He would be an insurmountable burden on these groups and their research efforts. In this regard, we ask that you note that switching from ^{3}He to xenon (assuming xenon is suitable for the proposed measurements; see above) would entail large equipment expenses, which current funding would not cover. A conversion of existing polarizers on loan from General Electric (or built in-house by scientists) would require major, expensive changes; imaging would have to occur with new rf coils (now often complex multi-receiver "phased arrays"), pulse and sequence development, and an established multi-year safety record. Even with such a large capital and time investment for xenon substitution, resultant images with ^{129}Xe would be inferior to what our current ^{3}He studies require.

Mallinckrodt Institute of Radiology
510 South Kingshighway • St Louis, MO 63110 • 314-362-9187 • Fax 314-935-6219 • jason.woods@wustl.edu

In summary, we see a huge loss of scientific productivity, a wasting of a large investment in medical research infrastructure, a forestalling of medical advances for the US patient population, and irreparable damage to careers of scientists and students without an immediate release of ^3He for use by the medical research community. While hyperpolarized xenon may, in the long term, meet some of the medical needs presently served by ^3He, we do not see this making an impact without a large investment in time (several years) and research dollars (>$10M), the funds for which do not exist. Even if that investment were made, clinical trials currently underway would have to be restarted. If, on the other hand, a programmatic release of ^3He over the next several years were allowed, important research with the existing infrastructure could continue. Market forces or quantity restrictions will rapidly result in technological and methodological ways of maximizing the progress using as little ^3He gas as possible.

On behalf of the Hyperpolarized Media Study Group of the International Society of Magnetic Resonance in Medicine,

Jason C. Woods, Ph.D.
Program Chair, Hyperpolarized Media Study Group
Assistant Professor of Radiology, Physics, & Molecular Biophysics
Assistant Dean of Arts & Sciences
Washington University

F. William Hersman, Ph.D.
President, Hyperpolarized Media Study Group
Professor of Physics, University of New Hampshire
CEO, Xemed, LLC

Mallinckrodt Institute of Radiology
510 South Kingshighway • St Louis, MO 63110 • 314-362-9187 • Fax 314-935-6219 • jason.woods@wustl.edu

Washington University in St. Louis

SCHOOL OF MEDICINE

Dr Jason C. Woods
Assistant Professor of Radiology, Physics, & Molecular Biophysics
Assistant Dean of Arts & Sciences
Director, MARC uSTAR Program

Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission

Cc: Spectra Gases, Inc. (Jack Faught, Keith Darabos, Michael Baselice)
3434 Route 22 West
Branchburg, NJ 08876

September 30, 2009

RE: modification of Spectra Gases' permit (license # 29-30779-01) for tritium contained within helium gas.

To whom it may concern:

We understand that the US Nuclear Regulatory Commission may benefit from some additional information and a statement from the hyperpolarized-gas community regarding the modification of Spectra Gases' license for tritium limits within the stable isotope ^{3}He, which our community uses routinely for pulmonary medical imaging via MRI. Our position is that the levels of allowed tritium within inhaled ^{3}He gas (5×10^{-6} µCi/cc) is many orders of magnitude below any level potentially harmful to humans. This position is based upon our own calculations and those provided by the Department of Energy, within the Handbook, *Tritium Handling and Safe Storage* (DOE-HDBK-1129-99). We urge that the requested modification to the license, which will allow more ^{3}He to be used for NIH-sponsored and other research projects within our scientific community, be granted expeditiously.

We offer a calculation below to illustrate the safety of the allowed level of tritium within ^{3}He gas. Since each research group uses a slightly different amount of ^{3}He per experiment (which range from 300 mL to 1000 mL) we assume the maximum of 1000 mL ^{3}He per experiment and 3000 mL ^{3}He per imaging session in the calculations.

The DOE Handbook *Tritium Handling and Safe Storage* correctly notes that tritium is not readily absorbed from inhaled gases or through the skin. (This is due to its very low solubility in tissue and blood—near the low value of ^{3}He gas itself.) They state on p. 5 that, "A very small fraction of the inhaled hydrogen isotopes, in gaseous form, is not exhaled, but is dissolved in the blood stream and then exhaled after a few minutes." This handbook concludes that a 0.5 µCi/cc concentration of tritium gas inhaled occupationally for 1 year would be the equivalent of a 5 rem dose. Therefore, the allowed level of tritium in ^{3}He (via Spectra Gases' license—5×10^{-6} µCi/cc)

Mallinckrodt Institute of Radiology

510 South Kingshighway • St Louis, MO 63110 • 314-362-9187 • Fax 314-935-6219 • jason.woods@wustl.edu

would be equivalent to 5×10^{-5} rem if exposed occupationally to this concentration over an entire year (assumes 2400 m^3 of gas at that concentration was inhaled--much more than ever feasibly inhaled for medical imaging). A typical value of a very large dose of ^3He (30 L, or 3 L per session for 10 sessions) would result in a dose of 6.3×10^{-10} rem.

The average American is subjected to multiple sources of radiation exposure, many of them from natural sources. By far the largest natural source of radiation exposure to humans is from radon (200 mrem/yr). However, even the chemical makeup of the human body includes carbon-14 and potassium-40 (40 mrem/yr). Cosmic rays deliver a continuous natural source of ionizing radiation (27 mrem/yr). Because the dose calculated above for tritium in ^3He is a roughly billion times smaller than the one year burden from these natural exposures, we argue that its contribution constitutes an insignificant risk.

On behalf of the Hyperpolarized Media Study Group of the International Society of Magnetic Resonance in Medicine,

Jason C. Woods, Ph.D.
Program Chair, Hyperpolarized Media Study Group
Assistant Professor of Radiology, Physics, & Molecular Biophysics
Assistant Dean of Arts & Sciences
Washington University

F. William Hersman, Ph.D.
President, Hyperpolarized Media Study Group
Professor of Physics, University of New Hampshire
CEO, Xemed, LLC

Washington University in St. Louis

SCHOOL OF MEDICINE

Jason C. Woods, Ph.D.
Assistant Professor of Radiology, Physics, & Molecular Biophysics
Assistant Dean of Arts & Sciences
Director, MARC uSTAR Program

Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission

Cc: Spectra Gases, Inc. (Jack Faught, Keith Darabos)
3434 Route 22 West
Branchburg, NJ 08876

November 18, 2009

RE: release of ^{3}He gas

To whom it may concern:

I write in support of the release of ^{3}He gas for medical imaging to Dr. Giles Santyr and Dr. Grace Parraga, of the Robarts Research Institute in London, Ontario. Both Dr. Santyr and Dr. Parraga are pillars of the hyperpolarized gas community. They have active collaborations within the United States, are both at the cutting edge of medical-imaging research; their requests for gas release should be granted.

The pulmonary-imaging group at Robarts has broken new ground in the quantification of ventilation defects and their relationship to disease severity and progression in both asthma and COPD. Researchers and clinicians in the United States have directly benefited from their work and will continue to do so if this request is granted. Their research is mainly funded by the Canadian Institutes of Health (similar to our National Institutes of Health), and they have advisers and collaborations with researchers in the United States. I personally have visited their facility in the past 6 months, in part to discuss a collaboration with our group at Washington University and in part in an advisory role, as I serve on an external board of advisors to one of their CIHR grants.

In addition to being active contributors to the US and international community of medical imaging, they have developed good educational-industrial partnerships with US companies such as General Electric. Their past work with US companies has resulted in significant improvements of ultrasound, CT, and MRI technology, which benefits the US companies, US researchers, and US citizens at large. A failure to release ^{3}He gas to this research team would significantly impede progress in the field and would have a detrimental impact on collaborations with US researchers and corporations.

Sincerely,

Jason C. Woods, Ph.D.

Mallinckrodt Institute of Radiology
510 South Kingshighway • St Louis, MO 63110 • 314-362-9187 • Fax 314-935-6219 • jason.woods@wustl.edu

Washington University in St.Louis
SCHOOL OF MEDICINE

Jason C. Woods, Ph.D.
Assistant Professor of Radiology, Physics, & Molecular Biophysics
Assistant Dean of Arts & Sciences
Director, MARC uSTAR Program

Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission

Cc: Spectra Gases, Inc. (Jack Faught, Keith Darabos)
3434 Route 22 West
Branchburg, NJ 08876

November 19, 2009

RE: release of ^{3}He gas

To whom it may concern:

I write in support of the release of ^{3}He gas for medical imaging to Dr. Frank Thien, of Monash University & Box Hill Hospital in Melbourne, Australia. Dr. Thien has recently been successful in performing ^{3}He MRI with gas transported via an intercontinental commercial airline. Their work supports the success of a model of central production and distribution, even to a destination halfway around the earth from the production facility.

Dr. Thien is funded by the National Health and Medical Research Council, which is the Australian equivalent of our National Institutes of Health. He has active collaborations in Europe and in the United States with Dr. Kim Prisk at the University of California San Diego. Their collective work together is very scientifically productive and important to the field of hyperpolarized-gas imaging. Researchers and clinicians in the United States have directly benefited from their work and will continue to do so if this request is granted.

In addition, the amount requested (30 STP liters) is rather modest and will represent only a very small fraction of the total medical-gas utilization of ^{3}He.

Sincerely,

Jason C. Woods, Ph.D.
Program Director, ISMRM Hyperpolarized Media Study Group

Mallinckrodt Institute of Radiology
510 South Kingshighway • St Louis, MO 63110 • 314-362-9187 • Fax 314-935-6219 • jason.woods@wustl.edu

BIOGRAPHY FOR JASON C. WOODS

Dr. Jason C. Woods received an undergraduate degree from Rhodes College in 1997 and his Ph.D. in physics from Washington University in St Louis in 2002. He is currently an Assistant Professor of Radiology, Physics, and Molecular Biophysics and Assistant Dean of Arts & Sciences at Washington University. He is also the Program Director for the Hyperpolarized Media Study group of the International Society for Magnetic Resonance in Medicine, where much of the world's hyperpolarized-gas MRI is reported. His internationally recognized, NIH-funded research has focused on the production and application of hyperpolarized gases (^{3}He in particular) to the study of lung ventilation, structure, and function in health and disease—COPD in particular. This interdisciplinary work has involved national and international collaborations with physicists, radiologists, pulmonologists, and surgeons—most recently in using imaging to guide new minimally-invasive interventions.

In his role as Assistant Dean within Arts & Sciences at Washington University, his multidisciplinary research is mirrored by multidepartmental administrative efforts in biomedically-related science fields and in the retention and graduate-school pursuits of STEM majors. He is Program Director for the MARC uSTAR program at Washington University—an NIH-funded program intended to increase the pipeline and diversity of biomedical scientists at the PhD level.

Chairman MILLER. Thank you, Dr. Woods.

I now recognize myself for the first round of questions. All of you have described your uses for helium-3. All of you obviously have relied upon technology or used or developed technologies that assumed the availability of helium-3. The only domestic supplier was the Department of Energy. Were any of you advised by the Department of Energy, by DOE of any future shortage? Mr. Anderson.

Mr. ANDERSON. Mr. Chairman, we had discussions with the isotope office who has been distributing helium-3 through the years, going back to the first auction back in the 2003 time frame. We were not aware of any shortages. At the time, we were under the impression that to understand exactly how much helium-3 was available might be, you know, sensitive information because of the nature of the generation of it.

Chairman MILLER. Anyone? Mr. Arsenault.

Mr. ARSENAULT. No, we were not notified. We rely on our vendors to let us know if there are any supply problems.

Chairman MILLER. Anyone else? Dr. Halperin.

Dr. HALPERIN. In the case of cryogenics, eight months ago, speaking on behalf of that entire community summarized at a recent conference, that there was no knowledge other than anecdotal from the marketplace. Nothing from the DOE specifically, and to the present date, nothing from the DOE.

Chairman MILLER. Dr. Woods?

Dr. WOODS. No, we were not notified by DOE. Our information came directly from the marketplace.

Chairman MILLER. Dr. Brinkman, we have heard that probably the current use of helium-3 that is going to be the hardest to find or substitute for is cryogenics. Is there any substitute in your work in cryogenics? I am sorry, Dr. Halperin. That is what I meant to say.

Dr. HALPERIN. There is absolutely no substitute. The reason is, it depends on the very interesting physical properties of helium-3, below one degree Kelvin. The range of materials and applications below the temperature of one degree Kelvin are not accessible unless you use refrigerators that depend on helium-3 and use helium-3.

Chairman MILLER. I am assuming that none of you are in a position to manufacture tritium or really to engage in any kind of research for alternatives. Do you have a sense of whether there should be research into manufacturing helium-3 if there is no substitute or finding alternatives, whether that is something that should be funded by some agency of the government? Mr. Anderson.

Mr. ANDERSON. Mr. Chairman, we have responded to a request for information from the DNDO with regard to processing helium-3 from natural gas, so we have looked at it and we do have an organization within GE that has the capability to explore that.

Chairman MILLER. Anyone else? We can go down and have everyone—Mr. Arsenault.

Mr. ARSENAULT. We are a small company, 70 employees, so we don't have a very large R&D group so we cannot pursue that. We have to use detectors and incorporate them in our tools. Our tools are 2-1/8, the smallest in the industry, so we have limited geometry, so we have to rely on technology that is existing, and it is used throughout the whole industry.

Chairman MILLER. Dr. Halperin.

Dr. HALPERIN. Yes. I had just mentioned that it turns out in cryogenics there isn't an alternative based on quantum mechanics, but the agencies could help extensively by supporting communication among all of those who are involved such that planning at the base level as well as in the agencies can take place, and this does not exist at the present time, and furthermore, the agencies, meaning the research agencies, could help significantly in recycling and conservation or funding suggestions for recycling and conservation.

Chairman MILLER. Dr. Woods, you may answer. You are not required to answer.

Dr. WOODS. Well, Chairman Miller, thank you. By my estimation, approximately 30 percent of the studies that are currently underway with helium-3 may be replaced with xenon–129 but that technology is still under development and some grants from the NIH or from NSF or development of xenon–129 would facilitate the transition of some of those studies to xenon–129.

Chairman MILLER. The Chair now recognizes Dr. Broun for five minutes.

Mr. BROUN. Thank you, Mr. Chairman.

Mr. Anderson, in your testimony you state that, "Federal research funding is essential to supplement private sector efforts to accelerate development of replacement technologies." Why is federal R&D essential when there is a clear and sizable market demand ready to pay for alternative technologies?

Mr. ANDERSON. It is a fairly significant endeavor to research these products. The first one, the boron-10 solution we are working on today, has come at quite a significant cost to GE and there is a fairly large market there, but as you start looking at the neutron scattering applications, the oil and gas applications and the nuclear safeguards applications, the technology development there is going to be very, very significant. I don't even know at this point what that is going to involve, and then again to commercialize it into a product that can be fielded is going to be very significant. So without funding, you know, we will do what we can do but it would certainly help accelerate our development programs.

Mr. BROUN. But in the private sector, isn't this part of the cost of development? Why can't it be rolled into the cost of just doing business, just roll it into the cost of what you are doing?

Mr. ANDERSON. Again, we have to look at the cost-benefit when we decide to engage in those programs, and for instance, the nuclear safeguards program, although it is incredibly important is still a relatively small program.

Mr. BROUN. All right, sir.

Dr. Woods, in order to mitigate demand for helium-3, guidance was issued to no longer allocate helium-3 for purposes that would lead to further increases in helium-3 demand. As a physician, I certainly appreciate the research that you are doing and I treated a lot of patients with COPD and asthma and other things that you are trying to find some better diagnostics as well as treatment modalities. The use of helium-3 for lung imaging was just beginning to take off. What would happen if helium-3 became so effective for medical purposes that demand increased?

Dr. WOODS. Clearly, if helium-3 were used as a routine diagnostic imaging tool in the clinic, then the total demand for helium-3 within the medical imaging community would increase. My opinion is that technology is more likely to be used in efficacy testing and in saving money for bringing drugs and devices to market and then in guiding interventions. And so my estimate, our community can probably survive on approximately 2,000 liters per year given that we would recycle 100 percent of the helium that is inhaled.

Mr. BROUN. So you are saying that you don't foresee an increase in demand above that level, the 2,000 liters, at this point. Is that correct?

Dr. WOODS. At this point, I do not foresee that increase.

Mr. BROUN. Okay. So if you had that amount of supply, then through recycling efforts it could be reutilized or recycled and that you wouldn't need any further increase in the supply of helium-3 as far as what you know right now. Is that correct?

Dr. WOODS. Correct, assuming that we had the approximately 2,000 liters per year.

Mr. BROUN. Okay. So if you were supplied that demand, we would need not be searching for alternatives but you don't have that demand. Is that correct?

Dr. WOODS. Correct.

Mr. BROUN. I mean, you don't have that demand met. So should we be seeking alternatives at this point?

Dr. WOODS. I think that we should be seeking alternatives in the same way that we are always seeking alternatives for diagnostic imaging. The main alternative, the only alternative is xenon–129 and I see it as an alternative in only 30, 40, 50 percent of the studies that we can perform, and that is mainly ventilation.

Mr. BROUN. Okay. How about negative impacts of xenon?

Dr. WOODS. They exist. Xenon has an anesthetic effect and so you have to limit the dose. I don't think that that is going to be a significant impediment to breathing in xenon, and the fact that xenon absorbs in human tissue can be used to advantage in certain scenarios.

Mr. BROUN. All right, Mr. Chairman. My time is up and I will yield back. Thank you.

Chairman MILLER. Thank you, Dr. Broun.

Mrs. Dahlkemper is recognized for five minutes.

Mrs. DAHLKEMPER. Thank you, Mr. Chairman.

Mr. Anderson, you testified that there is no drop-in replacement technology for helium-3 detectors. In what application do you think replacement is the easiest and which areas are most difficult?

Mr. ANDERSON. Certainly the easiest is the radiation portal monitors, and that is because you have a lot of space. For measurement requirements are, you are just trying to detect whether neutrons are there. As far as the most difficult, that is going to be very difficult. It is going to come somewhere between, I believe, between oil and gas potentially or neutron scattering. Well, for oil and gas you have very high temperatures, very high shock conditions and you have to have a very good ability to detect the neutron signal. For neutron scattering, you have to be able to do timing, and you have to be able to do very precise location of where those neutrons scattered into the array so that you can get the scientific measurements that are needed.

Mrs. DAHLKEMPER. I also wanted to ask you a little bit about the Russian supplies, and we were told yesterday that the Japanese neutron scattering facilities intend to obtain their future helium-3 needs from Russia. Is this a reliable long-term source in your opinion?

Mr. ANDERSON. The information that I have is that there is somewhere on the order of 8,000 to 10,000 liters per year coming out of Russia. The information is very sketchy, though, because there is a certain amount of it that becomes available on the open market and that is kind of a historical perspective on what has been released. I don't know what will be released in the future. And the other thing I don't know, is how much of it is actually being used within the former Soviet Union countries at this point.

Mrs. DAHLKEMPER. Mr. Arsenault, can helium-3 be recycled from the old tools?

Mr. ARSENAULT. Yes. If the tube is intact, it can be sent back and they can harvest the helium-3. The life expectancy in the downhole conditions that we are running at, the life expectancy is about five years and they have to be replaced.

Mrs. DAHLKEMPER. So they can be recycled but——

Mr. ARSENAULT. They can be recycled but if you are increasing your tool build, you are going to have increased supply of those tubes.

Mrs. DAHLKEMPER. I am from Pennsylvania. I am assuming this will be used in the Marcellus shale.

Mr. ARSENAULT. Marcellus shale, yes, which is very active right now.

Mrs. DAHLKEMPER. Right. Exactly.

Dr. Halperin, I have a question for you. We have been informed by the White House sources that helium-3 for research purposes has been provided to Spectra Gas and is being purified for release in May. Has this been conveyed to you? Are you aware of this?

Dr. HALPERIN. Yes. However, the schedule that has been established by Spectra Gas is that you sign up in a queue. That is a one-way street. That is to say, no information back. Occasionally there are releases. We know that from Spectra Gas, so there have been some deliveries. Leiden Cryogenics has received 100 liters or so. But the majority of those who are users, including other cryogenic instrumentation supplies, also including Leiden Cryogenics, do not have any word back as to whether the helium-3 gas will be provided even when they are in the queue. So this is—for a period of six months, this is a very difficult situation, particularly for junior faculty starting their research careers.

Mrs. DAHLKEMPER. So you have no idea if you will be receiving a supply?

Dr. HALPERIN. No idea. No information, no status.

Mrs. DAHLKEMPER. Thank you, Mr. Chairman. I yield back.

Chairman MILLER. The Chair now recognizes Mr. Rohrabacher for five minutes.

Mr. ROHRABACHER. Thank you very much, and Mr. Chairman, let me begin by suggesting, Mr. Chairman, that you are to be complimented, as soon as he gets done getting it from Dr. Broun. Mr. Chairman, you are to be complimented for bringing this hearing today and bringing forth a great panel of witnesses and discussing an issue that may be obscure to a lot of people but obviously has tremendous implications, so thank you, Mr. Chairman, for putting this together today.

About the oil and gas, how much do you use of this helium-3? How much does the oil and gas industry use?

Mr. ARSENAULT. I don't have an exact amount of how much is used. You know, a manufacturer would have to provide that. But, you know, every neutron logging tool has two detectors and you have got several small companies and four very large companies that provide this service around the world, not only in the United States, so it is a very large fleet of tools that are being used. You know, manufacturing would have to provide the number of tubes that are being sold and what volume of gas is filled into each tube but I believe it is about less than a liter per tube, if I remember right.

Mr. ROHRABACHER. Now, you say a liter per tube. Are we saying per time you drill?

Mr. ARSENAULT. Well, no. Each detector is approximately a liter of helium-3 per tube, as I recall. Each tool would have two detectors, and typically when you go out to a well you will have two tool strings you can bring to a well. So, you get two tools, which means you have got four detectors per job on these tools.

Mr. ROHRABACHER. So you are using at least four liters per job?

Mr. ARSENAULT. Yeah, and the average life expectancy, we are running at 300-plus degrees, harsh downhole conditions, a lot of shock and vibration, so the best life you are typically getting out of them is about five years and they have to be swapped out.

Mr. ROHRABACHER. Okay. So we are talking about nationally and internationally?

Mr. ARSENAULT. Yeah, it is nationally and internationally.

Mr. ROHRABACHER. It is a very significant product to the production of energy.

Mr. ARSENAULT. Yes.

Mr. ROHRABACHER. And shale oil in particular. Is that what you are involved in?

Mr. ARSENAULT. Well, Marcellus shale is very active right now in drilling. There is a lot of drilling going up there. There is a lot of shale places throughout the United States that are very active right now. If they open up the Atlantic continental shelf, Eastern gulf, you will see a very——

Mr. ROHRABACHER. Okay. So we are talking about more and more. Now, already we have noted that Dr. Halperin said that he was buying it at $2,000 a liter. Now, I would like to go back to my questions from the last panel. I think the—Mr. Chairman, I think the cost factor that we have been given is dramatically lower than the reality of what it costs to produce this material and the value of the material. The fact is that the $1,000 a liter may be based on what it costs right now, meaning if they were trying to say how much does it cost to take natural gas out of a landfill and all they did was calculate the cost of putting the tubes down and the natural gas that is coming up, well, that doesn't take into account the cost of filling the landfill, all the trucks necessary to produce the landfill, all the digging produced that made the landfill in itself. What we are talking about is something which is a lot more expensive if we are just taking a look at the cost of actually producing this, than $1,000 a liter, I would suggest, and especially as the demand goes up, and Dr. Woods is suggesting to us that the demand, if we are going to save money and we are going to do a job that is necessary to make our health care—you cited one study where the cost went from $500 million to $50 million—that we have got a huge market for this product and yet we are going through a shortage.

Now, I would suggest, and I know that everybody would like to not make light of this but I have read, many people in the field of space transportation suggest that we may have a market here, if you are talking about not $1,000 a liter but $3,000 or $4,000 a liter or even less than a liter what we are talking about, this may well provide the incentive for the type of private sector effort on the moon that would be necessary. Now, I am saying that we can do that for today. In the meantime, we have heard a lot of good evidence today and testimony about recycling and other alternatives, and some of the things that—other suggestions that have been right on target, but I don't think we should leave out the potential that space-based assets can be brought to use here on our planet for the very things that we have heard about through testimony today.

And I know Dr. Halperin is doing wonderful work for the benefit of humankind, as is Dr. Woods, and I think that providing energy is certainly an important element to prosperity and a good life for our people and we have private sector companies trying to do that job, so thank you very much again, Mr. Chairman. You have given us a very good perspective on this issue.

Chairman MILLER. Thank you, Mr. Rohrabacher, for only exceeding your time by 25 seconds, a new record for Mr. Rohrabacher.

I think the IAEA might have something to say about it if we allowed commercial manufacturing of tritium, but certainly the need is very much there.

We don't really have time for a second round, but without objection, I do have a couple of questions without having an entire second round of questions.

Mr. Anderson, you said you are recycling helium-3. Can you tell us how much you have been able to recycle and do you have a source of recycled helium-3, and if so, from whom are you getting it and how much are you getting of recycled helium-3?

Mr. ANDERSON. Yes, Mr. Chairman, we do recycle helium-3 and it comes from a number of different places. In some cases it would be a customer that may have some detectors that they are not using that they would send in. We would recover the gas and build a new detector for them to the design that they need. Other than that, there are a lot of detectors that are in inactive systems out at the national laboratories and several different places, and we bring those in and recover the gas from those detectors. Also, some of the oil and gas companies have started sending in detectors to recover the gas, and we have recovered well over 1,000 liters at this point. It is a fairly significant amount of gas that is out there that is not being used.

Chairman MILLER. And you spoke also of identifying substitutes. Do you have any idea at all where we can—what we can substitute, when those substitutes will be available in a sufficient quantity to make a difference?

Mr. ANDERSON. Well, for homeland security in the portal area, I think that a substitute will come fairly quickly, which is very important because it is the largest consumer and it is a very, very important application to protect our borders. Second, possibly some of the smaller homeland security instruments, because again, you are just doing basic counting, will probably be relatively straightforward. I think it is going to become more difficult, much more difficult when we start getting into oil and gas, neutron scattering and nuclear safeguards-type instruments because those are performing very specific functions.

Chairman MILLER. Thank you. Before we bring this hearing to a close, I want to thank all of our witnesses, this panel and the previous panel who I have already thanked. The record will remain open as it usually does for two weeks for Members to submit any additional statements and also remain open for answers to any follow-up questions from the Subcommittee to any of the witnesses, and somewhat unusually in consultation with Dr. Broun, we are leaving the record open until the end of days for the production of documents from the agencies that we have requested. We will pursue that and assure that we receive the documents to which Congress is entitled based upon a long history on the topic.

So I thank you all for appearing, and the hearing is now adjourned.

[Whereupon, at 11:47 a.m., the Subcommittee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6375
TTY: (202) 226-4410
http://science.house.gov

May 7, 2010

Dr. William Hagan
Acting Director
Domestic Nuclear Detection Office (DNDO)
Department of Homeland Security (DHS)
301 7th Street SW, Mail Stop 0150
Washington, DC 20528-0150

Dear Dr. Hagan:

On behalf of the Committee on Science & Technology, Subcommittee on Investigations and Oversight, I want to express my sincere appreciation for your participation in the Thursday, April 22, 2010 hearing entitled *Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis.*

I have attached a transcript of the hearing for your review. The Committee's rule pertaining to the printing of transcripts is as follows:

The transcripts of those hearings conducted by the Committee and Subcommittees shall be published as a substantially verbatim account of remarks actually made during the proceedings, subject only to technical, grammatical, and typographical corrections authorized by the person making the remarks involved.

Transcript edits, if any, should be submitted by May 21, 2010. If no edits are received by the above date, I will presume that you have no suggested edits to the transcript.

I am also attaching questions submitted for the record by Members of the Committee. There are questions that members were unable to pursue during the time allotted at the hearing but felt were important to address as part of the official record. All of the enclosed questions must be responded to no later than May 21, 2010.

All transcript edits should be submitted to me and directed to the attention of Douglas Pasternak at 2321 Rayburn House Office Building, Washington, DC 20515. If you have any further questions or concerns, please contact Mr. Pasternak at Doug.Pasternak@mail.house.gov or (202) 226-8892.

Sincerely,

Brad Miller

BRAD MILLER
Chairman
Subcommittee on Investigations and Oversight

Enclosure: Transcript

QUESTIONS FOR THE RECORD

For Dr. William Hagan

Question from Rep. Paul Broun (R-GA):

Impact on ASP Program

1. After He-3 alternatives are developed for neutron detection, do you believe further testing will need to be done at the Nevada Test Site (NTS) to verify the system? What are the cost and schedule impacts of returning to NTS?

Supplies of He-3 Alternatives

1. In your testimony you reassuringly state that "before any alternative is commercialized, we will check availability of the key components to avoid another shortage issue." Will this effort be an interagency review, or simply a DNDO exercise? Will this review be done early in the development process, or simply prior to any procurement? Will this review be based on current requirements, or projected needs?

June ASP Allocation

1. When was the decision made to stop all He-3 allocations for portal monitors? Did DOE allocate 8,500 liters of He-3 in June of 2009 for the ASP program in order to keep it on schedule? Was this allocation rescinded? If so, was any of the allocation used prior to the rescission?

RIIDs

1. In your testimony you indicate that DNDO stopped all allocations of He-3 for Radiation Portal Monitors (RPMs) in September 2009 but that you will continue to provide He-3 for Radioisotope Identification Devices (RIIDs) until alternatives are available.

- Is the timeframe for RIID replacement technology truly open-ended?
    - If not, how long do you plan to provide He-3 for RIIDs?
    - If so, what incentives are there for companies and agencies to seek alternatives?
- How much money do you plan on devoting to R&D for He-3 alternatives for RIIDs?
- Will you require that alternative technologies meet or exceed the performance of He-3?

2. Since 2008, Russia no longer exports He-3 internationally, but do other former Soviet states such as Kazakhstan, Belarus, or Georgia have He-3? Does China?

3. What are the roadblocks to accessing He-3 sources in other nations such as Argentina, India, and France?

Coordination

1. Dr. Hagan stated in his testimony DNDO first became aware of a potential problem with HE-3 supply through an email from a neutron detector tube manufacturer in the summer of 2008, but that it was unclear whether the problem was a result of delays in the supply chain or an actual shortage of He-3. He also stated that DOE has traditionally been responsible for managing and allocating the supply of He-3, and that they issued a report verifying the seriousness of the overall supply shortfall in the fall of 2008.

- What level of coordination and communication existed between DNDO and DOE regarding the supply of He-3 prior to the discovery of its shortfall?
- For an issue as important as the detection of nuclear materials at our borders and ports, why was there seemingly insufficient coordination related to the supply of a crucial component of this capability?

Dr. Hagan
Page Three
May 7, 2010

- What lessons can be learned going forward and what steps are being taken to ensure this does not happen again?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. William Hagan, Acting Director, Domestic Nuclear Detection Office, Department of Homeland Security

Questions submitted by Representative Paul C. Broun

Q1. After He-3 alternatives are developed for neutron detection, do you believe further testing will need to be done at the Nevada Test Site (NTS) to verify the system? What are the cost and schedule impacts of returning to NTS?

A1. No alternative technology will be used for Advanced Spectroscopic Portal (ASP), ASP deployments, when and if certified, will reuse the He-3 gas currently deployed in the poly-vinyl toluene (PVT) systems they would replace or from PVT units that are upgraded to use the alternative technology. This will require a reduction of the number of He-3 tubes used in ASP and a corresponding adjustment of configuration parameters, which means that testing of the neutron counting performance will be required, but not at NTS. This change will utilize all of the existing ASP electronics and software meaning that there will be only a slight impact to the schedule and cost. Moreover, since the ASP program is only seeking to deploy units in secondary inspection, the number of ASP units required is significantly reduced.

Alternative neutron technology used for other system, e.g. PVT based systems operated by the U.S. Customs and Border Protection (CBP), can be tested using surrogate sources at a variety of sites and do not require testing at NTS for this purpose.

Q2. In your testimony you reassuringly state that "before any alternative is commercialized, we will check availability of the key components to avoid another shortage issue." Will this effort be an interagency review, or simply a DNDO exercise? Will this review be done early in the development process, or simply prior to any procurement? Will this review be based on current requirements, or projected needs?

A2. DNDO will continue to work through the interagency group in examining alternative neutron detector technologies such as 6Lithium or 10Boron. Boron is widely known to be available in bulk but Lithium comes from the nuclear weapons programs just like He-3. Through the interagency group, DNDO has already requested and received assurances that 8,000 Kg of 6Lithium has been set aside for any future 6Lithim based neutron detector research or deployment. The allotment of 8,000 Kg of 6Lithium is anticipated to meet DHS needs for over 40 years because only a few grams of 6Lithium is required per detector.

Q3. When was the decision made to stop all He-3 allocations for portal monitors? Did DOE allocate 8,500 liters of He-3 in June of 2009 for the ASP program in order to keep it on schedule? Was this allocation rescinded? If so, was any of the allocation used prior to the rescission?

A3. The decision to no longer allocate He-3 to portal monitors was made by the interagency group on September 10, 2009. Although DHS/DNDO requested 8,500 liters of He-3 from the DOE Isotope Program on January 29, 2009 to address the needs of several DHS projects, including ASP, and subsequently procured the gas in June 2009, DNDO had made it clear from the start that all He-3 gas, including the 8,500 liters, ought to be available for use by the most critical programs across the USG, commercial industry, and other users. DNDO also understood that the relative criticality of programs must be determined by an interagency body. Accordingly, DNDO ceded the allocation of the 8,500 liters to the interagency group.

Q4. In your testimony you indicate that DNDO stopped all allocations of He-3 for Radiation Portal Monitors (RPMs) in September 2009 but that you will continue to provide He-3 for Radioisotope Identification Devices (RIIDs) until alternatives are available.

- *Is the timeframe for RIID replacement technology truly open-ended?*
    - *If not, how long do you plan to provide He-3 for RIIDs?*
    - *If so, what incentives are there for companies and agencies to seek alternatives?*
- *How much money do you plan on devoting to R&D for He-3 alternatives for RIIDs?*
- *Will you require that alternative technologies meet or exceed the performance of He-3?*

A4. Because handheld systems use very small He-3 tubes that contain small amounts of the gas, most vendors buy these tubes in large quantities to get a better price. Consequently, the commercial handheld vendors that DHS typically orders from had purchased sufficient quantities of He-3 tubes before the He-3 shortage was known, and have enough He-3 tubes to last a few more years based upon current procurement histories. Therefore, some backpack and new handheld (e.g., HPRDS) acquisitions will still need He-3 allocations, but DNDO estimates that it can support its handheld and backpack requirements with a few hundred liters of He-3 per year as allocated though the interagency process for the next 3–5 years.

Notwithstanding, the first priority is to find an alternative technology for portal monitor systems because no new He3 gas will be made available for this use. In order to perform market research on what is potentially available and to alert the commercial sector to the need for alternative neutron detection technologies, DNDO released a Request for Information (RFI) in July 2009, to identify alternative neutron detection technologies for portals, backpacks, and handheld radiation detectors.

DNDO has recently awarded several contracts to investigate technologies that could be used in handheld and backpack type applications. At this time there are a few promising technologies emerging from the research laboratories, which are well suited to backpack and handheld systems. For example, CLYC is a crystal scintillator material that detects both gammas rays and neutrons simultaneously. This material could be used as a single detector in a handheld application or grouped together for a backpack application. We anticipate that a minimum of 2–3 years will be needed to transition suitable technology into deployable devices.

Some of these new technologies may have neutron detection capabilities that meet or even exceed the abilities of current He-3-based detectors.

Q5. Since 2008, Russia no longer exports He-3 internationally, but do other former Soviet states such as Kazakhstan, Belarus, or Georgia have He-3? Does China?

A5. To date, helium-3 has been made available as a byproduct of tritium decay. Only nuclear weapons States or States that use heavy water reactors would have tritium. The U.S. Government intends to work with the IAEA to contact countries with installed heavy water reactors, such as Romania, South Korea, China and Argentina to identify other potential suppliers of helium-3. However, we note that some countries, including Argentina, do not currently detritiate their heavy water. Even for countries that do capture/store the tritium, once the detritiation process is begun, it takes several years before the tritium decays into an appreciable amount of helium-3. China's two heavy water reactors were brought on-line in late 2003 and early 2004 and do not yet have significant amounts of helium-3.

Q6. What are the roadblocks to accessing He-3 sources in other nations such as Argentina, India, and France?

A6. To obtain helium-3, it is necessary first to detritiate (or remove the tritium from) the heavy water. Some countries, including Argentina, do not currently detritiate their heavy water. Some countries, such as France, that store tritium may allow helium-3 to vent. Even for countries that do capture/store the tritium, once the detritiation process is begun, it takes several years before the tritium decays into an appreciable amount of helium-3. The U.S. Government is working with the IAEA to identify those countries that currently undertake all the necessary steps for tritium production and capture, and to work with them on how their tritiated water is handled. If needed, the United States will consider requests for assistance in the helium-3 extraction process by either licensing our helium-3 extraction technology or transporting helium3/tritium mixtures to the United States for extraction and use.

Q7. Dr. Hagan stated in his testimony DNDO first became aware of a potential problem with He-3 supply through an email from a neutron detector tube manufacturer in the summer of 2008, but that it was unclear whether the problem was a result of delays in the supply chain or an actual shortage of He-3. He also stated that DOE has traditionally been responsible for managing and allocating the supply of He-3, and that they issued a report verifying the seriousness of the overall supply shortfall in the fall of 2008.

- *What level of coordination and communication existed between DNDO and DOE regarding the supply of He-3 prior to the discovery of its shortfall?*
- *For an issue as important as the detection of nuclear material at our borders and ports, why was there seemingly insufficient coordination related to the supply of a crucial component of this capability?*
- *What lessons can be learned going forward and what steps are being taken to ensure this does not happen again?*

A7. In February 2006, DHS/DNDO confirmed with the DOE Isotope Program there was a sufficient supply of He-3 over the following five year period for the ASP program to procure a total of 1500 portals (about 240,000 liters of He-3). Through discussions with DOE, DNDO learned that He-3 was also supplied to the market by the Russians. Moreover, it was widely understood from the ASP vendors that He-3 was widely available on the open market (i.e., none of the ASP proposals indicated any concern over the ability to obtain He-3 tubes in sufficient number). Indeed, there was no indication of any He-3 supply issues until more than 2 years later, June 2008, when a vendor emailed DNDO indicating that there was a low stock of He-3. In August 2008, DOE held an isotope workshop to address many different isotope issues, including He-3. However, the workshop did not include supply information and because much of the information pertaining to the supply of He-3 was previously classified due to its connection to the tritium stockpile, information about the supply of He-3 was not openly and commonly discussed. It was not until a meeting between DOE and DHS on Jan 16, 2009, that it became clear that there was a real shortage in the USG supply of He-3.

From that point on DHS/DNDO worked closely with the interagency group to address the issue, and will continue to do so.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6301
(202) 225–6375
TTY: (202) 226–4410
http://science.house.gov

May 7, 2010

Dr. William Brinkman
Director
Office of Science
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Dr. Brinkman:

On behalf of the Committee on Science & Technology, Subcommittee on Investigations and Oversight, I want to express my sincere appreciation for your participation in the Thursday, April 22, 2010 hearing entitled *Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis.*

I have attached a transcript of the hearing for your review. The Committee's rule pertaining to the printing of transcripts is as follows:

The transcripts of those hearings conducted by the Committee and Subcommittees shall be published as a substantially verbatim account of remarks actually made during the proceedings, subject only to technical, grammatical, and typographical corrections authorized by the person making the remarks involved.

Transcript edits, if any, should be submitted by May 21, 2010. If no edits are received by the above date, I will presume that you have no suggested edits to the transcript.

I am also attaching questions submitted for the record by Members of the Committee. There are questions that members were unable to pursue during the time allotted at the hearing but felt were important to address as part of the official record. All of the enclosed questions must be responded to no later than May 21, 2010.

All transcript edits should be submitted to me and directed to the attention of Douglas Pasternak at 2321 Rayburn House Office Building, Washington, DC 20515. If you have any further questions or concerns, please contact Mr. Pasternak at Doug.Pasternak@mail.house.gov or (202) 226-8892.

Sincerely,

Brad Miller

BRAD MILLER
Chairman
Subcommittee on Investigations and Oversight

Enclosure: Transcript

QUESTIONS FOR THE RECORD

For Dr. William Brinkman

Question from Rep. Paul Broun (R-GA):

The Future of the Second Line of Defense (SLD)

1. In your testimony you state that past FY2011 the SLD program could be impacted by the He-3 shortage, and that alternatives will not be ready for 2 to 3 more years. What does DOE plan to do to fill this gap? Do Russian contractors supply the SLD program as well? If so, would it be possible to use Russian He-3 for these monitors?

June ASP Allocation

1. When was the decision made to stop all He-3 allocations for portal monitors? Did DOE allocate 8,500 liters of He-3 in June of 2009 for the ASP program in order to keep it on schedule? Was this allocation rescinded? If so, was any of the allocation used prior to the rescission?

Alternative Sources of He-3

1. In your testimony you state that a Dept. of Interior study from 1990 looked into the feasibility of acquiring He-3 from natural gas and found wide variations in the amount of He-3 at various drilling sites. Has any effort been made to further study this option? If yes, what were the conclusions? If no, why not?

2. Since 2008, Russia no longer exports He-3 internationally, but do other former Soviet states such as Kazakhstan, Belarus, or Georgia have He-3? Does China?

3. What are the roadblocks to accessing He-3 sources in other nations such as Argentina, India, and France?

Coordination

1. Dr. Hagen stated in his testimony DNDO first became aware of a potential problem with HE-3 supply through an email from a neutron detector tube manufacturer in the summer of 2008, but that it was unclear whether the problem was a result of delays in the supply chain or an actual shortage of He-3. He also stated that DOE has traditionally been responsible for managing and allocating the supply of He-3, and that they issued a report verifying the seriousness of the overall supply shortfall in the fall of 2008.

- What level of coordination and communication existed between DNDO and DOE regarding the supply of He-3 prior to the discovery of its shortfall?
- For an issue as important as the detection of nuclear materials at our borders and ports, why was there seemingly insufficient coordination related to the supply of a crucial component of this capability?
- What lessons can be learned going forward and what steps are being taken to ensure this does not happen again?

Oil and Gas Alternatives

1. All He-3 user communities seem to be represented by a government agency except for the oil and gas industry. Who is responsible for assuring that their needs are represented when allocations are determined?

Dr. Brinkman
Page Three
May 7, 2010

2. Are there any programs or projects within DOE exploring He-3 alternatives for oil and gas exploration? If so, please breakdown funding by year and office. If not, why not?

3. Are there any other isotopes that are necessary (and limited) for oil and gas exploration?

<u>Scientific Alternatives</u>
1. What alternatives exist for He-3 in neutron scattering?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. William Brinkman, Director of the Office of Science, Department of Energy

Questions submitted by Representative Paul C. Broun

The Future of the Second Line of Defense

Q1. In your testimony you state that past FY2011 the SLD program could be impacted by the He-3 shortage, and that alternatives will not be ready for 2 to 3 more years. What does DOE plan to do to fill this gap? Do Russian contractors supply the SLD program as well? If so, would it be possible to use Russian He-3 for these monitors?

A1. The Second Line of Defense (SLD) program has enough gas for its planned deployments through FY 2011; after that, the program is optimistic that alternative neutron detection technologies will be available for deployment in portal monitors. Both the public and private sectors are making significant investments in this new technology; SLD is carefully watching these developments and plans to test the most promising of these technologies in the field as soon as they become available. SLD uses Russian-manufactured monitors for some of its deployments, particularly in former Soviet Union countries, and these monitors use Russian gas. If the Russians make helium-3 available on the open market, it can also be used in U.S.-manufactured neutron detection tubes. The U.S. Government has formally requested that Russia provide, at reasonable cost, helium-3 in support of worldwide safeguards use. DOE has also requested that the IAEA contact Russia in this regard.

June ASP Allocation

Q1a. When was the decision made to stop all He-3 allocations for portal monitors?

A1a. The predominant use of helium-3 has been in portal monitors; in fact, approximately 25 percent of the total helium-3 demand is for large portal monitors used to scan vehicles and pedestrians. Since alternatives for these types of monitors have been used successfully in the past, in spring 2009, the Interagency Working Group (IWG) agreed to accelerate the effort to evaluate neutron detectors that do not rely on helium-3. Based on early studies within NNSA and the IWG's Technology Working Group, viable alternatives could become commercially available within 1–2 years. In September 2009, the Executive Office-led Interagency Policy Committee (IPC) approved the IWG recommendation that further allocation of helium-3 for portal monitors be deferred.

Q1b. Did DOE allocate 8,500 liters of He-3 in June of 2009 for the ASP program in order to keep it on schedule?

A1b. DOE provided and sold 8,763 liters of unprocessed helium-3 in to DHS March of 2009, primarily for the Advanced Spectroscopic Portals (ASP) program. The material was shipped to Spectra Gases (now Linde) for purification. DHS paid for the gas and any associated costs, and provided approval for any shipment from Spectra Gases. Concurrently, the IWG began reviewing how best to use remaining stores of helium-3. DHS and the IWG agreed on the need for a process to ensure that the most critical programs were allocated helium-3, including these 8,763 liters. Once the IPC was set up and the allocation process became operational, DHS transferred control of the 8,763 liters to the IPC in late June 2009.

Q1c. Was this allocation rescinded? If so, was any of the allocation used prior to the rescission?

A1c. DHS voluntarily submitted the 8,763 liters to the IPC for allocation decisions. None of the gas was used for the ASP program, or for any other DHS program, except through allocations via the IPC. Those agencies that were allocated the gas reimbursed DHS for the amount received.

Alternative Sources of He-3

Q1. In your testimony you state that a Dept. of Interior study from 1990 looked into the feasibility of acquiring He-3 from natural gas and found wide variations in the amount of He-3 at various drilling sites. Has any effort been made to further study this option? If yes, what were the conclusions? If no, why not?

A1. The Bureau of Land Management plans to conduct further sampling and analysis of the gas to better understand the helium-3 to helium-4 ratios. Specialized mass spectrometer instrumentation capable of differentiating helium-3 from helium-4 has been identified. Sampling is scheduled to be performed in May 2010, with analytical results expected by early summer.

Q2. Since 2008, Russia no longer exports He-3 internationally, but do other harmer Soviet states such as Kazakhstan, Belarus, or Georgia have He-3? Does China?

A2. To date, helium-3 has been made available as a byproduct of tritium decay. Only nuclear weapons States or States that use heavy water reactors would have tritium. The U.S. Government intends to work with the IAEA to contact countries with installed heavy water reactors, such as Romania, South Korea, China, and Argentina to identity other potential suppliers of helium-3. However, we note that some countries, including Argentina, do not currently detritiate their heavy water. Even for countries that do capture/store the tritium, once the detritiation process is begun, it takes several years before the tritium decays into an appreciable amount of helium-3. China's two heavy water reactors were brought on-line in late 2003 and early 2004 and do not yet have significant amounts of helium-3.

Q3. What me the roadblocks to accessing He-3 sources in other nations such as Argentina, India, and France?

A3. To obtain helium-3, it is necessary first to detritiate (or remove the tritium from) the heavy water. Some countries, including Argentina, do not currently detritiate their heavy water. Some countries, such as France, that store tritium may allow helium-3 to vent. Even for countries that do capture/store the tritium, once the detritiation process is begun, it takes several years before the tritium decays into an appreciable amount or helium-3. The U.S. Government is working with the IAEA to identify those countries that currently undertake all the necessary steps for tritium production and capture, and to work with them on how their tritiated water is handled. If needed, the United States will consider requests for assistance in the helium-3 extraction process by either licensing our helium-3 extraction technology or transporting helium/tritium mixtures to the United States for extraction and use.

Coordination

Q1. Dr. Hagen stated in his testimony DNDO first became aware of a potential problem with HE-3 supply through an email from a neutron detector tube manufacturer in the summer of 2008, but that it was unclear whether the problem was a result of delays in the supply chain or an actual shortage of He-3. He also stated that DOE has traditionally been responsible for managing and allocating the supply of He-3, and that they issued a report verifying the seriousness of the overall supply shortfall in the fall of 2008.

a. What level of coordination and communication existed between DNDO and DOE regarding the supply of He-3 prior to the discovery of its shortfall?

A1a. During FY 2006, the DHS Domestic Nuclear Defense Office (DNDO) and DOE had meetings and discussions on DNDO's needs for helium-3 through FY 2011. DOE previously sold over 95,000 liters to DNDO's tube manufacturers, and coupled with the Russian supply at that time, DOE projected that there was sufficient material to cover DNDO's short- to mid-term needs.

In August 2008, in anticipation of the transfer of the Isotope Program from the Office of Nuclear Energy to the Office of Science's Nuclear Physics (NP) program, NP organized a workshop among academic, national laboratory, industrial, and federal isotope stakeholders to identify shortages of isotopes important to the Nation. DNDO representatives were invited and participated in this workshop, which identified the seriousness of the helium-3 shortage.

b. For an issue as important as the detection of nuclear materials at our borders and ports; why was there seemingly insufficient coordination related to the supply of a crucial component of this capability?

A1b. Several factors limited awareness of the full extent of the shortfall: NNSA owned and allocated helium-3, a waste byproduct of their weapons program, while DOE's Isotope Program was responsible for vendor distribution of any helium-3 NNSA allocated to the Program; the quantity of available helium-3 was not widely known for security/classification reasons; the Isotope Program had limited contact with helium-3 customers who instead interacted directly with the vendors; and the Russian supply was variable and then declined abruptly. These various factors made it difficult to assess projected demand and supply for helium-3. All allocations are now being made through interagency coordination.

c. What lessons can be learned going forward and what steps are being taken to ensure this does not happen again?

A1c. All agencies involved in the helium-3 problem have learned the importance of interagency cooperation and coordination. The Interagency Working Group effort on helium-3 has been very effective and is expected to continue.

Helium-3 is but one example of an important isotope where demand exceeds supply; there are others. Since 2009, the Nuclear Physics (NP) program has taken a number of steps to ensure effective planning and interagency coordination. After organizing a national workshop on isotope shortages, NP charged its federal advisory committee, the Nuclear Science Advisory Committee, to develop a long range plan for isotope production and to set priorities for research isotopes in demand. NP also reached out to Federal agencies to identify their long-term isotope needs and has established interagency working groups, such as the DOE/NIH working group. While these efforts are focused on isotopes in short supply that are or could be produced by the Isotope Program, they also include discussion and forecast for those isotopes which the Isotope Program distributes as a service.

Oil and Gas Alternatives

Q1. All He-3 user communities seem to be represented by a government agency except for the oil and gas industry. Who is responsible for assuring that their needs are represented when allocations are determined?

A1. Representation of oil and gas industry needs in the He-3 allocation process is a DOE responsibility.

Q2. Are there any programs or projects within DOE exploring He-3 alternatives for oil and gas exploration? If so, please breakdown funding by year and office. If not, why not?

A2. There are currently no programs within DOE supporting helium-3 alternatives for oil and gas exploration. The needs of the oil and gas industry are modest, and the majority of that demand is being met from the existing supply. This community is only beginning to consider alternatives, such as boron trifluoride and lithium-6.

Q3. Are there any other isotopes that are necessary (and limited) for oil and gas exploration?

A3. Americium-241, like helium-3, is another byproduct material, and is used for oil and natural gas well-logging purposes. The americium-241 domestic supply has been exhausted, and industry is currently importing americium from Russia. Americium-241 is also used in smoke detectors, moisture gauges in agriculture, and quality-control gauges in construction and manufacturing. Legitimate commercial uses of americium-241 are authorized by law, and subject to public safety and security restrictions established by NRC and Agreement State regulations. DOE is working toward the re-establishment of a domestic supply of americium-241. Californium-252 is also a widely used isotope in oil and gas exploration. This isotope is produced only in the United States and Russia. In 2009, the domestic production ofcalifornium-252 was in jeopardy, but the Isotope Program worked with industry to ensure a long-term supply.

Scientific Alternatives

Q1. What alternatives exist for He-3 in neutron scattering?

A1. The major use of helium-3 within the Office of Science is for the Spallation Neutron Source (SNS). At present, there is no alternative technique which could replace helium-3 filled detectors and still provide all the capabilities of helium-3 without a loss in performance. This is particularly true for large area detector systems consisting of arrays of single counters. The SNS community has taken the lead within the global neutron scattering research community to establish international working groups to search for alternatives to helium-3, as well as alternative detector technology. Some of the alternatives being considered include boron trifluoride-filled neutron detectors, boron-10 lined proportional counters, gaseous detectors with solid lithium-6 or boron-10 converters, and various scintillation detectors. The research and development efforts for a new detector technology will take approximately five years to complete. We anticipate meeting this community's need until that time.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6375
TTY: (202) 226-4410
http://science.house.gov

May 7, 2010

Mr. Tom Anderson
Product Manager
Reuter-Stokes Radiation Measurement Solutions
GE Energy
8499 Darrow Road
Twinsburg, Ohio 44087-2398

Dear Mr. Anderson:

On behalf of the Committee on Science & Technology, Subcommittee on Investigations and Oversight, I want to express my sincere appreciation for your participation in the Thursday, April 22, 2010 hearing entitled *Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis.*

I have attached a transcript of the hearing for your review. The Committee's rule pertaining to the printing of transcripts is as follows:

The transcripts of those hearings conducted by the Committee and Subcommittees shall be published as a substantially verbatim account of remarks actually made during the proceedings, subject only to technical, grammatical, and typographical corrections authorized by the person making the remarks involved.

Transcript edits, if any, should be submitted by May 21, 2010. If no edits are received by the above date, I will presume that you have no suggested edits to the transcript.

I am also attaching questions submitted for the record by Members of the Committee. There are questions that members were unable to pursue during the time allotted at the hearing but felt were important to address as part of the official record. All of the enclosed questions must be responded to no later than May 21, 2010.

All transcript edits should be submitted to me and directed to the attention of Douglas Pasternak at 2321 Rayburn House Office Building, Washington, DC 20515. If you have any further questions or concerns, please contact Mr. Pasternak at Doug.Pasternak@mail.house.gov or (202) 226-8892.

Sincerely,

Brad Miller

BRAD MILLER
Chairman
Subcommittee on Investigations and Oversight

Enclosure: Transcript

QUESTIONS FOR THE RECORD

For Mr. Tom Anderson

Question from Rep. Paul Broun (R-GA):

1. Both you and Mr. Arsenault point out in your testimony that unless He-3 alternatives are found for the oil and gas industry, the exploration for future fields, the development of existing fields, and logging of new and existing wells will be severely curtailed. What efforts are underway to develop alternative technologies for this sector?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Tom Anderson, Product Manager, Reuter-Stokes Radiation Measurement Solutions, GE Energy

Questions submitted by Representative Paul C. Broun

Q1. Both you and Mr. Arsenault point out in your testimony that unless He-3 alternatives are found for the oil and gas industry, the exploration for future fields, the development of existing, and logging of new and existing wells will be severely curtailed. What efforts are underway to develop alternative technologies for this sector?

A1. Several technologies are available for neutron detection. Each has its favored scientific and industrial applications based on a variety of performance, physical and mechanical characteristics, and requirements. In the oil and gas industry, the neutron detector must be able to accurately measure neutron levels for hundreds or thousands of hours under high-temperature and high-shock operating conditions. For these reasons, the industry long ago recognized the advantages of Helium-3 tubes and to a lesser extent, Lithium-6 glass detectors. Both provide adequate neutron sensitivity to allow for packaging and installation within the limited space inside the drill string.

The annual consumption of Helium-3 for detectors used in oil and gas applications routinely exceeds 2,500 liters. This represents a major portion of the available supply. In response to the Helium-3 shortage, GE has resumed production of Lithium-6 glass neutron detectors. However, only a limited number of drilling and logging companies currently have tool strings designed to work with Lithium-6 detectors. Perhaps the biggest drawback to broader deployment of the Lithium-6 detector is the fact that its performance deteriorates significantly at the elevated temperatures experienced in many of today's drilling and logging operations. GE is exploring ways to improve the performance of Lithium-6 detectors at high temperatures, but the technical hurdles are significant and feasibility is still unknown.

GE is also reviewing a variety of other alternative technologies but none of those alternatives presents a drop-in replacement technology for oil and gas drilling applications. Considerable research will be required to identify a feasible alternate technology and develop a new sensor for oil exploration.

Although a key component of a drill string, the neutron detector accounts for only a small percentage of the overall cost of the system. With the decrease in oil prices over the past several months, the Helium-3 shortage has not yet had a significant impact on the oil industry. These factors, coupled with the urgent need to develop a replacement technology for homeland security applications, where the impact of the Helium-3 shortage has been felt more acutely, has led to a situation where only limited action has been taken to develop an alternate technology for oil drilling and logging.

Any new detector technology will take years to develop, test, and prepare for manufacturing. Furthermore, the oil industry will have to redesign its drilling and logging systems to retrofit any new detector technology, and the operators will have to characterize and interpret the data from the new detectors. We estimate that the time required to deploy a new detector technology industry-wide may exceed ten years. Federal funding is essential to facilitate parallel research efforts to accelerate technology and product development for oil and gas applications.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6375
TTY: (202) 226-4410
http://science.house.gov

May 7, 2010

Mr. Richard L. Arsenault
Director of Health, Safety, Security and Environment
ThruBit LLC
5300 W. Sam Houston Parkway N. Suite 101
Houston, Texas 77041

Dear Mr. Arsenault:

On behalf of the Committee on Science & Technology, Subcommittee on Investigations and Oversight, I want to express my sincere appreciation for your participation in the Thursday, April 22, 2010 hearing entitled *Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis.*

I have attached a transcript of the hearing for your review. The Committee's rule pertaining to the printing of transcripts is as follows:

The transcripts of those hearings conducted by the Committee and Subcommittees shall be published as a substantially verbatim account of remarks actually made during the proceedings, subject only to technical, grammatical, and typographical corrections authorized by the person making the remarks involved.

Transcript edits, if any, should be submitted by May 21, 2010. If no edits are received by the above date, I will presume that you have no suggested edits to the transcript.

I am also attaching questions submitted for the record by Members of the Committee. There are questions that members were unable to pursue during the time allotted at the hearing but felt were important to address as part of the official record. All of the enclosed questions must be responded to no later than May 21, 2010.

All transcript edits should be submitted to me and directed to the attention of Douglas Pasternak at 2321 Rayburn House Office Building, Washington, DC 20515. If you have any further questions or concerns, please contact Mr. Pasternak at Doug.Pasternak@mail.house.gov or (202) 226-8892.

Sincerely,

BRAD MILLER
Chairman
Subcommittee on Investigations and Oversight

Enclosure: Transcript

QUESTIONS FOR THE RECORD

For Mr. Richard Arsenault

Question from Rep. Paul Broun (R-GA):

1. Both you and Mr. Anderson point out in your testimony that unless He-3 alternatives are found for the oil and gas industry, the exploration for future fields, the development of existing fields, and logging of new and existing wells will be severely curtailed. What efforts are underway to develop alternative technologies for this sector?

2. All He-3 user communities seem to be represented by a government agency except for the oil and gas industry. Who is responsible for assuring that their needs are represented when allocations are determined?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Richard Arsenault, Director, Health, Safety, Security and Environment, ThruBit LLC

Questions submitted by Representative Paul C. Broun

Q1. Both you and Mr. Anderson point out in your testimony that unless He-3 alternatives are found for the oil and gas industry, the exploration for future fields, the development of existing fields, and logging of new and existing wells will be severely curtailed. What efforts are underway to develop alternative technologies for this sector?

A1. At the present time there are no publically disclosed or presently commercially available alternative technologies being developed by well logging companies. Most small to larger medium size companies have to continue their operations by using existing off the shelf detector technology to incorporate in their neutron tool designs. While there may be some existing well logging companies developing alternative detector methods, those would be trade secret and proprietary information not commercially available or publically disclosed. The vast majority of companies that are being impacted by this shortage do not have the funding for this type of research and development at their disposal and would depend totally on a commercially available product. Even in testimony from Mr. Anderson at Reuter Stokes, this is going to require government funding for additional research and development, which is not available at this time.

Q2. All He-3 user communities seem to be represented by a government agency except for the oil and gas industry. Who is responsible for assuring that their needs are represented when allocations are determined?

A2. The Association of Energy Services Companies needs be the focal point representing the companies who are using He-3 detectors for neutron logging. They represent numerous well logging companies that operate in the United States.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6375
TTY: (202) 226-4410
http://science.house.gov

May 7, 2010

Dr. William Halperin
John Evans Professor of Physics
Department of Physics
Northwestern University
Evanston, Illinois 60208

Dear Dr. Halperin:

On behalf of the Committee on Science & Technology, Subcommittee on Investigations and Oversight, I want to express my sincere appreciation for your participation in the Thursday, April 22, 2010 hearing entitled *Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis.*

I have attached a transcript of the hearing for your review. The Committee's rule pertaining to the printing of transcripts is as follows:

The transcripts of those hearings conducted by the Committee and Subcommittees shall be published as a substantially verbatim account of remarks actually made during the proceedings, subject only to technical, grammatical, and typographical corrections authorized by the person making the remarks involved.

Transcript edits, if any, should be submitted by May 21, 2010. If no edits are received by the above date, I will presume that you have no suggested edits to the transcript.

I am also attaching questions submitted for the record by Members of the Committee. There are questions that members were unable to pursue during the time allotted at the hearing but felt were important to address as part of the official record. All of the enclosed questions must be responded to no later than May 21, 2010.

All transcript edits should be submitted to me and directed to the attention of Douglas Pasternak at 2321 Rayburn House Office Building, Washington, DC 20515. If you have any further questions or concerns, please contact Mr. Pasternak at Doug.Pasternak@mail.house.gov or (202) 226-8892.

Sincerely,

Brad Miller

BRAD MILLER
Chairman
Subcommittee on Investigations and Oversight

Enclosure: Transcript

QUESTIONS FOR THE RECORD

For Dr. William Halperin

Question from Rep. Paul Broun (R-GA):

Scientific Alternatives

1. What alternatives exist for He-3 in neutron scattering?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. William Halperin, John Evans Professor of Physics, Northwestern University

Questions submitted by Representative Paul C. Broun

Scientific Alternatives

Q1. What alternatives exist for He-3 in neutron scattering?

A1. There is no immediate substitute that can meet all the technical specifications of He3 detectors for neutron scattering science. However, a collaboration agreement has been reached between all major neutron facilities, worldwide, to develop alternatives. Although these alternatives are not immediately deployable, it is hoped that this collaborative development effort will lead to realistic alternatives in 3–5 years. (This is a paraphrased response to this question from Ian S. Anderson, Associate Laboratory Director for Neutron Sciences, Oak Ridge National Laboratory, Oak Ridge Tennessee)

Appendix 2:

Additional Material for the Record

CORRECTION TO STATEMENT BY DR. WILLIAM BRINKMAN

On page 37, the witness requested that "That is roughly right" be changed to "About 20,000 liters is the mitigated domestic demand."

CORRECTION TO STATEMENT BY MR. RICHARD ARSENAULT

Mr. Arsenault clarified his testimony on page 80 by saying: "Each neutron tool will have a far and near He-3 detector. The volume of He-3 in each tube will be dependent on the model of tube, which are of different sizes and volumes."

A STAFF REPORT BY THE MAJORITY STAFF OF THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT OF THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY TO SUBCOMMITTEE CHAIRMAN BRAD MILLER

Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis

A Staff Report by the Majority Staff of the Subcommittee on Investigations and Oversight of the House Committee on Science and Technology to Subcommittee Chairman Brad Miller

Submitted to the Chairman on January 2, 2011

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6301
(202) 225–6375
http://science.house.gov

January 2, 2011

Dear Chairman Miller,

On March 8, 2010 you sent document request letters to the Department of Homeland Security and the Department of Energy asking for all records related to the causes and consequences of the shortage of Helium-3. As you know, Helium-3 is an important non-radioactive isotope used in radiation detection equipment and in numerous scientific applications requiring neutron detection. By the time of the hearing on April 22, 2010, only an insignificant pile of relevant documents had been produced, leaving the Members and staff of the Subcommittee unusually dependent upon the oral claims of Departmental witnesses. At the close of that hearing, you indicated to the witnesses that the record would remain open until all materials responsive to the request were produced so that the Subcommittee could have a more complete accounting of what led to the shortage of Helium-3.

This report is an effort by the Subcommittee staff to fulfill your desire to see an accurate portrayal of events be made a part of the hearing record. The basic theme of the April hearing was that an interagency process had been put in place that seemed to be working well. However, the documentation that has been provided to the Subcommittee reveals in more detail that neither the Department of Energy nor the Department of Homeland Security took reasonable steps to anticipate a shortage of Helium-3 and instead built large, multi-billion dollar programs around an assumed endless supply. Further, those documents reveal that the interagency process that appeared at the time of the hearing to have worked so well actually took much longer than was optimal to arrive at reasonable policies to ration He-3 and to identify alternative supplies or substances.

Finally, the report discusses issues that arose in the effort to have agencies produce all documents responsive to your March 8 requests. The bottom line is that the Subcommittee is still not in possession of all responsive documents. Even with some holes in the documentary record, the staff hope that with this report your hearing record can be closed out with more accuracy and balance than was possible on April 22.

Very Respectfully,

Daniel Pearson, Ph.D.
Subcommittee Staff Director

Edith Holleman
Investigative Counsel

EXECUTIVE SUMMARY

The Subcommittee on Investigations and Oversight has been conducting on-going oversight of the Department of Homeland Security's development and acquisition of Advanced Spectroscopic Portal (ASP) monitors since 2007. This multi-billion dollar program has been the subject of several Government Accountability Office reports done at the request of the Subcommittee as well as two Subcommittee hearings in the 111th Congress. At the second hearing, held on November 17, 2009, the public and Members learned for the first time that an acute shortage of helium-3 (He-3) was leading to a suspension of the acquisition of any new radiation portal monitors (RPMs). Virtually all of the current and future RPMs rely on He-3 to detect radioactive neutrons, such as plutonium.[1]

The shortage of He-3 has disrupted plans by the Department of Homeland Security (DHS) to deploy a new generation ofRPMs at the Nation's borders and ports. [2] However, the specific physical properties of He-3 also make it a very important ingredient for other applications, particularly in the large neutron spallation source machines being constructed or under construction in this country and around the world. So the shortage of He-3 is a matter that affects our national security, but also scientific research in a wide number of fields and applications. For all these reasons, the Subcommittee began investigating the cause and consequences of the shortage.

He-3 is a byproduct of tritium production which is used to enhanced thermonuclear explosions. As a result, the nation's stockpile of He-3 has always been managed by the Department of Energy's (DOE) weapons program. With its elaborate radiation portal detection systems, the Department of Homeland Security (DHS) has become the single largest consumer of He-3, but DOE with its Second Line of Defense programs begun after the end of the Cold War to stop the movement of nuclear material from the former Soviet Union and other "high priority" countries is also a large consumer. Both agencies have built multi-billion dollar programs and acquisition plans around an expectation that there would be a continuous large and reliable source of He-3, despite the fact that DOE managed what it knew to be rapidly declining stockpile as tritium has not been produced in this country since 1988. On March 8, 2010, in anticipation of a hearing on He-3, the Subcommittee sent document requests to the Department of Energy and the Department of Homeland Security. [3] The Subcommittee was seeking records that would shed light on how these two agencies had so mismanaged the stockpile and their own programs; what steps were being taken to identify alternative sources of He-3 or substitutes; and what the full range of impacts of the shortage meant for technology development, research and security.

On April 22, 2010, the Subcommittee on Investigations and Oversight held a hearing on

[1] He-3 is preferred as a neutron detector because it is "non-reactive/non-corrosive and performs very well as a converter gas in neutron detectors." It provides fewer false positives than other technologies and "has the highest intrinsic efficiency for a neutron detector." DOE, John Pantaleo, "Isotope Production and Applications: Helium-3," June 5, 2009.

[2] The previous generation of RPMs, known as PVTs for their polyvinyl toluene composition, also used He-3 for radiation detection, although in smaller quantities.

[3] Letters from Chairman Brad Miller to DHS Secretary Napolitano and DOE Secretary Steven Chu, March 8, 2010.

the crisis in the supply of helium-3 (He-3).[4] By the time of the hearing, the Subcommittee had received only a small volume of the records sought and, to a degree that is unusual for this investigative Subcommittee, we had to rely primarily upon the oral testimony of witnesses to understand how the crisis was identified and how agencies were coping with it. Because the lack of documents limited the Members ' ability to fully understand the crisis, Chairman Brad Miller, with the concurrence of Ranking Member Paul Broun, stated that he would hold the record open to receive additional documents.

It has taken many, many months to pry from the agencies those records that were responsive to the March 8 letter. To this day, the Subcommittee is still not in possession of all responsive records. This report, which is based on the examination of documents produced by agencies since the hearing, tells a somewhat more critical story than that heard at the hearing. It is a story of programmatic mismanagement leading to the crisis in the supply of He-3 and of a not always efficient interagency effort to set priorities for how to allocate what remained of the He-3 stockpile as well as to identify alternative supplies and substances. The documents help clarify that both DOE and DHS, which should have recognized that the U.S. and worldwide supplies of He-3 was decreasing rapidly, barreled ahead with expensive and important new programs and technologies that were premised on an inexhaustible supply.

But this report tells another story regarding the withholding of documents responsive to the Subcommittee's request. Just as examination of even the incomplete set of documents furnished to date raises nettlesome questions about the wisdom and honesty of actions taken by Executive Branch officials, the reluctance to produce these documents raises questions that may be even more troubling regarding the transparency of the Executive's dealings with the Congress.

Prior to the hearing, a Navy JAG attorney detailed to the National Security Council stated in an e-mail that documents that had not been produced were being subjected to a review for undefined "White House equities" and that the review would be completed "expeditiously."[5] That was not an accurate statement. Thousands of pages of responsive documents remained with the agencies for an unprecedented, and months-long "inter-agency " review under a restrictive interpretation of the guidelines for Freedom of Information Act (FOIA) requests by members of the public. Those documents were produced in dribs and drabs by the agencies over the next several months. Thousands of additional pages of responsive documents were sent to the White House for the undefined "White House equities " review. Some of these documents have never been produced to the Subcommittee, despite the failure of the White House to claim executive privilege or any other privilege to justify withholding them. When White House attorneys were asked for their gguidance h regarding how to review these documents, they produced a Justice Department guide for the Freedom of Information Act (FOIA). FOIA was passed by Congress to open the Executive Branch to greater transparency by the press and public. Congressional committees are explicitly exempt from FOIA, and FOIA exemptions go well beyond the traditional, and extraordinarily narrow grounds the courts have

[4] U.S. House of Representatives, Committee on Science and Technology, *Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis,* April 22, 2010.
[5] E-mail from Michael Bahar to Edith Holleman, Subcommittee, counsel entitled "Document Review," April 19, 2010.

established for withholding information from Congress. But if the White House was going to follow FOIA it would have been required to supply a list of the documents being withheld, this is something the White House Counsel 's office steadfastly refused to do. [6]

The He-3 crisis is not over. The search for alternative material for use in radiation detection devices to be used for national security and nuclear safeguards purposes is underway but is not yet successfully completed. The neutron scattering and MOX facilities that rely on He-3 have no ready alternative source of supply. An effort to obtain He-3 from a Canadian CANDU nuclear energy reactor is at least four years from fruition.

The Subcommittee's Investigation

On November 17, 2009, the House Science and Technology Subcommittee on Investigations and Oversight held its second hearing to examine the continuing problems with the Department of Homeland Security's (DHS) attempts to acquire its next generation of radiation portal monitors known as Advanced Spectroscopic Portals (ASPs).[7] Raytheon, the contractor for the ASPs, had been unsuccessful at meeting DHS 's requirements for the monitors. Numerous performance problems in what was planned ultimately to be a $2-3 billion acquisition of 1,400 ASPs by the federal government had been identified by the Government Accountability Office, the National Academy of Sciences and the National Institute of Standards and Technology.

Between the two hearings, Subcommittee staff had heard that, in addition to all of the ASP's performance problems, there might be a shortage of helium-3, the isotope used in most radiation detection devices to determine whether neutrons are present. Not only is He-3 particularly effective for this purpose, but it is also non-toxic and requires no such special handling as boron triflouride (Bf-3), the previous material used in neutron detection, did. Moreover, there is no economically viable natural supply of He-3. He-3 results from the decay of tritium, a component of the nuclear weapons program.[8] Only the Department of Energy in the United States and Russia produced it for their nuclear weapons programs. During the Cold War DOE amassed a large stockpile of excess He-3. However, the United States halted production of tritium in 1988 because of safety problems with the reactor. The end of the Cold War also reduced the need for tritium in both the U.S. and Russia.

[6] Attorneys from the White House Counsel's office have said they would not produce a list without a subpoena from the Committee.

[7] U.S. House of Representatives, Committee on Science and Technology, *The Science of Security, Part II: Technical Problems Continue to Hinder Advanced Radiation Monitors*, Serial No. 111-63, Nov. 17, 2009 (hereafter *The Science of Security, Part II*). The previous hearing was held on June 25, 2009. Portal monitors were used at border crossings to screen vehicles and cargo for radiation and prevent the importation of illegal nuclear materials. They are an essential component of DOE's Second Line of Defense program overseas and DHS' border security apparatus. Many other countries have also installed radiation portal monitors (RPMs). [this is first mention]

[8] Tritium, which results from transformation of lithium, has a half-life of only 12 years with a rapid and steady deterioration into He-3.

But new applications for He-3 were being developed at the same time its long-term production was inevitably decreasing. In the 1990s, DOE began to use it as a radiation detector in the RPMs that it began to install under its Megaports program to prohibit the movement of nuclear material from the former Soviet Union. It was an essential element in neutron scattering facilities that various countries were constructing.[9] After the attacks of September 11, 2001, and the creation of the Department of Homeland Security, a number of agencies began to demand radiation detection devices using He-3. The largest program by far was DHS 's ASP effort. It planned a multi-billion-dollar procurement of 1,400 ASPs to be placed at the nation 's borders to replace an earlier RPM technology that also used He-3. As originally planned, the DHS program would have required an estimated 200,000 liters of He-3.

Thus, even as the demand for He-3 was growing rapidly and the supply was not being fully renewed because tritium was no longer being produced, DOE warned no one that the nation was running out of He-3. And even when it became well-known inside the federal government that there was a critical shortage and an interagency working group had been formed to search for solutions, the agencies largely hid the facts from Congress and the public. During numerous meetings with Subcommittee staff during the summer and fall of 2009, this intensifying effort was not mentioned in relation to the ASP or other RPM programs.

To the degree DHS provided information on He-3 to the Congress, it came in the form of misleading testimony to the House Appropriations Committee. In April of 2009, Charles R. Gallaway, acting director of DHSs Domestic Nuclear Detection Office (DNDO) told the House Appropriations Homeland Security a story that suggested DHS was very near success on a forward-looking scientific program to identify a substitute for He-3. There was no note of crisis in this testimony nor any suggestion that this effort had anything to do with the ASP acquisition. He stated:

> For neutron detection, DNDO is accelerating the final development and initial production of new materials to replace the scarce, but presently used, helium-3 by the end of FY 2009 or early FY 2010. To put this in perspective, to advance from the discovery of a new detector material to construction of prototype instruments in the space of two – three years is really remarkable.[10]

In July 2009, three months after Gallaway had declared to Congress that DNDO had a ready alternative for Helium-3, DHS issued a Request For Information to potential contractors regarding "He3 Alternative Neutron Detectors."[11] Clearly, the "remarkable " progress in finding an alternative to He-3 that Gallaway had told Congress about three months earlier was not yet a reality.

The shortage was, however, becoming an issue for scientists who used He-3 in various non-security research applications and were finding it harder and more expensive to obtain. The

[9] Neutron scattering is used in many science and engineering applications to probe the composition of material. It has both commercial and research uses.
[10] Testimony of Charles R. Galloway, April 1, 2009, p. 4, accessed at http://appropriations.house.gov/images/stories/pdf/dhs/Chuck_Gallaway_04_01_09.pdf
[11] FedBizOps, DHS, "He3 Alternative Neutron Detectors," July 8, 2009.

October 2009 issue of *Physics Todayv* reported that DNDO estimated the supply-to-demand ratio was 1 to 10.[12] Nonetheless, the He-3 shortage was not addressed in the written testimony submitted to the Subcommittee by Dr. William K. Hagan, acting deputy director of DHS 's Domestic Nuclear Detection Office (DNDO), for the November 2009 Subcommittee hearing.

When told prior to the hearing that he would be asked about the impact of the He-3 supply shortage on the ASP program, Dr. Hagan quickly departed from his written testimony and dropped the following bombshell:

> However, one new obstacle has emerged that will greatly impact the path forward. The United States is facing a severe helium-3 shortage. Helium-3 is a gas that is used for neutron detection within both current and next generation RPMs. Because this decreased supply affects multiple agencies within the Federal Government and beyond, the White House has convened an Interagency Policy Committee, including DHS, to discuss the issue and possible solutions. This group decided in September that no more helium-3 will be allocated to RPMs for the time being. We are currently leading interagency efforts to identify alternative neutron detectors, and we are working to assess the impact this will have on our deployment strategy and path forward. (emphasis added)[13]

It was the first the Subcommittee had heard of this decision that severely impacted the ASP program. The Subcommittee also later found that, incredibly, the November hearing was the first time the prime ASP contractor, Raytheon, had learned of this decision as well. The Subcommittee followed the hearing with letters to President Obama and DHS Secretary Janet Napolitano asking that the troubled ASP program be halted.[14] After that hearing, Subcommittee staff began to investigate why both the Department of Energy--the producer of He-3 and also a significant user because of its Megaports and Second Line of Defense programs and the large spallation neutron scattering facility at the Oak Ridge National Laboratory – and the Department of Homeland Security – the primary U.S. consumer of He-3 – failed to see the supply/demand train wreck coming until it was too late.

A review of documents supplied to the Subcommittee subsequent to our hearing in March 2010, provides more detail as to the way awareness of the He-3 shortage came to light and how agencies responded. In 2006, when there were only 150,000 liters left in the He-3 stockpile for all uses, a DOE employee told DHS that there was enough to cover the 120,000 liters then estimated for the first phase of the ASP program.[15] It appears that there was no serious

12 US government agencies work to minimize damage due to helium-3 shortfall," *Physics Today,* October 2009.

13 Testimony of William Hagan, *The Science of Security, Part II, supra*, pp. 207-08.

14 Letters from Chairman Brad Miller to DHS Secretary Janet Napolitano and President Barak Obama, Nov. 20, 2009.

15 In 2006, DHS actually estimated that it would need 240,000 liters over the next six years for the ASP program. Series of e-mails among Brian Kagy, Ryan Eddy and Greg Slovik entitled "Helium-3 Availability," Feb. 16, 2006. Kagy then e-mailed John Carty of the DOE isotope office to verify that there will be a "suitable supply over the next five years." Carty responded that he is "sure" that DOE can supply enough He3 for 1,500 portals (120,000 ltr), and that majority of worldwide demand (100,000 ltrs) is supplied by Russia. Brain Kagy, Memorandum entitled "Helium-3 Availability r2.doc," Feb. 16, 2006.

supply/demand analysis done – even of DOE 's own needs – prior to the careless and unverified reassurance by low-level DOE employees to DHS that it had plenty of He-3 for the ASP program. And no one at DHS attempted to verify that conclusion at higher levels of DOE. DOE continued on its merry way of selling large amounts of He-3 without warning users that the supply was being rapidly depleted. In March of 2008, DOE 's Isotope office allocated approximately 33,000 liters of He-3 to the Oak Ridge National Laboratory for its spallation neutron scattering (SNS) facility.[16]

The result of these casual, low-level assurances from DOE to DHS was that in mid-2008, when commercial vendors began to warn of an He-3 shortage, DHS didn't appear to take them seriously. In May of that year, Robert Haer of GE Reuter-Stokes, which is a manufacturer of the tubes containing He-3 used in the full array of applications, wrote a letter to John Pantaleo, head of DOE's Isotope Office, which was in charge of selling He-3, and said that he had not known until a recent meeting that DOE's supply of He-3 was "nearly exhausted." Haer asked for a direct purchase of 25,000 liters. He also suggested that DNDO and DOE's National Nuclear Security Administration (NNSA) set national security priorities, give preference to detector designs that would maximize the limited He-3 supply, establish an allocation plan and develop alternative detection technologies.[17] Another GE Reuter-Stokes official sent an e-mail to Ernest Muenchau, DHS 's principal deputy assistant director for the Product Acquisition and Deployment Directorate, warning him that there was not enough He-3 for the ASP program.[18] He followed it up with a face-to-face meeting with DHS officials to ensure that they were aware of the significance to the ASP program of the pending shortage.

Over the next few months, there were numerous other warnings of the consequences of the He-3 shortage, but little action. The per-liter price for He-3 was spiking on the open market; a DOE workshop concluded that it was difficult to "foresee a supply-based solution" and that a technological solution was needed;[19] and NNSA was reduced to begging DOE 's Isotope Office for He-3 for the Second Line of Defense program.[20] A letter from two senators expressing concern to DOE Secretary Samuel Bodman was not answered for four months--and then the reply was superficial and reassuring.[21] But there still was no government-wide acknowledgement of the problem.[22]

[16] Memorandum from Nanette Founds, NNSA, DOE, to Paula Douglas, ORNL, entitled "Allotment of 4.4 Kilograms of Helium-3," March 20, 2008. This was in addition to the 2,922 grams received by ORNL for SNS for in 2001. E-mail from Abdul Dasti to John Pantaleo, Robert Rabun and Carroll McFall entitled "Historical Allocation of He3 from SRS.doc," April 28, 2009. Staff have converted to liters in the text to allow comparison to DHS and stockpile numbers.

[17] Letter from Robert Haer to John Pantaleo, May 27, 2008.

[18] E-mail from Tom Anderson to Ernest Muenchau entitled "He3 Shortage," June 5, 2008.

[19] DOE, "Workshop on the Nation's Needs for Isotopes: Present and Future," Aug. 5-7, 2008, p. 13.

[20] E-mail from Victor Gavron to John Pantaleo entitled "He3 supply for Second Line of Defense requirements," Aug. 11, 2008. Gavron said the alternatives were not as good and would delay deployment.

[21] Letter from Sens. George Voinovich and Sherrod Brown to DOE Secretary Samuel Bodman, Aug. 12, 2008. The letter was not answered until January of 2009. Letter from Dennis Spurgeon, assistant secretary for nuclear energy, to Sens. Voinovich and Brown, Jan. 12, 2009.

[22] DHS claimed it did not receive "official" word on the He-3 shortage until November of 2008. DHS, Slovik, "White Paper on the He3 Availability and Neutron Detector Alternatives," March 31, 2009.

By late 2008, DHS was well aware that there was not enough He-3 for the ASP and other detector programs, and that there was no alternative on the horizon. It had told DOE of its needs and – as an NNSA official exclaimed – "It's a lot!"[23] And vendors could not obtain enough He-3 to fill orders. Despite these warnings, DNDO was pushing forward and testing the Raytheon ASPs that required three times the amount of He-3 as compared to the current generation of radiation portal monitors. On January 12, 2009, officials from DOE, DHS and the Oak Ridge National Laboratory (ORNL) had a phone conference call on the future limitation of He-3 for neutron detection. By that time, DOE had already put restrictions on the use for which it would sell He-3. This group recommended that the following steps be taken:

1. DNDO would develop priorities for the allocation of He-3;
2. DNDO's Product Acquisition and Deployment Directorate would provide a white paper on alternatives to He-3 and test them; and
3. DNDO would initiate a working group with DOE on the He-3 issue.[24]

Over the next two months, officials from DHS, DOE, DOD, He-3 vendors and radiation detector manufacturers debated how to deal with the dwindling supply of He-3. Dr. Richard Kouzes of the Pacific Northwest National Laboratory (PNNL), which was involved in the testing of radiation detectors, told his staff, "We are now living on the steady state supply of ≈ 12k liters/y." Both the United States and Russia had depleted their stores and DOE couldn't push its defense program to produce more He-3 because it is "just a byproduct of tritium production."[25] Annual demand of He-3 was estimated to be about 80,000 liters per year, and annual production at only 8,000 liters.[26] Finally, in early 2009, DHS decided to set up an inter-agency working group to 1) develop priorities; 2) work on alternatives; and 3) make sure that DHS got a "reasonable level" of the remaining He-3 allocations, Kouzes added.[27] And agency officials finally seemed to understand that this problem was not going away. "Predicted availability of He3 in the coming years is less than we anticipated. It looks like 2010 will be a bad year," DNDO's Muenchau said in an e-mail.[28] By April, a formal inter-agency group had been

[23] E-mail from Elly Melamed, Second Line of Defense deputy director, to Ernest Muenchau entitled "He3," Oct. 10, 2008.

[24] DNDO, Summary of Jan. 12 phone conference on "Future Limitation on the Supply of Helium 3 Gas for Neutron Detector," Jan. 16, 2009. In a related e-mail from Ernest Muenchau to Nicholas Prins and Dr. William K. Hagan, DNDO acting deputy director, Muenchau warned "Predicted availability of He3 in the coming years is less than we anticipated. It looks like 2010 will be a bad year." E-mail from Ernie Muenchau entitled "HE3 shortage," Jan. 12, 2009.

[25] E-mail from Richard Kouzes to numerous PNNL staff entitled "He3," Jan. 28, 2009. was the author of an April 2009 report that concluded that because of the increased demand for He-3 for homeland security applications, the supply could no longer meet the demand. Contrary to Galloway's testimony before the Appropriations subcommittee that production of a substitute material by DNDO was imminent, Kouzes warned that none of the alternatives "meet the performance capability of for neutron detection, and there are no existing alternatives that combine all the capabilities of ." The process could take a number of years. Kouzes, R., Pacific Northwest National Laboratory, "The ^{3}He Supply Problem," April 2009, PNNL-18388, pp. 1 and 8.

[26] DOE, John Pantaleo, "Isotope Production and Applications: Helium-3," June 5, 2009.

[27] DHS, Summary of phone conference on "Future Limitation on the Supply of Helium 3 Gas for Neutron Detector,"

[28] E-mail from Ernest Muenchau to Nicholas Prins, deputy assistant director, DNDO Transformational and Applied Research Directorate, (cc: William Hagan) entitled "HE3 shortage," Jan. 12, 2009.

established, with the allocation of limited He-3 supply at the top of their agenda.[29]

The bad news continued. In June of 2009, PNNL issued a second report in which it told DNDO in no uncertain terms that "[b]ecause of the imminent shortage of ^{3}He. . . a replacement technology for neutron detection is required in the very near future." Additionally, DNDO would have to test each of the currently available technologies to see if they had the "appropriate capabilities" to replace He-3.[30] In July, a group of international detector experts who were mostly involved with the large scientific neutron scattering devices met in Munich. They estimated those facilities would need 125,000 liters of He-3 by 2015 and said there was nothing currently available that would substitute for the huge arrays of He-3-based detectors in those facilities.[31]

Over the summer of 2009, the inter-agency group, known as the Inter-agency Integrated Product Team (IPT), spent weeks establishing a charter for the overall group and four sub-groups on demand, policy and technology. It held many meetings on He-3 supply, demand and alternatives, including a large June workshop at Savannah River National Laboratory that was attended by scientists from government, industry and academia and where it was concluded that He-3 demand was understated and substitutes would not be ready in time to replace He-3.[32] The inter-agency group also worked on getting a stripped-down demand projection; establishing He-3 allocation criteria; talking with Ontario Power Generation, a Canadian utility, about obtaining tritium from one of its CANDU nuclear energy reactors; and putting together business cases for other possible interim sources. All international sales were cut off as DHS, vendors and DOE laboratories attempted to find substitute materials for various applications.

By early September of 2009, after Colonel Julie Bentz, the Defense Department representative on the IPT, was detailed to the National Security Council, the IPT morphed into a sub-group of the Interagency Policy Committee (IPC) operating out of the NSC. At its first meeting on September 10, it was determined that He-3 should be allocated as follows: 1) to programs that require the unique properties of He-3; 2) to programs that secure threats the furthest away from the U.S.; and 3) to programs where substantial costs had been incurred.[33] The ASP program would get no additional He-3. In late October, the IPT reviewed all alternative technology possibilities in a report to the IPC; none were ready to deploy.[34]

At the end of 2010, DOE had 38,000 liters of He-3 in its stockpile. A number of options for recycling and harvesting from old tritium beds are being considered, but the estimated production from those projects is quite small. The neutron scattering facilities have redesigned

29 "Inter Agency Discussions on the Helium-3 Availability, Meeting Minutes," April 16, 2009.

30 PNNL, "Radiation Portal Monitor Project: Alternative Neutron Detector Technologies for Homeland Security," June 9, 2009, PNNL-18471, executive summary.

31 "Report on the meeting of detector experts held at FRM II on July 7-8, 2009, accessed at http://cstsp.aaas.org/Helium3/He3%20Minutes-FRM-II.doc

32 DHS, Agenda for "Workshop on Helium-3 Issues and Alternatives for Neutron Detection," June 17, 2009. E-mail from Roger Lewis to Steve Goodrum entitled "Quick report on He3 visit to SRS," June 18, 2009.

33 Chain of e-mails among Joseph Glaser, David Bowman and Gerard Garino entitled "RE: IPC Summary of Conclusions," Sept. 11-14, 2009.

34 IPT, "Working Draft of the ^{3}He IPT Status and Plan to Search for alternatives to ^{3}He Based Neutron Detection."

some of their detectors to use less He-3, but SNS is still expected to double its capacity in FY 2017-18. Substitute technology has been thoroughly tested to meet the needs of the radiation detector community, but no substitute has been agreed upon. The only viable source of significant additional He-3 appears to be the tritium waste from Ontario Power's CANDU reactor, but the contract for the analysis that needs to be done prior to negotiating an agreement with the Canadian government to move radioactive material with proliferation capabilities into the United States has just been agreed to. Actual recovery of He-3 is not expected until at least 2014.[35]

[35] Subcommittee staff interview of John Pantaleo, Jehanne Gillo and Joseph Glaser, Oct. 17, 2010.

BACKGROUND

Since the Nuclear Non-Proliferation Treaty went into effect in 1970, helium-3 (He-3) has been used in instruments for neutron measurements to verify that nuclear material is not being illegally diverted.[36] He-3 was produced by both the United States' and Russia 's nuclear weapons programs as a byproduct resulting from the decay of tritium, which was used to enhance the explosive yield of thermonuclear weapons.[37] In 1988, the United States stopped producing tritium at its Savannah River facility because of safety problems and began recovering the required tritium from dismantled nuclear weapons. He-3 continued to be captured from the decay of unused tritium, but the rate of decay declined over time. Between 1991 and 1994, the Department of Energy (DOE) provided 98,000 liters of He-3 to various domestic and international users.[38] For the next seven years, however, it used the He-3 reserves for the accelerated production of tritium (APT) project,[39] which was one of the two proposals being considered for the restart of tritium production.[40]

By 2003, about 260,000 liters of unprocessed He-3 had been accumulated.[41] When APT was abandoned, the Savannah River facility, where the tritium was stored, negotiated an agreement with DOE 's isotope sales office to sell part of the He-3 inventory. Spectra Gas, a private company, invested $4 million in a facility to process the gas as DOE 's Mound processing facility had been closed in 1997. The first 22,000 liters went to the Spallation Neutron Scattering (SNS) research facility at the Oak Ridge National Laboratory.[42] Between 2004 and 2008, 146,000 additional liters were sold in three separate auctions, mostly to two vendors who cleaned or packaged it in containers for the final user.[43] Savannah River received 65 percent of the sale price, which was just above cost, to extract the He-3 from the tritium stores it held.[44] As Dr. William Brinkman, current head of DOE 's Office of Science, testified before the Subcommittee, "^{3}He production for commercial use has never been a mission of DOE. . . . DOE made this byproduct . . . available to scientific and industrial users at a price designed to recover extraction, purification, and administration costs. "[45]

The demand for He-3 in radiation detection devices, however, was growing. DOE's

[36] E-mail from James Sprinkle to Greg Slovik, Joe Glaser and Abdul Dasti entitled "RE: impending release of He-3 REVISED," July 1, 2009.

[37] Tritium has a radioactive decay rate of 5.5 percent per year and a half-life of a little over 12 years. Every year, less and less He-3 is produced from the tritium stockpile.

[38] E-mail from Abdul Dasti to John Pantaleo entitled "Historical Allocation of HE3 from SRS.doc," April 28, 2009.

[39] Robert Rabun, DOE, Power Point presentation entitled "Helium-3 Recovery at SRS," April 16, 2009.

[40] Ultimately, DOE decided to obtain tritium by using TVA's Watts Bar nuclear energy plant to obtain the necessary radiation to transform lithium into tritium.. Cong. Research Service, "The Department of Energy's Tritium Production Program," 97-002, Sept. 16, 1997.

[41] Statement of Dr. William F. Brinkman, director, Office of Science, DOE, before the Science and Technology Investigations and Oversight Subcommittee, April 22, 2010, p. 2.

[42] "Historical Allocation of HE3 from SRS.doc," April 28, 2009, *supra.*

[43] DOE Timeline. According to Dr. Brinkman, an average of 25,00 liters of Russian He-3 was also entering the U.S. annually. Statement of Dr. William F. Brinkman, *supra,* p. 2.

[44] *Ibid.*

[45] Statement of Dr. William F. Brinkman, *supra,* pp 1-2.

Second Line of Defense (SLD) program[46] used He-3 in radiation-detecting portal monitors overseas as part of its nuclear non-proliferation efforts. After the September 11, 2001 attacks and the creation of the Department of Homeland Security, a huge domestic demand developed for portal monitors at border crossings, ports of entry, embassies and other facilities and for a large variety of handheld and portable radiation-detecting devices. Other countries were also installing radiation portal monitors (RPMs). At the same time, large neutron scattering research facilities were being planned in several countries, and Japan 's mixed oxide (MOX) nuclear energy plant also required He-3 for radiation monitoring. Many of these facilities were counting on the U.S. as their source of He-3. As a result, the demand for He-3 skyrocketed at the same time the supply was diminishing because no additional tritium was being produced.

DOE and DHS: Agencies Asleep at the Switch

John Pantaleo, the head of DOE's isotope sales program, has described himself many times as merely a broker arranging the sale of surplus He-3. One reason for his characterization may have been the fact that for many years the exact amount of He-3 in DOE's stockpile was classified because of a fear that reverse engineering would give other countries an understanding of the size of the U.S. nuclear weapons arsenal. The amount was known only to employees at the Savannah River facility and DOE's National Nuclear Security Administration (NNSA).[47] Even Pantaleo did not know the size of the stockpile because the view was that he had no need to know. The Savannah River facility produced and arranged for the processing of He-3 from its tritium stores and then told Pantaleo fs office when and how much it could sell.

It was, however, publicly known that DOE was not producing tritium and had signed an agreement with the Tennessee Valley Authority (TVA) to process lithium into tritium in TVA's Watts Ferry civilian nuclear reactor, a process that has not yet been fully successful.[48]

As a result, the events of February 2006 which apparently spurred DHS into going forward with its plans for the ASPs were particularly surprising. On February 16, based on a request from Vayl Oxford, then head of DHS' Domestic Nuclear Detection Office (DNDO), Brian Kagy, a contract employee at DNDO, asked a low-level staffer in DOE's isotope office if there would be 120,000 liters of He-3 available over the next five years for 1,500 portals proposed for DHS' ASP program.[49] John Carty replied that he was "sure" DOE could supply the He-3, and that Russia was supplying most of the worldwide annual demand of 100,000 liters.

[46] The Second Line of Defense program includes Megaports, the goal of which is to equip 100 international seaports with RPMs to scan U.S.-bound cargo, and to place RPMs at border crossings from former Soviet Union countries and other "high priority" countries. DOE/NNSA, "Fact Sheet: Second Line of Defense," Feb. 2, 2010, accessed at http://www.nnsa.energy.gov/mediaroom/factsheets/nnsassecondlineofdefenseprogram

[47] The actual amount of He-3 held at Savannah River was not officially declassified until early 2009, although its was already being openly discussed inside the government.

[48] TVA Gets Military Contract: Will Produce Tritium for Nuclear Warheads," *Chicago Sun-Times,* Dec. 23, 1998, p. 33. The TVA board did not approve the $1-billion contract until a year later. "TVA Approves Plan to Make Weapons Material, *The Washington Post,* Dec. 9, 1999, A13, "Ingredient Shortage Slows a Program to Detect Smuggled Bombs," *New York Times,* Nov. 23, 2009, A12.

[49] Kagy seriously miscalculated the amount of He-3 each portal would consume. He projected 10 liters per portal when the design actually called for 40 liters. E-mail from Brian Kagy to John Carty entitled "He-3 Supply," Feb. 16, 2006.

Carty even proposed that the gas be sold directly to DHS as "GFM", and that he come to Kagy 's office to discuss how he could help.[50] There is no indication that Carty had the knowledge or the authority to make such a commitment, but apparently no one at DHS ever attempted to get an official confirmation of the availability of this amount of He-3 from Pantaleo or anyone else at a higher level at DOE. Based on his phone conversations and e-mails with Carty, Kagy then wrote a memo to DNDO 's policy office stating that DOE 's isotope program office had confirmed that 120,000 liters would be available over the next five years. "DNDO is confident that the supply of He-3 gas is sure, secure, and sufficient to meet the projected demand for the Radiation Portal Monitors and human portable devices programs, " he stated.[51] There is no evidence that anyone else at DOE knew of this "commitment. "

Moreover, there were many other demands on the He-3 stockpile besides DHS's. By 2008, 3/4 – of the 260,000 liters available in 2003 had been dispensed, including another 33,000 liters for the SNS facility.[52] The U.S. had only approximately 65,000 liters left in its stockpile, the multi-billion-dollar ASP program with its potential voracious demand for He-3 was not yet out of the development stage, and the annual new production of He-3 from tritium decay was only 10,000 liters while projected annual demand was 70,000 liters.[53] But no one seemed to be paying attention to the looming supply crisis until officials from GE Reuter-Stokes -- one of the two companies that purchased He-3 from DOE and the primary vendor of He-3-filled tubes for a variety of customers -- met with DOE officials in May of 2008 asking for a direct purchase of 25,000 liters to meet customer demand and found out that DOE 's supply of He-3 was "nearly exhausted. "

Robert Haer, strategic sourcing leader for GE Reuter-Stokes, quickly wrote a letter to Pantaleo expressing his shock.

> Based on past auctions we believed that a healthy supply of gas existed, and that our supply constraint was short-term in nature. As discussed, we are consuming an average of 25,000 liters/year and will deplete our current supply in August 2008. We are seeing more emphasis on international security programs and have customer requests requiring over 28,000 liters of ^{3}during the next year.

Haer reminded Pantaleo that his company was the leading producer of He-3 products for homeland security, neutron scattering research facilities, oil and gas exploration and nuclear safeguards applications. "While homeland security is the largest consumer of ^{3}gas, the importance of the other detectors applications cannot be discounted," he wrote.[54]

[50] Government-furnished material. E-mail from Brian Kagy to Ryan Eddy (cc: Greg Slovik) entitled "RE: He-3 Supply," Feb. 16, 2006.
[51] E-mail from Brian Kagy to Ryan Eddy (cc: Greg Slovik) entitled "Helium-3 Availability r2," enclosing "Helium-3 Availability r2.doc." Feb. 16, 2006. Kagy said the memo included "additional information from DOE, and a statement of our confidence in the availability of sufficient quantities of He-3 to support DNDO programs." *Ibid.*
[52] Russia was also supplying the U.S. with about 25,000 liters annually, but no one knew how long this would continue. DOE Timeline, *supra;* Testimony of William F. Brinkman, *supra,* p. 2.
[53] DOE Timeline, *supra.* Both the supply and demand estimates vary based on the time frame and the office making the estimates. The one constant is that the demands greatly exceeds the supply.
[54] Letter from Robert Haer to John Pantaleo, May 27, 2008.

Haer then made several prescient suggestions about how to deal with the shortage:

(1) Determine a fair allocation plan and sell gas on a multi-year purchase contract to allow the commercial sector to plan accordingly;

(2) Inform DNDO of the projected He-3 supply/shortage;

(3) Establish a DNDO/NNSA group to review current performance specifications and detector designs to maximize the effectiveness of the limited He-3 supply;

(4) Set national security priorities based on available He-3 supply; and

(5) Encourage DNDO to prioritize research funding to develop alternate neutron detection technologies.[55]

In response to Haer's proposal for a direct purchase outside of the auction process, Pantaleo said, "[W]e have a fairness of opportunity issue unless we find a reasonable way to allocate the He-3 to our customers. Not easy." He then sent the letter to Carroll McFall, who was in charge of the tritium stores at DOE's Savannah River facility where He-3 was produced and asked how many cylinders of He-3 he could expect in the future. McFall told Pantaleo that GE Reuter-Stokes' needs seemed to "far outstrip our long term recovery rate of 10,000 or so liters per year."[56] At the same time, NNSA's SLD was trying to get more He-3 for its programs and wanted to know if there was going to be an additional sale. It was told that the material being loaded into cylinders was for the SNS. After expressing concern that GE Reuter-Stokes was trying to get around the "normal open competition," McFall opined to Timothy Fischer, the site office's deputy acting manager in an e-mail that "It looks like I've finally gotten the point across that He-3 is in limited supply."[57] But it appears that neither McFall nor Fischer shared their views further up the DOE chain. Their "point" did not reach decision makers at either DOE or DHS.

Others tried, however. Within two weeks, Tom Anderson, another GE Reuter-Stokes official, sent an e-mail to Ernest Muenchau, DHS's principal deputy assistant director for the product acquisition and deployment directorate, warning him that there was not enough He-3 for the ASP program.[58] When Muenchau had not responded a week later, Anderson sent a second e-mail telling Muenchau that Thermo and Raytheon, the ASP contractors, had been told of the shortage and its impact on the ASP program.[59] A month later, he met with Muenchau, but the crisis continued unabated through the summer with little activity beyond the vendors telling various government agencies that they could not fulfill their orders and the sending of increasingly desperate messages from various government users searching for He-3. The

[55] *Ibid.*

[56] E-mail from John Pantaleo to Carroll McFall entitled "FW: DOE Visit," June 3, 2008; e-mail from McFall to Pantaleo entitled "Helium-3 Needs Memo from GE," June 3, 2008.

[57] E-mail from Carroll McFall to Timothy Fischer entitled "Fw: A Heads-up in He-3," June 10, 2008.

[58] E-mail from Tom Anderson to Ernest Muenchau entitled "He3Shortage," June 5, 2008.

[59] E-mail from Tom Anderson to Ernest Muenchau entitled "FW: He3 Shortage," June 11, 2008.

response was lackadaisical.[60] In August at a DOE-sponsored workshop on the nation's needs for isotopes, the working group on stable and enriched isotopes determined that (1) the demand for He-3 exceeded the supply from both the U.S. and Russia, (2) it was difficult to foresee a supply-based solution support by current production techniques, and (3) a technological solution was needed.[61] But when a representative of NNSA's SLD program asked for help getting He-3 for his program, McFall – who had privately discussed the "limited supply" of He-3 – told him only that Savannah River had 80,000 liters in stock, and 40,000 liters would be sold in the Autumn, which seemed to indicate that there was sufficient He-3 for SLD's purposes. There was no mention at all of a supply problem.[62] The frantic e-mails continued through the Autumn with everyone trying to secure supplies for their own purposes.[63] DOE needed 20,000 liters for its SLD programs, and DHS still needed 120,000 liters for the ASPs. In October, DOE scheduled an auction of 23,000 liters.[64] One of the ASP contractors asked DHS if it had made arrangements to "safeguard" some of the gas for the ASPs.[65] Finally, in November of 2008, DNDO seems to have been "officially" notified of the He-3 shortage,[66] but still took little action as they continued to try to push the ASP testing and certification process forward.[67]

In December, NNSA allocated 15,173 liters of He-3 for defense programs,[68] but this allocation did not hold. Both DOE and DHS continued their efforts to get their share of the He-3 allocation. DHS's Charles Galloway and Vayl Oxford were "officially" told that Savannah River could not "produce enough ^{3}He to even meet half of DHS needs – let alone what DOE needs – next year." Oxford responded by directing that contingency plans were needed. But Dr. William Hagan, the acting deputy director of DNDO whose main project was the ASP program, was even further behind the curve. On January 29, 2009, he said that he had read a paper provided by Greg Slovik, the technical director for DHS's Product Acquisition and Development Directorate and learned that "our demand way outstrips the production even today." He asked for a paper on alternatives.[69]

[60] See, *e.g.*, e-mail from Victor Gavron, Los Alamos National Laboratory to John Pantaleo entitled "He3 supply for Second Line of Defense requirements," Aug. 11, 2008. "At this time there already is no He3 available . . . . In short, lack of He3 would result in further jeopardy to our national security." In response, Pantaleo forwarded the e-mail to McFall and said, "There is a lot of interest and demand for he-3. We will need to chat soon." Aug. 12, 2008

[61] DOE, "Workshop on the Nation's Needs for Isotopes: Present and Future," Aug. 5-7, 2008, pp. 13-15 and 41, accessed at http://www.er.doe.gov/np/program/docs/Workshop%20Report_final.pdf

[62] E-mail from Carroll McFall to Abdul Dasti entitled "Fw: Help with obtaining He3 for national security (SLD)," Aug. 18, 2008.

[63] See, *e.g.*, e-mail from Carroll McFall to Abdul Dasti entitled "Fw: Help with obtaining He3 for national security (SLD)," Aug. 18, 2008; e-mail from Greg Slovik to Ernest Muenchau entitled "FW: He-3-STE needs the gas for the RADPACK (WCMP COTS buy)," Nov. 26, 2008.

[64] This auction never occurred.

[65] E-mail from Manuel Lopes, Raytheon, to Ernest Muenchau entitled "He3 Gas – October Auction," Oct. 21, 2008.

[66] DHS, Slovik, Greg, "White Paper on the He3 Availability and Neutron Detector Alternatives," March 31, 2009.

[67] E-mail from Huban Gowadia to Chuck Gallaway and Vayl Oxford entitled "He3," Dec. 18, 2008.

[68] DOE, John Pantaleo, Power Point presentation entitled "Isotope Production and Applications: Helium-3,) June 5, 2009.

[69] E-mail from Huban Gowadia to Chuck Galloway and Vayl Oxford entitled "He3," Dec. 18, 2008. E-mail from William Hagan to Chuck Galloway and Huban Gowadia entitled "Emailing: Tritium," Jan. 29, 2009. The next day, Muenchau asked for a campaign to test alternatives or detectors using less He-3. E-mail from Ernest Muenchau to Julian Hill entitled "Request SEED initiate planning for a test campaign on neutron detectors," Jan. 30, 2009.

On January 12, 2009, representatives of DOE, DHS and Spectra Gas had a phone conference and made plans to establish priorities for He-3 and testing of alternatives. After the call, Muenchau reported that the "Predicted availability of He3 in the coming years is less than we anticipated. It looks like 2010 will be a bad year" – something he should have known months before. DHS needed an accelerated program to look at alternatives.[70] At the same time, GE Reuter-Stokes was again asking how to prioritize its orders. The company had already shut down He-3 for civilian research and international security programs.[71] The military was also beginning to weigh in with its needs.[72]

But by February, little had been accomplished. A meeting held by the steering group for DOE's Network of Senior Scientists and Engineers (NSSE) to discuss alternative He-3 neutron detection systems was "nearly hi-jacked by the 3-He availability issue," according to a Savannah River participant, who said an allocation strategy might have to be developed. He also noted that there was "great concern in DOD . . . that they will not be able to fill the need for 3-He based neutron detectors for US national security." Roger Lewis of NNSA's Office of Military Applications and Stockpile Operations asked for a position paper. "The bottom line is that the availability of 3-He may soon come to be viewed as a national security issue if it isn't already," McFall reported. [73] But the battles among the agencies over the limited supply of He-3 continued. DHS groused that the SNS was "sucking up vast quantities of He3 ", and that DOE was not going to give up the gas it had at Reuter-Stokes that DHS needed for one of its contracts. The SLD representative again asked McFall for help in getting He-3 for their program and reminded him that in his August 18 e-mail, he had not indicated there was a supply problem.[74]

Rudy Goetzman, the Savannah River National Laboratory project manager for homeland security, neatly summed up the situation in two sentences: "This is a BFD! What are the other sources of He3 outside of SRS?"[75] Then, the SLD representative asked if the SNS facility should be asked to return some of its allotment for future use which was "very large. "[76]

The Inter-agency Project Team (IPT): A Slow Start

Finally, at the end of February 2009 with the prodding of both DOE and DHS, Greg Slovik put together an agenda for an inter-agency meeting in March.[77] Before the meeting, representatives of NNSA, DNDO, and the Pacific Northwest and Los Alamos national

[70] E-mail from Ernest Muenchau to Nicholas Prins (cc: William Hagan) entitled ""HE3 shortage," Jan, 12, 2009.
[71] E-mail from Tom Anderson to John Pantaleo entitled "He3," Jan. 19, 2009. Anderson said he was being pressured by "security" customers and had a backlog of orders from oil drilling firms.
[72] E-mail from Michael Thrift, U.S. Navy, to Donald Mitarotonda entitled "HRM and LRM He-3 shortage," Jan. 15, 2009l
[73] E-mail from Robert Rabun to Carroll McFall entitled "Heads up on the 3-He Situation," Feb. 13, 2009, reporting on Feb. 3-5, 2009 meeting; e-mail from Rabun to Debra Utley et al., SRNS, entitled "Heads up on the 3-He Situation," Feb. 13, 2009.
[74] E-mail from Ernest Muenchau to Nicholas Prins entitled "SNS," Feb. 3, 2009; series of e-mails among Ernest Muenchau, Elly Melamed and Greg Slovik, Feb. 10-11, 2009; e-mail from Abdul Dasti to Carroll McFall entitled "RE: Help with obtaining He3 for national security use (SLD)," Feb. 12, 2009.
[75] E-mail from Rudy Goetzman to Paul Cloessner entitled "Re: Heads up on 3-He Situation," Feb. 13, 2009.
[76] E-mail from Abdul Dasti to John Pantaleo and Carroll McFall entitled "He-3 allotments." Feb. 18, 2009.
[77] E-mail from Greg Slovik to Ernest Muenchau entitled "RE: DOE is send out a notice for a meeting at DHS," Feb. 27, 2009.

laboratories got together to discuss possible alternative technologies for portal detectors.[78] The first inter-agency meeting was held on March 24, 2009. Its purpose was to recognize that the He-3 supply was dwindling; present each agency 's anticipated requirements; acknowledge non-government requirements; and form an inter-agency group to define a path forward. Pantaleo indicated that his office would have 40,000 liters in 2009, but only 8,000 in annual production after that. Demand for FY09 was estimated at 213,448 liters and supply at 45,000 liters. It was decided to establish an interagency Integrated Product Team (IPT) and that two papers be prepared for a May 1 meeting: one to authorize pursuing an assessment of Ontario Power 's stockpile of deteriorating tritium and the tasks necessary to harvest its He-3; and the second to authorize contacting the Commerce Department to request restrictions on the export of He-3.[79]

Despite the fact that neither DHS nor DOE had done any work on looking for substitutes for He-3 for the portal monitors or any of their other radiation detection devices, and that he knew full well that there was no substitute on the horizon, Gallaway inexplicably testified before the House Appropriations Homeland Security Subcommittee in April that there had been "major advances" in finding new materials for detectors, and initial production would occur at end of FY09 or in early FY10.[80] In reality, the problem had become so serious that the DOD representative on the inter-agency group was bringing it to the attention of the White House.[81] That communication was followed up by a staffer from the National Security Council asking what the impact of the shortage would be on the global nuclear detection architecture. Based on the information provided by NNSA at the next IPT meeting, it was significant. The NNSA "core program " had covered only 213 of 600 planned sites, and Megaports had completed 19 of a possible 100 sites. NNSA also predicted a total worldwide demand of 952,000 liters with the majority being non-governmental and a total supply of 133,000 liters. For the past two years, the Russians had only been supplying 10,000 liters per year.[82]

After the March meeting, the CIA representative proposed a moratorium of He-3 sales until "we can collectively decide on a fair allocation system based on national priorities."[83] In early May, the IPT had been established with four sub-groups on supply, demand, technology and policy. DHS established its goal as chairing the IPT, making sure it got its fair share of He-3, investigating other potential supplies and alternative technologies and facilitating a new policy for use of He3 in neutron detection. The first task was to determine each agency 's He-3

[78] DOE Time Line.
[79] John Pantaleo, "InterAgency Discussion on the Helium-3 Availability," March 24, 2009; see also, March 13, 2009, draft of slides prepared by John Pantaleo; meeting minutes; and e-mail from Ernest Muenchau to Chuck Galloway entitled "Product Acquisition and Deployment Weekly Activity Report," May 1, 2009.
[80] Testimony of Charles R. Galloway, April 1, 2009, p. 4, accessed at http://appropriations.house.gov/images/stories/pdf/dhs/Chuck_Gallaway_04_01_09.pdf Slovik heavily promoted the use of Bf-3 as "THE SOLUTION," but PNNL researchers said it was a bad idea. Chain of e-mails from Richard Kouzes to Sonya Bowyer at al., April 28, 2009.
[81] E-mail from William Hagan to Greg Slovik entitled "He-3," April 8, 2009. Hagan asked for slides from the March 24 to share with Julie Bentz because "she is talking to the White House late today."
[82] E-mail from Korey Jackson, NSC, to Greg Slovik entitled "Re: He-3 Meeting tomorrow at DNDO," April 15, 2009; Lee Hamilton , NNSA, Power Point presentation entitled "3He Shortage Update to SRS," April 16, 2009; DHS, "Inter Agency Discussions on the Helium-3 Availability, Meeting Minutes," April 16, 2009.
[83] E-mail from "Deborah" to Joanna Ingraham, DTRA, Ernest Muenchau et al. entitled "RE: UK Home Office Helium-3 requirements," April 21, 2009.

demand.[84] Julie Bentz, the DOD representative, was detailed to the National Security Council, but was still available for consultation.[85]

The agencies spent the summer of 2009 compiling their He-3 requirements and drafting policies to allocate the existing He-3. Outside the government, other users of He-3 became increasingly concerned as supplies were not coming in from the commercial vendors they had traditionally relied upon. In June a workshop with governmental and non-governmental participants was held by the DOE's NSSE. The participants concluded that none of the alternatives would meet all of the various applications for which He-3 was used as they were not as efficient, nor as good at gamma ray detection. Different technologies would have to be developed for different applications.[86] Two of DOE 's laboratories wrote a white paper pointing out the need for He-3 in neutron scattering facilities and cryogenic research, both of which were funded by DOE.[87] An international group of detection experts met and said there was no technology that could replace the huge arrays of He-3 detectors in the neutron scattering facilities that were designed around those detectors. It was essential to get enough He-3 to maintain those facilities and do expedited development on alternatives.[88] Russian-sourced He-3 was now selling for $600 per liter.[89]

But at the Subcommittee's hearing on ASPs at the end of June, Dr. Hagan, DNDO's acting director, told the Members that ASPs were the "next generation of portal monitors" and that they were on their way to being certified. No mention was made of the shortage of He-3, or that using an alternative technology would radically change and delay the testing of the portal system.[90] Less than a month later, his office issued a request for information for alternate, non-He-3, neutron detector technology for portal monitors.[91]

The IPT's steering committee, however, could not agree on prioritization criteria or the proposed distribution plan.[92] Small shipments of He-3 were being distributed on a somewhat ad hoc basis. Perhaps as a result of the IPT 's inability to make decisions in a timely manner, Colonel Bentz was reorganizing the IPT into an Interagency Policy Committee (IPC) that subsumed the IPT and its subcommittees and was to be run out of her office at the NSC.[93] The

[84] DNDO, Greg Slovik, Power Point entitled "Helium-3 (3He) Project," May 28, 2009.
[85] "Meeting Minutes: Inter Agency Discussion on the Helium-3 Availability," May 6, 2009.
[86] PNNL, "Workshop Summary." Jun 2009.
[87] ORNL /PNNL, "Concept for White Paper (or Letter) Addressing 3He Shortage," June 29, 2009.
[88] "Report on the meeting of detector experts held at FRM II on July 7-8, 2009, accessed at http://cstsp.aaas.org/Helium3/He3%20Minutes-FRM-II.doc
[89] E-mail from Charles Gentile, PNNL, to Robert Rabun entitled "RE: He-3 Workshop at SRS," May 12, 2009.
[90] Testimony of William F. Hagan, U.S. House of Representatives, Science and Technology Investigations and Oversight Subcommittee, *The Science of Security: Lessons Learned in Developing, Testing and Operating Advanced Radiationl Monitors,* June 25, 2009, Serial No. 111-38, pp. 37-38.
[91] FedBizOps, DHS, "He3 Alternative Neutron Detectors," July 8, 2009; e-mail from Bill Lehnert to Greg Slovik entitled "Re: FW:RFI for alternative Portal Monitor neutron detector," July 17, 2009. At the same time, DNDO was busy conducting a new round of field tests of the He-3-based ASPs, knowing full well that they would not be able to deploy them. The ASPs failed the tests.
[92] E-mail from Julie Bentz to Roger Lewis entitled "summary of conclusions" with attached minutes, June 23, 2009; e-mail from John Broehm to Alan Spear entitled "RE: Final Minutes of the Helium-3 IPT Mtg 5 Aug 09," Aug. 5, 2009.
[93] Interagency Task Team – Technology Subcommittee Meeting, "Report from 3He at DNDO 7/27/09," July 27,

IPC had its first meeting on September 10, 2009, and established an allocation strategy that gave first priority to applications for which He-3 's unique properties were essential, second to programs that secure threats the furthest away from the U.S., and third to programs in which substantial investments had been made. There would be no additional He-3 used for the multi-billion-dollar ASP program or any other radiation portal monitors.[94] This decision completely changed DHS 's ASP strategy, but it was not made public until the Subcommittee 's hearing in November. When the *Physics Today* reporter contacted agency representatives about the He-3 shortage, the message was only that the government would "decrease demand (through conservation and alternative technologies) and increase supply (through international engagement and recycling). "[95]

Throughout the fall, the inter-agency efforts were concentrated on searching for alternatives to He-3 for various uses and developing He-3 need requirements for FY2010. DHS released a request for information (RFI) to determine interest in extracting He-3 from natural helium.[96] By the end of the 2009, there were 47,600 liters in stock with a demand for 16,548 liters. The decision to be made was whether to allocate only 7,500 in new supply or use some of the existing stockpile.[97] Ultimately, it was decided to allocate 11,757 liters of purified gas.[98]

Because of Congressional interest, the inter-agency group thought it needed to produce a document showing what the government was doing – and to show that it had been doing something. "Basically, with all the interest (and maybe some potential finger pointing) regarding the issue, the team needed to be able to prove that steps have been taken to get a handle on the situation just in case further inquiries come about," one participant wrote.[99] This Subcommittee 's interest was deemed so significant that someone in the Executive Office of the President was notified.[100]

In October of 2010, DOE officials reported to the Subcommittee that they had been successful in reducing demand and establishing a process for releasing the gas. But the reality is that during 2010, no economically viable substitutes for Savannah River's He-3 stockpile have been found beyond the conservation and re-use of existing He-3. The effort to obtain He-3 from Canada is still in the early stages. In the meantime, private companies, DOE's national laboratories and international researchers are testing various non-He-3 materials for use in radiation detectors. None of them are yet in production for government programs, and whether

2009; e-mail from Jehanne Gillo to Steve Binkley entitled "He-3 IPC," Sept. 2, 2009.

[94] E-mail chain among Joseph Glaser, David Bowman and Gerard Garino entitled "RE: IPC Summary of Conclusions," Sept. 11-14, 2009; testimony of William Hagan, *The Science of Security, Part II, supra*, pp. 207-08.

[95] Chain of e-mails from Julie Bentz to John Broehm entitled "He 3 media request," Oct. 15, 2009.

[96] E-mail from Ernest Muenchau to Chuck Galloway entitled "Product Acquisition and Deployment Weekly Activity Report," Dec. 3, 2009.

[97] E-mail from Julie Bentz to Steve Aoki et al. entitled "He-3 Sub IPC," Dec. 9, 2009.

[98] IPT minutes of Dec. 15, 2009 meeting. In March of 2010, 20,864 liters of raw He-3 was released to Linde Electronics and Speciality Gases for cleaning. Ultimately, about 20,000 liters would be available for release with proper approvals. It is unclear how much was released. e-mail from John Pantaleo to Julie Bentz et al. entitled "He-3 shipment update," March 4, 2010.

[99] E-mail from Julie Inocencio to Debbie Stumpff entitled "He-3 AI from 12/15 mtg," Dec. 15, 2009.

[100] E-mail from Julie Bentz to John Pantaleo entitled "RE: He-3 shipment update," March 4, 2010. After being told that Subcommittee staff had contacted two non-governmental sources to discuss the He-3 shortage, Bentz wrote, "I'm also cc'ing some folks in EOP for their situational awareness of the Congressional query."

any of them can meet previous criteria set for the ASP program is unclear. Limited amounts of He-3 have been set aside for cryogenic and other research in the United States. Industrial users and foreign facilities and projects are scrambling to find He-3 on the international market. An additional demand may come from the multi-billion-dollar International Thermonuclear Experimental Reactor (ITER), an international research and engineering project looking for a source of clean energy, also has a need for He-3.[101]

Clearly, the problem of finding substitute radiation detector materials for all of He-3's many uses is a thorny one that will not be easily or quickly solved. Developing an alternative detector for RPMs is probably the easiest task. Finding alternatives for neutron scattering facilities, cryogenic, energy and medical research, which require much more precision, will be extremely difficult and time-consuming.

If, however, the shortage had been addressed several years ago the nation would have been that much closer to a solution today that would not only benefit our national security and nuclear safeguards, but also scientific projects worldwide. It is inexplicable to understand that while it was public information that no tritium had been produced for decades, which meant that the He-3 supply would inevitably decline, no one inside the federal government saw this as a problem that would doom future He-3-based technologies. It is even more bewildering that two agencies appear to have taken steps to adopt programs that would require expanding demand for He-3. Those in charge of producing and selling He-3 knew or should have known that the demand was going up exponentially while the supply was declining. Those who developed technologies that relied completely on He-3 should also have determined whether there was a dependable supply of He-3 for the next 15 years before investing hundreds of millions of dollars in those technologies. None of them can or should be excused from their role in bringing this crisis into being and wasting taxpayer dollars. No steps to finally establish a reasonable regime for rationing He-3 nor any *ex post facto* paper to show that "steps have been taken to get a handle on the situation" can cover up the incompetence and failure to act at the appropriate time by these agencies.

The Canadian Initiative

In the end, after exploring all of the possibilities for obtaining He-3 from other sources, the inter-agency group focused its efforts on importing the excess tritium produced by a CANDU nuclear energy reactor operated by Ontario Power Generation, a Canadian company. The idea was first raised at the Nuclear Science Advisory Committee Isotopes Subcommittee meeting in February of 2009. The subcommittee was concerned about the supply of He-3 for non-defense research and development purposes.[102]

In DOE's initial phone conversation with Ontario Power, the company said it had 100,000 liters of He-3 and that several vendors were interested in it. It was considering issuing a request for proposals to potential purchasers, but it wanted a turnkey operation funded by the users in the January 2011 time frame. A few days later, Ontario Power officials said they

[101] Subcommittee staff interview of John Pantaleo, Jehanne Gillo and Joseph Glaser, Oct. 7, 2010.
[102] E-mail from Tracey Rudisill to Jeff Griffin entitled "Nuclear Science Advisory Committee Isotopes Subcommittee Meeting," Feb. 13, 2009.

weren't ready to make a decision or discuss details until some understanding with DOE had been reached, but would brief senior management.[103] However, because of numerous questions involving the condition of the tritium, whether purification would be done in Canada or the United States, and regulations and laws in both countries governing the movement of nuclear material, particularly one covered by nuclear non-proliferation agreements, a feasibility study needed to be done. But there was no budget at DOE for that work which would be done by a Canadian company.[104] At the first face-to-face meeting in August, Ontario Power indicated that it did not want to purify the helium, but wanted the tritium containers sent to the United States. It also wanted a "tangible " commitment for the gas from the US.[105]

By October, there was a team working to place a contract with a Canadian company to characterize the material it held and to study the ability to sell it to the United States. DHS estimated that 60,000 liters of He-3 could be extracted in the first three years with 70,000 more available in the next nine years.[106] In January of 2010, it was hoped that the Savannah River Site could contract with Canadian technical organizations to do the characterization work. But the cost was $1.2 million, and there were no funds designated for that purpose.[107] From recent agency briefings to Subcommittee staff, it appears that there is an agreement with a Canadian company to do this work, but it is not clear if funding for the study has been identified. At best, the actual availability of purified He-3 from the Ontario Power tritium would not be before 2014.[108]

Withholding Documents

The Subcommittee began asking for documents related to the government's response to the He-3 shortage on March 8, 2010, in preparation for our April 22, 2010, hearing.[109] Neither DOE nor DHS had produced a full set of responsive documents by the time of the hearing. Nor has a full set been produced to date. Even before the hearing, the Subcommittee staff was told that "applicable documents" would be submitted to the White House to review for "White House equities," apparently because the head of the inter-agency working group had been detailed to the National Security Council.[110] No one defined "White House equities," but the White House did not claim executive privilege over these documents. Then DOE and DHS subjected more responsive documents to a lengthy, inter-agency review which dragged on for months.

[103] E-mail from John Pantaleo to Jehanne Gillo entitled "weekly," April 27, 2009; e-mail from Robert Rabun to Paul Cloessner et al. entitled "OPG He-3 Recovery Business Case," April 29, 2009.
[104] E-mail from Roger Lewis to Douglas Dearolph entiled "He3 Feasibility Study SOW," June 25, 2009; e-mail from Greg Slovik to Elly Melamed and Joseph Glaser entitled "RE: Funding for Helium 3 study," June 30, 2009.
[105] E-mail from Debi Stumpff to Leslie Bowen et al entitled "Draft He-3 Supply working Group Minutes – 8/20/09," Aug. 27, 2009.
[106] E-mails from Ernest Muenchau to Chuck Galloway entitled "Product Acquisition and Deployment Weekly Activity Report," Oct. 22 and 30, 2009.
[107] Notes from Helium-3 Supply Working Group Teleconference, Jan. 6, 2010; "Helium-3 Procurement from Ontario Power Generation: Status," Feb. 16, 2010.
[108] Subcommittee staff interview of John Pantaleo, Jehanne Gillo and Joseph Glaser, Oct. 7, 2010.
[109] Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis," Science and Technology Subcommittee on Investigations and Oversight, April 22, 2010, webcast available at http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2798
[110] E-mail from Michael Bahar, National Security Council staff, to Edith Holleman, Subcommittee counsel, entitled "Document Review," April 19, 2010.

Subcommittee staff began communicating with White House attorneys in May of 2010 but did not make much headway until August of 2010, when DOE began to release documents that the White House had cleared. There was no basis for withholding many of the documents, some of which had already been shared with non-governmental parties, were factual reports, public documents or were just plain meaningless communications about such trivia as dates for meetings and phone calls.

A few examples of documents that should never have been subjected to White House review, but immediately released, include the following: (1) the October 2009 *Physics Today* article entitled "US Government Agencies Work to Minimize Damage Due to Helium-3 Shortfall;" (2) a Sept. 9, 2009, letter from Steve Fetter, Office of Science and Technology Policy, to two industry groups asking them to participate in the American Association for the Advancement of Science (AAAS) workshop on He-3 and to provide input to the "government interagency steering committee" on how to reduce He-3 demand; (3) a chain of e-mails from Nov. 5, 2009 to Jan. 13, 2010 between Ben Tennenbaum, then at AAAS, and agency officials discussing session moderators for the upcoming seminar on the helium-3 shortage; and (4) a report publicly available on the Web of the meeting of international neutron detector experts held on July 7-8, 2009.[111] But these documents were released only after several meetings with White House legal staff.

When asked the basis for their withholding of documents, the White House counsel's office produced the Justice Department's Freedom of Information Act (FOIA) guidance, [112] although federal law exempts Congressional committees from FOIA. Eventually, the Subcommittee agreed to review a set of documents withheld by the White House to determine which ones were necessary for the Subcommittee's work. It was our understanding that the White House would produce the documents selected. However, after the selection was made, the White House counsel's office returned with a set of documents redacted to such an extent that they were unusable. Another set of documents has never been viewed by the staff. They reportedly reside in a pile in the White House counsel's office described as the "not view" pile. White House refused to claim executive or any other privilege for these documents or to provide a list of the withheld documents without a Committee subpoena.

The Administration's position on its right to withhold documents from Congress in its oversight role is without legal precedent. The inability of responsible federal agencies to foresee the He-3 shortage while continuing to waste taxpayer funds by promoting technologies and projects that depended completely on a fictional expanding supply of He-3 was a gross failure on their part which they then tried to hide from Congressional committees with jurisdiction. The documents that the Subcommittee did obtain demonstrate that the agencies ignored well-founded warnings of the pending shortage and then dithered for almost a year after being told that there was a problem. The result was a waste of taxpayer funds and lengthy – and completely unnecessary – delays in developing equipment that this country needs both to maintain national security and to further its scientific, medical and commercial research. This is exactly the type of government failure that Congress should be investigating and bringing out into the open so that actions can be taken to prevent its recurrence.

[111] See fn. 30.
[112] Undated "DOJ FOIA GUIDE," accessible at http://www.justice.gov/

The months-long process this Subcommittee struggled with to educate the Executive as to their responsibilities served to run the clock out on the Subcommittee's options for more aggressive pursuit of these documents. However, all signs point to a disposition of the process issues raised in the He-3 investigation being expeditiously settled in the next Congress.

Documents for the Record Obtained by the Investigations and Oversight Subcommittee Prior to the April 22, 2010, Helium-3 Hearing

HELIUM-3 "DOCUMENTS FOR THE RECORD"

OBTAINED BY THE INVESTIGATIONS & OVERSIGHT SUBCOMMITTEE

PRIOR TO THE APRIL 22, 2010 HELIUM-3 HEARING

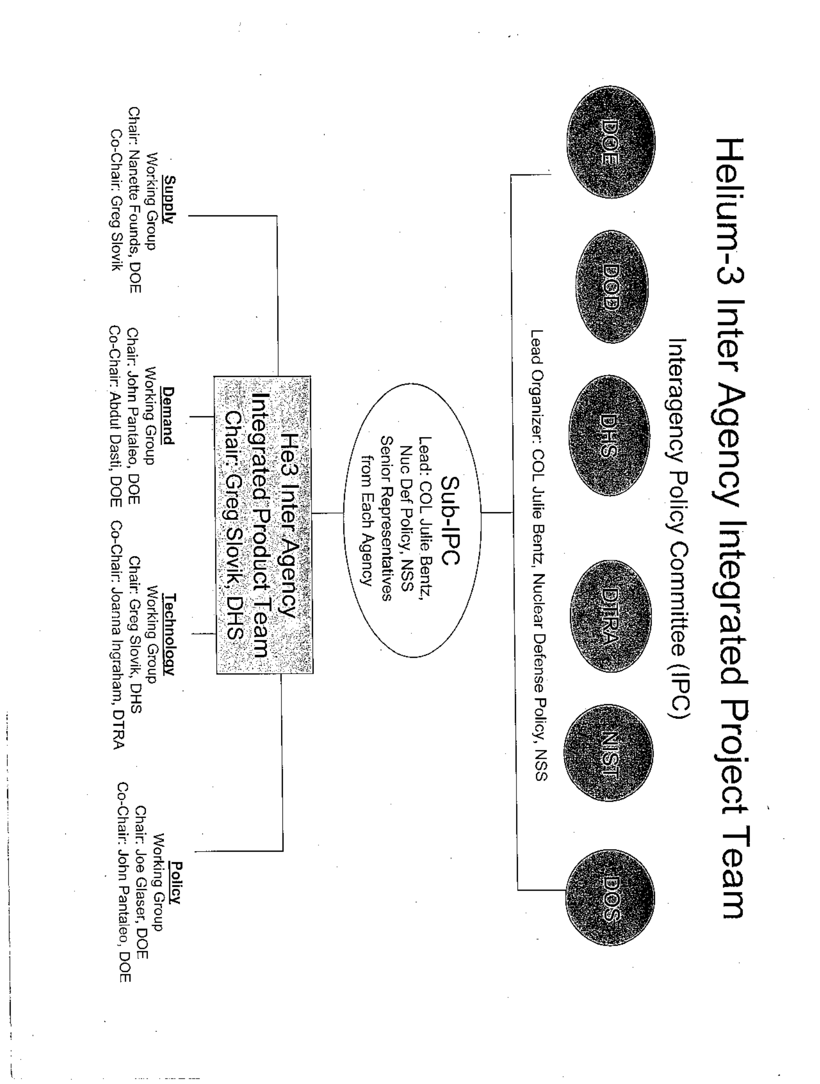
Caught by Surprise:

Causes and Consequences of the Helium-3 Supply Crisis

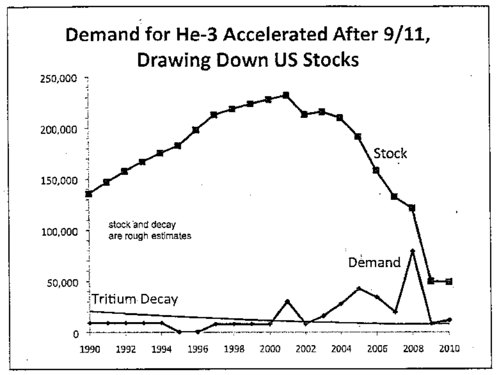
Thursday, April 22, 2010

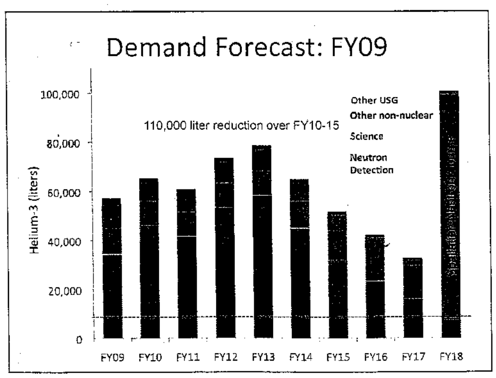
10:00 a.m. – 12:00 p.m.

2318 Rayburn House Office Building


Helium-3 Inter Agency Integrated Project Team
Interagency Policy Committee (IPC)
DOE
DOD
DHS
DTRA
NIST
DOS
Lead Organizer: COL Julie Bentz, Nuclear Defense Policy, NSS
Sub-IPC
Lead: COL Julie Bentz, Nuc Def Policy, NSS
Senior Representatives from Each Agency
He3 Inter Agency Integrated Product Team
Chair: Greg Slovik, DHS
Supply Working Group
Chair: Nanette Founds, DOE
Co-Chair: Greg Slovik
Demand Working Group
Chair: John Pantaleo, DOE
Co-Chair: Abdul Dasti, DOE
Technology Working Group
Chair: Greg Slovik, DHS
Co-Chair: Joanna Ingraham, DTRA
Policy Working Group
Chair: Joe Glaser, DOE
Co-Chair: John Pantaleo, DOE

4/14/2010


Demand for He-3 Accelerated After 9/11, Drawing Down US Stocks
250,000
200,000
150,000
100,000
50,000
0
Stock
stock and decay are rough estimates
Demand
Tritium Decay
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010


Demand Forecast: FY09
100,000
80,000
60,000
40,000
20,000
0
Helium-3 (liters)
110,000 liter reduction over FY10-15
Other USG
Other non-nuclear
Science
Neutron Detection
FY09
FY10
FY11
FY12
FY13
FY14
FY15
FY16
FY17
FY18

Muenchau, Ernest

From: Oxford, Vayl
Sent: Thursday, June 05, 2008 12:00 PM
To: Muenchau, Ernest; 'Todd.Pardue@dhs.gov'
Cc: Gallaway, Chuck; SIMMONS, PATRICK
Subject: Re: He3 Shortage

Let's contact DOE directly and get their sense on how severe this is

Vayl S. Oxford
Director
Domestic Nuclear Detection Office
202-254-7300 (O)

----- Original Message -----
From: Muenchau, Ernest
To: Pardue, Todd <Todd.Pardue@dhs.gov>
Cc: Gallaway, Chuck; Oxford, Vayl; SIMMONS, PATRICK
Sent: Thu Jun 05 11:21:36 2008
Subject: FW: He3 Shortage

FYI

I haven't responded

-----Original Message-----
From: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy) [mailto:thomas.anderson1@ge.com]
Sent: Thursday, June 05, 2008 11:17 AM
To: Muenchau, Ernest
Subject: He3 Shortage

Ernie,

I am the Product Line Leader for He3 filled detectors at GE Reuter-Stokes. We are one of the key suppliers of He3 detectors for the ASP program as well as many other homeland security applications. We have been working with the DOE, Mayak (Tenex) and the all the other gas distributors in an attempt to secure He3 gas for upcoming programs. We recently discovered that there is a shortage of He3 gas.

I met with John Pantaleo the Isotope Program Director at DOE last week and John clearly communicated that there is a shortage of He3. I learned yesterday that NNSA controls the He3 releases so I sent Bill Ostendorff an email asking for an audience to provide my perspective. I do not have an adequate supply to satisfy ASP requirements if the program gets moving later this year.

I currently have requests for ASP and other U.S. programs as well as detectors for security applications in China and Europe. All of these demands come in addition to Oil and Gas, neutron scattering research, and nuclear safeguards (many driven by the IAEA) programs.

We have 40 years of experience in this industry and have not experienced a shortage of this magnitude in the past. I would appreciate the opportunity to better understand the full scope of the situation and would like to know if we should be exploring alternate neutron detector technologies for the future.

Tom Anderson
Product Line Leader
GE Energy
Reuter-Stokes Radiation Measurement Solutions Twinsburg, Ohio 44087 Thomas.Anderson1@ge.com
[redacted]

Re: Fw: A Heads-up in He-3
Timothy Fischer to: Carroll Mcfall 06/10/2008 01:28 PM

I trust Mr. Pantaleo is familiar with the Competition in Contracting Act, making an exclusive arrangement with GE-Reuters problematic...

Timothy P. Fischer
Site Counsel
Savannah River Site Office
(803) 208-8656 (office)
(803) 507-8740 (mobile)

Carroll Mcfall/NNSA/DOE/Srs

SRS

Carroll Mcfall/NNSA/DOE/Srs
06/10/2008 01:06 PM
To: Timothy Fischer/NNSA/DOE/Srs@Srs
cc
Subject: Fw: A Heads-up in He-3

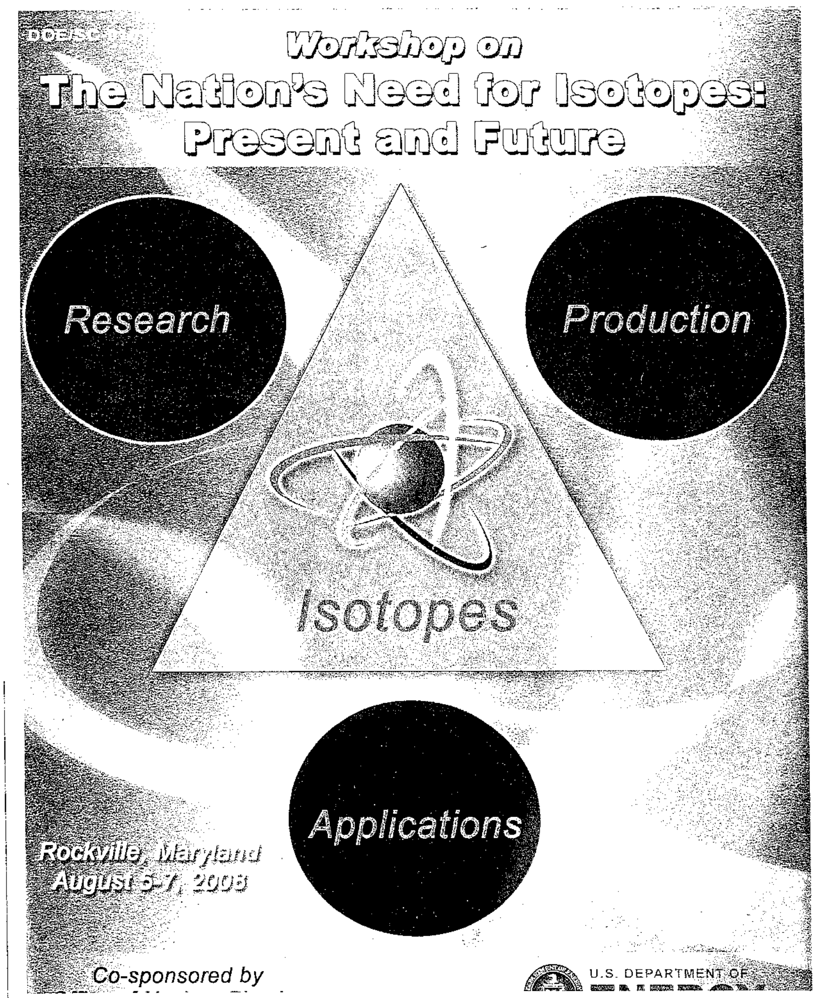
FYI, it looks like I've finally gotten the point across that He-3 is in limited supply. Contrary to the convoluted message below, we are reloading the cylinders for ORNL SNS (6 of 9 are complete). After that, the additional 20 old cylinders will be reloaded into new cylinders, which is expected to take until about Feb. 2009. When the first ten cylinders are reloaded, they will be placed on the market for sale. Apparently, GE-Reuters is trying to convince John Pantaleo (and maybe now Ostendorff) to allow them exclusive rights without going through the normal open competition. I'll keep you informed if I hear anything else.

Carroll McFall
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

----- Forwarded by Carroll Mcfall/NNSA/DOE/Srs on 06/10/2008 01:01 PM -----

Robert Rabun/WSRC/Srs
06/10/2008 12:58 PM
To: Carroll Mcfall/NNSA/DOE/Srs@Srs
cc: Susan Arnold/WSRC/Srs@Srs
Subject: A Heads-up in He-3

I just got a call from Dale Dunsworth of NNSA office fo Materials Management(?). He said Ostendorff got a message from GE/Reuters that they have used up their He-3 and NNSA would not release any more for sale. Dunsworth is looking into whether there is enough inventory for additional sales and if there are other big users of He-3. I mentioned SNS as one user and that we have material reserved for them.


Workshop on
The Nation's Need for Isotopes:
Present and Future
Research
Production
Isotopes
Applications
Rockville, Maryland
August 5-7, 2008
Co-sponsored by
U.S. DEPARTMENT OF

decay of tritium (^3H) at the Savannah River Facility and is also available from Russia. Russia is also currently the only available supplier for large amounts of the ^{76}Ge needed in the DBD studies.

What are the needs today and in the future?

A complete list of needed stable isotopes is given in Appendix G. In general, there are suppliers, either domestic or foreign, for most of the stable and enriched isotopes. The need for ^3He and special isotopes, such as ruthenium-96 (^{96}Ru) is not being met, and, in particular, the demand for ^3He is expected to rise in the future. Certain studies in medicine, human nutrition, and materials science are not being performed because of the high cost of the required isotopes, including iron-57 (^{57}Fe), ^{17}O, tin-119 (^{119}Sn), and europium-151 (^{151}Eu). The supply of ^{17}O is currently adequate to meet demand, but the evolution of magnetic resonance imaging (MRI) techniques could lead to a large increase in the need. Large quantities of specific isotopes, such as ^{76}Ge for the DBD studies, natural silicon for the electronics industry, lanthanum for detectors, and indium for low background detection, at present can only be found outside the United States. The use of isotopes in molecular-tagged vibrational spectroscopy (nuclear resonance vibrational spectroscopy, resonant Raman, and infra-red spectroscopy) is increasing and will lead to an increased need for small quantities of many isotopes that are used to differentiate vibrational modes between different ligands. Special enriched target materials, such as very neutron-rich isotopes including ^{48}Ca, titanium-50 (^{50}Ti), ^{58}Fe, and nickel-64 (^{64}Ni), are presently still available in the DOE inventory, but demands are expected to increase with the new Facility for Rare Isotope Beams (FRIB) proposed by the nuclear science community. Without some new domestic production facility, supplies of such isotopes could be limited or only available from foreign sources.

What is the status of the supply and what is missing?

Only limited quantities of deuterium (^2H) are currently available in the United States and current demand is met mainly through foreign sources, which can be erratic and expensive. The total supply of ^3He in the United States and Russia is not enough to meet current demands for ^3He neutron detectors, which account for about 80% of ^3He applications. In addition, these demands are growing and are not expected to diminish in the foreseeable future.

Boron, carbon, and oxygen isotopes are widely available domestically (from foreign producers) and the domestic supply exceeds the demand. Isotopes of nitrogen, the halogens, and the noble gases are available only from foreign sources such as China and Georgia. The large quantities of ^{76}Ge needed for the DBD study are not available domestically. Since the U.S. electromagnetic enrichment facility at ORNL was shut down there has been no domestic production of alkali, alkaline earths, and other metals. In general, most isotopes in the DOE inventory are in sufficient supply or are expected to be available to meet demands for the next 20 years based upon usage from past years. Table 2 provides a list of stable isotopes in the DOE inventory at ORNL that are currently not available or have limited availability.

While select Russian laboratories have generally met the needs for the raw isotopes, which are available through domestic brokers, the research community must occasionally

What are the options for increasing availability and associated technical hurdles?

The U.S. isotope community does not have access to domestic electromagnetic separators or gas centrifuges for production of over half of the isotopes in use. While there are currently reliable and dependable foreign supplies of stable and enriched isotopes, there is no assurance that they will be available domestically in the future. The DOE should consider the establishment of domestic production for all stable isotopes, particularly those that are not currently available domestically. From a risk management and disaster recovery standpoint, users prefer multiple reliable suppliers. Dependence on single-source availability of products may jeopardize research that is vital to national interest. A domestic supply insulates the United States from geopolitical influences on foreign supply including currency deflation, and ensures high-quality verification, such as through ISO 9001 certification. A diversity of suppliers usually leads to more competitive pricing. In some cases a research need for an isotope requires rapid purchase and delivery, which is best accomplished with a domestic supply. It may not be optimal for the United States to depend on foreign governments for the supply of stable isotopes because of the sensitive nature of the isotope applications, e.g., detectors for homeland security and power sources for naval reactors. Capabilities at existing accelerator facilities could be enhanced with the addition of electromagnetic separators or some other technical development.

Since ^{3}He is a by-product of tritium production for weapons systems, it is difficult to foresee a supply-based solution supported by current "production" techniques; therefore, a technology solution as well as efforts to maximize utilization of strategic reserves will be required to solve the problem of ^{3}He supply. The long-term demands will need to be defined by other agencies, such as DHS. However, current demands would deplete the reserves within two years and world production capacity meets only about 1/3 of current demand. It is possible that alternative production strategies could somewhat reduce the large anticipated demand. ^{3}He may be in some waste streams of some applications in other countries. International agreements could result in new supplies of ^{3}He for United States use, if transportation and export/import hurdles can be overcome.

In cases where technological options are not easily available for increasing the supply of a critical isotope, consideration should be given to identifying an alternate isotope that could replace the isotope in short supply, e.g., using boron-10 instead of ^{3}He for neutron detection. Production of deuterium by using new, cost-effective separation techniques from normal water should be reinvestigated. New technologies involve the need for R&D to identify a suitable replacement isotope.

An R&D plan for the development of novel separation and production techniques for stable and enriched isotopes should be generated. Access to less expensive, separated and enriched isotopes could lead to unanticipated breakthroughs in science and to new technologies. New enrichment techniques such as plasma ion cyclotron resonance separation, acoustic separation, cryogenic distillation, laser ionization, and plasma centrifuge have the potential to produce kilogram quantities of selected isotopes for specific purposes, as discussed above. In the short term, reliance on current techniques could provide the time needed to develop less expensive technologies for the future.

APPENDIX E: List of Isotope Working Group Attendees

Attendee	Attendees Title	Institution	Email
Stable and Enriched Isotopes			
Jack Faught - CoChair	Vice President	Spectra Gases Inc.	jackf@spectragases.com
Lee Riedinger - CoChair	Professor	University of Tennessee (UT)	lrieding@utk.edu
Scott Aaron	Isotope Development Group Leader, NSTD	ORNL	aaronws@ornl.gov
Thomas Anderson	Product Line Leader	General Electric Energy Reuter Stokes	thomas.anderson1@ge.com
Ercan Alp	Senior Scientist	DOE/BES	eea@aps.anl.gov
Darren Brown	President	Trace Sciences Inter.	darren@tracesciences.com
Abdul Dasti	General Engineer	National Nuclear Security Administration (NNSA) Stock/Stewship	abdul.dasti@nnsa.doe.gov
Brad Keister	Program Director	National Science Foundation	bkeister@nsf.gov
Nanette Founds	Supervisory General Engineer	NNSA Stock/Stewship	nfounds@doeal.gov
John Greene	Target Development Engineer	ANL	greene@anl.gov
Gary Hatch	Chief, Pulmonary Toxicology Branch	EPA	hatch.gary@epamail.epa.gov
Richard Kouzes	Laboratory Fellow	University of Washington	rkouzes@pnl.gov
Molly Kretsch	National Program Leader Human Nutrition	U.S. Department of Agriculture	molly.kretsch@ars.usda.gov
Craig Reynolds	Associate Director, NCI	National Institute of Health	craig.reynolds@nih.hhs.gov
Andreas Stolz	Assistant Prof.& Dept. Head of Operations	Michigan State University	stolz@nscl.msu.edu
Jehanne Gillo	Acting Associate Director	DOE/NP	jehanne.gillo@science.doe.gov
Clifford Unkefer	Director National Stable Isotope Resource	LANL	cju@lanl.gov
Robert Vocke	Research Chemist	NIST	robert.vocke@nist.gov
Alfred Wong	Professor	Nidnano	awong@nidnano.com
Alfred Yergey	Section Chief	NIH Institute of Child Health	yergeya@mail.nih.gov

Radioisotopes for Research and Development

Robert Atcher - Cochair	Team Leader, SNM (President)	LANL	ratcher@lanl.gov
Robert Tribble - Cochair	Professor of Physics and Director	Texas A&M Cyclotron	r-tribble@tamu.edu
Martin Brechbiel	Section Chief	NCI	martinwb@mail.nih.gov
Glenn Young	Division of Physics	ORNL	younggr@ornl.gov
William Courtney	Linac Operation Manager	Trace Life Sciences	bcourtney@thelinac.com
Jill Chitra	Vice-President, Strategic Technologies	MDS Nordion Inc	jill.chitra@mdsinc.com
John D'Auria	Professor Emeritus	DOE - NP	john.d'auria@science.doe.gov
Darrell Fisher	Scientific Director, Office of Nat. Isotope Programs	PNNL	dr.fisher@pnl.gov
Jim Harvey	Chief Science Officer	Northstar Medical Radioisotopes, Inc.	jharvey@northstarnm.com
Calvin Howell	Professor & Director	Duke University	howell@tunl.duke.edu
Randy Hobbs	Experimenter Interface Staff	UT-Battelle/ORNL	hobbsrw@ornl.gov
Michael Hughes	Research Toxicologist	EPA	hughes.michaelf@epa.gov
Lynn Kaczmarek	Director of PET Radiopharmaceutical Production	University of Buffalo	kaczmare@buffalo.edu
Russ Knapp	Manager, Nuclear Medicine Program	ORNL/Nuclear Medicine Program	knappffjr@ornl.gov
Claude Lyneis	Physicist	LBNL	cmlyneis@lbl.gov
Jason Lewis	Chief, Radiochemistry Service	Memorial Sloan-Kettering Cancer Center	lewisj2@mskcc.org
Steve Laflin	CEO	International Isotopes, Inc.	staflin@intisoid.com
Lester Morss	Program Manager	DOE/BES	lester.morss@science.doe.gov
Leonard Mausner	Senior Scientist, Isotope Program Site Manager	BNL	mausner@bnl.gov
Alexandra Miller	Senior Scientist	Uniformed Services University of the Health Sciences/ Armed Forces Radiobiology Research Institute	millera@afrri.usuhs.mil
Roger Moroney	Manager, Radiological Compliance	Siemens	william.moroney@siemens.com
Heino Nitsche	Professor of Chemistry	LBNL	hnitsche@lbl.gov
Meiring Nortier	Dr.	LANL	meiring@lanl.gov
Richard Pardo	ATLAS Operations Manager	ANL	pardo@phy.anl.gov
J. David Robertson	Professor and Associate Director	University of Missouri	robertsonjo@missouri.edu

Ram Ramabhadran	Branch Chief, Cellular Molecular Toxicology	NIST	ramabhadran.ram@epa.gov
Prem Srivastava	Program Manager	DOE/BER	prem.srivastava@science.doe.gov
Mark Stoyer	Experimental Nuclear Physics Group Leader	Lawrence Livermore National Laboratory (LLNL)	stoyer1@llnl.gov
John Snyder	Commercialization Manager	INL	john.snyder@inl.gov
Henry VanBrocklin	Professor of Radiology and Biomedical Imaging	University of California	henry.vanbrocklin@radiology.ucsf.edu
Michael Welch	Professor of Radiology	Washington University	welchm@wustl.edu
Brian Zimmerman	Research Chemist	NIST	brian.zimmerman@nist.gov
Radioisotopes for Applications			
Jeff Norenberg - CoChair	Assoc. Prof. & Dir., Radiopharmaceutical Science	University of New Mexico	jpnoren@unm.edu
Parrish Staples - CoChair	Director, GTRI, NA212	NNSA	parrish.staples@nnsa.doe.gov
Zane Bell	Senior Research Scientist	ORNL	bellzw@ornl.gov
Roy Brown	Senior Director Federal Affairs/ CORAR	CORAR	roywbrown@sbcglobal.net
Cathy Cutler	Research Associate Professor	MURR	cutlerc@missouri.edu
Ron Crone	Division Director Research Reactors Division	ORNL	cronera@ornl.gov
Thomas Deforest	Project Manager	PNNL/NNSA	thomas.deforest@nnsa.doe.gov
Hugh Evans	Vice President	QSA-Global Inc	hugh.evans@qsa-global.com
Dan Fenstermacher	Physical Scientist	State Dept./Office of Nuclear Energy, Safety and Security	fensteada@state.gov
Steven Goldberg	Physical Scientist	DOE Chicago Operations Office	steven.goldberg@ch.doe.gov
Ira Goldman	Project Manager	IAEA	i.goldman@iaea.org
Ken Inn	Research Chemist	NIST	Ken.inn@nist.gov
Jennifer Jackson	Assistant Professor of Geophysics	Caltech	jackson@gps.caltech.edu
John Jensen	USDA - Director	Radiation Safety Division	john.jensen@ars.usda.gov
Jerry Klein	ORNL Isotope Program Manager	Isotope Business Office/Federal	kleinja@ornl.gov
Manuel Lagunas-Solar	Research Chemist	University of California, Davis	Solar@crocker.ucdavis.edu
Tracey Lane	VP Marketing	Trace Life Sciences	tlane@thelinac.com
Elly Melamed	Deputy Director, 2nd Line of Defense Program	NNSA	elly.melamed@hq.doe.gov

Frances Marshall	Department Manager, Irradiation Testing	INL	frances.marshall@inl.gov
David Martin	Program Director	DHS/Nuclear	david.w.martin@associates.dhs.gov
Gene Peterson	Div. Head Chem.	LANL	ejp@lanl.gov
John Pantaleo	Isotope Program Director	DOE/NE	john.pantaleo@hq.doe.gov
Michael Pearson	Senior Technical Advisor	NNSA	mwp@lanl.gov
Thomas Ruth	Senior Research Scientist	TRIUMF	truth@triumf.ca
Wolfgang Runde	DOE Isotope Program Manager	LANL	runde@lanl.gov
Robert Reba	Professor	Georgetown University Hospital	rreba@comcast.net
Alan Remen	Chief Operating Officer	SABIA, Inc.	ironn@sabianinc.com
Eric Rosemann	Chair, Radiation, Safety and Security Committee Chair	Association of Energy Service Companies	eric.rosemann@graywireline.com
James Symons	Director, Nuclear Science Division	LBNL	tjsymons@lbl.gov
Jason Shergur	Test Scientist	DHS	jason.shergur@dhs.gov
David Schlyer	Senior Scientist	BNL	schlyer@bnl.gov
Susan Seestrom	Senior Scientist	LANL	seestrom@lanl.gov
Mike Shlesinger	Chief Scientist for Nonlinear Science	Office of Naval Research	mike.shlesinger@navy.mil
James Tatum	Ass. Dir-Div. of Cancer Treatment and Diagnosis	NIH/NCI	tatumj@mail.nih.gov
Anthony Veca	IRIGA Reactor Systems-Director	General Atomics	anthony.veca@gat.com
Bernard Wehring	Professor	North Carolina State University	bwwehrin@ncsu.edu
Jim Wilson	Director of Materials	Ecker & Ziegler Isotope Products	jim.wilson@ezag.com
Michael Zalutsky	Prof. of Radiology & Biomedical Eng.	Duke University	zalut001@mc.duke.edu

SRS **Fw: He3 supply for Second Line of Defense requirements**
Carroll Mcfall to: Kevin02 Hall, Timothy Fischer 08/18/2008 01:38 PM

This is the other He-3 request I received.

Carroll McFall
Assistant Manager for Mission Assurance
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

----- Forwarded by Carroll Mcfall/NNSA/DOE/Srs on 08/18/2008 01:38 PM -----

"Pantaleo, John"
<JOHN.PANTALEO@nuclear.energy.gov>
08/12/2008 08:35 AM

To carroll.mcfall@nnsa.srs.gov
cc
Subject FW: He3 supply for Second Line of Defense requirements

Hi Carroll,

We had our isotope workshop last week and it was well attended. A number of issues are looming for DOE. I am passing this e mail for you inform. There is a lot of interest and demand for he-3. We will need to chat soon.
John

-----Original Message-----
From: Victor Gavron [mailto:gavron@lanl.gov]
Sent: Monday, August 11, 2008 12:32 PM
To: Pantaleo, John
Subject: He3 supply for Second Line of Defense requirements

Dear John,

Following our brief discussion at the Isotope Workshop last wee, I would like to provide you with more details concerning the He3 supply issue. I ahve also sent this information to Abdul Dasty to solicit his response. If it is convenient for you, we could schedule time later this week to follow up via a phone call.

Here are the details:

The NNSA Second Line of Defense (SLD) program (run by NA-256), is tasked to prevent transportation and smuggling of radioactive materials, and in particular Special Nuclear Materials that can be used for nuclear weapons construction. It manages the "Core" and "Megaports" programs,

SRS **Re: FW: He3**
Carroll Mcfall to: McCollom, Wanda T 09/04/2008 06:44 AM

Wanda,

He-3 is in short supply. We have identified both government and commercial needs over the next few years that exceed our projected supply. If your needs are to support some government use, I would recommend you contact the DOE Isotope Program Manager John Pantaleo at (301)903-2525.

Carroll McFall
Assistant Manager for Mission Assurance
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

"McCollom, Wanda T" <Wanda.McCollom@pnl.gov>

"McCollom, Wanda T" <Wanda.McCollom@pnl.gov>
09/03/2008 02:31 PM
To <carroll.mcfall@nnsa.srs.gov>
cc
Subject FW: He3

Carroll: Please see messages below. Would you happen to have any excess He3?

Wanda T. McCollom
Excess Materials & Redeployment Services (EMRS)
Pacific Northwest National Laboratory
Phone: (509) 375-5941
Fax: (509) 375-2126

From: herbert.nigg@srnl.doe.gov [mailto:herbert.nigg@srnl.doe.gov]
Sent: Tuesday, September 02, 2008 12:24 PM
To: McCollom, Wanda T
Subject: Re: He3

Contact Mr. Carroll McFall here ats SRS who handles He3 requests.

Thanks,
Lee

carroll.mcfall@nnsa.srs.gov

Linkins, Venus <CTR>

From: Gowadia, Huban
Sent: Thursday, December 18, 2008 10:44 AM
To: Gallaway, Chuck; Oxford, Vayl
Cc: Muenchau, Ernest; Hagan, William K
Subject: He3

Chuck and Vayl

I've slowly been getting caught up on the whole ^{3}He business and only today did some of the numbers sink in. Sorry am a little late on the draw, and perhaps Ernie and Bill have already raised it to your attention. But as best as I can tell, SRNL is not on contract to produce enough ^{3}He to even meet half of DHS needs – let alone what DOE needs – next year. I recall one of you saying that you had an opportunity to address matters with D'Agostino – who was keen to help with the DOE-DHS relationship – and I wondered if you might consider this important enough to bring to his attention. I know that he doesn't have the Isotopes Program, which is under Office of Science, but perhaps he has a way of raising this issue with his peer?

Please excuse if all of this is naïve and you already have the matter under control, but as we lay down deployment targets, I worry that we might not be able to get there from here.

Hg

Spear, Alan <CTR>

From: Strangfeld, Charles [Charles.Strangfeld@dhs.gov]
Sent: Friday, January 30, 2009 12:08 PM
To: Slovik, Gregory
Cc: Simmons, Larry <CTR>
Subject: RE: Weekly Update -- Maritime

Greg,

This update is is most appreciated . . . How much of it, if any, can be shared with Kenny McDaniel in Coast Guard Headquarters at this point?

Charles V. (Chip) Strangfeld, CAPT, USCG
Maritime Mission Area Manager
Missions Management Directorate (MMD)
Domestic Nuclear Detection Office (DNDO)
W 202 254 7545
C 202 731 8753

From: Slovik, Gregory [mailto:Gregory.Slovik@dhs.gov]
Sent: Friday, January 30, 2009 11:53 AM
To: Strangfeld, Charles; Slovik, Gregory
Cc: Simmons, Larry <CTR>
Subject: RE: Weekly Update -- Maritime

Chip,

I am attaching a summary of a phone call with DOE to discuss the issue and a letter signed by Ernie to DOE to further engage on the He3 issue as well as to obtain more gas.

Please let me know if you need more information.

FY09 Requirements

System	liters/ tube	Number of tubes	Number of Systems	System Gas (l)	Total Gas Needed (l)	Detector Manufacturer
Radpack	1.69	7	22	260.26	276.8723	Reuter Stokes
HRM	0.23	1	1	0.23	0.244681	Reuter Stokes
LRM	0.23	9	6	12.42	13.21277	Reuter Stokes
GR-135P	0.5	1	1	0.5	0.531915	Spectra Gas / LND
IdentiFINDER	0.064	1	262	16.768	17.8383	Reuter Stokes

PackEYE	1.8	2	182	655.2	697.0213	Reuter Stokes
Raytheon ASP	10.754	12	1	129.048	137.2851	Reuter Stokes
Thermo ASP	5.6	8	1	44.8	47.65957	Reuter Stokes
SAIC Portal (4 panels)	9.2	4	140	5152	5480.851	Spectra Gas / LND
ARIS MDS	6.2	1	13	80.6	85.74468	Reuter Stokes
FHT752SH Neutron Probe	1	1	17	17	18.08511	Reuter Stokes

Total Gas Purified 6306.296
Total Gas 6726.911

Gas Needed at Spectra Gas 5480.85
Gas Needed at Reuters-Stokes 1246.06

FOUO

Expected FY10 Requirements

FY10 He3 Estimates

System	liters/ tube	Number of tubes	Number of Systems	System Gas (l)	Total Gas Needed (l)	Detector Manufacturer
Radpack	1.69	7	30	354.9	377.55319	Reuter Stokes
HRM	0.23	1	20	4.6	4.893617	Reuter Stokes
LRM	0.23	9	6	12.42	13.212766	Reuter Stokes
GR-135P	0.5	1	500	250	265.95745	Spectra Gas / LND
IdentiFINDER	0.064	1	250	16	17.021277	Reuter Stokes
PackEYE	1.8	2	180	648	689.3617	Reuter Stokes
Raytheon ASP	10.754	12	84	10840.03	11531.949	Reuter Stokes
Thermo ASP	5.6	8	1	44.8	47.659574	Reuter Stokes

SAIC Portal (4 panels)	9.2	4	117	4305.6	4580.4255	Spectra Gas / LND
ARIS MDS	6.2	1	15	93	98.93617	Reuter Stokes
FHT752SH Neutron Probe	1	1	20	20	21.276596	Reuter Stokes

Total Gas Purified	16269.952
Total Gas	17329.736

Gas Needed at Spectra Gas	4846.383
Gas Needed at Reuters-Stokes	12483.35

FOUO

Thanks,
Greg

Gregory C. Slovik, P.E., DHSPM
HPRDS Technical Director
Production Acquisition and Deployment Directorate (PADD)
Domestic Nuclear Detection Office (DNDO)

Office: 202-254-7222
BB: 202-746-0373

From: Strangfeld, Charles [mailto:Charles.Strangfeld@dhs.gov]
Sent: Friday, January 30, 2009 10:00 AM
To: Slovik, Gregory
Cc: Simmons, Larry <CTR>
Subject: RE: Weekly Update -- Maritime

Greg,

I met with Kenny McDaniel, the Coast Guard rad/nuc program manager in CG-532 yesterday, and the He3 issue was clearly his top concern -- he mentioned national security concerns associated with not getting RADPACKs where they are needed to properly execute their piece of the GNDA. Given the He3 uncertainty moving forward, he is ready to bring visibility on the issue to the CG Commandant for consideration of Secretary-level engagement with DOE/DOD if needed.

I told him I would check to verify DNDO's latest understanding of the future of He3 availability. Are you still the point man for this question? If so, request update.

Thanks, Greg!

Regards, Chip
Charles V. (Chip) Strangfeld, CAPT, USCG
Maritime Mission Area Manager
Missions Management Directorate (MMD)
Domestic Nuclear Detection Office (DNDO)
W 202 254 7545
C 202 731 8753

From: Gowadia, Huban [mailto:Huban.Gowadia@DHS.GOV]
Sent: Thursday, January 15, 2009 10:14 AM
To: Muenchau, Ernest; Hagan, William K; Gallaway, Chuck; Hill, Julian
Cc: Strangfeld, Charles; Slovik, Gregory
Subject: RE: Weekly Update -- Maritime

Many thanks, Ernie and Greg!

From: Muenchau, Ernest [mailto:Ernest.Muenchau@dhs.gov]
Sent: Thursday, January 15, 2009 10:06 AM
To: Gowadia, Huban; Hagan, William K; Gallaway, Chuck; Hill, Julian
Cc: Strangfeld, Charles; Slovik, Gregory
Subject: RE: Weekly Update -- Maritime

Greg is looking into this issue. I'll have him update the addressees

From: Gowadia, Huban [mailto:Huban.Gowadia@DHS.GOV]
Sent: Thursday, January 15, 2009 7:58 AM
To: Muenchau, Ernest; Hagan, William K; Gallaway, Chuck; Hill, Julian
Cc: Strangfeld, Charles
Subject: FW: Weekly Update -- Maritime

Ernie

First up, want to thank you and your team for helping us get the equipment out to the WCMP folks.

In his weekly update, CAPT Strangfeld tells me that the RADPACK systems have no delivery date on account of the ^{3}He shortage. The last time we spoke on this matter, your indication was that things were on track to meet the demand. Do you still believe that? Is there anything further we need to do to ensure we will be able to get the systems we need (across the board) this year?

Thanks,
Hg

From: Strangfeld, Charles
Sent: Wednesday, January 14, 2009 1:52 PM
To: Gowadia, Huban
Cc: Vogel, Daniel S; Simmons, Larry <CTR>
Subject: Weekly Update -- Maritime

Flow of HPRDS into Puget Sound has picked up -- still no RADPACK dates due to HE3 shortage , but 49 of 50 RIIDs are there, and 70 of 287 Polimaster pagers (in addition to the 75 Canberras that were delivered a while back). Larry's query to Polimaster indicated that they have 500 pagers currently in production, but no specifics on when to expect them. Again, training is progressing on schedule by shifting equipment in the region around.

FOUO

Jan 27 2009 1:50PM HP LASERJET FAX 8059642772. p.1

SENSOR TECHNOLOGY ENGINEERING, INC.

5553 Hollister Ave. #1, Santa Barbara, CA 93117 (805) 964-9507 FAX(805) 964-2772

January 26, 2009

Joyce Oliver, Contract Specialist
Navy EOD Technology Center
Procurement Department
Suite 132, Code C13J
4072 North Jackson Rd.
Indian Head MD 20640
Tel: 301-744-6575
Fax: 301-744-6547
e-mail: joyce.oliver@navy.mil

Re: 3He Shortage for N00174-07-D-0014

Ms. Oliver,

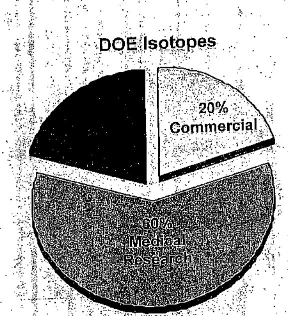
3He is a non-radioactive gas used for the detection of neutrons, such as those that emanate from Plutonium based nuclear weapons and components. The gas is pumped into small stainless steel tubes to make neutron detectors. 3He is a by-product of a nuclear weapons production complex. The gas is not made by commercial industry. The gas is only produced by nuclear weapon states such as the United States, Russia, France, and the UK. In the United States, the production of the 3He is managed by the USDOE. Historically, the 3He has been auctioned by the USDOE to neutron detector manufacturers, and/or specialty gas suppliers, and then purified commercially to remove radioactive contaminants. The USDOE has been auctioning less 3He in recent years, and post 9/11 more neutron detectors have been fabricated for national security applications than pre 9/11. The net effect is that in the winter of 2008 predictions of a 3He shortage began to surface. The actual reason for the 3He shortage is unclear, and can only be inferred by us. The contact at the DOE Office of Isotopes is John Pantaleo (301) 903-2525, john.pantaleo@nuclear.energy.gov. Mr. Pantaleo may be able to provide some clarity.

In order to mitigate the potential shortage, Sensor Technology Engineering, Inc. (STE) purchased significantly more neutron detectors in the early spring of 2008 than were required to fill existing orders at that time. This mitigation has postponed the 3He shortage problem for our customers. It is currently anticipated that deliveries on N00174-07-D-0014 will cease in late summer 2009 if 3He supplies are not made available to the vendor that we use to fabricate neutron detectors (GE Reuter Stokes). It is estimated that 1600 liters of 3He will be required to complete the contract. We cannot purchase neutron detectors for our instruments without a supply of 3He to our vendor. It may be important to note that the supply problem with 3He is predicted to continue indefinitely into the future, and may effect NAVEODTECDIV on requirements beyond N00174-07-D-0014.

The DOD, DOE, DOJ, and DHS are all now competing for a limited supply of 3He for their national security requirements. It appears that some organizations are outmaneuvering other organizations. There may be some specific programs within the DOE and DHS have arranged to

Mission of DOE's Isotope Program

- Produce and sell radioactive and stable isotopes, associated byproducts, surplus materials, and related isotope services
- He3 is just one of many isotopes of concern
- Maintain the infrastructure required to supply isotope products and related services
- Over 190 customers in FY 2008
- Over 560 shipments in FY 2008
- Ten customers provided over 85% of sales



Authority to Allocate

- Under the Defense Production Act (DPA), 50 U.S.C. app. §§ 2061-2171 (2008), DOE/NNSA has the authority to allocate materials, services, and facilities for national defense purposes.
- Section 101(a) of the Defense Production Act, 50 U.S.C. app. § 2071(a), gives the President the authority "to allocate materials, services, and facilities in such manner, upon such conditions, and to such extent as he shall deem necessary or appropriate to promote the national defense." This authority has been delegated to the Secretary of Energy "with respect to all forms of energy," and re-delegated to the Administrator of the NNSA and to the Director of the NNSA Office of Procurement and Assistance Management. *See* Executive Order No 12,919 (June 7, 1994); Executive Order No. 11790 (June 25, 1974); DOE Delegation Order No. 00-003.00; DOE Delegation Order No. 00-003.01.

Introduction

- ^{3}He Characteristics and Applications
- Program Background
- Historical and Projected Supply
- Projected Demand
- Inventory Status

Note: ^{3}He gas volumes provided in this presentation are at STP unless otherwise specified.

Neutron Detector Tubes Manufactures

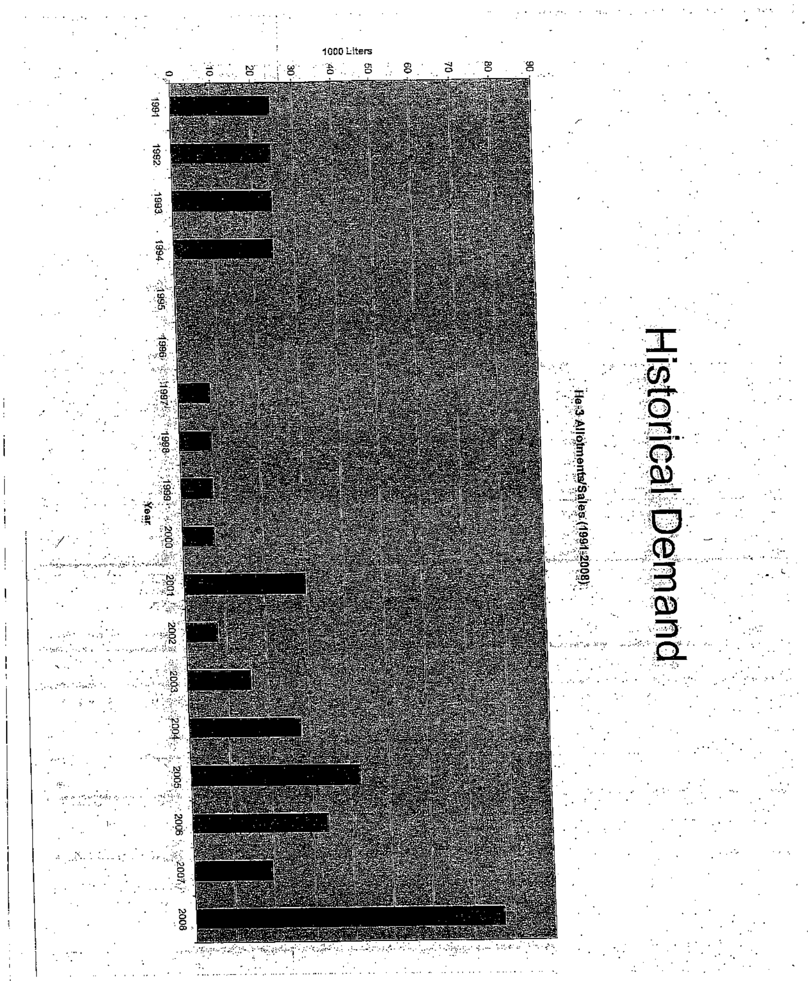
- Centronic (based in the USA and UK)
- Canberra (Connecticut and UK)
- Berthold (Germany)
- LND (based in New York)
- Saint Gobain (based in Ohio and Texas)
- Ordela (based in Tennessee)
- Troxler (based in North Carolina)
- Schlumberger (based in Texas)
- G. E. Reuter Stokes (based in Ohio)
- Thermal Fischer (Texas)
- Eurisys (France)
- Decision Sciences (San Diego & South Carolina)
- Bubble Technologies (Canada)
- Nutech (China)
- Beijing Nuclear (China)
- Sandia National Laboratory
- Los Alamos National Laboratory

Note: There may be other suppliers. With the exception of Canberra and perhaps Decision Sciences, none of the above organizations make the entire detection system—they only make the tubes.

Neutron Detector Supply Chain Example

- Second Line of Defense (SLD) issues contract SAIC
- Isotope Program sells crude He-3 from SRS to Spectra Gases
- Spectra Gases purified it and resells the gas to LND
- LND is subcontracted by SAIC to manufacture neutron detector tubes to their specifications
- SAIC sells the completed detection system under contract to PNNL

(So, in fact, ownership of the He-3 comes back to the U.S. Government)

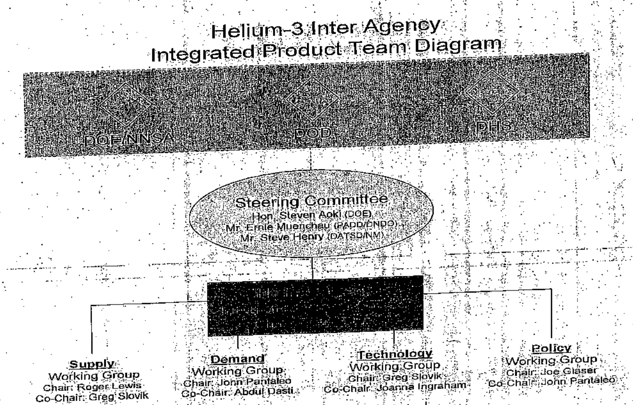

Historical Demand
He-3 Allotments/Sales (1991-2008)
1000 Liters
0
10
20
30
40
50
60
70
80
90
Year
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

Inventory Status

(values are approximate)

- December of 2008, 70% of 6 cylinders (15,173 liters of 21,675 liters) of ^3He were allocated to NNSA, DHS and other defense projects
- March 2009, 4 cylinders (15,327 liters) of ^3He have been allocated to DHS projects and other defense applications.
- Fall 2009, 7 cylinders (~25,000 liters) to be distributed
- 6 cylinders (~21,000 liters) in inventory/reserve
- Possible 7 cylinders at future date, and quantity, to be determined
- Future – 8,000 to 10,000 liters per year

Helium-3 Inter Agency Integrated Product Team structure



Near Term Actions:

- Collect He-3 needs from each agency and available inventory (SNS).
- Investigate availability of Canadian Helium-3 Resource
- Investigate Recycle old detectors to recoup He3 gas
- Investigate recovery of He-3 from Metal-Tritide Storage Beds, LANL.
- Develop a priority/allocation scheme
- Allocate the 7 cylinders (~25,000 liters) at SRO to the agencies and for other commercial applications

Rudy Goetzman/SRNL/Srs
02/13/2009 07:28 AM

To Paul Cloessner/SRNL/Srs@Srs
cc
bcc
Subject Re: Heads up on 3-He Situation

Let's discuss in your office on Tuesday at 11:00 if that works for you. Let me know. This is a BFD! What are the other sources of He3 outside of SRS?

Sent from my Blackberry......
Rudy Goetzman
(803) 507-6440 Cell
Freedom is not free.
Paul Cloessner

----- Original Message -----
From: Paul Cloessner
Sent: 02/13/2009 07:12 AM EST
To: Charles (Rudy) Goetzman; Jerry (Todd) Coleman; Gregory (Greg) Cefus; Matthew (M. John) Plodinec; Ray (Tony) Hicks; Alfred (Al) Goodwyn
Subject: Fw: Heads up on 3-He Situation

FYI. I figured this would become an issue sooner or later. I am on he IPTT that Rabun mentions. The NSSE is the Network of Senior Scientists and Engineers in NNSA, which the IPTT sponsors. The IPTT and NSSE met recently at the Naval Research Lab in D.C. I missed the meeting due to conflicts.

If any of you have any more background on this topic I would appreciate you passing it on to me.

Paul Cloessner, PhD
Manager, Defense Programs Technology
Savannah River National Laboratory
803-725-2198

----- Forwarded by Paul Cloessner/SRNL/Srs on 02/13/2009 07:01 AM -----

Robert Rabun/SRNS/Srs
02/12/2009 04:59 PM

To Debra Utley/SRNS/Srs@Srs, James Dollar/SRNS/Srs@Srs, Susan Arnold/SRNS/Srs@Srs, Paul Cloessner/SRNL/Srs@Srs, Crawford Price/SRNS/Srs@Srs, Lee Schifer/SRNS/Srs@Srs
cc Kevin Sessions/SRNS/Srs@srs, Joe Cordaro/SRNL/Srs@Srs, Jeffery Westergreen/SRNS/Srs@Srs
Subject Heads up on 3-He Situation

Last week the NSSE's took the first day of our meeting to visit the Naval Research Lab outside of Bethesda, MD. The meeting came about from our contacts with an NRL researcher that we recently provided with a significant quantity of 3-He. The planned purpose of the meeting was for the NNSA Plants and Labs to brief NRL on our capabilities, tour some of the NRL facilities, and look for potential areas of collaboration and technology exchange.

To: Gillo, Jehanne
Cc: Mustin, Tracy; Pantaleo, John
Subject: our discussion on He3
Dear Jehanne:

It was very helpful to speak with you. To better introduce our program, Second Line of Defense (SLD) is part of International Material Protection and Cooperation in NNSA under the Office of Defense Nuclear Nonproliferation. Working in cooperation with partner countries, SLD - which consists of the Core and the Megaports Components - provides radiation detection systems to deter, detect and interdict illicit trafficking of special nuclear and other radiological materials across international borders, thereby increasing U.S. and global security. The systems include fixed as well as handheld radiation detectors along with associated communication systems. Approximately 1000 fixed detectors have already been deployed in over 30 countries.

As a follow-up from our conversation, I am attaching two documents. One is a general background on the He3 issue that we have prepared for our management. The other is a technical piece we asked our lab colleagues to prepare on alternative technologies for He3 tubes. The technical piece has been reviewed by Bob Mayo.

We would appreciate the opportunity to meet with you and representatives from other Federal Agencies to discuss the He3 issue. In addition, we would also be pleased to meet with NSAC to discuss our concerns.

I am attaching my contact information below. I am copying the Director of SLD, Tracy Mustin, who is very interested in this issue and could possibly participate in any meetings that are set up. I am also copying John Pantaleo with whom we have been working very closely.

Thank you.

Sincerely,

Eleanor Melamed
Deputy Director
Second Line of Defense
NA-256
International Material Protection and Cooperation
Office of Defense Nuclear Nonproliferation
National Nuclear Security Administration

202-586-2216
elly.melamed@hq.doe.gov
[attachment "He3 Alternatives-3Nov08rev.doc" deleted by Rudy Goetzman/SRNL/Srs]
[attachment "He3 Issues revised.doc" deleted by Rudy Goetzman/SRNL/Srs]

Nuclear Science Advisory Committee Isotopes Subcommittee Meeting

Tracy Rudisill to: Jeff Griffin 02/13/2009 04:37 PM

Cc: Sharon Marra, Samuel Fink, Carroll Mcfall, Frederick Roemer

Jeff

I attended the Nuclear Science Advisory Committee (NSAC) Isotopes Subcommittee meeting this week (February 10-11) in Rockville, MD. I though you might be interested in a brief overview. The NSAC Isotopes Subcommittee included 18 members. The majority of the membership was composed of national laboratory personnel and university faculty; although, the membership did include representatives from the medical community, radiopharmaceuticals, and private industry. The subcommittee was co-chaired by Donald Geesaman (ANL) and Ani Aprahamian (University of Notre Dame). The subcommittee is advising the Office of Science's Office of Nuclear Physics on the proposed transfer of the DOE Isotope Production Program from the Office on Nuclear Energy to Nuclear Physics. The subcommittee's immediate charge is twofold: (1) to gather broad input regarding how isotopes are used and to identify compelling research opportunities using isotopes, and (2) study the opportunities and priorities for ensuring a robust national program and to recommend a long-term strategic plan. To accomplish these tasks, the subcommittee invited representatives from national laboratories, universities, and private industry to discuss their present capabilities and future plans for isotope production. There was a total of about 20 presentations over the two days. I gave a presentation on the isotope recovery activities at the SRS on Wednesday morning. I've placed a copy of the presentation in my folder at Srnl ssp on 'Wg07'.

Most of the interest in my presentation concerned the recovery of He-3 in the tritium facilities. As you are probably aware, the demand for He-3 has skyrocketed since the terrorist attack on the World Trade Center in 2001. The growth in demand is from national security applications, primarily for neutron detection. The demand for He-3 is now much greater than the amount which is available for recovery. Members of the subcommittee were frustrated that little could be done to produce more He-3 in this country. The production of more tritium to increase the amount of He-3 which can be recovered was even discussed. Negotiating a deal with Canada to buy He-3 from the decay of the tritium produced in CANDU reactors will likely be pursued by private industry. The subcommittee's report to Nuclear Physics (which will be issued in July) will likely contain recommendations on the priority of He-3 uses in non-defense R&D activities. (Prioritizing the national security applications for He-3 uses is outside the subcommittee's charter.) I was somewhat disappointed that the subcommittee did not express interest in the rare transuranic isotopes which are recoverable from the Mark 18 targets stored in L-Area. I would hate to see the targets dissolved and the isotopes discarded to waste.

Many of the other presentations at the meeting addressed shortfalls in the production of Mo-99. Mo-99 is used as the generator for Tc-99m which is used in about 85% of the nuclear medicine procedures performed in the US (for imagining and organ functionality). Most of the Mo-99 used in the US is produced in Canada. The Missouri University Research Reactor (MURR) is proceeding with an initiative to expand its isotope production capability to include 50% of the US demand for Mo-99. This will require the construction of new hot cells for the separation activities. The problem with the MURR initiative is the disposition of the waste stream from the recovery operations. If DOE agrees to take the waste, the project would likely move forward. However, this would be a change in current business practices where DOE has consciously refrained from subsidizing medical isotope production (except for supplying fuel to MURR). It was interesting that working with DOE was a sore

National Nuclear Security Administration

Helium-3 Issues

Briefing to Kevin Greenaugh

Abdul Dasti, NA-122.3

February 25, 2009

Helium-3 Demand

National Nuclear Security Administration

- **Helium-3** is a stable non-radioactive and light isotope of helium. He-3 is rare on earth but abundant quantities are thought to exist on the moon.
- He-3 can not be manufactured but is produced by the decay of tritium.
- Production is limited by the size of tritium reserve
- Two-thirds of the US inventory accumulated over 40 years has been dispensed in the past 6 years

He-3 demand is much more than production

Applications

National Nuclear Security Administration

- Neutron Detection – Advanced spectroscopic Portals
- Neutron Scattering – SNS (4.4KG)
- Safeguards – SNM assay
- Oil and Gas Exploration - "Well logging"
- Space Research
- Dilution Refrigeration – Cooling to 0.02K

He-3 Neutron Detection

National Nuclear Security Administration

- Portals –NNSA Second Line of Defense Program, NA-256
- Megaports
- Customs and Border Patrols
- Safe Commerce
- Safe Cities
- DoD – SPAWAR, RADIAC, DTRA
- State and Local Enforcement Agencies

He-3 Source of Supply

National Nuclear Security Administration

- Currently DOE and Russia are the only available sources
- Canada (Ontario Power Generation) has a significant quantity but has not previously had any interest in selling it
- SRS gas requires tritium remediation (Spectragases)
- Disposal of contaminated cylinders is also an issue

DOE Auctions

National Nuclear Security Administration

- DOE Auctioned
  - 2003 Dec 97000 liters
  - 2005 May 24000 liters
  - 2006 July 27000 liters
  - 2008 Dec 23000 liters

Helium-3

National Nuclear Security Administration

- SRS is the only facility left after closing of Mound plant for tritium production and recovery.
- He-3 is produced by the decay of tritium
- There is a need for an allocation and distribution System of He-3 resources
- This issue will become more urgent as He-3 supplies shrink

Background

National Nuclear Security Administration

- DP is responsible for production and distribution of He-3
- All He-3 was reserved for the Accelerator Project for tritium production.
- In 1998 due to high cost of Accelerator Project ($19 billions) the production of tritium from He-3 was dropped and all the He-3 was made available for other uses.
- SRS requested funds for upgrading He-3 separation and collection equipments
- DP under a memorandum of understanding allowed Isotopes Sales program to transfer part of sales proceeds to SRS for equipment improvements
- DOE/Sc Office of Isotope Sales has been selling He-3 to highest bidders. (Most recent sale was priced based on bids from prior sales)

Need to review current allocation

- Helium-3 is used for monitoring and detection of radiological materials
- Department of Home Land Security, NNSA, Customs and DoD have been directed to establish an enhanced detection capabilities
- All have been notified by their contractors that contract would not be filled due to short fall of Helium-3

DOE/NNSA He3 Usage Requirements

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
DOE/NNSA Demand										
Detection										
NA-24	12900	6900	6900	6900						
JMOX	6000	0	0	0						
IAEA (non-JMOX)	4700	4700	4700	4700						
US Domestic	2200	2200	2200	2200						
NA-25	4700	7222	17863	21819	19813	12782	10000	8000	2000	
NA-40	1750	1750	1750	1750	1750					
Total - Detection	19350	15872	26513	30469	21563	12782	10000	8000	2000	0
Other DOE uses										
Medical	0	0	0	0						
Scientific	0	0	0	0					78000	
Commercial - oil and gas	0	0	0	0						
Total DOE demand	19350	15872	26513	30469	21563	12782	10000	8000	80000	0
Demand reduction options										
New detection technology	0	722.2	3572.6	6545.7	7925.2	6391	5000	4000	1000	
Reduce He-3 load in portal monitors	940	1444.4	3572.6	4363.8	3962.6	2556.4				
Floating price										
Net Demand	18410	13705.4	19367.8	19559.5	9675.2	3834.6	5000	4000	79000	0
Supply										
Expected DOE allocation	13000	2500	2500	2500	2500	2500	2500	2500	2500	2500
Options										
a. Canada		20000	20000	20000	10000	10000	10000	10000	10000	10000
b. Russia, others	0	0	0	0						
c. Civil tritium production										
Expected DOE allocation	0	8000	8000	8000	3000	3000	3000	3000	3000	3000
Net Supply	13000	10500	10500	10500	5500	5500	5500	5500	5500	5500
Net position	-5410	-3205.4	-8867.8	-9059.5	-4175.2	1665.4	500	1500	-73500	5500

DOE/NNSA He3 Usage Requirements

Notes:											
Cell K16: next traunch of He3 for SNS and upgrade											
Line 22: Linear ramp up of 10%/yr in new technology to 50%											
Line 23: Assume 20% reduction in detector load											

OFFICIAL USE ONLY

DOE-NNSA
Second Line of Defense

National Nuclear Security Administration

Projected ^3He Needs

March 24, 2009

OFFICIAL USE ONLY

May be exempt from public release under the Freedom of Information Act (5 U.S.C. 552), exemption number and category: Exemption 5 – Privileged Information

Department of Energy review required before public release

Name/Org: Matthew Tremonte, NA-25 Date: March 24, 2009

Guidance: None

OFFICIAL USE ONLY

SLD Program Scope and Accomplishments through FY08

National Nuclear Security Administration

Second Line of Defense Program: Enhance radiation detection capabilities of foreign border officials, customs agents, port authorities and affiliated agencies

Core Program:
- Total Scope: 600 Sites
- Completed: 213 Sites
  - Over 950 RPMs
  - Handheld Equipment

Megaports Initiative:
- Total Scope: 100 International Seaports
- Completed: 19 Seaports
  - Over 150 RPMs
  - Spectroscopic Monitors, Straddle Carrier Detectors, and Handheld Equipment

OFFICIAL USE ONLY

National Nuclear Security Administration

Equipment Included in SLD Projections

Radiation Portal Monitors:

- TSA Systems: Pedestrian, Vehicle, Rail, and Skid-Mounted
- Mobile Radiation Detection System (MRDIS)
- Radiation Detection Straddle Carrier (RDSC)
- Spectroscopic Portal Monitors

Handheld Equipment:

- Thermo identiFINDER NGH+ RIID
- TSA PRM 470 CGN Handheld Survey Meter

OFFICIAL USE ONLY

OFFICIAL USE ONLY

National Nuclear Security Administration

SLD Projected ^{3}He Usage

Year	Annual (L)	Cumulative (L)
FY10	4,680	4,680
FY11	6,470	11,150
FY12	18,360	29,510
FY13	24,080	53,600
FY14	18,830	72,430
FY15	6,340	78,770

- Current SLD/NNSA allocation of ^{3}He: 7,130 liters
- Projections for future procurements only; does not include current inventory of equipment
- Excludes procurement of non-US equipment, e.g., Aspect

OFFICIAL USE ONLY

Inter Agency Discussions on the Helium-3 Availability

Domestic Nuclear Detection Office (DNDO)

1125 15th Street, Washington DC

March 24, 2009

Meeting Minutes

Attachments:

(1) Presentation Slides of DHS, DOE Isotope Program, and DOD

(2) Presentation Slides of DOE-NNSA Second Line of Defense

(3) Presentation on Helium-3 Issues - National Nuclear Security Administration NA-122.3

(4) Presentation on Upper Estimates of NA-42 Helium-3 Gas Needs

(5) Attendance Sign-in Sheets

Minutes:

Mr. Gregory Slovik, the Technical Director (TD) for the Product Acquisition Deployment Directive (PADD) DNDO chaired the meeting and welcomed all attendees. Each attendee introduced themselves and identified which organization they represented. Mr. Slovik summarized the purpose and expected outcome of the meeting:

- Recognize the supply of helium-3 (He3) gas is dwindling
- Present each Agency's requirements of He3 gas
- Recognize non-government requirements for He3 gas
- Reach agreement to establish a joint inter agency cooperation to define a path forward

Mr. John Pantaleo, Program Director of the Isotope Development and Production for Research and Isotope Program, Department of Energy (DOE) presented slides on the mission of DOE's Isotope Program, Program Authority, Authority to Allocate resources of materials, services and facilities for National Defense, Network of DOE production Sites, Sales to other federal agencies, and the National Isotope data Center. As a historical perspective DOE has released about 260,000 liters of He3 since 1980.

Mr. Pantaleo continued with his presentation emphasizing the limitations of the He3 gas supply from DOE as well as the various applications: neutron detectors, oil/gas exploration, medical imaging, general research, lasers, and cryogenics. He3 gas is used in the manufacturing of neutron detectors since this material has a high absorption cross section for thermal neutrons which results in a very efficient neutron detector. A list of domestic and international based neutron detector tube manufactures was presented to emphasize the impact the commercial sector may feel based on the Governments decision on how to allocate the gas.

The Isotope Program is expecting to obtain 13 (thirteen) additional cylinders containing ~45,000 liters of He3 by the end of 2009. The Isotope Program was considering releasing 7 (seven) cylinders containing ~25,000 liters in the Fall of 2009 and the remaining 6 (six) cylinders of ~20,000 liters in December 2009. The question for the group to consider was what should be the Government and non-government allocation. Further it was noted that after these releases, DOE will settle into an annual release rate of ~8,000 liters per year into the foreseeable future.

As a potential foreign source of He3, it was mentioned that preliminary discussions with Ontario (Canada) Power regarding the recovery of He3 from tritated heavy water within the CANDU reactor has occurred. However, further discussions with Ontario Power are required to determine the feasibility and the quantity of He3 that could be made available, if any.

Mr. Pantaleo concluded his presentation with the comment that the demand far exceeds the He3 supply from DOE's Isotope Program. The following options were presented for group discussion and consideration for the near term release of He3:

Near Term Release Options:

- Option 1: 7 cylinders (~25,000 liters) purified at Spectra Gases and held for distribution by DOE.
- Option 2: Allocate the 7 cylinders between the Government agencies and the non-government applications.
- Option 3: Auction the 7 cylinders or some portion on the open market and let the market place control the distribution.

One other Option was suggested from the group and was added to the mix:

- Option 4: Retain all 7 cylinders until the distribution of the gas is determined by the working group that will be established.

It was agreed any decision relating to the allocation of the 13 cylinders (~45,000 liters of He3) will be deferred until the Integrated Product Team (IPT), which will be formed by agreement from this meeting, has an opportunity to address the total He3 requirements from all stakeholders.

A list of Long Term Options was also presented for discussion and resolution:

Long Term Release Options/Considerations:

- On the Federal level, establish an Integrated Project Team (IPT) to mange the inter agency coordination
- IPT should discuss how the annual production of 8,000 to 10,000 liters will be allocated
- IPT should address who should lead the investigation into the potential Canadian source
- IPT should be the storehouse of knowledge as we collectively seek alternative technologies for neutron detection
- IPT should encourage, and where possible, facilitate all stakeholders to collectively seek alternative technologies that do not utilize He3

Mr. Slovik presented the He3 requirements for DHS/DNDO for FY09 through FY2015, see the table below. Numerous programs use He3 in their radiation detection devices as well as research projects. The demand for He3 ramps up as new acquisitions are scheduled but begins to drop off as the portal installation projects are completed in FY 2013.

Colonel Julie Bentz, Office of the Deputy Assistant to the Secretary of Defense (OSD) for (Nuclear Matters) presented the He3 requirements for the Department of Defense (DOD). Colonel Bentz identified users of He3 in detection devices as well as in missile guidance technologies. Insufficient time was available to have a complete picture of DOD's total requirement for He3 but Colonel Bentz indicated the requirements should be finalized by 7 April 2009. It was noted that prioritizing the He3 distribution for DOD resides in the Industrial Policy (IP) Office in OSD (AT&L). This office will need to be involved with any policy decision made by the IPT when they work through the many issues. See the table below for the March 24th estimate of DOD's He3 requirements.

Ms. Tracy Mustin, NNSA/NA-25 presented DOE-National Nuclear Security Administration (NNSA) Second Line of Defense (SLD) Projected He3 requirements. The Second Line of Defense (SLD) Program provides enhanced radiation detection capabilities at foreign borders, airports, and seaports to foreign customs agents and other law enforcement agencies, port authorities and affiliated agencies. Ms. Mustin presented SLD's projected He3 gas requirements for FY10 through FY15. SLD currently has enough He3 to last them through FY09 and FY10. NNSA-25's requirements are reflected in the table below.

Mr. Abdul Dasti, NNSA/NA-122.3 presented slides based on NA-122.3 perception of the He3 issue.

Mr. Gerard Garino from the DOE Office for Emergency Response (NA-42) presented their He3 requirements for the next 5 years. Also presented was the fact that NA-42 has a significant quantity of He3 in old tubes which may be recycled and applied against their current requirements. The recycled gas will offset about 25% of their He3 requirements in the same 5 year period. NA-42's requirements are reflected in the table below.

Mr. Slovik (DNDO/PADD) and Mr. Pantaleo (DOE) presented the non-government and international requirements. The end users are varied, but some of the users identified have vital roles in energy, science, and health:

- Oil & Gas Drilling
- Cryogenics
- Medical
- Lasers
- Detectors (i.e., both neutron & other commercial detectors)
- International Homeland Security and International Research
- State and Local Grants for radiation detection equipment

The He3 estimates in the table for non-government requirements generated several comments about the appearance of these values being inflated based on past experience. However, it was stated that these were the figures obtained from several commercial companies, and could go through another scrub, but the over all point was this sector must be considered in the gas allocation plan.

The table below is the accumulation of He3 requirements from the presentations, though incomplete until all agencies submit their final requirements, is a good indication of the He3 demand trend versus available supply from DOE.

Agency Requirements	**FY 09**	**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**
DOE (NNSA-25/NA-42)	---	6,624	8,414	20,304	26,024	20,774	6,340
DOD*	91,590	85,590	85,590	75,900	75,900	75,900	75,900
DHS	16,000	20,000	24,000	34,000	34,079	17,000	5,000
Other Government Agencies	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Non-Government	104,858	81,781	100,293	105,398	55,945	43,916	43,916
Total Agency Requirement	213,448	194,995	219,297	236,602	192,948	158,590	132,156
Total DOE Supply	85,000**	8,000	8,000	8,000	8,000	8,000	8,000

* DOD estimates will not be finalized until April 7, 2009. The gas figures were multiplied by 3 to adjust for He3 estimates provided at 3 atmospheres (see Attachment 1)

** Only 45,000 liters remain to be distributed from the Isotope Program for FY09

Mr. Ernest Muenchau Assistant Director of DNDO for the Product Acquisition Deployment Directive suggested Mr. Slovik serve as the point of contract (POC) and storehouse of information for all matters concerning the He3 for the IPT and all future data on alternative technologies for all Government agencies.

Action Items:

1. Form an over-arching Integrated Product Team (IPT) to address He-3 issues as an inter agency cooperation.
   a. Each Agency nominate a single point of contact (POC) by April 10, 2009 and forward the information to Gregory.slovik@hq.dhs.gov to coordinate the 16 April meeting
   b. Will engage additional agencies as necessary (e.g., National Institute of Health and the Nuclear Regulatory Commission)
   c. First meeting should be held on or about April 16, 2009. Location and meeting time to be determined by the POCs
2. Investigate using DOE's infrastructure in place for producing tritium in commercial reactors to produce extra tritium to decay into He3 as a potential source for future use.
   a. Roger Lewis (DOE/NNSA) will take the lead on this investigation.
3. Investigate whether He3 could be extracted from the Defense Program's reserve stockpile of tritium.
   a. Roger Lewis (DOE/NNSA) will take the lead on this investigation
4. Investigate the potential for obtaining He3 from Ontario Power, Canada, concerning the ability to recover He3 from their storage facilities. Action will be taken up by the IPT.
5. The IPT will arrange a presentation for the State Department and Commerce Department to inform them of the issues related to He3 as well as to discuss restricting unnecessary export of this material. The purpose of the meeting will also be to obtain direction/concurrence on the proper procedure to open discussions on international license agreements and the need to reserve He3 for domestic use. This matter will be addressed by the IPT once formed.
6. IPT should take up the task of looking for significant stock piles of He3 purchased but never used. Also, the IPT should look for discarded or unused neutron detectors to be recycled for the He3 gas.

7. Inform Office of Management and Budget (OMB) of the He3 gas Supply/Demand Issue but only after concurrence from each agency's senior managements.

    a. Defer action until all open issues have been identified and a resolution is available

8. IPT shall become the information warehouse to identify technologies that use alternative materials/resources for neutron detection, which reduces the demand for He3 gas in detectors.

9. The National Academy of Science is addressing He3 and helium-4 issues in a report which is due out this year.

    a. Ms. Joanna Gillo (DOE Isotope Program) volunteered to investigate status of the Report

10. Oak Ridge National Laboratory (ORNL) may have a significant stockpile of He3 from the Spallation Neutron Source project. This potential source should be investigated by the IPT once formed with the immediate recommendation that they conserve and store all He3 not already consumed.

11. The IPT should investigate legally what restrictions/actions can be enacted on the supply of He3.

    a. Should look into the Defense Production Act (DPA), 50 U.S.C. app.2071(a)

    b. The lawyers from the Isotope Program should be the first step in determining the legal alternative based on their familiarity with isotopes

12. Mr. John Pantaleo took an action to review/identify the list of He3 gas customers since 1990 to assist in finding unused stockpiles for He3.

13. The IPT should consider a program which will announce/identify old He3 gas in cylinders or neutron detectors which could be returned to a single point of control to be recycled and the gas extracted from these instruments for future use by the Government.

    a. Potential sources in the Government and Nuclear Reactor Facilities should be considered

    b. Each agency and non-government user should be encouraged to identify old He3 gas cylinders or neutron detectors for recycling

    c. Funding may be required to procure and process this material

14. It was recommended that all agencies complete their requirements for He3 and prioritize their programs internally since we may in the near future be required to prioritize across the Government.

Muenchau, Ernest

From:	Muenchau, Ernest
Sent:	Wednesday, April 01, 2009 3:07 PM
To:	Slovik, Gregory; Rayno, Bruce; Bachkosky, Janice
Cc:	Spear, Alan K
Subject:	RE: Discussing the He3 Priorities before committing it all

Let's all discuss next week

From: Slovik, Gregory [mailto:Gregory.Slovik@dhs.gov]
Sent: Wednesday, April 01, 2009 3:02 PM
To: Muenchau, Ernest; Rayno, Bruce; Bachkosky, Janice
Cc: Slovik, Gregory; Spear, Alan K
Subject: Discussing the He3 Priorities before committing it all

Ernie,

We have about 4,500 liters at Spectra and will be obtaining 8,500 liters more --- for a total of ~13,000 liters. Next year (and the years that follow) I would expect less than 2,000 liters per year from the DOE Isotope Program. Thus, I believe the crisis has begun and we need to think about prioritizing and conserving the He3 gas now. I do not want to run out and then wonder where it went – but would prefer we consciously select its application.

I am concerned that PNNL will write a contract with SAIC (and then LND) to procure so many systems that they use the available He3 gas.

Thus, I would like to discuss with you the concept of maybe directing PNNL to only ordering a few PVT systems at a time until DNDO can made a final decision on the ~13,000 liters we have.

I will stop by to discuss.

Greg

Gregory C. Slovik, P.E., DHSPM
HPRDS Technical Director
Production Acquisition and Deployment Directorate (PADD)
Domestic Nuclear Detection Office (DNDO)

Office: 202-254-7222
BB: 202-746-0373

Helium-3 (He3) Inter Agency Charter
27 April 2009

Charter: The Helium-3 Inter Agency Integrated Product Team (IPT) is being assembled to jointly address the impact of the He3 shortfall on all Government agencies. The IPT will investigate issues, collect data, analyze, and provide recommendations to the Steering Committee who will provide guidance to the IPT as well as a consensus plan of action to the senior management in each Government agency represented. The Steering Committee will use the input from the IPT to provide recommendations to the DOE concerning the appropriate distribution of the ${}^{3}_{2}He$ gas (i.e., the Isotope Program) as well as other associated activities, e.g., new ${}^{3}_{2}He$ sources, recycling old unused systems, policy, and export issues which may be executed by DOE/NNSA.

Mission: The Helium-3 Inter Agency Integrated Product Team (IPT) is being assembled to jointly address the shortfall impact of ${}^{3}_{2}He$ on all Government agencies. IPT will form four working groups: Supply, Demand, Technology, and Policy. These working groups will provide the needed information for the IPT Chair to provide information to the Steering Committee so a consensus among the represented Government agencies can be developed and presented to senior management in each Government agency represented. See Figure 1.

Purpose/Goal:

- Develop consensus on future distributions of ${}^{3}_{2}He$ gas between Government agencies and non-government applications
- Ensure He3 gas demand and priorities across the Government are identified and then provided with the appropriate levels of ${}^{3}_{2}He$ gas to execute critical missions
- Industry and Government agencies are informed of the future ${}^{3}_{2}He$ supply and plan accordingly to reduce dependence
- Collaborate on identifying and investigating potential new sources of ${}^{3}_{2}He$ gas from foreign sources, recycling old detectors, finding unused stockpiles, and new technologies to extract a higher yield of ${}^{3}_{2}He$ from current storage beds. This information, passed through the Steering Committee, will be provided to the DOE Isotope Program or DOE/NNSA to find the funding and set up a program to execute.
- Collaborate on establishing a Government wide consensus on ${}^{3}_{2}He$ Usage Policy
- Develop a shared list of technologies that could replace ${}^{3}_{2}He$ based neutron detectors as well as a running status of active programs in each Government agency that may be a potential alternative to using ${}^{3}_{2}He$ based neutron detectors
- IPT shall provide the Steering Committee with information, support, and reports needed to interact with senior management in the Government agencies to provide recommendations to the DOE Isotope Program and DOE/NNSA to control and accumulate a stock pile of ${}^{3}_{2}He$ for Government and non-government mission critical programs
- IPT will take on other tasks related to ${}^{3}_{2}He$ supply, demand, technology, or policy as needed to pursue closure of this issue

DRAFT

Helium-3 Technology Working Group Charter
27 April 2009

Charter: Investigate technologies that could be proposed as alternatives to $^{3}_{2}He$ based neutron detectors and disseminate the information to all Government agencies. The list of alternative technologies being pursued to replace He3 based neutron detectors across the Government will need to be documented and forwarded to the IPT Chair to be integrated and then passed to the Steering Committee for their consideration and dissemination.

Mission: Coordinate with each Government agency to investigate any activity in pursuit of an alternative to $^{3}_{2}He$ based neutron detectors. Develop a list of programs by Government agency that describes the technological approach, pros and cons of each technology, status of the program, and any test results. This information will be made available to all Government agencies to ensure each is aware of the most promising alternatives as soon as possible.

Purpose/Goal:	Completion:
1. Solicit input from Government agencies to identify programs Investigating alternatives to $^{3}_{2}He$ based neutron detection	Sept 09
2. Provide a status of all Government programs investigating alternative Technologies (and update bi-monthly)	July 09
3. Provide Test Campaign Reports as made available from each Government agency	On-going
4. Identify and recommend promising alternative technologies to the Steering Committee	On-going
5. Working Group will take on other tasks related to $^{3}_{2}He$ technology as needed to pursue closure of this issue	

Period of performance: One year from formation and can be renewed as needed.

IPT members:

Mr. Gregory Slovik – chair	PADD/DNDO	202-254-7222
Ms. Joanna Ingraham co-chair	DTRA	703-767-2372
TBD		

Period of performance: One year from formation and can be renewed as needed.

Steering Committee members include:

Hon. Steve Aoki	Deputy Under Secretary for Counterterrorism - DOE	202-586-1734
Mr. Ernie Muenchau	PADD/DNDO	202-254-7618
Col Julie Bentz	DOD	703-687-1124

IPT members include:

Mr. Gregory Slovik - chair	PADD/DNDO	202-254-7222
Mr. Alan Spear	PADD/SETA	202-254-7260

The Four Working Group leads and deputies are:

Supply	Roger Lewis (Lead)	DOE/NNSA	
	Greg Slovik (Deputy)	PADD/DNDO	202-254-7222
Demand	John Pantaleo (Lead)	DOE Isotope Program	301-903-2525
	Abdul Daski (Deputy)	DOE/NNSA	
Technology	Greg Slovik (Lead)	PADD/DNDO	202-254-7222
	Joanna Ingraham (Deputy)	DTRA	703-767-2372
Policy	Joe Glaser (Lead)	DOE/NNSA	202-585-2648
	John Pantaleo (Deputy)	DOE Isotope Program	301-903-2525

DRAFT

Helium-3 Supply Working Group Charter
27 April 2009

Charter: Investigate and analyze potential sources of $^{3}_{2}He$ to assist the DOE/NNSA in finding increased amounts of $^{3}_{2}He$ gas for distribution in the future. Each investigated and analyzed source will need to be documented and forwarded to the IPT Chair to be passed on to the Steering Committee for their consideration and action.

Mission: Investigate a potential source of $^{3}_{2}He$ from the Ontario Power company in Canada (and all other CANDU reactor types if this source is determined to be viable), recycling programs to recover $^{3}_{2}He$ gas from old detectors, unused stockpiles of $^{3}_{2}He$ gas, and technology to increase $^{3}_{2}He$ collection from stockpiles. Each investigated source will need to have independent government cost estimates for implementing the program.

Purpose/Goal:	Completion:
1. Evaluate the proposed Canadian source of $^{3}_{2}He$	TBD
2. Investigate a project to recycled $^{3}_{2}He$ gas from old detectors	TBD
3. Investigate technologies to increase $^{3}_{2}He$ collection	TBD
4. Investigate unused stockpiles of $^{3}_{2}He$	TBD
5. Investigate using DOE's infrastructure to produce extra tritium	TBD
6. Investigate if $^{3}_{2}He$ can be extracted from DP reserves	TBD
7. Working Group will take on other tasks related to $^{3}_{2}He$ supply as needed to pursue closure of this issue	

Period of performance: One year from formation and can be renewed as needed.

IPT members:

Mr. Roger Lewis- chair	NNSA-DOE	202-586-6864
Mr. Greg Slovik – co-chair	PADD/DNDO	202-254-7222
TBD		

Inter Agency Discussions on the Helium-3 Availability

Domestic Nuclear Detection Office (DNDO)

1125 15th Street, Washington DC

May 6, 2009

Meeting Minutes

Attachments:

(1) May 6th 2009 Agenda

(2) Attendance Sign-in Sheet

(3) The following documents were handed-out for review and comment:

a. ^{3}He Inter Agency IPT Charter

b. ^{3}He Inter Agency Steering Committee Charter

c. Supply Working Group Decision Paper

d. ^{3}He Supply Working Group Charter

e. ^{3}He Demand Working Group Charter

f. ^{3}He Technology Working Group Charter

g. ^{3}He Policy Working Group Charter

Minutes:

Mr. Gregory Slovik (chair) convened the ^{3}He Inter Agency Integrated Product Team (IPT) meeting and welcomed all attendees. Each attendee was requested to introduced themselves and identify which organization they represented. Mr. Slovik provided an over view of the Agenda and summarized the purpose and expected outcome of the meeting:

- Review the Charters for the following: ^{3}He Inter Agency IPT, Inter Agency Steering Committee, Supply Working Group, Demand Working Group, Technology Working Group and Policy Working Group
- Review the Supply Working Group Decision Paper (Ontario Power ^{3}He Harvesting)

- Discuss the He3 Export Issues
- Stakeholders identify and address new topics as appropriate

The IPT Chair requested further comments on the Charters that were distributed at the meeting (previously provided via e-mail). Comments provided on the Working Group's Charters should be adjudicated by the individual Working Group Leads. Discussions concerning Team membership were raised. It was decided to have the Charters reflect the Lead and Co-Lead names identified and participating Organizations (no individual names) identified. The intent was to reduce the number of revisions on a Charter when people are added or removed from active membership of a particular Working Group. Leads should maintain a listing of active participants and their respective organizations as well as contact information for communication purposes.

The IPT Chair requested concurrence on the IPT's membership i.e. Leads for each of the Working Groups will serve on the IPT as co-leads. The members agreed and the Working Group leads will serve as co-leads on the IPT.

The IPT was informed that Col Julie Bentz (OSD-NM) is being re-assigned to the White House and will require a replacement on the Steering Committee. The IPT will still have access to the Colonel for consultation, if they require assistance.

The IPT Chair requested clarification on the relationship between DOE and NNSA. After several minutes, it was stated they should be considered as "one group" with different missions. The Honorable Steven Aoki, who serves on the Steering Committee, will thus be representing DOE/NNSA.

It was noted that the Science Foundation has a significant demand for ^{3}He. The Foundation has been very proactive in pursuing a Neutron Imaging System, using an alternative technology which they claim is more sensitive than ^{3}He. It was further stated that they have a significant amount of unused ^{3}He which we may be able to acquire. The Supply Working Group will investigate the feasibility of obtaining access to this material.

Discussions were held concerning the need to expand the attendance of other Agencies at the IPT's meetings. These included the State Department, National Institute of Health (NIH), the Commerce Department, and the Nuclear Regulatory Commission (NRC). It was the consensus of the members that it would be more effective if the Agenda identified a specific need for additional Agencies to attend and then a special invite would be afforded them. Not all meetings have topics relating to their expertise and they may become uninterested in further attendance.

The Demand Working Group (WG) Charter was discussed. Mr. John Pantaleo serves as the lead for this WG. Summaries from each of the Agencies require refinement and prioritization. The Completion Date as identified on the "Draft" WG Charter was revised from 6/30 to 6/07. Mr. Slovik informed the IPT, that DNDO is finalizing their ^{3}He requirements.

He noted that the format could serve as a template. Values for ^{3}He gas will be in Standard Temperature and Pressure (STP) and specified as liters of purified gas.

The Supply WG Charter was discussed by Mr. Roger Lewis who is the lead for this WG. A "draft" Supply Working Group Decision Paper for endorsement by the IPT and action by the Steering Committee to explore the opportunity of acquiring Ontario Power's (OP) ^{3}He in-situ in Canada was presented.

The Technology WG Charter was discussed. Mr. Gregory Slovik serves as the lead for this WG. Considerable discussions centered upon the need to inform Governmental Agencies as well as Industry on the ^{3}He Supply Issue. Various Official Notification venues were suggested including Industry Day, Fed-Business, Pier Reviews, Symposiums and Workshops etc.

Mr. Lee Hamilton (DOE/NNSA) informed the IPT of an impending Helium-3 and Alternative Neutron Detection Technologies Workshop Hosted by the Savannah River National Laboratory on behalf of the NNSA Network of Senior Scientists and Engineers (NSSE) being held June 16 & 17 at the UGA SREL Conference Center in New Ellenton, SC. The 18th of June, the Workshop will coordinate a site visit to Savannah River National Laboratory with an open invitation to the ^{3}He IPT. The Workshop is non-classified, while the site survey will be classified and will be kept to a minimal security classification. Mr. Hamilton will forward the Workshop Announcement to the IPT for adding topics relating to our desire to identify alternative technologies to ^{3}He Neutron Detection Systems. Subsequent to the IPT meeting, on 7 May 2009 the Workshop Announcement was forward to the IPT membership for review and comment.

Dr. Joanna Ingraham announced the upcoming 2009 IEEE Nuclear Science Symposium and Medical Imaging Conference being held October 25-31. Joanna solicited inputs from the members for topics relating to ^{3}He and she would discuss with the Symposium Committee to incorporate our Topics. Subsequent to the IPT meeting, on 7 May 2009 the IEEE Symposium Conference Announcement was forwarded to the IPT membership for review and comment.

The Policy WG Charter was discussed. Mr. Joe Glaser serves as the Lead for the Policy WG. Joe identified several Questions/Actions resulting from the Steering Committees Meeting from the previous day.

- The Demand Requirements and Supply Allocations need to be finalized within the next few weeks.
- The Commercial Users Requirement for ^{3}He need to be scrutinized and articulated to ensure there is no duplication.
- Identify Emerging Technologies that may be fielded quickly (within 2 years) and identify risks associated with each alternative.
- Should the ^{3}He Commercial Users take the OP ^{3}He Harvesting Supply Operation vice US Government to Canadian Government Agreements?
- Need to expedite the review of the Export Policy of ^{3}He and identify any proposed changes.
- Should the IPT make a commitment to supply ^{3}He to non-government users?

Ms. Deborah Hanchar addressed the Commerce Department's agreement (February 16th 2009) to send 10K liters of ^{3}He to China. Approximately 2.5K liters of ^{3}He have been shipped to China. Subsequent deliveries are still pending. To stop the flow of ^{3}He gas to China will require several actions (which have a short fuse):

- Arrange a meeting with the Commerce Department informing them of the ^{3}He Supply Issue (Background Information and "Why" this is vital to our Nation's Security). Requested guidance on what is required to mitigate/stop transfer of the additional 7.5K liters of ^{3}He to China?
- Create a Decision Paper for Steering Committee's action which must be addressed at the Under Secretary's level i.e. Sec. M. Borman.

The next ^{3}He Inter Agency IPT meeting will be held 4 June 2009. Location: TBD

Action Items:

1. Mr. Slovik will supply DNDO draft ^{3}He requirement which reflects the total need for each program and provides further granularity to show types of systems and then ranks each program for prioritizing. It is expected to be released by May 27 via e-mail.

2. Mr. Roger Lewis will update the Supply Working Group Decision Paper for completeness and return for the IPT's endorsement before forwarding on to the Steering Committee for action.

3. Agencies nominate System Matter Experts (SME) to participate in the OP's Technical Discussions and Briefings and forward their names to Mr. Roger Lewis. Goal is to keep the team to those who have a vital role in the briefings.

4. Mr. Joe Glaser (Policy WG Lead) and Mr. John Pantaleo (Supply WG Lead) took the action to discuss with the Commerce Department (Short Supplies) and have them do the announcement.

Domestic Nuclear Detection Office (DNDO)

Quarterly Program Review

Helium-3 (^{3}He) Project
28 May 2009

Gregory Slovik, P.E.
Program Manager
Production Acquisition & Deployment Directorate (PADD)
Domestic Nuclear Detection Office (DNDO)

For Official Use Only

Agenda

- ^{3}He Mission and Goal Statements
- Background of ^{3}He
- ^{3}He Demand
- ^{3}He Inter Agency IPT
- Project's Organization Structure
- Test Campaign
- Budget and Contract Action Status
- Risk Management
- Issues for Management

^3He Project Mission and Goals

– Mission:
  - In light of the ^3He shortage, work within the Government complex to articulate the ^3He requirements needed for neutron detection to ensure the ^3He resources are used appropriately
  - Work within the Government complex to ensure DHS/DNDO obtains a reasonable portion of the available ^3He resources for FY09 and the out years
  - Investigate commercially available ^3He alternatives as well as near (~2 years) and far (~4 years) term research efforts across the Government to keep DNDO informed

– Goal:
  - Acquire an allotment of available ^3He Gas for DNDO for FY09
  - Chair the ^3He Inter Agency IPT to define the requirements for each Government Agency, investigate potential ^3He supplies, investigate current and upcoming alternative technologies, and facilitate a new Policy that address ^3He use for neutron detection
  - Work with TARD and SEED to investigate upcoming ^3He alternative technologies and facilitate test campaigns to evaluate their performance
  - Initiate a test campaign for characterization of possible ^3He alternative technologies for portal monitors
  - Facilitate information flow on ^3He issues and mange DNDO's allotment of ^3He when provided

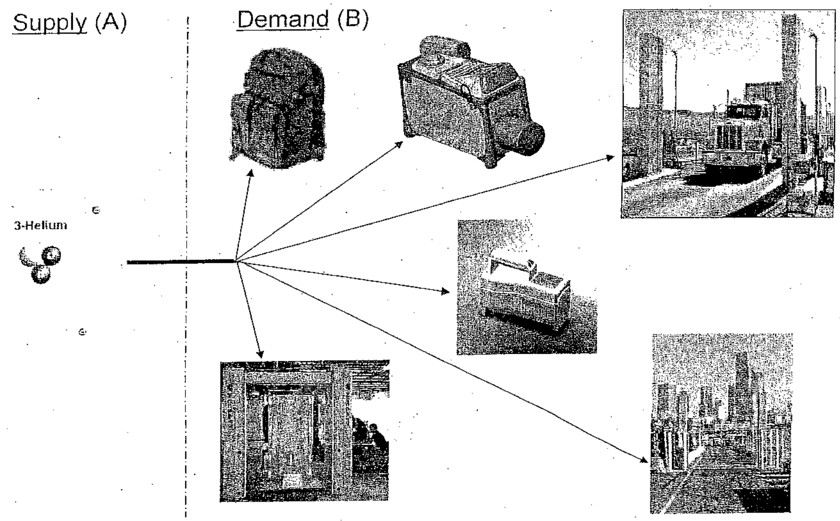
^{3}He Origins and Characteristics

- ^{3}He is a byproduct from decay of tritium produced for the US nuclear weapons program
  - Tritium decays to ^{3}He with a 12.4 yr half life
- ^{3}He Characteristics:
  - Most efficient material known for neutron detection
  - Inert and non-radioactive gas (0.00014% of all He gas)
  - Large cross section to absorb thermal neutrons
    - Absorption provides an energy signal that alerts the presence of neutrons, such as those from uranium and plutonium
    - Non-reactive/non-corrosive nature of the gas provides a long lasting, high intrinsic efficiency detector with few false positives (i.e., high gamma rejection)
- Other Applications include:
  - Medical research
  - Oil/gas exploration
  - Lasers
  - Missile guidance gyros
  - Cryogenics

Homeland Security

FOR OFFICIAL USE ONLY

Supply and Demand for ^3He



Homeland Security

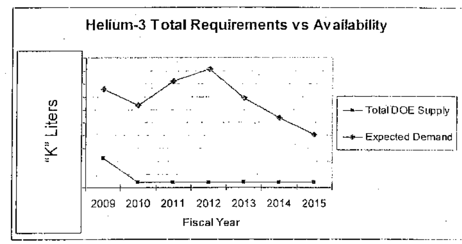
FOR OFFICIAL USE ONLY

What do We Know and When Did We Know It?

- DNDO alerted in Nov 2008 of the ^3He shortage issue
- **In the past Domestic and International demand has been met through the DOE Isotope Program and a limited supply from Russia.**
  - DOE has released 260,000 liters since 1980
  - Russia satisfies their domestic requirements and then release – this is expected to be high risk supplier
- United Kingdom asked US to ensure a supply available for them
  - Through NucSAFE equipment, UK has received ~5,800 liters this year
  - There are other foreign countries that relay on the US for ^3He either as a gas or within procured detectors
- China is importing from the US 10,000 liters this year

^{3}He Demand Across all the Stakeholders

- Demand for ^{3}He continues to Increase for the foreseeable future
  - FY09 Requirements – DOE, DOD, DHS, Other Gov't and Non-Gov't (Requirements are still being developed)
    - ~150,000 Liters
  - FY09 Requirements for DHS Alone
    - 16,000 Liters
- Projected supply of ^{3}He from DOE in FY09 is ~60,000 Liters
- DOE Isotope Program has not clarified the supply availability resulting in most switching to ^{3}He



Total expected Government and Non-Governmental requirements for ^{3}He

Homeland Security

FY08 & FY09 DNDO ^{3}He Allotment

- Dec 2008 DOE Isotope Program sold Spectra Gas 10,500 liters with restriction that 70% be provided to National Security (i.e., DHS and DOD programs)
  - After purification and proportioning the 70%, 7,129 liters were available
  - DOD has used 2600 liters to date
  - DHS plans to use 4,529 liters remaining on PVT Program
- DHS is in the process of procuring 8,763 liters of raw ^{3}He that will be purified into 8,500 liters of ^{3}He gas and dispersed as GFP
- DHS Total potential supply of ^{3}He is (4,529 + 8,500 =) 13,029 liters
- DHS expected shortfall for ^{3}He in FY09 is ~3,000 liters
  - – Assumes DNDO keeps all the material currently procuring (i.e., the Steering Committee has the authority to re-allocate)

DNDO ^3He Demands for FY09 thru FY13

Programs	PRI	FY09	FY10	FY11	FY12	FY13
HPRDS	#	0	25	250	250	250
ASP (Raytheon/Thermo)	#	6562	17036.48	17910.04	19629.84	18045.04
WCMP	#	614.7	454.79	626.87	626.87	627.325
MDDP	#	573.9	492.14	492.14	492.14	492.14
Grants	#	552.1	703.98	1337.88	1413.84	1489.8
VIPR	#	204	0	204	204	204
PVT	#	5860.8	3818.4	2353.2	2442	1998
RAIL	#	0	0	0	3335	3335
Airports	#	222	222	222	222	222
C&BP	#	259.5	242	276	175	175
USCG	#	398.06	403.58	398.06	398.06	0
STC	#	1037.968	0	0	0	0
Total-He3 liters		16285.028	23398.37	24070.19	29188.75	26838.305

Homeland Security

^3He Demand by Program and Devices

FOR OFFICIAL USE ONLY

^{3}He Inter Agency Integrated Product Team

– IPT Mission: The Helium-3 Inter Agency Integrated Product Team (IPT) is being assembled to jointly address the shortfall impact of ^{3}He on all Government agencies. IPT will form four working groups: Supply, Demand, Technology, and Policy. These working groups will provide the needed information for the IPT Chair to provide information to the Steering Committee so a consensus among the represented Government agencies can be developed and presented to senior management in each Government agency represented.

– Structure of the IPT comprised of:
- Supply Working Group
- Demand Working Group
- Technology Working Group
- Policy Working Group
- Steering Committee

Helium-3 Inter Agency
Integrated Product Team Diagram

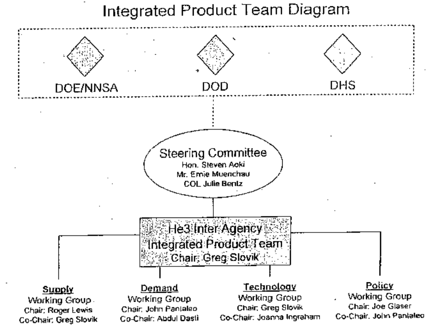


Figure 1

Homeland Security

FOR OFFICIAL USE ONLY

^3He Inter Agency Integrated Product Team

- Supply Working Group:
  - Investigate a potential source of ^3He from the Ontario Power company in Canada (and all other CANDU reactor types if this source is determined to be viable), recycling programs to recover ^3He gas from old detectors, unused stockpiles of ^3He gas, and technology to increase ^3He collection from stockpiles. Each investigated source will need to have independent government cost estimates for implementing the program.
- Technology Working Group:
  - Coordinate with each Government agency to investigate any activity in pursuit of an alternative to ^3He based neutron detectors. Develop a list of programs by Government agency that describes the technological approach, pros and cons of each technology, status of the program, and any test results. This information will be made available to all Government agencies to ensure each is aware of the most promising alternatives as soon as possible.
- Demand Working Group:
  - Obtain from with each Government agency current and future (5 years) requirements of their ^3He needs and ranked in priority order (critical and moderate) for distribution within their agency. Also, ascertain the non-government uses of ^3He gas and analyze past purchases to understand the nature of the applications e.g. medical, oil and gas, etc and the potential growth. The non-government uses of ^3He should also include investigating foreign unilateral/bilateral agreements with the United States to develop rad/nuc screening programs. Each agency should provide any existing inventory held in for their use thus to avoid double accounting. This working group should provide the weighting or proposed ^3He allocations based on each entity's priorities.
- Policy Working Group:
  - The Policy working group will investigate the legal authority available to restrict the use of ^3He as well as the future disposition of ^3He within domestic and international programs. The Policy working group will also meet with the Commerce Department to develop a position on export restrictions for ^3He, if any.

Inter Agency IPT Working Group's Missions

Homeland Security

FOR OFFICIAL USE ONLY

^{3}He Inter Agency Integrated Product Team

- The Steering Committee Membership Includes: DHS, DOE/NNSA, and DOD
  - Will provide guidance to the IPT on the data/information needed to develop the full situation related to ^{3}He demand, supply, technology, policy, and ultimate distribution.
  - Will be the interface to senior levels of Government to present a consensus recommendation and acceptance for any follow-on action.
  - The Steering Committee will be comprised of senior management representing DOE/NNSA, DOD and DHS.
- Steering Committee will review the demand requirements from each Government Agency and determine the overall allocation
  - Input will be provide from the IPT Chair from the Demand Working Group
  - DNDO's actual allocation will be established after this decision

Project's Organizational Structure

- Project Team
  - Ernest Muenchau — AD
  - Gregory Slovik — PM
  - Alan Spear — PADD/SETA
  - Margo Graves — Contracting Officer
  - Lead Test Eng — Walt Dickey
  - Test Scientist — Dr. John Blackadar
  - B & F Lead — Don Jillson
- Stakeholders
  - United States Coast Guard (USCG)
  - Transportation Security Administration (TSA)
  - Customs & Border Patrol (CBP)
  - ASP, PVT, Rail, Airports, HPRDS, VIPR
  - Grants & STC

Market Research Test Campaign

- A Milestone 0 was conducted on May 18th
- SEED estimates ~$1.8M needed to conduct the test campaign
- A Neutron Detection Market Research Test Campaign is being scheduled for Dec 2009
  - RPMP and ASP are predicted to use over 80% of DNDO's ^{3}He gas over the next few years.
  - One could argue ^{3}He should be saved for human portable systems such as handheld isotope identification detectors and backpacks which need lightweight, compact, high gamma rejection ratio, and efficient neutron detectors
  - RPMP program will not be able to procure portal monitors with ^{3}He neutron detectors after September 09
  - DNDO will be able to provide technical guidance to other Government agencies on possible alternatives for neutron detection in a timely manner

Test Campaign Purpose & Objective

- **Purpose: Identify a near term solution for an alternative neutron detector not based on ^{3}He for RPMP and ASP**
- **Test Objective: Establish and evaluate a performance baseline of neutron detectors against Pu guidance:**
  - Establish a comparative test against a RPMP ^{3}He detector as a technical baseline with reassessment against Pu guidance
  - Characterize neutron detector's inherent efficiency, required moderator thickness, sensitivity, response/dead time, environmental performance, and gamma rejection
  - Asses technical readiness of COTS neutron detectors

Test Campaign Schedule

Tasks:	Proposed Start Date:
Assign Team Membership	June 2009
Contract with LANL, BNL & ORNL	July 2009
Procure Systems to assess	September 2009
Test Plans & Procedures	September 2009
Analysis Plan	September 2009
Execute Market Research Test Campaign	December 2009
Review Draft Test and Analysis Reports	February 2010
Issue Final Reports	March 2010

Budget and Current Contract Action Status

Project	Estimate Cost	Task Description	Status	Contract Placement Date
DOE Isotope Program	$751,055	Procure 8,763 liters of ^3He, Shipping, Handling, and Packaging of gas	In Negotiation between OPO and DOE	5 June 2009
Spectra	$496,400	Purification, Storage, Loading & Shipping Canisters, monthly reporting on GFP balance	In Negotiation between OPO and Spectra	5 June 2009
Test Campaign	$1.8M	Market Research Test Campaign	Milestone 0 completed	July 09
Total Budget	**$3,047,455**			

Homeland Security

Technical (T) Risk Management

ID	P	Impact	Technical
T1	L	M	Definition of the Interface connection so any replacement system could be a direct use
T2	L	M	Neutron Detection Algorithm modification needed to use any alternate technology detector

Programmatic (P) Risk Management

ID	P	Impact	Programmatic
P1	M	H	Lack of He3 available for all FY09 DNDO programs
P2	M	M	Program He3 Priorities not based on criteria from the Architectural Directorate to ensure the higher priorities are being addressed with the Global Nuclear Detection Architecture
P3	M	M	Ensure DNDO Directorates modify their procurement contracts to accept GFP He3 gas
P4	M	H	Test Campaign completion and test data not available for a timely analysis
P5	M	M	S&L Contracts modified to accept He3 GFP from the Federal Government

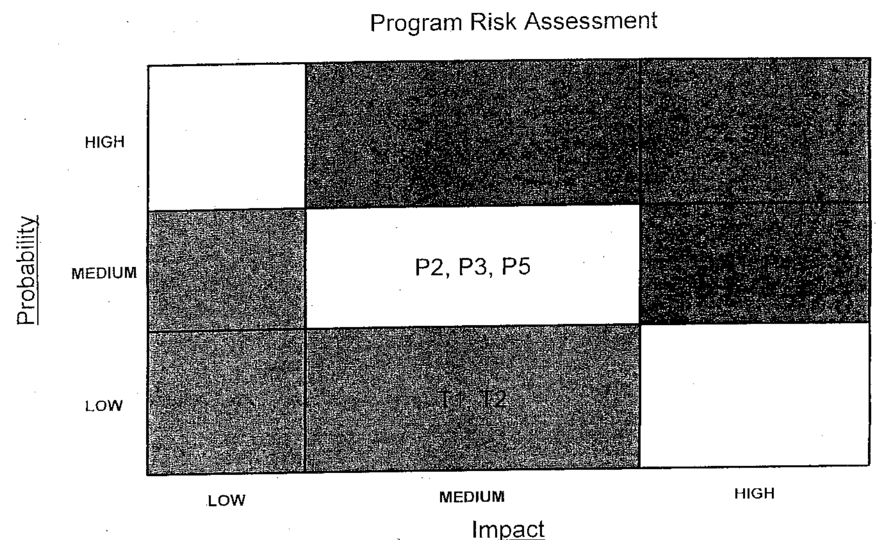
Homeland Security

FOR OFFICIAL USE ONLY

Schedule (S) Risk Management

ID	P	Impact	Schedule
S1	H	H	Alternative Technologies not found quickly enough to save the bulk of the gas for handheld and backpack systems

Program Risk Assessment Chart



Homeland Security

FOR OFFICIAL USE ONLY

Risk Mitigation Plan

No.	ID	Description	Open Date	Owner	Risk Trigger	Mitigation Plan
1	[redacted]	Lack of ^3He available for all FY09 DNDO programs	Apr-09	G Slovik	July Steering Committee results	Form an ^3He Inter Agency IPT to ensure DNDO requirements are known and addressed
2	P2	Program ^3He Priorities not based on criteria from the Architecture Directorate to ensure the higher risk priorities are being addressed with the Global Nuclear Detection Architecture	May-09	G Slovik	Completion of the DNDO demands list	Work within PADD to obtain approval to allow AD to review the list and provide their opinion on the program priorities relative to the Architectural Risk
3	P3	Ensure DNDO Directorates modify their procurement contracts to be able to use GFP ^3He gas	Jun-09	G Slovik	When He3 quantities are requested	Have internal DNDO meetings to ensure the information is known by all
4	[redacted]	Test Campaign completion and test data not available for a timely analysis	Jul-09	G Slovik		Work with the Test Director and Test Scientist to move the program along as quickly as possible
5	P5	S&L Contracts modified to accept ^3He GFP from the Federal Government	Aug-09	G Slovik		Conduct internal DNDO meetings to ensure the information is known by all involved
6	[redacted]	Alternative Technologies not found quickly enough to save the bulk of the gas for handheld and backpack systems	Sep-09	G Slovik		Work with TARD to keep an overview of upcoming research projects as well as to keep an open channel with the Research division of DTRA and other Government Agencies
7	[redacted]	Definition of the interface connections (mechanical/electrical) so any replacement system could be a direct use	9-May	G Slovik	Initiation of the test campaign	Obtain the interface information from the vendors where alterative systems are being considered
8	[redacted]	Neutron detection algorithm modification needed to use any alternate technology detector	10-May	G Slovik	Initiation of the test campaign	Work with vendors and test scientist to ensure the algorithm aspects are being addressed in real time if possible

Issues for Management

- DOE Isotope Program rejected DNDO's request to take back the three canisters the ^3T contaminated ^3He gas was shipped to Spectra Gas
  - Request discussions with DOE senior levels to resolve
  - If DNDO disposes the canisters, the funding is not currently in the budget (estimated ~$20k)
- Recommend DNDO schedule a test campaign for alternative neutron detection systems like the NucSafe Guardian or the Berthold 6414
  - DNDO Programs need data to redefine recommended equipment lists (i.e., VIPR, S&L, STC,..)
- Recommend a rapid review by the Architecture Directorate of the ^3He gas priorities relative to the Global Nuclear Detection Architecture
  - Recommended for DNDO program/equipment and across the Government programs
- Increased funding (~$700K) needed:
  - Analyze Pu Guidance as a function of fast/thermal flux levels, distance, and time (~$150k)
  - National Lab set up test system electronics or Vendors (~$150k)
  - Procure and assemble systems not offered in the response to the RFI (~$150k)
  - Travel Funds needed (~$35k)
  - Funding for Ontario Power's Assessment of ^3He harvesting potential (~$200k)
- RDO funds may be needed rather than the current ACQ funds put aside for this effort ($1.8M)

Homeland Security

U.S. DEPARTMENT OF HOMELAND SECURITY

FOR OFFICIAL USE ONLY

The ^{3}Helium supply crisis and alternative techniques to ^{3}Helium based neutron detectors for neutron scattering applications

Report on the meeting of detector experts held at FRM II on July 7-8, 2009

August 10th, 2009

A group of detector experts representing most of the major neutron scattering facilities and a research group has formed and met on July 7-8 at FRM-II to illuminate the consequences of the present ^{3}Helium supply problem for building future neutron detectors and to discuss about possible alternative techniques. The experts involved are:

Ron Cooper (SNS)
Debbie Greenfield (STFC)
Nigel Rhodes (STFC)
R. Engels* (JCNS)
Karl Zeitelhack (FRM II)
Bruno Guerard (ILL)
Günter Kemmerling (JCNS)
Oleg Kiselev (PSI)
G. Smith* (BNL)
Kazuhiko Soyama (J-Parc)
Thomas Wilpert (HZ Berlin)
Martin Klein (Univ. Heidelberg)
Ilario Defendi (FRM II)

** not attending the meeting*

^{3}Helium production and supply

^{3}Helium is a by product of Tritium production for use in nuclear weapons. Tritium decays by a radioactive ß-decay into ^{3}Helium with a half life of 12.3 years. It is collected in the occasional tritium cleaning process of stores of tritium. Only the US and Russia are presently providing significant amounts of ^{3}Helium. With the end of the Cold War the ^{3}Helium production from Tritium decay has been reduced significantly. However, since September 2001 the demand of ^{3}Helium has increased drastically due to security programs launched in the US and other countries. This has led to a severe depletion of the existing ^{3}Helium stockpile and caused the present shortage of ^{3}Helium.
In the US ^{3}Helium from Tritium production was available to commercial entities through an auction carried out by the Department of Energy (DOE) Isotope Program. Over the past several years about 60 kliter/y were provided by the Isotope Program. In early 2009 about 35 kliter were released by the Isotope Program about half of the quantity being restricted to US security applications, but due to the depleted stock pile the projected release in the period 2009 – 2014 is only 85 kliter in total[1]. For comparison, the projected demand for US security applications in the same period is about 100 kliter.

In Russia ^{3}Helium is produced in a single factory partially owned by the Department of Defense. It is estimated Russia will not supply any ^{3}Helium in 2009 until late in the year and only supply about 10 kliter. The present yearly production is estimated to 6-10 kliter[2]. ^{3}Helium from Russia was available via Spectra Gases and Chemgaz. Starting in 2010 Russia seems to be reorganising the commercialisation of ^{3}Helium by involving Russian companies (Isotop, Tenex). The future procedure of access to Russian Helium is presently unclear.

Canada has a potential stock of ^{3}Helium due to the Tritium production in its CANDU heavy water reactors owned by Ontario Power Generation. The Tritium is regularly separated from the heavy water and stored in Ti_3H_3 beds were it decays into ^{3}Helium. The present ^{3}Helium stock pile is estimated at 80 kliter and the steady state production to several kliter/year[3]. Although there are no actual plans for separation at Ontario Power Generation several interested organisations (DOE, the Japanese Government, GE Reuter Stokes) seem to be looking into this.
In summary, in the short term ^{3}Helium is only available from the US and Russia and the global amount available in the period 2009 – 2014 is about 20 kliter/year.

[1] RL Kouzes, PNNL-18388
[2] S. Ioffe, priv. communication
[3] RL Kouzes, PNNL-18388

karl.zeitelhack@frm2.tum.de

^{3}Helium demands for detectors in neutron scattering applications

With the upcoming new Spallation Sources (SNS, J-Parc, CSNS) and numerous projects for new instruments or upgrades at existing neutron scattering facilities the demand of ^{3}Helium for neutron detectors has significantly increased. The projected ^{3}Helium demand for neutron detectors at the major facilities in the period 2009 -2015 is shown in summary in table 1, while the specific demand at each facility is listed in more detail in Appendix A.

Facility	**Maintenance & research**	**New small detectors**	**New large detectors**
	[liter / year]	[liter]	[liter]
ORNL (SNS)	100	1,300	17,100
ORNL (HFIR)	100	1,210	1,060
Los Alamos	100	1,994	12,362
NIST	100	560	
BNL	50	180	
FRM II	100	650	4,500
HZ Berlin	100	520	7,850
ILL	100	1,000	3,000
JCNS	40	15	7,200
LLB	50	600	600
PSI	50		2,000
STFC	100	400	11,300
J-PARC	100	40	16,100
JRR-3	31	71	
KAERI*	150		2,000
CSNS*	200		21,000
Sum	**1,431**	**8,540**	**106,072**

Table 1: Projected demand of ^{3}Helium for neutron detectors at neutron scattering facilities in the period 2009 – 2015. (Estimation)*

The demand has been divided in three sections. Section *Maintenance and Research* covers the annual demand of ^{3}Helium for refurbishment or replacement of existing detectors and the demand for research on new ^{3}Helium based detector techniques. Section *New small detectors* covers the demand for building new small area detectors (MWPCs, MSGCs or small arrays of PSDs) e.g. used for Reflectometers, Diffractometers or SANS instruments. Section *New large detectors* covers the demand for detector arrays covering large areas e.g. for inelastic scattering instruments or powder Diffractometers.

In total, the projected demand of ^{3}Helium amounts to about 125 kliter in the period 2009-2015, which is only slightly less than the global available supply of ~20 kliter/year. While the sum of the annual demand for the two sections *Maintenance & Research* and *New small detectors* amounts to ~2.5kliter only, the overwhelming majority of ^{3}Helium is requested for detectors consisting of large arrays of single counters or PSDs.

In summary, the projected demand and the available supply show a huge discrepancy. However, a supply of ~2,5 kliter/year (~150 – 175 liter/year per facility on average) for neutron scattering applications would allow the facilities to maintain or upgrade existing instruments and equip new instruments requiring small or medium size detectors for many applications. Possibly, this demand can be further reduced by a more careful use and the recycling of existing ^{3}Helium resources. The envisaged construction of huge arrays of ^{3}Helium based PSDs or single counters which cover large areas seems to be impossible.

karl.zeitelhack@frm2.tum.de

Alternative technologies for neutron detection replacing ^{3}Helium detectors

^{3}Helium ($^{3}He(n,p)t$) provides outstanding performance as a converter in neutron detectors working in ionisation or proportional mode. Its high neutron absorption cross section in combination with high pressure operation allows the design of robust, highly efficient and long-lived neutron detectors. It provides excellent neutron/gamma separation (~10^{-7}) and it is inflammable and nontoxic. In view of the present supply shortage a replacement of ^{3}Helium is mostly needed for large area position sensitive detector systems. Presently, there is no alternative technique which could simply replace ^{3}Helium filled detectors without a loss in performance. Practically, only ^{10}Boron ($^{10}B(n,\alpha)^{7}Li$) and ^{6}Lithium ($^{6}Li(n,t)\alpha$) can be considered for use as alternative neutron converters in large area detectors. For thermal neutrons ^{10}B and ^{6}Li have ~70% and ~17% the reaction cross section of ^{3}Helium.
Both elements have an average abundance in the upper continental crust. ^{10}Boron occurs at 20% of natural Boron, ^{6}Lithium at ~7% of natural Lithium, respectively. ^{10}B (enrichment >97%) is commercially available at a price of ~20€/gram in an abundance of 100 tons/year. It is also delivered in various compounds as BF_3 or B_2O_3. In terms of being used as converters in neutron detectors there should be virtually an unlimited supply of both isotopes.

During the meeting several alternative technologies and attempts have been discussed that could be used to replace ^{3}Helium based detectors in neutron scattering applications. These shall be briefly described below.

$^{10}BF_3$ filled neutron detectors

$^{10}BF_3$ filled gas detector were widely used in neutron scattering until they were replaced by ^{3}Helium filled detectors in the 80's. Most, if not all, position sensing methods developed for the ^{3}He interaction work equally well with the BF_3 interaction with no change at all in the detector design. BF_3 gas detectors provide excellent neutron/gamma separation and high count rate capability. At least for thermal neutrons however, the lower cross section of ^{10}B and the limitation to operation close to atmospheric pressure result in a significant reduction in efficiency compared to ^{3}He filled detectors. Further drawbacks are high operational voltages and the high toxicity of BF_3 which has to be considered as an important health and safety issue in production, transport and installation of large quantities of detectors. Presently, BF_3 detectors are built by LND and Centronic. GE Reuter-Stokes stopped production in the mid 80's but is looking into a resumption of production if it is economically worthwhile.
Keeping the present detector designs, the use of BF_3 filled gas detectors for thermal and epithermal neutron detection applications would be associated with a significant loss in performance. However, it might well be considered for some cold neutron detection applications. It is worth noting that some of the present limitations in performance of BF_3 detectors might probably be overcome by an improved detector design.

^{10}Boron lined Proportional Counters

Presently available ^{10}B-lined proportional counters have far too low a detection efficiency to be used in neutron scattering applications. GE Reuter Stokes adumbrates that it is working on a new detector design, which could approximate to the performance of ^{3}He filled detectors. It is certainly worth pursuing this development.

Gaseous Detectors with solid ^{6}Lithium or ^{10}Boron converters

Solid ^{6}Lithium or ^{10}Boron converters in gaseous detectors have been proven to work in various detector assemblies. Pure ^{6}Li-metal foil converters are delicate to produce and handle, as they are highly reactive and need to be protected by a thin polymer protection layer. For a small sized prototype detector with a single ^{6}Li converter foil an efficiency of ~16% for thermal neutrons has been reported. While it is certainly interesting, it seems difficult to imagine the construction of large area devices in the near future using metallic ^{6}Li-converters.

Solid ^{10}Boron layers seem to be much more favourable for use as neutron converters. They

karl.zeitelhack@frm2.tum.de

can easily be produced in reasonable sizes using evaporation or sputtering techniques. A single ^{10}B-layer however provides only relatively low efficiency (~5%) for thermal neutrons. This can be partially balanced by cascading a series of conversion layers as in the CASCADE detector developed at Heidelberg. This detector consists of a stack of double sided Boron-coated GEM-foils which act in parallel as converter and active detector elements. Theoretically, a detection efficiency of ~50% for thermal neutrons may be achievable in a detector with 10 GEM foils. Operated with a typical proportional gas ($Ar-CO_2$) at atmospheric pressure, the detector provides moderate position resolution but rather high count rate capability. In view of production and costs of a large area detector the presently rather limited production size of GEMs and the large number of converter layers are a disadvantage.
A detector design using inclined ^{10}Boron converters read out by MWPC type structures as has been proposed by the ILL detector group could be envisaged to increase the detection efficiency. In summary, ^{10}Boron converters in gaseous detectors may turn out to be an interesting alternative technique, but they need more investigation.

^{6}LiF-ZnS(Ag) and B_2O_3-ZnS(Ag) scintillation detectors

^{6}LiF-ZnS(Ag) scintillator based neutron detectors with coded clear fibre PMT readout have for many years been widely used at several facilities. They can provide high position and timing resolution and a detection efficiency of ~50% for 1A neutrons which has to be compared to ~75% for an equivalent ^{3}Helium detector. Gamma sensitivity can be almost an order of magnitude worse than for ^{3}Helium. The long decay time of the ZnS scintillator significantly limits its local count rate capability to ~10 kHz and in view of the production costs it is not feasible to cover very large areas with those devices.
A promising attempt to cover large areas with small dead space between individual detector modules is the approach of reading a Li or B-doped ZnS scintillator with two orthogonal layers of wavelength shifting fibres mounted underneath the scintillator. A coincidence hit of orthogonal fibres provides the neutron impact position and a light pulse train analysis provides neutron/gamma separation as in ^{6}LiF-ZnS(Ag) detectors with clear fibre readout. Applying this technique about 30 ^{6}LiF-ZnS(Ag) scintillator based modules with 0,3m^2 active area each and small dead space with coded fibre readout have been built at SNS. The detection efficiency approximates a ^{3}Helium tube filled at 6.6 bar. Due to the scintillation properties of ^{6}LiF-ZnS(Ag) the device again has a lower count rate capability and poorer gamma separation than equivalent ^{3}Helium detector technology. At J-PARC at similar device is being built using a newly developed and now commercially available B_2O_3-ZnS(Ag) scintillator which should improve the detection efficiency for neutrons <1,8 A.
In summary, this technique could be a candidate for covering large detector areas if local count rate and neutron/gamma separation are not an issue. To approximate the performance of ^{3}Helium detectors however requires further improvement or the development of new scintillator materials.

GS20 ^{6}Li loaded glass scintillator

GS 20 ^{6}Li loaded glass scintillators produced by AST can provide detection efficiencies comparable to ^{3}Helium. They have a short decay time of only ~70 ns but suffer from a relatively poor neutron/gamma separation capability. The low photon yield per detected neutron requires a direct readout with PMTs, e.g. in an ANGER camera type configuration. Due to its relatively high costs it seems hard to imagine that this technique can be employed for large area detector systems.

karl.zeitelhack@frm2.tum.de

Summary

Presently, there is no alternative technique which could simply replace ^{3}Helium filled detectors and combine all the capabilities of ^{3}Helium without a loss in performance. This is particularly true for large area detector systems consisting of arrays of single counters or PSDs.

It is essential to guarantee an adequate annual supply of ^{3}Helium for neutron scattering applications that will allow the maintenance of existing detectors and the construction of high performing small area devices. The supply should at least amount to ~2,5 kliter/year in total, corresponding to ~150 – 175 liter/year per facility in average.

The saving of ^{3}Helium resources should be supported by a more careful use and the recycling of existing ^{3}Helium from refurbished detectors or detectors not used any more. This may require the building of gas recycling rigs, which as yet only exist at few facilities.

Although it has several of disadvantages, the use of BF_3 for specific applications in neutron scattering should not be excluded by definition. An experimental evaluation of BF_3 filled detectors should be undertaken.

Various new technologies like ^{6}LiF-ZnS(Ag) or B_2O_3-ZnS(Ag) scintillation detectors with WLS fibre readout or solid ^{10}Boron converters in gaseous detectors should be further explored in view of their potential to replace ^{3}Helium.

An effort on the development of improved scintillation materials should be considered.

Some facilities have already designed instruments and are in the process of building them in the anticipation that ^{3}Helium detector technology would be available. Others are slightly better off in that the next larger area detector array is perhaps 3 – 5 years away.

However, the development of new detector technology takes time and effort and suitable replacements will not be developed instantly. Even 5 years is a very short time to develop and implement a robust technology on a large scale. To shorten development time it is necessary that a number of potential development lines are pursued simultaneously. Priority should be given to technologies which allow the construction of large area position sensitive detectors.

To make the development process as efficient and timely as possible it is essential that the community works together to maximise available resources and avoid unnecessary duplication of effort. A means of doing this needs to be established. Industry should be involved wherever possible.

However, whilst $^{10}BF_3$ technology is more appropriately handled by industry, the neutron detector market is relatively small and therefore a lot of the neutron detector expertise lies within the facilities and research laboratories. Only when designs are sufficiently advanced or show sufficient potential is there generally scope for industry to become involved.

Current resources at facilities are already over subscribed for the required neutron detector development programmes even before the shortage of ^{3}Helium became apparent. If the community wants to develop alternatives to ^{3}Helium technology in a timely fashion it will have to find sufficient resources, both in terms of funds and skilled staff, in order to make a serious impact on the need to replace ^{3}Helium detector technology for large area detectors on timescale of 3 – 5 years.

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ³Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***FRM-II***

Consumption grouped into
Research and Maintenance of operational detectors (e.g. Refill or replacement of old detectors)
New small size detectors
New large detector systems

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	**Type of Instrument**	**When**	**Type of detector**	**3He estimate / liters**
StressSpec	Diffractometer	2010	MWPC	50
MIRA-II	Reflectometer	2010	MWPCs	50
StressSpec-II	Diffractometer	~2014	MWPCs	150
Small detectors built in house		> 2011		120
SPODI-II	Diffractometer	2013	Curved MWPC	180
UCN-source	Nuclear Physics	2013		100
Total				650

New large detectors:

Name of Instrument	**Type of Instrument**	**When**	**Type of detector**	**3He estimate / liters**
ToFToF - II	Inelastic	2015	Tubes 1", 2m	4500
Total				4500

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***ILL***

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
D1B	Diffractometer	2010	MWPC	150
D33	SANS	2010	MWPC	150
X-trem	Diffractometer	2011	MWPC	300
WASP	Spin-echo	2011	Prop Counters	100
Small detectors built in house		2009 → 2015	MWPC, MSGC, Multitube	300
Total				**1000**

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
IN4 refurbishement	Inelastic	2015	Multitube	3000
Total				**3000**

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***STFC***

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of instrument	When	Type of detector	3He estimate / liters
ZOOM	SANS	2010 / 2011	PSDs 8mm, 1m	160
LAMOR	SANS	2010 / 2011	PSDs 8mm, 0.6m	40
WISH stage 2	Magnetic diffractometer		PSDs 8mm, 1m	40
FIRES	Quasi inelastic spectrometer	2015	PSDs 8mm, 0.15m	40
Small detectors built in house	Reflectometer -linear	2011 → 2015	MSGC's	120
Total				**400**

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
EXCESS	Inelastic	2015	PSDs 25mm, 3m	7800
JANUS	Molecular spectroscopy	2015	PSDs 25mm, 1m	3500
Total				**11300**

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: *JCNS*

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
SPHERES	Backscattering	2011		15
Total				15

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
POWTEX	Diffractometer	2012	PSD 1", 2m	3200
TOPAS	Inelastic spectrometer	2012	PSD 1", 2m	4000
Total				7200

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***HZ Berlin***

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
V1	Diffractometer	2010	MWPC	40
SPAN	Spin-Echo	2012	MWPC	20
SANS	SANS	2010	MWPC	30
FLEX	Triple-Axis	2011	PSDs	180
E1	Triple-Axis	2012	PSDs	250
Total				**520**

New large detectors:

Name of Instrument	Type of instrument	When	Type of detector	3He estimate / liters
EXED	Diffractometer	2012	450 PSDs ½", 3m	2550
NEAT	Inelastic	2011	700 PSDs, 1", 3m	5300
Total				**7850**

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***PSI***

Research and Maintenance:

Annual estimate / liters
50

New small detectors:

Name of Instrument	**Type of Instrument**	**When**	**Type of detector**	**3He estimate / liters**
Total				

New large detectors:

Name of Instrument	**Type of Instrument**	**When**	**Type of detector**	**3He estimate / liters**
EIGER	Diffractometer	~ 2013	Single tubes or MWPC	700
DMC-2	Diffractometer	~ 2011	MWPC	1300
Total				**2000**

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: *J-PARC*

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
ARISA	Reflectometer	2010 - 2012		20
Polarized Reflectometer	Reflectometer	2011 - 2013		20
Total				40

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
4 Seasons	Dir. Chopper	2009 - 2010	Tube1.9cm, 2.5m	1,988
DNA	Inv. Chopper	2010 - 2011	Tube1.27cm, 0.6m	252
SHRPD	Powder	2010 – 2012	Tube1.27cm, 0.6m	912
PLANET	Powder	2009 - 2010	Tube1.27cm, 0.6m	608
HRC	Dir. Chopper	2009 - 2011	Tube	1,000
AMATERAS	Dir. Chopper	2009 - 2010	Tube2.54cm, 3m	3,040
TAIKAN	SANS	2010 - 2011	Tube1.27cm, 80cm 0.8cm, 80cm	3,317
NOVA	Total scattering	2010 - 2012	Tube1.27cm, 60cm	1,824
KUR-DIF	Powder	2010 - 2012		3,000
Total				16,081

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: *JRR-3*

Research and Maintenance:

Annual estimate / liters
31

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
TAS-1	3-axis	2010	Single detector	10
LTAS, MUSASHI	3-axis & 2-axis	2011	Single detector and 1-D PSD	10
AGNES	Inelastic	2010	Tubes 1 inch x 10 inch	51
Total				71

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
Total				

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***LLB***

Research and Maintenance:

Annual estimate / liters
50

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
PA20		2010	Tubes	150
PAXI		2011	Tubes	150
7C2	Diffractometer	2009	PSDs	300
Total				600

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
TOF	Inelastic	2013 - 2014	Tubes	600
Total				600

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: *BNL*

Research and Maintenance:

Annual estimate / liters
50

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
			Curved MWPC	180
Total				180

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
Total				

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ORNL/SNS

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
Basis	spectrometer	2010	LPSD	100
Nomad	diffractometer	2011	LPSD	400
EQ-SANS	diffractometer	2012	LPSD	300
SERGIS	spectrometer	2013	MWPC	300
Imaging	Imaging	2013	MWPC	300
Total				**1300**

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
CNCS	spectrometer	2011	LPSD	3500
Sequoia	spectrometer	2012	LPSD	3000
Hyspec	spectrometer	2011	LPSD	600
Corelli	diffractometer	2012	LPSD	2800
Rapid powder	diffractometer	2014	LPSD	6000
High magnetic field	diffractometer	2015	LPSD	1200
Total				**17100**

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ORNL/HFIR

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
Powder diffractometer	diffractometer	2011	LPSD	150
Wand upgrade	diffractometer	2012	LPSD	160
Spin-Echo SANS	diffractometer	2013	LPSD	300
MIEZE	spectrometer	2013	MWPC	300
Cold powder	diffractometer	2014	LPSD	150
Polarized powder	diffractometer	2015	LPSD	150
Total				**1210**

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
GP SANS	diffractometer	2010	LPSD	530
BioSANS	diffractometer	2011	LPSD	530
Total				**1060**

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ......LANL/Lujan canter..............

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
NPDF				242
SMARTS				493
FDS				247
Spear				38
LQD				111
Asterix				493
Nucl				123
PCS				247
Total				1994

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
HIPD				555
HOT				1208
LAPTRON				616
INS1				2465
INS2				5546
Pharos				1972
Total				12362

karl.zeitelhack@frm2.tum.de

APPENDIX A

Estimated ^{3}Helium Consumption for neutron detectors intended over period 2009 - 2015

Facility: ***NIST***

Research and Maintenance:

Annual estimate / liters
100

New small detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
vSANS	SANS		PSDs	250
			MWPC	12
MAGIK			MWPC	4
MDD	Diffractometer		PSDs	270
CANDOR	Reflectometer		PSDs	22
Total				**560**

New large detectors:

Name of Instrument	Type of Instrument	When	Type of detector	3He estimate / liters
Total				

karl.zeitelhack@frm2.tum.de

APPENDIX B

Meeting of detector experts, Garching July 7-8, 2009

Agenda:

Time	TUESDAY JULY 7th
14:00	Welcome (Prof. W. Petry)
14:10	Introduction and Meeting Organization
14:15	3Helium shortage – a brief overview (Karl, Ron, ...)
14:30	Reports on the situation at the different Facilities
ca. 15:30	Round table discussion on possible alternatives Reports on Scintillator based devices (Ron, Nigel, Kazuhiko, Günter) Reports on 10Boron based devices (Bruno, Martin)
Ca. 18:30	End of session

Time	WEDNESDAY JULY 8th
09:00	Continue Round table discussion on possible alternatives
Ca. 10:00	Discussion on priorities, definition of the problems to solve
11:00	Discussion on possible activities
12:30	Lunch
ca. 13:30	Continue Discussion on possible activities
ca. 15:00	Summary , Discussion on possible decisions
16:00	FRM-II facility visit

karl.zeitelhack@frm2.tum.de

DOE Isotope Program Helium-3 Sales and Allocations

Transaction Type	Date	DOE Customer	Recipient	Recipient Quantity (liters)
Auction	Dec-03	G. E. Reuter-Stokes, Inc.	general (medical, scientic research, cryogenics, oil & gas, other)	95,960
	Jun-05	Spectra Gases, Inc.	general (medical, scientic research, cryogenics, oil & gas, other)	23,746
	Aug-06	Spectra Gases, Inc.	general (medical, scientic research, cryogenics, oil & gas, other)	26,694
Auction Total				**146,400**
Allocation	Dec-08	G. E. Reuter-Stokes, Inc.	DHS (neutron detectors) 70%	7,761
			general (medical, scientic, research, oil & gas, other) 30%	3,326
		Spectra Gases, Inc.	NNSA (SLD) (neutron detectors) 70%	7,411
			general (medical, scientic, research, cryogenics,oil & gas, other) 30	3,176
	Mar-09	Spectra Gases, Inc.	DHS (neutron detectors)	3,791
			DOD (neutron dectectors)	1,022
			general (medical, scientic research, oil & gas, other)	8,964
			Olympic Games	50
			Sandia (Detectors)	1,500
	Jun-09	Spectra Gases, Inc.	Cryogenics	1,800
			DHS (neutron dectectors)	772
			DOD (neutron dectectors plus other defense applications)	882
			DOE (Detection)	1,520
			DOE (Emergency Response)	1,750
			DOE (NIF/NNSA)	80
			DOE (Safeguards)	800
			DOE SC scientic research, cryogenics	341
			DOS	100
			NASA	80
			NIH (Med Imaging)	1,800
			NIST	832
			oil and gas	1,000
			reserved for future distribution	8,243
Allocation Total				**57,001**
Grand Total				**203,401**

Source: Department of Energy, April 2010

Demand and inventory of He-3

	FY'99	FY'00	FY'01	FY'02	FY'03	FY'04	FY'05	FY'06	FY'07	FY'08	FY'09	FY'10	FY'11
Demand	8,000	8,000	30,000	8,000	15,800	27,600	42,500	34,000	19,400	77,500	60,948	77,251	70,866
Supply	260,000	262,000	264,000	244,000	246,000	240,200	222,600	190,100	166,100	156,700	39,600	26,032	9,000

Source: Department of Energy, April 2010

DOCUMENTS FOR THE RECORD OBTAINED BY THE INVESTIGATIONS AND OVERSIGHT SUBCOMMITTEE AFTER THE APRIL 22, 2010, HELIUM-3 HEARING

HELIUM-3 "DOCUMENTS FOR THE RECORD"

OBTAINED BY THE INVESTIGATIONS & OVERSIGHT SUBCOMMITTEE

AFTER THE APRIL 22, 2010 HELIUM-3 HEARING

Caught by Surprise:

Causes and Consequences of the Helium-3 Supply Crises

Thursday, April 22, 2010

10:00 a.m. – 12:00 p.m.

2318 Rayburn House Office Building

Slovik, Gregory

From:	Kagy, Brian <CTR>
Sent:	Thursday, February 16, 2006 4:44 PM
To:	Eddy, Ryan
Cc:	Reichel, Howard; Slovik, Gregory; 'Taylor, David'; Culp, Donald <CTR>; Thomason, John <CTR>; Bunn, Dennis
Subject:	Helium-3 Availability r2
Attachments:	Helium-3 Availability r2.doc

Ryan,

As requested, I've included the additional information from DOE, and a statement of our confidence in the availability of sufficient quantities of He-3 to support DNDO programs.

--- Brian Kagy 202-254-5822 Cell 202-538-2751 Fax 202-254-2416
--- Systems Development and Acquisition
--- Domestic Nuclear Detection Office (DNDO)
--- Brian.Kagy@associates.dhs.gov
--- Part of the DGI SETA Support Team

Helium-3 Availability r2.doc (...

Helium-3 (He-3) Gas-Filled Neutron Detectors

The Domestic Nuclear Detection Office (DNDO), established within the Department of Homeland Security, is chartered by HSPD-14/NSPD-43 to "develop, acquire and support the deployment and improvement of a domestic system to detect attempts to import, assemble, or transport a nuclear explosive device, fissile material or radiological material intended for illicit use." Inspection of cargo containers, trucks, personally owned vehicles, mail and bundled cargo using passive radiation detection techniques is a critical element of the DNDO detection architecture. As such, DNDO intends to continue to deploy first generation detection equipment (Radiation Portal Monitors), as well as the development and deployment of next generation systems, termed Advanced Spectroscopic Portal (ASP) Systems that enhance our ability to detect small or shielded materials and reduce the false-alarm burden seen in first generation RPM systems.

Current generation (RPM/PVT), next generation Radiation Portal Monitor (RPM/ASP), and human portable systems include the ability to detect neutrons (emitted by Special Nuclear Material) through the use of Helium 3 (He-3) gas-filled ionization chamber neutron detector assemblies. The average ASP portal uses eight 2" diameter, 36" to 79" long (6 to 12 liters of He-3) neutron detectors. Human portable devices use small size neutron detector cylinders.

Availability of He-3 Gas

He-3 is sold by auction by the Department of Energy (DOE) Oak Ridge National Laboratory, Isotope Business Office, from supplies provided by the National Nuclear Security Administration (NNSA), Savannah River Site, Aiken, SC, in pressurized cylinders. An auction for 95,800 liters with a minimum price of $42.50 per liter ended in December 2003 for delivery by December 2005. A subsequent auction for approximately 23,904 liters was also conducted. He-3 gas is also available from Mayak in Russia which operates a nuclear reprocessing facility and supplies most of the annual worldwide demand of approximately 100,000 liters.

General Electric (GE) Ohio is a major U.S. supplier of He-3 gas-filled ionization chamber neutron detectors. GE purchased He-3 gas from the DOE auction in 2003 and has the He-3 gas purified through a proprietary process to assure a very high level of neutron sensitivity. GE's current on-hand gas inventory is sufficient to produce neutron detectors for approximately 6,400 He-3 gas-filled neutron detectors (i.e., for more than 800 RPM/ASP systems).

Spectra Gases, located in Branchburg, NJ has tens of thousands liters of He-3 gas in stock (and has international contracts in place for more, including from Mayak) to deliver more than 30,000 liters (i.e., for more than 300 RPM/ASP systems) of purified gas over a 12 month period. Spectra Gases processes the Savannah River He-3 gas (even the gas sold to GE Ohio) to meet the purity requirements for our applications.

The DOE Isotope Program office has confirmed the availability to supply He-3 for 1500 portals over the next 5 years from Savannah River (in addition to that currently in stock by vendors).

Domestic Nuclear Detection Office

Anacostia Naval Annex
245 Murray Lane,
SW. Bldg 410
Washington, DC
20528

DNDO is confident that the supply of He-3 gas is sure, secure, and sufficient to meet the projected demand for the Radiation Portal Monitors and human portable devices programs.

Domestic Nuclear Detection Office

Anacostia Naval Annex
245 Murray Lane, SW. Bldg 410
Washington, DC 20528

Slovik, Gregory

From:	Kagy, Brian <CTR>
Sent:	Thursday, February 16, 2006 4:10 PM
To:	Eddy, Ryan
Cc:	Reichel, Howard; Slovik, Gregory; 'Taylor, David'; Culp, Donald <CTR>; Thomason, John <CTR>
Subject:	RE: He-3 Supply

Ryan,

I just got of the phone with John Carty of the DOE Isotope Programs office.

They are sure they can supply enough He-3 for 1500 portals over the next 5 years from Savannah River (in addition to that currently in stock by vendors). The He-3 is processed by Spectra Gases New Jersey (even the gas sold to GE Ohio) to meet the purity requirement for our applications.

They also confirmed that the majority of the worldwide demand (approx 100,000 liters per year) is supplied by Mayak, Russia.

John said that they have heard conflicting stories from PNNL on who is now in charge of the Radiation Portal Monitor program; and is wondering who is controlling the ordering of portals, and when He-3 supplies need to be available for the neutron detector manufacturers.

John Carty would like to come down (from Germantown) to meet us and discuss how they can help, so I invited him. John said that they could sell the gas to us, and we could provide as GFM to portal vendors.

--- Brian Kagy 202-254-5822 Cell 202-538-2751 Fax 202-254-2416
--- Systems Development and Acquisition
--- Domestic Nuclear Detection Office (DNDO)
--- Brian.Kagy@associates.dhs.gov
--- Part of the DGI SETA Support Team

-----Original Message-----
From: Kagy, Brian <CTR>
Sent: Thursday, February 16, 2006 10:20 AM
To: 'Carty, John'
Subject: RE: He-3 Supply

John,

Thank you for responding by voice mail and e-mail.

We are looking at a demand of about 240,000 liters from 2006 to 2011 (with the first 120,000 liters pretty firm and the second 120,000 liters very likely) with annual consumption approximately equal each year.

Does that explanation make sense ?

The inquiry from up the chain of command is for DNDO to verify that there is, or will be, a suitable supply over the next five years- not asking for the specific production capacity. We understand that DOE is the primary source of supply, but also have been told that on the world market there is at least one other commercial source- from Mayak, Russia.

--- Brian Kagy 202-254-5822 Cell 202-538-2751 Fax 202-254-2416
--- Systems Development and Acquisition
--- Domestic Nuclear Detection Office (DNDO)

--- Brian.Kagy@associates.dhs.gov
--- Part of the DGI SETA Support Team

-----Original Message-----
From: Carty, John [JOHN.CARTY@nuclear.energy.gov]
Sent: Thursday, February 16, 2006 9:19 AM
To: Kagy, Brian <CTR>
Cc: Reichel, Howard; Eddy, Ryan
Subject: RE: He-3 Supply

Brian,

Do you mean that you need 120,000 liters over the next 5 years to 2011 and then 240,000 liters from 2011-2018 or do you need 360,000 liters from 2006 - 2013? When you phone again we can discuss this in more detail and then I will get you the answers. He-3 production rate is classified.

John Carty

-----Original Message-----
From: Eddy, Ryan [Ryan.Eddy@dhs.gov]
Sent: Thursday, February 16, 2006 3:50 PM
To: Kagy, Brian <CTR>
Subject: RE: He-3 Supply

Brian -

Any update? I was hoping to get something up to Vayl by the end of today.

Thanks,

Ryan R. Eddy
Special Assistant for Policy
Domestic Nuclear Detection Office
Department of Homeland Security
(202) 254-6370
(202) 431-6614 - cell
ryan.eddy@dhs.gov

-----Original Message-----
From: Carty, John [mailto:JOHN.CARTY@nuclear.energy.gov]
Sent: Thursday, February 16, 2006 9:19 AM
To: Kagy, Brian <CTR>
Cc: Reichel, Howard; Eddy, Ryan
Subject: RE: He-3 Supply

Brian,

Do you mean that you need 120,000 liters over the next 5 years to 2011 and then 240,000 liters from 2011-2018 or do you need 360,000 liters from 2006 - 2013? When you phone again we can discuss this in more detail and then I will get you the answers. He-3 production rate is classified.

John Carty

-----Original Message-----
From: Kagy, Brian <CTR> [mailto:Brian.Kagy@associates.dhs.gov]
Sent: Wednesday, February 15, 2006 5:49 PM
To: Carty, John
Cc: Reichel, Howard; Eddy, Ryan
Subject: He-3 Supply
Importance: High

John,

One of the items which DNDO is responsible for is the next generation Radiation Portal Monitor / Advanced Spectroscopic Portal (RPM/ASP) program.

The portals, which are being installed at our Ports of Entry to screen incoming cargo containers, include He-3 gas-filled ionization chamber neutron detectors.

A question has been raised concerning the availability of He-3 for these programs- (perhaps 8 detectors per portal, 10 liters per detector, 1500 portals = 120,00(liters) over five years. And double that quantity to support all envisioned worldwide installations over the next seven years.

Is that supply reasonably available ?

--- Brian Kagy 202-254-5822 Cell 202-538-2751 Fax 202-254-2416
--- Systems Development and Acquisition
--- Domestic Nuclear Detection Office (DNDO)
--- Brian.Kagy@associates.dhs.gov
<mailto:Brian.Kagy@associates.hq.dhs.gov>
--- Part of the DGI SETA Support Team

Clenney, Jaclyn

From: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy) [thomas.anderson1@ge.com]
Sent: Friday, February 15, 2008 10:21 AM
To: Carroll.mcfall@nnsa.srs.gov; Pantaleo, John
Cc: Cooper, Ronald G.; Haer, Robert E (GE Infra, Energy).
Subject: RE: He3 Gas Transfer

John, Carroll,

Is there any status? Do you have any idea when the transfer station will be back in operation? Can SNS go ahead and ship their cylinders to you now?

Thanks for your assistance,

Tom Anderson
GE Reuter-Stokes
Product Line Leader
Radiation Measurement Solutions

> ____
> From: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy)
> Sent: Monday, February 11, 2008 4:21 PM
> To: 'Carroll.mcfall@nnsa.srs.gov'
> Cc: 'John.pantaleo@hq.doe.gov'; 'Cooper, Ronald G.'; Haer, Robert E
> (GE Infra, Energy)
> Subject: He3 Gas Transfer
>
> Carroll,
>
> I am attempting to facilitate the process of getting four cylinders of
> DOE He3 gas from Ron Cooper at SNS Oak Ridge through your cylinder
> transfer process -- so that I can get it moved to Spectra Gas for
> tritium removal. I understand your transfer rig is down but I am
> hoping it will be back on line soon. I am running low on gas and need
> the gas as soon as possible. I would like to ask SNS to ship the gas
> to you now so that it can be transferred to the new cylinders as soon
> as your repairs are complete. Are you setup to accept gas from SNS if
> they ship it in the near future?
>
> Thanks,
>
> Tom Anderson
> 330-963-2437

Clenney, Jaclyn

From:	Jack Faught [JackF@spectragases.com]
Sent:	Thursday, March 06, 2008 9:30 AM
To:	Pantaleo, John; Pantaleo, John
Cc:	Cline, R. L.
Subject:	FW: Status of transfered 3He
Importance:	High

John,

Keith has been trying for sometime to get Helium-3 gas released from SR, but due to problems with their system they could not transfer gas. We have been trying to get cylinder numbers and quantities so we can send the money for the release of product, but without the product transfer, this was not possible.

Now we find that four cylinders of gas is being transferred to us for purification for the Spallatial Neutron detector project. Our customers also have government projects which require this gas and it seems that since there is a shortage of gas, allocation would be in order. We would like to get two of the four cylinders.

The DOE is now behind schedule in making the gas available to us, and our business is being adversely affected by the problem. I would like to speak to you today and try to resolve the matter. I will call you today if I do not hear from you.

Best regards,

Jack Faught
908-347-1090

-----Original Message-----
From: Keith Darabos
Sent: Wednesday, March 05, 2008 5:09 PM
To: Cline, R. L.
Cc: carroll.mcfall@nnsa.srs.gov; 'Pantaleo, John'; Jack Faught
Subject: Status of transfered 3He
Importance: High

Rocky,

Due to my travel schedule I want to submit check requests this week so we can pay for the next two cylinders of 3He. I can wait on the tritium number. I'd like to be prepared to schedule the common carrier for pickup as soon as possible. Can you provide invoices no later than Friday noon time? I also need to know that the transfer of gas is continuing and estimates of availability.

Regards,

Keith Darabos
Spectra Gases, Inc.

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Thursday, March 27, 2008 4:59 PM
To: Pantaleo, John
Subject: Helium-3

Hi John,

Do you have any time to see me to discuss the release of more helium-3 beyond our current contract? It appears to us that the market is going to require at least another 80,000 liters of gas over the next 18 months over and above what we have remaining on our contract. At least 80% of these requirements are for homeland security projects.

Regards,

Jack Faught

Clenney, Jaclyn

From: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy) [thomas.anderson1@ge.com]
Sent: Monday, June 16, 2008 4:11 PM
To: Ostendorff, Bill
Cc: Pantaleo, John; Dunsworth, Dale
Subject: RE: He3 Supply

Bill,

Great to hear from you - wish it could be under better circumstances.

I just wanted to give you a heads up. Unless someone is sitting on a supply I don't know about - there will probably be an impact at DNDO and internationally. I am currently not quoting some big security programs.
John sent me a plan last week but it won't meet the timeline of some of these programs as they are currently being communicated by our customers. I have started a dialog with DNDO to make them aware of the issue.

Thanks,
Tom

-----Original Message-----
From: Ostendorff, Bill [mailto:Bill.Ostendorff@nnsa.doe.gov]
Sent: Friday, June 13, 2008 10:02 AM
To: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy)
Cc: Pantaleo, John; Dunsworth, Dale
Subject: RE: He3 Supply

Tom- Hi. Good to hear from you. Apologize for delay in repsonding but was out of the country all last week and am now catching up.
It is my understanding that John Pantaleo is in fact the right person on He3(Isotopic Sales for the Office of Nuclear Energy). The Nuclear Materials Program Manager for NNSA- Dale Dunsworth- can address questions associated with NNSA materials. Both are cced here.
Good luck in the job! Best wishes, Bill

-----Original Message-----
From: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy) [mailto:thomas.anderson1@ge.com]
Sent: Wednesday, June 04, 2008 9:37 AM
To: Ostendorff, Bill
Subject: He3 Supply

Bill,

It looks like you have progressed well since your retirement. Well Done!

I have been at GE since my retirement where I am the Product Line Leader for our radiation measurement products. We are the largest user of He3 in the world. We use He3 to manufacture neutron detectors for a variety of homeland security applications, neutron scattering research instruments, oil & gas drilling, nuclear material assay equipment (including many IAEA programs) and an assortment of other ancillary applications.

We met with John Pantaleo, the Isotope Program Director in the Office of Nuclear Energy last week to discuss our urgent need for He3. I purchased 96,000 liters at auction in 2003 and we have exhausted that supply. John informed my buyer this morning the NNSA controls the release of He3 and he still can't commit to a release date. I have several customers asking for detectors that I can't build due to the gas shortage. The most immediate impact will be the DNDO ASP program. I don't know if Howard Reichel is aware of the situation but the cat is about to get out of the bag.

DOE has and continues to protect any information pertaining to the availability of He3. This has not been a concern in the past because of the availability. However, I now find myself in a position of deciding which customers and programs will be supported

I would appreciate the opportunity to provide my perspective to you and/or your staff.

Thanks,

Tom

Tom Anderson
Product Line Leader
GE Energy
Reuter-Stokes Radiation Measurement Solutions
8499 Darrow Road
Twinsburg, Ohio 44087
330-963-2437
Thomas.Anderson1@ge.com

Helium-3 Needs Memo from GE
Carroll Mcfall to: Kevin02 Hall, Timothy Fischer 06/03/2008 01:49 PM

You might find this interesting. The attached memo from GE Reuter-Stokes (they bought about 100,000 liters of He-3 from us between 2002 and 2006) describes their future needs. Their needs seem to far outstrip our long term recovery rate of 10,000 or so liters per year.

Carroll McFall
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

----- Forwarded by Carroll Mcfall/NNSA/DOE/Srs on 06/03/2008 12:59 PM -----

"Pantaleo, John" <JOHN.PANTALEO@nuclear.energy.gov>
06/03/2008 11:38 AM

To carroll.mcfall@nnsa.srs.gov
cc
Subject FW: DOE Visit

Carol,

Attached are the meeting notes from a discussion we had here in sunny Germantown last week with G.e.Reuter Stokes regarding He-3. They would like to make a direct purchase and as I explain that we have a fairness of opportunity issue unless we find a reasonable way to allocate the He-3 to our customers. Not easy.

Could you please provide what how many cylinders we expect to have reload and total available for the Sept/Oot timeframe and for the future. I know you have provide these number but I have miss placed them.

PS don't worry about the U-234.

Thanks john

-----Original Message-----
From: Haer, Robert E (GE Infra, Energy) [mailto:robert.haer@ge.com]
Sent: Friday, May 30, 2008 2:38 PM
To: Pantaleo, John
Cc: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy); Toney, Russell E (GE Infra, Energy)
Subject: DOE Visit

John -

Thank you for meeting with us on May 27th, attached please find our formal thanks and a summary of our issues, we look forward to your response.

<<DOE.pdf>>

Rob Haer
GE Sourcing
GE Energy - Reuter Stokes
8499 Darrow Road
Twinsburg, OH 44087
Internal: *766-2347
Phone: 330-963-2347
Cell: 330-352-2468
Fax: 330-963-2466

DOE.pdf

May 30, 2008

GE Energy
Reuters Stokes
8499 Darrow Road
Twinsburg, OH 44087

U.S. Department of Energy
Germantown Building
1000 Independence Ave
Washington, DC 20585

Attention: John Pantaleo

I would like to thank you, Dr. Simon-Gillo and John D'Auria for taking time out of your busy schedule to meet with us to discuss our ^{3}He and ^{234}U requirements. We appreciate the support DOE has provided GE and would like to continue to support our customers as they use these isotopes to provide products and services of great importance to the nation. I would like to take this opportunity to highlight some of the key points of our presentation and provide suggestions as we move forward.

Helium 3

Prior to meeting we were unaware of the fact that the DOE's supply of ^{3}He was nearly exhausted. Based on past auctions we believed that a healthy supply of gas existed, and that our supply constraint was short-term in nature. As discussed, we are consuming an average of 25,000 liters/year and will deplete our current supply in August 2008. We are seeing more emphasis on international security programs and have customer requests requiring over 28,000 liters of ^{3}He during the next year.

GE is the leading provider of ^{3}He products; we provide products for Homeland Security, Neutron Scattering Research facilities, Oil & Gas exploration and for nuclear safeguards applications. While homeland security is the largest consumer of ^{3}He gas, the importance of the other detectors applications cannot be discounted.

GE would like to offer the following suggestions regarding ^{3}He

- Allow a direct purchase by GE of 25,000 liters of $^{3}He3$ gas by the end of July 2008.
- Due to the urgent nature of our need for ^{3}He, and the potential supply disruption to vital Homeland Security products, this direct purchase should be executed immediately.
- Determine a fair allocation plan and sell gas via a multi year purchase contract to allow the commercial sector to plan accordingly.
- DOE inform the Domestic Nuclear Detection Office (DNDO) of the projected ^{3}He supply/shortage
- Encourage DNDO and/or NNSA to:
  - Establish a group to review current performance specifications and detector designs to maximize effectiveness of the limited ^{3}He supply. GE would appreciate the opportunity to participate in this effort.
  - Set national security priorities based on available ^{3}He supply.
- Encourage DNDO to prioritize research funding to develop alternate neutron detection technologies.

Uranium 234

As a global leader of nuclear sensors, we are concerned about DOE proposal to sustain ^{234}U. The lack of availability of ^{234}U will greatly impact both current and future reactor costs and efficiencies. We have confidence the DOE will work with GE on finding ways to secure the supply and support the DOE Vision of Energy Security. Currently GE has material to cover our estimated usage through 2010. This date corresponds with the DOE's planned timing to extract ^{234}U. However, this plan is currently predicated on GE providing all the funding and the DOE ability to recreate the extraction process from ^{238}P. As a commercial entity, GE does not typically provide advances for materials without firm guarantees for product delivery or re-payment of funds.

GE would like to offer the following recommendations regarding ^{234}U supply

- DOE to advise the NRC and the Utilities Commission of the current supply situation and the potential impact of a supply disruption
- Re-assess the costs and timing for extraction and provide a detailed plan to GE
- Work with GE to develop a revised framework agreement that will be acceptable to all concerned parties

While these are both complex issues to resolve, we believe by working together we can come up with solutions that support both parties' goals and objectives. We look forward to reviewing your response regarding the current supply availability of ^{3}He, your support for an immediate direct sale of ^{3}He to GE, and any additional comments and suggestions on how we should move forward.

Due to several open government requests we have regarding homeland security programs, we would appreciate a response regarding the immediate release of ^{3}He no later than Thursday June 5th. Additionally, we are available for follow-up meetings at your convenience, and would like to have another discussion or formal reply regarding these issues on or before June 13th if possible.

Sincerely,

Robert Haer
Strategic Sourcing Leader
Phone: 330-963-2347
E-Mail robert.haer@ge.com

From: Grubbs, William K (Kevin)
To: Berube, Laurie P
Cc: Panisko, Mark E
Subject: SAIC RPM procurement
Date: Friday, July 11, 2008 2:00:12 PM

Laurie,

I just heard from Tom Taylor that SAIC is still reviewing the contract I sent yesterday - they haven't executed it yet. Tom says that their procurement folks have advised that there is a world-wide shortage of helium and that their supplier is totally out and not sure when they can obtain additional stock. Tom says the price has risen from $40/liter to $200/liter now and that DOE controls the market for helium.

Kevin Grubbs
Contracts Manager
National Security Directorate

Pacific Northwest National Laboratory
902 Battelle Boulevard
P.O. Box 999, MSIN K8-18
Richland, WA 99352 USA
Tel: 509-372-4050
Fax: 509-375-6617
kevin.grubbs@pnl.gov
www.pnl.gov

Kevin

From: Taylor, Thomas M. [mailto:THOMAS.M.TAYLOR@saic.com]
Sent: Tuesday, July 15, 2008 12:13 PM
To: Grubbs, William K (Kevin)
Cc: Panisko, Mark E; Courtney Burnett
Subject: Contract 68847 Helium -3 issue

Kevin,

As we discussed, DOE controls the supply of Helium -3 and the supply is drying up leaving some of our vendors without any helium and driving up the price. DOE periodically auctions the gas to a few key controlled refiners - GE Rueter-Stokes and SpectraGas- who refine the gas for applications such as our HE3 tube requirements. DOE has not released sufficient gas to meet demand causing current real shortage/Price increase of over 5X from end of last year's price of about $40/liter to over $200/liter (our RPM HE3 tube uses 10.5 liters). This is a big cost increase that we cannot absorb without an adjustment. Our lowest cost vendor presently has a supply to meet the current contract quantity and schedule if we act quickly, but we will have to increase the price by $1,836 per HE3 tube. The next lower vendor is almost twice the price and has a longer delivery time by a month. Therefore, we need an increase of $1,836 per tube in order to accept this interim contract. This would result in a total price increase of $257,040. The detailed impacts and resulting prices are shown in the below table.

item	*Quantity*	*description*	*Number of HE3 tubes per system*	*Price delta based on $1836/ HE3 tube*	*Old unit price*	*New unit price*	*New total*
1	17	2-panel RPM	4	$7,344	$56,822	$64,166	**$1,090822**
2	10	4-panel RPM	4	$7,344	$87,955	$95,299	**$952,990**
3	4	8-panel RPM	8	$14,688	$165,069	$179,757	**$719,028**
		140 Total				**TOTAL**	**$2,762,840**

Our first priority is to get this contract awarded and then we should discuss how we're going to handle this new market volatility for the IDIQ contract. We should investigate negotiating a price adjustment provision similar to what we negotiated for lead on the first RPM-8 contract. If you have any other ideas on how to mitigate or handle this shortage and market disruption in the supply of the HE3 tubes, we would certainly appreciate it. Please call me if you have any questions.

Tom

Thomas Taylor

Contracts Manager

Security and Transportation Technology

(858)826-6293

From: Panisko, Mark E
To: Craig, Jeffrey R
Subject: RE: Helium-3 shortage
Date: Wednesday, July 16, 2008 9:46:16 AM

We can't get the quantities we need from the GSA schedule.

Mark

From: Craig, Jeffrey R
Sent: Tuesday, July 15, 2008 6:04 PM
To: Panisko, Mark E
Subject: RE: Helium-3 shortage

Why not just order off of the GSA schedule?

From: Panisko, Mark E
Sent: Tuesday, July 15, 2008 3:16 PM
To: Khawaja, Asim; Henderson, John M (Mark); Craig, Jeffrey R; Middleton, Keith R
Cc: Hevland, Mark E; Wiborg, James C; Morrey, Eugene V; Ely, James H; Grubbs, William K (Kevin); Fisher, Darrell R
Subject: Helium-3 shortage

There has been a major spike in the price and availability of helium-3. SAIC has not signed the bridging purchase order for the $2.5M. They have come back with a "counteroffer" of $2.75M.

Efforts underway.

I will start a requisition for $500k increase for the first bridging order. The final agreed to pricing should be less than that, but will depend on how fast we can come to terms and how fast the requisition is approved.

I will also generate a requisition for $2.9M for the second bridging order. We need to discuss this with PNSO before issuing, but I want to get the requisition moving.

I have engaged Darrell Fisher to help support increasing the supply of helium-3 or increasing the priority for RPMP to get helium-3. He is the scientific advisor for the DOE office of isotope production, which controls the supply of He-3. He usually doesn't interface with the sales side, but he is going to make some calls tomorrow and get back to me on what we can do next.

Please make every effort to approve this requisitions ASAP.

Thanks,
Mark P.
5-2778

Domestic Nuclear Detection Office (DNDO)

The Roles of Isotopes in Homeland Security

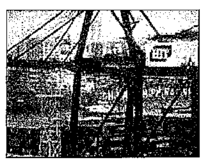
August 5, 2008

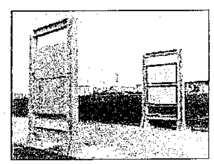
Dr. Chuck Gallaway
Deputy Director, DNDO
Department of Homeland Security

Homeland Security

The Radiological and Nuclear Threat

- The risk of a terrorist acquiring and using a nuclear or radiological device is one of the greatest threats to the Nation
  - A robust, layered defense must be developed
  - Each layer must reduce the terrorist's ability to use such threats against us
- The layered defense concept includes:
  - Eliminating excess stocks of nuclear materials and weapons
  - Protecting existing stocks from theft or diversion
  - Detecting illicit movement of nuclear or radiological material overseas
  - Enhancing domestic detection and interdiction efforts






Homeland Security

DNDO Mission and Objectives

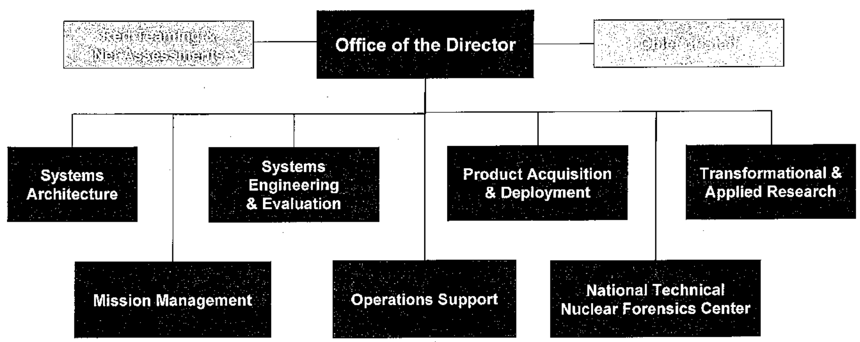
DNDO is a jointly-staffed, national office founded on April 15, 2005 to improve the Nation's capability to detect and report unauthorized attempts to import, possess, store, develop, or transport nuclear or radiological material for use against the Nation, and to further enhance this capability over time.

- Develop the global nuclear detection and reporting architecture
- Develop, acquire, and support the domestic nuclear detection and reporting system
- Thoroughly characterize detector system performance before deployment
- Establish situational awareness through information sharing and analysis
- Establish operation protocols to ensure detection leads to effective response
- Conduct a transformational research and development program
- Maintain the National Technical Nuclear Forensics Center to provide centralized planning and integration of USG nuclear forensics programs

Homeland Security

DNDO Organization

- DNDO and its Directorates are oriented towards addressing key mission areas while meeting the functional objectives outlined in its founding Presidential Directive



Isotopes play a role across all DNDO mission areas

Homeland Security

Key Mission Areas

- DNDO focuses on increasing detection capabilities in key mission areas as part of a comprehensive strategy to protect the Nation against radiological and nuclear threats.
  - At Ports of Entry
  - Between Ports of Entry
  - Small Maritime Vessels
  - General Aviation
  - Domestic Interior
- DNDO collects requirements and develops integrated plans with executing partners in each mission area that address:
  - Product acquisition and deployment
  - Support of field operations
  - Information sharing and alarm resolution

Homeland Security

Material-centric Mission

Reduce illicit trafficking of radiological and nuclear materials

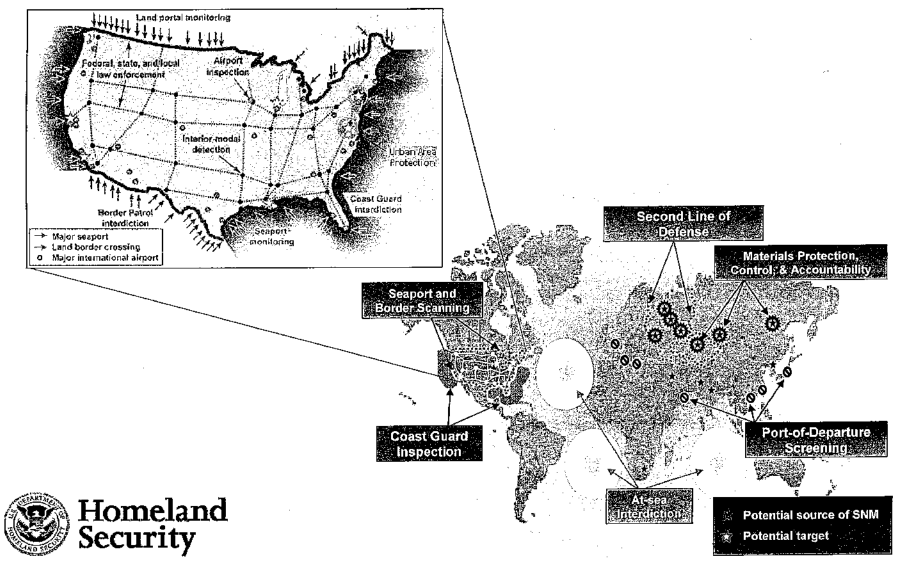
1. Detection of nuclear or radiological material
   - Interdict suspect material shipments
   - Perform forensics on seized or found material
   - Utilize isotopes for testing systems

2. Elimination of radiological material from stream-of-commerce
   - Secure material at the point of origin
   - Support the development of source replacement technologies

Homeland Security

System Architecture

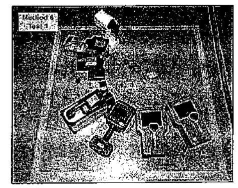
Develop the global framework for source security and detection

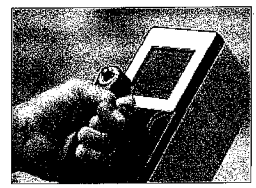


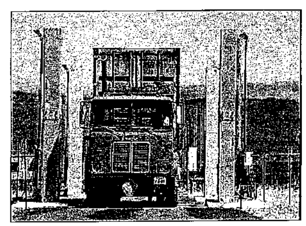
Homeland Security

Product Acquisition and Deployment

- Develop, acquire, and support current and next generation nuclear detection systems
- Programs rely on the availability of Isotopes:
  - Stable isotopes (i.e. Helium-3): in detectors
  - Radioactive isotopes: as threat and nuisance materials for development and testing of new detection systems



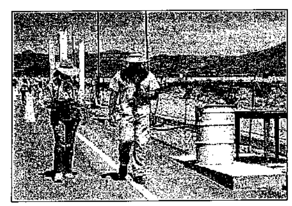




Homeland Security

Systems Engineering and Evaluation

- Develop standards and performance specifications
  - Identify the isotopes of interest
- Conduct thorough test and evaluation of all systems prior to full-scale deployment
  - Full range of isotopes
- Conduct pilot deployments
  - Demonstrate capabilities for future, larger-scaled deployments of technologies and concepts of operations



Homeland Security

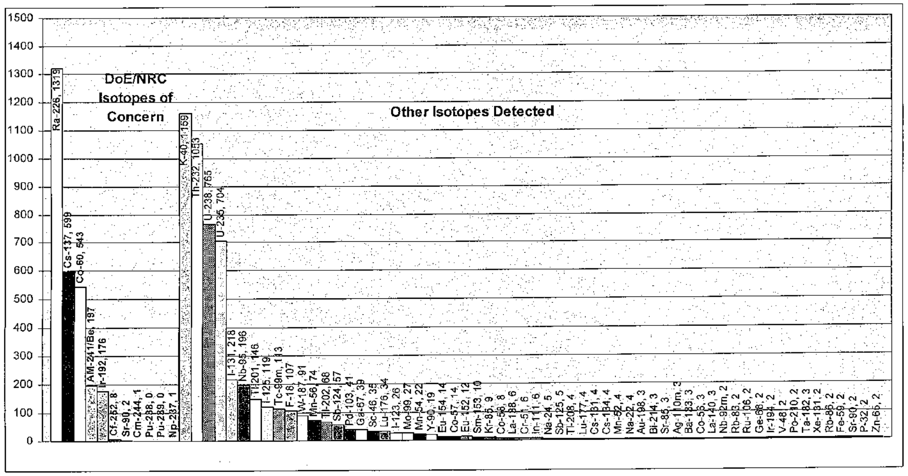
*Isotopes in Detection Standards**

Radionuclide	Activity (μCi) unshielded [1]	Activity (μCi) steel shielded (3 cm) [4]	Activity (μCi) poly shielded [4] [5]
^{241}Am	47	—	—
^{133}Ba(i)	9	148	—
^{133}Ba(g)	3	—	—
^{57}Co(i)	15	—	—
^{57}Co(g)	5	—	—
^{60}Co	7	25	—
^{137}Cs	16	85	—
DU [6]	4.5 kg (46 cm^3)	—	—
^{67}Ga	16	—	94
HEU [6]	237 g (6.5 cm^3)	—	—
^{131}I	10	—	23
^{192}Ir	6	61	—
^{40}K	128	—	—
^{237}Np [6]	90 mg with 1 cm Fe shielding	—	—
^{99m}Tc	16	—	127
^{201}Tl	10	—	88
^{226}Ra	8	—	—
^{232}Th	14	—	—
RGPu [6]	1.4 g with 1 cm Fe shielding	—	—
WGPu [6]	15 g with 1 cm Fe shielding	—	—
^{252}Cf [3]	2×10^4 n/s ± 20%	—	—

Homeland Security

*Example shown is ANSI N42.38 ("*American National Standard Performance Criteria for Spectroscopy-Based Portal Monitors Used for Homeland Security*")

Isotopes in the Stream-of-Commerce

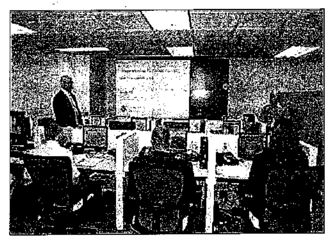


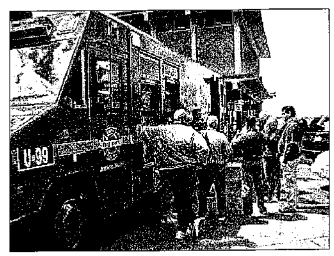
Not all isotopes are of equal importance.

Homeland Security

Support for Field Operations

- Training and exercises
  - Relevant radioactive materials required for law enforcement personnel to develop requisite skill using equipment and confidence in radiation detection systems
- Daily Operation
  - Defining calibration sources and techniques
- Joint Analysis Center
  - Participating in adjudication of radiation alarms
  - Providing feedback to developers and testers on isotopes of interest
- Operational Red Teaming and Covert Testing
  - Radioactive isotopes: threat and legitimate sources and naturally occurring materials to emulate illicit trafficking activities

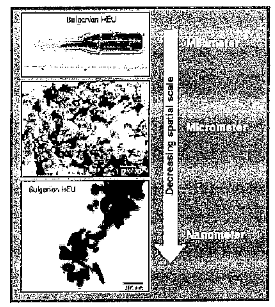




Homeland Security

National Technical Nuclear Forensics Center

- Centralized planning, integration, assessment, exercising, stewardship and readiness of USG nuclear forensics capabilities.
- Pre-Detonation rad/nuc materials forensics "capability provider":
  - Developing and improving diagnostic signatures (chemical, physical, isotopic, and pathways)
  - Developing standards for materials analyses
  - Developing Nuclear Forensics Knowledge Management & Analysis System (KMAS) evaluation tools, methods and knowledge capture



Need for reference samples of various isotopes

Homeland Security

DNDO Isotopes

Isotope	Purpose
HEU (High fraction ^{235}U)	System Test and Evaluation
RGPu or WGPu (high fraction ^{239}Pu)	
^{237}Np	SNM
^{252}Cf	Surrogates
^{133}Ba	Suspicious
^{57}Co	RDD
^{232}U	Medical
Depleted Uranium (DU, ^{238}U)	NORM
^{241}Am	
^{60}Co	
^{137}Cs	
^{192}Ir	
^{226}Ra	
$^{90}Sr/^{90}Y$	
^{131}I	
^{99m}Tc	
^{67}Ga	
^{125}I	
^{176}Lu	
^{201}Tl	
^{228}Th	
^{40}K	
^{232}Th	
Helium-3	System development and device manufacturing
^{137}Cs	Equipment Calibration
^{232}Th	
^{137}Cs	Operational Check Sources
HEU (High fraction ^{235}U)	Forensic References and Exercise Materials
RGPu or WGPu (high fraction ^{239}Pu)	
Irradiated Uranium foils for Thermal Calibrations	
^{60}Co	
^{90}Sr	
^{137}Cs	
^{192}Ir	
^{241}Am	
^{210}Po	
Other isotopes as delineated by continuing threat assessment	

Eliminating Radioactive Material

- CsCl replacement study
  - Reduce dispersability
- Irradiator hardening project
  - Increase difficulty of material diversion
- Non-radioactive techniques to replace current industrial devices
  - Reduce number of sources in the stream-of-commerce

Develop break-through technologies and methods

Homeland Security

DNDO CsCl Alternatives Study

- Define the economic impact of the replacement of CsCl with alternate technologies, other forms of CsCl or different sources.
- Build on the National Academies of Science (NAS) report that recommended phase-out of CsCl.
- Apply the results of the Nuclear Regulatory Commission (NRC) effort that is investigating the production capability of suppliers of alternate forms of CsCl.
- Define the costs to the licensee community and US Government for source replacement, disposal, recycling or long term storage to better advise a path forward to implement the results of the NAS study.
- Challenges:
  - The domestic and international ability to produce an alternate form of CsCl does not exist at present in quantities that support an immediate 100% source change out.
  - CsCl source replacement by X-ray or accelerator-based technology can be a large financial burden to the licensee.

Homeland Security

Radioactive Source Replacement Technologies

- DNDO, in coordination with DHS Homeland Security Advanced Research Projects Agency (HSARPA) SBIR program, is participating in an effort to promote the design and production of non-nuclear alternatives for industrial devices that currently use radioactive sources.
- Three existing SBIR contracts:
  - Replace the Cs-137/Am-241 soil moisture density gauges with an alternative impedance method
  - Replace the Ni-60 ionization source with carbon fiber nano-tubes in GCMS and other applications
  - Replace the Cs-137 (or other) thickness gauges with an with an alternative impedance method

Homeland Security

Summary

- DNDO will develop a global framework for detection of radioactive and nuclear material
- The availability of Helium-3 is vital to DNDO's mission.
- The availability of radioactive isotopes is essential for the effective testing of systems/procedures and the training of personnel
  - The importance of SNM to the DNDO mission supports the continued production of SNM sources by the DOE infrastructure
  - For DNDO to support the development of systems capable of detecting materials in the stream of commerce, it needs to remain aware of what isotopes are available rather than driving the market
  - However, Cf-252 is an essential isotope for neutron detector diagnostics
- DNDO is actively pursuing the development of source replacement technologies

Homeland Security

U.S. Department of Homeland Security

Homeland
Security

Clenney, Jaclyn

From: Cline, R. L. [clinerl@ornl.gov]
Sent: Wednesday, August 20, 2008 5:48 AM
To: carroll.mcfall@nnsa.srs.gov
Cc: Pantaleo, John
Subject: RE: Question Regarding He-3 Past Sales
Attachments: HE-3SRP.xls

BUSINESS CONFIDENTIAL

Carroll,

See attached spreadsheet. A couple of things:

1. This is Business Confidential and should be treated as such.

2. In the beginning, particularly from GE Reuter Stokes, they recorded in their system by lot - i.e. 1 each cylinder for each sale and we had to match in order to use their electronic billing system. If you need the liters we can pull the records and fill it in from the information in the files.

Let me know if you need anything else.

Rock

BUSINESS CONFIDENTIAL

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

R. L. Cline, Manager

Isotope Business Office

P. O. Box 2008

Oak Ridge, TN 37831-6158

Telephone: (865) 574-6984

Facsimile: (865) 574-6986

Email: clinerl@ornl.gov

Catalog: www.ornl.gov/isotopes/catalog.html

From: carroll.mcfall@nnsa.srs.gov [mailto:carroll.mcfall@nnsa.srs.gov]
Sent: Tuesday, August 19, 2008 2:05 PM
To: Cline, R. L.
Cc: JOHN.PANTALEO@hq.doe.gov
Subject: Question Regarding He-3 Past Sales

Rock,

I am trying to gather some info for John Pantaleo answer a Congressional inquiry regarding He-3. I know that our last sale was to Spectra in July 2006 and the previous sale was to GE-Routers in Feb. 2004. What was the date of the earlier sale to Specta of six cylinders?

Thanks,
Carroll McFall
Assistant Manager for Mission Assurance
National Nuclear Security Administration Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

From: Panisko, Mark E
To: Berube, Laurie P
Subject: RE: OPA nomination
Date: Friday, February 13, 2009 3:46:00 PM

Laurie,

To update you on our helium-3 recycling project, SAIC has just shipped the first 5 systems with the GFE gas. The price of helium-3 (in large quantities) is in the $300 to $500 per liter range, so it does look like we will be saving the government around $2M. From the national security perspective it is probably more important that this effort has provided the systems to secure the northern board on schedule.

Thanks again,
Mark
5-2778

From: Conger, Martin D
Sent: Thursday, August 28, 2008 8:30 PM
To: Davidson, Suzanne M
Cc: Armstrong, Christopher B; Martinez, Donna L (PNNL)
Subject: FW: OPA nomination

Seems worthy of a OPA.

Marty Conger
Associate Laboratory Director, Business Systems & Chief Financial Officer Pacific Northwest National Laboratory
902 Battelle Boulevard
P.O. Box 999, MSIN K1-70
Richland, WA 99352 USA
Tel: 509 375-3712
Cell: 509 521-4065
Fax: 509 375-6695
martin.conger@pnl.gov
www.pnl.gov

From: Panisko, Mark E
Sent: Thursday, August 28, 2008 4:20 PM
To: Conger, Martin D; Kluse, Michael
Subject: OPA nomination

Helium-3 is an isotope which is currently only produced for commercial use by two entities, the US DOE Isotope Program at Savannah River and at the Russian facility at Mayak. Helium-3 is used in neutron detectors (it captures a neutron to become Helium-4) for numerous applications (safety, security, medical and basic research).

Commercial Helium-3 is in EXTREMELY short supply and prices have gone up approximately 10 fold to $400 per liter in the pass year (faster that the price of gas). Each RPM requires 45 liters of Helium-3 for their neutron detectors. According to our vendors there is no longer a sufficient supply of Helium-3 for our current RPM needs and we do not expect that to change until DOE releases more in a few months.

Laurie, with the help of Wanda McCollom, set out to look for neutron detectors across the DOE complex in the hopes we could recycle the gas and use it in new detectors. As it turns out they have located 5,000 liters of Helium-3 in tubes that have been designated for excess here at the Lab. I have discussed with our vendors the technical aspects of recycling this gas and they have estimated that we should be able to recover 90% of the gas. The 100 RPMs we can outfit with these tubes will support three months of deployments so we should be able to bridge the gap until more Helium-3 is released and avoid a work stoppage, in addition to saving the client about $2,000,000.

I am not sure what the going rate for OPAs for saving clients $2M and avoiding work stoppages on major projects, but whatever it is you should put Laurie and Wanda down for it next time you are passing out checks.

Thanks,
Mark
5-2778

FW: He3 supply for Second Line of Defense requirements
Pantaleo, John to: carroll.mcfall 08/12/2008 08:38 AM
Bcc: Carroll Mcfall
History: This message has been replied to and forwarded.

Hi Carroll,

We had our isotope workshop last week and it was well attended. A number of issues are looming for DOE. I am passing this e mail for you inform. There is a lot of interest and demand for he-3. We will need to chat soon.
John

-----Original Message-----
From: Victor Gavron [mailto:gavron@lanl.gov]
Sent: Monday, August 11, 2008 12:32 PM
To: Pantaleo, John
Subject: He3 supply for Second Line of Defense requirements

Dear John,

Following our brief discussion at the Isotope Workshop last wee, I would like to provide you with more details concerning the He3 supply issue. I ahve also sent this information to Abdul Dasty to solicit his response. If it is convenient for you, we could schedule time later this week to follow up via a phone call.

Here are the details:

The NNSA Second Line of Defense (SLD) program (run by NA-256), is tasked to prevent transportation and smuggling of radioactive materials, and in particular Special Nuclear Materials that can be used for nuclear weapons construction. It manages the "Core" and "Megaports" programs, that set up monitoring stations around the world. One essential component of the monitors that are being implemented in many ports and points of entry around the world is a neutron monitor. These neutron monitors are essentially the only way to detect smuggling of plutonium, whose gamma rays may be shielded by lead or other materials.

Standard neutron detectors include a proportional counter, filled with several atmospheres of He3. This gas is very efficient in capturing thermal neutrons and producing a large amount of energy in the associated capture. Pulses produced by this energy release are easily counted. The He3 tubes are embedded in a small amount of moderating material to increase the capture efficiency. Many such tubes have already been distributed world-wide as part of the TSA portal monitor.

The SLD program is committed to install such monitors world-wide, requiring a total of 5 Kg's (37,300 liters) of He3 by the year 2015. In addition, other types of monitors that we will be required to install in the foreseeable future, may require additional He3.

Needless to say, detecting plutonium smuggling is a vital US national security concern that we face today. Thus, anything you can do to help us obtain the He3 that we need, or any information you can provide about alternative sources, would be of immense help!

At this time, there already is no He3 available - we would like to know when the supply will be renewed.

The unavailability of He3 would force us to look for alternatives. The alternatives we are aware of
1) would have less efficiency and stability (implying a lower probability of smuggling detection)
2) would require significant development and changes in implementation, delaying deployment by several years (during which, our commercial supply lines will be unprotected)

In short, lack of He3 would result in further jeopardy to our national security.

Thank you for your help!

Victor

--

Victor Gavron, Ph.D.
Senior Advisor
Supporting NNSA - Second Line of Defense (NA-256) Los Alamos National Laboratory Los Alamos, NM 87545 USA

505-667-5475

http://public.lanl.gov/gavron

Foreign: TSPA

SRS **Re: FW: He3**
Carroll Mcfall to: McCollom, Wanda T 09/04/2008 06:44 AM

Wanda,

He-3 is in short supply. We have identified both government and commercial needs over the next few years that exceed our projected supply. If your needs are to support some government use, I would recommend you contact the DOE Isotope Program Manager John Pantaleo at (301)903-2525.

Carroll McFall
Assistant Manager for Mission Assurance
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

"McCollom, Wanda T" <Wanda.McCollom@pnl.gov>

"McCollom, Wanda T" <Wanda.McCollom@pnl.gov>
09/03/2008 02:31 PM
To <carroll.mcfall@nnsa.srs.gov>
cc
Subject FW: He3

Carroll: Please see messages below. Would you happen to have any excess He3?

Wanda T. McCollom
Excess Materials & Redeployment Services (EMRS)
Pacific Northwest National Laboratory
Phone: (509) 375-5941
Fax: (509) 375-2126

From: herbert.nigg@srnl.doe.gov [mailto:herbert.nigg@srnl.doe.gov]
Sent: Tuesday, September 02, 2008 12:24 PM
To: McCollom, Wanda T
Subject: Re: He3

Contact Mr. Carroll McFall here ats SRS who handles He3 requests.

Thanks,
Lee

carroll.mcfall@nnsa.srs.gov

"McCollom, Wanda T" <Wanda.McCollom@pnl.gov>

08/26/2008 03:54 PM

To "herbert.nigg@srnl.doe.gov" <herbert.nigg@srnl.doe.gov>
cc
Subject He3

Lee: I am looking for some excess He3 and was given your name as a possible source. Would you happen to have any that is excess to your needs?

Wanda T. McCollom
Excess Materials & Redeployment Services (EMRS)
Pacific Northwest National Laboratory
Phone: (509) 375-5941
Fax: (509) 375-2126

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Friday, October 24, 2008 4:36 PM
To: Pantaleo, John
Subject: He3supply
Attachments: He3supply.doc

John,

Please use this version. There were some formatting errors in the last version I sent. I hope this meets your requirements for information.

I will call you on Monday afternoon.

Jack

October 21, 2008

Mr. John Pantaleo
United States Department of Energy
19901 Germantown Rd.
Germantown, MD 20874-1290

Dear Mr. Pantaleo,

Spectra Gases, Inc. is engaged in the business of supplying stable isotopes to meet the needs of the industrial, research, defense, and homeland security markets since 1991. Helium-3 is one of the many stable isotopes which Spectra manufactures for these markets. We are experiencing a critical shortage of helium-3 to meet current demand and therefore we have requested an emergency release of material to meet these demands. An immediate release of 11,000 liters would alleviate supply concerns through February 2009 for the customers supplied by Spectra Gases.

Prior to 1998 Spectra Gases purchased helium-3 gas from the Department of Energy. When the DOE stopped supplying helium-3 we secured supplies from Russia to meet the needs of the market. Up until 2002 the world demand for helium-3 had consistently been in the range of 20,000 STP liters per year. However, after the events of 9/11 the requirements have grown to about 75,000 STP liters per year.

During the past five years Spectra has sold over 205,000 liters of helium-3 gas comprised of both Russian and United States sourced helium-3. Spectra also purified an additional 104,000 liters of helium-3 gas supplied from the DOE to GE Reuter Stokes and the SNS project. Spectra Gases helium-3 tritium remediation system was designed and built in 2002 specifically to handle tritiated helium-3 supplied to the market through the DOE via SRNL. The DOE material since 2003 has made up about 60% (160,000 STP liters) of the world supply of helium-3, which has enabled us to meet the demands of the various industrial, research, and defense related requirements in the United States and abroad.

Several of Spectra Gases customers have defense/homeland security contracts to provide neutron detection systems. We also have customers who are funded through the NIH for research of Chronic Obstructive Pulmonary Diseases (COPD) which require helium-3 as a diagnostic material in MRI studies of the human lung. Still other customers are involved in Oil Logging operations, while others are involved in important low temperature physics research and spalatial neutron detection systems in Europe and Japan.

Spectra averaged 45,000 liters of helium-3 sales per year since 2003. Following is a breakdown of our sales by market application:

- Neutron Proportional Counters/other defense applications 60.8%
- Cryogenics/Low Temperature physics research 12.2%
- University Research 6.6%
- Commercial Manufactures of Helium-3 refrigerators 5.5%
- Oil Well Logging operations 5.4%
- High Energy Labs (Neutron Scattering) 5.1%
- Lung Imaging for COPD research 4.4%

Spectra has prided itself in its stewardship of the helium-3 resources provided to us from both the United States and Russia. We maintain certificates of use for each of our customers and follow-up with personal visits and audits of the customers to assure that the materials are being used as specified in the certificates. We have worked very closely with the Department of Commerce to assure that the materials we supply to foreign customers are used as agreed. As a result of our responsible stewardship we are in a very good position to determine the allocation of product to all customers in the event that demand exceeds supply. Today we are in this position and we are working very hard to develop an allocation system that will keep the market supplied. The release of additional material from the DOE is essential in this plan.

As per your request I have provided a list of a few select customers with their specific United States Government contract numbers and some well known customers involved in activities critical to the interests of the United States, to aid you in the evaluation of our request for emergency supply of helium-3 to meet their requirements. They are as follows:

- Honeywell, Sensor and Guidance Products (missile guidance systems):
  - Contract 4200053402 Priority DOA5
  - Contract 100687 Priority DOA5
  - Contract 115777 Priority DOA3
- SAIC (neutron proportional counters for the PNNL project): Contract No. DE-AC05-76RL01830
  - Short 3,000 liters for current orders for 2008
  - Short 8,000 liters for early 2009
- University of Pennsylvania & University of Virginia (COPD research under an NIH project): Project number will be supplied.
- Thermo-Fisher (neutron detectors for Homeland Security): Contract numbers to be supplied
- Saint Gobain (neutron detectors for Homeland Security): Contract numbers to be supplied
- Ordela, Inc. (refurbish neutron proportional counters for ORNL): Contract/PO to be supplied
- Schlumberger (Oil Logging Operations): no contracts but they are the largest Oil Logging operation in the United States.
- Oxford Instruments, Inc. (Helium-3 dilution refrigerators critical for all low temp research)

If you require additional information please do not hesitate to contact me directly. We look forward to your response.

Sincerely,

Jack Faught

Vice President
Spectra Gases, Inc.

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Tuesday, October 28, 2008 11:39 AM
To: Pantaleo, John
Subject: Helium 3 Supply

John,

We are very concerned about the proposed allocation plan for helium-3.
I can understand the approach to allocate product to the DHS and NNSA, but it seems unfair that remaining product is not allocated to Spectra (at the same price as HDS and NNSA) for use in the United States to support the other applications such as Medical, Oil Logging, Cryogenics, and Research markets. Spectra has supported this market for over ten years and it is made up of a lot of small users that will not be able to compete to buy the product. If we are unsuccessful in obtaining the product these important areas of work may be left out in the cold, and it will go to the neutron detector giants who are already being allocated product through the HDS and NNSA. Can we discuss this further?

Jack Faught

From: Rither, Alan C
To: Panisko, Mark E; Branton, Vincent A
Cc: Grubbs, William K (Kevin)
Subject: RE: Remanufacturing "proprietary" equipment
Date: Wednesday, November 05, 2008 10:20:56 AM

In the famous words of that Masked Man's sidekick, "NO SWEAT, KIMOSABE." When we own an item, the He-3 contained in it is ours to use however we wish.

Thanks!

Alan

http://en.wikipedia.org/wiki/Helium-3

From: Panisko, Mark E
Sent: Tuesday, November 04, 2008 5:07 PM
To: Branton, Vincent A
Cc: Grubbs, William K (Kevin); Rither, Alan C
Subject: Remanufacturing "proprietary" equipment

Vincent,

Alan is out of the office, so I am passing this on to you.

We have some "excess" neutron detectors that we most likely received from the DoD 20 years ago or so. These tubes contain helium-3 which is in such short supply, that we can not get any suppliers to contract for new tubes without providing the helium-3 as GFE. The tubes we have were manufactured by GE Reuter-Stokes. Their sales representative was not very happy that we were considering competing the award for new tubes this way as "their" tubes may end up at their competitors.

I first gave him my "I am not a PNNL contracts specialist or attorney and my opinions are not those of Battelle, PNNL or DOE" speech. I also told him if there were any issues with their equipment being proprietary I would guess they would have been detailed in the acquisition contract. I told him I would provide him with our contracts and legal contact information. I was going to give him Kevin's and Alan's but Alan is out.

Kevin is on travel today and tomorrow but I have briefed him on his cell (521-5022).

Please give me a call or point me to another contact in legal.

Thanks again,

Mark

5-2778

521-4714

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Thursday, November 06, 2008 4:18 PM
To: Pantaleo, John
Subject: Helium 3 Supply

John,

I finally had to respond back to SAIC regarding supply of helium-3.
During my conversation with their representative it was disclosed to me that they have already been assured of supply through their contracting agency, stating that they will be allocated "clean" (meaning detritiated Helium 3 gas) to fulfill the PNL contracts. Since they are our largest customer, it is extremely disheartening to Spectra to hear this news. I was under the impression from talking to you that this was just in the proposal stage. I would appreciate clarification on this point as it has serious implications to our business.

In my recent letter to you I disclosed that Spectra is currently supplying 67% of the world supply of helium 3 using both the DOE material that we won on competitive bid and the Russian material that we purchased under contract. Spectra will be placed at a competitive disadvantage if the DOE proceeds with the proposed method of distributing 2/3 of the DOE product through DHS and NNSA and 1/3 through competitive bid. It will unfavorably disrupt supply, create shortages to other strategically important markets such as Oil Exploration, and Medical Research of drugs for Chronic Obstructive Pulmonary Diseases, etc. It will also drive prices up to unreasonable level with no assurance of supply to the markets beyond neutron detectors.

Spectra Gases requests a meeting to discuss the DOE distribution plan before it is implemented. The requirements for this Isotope for ALL markets are all in serious short supply as a result of the failure to release this material, but it is essential that it be released in a fair and equitable way.

Regards,

Jack Faught

From: Panisko, Mark E
To: Bowyer, Sonya M
Subject: FW: Helium-3 update
Date: Friday, November 21, 2008 12:30:00 PM

From: Panisko, Mark E
Sent: Friday, November 21, 2008 12:30 PM
To: Henderson, John M (Mark); Dalzell, John J; Craig, Jeffrey R; Morrey, Eugene V; Grubbs, William K (Kevin)
Subject: Helium-3 update

SAIC has informed us that their neutron tube supplier is NOT going to be able to fulfill their order for tubes to cover part of the second bridging contract and any of the third bridging contract (a 204 tube deficit total). Kevin and I are working quickly to modify the existing bridging contracts to provide our "old" tubes as GFE for a discount in purchase price as well as place a new order for systems with helium-3 provided as GFE.

The latest rumor has DOE releasing some gas in December, but the specifics on how to divvy up the gas has not been finalized.

Unless something changes soon, I expect us to have a shortage of neutron tubes in June 2009.

Thanks,
Mark
5-2778

Battelle
The Business *of* Innovation

Internal Distribution

File/LB

Date November 24, 2008

To File

From Kevin Grubbs

Subject Memorandum of Procurement – SAIC

Background
This procurement is to obtain deployable radiation portal monitors (RPM) systems consisting of hardware and software intended as the primary screening tool for the detection of radionuclides within fully loaded intermodal cargo containers, trucks, passenger vehicles, rail cars, and mail at United States (U.S.) ports of entry (POE).

In September 2003 Battelle awarded an Indefinite Quantity, Fixed Unit Price competitive contract to SAIC for delivery of RPM's. The maximum value of Contract No. 8336 was in excess of $80M and the contract expired on 12/31/2006. An additional procurement for RPMs (Contract No. 43185 valued at just under $10M) was awarded in July 2007.

Due to the delays in the Advanced Spectral Portal (ASP) acquisition (the next generation RPMs being acquired by DHS), the project has determined that 550 RPMs will need to be acquired over the course of the next two years for Port-of-Entries that were previously identified to have ASPs installed and those Port-of-Entries undergoing expansions.

Previous actions to develop competition and to eliminate a noncompetitive situation in future procurements of the proposed goods or services have been limited by intellectual property rights of the supplier. Under a previous contract (No. 43185), SAIC provided government use rights for the RPM8 software on February 12, 2008. PNNL is developing the specification package that will be provided to potential suppliers so they are able to modify system hardware to accept and properly run the government use rights software.

The contract negotiations, approvals and award are still ongoing for a new contract for the 550 systems, but at our current schedule we will run out (during the 130 days ARO) if we do not place this order for an additional 36 systems. PNSO was advised of this requirement and approved of this separate contract.

Sole Source Procurement
During the course of the RPM project over 1,000 SAIC RPM8s have been acquired. Additional RPMs need to be acquired over the course of the next 2 years for Ports of Entry that are undergoing expansion and these new RPMs must be identical to the previously installed RPMs.

A complete, approved Sole Source Justification is located in the Contract File, Section VI, Tab A.

Under Contract No. 43185 PNNL was able to obtain Government Use Rights to the SAIC RPM8 algorithm, and this algorithm will be used to bring other manufacturers' RPMs up to the same

File 74941
Page 2

specifications as the SAIC RPMs. This process may take 1-2 years but PNNL anticipates that at the end of 2 years we will be able to issue a competitive solicitation for future RPM needs.

Contract Type
The required RPM systems are commercial items available from SAIC on a published price list. The contract will be Fixed Unit Price for the 36 required RPM systems. This contract type will provide for the appropriate assumption of contract risk by the Contractor and afford maximum financial protection to the Government, as payments will only be made for equipment that has been delivered and accepted by Battelle.

Solicitation
In April 2008 PNNL issued a formal RFP (RFP No. 60260) to SAIC for an IDIQ contract for RPMs. The draft IDIQ contract (No. 67258) was submitted to DOE for review and approval in July 2008, however, Battelle was subsequently notified by SAIC that the price of Helium 3 used in the RPM neutron detector tubes had risen substantially since prices were first quoted to Battelle in February 2008 and that SAIC could not execute the IDIQ contract without a price increase. Battelle advised PNSO of the HE-3 issue and requested that Contract No. 67258 be withdrawn from review until new prices could be negotiated with SAIC.

Three contracts for RPMs have subsequently been awarded to SAIC. Contract No. 68847 was awarded in August 2008, Contract No. 72664 was awarded in September 2008 and Contract No. 74941 was awarded in September 2008.

Negotiations for the IDIQ contract with SAIC are still ongoing and PNNL still has an urgent need for additional RPMs. This procurement is for an additional 36 RPMs.

The Manager, Contracts (Laurie Berube) approved the use of simplified acquisition procedures for this procurement.

Upon completion of a review by the Battelle Acquisition Review Board, Request for Proposal (RFP) 81674 was issued to SAIC on October 17, 2008.

SAIC's proposal was received October 31, 2008.

Proposal Evaluation
A formal technical evaluation was not requested since SAIC proposed to provide the requested RPMs.

Responsive/Responsible Offeror
I deemed SAIC to be responsive and responsible based on their past performance on Battelle projects and their long standing positive position with the Laboratory.

For Contract 8336 PNNL's Cost/Price Office Manager, Mr. Mike Terrell provided a detailed analysis of SAIC financial condition to include an "Altman Z Score Analysis" and found them to be a financially capable supplier. SAIC continues to be a financially capable supplier

For Contract 8336 three entities which held contracts with SAIC were contacted and provided very

OFFICAL USE ONLY
BUSINESS SENSITIVE

Notes from Helium-3 December 03, 2008 telecon

We had a bad line so it was a little hard to hear names and determine who was talking, but here we the players.

John Pentalao – Isotope Production
Louisa Romera – John's deputy
ORNL – Jerry and Rocky Kline
SRNL – Wolfgang, Carol and Tim Fisher (general counsel)
GE – Rob Hair and Tom Anderson
Spectra Gases - Jack
SLD- Elly Melamed
Office of Nuclear Physics – didn't catch her name

John led the meeting. He plans to sell 6 cylinders (~20k liters total) at last years pricing right now with the caveat that a certain percentage (he batted numbers between 65% - 75%) be held at each supplier (GE & Spectra Gases) and only sold for National Security programs. He also said he didn't care about what prices they sold the gas (back to the government).

First all the gas needs to be sent to Spectra Gases for purification. They provided a 3 week estimate (after receipt) to purify the gas. 3 cylinders will then be shipped to GE.

They have no idea on how the gas should be divvied up. Elly emailed me during the telecon to call her after the meeting.

She voiced her concern that she was "end user" on the telephone. I told her I would prefer that Isotope Production sell me (PNNL) the gas directly and then I can compete contracts for producing tubes with helium-3 being provided as government furnish equipment (GFE). She indicated that was discussed previously and she wants all of SLD's gas to go to GE and Ernie told her that RPMs tube were also manufactured by GE. I told her that wasn't the world for us if the gas were provided to the two suppliers. My guess is that Isotope Production has only sold the gas to these two in the past and they may have some political pull. We discussed how to divvy up the gas and she indicated that wanted two cylinders for SLD to go to GE. I recommended that two cylinders go to Spectra for DHS. If we need tubes for ASPs we can have Spectra sell some to GE. DoD and the other players would then have priority on the remaining gas.

John also plans to auction 4 cylinders (~14k liters total) in February.

The folks at SRNL them said they are under contract to produce 10k liters per year and that would be all that would available as their reserves are now small (they didn't give a number). So it looks like we are going to have a real shortage for a long time.

From: Bowyer, Sonya M
To: "Melamed, Elly"; Panisko, Mark E
Cc: Deforest, Thomas; Kostorowski, David G
Subject: RE: RPM tube producers
Date: Friday, December 05, 2008 10:37:33 AM

Hi Elly,

I received your email early this morning and I am working through the delicate subtle process of ensuring no one at DHS is blind-sided or opposed to my name being given as the POC for the DHS material. I will get back with you as soon as I can with a definitive answer. Hope this isn't putting you in a time crunch. Call if you want to discuss further. Thanks. -Sonya

Sonya M. Bowyer, Ph.D.
Rad/Nuc, DHS Sector
National Security Directorate

Pacific Northwest National Laboratory
902 Battelle Boulevard
P.O. Box 999, MSIN K8-30
Richland, WA 99352 USA
Tel: 509-372-6986
Cell: 509-378-0523
sonya.bowyer@pnl.gov
www.pnl.gov

-----Original Message-----
From: Melamed, Elly [mailto:Elly.Melamed@nnsa.doe.gov]
Sent: Friday, December 05, 2008 6:54 AM
To: Bowyer, Sonya M; Panisko, Mark E
Cc: Deforest, Thomas; Kostorowski, David G
Subject: RE: RPM tube producers

Can I give you as the contact for the DHS material, Sonia?

-----Original Message-----
From: Bowyer, Sonya M [mailto:sonya.bowyer@pnl.gov]
Sent: Thursday, December 04, 2008 6:16 PM
To: Melamed, Elly; Panisko, Mark E
Cc: Deforest, Thomas; Kostorowski, David
Subject: RE: RPM tube producers

Elly,
Two cylinders does a lot for us so I certainly understand if the train has left the station and it is too late to make changes now. Again, we really appreciate all your efforts on this and your willingness to look out for the DHS needs. Please let me know if we can help with anything. Thanks. -Sonya

Sonya M. Bowyer, Ph.D.
Rad/Nuc, DHS Sector
National Security Directorate

Pacific Northwest National Laboratory
902 Battelle Boulevard

P.O. Box 999, MSIN K8-30
Richland, WA 99352 USA
Tel: 509-372-6986
Cell: 509-378-0523
sonya.bowyer@pnl.gov
www.pnl.gov

-----Original Message-----
From: Melamed, Elly [mailto:Elly.Melamed@nnsa.doe.gov]
Sent: Thursday, December 04, 2008 2:53 PM
To: Bowyer, Sonya M; Panisko, Mark E
Cc: Deforest, Thomas; Kostorowski, David G
Subject: RE: RPM tube producers

Frankly, I don't know about 3 cylinders. I had spoken earlier with Ernie and he had agreed to the two cylinders and the process has moved along so not sure I can fix. However, I am working on crafting language for use and will try to think of a way for you to get priority on the material not targeted for you. Also, you can also bid in February for the additional three cylinders.

Been a bit crazy here but I will be working on the language tomorrow and will keep you informed.

E.

-----Original Message-----
From: Bowyer, Sonya M [mailto:sonya.bowyer@pnl.gov]
Sent: Wednesday, December 03, 2008 5:55 PM
To: Melamed, Elly; Panisko, Mark E
Cc: Deforest, Thomas; Kostorowski, David
Subject: RE: RPM tube producers

Hi Elly,

I chatted with Mark Panisko after his conversation with you. Sorry I couldn't be on longer. I understand that the question we need to answer for you right now is how much gas needs to be designated for DHS short term needs. The estimates we put together for FY09 shows us needing ~12,000 liters. If each cylinder is around 3,300 liters than we need way more than two. Do you think we could get 3 out of the 6 cylinders designated for DHS?
As I am sure you got from Mark, we can accommodate working with Spectra and/or GE getting the DHS portion of the gas. We would then look to compete the tube manufacturing. We will work with DHS to be designated the responsibility for managing the gas. Does that sound reasonable?

What do you see as the next steps?

Thanks so much for allowing us to participate today. We really appreciate it. -Sonya

---

Sonya M. Bowyer, Ph.D.
Rad/Nuc, DHS Sector
National Security Directorate

Pacific Northwest National Laboratory
902 Battelle Boulevard

P.O. Box 999, MSIN K8-30
Richland, WA 99352 USA
Tel: 509-372-6986
Cell: 509-378-0523
sonya.bowyer@pnl.gov
www.pnl.gov

-----Original Message-----
From: Melamed, Elly [mailto:Elly.Melamed@nnsa.doe.gov]
Sent: Wednesday, December 03, 2008 11:11 AM
To: Panisko, Mark E
Cc: Bowyer, Sonya M
Subject: RE: RPM tube producers

Why don't you call me when this call is finished.

-----Original Message-----
From: Panisko, Mark E [mailto:mark.panisko@pnl.gov]
Sent: Wednesday, December 03, 2008 1:26 PM
To: Melamed, Elly
Cc: Bowyer, Sonya M
Subject: RPM tube producers

Elly,

For our needs we do not want to call out a specific tube manufacture. We will want to send out requests for bids to produce the tubes with the helium provided as government furnish equipment (GFE). And then award to the lowest responsive responsible offeror. We are currently doing this with "old" tubes for recycling.

Thanks,
Mark
509-375-2778

Clenney, Jaclyn

From: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy) [thomas.anderson1@ge.com]
Sent: Tuesday, December 09, 2008 4:10 PM
To: Melamed, Elly
Cc: Pantaleo, John; Haer, Robert E (GE Infra, Energy)
Subject: He3 gas for US Security Applications

Elly,

I am hoping to get 30 minutes to talk with you either Wednesday or Thursday to discuss how we will manage the gas slated for US security programs. Are you available? If not, do you have time early next week?

Following is a list of items I would like to discuss:
1. Your expectations and how you would like to run the program. I want to make sure I meet your expectations. Will you be the clearinghouse for questions/issues or will someone else support?
2. How much info do I need to allocate "Security Gas." In some cases my customer, because of lead times, will place an order for detectors based on a verbal from the govt.
3. I need further clarification on US Security - in some cases it is very obvious but we do a lot of work for the DOE labs? I have an order in house for detectors that will be used in a nuclear assay system at Savannah River. Can I allocate "Security Gas" for this application.
4. How do we handle (what proof is required) systems sold to states and local governments.
5. I have OEMs in Europe and Asia who assert that they are in the process of developing systems (and one OEM who asserts they will soon be providing systems) for Megaports. However, some feel their connection to the Megaports program is sensitive so they are unwilling to give me the info I need to allocate Security gas. I know some of these OEMs supply internationally - how do I tie these guys off and clearly understand the US Security piece - I will specify that any gas I supply as "Security gas" is expressly restricted and must go to meet Megaports requirements.
6. I understand the Security gas will be used for US Security. Has any thought been given to supporting IAEA international safeguards programs. Most of these are fairly small but some can be relatively large for instance the Rokkasho fuel processing plant in Japan (they will be reprocessing 5 to 8 tons of Plutonium per year). They will be purchasing a system to verify the accountability of the plutonium.

I recommend a monthly report initially until we sort through the issues.
I am still collecting info from OEMs. I will get USG contract numbers wherever possible.

Thanks,

Tom

From: Panisko, Mark E
To: Henderson, John M (Mark)
Cc: Sturges, Marcus H; Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H; Pagh, Richard T; Dalzell, John J; Craig, Jeffrey R; Grubbs, William K (Kevin)
Subject: RE: Helium-3 update
Date: Monday, December 15, 2008 11:55:00 AM

The fourth bridging order (with He-3 as GFE) was awarded to SAIC and all available excess He-3 tubes are en route to SAIC's tube manufacture (should arrive in NY this week, weather permitting). The RFP for the fifth bridging order is at SAIC. We do not believe we have enough GFE He-3 to fulfill this complete order, so we asked SAIC to provide pricing for some of the systems without tubes if they can not acquire the He-3 in time to complete the systems. Based on my latest deployment schedule we will be delivering the systems without tubes to the field in May right after we receive them. I am not sure how quickly the systems without tubes are scheduled to be commissioned but you certainly will have some by July.

The He-3 rumor mill has some gas being sold by DOE to SAIC's tube manufacture and allocated only for DHS proposes in the near future. As of Friday their tube manufacture would/could not confirm that. How the gas will be disturbed to projects from there is unknown.

Thanks,
Mark

From: Panisko, Mark E
Sent: Tuesday, November 25, 2008 9:59 AM
To: Henderson, John M (Mark);
Cc: Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H
Subject: RE: Helium-3 update

The fourth bridging order is going to the PNNL Acquisition Review Board (ARB) for approval tomorrow. Part of that includes approving SAIC proposed $2,388/tube price decrease for providing our "old" tubes as GFE. After ARB approval it goes to DOE's IP attorney for approval (there is "canned" IP language that SAIC, PNNL and DOE have approved on the earlier orders but it requires DOE approval for each contact award). Once approved, Kevin will move forward to modify POs# 72664 & 74941 to include tubes as GFE and reduce the price - assuming you approve Req# 86079. I have an approved requisition for the fifth bridging contract that will consume the remainder of the gas from the "old" tubes.

From: Hevland, Mark E
To: Bowyer, Sonya M; Martin, Steven W
Subject: FW: Helium-3 update
Date: Monday, December 15, 2008 12:09:06 PM

FYI

Mark Hevland

Deputy Project Manager
Radiation Portal Monitor Project
Pacific Northwest National Laboratory
Tel: 509-372-4471
Cell: 509-430-9571
mark.hevland@pnl.gov

From: Panisko, Mark E
Sent: Monday, December 15, 2008 11:56 AM
To: Henderson, John M (Mark)
Cc: Sturges, Marcus H; Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H; Pagh, Richard T; Dalzell, John J; Craig, Jeffrey R; Grubbs, William K (Kevin)
Subject: RE: Helium-3 update

The fourth bridging order (with He-3 as GFE) was awarded to SAIC and all available excess He-3 tubes are en route to SAIC's tube manufacture (should arrive in NY this week, weather permitting). The RFP for the fifth bridging order is at SAIC. We do not believe we have enough GFE He-3 to fulfill this complete order, so we asked SAIC to provide pricing for some of the systems without tubes if they can not acquire the He-3 in time to complete the systems. Based on my latest deployment schedule we will be delivering the systems without tubes to the field in May right after we receive them. I am not sure how quickly the systems without tubes are scheduled to be commissioned but you certainly will have some by July.

The He-3 rumor mill has some gas being sold by DOE to SAIC's tube manufacture and allocated only for DHS proposes in the near future. As of Friday their tube manufacture would/could not confirm that. How the gas will be disturbed to projects from there is unknown.

Thanks,

Mark

As the "old" tubes are only half the pressure, they are not considered pressurized (and they are not cryogenic, radioactive or hazardous) by the DOT and therefore they non-regulated for transportation per the PNNL Hazardous Material Transportation Officers (HMTOs). The HTMOs recommended using a crate designed for BFE tubes to protect the tubes during shipment. I had a service request submitted last week to build four crates. Once the contracts are signed and the crates are built I will have the tubes swipe tested for rad contamination, loaded in the crates, spray foamed and sent directly to the neutron tube manufacture.

At this time we still need to procure systems without tubes, so Kevin and I will push forward on that once we have the contracts in place to consume the helium-3 we have on hand.

Mark
5-2778

From: Henderson, John M (Mark)
Sent: Tuesday, November 25, 2008 9:24 AM
To: Panisko, Mark E; Sturges, Marcus H
Cc: Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H
Subject: RE: Helium-3 update

Mark - what is the detailed plan for providing the He tubes as GFE? I have not seen anything clearly defined. I will need to see this ASAP.

Richard - what is the status on the analysis / briefing on alternatives for He tube configurations in the SAIC portals?

Thanks,

J Mark

From: Panisko, Mark E
Sent: Friday, November 21, 2008 12:30 PM
To: Henderson, John M (Mark); Dalzell, John J; Craig, Jeffrey R; Morrey, Eugene V; Grubbs, William K (Kevin)
Subject: Helium-3 update

<< File: Body_Rtf.rtf.ent >> << File: Body_Txt.txt.ent >>

From: Panisko, Mark E
To: Henderson, John M (Mark); Sturges, Marcus H
Cc: Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H; Grubbs, William K (Kevin)
Subject: RE: Helium-3 update
Date: Tuesday, November 25, 2008 10:53:00 AM

We are providing the old tubes to SAIC as GFE for discounted system pricing (we are shipping directly to the tube manufacture to save time and shipping costs). SAIC will contract for the gas recycling (they have already competed this action and provided us with the quotes so that we could determine price reasonableness.

When we place an order for systems without tubes we will need to get SAIC's specification for their tubes in order to assure the "replacement" tubes are spec compliant.

Mark
5-2778

From: Henderson, John M (Mark)
Sent: Tuesday, November 25, 2008 10:41 AM
To: Panisko, Mark E; Sturges, Marcus H
Cc: Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H
Subject: RE: Helium-3 update

Reading past the message below, I assume that we will place a contract with the He tube mfg to recover the He from our tubes, and produce RPM8-spec compliant tubes for GFE supply to SAIC. Can you confirm this please.

Thanks,

J Mark

From: Panisko, Mark E
Sent: Tuesday, November 25, 2008 9:59 AM
To: Henderson, John M (Mark); Sturges, Marcus H
Cc: Hevland, Mark E; Khawaja, Asim; Prigge, Jami G; Ely, James H
Subject: RE: Helium-3 update

<< File: Body_Rtf.rtf.ent >> << File: Body_Txt.txt.ent >>

Domestic Nuclear Detection Office (DNDO)

The Roles of Isotopes in Homeland Security

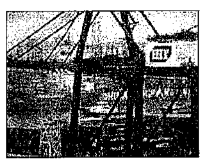
December 15, 2008

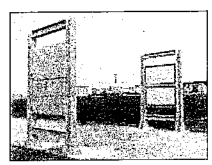
Jason Shergur
Test Scientist, DNDO
Department of Homeland Security

Homeland Security

The Radiological and Nuclear Threat

- The risk of a terrorist acquiring and using a nuclear or radiological device is one of the greatest threats to the Nation
  - A robust, layered defense must be developed
  - Each layer must reduce the terrorist's ability to use such threats against us
- The layered defense concept includes:
  - Eliminating excess stocks of nuclear materials and weapons
  - Protecting existing stocks from theft or diversion
  - Detecting illicit movement of nuclear or radiological material overseas
  - Enhancing domestic detection and interdiction efforts





Homeland Security

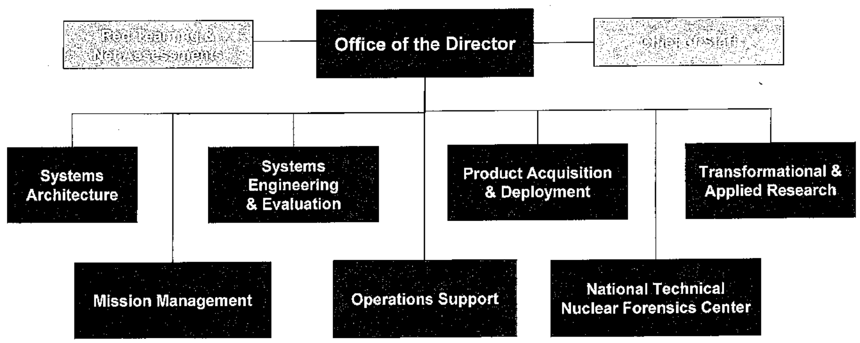
DNDO Mission and Objectives

DNDO is a jointly-staffed, national office founded on April 15, 2005 to improve the Nation's capability to detect and report unauthorized attempts to import, possess, store, develop, or transport nuclear or radiological material for use against the Nation, and to further enhance this capability over time.

- Develop the global nuclear detection and reporting architecture
- Develop, acquire, and support the domestic nuclear detection and reporting system
- Thoroughly characterize detector system performance before deployment
- Establish situational awareness through information sharing and analysis
- Establish operation protocols to ensure detection leads to effective response
- Conduct a transformational research and development program
- Maintain the National Technical Nuclear Forensics Center to provide centralized planning and integration of USG nuclear forensics programs

DNDO Organization

- DNDO and its Directorates are oriented towards addressing key mission areas while meeting the functional objectives outlined in its founding Presidential Directive



Isotopes play a role across all DNDO mission areas

Homeland Security

Key Mission Areas

- DNDO focuses on increasing detection capabilities in key mission areas as part of a comprehensive strategy to protect the Nation against radiological and nuclear threats.
  - At Ports of Entry
  - Between Ports of Entry
  - Small Maritime Vessels
  - General Aviation
  - Domestic Interior
- DNDO collects requirements and develops integrated plans with executing partners in each mission area that address:
  - Product acquisition and deployment
  - Support of field operations
  - Information sharing and alarm resolution

Material-centric Mission

Reduce illicit trafficking of radiological and nuclear materials

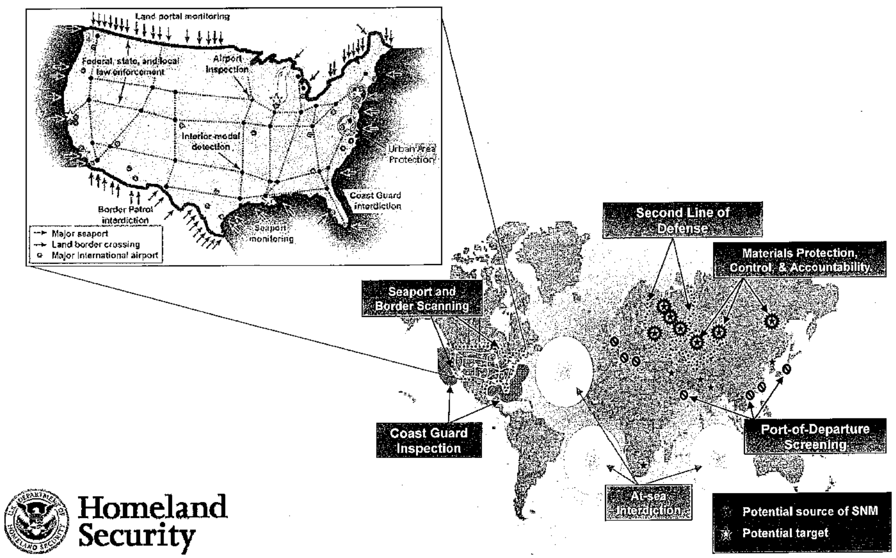
1. Detection of nuclear or radiological material
   - Interdict suspect material shipments
   - Perform forensics on seized or found material
   - Utilize isotopes for testing systems

2. Reduction of radiological material from stream-of-commerce
   - Secure material at the point of origin
   - Support the development of source replacement technologies

Homeland Security

System Architecture

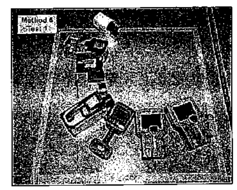
Develop the global framework for source security and detection

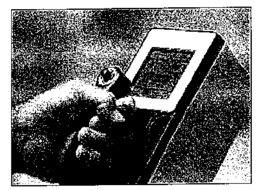


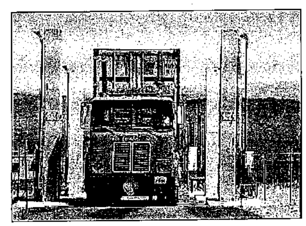
Homeland Security

Product Acquisition and Deployment

- Goal: to develop, acquire, and support current and next generation nuclear detection systems
- Making a sound determination for acquisition requires thorough testing of systems which relies on the availability of Isotopes:
  - Stable isotopes (i.e. ^{3}He): in detectors
  - Radiological isotopes: benign, threat, and nuisance materials for the development and testing of new detection systems



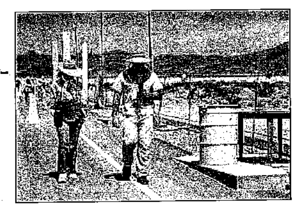




Homeland Security

Systems Engineering and Evaluation

- Develop standards and performance specifications
  - Identify the isotopes of interest
- Conduct thorough test and evaluation of all systems prior to full-scale deployment
  - Full range of isotopes
- Conduct pilot deployments
  - Demonstrate capabilities for future, larger-scaled deployments of technologies and concepts of operations



Homeland Security

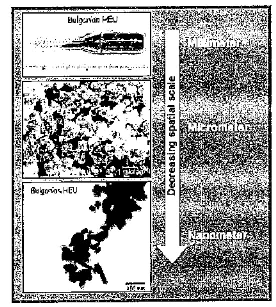
Support for Field Operations

- Training and exercises
  - Relevant radiological materials required for law enforcement personnel to develop requisite skill using equipment and confidence in radiation detection systems
- Daily Operation
  - Definines calibration sources and techniques
- Joint Analysis Center
  - Participates in adjudication of radiation alarms
  - Provides feedback to developers and testers on isotopes of interest
- Operational Red Team
  - Requires access to materials used during potential illicit trafficking activities

Homeland Security

National Technical Nuclear Forensics Center

- Centralized planning, integration, assessment, exercising, stewardship and readiness of USG nuclear forensics capabilities.
- Pre-Detonation rad/nuc materials forensics "capability provider":
  - Developing and improving diagnostic signatures (chemical, physical, isotopic, and pathways)
  - Developing standards for materials analyses
  - Developing Nuclear Forensics Knowledge Management & Analysis System (KMAS) evaluation tools, methods and knowledge capture



Need for reference samples of various isotopes

Homeland Security

Eliminating Radiological Material

- CsCl replacement study
  - Reduce dispersibility
- Irradiator hardening project
  - Increase difficulty of material diversion
- Non-radiological techniques to replace current industrial devices
  - Reduce number of sources in the stream-of-commerce

Develop break-through technologies and methods

Homeland Security

DNDO CsCl Alternatives Study

- Define the economic impact of the replacement of CsCl with alternative technologies, other forms of CsCl or different sources.
- Build on the National Academies of Science (NAS) report that recommended phase-out of CsCl.
- Apply the results of the Nuclear Regulatory Commission (NRC) effort that is investigating the production capability of suppliers of alternative forms of CsCl.
- Define the costs to the licensee community and US Government for source replacement, disposal, recycling or long term storage to better advise a path forward to implement the results of the NAS study.
- Challenges:
  - The domestic and international ability to produce an alternative form of CsCl does not exist at present in quantities that support an immediate 100% source change out.
  - CsCl source replacement by X-ray or accelerator-based technology can be a large financial burden to the licensee.

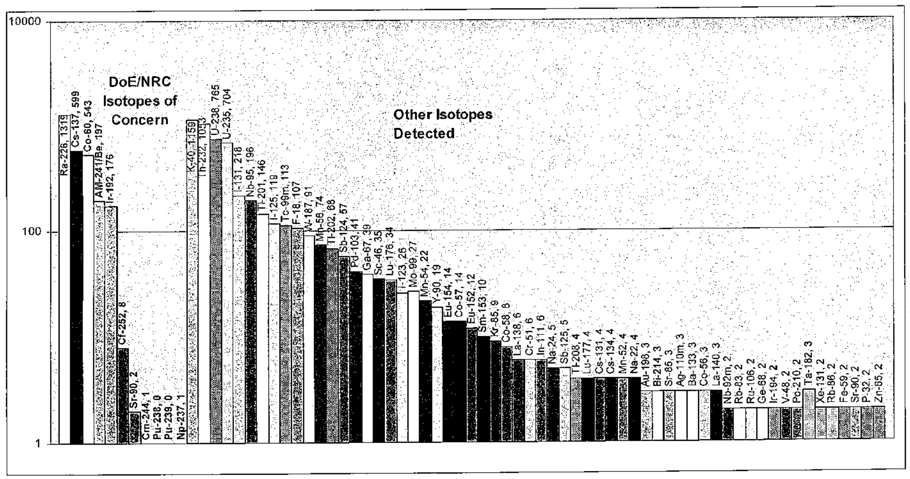
Radiological Source Replacement Technologies

- DNDO, in coordination with DHS Homeland Security Advanced Research Projects Agency (HSARPA) Small Business Innovative Research (SBIR) program, is participating in an effort to promote the design and production of non-nuclear alternatives for industrial devices that currently use radiological sources.

- Three existing SBIR contracts:
  - Replace the Cs-137/Am-241 soil moisture density gauges with an alternative impedance method
  - Replace the Cs-137 (or other) thickness gauges with an with an alternative impedance method
  - Replace the Ni-60 ionization source with carbon fiber nano-tubes in GCMS and other applications

Homeland Security

Isotopes in the Stream-of-Commerce



Not all isotopes are of equal importance.

Homeland Security

DNDO Isotopes

Isotope		Purpose
HEU (High fraction ^{235}U)		System Test and Evaluation
RGPu or WGPu (high fraction ^{239}Pu)		
^{237}Np	$^{90}Sr/^{90}Y$	SNM
^{252}Cf	^{131}I	Surrogates
^{133}Ba	^{99m}Tc	Suspicious
^{57}Co	^{67}Ga	RDD
^{232}U	^{125}I	Medical
Depleted Uranium (DU, ^{238}U)	^{176}Lu	NORM
^{241}Am	^{201}Tl	
^{60}Co	^{228}Th	
^{137}Cs	^{40}K	
^{192}Ir	^{232}Th	
^{226}Ra		

Isotope	Purpose
Helium-3	System development and device manufacturing
^{137}Cs	Equipment Calibration
^{232}Th	
^{137}Cs	Operational Check Sources
HEU (High fraction ^{235}U)	Forensic References and Exercise Materials
RGPu or WGPu (high fraction ^{239}Pu)	
Irradiated Uranium foils for Thermal Calibrations	
^{60}Co	
^{90}Sr	
^{137}Cs	
^{192}Ir	
^{241}Am	
^{210}Po	
Other isotopes as delineated by continuing threat assessment	

*Isotopes in Detection Standards**

Radionuclide	Activity (μCi) unshielded [4]	Activity (μCi) steel shielded (3 cm) [4]	Activity (μCi) poly shielded [4,5]
^{241}Am	47	—	—
$^{133}Ba(i)$	9	148	—
$^{133}Ba(g)$	3	—	—
$^{57}Co(i)$	15	—	—
$^{57}Co(g)$	5	—	—
^{60}Co	7	25	—
^{137}Cs	16	85	—
DU [6]	4.5 kg (46 cm^3)	—	—
^{67}Ga	16	—	94
HEU [6]	237 g (6.5 cm^3)	—	—
^{131}I	10	—	23
^{192}Ir	6	61	—
^{40}K	128	—	—
^{237}Np [6]	90 mg with 1 cm Fe shielding	—	—
^{99m}Tc	16	—	127
^{201}Tl	10	—	88
^{226}Ra	8	—	—
^{232}Th	14	—	—
RGPu [6]	1.4 g with 1 cm Fe shielding	—	—
WGPu [6]	15 g with 1 cm Fe shielding	—	—
^{252}Cf [5]	2×10^4 n/s ± 20%	—	—

Homeland Security

Example shown is ANSI N42.38 ("American National Standard Performance Criteria for Spectroscopy-Based Portal Monitors Used for Homeland Security"*)

DNDO's long-term need for ^{3}He

RPMP Initial Deployment (Most Conservative Scenario)	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	Totals (Liters)
Number of systems to be procured	245	295	395	495	495	245		
Replacements (Damage or end-of-life replacement)	2	2	3	5	5	6	6	
Liters of ^{3}He needed for RPMP from DOE$^{(A)}$	12,128	14,583	19,542	24,550	24,550	12,324	295	107,971

(A) Liters of ^{3}He needed from DOE for four panel equivalent RPM systems is calculated as [(4 tubes/system * 11.58 liters/tube)*1.06] = 49.1 liters/system. The additional 6% is a conservative estimate that takes into account losses during the gas purification process and all gas transfer procedures.

Homeland Security

DNDO's long-term need for ^{252}Cf

- Cf-252 issue was addressed as part of National Security needs, but could be emphasized more in terms of:
  - This isotope is essential for calibrating and testing neutron detectors (this was addressed briefly)
  - This radioisotope can be used in combination with other radioisotopes as a surrogate for Pu-239
  - Considering the number of RPMs and other radiation detection equipment that is and will be deployed, it will be essential for the DNDO to not have to rely on foreign suppliers

Homeland Security

Summary

- DNDO will develop a global framework for detection of radiological and nuclear material
- The availability of other radiological isotopes is essential for the effective testing of systems/procedures and the training of personnel
  - The importance of SNM to the DNDO mission supports the continued production of SNM sources by the DOE infrastructure
  - For DNDO to support the development of systems capable of detecting materials in the stream of commerce, it needs to remain aware of what isotopes are available rather than driving the market
- The availability of ^{3}He and ^{252}Cf is vital to DNDO's mission

Homeland Security

Clenney, Jaclyn

From: Haer, Robert E (GE Infra, Energy) [robert.haer@ge.com]
Sent: Monday, January 05, 2009 1:29 PM
To: Pantaleo, John
Subject: RE: He-3 to GE Reuter Stokes

John -

Below is our recommendation for DOE allocation:

70% for approved NNSA, DHS, DoD, and DOJ programs. NNSA and DHS (including State DHS programs) approvers as provided -- DoD and DOJ programs as approved by John Pantaleo (probably less than 5 programs).

Reason for requested changes:

Our most urgent need is for a rated order for national defense use. If not covered under the allocation, this order will consume our 30% portion and will limit our ability to support future DoD requirements.

SLD - the US OEM Supplier forecasts 2,750 liters of He3 for 2009 SLD requirements. We don't have specifics on any other SLD requirements other than possibly 900-1,800 liters by a foreign supplier. This would indicated we will be sitting on several thousand liters of SLD gas into 2010 and possibly beyond.

We have DHS/DNDO/State projects on the near horizon - some as early as Mar 2009.

As you can imagine the 30% we have for discretionary use will be used for the IAEA, international homeland security programs, National Labs, Nuclear Material Assay, Nuclear Safeguards, oil well drilling and research applications - many of which simply won't happen.

Again, we request the DOE consider modifying our restrictions to allow GE-RS to support our customer base.

Thanks,

Rob Haer & Tom Anderson
GE Rueter Stokes

From: Pantaleo, John [mailto:JOHN.PANTALEO@nuclear.energy.gov]
Sent: Friday, December 19, 2008 4:58 PM
To: Haer, Robert E (GE Infra, Energy)
Cc: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy); IRC@ORNL.GOV; jak@ORNL.GOV; Melamed, Elly
Subject: RE: He-3 to GE Reuter Stokes

Rob,

See my comments below. You can call us early next week to discuss.

Cheers

John

-----Original Message-----
From: Haer, Robert E (GE Infra, Energy) [mailto:robert.haer@ge.com <mailto:robert.haer@ge.com>]
Sent: Wednesday, December 17, 2008 1:49 PM
To: Pantaleo, John
Cc: Anderson, Thomas, Reuter-Stokes (GE Infra, Energy)
Subject: RE: He-3 to GE Reuter Stokes

John -

See my comments below

1. 70% restriction for SLD program - I thought restriction was for US security programs use, and SLD is just one program

We have always said/meant SLD program

2. Will both parties have the same language restriction and % restrictions Yes

3. Please note under note 2 "Fair and Reasonable Price" gas requires further cleaning and cost to use. Thus our base price is not $85/liter it is $85/liter plus tritium remidation, cylnder disposal, transportation, and chemical processing. We understand that there are others costs that will add to the $85 base but we additions should be fair and resonable percentage/direct cost increase.
Let me know when we can meet further to discuss

From: Pantaleo, John [mailto:JOHN.PANTALEO@nuclear.energy.gov <mailto:JOHN.PANTALEO@nuclear.energy.gov>]
Sent: Wednesday, December 17, 2008 10:57 AM
To: Haer, Robert E (GE Infra, Energy)
Cc: IRC@ORNL.GOV; jak@ORNL.GOV
Subject: He-3 to GE Reuter Stokes

Rob,

Attached for your review is the draft He-3 sales contract. We are available this Friday, and also Monday or Tuesday of next week to discuss the terms and conditions. We hope we can do this before the Holidays.

John Pantaleo
301 903-2525

From: Panisko, Mark E
To: Bliss, Mary
Subject: RE: He-3 supply
Date: Friday, January 09, 2009 11:14:00 AM
Attachments: image.jpg

I don't have any pricing on He-3 alone. But based on the increases were are seeing in detector pricing, I would say these match up fairly well. My guess is people are definitely looking at alternatives to He-3.

Mark
5-2778

From: Bliss, Mary
Sent: Friday, January 09, 2009 9:53 AM
To: Panisko, Mark E
Subject: FW: He-3 supply

Mark,

Are you hearing the same numbers as Nucsafe?

-Mary
--
Mary Bliss, Ph.D.
Scientist V
Pacific Northwest National Laboratory
PO Box 999
MS P8-20
Richland, WA 99352

Ph: 509/376-5578
FX: 509/376-5824
Cell: 509/430-3147

------ Forwarded Message
From: Rick Seymour <rseymour@nucsafe.com>
Date: Thu, 8 Jan 2009 15:54:42 -0500
To: d3e648 <mary.bliss@pnl.gov>
Cc: Lester Sideropoulos <Lsidero@Nucsafe.com>
Subject: He-3 supply

Hi Mary,

Firstly, Happy New Year belated!

We are all thinking about and praying for Dick today.

We are having a hell of time getting He-3 for our projects. We were wondering if any more has come out of your query about Li-6 fibers as a substitute for He-3. We are working on some ideas.

Here is a data point from today, Centronics priced He-3 from France (Russian gas) at $530 / liter. This is nearly double the price of the gas from DOE through Spectra Gases, but their gas is $275 / liter. We think at these prices Li-6 is getting very price competitive to He-3. Any inputs from you are appreciated.

Regards, Rick

Nucsafe Inc.
601 Oak Ridge Turnpike
Oak Ridge, TN 37830 USA

Tel: +1-865-220-5050
Fax: +1-865-220-5090

------ End of Forwarded Message

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Friday, January 09, 2009 10:46 AM
To: Pantaleo, John
Subject: USA He3 security require 1208.xls
Attachments: USA He3 security require 1208.xls

Helium usage projections

Helium 3
7 year forecast of DHS NNSA

4/16/2010

Year	DHS	NNSA	Total	DOE Sup.
2009	10,065	2,890	12,955	37,000
2010	10,065	4,541	14,606	12,000
2011	14,485	8,257	22,742	12,000
2012	19,149	8,257	27,406	12,000
2013	24,304	10,734	35,038	12,000
2014	24,304	5,780	30,084	12,000
2015	10,065	4,541	14,606	12,000
Total	**112,437**	**45,000**	**157,437**	**109,000**

DHS = Department of Homeland Security and the systems are interior domestic based only.

NNSA = National Nuclear Safety Administration and the systems are deployed for border security and ports of entry and about 75 international ports.

From: Panisko, Mark E
To: Sturges, Marcus H
Cc: Stephens, Daniel L; Pagh, Richard T
Subject: He3
Date: Wednesday, January 28, 2009 5:03:00 PM
Attachments: PNNLHe3Update_1_23_09.doc

Mark,

Attached is some background on the helium-3 shortage.

Just to keep you up to speed here are three stupid ideas (because their mine) on where we can steal tubes.

Originally the mRPMs required 1 tube per panel but as we buy systems from SAIC not components it was easier to go with 2 tubes per panel from a contracts/logistics perspective. So we may be able to secure these "extra" 120 tubes.

The wide-load RPMs (8-panels) have 8 tubes; but they may require less (there are about ~40 deployed to date).

The Ludlum tubes (GE & Saint-Gobain) are the same form factor, pressure and have the same "HN" style connector as the SAIC (LND) tubes. So I am looking into if we can interchange between systems types (as we have a few decommissioned Ludlum units).

Thanks,
Mark
5-2778

From: Prigge, Jami G
Sent: Thursday, January 22, 2009 10:23 AM
To: Khawaja, Asim; Hevland, Mark E; Martin, Steven W; Berube, Laurie P; Pagh, Richard T; Panisko, Mark E; Stephens, Daniel L; Kouzes, Richard T; Fisher, Darrell R
Subject: Agenda for Friday's He3 meeting

Attached you will find the proposed agenda for tomorrow's He-3 discussions. Additionally, I have included a paper that Sonya has pulled together which documents the PNNL He-3 issue. This paper should provide a good starting point for the discussions tomorrow.

-Jami

PNNL He-3 Update
January 23, 2009

He-3 Requirements:

RPMP Needs:
RPMP (including rail and air) approximate projected needs for He-3 are as follows:

FY2009 - 12,128 liters
FY2010 – 14,583 liters
FY2011 – 19,542 liters
FY2012 – 28,479 liters
FY2013 – 28,479 liters
FY2014 – 12,570 liters
FY2015 – 295 liters (replacements which will continue……)
"
"

These are conservative numbers with lots of caveats. The need for RPMP alone through completion of initial deployments (FY2009-FY2014) is **~115,781 liters.**

DOE Needs:

Don't know the projections here. Current administration is serious about 2012 deadline for achieving 100% scanning (radiography and radiation) of cargo containers departing PODs on route to the U.S. which could significantly increase DOE needs. GUESS needs are ~50% those of RPMP in FY2009-FY2014 timeframe or **~50,000 liters.**

DOD Needs:
?????

Is There a Crisis?

DOE Office of Science Isotopes Program:
- FY09 Release – Released ~20,000 liters (4 cylinders) in December. This release was divided into three equal parts. Approximately 7,700 liters to be designated for each NA-25 use, DHS use, and free market use.
- An addition of ~15,000 liters is to be released in February. As far as we know, there will be no designation for this release.
- Releases in subsequent years are expected to be at ~10,000 liters/year.

Other Sources:
- Spectra Gases receives somewhere around 10,000 liters from Russia annually.
- Spectra Gases is looking to work with the Canadians and other countries, ex., China, to increase their supply.

- Spectra Gases expects He-3 production at about 25,000 liters/year from here on out.

DOE plus DHS FY2009-FY2014 needs alone is ~ 166,000 liters

Isotopes Program release FY2009-FY2014 is ~ 85,000 liters.

From DOE this is a FY2009-FY2011short fall of ~81,000 liters.

If Spectra Gases ***somehow*** receives 25,000 liters per year this supplies 150,000 liters in FY2009-FY2014 – ***Still a Shortfall of 16,000 liters and with NO GAS GOING ANYWHERE BUT Megaports and RPMP.***

Therefore, there is a crisis.

Issues:

1. DHS POC to Isotopes Program is Greg Solvik (works for Ernie Muenchau in PAD at DNDO). Ernie has directed Spectra Gases NOT to release large quantities. Mark Panisko understands from Spectra Gases that they intend to release only ~1,400 liters/month.
2. According to Spectra Gases, DOE is no longer taking the responsibility for disposal of the contaminated gas cylinders and so Spectra Gases must increase prices to cover this new cost to them.
3. Best guesses are that we can expect sales price for gas from DOE to RPMP more than tripling.

Ongoing Activities (Will be discussed in the meeting):

1. Letter to DOE Isotopes Program
2. Request for quote from Spectra Gas
3. Discussions with SAIC
4. ?

Path Forward:

Two distinct scenarios must be kept in mind. The first scenario is that we continue work with DNDO and CBP under the current federal RPMP program management construct. The second scenario is that CBP gains authority over RPMP ACQUISITION funds (including ASP – see Sonya for discussion).

Scenario 1 (DNDO control):

1. Appeal to DOE Isotopes Program to provide gas directly to one of its national labs, namely, PNNL. (Letter from PNSO)
2. Push CBP to get designated as the POC for DHS.
3. Appeal at level of best value to the government through GFE with PNNL managing.
4. ?

Scenario 2 (CBP control):

1. (same as 1 above)
2. Contract with Spectra Gases for as much He-3 as we can. (Getting Quote)
3. ?

Background:

He-3 is produced and collected in the process to produce tritium for the US weapons program. Tritium (H-3) was/is generated in rods irradiated at the Watts Bar Nuclear Generating Station. These rods were/are processed at SRNL. Tritium has a half life of 12.3 years and decays into He-3 so stores of Tritium must be occasionally separated if certain tritium concentrations are desired. This separation process provides the He-3 managed by the DOE Isotopes Program.

From: wjlehnert@gmail.com on behalf of William Lehnert
To: Usaha, Choosak B.; Panisko, Mark E
Subject: DOE Gas
Date: Friday, January 30, 2009 10:03:25 AM

Hi Guys,

I just spoke to Spectra who called to tell me that there is a meeting next week between the He-3 super powers. At the very least this will include DHS, DOE, DNDO, and the Pentagon. The purpose of the meeting is to re-prioritize what projects the limited amount of He-3 goes to and how much.
Spectra called to encourage me to encourage you guys to move quickly on this 1400 liters before it 'might' get re prioritized.
I don't want to beat the same drum but I wanted to share all the information I have.
I look forward to your replies.

Regards,

Bill Lehnert
LND, INC.
3230 Lawson Blvd.
Oceanside, NY 11572
Phone: 516-678-6141
Fax: 516-678-6704
www.lndinc.com

Belton, Barbara

From: Lewis, Roger
Sent: Wednesday, July 29, 2009 10:23 AM
To: Chalk, Edie
Subject: Re: Classification issue.

Edie,

I have cleared it with Steve G. He asked that I close with Doug Downey and then send it--should be accomplished tomorrow.

Roger

----- Original Message -----
From: Chalk, Edie
To: Lewis, Roger
Sent: Wed Jul 29 09:58:22 2009
Subject: RE: Classification issue.

Andrew.weston-dawkes@hq.doe.gov

We made a modification to the 2nd sentence.

This e-mail is being sent at the direction of Mr. Steve Groodrum. The Office of Science, Engineering and Production, Office of Defense Programs, would like to be able to declassify some tritium related information, i.e. the amount of He-3 produced annually by decay of the tritium stockpile. This is related to the Helium-3 supply issue that Roger Lewis discussed with Ms. Chalk and others on the morning of July 29th.

-----Original Message-----
From: Lewis, Roger
Sent: Wednesday, July 29, 2009 9:45 AM
To: Chalk, Edie
Subject: Re: Classification issue.

Edie,

I am having trouble pulling andy's e-mail address from my blackberry--can you mail it to me? The proposed text is:

This e-mail is being sent at the direction of Mr. Steve Groodrum. The Office of Science, Engineering and Production, Office of Defense Programs would like to be able to declassify some tritium related information, such as the amount annual extracted from the stockpile. This is related to the Helium-3 supply issue that Roger Lewis discussed with Ms. Chalk and others on the morning of July 29th.

Comments?

Thanks again for the quick meeting.

Roger

----- Original Message -----
From: Chalk, Edie
To: Lewis, Roger
Cc: Adams, John (NNSA)
Sent: Wed Jul 29 07:59:07 2009
Subject: RE: Classification issue.

I have a meeting from 10 to 10:30 today, but other than that, I am free all day. Why don't you give me a call when you're out here?

Edie
x3-1185

-----Original Message-----
From: Lewis, Roger
Sent: Tuesday, July 28, 2009 5:17 PM
To: Chalk, Edie
Cc: Adams, John (NNSA)
Subject: Classification issue.

Edie,

Would you have some time tomorrow morning or early afternoon--I will be in GTN.

An issue has arisen with respect to Helium-3 availability. Previously, DOE has been unwilling to provide information on anticipated future availability of He-3 because this could be reverse engineered to reveal something about the active stockpile.

I would like to explore just what our flexibility is with respect to providing forecasts of annual He-3 available to the DOE Isotope Sales Program and to other agencies/public.

If tomorrow is not good, I will be happy to come out another time to discuss this with you or whomever you feel would be the most appropriate contact.

Roger

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4 Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12 Office of Defense Programs National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

Rudy Goetzman/SRNL/Srs
02/13/2009 07:28 AM

To Paul Cloessner/SRNL/Srs@Srs
cc
bcc
Subject Re: Heads up on 3-He Situation

Let's discuss in your office on Tuesday at 11:00 if that works for you. Let me know. This is a BFD! What are the other sources of He3 outside of SRS?

Sent from my Blackberry......
Rudy Goetzman
(803) 507-6440 Cell
Freedom is not free.
Paul Cloessner

----- Original Message -----
From: Paul Cloessner
Sent: 02/13/2009 07:12 AM EST
To: Charles (Rudy) Goetzman; Jerry (Todd) Coleman; Gregory (Greg) Cefus; Matthew (M. John) Plodinec; Ray (Tony) Hicks; Alfred (Al) Goodwyn
Subject: Fw: Heads up on 3-He Situation

FYI. I figured this would become an issue sooner or later. I am on he IPTT that Rabun mentions. The NSSE is the Network of Senior Scientists and Engineers in NNSA, which the IPTT sponsors. The IPTT and NSSE met recently at the Naval Research Lab in D.C. I missed the meeting due to conflicts.

If any of you have any more background on this topic I would appreciate you passing it on to me.

Paul Cloessner, PhD
Manager, Defense Programs Technology
Savannah River National Laboratory
803-725-2198
----- Forwarded by Paul Cloessner/SRNL/Srs on 02/13/2009 07:01 AM -----

Robert Rabun/SRNS/Srs
02/12/2009 04:59 PM

To Debra Utley/SRNS/Srs@Srs, James Dollar/SRNS/Srs@Srs, Susan Arnold/SRNS/Srs@Srs, Paul Cloessner/SRNL/Srs@Srs, Crawford Price/SRNS/Srs@Srs, Lee Schifer/SRNS/Srs@Srs
cc Kevin Sessions/SRNS/Srs@srs, Joe Cordaro/SRNL/Srs@Srs, Jeffery Westergreen/SRNS/Srs@Srs
Subject Heads up on 3-He Situation

Last week the NSSE's took the first day of our meeting to visit the Naval Research Lab outside of Bethesda, MD. The meeting came about from our contacts with an NRL researcher that we recently provided with a significant quantity of 3-He. The planned purpose of the meeting was for the NNSA Plants and Labs to brief NRL on our capabilities, tour some of the NRL facilities, and look for potential areas of collaboration and technology exchange.

The meeting was nearly hi-jacked by the 3-He availability issue. Others in DoD became aware that NNSA representatives would be at NRL and requested to attend. Our host asked if I could give a presentation on 3-He, but I suggested that we address the issue in a side meeting during lunch. They agreed, but someone from DTRA wanted to get on the agenda anyway. They also invited John Pantaleo of DOE/NE Isotope Sales and Jack Faught, VP of Spectra Gases, to attend. The 20 minute scheduled presentation on the needs of DTRA for 3-He turned into an hour-long discussion. The 15 minute lunch sidebar turned into an hour meeting as well with 15 participants. Out of these discussions, it became apparent that there is great concern in DoD (NRL, DTRA, and maybe others) that they will not be able to fill the need for 3-He based neutron detectors for US national security.

Also, during the trip, a PNNL NSSE member asked about 3-He availability for a DHS rad detection program that they are supporting. After the trip, I was forwarded the information below which indicates that NNSA Second Line of Defense in NNSA/NN is also concerned about not having enough 3-He. The attachments are a good summary of the 3-He situation and the possibilities for alternatives for neutron detection in the near future.

Roger Lewis has asked one of the NNSA/HQ program managers for a position paper on the 3-He issue. I was tasked by the IPTT/NSSE to organize an NSSE workshop on alternatives to 3-He for neutron detection.

The bottom line is that the availability of 3-He may soon come to be viewed as a national security issue if it isn't already. As a result of all of this:

- DoD, NNSA, and DHS may increase pressure to ensure that they each get 3-He to meet their neutron detection needs.
- An allocation strategy may need to be developed (this was discussed at the NRL lunchtime side meeting).
- The cost/value of 3-He is likely to rise as the supply dwindles (Pantaleo chose to price the most recent sale of 3-He at the prior rate to avoid a bidding war that would wind up being passed on the the government users as increased cost).
- NNSA may ask us to consider recovery of 3-He that we currently view as difficult to recover.
- An opportunity will likely open up for development of neutron detectors that do not require 3-He and do not have the drawbacks of the currently available alternatives.

This might also help break the logjam in the 3-He recovery project.

Bob Rabun
8-8755

Forwarded by John Pantaleo:

From: Melamed, Elly
Sent: Monday, November 10, 2008 2:35 PM

To: Gillo, Jehanne
Cc: Mustin, Tracy; Pantaleo, John
Subject: our discussion on He3
Dear Jehanne:

It was very helpful to speak with you. To better introduce our program, Second Line of Defense (SLD) is part of International Material Protection and Cooperation in NNSA under the Office of Defense Nuclear Nonproliferation. Working in cooperation with partner countries, SLD - which consists of the Core and the Megaports Components - provides radiation detection systems to deter, detect and interdict illicit trafficking of special nuclear and other radiological materials across international borders, thereby increasing U.S. and global security. The systems include fixed as well as handheld radiation detectors along with associated communication systems. Approximately 1000 fixed detectors have already been deployed in over 30 countries.

As a follow-up from our conversation, I am attaching two documents. One is a general background on the He3 issue that we have prepared for our management. The other is a technical piece we asked our lab colleagues to prepare on alternative technologies for He3 tubes. The technical piece has been reviewed by Bob Mayo.

We would appreciate the opportunity to meet with you and representatives from other Federal Agencies to discuss the He3 issue. In addition, we would also be pleased to meet with NSAC to discuss our concerns.

I am attaching my contact information below. I am copying the Director of SLD, Tracy Mustin, who is very interested in this issue and could possibly participate in any meetings that are set up. I am also copying John Pantaleo with whom we have been working very closely.

Thank you.

Sincerely,

Eleanor Melamed
Deputy Director
Second Line of Defense
NA-256
International Material Protection and Cooperation
Office of Defense Nuclear Nonproliferation
National Nuclear Security Administration

202-586-2216
elly.melamed@hq.doe.gov
[attachment "He3 Alternatives-3Nov08rev.doc" deleted by Rudy Goetzman/SRNL/Srs]
[attachment "He3 Issues revised.doc" deleted by Rudy Goetzman/SRNL/Srs]

Aoki, Steven

From:	Aoki, Steven
Sent:	Friday, February 13, 2009 3:27 PM
To:	DAgostino, Thomas; Ostendorff, Bill
Cc:	Krol, Joseph; Mickus, Kimberly
Subject:	NA-4 Update - February 13

Tom/Bill:

A couple of recent items of possible interest:

... f the National

be premature to speak.

Helium-3: Within the last week or so we've received expressions of concern from several organizations, including the UK MOD, about the adequacy of supplies of helium-3, which is used in neutron detection tubes. We understand that there is a letter to the Secretary from two senators on this question. Helium-3 is harvested during the refurbishment of tritium bottles, and is auctioned by the Office of Science for commercial use. NA-25 and DHS DNDO have negotiated set-aside amounts for their programs, leaving contractors for DOD and other organizations to compete for the remainder of the available material. We will be meeting next week with the Office of Science to discuss prospects for future supply and how to ensure there is adequate material for a growing community of national security-related users.

RE: He-3 allotments
Dasti, Abdul to: carroll.mcfall 02/19/2009 12:52 PM
Cc: "Pantaleo, John", "Founds, Nanette"
Bcc: Carroll Mcfall

Carroll,

I am going to send a memo under Nanette signature for return of some of the materials back because of higher priority for Home Land Security and NNSA needs.

John – What is your idea? Since SNS is under Office of Science you are in better position to assess their needs as compared to other requirements.

Abdul Dasti
Office of Stockpile Technology and Special Materials
NNSA NA-122.3
email: Abdul.dasti@nnsa.doe.gov
SecureNet: dasti@mnet.nnsahq.gov
Telephone: 202-586-4072
Fax: 202-586-1966

From: carroll.mcfall@nnsa.srs.gov [mailto:carroll.mcfall@nnsa.srs.gov]
Sent: Wednesday, February 18, 2009 1:49 PM
To: Dasti, Abdul
Cc: Pantaleo, John; Founds, Nanette
Subject: Re: He-3 allotments

Abdul,

We provided SNS with the 4.4 kg (32,700 liters) last year. I don't know how or when they plan to use the material so I don't know if they would be willing to give some of it back. Given the needs out there, it would probably be a good idea to at least ask them.

Carroll McFall
Assistant Manager for Mission Assurance
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

"Dasti, Abdul" <Abdul.Dasti@nnsa.doe.gov>
02/18/2009 11:38 AM

To "Pantaleo, John" <JOHN.PANTALEO@nuclear.energy.gov>, carroll.mcfall@nnsa.srs.gov
cc "Founds, Nanette" <nfounds@doeal.gov>
Subject He-3 allotments

Carroll/John

The only He-3 allotments I can think of issuing is to SNS. The following allotments were issued.

Fiscal year	Quantity
2001	730 grams
2002	727 grams
2003	297 gms
2004	431 gms
2005	727 gms
2006-20011	3 gms each year

March 20, 2008 4.4 kg for future use

4.4 kg is very large considering the huge demand for Home Land Security and DoD. Should we try to contact SNS for returning some of the Helium-3?

Abdul Dasti
Office of Stockpile Technology and Special Materials
NNSA, NA-122.3
email: Abdul.dasti@nnsa.doe.gov
SecureNet: dasti@snet.nnsahq.gov
Telephone: 202-586-4072
Fax: 202-586-1966

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Friday, February 20, 2009 3:30 PM
To: Pantaleo, John
Subject: Neutron Detector Tube Manufactures

John,

Following is a list of Companies or Government Groups which manufacture neutron detector tubes:

Centronic (based in the USA and UK)
LND (Based in New York)
Saint Gobain (based in Ohio and Texas)
Ordela (based in Tennessee)
Troxler (based in North Carolina)
Schlumberger (based in Texas)
G. E. Reuter Stokes (based in Ohio)
Thermal Fischer (Texas)
Eurisys (France)
Canberra (Connecticut and UK)
Berthold (Germany)
Decision Sciences (San Diego & South Carolina) Bubble Technologies (Canada) Nutech (China) Beijing Nuclear (China) Sandia National Laboratory Los Alamos National Laboratory

As I mentioned earlier, Toshiba has dropped out of the business.

There may be other Companies but these are the ones we have supplied.
With the exception of Canberra and maybe Decision Sciences, none of these companies make the entire detection system, just the tubes.

Jack

"WILLIAMS Denny -DARLINGTON" <denny.williams@opg.com>

03/24/2009 06:44 PM

To <robert.rabun@srs.gov>

cc

bcc

Subject Helium-3 Recovery from Titanium Tritide

History: This message has been replied to.

Hello Bob,

I am Manager of the Technical Support Section for the Tritium Removal Facility at the Darlington Nuclear Site of OPGN.

There has been a significant amount of interest being shown in our ability to supply Helium-3, based on the current supply/demand situation and the large quantity we have available in our Tritium storage containers. As you are aware, we utilize a titanium getter for storage and the Helium-3 has always been considered a nuisance by product during immobilization and recovery. Consequently, we have very little technical information on the most viable process scheme of recovering the helium-3, without compromising the integrity of the storage container and the Titanium tritide contained. Obviously I would like to minimize the amount of laboratory investigatory work we have to do, so I am trying to glean as much OPEX as possible, prior to starting any lab work.

Would you have technical information on this subject or any related research that you could share with us. If not, do you have any suggestions on referrals who might be of help. I will also be making a similar inquiry to Scott Willms at LANL.

Thxs in advance for your assistance.

G.I. D. Williams
Section Manager
Darlington TRF/HWM
Darlington Nuclear Division
denny.williams@opg.com
905-623-6670 ext 1012

Inter Agency Discussions on
Helium-3 (He3) Availability
1125 15th Street, Washington DC

Department of Homeland Security
Department of Defense
Department of Energy

Homeland Security

March 24, 2009

Official use Only

Agenda

1300-1315	Welcome & Introductions	Gregory Slovik
1315-1330	Purpose & Expected Outcome	Gregory Slovik
1330-1415	He3 Gas Supply Availability (DOE)	John Pantaleo
1415-1430	DHS Requirements (FY09-FY13)	Gregory Slovik
1430-1445	DOD Requirements (FY09-FY13)	Allen Strouphauer
1445-1500	DOE & NNSA RQMT'S (FY09-FY13)	Steven Aoki
1500-1515	Break	All
1515-1530	Non-Government & International Requirements	John Pantaleo & Gregory Slovik
1530-1640	Open Discussion on He3 Requirements	All
1630-1700	Summarize Action Items/Agreements	All

Welcome

Introduce yourself and please sign
attendance sheet

Purpose & Expected Meeting Outcome

- Recognize He3 issue and start planning
- Understand He3 Future Supply
- Understand the Individual Agency Requirements
  - Interagency cooperation will be needed
- Understand Non-government Requirements for He3
- Work together to create a path forward

Projected DHS

Helium-3 (He3) Requirements

March 24, 2009

Gregory C. Slovik, P.E.

PADD Technical Director

Product Acquisition Deployment Directorate (PADD)

Domestic Nuclear Detection Office (DNDO)

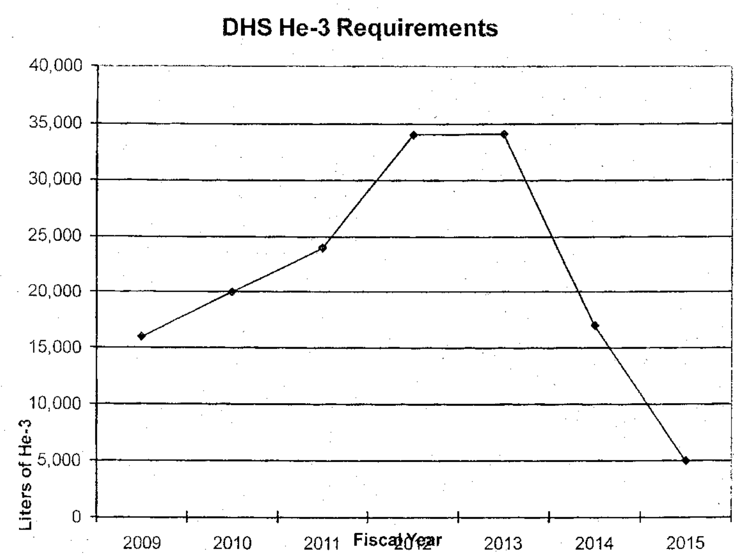
Homeland Security

March 24, 2009

Domestic Nuclear Detection Office (DNDO)

- DHS/DNDO He3 requirements for FY09-FY2014 will include the following end users:
  - United States Coast Guard (USCG)
  - Customs Border Patrol (CBP)
    - Portals and Handheld systems
  - Advanced Spectroscopic Portal (ASP)
  - Human Portable Radiation Detection Systems (HPRDS)
  - Commercial off the Shelf (COTS) Radioactive Isotope Identification Devices (RIIDs)
  - West Coast Marine Pilot (WCMP)
  - Visible Inter-modal Prevention and Response (VIPR) Program
  - Research projects

Domestic Nuclear Detection Office (DNDO)



Introduction on the He3 Issue

- World Supply of He3 is dwindling
  - DNDO alerted in Nov 2008 of the issue
  - United Kingdom asked US to ensure a supply available for them
  - US Government uses ~60-70% of the gas while ~40-30% of the gas is used for oil & gas exploration, medical, research, and foreign government through equipment procurements
- Inter Agency discussion between DHS/DOE/DOD encouraged by DOE Isotope Program (i.e., agency release the He3)
  - DNDO hosting the meeting today for the first scheduled inter agency discussion
  - DOE/DOD/DHS & Commercial requirements are expected to be significant
- Estimate only ~20,000 liters available from FY10 and beyond
  - 8,000 to 10,000 liters from DOE
  - 8,000 to 10,000 liters from Russia (a lot of uncertainty)
- Potential foreign sources need to be investigated
  - Does the Canadian CANDU reactors make available tritium which decays into He3?

"Hamilton, Lee"
<Lee.Hamilton@nnsa.doe.gov>
03/25/2009 12:12 AM

To carroll.mcfall@nnsa.srs.gov, robert.rabun@srs.gov, richard.poland@srnl.doe.gov, "Henry King" <henry.king@srnl.doe.gov>, steven.wyrick@srnl.doe.gov

cc "Dasti, Abdul" <Abdul.Dasti@nnsa.doe.gov>

bcc

Subject He3 meeting at Homeland Security - Action Items

History: This message has been replied to and forwarded.

Here are some action items from today's He3 meeting. It was very well attended - multiple agencies, high level feds including Deputy Secretary for Counterterrorism. The meeting strongly conveyed a sense of urgency, so follow up will be swift. I expect to receive the slides soon - will forward them to you. I have several action items from after the meeting:

- Identify cost to produce He3 from SRS and DP Tritium sources including HAOM, HANM, TEF normal operations and outright irradiation of TPBARs for that specific purpose. (It's expected to be cost-prohibitive, but baseline is needed)
- TEF Duty cycle - At what capacity are we planning to run it to meet DP needs?
- TPBAR irradiation - Is it possible to increase for non DP purposes?
- Describe current inventory of He3 at SRS. (Clean and tritiated)
- Predict "production" of He3 from all SRS sources over next five years
- Interagency Rad-Nuke Working Group - Any SRS / SRNL participation?
- Any SRS WFO or SRNL LDRD activities that use or relate to He3?

Another item discussed but not mentioned below is to identify large quantity purchasers from previous auctions, such as SNS, and find out if they overbought to build a surplus. It's not my action item, but it will be followed up by someone - probably DOE Isotopes Sales (Pantaleo). If you know relevant information to answer this, I'd like to pass it along.

I expect some of this data to be classified, or at least OUO. I'll call you to discuss how to transfer it.

Note also that Roger Lewis is now planning a trip to SRS to discuss this.

Regards,

Lee
202-586-7094

been finalized. I had understood that it was for the 15th and 16th, but may now be largely on the 16th. I am able to devote any or all of the 15th, 16, and 17th to the several purposes of this visit. If it works out that we can do the He3 largely on the 15th and I could shift to Pits for the 16th that is fine, but Julianne Levings will be covering the Pit meeting, so I am happy to structure my visit to what which is most convenient for those who can help me with the 5 objectives above. If your schedule permits, I would like some time toward the end just to close out with you so that you can get a sense of the 'take-aways' I have for the upcoming interagency meeting.

I hope that you all are able to enjoy the spring break and the masterful weather you are having.

Roger

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4
Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12
Office of Defense Programs
National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

From: Douglas.Dearolph@nnsa.srs.gov [mailto:Douglas.Dearolph@nnsa.srs.gov]
Sent: Monday, April 06, 2009 6:42 PM
To: Lewis, Roger
Subject: Re: Probably visit to SRS

Roger,
Good to hear from you. Regarding the VTC for PEP we'll support your needs as we learn of them.

At the outset, I suspect there is not a viable business case for producing additional Tritium for the purpose of producing additional He. The overwhelming expense to do so will be hard to defend absent a stockpile need for tritium. You no doubt are aware of the current pressure to stop production soonest in favor of saving money. If we can't defend continuing production given the stockpile needs/importance, I am skeptical the He arguments will further impress.

I would like to work the He discussion in during the 15th or 16th. Our production numbers are sensitive and our discussions will be tailored to focus on our current He inventory, handling, challenges, and expected gains at a summary level.

We look forward to your visit.

Douglas J. Dearolph
Manager, Savannah River Site Office
803-208-3689 (Office)
803-507-3002 (Cell)

douglas.dearolph@nnsa.srs.gov

"Hamilton, Lee" <Lee.Hamilton@nnsa.doe.gov>
04/07/2009 05:17 PM

To "Bob Rabun" <robert.rabun@srs.gov>, thomas.varallo@srnl.doe.gov, richard.poland@srnl.doe.gov
cc
bcc
Subject FW: Probably visit to SRS

History: This message has been forwarded.

This is the summary of request for the meeting.

Thanks,

Lee
(202) 586-7094

From: Lewis, Roger
Sent: Tuesday, April 07, 2009 3:41 PM
To: Dearolph, Douglas J
Subject: RE: Probably visit to SRS

Doug,

Thanks for the positive response for my upcoming visit.

Carroll McFall and Bob Rabun were on the phone for the recent (March 24th) interagency meeting on Helium 3 issues. If you have not had an update from either of them on the meeting, and the issues, I hope you can get their take on the meeting and the broader concerns.

I view this emerging issue as both a challenge and an opportunity.

The challenge is presented by a previously unappreciated (and unexpected) change in the requirements for He3 for governmental and commercial purposes. Our previous strategy of disposal of our He3 supplies through the Isotope Sales Program was well conceived when started, and I believe successfully executed. However, especially after the 9/11 attacks, the demand for devices using He3--neutron detectors and other applications--have increased at an exponential rate. Concurrently, there appears to also be a discernable increase in commercial demand in the oil and gas, medical imaging, and other applications areas. There is an available industrial base to manufacture the devices, but we now find that these firms are unable to fill orders to DOE, Homeland Security and others because of a shortage of He3. The opportunity is to mobilize DP's infrastructure and expertise to safely and reliably supply He3 for essential immediate demands, identify a sustainable production strategy and to develop the alternative technologies that will eventually reduce the need for the gas. NNSA is expected to fully understand the supply curve and have some ideas of alternative technologies before the next interagency meeting (probably around April 22), and to do that we must work together. We will begin to develop this collaboration when I visit the site next week.

As I currently see this evolving issue, when I visit the site I hope to:

1. Share, if you feel it is appropriate, information from the interagency meeting on the demand pull we are seeing, time frames, interest in alternatives, etc. I clearly see the problem as having distinct near term, mid-term, and supply sustainment time frames.

2. To gain a current understanding of our He3 activities and where they are performed. We may want to invite representatives from the interagency community to visit later this year to see for themselves.

3. To discuss untapped He3 resources at SRS, including extraction from retired process equipment, efficiency improvements in extractions from field returns, etc, and total cost in time and dollars compared to potential yield.

4. To discuss options for responding to an interagency demand for a sustained multi-year supply. This could involve the interagency community funding a parallel TPBAR and extraction process and there would be nonproliferation issues if Defense Programs retained the tritium as a residue or waste product from the He3 operations. While this would be expensive, if the demand is significant, the consequences of not fulfilling current requirements not acceptable to other agencies, and the costs in time and dollars for alternative technologies comparable with less certainty of a successful technology deployment, then other agencies may be resourced sufficiently to use this option. If we support their extraction operations at our site, with our workforce, and our facilities, then there would be no need for other agencies to go to the time and expense to recreate this option elsewhere.

5. To explore with SRNL and others at the site the role that it, and other NNSA and DOE laboratories and facilities could potentially play in an interagency exploration of alternate technologies and materials.

We cannot afford to ignore the current shortage. The best we can do, I think based upon current information, is to manage the remaining material so that we meet the highest priority needs for the next 2-3 years. This may also involved retrieving materials previously provided to the Spallation Neutron Source and others who may have stockpiled them. To do so may require that we commit to providing annual allocations from future extractions. This will need to be understood, documented, resourced, and managed. During this period while we are bridging the looming gap, we need to move aggressively to significantly increase the amount of He3 that can be made available from all sources (domestic and international). This may buy us some additional time beyond the 2-3 year period I mentioned. Concurrently, there needs to be an interagency evaluation of requirements, alternative technologies, and costs for development and deployment. For example, there are alternatives being developed that may eventually reduce or eliminate He3 dependence for large portals, but those alternatives are inadequate for portable or even smaller personal detectors. Demand curves revealed by DOD, DNDO, DOE- SLD and others at the interagency meeting show that even with a focused investment in alternative technologies, enduring requirements for He3 exceed what can reasonably be projected to be supplied from all sources. It is for this latter category, the enduring annual requirement for He3 that we may be able to begin forging an interagency consensus that supports a level of sustainment of our tritium capabilities and operations at a level greater than is necessary just to meet the current and projected stockpile requirements.

There will be an internal meeting under the auspices of Dr. Aoki's office Thursday in preparation for an anticipated second interagency meeting later this month. I may have some additional thoughts on how best to maximize my time at the site after this meeting.

Through Mr. McFall and Mr. Rabun the site is already engaged. Jonathan Barnett and Lee Hamilton (SRNL detailed to NA-122.3 here) began developing an agenda today which we will discuss here on 4//9. Your input to that agenda is sought and appreciated. I hope through my visit to further engage the site in supporting the NNSA and DOE participation in the interagency process and at the same time to help assure that the interagency community understands the scope of SRS capabilities and capacity to contribute to a solution set for the He3 supply issue.

I understand that the agenda for the Pit Disassembly and Conversion Technical Oversight Group has not

Official Use Only

3He Shortage
Update to SRS

Lee Hamilton
Technology Advisor
NNSA Stockpile Technology and Special Materials Division, NA 122.3

April 16, 2009

Official Use Only

NNSA Second Line of Defense

- Enhance Radiation Detection capabilities of foreign border officials, customs agents, port authorities and affiliated agencies
  - Core Program
    - 213 of planned 600 sites complete
    - Over 950 RPMs and handheld detectors
  - Megaports Initiative
    - 19 of 100 international ports completed
    - Over 150 RPMs, Spectroscopic Monitors, Straddle Carrier Detectors, and Handheld Equipment

Current inventory sufficient for FY09 deployments

Official Use Only

NNSA Second Line of Defense

SLD equipment requiring 3He:

- Radiation Portal Monitors:
  - TSA Systems: Pedestrian, Vehicle, Rail, and Skid-Mounted
    - Use X liters of 3He per portal, on average
    - TSA needs 3-4 months after receiving 3He to manufacture components
  - Mobile Radiation Detection System (MRDIS)
  - Radiation Detection Straddle Carrier (RDSC)
  - Spectroscopic Portal Monitors
- Handheld Equipment:
  - Thermo identiFINDER NGH+ RIID
  - TSA PRM 470 CGN Handheld Survey Meter

Defense Threat Reduction Agency (DTRA)

- Defense Threat Reduction Agency (DTRA) is DoD's Executive agent for detecting radioactive materials
  - AN/PDX-2 kits provide this capability
- NAVSEA PMS 480: program office responsible for procuring and distributing AN/PDX-2 kits
  - Current Requirement: 855 AN/PDX-2 kits for FY09/10
    - One kit per four man team
    - Kit components require Helium-3 (He-3) for Neutron detection

Official Use Only

Defense Threat Reduction Agency (DTRA)

- Jan 09
  - Vendor notified PMS 480 that contract cannot be filled due to 3He shortage
    - ~ 300 of 855 (~ 41%) kits have been fielded
    - Shortfall: 1000 ltrs in FY09 and 600 ltrs in FY10 to complete the contract
- Feb 09
  - DTRA briefs DoD
- Mar 09
  - DTRA joins interagency conference

Official Use Only

Official Use Only

Domestic Nuclear Detection Office (DNDO)

- DHS/DNDO He3 requirements for FY09-FY2014 will include the following programs:
  - Advanced Spectroscopic Portal (ASP) Program
    - Customs and Border Protection (CBP)
  - Radiation Portal Monitor Project (RPMP)
    - CBP
  - Human Portable Radiation Detection Systems (HPRDS)
    - United States Coast Guard (USCG)
    - CBP
    - Transportation Security Agency (TSA)
  - Visible Inter-modal Prevention and Response (VIPR) Program
    - TSA

Domestic Nuclear Detection Office (DNDO)

- DHS/DNDO He3 requirements continued
  - Commercial off the Shelf (COTS) Radioactive Isotope Identification Devices (RIIDs)
    - USCG
    - CBP
    - TSA
  - West Coast Marine Pilot (WCMP)
    - State and Locals
    - USCG
  - Research projects

Official Use Only

Non-Government and International Requirements

- The requirement for Non-Government (includes International requirements) and State and Local Grants (for the RAD/NUC effort) spread across a wide spectrum of end-users:
  - Oil & Gas Drilling
  - Cryogenics
  - Medical
  - Lasers
  - Detectors (neutron & other)
  - International Homeland Security and International Research
  - State and Local Grants for radiation detection

FY 2009	FY 2010	FY 2011	FY2010	FY2013
Non Gov - 99,940 State & Local - 2,500	82,890 3,500	80,690 3,800	85,590 3,800	85,890 3,800

Official Use Only

Official Use Only

Total 3He Needs

Across DHS, DOE-SLD, DOD and Non-Government Agencies

(Estimated on 24 March 2009)

Agency Requirements	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15
DOE-SLD	0	4680	6470	18360	24080	18830	6380
DOD	30,530	28,530	28,530	25,000	25,000	25,000	25,000
DHS	16,000	20,000	24,000	34,000	34,079	17,000	5,000
Non-Government	104,858	81,781	100,293	105,398	55,945	43,916	43,916
Total Agency Requirement	151388	134991	159293	182758	139104	104746	80296
Total DOE Supply	85,000	8,000	8,000	8,000	8,000	8,000	8,000

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Wednesday, May 13, 2009 11:52 AM
To: Pantaleo, John
Subject: RE: Recycle of He-3 from NSTec Remote Sensing Lab

John,

Yes, the process is a closed loop back to the US Government. We purchase helium-3 crude from the DOE (SRS), purify it and resell it to a company such as LND (neutron detector tube manufacture), who in turn is subcontracted by SAIC to manufacture neutron detector tubes to their specifications, and SAIC sells the complete detection system under contract to PNNL. So in fact the US Government retains ownership of the helium- 3 gas through its ownership of the completed SAIC system.

Let me elaborate a little further. Purification of reclaimed helium-3 gas from a detector tube is a requirement if it is to be re-used in the production of new tubes. One of the reasons helium-3 works so well in the current systems is the high quality of the gas purity, both chemical and activity. I have included a copy of the purity specifications below for the product we have been producing from the "crude" helium-3 gas supplied from SRS. As you know this gas is now the gold standard for the neutron detector market and without high quality gas the detector tube will not perform properly. We believe this is the critical operating parameter for any neutron detection system. Pay close attention to the specification for activity (background radiation in the gas). The activity in the product we are producing now consistently is less than product produced in past years by either the Russian or USA laboratories. This is the reason why a helium-3 tube works so well. Our systems are the only systems in the world which can produce the product to these specifications.

Most of the neutron detector tube manufactures have contracted Spectra Gases to purify recovered detector tube gases. They include G.E. Reuter Stokes, LND, Ordela, Canberra, and Saint Gobain to name a few. We analyze the gas before purifying it and we have found that nearly all of the gas has contaminants in the per cent range and include such gases as carbon tetrafluoride, carbon dioxide, methane, and all of the usual atmospheric gases such as nitrogen and oxygen.

The DOE group in Nevada recently went out for a solicitation on the NNSA website to seek companies interested in reclaiming gas (approximately 2,000 liters) from used detector tubes and use the gas to make new detector tubes. In our opinion the gas will not meet the specifications below without extensive purification. Not a single detector tube manufacture has the systems to achieve these purities, and it is very easy to lose the gas if the systems are not properly designed. We have systems which we designed and are routinely used to extract the gas from neutron detector tubes. We recently (in 2008) recovered 1,800 liters for Canberra from 6 foot long by 1 inch o.d. tubes. We did not lose any gas and it was repackaged to these specifications.

In view of the severe shortage of product and the fact that it cannot be replaced, I urge the Department to make recommendations to prevent these tubes from being processed by Companies which are ill equipped and unprepared to deal with the issues associated with such a process.

Call me if you have questions. I hope to hear from you later today as we discussed. I remain very concerned about the current path we are taking. Our operating costs for the NRC facility to purify the gas required are very much fixed, and without gas to sell to the non defense markets we may not be able to keep this facility operational without raising the prices for purification to absurdly high numbers. I think we need to find a balance that will allow the commercial non defense markets to bear this expense and then provide purification to the US Government for prices that are largely subsidized by the private sector. We could probably keep the prices to the current level if we could sustain annual purchases in the range of 2,500 to 3,000 liters and also adequately supply the private sector applications for COPD drug discovery, oil logging, and low temperature cyrogenics (< 1 degree Kelvin).

We are already working with these sectors to install recovery systems for their processes. Schlumberger is discussing this with us and we already have systems in place at several medical research facilities.

Regards,

Jack Faught

Helium-3 Specifications

FW: HE3 JUNE 2009.ppt

Pantaleo, John to: carroll.mcfall, Jerry Klein, Dasti, Abdul 01/27/2010 10:25 AM

Bcc: Carroll Mcfall

Guys, this is the presentation I gave to Pat Dehmer that includes some past sales and allocation. Can we discuss this at 11AM today!

Isotope Production and Applications

Helium-3

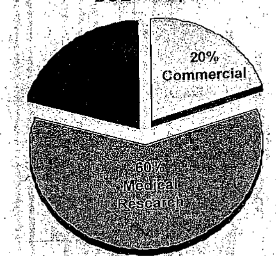
Presentation to
Patricia Dehmer
Deputy Director for Science Programs

John Pantaleo
Program Director

June 5, 2009

Mission of DOE's Isotope Program

- Produce and sell radioactive and stable isotopes, associated byproducts, surplus materials, and related isotope services
- He3 is just one of many isotopes of concern
- Maintain the infrastructure required to supply isotope products and related services
- Over 190 customers in FY 2008
- Over 560 shipments in FY 2008
- Ten customers provided over 85% of sales



Program Authority

- Public Law 101-101, as modified by Public Law 103-316 created the Isotope Production and Distribution Program Fund (a revolving fund) and allow prices charged for products and services to be based on production costs, market value, U.S. research needs and other factors.
- Prices for commercial isotopes are based on full cost recovery of the batch produced.
- Prices for research isotopes are based on direct cost for the entire batch.
- Currently, the pricing policy for research isotopes is being reconsidered.

Authority to Allocate

- Under the Defense Production Act (DPA), 50 U.S.C. app. §§ 2061-2171 (2008), DOE/NNSA has the authority to allocate materials, services, and facilities for national defense purposes.
- Section 101(a) of the Defense Production Act, 50 U.S.C. app. § 2071(a), gives the President the authority "to allocate materials, services, and facilities in such manner, upon such conditions, and to such extent as he shall deem necessary or appropriate to promote the national defense." This authority has been delegated to the Secretary of Energy "with respect to all forms of energy," and re-delegated to the Administrator of the NNSA and to the Director of the NNSA Office of Procurement and Assistance Management. *See* Executive Order No 12,919 (June 7, 1994); Executive Order No. 11790 (June 25, 1974); DOE Delegation Order No. 00-003.00; DOE Delegation Order No. 00-003.01.

Sales to Other Federal Agencies

- US Air Force (Cf-252)
- US Navy (He-3)
- Center for Disease Control (Ni-62)
- NASA (stable isotopes, irradiation services)
- NIST (Cf-252, Po-209, Th-229, stable isotopes, irradiation services)
- NIH (Ac-225, Ra-224, Cu-67, Zn-65, Y-88, stable isotopes)
- US Department of Agriculture (As-73, Zn-65, stable isotopes)
- US Department of Interior (stable isotopes)
- US EPA (As-73, Zn-65, stable isotopes)
- US Geological Survey (As-73, Cd-109, Zn-65)

Introduction

- ^{3}He Characteristics and Applications
- Program Background
- Historical and Projected Supply
- Projected Demand
- Inventory Status

Note: ^{3}He gas volumes provided in this presentation are at STP unless otherwise specified.

^{3}He Characteristics and Applications

- He3 is a non-radioactive isotope of helium from β^- decay of tritium
- Very rare isotope – it can not be extracted from nature
- Applications
  - Neutron detectors
  - Oil/gas exploration
  - Medical imaging-
  - Cryogenics
- Why He-3 in neutron detectors?
  - He-3 is non-reactive/non-corrosive and performs very well as a converter gas in neutron detectors
  - He-3 provides fewer false positives in neutron detection, compared to other technologies, and has the highest intrinsic efficiency for a neutron detector

Neutron Detector Tubes Manufactures

- Centronic (based in the USA and UK)
- Canberra (Connecticut and UK)
- Berthold (Germany)
- LND (based in New York)
- Saint Gobain (based in Ohio and Texas)
- Ordela (based in Tennessee)
- Troxler (based in North Carolina)
- Schlumberger (based in Texas)
- G. E. Reuter Stokes (based in Ohio)
- Thermal Fischer (Texas)
- Eurisys (France)
- Decision Sciences (San Diego & South Carolina)
- Bubble Technologies (Canada)
- Nutech (China)
- Beijing Nuclear (China)
- Sandia National Laboratory
- Los Alamos National Laboratory

Note: There may be other suppliers. With the exception of Canberra and perhaps Decision Sciences, none of the above organizations make the entire detection system—they only make the tubes.

Program Background

- Prior to 1980, ^3He from SRS was purified at Mound. It continued to be distributed from Mound until about 1997.
- In October 1996 the existing inventory was shipped to ORNL for Distribution.
- In March 2000 sales were restricted because of the limited amount of purified ^3He.
- Sales of stored He-3 from SRS began in 2003 as a remediation test project with Spectra Gases.
- Spectra Gases invested in excess of $4,000,000 to support the various applications of He-3.
- Since 1980, SRS has accumulated about 260,000 liters of ^3He from tritium reprocessing.

Neutron Detector Supply Chain Example

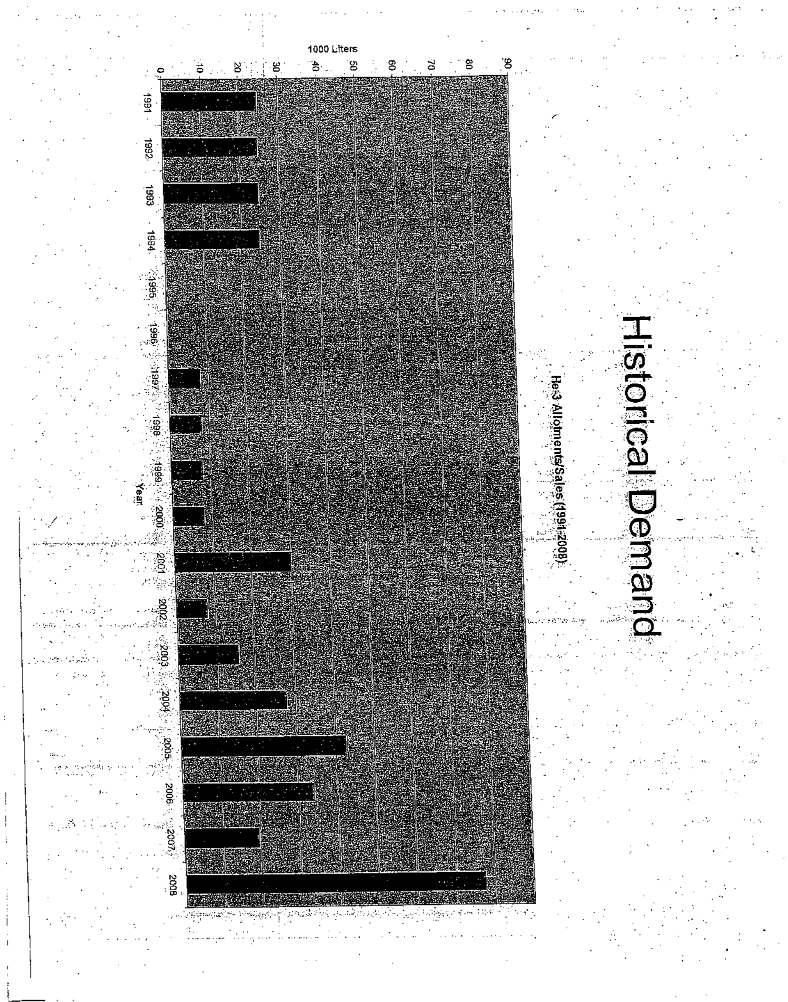
- Second Line of Defense (SLD) issues contract SAIC
- Isotope Program sells crude He-3 from SRS to Spectra Gases
- Spectra Gases purified it and resells the gas to LND
- LND is subcontracted by SAIC to manufacture neutron detector tubes to their specifications
- SAIC sells the completed detection system under contract to PNNL

(So, in fact, ownership of the He-3 comes back to the U.S. Government)

Historical and Projected Supply

(values are approximate)

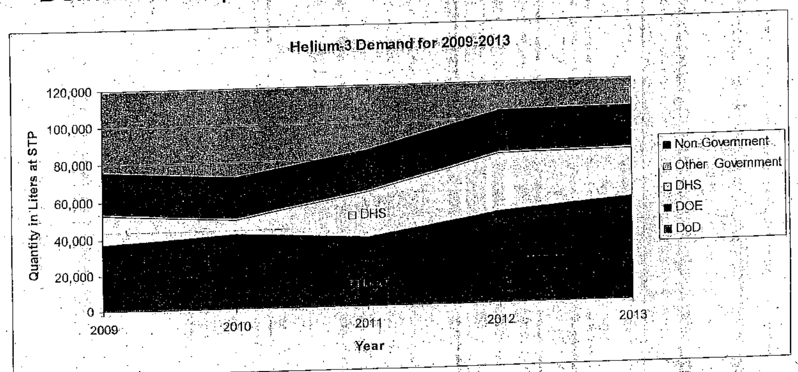
- Between 2004 and 2008, 146,000 liters have been supplied, primarily to two vendors.
- In 2008, about 35,000 liters were provided to ORNL SNS (outside the Isotope Program).
- 20,000 liters of Russian He-3 entered the US market in 2007. Availability of additional Russian supplies are unknown.
- Very preliminary discussions were initiated with Ontario Power regarding recovering ^3He from tritiated heavy water.
- Long term, the ^3He recovery from tritium decay is expected to be about 10,000 liters per year.


Historical Demand
He-3 Allotments/Sales (1991-2008)
1000 Liters
0
10
20
30
40
50
60
70
80
90
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year

Projected Demand

(values are approximate)

- Demand far exceeds supply
- Demand is expected to be about 80,000 liters per year



Inventory Status

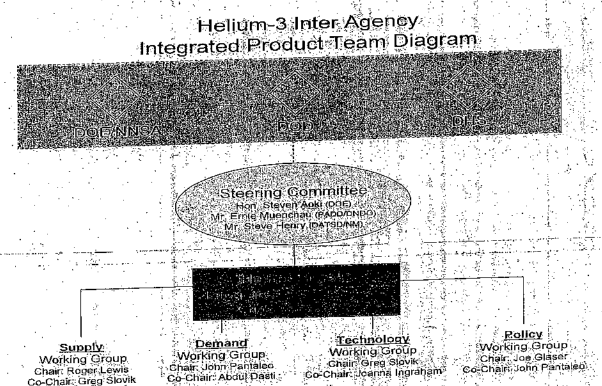
(values are approximate)

- December of 2008, 70% of 6 cylinders (15,173 liters of 21,675 liters) of ^3He were allocated to NNSA, DHS and other defense projects
- March 2009, 4 cylinders (15,327 liters) of ^3He have been allocated to DHS projects and other defense applications.
- Fall 2009, 7 cylinders (~25,000 liters) to be distributed
- 6 cylinders (~21,000 liters) in inventory/reserve
- Possible 7 cylinders at future date, and quantity, to be determined
- Future – 8,000 to 10,000 liters per year

He-3 Federal Inter Agency Working Group

- He-3 Inter Agency Integrated Product Team (IPT) has been assembled to jointly address the impact of the 3He shortfall on all Government agencies.
- The IPT will investigate issues, collect data, analyze, and provide recommendations to the Steering Committee who will provide guidance to the IPT as well as a consensus plan of action to the senior management in each Government agency represented.
- IPT will form four working groups: Supply, Demand, Technology, and Policy

Helium-3 Inter Agency Integrated Product Team structure



Allocations Options

Near term (Fall 2009):

- Allocate the 7 cylinders (~25,000 liters) to the agencies and for other commercial applications.

Longer term:

- Establish a Federal inter Agency working group
- - Who should take the lead and work with Ontario Power?
- Seek alternative technologies

Near Term Actions:

- Collect He-3 needs from each agency and available inventory (SNS).
- Investigate availability of Canadian Helium-3 Resource
- Investigate Recycle old detectors to recoup He3 gas
- Investigate recovery of He-3 from Metal-Tritide Storage Beds, LANL.
- Develop a priority/allocation scheme
- Allocate the 7 cylinders (~25,000 liters) at SRO to the agencies and for other commercial applications

Future Year Actions:

– Develop Policy for the He-3 allocation

– Identify alternative technologies within commercial sector and transformational research projects

– Identify alternative isotopes Li-6 and B-10

– Share lessons learned across all stakeholders

– Allocate the 8,000 to 10,000 liters.

SRS **Fw: A Heads-up in He-3**
Carroll Mcfall to: Timothy Fischer 06/10/2008 01:06 PM

History: This message has been replied to.

FYI, it looks like I've finally gotten the point across that He-3 is in limited supply. Contrary to the convoluted message below, we are reloading the cylinders for ORNL SNS (6 of 9 are complete). After that, the additional 20 old cylinders will be reloaded into new cylinders, which is expected to take until about Feb. 2009. When the first ten cylinders are reloaded, they will be placed on the market for sale. Apparently, GE-Reuters is trying to convince John Pantaleo (and maybe now Ostendorff) to allow them exclusive rights without going through the normal open competition. I'll keep you informed if I hear anything else.

Carroll McFall
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

----- Forwarded by Carroll Mcfall/NNSA/DOE/Srs on 06/10/2008 01:01 PM -----

Robert Rabun/WSRC/Srs
06/10/2008 12:58 PM

To Carroll Mcfall/NNSA/DOE/Srs@Srs
cc Susan Arnold/WSRC/Srs@Srs
Subject A Heads-up in He-3

I just got a call from Dale Dunsworth of NNSA office fo Materials Management(?). He said Ostendorff got a message from GE/Reuters that they have used up their He-3 and NNSA would not release any more for sale. Dunsworth is looking into whether there is enough inventory for additional sales and if there are other big users of He-3. I mentioned SNS as one user and that we have material reserved for them.

I gave him your name as the NNSA/SR contact. He was already planning to discuss this with Pantaleo.

Bob R.

Re: Fw: A Heads-up in He-3
Timothy Fischer to: Carroll Mcfall 06/10/2008 01:28 PM

I trust Mr. Pantaleo is familiar with the Competition in Contracting Act, making an exclusive arrangement with GE-Reuters problematic.

Timothy P. Fischer
Site Counsel
Savannah River Site Office
(803) 208-8656 (office)
(803) 507-8740 (mobile)

Carroll Mcfall/NNSA/DOE/Srs

Carroll Mcfall/NNSA/DOE/Srs
06/10/2008 01:06 PM

To Timothy Fischer/NNSA/DOE/Srs@Srs
cc
Subject Fw: A Heads-up in He-3

FYI, it looks like I've finally gotten the point across that He-3 is in limited supply. Contrary to the convoluted message below, we are reloading the cylinders for ORNL SNS (6 of 9 are complete). After that, the additional 20 old cylinders will be reloaded into new cylinders, which is expected to take until about Feb. 2009. When the first ten cylinders are reloaded, they will be placed on the market for sale. Apparently, GE-Reuters is trying to convince John Pantaleo (and maybe now Ostendorff) to allow them exclusive rights without going through the normal open competition. I'll keep you informed if I hear anything else.

Carroll McFall
National Nuclear Security Administration
Savannah River Site Office
Phone: 803.208.3519
Pager: 803.725.7243 (11595)

----- Forwarded by Carroll Mcfall/NNSA/DOE/Srs on 06/10/2008 01:01 PM -----

Robert Rabun/WSRC/Srs
06/10/2008 12:58 PM

To Carroll Mcfall/NNSA/DOE/Srs@Srs
cc Susan Arnold/WSRC/Srs@Srs
Subject A Heads-up in He-3

I just got a call from Dale Dunsworth of NNSA office fo Materials Management(?). He said Ostendorff got a message from GE/Reuters that they have used up their He-3 and NNSA would not release any more for sale. Dunsworth is looking into whether there is enough inventory for additional sales and if there are other big users of He-3. I mentioned SNS as one user and that we have material reserved for them.

I gave him your name as the NNSA/SR contact. He was already planning to discuss this with Pantaleo.

Bob R.

Clenney, Jaclyn

From:	Jack Faught [JackF@spectragases.com]
Sent:	Friday, July 17, 2009 12:02 PM
To:	Pantaleo, John
Subject:	Helium 3 Medical Useage.ppt
Attachments:	Helium 3 Medical Useage.ppt

<<Helium 3 Medical Useage.ppt>>

John,

I blind carbon copied you on the response I sent back to the Hypepolarized Gas Group which is doing the COPD medical studies which are largely NIH funded. I asked for more clarification on their usage requirements and also who their contacts are at NIH. In the power point attachment to this message I have a list of some of the NIH funded groups showing how much NIH dollars are at risk. Most of this reearch is less than 25% completed. As you know if the studies are not completed, most of the money spent will be wasted.

In addition to the NIH funded work in the USA and Canada, there is a group of 5 institutions funded by the EU and some NIH funding. I am getting more information on this as well.

So far I have annual requirements in the range of 1,600 liters per year for medical COPD work. The slide in the attachment breaks it down by institution. The PNNL work may not be funded yet, but it is only a small part of the requirements. All of the other work is funded according to the researchers.

I hope you will share this information with the interagency panel. We will be totally out of gas by August. I am reserving the last few liters for this group but it will not be enough. I hope you will continue to press for the support we need and I am going to get you the NIH contacts to back you up.

Jack

NIH Funded COPD Research Requiring Helium 3

- University of Massachusetts $4.4M
- University of Pennsylvania $7.0M
- Washington University, St. Louis $20.3M
- Univ. of Virginia Health Systems $5.0M
- Duke University $5M
- University of Wisconsin-Madison $2.0M
- Harvard-Smithsonian $2.5M

Belton, Barbara

From: Lewis, Roger
Sent: Monday, August 10, 2009 2:23 PM
To: Glaser, Joseph
Subject: FW: Link shared by sivils@lanl.gov

Joe,

Still trying to solve the entrust issue. this is what I sent back to Kwei.

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4
Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12
Office of Defense Programs
National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

From: Lewis, Roger
Sent: Monday, August 10, 2009 2:22 PM
To: Kwei, Lawrence K; McConnell, James
Cc: njnicholas@lanl.gov; Griego, Juan
Subject: RE: Link shared by sivils@lanl.gov

Larry,

Thanks. Following proper procedures is important, but also recognizing exceptional circumstances and exercising judgment are important also. While this may not be a situation where blame for a proper action may be assigned, there could be reason to assign culpability for failure to recognize a strategic asset and suboptimization of an asset/opportunity.

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4
Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12
Office of Defense Programs
National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

From: Kwei, Lawrence K. [mailto:lkwei@doeal.gov]
Sent: Monday, August 10, 2009 2:02 PM
To: Lewis, Roger; McConnell, James; Glaser, Joseph
Cc: njnicholas@lanl.gov; Griego, Juan
Subject: RE: Link shared by sivils@lanl.gov

Roger and Joe: Here are some details that were missing in the message from Mark Abhold (LANL). The HE3 in question (1000 liters) was contained in old detectors remaining from closed out activities at TA-18. The individual pieces of equipment were not associated with specific program codes, but funding for procurement and maintenance of these were shared by a number of programs and outside customers. I have been told that the Laboratory followed proper federal property requirements for declaring the equipment excess. With no perceived need for the equipment, the

Laboratory entered into an agreement with GE-Reuter Stokes to recycle the material, with the Laboratory receiving on the order of $ .5M in "store credit." It is not clear that the Site Office was directly involved in some of the details of the decision process that occurred, but was pushing the Laboratory (with several Performance Based Incentives) to complete the D&D project at TA-18 on schedule.

Please let me know if there is any further questions that you have or other information that I may provide. I have asked the Laboratory for a detailed inventory of the HE3 remaining at TA-35.

Lawrence K. Kwei
Program Support Team Leader
Office of National Security Missions
Los Alamos Site Office
National Nuclear Security Administration
US Department of Energy

lkwei@doeal.gov
Office: 505-665-8774
Mobile: 505-231-9049
Pager: 505-664-8546

From: Lewis, Roger [mailto:Roger.Lewis@nnsa.doe.gov]
Sent: Monday, August 10, 2009 8:41 AM
To: Kwei, Lawrence K.
Subject: FW: Link shared by sivils@lanl.gov

FYI--had to send unencrypted within the HQ LAN

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4
Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12
Office of Defense Programs
National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

From: Lewis, Roger
Sent: Monday, August 10, 2009 10:41 AM
To: Glaser, Joseph
Cc: McConnell, James; Founds, Nanette; Dasti, Abdul; Inocencio, Julie; Hamilton, Lee; Greenaugh, Kevin; Goodrum, Steve
Subject: RE: Link shared by sivils@lanl.gov

Joe,

I copied Larry Kwei from the Site Office in the earlier message in the hopes that he may be able to look into this and answer your very question. I am still having trouble sending you entrusted messages in a reply mode, so I have taken Larry off this message and will forward it to him separately.

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4
Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12

Office of Defense Programs
National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

From: Glaser, Joseph
Sent: Monday, August 10, 2009 10:36 AM
To: Lewis, Roger
Cc: McConnell, James; Founds, Nanette; Dasti, Abdul; Inocencio, Julie; Hamilton, Lee; Greenaugh, Kevin; Goodrum, Steve; Kwei, Lawrence K
Subject: RE: Link shared by sivils@lanl.gov

Roger, I agree with what you say. I'm wondering where the gas is going to, cause it may be meant for an already made allocation. joe g

---

From: Lewis, Roger
Sent: Monday, August 10, 2009 8:41 AM
To: Glaser, Joseph
Cc: McConnell, James; Founds, Nanette; Dasti, Abdul; Inocencio, Julie; Hamilton, Lee; Greenaugh, Kevin; Goodrum, Steve; Kwei, Lawrence K
Subject: FW: Link shared by sivils@lanl.gov

Joe,

This just reached me. We are trying to get a better handle on orphan supply/recycleable quantities. However, as an interin measure, I think we should work through all the Site Offices/Operations Offices to inform all M&O contractors that: 1. We require a comprehensive review of their Tritium and He-3 holdings, especially any that may not be currently applied to programmatic activities; and 2) to remind each of them that the government owns this material and that there should be no further agreements for sale and no bartering agreements for any recoverable amounts. Additionally, I have copied Mr. McConnell on this message, I believe that Los Alamos certainly knew about the shortage and that their fee should be reduced by triple the amount of dollars gained from this extraction and sale because I do not believe it was their's to sell or that it was properly coordinated with DOE/NNSA senior management.

Roger A. Lewis, Director
Plutonium and Uranium Manufacturing Division, NA-122.4
Military Applications and Stockpile Operations, NA-122 Science, Engineering and Production Programs, NA-12
Office of Defense Programs
National Nuclear Security Administration
(202) 586-6864 (888-657-6829--pager) (202-586-4688--fax)

From: Dale Sivils [mailto:sivils@lanl.gov]
Sent: Friday, August 07, 2009 4:05 PM
To: robert.rabun@srs.gov
Cc: Lewis, Roger
Subject: RE: Link shared by sivils@lanl.gov

Here's a PDF of the article.

Dale Sivils

LANS, LLC
Corporate Representative for Mission, Integration and S&T
4200 W. Jemez Rd, Suite 400
Los Alamos, NM 87544
Phone: 505-663-5822
Pager: 505-664-7654

From: robert.rabun@srs.gov [mailto:robert.rabun@srs.gov]
Sent: Friday, August 07, 2009 12:59 PM
To: sivils@lanl.gov
Subject: Re: Link shared by sivils@lanl.gov

I tried it, but it appears to be behind your firewall

We just got this info last week that is probably the same effort. I would like to see what the official writeup says.

Thanks,
Bob Rabun
8-8755

From: Mark Abhold [mailto:mabhold@lanl.gov]
Sent: Tuesday, July 28, 2009 5:30 PM
To: Melamed, Elly
Cc: 'Gavron, Victor'; 'Chris Lovejoy'; Mustin, Tracy
Subject: RE: spare he3 tubes

Elly,

I have more information about the He-3 recovered from LANL so far

LANL had about 1000 liters of He-3 in unused tubes stored at TA-18. These tubes needed to be removed and relocated to be able to close TA-18, but the tubes are considered by LANL's shipping department to be a pressure hazard requiring special handling. Since GE-Reuter Stokes has a DOT exemption that allows them to transport He-3 tubes, it was easier to have GE-Reuter Stokes come to Los Alamos, package the tubes, and transport them to GE's facility in Ohio than it would have been for LANL to transport them across LANL for storage in another technical area. To expedite the closing of TA-18, LANL approved the transfer of the He-3 to GE Reuter Stokes. LANL did not receive any compensation for the He-3. A single large pressurized cylinder of He-3 remains at TA-18, the hold up in transporting that cylinder is that it must be sampled for contamination and (I think) it may not qualify under GE's DOT exemption.

LANL has other unused He-3 tubes stored outside TA-18. For example, I'm aware of an inventory of unused tubes at TA-35 accumulated from NA-24 R&D projects. Since there is no immediate need to relocate these tubes for building closure, I suspect that LANL will need direction from DOE on what should be done and what, if any, compensation (to DOE) should be arranged.

This brings up the possibility that DOE might be able to recover a significant amount of He-3 by directing all DOE facilities to perform an inventory of unused He-3 and directing facilities, as appropriate, to make the necessary arrangements for GE or Spectra Gas to pick up the tubes.

Mark

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Tuesday, October 27, 2009 9:55 AM
To: Cline, R. L.
Cc: Pantaleo, John
Subject: DOE Research Orders 102709.xls
Attachments: DOE Research Orders 102709.xls

I forgot to update the total in the last version of the file. Please disregard it and use this version. If we have decided not to consider NASA then I will remove them from this file and keep them in a separate file for all requests denied. Let me know. I did send out a request to the customes with DOE sponsored projects to submit the contact name at DOE.

Jack

Customer	Funding Agency	Contract	Volume (liters)
Starting Inventory			**2400**
Harvard Smithsonian Center for Astrophysics	NIH/NIBIB	5R21EB006475	120
Lawrence Livermore National Laboratories	DOE	DE-AC52-07NA27344	50
Leiden Cryogenics	DOE	DE-AC02-76SF00515	45
Leiden Cryogenics	NASA	GSA RFQ AG-2622-701784; PO 1363667	35
Leiden Cryogenics	NASA	08-APRA08-0051	45
Leiden Cryogenics	NSF	DMR-0805045	45
Oxford Instruments	American recovery And Reinvestment Act	NB817030-9-04880 solicitation no. SB11341-009-RQ-0316	100
Oxford Instruments	DOE	CPO_A09-1816	20
University of Minnesota	DOE	DE-FG02-02ER46004	9
University of Minnesota	NSF	DMR- **0854752**	9
University of Pennsylvania	NASA	NNX-09AB98	
University of Pennsylvania	NSF	AST-0406898	100
University of Wisconsin-Madison	NIH	NHLBI R01 HL080412	38
University of Wisconsin-Madison	NIH	NHLBI R01 HL069116	29
University of Wisconsin-Madison	NIH	NHLBI P01 HL070831	22
Xemed	DOE	DE 85387T08-2	50
Xemed	NIH	5R44EB007439-03	50
University of Virginia	NIH	R01 HL079077	90
University of Virginia	NIH	R21 HL089525	48
University of Virginia	NIH	R01 HL090806	50
University of Virginia	NIH	R01 HL088174	30
Ending Inventory			**1547**

Clenney, Jaclyn

From: Spear, Alan <CTR> [Alan.Spear@associates.dhs.gov]
Sent: Tuesday, October 27, 2009 1:41 PM
To: Dasti, Abdul; Spear, Alan <CTR>
Cc: Pantaleo, John; Slovik, Gregory; Glaser, Joseph
Subject: RE: Task 5 FY10 Demand Presentation to IPC doc 102709.doc

Good afternoon,
No further updates will be incorporated. The cut-off time is now past. The rest of our time will be focused on marrying the documents into a "Rollup" single document for the IPC which is due COB today. Thank you all for your assistance.

r/
Alan Spear
PADD/SETA
202-254-7260 (o)
703-405-7979 (c)

From: Dasti, Abdul [mailto:Abdul.Dasti@science.doe.gov]
Sent: Tuesday, October 27, 2009 1:28 PM
To: Spear, Alan <CTR>
Cc: Pantaleo, John; Slovik, Gregory
Subject: Task 5 FY10 Demand Presentation to IPC doc 102709.doc

Some more revisions.

Abdul

Government Rollout Plan
Draft Outline

Title Page
Table of Context
1.0 Executive Summary

2.0 Policy
- Outline the He3 allocation guidance provided by the IPC and Sub-IPC for implementation
- Summary of the International Reach Out program
- Any other issues

3.0 He3 Supplies (Plots of Supply vs Demand are needed)
Summary graph of the He3 Supplies
Details of th Domestic Supplies
- Tritium Decay
- Harvest from Recycle Program
- Natural Gas extractions
Details on the potential International Supplies
- Russia, China, and French sources
- CANDU reactors
- Natural Gas extraction from foreign sources

4.0 Demand on He3
Summary graph for the Government and Commercial Demand on He3
Detail on:
- Neutron Detection
- Cryogenics
- Basic Science
- Medical Applications
- Predicted Totals Demand

5.0 Development of Alternatives for He3 Neutron Detection
Summary graph/tables of alternatives to He3 based systems
Details by Agency (DOE, DHS, NIST, DOD,..)
- Current and Planned FY10 List of projects/technologies under investigation
- Planned FY10 -- FY14 (?) list of projects/technologies to be investigated
- List of projects that could be accelerated and the associated costs

6.0 Summary across the agencies for the technology to replace He3 neutron detection (looking for the duplication and ensuring coordination between agencies)
- Estimate what projects and technologies will be available to replace He3 detectors
- Estimate the time line
- Estimate funding levels required for:
  - Current funding
  - If increase funding is available for acceleration

1.0 Policy Executive Summary

The charter of the Policy group is to identify the policy and procedural issues associated with the interagency activities to address the identified ^3He shortage. Based on available legal authority for managing the allocation of ^3He, develop draft policies, and procedures associated with the current and projected use of ^3He for Government and non-government applications. In support of that goal, the Policy Group has met with Legal and Commerce representatives to place potential neutron detector materials on the short supply list as appropriate. The Policy Group also suggested that Departments request that the Department of Commerce (DOC) issue a Rating Authorization under the Defense Priorities and Allocations System (DPAS) to support acquisition of neutron detectors and associated equipment for specified programs. The current process focuses on both He-3 and Li-6. For Li-6, Commerce will be requesting technical assistance in developing guidance for its use (currently any quantity of Li-6 must be approved).

Draft use guidance for remaining stores of He-3 has been developed. It is currently focused on the largest US users and requires that there be no new starts for He-3 use and no use in Portals. Until a better understanding of near term He-3 needs are, the guidance also allocates only new production for distribution, holding remaining He-3 in reserve. Both of these guidance items will require review and revision in the next few months as enduring demand is better understood including Science and Industrial applications.

Before an information campaign could be started, Classification Guidance was developed on what information could be shared. Additionally, Q and A's were also drafted and circulated around the Interagency group. From this guidance, a full scale publicity campaign designed to alert the international community of the He-3 supply/demand imbalance has been instituted. The goal of this activity is to stress that the He-3 issue cannot be resolved only through USG efforts, but is an international issue demanding an international focus.

AAAS has volunteered to host a Workshop on the He-3 issue in February 2010. A letter, signed out by OSTP, has been delivered to technical organizations inviting their participation in this general meeting. More targeted technical meetings are also being supported, specifically, the October 2009 IEEE meeting in Orlando, and as part of upcoming ANS and INMM meetings.

Internationally, a flyer was circulated during the September 2009 IAEA General Conference that provided this information. Several representatives, including Argentina expressed their support. A phased-in approach to international engagement has also been developed. In this plan, priority has been given to potential He-3 supplier nations. As the largest potential holder of He-3, priority is being given to Canada, with an estimated holding of 100,000 liters of He-3 at the Ontario Power Generation (OPG) Company. A Statement of Work for engagement with OPG is being drafted. A technical meeting with OPG representatives to help better understand the tasks required to acquire their He-3 was recently concluded.

2.0 Policy

The charter of the Policy Group is to identify the policy and procedural issues associated with the interagency activities to address the identified ^3He shortage. Based on available legal authority for managing the allocation of ^3He, develop draft policies, and procedures associated with the current and projected use of ^3He for Government and non-government applications. The policy process will be developed and implemented in a consensus manner with the represented Government agencies. The results of the policy and procedural review and subsequent recommendations will be forwarded to the Integrated Product Team (IPT) Chair to be passed to the Steering Committee for their consideration and either direct action or consultation with a Lead Agency member.

The Policy working group has been charged with investigating the existing authorities available to immediately restrict the use of ^3He as well as to allocate ^3He within domestic and international programs in the future. The Policy working group is working with the Commerce Department to develop a position on export restrictions for ^{3}He, if any. The Policy working Group is also reviewing with the Department of State and other agencies other international aspects and issues, such as establishing government to government relationships and agreements for accessing foreign supplies of ^{3}He, and the use of agreements already in place. Additionally, the Policy working group is working closely with the Department of Energy's Isotope Sales Program with respect to ensuring fair and equitable provision of a fairness of opportunity for private sector entities to compete via auction for any allocations of ^{3}He determined from a prioritization process to be appropriate.

Legal Authorities to Allocate Supply
Interagency meetings were held with the Department of Commerce, Office of National Security and Technology Transfer Controls, Bureau of Industry and Security to investigate the possibility of placing helium-3 on the DOC "Short Supply" list. Such findings are required by Section 3(2)© of the EAA. This involves economic information about the effect of the foreign demand for He 3 as well as export quantities of He 3. Very quickly Commerce noted that for cases of this nature (national security) the Defense Production Act (DPA) could/should be invoked. (This commodity is used for neutron detection in instruments designed and deployed for national and homeland security purposes.) The group quickly came to the conclusion that DPA (vs the DOC "Short Supply" list) was not only the more appropriate avenue to pursue, but would be much more timely.

The Defense Production Act (DPA) reads: "Under the Defense Production Act (DPA), 50 U.S.C. app. §§ 2061-2171 (2008), DOE/NNSA has the authority to allocate materials, services, and facilities for national defense purposes. Section 101(a) of the Defense Production Act, 50 U.S.C. app. § 2071(a), gives the President the authority 'to allocate materials, services, and facilities in such manner, upon such conditions, and to such extent as she/he shall deem necessary or appropriate to promote the national defense.' This authority has been delegated to the Secretary of Energy "with respect to all forms of energy," and re-delegated to the Administrator of the NNSA and to the Director of the NNSA Office of Procurement and Assistance Management. See Executive Order No 12,919 (June 7, 1994); Executive Order No. 11790 (June 25, 1974); DOE Delegation Order No. 00-003.00; DOE Delegation Order No. 00-003.01."

Policy Suggestion to request DPAS
As a result of the meetings with Commerce, the Policy Group suggested that Departmentsformally request from Commerce a determination, pursuant to section 202 of Executive Order 12919, that the preservation of the current ^{3}He stockpile and future production is necessary to promote the national defense. Upon issuance of the program determination, the Department of Commerce (DOC) will be able to issue a Rating Authorization under the Defense Priorities and Allocations System (DPAS) to support acquisition of neutron detectors and associated equipment for the identified programs.

Publicity
Classification: identifying what information can be shared
Before an information campaign could be started, Classification Guidance was developed on what information could be shared. Additionally, Q and A's were also drafted and circulated around the Interagency group. From this guidance, a full scale publicity campaign designed to alert the international community of the He-3 supply/demand imbalance has been instituted. The goal of this activity is to stress that the He-3 issue cannot be resolved only through USG efforts, but is an international issue demanding an international focus. Draft guidance was provided as SOC #1.

Standard Q and A's
In order to help ensure a standard response to frequently asked questions, The DOE Public Affairs Group developed standard Q and A's. These were distributed for comment and provided to identified Points of Contact. For completeness, they are provided as Attachment 1.

General meeting (AAAS) and IAEA

Internationally, a flyer was circulated during the September 2009 IAEA General Conference that provided information on the He-3 issue. Several representatives, including Argentina expressed their support. A phased-in approach to international engagement has also been developed.

AAAS has volunteered to host a Workshop on the He-3 issue in February 2010. A letter, signed out by OSTP, has been delivered to technical organizations inviting their participation in this general meeting.

Technical Meetings
IEEE, ANS, INMM
More targeted technical meetings are also being supported, specifically, the October 2009 IEEE meeting in Orlando, and as part of upcoming ANS and INMM meetings.

<u>Demand guidance</u>
Draft use guidance for remaining stores of He-3 has been developed. It is currently focused on the largest US users and requires that there be no new starts for He-3 use and no use in Portals. Until a better understanding of near term He-3 needs are, the guidance also allocates only new production for distribution, holding remaining He-3 in reserve. Both of these guidance items will require review and revision in the next few months as enduring demand is better understood including Science and Industrial applications.

<u>Supply: International Engagement Effort</u>
General Plan
A phased-in approach to international engagement has also been developed. In this plan, priority has been given to potential He-3 supplier nations. Initial focus is on Canada (see below). The general schedule, based on potential supply and upcoming meeting opportunities is as follows:

Foster contacts with Argentina: explore commercial supply of tritium/He-3	Oct. 2009
Foster contacts with France: explore prospects of restarting production	Oct. 2009
Foster contact with India	Nov. 2009
Contact Russia: explore expanded production of He-3	Jan. 2010
Contact China: explore commercial supply of tritium/He-3	Feb. 2010
Contact Romania: explore commercial supply of tritium/He-3	Mar. 2010
Contact Republic of Korea: explore commercial supply of tritium/He-3	Apr. 2010

Each country presents its own challenges for cooperation in resolving the He-3 issue. A country plan approach is to be drafted.

Canada
As the largest potential holder of He-3, priority is being given to Canada, with an estimated holding of 100,000 liters of He-3 at the Ontario Power Generation (OPG) Company. A Statement of Work for engagement with OPG is being drafted. A technical meeting with OPG representatives to help better understand the tasks required to acquire their He-3 was recently concluded.

<u>Identifying other potential short supply materials</u>
One of the potential alternative materials to replace He-3 as a neutron detector material is Li-6. Commerce has classified Li-6 as a short supply material that requires approval for any quantity of Li-6 used in a device. Commerce is in the process of redefining the Li-6 section of their guidance. We have met with them to offer technical information to assist in the revision to this guidance.

Attachment 1

The following are suggested answers to potential questions regarding the current shortage in Helium 3 supply.

What is Helium 3?

He3 is a non-radioactive and non-hazardous isotope of helium. It is a very rare isotope that cannot be extracted from nature. He3 is a byproduct of the decay of tritium, which is a gas that is used in nuclear weapons.

What is Helium 3 used for?

Currently, the majority of He3 is used for neutron detection. This detection, whether in nuclear facilities or at ports, border crossings, or during active searches, helps prevent nuclear materials from being diverted or smuggled for illicit purposes. The Department of Defense, the Department of Homeland Security, and the National Nuclear Security Administration each have nuclear detection programs that use Helium 3 based sensors

It is also used in other areas such as oil and gas exploration, medicine, cryogenics and physics.

Can Helium 3 be replaced for use in neutron detection?

Yes, but He3 is the preferred choice. It is non-reactive, non-corrosive, and performs very well compared to other technologies. No other currently available detection technology offers the same stability, sensitivity, and gamma/neutron discrimination.

Why is demand for Helium 3 so much higher than supply?

Helium 3 is produced through the U.S. nuclear weapons program. It is a byproduct of tritium, a gas used in nuclear weapons. As the number of weapons has gone down over the years, the amount of tritium produced has also gone down. This has resulted in a finite amount of Helium 3 being produced.

After the terrorist attacks of Sept 11, the U.S. government began to significantly increase its nuclear detection capabilities both at home and around the world. This resulted in a corresponding spike in the amount of Helium 3 that was needed.

At the same time, private industry continued to need a steady supply of Helium 3 to continue their important work.

As a result, the demand for the isotope quickly outpaced the supply.

What is being done to address this issue?

An interagency steering committee was formed that is composed of various federal agencies that are affected by the Helium 3 shortage. The group is discussing potential options to both increase the supply of Helium 3, and to reduce the demand for it in certain areas.

Some of the options being discussed include:

- Pursuing alternative technologies for neutron detection
- Finding alternative methods for production of He-3

- Working with other countries to identify additional sources of He-3
- Prioritizing the existing supply of He-3 based on need.

Private industry and international stakeholders will also be engaged.

Is there a solution?

The different government agencies are discussing potential options to resolve this situation. They will also be engaging the technical, commercial and international communities to solicit ideas to address and resolve the issue. We are confident that the government, private industry, and international stakeholders will be able to find a path forward.

In the near term, USG Departments are working with the commercial sector to identify alternative detection products that are ready for commercialization. As these are identified, prototypes will be purchased for test and analysis, the goal being to spur technology innovation especially in the area of neutron detection for security.

Report to the Interagency Policy Committee (IPC)

Working Draft of the ^{3}He IPT Status and Plans to Search for Alternatives to ^{3}He Based Neutron Detection

Chair:
Gregory C. Slovik, P.E.
Department of Homeland Security
Domestic Nuclear Detection Office

Co-Chairs:
Dr. Joseph Glaser, DOE – Policy Working Group Lead
Ms. Nanette Founds, DOE – Supply Working Group Lead
Mr. John Pantaleo, DOE – Demand Working Group Lead
Mr. Gregory C. Slovik, DHS – Technology Working Group Lead

DHS/DNDO Document Number 500-HE3-109611

October 29, 2009

Executive Summary

Historically, most of the ^{3}He used in the United States has been provided from the decay of Tritium produced for the U.S. nuclear weapons program. The U.S. Government (USG) ceased production of Tritium for the nuclear weapons program in 1988. At the end of the Cold War, there was a surplus of over 250,000 liters of ^{3}He. Once DOE began distributing the gas, the USG, international communities, and the private sector migrated to a ^{3}He-based infrastructure for neutron detectors.

A noticeable increase in the demand for ^{3}He caused DOE-Isotope Program to halt its sale in 2008. Data pulled by the Domestic Nuclear Detection Office (DNDO) from all USG Departments regarding their ^{3}He demand showed that the USG has at least a ~55,000 liter/year demand. The scientific community and international demand adds on average another ~20,000 liters/year. At current consumption rates, ^{3}He supply is predicted to only meet ten percent of the projected demand per year, starting in FY2010.

In March, 2009, an Integrated Project Team (IPT) was formed with members from Department of Energy (DOE), Department of Defense (DOD), Department of Homeland Security (DHS), Department of State (DOS), National Institute for Standards and Technology (NIST), and other Government Agencies. The commercial sector is also being represented by the DOE Isotope Program that has the history and knowledge of industries need for this isotope. Oversight and guidance is being provided by a Secretarial-level Interagency Policy Committee (IPC) being run from the Nuclear Defense Policy National Security Staff. More hands-on oversight is provided by a Director-level panel designated the Sub-IPC.

Subordinate to the IPT are four chartered Working Groups: (1) Policy, (2) Supply, (3) Demand, and (4) Technology. The following sections provide the status of the ongoing effort in each working group.

Policy: The Policy Working Group identifies policy and procedural issues associated with the interagency activities required to properly address the ^{3}He shortage. Its goal is to develop draft policies, and procedures, based on available legal authority for managing the allocation of ^{3}He, associated with the current and projected use of ^{3}He for Government and non-government applications. In support of that goal, the Policy Working Group has taken action in several key areas.

Commercial Policy A request is drafted requesting that the Department of Commerce (DOC) issue a Rating Authorization under the Defense Priorities and Allocations System (DPAS) to support acquisition of neutron detectors and associated equipment for specified programs and that potential neutron detector materials be placed on the short supply list as appropriate.

Prioritization Use guidance is drafted for the remaining stores of ^{3}He. It is currently focused on the largest US users and requires there be no new program starts requiring ^{3}He and no more use in portal monitors. Until a better understanding of what near term ^{3}He needs are, the guidance also allocates no new production for distribution, holding remaining ^{3}He in reserve.

Classification Before an information campaign could be started, Classification Guidance was developed on what information could be shared.

Outreach and International Partnership Based upon guidance from the IPC, a publicity campaign has been initiated to alert the international community of the ^{3}He shortage. This activity stresses that the ^{3}He issue cannot be resolved by US Government (USG) efforts alone, but it is broad issue demanding a cooperative response with US industry and international partners. Among the outreach actions already performed are:

Outreach The American Association for the Advancement of Science (AAAS) has volunteered to host a Workshop on the ^{3}He issue in February 2010. A letter, issued by Office for Science and Technology (OSTP), has been delivered to technical organizations inviting their participation in this general meeting. More targeted technical meetings are also being supported. More specifically, the October 2009 Institute of Electronic and Electrical Engineers (IEEE) meeting in Orlando, is one venue, and information will be provided as part of upcoming American Nuclear Society (ANS) and Institute of Nuclear Materials Management (INMM) meetings.

International Partnership A flyer was circulated during the September 2009 IAEA General Conference that provided information on the ^{3}He shortage. Several representatives, including Argentina, expressed their support. A phased-in approach to international engagement has also been developed. In this plan, priority has been given to potential ^{3}He supplier nations. As the largest potential holder of ^{3}He, priority is being given to Canada, with an estimated current holding of 60,000 liters of ^{3}He at the Ontario Power Generation (OPG) Company. A Statement of Work for engagement with OPG is being drafted. A technical meeting with OPG representatives to help better understand the tasks required to acquire their ^{3}He was recently concluded.

Supply: The Supply Working Group identifies all viable sources of ^{3}He, nationally and internationally, and characterizes them in terms of cost, technical considerations, and schedule. Concurrently, a Request for Information (RFI) is drafted to solicit industry's insights regarding additional sources of ^{3}He and/or alternative or mitigating technologies. This RFI is discussed more fully in the *Technology* section below. Thus far, the Supply Working Group has identified, and to various degrees characterized, the following potential sources of ^{3}He.

Tritium Stockpiles Tritium, a byproduct of various US nuclear programs is stockpiled at the Savannah River Site (SRS). Over time, Tritium decays naturally to ^{3}He. This process at SRS has traditionally provided the nation its greatest source of ^{3}He.

Cost: Byproduct of existing Defense Programs
Schedule: FY 10 produces 43K liters; FY 11 products 22K liters; FY 11+ produces 7-8K liters
Technical: Established source with predictable yields

Retired Metal Hydride Tritium Storage Beds In addition to the bulk storage of Tritium described above, SRS also uses large-scale metal hydride beds that store smaller quantities of Tritium. Here again Tritium decays naturally to ^{3}He and, under the normal operating conditions, is retained within the metal hydride material. Fourteen metal hydride storage beds have been emptied of Tritium and removed from service. It is estimated that together these beds contain a total of 8,000 to 10,000 STP liters of recoverable ^{3}He. Recovery of ^{3}He from hydride beds could be repeated about once every 10 years as aged storage beds are replaced.

Cost: Undetermined; $75K to develop a recovery strategy
Schedule: FY12 to FY15 may produce 8-10K liters
Technical: Readily executable, but funding not provided to proceed

Recycling (Harvesting ^{3}He from Retired/Excess Equipment) ^{3}He in retired and excess equipment can be harvested. A program to do this must consider various factors including cost effectiveness. One consideration, whether recycled ^{3}He goes back to a central storage for distribution or remains the property of the recycling originator, will be put to the IPC for a recommendation

Cost: Undetermined
Schedule: FY10 to FY15 may produce a total of ~10k liters over two years (estimate for planning purposes only, actual amount is to be determined)
Technical: Readily executable, but funding not provided to proceed

Bureau of Land Management (BLM) Helium and Natural Gas The ability to extract ^{3}He from regular Helium (^{4}He) has been demonstrated on a laboratory scale. Fundamentally, it is plausible on an industrial scale, and this could potentially yield long-term annual quantities capable of significantly alleviating the ^{3}He shortage. Natural Helium, as a trace element within natural gas, may be available in sufficient quantities to make it an attractive source of ^{3}He. The extraction of ^{3}He from regular Helium found in Helium reserves and natural gas may prove to be profitable but it all depends on the ^{3}He concentration in natural Helium. If the ^{3}He concentration is high enough, market forces may help to solve the ^{3}He shortage problem with only minimal government intervention.

Cost: Undetermined; may be funded by industry following government incentives
Schedule: FY12 to FY18+ may produce up to 200K liters annually
Technical: Demonstrated on a small scale, feasible on industrial scale, huge supply potential

Heavy Water Reactors Canada's Ontario Power has a total of 20 heavy water reactors, in operation or under a restart program, using the trademarked "CANada Deuterium Uranium" (CANDU) process. These reactors generate Tritium as a byproduct, which is stored in immobilized tritium containers (ITCs) while it decays to ^{3}He. OP has been contacted to investigate the purchase approximately 700 ITCs with the possibility of acquiring more if this proves to be a competitively viable source. In addition to the Canadian reactors, there are reactors in several other countries employing the CANDU process or similar processes that generate Tritium. These may also be viewed as potential contributors to the worldwide ^{3}He supply, but no steps have been taken to explore these options at this time.

Cost: Procurement cost is undetermined; Phase I is assumed to be about $450K for SRNL to develop a recovery strategy and work with OP. It is assumed the OP contract will be ~$400k
Schedule: FY22 to FY73 may produce up to ~250K liters
Technical: Low technical risk; complex policy, legal, and procedural challenges

Supplemental Tritium Production Tritium production for national defense currently uses roughly half of the available national capacity and infrastructure. The excess can be leveraged without expanding current operations. As a result, significant ^{3}He production can be obtained while working within and not expanding the current capabilities, although these capabilities could be expanded if required in the future. This alternative could begin generating small volumes of ^{3}He in five to seven years, depending on priority, with gradually increasing annual yields as long as required.

Cost: Approximately $10K/liter
Schedule: FY20 and beyond, 1.5K liters growing to 7.7K liters annually
Technical: Low technical risk

Demand: The Demand Working Group has queried Government and industry to compile a list of unmitigated (before the shortage was recognized) and mitigated (responsive to the IPC and Sub-IPC guidelines) demands for ^{3}He. Justifications were also provided by each ^{3}He claimant to facilitate prioritization as required. This a currently a dynamic learning process requiring that demands be reviewed regularly; therefore, the Demand Working Group has recommended that its database be refreshed quarterly, at least until it stabilizes. The following is a discussion of planning guidance introduced by the IPC and Sub-IPC along with a summary of the dominant demands for ^{3}He.

IPC and Sub IPC Planning Guidance

Sub-IPC Guidance. The Sub-IPC provided guidance in the past that ^{3}He was a national asset and a critical situation exists. Any ^{3}He harvested in a year over 7,700 liters will be placed in the reserve for emergency and critical requests that may arise. Moreover, during the 11 August 2009 meeting it was agreed the strategic path forward on further ^{3}He allocations will be the following:

- Defer all further allocations of ^{3}He for portal monitors beginning in FY10.
- The USG will not support allocating ^{3}He for any new initiatives that would result in an expansion of the ^{3}He infrastructure.
- An allocation goal of 7,700 liters per year, commencing in FY10 will be implemented and any additional Supply will be ear marked as reserve for emergency and critical needs.

IPC Guidance. On 10 September 2009 the IPC provided the following requirements that must be considered when requesting ^{3}He and will be used as the prioritization criteria:

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

Summary of Demands Data collected focused upon FY10 through FY15. Each Government Agency provided its own demand and justification. The commercial sector (i.e., cryogenics, oil & gas, medical, etc.) was represented by the DOE Isotope Program (leading the Demand Working Group) who has intimate knowledge on the usage history and projected requirements of ^{3}He. The three principal users of ^{3}He throughout the period examined are DOE, DHS, and DoD. The sum of DOE and industry demands are notionally 35-45K liters per year. Total demand is notionally 70-80K liters per year.

Technology: The Technology Working Group reviewed the research being pursed across the government to find alternative technologies to replace ^{3}He based neutron detection. This effort benefits by coordination with the currently on-going Rad/Nuc Working Group that coordinates research activities among DHS, DOE, and DoD, and which is focused upon eliminating wasteful duplication and increasing research efficiency and effectiveness. Emerging technologies are evaluated on the basis of their maturity and perceived ability to yield affordable, effective, and suitable neutron detection within a timeframe that may impact the ^{3}He shortage issue. The scope and complexity of the systems engineering required to develop appropriate systems based upon the emerging technology is factored into these assessments. The following is a review of the key technologies that offer promise.

Near Term Projects The following initiatives are ongoing or thought to offer the possibility of solutions or insights within the next 1 – 2 years.

Market Research and Testing of Commercial Products. A RFI in Jun 2009 was released to request information from the commercial sector on technologies available for application in handhelds, backpacks, and portal monitors that are not based on ^{3}He technology and will be available by Jan 2010. The RFI also served to inform industry the Government is looking for alternative technologies to ^{3}He-based neutron detection to encourage them to also take on the challenge. DNDO is testing several of the detectors submitted with the RFI from late Oct to late Nov 2009. The testing results, if favorable, may lead to a Request for Proposal (RFP) to develop detectors that could be deployed in portal monitors in the near future.

BF_3 based neutron detection. DNDO is initiating a program to develop a neutron detector for portal monitors. The effort would focus on engineering a detector with the proper safety features and performance. There is essentially no performance risk in using the BF_3 technology because it was the workhorse for neutron detection before ^{3}He was available. The BF_3 option is being pursed because this technology will not only perform but will also have the lowest cost (e.g., ~$7k vs ~$30k for some other technologies). Furthermore, indications are the toxicity of BF_3 can be engineered away with a ruggedized housing, low detector pressure, and better material to neutralize the effects of the gas.

Follow on Testing. Several of the companies that responded to RFI by submitting equipment continued to develop portal neutron detectors. DNDO plans to evaluate those 2nd generation detectors (e.g., Innovative American Technology [IAT] and GE) to assess the performance and the continual changing status of the commercial market.

Mid Term Projects These projects are developing technologies that promise viable alternatives within 3 – 5 years.

CLYC (Cs_2LiYCl_6:Ce). is a new crystal with a bright scintillation response to neutrons and can detect thermal as well as fast neutrons. DNDO and Defense Threat Reduction Agency (DTRA) are working together on improving the detection performance as well as to increase the crystal size.

STRAWS. The technology applies a collection of 100s of small tube coated with ^{10}B and shows significant promise for use in portal monitor neutron detection.

Far Term Projects DTRA, DOE, and DHS all have very active long term research and development programs investigating alternative technologies to ^{3}He neutron detection.

Currently, about 22 relevant projects are expected to reach the Technology Readiness Level (TRL) 3 – 6 (mature enough for system prototype demonstration) in the next 3 – 5 years. Successful technologies from these projects will go through a systems engineering process requiring notionally another 1 – 2 years before a system can be delivered to end users; therefore, they are 4 – 7 years from delivering viable alternatives.

Table of Contents

Table of Contents
(Continued)

Table of Contents
(Continued)

1.0 Preface

The goal of this report is to provide an overarching view on the status of the actions being taken across the Government to address the ^3He shortage issue. To manage the remaining reserves, identify the priorities, and control the release of future allotments of ^3He, a ^3He Integrated Project Team (IPT) was formed with members from Department of Energy (DOE), Department of Defense (DOD), Department of Homeland Security (DHS), National Institute for Standards and Technology (NIST), Department of State (DOS), and other Government Agencies. The commercial sector is also being represented by the DOE Isotope Program that has the history and knowledge of industries need for this isotope. Oversight and guidance is being provided by an Interagency Policy Committee (IPC) being run from the Nuclear Defense Policy National Security Staff.

The ^3He IPT has been formed with several Working Groups: (1) Policy, (2) Supply, (3) Demand, and (4) Technology. The following sections will provide the status of the ongoing effort in each of the above mentioned Working Groups.

2.0 Policy Working Group

The Policy Working Group's charter is to identify the policy and procedural issues associated with the interagency activities required to properly address the ^3He shortage. The goal is to develop draft policies, and procedures, based on available legal authority for managing the allocation of ^3He, associated with the current and projected use of ^3He for Government and non-government applications. The policy process will be developed and implemented in a consensus manner with the represented Government agencies. The results of the policy and procedural review and subsequent recommendations will be forwarded to the Integrated Project Team (IPT) Chair to be passed to the Sub-IPC for their consideration and either direct action or consultation with a Lead Agency member.

The Policy Working Group has been charged with investigating the existing authorities available to immediately restrict the use of ^3He as well as to allocate ^3He within domestic and international programs in the future. The Policy Working Group is coordinating with the Commerce Department to develop a position on export restrictions for ^3He, if any. The Policy Working Group is also reviewing with the Department of State (and other agencies) the international aspects and issues, such as establishing government to government relationships and agreements for accessing foreign supplies of ^3He, and the use of agreements already in place. Additionally, the Policy Working Group is working closely with the Department of Energy's Isotope Sales Program with respect to ensuring fair and equitable provision of a fairness of opportunity for private sector entities to compete via auction for any future allocations of ^3He.

Legal Authorities to Allocate Supply

Interagency meetings were held with the Department of Commerce, Office of National Security and Technology Transfer Controls, Bureau of Industry and Security to investigate the possibility of placing ^3He on the DOC "Short Supply" list. Such findings are required by Section 3(2)(c) of the EAA. This involves economic information about the effect of the foreign demand for ^3He as well as export quantities of ^3He. Very quickly Commerce noted that for cases of this nature (National Security) the Defense Production Act (DPA) could/should be invoked. (This commodity is used for neutron detection in instruments designed and deployed for national and homeland security purposes.) The group quickly came to the conclusion that DPA (vs the DOC "Short Supply" list) was not only the more appropriate avenue to pursue, but would be much more timely.

The Defense Production Act (DPA) reads: "Under the Defense Production Act (DPA), 50 U.S.C. app. §§ 2061-2171 (2008), DOE/NNSA has the authority to allocate materials, services, and facilities for national defense purposes. Section 101(a) of the Defense Production Act, 50 U.S.C. app. § 2071(a), gives the President the authority 'to allocate materials, services, and facilities in such manner, upon such conditions, and to such extent as she/he shall deem necessary or appropriate to promote the national defense.' This authority has been delegated to the Secretary of Energy "with respect to all forms of energy," and re-delegated to the Administrator of the NNSA and to the Director of the NNSA Office of Procurement and Assistance Management. See Executive Order No 12,919 (June 7, 1994); Executive Order No. 11790 (June 25, 1974); DOE Delegation Order No. 00-003.00; DOE Delegation Order No. 00-003.01."

Policy Suggestion to request DPAS

As a result of the meetings with Commerce, the Policy Group suggested that Departments formally request from Commerce a determination, pursuant to section 202 of Executive Order 12919, that the preservation of the current ^{3}He stockpile and future production is necessary to promote the national defense. Upon issuance of the program determination, the Department of Commerce (DOC) will be able to issue a Rating Authorization under the Defense Priorities and Allocations System (DPAS) to support acquisition of neutron detectors and associated equipment for the identified programs.

Publicity

Classification: identifying what information can be shared

Before an information campaign could be started, Classification Guidance was developed on what information could be shared. Additionally, Q and A's were also drafted and circulated around the interagency group. From this guidance, a full scale publicity campaign designed to alert the international community of the ^{3}He supply/demand imbalance has been instituted. The goal of this activity is to stress that the ^{3}He issue cannot be resolved only through USG efforts, but is an international issue demanding an international focus. Draft guidance was provided as SOC #1.

Standard Q and A's

In order to help ensure a standard response to frequently asked questions, The DOE Public Affairs Group developed standard Question and Answers (Q and A's). These were distributed for comment and provided to several Points of Contact (POCs). The released version of the Q and A's are provided as Attachment 1.

General meetings

Internationally, a flyer was circulated during the September 2009 International Atomic Energy Agency (IAEA) General Conference that provided information on the ^{3}He issue. Several representatives, including Argentina expressed their support. A phased-in approach to international engagement has also been developed.

AAAS has volunteered to host a Workshop on the ^{3}He issue in February 2010. A letter, signed by Office of Science and Technology Policy (OSTP), has been delivered to technical organizations inviting their participation in this general meeting.

Technical Meetings

More targeted technical meetings are also being supported, specifically, the October 2009 Institute of Electronic and Electrical Engineers (IEEE) meeting in Orlando, and as part of upcoming American Nuclear Society (ANS) and the Institute of Nuclear Materials Management (INMM) meetings.

Demand guidance
Draft use guidance for remaining stores of ^3He has been developed. It is currently focused on the largest US users and requires there be no new starts for ^3He use and no further use in portal monitors. Until a better understanding of what near term ^3He needs are, the guidance also allocates only new production for distribution, holding remaining ^3He in reserve. Both of these guidance items will require review and revision in the next few months as demand is better understood.

Supply: International Engagement Effort
General Plan
A phased-in approach to international engagement has also been developed. In this plan, priority has been given to potential ^3He supplier nations. Initial focus is on Canada (see below). The general schedule, based on potential supply and upcoming meeting opportunities is as follows:

Foster contacts with Argentina: explore commercial supply of tritium/^3He	Oct.2009
Foster contacts with France: explore prospects of restarting production	Oct. 2009
Foster contact with India	Nov. 2009
Contact Russia: explore expanded production of ^3He	Jan. 2010
Contact China: explore commercial supply of tritium/^3He	Feb. 2010
Contact Romania: explore commercial supply of tritium/^3He	Mar. 2010
Contact Republic of Korea: explore commercial supply of tritium/^3He	Apr. 2010

Each country presents its own challenges for cooperation in resolving the ^3He issue. A country plan approach is to be drafted.

Canada
As the largest potential holder of ^3He, priority is being given to Canada, with an estimated holding of 100,000 liters of ^3He at the Ontario Power Generation (OPG) Company. A Statement of Work for engagement with OPG is being drafted. A technical meeting with OPG representatives to help better understand the tasks required to acquire their ^3He was recently concluded.

Identifying other potential short supply materials
One of the potential alternative materials to replace ^3He as a neutron detector material is ^6Li. Commerce has classified ^6Li as a short supply material that requires approval for any quantity of ^6Li used in a device. Commerce is in the process of redefining the ^6Li section of their guidance. We have met with them to offer technical information to assist in the revision to this guidance.

3.0 Supply Working Group

3.1 Introduction
Demand for ^3He has exponentially increased due to its desirability for use in gas proportional counters for neutron detection. Additionally, the number of applications requiring the unique isotopic properties of ^3He, such as fusion research, novel imaging technologies, superconductivity and superfluidity, has grown. The typical source of ^3He is tritium decay. Tritium, used in thermonuclear weapons, is routinely replaced in weapons and through this process the ^3He is removed. However; as weapon stockpiles trend downward, less tritium is manufactured for weapons so that progressively smaller amounts of its byproduct ^3He are being produced. In fact, the world has already passed a tipping point where annual ^3He demand outstrips historic peak production. For this reason, some

alternative ^{3}He sources previously determined to be unviable due to cost or difficulty of extraction are being reconsidered.

From a historical perspective, the following table provides the releases that have occurred since the formation of the ^{3}He Integrated Product Team (IPT).

Table 3.1: Record of FY09 USG ^{3}He Releases

Quantity (liters) Unpurified	Quantity (liters) Purified	Comments
7,700	7,469	Dec 08 11,000 liters of gas was sold to Reuter Stokes with a restriction that 70% was for DOE/National Nuclear Security Administration (NNSA) SLD-CORE program and 30% for commercial use. The gas is either used or under contract.
7,350	7,130	Dec 08 10,500 liters sold to Spectra Inc with a restriction that 70% for National Security (DHS/DOD) and 30% for commercial use. DOD used 1,600 liters and the rest was used by DHS RPMP program. Gas supply exhausted in June 2009
4,124	4,000	May 2009 gas was sold to NucSafe to satisfy a UK contract. Gas supply exhausted in June 2009
2,440	2,367	Released to the commercial sector in May 2009. Was part of the shipment for NucSafe from the DOE Isotope Program.
8,763	8,500	June 2009 purchased by DHS but placed under the Steering Committee authority. In July 09 the SC decided to allocate: (1) 2400 liters to DOE for Commercial use (medical imaging and cryogenics) (2) 1926 liters for DHS, (3) 1500 Other Gov agencies, and (4) 722 liters for DOD. The remaining quantity is 1952 liters.
30,377	29,466	Total Quantities

The purpose of the ^{3}He Supply section is to investigate all future sources of ^{3}He as well as potential supplies from non-traditional sources. In the below sections the information presented will go from government controlled sources to the more high risk and cost options that potentially exist.

3.2 (Traditional) SRS Sources

From the SRS tritium stockpiles the anticipated FY10 domestic reserves are presented in Table 3.2 while the domestic supply held for research is shown in Table 3.3. Table 3.1 provides the anticipated domestic supply and current reserves for FY10 as well as the estimated future supplies out to FY15. The data indicates the US Government has about 65,500 liters between FY10 and FY11 but the steady state supply reaches 7,760 liters a year by FY12 and remains so out into the future (i.e., the steady state supply from the stockpile). Beginning in FY12, the anticipated supply of ^{3}He is minimal; roughly one fifth of the USG estimated requirements. The quantities in Table 3.2 represent the only guaranteed supply of ^{3}He. The others presented below sources all have either a long delay, technical issues, high cost or high risk associated with them.

Table 3.2: Domestic ^{3}He Reserve and Estimated Future Supplies from the Tritium Stockpile at Savannah River Site (SRS)

Comments	Purified Quantity (Liters)					
	FY10	FY11	FY12	FY13	FY14	FY15
DHS gas remaining from 8500 liter purchase (252 liters holdback	1,700					

to address measurement uncertainties and shipment loses)						
Located at Savannah River Site (SRS) in new cylinders and available for release (raw gas is 20,800 liters)	20,176					
Located at SRS in old cylinders and will need to be reloaded (raw gas is 14,000 liters)	13,580					
Located at SRS in old cylinders and will need to be verified and reloaded. Evaluation planned to be initiated in June 2010 (raw gas is estimated to be 15,000 liters)		14,550				
Estimate from SRS for out-years ~8,000 per year of raw gas	7,760	7,760	7,760	7,760	7,760	7,760
TOTAL Purified Liters	43,216	22,310	7,760	7,760	7,760	7,760

Table 3.2 represents the ^{3}He supplies known to exist but are earmarked for specified high priority scientific purposes. The Spallation Neutron Source (SNS) located at Oakridge National Laboratory was designed over a decade ago to use highly accurate ^{3}He neutron detectors. The 1.5 billion dollar facility requires over 100,000 liters of ^{3}He with the final 35,000 liters being stored at SNS to build the second line neutron detectors needed to complete the systems' performance specifications. The ^{3}He IPT will work with SNS to evaluate whether an alternative neutron detector can be used and to validate the amount of ^{3}He required. The analysis is expected to be completed in March 2010.

The second entry in Table 3.3 represents a quantity of ultra pure ^{3}He that was produced at the Mound Facility (which has been shut down) and is recognized to be unique and will not be considered as part of any reserve. This resource has been approved by the SC to remain under DOE control for scientific experiments that require ultra pure ^{3}He.

Table 3.3 Domestic Supply Held for Research
(NOTE: Quantities are in addition to those included in Table 3.1)

Quantity (liters) Purified	Comments
35,000	Allocated to SNS by DOE back in FY2007. The ^{3}He is needed for second line neutron detector arrays. While the ^{3}He gas is not needed immediately, it is crucial to the effective operation of the facility. 23 Jun 09 Steering Committee (SC) agreed with the ^{3}He IPT recommendation to not touch this material until the need is analyzed. ^{3}He IPT will investigate whether any of the gas can be released by the development of an alternative neutron detector system. Analysis expected to be completed March 2010
2,000	Specially processed ^{3}He gas (from the Mound Facility) that was made to be ultra pure. June 23, 2009 SC approved the ^{3}He IPT recommendation the material remain under DOE control to be released for special research projects that require high levels of ^{3}He purity. This resource would be nearly impossible to be replenished.

<u>3.3 Non Tradition Potential Future Sources of He3</u>

Additional sourcing alternatives for ^{3}He are being explored. There are many alternative sources of ^{3}He, from extraterrestrial - the moon for example - to the earth's atmosphere, oceans, and mantle, and natural helium and natural gas reserves. Both domestic and worldwide sources are being evaluated.

Several options are discussed below with some generating ^{3}He as early as 2012 while other options may not harvest ^{3}He for a number of years.

The potential sources will be presented from those that appear to be near term and cost effective to those that has high risk or cost.

3.4 Recycling Program to Harvest ^{3}He from Retired/Excess Equipment

A program to extract ^{3}He from retired and excess equipment – equipment no longer in-use or needed for programmatic purposes – has been proposed. The program will include performing a market analysis (inventory) to determine the type and quantity of retired equipment that is available; shipment of the excess equipment to a centralized storage/recycling location: recycling and purification of the gas; and storage of the gas for future use. The pilot phase will include all DOE and NNSA Laboratories and production sites. DOE will be the focal point to collect the ^{3}He gas for the USG and manage the program. Once the pilot phase of the program has been completed and DOE/NNSA has established facilities to receive, recycle the ^{3}He, and store the gas, the program will be opened to other government agencies such as the Department of Defense, DHS, the National Institute of Standards, etc. Potential recycling locations that are being investigated include Savannah River Site (SRS), Oak Ridge National Laboratory, Brookhaven National Laboratory, and commercial entities such as Spectra Gases and G.E. Reuter Stokes. A memorandum to all DOE/NNSA Labs and sites requesting they perform an inventory of ^{3}He containing equipment is currently in DOE signature channels. Estimated quantities recoverable through the recycling effort, program costs and timeline are to be determined. Program costs may include: the labor to perform the inventory (which could be a significant effort for some of the laboratories); transport of the retired equipment to the centralized recycling location; storing the equipment (while awaiting recycling process); dismantling the equipment (if necessary); disposing of old metal parts and/or hazardous materials from the dismantlement, determining the type of "other" gases which may be present in the tubes; recycling and purification of the ^{3}He; disposing the dismantled equipment; storing the recycled/purified gas for future use; as well as costs associated with an inventory/tracking system.

There is an issue that needs to be addressed by the Sub-IPC and that is the determination of whether recycled ^{3}He goes back to a central storage for distribution by the ^{3}He IPT or should the ^{3}He remain the property of the recycling originator.

Timeline and Estimated Quantity of ^{3}He

The quantity of ^{3}He to be extracted from this effort is still to be determined and should be known after the initial inventory is taken in the next few months. For planning purposes it is expected that a few 10s of 1000 liters could be collected. The program is expected to last only a few years or until the recycling winds down to a trickle. The cost and timeline for this activity is to be determined. Funding is required to initiate a program plan to determine the cost and timeline for this effort. Funding to initiate or execute this effort has not yet been identified.

3.5 Recovery of ^{3}He from Retired Metal Hydride Tritium Storage Beds

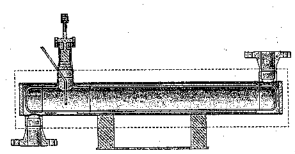
For the past 30+ years, the sole source of U. S. ^{3}He has been ^{3}He recovery from aged tritium-containing components from the USG nuclear weapons stockpile by the SRS Tritium Facility. An additional potential source of a significant quantity of ^{3}He (8,000 to 10,000 STP liters) has been identified in the SRS Tritium Facility.

Large-scale metal hydride beds are used to store tritium at SRS. During storage, some of the tritium decays to ^{3}He, and under the normal operating conditions of the storage beds, the ^{3}He is retained within the metal hydride material. Over the 10-year useful life of a metal hydride storage bed, a significant quantity of ^{3}He is retained in the metal hydride material. Fourteen metal hydride storage beds have been emptied of tritium and removed from service. It is estimated that together these beds contain a total of 8,000 to 10,000 STP liters of recoverable ^{3}He. Recovery of ^{3}He from hydride beds could be repeated about once every 10 years as aged storage beds are replaced.

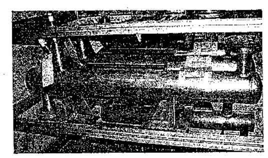
Recovery and capture of the ^{3}He from these retired metal hydride beds will require heating to high temperatures under vacuum conditions. There are two processing systems at the SRS Tritium Facility that are candidates for extracting ^{3}He from the hydride beds. At a minimum, changes to operating procedures will be required, and modifications to equipment may also be necessary.

The following activities are required to determine the method and prepare for the maximum recovery of hydride bed ^{3}He in the most cost-effective manner:

- Perform laboratory tests at Savannah River National Laboratory (SRNL) to determine the required temperature, pressure, and time to extract the maximum amount of ^{3}He from the metal hydride.
- Evaluate and compare the capabilities of the candidate processes to meet the conditions for maximum ^{3}He recovery and select the optimum process.
- Modify procedures and equipment to perform ^{3}He recovery.



Cross-section of Metal Hydride Bed



Spare Metal Hydride Beds

Timeline and Estimated Quantity of ^{3}He

The estimated quantity of ^{3}He to be extracted is 8,000 to 10,000 liters once every 10 years. The cost and timeline for this activity is to be determined but for planning purposes this material is expected to be available within two years after initiation of the program. Funding required for SRNL to develop a program plan is estimated to be $75K. Funding to initiate this effort has not yet been identified.

3.6 ^{3}He from Bureau of Land Management (BLM) Natural Helium Reserves

The Bureau of Land Management has controlled the supply of natural helium from 1925 until 1998, when Congress passed a law privatizing the production of helium. There are now several companies along the conservation pipeline at the Cliffside Field in Amarillo, Texas that produce the natural helium from their mines and also purchase helium from the BLM reserves every year. The current estimate of natural helium reserve is approximately 500 x 10^9 liters (or 18 billion cubic feet); 22 x 10^9

liters (.8 billion cubic feet) must remain in the reserves for the USG and about 480 x 10^9 liters is available for sale into the future. BLM is authorized to release 59 x 10^9 liters per year (2.1 billion cubic feet) but typically has been releasing 28 x 10^9 (1 billion cubic feet) liters per year. This means there is enough helium in the reserves to last about 10 – 15 years into the future, depending upon the demand.

Separation of ^3He from ^4He has been practiced since the late 40s and early 50s using the superfluid heat flush process. Purification in a single cycle can give more than a factor of a thousand in ^3He concentration increase. The natural abundance of ^3He in ^4He ranges from as high as 1064 ppb [near-surface atmospheric air] to as low as .44 ppb at the USBM-1R mine at the Bush Dome and Tuck-Trigg Dome at the Amarillo Plant Bureau of Mines. The companies along BLM's conservation pipeline continue to mine and extract helium gas from the BLM reserve to meet the yearly demands for natural helium. The largest possible recoverable amount of ^3He from the Cliffside Field is determined by the supply of He-4 and the associated concentration of ^3He. Since the estimated world production of natural He is 221 ML of liquid/year (ML = million liters), the yearly harvest could range from 400 to 200,000 liters of ^3He gas at standard temperature and pressure (STP)/year. (Over a 10 year period the helium reserve could supply 4,000 to 2,000,000 liters depending on the ^3He concentration.) According to a recent study 5/6 of this production is from within the USA and 50% is consumed in the USA. The production of natural He is defined by market conditions and requirements for purification of natural helium. It is clear that it would be a technical feat to coordinate purification of liquid He such as to recover a substantial fraction of ^3He from all natural He given the diverse sources for He. Figure 1 indicates the dispersed geographic distribution of ^4He production that is joined by a number of pipelines under the jurisdiction of the Bureau of Land Management. The large single area of high helium concentrations in Figure 1 corresponds to the Amarillo Texas BLM reserves.

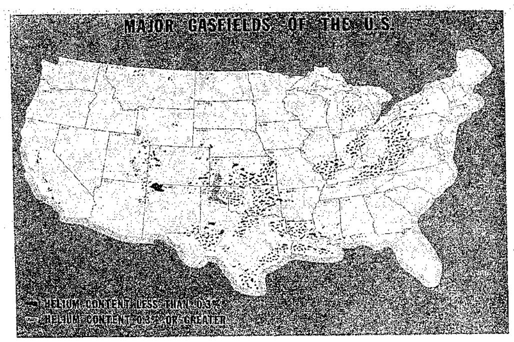


Figure 1. Major U. S. Gasfields with Helium Concentrations

Figure 1 illustrates the helium concentration estimates and the location of the BLM's Cliffside Field, Amarillo, TX, Helium Reserve as well as locations of some natural gas fields. It is clear from the number of private processing plants along the conservation pipeline that the technology for a high rate of He liquefaction already exists and that obtaining helium from the BLM reserves is not an issue. The main difficulty in recovering a substantial amount of natural abundant ^{3}He from ^{4}He is handling and purifying the massive amounts of liquid He. This effort should also be coupled with identifying mines that have the highest concentrations of the ^{3}He isotope to co-locate any processing facilities to minimize the plant size, energy requirements, and efficiency of extraction.

The Supply Working Group is placing a Request for Information (RFI) out through the Department of Homeland Security (DHS) on the FedBizOPs to obtain industries' input and analysis concerning their interest to develop the needed processes and facilities required to provide a future ^{3}He supply. The RFI is expected to be released on or about 30 October 2009 with an industry submittal date of mid-December 2009. It is too early in the investigation to determine the estimated supply per year and when the supplies would begin, if ever. This information will be provided in future versions of this report when the information is available.

Timeline and Estimated Quantity of ^{3}He

The estimated world production of natural He is 221 ML of liquid/year (ML = million liters), the yearly harvest could range from 400 to 200,000 liters of ^{3}He gas at standard temperature and pressure (STP)/year. The final quantity produced will depend mostly on the ^{3}He concentration and efficiency of the extraction process.

The strategy to develop a supply of ^{3}He from the helium reserves could be explored in two ways: (1) USG encourages private industry to pursue a business case where they harvest and sell ^{3}He on the open market, or (2) the USG funds the design, construction, and management of the ^{3}He separation plant and controls the ^{3}He supply. While both options need to be on the table at this early stage of the investigation, the preferred path would be for industry to develop this resource on their own. If industry sees a business case (i.e., high ^{3}He concentrations found) and invest capital, ^{3}He could be for sale on the open market within 2 – 3 years. If the Government needs to be involved to share in the developmental costs and construction of a facility, it is anticipated that would add another 1 – 2 years to the process.

3.7 ^{3}He from Natural Gas

It is estimated U. S. gas fields extract and sell about 590 trillion liters (21 trillion cubic feet) of natural gas each year. As noted in Figure 1 the concentration of helium and the ratio of ^{3}He to He-4 is dependent on the location and depth of the mine (i.e., shallow mines typically have higher concentrations of helium).

The potential of this supply could be quite enormous. If assuming there was .0001 to .003 fraction of helium in the natural gas supply that could be separated out as a trace element, the helium that could be collected would range from 590 x 10^9 to 1.77 x 10^{12} liters of natural helium. If also assuming the concentration ratio of ^{3}He to ^{4}He ranged from .44 to 1064 ppb, that would result in a supply of 300 liters to well over 200,000 liters per year. A very significant weakness of this simple analysis is that all the natural gas could be processed to extract the trace amounts of He and that it would be processed with 100% efficiency. This is not realistically possible but it does provide an upper limit to be imagined.

The Supply Working Group is in the process of placing a RFI through DHS on the FedBizOPs to obtain industries' input and analysis of their interest in developing the needed processes and facilities required to provide future ^{3}He supplies. The RFI is expected to be released on or about 30 October

2009 with a submittal date of mid-Dec 2009. It is also too early in the investigation to determine the estimated supply per year and when the supplies would begin, if ever. This information will be provided in future versions of this report when the information is available.

Timeline and Estimated Quantity of ^{3}He

Currently the natural gas purification process and extraction of trace elements (e.g., Ar, N, CO_2 ... etc) do not include natural helium. To develop a source from this process will take time since these companies will be essentially starting from scratch to harvest ^{3}He. The strategy to develop a supply of ^{3}He from the natural gas could be explored in two ways: (1) USG encourages private industry to pursue a business case where they harvest and sell ^{3}He on the open market, or (2) the USG funds the design, construction, and management of the ^{3}He separation plant and controls the ^{3}He supply. While both options need to be on the table at this early stage of the investigation, the preferred path would be for industry to develop this re^{3}He source on their own. If industry sees a business case (i.e., high ^{3}He concentrations found) and invest capital, ^{3}He could be for sale on the open market within 3 – 4 years. If the Government needs to be involved to share in the developmental costs and construction of a facility, it is anticipated that would add another 1 – 2 years to the process.

3.8 Heavy Water Reactors

Heavy water reactors use heavy water (deuterium oxide) as a neutron moderator. The most common pressurized heavy water reactor is the CANDU reactor: a Canadian-invented reactor. The acronym CANDU stands for "CANada Deuterium Uranium" and refers to the reactors' deuterium oxide moderator and use of natural uranium for fuel. All current power reactors in Canada are of the CANDU type and Canada markets this power reactor abroad. Tritium is extracted from the heavy water and stored in a device called an immobilized tritium containers (ITCs) as a decontamination product extracted from the moderator (i.e., the deuterium picks up a neutron and becomes a radioactive triton) during CANDU operations to reduce the radiation dose levels to staff working around the reactor and its subsystems. ^{3}He can be harvested from the decay of the tritium which has a 12.3 year half life.

Canada has a total of 20 heavy water reactors in operation or under a restart program all using the CANDU process. The Bruce site has 6 heavy water reactors in operation and two under a restart program; the Darlington site has 4 operational heavy water reactors and the Pickering site has 6 operational heavy water reactors. The Gentilly and Point Lepreau sites each have one operational reactor. Ontario Power owns the Darlington and Pickering sites, and leases the Bruce site to Bruce Power. However, the heavy water detritiation process is performed by Ontario Power at the Darlington site for the Darlington, Pickering and Bruce sites.

In addition to Canada, India has 15 operating heavy water reactors and 3 under construction that all use a reactor process developed in India and are much smaller than the Canadian reactors. South Korea has 4 operating heavy water reactors using the CANDU process and is the only other country that currently operates a de-tritiation facility. Argentina has 2 operating heavy water reactors and another under construction. One reactor uses the CANDU process and the other operating reactor and the one under construction use a reactor process developed in Germany. China and Romania each have two and Pakistan has one operating heavy water reactor that uses the CANDU process.

The USG has contacted Ontario Power (OP) to purchase approximately 700 immobilized tritium containers (ITCs) located at the OP Darlington Nuclear Generating Station (DNGS) to obtain ^{3}He. The USG is also pursuing an agreement with OP to purchase all future quantities of ^{3}He to be generated within new USG supplied ITCs. One option is to procure and ship the ITCs to the US and extract the ^{3}He at the Savannah River National Laboratory (SRNL) where Defense Programs performs a tritium extraction process. The procurement process has two phases. In Phase I a Statement of Work (SOW) was developed as a joint assessment with OP to define the legal framework and tasks needed to execute the procurement and transport of the ITCs to the US. The Phase I effort will also pursue an agreement with OP to procure future supplies of ^{3}He produced at OP. If the Phase I Assessment is determined to have a favorable result with USG acceptance, a Phase II SOW will be issued for the execution phase of the procurement. Under Phase I the USG is currently in negotiations with Ontario Power and a DOE Contracting Officer has been assigned.

Timeline and Estimated Quantity of ^{3}He - As stated by the Canadians during the first informal round of discussions, the US should be able to harvest 20,000 liters a year for the first three years and 7,000 liters a year for the next ten years. The cost for Ontario Power's labor and effort during the Phase I assessment will be negotiated by the DOE contracting Officer remains is to be determined. The cost for Phase II (procurement and transport of the ITCs to the US) is also unknown at this time and will be negotiated through the appropriate contracting officer. The ^{3}He gas quantities predicted from this procurement is shown Table 3.4.

If the negotiations with OP are successful, the procurement price is acceptable, and the storage/processing lifecycle cost are reasonable, and the funds are found to pursue this resource, the extractions will be 20,000 liters in FY12- FY14 with 7,000 liters per year from FY15 – FY22.

Table 3.4 ^{3}He release timeline for CANDU procurement

#	Years (Yrs) from 2009	Liters	Comments
1	12.5 yrs (or by 2022)	130,000	^{3}He generated between 1990 and 2022 from tritium decay. Could extract for 3 years: 20,000 liters/year (already in the cover gas) and 7,000 liters/yr (will be released into the ITC gas space as the tritium decays)
2	25 yrs (or by 2034)	65,000	^{3}He generated between 12.5 yrs and 25 yrs of tritium decay
3	37.5 yrs (or by 2047)	32,500	^{3}He generated between 25 yrs and 37.5 yrs of tritium decay
4	50 yrs (or by 2060)	16,250	""
5	62.5 yrs (or by 2073)	8,124	""
	Total He3 harvested from the 700 ITCs	~251,900	Total dependent upon the ^{3}He extraction efficiency and gas trapped within the ITC when disposed

The scope of work required by SRNL to recover ^{3}He from the ITCs is greatly dependent on the effort required to satisfy any issues yet to be discussed with the Canadian government as well as to evaluate the full lifecycle of this purchase. For example, issues such as:

- tritium accountability by the Canadian Government
- packaging and transportation through Canada and the US
- availability of the overpacks needed to ship the ITCs to the US and whether 1 or up to six ITCs could be handled per shipment
- locating a facility at SRNL to house the 700 ITCs for up to 60 years
- resolve whether South Carolina (where SRNL is located) will accept the ITCs to be buried as low level radioactive waste in the future

- SRNL labor costs over the life of the effort
- if tritium accountability is required, SRNL site visits by OP staff
- design, testing with OP, and acceptance of a SRNL ITC for future purchases of ^{3}He to simplify handling of future purchases of ^{3}He from OP

The solution to these issues will dictate where the work can be performed, the sophistication of measurements on tritium content, and the rigor imposed on shipping and facility handling. The answers to these issues and others will have a significant impact on the cost of performing the work. An exact cost estimate cannot be prepared until after discussions with the Canadian government and collection of additional data. Funding required for SRNL to support the Phase I assessment and to estimate the cost to recover ^{3}Hefrom the ITCs is $484K. Finally, it is estimated that within two months the Phase I contract should be placed with OP and the full cost of the project (i.e., packaging, transportation, SRNL lifecycle, Canadian Government restrictions, and OP's procurement cost) is estimated to be established about 6 months afterwards. To go forward with this project the funds will need to be identified within the next 6 months.

Although the focus is currently on discussions and negotiations with the Canadian government, the Department of State plans tailored discussions with other countries which may include Argentina, France, India, Russia, China, Romania, and Republic of Korea.

3.9 ^{3}He from Supplemental Tritium Production

If future demand for ^{3}He cannot be significantly reduced through development of alternative technologies, or if supply cannot be increased to meet demand through the sourcing options previously discussed, a back-up capability for producing ^{3}He from tritium production is available. This alternative could begin generating small volumes of ^{3}He in five to seven years, depending on priority, with gradually increasing annual yields as long as required. A preliminary business case analysis has generated cost estimates for providing the capability to produce ^{3}He from supplemental tritium production using available capacity in NNSA's tritium production infrastructure. Tritium production operations to support national defense are expected to use roughly half of the available throughput of the capital infrastructure, leaving excess capacity that can be leveraged without expanding government facilities. As a result, significant ^{3}He production can be obtained while working within and not expanding the current capabilities, although these capabilities could be expanded if required in the future.

An investment of approximately $60M in budget-year dollars ($50M in FY 09$) would be required to tailor the existing facilities and provide dedicated ^{3}He storage and harvesting equipment, as well as the required safety and environmental approvals. Table 3.5 shows the non-recurring budget requirements to establish the capability along with an outer bound production profile that would maximize the throughput of the existing production infrastructure. Any level of production below this rate would also be feasible.

Escalated $ Millions

	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	SUM
Establish Capability:	5	7	11	9	7	6	6	4	3	2	60
Funding Max. Production:	0	0	16	37	57	61	79	95	112	118	575
Total Annual Funding:	5	7	27	46	64	67	85	99	115	120	635

Table 3.5- Budget Dollars to Provide Enduring ^{3}He Harvesting Capability Plus Production

For example, if the demand is to require use of all available production capacity, a fifteen year production run would provide sufficient tritium inventory to harvest 145,000 liters of ^{3}He over a forty year period. This production timeframe is chosen for convenience in bounding the business case analysis and continuing production as an enduring source of ^{3}He that would require no additional infrastructure investment.

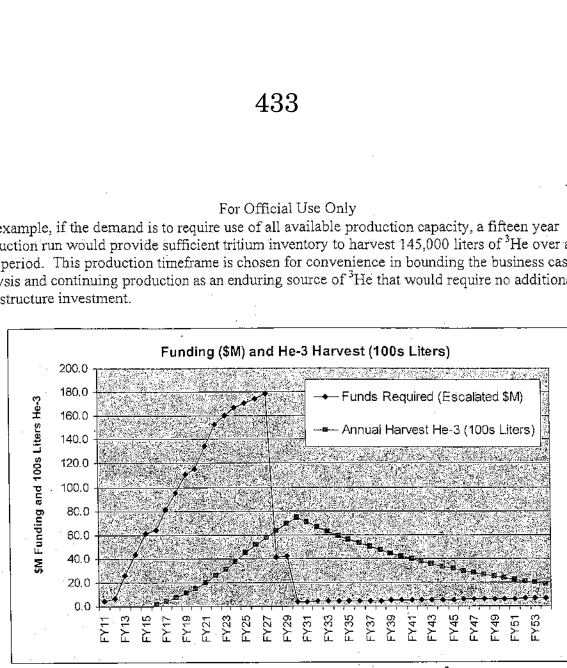


Figure 2 – Profiles of Funding and Harvesting of ^{3}He

The average unit cost from such an operation will be approximately $10,000 (FY 09$) per liter of ^{3}He at STP. Figure 2 shows the funding profile for maximum production utilization for a fifteen year production run, along with the resulting annual ^{3}He harvest shown in hundreds of liters. The figure shows that production costs peak with purchase of reactor fuel for the last irradiation run, and the maximum annual generation of ^{3}He occurs the year after the last extraction.

Timeline and Estimated Quantity of ^{3}He

The program could harvest 1,500 liters in FY20 and 7,700 liters in FY30.

3.10 Summary

Each of the previously discussed options has varying degrees of costs, anticipated quantities of ^{3}He extraction, and timelines. Some options, such as the Ontario Power procurement; recycling program, and recovery of ^{3}He from retired metal hydride tritium storage beds located at SRS, could generate ^{3}He within the next 2-3 years. Other options may require more time to develop the capability before routine extraction of ^{3}He is possible. This document is a living document and program costs, estimated ^{3}He quantities, and timelines will be updated as more information becomes available and the options are further refined.

4.0 ^{3}He Demand Working Group

The following sections in this chapter have been assembled by the Demand Working Group within the ^{3}He Integrated Project Team. The goal of the Demand Working Group was to provide the Sub-IPC with enough information so they could prioritize the ^{3}He allocation for FY10 across the Government and to determine a reasonable release amount for the commercial sector.

4.1 Introduction

The ^{3}He Inter Agency Integrated Product Team (IPT) was initiated in June 2009 with representatives from the Department of Defense (DoD), the Department of Energy (DOE), the Department of Homeland Security/Domestic Nuclear Detection Office (DHS/DNDO and other Government Agencies. The IPT formulated four working groups to address; Supply, Demand, Technology and Policy. An over-arching committee; Interagency Policy Committee (IPC) was stood-up to provide over sight of the ^{3}He IPT.

On 10 July 2009, the IPC allocated the ^{3}He FY09 Close-Out to the various stakeholders. The results of that decision are as listed in Table 4.1.

Agency/Stakeholder	FY09 IPC Approved ^{3}He Allotment
Commercial Sector	2400 liters
Department of Energy	0 liters
Department of Defense	722 liters
Department of Homeland Security	1926 liters
Total Allocated:	5048 liters

Table 4.1 IPC FY09 Approved ^{3}He Allocations

When filling out the justification for the ^{3}He request each Government agency was requested to answer the following questions to provide the information necessary for the Sub-IPC to set priorities across the Government and Commercial sector and the allocations for FY10:

1. What is the Mission of your Program?
2. Identify the equipment which uses ^{3}He.
3. Are there any alternative technologies available to offset the need for the ^{3}He being requested?
4. What actions are being taken to reduce the need for ^{3}He?
5. Indentify any impacts of not receiving ^{3}He.

This section will address the questions for the FY10 "mitigated" demand from each of the stakeholders requesting ^{3}He. Responses associated with non-governmental agencies to these specific questions may deviate slightly but will still be within the intent of the IPC's questions.

In the below each of the Government agencies and commercial sector will be addressed.

4.2 DOE/NNSA ^{3}He Demands

DOE Isotope Program has been designated as the repository of all the ^{3}He demands information for all programs since they are lead for the Demand Working Group. The area of responsibility also includes the commercial stakeholders who will be requesting ^{3}He. The list of Government and commercial stakeholders are listed below:

- Office of Science
- Safeguards (NA-241)
- Second Line of Defense (NA-25)
- Counterterrorism (NA-10)
- National Institute of Standard Technology (NIST)
- National Institute of Health (NIH)
- Oil and Gas
- Medical Imaging
- Cryogenic
- National Aeronautics and Space Administration (NASA)
- The Office Environmental Management (EM)

For each respective commercial stakeholder, a point of contact has been identified to DOE for coordination purposes and will be identified under each sector

4.2.1 Program: DOE - Office of Science FY2010 Mitigated Demand: 1672 liters (See Table 4.2).

1. *Mission*: The Office of Science manages fundamental research programs in basic energy sciences, biological and environmental sciences, and computational science. In addition, the Office of Science is the Federal Government's largest single funder of materials and chemical sciences, and it supports unique and vital parts of U.S. research in climate change, geophysics, genomics, life sciences, and science education. It has well established research programs that provide unique insight into the structure and dynamics of materials, across a wide range of research fields. The applications include solving the structure of high temperature superconductors, determining the atomic function of materials in novel battery storage devices and the development of new drugs and delivery systems. The importance of the technique for fundamental sciences has been recognized by the construction of the Spallation Neutron Source at ORNL which re-establishes the US research community as leaders in the field. The instrumentation at this and other DOE neutron facilities relies, and has been designed around, the use of unique ^{3}He detectors. ^{3}He is also used for cryogenic devices, and for polarizing neutron beams to study magnetic materials. For detection purposes, ^{3}He detectors possess a unique combination of capabilities that are unmatched by any other neutron detector system. These detectors are efficient, stable, have very low electronic noise characteristics, excellent gamma ray rejection, and microsecond timing for neutron events. While other detector systems have some of these characteristics and are useful for nonscientific applications, only ^{3}He can meet all of the requirements for neutron sciences. For this research the requirements are very demanding, 90% efficiency for thermal neutrons, stability at 0.1% per day, gamma ray rejection at the 10^{-7} level, and microsecond timing. If these levels cannot be maintained the reach of neutron scattering science will be severely restricted. In addition, because of its unique physical properties, ^{3}He is the only option for achieving temperatures below 1 K, which is critical for cryogenic research, and the only option for neutron polarization and analysis, a critical requirement for the study of magnetic materials.
2. *Equipment*: ^{3}He is used for dilution refrigerators that can reach temperatures below 1 K. It is also used for polarization cells and analyzer cells for the study of the magnetic properties of materials. In detector systems, ^{3}He is used for five different instrument types. These are Reflectometers, Inelastic Instruments, SANS Instruments, Liquids and Amorphous Diffractometers, and Statistical Diffractometers. There are 18 instruments using ^{3}He detectors currently contributing to DOE's neutron science program.

3. *Alternative Technology:* Neutron scattering experiments have been undertaken for over 40 years, but the tremendous benefit of this research was not generally acknowledged until about 20 years ago. Since then, construction has begun on several facilities around the world, and this construction significantly increased the demand for ^3He. There are no alternatives to ^3He that meet the immediate needs of the neutron science program for the types of instruments mentioned above. As described below, an R&D program aimed at pursuing alternative detector materials is underway, but due to the time scale required to develop alternative approaches this is of no use to current generation neutron scattering instruments. Because of its unique physical properties, ^3He polarizers provide the only means of looking at magnetic structures in bulk materials, or of providing environments with tem^{3}He peratures below 1 K.
4. *Actions taken to reduce the need for* ^3He: With the aim of reducing long term (i.e. greater than five years from now) needs for ^3He R&D efforts are underway to pursue alternatives for detector applications. Alternatives under consideration include BF3 filled detectors, multi-blade detectors with boron conversion layers, and scintillator detectors with Wavelength Shifting Fibers (WSF). These are the only promising approaches at the moment and all of these have significant drawbacks when compared to ^3He. The two detector types that use boron will be useful for cold neutron applications only. The WSF detector is seen as the only option for inelastic instruments with high energy transfer requirements, and for epithermal neutron detection. This option is uncertain because scintillator based detectors lack the stability and gamma ray rejection needed for this science. In addition a significant R&D effort will be needed to make these systems vacuum compatible. To pursue these alternatives, an international collaboration is being formed, that includes US detector developers, to create a research roadmap. This group has met twice already, and an open meeting is planned for the IEEE/NSS conference on October 29. It is hoped that representatives from neutron scattering, security applications, and industry will attend this meeting to provide a general framework for research. For cryogenics and polarization there are no alternatives to ^3He because of its unique physical properties.
5. *Impact of not getting* ^3He: Science that benefits from neutron scattering measurements will suffer if ^3He becomes unavailable. At present there are half-built instruments with significant sunk costs that could not be completed if ^3He was no longer available. Furthermore, science requiring very low temperatures (< 1 K) and polarization studies would cease. The importance of neutron scattering science has been established and the potential for important break through science is very high. Without ^3He there will be entire areas of research that cannot be pursued.

Organizaion	Fiscal Year						
	2010 Unmitigated	2010 Mitigated	2011 Unmitigated	2012 Unmitigated	2013 Unmitigated	2014 Unmitigated	2015 Unmitigated
Nuclear Physics Research - Use in Dilution Refrigerator for Polarized NH3 and ND3 targets	100	100	100				
Development work for planned nuclear physics research using high-luminosity Polarized 3He Targets	50	50	50	50	50		
Anticipated Nuclear Physics Research needs for Polarized 3He Targets for Planned Experiments with the 12 GeV Upgrade						100	100
Argone National Laboratory							
Nuclear Physics: ATLAS Operations Beams	1						
Nuclear Physics: ATLAS Research gas targets for for (3He, X) studies	1		1	2	2	2	2
Nuclear Physics: Medium Energy Physics Jlab experiment			3				
Los Alamos National Laboratory							
Nuclear Physics: NPDG & abBA Experiments	3	3	3	3	3		
Nuclear Physics: Beam Counters for DANCE			0.05			0.05	
Nuclear Physics: nEDM Experiments	10	10	10	60	60	60	60
Pacific North National Laboratory							
Isotope Program: Neutron detectors	1	1	1	1	1	1	1
Brookhaven National Laboratory							
Nuclear Pjhysics: Polarized 3He++ ion source for the RHIC, eRHIC spin program	100	100	100	100	100	100	100
Oak Ridge National Laboratory							
Basic Energy Science: neutron science program at SNS & HFIR	6000	0	6000	6000	6000	6000	6000
Los Alamos National Laboratory							
Basic Energy Science: Neutron science program at Lujan Center	2400	1331	2400	2400	2400	2400	2400
Basic Energy Sciences: Protein Crystallography Station at LANSCE: regular maintenance top-up of detector	0	0	24				24
Basic Energy Science: Protein Crystallography Station at LANSCE: initial supply for second detector if it is constructed					216		
Basic Energy Science: Protein Crystallography Station at LANSCE: complete refill in case of catastrophic failure of current detector	0	0		216			
Stanford Linear Accelerator Center							
Simes Program Dilution Refrigerator	50	50	0	0	0	0	0
Refill Nano Probes	25	25	0	0	0	0	0
Lawrence Berkeley National Laboratory							
Basic Energy Science: Refill detector for x-ray spectroscopy for structural biology at Advanced Light Source			10			10	
Oak Ridge National Laboratory							
Atomic Data Group	1	1	1	1	1	1	1
Massachussetts Institute of Technology (MIT)							
Fusion Energy Science research at MIT	1	1				10	15
Total:	8743	1672	8703.05	8833	8833	8684.05	8703

Table 4.2

FY10 ^{3}He DOE Office for Science Mitigated Demand

4.2.2 Program DOE Safeguards (NA-241) FY10 Mitigated Demand: 3600 Liters (See Table 4.4)

1. *Program Description:*
Instrument suppliers need to confirm the availability and cost of ^{3}He to respond to safeguards instrumentation bid requests in FY09 and FY10. For example, the IAEA plans to request commercial contract quotes for nine NDA systems for the Japanese MOX fuel fabrication facility in the next few months. These initial IAEA systems will require about 2500 L of ^{3}He for fabrication of tubes in FY2010. However, there is a more immediate need. Vendors will need an ^{3}He supply quote from Reuter-Stokes to respond to the IAEA RFQ. Since no ^{3}He is currently allocated to safeguards, vendors are unable to offer NDA system quotes.

Decades of experience with international safeguards instrumentation indicates there is no need to replenish ^{3}He after it is initially installed in an instrument designed for safeguards use. ^{3}He -based instruments endure for the life of a facility, allowing routine maintenance to focus on other needs. Detector tubes do not leak and the gas is not consumed. As a result, once a facility is decommissioned and demolished, the ^{3}He gas detectors can be recovered and recycled for other applications. The annual additional needs for ^{3}He are for new instruments, primarily for new facilities coming under inspection or new IAEA commitments.

2. List of Equipment (see Table 4.3) Safeguards Instrumentation

System	QTY	Helium-3 Unmitigated	Helium-3 Mitigated	Application
JMOX				
AMGB (Advance Material Glove Box)	9	2800	2800	JMOX
AFPA (Advanced Fuel Pin Assay)	1	300	0	JMOX
AFPM (Advanced Fuel Pin Magazine)	1	200	0	JMOX
PCAS-2 (Plutonium Canister Assay System)	1	100	0	JMOX
WPAS (Waste Package Assay System)	1	200	0	JMOX
RSMC (Recycled Scrap Muliplicity Counter)	1	300	0	JMOX
Guam (Glovebox Unatteneded Assay and Monitor	27 Boxes	2500	0	JMOX
Sub-total:		6400	2800	
IAEA (Non JMOX)				
ENMC (Epi-thermal Neutron Muliplicity Counter)	1/y	500	0	Impure Pu verification U-235 verification plants
AWCC (Active Well Coincidence Counter)	2/y	300	150	Dismantlement
UNCC (Uranium Neutron Coincidence Counter)	2/y	100	100	UO2 fabrication plants and reactors
Portable equipment	10/y	500	200	Flexiable applications worldwide
Spent Fuel Monitors	10/y	200	0	Reactor sites
UF6 Verification	1/y	800	0	Enrichment Plants
Plutonium In-Process Verification	1/y	500	0	Reprocessing plants
Waste Assay Systems	2/y	1000	0	Enrichment, reprocessing, fabrication plants
Other	TBD	800	0	TBD
Sub-total:		4700	450	
U.S. Domestic				
ENMC (Epi-thermal Neutron Multiplicty Counter)	1/y	500	0	U.S. MOX plant, High accuracy NDA R&D
AWCC (Active Well Coincidence Center) & UF6 monitors	1/y	100	100	Uranium enrichmant plants
Portable Search Equipment	TBD	500	250	Emergency search activities
Waste Assay Equipment	TBD	600	0	All bulk processing facilities
Other	TBD	500	0	TBD
Sub-total:		2200	350	

Table 4.3 List of Equipment

3. *Effort to find alternatives*
There are no currently available alternatives to ^{3}He based detectors that meet required technical specifications. There are no near-term (1-3 years) commercial products that will meet safeguards needs.

The Technology Development Group at DOE/NNSA is funding detector research that may lead to alternatives in the longer term (4+ years). The program is also looking into a partnership with GE to asses B-10 lined tubes for some material accountancy measurements, but this is more of a mid-term alternative (3-5 years). We also plan to assess liquid scintillators for multiplicity measurements, again another mid-term alternative.

4. *Actions to reduce* ^{3}He *need*
Program has slowed rate at which instrumentation will be introduced. The original program plan envisioned a request for 12,900 liters of ^{3}He gas for rapid fielding of safeguards equipment to multiple facilities. The FY2010 request is for 3600 liters which will allow safeguarding of the Pu stored at the MOX facility in Japan and meet critical IAEA and US facility safeguards commitments (see item 5: justification)

5. *Justification*
We have scrubbed our estimate of ^{3}He needs for 2010 and believe that the absolute must – have for International Safeguards in 2010 is 3,600L, with the following breakdown: 2,800L for the Japan Mixed Oxide Fuel Fabrication Plant (JMOX)

Use
The IAEA is soliciting bids for nine (9) Advanced Material Glovebox (AMGB) systems (300+ liters each) for JMOX with the goal of system manufacturing and testing in the 2010-2012 time frame. The ^{3}He tubes must therefore be procured in 2010, and the supplier must secure the availability of the ^{3}He tubes in order to be able to provide a quote to the IAEA.

Justification
Japan is a signatory to the Non-Proliferation Treaty, Article III of which requires it to accept IAEA safeguards on its nuclear facilities and materials. USG policy is to strengthen IAEA safeguards in non-weapons states for enrichment and reprocessing facilities such as JMOX. The IAEA works with the Japan Safeguards Office (JSGO) to define adequate safeguards for new nuclear plants in Japan and has defined the measurement systems that are needed to bring the JMOX plant into NPT compliance. The 2,800L for the nine AMGB systems are part of the requirement. The USG has helped develop the safeguards approach for the IAEA to apply to JMOX and has a legal sign off agreement with the JSGO that the overall safeguards approach and systems for the JMOX plant are adequate. A key reason for the State Department's signoff was that JMOX safeguards would meet the IAEA and USG requirements. No alternative detector material exists for the AMGB systems. It would be particularly embarrassing for both Japan and the USG if their jointly developed safeguards approach for Japan's JMOX could not be implemented at the same time as the new Japanese Director General for the IAEA, who was supported by the USG, assumes his new assignment.

IAEA safeguards is part of the "first line of defense" against the misuse of nuclear materials. The president's Prague speech calling for "more resources and authorities to strengthen international inspections" is a strong indication of his support for this "first line of defense". 450L for other IAEA safeguards equipment is the FY10 Mitigated Demand.

Use
(1) Procurement of one Active Well Coincidence Counters (AWCC), requiring ~150L of ^{3}He, for accountancy measurements at conversion and enrichment plants.
(2) Procurement of one Uranium Neutron Coincidence Counter (UNCC), requiring ~100L of ^{3}He, for accountancy measurements at UO2 fuel fabrication plants and reactors.
(3) Portable equipment for flexible IAEA inspection applications worldwide, requiring 200L

Justification
IAEA safeguards are part of the "first line of defense" against the misuse of nuclear materials. The president's Prague speech calling for "more resources and authorities to strengthen international inspections" is a strong indication of his support for this "first line of defense". The IAEA is responsible for verifying that nuclear materials worldwide are not diverted for non-peaceful purposes. Nuclear material accountancy measurements are the "bread and butter" of IAEA safeguards, and ^{3}He is the only material currently available for coincidence and multiplicity counting (nuclear material accountancy) applications. No alternative detector material exists for these types of measurements. The IAEA Mitigated Demands for FY10 is 350L (Domestic Safeguards).

Use
1) Procurement of one Active Well Coincidence Counter (AWCC), requiring ~100L, for accountancy measurements at U.S. enrichment plants
2) Portable search equipment for U.S. emergency search teams, requiring ~250 L

Justification
1) NRC guidelines for U.S. facilities require strict compliance with nuclear material accountancy standards and practices.
2) Deployment of ^{3}He detectors is required to support emergency response capabilities. The portable search equipment might overlap with a NNSA NA-40 request.

4.2.3 Program: DOE Second Line of Defense Program (SLD) NA-25 FY10 Mitigated Demand: 1520 liters (See Table 4.4.)

1. *Program Description:* NA-25's MPC&A Program works to implement material control and accounting measures and physical protection upgrades in Russia and other FSU-states, and to foster the adoption of nuclear security best practices in Russia and other partner countries. NNSA assists partner countries in developing and maintaining a nation-wide material, protection, control, and accounting (MPC&A) infrastructure, thereby improving the security of proliferation-attractive nuclear material at fixed sites and in transit. Additionally, NA-25 has partnered with NA-42 to improve the emergency response capabilities of some partner countries.

2. The Equipment
The Emergency Response Team includes the following: 75 RadPacks and 25 RSI 701 devices which are deployed to partner countries' ability to respond to radiological events.

3. *Effort to find alternatives*
No alternative technology is currently available as an alternative to ^{3}He for the following needed equipment:

a. STE RadPack: backpack system used for searching large areas and is the only performer available with the neutron flux sensitivity needed for the mission.

b. RSI 701: is used in Mobil Searches in vehicles and no other devices are available to perform this function

For requested handheld portable devices, there are no currently available alternatives to ^{3}He based detectors that meet required technical specifications. There are no near-term (1-3 years) commercial products that will meet search needs.

The technology development group at DOE/NNSA is funding detector research that may lead to alternatives in the longer term (4+ years). The program has active technical exchanges with other Agencies that require similar capabilities (eg DoD) on alternative technology development efforts. At this time, there does not appear to be any commercially available alternatives in the 3+ year horizon.

For large scale users (eg Portals), the Program is actively engaging companies and the research community for alternatives. During FY2010, several potential alternatives will be purchased for test and evaluation.

4. *Actions to reduce* ^{3}He *need*
For large scale users (eg Portals), Program Plan would have requested approximately 5000 liters. Instead, for FY2010, the request for ^{3}He gas for Portal use has been zeroed out.

5. *Justification*
The STE RadPack and the RSI 701 are the only equipment items that presently have the functionality to perform the mission. An inability to procure the needed emergency response equipment for use by the partner country would leave the partner country unable to effectively act in a response or search situation. This would negatively impact U.S. national security.

4.2.4 DOE Counterterrorism NA-40 FY10 Mitigated Demand: 1750 liters (See Table 4.4)

1. *Program Description:*
NNSA NCTIR provides technical support to the Departments of State, Homeland Security, Justice, and Defense for nuclear terrorism events or nuclear weapon accidents and incidents both internationally and domestically. The NNSA Emergency Response assets also provide support for National Special Security events and nuclear site and facility accidents and incidents.

The goal of the Nuclear Counterterrorism Incident Response program is to respond to and mitigate nuclear and radiological incidents worldwide. There are three core functions to the program: search for radioactive material, render safe of nuclear devices and RDDs, and consequence management after a dispersal of material. ^{3}He is needed for detection and characterization of neutron emitting sources. Alternatives to ^{3}He are not ideal because they have lower sensitivities that require heavier and/or larger detectors to achieve the same response. This is important for several reasons. First, the need to transport equipment in an emergency makes space and weight restrictions on aircraft significant and because the need for equipment to be man portable makes reducing the weight important.. In addition, alternatives typically have more onerous transportation requirements due to hazardous material restrictions.

2. List of Equipment
   Includes seventy-five (75) Vector Systems and each systems has ~ 23.3 liters each.

3. *Effort to find alternatives*
   There are no currently available alternatives to ^3He based detectors that meet required technical specifications. There are no near-term (1-3 years) commercial products that will meet search needs.

   The technology development group at DOE/NNSA is funding detector research that may lead to alternatives in the longer term (4+ years). The program has active technical exchanges with other Agencies that require similar capabilities (eg DoD) on alternative technology development efforts. At this time, there does not appear to be any commercially available alternatives in the 3+ year horizon.

4 *Actions to reduce ^3He need*
   To the best of our knowledge, NA-40 was the initial office within the Federal government that began exploring the possibility of reclaiming ^3He from older detectors that are no longer in use. This recycling effort is expected to reduce FY10 requirements by 12% from 2000 liters to the current request of 1750 liters. With this amount, the Program will be able to meet USG/DOE mission goals for search equipment. In the future, the possibility of reducing the ^3He needs by 10% through redesign of equipment is also being explored.

(5) *Justification*

Mission: The Office of Emergency Response (OER) requests 1750 liters to be used in radiation search equipment. The OER deploys assets to conduct emergency response to search for and identify radioactive materials typically in response to a request by another agency. The office supports preplanned events such as National Special Security Events (NSSE). In addition to domestic response, the office also supports the Dept. of State for international emergency response, such as the classified FEST exercise, and preplanned events, such as the Olympics

Equipment: Over the past several years, the office has developed a directional radiation search backpack, the Vector, to better conduct the search efforts, and procurement of these units began last year. The office plans to continue to procure these units over the next several years until the final complement of 220 is reached. The office requests 1520 Liters of ^3He in FY 10 to support continued procurement.

Alternatives: No alternative technology is currently available as an alternative to ^3He. The gas makes it possible to produce man portable systems that can easily be transported on military or commercial aircraft with minimal hazardous materials concerns.

Impact of not Deploying: The current suite of NA-40 detection equipment is reaching the end of its planned lifecycle. Without ^3He gas to execute our planned equipment replacement, risks for critical equipment failure will be increased. This office currently relies on a non-directional radiation sensor to conduct its missions. A directional backpack provides an increased signal to noise ratio, allowing for a lower minimum detectable activity. In addition, because of the sensitive nature of emergency response operations, the directionality is important because it allows the searcher to more quickly locate the source. This detector will be used by all Office of Emergency Response teams, include the Radiological Assistance

Program (RAP), the Search Response Team (SRT), and the Nuclear/Radiological Advisory Team (NRAT) in both domestic and international deployments.

4.2.5 PROGRAM: DOE DEFENSE PROGRAM (NA-10) FY10 Mitigated Demand: 408 liters (See Table 4.4)

1. Mission is to insure the integrity and safety of the country's nuclear weapons. For this ^3He is used in the NIF and Lujan Center for research. There is no alternative for ^3He for these applications. Twenty percent of LANSCE accelerator experiments are for NNSA, Defense Program's mission for weapons integrity and safety. The detail may be classified.

2. List of equipments are same as described under Office of Science.
3. Alternatives – there are no alternatives
4. Justifications:

SLD Radiation Detection Equipment Helium-3 Needs (In Liters at STP)							
Project	**Application**	**FY10** Unmitigated	**FY10** Mitigated	**FY11**	**FY12**	**FY13**	**FY14**
Safeguards (NA-241)	International Safeguards	12900	3,600	3,400	3,000	3,000	2,000
SLD (NA-25)	Deployment of Radiation Detection Equipment	4700	1520	210	17,952	21,124	18,281
Counterrorism (NA-40)	Rad/nuke search	1750	1750	1,750	1,750	1,750	1,750
Defense Programs (NA-10)	NIF and National Security Applications	408	408	600	600	600	600
	Totals:	19758	3678	2560	20,302	23,474	20,631

Table 4.4 FY10 NA-10, 25, 40, and 241 ^3He Demands

4.2.6 Program: NIST Quantum Hall Research for Electrical Standards FY10 Mitigated Demand: 20 liters (See Table 4.5) POC: Mr. Alan Thompson

1. This program investigates the electrical properties of novel materials (graphene) at low temperatures with an immediate goal of creating secondary electrical standards for use by industry. This materials research program, and the refrigerator, is approximately 14 years old. The program also provides the US national standard for resistance (the ohm) which includes traceability from temperature, phonics, pressure, and other national standards.
1. Equipment includes: 14/16 Tesla Oxford cryomagnetic system with ^3He insert (dilution refrigerator) for 0.2 K operations.
2. No alternative technology is currently available as an alternative to the ^3He dilution refrigerator. Without the refrigerator we will be unable to measure at the lowest temperatures.
3. Because there is no alternative technology for reaching these low temperatures, and the amount used is low, there are no efforts currently underway to reduce need.
4. *Impact of not Deploying:* The full temperature range investigation of these novel devices are expected to allow the creation of inexpensive, cryogen-free quantum electrical standards,

which are essential to the continued viability of major sections of the US electronics industry in three to five years. The impact on US industry of losing the national standard of resistance and, through that, temperature, pressure, etc., would be immense. As existing calibrations expired, the US would be unable to export manufactured goods and measurement devices depending on those standards.

4.2.7 Program: NIST Very Small Angle Neutron Spectrometer (vSANS) FY10 Mitigated Demand: 250 liters (See Table 4.5) POC: Mr. Alan Thompson

1. This program's purpose is to determine the structure of large scale (greater than 1 nm) systems by measuring diffraction from those systems at small angles. This program was part of a Congressionally-mandated expansion of the NIST Center for Neutron Research in 2007, though preliminary work started a few years before 2007.
2. Equipment includes: linear position-sensitive tube neutron detectors.
3. No alternative technology is currently available as an alternative to the ^{3}He-based linear position-sensitive tube detectors, though there are some promising technologies under development. These alternate technologies, should they come to fruition, would probably require significant redesign and additional infrastructure fabrication.
4. We are investigating alternative neutron-detection technology (boron-lined proportional tubes, neutron sensitive scintillation materials) but the performance and resource requirements of these alternate technologies is not currently known.
5. *Impact of not Deploying:* If the vSANS is delayed by not receiving these detectors, the ability of the petrochemical, electronic, aerospace, biomedical, and other industries in the United States to investigate the properties of large-scale systems of economic importance to them will be severely hampered. These industries have received significant competitive advantages in the past from their research using Small Angle Neutron Scattering (SANS) instruments at the NIST Center for Neutron Research; lack of access to vSANS would presumably put them at a significant competitive disadvantage to their counterparts in other regions.

4.2.8 Program: NIST MAGIK Spin Polarized Reflectometer FY10 Mitigated Demand: 4 liters (See Table 4.5) POC: Mr. Alan Thompson

1. MAGIK is a spin polarized reflectometer. Its purpose is to determine the structure of layered systems by measuring neutrons which have been specularly reflected from those specimens. By using a 2-dimensional position-sensitive detector, experimenters will be able to measure off-specular features (providing information regarding surface roughness, magnetic structure, *etc.*) as well as the specular ones. This program was part of a Congressionally-mandated expansion of the NIST Center for Neutron Research in 2007, though preliminary work started a few years before 2007.
2. Equipment includes: linear position-sensitive tube neutron detectors.
3. No alternative technology is currently available as an alternative to the ^{3}He-based 2-dimensional position-sensitive detectors, though there are some promising technologies under development, especially scintillating fiber arrays. These alternate technologies, should they become commercially available, would probably require significant redesign and additional infrastructure fabrication.
4. We are investigating alternative neutron-detection technology, especially scintillating fiber arrays, but the performance and resource requirements of these alternate technologies is not currently known.
5 *Impact of not Deploying:* If the vSANS is delayed by not receiving these detectors, the

ability of the petrochemical, electronic, aerospace, biomedical, and other industries in the United States to investigate the properties of large-scale systems of economic importance to them will be severely hampered. These industries have received significant competitive advantages in the past from their research using Small Angle Neutron Scattering (SANS) instruments at the NIST Center for Neutron Research; lack of access to vSANS would presumably put them at a significant competitive disadvantage to their counterparts in other regions.

4.2.9 Program: NIST Polarized ^{3}He Spin Filter Research and Development FY10 Mitigated Demand: 40 liters (See Table 4.5) POC: Mr. Alan Thompson

1. Polarized ^{3}He spin filters use the unique atomic *and* nuclear properties of ^{3}He to produce devices capable of producing or measuring neutron spin that are insensitive to neutron energy and incident angle. There has been a neutron spin filter research and development program at the NCNR since 1993.
2. Equipment includes: NIST-produced spin filter cells (multiple, depending on exact application, estimate approximately 10).
3. No alternative technology is currently available as an alternative to the polarized ^{3}He spin filters. Supermirror polarizers are used for many polarization production and polarization analysis tasks, but will simply not work in certain applications where polarized ^{3}He spin filters work well.
4. Sealed cells already use ^{3}He extremely efficiently – once produced, the cells usually continue to work without consuming additional ^{3}He for many years. Recovery of ^{3}He would be implemented if valved cells were to be used, and we anticipate (given the current and expected price of ^{3}He) implementing ^{3}He recovery from failed cells or cells that we do not anticipate using again.
5. *Impact of not Deploying:* In the absence of ^{3}He, certain neutron scattering measurements (magnetic SANS analysis, magnetic crystallography, wide-angle diffraction magnetic analysis, specular reflectometry with magnetic analysis) could not be done. This would close off scientific investigation of materials that could have immense economic impact in a wide variety of applications.

4.2.10 Program: NIST NCNR Sample Environment Equipment FY10 Mitigated Demand: 8 liters (See Table 4.5) POC: Mr. Alan Thompson

1 The NCNR maintains a fleet of sample environment equipment used in conjunction with its neutron scattering instruments. The NCNR maintains and expands this fleet in accord with areas of scientific inquiry that are deemed cost-effective and desirable. This is not a new program. The fleet of sample environment equipment is an integral part of the NCNR scientific program. The dilution refrigerator listed is part of the five year budget plan for the Center for High Resolution Neutron Scattering (CHRNS) proposal under current review by the NSF.
2. Equipment: Dilution refrigerator and ^{3}He cryostat. The dilution refrigerator adds low temperature capability both by itself and for use in high magnetic fields. The ^{3}He cryostat adds low temperature capability to one of our high field magnets, and is a replacement for a failing system. High magnetic fields coupled with low temperatures is the highest priority defined by NCNR user surveys. The dilution refrigerator requires 2 Liters, and the ^{3}He cryostat requires 6 Liters. The total amount is 8 Liters.
3. There is no alternative to the use of ^{3}He as we are using the unique cryogenic

characteristics of ^{3}He to achieve these milli-Kelvin temperatures. In the case of the dilution refrigerator, no alternative technology exists that fits the space requirements. In the case of the ^{3}He cryostat, no alternative technology fits the space requirements and the requirement to work in a high magnetic field. Adiabatic demagnetization refrigerators have been considered but are not compatible with the magnetic field requirements or are too bulky to fit into existing equipment, which is a requirement for these systems.
4. The NCNR is exploring alternative technologies to achieve low temperatures without the use of ^{3}He, including exploration of Adiabatic Demagnetization Refrigerators (ADR). More development is required to achieve an ADR that meets stringent requirements for low magnetic fields at the sample position.
5. *Impact of not Deploying:* The NCNR could not offer low temperature capability along with high magnetic fields in temperature ranges on interest on specific instruments. This limits the number of common experimental conditions that are available to researchers, thereby hindering the historically highly productive and economically important science program.

4.2.11 Program: NIST NCNR Sample Environment Exchange Gas and General Needs FY10 Mitigated Demand: 15 liters (See Table 4.5) POC: Mr. Alan Thompson

1. The NCNR maintains a fleet of cryogenic equipment used in conjunction with its neutron scattering instruments. This fleet includes nine ^{3}He or dilution refrigerators that depend on the special cryogenic properties of ^{3}He to operate. ^{3}He is used as an exchange gas in some applications because it is the only cryogenic gas that suits the particular purpose. In addition, some of our sealed systems require maintenance or repair and a small quantity of gas is required for these operations. This is not a new program. The fleet of sample environment equipment is an integral part of the NCNR scientific program, and has been for decades.
2. The gas is procured in a small bottle, not as part of any equipment. The total amount is 15 Liters.
3. This ^{3}He is to be used for the maintenance, upkeep, and operation of existing equipment. No alternatives are available that would keep this equipment operational.
4. The NCNR is exploring alternative technologies to achieve low temperatures without the use of ^{3}He, including exploration of adiabatic demagnetization refrigerators (ADR). More development is required to achieve an ADR that meets stringent requirements for low magnetic fields at the sample position.
5. *Impact of not Deploying:* The nine piece fleet of low temperature equipment just listed is put in a precarious position since we would lose the ability to effect repairs. We are currently working on issues with three of these pieces. The loss of exchange gas would also make experiments last much longer on our heavily over-subscribed instruments. The science program would be hindered from lack of available equipment, with potentially severe impacts on scientific research and the US economy.

4.2.12 Program: NIST NCNR SANS Detector Refurbishment FY10 Mitigated Demand: 65 liters (See Table 4.5) POC: Mr. Alan Thompson

1. Small angle neutron spectrometer. Its purpose is to determine the structure of large scale (> 1 nm) systems by measuring diffraction from those systems at small angles. Structure on this length scale is critical to the performance of advanced engineering materials. For example, the toughness of high impact plastics depends on the admixture of stiff and flexible segments of polymer molecules on the nano-to-micro scale. Nanometer/micrometer structure is also crucial to biological processes in cells, to the storage of information on magnetic disks, to the hardness of steels and superalloys, to the conduction of current in superconductors, and many

other materials properties. The two SANS instruments have been in operation for more than 10 years.
2. The gas is procured in a small bottle, not as part of any equipment. The total amount is 65 Liters.
3. As this is existing equipment, no alternative exists without replacement. Neutron sensitive scintillator materials or tubes containing BF_3 could be used. There is a great deal of technological risk with the scintillators and we presently have no sources for BF_3 linear position sensitive tubes. BF_3 is highly toxic, a poor proportional gas, and few detector manufacturers will handle it.
4. We are beginning a program of developing scintillator detectors for another, simpler instrument and are considering alternatives for detection of low energy neutrons.
5. *Impact of not Deploying:* Not receiving the requested ^{3}He will cause the effectiveness of the SANS instruments to decay rapidly as the detectors start to fail. Trying for a replacement will require development of an alternative solution and then the purchase of that alternative. This cannot be accomplished in the time before the current detector systems begin to fail, leaving US industry, government, and universities unable to perform measurements on advanced engineering materials.

4.2.13 Program: NIST NCNR "pencil" (Small Diameter Proportional Tube) neutron detectors FY10 Mitigated Demand: 10 liters (See Table 4.5) POC: Mr. Alan Thompson

1. Various neutron spectrometers. Their purpose is to determine the structure material systems by measuring neutron diffraction from those systems.
2. These detectors require servicing periodically due to aging. Their sensitivity and effectiveness is restored by the introduction of new ^{3}He gas in addition to overall servicing. The total volume required is 10 Liters. The various neutron scattering instruments have been in operation for several years.
3. As this is existing equipment, no alternative exists without replacement. Neutron sensitive scintillator materials or tubes containing BF_3 could be used. There is a great deal of technological risk with the scintillators and we presently have no sources for BF_3 linear position sensitive tubes. BF_3 is highly toxic, a poor proportional gas, and few detector manufacturers will handle it.
4. We are beginning a program of developing scintillator detectors for another, simpler instrument and are considering alternatives for detection of low energy neutrons.
5. *Impact of not Deploying:* Not receiving the requested ^{3}He will cause the effectiveness of the triple-axis (crystallography) and other instruments to decay as available detectors start to fail. Trying for a replacement will require development of an alternative solution and then the purchase of that alternative. This cannot be accomplished in the time before the current pencil detector systems begin to fail. The ability of US research institutions to measure crystal structure could have significant impacts on high-tech industry.

4.2.14 Program: NIST Lyman Alpha Neutron Detector research FY10 Mitigated Demand: 20 liters (See Table 4.5) POC: Mr. Alan Thompson

1. This project is a research program investigating neutron detectors based on detection of atomic processes in gases following neutron absorption. The current system uses ^{3}He as the source of the nuclear reaction. Possible future directions include lithium and boron (metal or compounds). This project has been underway for approximately three years.

2. The gas is procured in a small bottle, not as part of any equipment. The total amount needed in FY10 is 20 Liters.
3. This research program requires ^{3}He at this stage, and there are no alternatives.
4. As mentioned above, we are considering how to extend this work to other materials, but we must complete our current research before moving in that direction. If our efforts in that direction do not pan out, the ^{3}He-based system might produce a detector with the same sensitivity as traditional ^{3}He proportional tubes, with modestly lower amounts of ^{3}He (perhaps 15% less).
5. *Impact of not Deploying:* Without the additional ^{3}He, our current research would quickly come to a halt. We would have to start over (establishing a baseline of systematic effects, efficiencies, etc.) before moving on to non-^{3}He nuclear reactions. This could delay eventual deployment of the alternative techniques by 1-2 years, or cause the project to be shelved, thereby reducing future possible alternative neutron detection technologies.

4.2.15 Program: NIST Future Electronics FY10 Mitigated Demand: 30 liters (See Table 4.5) POC: Mr. Alan Thompson

1. This program characterizes nanophotonic devices, transport in nanoscale devices, investigates spin metrology, and characterizes nanotube electronic devices.
2. Equipment includes: Existing Janis dilution refrigerator; ^{3}He is to replenish supply used in sealed system.

3. No alternative technology is currently available as an alternative to the ^{3}He dilution refrigerator.
4. Because there is no alternative technology for reaching these low temperatures, and the amount used is low, there are no efforts currently underway to reduce need.
5. Impact of not Deploying: NIST's Center for Nanoscale Science and Technology (CNST) is specifically dedicated to developing the measurement methods and tools needed to enable nanotechnology. If we do not receive this ^{3}He, the ability of CNST to develop the tools will be hampered, and the future ability of our partners in industry, academia, and government to deploy nanoscale electronic devices will be threatened.

4.2.16 Program: NIST Quantum Metrology (EEEL) FY10 Mitigated Demand: 125 liters (See Table 4.5) POC: Mr. Alan Thompson

1. The Group currently operates 4 dilution refrigerators using ^{3}He. Programs include:
   - Quantum Information: Quantum computing using superconducting elements (qubits) that only operates below 50 mK.
   - Quantum-limited measurements: Quantum amplifiers based on superconducting devices for measuring microwave signals at the quantum limit.
   - Quantum Sensors: Photon and particle detectors based on superconducting elements for applications including x-ray detection for materials analysis and astronomy, gamma ray and alpha particle detection for nuclear forensics, and mm-wave detection for cosmology.
2. Under ARRA funding the Group has ordered 5 new closed cycle dilution refrigerators from a commercial vendor. At least 2 of these are scheduled to be delivered in 2010. Each DR will contain approximately 25 liters of ^{3}He.
3. Dilution refrigerators are the only cooling mechanism capable of achieving the temperatures, cooling power and operation time required for these quantum-based experiments.

4. All of these systems are closed cycle, and once charged with ^{3}He should not require additional ^{3}He.
5. All of the programs described above are completely dependent on achieving low temperatures to perform their research. Loss of this capability would stop all research in the Group on quantum devices.

4.2.17 Program: NIST Metrology for Cosmological Physics (EEEL) FY10 Mitigated Demand: 130 liters (See Table 4.5) POC: Mr. Alan Thompson

1. We are constructing a instrument designed to search for gravity waves from the Big Bang under our "Metrology for Cosmological Physics" IMS program. The instrument is part of an ongoing IMS program (in its 4th year). The collaboration with Princeton University to bring the IMS program to fruition is new this year.
2. The refrigerator being constructed to cool this experiment will require 130 liters of ^{3}He to operate.
3. None. ^{3}He refrigerators are the only cooling mechanism capable of achieving the temperatures, cooling power and operation time required for these extremely low noise experiments.
4. All of these systems are closed cycle, and once charged with ^{3}He should not require additional ^{3}He.
5. The joint IMS and collaboration described above is completely dependent on achieving low temperatures to perform their research. Loss of this capability would prevent the completion of this important instrument, and would put at risk significant outside agency funding to NIST.

4.2.18 Program: NIST KiloPixel Array Cryostat FY10 Mitigated Demand: 100 liters (See Table 4.5) POC: Mr. Alan Thompson

1. EEEL has a phase II SBIR with a company to develop an advanced refrigerator that includes a ^{3}He sorption stage. We will use the requested 100 l of ^{3}He to fill this sorption refrigerator. The KPAC will be used to refrigerate arrays of gamma-ray sensors being developed by NIST with DOE support for nuclear safeguards applications. The Phase I SBIR design study was executed in FY08 and the Phase II began in June 2009. The company that received the Phase II award is supposed to deliver the KPAC refrigerator no later than 6/23/11.
2. The complete refrigerator consists of a pulse tube cooler to reach 3 K, a ^{3}He sorption stage, and then a single stage adiabatic demagnetization refrigerator. Its formal name is the KiloPixel Array Cryostat (KPAC).
3. A ^{4}He sorption stage could be substituted for the ^{3}He stage, but the performance of the KPAC prototype would be so badly compromised that it would no longer be suitable for use. It would just serve as an incomplete demonstration of what would be feasible if/when ^{3}He was available.
4. We will maximize the transfer efficiency from the storage vessel to the KPAC vessel. Any excess ^{3}He can be returned to the supplier once the KPAC vessel is filled and verified to be leak tight. This system is closed cycle, and once charged with ^{3}He should not require additional ^{3}He.
5. The design of the KPAC refrigerator depends on the ^{3}He stage. Without the ^{3}He stage as an intermediate heat sink, the KPAC cannot meet its goal of providing a long-duration, high-reliability cooling platform for large gamma-ray sensor arrays. The company with the Phase II SBIR will not be able to develop their planned product, and EEEL will not have a

cryogenic platform that meets the long term needs of our DOE sponsors for a gamma-ray spectroscopy platform.

4.2.19 Program: NIST Quantum Sensors FY10 Mitigated Demand: 15 liters (See Table 4.5) POC: Mr. Alan Thompson

1. The Group currently operates 1 dilution refrigerator using ^3He and a closed cycle ^3He refrigerator. Programs include:

- Quantum Information: Production of nonclassical states of microwave signals using superconducting circuits that operates below 50 mK.
- Amplifiers based on superconducting devices for measuring microwave signals below the quantum limit.
- Ultrasensitive force detectors based on nanomechanical oscillators.

2. A dilution refrigerator is scheduled for delivery in Dec. 2009. It will require 15 liters of ^3He to operate, which the vendor is refusing to provide, in spite of a contract to deliver, for precisely the reason that ^3He is no longer available. An additional 15 liters is required to support existing cryostat into future.
3. No alternative technology is available. The dilution refrigerator is the only ultralow temperature technology capable of managing the large heat loads associated with microwave electronics at ultralow temperatures.
4. All systems are closed cycle, and have multiple interlocks to prevent loss of ^3He
5. End of all listed programs.

Device	FY10 Liters "Unmitigated"	QTY	Total Liters Requested	FY10 Total Liters "Mitigated"	FY11 "Unmitigated"	FY12 "Unmitigated"	FY13 "Unmitigated"	FY14 "Unmitigated"
Dilution Refrigerator	20	2	0	20	0	0	0	0
vSANS	400	1	1207	250	0	0	0	0
MAGIK	4	1	158.5	4	0	0	0	0
Other Expansion Instruments	0			0	100	100	100	100
Spin filter	40	10		40	40	40	40	40
Dilution Refrigerator/3 He Cryostat	8	2+		8	35	20	20	20
Dilution Refrigerator	15	9		15	15	15	15	15
SANS detector	65	1		65	75	75	75	85
Pencil detectors	10	20		10	10	10	10	10
Experimental prototype	20	n/a		20	10	0	0	0
Dilution Refrigerator	30	1		30	5	5	5	5
Dilution Refrigerator	130	1		130	5	5	5	5
Dilution Refrigerator	125	5		125	0	0	0	0
3He Absorption refrigerator	100	1		100	0	0	0	0
Dilution Refrigerator	15	1		15	0	0	0	0
Totals:	982			832	295	270	270	280

Table 4.5
NIST FY10 ^{3}He Mitigated Demands

4.2.20 Oil and Gas ^{3}He FY10 Mitigated Demand: 1000 liters

1. Mission: Oil and gas drilling company's mission is to explore Oil and Gas sources. The detection equipments are fabricated by companies such as GE Reuter Stokes, LND and others. The detection equipment contains ^{3}He to measure Hydrogen porosity.
2. Equipment includes: detection equipment filled with ^{3}He tubes.
3. All are ongoing programs.
4. No portal monitors are used.

5. No Alternative technology is currently available. Other isotopes for use in detection equipment such as Am-241 are also in short supply

The POC for Oil and Gas' Demand is: Mr. John Pantaleo

4.2.21 National Institute of Health (NIH) ^{3}He FY10 Mitigated Demand: 1800 liters

1. Mission: ^{3}He has emerged as a new and unique standard for pulmonary imaging, both for its high signal, physical properties (specifically, a high diffusion coefficient, allowing morphometric measurements of alveolar spaces), developed infrastructure, and mature polarization technology.
2. Equipment: ^{3}He is used in high quality imaging as compared to other gases such Xe-129. The magnetic moment of 129Xe (the spin ½ stable isotope) is only about 1/3 that of ^{3}He, and the natural abundance of 129Xe is only 26%; both of these reduce the available signal in the hyperpolarized gas. The achievable polarization with xenon has also been historically lower than with ^{3}He, and the delivered dose of xenon gas is limited by its anesthetic activity. In short, hyperpolarized xenon does not yield the high signal-to-noise that ^{3}He does at this point in time, which means that xenon delivers poorer quality images and less physiological information. The sum of the effects of lower gyromagnetic ratio, lower abundance, lower polarization, and lower dose add up to an approximate reduction in signal by a factor of 50. In the future, the achievable polarizations of xenon are expected to improve, though we do not view this as a viable replacement for ^{3}He for the reasons stated herein.
3. Alternatives: There has been some discussion in the literature about using hyperpolarized xenon instead of ^{3}He gas for specific future studies, but hyperpolarized xenon is simply not suitable to replace ^{3}He at this point, both for scientific and practical reasons.

The POC for The National Institute of Health (NIH) is: Mr. John Pantaleo

4.2.22 Cryogenic ^{3}He FY10 Mitigated Demand: 3200 liters. Fifteen (15) Universities and three (3) Government Laboratories require ^{3}He. Cryogenics (Total Requirement: 1800 liters for FY2010)

1. *Mission:* ^{3}He is crucial to research and development on new materials, superconductivity, magnetism, nanoscience and quantum information, an essential core of American scientific activity. To conduct research in cryogenics and to develop new processes and techniques for achieving temperatures close to 0.1 Kelvin and to find properties of materials at very low temperatures where materials exhibit superconductivity and super fluidity.
2. Equipment includes: refrigerators filled with ^{3}He gas.
3. No portal monitors are used
4. There are two classes of users of ^{3}He. The commercial suppliers of refrigerators: the "majors" are: Janis Research, Oxford Instr., and Leiden Cryogenics. Approximately 100 refrigerators sold per year require, 40% in the USA. The second class of user, individual researchers, builds, replace, and maintain their refrigerators and require ^{3}He for experimental samples. No alternative technology is available.

5. The impact of interruption in the supply of ^{3}He for cryogenic purposes will be catastrophic to American science: loss of personnel and eventual termination of government and industrially funded programs in excess of 100 million USD.

The POC for Cryogenics is: W.P. Halperin, Northwestern University

4.2.23 National Aeronautics and Space Administration (NASA) ^{3}He FY10 Mitigated Demand: 1200 liters

NASA's ^{3}He Mitigated Demand is the same as their Unmitigated Demand.

The POC for NASA is: Mr. John Pantaleo

4.2.24 Office of Environmental Management (EM) ^{3}He FY10 Mitigated Demand: 0 liters

EM's Mitigated and Unmitigated are zero for FY10

The POC for EM is: Mr. John Pantelo

4.3 Other Government Agency ^{3}He FY10 Mitigated Demand: 0 liters

The Other Government Agency has filled their FY10 "Mitigated" Demand from last year's IPC's Allocation.

The POC for Other Government Agency is: Mr. Dave Schneider, CIA

4.4 DHS/DNDO ^{3}He FY10 Mitigated 885.5 Liters (See Table 4.6)

Program: DNDO The Mobile Detection Deployment Program (MDDP) FY2010 Mitigated Demand: 368 liters

1. Mission: Provides a Continental United States (CONUS) preventive radiological/nuclear detection (PRND) equipment package for Federal, State and local authorities to augment their incident response teams, including the Department of Energy (DOE) Radiological Assistance Program (RAP) teams and the National Guard's Civil Support Teams (CSTs). The system design and the support personnel are postured to support time planned activities such as National Special Security Events (NSSE), rather than time sensitive radiation/nuclear detection operations.
2. Equipment includes: Packeye (qty 44), Detective EX (qty 8) and ORTEX NAI-SS (qty 6)
3. All programs are under existing on-going contracts
4. No portals monitors are used
5. No alternative technology is currently available as an alternative to ^{3}He (see below)
a. Packeye: the only performer available and no alternative is available
b. Detective EX: this device is only used when nothing else works by the Specialty Search Teams
c. ORTEX NAI-SS is used in Mobil Searches and no ther devices are available for replacement
6. *Alternative Technologies*: The Technology Working Group is investigation this issue
7. Impact of not Deploying: It has been determined 9 (nine) systems are needed within the continental United States for this mission. Currently 4 (four) Systems are under contract, and the systems are presently on-hold pending release of the ^{3}He gas. Surge Capacity & High Profile Special Events may not be supportable if the neutron radiation detection devices are not installed in the Mobile SUV/truck/van Suite of Detectors included in MDDP.

Program: DODO Human portable detectors for United States Coast Guard (USCG) FY2010 Mitigated Demand: 522 liters

1. Mission: The Coast Guard's primary mission is the surveillance of the countries port, waterways, and Coastal Security to identify and localize radiological material that may be transported into the United States. The USCGs Maritime Security Response Team (MSRT) boards targeted ships hundreds of miles off shores to ensure that radiological and nuclear threats are not aboard a vessel before the ship approaches the United States coast.
2. Equipment includes: Radpack (qty 33), LRM (qty 6)
3. All programs are under existing on-going contracts
4. No portals monitors are used
5. No alternative technology is currently available as an alternative to ^{3}He (see below)
a. Radpack: This is a high performer to search vessels with high sensitivity
b. LRM: This is a Linear Radiation Monitor and is the only system that can be lowered down and scan containers.
6. The Technology Working Group is investigation this issue
7. Impact of not Deploying: Four contract actions are open and on-hold as the manufacturer of backpacks (RAPDPACK), linear radiation monitors (LRMs), and handheld radiation monitors (HRMs) can not produce the hardware without the release of ^{3}He. USCG will be significantly hampered in their ability to perform their mission of identifying and localizing radiological material.

DHS FY10 - FY14 Helium-3 Demand Requirements

Program	User	Device	FY10 Liters "Unmitigated"	Qty	FY10 Total Liters "Mitigated"	FY11 "Unmitigated"	FY12 "Unmitigated"	FY13 "Unmitigated"	FY14 "Unmitigated"
HPRDS	USCG	RIIDs	25	50	0	250	250	250	250
Grants	State & Locals	Backpacks	852	72	0	960	960	960	960
		GR-135P	90	180	0	150	150	150	150
MDDP	State & Locals	Packeye	158.5	44	158.5	158	0	0	0
		Radpack	0	0	0	0	C	0	0
		Detective EX	48	24	48	16	16	0	0
		ORTEX NAI-SS	160.5	6	160.5	160.5	0	0	0
		IdentiFINDER	0.5	8	0	0	0	0	0
West Coast Marine Pilot		Backpacks	118.5	10	0	0	0	0	0
		IdentiFINDER	0.7	10	0	8	8	8	9
ASP		Portal Monitors	12599	90	0	17910	19630	18045	18045
Visible Intermodal Prevention & Response (VIPR)	TSA	Packeye	0	0	0	0	0	0	
		RIIDs	0	0	0	0	0	0	0
CBP	BP	GR-135P	67	135	0	12	12	12	12
	OPO	GR-135P	175	350	0				
PVT	CBP	Portal Monitors	5011	116	0	2797	2442	1998	1998
International Rail	CBP	Portal Monitors	0	0	0	0	3335	3335	3335
Airport	CBP	Portal Monitors	216	5	0	216	216	216	216
USCG	USCG	RadPack	391	33	391	391	391	391	391
		IdentiFINDER	8	118	0	8	8	8	8
		HRM	0	0	0	0	0	0	0
		LRM	130.5	6	130.5	130.5	0	0	0
		HPGe RIID	0	0	0	0	0	0	0
Securing the Cities (STC)	STC	FHT752SH NP	12	12	0	0	0	0	0
		PackEye	360	100	0	0	0	0	0
		Mobile Detector	19	3	0	0	0	0	0
		MDSI	57	9	0	0	0	0	0
		IdentiFINDER	12	12	0	0	0	0	0
Transformational & Applied Research Directorate	DNDO	Shielded Nuclear Alarm Resolution	200	0	0	200	200	200	200
		Total:	20711.2		888.5	23367	27618	25573	25574

Table 4.6

DHS FY 10 ^{3}He Mitigated Demands

4.5 DoD ^{3}He Demands FY10 Mitigated 882 Liters (See Table 4.7)

Program: DoD SSC Pacific's Support of DTRA's Operations Enterprise (OP-CSCT) FY2010 Mitigated Demand: 882 liters

1. Mission:. Provides the DTRA Combat Support Contingency operations groups with radiation detection and identification systems to support their combating weapons of mass destruction mission. The systems are deployed CONUS and OCONUS in support of this mission. The program has been underway for several years.

2. Equipment: Multiple Platform System (quantity forty-four (44)), Simple Search and Identify (quantity four (4))

3. Alternative Equipment: Currently evaluating alternative technologies however none is currently available which met the required sensitivity, robustness, and gamma rejection requirements.

4. Way Forward: The Multiple Platform System is currently the only equipment with the reliability and sensitivity to perform the mission. Designs are underway to build new systems with ^{3}He alternative technologies as they become available.

5. Impact of not Deploying: In the near term new systems and spares will not be available, which will compromise the readiness levels of deployed forces.

Program	User	Device	FY10 Liters "Unmitigated"	Qty	FY10 Total Liters "Mitigated"	FY11 "Unmitigated"	FY12 "Unmitigated"	FY13 "Unmitigated"	FY14 "Unmitigated"
Missile Guidance	Army	Manufacturing "process" for RLG's	350	N/A	0	0	0	0	0
Navy S&T; Maritime WMD	Navy	Radiation Detectors	300	N/A	0	300	300	300	300
Joint Service EOD	Navy	AN/PDX-2 radiac sets	0	N/A	0	0	800	800	800
Special Programs & Development	DTRA	Multiple Platform System	1148	44	882	1000	1000	1000	1000
		Simple Search and Identify		4					
Technical Support Groups	DTRA	Eagle Ray II (2.07L)	1792.7	2	0	1000	1000	1000	1000
		RAD ROV Hull Crawler (50L)		1					
		PWCSensor (50L)		2					
		Harley II (16.81L)		5					
SPAWAR	DTRA		8000	N/A	0	8000	8000	8000	8000
R&D and Emergency Buildout Support	DTRA		1000	N/A	0	1000	1000	1000	1000
Smart Thread JCTD	DTRA		600	N/A	0	0	0	0	0
	SOCOM			N/A					
		Total:	12590.7		882	11300	12100	12100	12100

Table 4.7
DOD FY10 ^{3}He Mitigated Demands

4.6 Summary of ^{3}He Demand

Table 4.8 provides a summary of all the detailed Unmitigated individual stakeholder's requests for ^{3}He commencing in FY10 through FY15. The table also provides the Mitigated demand request for FY10.

This section of the report contains the associated responses by each individual organization to justify their individual requests to afford the Sub-IPC insight into how to prioritize the FY10 ^{3}He allocations both across the Government as well as to the commercial sector.

It is recommended the ^{3}He demand evaluation be performed every quarter to allow for emerging requirements to be brought up to the Sub-IPC during the year.

	FY10		FY11	FY12	FY13	FY14	FY15
	UNMITIGATED	MITIGATED	UNMITIGATED	UNMITIGATED	UNMITIGATED	UNMITIGATED	UNMITIGATED
DOE/NNSA Demand							
Safeguards (NA-241)	12900	3600	6900	6900	6900	6900	6900
Second Line of Defense (NA-25)	4700	2000	7222	17863	21819	19813	12782
Counterterrorism (NA-40)	1750	1520	1750	1750	1750	1750	1750
Defense Program (NA-10)	408	408	625	725	840	725	400
DOE - Science	8667	1672	8703	8833	8833	8684	8703
NIST	982	832	295	270	270	280	280
Oil and Gas	2600	1000	2000	2000	2000	2000	2000
NIH/Medical Imaging	5000	1800	5000	5000	5000	5000	5000
Cryogenic <1 k	1600	3200	1600	1200	1200	1200	1200
NASA	80	80	0	0	0	0	0
EM	0	0	0	0	0	500	500
Sub-total DOE demand	38687	16112	34095	44541	48612	46852	39515
Other Government Agency	0	0	500	500	500	500	500
DHS Demand	25446.33	885.5	24421	25493.86	26502	25000	25000
DoD Demand	12198	882	11450	12250	12250	12250	12250
FY10 Total (Liters):	76331.33	17879.5					
Notes:							
1- Medical Imaging and NIH demands are combined.							
2- Oil and Gas 2600 liters Unmitigated demand but they only need 1000 liters for FY2010.							
3- Spallation Neutron Source's (SNS) annual demand of 6000 liters in 2010 will be met by SNS He-3 inventory							
4- NA-10 demand includes He-3 requirements for NIF and 20% of Lujan Center's requirements							

Table 4.8
FY10 through FY15 Demands

5.0 Technology Working Group

5.0.1 Introduction

The major Government agencies working on research and development of neutron detection are DOD/DTRA, DOE/NNSA, and DHS/DNDO. Improvements in neutron detection has been an area of interested and research for each of these organizations for many years with the objective to improve performance, reduce weight, increase ruggedness, and lower the power consumption with a material other than ^{3}He. However, in the past year it has been made clear from the shortage of ^{3}He that an increase in effort is needed to find an alternative to ^{3}He based neutron detection as soon as possible. The below sections will layout the current research efforts for each of the above organizations in the area of neutron detection research and development. The order of this section will be presented from near term solutions to those that will unfold in several years or with significant risk.

It also must be recognize that once a technology has been demonstrated to have viability and it is considered to be at a Technology Readiness Level (TRL) – 6 (i.e., System/subsystem model or prototype demonstrated in a relevant environment), a systems engineering development process is needed to integrate that technology into a commercial product as well as to characterize the systems performance as suitable for the intended application.

Besides Government sponsored research and development, there is also the Government encouragement to private industry to search for and develop alternatives for ^{3}He based detectors on their own. One way to address this type of encouragement to private industry is with a release of a Request for Information (RFI) where the need can be laid out and the challenges facing the Government defined. The hope is the companies will take the challenge on as well. Furthermore, systems that are commercial off-the-shelve (COTS) must also go through an evaluation process to characterize/validate performance before the device could be deployed as suitable for an application. The engineering process that is usually applied to develop commercialized products for Government is one of the missions the DHS/DNDO Production, Acquisition, and Deployment Directorate (PADD) performs and the engineering steps associated with this process will also be discussed in the below sections.

5.1 Department of Homeland Security

5.1.1 Organizational Description

The Domestic Nuclear Detection Office (DNDO) is a jointly-staffed, national office established to improve the nation's capability to detect and report unauthorized attempts to import, possess, store, develop, or transport nuclear or radiological material for use against the United States, and to further enhance this capability over time. DNDO includes seven directorates that are oriented towards addressing key mission areas while meeting the functional objectives outlined in its founding Presidential Directive. DNDO directly supports the research and development of novel radiation detection methods and materials. Research is supported in three-year lifecycles with an opportunity for renewal through a competitive proposal review process. Typically, DNDO will support research only to a demonstration of feasibility (TRL 1 to 4) through the exploratory research program, and will continue to the point of prototype demonstration (TRL 5 to 6) through the advance technology demonstration programs. Once the research reaches the TRL 5/6 level and there is a mission to deploy that technology, DNDO has a directorate that will put the technology through a systems engineering (SE) process to integrate that technology into a commercial product and setup the framework to procure the needed systems. A listing of the research and development programs underway can be found Table 5.2 and a discussion of each project is provided below.

5.1.2 SE Process to commercialize an emerging technology or deploy a COTS product

An emerging technology from a research/development project or the procurement of a COTS product will have to go through a systems engineering process before it can be deployed out in the field. For the case when an emerging technology successfully reaches the TRL 5/6 level, the technology will need to be captured by competitively awarded Request for Proposal (RFP) which requires the technology to be processed through a system engineering (SE) process which could range from 1 - 2 years (or longer) before a commercial system could be produced and deployed. It should be noted that not all technologies will be able to pass the challenges related to mass production, system reliability, suitability (i.e., environmental, ruggedness, performance, and communications) in field operations, and a reasonable life cycle costs. Time and resources are needed to integrate the new technology into a system, perform the necessary developmental testing during the integration phase, develop any threat based alarm algorithms, and perform the independent testing needed to validate the performance of a system before it can be deployed. In many cases a few engineering adjustments are needed after the independent testing before the system can be deployed.

There is also the need for commercial off-the-shelf (COTS) systems to be characterized by independent testing and evaluation (T&E) before a procurement delivery order can take place. An independent validation the system performs as advertised has not only been shown to be prudent but also necessary when facing a costly procurement and when solid performance is needed to accomplish the mission. The following sections outline the system engineering process that is needed for any new technologies that goes through the research and developmental phase as well as the process needed for COTS systems to be characterized.

5.1.2.1 Test & Evaluation (T&E) of Neutron Detection Component Technology

T&E of COTS and prototype neutron detection technology require component characterization testing. The government will conduct this testing at the some independent location (e.g., RNCTEC at the Nevada Test Site). Performance characterization testing is focused on verification of component functional performance in the areas of efficiency, gamma ray interference and environmental testing. Environmental testing includes how well technologies perform in the presence of electromagnetic, impact, thermal and vibration interferences. Estimated time to plan, execute and report test results is 5 to 6 months. Estimated cost for characterization testing: $500K

T&E of Engineering Development Model (EDM) and Low Rate Initial Production (LRIP) neutron detection component technology requires the vendor to conduct Government Acceptance Testing (GAT). The GAT is normally performed at the vendor's facility and is witnessed by the government. It is focused on verifying the component meets the requirements and constraints in the performance specification and demonstrates the production process has not adversely impacted the verification of the baseline design. Estimated time to plan, execute and report test results is 4 to 5 months. Estimated cost for a GAT: $500K

5.1.2.2 T & E of Integrated System Neutron Detection Technology

Integrated system testing involves testing a full up system such as a portal monitor that includes newly integrated neutron detection component/s. The following are the types of tests for integrated systems:

(1) System Qualification Test (SQT) verifies the technical achievement of performance specifications. It is primarily conducted at the vendor's facility and is witnessed by the government. Estimated time to plan, execute and report test results is 4 to 5 months. Estimated cost for an SQT: $500K

(2) Environmental Qualification Product Test (EQPT) tests how well the system performs in simulated operational environmental conditions. It is primarily conducted at the vendor's choice of facilities approved by the government. The government will witness the EPQT. Estimated time to plan, execute and report test results is 4 to 5 months. Estimated cost for an EPQT: $500K

(3) Integration Testing (IT) demonstrates that systems are ready to be integrated into interdiction operations. For portals, IT is conducted by the government at a qualified national laboratory.

Estimated time to plan, execute and report test results is 6 to 7 months. Estimated cost for an IT: $1,000K

(4) Performance Tests (PT) evaluate system performance requirements in an operationally relevant environment and collect data to support an operational test and evaluation (OT&E) campaign which cannot use Special Nuclear Materials (SNM). PT is conducted by the government at the Radiological Nuclear Countermeasures Test & Evaluation Complex (RNCTEC) at the Nevada Test Site (NTS). Estimated time to plan, execute and report test results is 8 to 9 months. Estimated cost for a PT: $3,000K

(5) Field Validation (FV) provides the operational user with complete and structured introduction to the use and application of the system. It is conducted by the operational user in actual operational environments. Estimated time to plan, execute and report test results is 8 to 9 months. Estimated cost for a FV: $1,500K

(6) Operational Test & Evaluation (OT&E) confirms that LRIP or production units are ready for unrestricted deployment in screening applications and to support the intended acquisition decision. OT&E is conducted by the government at operational user venues. Estimated time to plan, execute and report test results is 5 to 6 months. Estimated cost for an OT&E: $1,000K

Each emerging technology from a research/development program or COTS product will need to perform a tailored variant of the system engineering process outlined above. After the technology is captured by a competitively awarded RFP, the technology will be processed to a well known system engineering process to ensure the system will perform once deployed. The amount of T&E actions and the timing needed dictates the duration to complete the effort will usually take 18 to 24 months with a typical cost of about $2 - $5 million dollars.

5.1.3 BF_3 based neutron detector for a Portal Monitor

Before ^{3}He was available in any significant quantities (i.e., 1960 – 2000), the workhorse for neutron detection was boron tri-fluoride (BF3). There are still many systems deployed based on BF3 after more than 30 years. It is known this technology satisfies the performance requirements (e.g., excellent pulse height discrimination and gamma rejection) but it requires more volume (~3 BF_3 tubes at 1 atm would match the performance of a single 3 atm ^{3}He3 detector), a higher voltage supply (2000 volts vs 1000 volts in ^{3}He systems), and BF_3 is a toxic substance.

DNDO is planning on pursuing this technology for deployment in portal monitors because BF_3 neutron detectors work, can be made operational in ~1.5 years, would be placed out in the open air, there is only 3 grams per tube, the portal stand is made of ½" steel which will act as a protective shroud, tubes will be loaded to only ~1 atm which is not conducive to leaking, and any leaking BF_3 would naturally be mitigated by venting directly into the atmosphere. (There is no record of any BF_3 tube leaks reported to date.) Moreover mitigation techniques can be engineered into the detector to trap and neutralize the BF_3 gas in the detector assemble in the very rare event of a tube leak by incorporating a "getter" material within a hard poly shell around the tubes that is ruggedized to the environment. Furthermore, it is estimated BF_3 detectors would cost the same as or even less then ^{3}He detector did several years ago. It is currently estimated that each neutron detector assembly in a panel would cost about $7k per detector or about $28k per portal that requires 4 panels. The other known alternative neutron detector systems being pursued by industry (e.g, GE and Innovative American Technologies) are currently estimated to cost $100k - $130k for a four panel portal which would mean the neutron detection portion of the portal system would be four times more than past expectations.

The current plan is to set up a working group with the potential stakeholders to address the performance requirements and safety issues related to working with BF_3. Once the safety issues and performance requirements are captured and agreed to, DNDO will release an RFP in the early 2010 with the goal to sign a contract with a vendor in the second quarter of FY10. A BF_3 detector assembly would be readied for full rate production within ~1 year of contract award which would include completing the initial operational assessment. At the end of the effort the system will be fully characterized and the risk mitigation validated. The contract will be structured such that if the BF_3 safety issues are not addressed sufficiently to mitigated the effects of the BF_3 to the satisfaction of the stakeholders, the program will be terminated.

5.1.4 Market Research and Testing of Commercially available COTS systems

The Department of Homeland Security (DHS), Domestic Nuclear Detection Office (DNDO), released a Request for Information (RFI) seeking information on alternative neutron detectors that do not use ^{3}He technology in June 2009. It was also announced DNDO will perform laboratory tests on the detector modules with neutron and gamma ray emitting sources to characterize parameters such as the neutron detector's inherent efficiency, response/dead time, environmental/mechanical performance, and gamma rejection on any system that responds to the RFI and is capability of performing the test. This announcement also was used by DHS to inform the commercial sector working on radiation detection equipment that the Government is looking for replacements to ^{3}He based neutron detection.

Through this RFI, DNDO obtained technical information responses to determine the capability of the market to provide alternate technologies that have efficiencies and gamma discrimination properties such that they can replace ^{3}He neutron detectors in radiation detection systems for application in four categories:

1. Portal COTS
   - High efficiency neutron detection systems able to detect neutrons from distances consistent with current vehicle portal monitor installations.
   - Potential to quickly (less than 5 s) detect a 5×10^4 n/sec ^{252}Cf point source 2.5 m from the detector.

2. Portal prototypes
   - High efficiency neutron detection systems able to detect neutrons from distances consistent with current vehicle portal monitor installations.
   - Potential to quickly (less than 5 s) detect a 5×10^4 n/sec ^{252}Cf point source 2.5 m from the detector.

3. Portable COTS or prototypes
   - Smaller, lighter neutron detection systems suitable for use in man portable radiation detection systems. Potential to quickly (less than 5 s) detect a 5×10^4 n/sec ^{252} Cf point source 2 m from the detector.

4. Handheld COTS or prototypes

- Smaller, lighter neutron detection systems suitable for use in handheld type radiation detection systems. Potential to quickly (less than 5 s) detect a 5 x 10^4 n/sec ^{252} Cf point source 60 cm from the detector.

The systems and components selected for testing are listed in Table 5.1. The testing will be performed in late November 2009 with the preliminary test results available in late December 09 and the final report due in early February 2010.

Table 5.1 Devices to be tested by DNDO in November 09 from the RFI submissions

#	Module	Manufacturer/Supplier	Comments
1	^{3}He Radiation Portal Monitor Program (RPMP) Neutron Detector	SAIC RPM8	Performance Baseline to compare other detector against
2	n-gamma (Shield2)	DNDO/SNL	Neutron detection from Fe absorption by looking for the ~7.5 Mev gamma line
3	10-B Coated Proportional Detector	General Electric (GE)	First Generation detector from Ge based on a cluster (~20 tubes) of B-10 lined tubes
4	^{6}Li Glass Fiber Neutron Detector	NUCSAFE, Inc.	^{6}Li doped fibers
5	Scintillator-based Wavelength Shifting Fiber (fiber strands to detect neutron location on detector)	PartTec, LTD	^{6}Li F:ZnS(Ag) scintillator with wave length shifting fibers
6	Scintillator-based Wavelength Shifting Fiber (fibers arranged for gross count of neutron detections)	Innovative American Technology (IAT)	^{6}Li F:ZnS(Ag) scintillator with wave length shifting fibers
7	PVT n-gamma panel	DNDO/SLD	DNDO/SLD device investing if PVT can detect the ~7.5 Mev gamma line from neutron absorption in Fe
9	Neutron Capture Scintillator: Li6 Gd(BO3)3:Ce	LLNL	Nano particles suspended in an acrylic

The n-gamma system (i.e. test article #2 in the above table) was sponsored by DNDO and developed by SNL. A patent application is being processed for the US Government. The technical approach uses high density poly as a moderator sandwiched between several layers of steel which is then warped around a 2" (wide) x 4"(deep) x 16"(long) NaI (sodium iodine) gamma detector (Figure 1). The theory is the poly will moderate the neutrons into the thermal energy range resulting in a neutron absorption in Fe. The Fe absorption results in a ~7.5 MeV gamma ray that has significant penetration to be detected by the gamma detector. This approach was expanded to PVT gamma detector in a joint project between DNDO and the DOE SLD program to develop a n-gamma PVT version of this detector to investigate if this configuration has the potential to also detect a neutron flux using the same Fe absorption approach.

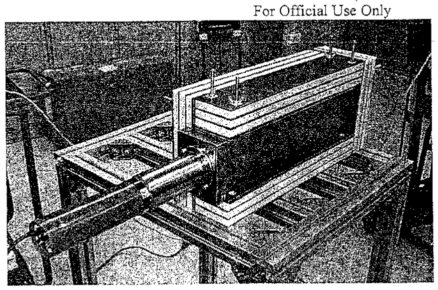


Figure 5.1 The n-gamma detector with a 2″×4″×16″ NaI detector surrounded by poly and steel

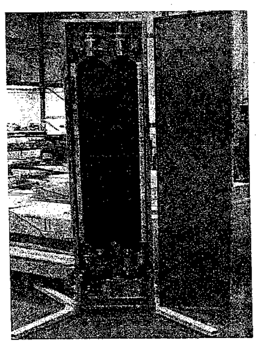


Figure 5.2 IAT has developed a follow-on design for the portal application in response to the RFI

It should be noted the RFI has performed the result DNDO was aiming for i.e., industry is actively looking for an alternative to ^{3}He based neutron detection. Both GE and IAT (Figure 5.2) have submitted devices to be tested but also continued to develop their alternative neutron detectors. A follow on test and evaluation is expected in early February 2010 to investigate the performance of the next generation neutrons detectors they have produced for the portal application. The information gathered from this RFI and the follow on testing not only allows DHS to understand the state of the commercial market but it also has served the purpose of informing the private sector the Government has an interest in finding portal monitor detectors not based on ^{3}He detectors. It is anticipated the

DNDO will release a follow on RFP to competitively award a contract to develop the replacement technology when the proper technology base is advanced and success will be reasonably assured.

5.1.5 Research into ^{3}He Technology Alternatives in FY10

The following research projects are being explored by the Transformational Applied Research Directorate (TARD) in DNDO. The projects described below are expected to reach the TRLs 4 – 6 levels in the next few years. Successful demonstration will place the technology ready to be applied against a system engineering process to commercialize an integrated system. A consolidated listing of the projects can be found in Table 5.2.

5.1.5.1 Cs_2LiYCl_6:Ce (CLYC) Scintillators for Neutron Detection

This program will develop a low rate production facility of a promising thermal neutron scintillator, Cs_2LiYCl_6:Ce (CLYC). CLYC provides high light output (over 70,000 photons) for thermal neutrons, and very importantly, has capability to provide gamma-neutron discrimination on the basis of pulse shape as well as pulse height. Thus, high efficiency may be realized with CLYC with the potential of excellent gamma discrimination while maintaining gamma energy resolution. Current gamma resolution is on the order of 4% at 662 KeV. Due to the cubic structure of CLYC, crystals sizes should be easier to scale-up to large sizes. This effort is to setup a facility that can provide a supply of optimized CLYC crystals for evaluation while scaling up the CLYC crystal sizes up to 2" diameter. Packaging issues will be addressed. This project is in its first year under the BAA09-101 solicitation (Radiation Monitoring Devices [RMD]).

5.1.5.2 New Neutron Detectors with PSD: $Cs_2LiLaCl_6$ (CLLC), $Cs_2LiLaBr_6$ (CLLB)

Ce doped $Cs_2LiLaCl_6$ is an excellent thermal neutron (due to Li) scintillator with an effective pulse shape discrimination. CLLC has a cubic crystal structure that makes the growth of large crystals easier. The phase I project showed this material can provide high light yield of ~125,000 photon/neutron. In terms of gamma energy the neutron peak position corresponds to about 3.3 MeV in energy spectra, which allows for a very easy discrimination of all gamma events having lower energies. Furthermore, CLLC with low Ce concentration levels upon gamma ray interaction produces a very fast scintillation component (with ~1 ns decay time). This component is absent in scintillation pulses produced upon neutron interaction. This fact makes pulse shape discrimination between neutron and gamma events not only possible but also very effective. These materials are predicted to show even better gamma energy resolution than CLYC. This project is currently in Phase II (Radiation Monitoring Devices, Inc., SBIR).

5.1.5.3 Straw Directional Neutron-Gamma Detector

This DTRA co-funded program is developing a large area detector for neutron & gamma radiation detection with low panel weight and large area diameter for near term portal neutron detection. The detector uses 4 mm diameter "straws" which have a ^{10}B and C inner coating to detect radiation. The coating material allows for good stopping power and efficiency. Since there is no pressurization required, there is no bulky vessel so it is more easily transportable. The goal is to produce a component suitable for portal applications and characterize it (DTRA).

5.1.5.4 Scalable Solid-State Thermal Neutron Detectors

The overall objective of this project is to demonstrate a high efficiency solid state thermal neutron detector that has operational characteristics that exceed current ^{3}He tube technology. In addition, the manufacturability of these detectors such that they could be readily transitioned to industry for mass production will be explored. The DNDO approach consists of an array of current collecting "pillars" embedded within ^{10}Boron, the neutron sensitive material. This 3D structure is optimized in terms of both material selection (silicon and ^{10}B) and architecture (pillar height and pitch). Our detailed simulations show our Pillar Detector will have an efficiency of 50% while maintaining gamma discrimination of 10^5 when scaled to a device height of 50 μm. This project is currently in its second year (LLNL).

5.1.5.5 CVD Diamond for Fission Neutron Detection

This project seeks to develop an efficient, solid state detection system that allows for the detection of fast neutrons with the ability to discriminate between neutron and gamma ray events. The goal of the Phase I program is to demonstrate the feasibility of producing novel, fast neutron detectors from chemical vapor deposition (CVD) diamond capable of operating in active as well as passive interrogation environments. Due to its high atomic density and low atomic number, diamond has a high neutron linear attenuation coefficient and very low gamma-ray linear attenuation coefficient. In addition, diamond is chemically very stable and exhibits excellent radiation hardness. Diamond also has a wide band gap for low noise operation at room temperature. This project is currently in Phase II (Radiation Monitoring Devices, Inc., SBIR).

5.1.5.6 Combined Solid-State Neutron-Gamma High Efficiency Detector

Neutron-sensitized Multi-channel plates (MCPs) have been shown theoretically to have neutron detection efficiencies equivalent to that of ^{3}He gas tubes and neutron detection efficiencies of >25 % have been measured with a ^{252}Cf source. The Phase I resulted in the improvement of the electronic coincidence neutron verification procedure which essentially eliminated spurious counts and interference from gamma photons. The MCP neutron detector components have been clearly demonstrated in the laboratory environment. Further component improvement and integration maturity are required to establish functional prototypes for field operations. In Phase II the program will move the component capabilities to their full potential and establish a fully integrated detector system (NOVA Scientific, SBIR).

5.1.5.7 Improved Solid-State Neutron Detector

The detector in development is rugged, operates at low voltages, can be mass produced with commercially available, inexpensive CMOS (complementary metal oxide semiconductor) technology processes, and it is fast and lightweight. This makes it a strong candidate for large-scale deployment creating a distributed detection network to improve the chances of detecting illegally trafficked nuclear materials. The goal of the Phase I program is to design a solid-state neutron detector that exceeds the sensitivity and discrimination performance of a ^{3}He tubes, i.e. has adequate sensitivity to neutrons and can reject gamma rays (Radiation Monitoring Devices, Inc., SBIR).

5.1.5.8 Novel Solid-State Self Powered Neutron Detector

In this work an efficient, self-powered (no bias voltage) solid-state neutron detector is developed. With no moving parts it will be robust and will work in a variety of different environments. Furthermore the device simplicity will make it easily scalable and can be employed for a variety of uses. P^+-n junctions have been formed on the detector structures that were simulated previously.

Electroplating, nanoparticle refilling and low pressure chemical vapor deposition have been studied and their results presented. Initial work has been conducted to create a basic packaging procedure for the detector. This has allowed for the macroscopic testing of the detector with external alpha particle and neutron sources (Rensselaer Polytechnic Institute, ARI).

Table 5.2 Current Projects at DNDO

#	Project Title	Technology Description	Detector Application	Project Risk (H, M, or L)	Develop-ment Completion Date	Develop-ment Cost
1	Cs_2LiYCl_6:Ce (CLYC) Scintillators for Neutron Detection	CLYC has a bright response for neutrons and can detect thermal as well as fast neutrons	Person-portable systems and compact, small systems	L	1-2 years	$2,130K
2	New Neutron Detectors with PSD: $Cs_2LiLaCl_6$ (CLLC), $Cs_2LiLaBr_6$ (CLLB)	^{6}Li allows for the material to be a good thermal neutron scintillator	Personal-portable systems and compact, small systems	M	3-5 years	$650K
3	Straw Directional Neutron-Gamma Detector	4mm diameter straws coated with ^{10}B and C	Portal Monitoring	L	2-3 years	$2000K
4	Scalable Solid-State Thermal Neutron Detectors	Si pillars filled with ^{10}B to achieve 50% efficiency and gamma discrimination of 10^5	Personal-portable systems and compact, small systems	M	4-5 years	$4,762K
5	CVD Diamond for Fission Neutron Detection	Chemical Vapor Deposition diamond capable of operating in active and passive detection environments	Personal-portable systems and compact, small systems	H	4-5 years	$1,150K
6	Combined Solid-State Neutron-Gamma High Efficiency Detector	^{10}B/Gd loaded microchannel plates integrated with gamma scintillator to verify neutrons and reject gammas	Personal-portable systems and compact, small systems	H	3-5 years	$1,150K
7	Improved Solid-State Neutron Detector	Rugged detector capable of low voltage operation and can be produced with COTS, inexpensive CMOS technology	Personal-portable systems and compact, small systems	H	4-5 years	1150K
8	Novel Solid-State Self Powered Neutron Detector	Neutron interaction with ^{10}B creates alpha particles which excite electron-hole pairs in the PN-junction	Compact, small systems	H	4-5 years	319K

5.1.5.9 ^{3}He Technology Alternatives Accelerated for FY10/FY11

The long-term research supported by DNDO is funded under a phased risk mitigation approach. Additional funds will not necessarily accelerate the production of these materials until the basic science is more thoroughly understood. The SBIR projects are already funded at the maximum level. The new crystal growth projects (CLYC) appear to have the largest potential for impact, but are already well funded for production and optimization of small (1" diameter) crystals. Additional funding could be used to push growth of larger crystals, see Table 5.3.

5..1.5.9.1 Growth of Large Volume Scintillators

DNDO has already invested in the acceleration of producing and optimizing the new scintillator crystals. These efforts are currently focused on small crystals, additional efforts could look in parallel at the requirements to optimize and produce large crystals. This would require more investigation into growth conditions and furnace requirements for the related elpasolite crystal growth (CLYC, CLLC, CLLB).

Table 5.3 Projects at DNDO that could be accelerated

#	Project/ Technology Description	Equipment use (e.g., portals, backpacks)	Current Cost	Increase Requested	Performance Risk (H, M, or L)	Schedule Risk (H, M, or L)	Cost Risk (H, M, or L)	Estimated Completion Date for Independent testing
1	Growth of Large Volume Scintillators	Portals, Backpacks, Handhelds	0	$4.0M	H	M	H	3 years

5.1.6 DNDO Summary

The Product Acquisition and Deployment Directorate (PADD) and the System Engineering and Evaluation Directorate (SEED) within DNDO procure and develop systems as well as apply the appropriate system engineering (SE) process to bring an emerging technology to commercialization. A full characterization of any COTS system being considered for procurement can also be performed following the same system engineering process tailored to the specific device.

PADD is pursing the development of a BF3 detector with the appropriate level of mitigation to remove the safety concern of the BF3 gas. PADD has also released an RFI to not only inform the commercial sector the Government is looking for an alternative to ^{3}He but is also has arranged for several of the devices to be tested to gauge the current status of the commercial market. The RFI was also used to encourage the commercial sector to take on the challenge of investigating ^{3}He alternative neutron detectors. Since two of the vendors who submitted device for the November 2009 test has continued to develop their detectors, a second round of tests and evaluation is expected in February 2010 which may lead to an RFP to pursue a develop and procurement of alternative neutron detectors for portal monitors.

The Transformational Applied Research Directorate (TARD) in DNDO is primarily geared to the research and development of scintillator and solid-state handheld, portal and backpack instruments.

TARD is actively researching emerging technologies that could address the replacement of ^3He tube technology. Additional funding would be used to address improvements in previously funded technology that is applicable to large area, low cost detection.

5.2 Department of Defense's Department of Defense (DTRA)

5.2.1 Organizational Description

The Nuclear Technologies Directorate's Locate and ID Branch supports research, development, testing and experiments for radiation detection technology in support of the Department of Defense's efforts to reduce the threat from weapons of mass destruction. The Nuclear Detection Technology programs are primarily geared to support the development of novel radiation detection methods and materials and prototypes for next generation detection systems. Research efforts are coordinated through interagency cooperation with the Departments of Homeland Security and Energy and a summary of the on-going projects can be found in Table 5.4. Typically, DTRA NTDL will support research from TRL 3 to 6, to include advanced prototypes for developmental testing. DTRA NTDL does not procure systems.

5.2.2 Research of ^3He Technology Alternatives in FY10

The following research projects are being explored by the DTRA NTDL. The projects described below are expected to reach the TRLs 3 – 6 levels in the next few years. Successful demonstration will place the technology ready to be applied against a system engineering process to commercialize an integrated system.

5.2.2.1 Neutron Smart Threads

The scintillating glass fibers incorporate ^6Li and Ce^{3+} into the glass bulk composition. The ^6Li has a high cross-section for thermal neutron capture. The capture reaction produces a tritium ion and an alpha particle along with a significant amount of kinetic energy. The triton ion will likely interact with a cerium ion through coulomb interactions. This interaction results in the excitation of cerium electrons. The resulting de-excitation of the electron produces a flash of light. This scintillation propagates through the glass fiber which acts as a wave guide. The fibers are optically coupled to a photomultiplier tube. The light is then multiplied and converted to an electronic pulse that can be processed and counted which results in the system's ability to detect neutrons in the environment.

In support of a DTRA Joint Capability Technology Demonstration (JCTD), a mature technology family of sensors to locate nuclear/radiological threats was demonstrated with near-term transition potential. This JCTD demonstrated an integrated, manned and unmanned "system-of systems" radiation sensor capability for force protection and counter-proliferation missions across multiple mission environments integrated within current/future joint architecture for sensor network and data fusion. The current contract is with NUCSAFE.

5.2.2.2 Neutron Straws

Although ^3He pressurized area detectors can provide good spatial resolution, sensitivity and gamma ray discrimination, this technology cannot support the required high level neutron absorption rates without further development. A detector technology based on thin-walled straws, lined with enriched boron carbide (10B4C) may consist of several thousand close-packed individual straws, which are read out independently, can easily support high event rates. Tests conducted in a thermal neutron beam focused on the count rate capability of the detector and the effect of high neutron rates and a high gamma ray flux on spatial resolution. Recent results show thermal neutron efficiencies greater than 30 percent. The current contract is with ALION.

5.2.2.3 Perforated Neutron Detector

Compact neutron detectors are being designed and tested for use as ruggedized low-power real-time thermal neutron counting efficiencies greater than 30 percent. The neutron detectors are pin diodes that are mass produced from high-purity Si wafers. Each detector has perforations etched into the device. The perforations are backfilled with ^{6}LiF to make the pin diodes sensitive to thermal neutrons. The current contract is with ALION.

5.2.2.4 Neutron Scatter Camera

A neutron scatter camera is an array of two orthogonal detectors aligned so any incident (0.5 to greater than 10 MeV) neutron can be traced to identify the direction of origin, as well as the energy level. High-energy neutrons typical of radioactive materials can also imaged. The extreme sensitivity of a neutron-scatter camera is based on liquid detectors. The prototype is mounted on a truck for mobile applications. The detectors are housed in a proton-rich liquid-filled scintillator, which fluoresces when struck by neutrons. Photomultiplier tubes are coupled to the scintillator to detect the visible light photons. Software analyzes the output from the photomultiplier and constructs a visual image that identifies the nuclear hot spots. The current effort is with Sandia National Laboratory.

5.2.2.5 Neutron Spectroscope

The Neutron Spectroscope will provide real-time detection and identification of Special Nuclear Materials (SNM). The detection principle is based upon multiple elastic neutron-proton scatterings in an organic scintillator. The instrument utilizes two detector panel layers. By measuring the recoil proton and scattered (1 to 20 MeV) neutron energies, the direction and energy spectrum of the incident neutrons can be determined and discrete sources identified. Event reconstruction gives NSPECT the capability to provide an image of the source of interest. The current contract is with the Michigan Aerospace SBIR.

Table 5.4 Current Projects at DTRA NTDL

#	Project Title	Technology Description	Detector Application	Project Risk (H, M, or L)	Development Completion Date	Development Cost
1	Smart Threads	Li-6 glass fiber	Portals, vehicle (marine, land, sea) Backpacks, Handhelds	L	2010	Since 2002
2	Neutron Straws	B-10 carbide	Scalable to all applications, current focus	M	< 3 years	Leveraged from National Science

			on large He-3 tube replacements, standoff detection and portals			Foundation and NA-22 development
3	Perforated Neutron Detector	Li-6 on Si	Portable, arrayable, low power, ruggedized (e.g., handheld, dosimetry)	L	<2 years	Leveraged from National Science Foundation and NA-22 development
4	Neutron Scatter Camera	EJ309 liquid for fast neutron detection	Mobile, standoff, imaging	L	< 2 years	Leveraged from National Science Foundation and NA-22 development
5	Neutron Spectroscope	Solid media for fast neutron detection	Mobile, transportable, low power, standoff	M	< 2 years	SBIR, leveraged from prior NASA development

5.2.3 DTRA Summary

The current DTRA Located and ID effort is geared to the development of multiplatform combat support missions, and not towards the replacement of ^{3}He tubes in portal applications. Additional funding would be used to address improvements applicable to these mission areas. DTRA's Basic and Applied Science grants are at the 6.1 level, and no specific applications are identified for these projects.

5.3 The Department of Energy (DOE)

5.3.1 Organizational Description

The Office of Nuclear Nonproliferation Research and Development (NA-22) supports long-term research for next-generation technology in support of the Department of Energy's efforts to uncover the proliferation of nuclear weapons and nuclear materials beyond the borders of our country. The Special Nuclear Material Movement, Radiation Detection, and Advanced Materials programs are primarily geared to support the development of novel radiation detection methods and materials. In addition to directly supporting research for advanced radiation detectors, NA-22 also supports efforts to evaluate radiation detector response, model active interrogation scenarios, and model scenarios where imaging may be beneficial. Research is supported in three-year lifecycles with an opportunity for renewal through a competitive proposal review process. All projects are reviewed by external reviewers in their second year to assure high program quality. Typically, NA-22 will support research only to a demonstration of feasibility (TRL 3 to 4), but will continue to the point of prototype demonstration (TRL 5 to 6) if no other development path is identified and a clear need exists. NA-22 does not procure systems. A listing of the research and development programs underway can be found Table 5.5 and a discussion of each project is provided below.

5.3.2 Research ^{3}He Technology Alternatives in FY10

The following research projects are being explored by NA-22. The projects described below are expected to reach the TRLs 3 – 6 levels in the next few years. Successful demonstration will place the technology ready to be applied against a system engineering process to commercialize an integrated system.

5.3.2.1 Rapid Growth of Salicylic Acid Derivatives for High-Energy Neutron Detection

This project has two major objectives: 1) screening of a large number (>100) of organic crystals for fast neutron sensitivity and for pulse-shape discrimination (PSD) of the neutron response from the gamma response, and 2) demonstration of the fast and inexpensive growth of very large organic crystals from solution. Organic crystals with extended π-electron systems interact with energetic neutrons produced by fission of SNM to produce recoil protons that cause the π-electron system to produce light. The temporal characteristics of this light emission allows the separation of gamma and neutron events Screening of candidates has been completed and several promising candidates have been identified that exceed the performance of existing materials such as stilbene. First growth of large crystals has been performed and crystals larger than 8 cm on a side have been grown. Rapid growth was limited only by the size of the crystallizer. Successful research will lead to a detector with a potential of a COTS availability in 3 to 5 years. This project is beginning its third year. (LLNL)

5.3.2.2 Semiconducting Lithium-Containing Chalcopyrite Neutron Detectors

A semiconductor that contained ^{6}Li as a major component would allow for the direct electrical measurement of thermal neutrons without the need for an optically sensitive element for readout as is required for a scintillator type detector. In addition to reduced complexity, lithium containing semiconductors are expected to have significantly lower voltage requirement, be more rugged, have high maximum count rates with good timing, and to be opaque to thermal neutrons at thicknesses as thin as 1 mm. Unfortunately, very few wide-band gap semiconductors containing lithium are known. Compounds that are known are the chalcopyrites with the chemical form $A^{+1}B^{+3}X_2^{-2}$ such as $LiGaTe_2$. Several of these compounds are reported to have nearly ideal band gaps for room temperature operation (1.8 to 2.2 eV), but have not been prepared as semiconductor single crystals. Technical obstacles include purification of highly reactive ^{6}Li metal and discovery of non-reactive crucible materials and/or coatings. In addition, a detector system constructed from these materials will need to deal with gamma and x-ray sensitivity. Although it is difficult to determine when a crystal growth effort might produce a useful product, COTS availability is likely to be greater than 5 years. This project is beginning its second year. (Y-12 and Fisk University)

5.3.2.3 Lithium Containing Ternary Compounds for Solid-State Neutron Detectors

Similar in some respects to the chalcopyrites discussed in the previous section, these compounds also contain lithium as the neutron sensitive component. The materials under investigation are a class of Nowotny-Juza compounds of the general chemical form $A^{+1}B^{+2}X^{-3}$, but are best understood as a tetrahedral lattice of $(BX)^-$ with the interstitial spaces half filled by A^{+1} cations (lithium). A representative compound would be LiZnN which has a near ideal band-gap of 1.9 eV. These materials have never been grown as large single-crystals, so all of standard issues of crystal growth (chemical purity, thermodynamic stability, container materials, growth conditions) will need to be addressed. A large number of compounds are known as powders, so there should be opportunities to tune the response of the material. It is hoped that the atomic number of the atoms in the lattice can be kept low to minimize gamma sensitivity. COTS availability is likely to be greater than 5 years. This exploratory project is beginning its second year. (Kansas State University)

5.3.2.4 Water-based Neutron Detectors

This project will construct and test a gadolinium-doped water Cerenkov detector for portal applications. The detector measures the flash of Cerenkov light produced by the gamma ray cascade that is generated when neutrons capture on gadolinium in the water. The edges of the detector would be instrumented with photomultipliers immersed in the water. The water Cerenkov technique has proven to be a highly successful technology in the field of solar and atmospheric neutrino physics. In addition to gross counting, the device may produce directional information useful for either background rejection or imaging, and may be capable of neutron multiplicity measurements. It is hoped that the detector should be very low cost and would allow a significantly larger collection volume compared to current ^{3}He tubes. Technical challenges include light transmission and collection, and optimization of the overall detector design. COTS availability is likely greater than 3 years. (LLNL)

5.3.2.5 High-efficiency solid-state neutron detector

One type of thermal neutron detectors is based on capture conversion of thermal neutrons to charged particles in a conversion layer (typically ^{10}B or ^{6}Li) and then detection of the charged particles in a detector such as silicon. Unfortunately, the maximum efficiency of a planar structure is only about 4%. In this project, boron-containing buried trenches are fabricated in a silicon diode which when struck by a thermal neutron produces a lithium nuclei and an alpha particle. These charged particles create electron-hole pairs in the depleted region of the diode that are detected directly as an electrical signal. The dimensions of the trenches were chosen to allow the efficient escape of the charged particles and to allow simple trench filling techniques to be used. The buried trenches are created on a silicon-on-insulator (SOI) wafer by silicon etch, boron fill, and boron planarization processes. The wafer is then bonded to a base wafer and the oxide region of the SOI wafer is etched to release the buried trench layer. By successive bonding and etching steps, a multi-layer structure is created with sufficient boron to stop all thermal neutrons. It is hoped that the increased volume of boron will lead to efficient detection of neutrons. Technical obstacles include gamma sensitivity, determination of an optimum structure, and fabrication process complexity. Completion of a prototype is schedule for the end of 2010. (NuTrek, SBIR)

5.3.2.6 Fiber-Based Neutron-Sensitive Electron Multipliers

Based on a derivative of micro-plate electron multipliers, this project uses conversion electrons from gadolinium or secondary electrons produced by collision of charged particles produced following the capture conversion of thermal neutrons with ^{10}B to initiate an electron cascade. Thus, a single neutron event can result in more than 10^{6} electrons for detection. By using layers of spheres or woven mats of fibers, large area detectors can be produced at low cost. In addition to simple detection and gross neutron counting, patterning of the collection electrode allows for the detector to image. The first devices have demonstrated gamma insensitivity comparable to ^{3}He tubes. Technical obstacles include demonstration of efficiency and optimization of design.
Completion and testing of a prototype is schedule for the end of 2010. (NOVA Scientific, SBIR)

Table 5.5 Current Projects at DOE

#	Project Title	Technology Description	Detector Application	Project Risk (H, M, or L)	Develop-ment Completion Date	Develop-ment Cost
1	Rapid Growth of Salicylic Acid Derivatives for High-Energy Neutron Detection	Stilbene like organic materials for direct detection of fast neutrons	Portals, Backpacks, Handhelds	M	2012	$2,130K
2	Semiconducting Lithium-Containing Chalcopyrite Neutron Detectors	Wide-band gap semiconductor for direct detection of thermal neutrons	Backpacks, Handhelds	H	> 5 years	$900K
3	Lithium containing ternary Compounds for Solid-State Neutron Detectors	Wide-band gap semiconductor for direct detection of thermal neutrons	Backpacks, Handheld	H	> 5 years	$700K
4	Water-based Neutron Detectors	Gd-water Cerenkov detector with directional capability	Portals	H	2012	$2,382K
5	High-efficiency solid-state neutron detector	Buried B channels in a Si particle detector	Backpacks, Handhelds	H	2010	$750K
6	Fiber-Based Neutron-Sensitive Electron Multipliers	Microfiber plate technology, solid-state, electronic detection	Backpacks, Handhelds	H	2010	$750K

5.3.3 ^{3}He Technology Alternatives Accelerated for FY10/FY11

The long-term research supported by NA-22 does not readily allow for short-term acceleration of projects. The three crystal growth projects are not easily scaled up due to manpower considerations and the long growth times for most materials. The Cerenkov project is well funded and the two SBIR projects are funded at the maximum level. Since we believe that the pursuit of improved neutron detectors will extend beyond the current crisis with portal monitors, we would use additional funding to refine several existing concepts. A summary of the projects that could be accelerated for listed in Table 5.6

5.3.3.1 Pulse Shape Discrimination and Improvements to Lithium-Containing Glass Fibers

There are two major problems with lithium-containing glass fiber: 1) light transmission, and 2) gamma sensitivity. The first problem might be addressed by improvements in the fiber fabrication process to improve homogeneity and decrease micro-crystalline regions using improved technology developed for the glass-fiber communication industry. The second problem might be addressable by the development of a pulse shape determination process for the readout system.

5.3.3.2 Growth of Large Volume Scintillators

NA-22 has previously looked at composite materials such as lithium phosphate nanoparticles/organic dye in polystyrene. This project produced a transparent, high brightness scintillator but was not optimized for portal replacement applications. Improvements such as wavelength shifting agents and optimization of composition could result in a significant improvement in absolute neutron detection efficiency.

5.3.3.3 Gadolinium Conversion Structures

NA-22 would like to continue exploration of amorphous and polycrystalline semiconductors containing admixed gadolinium. Gadolinium has an enormous cross-section for thermal neutrons, but the conversion electrons that are produced are difficult to detect. When admixed with an amorphous or small grain polycrystalline semiconductor, efficient detection may be possible. In addition to silicon, several wider band-gap amorphous materials might be explored.

5.3.3.4 Mechanisms of Pulse Shape Discrimination in Inorganic Materials

This effort would be a combined theoretical and experimental effort to look at the temporal response of several common gamma detection crystals when exposed to neutrons. For example, it is known that NaI produces a nuclear recoil response when exposed to fission neutrons. Likewise, materials such as cadmium zinc telluride (CZT) and mercuric iodide contain components with thermal neutron sensitivity. Success in this effort might allow for combined neutron and gamma instruments.

Table 5.6. Additional DOE projects that could be accelerated

#	Project/ Technology Description	Equipment use (e.g., portals, backpacks)	Current Cost	Increase Requested	Performance Risk (H, M, or L)	Schedule Risk (H, M, or L)	Cost Risk (H, M, or L)	Estimated Completion Date for Independent testing
1	Development of Pulse Shape Discrimination for Glass Fibers	Portals, Backpacks, Handhelds	0	$1.8M	M	M	M	1.5 years
2	Growth of Large Volume Scintillators	Portals, Backpacks, Handhelds	0	$3.5M	H	M	H	2 years
3	Gd Conversion Structures	Backpacks, Handheld	0	$1.4M	H	H	H	Unknown
4	Mechanisms of Pulse Shape	Portals, Backpacks,	0	$1.8M	L	M	L	Unknown

	Discrimination in Inorganic Scintillators	Handhelds						

5.3.4. DOE Summary Section

The current NA-22 effort is primarily geared to the development of solid-state handheld and backpack instruments, and not towards the replacement of ^{3}He tubes in portal applications. Additional funding would be used to address improvements in previously funded technology that is applicable to large area, low cost detection.

Attachment A:

Questions and Answers (Q&As)

The following are suggested answers to potential questions regarding the current shortage in ^{3}He supply.

What is ^{3}He?

^{3}He is a non-radioactive and non-hazardous isotope of helium. It is a very rare isotope that cannot be extracted from nature. ^{3}He is a byproduct of the decay of tritium, which is a gas that is used in nuclear weapons.

What is ^{3}He used for?

Currently, the majority of ^{3}He is used for neutron detection. This detection, whether in nuclear facilities or at ports, border crossings, or during active searches, helps prevent nuclear materials from being diverted or smuggled for illicit purposes. The Department of Defense, the Department of Homeland Security, and the National Nuclear Security Administration each have nuclear detection programs that use ^{3}He based sensors

It is also used in other areas such as oil and gas exploration, medicine, cryogenics and physics.

Can ^{3}He be replaced for use in neutron detection?

Yes, but ^{3}He is the preferred choice. It is non-reactive, non-corrosive, and performs very well compared to other technologies. No other currently available detection technology offers the same stability, sensitivity, and gamma/neutron discrimination.

Why is demand for ^{3}He so much higher than supply?

^{3}He is produced through the U.S. nuclear weapons program. It is a byproduct of tritium, a gas used in nuclear weapons. As the number of weapons has gone down over the years, the amount of tritium produced has also gone down. This has resulted in a finite amount of ^{3}He being produced.

After the terrorist attacks of Sept 11, the U.S. government began to significantly increase its nuclear detection capabilities both at home and around the world. This resulted in a corresponding spike in the amount of ^3He that was needed.

At the same time, private industry continued to need a steady supply of ^3He to continue their important work.

As a result, the demand for the isotope quickly outpaced the supply.

What is being done to address this issue?

An interagency steering committee was formed that is composed of various federal agencies that are affected by the ^3He shortage. The group is discussing potential options to both increase the supply of ^3He, and to reduce the demand for it in certain areas.

Some of the options being discussed include:

- Pursuing alternative technologies for neutron detection
- Finding alternative methods for production of ^3He
- Working with other countries to identify additional sources of ^3He
- Prioritizing the existing supply of ^3He based on need.

Private industry and international stakeholders will also be engaged.

Is there a solution?

The different government agencies are discussing potential options to resolve this situation. They will also be engaging the technical, commercial and international communities to solicit ideas to address and resolve the issue. We are confident that the government, private industry, and international stakeholders will be able to find a path forward.

In the near term, USG Departments are working with the commercial sector to identify alternative detection products that are ready for commercialization. As these are identified, prototypes will be purchased for test and analysis, the goal being to spur technology innovation especially in the area of neutron detection for security.

Clenney, Jaclyn

From: Giorgio Frossati [giorgio@leidencryogenics.com]
Sent: Tuesday, December 15, 2009 3:50 AM
To: Gillo, Jehanne
Cc: William F. Brinkman; Gillo, Jehanne; Pantaleo, John; Bill Halperin; leicryo@euronet.nl
Subject: RE: Non-avaiability of 3He

Dear Jehanne
Thank you very much for your message. I am very glad that the problem of lack of 3He for the low temperature community has been discussed and that a solution is in view. I will ask John Pantaleo for more details on some very urgent requests. I know that the situation is difficult due to the large demand but considering that our low temperature community (and I mean the whole world) needs only around 2000liter/year which according to published statistics is less than 2% of the total annual request, it seems unfair that scientists of other countries other than the US should be heavily penalized paying nearly 5 times more for the gas needed for their low temperature equipment (2000$ against 450$). I wonder wether there couldn't be a uniform price for companies making very low temperature equipment like Oxford, Janis, and ourselves (Leiden Cryogenics) provided we would give you the details of our foreign client's requests. I think this would be beneficial for science and I am sure it is in the spirit of the American fair-play.
Best regards
Giorgio

Prof. Dr. Giorgio Frossati
Leiden Cryogenics b.v.
Kenauweg 11
2331 BA Leiden
The Netherlands
Tel.+31-71-5721824
Fax: +31-71-5722734
Chamber of Commerce nr 28056762
www.leidencryogenics.com
frossati@leidencryogenics.com
info@leidencryogenics.com

-------Original Message-------

From: Gillo, Jehanne
Date: 12/14/2009 9:54:12 PM
To: Giorgio Frossati
Cc: William F. Brinkman; Gillo, Jehanne; Pantaleo, John
Subject: RE: Non-avaiability of 3He

Dear Professor Frossati,
The DOE Isotope Program in the Office of Science has been working closely with Spectra Gas to make allocations of gas to high priority needs. We appreciate your patience. It took time for the agencies to poll their communities and identify their priorities. As Dr. Brinkman mentioned below, an interagency group organized by the National Security Council in the Executive Office of the President met last week to decide on He-3 allocations for Fiscal Year 2010. The Isotope Program will now begin working with the various federal agencies to allocate the gas in support of these decisions. We are aware of several requests made by Leiden Cryogenics to Spectra Gas. Should you have any questions regarding a specific request that you made and would like to know the status, please feel free to contact John Pantaleo, Director of the Isotope Program (john.pantaleo@science.doe.gov), who has been interacting with Spectra Gas. Please note that these decisions are recent and it will take us some time to work through all of the requests, but one should see some distribution of He-3 in the very near future.
Best regards,
Jehanne Gillo

Dr. Jehanne Simon-Gillo
Director
Facilities and Project Management Division
Office of Nuclear Physics, SC-26.2
Department of Energy
phone: (301)-903-1455

From: William F. Brinkman [mailto:wfb@Princeton.EDU]
Sent: Saturday, December 12, 2009 10:19 AM
To: Giorgio Frossati
Cc: Gillo, Jehanne
Subject: RE: Non-avaiability of 3He

I am forwarding your email to the people here who are working this issue. We have done an assessment of the amounts that everyone needs and believe that we have sufficient amounts to keep the low temperature field going etc. We work closely with Spectra on this.

Bill B

From: Giorgio Frossati [mailto:giorgio@leidencryogenics.com]
Sent: Fri 12/11/2009 5:57 AM
To: William F. Brinkman
Subject: RE: Non-avaiability of 3He

Hello Bill
I have several requats of He with DOE-DOD etc funding placed at Spectra gases for which there is no information and this has been so for a number of months. Our company and the customers are suffering mostly because of the lack of information. Will the requests that comply with the new rules be granted or not and if yes, when can we expect them? I get no answer from Spectra, despite many mails and I have only 90 liter of the 400 requested. Note that despite the difficult times this is a very small amount compared to the rest and it is causing much more damage than a couple of neutron detectors less per year.
Thank you for any information you can give me, or if you can address me to somebody who is taking care of these matters
Best regards
Giorgio

Prof. Dr. Giorgio Frossati
Leiden Cryogenics b.v.
Kenauweg 11
2331 BA Leiden
The Netherlands
Tel.+31-71-5721824
Fax: +31-71-5722734
Chamber of Commerce nr 28056762
www.leidencryogenics.com
frossati@leidencryogenics.com
info@leidencryogenics.com

-------Original Message-------

From: William F. Brinkman
Date: 10/31/2009 6:48:55 PM
To: Moses Chan; wfb@princeton.edu

Cc: Giorgio Frossati; w-halperin@northwestern.edu; Charles Marcus; Douglas D. Osheroff; rcr2@cornell.edu
Subject: RE: Non-avaiability of 3He

I have been looking into this. There is a high level government committee that is trying to figure out how to allocate the very limited supply we have. I am on the guiding committee and as soon as I know anything I will try to get it out.

Bill B

From: Moses Chan [mailto:chan@phys.psu.edu]
Sent: Fri 10/30/2009 1:16 AM
To: wfb@princeton.edu
Cc: Giorgio Frossati; w-halperin@northwestern.edu; Charles Marcus; Douglas D. Osheroff; rcr2@cornell.edu
Subject: Re: Non-avaiability of 3He

Dear Bill,

I want to echo the concerns expressed by Giorgio and Bill Helperin and also by Bob and Doug in earlier e-mails. We know your plate is very full with multiple issues, but we hope you can personally look into a more sensible short and long term solution.

Thanks,

Moses
104 Davey Lab.,
Penn State University,
University Park, PA 16802.
814-863-2622

On Thu, 29 Oct 2009, Bill Halperin wrote:

> Bill and Giorgio,
>
> The non-availability of 3He is having a disastrous impact on basic and
> applied research. It is a problem that must be solved to maintain our
> scientific technological infrastructure which, as you know, spreads broadly
> throughout condensed matter physics, low temperature physics, materials
> science, research on quantum information, applications of neutron scattering
> and many other areas of pure and applied science. As Giorgio points out it
> is a global problem. Price is an issue of course, but the reason the price
> is outlandishly high is because the supply is infinitesimal and it is this
> non-availability that poses a threat to our society.
>
> Bill
>
> At 7:28 PM +0100 10/28/09, Giorgio Frossati wrote:
>> Dear Bill
>> You certainly don't know me and I am very sorry to bother you. You have
>> received several messages from my friends of the low temperature community,
>> including Bill Halperin, Doug. Osheroff, Cahrlie Marcus and probably
>> others. We met many years ago when you were at Bell Labs and I was visiting
>> Doug. Anyway, I am now 70 and retired from the Leiden University. I have a
>> company called Leiden Cryogenics already 18 years old, and we make
>> exclusively dilution refrigerators . We have been quite successful and do
>> have a considerable part of the market, just below Oxford. As you well know
>> we cannot buy 3He unless there is some agreement from DOE, and we have to
>> send a list of our clients who have NSF, DOE etc funding. It is now very

>> complicated and a big hindering for our work, also because many
>> refrigerators are for other countries and apparently we cannot get helium
>> for them. Spectra gases is really exploiting the situation with prices that
>> I heard to be in the several thousand dollers per liter. Our refrigerators
>> use around 40 liter each with smaller and larger modesl up to 100 liter.
>> Spectra gases had promised us 100 liter every 2 months at 400$/liter and I
>> had received already 100 lieter in April. Since then no delivery occurred
>> anymore. Yesterday an Indian post-doc from the Tata Institute got quoted
>> from a French company the absurd amount of 9.000 euro for 2.4 liter so
>> about 5600 $ per liter. I am aware of all the problems, read several
>> reports etc, but our community uses only 2% of the annual amount available.
>> I had understood from Charlie that you had solved the problem but Spectra
>> says that the gas you allotted them was not particularly for low
>> temperatures. Also, I think that the prices they are quoting will kill the
>> low temperature research for new researchers with normal budgets, without
>> counting the rest of the World. In the past I had even bought 3he in Russia
>> but apparently they sold everything to Spectra (although I am not surew
>> this is true). What I know is that one cannot buy 3he anymore or at prices
>> that are just ridiculous. Could you please let me know what you think and
>> if Spectra has the right to exploit us in such a way? Of course we can pass
>> the higer prices to the future clients but I was an experimentalist myself
>> and I know how though it is to get financing.
>> I would really appreciate your advise
>> Best regards
>> Giorgio
>>
>> Prof. Dr. Giorgio Frossati
>> Leiden Cryogenics b.v.
>> Kenauweg 11
>> 2311 VZ Leiden
>> The Netherlands
>> Tel.+31-71-5721824
>> Fax: +31-71-5722734
>> Chamber of Commerce nr 28056762
>> <http://www.leidencryogenics.com/>www.leidencryogenics.com
>> <mailto:frossati@leidencryogenics.com>frossati@leidencryogenics.com
>> <mailto:info@leidencryogenics.com>info@leidencryogenics.com
>
>
> --
> Bill Halperin
> w-halperin@northwestern.edu
>
> Room F126,
> Technological Institute
> Dept. of Physics and Astronomy
> Northwestern University
> 2145 Sheridan Rd.
> Evanston IL 60208
> tel: (847)491-3686
> FAX: (847)491-9982

Clenney, Jaclyn

From:	Jack Faught [JackF@spectragases.com]
Sent:	Wednesday, November 04, 2009 3:37 PM
To:	Pantaleo, John
Cc:	Cooper, Ronald G.; karl.zeitelhack@frm2.tum.de
Subject:	FW re: Neutron Scattering Research

This information from Karl Zeitelhack for the FRM-11 facility in Europe shows that a significant number of US Scientists are applying for and getting approved beam time on the FR-II facility in Europe which is a cousin to the SNS facility at ORNL. I sent you a report from Bruno Guerard at the ILL facility in France which had a slightly higher estimate of beam team utilized by US Scientists. It seems to me that this is a very close knit group of scientists with many common goals and in view of the critical shortage of helium 3 we should encourage the co-use of these facilities by the communities in the United States, Europe, and Japan. Sharing systems with the groups in these countries could reduce the need for new systems if we can access time at existing systems at sister facilities abroad. Since production of more helium 3 is a long range solution we should work out cooperative agreements between these facilities and share what we have.

Jack

-----Original Message-----
From: Karl Zeitelhack [mailto:Karl.Zeitelhack@frm2.tum.de]
Sent: Wednesday, November 04, 2009 11:02 AM
To: Jack Faught
Cc: Cooper; Ron
Subject: Re: IEE Conference re: Neutron Scattering Research

Dear Jack,
thanks very much for your support of our neutron scattering community.
Following our discussion during the IEEE 2009, I tried to figure out US-engagement at my facility FRM-II. In the period 2005 - 2009, 70 proposals were sent in by US-researchers (4.3% of all proposals sent in), and 42 of them were accepted (3.6% of all proposals accepted). In total 229 days of beam time were given to US-researchers. Unfortunately this is fairly low to be used as a strong argument. Anyway, thanks again.
Best wishes
KArl

Jack Faught schrieb:
> John,
>
>
>
> Last week I attended the IEEE Conference in Orlando, Florida. During
> the conference I met with two of the lead people in the Neutron
> Scattering and Neutron Detector Group from Europe. Karl Zeitelhack of
> the Technische University Munich (FRM2) and Bruno Guerard of the ILL
> in France. I also met Ron Cooper at the meeting when I was discussing
> the requirements of helium 3 with Karl Zeitelhack. Karl gave me a
> copy of the report from a meeting they held in August 2009 which
> contains a very good summary of the requirements for Helium-3 for the
> world wide Neutron Scattering community (Inclusive of the labs in the
> UnIted States). In attendance at August meeting were:

>
>
>
> Ron Cooper (SNS) Bruno Guerard (ILL) Kazuhiko Soyama (J-Parc)
>
> Debbie Greenfield (STFC) Günter Kemmerling (JCNS) Thomas Wilpert (HZ
> Berlin)
>
> Nigel Rhodes (STFC) Oleg Kiselev (PSI) Martin Klein (Univ. Heidelberg)
>
> R. Engels* (JCNS) G. Smith* (BNL) Ilario Defendi (FRM II)
>
> Karl Zeitelhack (FRM II)
>
> · /not attending the meeting/
>
> / /
>
>
>
> I was very impressed with the approach that they have taken to outline
> their requirements for Helium 3 gas. They broke it down into
> maintenance requirements, new small detectors, and large detectors for
> the time period of 2009 through 2015. From the meeting I had with
> Karl Zeitelhack, they are hopeful that Spectra and the DOE will help
> them to acquire the gas they need for their maintenance requirements
> and their new small detectors. I found this request to be extremely
> rational given the limited supply available. Their request for
> maintenance and research requirements over the six year time frame is
> only 1,521 liters per year and this includes 451 liters of gas per year for U.S.
> Laboratories (ORNL, BNL, NIST, LANL). Their requests for the small
> detectors over the same time frame are 8,658 liters (1,443 liters per
> year) which again includes 874 liters per year for NIST, LANL, BNL, and
> ORNL.
>
>
>
> Given the amount of money funded by the European Community, the United
> States, and Japan on the SNS type systems around the world and given
> the extremely close collaboration of these groups in the use of their
> equipment, I cannot fathom why we would not make every effort to keep
> these systems operational. Additionally it is my belief that we
> should seek to utilize their expertise in the development of Boron 10
> as an alternative detection source. Spectra is committed to make the Boron 10
> available in all three forms, BF3, B4C, and B. Additionally we will
> make every effort to acquire gas from outside sources such as Russia
> and from our recycling efforts to reclaim gas and make this gas
> available to these groups.
>
>
>
> From all information that I have been able to acquire it appears that
> USA scientists employ upwards of about 7% of available beam time at
> the ILL and J-Parc, which makes it even more compelling to support
> them with some product from the USA based supply chain.
>
>

>
> We are all very appreciative of the efforts of the DOE Isotope Program
> and of your individual efforts to be our champion to acquire product
> for research and we look forward to working closely with you to
> support the requests with the data required.
>
>
>
> Please call me if you have questions, but I have copied Ron Cooper,
> and Karl Zeitelhack above so that you can contact them directly.
>
>
>
> Best regards,
>
> Jack M. Faught
> Vice President
> Spectra Gases, Inc.
> Telephone: 908-454-7455, ext. 5253
> Cell phone: 908-347-1090
> Fax: 908-213-0641
>
>
>

--
****

Dr. Karl Zeitelhack
TU Muenchen — Tel: +49 (0)89 289 -14703
ZWE FRM-II — Fax: +49 (0)89 289 -14989
Detektor- & Elektroniklabor
Lichtenbergstr. 1
D - 85747 Garching
Germany
****

Linkins, Venus <CTR>

From: Hagan, William K

Sent: Tuesday, November 17, 2009 4:38 PM

To: Bentz, Julie A.

Subject: Hearing today and the He-3 IPC

Julie,

I wanted to let you know that in the hearing today, I was asked a fair amount of questions about He-3 and the IPC. At one point Chairman Miller asked who was in control of the IPC and I gave him your name. I don't know what will come of this but I thought you should be aware.

Please call me if you have any questions.

Regards,

PS. I left you a VM about this as well.

William K. Hagan
Acting Deputy Director
Domestic Nuclear Detection Office
Department of Homeland Security
202-254-7600 (office)
202-664-0257 (cell)
william.hagan@dhs.gov

Muenchau, Ernest

From:	Muenchau, Ernest
Sent:	Friday, November 27, 2009 2:28 PM
To:	Hagan, William K; Gallaway, Chuck; Patrick, Shirley A <CTR>
Subject:	RE: Conference Call on He-3 (today at 9:30am)
Attachments:	11-20-09 Miller to Obama re Helium-3.pdf; 11-20-09 Miller to Dodaro re Helium-3.pdf

A letter from Rep. Miller went to the White House and to the GAO asking for an investigation into the He3 issue

From: Hagan, William K
Sent: Friday, November 27, 2009 1:18 PM
To: Gallaway, Chuck; Patrick, Shirley A <CTR>
Cc: Muenchau, Ernest
Subject: RE: Conference Call on He-3 (today at 9:30am)

Ernie, what happened in the call? Has a letter gone to the White House regarding He-3?

William K. Hagan
Acting Deputy Director
Domestic Nuclear Detection Office
Department of Homeland Security
202-254-7600 (office)
202-664-0257 (cell)
william.hagan@dhs.gov

From: Gallaway, Chuck
Sent: Tuesday, November 24, 2009 9:29 AM
To: Patrick, Shirley A <CTR>; Hagan, William K
Cc: Muenchau, Ernest
Subject: Re: Conference Call on He-3 (today at 9:30am)

Ernie. You have it. Thanks. Chuck

From: Patrick, Shirley A <CTR>
To: Hagan, William K
Cc: Gallaway, Chuck; Muenchau, Ernest
Sent: Tue Nov 24 09:02:30 2009
Subject: RE: Conference Call on He-3 (today at 9:30am)

Chuck is going to call in from the car. He's going to the NAC for the Bi-Weekly meeting with S1. Thanks!

Shirley Patrick, Executive Assistant
Office of the Director
Domestic Nuclear Detection Office (DNDO)
Department of Homeland Security
Shirley.Patrick@associates.dhs.gov
202-254-7303 (Office)
202-579-6258 (Blackberry)
202-254-7755 (Fax)

From Science to Solutions℠

27 January 2010

Pacific Northwest National Laboratory
902 Battelle Boulevard
Richland Washington 99352

Attn: Mr. Michael Catalan

Subject: Status of new neutron detector

Dear Mr. Catalan,

In order to provide updated information concerning the progress and development of a safe COTS replacement for the existing Helium-3 neutron detector technology in its AT980 radiation portal monitoring system and all SAIC RPM product families that utilize neutron detection, SAIC provides the following synopsis of our efforts to date. We will provide follow-up briefings as SAIC moves closer to full production.

SAIC has held technical discussions with many possible OEMs over the past year or so regarding possible alternate neutron detectors. The key parameters of these discussions were neutron detection efficiency, gamma rejection capability, ability to perform simple and robust field upgrades, and speed of availability. Over the past several months, three technologies have emerged as clearly superior to the rest of the field. The OEMs of these technologies have provided working prototypes to SAIC and sent personnel to our factory to assist in installing and testing the prototype units. We have had an engineering team working very hard to develop and test these new units, and they have been pleased with the OEM efforts to date.

Of the three leading candidate OEMs, one appears to be lagging in overall detection efficiency, and it is not clear that the core technology will get there anytime soon. In SAIC lab tests the prototype achieved 16% of the efficiency of a single 3-atm. He-3 tube (we'll call that comparative efficiency), and the OEM has a roadmap to only achieve about 40% comparative efficiency in production volumes. We will continue to encourage this OEM to develop the technology, but for now, this OEM is on the sidelines.

A second OEM has a prototype with good detection efficiency (about 96% measured by SAIC) and gamma rejection, but the electrical interface is more complex and the cost is significantly more expensive. Additionally, management at this OEM has said that they are not necessarily committed to a development program and future work would hinge on the size of any downstream orders received. We will continue to encourage the OEM towards a more flexible, open interface which SAIC has defined and the other OEMs have adapted to with little problem.

The third OEM has provided a prototype with very good performance (97% comparative efficiency tested by SAIC) and a straightforward means of adapting to existing hardware in a plug-and-play sense. Based on SAIC lab tests, there are a few minor changes to be made to the system configuration before a full validation effort and field test can be performed. These changes are in progress at the OEM, and a unit is expected to be delivered to SAIC for further testing around Feb. 19, 2010. Assuming this unit has satisfactory performance, an additional six units will be quickly made and sent to SAIC. Of these seven units, SAIC needs five for continued testing, including some potentially destructive tests at external laboratories for shock and vibration, EMI, etc. To ensure rapid progress throughout all phases of testing, and detection of problems as early and quickly as possible, SAIC would like to invite and encourage PNNL to send technical experts to observe testing of these units at the SAIC factory in Vista, California.

Because PNNL has extensive facilities and expertise in this area, SAIC would also like to send the remaining two units to PNNL for further testing. Considering testing time, shipping, etc., we currently expect to send the two units around mid-April 2010. Because time is of the essence, it is important to have rapid progress and meaningful testing done as quickly as possible. To support this testing, SAIC would send one or two engineers to PNNL to meet the hardware on-site and assist with installation and setup of the units.

Assuming testing at PNNL uncovers no need for significant changes, the OEM would be able to ramp up to production volumes within 4-8 weeks after a notice-to-proceed.

In order to fill all current open orders and any new orders for the AT980 RPM with neutron detection option, SAIC has already begun production of the RPM systems less the neutron detection assembly. Once the neutron assemblies are available for insertion into the production runs, SAIC will install that assembly, perform final test and ship. SAIC expects the first shipments based on this present testing schedule to begin May 2010.

In summary, the nominal schedule for test and deployment of the new detector technology starts with receipt of a drop-in prototype around Feb. 19, 2010. After two weeks of testing, SAIC will approve this design for limited production and field testing. An additional six units would then arrive at SAIC in mid-March. After a quick operational test, two of these units would be sent to PNNL for testing in their test lane. Assuming this testing progresses expeditiously, field deployment should be approved in early May, 2010. By that time, SAIC will have limited production quantities and will be ready to ship units for field testing at operational sites. After this time, production is not limited by material and can ramp up as needed to support any reasonable deployment schedule.

As we have stated previously, SAIC fully understands the importance of these detectors, and the programs they support, to the national security of the United States. SAIC remains committed to the long term product development and support of the RPM program.

Regards,

Jerome E. Gormley

Jerome E. Gormley
Director of Science and Technology
Security and Transportation Technology

From: Panisko, Mark E
To: Khawaja, Asim; Heyland, Mark E; Bowyer, Sonya M; Martin, Steven W; Berube, Laurie P; Pagh, Richard T; Prigge, Jami G; Grubbs, William K (Kevin); Dalzell, John J; Henderson, John M (Mark)
Subject: more Helium 3 information
Date: Tuesday, January 20, 2009 8:20:00 AM

Here are some highlights of my talk this morning with Jack Faught VP at Spectra Gases.

A large component of the latest price jump in He-3 was the cost of disposing of contaminated gas cylinders that DOE made their responsibility with they received the last gas release.

Ernie Muenchau has requested that Spectra Gases NOT release gas in large quantities. So they intend to release 1,400 liters a month to LND for SAIC RPMs.

Each time they receive an order they send the contracting information to John Pentaleo (DOE, Isotope Program Director) who then forwards the information to Ernie and Greg Slovik.

Jack estimates the combined US and Russian He-3 production at 25k liters per year. In addition to trying to work with the Canadians to capture their He-3, Spectra Gases is also attempting to work with the other countries like the China.

Thanks,
Mark
5-2778

He-3 Historical Demand Chart-2.xls

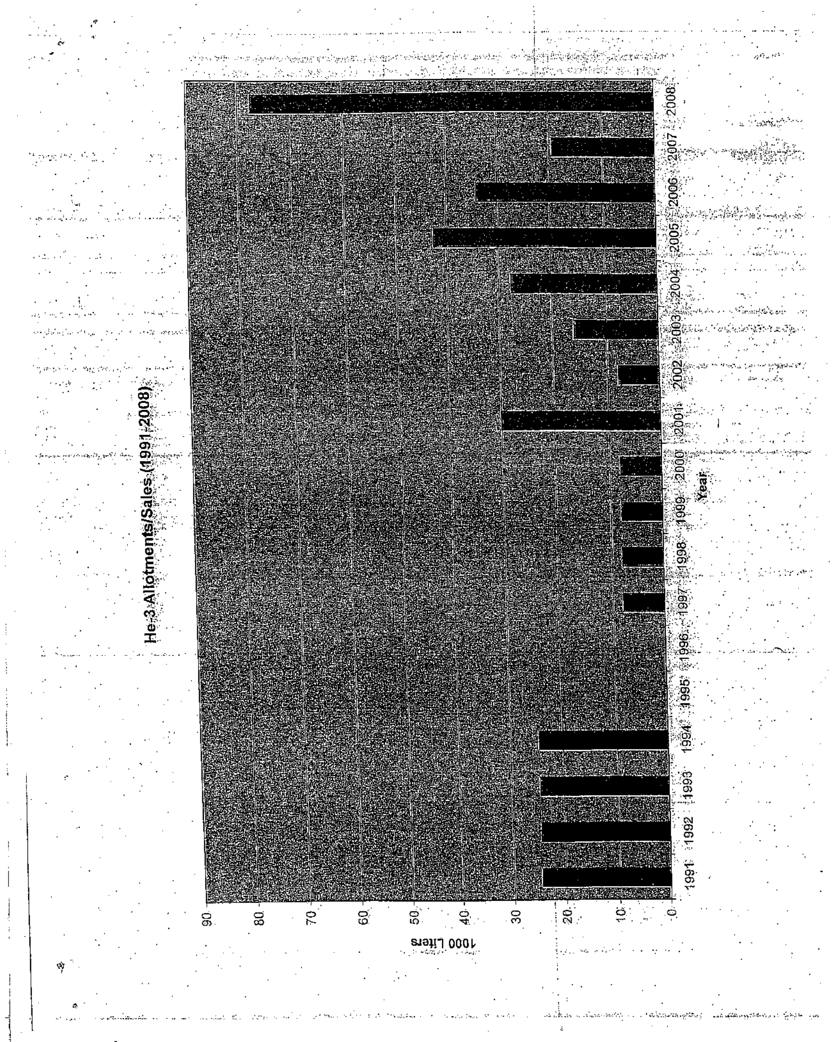
Pantaleo, John to: Dasti, Abdul, Jerry Klein, carroll.mcfall, Glaser, Joseph 01/27/2010 11:11 AM

Cc: "Gillo, Jehanne"
Bcc: Carroll Mcfall

To all:

This is the information I have on the sales and allocation. Please return and provide any comments to Abdul and me. What I am not clear about is past inventories we do know that we have sold and allocated around 180,00 liters from 2004 to 2008. We need to add the FY09 approved allocation Carroll how does this match with your records.

John


He-3 Allotments/Sales (1991-2008)
1000 Liters
0
10
20
30
40
50
60
70
80
90
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year

He-3 Allotments/Sales (1991-2008)

Year	SRS Allotments	No Material Sold	Isotope Program Sales	SNS Allotment	IP Sales to Spectra	IP Sales to GE	Total
1991	24.5						24.5
1992	24.5						24.5
1993	24.5						24.5
1994	24.5						24.5
1995		0					0
1996		0					0
1997			8				8
1998			8				8
1999			8				8
2000			8				8
2001			8	22			30
2002			8				8
2003			8		7.8		15.8
2004					0	27.6	27.6
2005					11.9	30.6	42.5
2006					3.9	30.1	34
2007					11.8	7.6	19.4
2008				33	33.4	11.1	77.5
							384.8

Note: Numbers reflect average sales/allotments. They do not reflect annual demand due to bulk purchases and various inventories that may be keep active at user sites.

Clenney, Jaclyn

From: Giorgio Frossati [giorgio@leidencryogenics.com]
Sent: Saturday, February 13, 2010 9:26 AM
To: Pantaleo, John
Cc: Gillo, Jehanne
Subject: RE: 3he requests

Dear John
I believe the whole low temperature community uses less than 2% of the available 3He compared to 85% of the Homeland Security project and the rest like the 100.000 liter that the Japanese reactor needs. We make dilution refrigerators for the low temperature community that does very important experiments particularly quantum computers that are strategically very important too. I am sure that the 2500-3000 liter that the whole LT community needs can be found by giving a little less to the 3He gas guzzlers. Bill Brinkman said that there will be enough 3He for low temperatures. You say that the 90 liter that we got is alot, but it is only for two machines. We have many more to deliver and several clients waiting. Oxford Instruments published that they delivered 50 refrigerators during the last two yers. I wonder how much 3He did the get. Is this something that you could tell me?
Best regards
Giorgio

Prof. Dr. Giorgio Frossati
Leiden Cryogenics b.v.
Kenauweg 11
2331 BA Leiden
The Netherlands
Tel.+31-71-5721824
Fax: +31-71-5722734
Chamber of Commerce nr 28056762
www.leidencryogenics.com
frossati@leidencryogenics.com
info@leidencryogenics.com

-------*Original Message*-------

From: Pantaleo, John
Date: 2/12/2010 8:00:30 PM
To: Giorgio Frossati
Cc: Gillo, Jehanne; leicryo@euronet.nl
Subject: RE: 3he requests

Hello Giorgio,
I was looking forward to seeing you at the AAAS meeting to discuss your recent requests for He-3. As you know the AAAS got postponed and is now being scheduled for April 6th. Spectra Gases sold Leiden Cryogenics in 2009, 90 liters of DOE He-3 for dilution refrigerators (45 for DOE and 45 for NSF responded work). This was a fair share of the 2009 allocation for science projects. As you know, all of the 2009 material has been sold. There was an allocation made for 2010. The he-3 needs to be shipped from SRO to Spectra Gases for purification before distribution can be made. The gas should be available in about one month.
As Jack Faught advised you, we need to know who at DOE is funding the US-Israel Bi-national work at the Weizman Institute. Can you get one or your contacts at Weizman to get someone who represents their interests in Washington to contact me directly. The 160 liters needed is a large request given the limited amount of gas available in 2010 and all the other government science project needs.
Regarding the two NASA requests, Jack Faught is trying to contact Jet Propulsion and UC Santa Barbara to obtain a contact at NASA.
Look forward to chatting with in April.
Regards,
John Pantaleo

I want to echo the concerns expressed by Giorgio and Bill Helperin and also by Bob and Doug in earlier e-mails. We know your plate is very full with multiple issues, but we hope you can personally look into a more sensible short and long term solution.

Thanks,

Moses
104 Davey Lab.,
Penn State University,
University Park, PA 16802.
814-863-2622

On Thu, 29 Oct 2009, Bill Halperin wrote:

> Bill and Giorgio,
>
> The non-availability of 3He is having a disastrous impact on basic and
> applied research. It is a problem that must be solved to maintain our
> scientific technological infrastructure which, as you know, spreads broadly
> throughout condensed matter physics, low temperature physics, materials
> science, research on quantum information, applications of neutron scattering
> and many other areas of pure and applied science. As Giorgio points out it
> is a global problem. Price is an issue of course, but the reason the price
> is outlandishly high is because the supply is infinitesimal and it is this
> non-availability that poses a threat to our society.
>
> Bill
>
> At 7:28 PM +0100 10/28/09, Giorgio Frossati wrote:
>> Dear Bill
>> You certainly don't know me and I am very sorry to bother you. You have
>> received several messages from my friends of the low temperature community,
>> including Bill Halperin, Doug. Osheroff, Cahrlie Marcus and probably
>> others. We met many years ago when you were at Bell Labs and I was visiting
>> Doug. Anyway, I am now 70 and retired from the Leiden University. I have a
>> company called Leiden Cryogenics already 18 years old, and we make
>> exclusively dilution refrigerators . We have been quite successful and do
>> have a considerable part of the market, just below Oxford. As you well know
>> we cannot buy 3He unless there is some agreement from DOE, and we have to
>> send a list of our clients who have NSF, DOE etc funding. It is now very
>> complicated and a big hindering for our work, also because many
>> refrigerators are for other countries and apparently we cannot get helium
>> for them. Spectra gases is really exploiting the situation with prices that
>> I heard to be in the several thousand dollers per liter. Our refrigerators
>> use around 40 liter each with smaller and larger modesl up to 100 liter.
>> Spectra gases had promised us 100 liter every 2 months at 400$/liter and I
>> had received already 100 lieter in April. Since then no delivery occurred
>> anymore. Yesterday an Indian post-doc from the Tata Institute got quoted
>> from a French company the absurd amount of 9.000 euro for 2.4 liter so
>> about 5600 $ per liter. I am aware of all the problems, read several
>> reports etc, but our community uses only 2% of the annual amount available.
>> I had understood from Charlie that you had solved the problem but Spectra
>> says that the gas you allotted them was not particularly for low
>> temperatures. Also, I think that the prices they are quoting will kill the
>> low temperature research for new researchers with normal budgets, without
>> counting the rest of the World. In the past I had even bought 3he in Russia
>> but apparently they sold everything to Spectra (although I am not surew

>> this is true). What I know is that one cannot buy 3he anymore or at prices
>> that are just ridiculous. Could you please let me know what you think and
>> if Spectra has the right to exploit us in such a way? Of course we can pass
>> the higer prices to the future clients but I was an experimentalist myself
>> and I know how though it is to get financing.
>> I would really appreciate your advise
>> Best regards
>> Giorgio
>>
>> Prof. Dr. Giorgio Frossati
>> Leiden Cryogenics b.v.
>> Kenauweg 11
>> 2311 VZ Leiden
>> The Netherlands
>> Tel.+31-71-5721824
>> Fax: +31-71-5722734
>> Chamber of Commerce nr 28056762
>> <http://www.leidencryogenics.com/>www.leidencryogenics.com
>> <mailto:frossati@leidencryogenics.com>frossati@leidencryogenics.com
>> <mailto:info@leidencryogenics.com>info@leidencryogenics.com
>
>
> --
> Bill Halperin
> w-halperin@northwestern.edu
>
> Room F126,
> Technological Institute
> Dept. of Physics and Astronomy
> Northwestern University
> 2145 Sheridan Rd.
> Evanston IL 60208
> tel: (847)491-3686
> FAX: (847)491-9982

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Wednesday, February 17, 2010 11:59 AM
To: mario.perez@nasa.gov
Cc: Pantaleo, John
Subject: Helium 3

Mario,

We are the company handling the sale of Department of Energy Helium 3 for United States Research requirements. One of our accounts is Leiden Cryogenics and they are building a Dilution refrigerator for a Dr. Ben Mazin at the University of California Santa Barbara under a NASA grant or contract. The contract number is 08-APRA08-0051 and they list you as the contact person at NASA. John Pantaleo of the Department of Energy and I need to know which government agency is actually funding the project before we can make a decision on supply of the Helium 3. Can you help us with this information?

Regards,

Jack

Jack M. Faught
Head of Isotope Products

Linde Electronics and Specialty Gases

A Division of Linde Gas North America, LLC
Telephone: 908-454-7455, ext. 5253
Cell phone: 908-347-1090
Fax: 908-213-0641

Clenney, Jaclyn

From:	Jack Faught [JackF@spectragases.com]
Sent:	Wednesday, February 17, 2010 12:16 PM
To:	eric.p.smith@hq.nasa.gov
Cc:	Pantaleo, John
Subject:	Jet Propulsion Labs re: Helium 3

Eric,

I got your name from Dr Peter Day at the Jet Propulsion Laboratory. The Company I work for is handling the sale of helium 3 gas in conjunction with the Department of Energy and we are trying to verify the source of funding for a project at the Jet Propulsion Laboratory. Our customer is Leiden Cryogenics and they are building a dilution refrigerator which requires helium 3 gas to operate. The refrigerator is to be supplied to Dr. Day's group at Jet Propulsion Labs. Is this project funded directly by NASA or is it funded by a different government agency? Leiden claims they need 35 liters of gas which is a significant quantity. As the product is in short supply we need your help to confirm the need.

Regards,

Jack

Jack M. Faught
Head of Isotope Products

Linde Electronics and Specialty Gases

A Division of Linde Gas North America, LLC
Telephone: 908-454-7455, ext. 5253
Cell phone: 908-347-1090
Fax: 908-213-0641

Clenney, Jaclyn

From: Jack Faught [JackF@spectragases.com]
Sent: Tuesday, February 23, 2010 12:44 PM
To: Pantaleo, John
Subject: 2010 allocations and pricing

John,

I want to put into perspective the issues as I see them that are applicable to the process of how to handle the 2010 allocations. The process we followed last year was cumbersome, costly, wasteful, and put my Company at significant financial risk. We simply cannot proceed with that process. Here is what I propose and why I propose it:

Currently we are holding several thousand liters of helium 3 for the DHS, and others. We processed this material last summer with the idea that it would quickly be directed for shipment to the neutron detector manufactures that the DHS, NNSA, and others wanted to use for their security projects. Additionally the DHS was to handle disposal of the empty source gas cylinders when they were empty, and here we sit almost a year after they were emptied and we have not had any movement on the part of the DHS to take responsibility for the disposal of the radioactive cylinders and we are holding about half of the product in storage for potential use with that liability (risk of loss of product due to such things as fire, sabotage, or unexpected leaks) hanging over our heads. The product if lost cannot be replaced and we would be expected to reimburse the DHS some unknown amount of money.

I propose that we purchase all of the product from the DOE and sell it to the customers that the Working Group has approved. I propose that we would sell all 12,000 liters at a price of $350 per liter (based on a $90 purchase price) to all customers regardless of application. This would create a level playing field in the market for all government approved customers/applications, and would define Linde's level of risk. Linde would purchase and dispose of the contaminated source cylinders. Linde would handle all customer requests and report back to the Working Group with the pertinent information behind each request for the Working Group to consider. Linde would keep records on the disbursement of all product and assume all liability with respect to the transactions.

The price of $350 per liter is consistent with the market price prior to the Government controlled allocation program and prior to the Russians significant decrease in supply. Linde has annual operating costs (at a $90 per liter purchase price) in excess of $3 million.

Linde adds significant value to the process. We have the only validated helium 3 purification process in the world. We have validation data on the entire process to chemically purify including tritium remediation, and we have validated the product to be safe for human medical studies. Additionally we have the only cGMP helium 3 process in the world today to supply product for the COPD clinical studies. Our ISO program also includes our processes and procedures to supply helium 3 gas to all other applications. We currently process not only all of the DOE gas to these standards, but we also process (purify) the Russian product to the same standards. These are extremely important factors to consider because the helium 3 gas is the critical component in all of the research and the neutron detectors. If you introduce a new lab to process the product they will not have any validated processes and you risk jeopardizing the security systems, the energy exploration systems, missile guidance systems, as well as patient safety in clinical studies, and the performance of the dilution refrigerators used in low temperature work. We have been at the center of all of these markets for over a decade as the primary supplier.

Jack

Jack M. Faught
Head of Isotope Products

Linde Electronics and Specialty Gases

A Division of Linde Gas North America, LLC
Telephone: 908-454-7455, ext. 5253
Cell phone: 908-347-1090
Fax: 908-213-0641

Linkins, Venus <CTR>

From: Muenchau, Ernest [Ernest.Muenchau@dhs.gov]
Sent: Thursday, March 04, 2010 5:41 PM
To: Hagan, William K; Vandervort, Adam
Subject: FW: Staffer with the House Science & Technology Committee

Just a heads up to let you know that Doug Pasternak is asking questions about He3 supply and demand.

Seems reasonable to me.

ernie

From: Slovik, Gregory
Sent: Thursday, March 04, 2010 5:32 PM
To: Muenchau, Ernest
Cc: Slovik, Gregory
Subject: Staffer with the House Science & Technology Committee

FYI

Gregory C. Slovik, P.E., DHSPM
PADD Technical Director
Production Acquisition and Deployment Directorate (PADD)
Domestic Nuclear Detection Office (DNDO)

Office: 202-254-7222
BB: 202-746-0373

From: prvs=672fab7d6=Julie_A._Bentz@who.eop.gov [mailto:prvs=672fab7d6=Julie_A._Bentz@who.eop.gov]
On Behalf Of Bentz, Julie A.
Sent: Thursday, March 04, 2010 5:12 PM
To: Pantaleo, John
Cc: Glaser, Joseph; Slovik, Gregory; Founds, Nanette; Gowadia, Huban A SES OSD ATL; Gillo, Jehanne; Dimeo, Robert M.; Fetter, Steven A.; Taylor, Tammy P.; DL-NSC-Legislative Affairs
Subject: RE: He-3 shipment update

Thanks for the update, John! I'm looping in Rob Dimeo to complete the Fed's who need to direct these shipments. I'm also cc'ing some folks in EOP for their situational awareness on the Congressional query.

Thanks!
Julie Bentz
202-456-2289

From: Pantaleo, John [mailto:John.Pantaleo@science.doe.gov]
Sent: Thursday, March 04, 2010 4:50 PM
To: Bentz, Julie A.
Cc: Glaser, Joseph; Pantaleo, John; Slovik, Gregory; Founds, Nanette; Gowadia, Huban A SES OSD ATL; Gillo, Jehanne
Subject: He-3 shipment update

Julie,

The Authorization Proforma has been sent to SRNL to release the raw He-3. SRNL will be shipping six helium-3 cylinders totaling 20,864 liters (~ 20,000 liters of clean He-3) to Linde Electronics and Specialty Gases, Newark, NJ 07104, on March 11,2010. After one day of unloading and weighting Linde will start processing the material. It is a continues process by cylinder and in about four weeks ~4,000 clean gas will be available for shipment then followed each week by another ~4,000 liters. No shipment will be made until directed by each Federal agency's POC. Non-federal agency sales will be authorized by the IP. The balance of ~8,243 liters will be held for future use as directed by IP.

Once the six cylinders have shipped, SRS will have about 18,800 liters ready to ship plus five old cylinders (with no current sample analysis potentially totaling 15,000 liters) remaining to repackage.

Also, Jack Faught has brought to my attention that he was contacted by Douglas Pasternak, a staffer with the House Science & Technology Committee. They are looking into issues regarding the supply shortages of He-3 gas and the impact this shortage has had on commercial industries, academic and scientific research initiatives, technological development and various federal programs. Douglas Pasternak told Jack Faught that he is trying to get a handle on how industries and individuals have been directly affected, if at all, by the supply shortages of He-3 in recent months and how they are dealing with the limited supply of He-3 gas currently available.

Douglas Pasternak also contacted Jim Wild a Professor of Magnetic Resonance Physics at Sheffield University, England. Jim Wild is a member of the European Philinet group that is studying COPD diseases and they all collaborate with the groups that sent in the letters of support for Robarts.

More to follow!

Regards

John Pantaleo

From: Ely, James H
To: Eugene Yamamoto;
Subject: RE: PNNL publications on neutron detection technologies
Date: Friday, March 05, 2010 1:41:00 PM

Hi Eugene,
Nice to hear from you. Things are going well – keeping busy and spring is starting to arrive – so nicer weather.

We have been doing some work here at PNNL looking at alternatives to He-3 for neutron detection. The work I'm involved in is mostly testing commercial neutron detector technologies to see if they would work in the same footprint as the currently deployed radiation portals. They all detect neutrons, but some are less capable than others, so challenging to get the required efficiency and fit in the same panel. It's possible to make a bigger panel, but would be nice if the design didn't have to change.

The technologies we have looked at (only commercial systems we could find that seemed like they might work) are BF3, boron-lined proportional counters, Li6 ZnS coated wave-length shifting fibers (coated fibers), and scintillating glass fibers. They all appear to be capable of meeting the current (PVT-based) portal requirements in the footprint. The BF3 and B-lined have good gamma discrimination, the coated fibers are not bad (use pulse shape discrimination), but the glass fibers are fairly gamma sensitive, and so are challenged in the gamma discrimination.

The BF3 will work fine – but need about 3 tubes (same size) to replace a single He-3 – primarily since they only put in about an atmosphere of BF3 (higher pressures require much higher voltages). Also a hazardous gas, so less attractive. The boron-lined tubes are less sensitive than the BF3 – since the boron is only on the surface (and has to be thin to get the products into the tube itself). So need a lot more tubes or ways to increase the surface area. GE Reuter-Stokes has been building neutron modules which we have been testing – so don't know exactly what they are doing inside, but guessing a lot of tubes. The latest proto-type can meet the sensitivity requirements in the same size and can discriminate gammas. The coated fiber technology is interesting – quite good detection capability per unit area --and just about meet the requirements – so the next version will likely be good. The pulse shape discrimination is not bad either.

So think there are 3 candidates that (at least very soon) will meet the basic requirements – we haven't done any environmental tests yet. Most people think the coated fibers and B-lined are leading, since the BF3 is hazardous. For the 4th technology, the glass fiber vendor is working on the gamma discrimination issue – and may be OK in the near future. There are a number of other things on the horizon, but may be another year or so before they are commercially available.

I think that the 3 candidates are worth looking into for CMS – but since the space is even more limited, there might be additional challenges to get the sensitivity out in a small package (the portals have a quite a large moderator box). The coated fibers (as you may know) were used in the other CMS system tested at Tacoma, and worked well, so certainly a possibility.

Hope this helps, let me know if you have questions.

Thanks, James

(509)-376-0115

From: Eugene Yamamoto [mailto:eugene.yamamoto@veritainer.com]
Sent: Friday, March 05, 2010 11:56 AM
To: Ely, James H
Cc: 'Eugene Yamamoto'
Subject: PNNL publications on neutron detection technologies

Hey James,
I hope you're doing well. I just read an interesting series of publications regarding testing done at PNNL with neutron detection technologies. Since you're a co-author, I was wondering if you would be willing to share your thoughts on the various technologies. My take-away from the publications was that B-lined proportional counter technology was/is the leading candidate for a drop-in replacement to He3, at least in RPMs. Does that sound right?
Also, there was the usual hedging in the publications with regards to the efficacy of the various technologies once they were scaled up, but do you have any intuition as to how well these technologies would scale and do you have any opinions on what would be suitable for CMS?
Thanks!
-Eugene

--
Eugene Yamamoto
VeriTainer Corp.
48017 Fremont Blvd.
Fremont, CA 94538

○