

# HELIUM

By Joseph B. Peterson

Grade-A helium (99.995% or better purity) sales volume in the United States by private industry and the Bureau of Land Management (BLM) was 77.4 million cubic meters (2,790 million cubic feet) in 1997.<sup>1</sup> Grade-A helium exports by private producers were 29.5 million cubic meters (1,060 million cubic feet) for total sales of 107 million cubic meters (3,850 million cubic feet) of U.S. helium, about a 13% increase over 1996. The BLM price for grade-A helium, f.o.b. plant, was \$1.983 per cubic meter (\$55 per thousand cubic feet), and bulk liquid helium was \$2.524 per cubic meter (\$70 per thousand cubic feet) on January 1, 1997, with additional costs for container services and rent.

## Legislation and Government Programs

The Federal Helium Program was established to provide all Federal agencies with current and estimated future helium needs to carry out Government programs authorized and funded by Congress. The BLM major helium customers were the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE).

On October 9, 1996, the President signed the Helium Privatization Act of 1996 (Public Law 104-273). This legislation directed Helium Operations to discontinue production and sale of refined helium by April 9, 1998. Key components of the legislation and status updates are as follows:

- a. Cease production and sales of grade-A helium on or before April 9, 1998, allowing customers to purchase helium from private industry. Status: Dewar sales of liquid helium ceased on October 1, 1997; preparation of special analyzed cylinders ceased November 1, 1997; all liquid trailer filling ceased effective January 1, 1998; and on April 4, 1998, Helium Operations decommissioned its Exell Helium Plant.
- b. Dispose of all helium production, refining, and sales-related assets not later than 24 months after helium refinery closing. Status: Preliminary studies such as 106 Historical Review, Phase 1 Environmental Site Assessment, and property disposal actions are underway.
- c. Begin selling Federal crude helium reserves in excess of 600 million cubic feet on or before January 1, 2005, and complete sales by January 1, 2015. Sale of crude helium is contingent on a legislatively mandated study by the National Academy of Sciences concerning the impact of

selling Federal helium reserves on national scientific and military interests. Status: National Academy of Sciences study is underway.

- d. Continue operation of the helium storage system, which includes the storage field and crude helium pipeline that are used for storage and distribution of both Government-owned and privately owned crude helium.
- e. Continue collection of helium royalties and fees from sales of helium extracted from gas produced from Federal lands.
- f. Continue helium resource evaluation and reserve tracking to monitor helium availability for essential Government programs.
- g. Complete land transfer to Girl Scout Council. Status: A legislatively mandated transfer of the tract of land (known as the Landis property) to the Texas Plains Girl Scout Council is pending. A baseline human and environmental risk assessment for a 331-acre tract of land owned by Helium Operations was sent to the Texas Natural Resources Conservation Commission. The assessment is required to officially close two old landfills on the property before transfer of ownership of the tract can be completed.

## Production

In 1997, 21 privately owned domestic helium plants were operated by 14 companies. Thirteen of the privately owned plants and the BLM plant extracted helium from natural gas. All extraction plants except two use cryogenic extraction processes. The volume of helium recovered from natural gas increased 2% over that of 1996, while total sales of U.S. produced helium increased 13% in 1997 from 1996. All natural gas processed for helium recovery came from gasfields in Colorado, Kansas, Oklahoma, Texas, Utah, and Wyoming. Ten private plants and the BLM plant purified helium this year. Pressure-swing adsorption is used for helium purification at 8 of the 10 private helium plants and at the BLM plant. The BLM also used cryogenic purification for backup. The BLM and eight private plants that produce grade-A helium also liquefy helium. The plant operators and locations are Air Products and Chemicals, Inc., Hansford County, TX, and Liberal, KS; BOC Gases, Inc., Otis, KS; CIG Company, Keyes, OK; Exxon Co., U.S.A., Shute Creek, WY; Praxair, Inc., Bushton and Ulysses, KS; and Unocal, Moab, UT. Nitrotec's helium plants near Burlington, CO, and near Cheyenne Wells, CO, produce grade-A helium but do not liquefy it. (See tables 1, 2, and 3, and figures 1 and 2.)

Domestic production data for helium were developed by the BLM from records of its own operations as well as the High Purity Helium Survey, a single, voluntary canvass of private U.S. operations. Of the seven operations to which a survey request was sent, 100% responded, and those data plus data from BLM operations represent 100% of the total helium sales and recovery

<sup>1</sup> All metric helium volumes herein reported are at 101.325 kilopascals absolute (14.696 psia) and 15°C (59°F). Helium volumes, reported in parentheses following metric units, are measured in cubic feet at 14.7 psia and 70°F. One thousand cubic feet at 14.7 psia and 70°F = 27.737 cubic meters at 101.325 kilopascals absolute and 15°C. One cubic meter at 101.325 kilopascals and 15°C = 36.053 cubic feet at 14.7 psia and 70°F.

shown in table 2.

Domestic measured and indicated helium resources as of January 1, 1997, (the latest figures available) are estimated to be 13 billion cubic meters (470 billion cubic feet). The resources include measured reserves and indicated resources estimated at 6.7 billion cubic meters (242 billion cubic feet) and 0.9 billion cubic meters (32 billion cubic feet), respectively, in natural gas with a minimum helium content of 0.3%. The measured reserves included nearly 1 billion cubic meters (36 billion cubic feet) stored by the BLM in the helium conservation storage system. Measured helium resources in natural gas with a helium content of less than 0.3% are estimated to be 1.3 billion cubic meters (47 billion cubic feet). Indicated helium resources in natural gas with a helium content of less than 0.3% are estimated to be 3.9 billion cubic meters (141 billion cubic feet). Approximately 4.4 billion cubic meters (159 billion cubic feet) or 93% of the domestic helium resources under Federal ownership are in the Riley Ridge area and the Church Buttes Field in Wyoming and in the Cliffside Field in Texas.

Most of the 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 85% of these reserves is contained in the Hugoton Field in Kansas, Oklahoma, and Texas; the Panoma Field in Kansas; the Keyes Field in Oklahoma; the Panhandle and Cliffside Fields in Texas; and the Riley Ridge area in Wyoming. The BLM analyzed a total of 70 natural gas samples from 13 States during 1997 in conjunction with its program to survey and identify possible new sources of helium.

### Consumption

The major domestic end uses of helium were cryogenics, pressurizing and purging, welding, and controlled atmospheres. Minor uses included synthetic breathing mixtures, chromatography, leak detection, lifting gas, and heat transfer. (See figure 3.)

The BLM sales to Federal agencies and their contractors totaled 5.26 million cubic meters (190 million cubic feet) in 1997. Direct helium purchases by DOD, NASA, and DOE constituted most of the BLM grade-A helium sales. Most remaining helium sales to Federal agencies were made through BLM contract distributors, who purchased equivalent volumes of BLM helium under contracts described in the Code of Federal Regulations (30 CFR 602). Some of the contract distributors also have General Services Administration helium supply contracts. These contracts make relatively small volumes of helium readily available to Federal installations at lower freight charges by using the contractors' existing distribution systems.

Estimated 1997 domestic consumption by end use was based on a 1995 domestic end-use survey conducted to determine the trends in helium usage. The information from that survey showed that welding, pressure/purging, lifting gas, leak detection, and inert atmosphere applications continue to be the leading usages of gaseous helium. Cryogenics, specifically magnetic resonance imaging applications, dominated liquid helium usage. (See figure 3.)

### Stocks

The volume of helium stored in the BLM helium conservation storage system, including the conservation pipeline network and Cliffside Field, totaled 988 million cubic meters (35.6 billion cubic feet) at yearend. The storage system contains crude helium purchased under contract by the BLM from 1962 to 1973 and privately owned helium stored under contract. Excess private helium is extracted from natural gas supplying fuel markets and stored by the BLM under contract. This privately owned crude helium is returned to the owners as needed for purification to supply private demand. During 1997, 36.7 million cubic meters (1,320 million cubic feet) of private helium was delivered to the BLM's helium conservation storage system and 21.3 million cubic meters (768 million cubic feet) was withdrawn for a net increase of 15.4 million cubic meters (555 million cubic feet) of private helium in storage. (See table 4.)

### Transportation

All grade-A gaseous helium sold by the BLM was shipped in modules (large gas cylinders), special railway tankcars, or highway tube semitrailers from either the Amarillo Helium Plant or the Exell Helium Plant, Masterson, TX. The BLM liquid helium was shipped in dewars and semitrailers from the Exell plant. Private producers and/or distributors shipped helium predominantly as a liquid in semitrailers. These semitrailers delivered the liquid helium to distribution centers where some of it was gasified and compressed into trailers and small cylinders for delivery to the end user. The remaining liquid helium was sold as bulk liquid or repackaged in dewars of various sizes for delivery.

### Prices

The BLM price for grade-A helium, f.o.b. plant, was \$1.983 per cubic meter (\$55 per thousand cubic feet) and bulk liquid helium was \$2.524 per cubic meter (\$70 per thousand cubic feet) on January 1, 1997, with additional costs for container services and rent.

### Foreign Trade

Exports of grade-A helium, all by private industry, increased by 22.7% in 1997 to 29.5 million cubic meters (1,060 million cubic feet). (See table 3.) About 55% of the U.S. helium exports went to Asia, with Japan receiving about 73% of the Asian export. About 22% of the exported helium was shipped to Europe. Belgium, France, Germany, and the United Kingdom, collectively, received about 99% of the European exports. Other exports were as follows: about 11% to North America; about 3% to Australia-New Zealand, 2% to the Middle East; 6% to South America; less than 1% to Africa; and the remainder to the Caribbean and to Central America. Although a small quantity, 139 thousand cubic meters, of helium was imported by the United States in 1997, import tariffs on helium remained at the 3.7% rate for most favored nations established on January 1, 1987. The non-most-favored-nation tariff also remained unchanged at 25%.

## World Review

World production capacity of helium, excluding the United States, was estimated to be 29 million cubic meters (1,000 million cubic feet). Most of the helium produced outside of the United States was extracted in Algeria, Poland, and Russia. (See table 5.)

## Current Research and Technology

Technology that uses liquid helium to produce superconducting temperatures continues to be developed and utilized. Liquid helium use in magnetic resonance imaging (MRI) continues to increase as the medical profession develops new uses for this equipment. The MRI equipment is providing accurate diagnoses of medical problems where exploratory surgery was previously required. Experiments using laser polarized helium gas or a noble gas dissolved in the bloodstream have improved medical imaging techniques and could lead to extensive advances in medical diagnostics. The method could also be used to determine the relationships between brain functions and the effect stimuli have on blood flow to the brain, or it could be used to image blood vessels to determine various heart conditions.

Other evolving technologies that require the unique properties of helium are (1) metastable helium for energy storage, which involves raising helium electrons to an excited energy state and then stabilizing the atom; (2) fiber-optic production and crystal growth applications, where an ultra-pure inert atmosphere is required; and (3) liquid helium-cooled superconducting microswitches.

## Outlook

The total market for U.S. produced helium increased 13% from the 1996 sales level. Market growth rate for the 5-year period 1992-97 was about 2.5%. Market growth rate for private industry helium increased nearly 15% over the 1996 sales level and at a growth rate of about 3.5% for the 5-year period 1992-97.

In 1997, private industry supplied about 95.1% of the domestic demand, while the Federal Government supplied the remaining 4.9%. Helium exports increased 29.4% compared with 1996, and

accounted for 27.6% of U.S.-produced helium sales. Private industry supplied all of the U.S. helium exports. Expansion of the Asian helium market is expected to continue; however, economic problems may slow the rate of growth. Competition from foreign helium suppliers will provide continued uncertainty of the strength of U.S. exports to the global helium market. Helium sales in the private sector are expected to continue at moderate growth over the next 3 years (about 5%). Use of high-temperature superconductor materials in electric motor windings and increased fiber optics demands are expected to increase helium demand.

## SOURCES OF INFORMATION

### U.S. Geological Survey Publications

Helium. Ch. in Mineral Commodity Summaries, annual.<sup>2</sup>

Helium. Ch. in Minerals Yearbook, annual.<sup>2</sup>

Helium. Ch. in United States mineral resources, U.S. Geological Survey Professional Paper 820, 1973.

### Other

Analyses of natural gases, 1917-85, U.S. Bureau of Mines Information Circular 9129, 1987.

Analyses of natural gases, 1986-90, U.S. Bureau of Mines Information Circular 9301, 1991.

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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.

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.

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<sup>2</sup>Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1  
OWNERSHIP AND LOCATION OF HELIUM EXTRACTION PLANTS  
IN THE UNITED STATES IN 1997

Category and owner or operator	Location	Product purity
Government-owned:		
Bureau of Land Management (BLM)	Masterson, TX	Grade-A helium. 1/
Private industry:		
Air Products and Chemicals, Inc.	Hansford County, TX	Do.
Do.	Liberal, KS	Do.
BOC Gases, Inc.	Otis, KS	Do.
CIG Company	Keyes, OK	Do.
Do.	Lakin, KS	Crude helium.
Exxon Co., U.S.A.	Shute Creek, WY	Grade-A helium. 1/
GPM	Moore County, TX	Crude helium. 2/
Do.	Hansford County, TX	Crude helium.
KN Energy, Inc.	Bushton, KS	Do.
Do.	Scott City, KS	Crude helium. 3/
Maxus Energy Corp.	Sunray, TX	Crude helium.
Mesa, Inc.	Fain, TX	Do. 4/
Do.	Satanta, KS	Crude helium.
National Helium Corp.	Liberal, KS	Do.
Nitrotec	Burlington, CO	Grade-A helium.
Do.	Cheyenne Wells, CO	Do.
Praxair, Inc.	Bushton, KS	Do. 1/
Do.	Ulysses, KS	Do. 1/
Trident NGL, Inc.	Do.	Crude helium.
Unocal	Moab, UT	Grade-A helium. 1/
Williams Field Services	Baker, OK	Crude helium.

1/ Including liquefaction.

2/ Resumed production in September 1997.

3/ Output is piped to Ulysses, KS, for purification.

4/ Resumed production in February 1997.

TABLE 2  
HELIUM RECOVERY IN THE UNITED STATES 1/ 2/

(Thousand cubic meters)

	1,993	1994	1995	1996	1997
Crude helium:					
Bureau of Land Management (BLM) total storage	(8,850)	(7,200)	(7,600)	(7,230)	(6,130)
Private industry:					
Stored by BLM	29,600	38,800	36,100	36,700	36,700
Withdrawn	(16,400)	(19,500)	(23,200)	(21,200)	(21,300)
Total private industry storage	13,200	19,300	12,900	15,500	15,400
Total crude helium	4,350	12,100	5,300	8,270	9,270
Stored private crude helium withdrawn from storage and purified by the BLM for redelivery to industry	(638)	(610)	(69)	--	--
Grade-A helium:					
BLM sold	7,930	6,610	7,210	6,060	5,260
Private industry sold	87,600	93,800	88,900	88,600	102,000
Total sold	95,500	100,000	96,100	94,700	107,000
Total stored	3,710	11,500	5,230	8,270	9,270
Grand total recovery	99,200	112,000	101,000	103,000	116,000

1/ Negative numbers are enclosed in parentheses ( ) to denote net withdrawal from the BLM's underground storage facility, a partially depleted natural gas reservoir in Cliffside Field near Amarillo, TX.

2/ Data rounded to three significant digits; may not add to totals shown.

TABLE 3  
TOTAL SALES OF GRADE-A HELIUM PRODUCED  
IN THE UNITED STATES

(Million cubic meters)

Year	Volume		Total sales
	Domestic sales	Exports 1/	
1993	67.6	28.0	95.6
1994	75.4	25.0	100.4
1995	68.4	27.7	96.1
1996	71.9	22.8	94.7
1997	77.4	29.5	106.9

1/ Source: Bureau of the Census.

TABLE 4  
SUMMARY OF BUREAU OF LAND MANAGEMENT (BLM)  
HELIUM CONSERVATION STORAGE SYSTEM OPERATIONS 1/ 2/

(Thousand cubic meters)

	1995	1996	1997
Helium in conservation storage system at beginning of period:			
Stored under BLM conservation program	878,000	870,000	863,000
Stored for private producers under contract	87,500	100,000	116,000
Total	965,000	970,000	979,000
Input to system:			
Net deliveries from BLM plants 3/	(7,600)	(7,230)	(6,130)
Stored for private producers under contract	36,100	36,700	36,700
Total	28,500	29,500	30,600
Redelivery of helium stored for private producers under contract 3/	(23,200)	(21,200)	(21,300)
Net addition to system	5,300	8,260	9,230
Helium in conservation storage system at end of period:			
Stored under BLM conservation program	870,000	863,000	857,000
Stored for private producers under contract	100,000	116,000	131,000
Total	970,000	979,000	988,000

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

2/ Data rounded to three significant digits; may not add to totals shown.

3/ Numbers in parentheses indicate net withdrawal from storage.

TABLE 5  
WORLD GRADE-A HELIUM PRODUCTION  
ANNUAL CAPACITY, DECEMBER 31, 1997

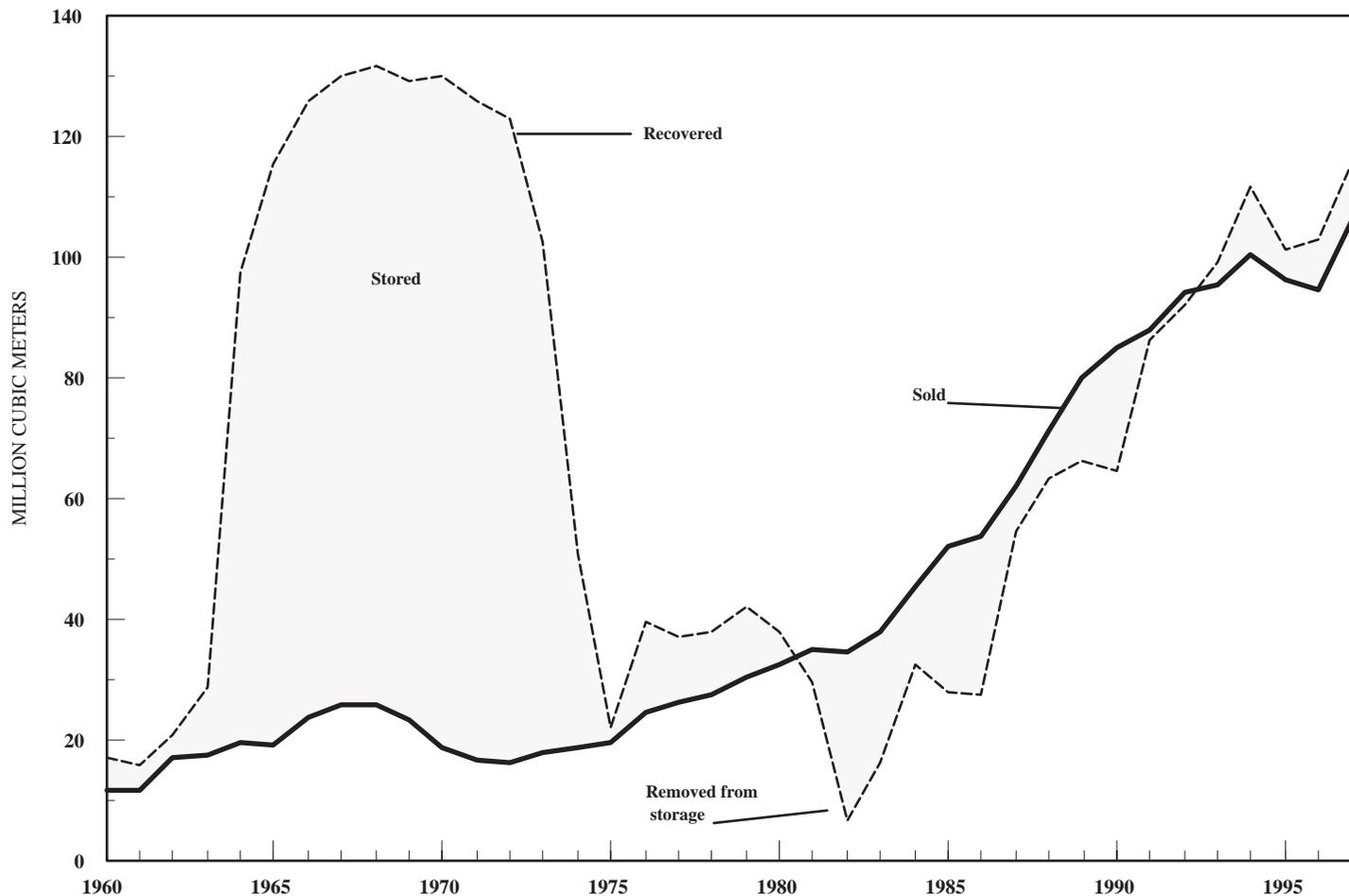
(Million cubic meters)

	Capacity
United States 1/	130
Rest of world e/	29
Total e/	159

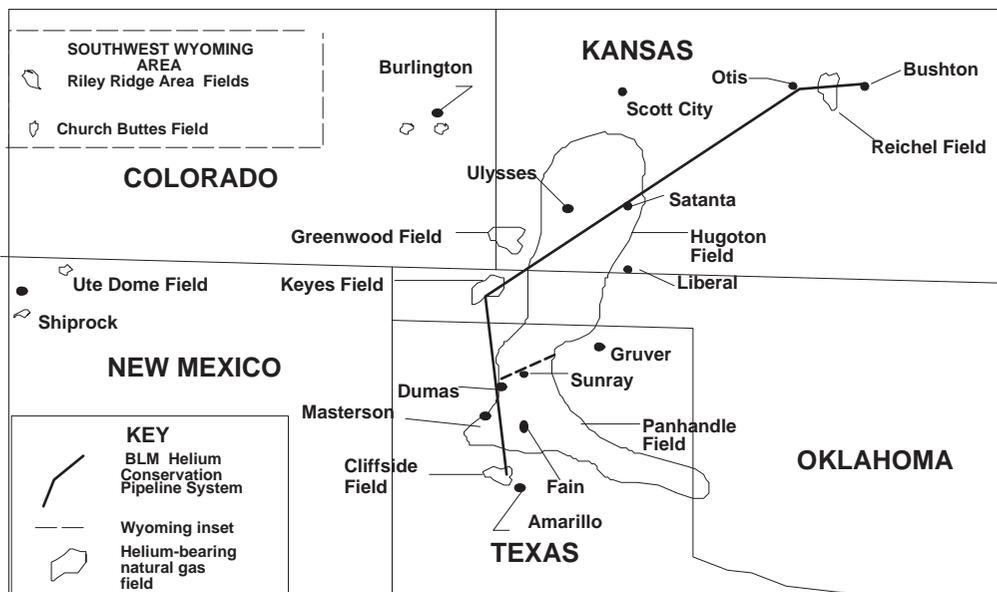
e/ Estimated.

1/ Includes capacity of plants on standby as well as operating plants.

**FIGURE 1  
HELIUM RECOVERY IN THE UNITED STATES**

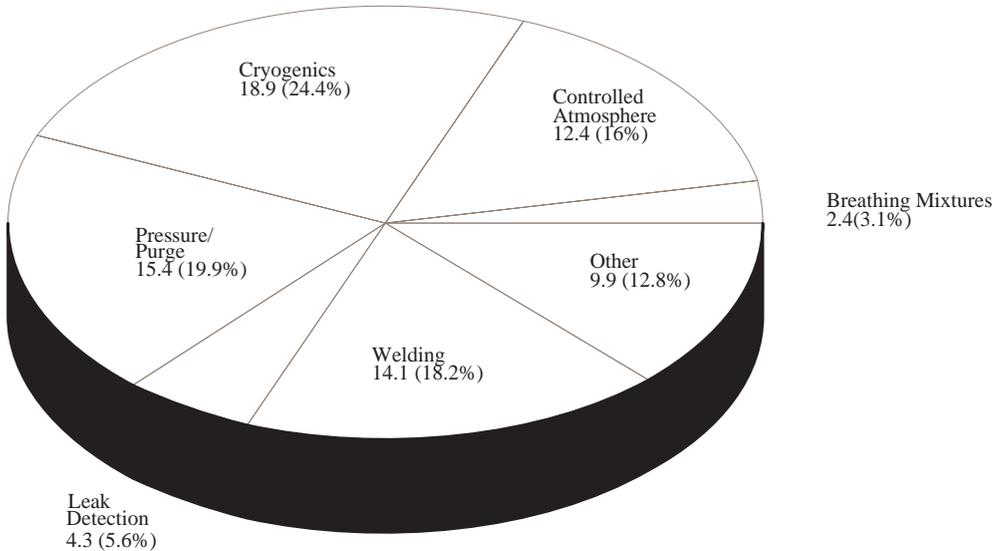


**FIGURE 2  
MAJOR U.S. HELIUM-BEARING NATURAL GAS  
FIELDS**



**FIGURE 3**  
**ESTIMATED HELIUM CONSUMPTION, BY END USE, IN THE UNITED STATES IN 1997**

(Million cubic meters)



Estimated total helium used  
(77.4 million cubic meters)