United States House of Representatives
Committee on Natural Resources
Subcommittee on Energy and Mineral Resources
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Hearing on
Helium: Supply Shortages Impacting our Economy, National Defense and Manufacturing

Testimony of John Campbell
Member – Committee on "Understanding the Impact of Selling the Helium Reserve" National Research Council of the National Academies

Good morning Chairman Lamborn, Ranking Member Holt and members of the Subcommittee. I appreciate the opportunity to testify before you today. My name in John Campbell. I am President of J. R. Campbell & Associates, Inc, of Lexington, MA, a leading international consulting firm specializing in industrial, medical and specialty gases and related markets and technologies. I have been involved with helium since 1962, when I started working with Air Products & Chemicals, Inc. Since 1981 when I started by own business I have been more heavily involved in a wide variety of helium issues. From 1987 to 1992 that included being special consultant to the U.S. Bureau of Mines. BOM was the predecessor to the U.S. Interior's Bureau of Land Management (BLM) with responsibility for operation of the U.S. Government's helium business. Helium is a fascinating and multifaceted sector of the economy, comprised of multibillion oil and gas exploration companies, large and small industrial gas producers and distributors, and a wide array of industrial and commercial interests ranging from MRI and fiber optic cable manufacturers to welders to a billion dollar domestic balloon industry.

Since 1981 my firm has also performed many in depth studies for several of the world's major helium stakeholders, including Exxon Mobil, Sonatrach of Algeria, and RasGas and Qatargas of Qatar. That work has included evaluating and quantifying:

- Regional, by-country and market segment helium demand, together with crude and pure/liquid helium costs and prices. These factors are defined at the crude source, at the refiner's plant, at wholesale and retail helium distributor levels, and at retail customer levels.
- Sourcing and supply chain specifics for liquid and gaseous helium volumes and uses, including the quantification of most aspects of the US and international helium supply chain,
- Many of the important uses and applications for helium, and
- Forecasts for most aspects of the US and international helium markets and sourcing.

In 2010 I served on the National Research Council (NRC)[1] committee which studied the impact of selling the Nation's Helium Reserve. That committee reviewed and worked on a wide variety of issues including:

- The uses and markets for helium, together with those critical uses by the U.S. government, together with the sourcing of crude helium for those uses directly and indirectly by BLM,
- The operations of the BLM, with particular attention to the operation and maintenance of the Cliffside, TX reservoir, the withdrawal rates of crude helium, and the transfer of crude to/from the crude pipeline, and from/to the helium refiners on the pipeline.
- The emerging and rapidly growing markets of Asia, together with the new major offshore crude and liquid helium sources in Algeria, Qatar, Poland and Russia,
- The current shift in the world's helium supply from the U.S. to those offshore sources resulting from the depletion of the U.S.'s Hugoton field crude and the BLM's crude helium reserves,
- The relationships of these issues to BLM's current and future helium business, and
- The important issue of BLM's price for crude helium supplied to helium refiners located on the helium pipeline. We also studied BLM as the crude helium source for the U.S. government's own uses in defense, energy, R&D, and environmental requirements through the mandated "in-kind" pricing programs.

Important conclusions reached in these areas, particularly with regard to the important prospects for extension of BLM's helium operations beyond the current authorization which terminates in 2014, included:

1. As the reserve was created, authorized and funded originally for use by the US Government, those users should have a stronger service priority and a discounted price for the crude component of delivered liquid and gas relative to the private sector's purchase of the crude.

2. The BLM's helium operations should better reflect normally practiced gas reservoir operations to improve the outflow from the reservoir and to maximize the longevity and utility of the reserve within reasonable constraints of reservoir operations.

3. If the strategic issue and decision were to maintain the U.S. independence from offshore helium supply, efforts and funding should be provided to extend the reach of BLM's crude helium activities, and/or to price BLM helium as the source of last resort to the private sector thereby stimulating more private sector crude helium sourcing investment in the US.

4. BLM's crude price should better reflect a crude helium market price structure.

[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.

While there were a number of other conclusions and recommendations, and while the first three conclusions above were quite thoroughly evaluated, attempts to frame a new BLM crude price per conclusion #4 was not accomplished within the time available to the committee. Some reasons for that were:

- Most of the U.S. based crude pricing from companies supplying "only crude" in the Hugoton gas field, negotiate those prices with the helium refiners under highly confidential supply contracts eliminating the availability of those prices to establish a market price for crude.
- As a basis for escalation of crude prices, most of the contracts tie their prices to the BLM crude "open market" price.
- The large U.S. and offshore producers of "liquid" helium produce and sell under long term, highly confidential supply contracts. Those liquid helium prices are directly or indirectly indexed to the BLM crude open market price. Again that makes it difficult to use those prices in establishing a BLM market reflective price.

In my own opinion, while the combination of these factors makes the development of a new BLM market reflective price difficult, the fact remains that the BLM crude price needs a rationale basis for its formulation.

Relative to the current worldwide shortage of helium supply I would observe the following:

1. Helium is a byproduct of large scale natural gas processing like the production of liquefied natural gas (LNG) and natural gas liquids (NGL's). As such the capture of crude helium feeding the purification and liquefaction of helium is highly dependent on the reliability of the natural gas operations.

2. The helium industry has been dwelling for years on Nameplate Capacity as the benchmark for planning enough capacity to meet demand. It has also been relying for years on the availability of the Cliffside reserve as the spinning reserve to clear demand in the cases of serious helium crude and plant outages. Both of these assumptions are passé. There is much slippage between Nameplate Capacity and Maximum Deliverable Production that needs to be accounted and planned for as world helium demand becomes more complex. In addition, the private sector must include a spinning reserve investment in its planning for balancing capacity with forecast demand.

3. But for the next 18 to 24 months, and before new offshore helium capacity is brought on line, the BLM crude operations is critical to meeting US and worldwide demand.

4. Beyond 2014, and with continuation of BLM's crude operations, there should be consideration given to making those operations really the crude source of last resort. That should be an important part of the rationale behind the future pricing of BLM's valuable crude helium pricing policy.

The rest of my testimony includes the following:

- An update from an article on helium with attachments - “Tight Supply Reins In the Worldwide Helium Market” in *CryoGas International*, October 2011, by Maura Garvey, Director of Market Research, J. R Campbell & Associates, Inc.
- A summary from the 2010 NRC study, Selling the Nation’s Helium Reserve, a report of the NRC committee. (Page 18)

An update from an Article - "Tight Supply Reins In the Worldwide Helium Market," *CryoGas International*, October 2011, by Maura Garvey, Director of Market Research, CryoGas International

Note: Important components from the article were extracted and updated for this written testimony.

Tight supply is the most notable aspect of this year's review of worldwide helium market. Uncertainties relating to timing of future supply sources, projecting market demand during uncertain economic times, and the United States' Bureau of Land Management's (BLM) changing role in supply make this a challenging market to manage. This year was particularly tough with supply disruptions at most major sources of helium across the globe. Disruptions were caused by a range of factors including the lack of feedstock from LNG plants caused by lower consumption during the economic recession, planned and prolonged planned shutdowns, the Russian discontinuation of exports, and trouble maintaining pressure in the BLM pipeline, a system entering declining stages of output. The tight supply of helium is expected to remain until significant new planned supply comes on at Qatar II in mid-2013, with two projects due to come on line prior to end 2013 providing some respite. These include the startup of the Air Products/ MATHESON joint venture at Riley Ridge in Wyoming schedule for late 2012 and the Skikda LNG megatrain plant coming on mid 2013, which will supply additional feedgas volumes to their existing helium plant. We expect that these additional supplies will be fully consumed by increasing demand.

To get the insider's view of this critical industrial gas market, CryoGas International spoke with the helium experts at major industrial gas companies. An important point noted by all is the changing role of the BLM on the global supply chain. The global helium supply chain has become more unreliable over the past few years and it is becoming evident that BLM is not able to remain the fly-wheel. The result is that industrial gas companies are losing their flexibility to manage supply in the face of planned or unplanned supply disruptions. The BLM used to be able to operate at higher rates than the 2.1 billion cubic feet per year (Bcf/yr) for short periods of time, masking other disruptions in helium supply. Due to the natural decay of the Hugoton field and reduced pressure in the reserve, BLM has been unable to support all the plants on the pipeline, eliminating their capability to temporarily mask other disruptions.

The 2011 Helium Market

The global economic recession that drove helium demand down during 2008 and 2009 improved in 2010 and into 2011, but to varying degrees across all geographic regions. This demand was primarily driven by Asia and the Middle East (ME) regions and the electronics industry, including semiconductor manufacturing, LCD, and fiber optics.

Our assessment of the 2010 worldwide market for helium is about 6.2 Bcf, and leveling off to 6.3 Bcf in 2011 due to continued tightness in supply. (see Figure 1 in the attachment) We are at the stage where all helium produced is being consumed and demand growth is constrained by supply. If demand were unrestricted by supply, we

estimate demand could be closer to 6.4 Bcf. Industrial gas companies believe that without the disruptions in helium sources, growth could have been more robust in 2011 heading into 2012 and 2013. The disruptions in the various helium sources affected all industrial gas companies at one time or another. This shortage will have lasting impact to valuation of helium supply in all business segments.

Overall, the consensus is future demand growth worldwide will be in the 2–4 percent range, with supply and global economic growth being key factors. Global growth in demand will depend on whether the product is available to meet the demand and the global economy. At this time, the future of the global economy remains uncertain.

Recovering Demand

The industry consensus is that the helium market should be able to recover demand levels by late 2013 when planned major new supply is added. This projection reflects a best estimate based on known demand data and historical information on how helium markets have recovered in past economic downturns. *CryoGas International* discussed this helium demand scenario and projections for future growth in North America, Europe, Asia, and the ME with the major gas companies. We also reviewed the applications behind the demand and the basis for growth in the fastest growing segments.

The overall consensus among industrial gas producers is that new demand for helium will grow the fastest in Asia at around 7–10 percent and in the ME at around 4–7 percent. Demand growth in the US and in Europe will be slower, 1–2 percent projected in the US and 2–3 percent in Europe.

The electronics industry will remain the main growth driver for helium as that market has rebounded more quickly than others. The growth in Asia can be expected to be broad-based, encompassing electronics-related segments, such as fiber optics, LCD, and semiconductor manufacturing, and general manufacturing and healthcare related applications as the overall economy expands.

Currently, the US remains the largest market for helium demand worldwide, at about 37 percent, or about 2.3 Bcf/yr, as shown in Figure 2. The rate of demand growth for helium in the US has declined since 2000 as large markets for helium, such as MRI, matured. Debt issues in the US and Europe as well as increased helium conservation and recycle measures are also responsible for reduced demand in these more mature markets.

Asia represents the second largest market for helium with 28 percent of worldwide demand, about 1.8 Bcf/yr. Japan and China are the largest markets in Asia, but demand growth is largely driven by the booming Korean and Taiwanese electronics markets. Manufacturing in Asia is also contributing to demand. Welding techniques are becoming sophisticated causing increased helium demand in China and emerging markets. The primary supplier of helium for Asia is the US. Additional supply comes from the RasGas plant in Qatar. Linde’s new Darwin, Australia plant also supplies this region.

Europe, the third largest market for helium, comprises about 22 percent, or 1.4 Bcf, of worldwide helium demand. Helium applications remain less saturated in Europe than in the US. Current and planned helium production from Algeria, with backup from the US and Qatar, will keep Europe adequately supplied.

The other Americas (Canada and Latin America) and The Rest of the World (ROW), including the ME, together represent thirteen percent of the global market. These regions traditionally have contributed to strong demand growth, and are expected to grow about 4–5 percent per year going forward, driven by industrialization in their emerging economies.

US Government's Role in Helium

The US government operates an extensive helium pipeline system that includes the storage reservoir in the Bush Dome–Cliffside Field, TX and a 425-mile pipeline system originating at the Cliffside plant and ending near Bushton, KS. (see Figure 3) The government manages this system through the BLM, which is an agency of the US Department of the Interior. The pipeline connects nine privately-owned crude helium plants and six privately-owned helium purification/liquefaction plants to the Cliffside Gas Field. The current withdrawal rate from BLM storage (operationally capped at 2.1 Bcf/yr), unaccounted-for losses and depletion in the Hugoton, will bring the Cliffside Fields contained helium to an estimated 8 Bcf by 2015. This drawdown is an issue of concern to the US government and is one of the reasons the National Research Council (NRC) formed the Committee on Understanding the Impact of Selling the US Helium Reserves, which produced the report *Selling the Nation's Helium Reserve* in January 2010.

That study, however, did not provide any guidance about the role of the BLM after 2015. The 1996 Helium Act requires that the product be "offered for sale" by 2015—not all to be either sold or redelivered by 2015. This means in practice that significant crude helium will remain in the Cliffside reservoir after 2015, and that crude will likely be delivered to refiners after 2015. The impact of this change on the BLM operations is unknown. Of interest to our industry is whether Congress will define a new pricing model for any available and unsold helium after the Helium Act expires. The Helium Stewardship Act of 2012 is currently being drafted to address this issue.

The worldwide helium supply chain is quite complex. Figure 4 shows the U.S. helium supply chain from liquid helium production through primary and secondary distribution to large customers and through gas distributors to smaller customers. As the U.S. is an important supplier to the world, delivery of liquid in ISO containers to U.S. ports for ocean shipping to off-shore transfill facilities. A unique feature of the worldwide industrial gas business, including the helium supply chain, is that virtually all transportation vehicles and storage containers are owned by the helium producers and distributors and provided under rental features in the pricing sections of helium supply agreements. Figure 5 provides more detail for the U.S. supply chain starting with crude helium supplied from oil and gas producers to the liquid production refiners.

BLM raised their open market crude helium price 10.9 percent to $84.00 for FY2013 as compared with the 1.0 percent increase to $75.75/Mcf for FY2012. (see Figure 6) The percent change variation between these two years has industry leaders concerned. The FY2012 price was based on research into market pricing. The BLM had difficulty obtaining market pricing, so they went back to the Consumer Price Index (CPI) to determine the FY2012 crude helium pricing.

The BLM pricing has caused some confusion. This makes the BLM index on the market valuation of helium unpredictable. Until the BLM is able to establish a market price-based mechanism, budgeting and planning is also a problem for the industry. The industry needs consistency as large swings make it hard for our industry to budget and plan accordingly.

It is well known in the industry that all new supply sources use the BLM as a benchmark as it is the only published price. The BLM price typically sets the floor of increases in the market. Non-BLM providers, which make up approximately 70 percent of the supply, have been increasing prices at rates nearly three times greater than the BLM over the last decade. This is representative of the value of the product as a scarce and non-renewable resource as well as the cost to invest in new sources, which are more difficult to develop and more challenging logistically. The price of helium is a reflection of these trends and the result is that prices will most likely rise by double-digit percentages annually for the next several years.

The consensus among the helium experts is that natural market forces of supply and demand will set the price of helium once the BLM posted price comes to an end. Prices will probably be much higher once the BLM benchmark goes away as was demonstrated by the bids on overseas supply.

Worldwide Helium Supply

As noted, new sources and expansions to helium capacity/production have come on-stream or are planned in Darwin, Australia, Riley Ridge in the US, and in the ME/Africa (i.e., Qatar II and Skikda) during the next three years. These sources should be sufficient to meet worldwide demand for the next four years, given moderate growth in demand and continued global economic recovery. Figures 7 to 8 address the difference between Nameplate Capacity and Maximum Deliverable Production volumes. That difference accounts for supply disruptions at helium sources across the globe, lack of feedstock from LNG plants caused by lower consumption during the economic recession, as well as planned and prolonged planned shutdowns. There should be adequate future sources of helium from natural gas projects, even in the US (i.e., carbon dioxide recovery for enhanced oil recovery projects like the one being considered by Kinder Morgan in St. Johns, AZ). However, consensus is that they will provide helium at much higher prices than users are accustomed to paying.

Substantial worldwide helium reserves exist in North America, the ME/Africa, and Russia that could sustain the helium industry for hundreds of years. However, those reserves are typically more difficult and costly to develop, which is why they have remained undeveloped to date. We expect those reserves to be developed to meet future demand as the supply/demand and pricing situation begins to justify the increased level of investment required. In early July, Gazprom of Russia announced plans to recover significant volumes of helium in the Russian Far East beginning 2017. The helium market consists of applications that, in the next 10–20 years, cannot substitute helium due to its unique properties; hence the demand for helium will continue to grow.

Figure 9 provides the estimated Maximum Deliverable Production by the Region in which the crude/pure liquid production plants operated. It is readily apparent to see how capacity and production will have shifted from the U.S. in 2007 to the Middle East and North Africa in 2020, and how crude sourcing from the BLM will have been reduced from 2.1 bcf in 2007 to about 600 million in 2020.

ATTACHMENTS – to written Testimony of John Campbell

Figure 1. Worldwide Helium Demand. SOURCE: CryoGas International

The following graph shows the increase in worldwide helium demand from 5.3 billion cf in 2000 to a forecast 6.3 bcf in 2012, with the US demand declining from 3.2 bcf in 2000 to a projected 2.3 bcf in 2012, which offshore demand increased from 2.1 bcf in 2000 to a projected 4.0 bcf in 2012. During this period with no surplus production to clear increased real demand during 2010 to 2012. In fact, production capacity during 2011 and 2012 constrained worldwide demand, particularly in the U.S.

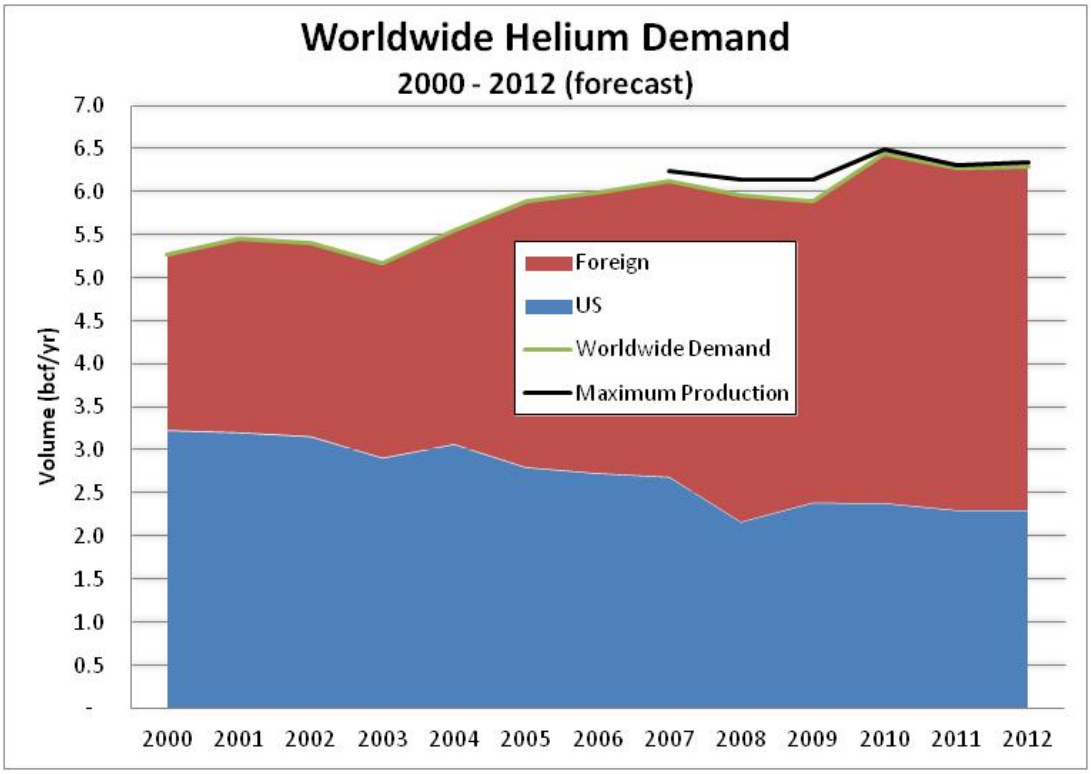


Figure 2. Worldwide Helium Regional Demand and Supply - 2011(BLM Crude Helium Supply – 2.1 bcf/yr) SOURCE: CryoGas International.

The following map shows the regional markets for Grade A helium in bcf in the red boxes, together with the location of significant helium production sites, and the primary and secondary helium supply vectors to major markets served. The U.S. with a demand of 2.3 bcf is the largest of the regional markets. Of the 5.0 bcf produced in the US in 2012, 2.7 is exported.

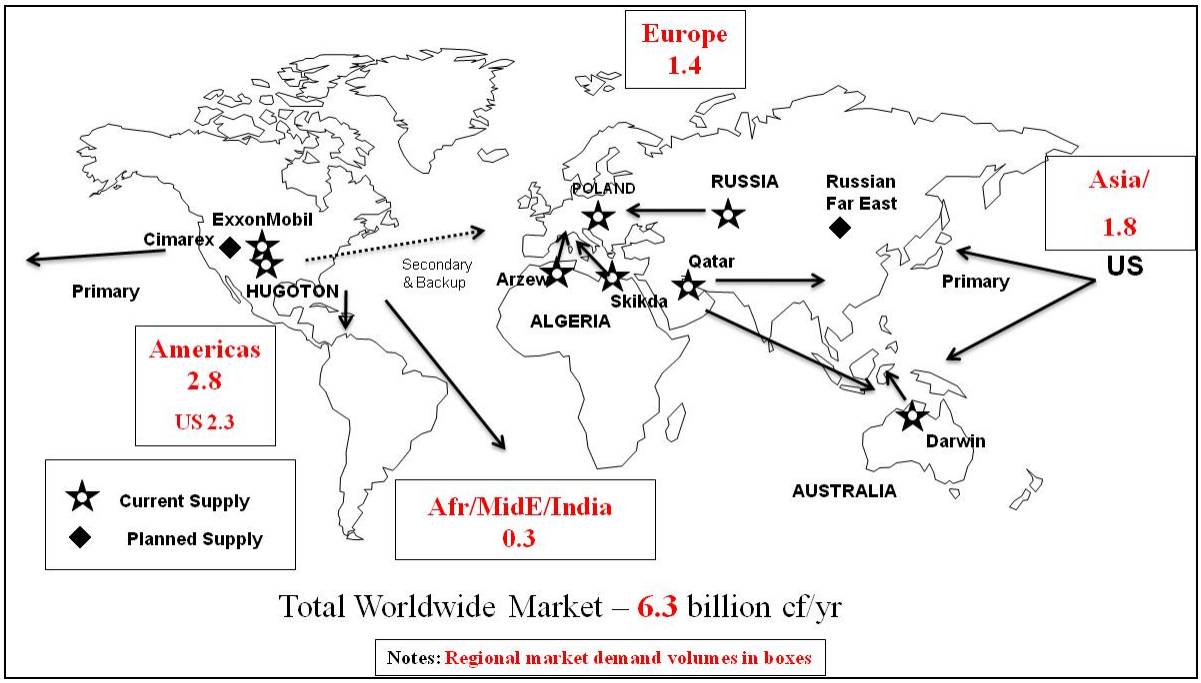


Figure 3. The United States crude helium supply system.

Historically, the Hugoton and surrounding fields have been the principal sources of helium, both to supply U.S. demand and for serving export supplied demand. In the late 1980's, natural gas fields in Wyoming with rich helium, CO2 and natural gas become an increasingly important source of helium, while potential new fields became known in the Four Corners area. SOURCE: U.S. Geological Survey 2006 Minerals Yearbook (Helium).

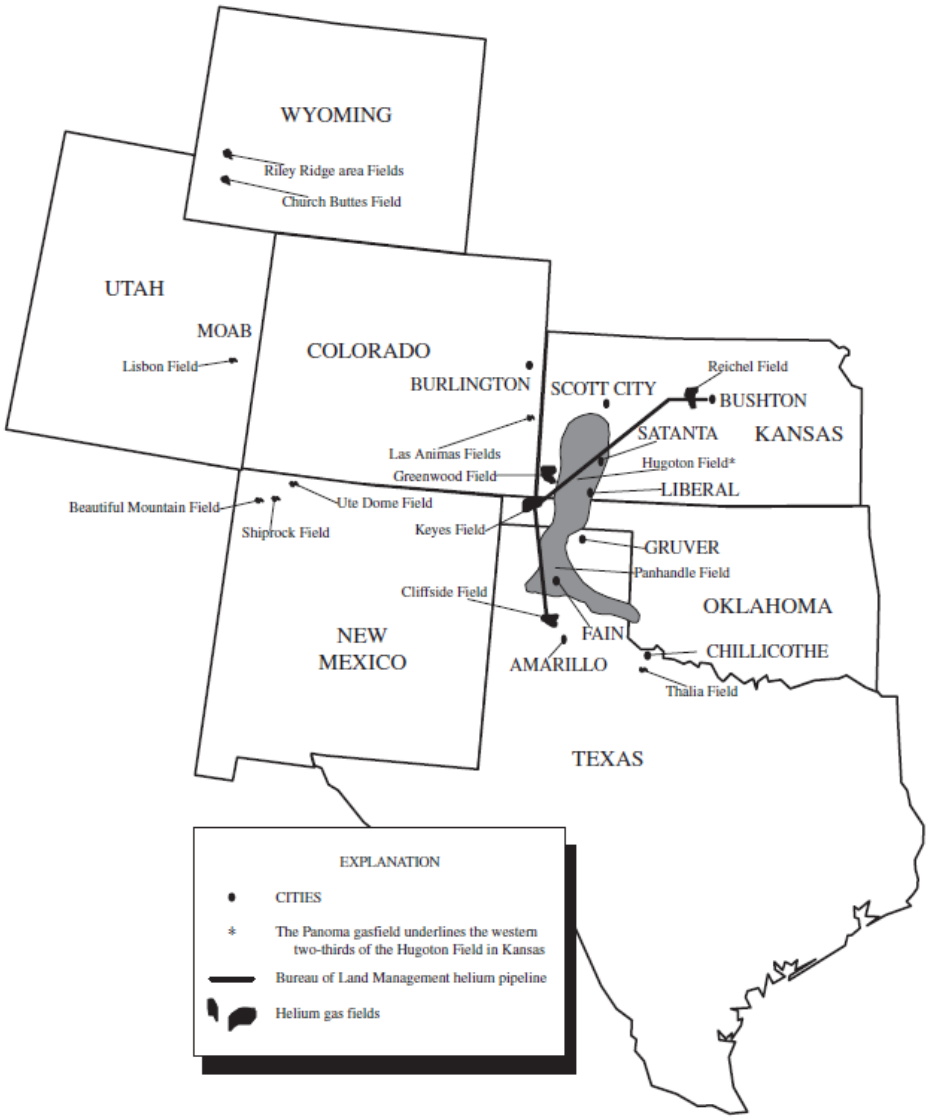


Figure 4. Worldwide Helium Regional Demand and Supply - 2011(BLM Crude Helium Supply – 2.1 bcf/yr) SOURCE: CryoGas International.

The pictorial schematic below illustrates the primary supply chain activities of production, primary and secondary distribution of helium to Distributors and Customers.

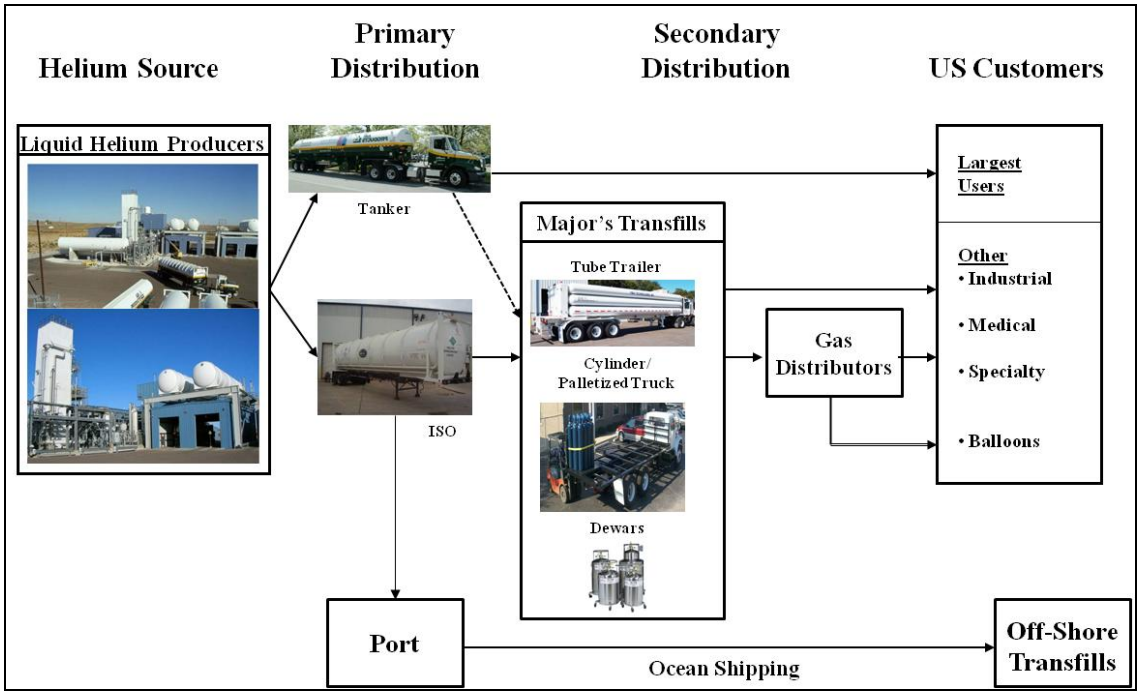


Figure 5. Helium Supply Chain Structure – 2012 – For Shipment of US Produced LHe to Major US and Offshore Markets. SOURCE: CryoGas International

The following schematic provides more detail to the supply scheme shown in Figure 4. The significant companies noted in the functions they serve within the U.S. helium supply chain.

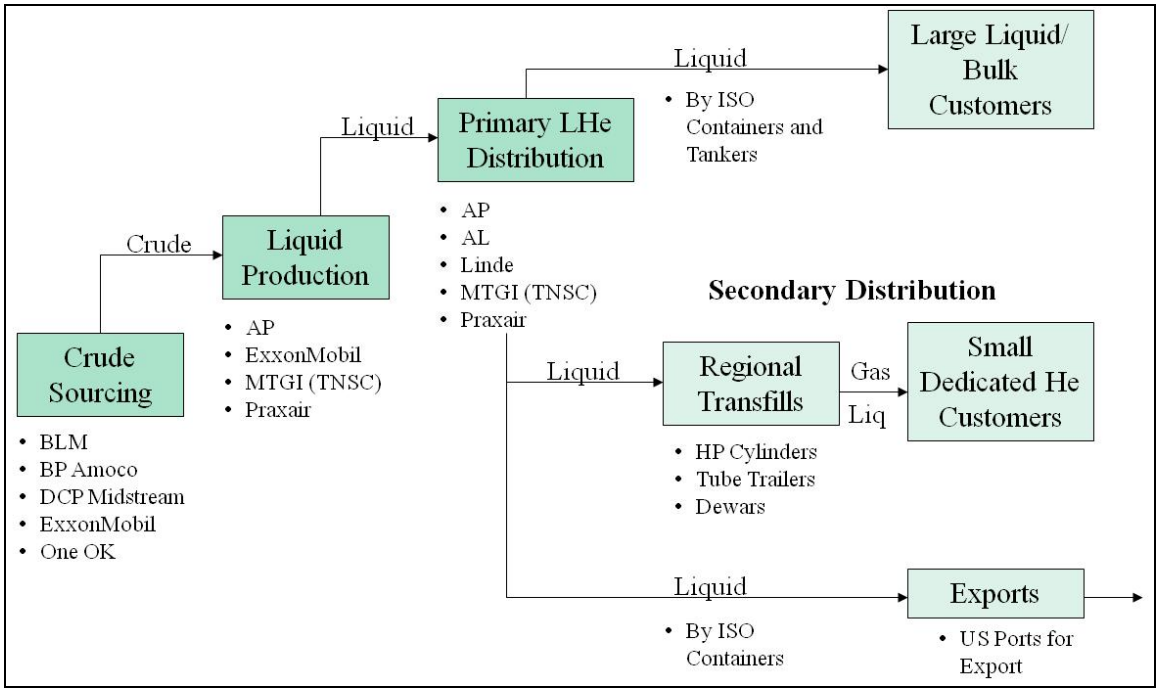
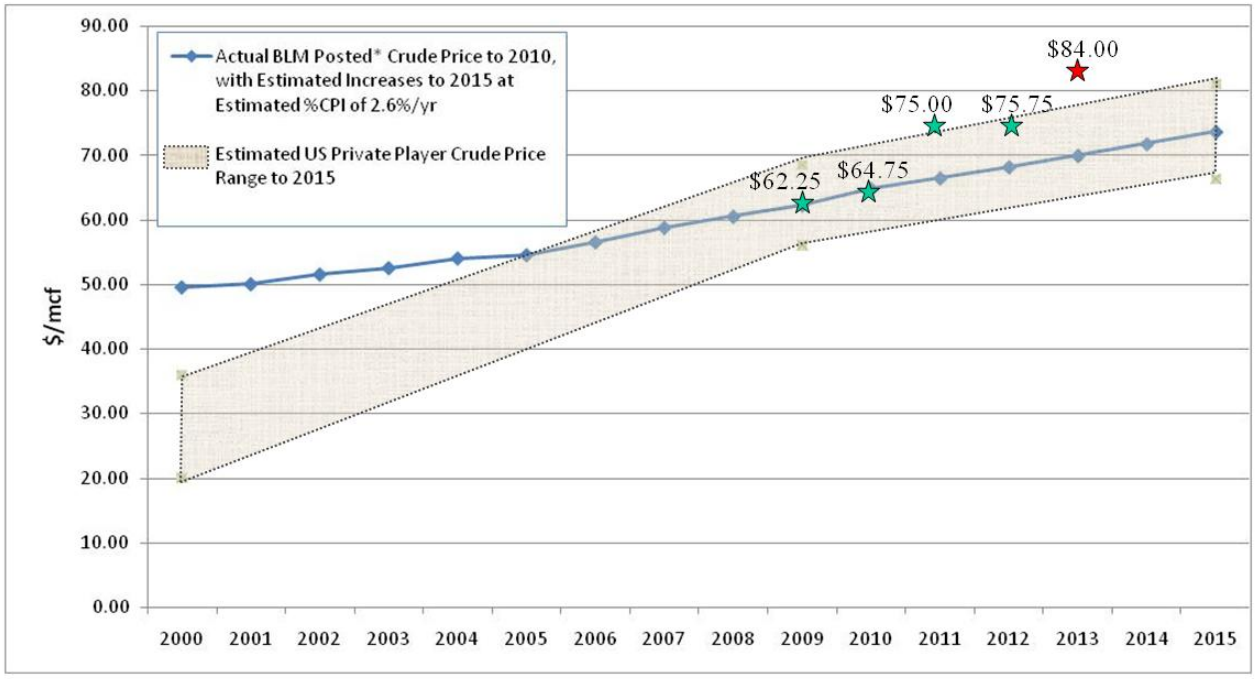


Figure 6. US Crude Helium Prices (Provided to NRC/NAS for the 2010 Helium Reserve Report) SOURCE: CryoGas International

The following graph tracks the price of BLM crude helium from 2000 to the price effective October 1, 2012, of $84.00/bcf, against the band of estimated U.S. private sector pricing for the same period. Note that while the BLM started in 2000 to be significantly higher that that of the private sector crude suppliers, the prices have converged to the BLM price as a result of renegotiated adjustments reflected in the crude helium supply contracts.



* Based on NRC's crude pricing recommendation, BLM increased the Fiscal Year (FY) 2011 crude price to $75.00/kscf, a 15.8% increase over the FY 2010 crude price. The FY 2013 crude price was increased to $84.00/kscf, a 10.9% increase over the FY 2012 crude price.

Figure 7. WW Helium Nameplate Plant Capacity vs Maximum Deliverable Production For 2007, 2011, 2016, and 2020. SOURCE: CryoGas International

The graph below compares the worlds Nameplate Capacity for pure/liquid helium with the Maximum Deliverable Production available to serve total customer requirements, and accounts for the slippage between the two capacity volumes.

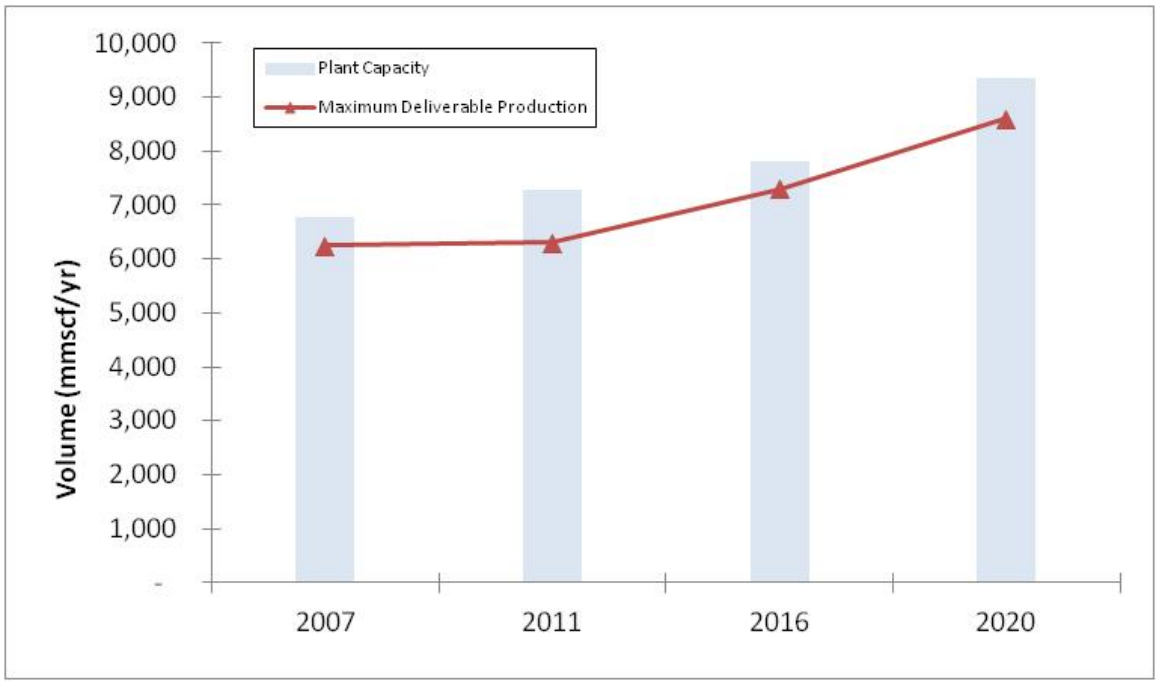


Figure 8. WW Helium Demand vs Capacity and Deliverable Production – 2010 – 2020. SOURCE: CryoGas International

The graph below now adds demand to the Figure 7 graph and shows how tight Maximum Deliverable Production is compared with demand. This lack of a capacity flywheel of additional capacity results in unforeseen shortages when extraordinary operational problems arise or when demand exceeds forecast production needs.

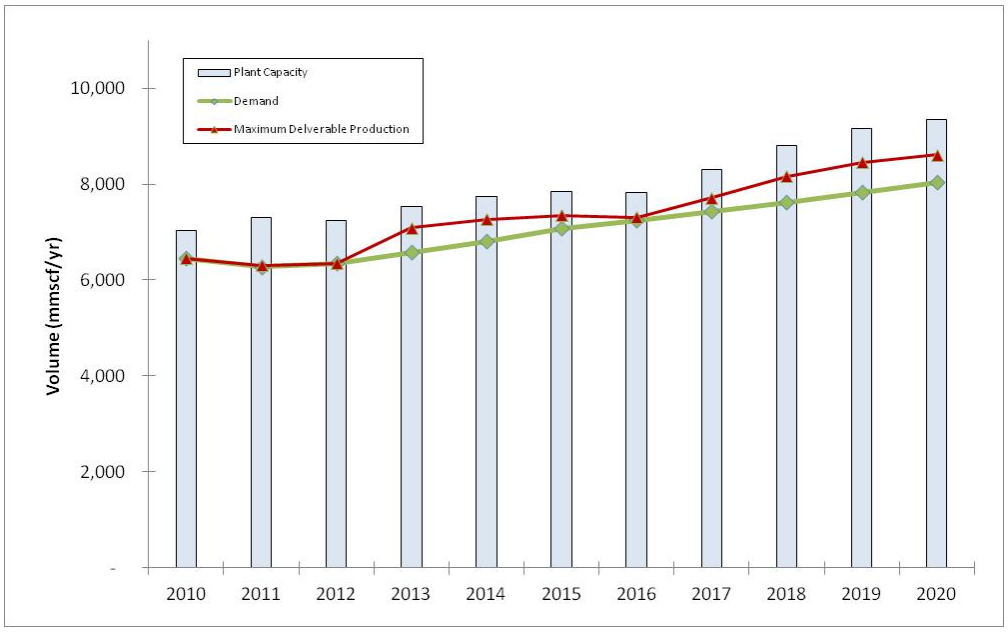
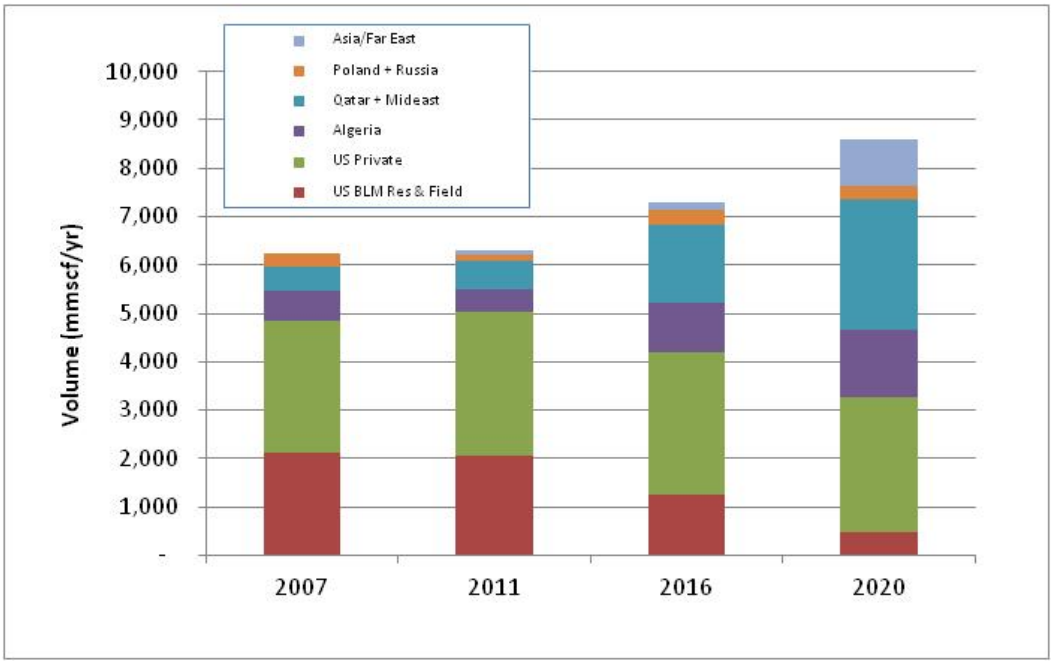


Figure 9. Forecast of WW Helium Maximum Deliverable Production by Region
SOURCE: CryoGas International

The graph below displays the estimated Maximum Deliverable Production by the Region in which the crude/pure liquid production plants operated. It is readily apparent to see how capacity and production will have shifted from the U.S. in 2007 to the Middle East and North Africa in 2020, and how crude sourcing from the BLM will have been reduced from 2.1 bcf in 2007 to about 600 million in 2020.



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**

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[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.