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Up in the Air: The BLM's Disappearing Helium Program

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Good morning, Mr. Chairman and members of the Committee. My name is Charles Groat. I am Director of the Energy and Earth Resources Graduate Program and Professor in the Jackson School of Geosciences and a Professor in the LBJ School of Public Affairs at the University of Texas at Austin. My name is Robert Richardson. I am the F.R. Newman Professor of Physics at Cornell University. We are co-chairs of the National Research Council's Committee on Understanding the Impact of Selling the Helium Reserve.[1]

The study we will be discussing was commissioned by the Department of the Interior's Bureau of Land Management (BLM) and the principal task of our committee was to determine whether the sell-off of the nation's helium reserve as prescribed by law has had an adverse effect on the United States' scientific, technical, biomedical, and national security users of helium. Our committee concluded that the sell-off has had and will continue to have adverse effects and we developed a series of recommendations to address several outstanding issues with respect to the reserve.

To provide context for those recommendations, we will first give a brief overview of our critical helium needs, with a focus on the plight of the small research user community, and also discuss those uses where substitutes or conservation and recycling are possible. We will follow this with a discussion on helium supply issues, the federal helium reserve itself and the sale of federally owned helium. Our testimony will conclude with a discussion of our major recommendations regarding the reserve and its management in the future.

Uses of Helium

Ready access to affordable helium is critical to many sectors in academe, industry and government and the range of those uses is quite impressive, enabling research at the coldest of temperatures, weather monitoring, surveillance in areas of combat, and optical fiber production, among many other applications.

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[1] The National Research Council is the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology.

The diversity in uses for helium arises from its unique physical and chemical characteristics—specifically, its stable electronic configuration and low atomic mass. Among those unique characteristics are the temperatures at which helium undergoes phase transitions (liquefies and freezes). Helium has the lowest melting and boiling points of any element: It liquefies at 4.2 Kelvin and 1 atmosphere and solidifies only at extremely high pressures (25 atmospheres) and low temperatures (0.95 Kelvin). These characteristics have led to many cryogenic applications for helium; the largest single category of applications by percentage of helium consumed. These range from the efforts of individuals engaged in small-scale cryogenic research to large groups using high-energy accelerators and high-field magnets. All rely upon helium to conduct their research and because the federal government supports many of these researchers, it has a direct stake in their continued success. Cryogenic users also include segments of the medical profession, not only for biological research in devices such as superconducting quantum interference devices (SQUIDS), but also for diagnosis with tools such as magnetic resonance imaging (MRI) devices.

Helium's ability to remain liquid at extremely low temperatures also gives rise to its usage for purging and pressurizing systems and as such, helium is a critical component in our nation's space exploration and defense efforts. The National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD) use significant amounts of helium, as it is the only gas that can be used to purge and pressurize the tanks and propulsion systems for rockets fueled by liquid hydrogen and oxygen.

Other uses rely on helium's lifting capabilities. As the second lightest element, gaseous helium is much lighter than air, causing it to be quite buoyant. When combined with helium's chemical inertness—especially when compared with the highly flammable alternative, hydrogen—its buoyancy makes helium an ideal lifting gas. NASA and the Department of Energy (DOE) use helium to support weather-related missions and various research and development programs funded by these agencies, both at government facilities and at universities. DOD also must have ready access to helium to operate the balloon- and dirigible-based surveillance systems needed for national security.

Other applications draw on other characteristics of helium—its relatively high thermal conductivity, low viscosity, and high ionization potential—either alone or in combination. These applications include welding, providing controlled atmospheres for manufacturing operations, and detecting leaks in equipment providing vacuum environments to science and industry. Table 1 summarizes the principal applications of helium and the share of use in the United States.

Small-Scale Researchers. Among the events that triggered this study were soaring prices and limited supplies that characterized the refined helium market in the fall of both 2006 and 2007. The committee, composed of individuals from a wide range of professions—economists, business people, and scientists—noted that small-scale scientists were particularly hard hit by price shocks and interruptions in the supply of refined helium during that time. An informal poll conducted by committee members of approximately 40 research programs at universities and national laboratories that use helium indicated that shortages of liquid helium interrupted the helium supply for almost half of these programs, with some interruptions lasting for weeks at a time during the late

summer and fall of both 2006 and 2007. For many of those scientists, losing access to helium, even temporarily, can have long-term negative repercussions for their research.

In general, the federal grant programs that support these researchers simply are not designed to cope with significant pricing shifts and other market volatilities experienced here. Grants typically are for a two to three year period and for a set amount that does not adjust if a principal expense of research such as helium significantly increases. Further, the relatively short duration of such grants, with no guaranty of renewal, effectively precludes these research programs from entering into long-term contracts that might at least partially reduce the risk of significant prices increases and shortages.

Domestic vs. foreign consumption. The balance between domestic and foreign consumption of helium has shifted significantly in the past 15 years. Until the mid-1990s, substantially all helium production took place in the United States. This factor, combined with high shipping costs and limited availabilities, meant that until recently, the amount of helium consumed abroad was fairly small. In 1990, for example, 70 percent of worldwide helium consumption was in the United States.

Since 2000, the demand for helium in the United States has remained fairly constant but has grown significantly elsewhere, reducing the U.S. share of total consumption. See Figure 1. Foreign growth has been assisted by the opening of several helium-producing facilities outside the United States that will be discussed later in this testimony, as well as by improved capabilities in the short-term storage and handling of refined helium. This period also saw a significant increase in industrial applications, principally in semiconductor and optical fiber fabrication facilities outside the United States, and the shifting of industrial facilities that use helium from the United States to foreign countries. By 2007, United States helium consumption had dropped to below 50 percent of worldwide demand. Despite a slight downturn in overall demand for helium associated with the global recession in 2008-2009, the committee believes, based on recent trends, that foreign demand should continue to increase relative to demand in the United States, such that U.S. relative consumption is expected to drop even further by 2012, to slightly more than 40 percent.

Substitution, Conservation, Recovery. For some applications, other gases can replace helium, but other applications rely critically on helium's unique properties and there are no alternatives. Applications in the first category, where substitutes for helium might exist, include these:

- *Lifting*. For these uses, where low density is the only requirement, hydrogen is sometimes substituted if safety concerns can be met.

- *Welding.* Here, chemical inertness is the key property. For processes such as gas tungsten arc welding—a critical process applicable to reactive metals such as stainless steel, titanium, aluminum, and others in high-value, high-reliability applications—Europe mostly uses argon, while the United States uses helium.

- *Semiconductor and fiber optics manufacturing*. In these

applications, high thermal conductivity is the important property. Often, hydrogen may be substituted.

In the above applications, economics, market conditions, availability, safety, and legislation can influence the choice among helium and other gases.

In contrast, other applications require the unique properties of helium, typically relying on the extremely low boiling point of liquid helium to achieve a desired result. These applications include the following:

- *Purging/Pressurizing*. Entities such as NASA and DOD must purge and then pressurize liquid hydrogen (LH_2) and liquid oxygen (LOx) rocket propulsion systems and fuel tanks that may be at liquid air temperatures or colder. Although gaseous hydrogen might have the right physical properties for use in LOx systems, its reactivity with oxygen precludes its use. Nitrogen is not desirable because nitrogen might contaminate the LOx. In LH_2 environments, all gases other than helium and hydrogen would freeze, clogging fuel lines and systems and rendering the rocket engines nonfunctional.

- *Superconductivity*. All applications that employ superconducting magnets, including medical magnetic resonance imaging (MRI) machines, high energy accelerators and many high field magnets used in research, rely on the continued availability of helium. Current materials and technologies dictate that only helium can act as the crucial refrigerant to cool these materials below superconducting thresholds.

- *Basic research*. Here, no other substance can be used as a refrigerant to achieve temperatures from 4.2 K above absolute zero down to millikelvins.

Supply of Helium

Sources. Helium is the second-most-abundant element in the universe, but its diffusive properties mean that atmospheric helium leaks into space, rendering it relatively scarce on Earth. At only 5.2 parts per million (ppm) in air, it is not economically feasible to extract helium from the atmosphere using current technology. Rather, the principal source of helium is natural gas fields. Helium nuclei (or alpha particles) are produced in the radioactive decay of heavy elements such as uranium and thorium, located in Earth's crust. While most of these helium atoms find their way to the surface and escape, a small fraction are trapped by the same impermeable rock strata that trap natural gas. Such natural gas usually consists primarily of methane and secondarily of ethane, propane, butane, and other hydrocarbons and various other contaminants, including H_2S, CO_2, and He.

There are three different situations in which helium contained in natural gas may be economically recovered:

- Helium may be extracted as a secondary product during the primary process of producing methane and natural gas liquids (NGLs) such as propane, ethane, butane, and benzene.
- For natural gas fields that have sufficient concentrations of helium and other non-fuel gases such as sulfur and CO_2 to economically justify their extraction, the gas in those fields may be directly processed for the non-fuel constituents.
- Helium may be extracted during the production of liquefied natural gas (LNG), which consists primarily of liquefied methane.

For the first two recovery processes, current technology requires threshold concentrations of 0.3 percent helium before separation of the helium is commercially feasible. For the third process, the helium is extracted from the tail gases, the gases that remain after the methane has been liquefied. The helium concentration in those tail gases is much higher than in the original gas, allowing the economical extraction of helium even through the original natural gas might contain as little as 0.04 percent helium.

Figure 2 shows the principal domestic sources of helium. Historically, most helium in the United States has been recovered using the first method described above, as a byproduct of producing methane and natural gas liquids. Almost all of that helium has been produced in the mid-continental region around the Hugoton Field. As is described in later testimony, this is where the federal helium reserve system is located. The Hugoton Field is mature and the production of methane, NGL and secondary products such as helium from that field is expected to significantly decline over the next several years. In the last few decades, helium has been produced in Wyoming using the second method described above, where the natural gas is directly processed for its helium and other non-fuel content. Potential helium reserves have also been explored in the Four Corners area.

Outside of the United States, only small reserves of the first two sources of helium have been exploited and for many years, the rest of the world has relied upon the United States as their principal source of helium. Recently, the development of large LNG facilities has opened up new, potential sources of helium. The principal countries in which those facilities are being developed are Algeria, Qatar, and Russia, with smaller facilities coming online in Australia. These areas are expected to become increasingly more important sources of helium as the Hugoton and adjoining fields mature. See Figure 3.

Supply Chain. After being refined, helium is transported to end users through a fairly complicated supply chain. In the United States, the helium typically is liquefied and delivered by refiners either to their transfill stations situated throughout the United States or to distributors of industrial gases. This transportation is handled using expensive domestic tanker trucks or bulk-liquid shipping containers standardized according to the International Organization for Standardization (ISO), each of which holds approximately 1.0 to 1.4 million cubic feet (MMcf) of helium. While some of the largest helium users contract directly with a refiner for their helium purchases and deliveries, most sales to end users are through the retail division of a refiner or a distributor. The refiners and distributors then repackage the helium, either in its liquid state into dewars—evacuated, multiwalled containers designed to hold liquid helium—of varying sizes or in its gaseous

state into pressurized cylinders, tube-trailers, or other modules as needed by the end users.

Federal Policy Regarding Helium

Helium has long been the subject of public policy deliberation and management, largely because of its many strategic uses and its unusual source. Shortly after natural gas fields containing helium were discovered at the beginning of the last century, the U.S. government recognized helium's potential importance to the nation's interests and placed its production and availability from federally owned mineral interests under strict governmental control. In the early years, helium principally was used for its lifting capability, as a safe alternative to highly flammable hydrogen. By the mid-1920s full-scale production facilities had been built and were being operated by the federal government to support its lighter-than-air aviation programs.

In the 1960s, helium's strategic value in cold war efforts was reflected in policies that resulted in the creation of the federal helium reserve. Although much of the infrastructure predates the cold war, the Federal Helium Reserve as a program began and currently consists of

- The Bush Dome reservoir, a naturally occurring underground structural dome in the Cliffside Field near Amarillo, Texas, where federally owned (and some privately owned) crude helium is stored;
- An extensive helium pipeline system running through Kansas, Oklahoma, and Texas (the Helium Pipeline) that connects crude helium extraction plants with each other, with helium refining facilities, and with the Bush Dome reservoir,
- Various wells, pumps and related equipment used to pressurize the Bush Dome reservoir, to place into and withdraw crude helium from it, and to operate other parts of the helium reserve.

The 1960s efforts also included inducements for private companies to develop helium extraction and refining facilities and to sell crude helium to the United States. The program was quite successful, resulting in the accumulation of approximately 35 billion cubic feet (Bcf) of helium by the mid 1970s. This amount was many times the 600 (750) million cubic feet (MMcf) of helium then being consumed domestically (globally) and so further purchases were suspended. The amount of helium maintained in the helium reserve remained fairly constant for the next 20 years.

The latest manifestation of public policy is expressed in the Helium Privatization Act of 1996 (1996 Act), which directs that substantially all of the helium accumulated as a result of those earlier policies be sold off by the year 2015, at prices sufficient to repay the federal government for its outlays associated with the helium program, plus interest.

Context of Current Study. The last section of the 1996 Act called for the Secretary of the Interior to commission a study from the National Academies to determine whether disposal of federally owned helium pursuant to the 1996 Act would have a substantial adverse effect on critical interests of the country. The report that followed (2000 Report) found that because the helium market had been quite stable since

the 1980s and the price at which federally owned helium must be sold under the 1996 Act was significantly higher than the price at which privately owned crude helium was then being sold, the sell off of the helium would not have a substantial adverse effect on critical users. The report predicted that the price of privately owned crude would gradually rise to the price at which federally owned helium was being offered, and until it reached that level very little federally owned helium would be purchased, given the availability of cheaper sources.

While the helium market remained fairly stable for several years after issuance of the 2000 Report, that report did not accurately predict the market's response to efforts to sell-off federally owned helium. In March 2003, when BLM first offered federally owned helium for sale, the entire 1.6 Bcf offered for sale was purchased. Rather than gradually rising, the prices for privately owned crude helium rapidly rose such that by 2007, those prices were on par with and often exceeded the legislatively prescribed price for federally owned helium. Retail prices for helium commensurably rose, more than doubling between 2003 and 2008. In addition, during the summer and fall of 2006 and 2007, the helium market encountered widespread shortfalls, with some of the interruptions lasting for weeks at a time.

The amount of federally owned helium being sold is enormous: it is currently equivalent to approximately one-half of U.S. helium needs and almost one-third of global demand. One consequence is that the price of federally owned helium, which is set not by current market conditions but by the terms of the 1996 Act, dominates, if not actually controls, the price for crude helium worldwide.

Committee Findings, Recommendations. As mentioned at the beginning of this testimony, the principal charge of our committee was to determine whether the sell-off of the nation's helium reserve as prescribed by law has had an adverse effect on the United States' scientific, technical, biomedical, and national security users of helium. In response to this charge, the committee determined that selling off the helium reserve, as required by the 1996 Act, has adversely affected critical users of helium and is not in the best interest of U.S. taxpayers or the country. The sell-down of federally owned helium, which had originally been purchased to meet the nation's critical needs, is coming at a time when demand for helium by critical and noncritical users has been significantly increasing, especially in foreign markets. If this path continues to be followed, within the next ten to fifteen years the United States will become a net importer of helium whose principal foreign sources of helium will be in the Middle East and Russia.

In addition, the pricing mandated by the 1996 Act has triggered significant increases in the price of crude helium, accompanied by equally significant increases in the prices paid by end users. Finally, the helium withdrawal schedule mandated by the 1996 Act is not an efficient or responsible reservoir management plan. If the reserve continues to be so managed, a national, essentially nonrenewable resource of increasing importance to research, industry, and national security will be dissipated.

The committee recommends several ways to address the outstanding issues. Several of its recommendations respond to the very large impact that selling off the reserve has had and is continuing to have on the helium market in general, including a

recommendation that procedures be put in place that open the price of federally owned helium to the market.

Another of the committee's concerns is that the drawdown schedule required by the 1996 Act, which dictates that the reserve helium be sold on a straight-line basis—the same amount must be sold each year until the reserve is substantially gone—is a wasteful way to draw down a reservoir. Because it is much more costly and more likely to leave significant amounts of helium unrecoverable than alternative drawdown scenarios, the committee recommends that this portion of the 1996 Act be revisited. In addition, given recent developments in the demand for and sources of helium (the principal new sources of helium will be in the Middle East and Russia, and if the sell-down continues, the United States will become a net importer of helium in the next 10 to 15 years), the committee recommends that Congress reconsider whether selling off substantially all federally owned helium is still in the nation's best interest.

The committee also addresses the needs of small-scale government-funded researchers who use helium, a group that has been hit particularly hard by sharp price rises and shortages that have characterized the helium market in recent times. This group was singled out mainly because such research is an important public enterprise and the funding mechanisms available to the researchers, typically grants on 3-year cycles for set amounts, do not allow them to respond to short-term fluctuations. These research programs should have some protection from the instabilities recently characterizing the helium market. Accordingly, the committee recommends that the researchers be allowed to participate in an existing program for government users of helium that would give them priority when there is a helium shortage. It also recommends that funding agencies help such researchers to acquire equipment that would reduce their net helium requirements. Implementing these recommendations would not subsidize such users nor would it require significant additional outlays: Indeed, over time, it would lead to the much more efficient use of the federal funds with which helium is purchased.

Because the helium market is rapidly changing and helium is critically important to many critical users, the committee includes recommendations that would facilitate long-range planning to meet the nation's helium needs, including the collection and dissemination of needed information and the formation of a standing committee to regularly assess whether national needs are being appropriately met. The remaining conclusions and recommendations consist of steps to help properly manage the helium reserve and protect this important national resource. The language of the committee's full recommendations is contained in the summary of the report, which is attached to this statement.

Finally, while noting that the question of how critical helium users in the United States will be assured a stable supply of helium in the future is beyond the scope of its charge, the committee points out that several important issues related to this topic remain unanswered. How will the large amounts of federally owned helium that remain after the mandated sell-off deadline in 2015 be managed after that date? Moreover, from a wider perspective, should a strategic helium reserve be maintained? These questions need to be answered in the near future, well before most federally owned helium is sold.

This concludes our testimony to the committee. Thank you for the opportunity to testify on this important topic. We would be happy to elaborate on any of our comments during the question and answer period.

ATTACHMENTS –

TABLE 1 Helium Uses in the United States

Category	Representative Application	U.S. Share (%)
Cryogenics		28
	Magnetic resonance imagining	
	Fundamental science	
	Industrial cryogenic processing	
Pressurize/purge		26
	Space and defense rocket purging and pressurizing	
Welding		20
Controlled Atmospheres		13
	Optical fiber manufacturing	
	Semiconductor manufacturing	
Chromatography/ lifting gas/heat transfer		7
	Chromatography	
	Weather balloons	
	Military reconnaissance	
	Heat transfer in next-generation nuclear reactors	
	Party balloons	
Leak detection		4
Breathing mixtures	Commercial diving	2

SOURCE: USGS, 2007. These data are extrapolated from data in a USGS survey conducted by BLM personnel in 2003. Current shares are not known precisely but are expected to be approximately as shown.

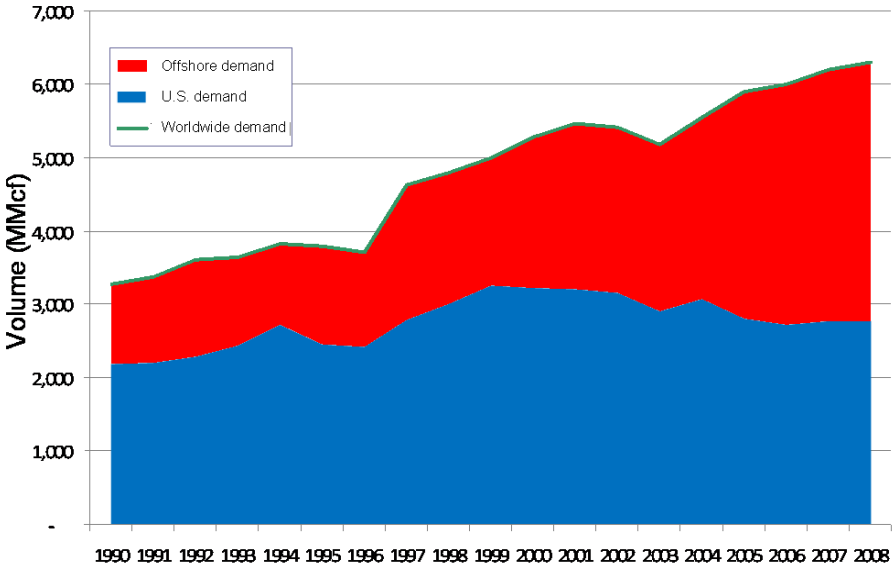

FIGURE 1. Market demand for refined helium in the United States (blue), in other countries (red), and worldwide (green line) for the years 1990 through 2008. SOURCE: U.S. Geological Survey 1990-2008 Minerals Yearbook (Helium).

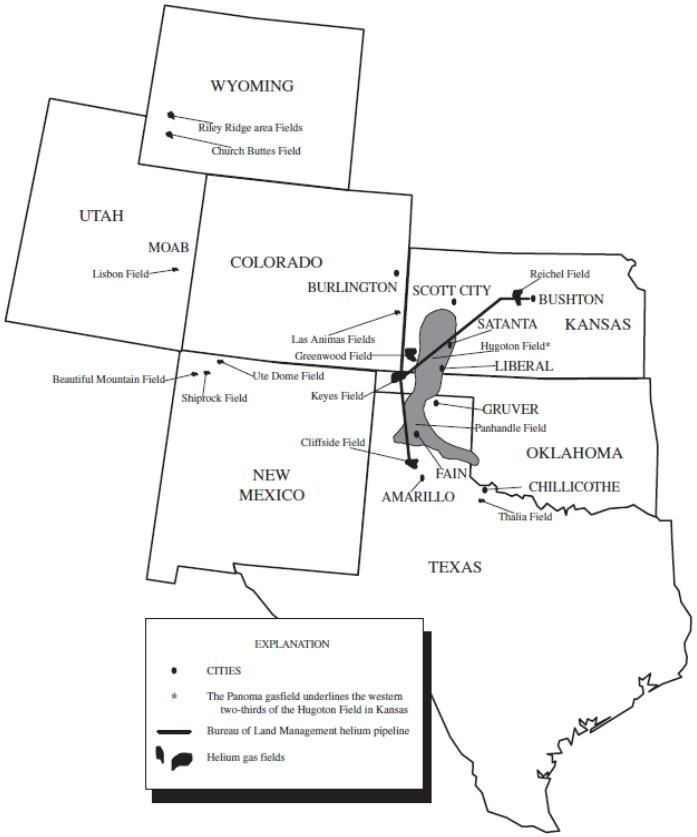

Figure 2.The United States crude helium supply system. Historically, the Hugoton and surrounding fields have been the principal sources of helium. Recently, natural gas fields in Wyoming with rich helium and other non-fuel content have become an increasingly important supply of helium, while potential new fields are located in the Four Corners area. SOURCE: U.S. Geological Survey 2006 Minerals Yearbook (Helium).

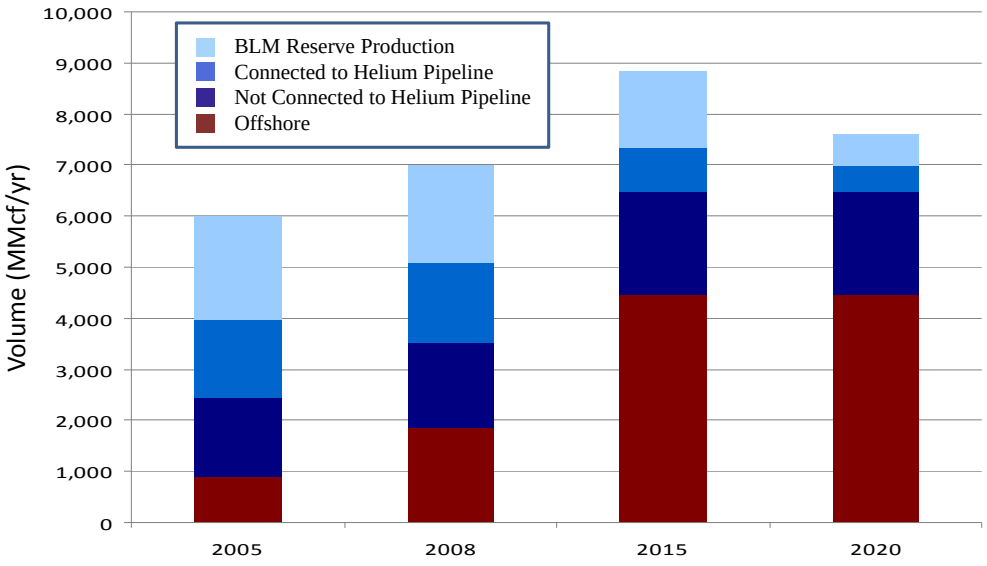

FIGURE 3. Actual (2005 and 2008) and estimated (2015 and 2020) crude helium capacities by crude helium source. Light blue represents helium available through the sell-off of the federal helium reserve; medium blue represents crude helium being produced from neighboring natural gas fields such as the Hugoton Field by those refining facilities connected to the helium pipeline; dark blue are domestic helium sources, principally in Wyoming, not connected to the helium pipeline; brown are foreign sources of helium.

Summary from *Selling the Nation's Helium Reserve*
A Report of the National Research Council

Ready access to affordable helium is critical to many sectors in academe, industry and government. Many scientists—from individuals engaged in small-scale cryogenic research to large groups using high-energy accelerators and high-field magnets— rely upon helium to conduct their research and because the federal government supports many of these researchers, it has a direct stake in their continued success. The medical profession also depends on helium, not only for biological research in devices such as superconducting quantum interference devices (SQUIDS), but also for diagnosis with tools such as magnetic resonance imaging (MRI) devices. Industrial applications for helium range from specialty welding to providing the environments in which semiconductor components and optical fiber are produced. Government agencies that require helium include the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD), as only helium can be used to purge and pressurize the tanks and propulsion systems for NASA and DOD's rockets fueled by liquid hydrogen and oxygen. NASA and the Department of Energy (DOE) also use helium to support weather-related missions and various research and development programs funded by these agencies, both at government facilities and at universities. Finally, DOD must have ready access to helium to operate the balloon- and dirigible-based surveillance systems needed for national security.

The Federal Helium Reserve, managed by the Bureau of Land Management (BLM) of the U.S. Department of the Interior, is the only significant long-term storage facility for crude helium in the world and currently plays a critical role in satisfying not only our nation's helium needs but also the needs of the world. The federally owned crude helium now on deposit in the Reserve was purchased by the federal government as a strategic resource during the cold war. After the cold war, Congress enacted legislation (the Helium Privatization Act of 1996 referred to hereinafter as the 1996 Act) directing that substantially all of the federally owned helium in the Reserve be sold at prices sufficient to repay the federal government's outlays for the helium and the infrastructure, plus interest. The present report, called for by BLM, examines whether BLM's selling of this helium in the manner prescribed by law is having an adverse effect on U.S. users of helium and, if so, what steps should be taken to mitigate the harm.[2]

This report assesses the current status of the supply and demand for helium as well as the operation of the federal helium program. It concludes that current efforts to comply with legislative prescriptions have had and will continue to have negative impacts on the needs of both current and future users of helium in the United States. The sell-down of federally owned helium, which had originally been purchased to meet the

[2] As discussed more fully in the section of Chapter 1 entitled "Review of the 2000 Report's Conclusions," the 1996 Act called for an Academy study to determine if such disposal would have a substantial adverse effect on U.S. interests. That study, The Impact of Selling the Federal Helium Reserve, published by the NRC in 2000 and referred to hereinafter as the 2000 Report, concluded that the 1996 Act would not substantially affect matters. While several of that study's findings remain valid, it did not correctly predict how the 1996 Act would impact prices or how the demand side of the helium market would grow, in part a response to the ready availability of helium arising from the sell-off of the Helium Reserve pursuant to the 1996 Act. These factors have significantly impacted the current market for helium.

nation's critical needs, is coming at a time when demand for helium by critical and noncritical users has been significantly increasing, especially in foreign markets. *If this path continues to be followed, within the next ten to fifteen years the United States will become a net importer of helium whose principal foreign sources of helium will be in the Middle East and Russia.* In addition, the pricing mandated by the 1996 Act has triggered significant increases in the price of crude helium, accompanied by equally significant increases in the prices paid by end users. Finally, the helium withdrawal schedule mandated by the 1996 Act is not an efficient or responsible reservoir management plan. If the reserve continues to be so managed, a national, essentially nonrenewable resource of increasing importance to research, industry, and national security will be dissipated.

FINDINGS AND RECOMMENDATIONS
Specific Recommendations for Immediate Improvements

To address these issues, the committee first lays out three specific recommendations for improving the federal helium program: changing the methods for pricing the helium being sold, committing more resources to managing the physical facilities at the Federal Helium Reserve, and providing assistance for small-scale scientists by expanding the sales program for government users to include them and promoting conservation and reuse by these users.

Pricing Mechanism

The 1996 Act set minimum selling prices, adjusted for inflation, for crude helium held by the BLM such that the sale of that helium at those prices would generate sufficient revenue to repay the federal government for what it originally spent to purchase the helium and to build the supporting infrastructure, plus interest. BLM has elected to sell its helium at those minimum prices. At the time of the 1996 Act, the minimum selling price was almost double the price being paid for privately owned crude helium. A market that had been stable for several decades prior to the sell-off of federally owned helium, experiencing neither drastic price increases nor shortages of supply,[3] began to change after BLM started to sell its crude helium. Almost immediately, privately sourced crude helium prices began to rise, and those prices continued to steadily increase so that they now meet or exceed BLM's price, and many of the sales contracts for private helium expressly tie future selling prices to BLM's price. Thus this legislatively set price for federally owned helium is now setting the price for crude helium, and there is no assurance that this price has any relationship to the current market value of that helium.

To the extent BLM's price is lower than the price the market would otherwise set for crude helium, this pricing mechanism could have several negative consequences: (1) it could lead to inaccurate market signals, increased consumption, and accelerated depletion of the Federal Helium Reserve; (2) it could retard efforts to conserve and develop alternative sources of crude helium, (3) it could result in transfers of taxpayer assets to private purchasers at below-market values—that is, it could amount to a taxpayer-financed subsidy for consumption of this scarce publicly owned resource; and (4) sales of federally owned crude helium could end up subsidizing exports of helium.

[3] 2000 Report, page 9.

The managers of the Reserve should shift to a market-based pricing policy to improve the exploitation of this important national asset. The report notes that several mechanisms could be used to implement market-based pricing and thereby introduce competition, or the threat of it, to the process. However, one complicating factor is that before federally owned helium can be used, it must be refined, and the refining capacity linked to the Reserve is owned by four companies. The committee believes that market-based pricing of crude helium from the Reserve will require that purchasers other than those four companies have access to refining capacity linked to the Reserve. However, additional details on mechanisms to provide access to excess refining capacity and to attain the goal of market-based pricing of crude helium from the Reserve are beyond the committee's charge.

> **Recommendation. The Bureau of Land Management (BLM) should adopt policies that open its crude helium sales to a broader array of buyers and make the process for establishing the selling price of crude helium from the Federal Helium Reserve more transparent. Such policies are likely to require that BLM negotiate with the companies owning helium refining facilities connected to the helium pipeline the conditions under which unused refining capacity at those facilities will be made available to all buyers of federally owned crude helium, thereby allowing them to process the crude helium they purchase into refined helium for commercial sale.**

Management of the Reserve

An additional aspect of the 1996 Act that has significant—and undesirable, in the judgment of this committee—implications for the overall management of the Helium Reserve is the Act's requirement that the sale of federally owned crude helium is to take place on a straight-line basis.[4] The mandated constant extraction rate conflicts with standard practices for the exploitation of this type of reservoir, which is that production rates vary over the economic life of a deposit, typically declining over time. Declining production rates and reservoir pressures delay encroachment of water from nearby aquifers and connected reservoirs, and promote the efficient drainage and recovery of the resource gas in place.

> **Recommendation. The BLM should develop and implement a long-term plan that incorporates appropriate technology and operating practices for delivering crude helium from the Reserve in the most cost-effective manner.**

Assistance for Small-Scale Researchers

[4] The law directs that crude helium from the reserve be offered for sale in such amounts as may be necessary to dispose of all helium in excess of 600,000,000 cubic feet on a straight-line basis between January 1, 2005 and January 1, 2015. Although BLM has offered helium for sale in the amounts required by the 1996 Act, not all such helium has been purchased and as a consequence significant amounts of federally owned helium will remain in the Federal Reserve after January 1, 2015. This is discussed in more detail in Chapter 5 in the section entitled "Sell-Down of Crude Helium Pursuant to 1996 Act."

Among the events that triggered this study were the soaring prices and limited supplies that characterized the refined helium market in the fall of both 2006 and 2007. The committee, composed of individuals from a wide range of professions—economists, business people, and scientists—notes that small-scale scientists were particularly hard hit by price shocks and interruptions in the supply of refined helium during that time. An informal poll conducted by committee members of approximately 40 research programs at universities and national laboratories that use helium indicated that shortages of liquid helium interrupted the helium supply for almost half of these programs, with some interruptions lasting for weeks at a time during the late summer and fall of both 2006 and 2007. While anecdotal, these poll results provide clear indication that this community of users is directly impacted by general shortages of helium. For many of those scientists, losing access to helium, even temporarily, can have long-term negative repercussions for their research.

In general, the federal grant programs that support these researchers simply are not designed to cope with the pricing shifts and other market volatilities experienced here. The grants typically are for a two to three year period and for a set amount that does not adjust if a principal expense of research such as helium significantly increases. Further, the relatively short duration of such grants, with no guaranty of renewal, effectively precludes these research programs from entering into long-term contracts that might at least partially reduce the risk of significant prices increases and shortages. Further, if BLM were to implement the market-based pricing mechanism recommended in this report, the retail price for helium may commensurably increase, which will have an even greater negative impact on those helium users.

These negative impacts could, however, be mitigated at least in part through a programmatic and policy change that would allow small users being supported by government contracts and grants to participate in a program—commonly referred to as the in-kind program[5]—operated by BLM for the sale of helium to federal agencies and their contracting agents. Under that program, qualified buyers purchase their refined helium indirectly from BLM on a cost-plus basis.[6] Notably, participants in the program have priority access to helium in times of shortages.[7] The committee believes that such an expansion of the in-kind program would eliminate supply concerns and many of the price fluctuations that have negatively affected federally funded researchers during the past few years. Further, such an extension would be without significant cost to the programs supporting these researchers and, indeed, should lead to a more efficient use of the federal funds being used to purchase helium.

> **Recommendation. The crude helium in-kind program and its associated customer priorities should be extended by the Bureau of Land Management, in cooperation with the main federal agencies not currently participating in the in-kind program—for example, the National Science Foundation, the National Institutes of Health, and the extramural grant programs of the**

[5] The in-kind program is discussed in more detail in Chapter 5 in the section entitled "'In-Kind' Program of Crude Helium Distribution."

[6] As discussed more fully in the section of chapter 5 entitled "In-Kind Program of Crude Helium Distribution" the price is negotiated between the supplier and user and includes BLM's cost of crude helium plus refining and transportation costs and profits for the refiner and distributor.

[7] 50 U.S.C.A Section 167d (a);

Department of Energy—to research being funded in whole or in part by government grants.

In addition to recommending that these users be allowed to participate in the in-kind program, the committee believes that the conservation and reuse of helium by these users should be promoted by the agencies funding this research. Although adopting such a policy may be costly in the short-run, the committee judges that it would save money in the long-run and would help to reduce many of the negative effects of the price and supply disruptions referred to in the preceding discussion.

Recommendation. Federal agencies such as the Department of Energy, the National Science Foundation, the National Aeronautics and Space Administration and the Department of Defense, which support research using helium, should help researchers at U.S. universities and national laboratories acquire systems that recycle helium or reduce its consumption, including low-boil-off cryostats, modular liquefaction systems, and gaseous recovery systems.

The committee notes that because total U.S. research applications account for only 2 to 4 percent of all usage of refined helium in the United States, the negative effects of supply and price disruptions for the U.S. research community not currently participating in the in-kind program could be addressed at relatively low cost. Moreover, in the judgment of this committee, the benefits for the nation that would accrue from minimizing these disruptions would be substantial.

General Recommendations for Meeting U.S. Helium Needs

In addition to the specific recommendations just discussed, the committee sets out more general recommendations for how to best meet the nation's current and future helium needs. These include recommendations for (1) collecting and making available the information needed to more effectively manage the Federal Helium Reserve and to formulate future helium policy, and (2) initiating strategies to develop a more comprehensive long-term program for meeting the nation's helium needs.

Collection of Information

One of the difficulties encountered by this committee and the previous NRC committee that issued the 2000 Report was the lack of timely and sufficient information to evaluate the supply and demand sides of the helium market, especially non-U.S. supply and demand, and the operation of the Federal Helium Reserve. Such information is needed by those who formulate and carry out U.S. policies on helium in order to make good decisions.

Recommendation. The Bureau of Land Management (BLM) should acquire, store, and make available to any interested party the data to fill gaps in (1) the modern seismic and geophysical log data for characterization of the Bush Dome reservoir, (2) information on the helium content of gas reservoirs throughout the world, including raw data, methodology, and economic

assessment that would allow the classification of reserves contained in specific fields, and (3) trends in world demand. BLM or other agencies with the necessary expertise, such as the U.S. Geological Survey, should develop a forecast over the long term (10-15 years) of all U.S. demand for helium for scientific research and for space and military purposes.

Recommendation. Unless expressly prohibited from doing so, Bureau of Land Management should publish its database on the helium concentrations in the more than 21,500 gas samples that have been measured throughout the world and provide its interpretations of gas sample analyses, especially those reflecting likely prospective fields for helium.

Long-Range Planning

Helium is critically important to many U.S. scientific, industrial, and national defense sectors. Further, the helium market is rapidly changing, as evidenced by the unforeseen developments on both the supply side and demand side of that market since the 2000 Report was released. Finally, because the Reserve is so large, steps undertaken in connection with it can have unintended consequences, the most pertinent being the effect of the pricing mechanism adopted by BLM pursuant to the 1996 Act on worldwide prices for helium. These considerations merit the development of a more permanent and sustained plan for managing this valuable resource.

In addition, the Federal Helium Reserve is a finite resource and so at some point in the future will be depleted. However, the helium needs of users in the in-kind program will continue. The BLM and the White House Office of Science and Technology Policy (OSTP) should develop a strategy to address these important future needs.

Recommendation. The Bureau of Land Management should promptly investigate the feasibility of extending the Helium Pipeline to other fields with deposits of commercially available helium as a way of prolonging the productive life of the Helium Reserve and the refining facilities connected to it.

Recommendation. The Bureau of Land Management (BLM) should form a standing committee with representation from all sectors of the helium market, including scientific and technological users, to regularly assess whether national needs are being appropriately met, to assist BLM in improving its operation of the Federal Helium Reserve, and to respond to other recommendations in this report.

Recommendation. The Bureau of Land Management, in consultation with the Office of Science and Technology Policy and relevant congressional committees, should commission a study to determine the best method of delivering helium to the in-kind program, especially after the functional depletion of the Bush Dome reservoir, recognizing that this will not happen until well after 2015.

Recommendation. The congressional committee or committees responsible for the federal helium program should reevaluate the policies behind the portions of the 1996 Act that call for the sale of substantially all federally-owned helium on a straight-line basis. It or they should then decide whether the national interest would be better served by adopting a different sell-down schedule and retaining a portion of the remaining helium as a strategic reserve, making this reserve available to critical users in times of sustained shortages or pursuant to other predetermined priority needs.

Conclusion

The committee notes that securing a stable and accessible helium supply in the future requires addressing several important issues that are beyond the scope of this study. For example, the legislative framework for the operation of the federal helium program is silent on the management of the Federal Helium Reserve after January 1, 2015, the mandated date for disposal of substantially all federally owned crude helium. What is to be done with the remaining federally owned crude helium? How will BLM operations beyond 2015 be financed? Should the Reserve, either as a federal or a private entity, as appropriate, continue to exist after the BLM debt to the U.S. Treasury has been retired? While the committee supports maintaining a strategic reserve, addressing these issues requires the involvement of Congress and the broader federal science policy establishment because they go well beyond the reserve management responsibilities of BLM.