

HELIUM

By Norbert Pacheco¹

Grade-A helium (99.995% or better purity) sales volumes by private industry were 89.6 million cubic meters² (3,230 million cubic feet) in the United States in 2000 (table 1). Grade-A helium exports by private producers were 37.0 million cubic meters (1,330 million cubic feet) for total sales of 126.6 million cubic meters (4,564 million cubic feet) of U.S. helium, about an 8% increase from 1999. For 2000, domestic helium sales growth remained relatively stable. However, helium exports increased significantly. The increase in exported helium was mostly due to increased European demand for helium.

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

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²All 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 pounds 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).

National Aeronautics and Space Administration, the U.S. Department of Defense, and the U.S. Department of Energy.

On October 9, 1996, the Helium Privatization Act of 1996 (Public Law 104-273) was signed into law. This legislation directed the Federal Helium Program to discontinue production and sale of refined helium by April 9, 1998. Some of the remaining key components of this legislation and applicable status updates are as follows:

- Dispose of all assets related to helium production, refining, and sales not later than 24 months after helium refinery closing.

STATUS: A 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. The National Park Service was preparing a historic architectural engineering report on the Amarillo and Exell Plants. Additionally, an application was been filed with the Texas Voluntary Compliance Program for the Landis property, and a contractor was secured for sampling and assessment. Property disposal actions continued.

- Begin selling Federal crude helium reserves in excess of 16.6 million cubic meters (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

Helium in the 20th Century

In 1900, helium was essentially unknown. Even though it was first detected during the solar eclipse of August 18, 1868, and it was found to exist in rather large quantities in natural gas wells of the midcontinental United States, commercial recovery of helium did not develop until the onset of World War I. At that time, the British Government became interested in helium as a lifting gas and initiated a research program at the University of Toronto. By 1918, a small experimental plant was operating near Hamilton, Ontario. When the United States entered World War I, the task of establishing a domestic source of helium was given to the U.S. Bureau of Mines. In 1921, the first full scale U.S. helium production plant was completed near Forth Worth, TX, where about 47 million standard cubic feet of helium was produced from the Petrolia Field. It operated until 1929. Because the U.S. Navy was using almost all of the helium produced in the country for the Airship Program, the Bureau of Mines built a new plant near Amarillo, TX, which could produce as much as 25 million cubic feet per year of helium. Later, the Bureau of Mines built the Exell plant, also in Texas, which eventually became its last operating plant. These two plants extracted helium from natural gas produced from the Government's Cliffside Field. Later, the Cliffside Field reservoir (also

known as the Bush Dome) would become the only helium storage reservoir in the world.

In the 1950s, optimism about future markets for helium developed, and helium began to be considered as a resource during the cold war. Widespread use led to the Helium Act of 1960, which created the Helium Conservation Program, allowing for private helium production. As a result, five new private helium extraction plants were built over the next several years. From 1963 to 1973, the U.S. Government purchased helium from the private producers and stored it in Bush Dome. The helium industry continued to grow as more uses for helium were discovered. By 1996, 14 private companies owned a total of 20 helium plants, and U.S. helium consumption had grown to 2.6 billion standard cubic feet per year.

In 2000, the United States still led the world in helium production, accounting for about 80% of world output. Twelve U.S. private companies owned and operated 21 domestic helium production plants. U.S. helium consumption had grown to over 3.4 billion standard cubic feet per year, and demand for helium continued to grow worldwide. By then, helium uses included cryogenics, pressurizing and purging, welding, atmospheric control, leak detection, breathing mixtures, lifting, and medical applications.

to Federal agencies and their contractors by private companies began in January 1998. Open-market sales of crude helium were reviewed in a legislatively mandated study conducted by the National Academy of Sciences (NAS) concerning the impact on national, scientific, and military interests. The NAS study was completed in March 2000. Helium regulations, however, are being developed and, once in place, will be used to guide open-market sales of the crude helium.

- 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 Texas Plains Girl Scouts Council.

STATUS: Historical and archeological reviews and environmental assessments were being carried out and were expected to be completed by August 2001.

Production

In 2000, 12 companies operated 21 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 12.0% compared with that of 1999. All natural gas processed for helium recovery came from gasfields in Colorado, Kansas, Oklahoma, Texas, Utah, and Wyoming. During 2000, 11 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 Bureau of Land Management (BLM) from records of its own 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. 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, 2000, were estimated to be 8.9 billion cubic meters (323 billion cubic feet). The resources include measured helium reserves estimated to be 4.1 billion cubic meters (147 billion cubic feet) in natural gas from which helium is being extracted. The measured reserves included nearly 951 million cubic meters (34.3 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% are estimated to be 1.8 billion cubic meters (65 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 3.1 billion cubic meters (111 billion cubic feet). The majority of these indicated reserves were derived from the Potential Gas Committee designation of unconfirmed/probable reserves (Curtis, 2000, p. 2-3). Approximately 2.6 billion cubic meters

(94 billion cubic feet), or 98% of the domestic helium reserves that are under Federal ownership from which helium is being extracted, is located in the Riley Ridge area in Wyoming and the Cliffside Field in Texas.

The changes in how the helium reserves have been reported above are meant to provide the reader a better view of the helium reserves from which helium is being extracted. The 4.1 billion cubic meters (147 billion cubic feet) is estimated helium reserves that can be extracted from natural gas production over the expected life of gasfields from which gas is currently being produced. The 1.8 billion cubic meters (65 billion cubic feet) is estimated measured helium reserves in gasfields, from some of which helium could be extracted in the future. The 3.1 billion cubic meters (111 billion cubic feet) is indicated helium resources in probable/unconfirmed natural gas resources from which helium is not likely to be extracted.

Most of the domestic helium resources are in the midcontinent and the Rocky Mountain regions of the United States. The measured helium reserves are in approximately 102 gasfields in 11 States. About 97% of these reserves are 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 2000, the BLM analyzed 506 natural gas samples from 4 States in conjunction with its program to survey and identify possible new sources of helium.

Consumption

In 2000, 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 2000 domestic consumption by end use was based on a 1996 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 2000, in-kind crude helium sales were 6.4 million cubic meters (231 million cubic feet) and were made by nine 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 952 million cubic meters (34.3 billion cubic feet) on December 31, 2000. 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 and privately owned helium is returned to

the owners as needed for purification to supply private demand. During 2000, 23.3 million cubic meters (840 million cubic feet of private helium was delivered to the BLM's helium conservation system, and 51.9 million cubic meters (1,870 million cubic feet) was withdrawn for a net decrease of 28.6 million cubic meters (1,030 million cubic feet) of private helium in storage (table 4).

Transportation

Private producers and 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 \$1.785 per cubic meter (\$49.50 per thousand cubic feet) for fiscal year 2000.

Foreign Trade

In 2000, exports of grade-A helium increased to 37.0 million cubic meters (1.33 billion cubic feet) (table 1). Helium exports increased by 38.1% compared with those of 1999 and accounted for 29.2% of the U.S.-produced helium sales; private industry supplied all U.S. helium exports. The large increase in helium exports is attributed to increased European demand for helium. About 55% of the U.S. helium exports went to Asia, with Japan receiving about 71% of those exports. About 24% of the exported helium was shipped to Europe. Collectively, Belgium, France, Germany, and the United Kingdom received 94% of the helium exported to Europe. Other exports were as follows: Canada and Mexico, 8%; South America, 5%; Australia-New Zealand, 5%; the Middle East, 2%; Africa, 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% rate for non-normal-trade-relations nations.

World Review

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

Outlook

The total market for U.S.-produced helium increased by 8.2% compared with that of 1999. From 1995 to 2000, the market growth rate was about 5.7%.

Expansion of the Asian helium market over the next 2 years is expected to moderate owing to the uncertain economic conditions in that region of the world. Competition from foreign helium producers will provide continued uncertainty to 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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TABLE 1
TOTAL SALES OF GRADE-A HELIUM PRODUCED IN THE UNITED STATES 1/

(Million cubic meters)

Year	Volume		Total sales
	Domestic sales	Exports 2/	
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
2000	89.6	37.0	127

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 2000

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/
BOC Gases, Inc.	Otis, KS	Do. 2/
BP p.l.c.	Sunray, TX	Crude helium
Do.	Ulysses, KS	Do.
CIG Co. (a subsidiary of El Paso Corp.)	Keyes, OK	Grade-A helium 2/
Do.	Lakin, KS	Crude helium
Duke Energy Field Services	Cheyenne Wells, CO	Crude and grade-A helium 2/
Do.	Hansford County, TX	Crude helium
Do.	Liberal, KS	Do.
Do.	Moore County, TX	Do.
Exxon Co., U.S.A.	Shute Creek, WY	Crude and grade-A helium 2/
Nitrotec Energy Corp. 3/	Cheyenne Wells, CO	Grade-A helium
Do.	Chillicothe, TX	Do.
ONEOK, Inc.	Bushton, KS	Crude helium
Do. 4/	Scott City, KS	Do.
Pioneer Natural Resources Co.	Fain, TX	Do.
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/ Stopped production in late 1999.

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

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

(Thousand cubic meters)

	1996	1997	1998	1999	2000
Crude helium:					
Bureau of Land Management (BLM) total storage	(7,230)	(6,130)	(100)	--	--
Private industry:					
Stored by BLM	36,700	36,700	33,000	32,000	23,300
Withdrawn	(21,200)	(21,300)	(31,400)	(35,100)	(51,900)
Total private industry storage	15,500	15,400	1,600	(3,100)	(28,600)
Total crude helium	8,270	9,270	1,500	(3,100)	(28,600)
Grade-A helium:					
BLM sold	6,060	5,260	2,000	--	--
Private industry sold	88,600	102,000	110,000	117,000	126,600
Total sold	94,700	107,000	112,000	117,000	126,600
Total stored	8,270	9,270	1,500	(3,100)	(28,600)
Grand total recovery	103,000	116,000	114,000	114,000	98,000

-- 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)

	1998	1999	2000
Helium in conservation storage system on January 1:			
Stored under BLM conservation program 4/	852,000	847,000	841,000
Stored for private producers under contract	131,000	135,000	138,000
Total 4/	983,000	983,000	979,000
Input to system:			
Net deliveries from BLM plants	(100)	--	--
Stored for private producers under contract	33,000	32,000	23,300
Total 4/	33,000	32,000	23,300
Redelivery of helium stored for private producers under contract	(31,500)	(35,100)	(51,900)
Net addition to system 4/	1,500	(3,100)	(28,600)
Helium in conservation storage system on December 31:			
Stored under BLM conservation program 4/	847,000	841,000	836,000
Stored for private producers under contract	135,000	138,000	116,000
Total 4/	983,000	979,000	952,000

-- 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, 2000

(Million cubic meters)

	Capacity
United States 1/	145
Rest of the world e/	29
Total e/	174

e/ Estimated.

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

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

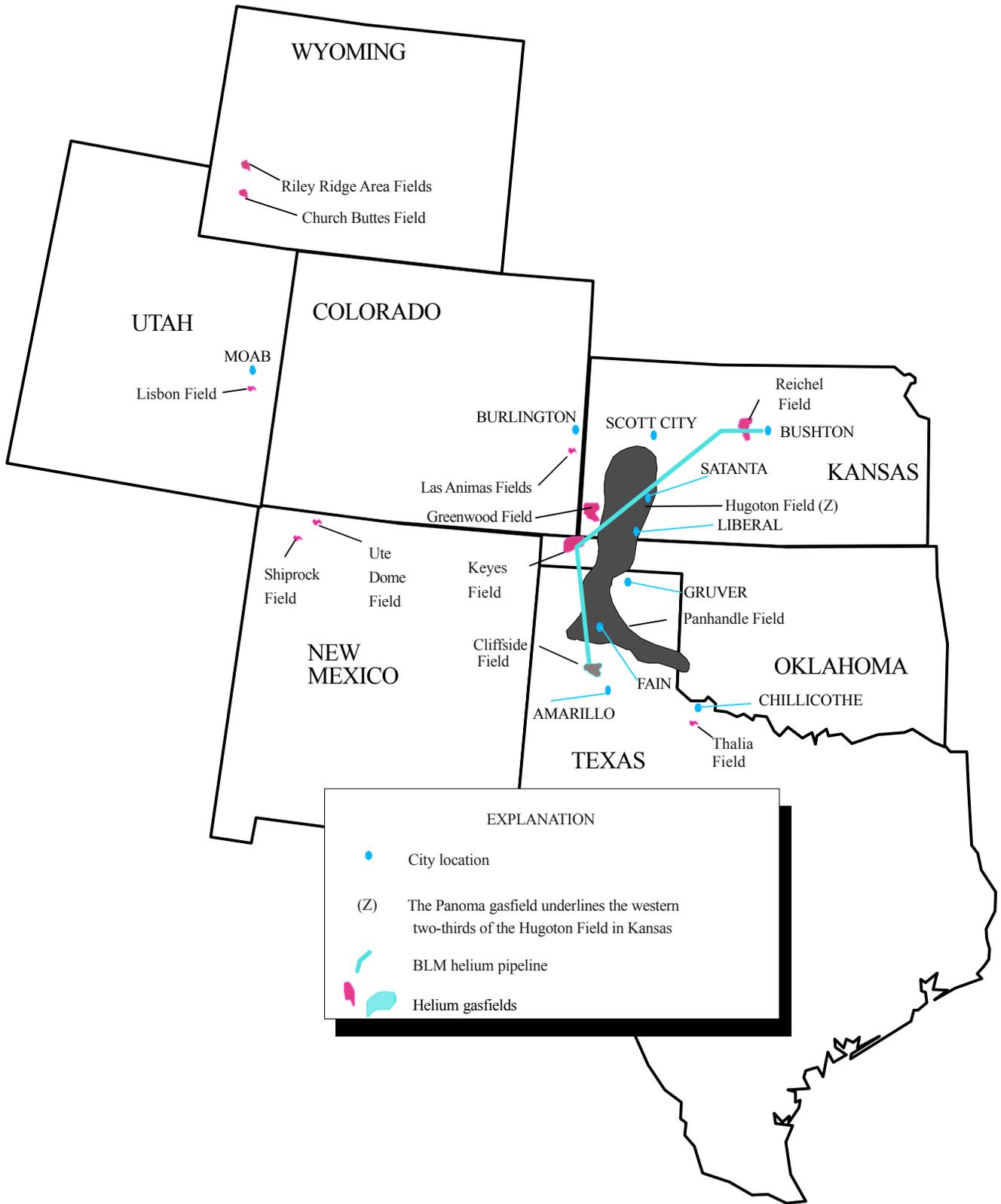


FIGURE 2
HELIUM RECOVERY IN THE UNITED STATES

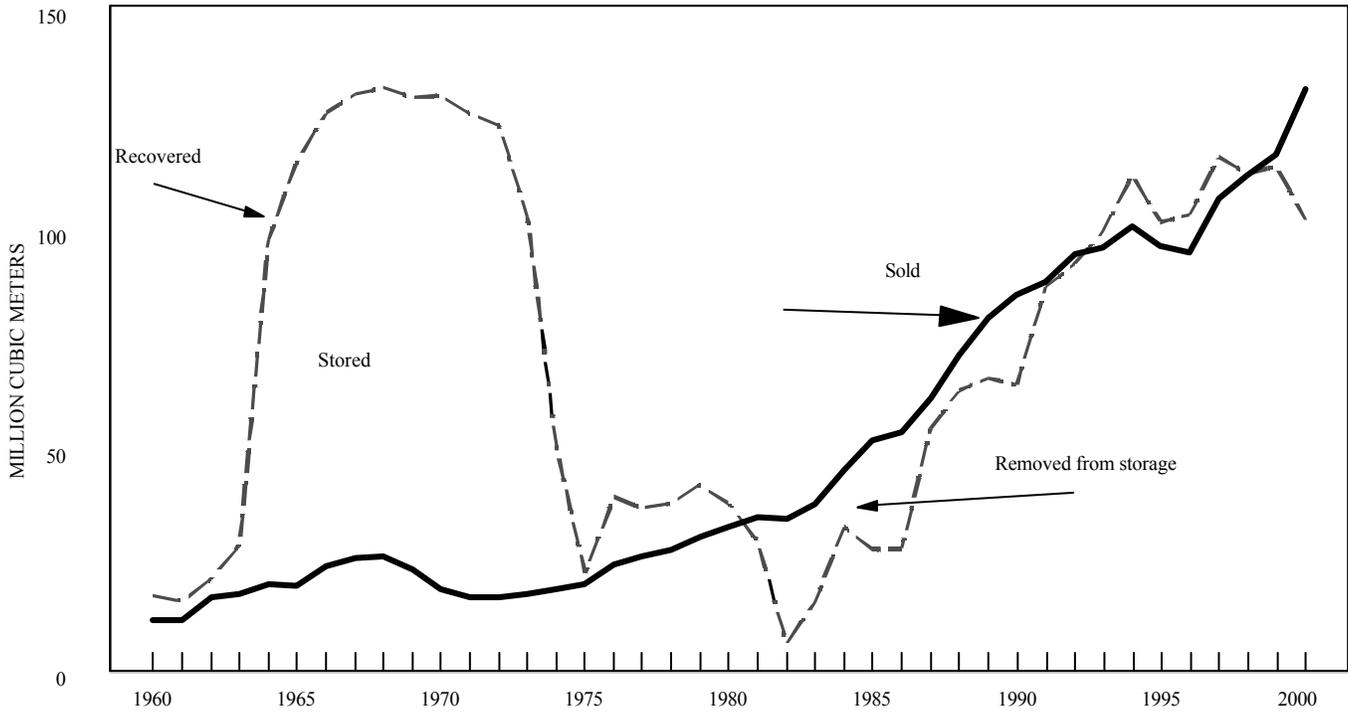


FIGURE 3
ESTIMATED HELIUM CONSUMPTION, BY END USE,
IN THE UNITED STATES IN 2000
(Million cubic meters)

