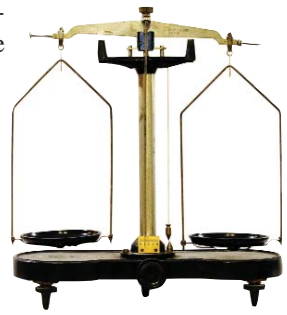
Supply in Balance with Demand, Relatively Speaking

2008 Worldwide Helium Market Update

By Maura D. Garvey

Relative to the very tight balance of supply experienced during 2006 and 2007, worldwide helium supply has been in balance with demand during the first eight months of 2008. This balance has been struck primarily because ExxonMobil, the largest private supplier of helium in the world, has been producing at close to capacity. In addition, the RasGas (Qatar) and Skikda (Algeria) helium plants are coming up to higher production rates and the withdrawal of crude helium from BLM's Cliffside, TX reserve has occurred at planned rates. However, with continued increases in worldwide demand and with the planned maintenance shutdowns expected during the remainder of 2008, and perhaps some unplanned outages, supply of helium is likely to be much tighter and continue to be tight into 2009. With continued moderate increases in Mideast, Asian and South American demand and no appreciable new helium capacity expected before 2012, this tight supply situation is likely to continue until 2012 when a few new, large, planned helium plants are expected to come on-stream. If plant on-stream times are delayed, as has happened in the past, tight helium supply could extend beyond 2012. Until new supplies come on-stream, we can expect allocations and price increases to remain a major issue for many helium distributors and customers.



In addition to the tight supply situation forcing retail prices up, high crude helium and energy costs have also driven up production and delivery costs along the helium supply chain. The major international helium players are actively managing this situation by focusing on the reliability of each stage of this supply chain to service customer requirements with minimum disruptions.

Improvement in European and Mideast production has offset the long-term decline in the US mid-continent (Hugoton) supply of crude helium to the refiners. However, investment in new worldwide crude supply sources is necessary, or supply will be capped and worldwide demand constrained. While there is plenty of helium purification and liquefaction capacity around the world, the prospects for adequate crude helium feedstock are limited.

INVESTMENT IN HELIUM RECOVERY PLANTS

Helium is a by-product of natural gas production, either from the refining of NGLs (natural gas liquids) or from the conversion to LNG (liquid natural gas). As crude helium is a by-product of natural gas production, its availability is limited to the whims of the primary products (NGLs and LNG) and their markets. In addition, the helium contained in the natural gas must be a refinable level and occur in an economically meaningful size. If the helium concentration in the natural gas is too low and/or there's not enough of it, it is not worth the investment to produce it.

The investment in helium recovery plants is increasing rapidly around the world and is a significant part of the increased costs to produce the new helium required by the market. A significant portion of the pure/liquid helium today comes from LNG companies and natural gas processors that have made the investment to recover more crude. While this has eased the tight supply situation, it has forced prices up. As for all construction, the capital costs to build helium recovery plants have risen significantly in the past five years due to energy, steel prices, and labor.

With helium supply so closely tied to natural gas or LNG production, helium plants tend to have outages when these upstream facilities undergo maintenance or have supply disruptions. Some of these disruptions are planned, while others are not. It is the number of unplanned disruptions in helium supply and delays in new plants coming on-stream that makes the management of the helium business difficult, particularly when supplies are very tight.

Currently, the two most recent sources of helium, Algeria and Qatar, are resolving their technical problems and are likely to reach planned capacity utilization by the end of 2008 or early 2009. The number of supply interruption problems encountered last year, especially in the US, brought to the forefront just how tight world supply of helium is in the face of growing worldwide demand and only moderate increases in total capacity. According to Phil Kornbluth, EVP, Global Helium, Matheson-TriGas (MTG), "This year has been better than 2007 because plants have operated closer to full capacity than they did last year. As a result, supply and demand have been in balance. However, we, as well as the other industrial gas companies that buy helium from ExxonMobil, will experience a temporary shortage in the fall because of the planned ExxonMobil maintenance shutdown in September."

Two smaller helium recovery projects are on the near horizon including the Linde Group project in Darwin, Australia and the Air Products and MTG joint venture with Cimarex Energy in Riley Ridge, Wyoming. The Darwin, Australia plant is scheduled to come on-line at the end of 2009 (see "Projects in the News" p. 4). The start-up of the Riley Ridge plant has probably slipped to mid-2010. The environmental approval process has apparently caused delays in construction. However, based on conversations with Air Products, the helium liquefaction plant portion of this project will probably be operational ahead of schedule. The initial crude production from these two plants will represent roughly seven percent of worldwide demand. These two plants will help to offset the ongoing reduction in crude supply from the Hugoton. Larger crude and pure/liquid helium investments are being considered for St. John, Arizona, Qatar, Algeria, the Russian Far East, and a few other places.

MANAGING THE RELIABILITY OF HELIUM SUPPLY

In a market typified by tight supply and increased demand, industrial gas companies have to manage their supply chains with even greater care. *CryoGas International* had discussions with some of the major industrial gas companies to find out how they have been managing the reliability of helium supply and mitigating risks to get their product to the customer in the most cost-efficient and timely manner.

John Van Sloun, General Manager, Helium and Rare Gases for Air Products, described how Air Products, the global industrial gas leader in helium production and in the design/build of helium containers, uses a robust process to manage its helium business. "We are able to meet our supply commitments by using multiple sources for diversity of supply and we don't over commit to contractual obligations. The diverse sourcing strategy allows us to mitigate the problems and risks of planned and unplanned plant outages and new plant delays as well." Van Sloun also discussed production efficiency improvements they have been making at their production plants and transfil facilities to reduce losses.

Linde Gases and Praxair have made similar efforts to improve reliability and efficiency along the supply chain. Jane Hoffman, Global Helium Manager for Praxair stated, "We have used our experience as a Six Sigma organization to take some of the best practices and engage our customers directly on productivity improvements relating to the use of helium."

Nick Haines, Americas Zone Director of Linde Global Helium, said, "We are undertaking productivity improvement programs at existing locations and increasing reliability of supplies. Linde is actively working with its sourcing partners to improve plant reliability and uptime."

HELIUM CONSERVATION AND RECOVERY

Helium use has been capped by supply for the past year and a half, so part of the difference between natural demand and the real use of helium molecules is being made up through helium conservation and recovery techniques. For example, annual growth in the US helium natural demand over the past several years has been around 2–3 percent, and even slightly negative in 2007. Part of the reduction in demand has been in response to the very tight supply. The tight demand scenario has resulted in important initiatives in recovery/recycle of spent helium, increased focus on production and distribution efficiencies including loss reduction, and in substituting other products for helium (e.g. argon for helium in welding).

The major gas producers continue to actively develop and promote systems for helium recovery, recycle and, conservation with their larger customers. Several gas producers have reported that demand for these systems has increased. According to Haines of Linde, "Linde, through its engineering division, is well positioned to respond to such demands. Examples include our mechanical cooling technology as a replacement for liquid helium losses. Specifically, when implemented later this year at one of our large end-use customers, we expect to save a minimum of 30 percent on fresh helium volumes at that location. Linde is now working with customers in almost every application to evaluate recovery, substitution and conservation opportunities. As an example, in 2008, Linde was granted patents on a unique process of recovering helium from fiber optics manufacturing, an industry requiring large volumes of gaseous helium."

Helium recovery is also on the increase to minimize helium losses during the MRI manufacturing process, which uses helium intensively to cool the magnets that power the MRIs, as well as at helium transfer facilities. Van Sloun of Air Products said they have been working with customers to introduce the concept of recycle and to improve processes to recover more of the helium losses so that helium can be recovered and re-consumed. These measures help to offset total cost increases arising from increased price.

The industrial gas companies are also reporting increases in the use of equipment technologies to reduce helium consumption and to recover and liquefy helium, such as low-loss cryostats, bucket dewars with mechanical refrigeration, and on-site helium recovery and liquefiers to reduce helium consumption, losses, and costs for customers. These products are used primarily for small applications such as government and private sector R&D and university labs.

(For more information see "Helium Conservation and Recycle," CryoGas International, November 2007, p. 36 and "Helium Conservation in the Supply Chain, CryoGas International, December 2007, p. 32.)

US SUPPLY AND DEMAND

The US government's extensive helium pipeline system 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, Kansas. The government manages this system through the Bureau of Land Management (BLM), 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 Cliffside Fields contained 21.70 billion cubic feet (bcf) of helium as of December 2007. This is further broken down to 20.7 bcf in storage and about 1.0 bcf stored for private industry. The current withdrawal rate from BLM storage (oper-

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UNDERSTANDING THE IMPACT OF SELLING THE HELIUM RESERVE

At the request of the Department of Interior's Bureau of Land Management, the National Research Council has formed a committee to determine whether selling off the U.S. Helium Reserve in the manner prescribed by law has had any adverse effect on U.S. scientific, technical, biomedical, and national security users of helium. To provide a meaningful context for this effort, the committee will examine the helium market and the helium supply chain and seek to identify measures that would enable the Federal Helium Program to respond to future changes in the dynamics of the helium market. The committee has met twice and will have two more meetings, scheduled for November 3-5, 2008 and January 27-29, 2009 in Irvine California. More information about the study can be found on the web at http://www.nationalacademies.org/helium. In addition the committee welcomes public input into its deliberations. Public input can be emailed to the committee at helium@nas.edu. Please note that all external input circulated to the committee is made freely available on the committee's public access file.

ationally capped at 2.1 bcf/yr), unaccounted for losses and depletion in the Hugoton, will bring the Cliffside Fields contained helium below 10 bcf within five years. This issue is the key reason the BLM is sponsoring The National Academies of Science and Engineering to study and report on "Understanding the Impact of Selling the US Helium Reserves." The study team has been formed and began work in June 2008.

US HELIUM PRODUCTION

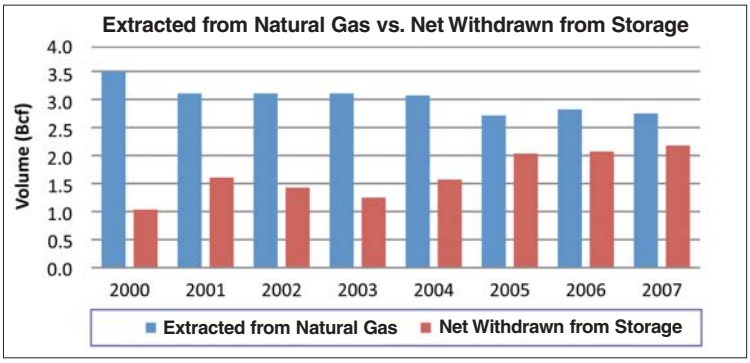

Figure 1 Source: USGS, Mineral Commodity Summaries, January 2008

Figures 1 and 2 track the source and volumes of helium sold in the US from 2000 through 2007, as reported in the United States Geological Survey (USGS) Mineral Commodity Summaries (US data originates from the US BLM helium group). Helium volumes extracted from natural gas remained relatively constant at just over 3 bcf from 2001 to 2004 after falling from their high of 4 bcf in 1998. However, from 2005 to the present, volumes extracted from natural gas dropped again to about 2.7 bcf as shown in Figure 1. This is a reflection of the continued depletion of the larger natural gas fields in the Hugoton and Panhandle of Texas. *Net Withdrawn from Storage* and the amount refined grew through 2005 to meet the steadily increasing demand that began after the worldwide economic slowdown of 2001-2002. However, net withdrawal from the field reached its limits in 2005 and will remain flat for the next few years as crude supply is at maximum capacity utilization.

US HELIUM CONSUMPTION

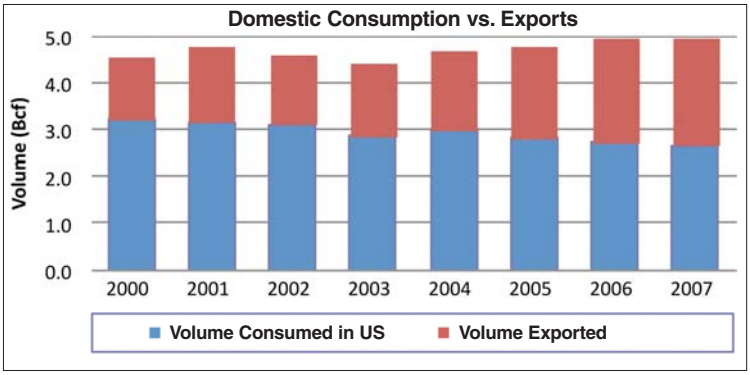

Figure 2 Source: USGS, Mineral Commodity Summaries, January 2008

According to the US Department of Commerce, total volume sold is estimated to have increased just 0.4 percent in 2007. Domestic consumption of helium declined between 2000 and 2007 by an average annual growth rate (AGR) of -2.7 percent (see Figure 2). Exports of helium increased at an AGR of 7.9 percent over the same seven-year period, reflecting demand increases in emerging economies where helium is not produced.

As shown in Figure 3, exports increased by 8.6 percent AGR from 2000 to 2006, but have since declined. Exports fell to 4.1 percent AGR in 2007, and an estimated 0.2 percent AGR in 2008 as demand became constrained by US crude supply. Supply to Europe is also now on the decline as the new helium sources in those regions have come fully on-stream.

HELIUM DEMAND/MARKETS AND PRICE

Over the past ten years, US and non-US regional growth in helium demand has shifted. From 1996 to 1999, there was rapid growth in worldwide demand for helium, which put pressure on US resources. Between 2000 and 2007, growth outside the US remained relatively strong. Within the US, however, demand shrank from 3.2 bcf/yr to 2.7 bcf/yr, an overall reduction of 550 million cf/yr (mmcf/yr). This fall in demand was reflective of the overall weakness in the US economy at that time, the serious stalling of the US fiber optics industry, and the movement of electronics fabs overseas. David Smith, Business Manager Worldwide Helium for Air Products, notes that "Fiber optics crashed in 2001 mostly because the industry had ramped up production too fast, driving up the inventories. Real demand growth in fiber optics has remained around 8–10 percent per year." Since 2004, fiber optics production has been recovering worldwide. Corning announced in 2007 the partial reopening of its Concord, NC optical fiber manufacturing facility. Corning's NC facility has Praxair helium recycle units to reduce the consumption of helium.

Worldwide market demand is expected to grow at about 2–4 percent over the next five years. The recent growth in demand for helium has not been driven by new applications for helium (like MRI) as in the past, but by the increased use of helium in existing markets that are experiencing rapid growth. Helium use in the electronics industry is one key example. The helium business has seen continued growth in traditional electronics applications such as chip and flat panel display manufacturing, but also in newer areas such as photovoltaics cell manufacturing. The growth in photovoltaics is driven by the need for alternative energy. However, the amount of helium demand growth expected from photovoltaics is difficult to predict because the consensus is still out as to how big this market will be and how much helium will be consumed in the manufacturing process. Smith of Air Products said, "The photovoltaics industry is young and which manufacturing process will get traction will be critical to the future consumption of helium. Some processes use helium, but others do not."

In addition, Hoffman of Praxair noted, "The electronics industry in Asia has been ramping up in the last five years. Given the experience of the cyclicality in this segment, how long this demand will continue to drive these geographies is unknown." Growth in basic industry and infrastructure in countries like China have driven demand for helium used in more traditional applications, like cutting and welding.

Currently, the US is responsible for about 44 percent of worldwide helium demand, as shown in Figure 4. From 2004 to the present, natural demand growth for helium in the US has been about 1–2 percent. This slight rate of growth is due to the fact that helium demand in the US comes from the largely mature industries (like MRI) and to the effective-

ness of increased helium conservation and recycle measures. This rate of growth is expected to continue at the low end for the next five years.

Europe is the second largest market for helium behind the US and comprises about 26 percent, or 1.6 bcf/yr, of worldwide helium demand. Helium demand growth in Europe has tended to be slightly higher than in the US as helium applications are less saturated there than in the US. For example, MRI is still growing in hospitals in the UK, France and Germany. Also, there has been a migration of the older liquid helium consuming MRI units from Western European into Eastern European facilities. The older units are not as efficient as the newer units and the helium volume consumption is higher. In addition, Europe has a good variety of heavy and light manufacturing sectors that tend to use applications involving helium, like specialty and electronic gas mixtures, helium leak detection, etc. *Cryogas International* estimates that European demand will grow at about 2–3 percent per year over the next five years, a bit higher than in the US. Our supply chain models indicate that Europe will be adequately supplied from current and planned production from Algeria with backup from the US and Qatar.

US HELIUM EXPORTS BY REGION BY YEAR (mmscf)

Region	2000	2006	2007	% Change 2000-2007
Americas (Excluding US)	189	354	443	12.9%
Europe	316	519	470	5.1%
PacRim	815	1,292	1,379	6.8%
ROW	42	63	29	-5.3%
Total	1,362	2,228	2,320	7.9%
% AGR		8.6%	4.1%	

Figure 3 Source: Department of Commerce and US Trade Online (Exports)

WORLDWIDE HELIUM DEMAND — 2007

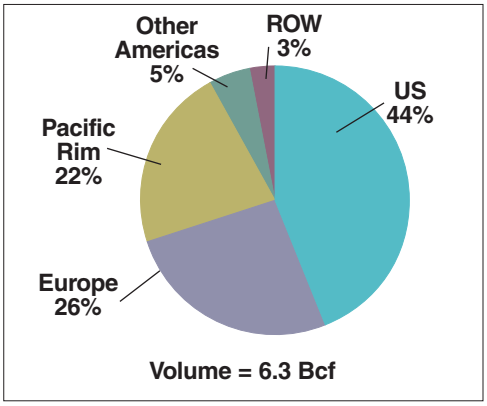

Figure 4 Source: *Cryogas International* Estimates

The Pacific Rim (PacRim) represents the third largest market at 22 percent of worldwide helium demand, or about 1.4 bcf/yr, not far behind Europe. The US is the primary supplier for the PacRim with the remainder of the supply coming from the new RasGas plant in Qatar. Linde's new Australian plant will provide primary supply to its local market and that of the close-in Asian markets. The PacRim has experienced mid-to-high single digit demand growth for the past five years, with Japan and China being the largest markets. The future of helium demand growth in specific regional markets depends on each area's mix of new technology-driven applications and traditional industrial uses. Much of the electronics industry and manufacturing facilities that require large amounts of helium are located in the PacRim. Overall, the demand for helium in the PacRim is expected to grow at 8–9 percent per year.

The Other Americas (Canada and Latin America) and the Rest of the World (ROW), including the Mideast, together represent about eight percent of the global market. These regions have contributed to strong demand growth, about 7–8 percent per year, driven by emerging industrial economies in these areas. This rate of growth is likely to continue, given adequate supply, over the next five years.

For the most part, the worldwide wholesale prices for crude helium are tied to the US BLM set/auction Open Market Sales price posted annually. *(For a complete explanation of the BLM's role in world helium markets see, "What is the Government's Role in Providing Helium to Worldwide Markets," Cryogas International, October 2007, p. 32.)* Increases in the BLM's Open Market Sales price for helium are based on the change in the US Consumer Price Index. Price increases by major helium producers of late have been greater than this increase, due to increased production, feedstock and distribution costs. In the US, the cost to retrieve mid-continent crude helium is going up because of the acceleration of natural gas depletion in the US mid-continent. This has caused an increase in the price of crude helium and ultimately led to significant increases in wholesale and retail helium pricing.

WORLD HELIUM RESERVES AND CRUDE PRODUCTION

The Worldwide Helium supply is best defined as "US" and "Non-US" sources. US helium supply sources include: the mid-continent Natural Gas Fields connected to the US BLM Crude Pipeline, the BLM Crude reserve at Cliffside, TX, and a number of plants not connected to the US BLM Crude Pipeline (e.g., ExxonMobil at LaBarge, WY; Cimarex at Riley Ridge, WY; Moab, UT; and EOR Inc. at St. John's, AZ). Non-US helium supply sources include: Poland, Russia, Algeria (i.e., Arzew #1, Skikda, and Arzew #2), Mideast (i.e., Qatar #1, Qatar #2 and possibly Qatar #3), Australia (Darwin, AU), and the Russian Far East.

According to data published in the *USGS Mineral Commodity Summaries* of January 2008, the United States represents 21 percent of the world's known helium reserves, produces 71 percent of the world's helium and is the single largest consumer of helium. Helium produced in Algeria, Poland and Russia is sold almost exclusively into Central and Eastern European markets. Helium produced in Qatar is sold almost exclusively into Asian markets. These countries combined own 79 percent of the worldwide helium reserves yet currently produce only 29 percent of the world's helium. We forecast that over the coming years, production will naturally shift to where the helium molecules can be recovered economically.

Based on our analysis, world production of helium increased about 29 percent between 2006 and 2007, while US production increased only 0.7 percent. The world production rate primarily reflects the ramping up of the plants in Algeria (Skikda) and Qatar (RasGas). US helium production from natural gas has been producing at maximum capacity since 2006.

Potential for shortages of helium in the US remain. US helium demand is constrained by available supply as the US experiences continued depletion of its mid-continent gas fields, and from production interruptions. The mid-continent gas fields depletion rate will probably reach about 10 percent per year in 2010. If we assume that mid-continent extraction of crude helium was 1,400 mmcf/yr in 2007, at current depletion rates this will reduce supply to about 700 mmcf/yr in ten years, half of today's crude supply. This decline exceeds the

crude required to feed the currently typical 600 mmcf/yr pure liquid plant operating at Arzew or Liberal, KS. A year ago the pipeline managed by the US BLM experienced pressure problems, which made it difficult for refiners connected to BLM's crude pipeline to withdraw crude helium. That problem was resolved, but new problems, like frozen well heads due to a severe winter in the mid-West, emerged and reduced crude supply from the field.

The first half of 2008 has been free of significant problems and the pipeline has only experienced normal shutdowns for maintenance. However, there have been recent reports of increased plant outages in the Hugoton, so this fall the market will experience further tightening of supply. These supply interruptions are a normal occurrence and will continue as plants age. However, since the BLM is now producing at maximum capacity, this means helium will remain tight and prices will continue to increase until new investments in crude helium supply are made and production exceeds supply.

With the US producing at maximum capacity utilization and the new plants in Algeria and Qatar nearing their planned production rates, some of the supply constraints on US crude will be alleviated.

FUTURE SUPPLY

While the world has plenty of helium refining and liquefaction capacity, future production of crude helium hinges upon additional natural gas processing (or other processing), where the natural gas contains a critical amount of helium. Investment in this type of processing typically takes three to five years to establish. The Linde Group's project in Australia will produce 150 – 175 mmcf/year when it comes fully online by the end 2009. New potential sources of helium exist in Algeria, Qatar, Wyoming, Kovytka in Eastern Russia, and possibly EOR Inc. at St. John's, AZ. Regardless of where the raw helium exists, however, given the ramp-up time for a new helium recovery plant, it is likely to take at least three years to produce crude and then pure/liquid.

The business model being used by most LNG and natural gas processing companies in the recent past, encourages companies to not only recover the helium, but to invest in the pure/liquid production themselves. This follows the helium business model of ExxonMobil in LaBarge, Wyoming. The industrial gas companies then negotiate with natural gas companies to purchase the pure/liquid production.

TIGHT UNTIL 2012

We expect the tightness in worldwide crude helium supply to continue until 2012. At that time, when large, new, planned helium production comes on-stream, supply and demand should be more balanced. With the US producing at maximum capacity utilization and the new plants in Algeria and Qatar nearing their planned production rates, some of the supply constraints on US crude will be alleviated. In addition, the initial crude production from the new plants in Darwin, Australia and Riley Ridge, WY will help to offset ongoing reduction in crude supply from the Hugoton once they are on-stream. However, other new investments in worldwide crude supply sources will still be necessary to alleviate tight market conditions, particularly in the US. While there is plenty of purification and liquefaction capacity around the world, crude feedstock is in short supply. With worldwide market demand expected to grow at about 2–4 percent over the next five years, the scenario of slowing demand growth from constrained supply will permanently effect future demand growth unless some new large application for helium is developed.

Helium allocations and price increases will remain a major issue for many distributors and customers as high energy costs continue to drive up the costs along the helium supply chain. In addition, maintaining a balance in worldwide helium supply and demand through new capital-intense plant projects is likely to continue to drive helium prices up. Major industrial gas companies will need to continue their focus on conservation and recycle techniques, in addition to efficiency improvements, to increase the reliability of the supply to get the product to their customers.

Maura D. Garvey is Director of Market Research at CryoGas International. She has authored several reports on US and worldwide helium markets. All CryoGas International Helium reports are available for purchase by calling Cryogas at 781-862-0624. Maura Garvey can be reached at mdgarvey@cryogas.com. ❑

US DEPARTMENT OF INTERIOR

Inspector General's Report on BLM Helium Operations

On August 18, 2008 the Inspector General of the US Department of Interior submitted a report of the results of a joint review of the US BLM's Helium Program to the Director, BLM focusing on the two 15 year cooperative agreements between the BLM and Cliffside Partners LP for Cliffside Refiners, L.P. (CRLP) to design/build increased compression capacity and an Enhanced Gas Recovery Plant for BLM and its Cliffside, TX crude helium operations. The Report No.WR-IV-BLM-0003-2008/OI-CO-)&-0206-1 can be obtained from the U.S. Dept of Interior, Office of Inspector General, at that website of www.DOIOIG.gov; go to Recently Released Reports.

According to Mr. Nick DeMai, General Manager, CRLP, "We are aware of the report by the Department of the Interior's Office of Inspector General. We had no prior knowledge of this inquiry into the Bureau of Land Management's (BLM) procurement process or its agreements. We believe we are operating properly under valid and authorized agreements with the BLM. The report identifies itself as being incomplete, and clearly states that no one from Cliffside Refiners was contacted for information during its preparation. We are surprised by this preliminary report and have begun our own evaluation of its content."