HELIUM

By Joseph B. Peterson[1]

Grade-A helium (99.995% or better purity) sales volumes were 89.8 million cubic meters (Mm^3)[1] (3,238 million cubic feet) in the United States by private industry in 1999 (table 1). Grade-A helium exports by private producers were 26.8 Mm^3 (966 million cubic feet) for total sales of 117 Mm^3 (4,203 million cubic feet) of U.S. helium, about a 4.5% increase from 1998. On January 1, 1999, the estimated prices for Grade-A helium and bulk liquid helium were $1.983 per cubic meter ($55 per thousand cubic feet) and $2.524 per cubic meter ($70 per thousand cubic feet), respectively, 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 the U.S. Congress. The major Federal helium customers were the National Aeronautics and Space Administration (NASA), 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. Key components of this legislation and applicable status updates were as follows:

- Cease production and sales of refined helium on or before April 9, 1998.
  STATUS: All refining and sales were discontinued in March 1998.

- Dispose of all assets related to helium production, refining, and sales not later than 24 months after helium refinery closing.
  STATUS: An historical review was initiated in June 1999, and reports were completed in August 1999. The Phase 1 environmental site assessment was initiated in early 1999, and reports were completed in July 1999. Property disposal actions are underway.

- 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.
  STATUS: Crude helium sales (in kind) for helium that is sold to Federal agencies and their contractors by private companies began in January 1998. Open-market sale of the crude helium is dependent on a legislatively mandated study by the National Academy of Sciences (NAS) concerning the impact on national, scientific, and military interests. The NAS study was scheduled to be completed in March 2000.

- Continue operation of the helium storage field system, which includes the storage field and the crude helium pipeline used for storage and distribution of Government-owned and privately owned crude helium.

- Continue collection of helium royalties and fees from sales of helium extracted from gas produced from Federal lands.

- Continue helium resource evaluation and reserve tracking to monitor helium availability for essential Government programs.

- Complete land transfer to the Girl Scout Council.
  STATUS: Historical/archeological reviews and environmental assessments are being carried out and are expected to be complete by August 2001.

Production

In 1999, 15 companies operated 22 privately owned domestic helium plants, 15 of which extracted helium from natural gas (table 2; figures 1-2). All but two extraction plants used cryogenic extraction processes. The total sales of U.S.-produced helium increased by 4.5% compared with that of 1998. All natural gas processed for helium recovery came from gasfields in Colorado, Kansas, Oklahoma, Texas, Utah, and Wyoming. During 1999, 11 private plants purified helium by using pressure swing adsorption technology. Nine privately owned plants that produced Grade-A helium also liquified helium. Those plant operators and locations were as follows: Air Products and Chemicals, Inc., Hansford County, TX, and Liberal, KS; BOC Gases, Inc., Otis, KS; Coastal Corp., Keyes, OK; Duke Energy Corp., Cheyenne Wells, CO; Exxon Co., U.S.A., Shute Creek, WY; GPM, Hansford County, TX, and Moore County, TX; Praxair, Inc., Bushton, KS, and Ulysses, KS; and Tom Brown Inc., Moab, UT. The Nitrotec Energy Corp., Cheyenne Wells, CO, and Chillicothe, TX, plants purify, but do not liquefy, helium.

Domestic production data for helium were developed by the Bureau of Land Management (BLM) from records of its own

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[2]All metric helium volumes herein reported 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 pound per square inch absolute and 70° F) = 27.737 cubic meters (101.325 kilopascals absolute and 15° C) and 1 cubic meter (101.325 kilopascals and 15° C) = 36.053 cubic feet (14.7 pounds per square inch absolute and 70° F).

operations, as well as from its own High Purity Helium Survey, a single voluntary canvass of private U.S. operations. Of the nine 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 data shown in table 3.

Domestic helium measured reserves and indicated helium resources as of January 1, 1999, were estimated to be 11 billion cubic meters (Gm^3) (395 billion cubic feet). The resources include measured reserves and indicated resources as estimated at 6.0 Gm^3 (215 billion cubic feet) and 900 Mm^3 (32 billion cubic feet), respectively, in natural gas with a minimum helium content of 0.3%. The measured reserves included nearly 960 Mm^3 (34.8 billion cubic feet) stored by the BLM in the helium storage conservation system. Measured helium reserves in natural gas with helium content of less than 0.3% and greater than 0.05% were estimated to be 400 Mm^3 (14 billion cubic feet). Indicated helium resources, a category of reserves slightly less certain than measured reserves, in natural gas with less than 0.3% helium, were estimated to be 3.7 Gm^3 (134 billion cubic feet). The majority of these indicated reserves were derived from the Potential Gas Committee designation of unconfirmed/probable reserves (Curtis, 1999). Approximately 4.3 Gm^3 (154 billion cubic feet), or 93%, of the domestic helium reserves under Federal ownership was 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 the Rocky Mountain regions of the United States. The measured helium reserves were in approximately 102 gasfields in 11 States. About 93% 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 the Cliffside Fields in Texas; and the Riley Ridge area in Wyoming. During 1999, the BLM analyzed 46 natural gas samples from 5 States in conjunction with its program to survey and identify possible new sources of helium.

Consumption

In 1999, private industry supplied 100% of the domestic demand. The major domestic end uses of helium were cryogenics (24.4%), pressurizing and purging (19.9%), welding (18.2%), and controlled atmospheres (16.0%). Minor uses included leak detection (5.6%), synthetic breathing mixtures (3.1%), and chromatography/lifting gas/heat transfer (total 12.8%) (figure 3). Cryogenics, specifically magnetic resonance imaging applications, dominated liquid helium use. Estimated 1999 domestic consumption by end use was based on a 1995 end-use survey conducted by BLM Helium Operations to determine the trends in helium usage.

New regulations, effective November 23, 1998, concerning in-kind crude helium sales were published in 43 CFR Chapter II, Part 3195. These regulations require that helium refiners selling to Federal agencies and their contractors must buy an equivalent amount of crude helium from the BLM. Such sales are referred to as "in-kind crude helium sales." In 1999, in-kind crude helium sales were 6.0 Mm^3 (218 million cubic feet) and were made by seven 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 979 Mm^3 (35.3 billion cubic feet) on December 31, 1999. 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-suppling fuel markets, stored under contract. This privately owned helium is returned to the owners as needed for purification to supply private demand. During 1999, 32.0 Mm^3 (1.154 billion cubic feet) of private helium was delivered to the BLM's helium conservation system and 35.1 Mm^3 (1.265 billion cubic feet) was withdrawn for a net decrease of 3.1 Mm^3 (112 million cubic feet) of private helium in storage (table 4).

Transportation

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 end users. The remaining liquid helium was sold as bulk liquid or repackaged in dewars of various sizes for delivery.

Prices

The price charged for crude helium to private companies for in-kind crude helium sales was $1.767 per cubic meter ($49 per thousand cubic feet) for fiscal year 1999.

Foreign Trade

In 1999, exports of Grade-A helium decreased to 26.8 Mm^3 (966 million cubic feet) (table 1). Helium exports decreased by 3.6% compared with that of 1998 and accounted for 22.9% of the U.S.-produced helium sales; private industry supplied all U.S. helium exports. About 55% of the U.S. helium exports went to Asia, with Japan receiving about 77% of those exports. About 20% of the exported helium was shipped to Europe; collectively, Belgium, France, Germany, and the United Kingdom, received 94%. Other exports were as follows: Canada and Mexico, 12%; South America, 6%; Australia-New Zealand, 5%; and the Middle East, Africa, 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 nations and at the 25% for non-normal-trade-relations nations.

World Review

Excluding the United States, world production capacity of helium was estimated to be 29 Mm^3 (1.045 billion cubic feet). All known helium produced outside of the United States was extracted in Algeria, Poland, and Russia (table 5).

Outlook

The total market for U.S.-produced helium increased by 4.5% compared with that of 1998. From 1993 to 1999, the market growth rate was about 3.4%.

Expansion of the Asian helium market over the next 2 years is expected to moderate owing to the uncertain economic condition in that region of the world. Competition from foreign helium producers will provide continued uncertainty in the strength of the U.S. exports to the global helium market. Helium sales in the private sector are expected to continue at a moderate growth rate of 5% during the next 3 years. Use of high-temperature superconductor materials in electric motor windings and increased fiber optics demands are expected to increase helium demand.

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[2]Prior to January 1996, published by the U.S. Bureau of Mines.

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

(Million cubic meters)

Year	Volume		
	Domestic sales	Exports 2/	Total sales
1995	68.4	27.7	96.1
1996	71.9	22.8	94.7
1997	77.4	29.5	107
1998	84.2	27.8	112
1999	89.8	26.8	117

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Source: U.S. Census Bureau.

TABLE 2
OWNERSHIP AND LOCATION OF HELIUM EXTRACTION PLANTS IN THE UNITED STATES IN 1999

Category and owner or operator	Location	Product purity
Government owned:		
Bureau of Land Management 1/	Masterson, TX	Grade-A helium 2/
Private industry:		
Air Products and Chemicals, Inc.	Hansford County, TX	Do. 2/
Do.	Liberal, KS	Do. 2/
Amoco 3/	Ulysses, KS	Crude helium
BOC Gases, Inc.	Otis, KS	Grade-A helium 2/
CIG Co. (a subsidiary of Coastal Corp.)	Keyes, OK	Do. 2/
Do.	Lakin, KS	Crude helium
Crescendo Resources	Sunray, TX	Do.
Duke Energy Corp.	Cheyenne Wells, CO	Crude and Grade-A helium 2/
Exxon Co., U.S.A.	Shute Creek, WY	Crude and Grade-A helium 2/
GPM	Hansford County, TX	Crude helium
Do.	Moore County, TX	Do.
KN Energy Inc.	Bushton, KS	Do.
Do. 4/	Scott City, KS	Do.
National Helium Corp.	Liberal, KS	Do.
Nitrotec Energy Corp.	Cheyenne Wells, CO	Grade-A helium
Do. 5/	Chillicothe, TX	Do.
Pioneer Natural Resources Co.	Fain, TX	Crude helium
Do.	Satanta, KS	Do.
Praxair, Inc.	Bushton, KS	Grade-A helium 2/
Do.	Ulysses, KS	Do. 2/
Tom Brown Inc.	Moab, UT	Crude and Grade-A helium 2/
Williams Field Services Co.	Baker, OK	Crude helium

1/ Stopped production in March 1998.
2/ Including liquefaction.
3/ Began production in May 1998.
4/ Output is piped to Ulysses, KS, for purification.
5/ Began production in March 1999.

TABLE 3
HELIUM RECOVERY IN THE UNITED STATES 1/ 2/

(Thousand cubic meters)

	1995	1996	1997	1998	1999
Crude helium:					
Bureau of Land Management (BLM) total storage	(7,600)	(7,230)	(6,130)	(100) r/	--
Private industry:					
Stored by BLM	36,100	36,700	36,700	33,000	32,000
Withdrawn	(23,200)	(21,200)	(21,300)	(31,400)	(35,100)
Total private industry storage	12,900	15,500	15,400	1,600	(3,100)
Total crude helium	5,300	8,270	9,270	1,500 r/	(3,100)
Stored private helium withdrawn from storage and purified by BLM for redelivery to industry	(69)	--	--	--	--
Grade-A helium:					
BLM sold	7,210	6,060	5,260	2,000 r/	--
Private industry sold	88,900	88,600	102,000	110,000	117,000
Total sold	96,100	94,700	107,000	112,000	117,000
Total stored	5,230	8,270	9,270	1,500 r/	(3,100)
Grand total recovery	101,000	103,000	116,000	114,000 r/	114,000

r/ Revised. -- Zero.
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 are rounded to no more than three significant digits; may not add to totals shown.

TABLE 4
SUMMARY OF BUREAU OF LAND MANAGEMENT HELIUM CONSERVATION STORAGE SYSTEM OPERATIONS 1/ 2/ 3/

(Thousand cubic meters)

	1997	1998	1999
Helium in conservation storage system on January 1:			
Stored under BLM conservation program 4/	859,000 r/	852,000 r/	847,000
Stored for private producers under contract	116,000 r/	131,000	135,000
Total 4/	975,000 r/	983,000 r/	983,000
Input to system:			
Net deliveries from BLM plants	(6,130)	(100) r/	--
Stored for private producers under contract	37,100 r/	33,000	32,000
Total 4/	31,000 r/	33,000 r/	32,000
Redelivery of helium stored for private producers under contract	(20,900) r/	(31,500) r/	(35,100)
Net addition to system 4/	11,670 r/	1,500 r/	(3,100)
Helium in conservation storage system on December 31:			
Stored under BLM conservation program 4/	852,000 r/	847,000 r/	841,000
Stored for private producers under contract	131,000	135,000 r/	138,000
Total 4/	983,000 r/	983,000 r/	979,000

r/ Revised. -- Zero.
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 are rounded to no more than three significant digits; may not add to totals shown.
3/ Numbers in parentheses indicate net withdrawal from storage.
4/ Net additions to system do not include in-kind crude sales or transfers. However, totals do include crude sales and transfers.

TABLE 5
WORLD GRADE-A HELIUM PRODUCTION
ANNUAL CAPACITY, DECEMBER 31, 1999

(Million cubic meters)

	Capacity
United States 1/	138
Rest of world e/	29
Total e/	165

e/ Estimated.
1/ Includes plant on standby, as well as operating plants.

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

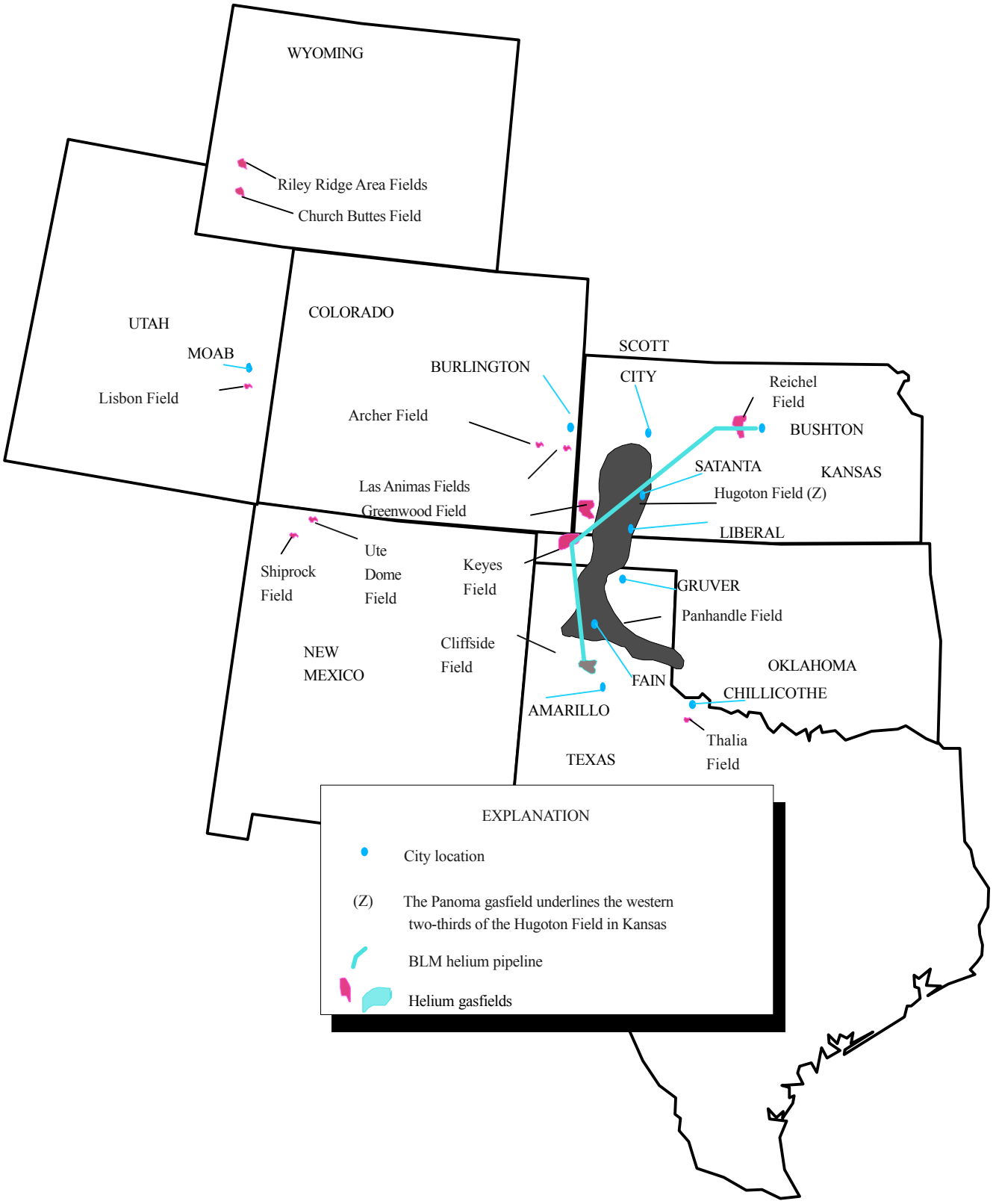


FIGURE 2
HELIUM RECOVERY IN THE UNITED STATES

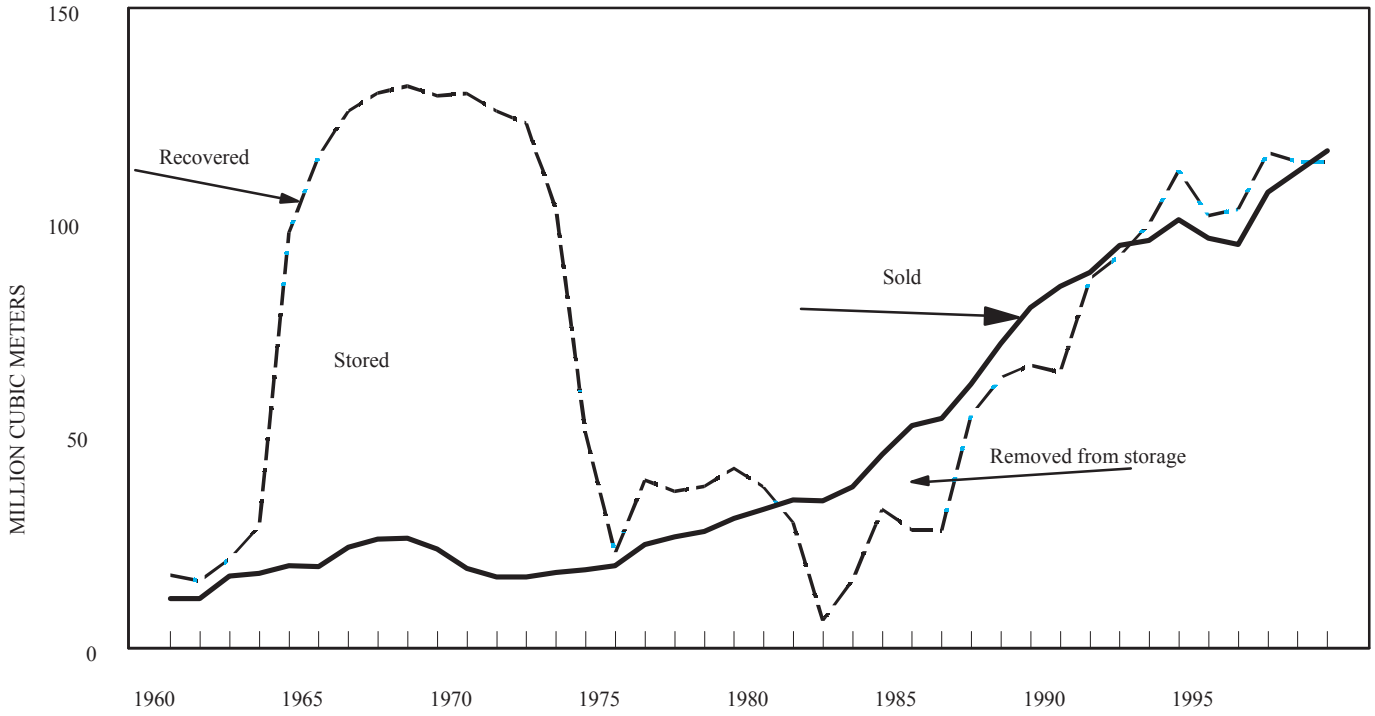
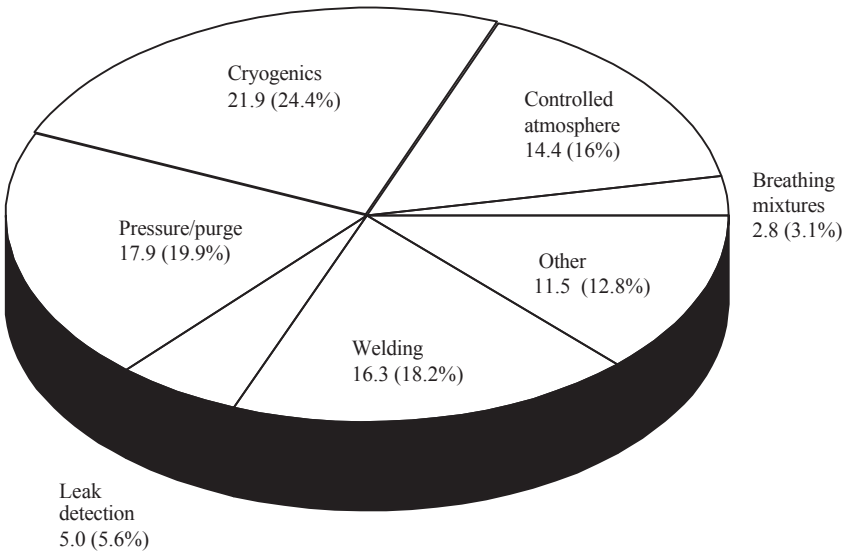


FIGURE 3
ESTIMATED HELIUM CONSUMPTION, BY END USE,
IN THE UNITED STATES IN 1999

(Million cubic meters)



Estimated total helium used was 89.8 million cubic meters in 1999.