

# HELIUM

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Sales of Grade-A helium (99.995% or greater purity) by private industry were 80.8 million cubic meters<sup>2</sup> (about 2.91 billion cubic feet) in the United States in 2003, and exports by private producers were 41.3 million cubic meters (about 1.49 billion cubic feet) for total sales of 122 million cubic meters (about 4.40 billion cubic feet) of U.S. helium, about a 4% decrease from 2002 (table 1). During 2003, domestic helium sales declined by about 8%, while helium exports increased by about 5%.

## Legislation and Government Programs

The Federal Helium Program was established to promote the conservation of helium to provide Federal agencies with current and future helium needs to carry out Government programs authorized and funded by the U.S. Congress. The major Federal helium customers were the National Aeronautics and Space Administration, the U.S. Department of Defense, and the U.S. Department of Energy. On October 9, 1996, the President signed the Helium Privatization Act of 1996 (Public Law 104-273). This legislation directed the Federal Helium Program to discontinue production and sale of refined helium by April 9, 1998. The remaining key components of this legislation and applicable status updates are as follows:

- The final affected property assessment report and final response action plan for the Amarillo plant and the Landis property were submitted to the Texas Commission on Environmental Quality (TCEQ) for final approval in August 2003. Approval to proceed on the Landis property and the Amarillo plant was received from the TCEQ in February 2004.
- Begin selling Federal crude helium reserves in excess of 600 million cubic feet (16.6 billion cubic meters) on or before January 1, 2005, and complete sales by January 1, 2015. STATUS: Crude helium sales (in kind) for helium sold to Federal agencies and their contractors by private companies began in January 1998. The first open market sale of crude helium was conducted in February 2003. A second open market crude helium sale was conducted in October.
- Continue the operation of the helium storage field system, which includes the storage field and the crude helium pipeline system used for the storage and distribution of Government-owned and privately owned crude helium.
- Continue the collection of helium royalties and fees from sales of helium extracted from gas produced from Federal lands.
- Continue the helium resources evaluation and reserve tracking program to monitor helium availability for essential Government programs.

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<sup>2</sup>All metric helium volumes herein are at 101.325 kilopascals absolute (14.696 pounds per square inch absolute) and 15° C (59° F). Helium volumes, reported in parentheses following metric units are measured in cubic feet at 14.7 pounds per square inch absolute and 70° F—1,000 cubic feet (14.7 pounds per square inch absolute and 70° F) equals 27.737 cubic meters (101.325 kilopascals absolute and 15° C) and 1 cubic meter (101.325 kilopascals and 15° C) equals 36.053 cubic feet (14.7 pounds per square inch absolute and 70° F).

- Complete land transfer to the Texas Plains Girl Scout Council. This land transfer was projected to be completed in early 2005.

## Production

In 2003, 12 companies operated 21 privately owned domestic helium plants, 16 of which extracted helium from natural gas (table 2). All but two extraction plants used cryogenic extraction processes. The total sales of U.S. produced helium decreased by about 4% compared with those of 2002. All natural gas processed for helium recovery came from gasfields in Colorado, Kansas, New Mexico, Oklahoma, Texas, Utah, and Wyoming (figure 1). During 2003, 10 private plants purified helium by using pressure swing adsorption technology. Nine privately owned plants that produced Grade-A helium also liquefied helium. The plant operators and plant locations are listed in table 2.

Domestic production data for helium were developed by the U.S. Bureau of Land Management (BLM) from records of its own operations as well as from its own high-purity helium survey, an annual voluntary canvass of private U.S. operations. Of the eight operations to which a survey request was sent, all responded, and those data plus data from BLM operations represent 100% of the total helium sales and recovery data listed in table 3.

Domestic measured helium reserves and indicated helium resources as of January 1, 2003, were estimated to be 8.5 billion cubic meters (305 billion cubic feet). The resources included measured helium reserves estimated to be 3.7 billion cubic meters (133 billion cubic feet) in natural gas from which helium is being extracted. The measured reserves included nearly 867 million cubic meters (31.2 billion cubic feet) stored by the BLM in the helium storage conservation system. Measured helium reserves from indicated resources of natural gas with helium content greater than 0.05% were estimated to be 1.8 billion cubic meters (65 billion cubic feet). Indicated helium resources, a category slightly less certain than measured reserves, in natural gas with less than 0.3% helium were estimated to be 3.0 billion cubic meters (107 billion cubic feet). The majority of these indicated reserves were derived from the Potential Gas Committee designation of unconfirmed/probable reserves (Curtis, 2002). Approximately 2.5 billion cubic meters (91 billion cubic feet), or 98%, of the domestic helium reserves under Federal ownership and from which helium is being extracted is located in the Riley Ridge area in Wyoming and the Cliffside field in Texas.

Most domestic helium resources are in the Midcontinent and Rocky Mountain regions of the United States. The measured helium reserves are in approximately 102 gasfields in 11 States. About 98% of these reserves is contained in the Hugoton field in Oklahoma, Kansas, and Texas; the Panoma field in Kansas; the Keyes field in Oklahoma; the Panhandle West and Cliffside fields in Texas; and the Riley Ridge area in Wyoming. During 2003, the BLM analyzed 168 natural gas samples from 13 States in conjunction with its program to survey and identify possible new sources of helium.

## Consumption

In 2003, private industry supplied 100% of the domestic demand. The major domestic end uses of helium were cryogenics (28%), pressurizing and purging (26%), welding (20%), and controlled atmospheres (13%). Minor uses included chromatography/lifting gas/heat transfer (7%), leak detection (4%), and synthetic breathing mixtures (2%) (figure 3). Cryogenics, specifically magnetic resonance imaging applications, dominated liquid helium use. Estimated 2003 domestic consumption by end use was based on a 2003 end-use survey conducted by BLM's Helium Operations to determine the trends in helium usage.

In-kind crude helium sales regulations (43 CFR part 3195), which became effective on November 23, 1998, require helium refiners that sell helium to Federal agencies and their contractors to buy an equivalent amount of crude helium from the BLM. Such sales are referred to as "in-kind crude helium sales." In 2003, in-kind crude helium sales were 5.6 million cubic meters (203 million cubic feet). The sales were made by eight companies through contracts with the BLM.

## Stocks

The volume of helium stored in the BLM helium conservation storage system, including the conservation pipeline network and the Cliffside field, totaled 832 million cubic meters (about 30 billion cubic feet) on December 31, 2003. The storage system contained crude helium purchased under contract by the BLM from 1962 to 1973 and privately owned helium extracted by industry from natural-gas-supplying fuel markets and stored under contract. This privately owned helium is returned to the owners as needed for purification to supply private demand. During 2003, 19.4 million cubic meters (700 million cubic feet) of private helium was delivered to the BLM's helium conservation system, and 54.5 million cubic meters (about 1.97 billion cubic feet) was withdrawn for a net decrease of 35.1 million cubic meters (about 1.27 billion cubic feet) of private helium in storage (table 4).

## Transportation

Private producers and/or distributors shipped helium, predominantly as a liquid, in semitrailers, which delivered the liquid helium to distribution centers where some of it was gasified and compressed into trailers and small cylinders for delivery to end users. The remaining liquid helium was sold as bulk liquid or repackaged in dewars of various sizes for delivery.

## Prices

In fiscal year 2003, the price that the BLM charged private companies for in-kind crude helium sales was \$1.893 per cubic meter (\$52.50 per thousand cubic feet).

## Foreign Trade

In 2003, exports of Grade-A helium increased to 41.3 million cubic meters (1.49 billion cubic feet) (table 1). Helium exports increased by about 5% compared with those of 2002 and

accounted for about 34% of sales of U.S.-produced helium; private industry supplied all U.S. helium exports. The increase in helium exports is attributed to increased demand for helium from Asia and Europe. About 53% of the helium exported from the United States went to Asia, with Japan receiving about 29% of exports to Asia. About 29% of the exported helium was shipped to Europe; collectively, Belgium, France, Germany, and the United Kingdom received 92% of the helium exported to Europe. Other exports were as follows: Canada and Mexico, 6%; South America, 4%; the Middle East, 4%; Australia and New Zealand, 3%; Africa, 1%; and Central America and the Caribbean, less than 1% each. Import tariffs on helium established on January 1, 1998, remained at the 3.7% rate for normal trade relations (NTR) nations and 25% for non-NTR nations.

## World Review

Excluding the United States, world production capacity of helium remained at an estimated 29 million cubic meters (1.05 billion cubic feet) (table 5). All known helium that was produced outside the United States in 2003 was extracted in Algeria, Poland, and Russia.

## Outlook

In 2003, total market sales for U.S.-produced helium decreased by about 4% compared with those of 2002. From 1998 to 2003, the market growth rate was about 2.4% per year, while from 1993 to 2003, the growth rate was less than 1% per year. Sales of U.S.-produced helium are expected to remain level during the next few years because, while demand for helium exports is growing, domestic use has dropped in the past 2 years. Also, overseas helium projects will be adding new helium production sometime during 2005. This addition of helium to the market will probably slow down export demand growth. The Skikda, Algeria, helium expansion project will be adding a minimum 8.3 million cubic meters (300 million cubic feet) of new production at startup, and the new helium extraction facility under construction in Qatar will have a helium production capacity of 8.3 million cubic meters (300 million cubic feet).

Even though U.S. exports to Asia increased in 2003, the Asian helium market is expected to remain stable during the next several years.

## Reference Cited

Curtis, J.B., 2002, Table 1, *in* National resource estimates for 2002—A report of the Potential Gas Committee: Golden, CO, Colorado School of Mines, 2 p.

## GENERAL SOURCES OF INFORMATION

### U.S. Geological Survey Publications

Helium. Ch. in Mineral Commodity Summaries, annual.  
Helium. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

## Other

Analyses of Natural Gases, 1917-1985. U.S. Bureau of Mines Information Circular 9129, 1987.  
 Analyses of Natural Gases, 1986-1990. U.S. Bureau of Mines Information Circular 9301, 1991.  
 Analyses of Natural Gases, 1991. U.S. Bureau of Mines Information Circular 9318, 1992.  
 Analyses of Natural Gases, 1992. U.S. Bureau of Mines Information Circular 9356, 1993.  
 Analyses of Natural Gases, 1993. U.S. Bureau of Mines Information Circular 9400, 1994.

Analyses of Natural Gases, 1996-1997. U.S. Bureau of Land Management Technical Note 404, 1998.  
 Analyses of Natural Gases, 1998-2001. U.S. Bureau of Land Management Technical Note 412, 2003.  
 Helium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.  
 Helium Resources of the United States, 1991. U.S. Bureau of Mines Information Circular 9342, 1993.  
 Helium Resources of the United States, 1997. U.S. Bureau of Land Management Technical Note 403, 1998.  
 Helium Resources of the United States, 2001. U.S. Bureau of Land Management Technical Note 408, 2001.

TABLE 1  
 TOTAL SALES OF GRADE-A HELIUM  
 PRODUCED IN THE UNITED STATES<sup>1</sup>

(Million cubic meters)

Year	Volume		Total sales
	Domestic sales	Exports <sup>2</sup>	
1999	89.8	26.8	117
2000	89.6	37.0	127
2001	89.0	43.0	132
2002	87.6	39.5	127
2003	80.8	41.3	122

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Source: U.S. Census Bureau.

TABLE 2  
 OWNERSHIP AND LOCATION OF HELIUM EXTRACTION PLANTS IN THE UNITED STATES IN 2003

Owner or operator	Location	Product purity
Air Products and Chemicals, Inc.	Hansford County, TX	Grade-A helium. <sup>1</sup>
Do.	Liberal, KS	Do.
BCCK Engineering, Inc.	Dodge City, KS	Crude helium.
BOC Gases	Otis, KS	Grade-A helium. <sup>1</sup>
BP America Production Company	Sunray, TX	Crude helium.
Do.	Ulysses, KS	Do.
Colorado Interstate Gas Co.	Keyes, OK	Do. <sup>1</sup>
Do.	Lakin, KS	Do.
Duke Energy Field Services	Cheyenne Wells, CO	Crude and Grade-A helium. <sup>1</sup>
Do.	Hansford County, TX	Crude helium.
Do.	Liberal, KS	Do.
Do.	Borger, TX	Do.
Exxon Mobil Corp.	Shute Creek, WY	Crude and Grade-A helium. <sup>1</sup>
Newpoint Gas Services, Inc. <sup>2</sup>	Shiprock, NM	Grade-A helium.
ONEOK, Inc. <sup>3</sup>	Bushton, KS	Crude helium.
Do. <sup>4</sup>	Scott City, KS	Do.
Pioneer Natural Resources Co.	Fain, TX	Do.
Do.	Satanta, KS	Do.
Praxair, Inc.	Bushton, KS	Grade-A helium. <sup>1</sup>
Do.	Ulysses, KS	Do.
Tom Brown, Inc.	Moab, UT	Crude and Grade-A helium. <sup>1</sup>

<sup>1</sup>Including liquefaction.

<sup>2</sup>This plant is the old Cardinal Resources, Inc. Chillicothe, TX, plant.

<sup>3</sup>Plant only produced the first 2 months of 2003.

<sup>4</sup>Output is piped to Ulysses, KS, for purification.

TABLE 3  
HELIUM RECOVERY IN THE UNITED STATES<sup>1</sup>

(Thousand cubic meters)

	1999	2000	2001	2002	2003
<b>Crude helium:</b>					
Bureau of Land Management (BLM) sold (in-kind and open market)	--	--	--	--	51,800
<b>Private industry:</b>					
Private helium accepted and stored by BLM <sup>1</sup>	32,000	23,300	18,000	16,600	19,400
Helium withdrawn from storage	-35,100	-51,900	-62,900	-56,300	-54,500
Total net helium put into storage	-3,100	-28,600	-44,900	-39,700	-35,100
<b>Grade-A helium:</b>					
Private industry sold	117,000	126,600	131,900	127,100	122,000
Total helium stored	-3,100	-28,600	-44,900	-39,700	-35,100
Helium recovery from natural gas	113,900	98,000	87,000	87,400	86,900

-- Zero.

<sup>1</sup>Negative numbers denote a net withdrawal from BLM's underground storage facility, a partially depleted natural gas reservoir at the Cliffside field near Amarillo, TX.

TABLE 4  
SUMMARY OF BUREAU OF LAND MANAGEMENT HELIUM CONSERVATION STORAGE SYSTEM OPERATIONS<sup>1,2</sup>

(Thousand cubic meters)

	2001	2002	2003
<b>Helium in conservation storage system on January 1:</b>			
Stored under BLM conservation program <sup>3</sup>	836,000	829,000	822,000
Stored for private producers under contract	116,000	78,000	45,000
Total <sup>3</sup>	952,000	907,000	867,000
<b>Input to system:</b>			
Net deliveries from BLM plants	--	--	--
Stored for private producers under contract	18,000	16,600	19,400
Total <sup>3</sup>	18,000	16,600	19,400
Redelivery of helium stored for private producers under contract	-62,900	-56,300	-54,500
Net addition to system <sup>3</sup>	-44,900	-39,700	-35,100
<b>Helium in conservation storage system on December 31:</b>			
Stored under BLM conservation program <sup>3</sup>	829,000	822,000	770,000
Stored for private producers under contract	78,000	45,000	62,000
Total <sup>3</sup>	907,000	867,000	832,000

-- Zero.

<sup>1</sup>Crude helium is injected into or withdrawn from BLM's underground storage facility, a partially depleted natural gas reservoir at the Cliffside field near Amarillo, TX.

<sup>2</sup>Negative numbers denote a net withdrawal from BLM's storage facility.

<sup>3</sup>Net additions to system do not include in-kind crude sales or transfers. Totals, however, do include crude sales and transfers.

TABLE 5  
WORLD GRADE-A HELIUM  
PRODUCTION ANNUAL  
CAPACITY, DECEMBER 31, 2003

(Million cubic meters)

	Capacity
United States <sup>1</sup>	152
Rest of world <sup>e</sup>	29
Total <sup>e</sup>	181

<sup>e</sup>Estimated.

<sup>1</sup>Includes plants on standby as well as operating plants.

FIGURE 1  
 MAJOR U.S. HELIUM-BEARING NATURAL GAS FIELDS

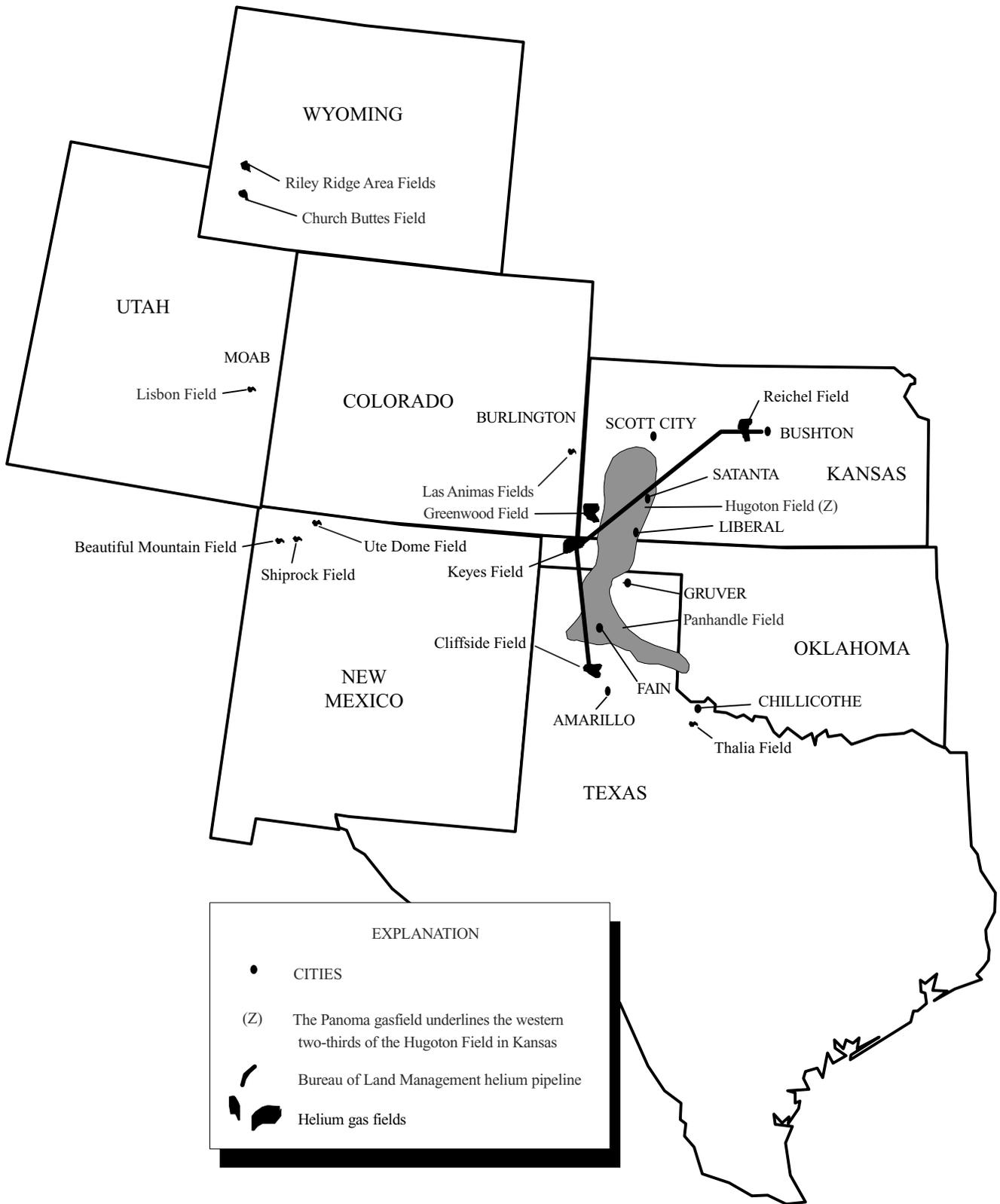


FIGURE 2  
HELIUM RECOVERY IN THE UNITED STATES

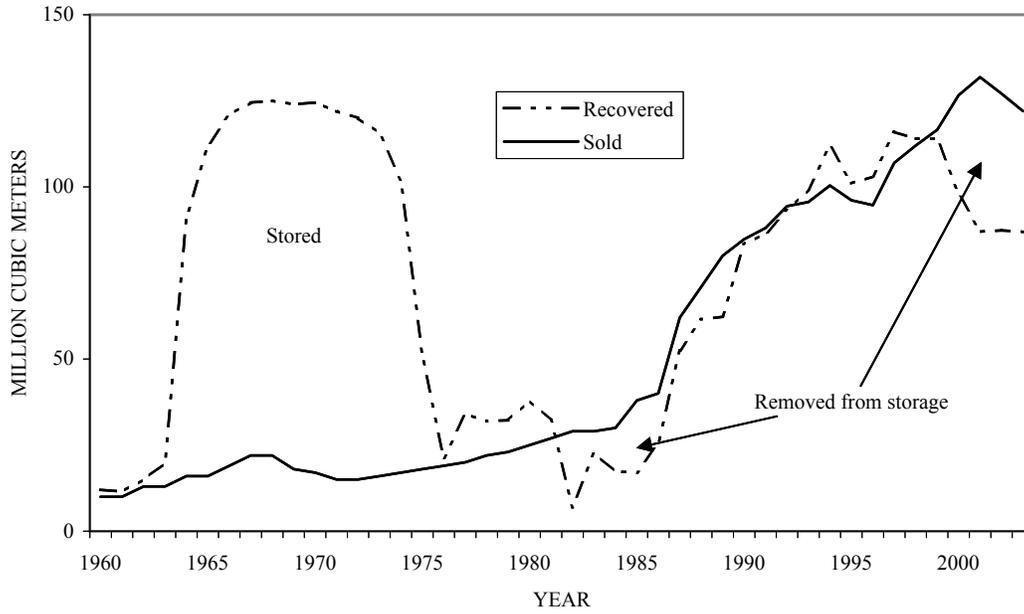
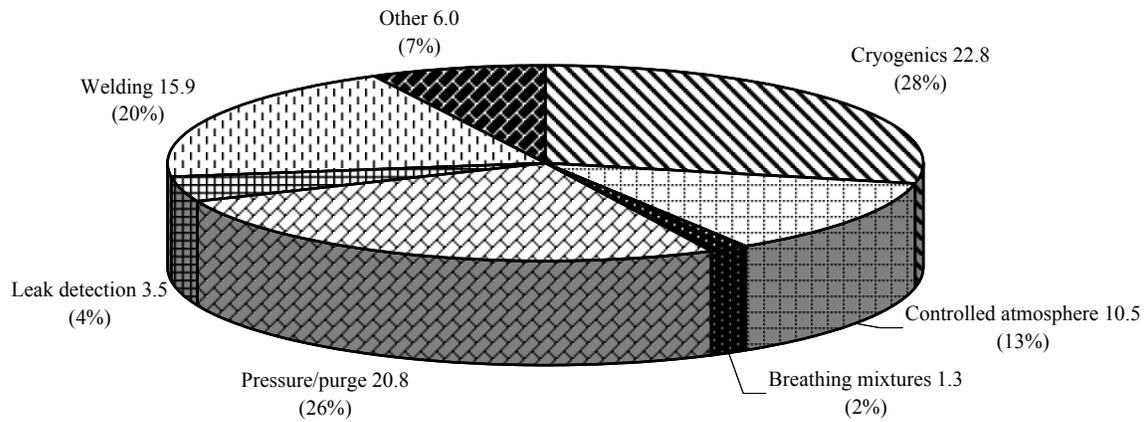


FIGURE 3  
ESTIMATED HELIUM CONSUMPTION, BY END USE, IN THE UNITED STATES IN 2003<sup>1</sup>  
(Million cubic meters)



<sup>1</sup>Total helium used in 2003 was estimated to be 80.8 million cubic meters.