BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Unique Helium Resources Are Wasting: A New Conservation Policy Is Needed

Large amounts of unique, nonrenewable helium are lost each year as its most economical source, natural gas, is used as fuel. The Government should act on available alternatives to conserve helium because of its large continuing investment in helium-dependent, energy-related, technologies. These technologies may sharply increase demand after the year 2000 when helium resources are expected to be scarce.

Before available conservation alternatives can be adequately considered, the Congress needs to legislate a policy which would establish Federal responsibility for conserving helium for national needs. The present helium program is at a standstill, limited in scope, and hampered by legal and financial problems to such an extent that no new helium conservation efforts are likely to occur without congressional action.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

The question of helium conservation has been stirring controversy since 1973 when the existing Federal helium program ceased stockpiling significant amounts of helium. This report summarizes our analysis of the helium situation and recommends enactment of new legislation establishing responsibility for meeting national helium needs.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of the Interior; the Secretary of Energy; and the Attorney General.

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

UNIQUE HELIUM RESOURCES ARE WASTING: A NEW CONSERVATION POLICY IS NEEDED

D I G E S T

The United States faces a dilemma with respect to management of one of its most unique and nonrenewable resources--helium. Helium is essential for many scientific and technical purposes, such as cooling materials to the point where they become superconductors of electricity.

On the one hand, the best source of helium, natural gas, is depleting rapidly. Some estimates indicate it may be scarce after the year 2020 even as the United States is investing millions in energy research and development efforts that could require large amounts of helium after the year 2000.

On the other hand, long-range resource and demand projections are only estimates. The possibility exists that additional helium resources may be discovered and/or presently envisioned helium dependent technologies may not prove viable.

Because of its unique attributes, the large continuing investment in helium dependent energy technologies, and the continuing and potential loss of important helium resources, the Government should act on available alternatives to prevent the loss of helium to the atmosphere.

There is need for the Congress to develop a new policy which would establish within the Federal Government responsibility for conserving helium for national needs.

Present helium conservation legislation is limited to providing for Federal agency needs and is hampered by financial and legal problems to the extent that significant additional conservation efforts are unlikely to occur.

BACKGROUND

Helium is the lightest of all gases, except hydrogen, and liquefies at the lowest temperature of any element. It is found only in the atmosphere and in underground natural gas deposits. Relatively few gasfields have significant helium concentrations. Because helium does not burn, it escapes into the atmosphere, unless it is extracted for use or stored.

Recovery of helium from helium-rich natural gasfields is relatively inexpensive--$13 or less per thousand cubic feet. Recovery of helium from the atmosphere will require large amounts of energy and is conservatively estimated to cost $2,000 per thousand cubic feet, or about 160 times the cost of present-day, commercially-produced helium extracted from natural gas.

In response to a growing Government helium demand, the Helium Act of 1960 established a Federal helium conservation program. This act authorizes the Secretary of the Interior to purchase helium from private producers for Federal agency consumption and conservation for future Government use. Approximately 37 billion cubic feet of helium have been stored under this program.

CURRENT HELIUM CONSERVATION LIMITED

The Federal helium conservation program is at a virtual standstill and private storage has been minimal. The helium purchase program ended in 1973 when the Secretary of the Interior determined that enough helium had been purchased to meet foreseeable Government needs and terminated helium purchase contracts with private producers. The one operating Federal helium plant supplies Government agencies. Only a small Federal production surplus--0.1 billion cubic feet in fiscal year 1977--goes into storage. A small amount of helium--1.6 billion cubic feet as of October 1977--has been stored over the years by the private sector.

These storage figures contrast dramatically with the 2.7 billion cubic feet that is lost annually from existing private facilities. The loss is even more disturbing because the Government could end up paying a substantial amount in damages if helium extraction companies prevail in their breach of contract claims against the Government. These claims arose as the result of the Government's early termination of the contracts.

Presently, the Federal helium conservation program is entangled in fiscal and legal problems to the extent that it appears unlikely that any significant additional storage of helium will occur. Moreover, existing tax and legal disincentives, as well as the short-term profit orientation of private business, have resulted in the small amount of helium in private storage.

DEMAND AND SUPPLY PROJECTIONS

As natural gas resources in the United States are produced for fuel, the commingled helium is lost unless extracted and used or conserved.

Each year about 13 billion cubic feet of helium escape into the atmosphere. The key question is: How long will natural gas continue to be produced, and therefore provide the potential for a relatively cheap supply of helium?

Long range natural gas projections are only estimates. Not surprisingly, a number of studies have reached different conclusions regarding the availability of gas resources in future years and the desirability of additional helium conservation efforts.

A 1975 report prepared by the Energy Research and Development Administration concluded that by 2020 natural gas resources will have been depleted to a great extent and that helium will have to be obtained from other sources. A 1978 Interagency Helium Study concluded that substantial domestic helium resources (over 350 billion cubic feet) would remain in natural gas by 2030.

However the interagency study contains serious weaknesses. For example, the Bureau of Mines made the resource projections for that study under the assumption that certain measures would be taken to preserve presently identified nondepleting helium-rich gas (over 123 billion cubic feet). The final report did not contain any recommendations towards that end. (See p. 73.)

Conventional helium demands are expected to rise steadily through the year 2000 and total demand may rise sharply thereafter. According to the Department of Energy and others, helium may be essential to the future development and implementation of several developing energy-related technologies.

Nuclear fusion reactors, superconducting transmission lines, and magnetic energy storage devices could require up to 5 billion cubic feet of helium per year by 2030. In fiscal year 1979 alone, the Government plans to spend over $300 million developing these helium-dependent technologies.

CONGRESSIONAL AND EXECUTIVE BRANCH ACTION NEEDED

The Congress should legislate a new helium policy that will establish within the Federal Government responsibility for conserving helium to meet national needs. Such a policy is needed to conserve a potentially valuable, nonrenewable resource that has not been conserved adequately by the private sector. It would allow the Congress, with the aid and advice of the relevant executive branch agencies, to consider and act on the available alternatives for additional conservation. For specific reasons justifying a new policy, see p. 75.

The new helium policy should place responsibility on the executive branch for dealing with the following problems and issues:

--the amount of helium to be stored for national needs;

--the most efficient way to accomplish conservation goals;

--the responsibility of the taxpayers and of natural gas consumers for bearing conservation costs;

--encouraging private industry to undertake conservation to the maximum extent possible;

--determining the conditions and the price under which helium controlled by the Federal Government could be made available.

Within the spirit of the new policy, the Congress should act to:

--insure the conservation of potentially large nondepleting helium resources through such means as placing helium extraction responsibilities with the gas producer under new Federal land leases;

--remove deterrents to the private storage of helium and eliminating the waste of helium from existing facilities; and

--authorize additional measures such as a new purchase program, should the first two approaches prove insufficient.

Under the new policy, priority consideration needs to be given immediately to determining and acting on the most efficient means to conserve helium from the large Tip Top Gasfield in Wyoming. Tip Top contains by far the largest amount of currently known nondepleting helium reserves (over 42 billion cubic feet). Gas production is scheduled to begin at Tip Top in 1982.

While a number of specific actions to conserve helium from nondepleting fields and existing facilities appear to be most prudent, our analysis of even a relatively expensive alternative--expenditures for a new purchase program from existing facilities --indicates that such an investment would prove to be sound if certain assumptions hold true. (For details of GAO's analysis, see chapter 3.)

RECOMMENDATIONS TO THE CONGRESS

New legislation should be enacted redefining the Nation's helium conservation program to

--take cognizance of the changing needs for helium, and

--establish the objective of conserving helium resources to meet national requirements.

Under this new policy the Department of the Interior should continue to act as the single manager of Federal helium facilities, as well as sales and storage operations. However, the responsibility for determining energy-related helium conservation needs and for providing related funding should be placed with the Secretary of Energy. (See p. 81.)

To accomplish helium conservation for national needs the legislation should authorize:

--actions to conserve helium in present nondepleting resources;

--actions to encourage conservation from private facilities; and

--further recovery of helium from helium-rich gasfields.

Congress should take a series of specific steps to conserve helium in present non-depleting resources, and to encourage conservation from existing private facilities. Also under the new policy immediate attention needs to be given to determining and acting on efficient means to conserve the helium in the Tip Top Gasfield. (See p. 81.)

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

While working with the Congress on the development of a new helium policy, the Secretary of the Interior should undertake steps necessary to conserve helium from the Tip Top Gasfield in the most efficient manner. (See p. 83.)

The Secretary should include in new Federal land leases a clause placing responsibility for extracting helium, when it exists in significant amounts, with the developer or lessee. (See p. 83.)

AGENCY COMMENTS

The Department of Justice has no objection to the issuance of the report.

The Department of the Interior strongly disagreed with GAO's analysis and several of its recommendations.

As GAO points out throughout the report, the helium policy issue is controversial and opinions must be formed on the basis of long-term future projections. Thus, there is ample opportunity for a number of supportive arguments to be made on different views on which steps should or shouldn't be pursued. The tone of Interior's comments suggesting that its view is the only position with a valid basis is counterproductive.

The main objective of GAO's report is to emphasize the importance of new policy legislation which would establish responsibility for meeting national needs for helium. Interior failed to comment on this most central issue of the report but rather commented that a number of our recommendations are covered under the existing program's legislation. According to the executive branch, this legislation is, however, limited to only Federal needs.

Interior's final comments, as contained in appendix I, repeat criticisms of portions of the report which either were deleted or revised as the result of comments received from Interior on an earlier draft. GAO seriously considered Interior's earlier views in revising its report and concludes that the responsible officials did not carefully examine the revised report in providing further comments. Sections of Interior's letter considered to be irrelevant are noted in appendix I.

For a detailed response to Interior's specific comments, see p. 84.

The Department of Energy, while not fundamentally opposed to prudent helium conservation measures, has reservations regarding certain areas of the report. These reservations center on (1) the cost of what it would consider to be premature separation and (2) the emphasis in the report placed on high cost options of helium purchase or extraction, specifically in the case of the Tip Top Gasfield, to the exclusion of low cost options. (See app. II.)

GAO agrees that the most efficient means to conserve helium ought to be immediately explored and deems this determination to be the responsibility of the Department of the Interior under the new policy. GAO notes that the Department of Energy states that relatively large amounts of natural gas are now being found at higher prices since natural gas price deregulation, and that the withholding of gasfields for their helium content may be a viable alternative and one that should be explored by the Department of the Interior. (Interior stated in its comments that this may be contrary to the Nation's energy policy.)

GAO continues to emphasize that because of the tremendous reserves of helium in the Tip Top Gasfield, it warrants special consideration. In this context, GAO agrees with the Bureau of Mines's Helium Division which has urged the Department of the Interior to make plans to conserve this most important of helium reserves.

For a complete discussion of the Department of Energy's comments, see p. 87.

Contents

ABBREVIATIONS

BCF	billion cubic feet
DOE	Department of Energy
ERDA	Energy Research and Development Administration
F	Fahrenheit
GAO	General Accounting Office
MCF	thousand cubic feet
MMCF	million cubic feet
NAS	National Academy of Sciences
NSF	National Science Foundation
OMB	Office of Management and Budget
TCF	trillion cubic feet

CHAPTER 1

HELIUM: A UNIQUE NONRENEWABLE RESOURCE

Helium is a gas formed in the earth as a product of the radioactive decay of uranium and thorium. It is a nonrenewable resource recoverable from only two sources. If it is not trapped underground, it escapes into the atmosphere. To form helium in the ground at present concentrations took millions of years. This lengthy process of forming helium in the earth is continuing. However, the amount of helium formed annually in the earth is not equal to the amount of helium escaping to the atmosphere as natural gas is processed. Consequently, helium is referred to as a nonrenewable resource.

The best source of helium is underground natural gas deposits. Although it is found in all natural gas in amounts ranging from a trace to 8 percent, more concentrated helium is less costly to extract. At today's prices and with present technology, helium is not extracted from gases containing less than 0.3 percent helium.

Although helium is also found in the atmosphere, it exists there in very low concentrations--five parts per million or .0005 percent. Because it is so dispersed in the air, extraction of helium from the atmosphere is very expensive and requires large amounts of energy.

Practically all helium used today is extracted from natural gas. As gas is used for fuel, however, helium not being consumed or conserved is dissipated into the atmosphere. Moreover, once existing natural gasfields are depleted, and if no new sources are found, then the only source of helium will be the costly and energy-demanding process of extracting helium from the atmosphere.

HELIUM: A UNIQUE ELEMENT WITH MANY USES

Helium is a unique element because it is (1) chemically inert, (2) the lightest of all gases except hydrogen, (3) liquefies at the lowest temperature of any gas (-452.13 degrees F., only 7.69 degrees F. above absolute zero), and (4) does not freeze at the lowest produced temperature. At room temperature and pressure, helium is colorless, odorless, tasteless, nonflammable, and nontoxic.

Helium's various unique properties make it essential for many industrial uses and developing technologies. For example, because helium is the lightest of all gases except hydrogen and will not burn as hydrogen does, it is used in lighter-than-air vehicles and in preparing controlled atmospheres. In the space program, helium is used in liquid fuel tanks of rocket boosters to pressurize the fuel. Injecting helium into the fuel tanks pushes the fuel into the rocket engine and enables the thin walls to resist collapse. Because of its inertness, helium does not contaminate the fuel; because of its lightness, only minimum rocket payload is sacrificed.

Because of other unique attributes, helium is also widely used today as a leak detector, as an arc weld shield, and as a heat transfer medium. Helium is used as a leak detector because it has the greatest permeation rate of any substance. Large amounts of helium are used as arc welding shields because of its inertness. Resistance to radioactivity and high thermal conductivity make helium useful as a heat transfer medium in nuclear powerplants.

The fastest growing uses for helium are in cryogenics, the study of how matter and energy react to temperatures near absolute zero. For example, because helium can tolerate very low temperatures without freezing it is needed to cool certain materials to temperatures where they become superconductors of electricity. Presently, several energy-related technologies are already being developed. If these technologies prove commercially viable they will require large amounts of helium because of its cryogenic properties.

The following table shows the estimated uses of helium in 1977 in millions of cubic feet (MMCF).

Projected Helium Uses for 1977

Use	Volume (MMCF)	Percent of total volume
Cryogenics	235.41	33.1
Welding	137.79	19.4
Pressurizing	113.97	16.0
Breathing mixtures	59.43	8.4
Chromatography	30.62	4.3
Leak detection	29.70	4.2
Heat transfer	23.94	3.4
Lifting gas	26.02	3.7
Controlled atmospheres	18.29	2.6
Purging	14.31	2.0
Medical/clinical	2.72	0.4
Other	18.00	2.5
Total	710.20	100.0

Source: "Comprehensive Investigation and Report on Helium Uses," Midwest Research Institute.

THE FEDERAL HELIUM PROGRAM

Because of the Government's early recognition of helium's various technical and scientific uses, steps were taken to insure a supply of helium. The Bureau of Mines with the cooperation of the Army Air Service and Department of the Navy began extracting helium from natural gas in 1918 to meet wartime needs. The first full-scale helium recovery plant was built in 1921 by the Linde Air Products Company and operated under a Navy contract. The jurisdiction of all helium activity was transferred from the Department of the Navy to the Bureau of Mines in July 1925. Since then, the Bureau of Mines has managed the Federal helium program under legislation enacted in 1925, 1927, 1937, and 1960.

Since 1925 the Bureau's Division of Helium has accumulated helium plants, equipment, and other facilities for helium production, purification, storage, sales, and distribution. The Division currently employs about 250 people to administer the helium conservation program authorized in 1960. The principal capital assets of the Bureau of Mines Helium Division are described below.

--Cliffside Gasfield, under a 50,000-acre tract near Amarillo, Texas, is the Bureau's storage center. Helium purchased by the Bureau and excess federally-produced helium is injected underground into the partially depleted gas reservoir for storage. The helium can be later extracted when needed. Cliffside contains 6 injection wells, 18 withdrawal wells, and 5 observation wells.

--The Keyes Helium Plant, located near Keyes, Oklahoma, is the Bureau's principal helium extraction facility. The plant produces helium from a natural gas fuel stream provided by the Colorado Interstate Gas Company under a 1958 contract.

--The Exell Plant near Amarillo, Texas, processes native natural gas withdrawn from the Cliffside Gasfield to make room for additional helium storage. As the Keyes field depletes, the Exell plant will also become the Bureau's main helium purification center.

--The Amarillo terminal ships helium to Federal agencies and the commercial market. The Bureau's helium liquefaction plant is also at the Amarillo terminal.

--A 425-mile pipeline system connects the Federal extraction facilities, five private helium recovery plants, and Cliffside Gasfield.

SCOPE OF REVIEW

Our examination includes a review of the law authorizing, as well as the regulations administering, the Federal helium conservation program. We also reviewed pertinent reports, documents, congressional hearings, and files on the administration of the Federal helium program.

While conducting our review, we contacted many experts on the helium question. In addition to contacting knowledgeable program officials in the Department of the Interior, including operations personnel of the Helium Division in Amarillo, Texas, we spoke with Department of Energy and Justice officials. Further, in analyzing the development of helium-dependent energy technologies we talked to Dr. Edward Hammel, Assistant Director for Energy at the Los Alamos Scientific Laboratory. Dr. Hammel prepared a 1975 report for the Energy Research and Development Administration (ERDA), on the energy applications of helium and continues to monitor the area under a Department of Energy contract.

We also interviewed knowledgeable persons outside Government to obtain the views of the private helium extractors. These persons included Mr. Clarence T. Kipps, a partner with the law firm of Miller and Chavelier, and Mr. F. Clayton Nicholson, a consultant to Northern Natural Gas. We attended a National Academy of Sciences Helium Forum in late 1977. At that forum all interested parties were invited to present their views on the helium problem. Attendees included

--Robert M. Drake, Jr., Studebaker-Worthington, Inc. (Chairman, Helium Forum).

--Dr. Charles Laverick, Consultant (author of National Science Foundation (NSF) report on helium).

--H. Richard Howland, Westinghouse Research and Development Center.

--Leroy Culbertson, vice president, Phillips Petroleum.

--M. King Hubbert, consultant.

--Lester Lave, economist, Carnegie-Mellon University.

Through interviews and contacts with the aforementioned officials, we defined the issues and problems surrounding the helium conservation question as it applies to future needs.

CHAPTER 2

RAPID DEPLETION OF HELIUM RESOURCES

Most experts agree that because the United States' known natural gas resources are being rapidly depleted, our most economical source of helium is fast disappearing. In addition, most known helium-rich gas reserves in Texas, Kansas, and Oklahoma are now under production and are expected to be substantially depleted between 1990 and 1995. Further, foreign gas resources, although extensive, are not helium-rich and for many reasons are not expected to be a major future U.S. supply source.

U.S. NATURAL GAS RESOURCES

Natural gas will always be a more economical source of helium than the atmosphere because helium is present in all natural gas in greater concentrations than in the air. Natural gas resources, however, are being rapidly depleted. Approximately 425 trillion cubic feet (TCF) of natural gas have already been produced in the United States. This gas contained well over 425 billion cubic feet (BCF) of helium. Only about 11 percent, or about 48 BCF, of this helium has been separated and either used or stored. The remaining 89 percent, at least 377 BCF, has dissipated into the atmosphere.

Considerable effort has gone into estimating available future resources of natural gas. Unfortunately, the estimates vary widely, primarily because of different economic assumptions made for each projection. Natural gas resource estimates made by experts during the past 6 years range from a low of 751 TCF by Dr. M. King Hubbert to a high of 1,412 TCF obtained by combining American Gas Association (AGA) and Potential Gas Committee data. U.S. Geological Survey predictions range from a low of 809 TCF to a high of 1,142 TCF.

DOMESTIC HELIUM RESOURCES

Helium resources include all helium contained in natural gas, and that helium which has been extracted from natural gas and is being stored for future use. However, helium resource projections do not include the estimated 5,000 cubic miles of helium contained in the atmosphere.

The Bureau of Mines does not have an exploration program to locate new resources of helium; however, the Bureau does develop projections of helium resources and reserves from natural gas availability estimates and from its analysis of the helium content of existing gasfields. Since 1917 it has collected over 15,000 samples of gases and analyzed them for their helium content. It uses the results of the analyses and various natural gas resource estimates to determine an average helium content in each of 12 geographical areas. The Bureau estimates helium resources by multiplying the average natural gas helium content in each of the 12 geographical areas by the respective estimated natural gas resources in the area. As of January 1, 1977, the Bureau projected that the United States has 714 BCF of helium resources. Included in the 714 BCF resource base is 39 BCF of stored helium (including about 2 BCF owned by private concerns) at the Bureau's Cliffside storage center.

The Bureau has been meeting the annual needs of Federal agencies through production from its Keyes, Oklahoma extraction facility. Because the supply source for the Keyes plant is expected to deplete by 1985, the Bureau plans to then use its Exell facility in Texas to meet Federal needs. At present levels of Federal agency consumption, existing helium reserves in storage are adequate to service presently defined agency needs for over 100 years. This projection, however, does not consider any of the potential private sector needs.

Undiscovered, uneconomical, and depleting helium resources

The major helium resource problem is that 591 BCF (or about 83 percent) of the 714 BCF estimated helium resource base is contained in natural gas which either is depleting or undiscovered. Depleting resources are those contained in natural gas currently being produced to satisfy market demand for heating and other purposes. As of January 1, 1977, of the 591 BCF, 136 BCF of helium was in natural gas currently being produced. The remaining 455 BCF was estimated to be in undiscovered natural gas.

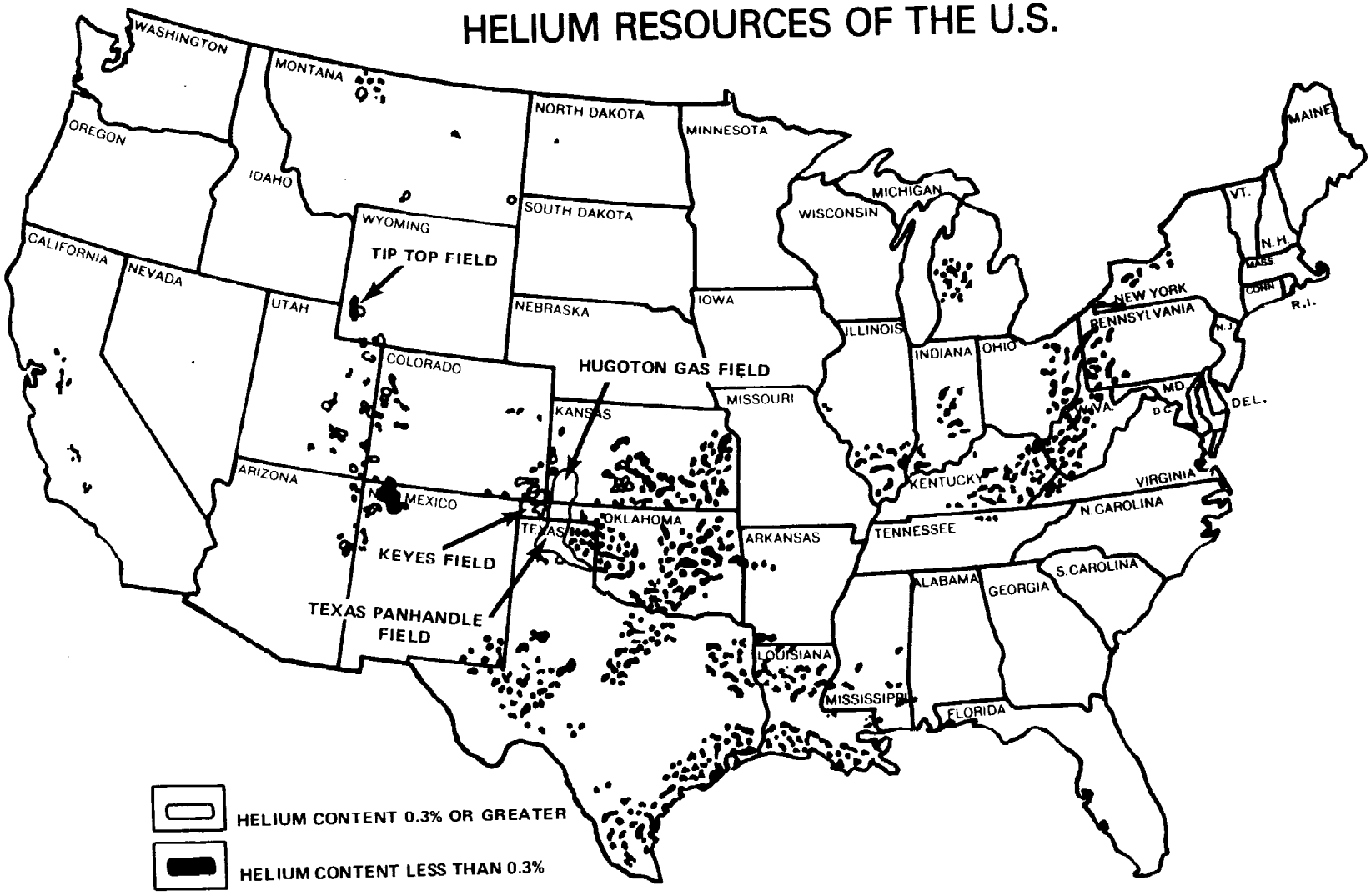
Not all helium present in natural gas resources is economically producible. The helium content in U.S. natural gas ranges from a trace to about 8 percent. According to the Bureau, natural gas containing 0.3 percent helium or more can generally be economically extracted using today's technology. Helium recovery below 0.3 percent is technically feasible, however, and may be economically feasible depending on the specific circumstances. Actual economic feasiblity of helium recovery depends on a number of factors for each location and operating organization.

The Bureau classifies that portion of the identified helium resource base which has a 0.3 percent or greater helium content as helium reserves. Of the 714 BCF of helium resources estimated by the Bureau as available to the United States, only about 185 BCF--some 26 percent--is considered helium reserves. The 185 BCF of helium reserves is comprised of 39 BCF already in storage (including private storage) and 146 BCF available in discovered but unproduced natural gas supplies. The remaining 529 BCF, or 74 percent, is considered uneconomically recoverable or has not as yet been discovered.

Richest helium-bearing natural gas being produced first

Although helium-rich natural gas (0.3 percent or more) is contained in reservoirs of over 100 gasfields located in 10 States, the bulk of the reserves are in 5 fields: the Tip Top Field in Wyoming; the Hugoton Field in Kansas, Oklahoma, and Texas; the Keyes Field in Oklahoma, and the Cliffside and West Panhandle field in Texas. (See map on the following page.) The Hugoton Field and the adjacent Panhandle Field in Kansas, Oklahoma and Texas, together contain the largest known helium-rich gas deposits in the world. All of these fields except Tip Top are currently being produced for their natural gas, and the Mobil Oil Company has recently announced plans to begin extraction from the Tip Top Field by 1982. From 1963 to 1976, over 115 BCF of helium was available from helium-rich gasfields, but only 48.1 BCF --42 percent--was recovered. The remaining 67 BCF--58 percent--was lost. Yet an even greater percentage is lost today because existing plants are not recovering at full capacity.

HELIUM RESOURCES OF THE U.S.



Natural gas production is expected to increase between 1978 and 1995 and then start to decline. Because helium-rich gas is being consumed first, however, the amount of helium available for production will decline.

Nondepleting helium resources

Nondepleting helium resources are those contained in natural gas which, because of its low heating value, unusual composition, or location, are not now being produced. A total of 123 BCF of the helium resources are considered nondepleting; 27 BCF under non-Federal control and 96 BCF under Federal control. The 96 BCF located on Federal land are made up of the following:

	BCF
Cliffside storage	37.1
Cliffside native gas	3.8
Tip Top, Wyoming field	42.0
Church Buttes, Wyoming field	8.8
Other Federal oil and gas leases	4.5
Total	96.2

For those nondepleting resources located on Federal land or on land where the Government owns the gas rights, the helium is reserved for the Government. Under the Mineral Lands Leasing Act of 1920,the Secretary of the Interior has the right to extract the helium from this gas before its use as fuel. If the Government has leased the gasfield to a gas company for development, the Government still has the option of extracting the helium if and when the company processes the gas. The Government, however, cannot delay the gas companies' production of the gas.

A majority of the gasfields containing helium in the nondepleting resource category are leased to gas companies. For example, the largest nondepleting helium reserve gas field, Tip Top Field in Wyoming, contains an estimated 44.0 BCF of helium. About 95 percent or about 42.0 BCF of the Tip Top helium reserves lie under Federal lands and are leased to private producers but have not been developed to date, primarily because the gas has a low fuel value.

Bureau of Mines officials told us in 1977 that if the gas prices rise, some of these presently nondepleting fields will become economical to process for gas. The Bureau would then find itself in the position of either allowing the helium to be lost to the atmosphere or having to immediately build helium extraction plants. The Bureau has no contingency plans for such action.

In June 1978 the Bureau became aware of the Mobil Oil Company's intention to drill wells into the Tip Top Gasfield to produce the gas for its fuel content. Mobil anticipates that production will begin in 1982. Tip Top contains about 71 percent of the known nondepleting supplies on Federal land (not including Cliffside), and may contain even more helium than originally estimated. More complete information will be available by the end of 1979, after additional wells are drilled. Bureau officials are optimistic that helium could be extracted relatively cheaply from Tip Top gas, perhaps for as low as $5 per MCF.

In a June 1978 memo to the Assistant Secretary of the Department of the Interior, the Bureau recommended that "* * * it is imperative that action be taken to conserve Tip Top helium." As of October 1978 the Department had not acted on the Bureau's recommendation.

Summary of domestic helium resources

The following table summarizes in BCF previous discussions on domestic helium resources as of January 1, 1977.

Domestic Helium Resources
(BCF)

Category	Reserves	Resources (excluding reserves)	Total resources
Depleting	81	55	136
Nondepleting	65	19	84
Stored	39	-	39
Undiscovered	-	455	455
Total	185	529	714
Portion of total under Federal control	87	9	96

HELIUM RESOURCES IN THE YEAR 2000 AND BEYOND

Helium resources available in any given year depend upon remaining natural gas resources and natural gas production rates. As pointed out above, estimates of remaining natural gas resources vary widely. Projections of what helium resources will be available in any future year are even more speculative because there is a great dearth of information on what future gas discovery and production rates will be. Even the Department of Energy to date has has not attempted long-range gas production projections due to rapidly changing economic conditions affecting the gas market. Thus predicting available helium resources in the years 2000 and beyond is very difficult. Not suprisingly, existing studies have arrived at different conclusions on the amount of helium available after the year 2000, and thus the desirability of futher conservation measures.

In a 1975 report 1/, see p. 22, ERDA did estimate natural gas resources, and production rates. The report projected that gas production would rise until about 1980, begin to decline after that, and by the year 2000, less than 10 TCF of gas will be produced annually, with less than one billion cubic feet of helium available for extraction. By 2020 the report concluded that practically all gas resources will have been exhausted; thus very little would be available for helium extraction and atmospheric extraction would be necessary.

In 1976 and 1977, natural gas production declined due to a number of economic factors including regulation of interstate gas sales. This led the Bureau of Mines to conclude in the February 1978 Interagency Helium Study (IHS), see p. 29, that gas production would be substantially less than thought previously and that by the year 2000 about 501 BCF of helium would remain in natural gas deposits.

1/ The ERDA report is currently being updated. No significant changes are anticipated in helium demand and supply projections cited in the 1975 report. A recent National Academy of the Sciences report on helium cited the ERDA report extensively, giving evidence that it is still considered a valid study.

In contrast to the ERDA study, the IHS Study projected that by 2030, about 350 BCF of helium would still remain in natural gas. These projections assumed that steps would be taken to conserve approximately 125 BCF of helium presently stockpiled or in identified nondepleting gasfields. However, the report and subsequent follow-up analysis did not recommend any specific steps be taken.

Following the issuance of the IHS report, legislation deregulated interstate gas sales. According to Bureau officials deregulation undoubtedly will promote gas discovery and production above recent rates and faster than anticipated in the IHS. One study by the American Gas Association has already predicted that cumulative additional production over that which would have occurred without deregulation to reach 26 TCF by 1990. In 1990 alone, additional production will be 4.7 TCF.

HELIUM EXPORTS AND INTERNATIONAL RESOURCES

Most natural gas found outside North America has been found while searching for oil. Where this gas is not marketable, as in the Middle East and elsewhere, enormous quantities are flared. Information on foreign gas deposits is limited and the Bureau has collected little information on worldwide helium resources. Known natural gas resources outside the United States, however, appear to have low helium content. See following table.

Helium Concentrations in Foreign Gasfields

Country(field)	Helium content (volume percent)
North Sea Gasfields:	
British sector	0.05-0.12
Norway sector	0.02
Netherlands sector	0.06
Algeria	0.17
Nigeria	0.02
Canada	0.02-1.9
Mexico	0.05
Australia	0.08
New Guinea	0.02
Poland	0.02-0.14
Soviet Union	various but less than 0.15

Source: "The Energy Related Applications of Helium," the Energy Research and Development Administration, 1975.

At the present time, U.S. helium production capability far exceeds demand. U.S. helium plants have a combined capability of about 3.2 BCF per year. Current private and Bureau of Mines domestic sales total about 0.7 BCF each year. Therefore, U.S. helium extraction capability exceeds demand by four times.

As the largest producer of helium in the world, the United States has exported helium for many years. Helium exports were only 5 MMCF in 1960 but have risen significantly since 1970. See table below.

Exports of Helium from the United States

Fiscal year	Quantity (MMCF)
1970	38
1971	50
1972	63
1973	81
1974	103
1975	135
1976	135
1976 Transition quarter	45
1977	178

Source: Bureau of Mines

All exports are from private industry plants that depend on foreign markets for about 30 percent of their high-purity helium sales. Most exports are shipped to Western Europe.

Production of helium outside the United States is minimal. Foreign countries produced only 146 MMCF of helium during 1975 as compared with 775 MMCF for the United States. Foreign production took place in plants located in Canada (35 MMCF), France (10 MMCF), the Soviet Union, and countries of Eastern Europe (100 MMCF). Foreign helium production is expected to almost double with the completion of an extraction plant in Poland which has the capacity to produce 150 MMCF of helium per year.

According to the Department of Energy (DOE), demand in the United States will exceed supply around the year 1990. Imports will then be an alternate supply source. DOE expects, however, that worldwide demand will also increase, thus limiting the United States' ability to import significant amounts of helium.

EXTRACTION FROM THE ATMOSPHERE

Although helium resources in the atmosphere are practically unlimited, helium concentration in the atmosphere is only 0.0005 percent, thus making its extraction extremely expensive with current technology. According to a current

internal DOE report, costs to extract helium from the atmosphere are now about $2,000 per thousand cubic feet, (MCF) (1978 dollars). This figure compares to the $11 it costs the Bureau to produce a MCF of helium at Keyes. The cost of atmospheric extraction is high because large amounts of energy are required to compress enough air to extract significant amounts of helium. According to a 1975 ERDA report, the energy required for extracting 1 BCF of helium --approximately the current annual market demand for U.S. helium--would be about 70 percent of the projected annual output of the Alaskan oil pipeline, or 16 percent of current annual domestic coal production. One DOE official said that although the cost of extracting helium from the atmosphere could in theory be reduced to $100 to $200 per MCF, technology for doing so has not been developed. Most of the experts we consulted, however, believe that because atmospheric extraction technology is already well advanced, they do not expect any such breakthrough.

CONCLUSIONS

As with long-range helium demand projections, the calculation of future available helium resources is speculative. Until better natural gas resource and production projections can be obtained, helium projections will be questionable. It is generally believed, however, that not only has the United States already dissipated as much as 50 percent of its original helium resources, but it continues to lose 13 BCF a year to the atmosphere. By the year 2000, most known helium-rich natural gas under production will be substantially depleted and only presently undiscovered sources of natural gas will be available for helium extraction.

CHAPTER 3

ECONOMIC JUSTIFICATION FOR STORING HELIUM TO MEET POTENTIAL DEMAND

No one can accurately project the long-range demand for any resource. Helium demand is especially difficult to project because its unique characteristics lead to the real possibility that it may become essential to as yet undeveloped technologies. Yet despite the difficulties of long-range forecasting, a number of studies (see pp. 21-33) do show that current uses of helium will continue to substantially increase demand through the year 2000. After that date these studies also predict that emerging energy technologies will rapidly increase helium demand in the private sector, when helium resources will be scarce and very expensive. If the future demand studies discussed in this chapter are indicative, energy-related helium demand may expand to 5 BCF each year by 2030, a demand rate which could consume the existing stockpile in 8 years.

We believe that there are three possible alternatives to conserving additional helium; (1) insuring that helium-rich nondepleting resources are conserved for future use; (2) removing current deterrents to private storage from existing facilities (see ch. 5); and (3) authorizing additional means to conserve helium such as a new purchase program. Priority consideration needs to be given to means to conserve the helium from the Tip Top Gasfield. On the surface, the first two alternatives appear to be the most reasonable approaches, at least initially. However future information on the Tip Top situation will not be available until late 1979 and diminishing disincentives will not guarantee additional storage by private concerns. Therefore, for purposes of an economic analysis of the helium storage situation we examined the economic feasibility of Government purchase of helium from existing facilities. Our analysis indicates that such a program could be a sound investment should certain assumptions prove true.

HELIUM DEMAND CHARACTERISTICS

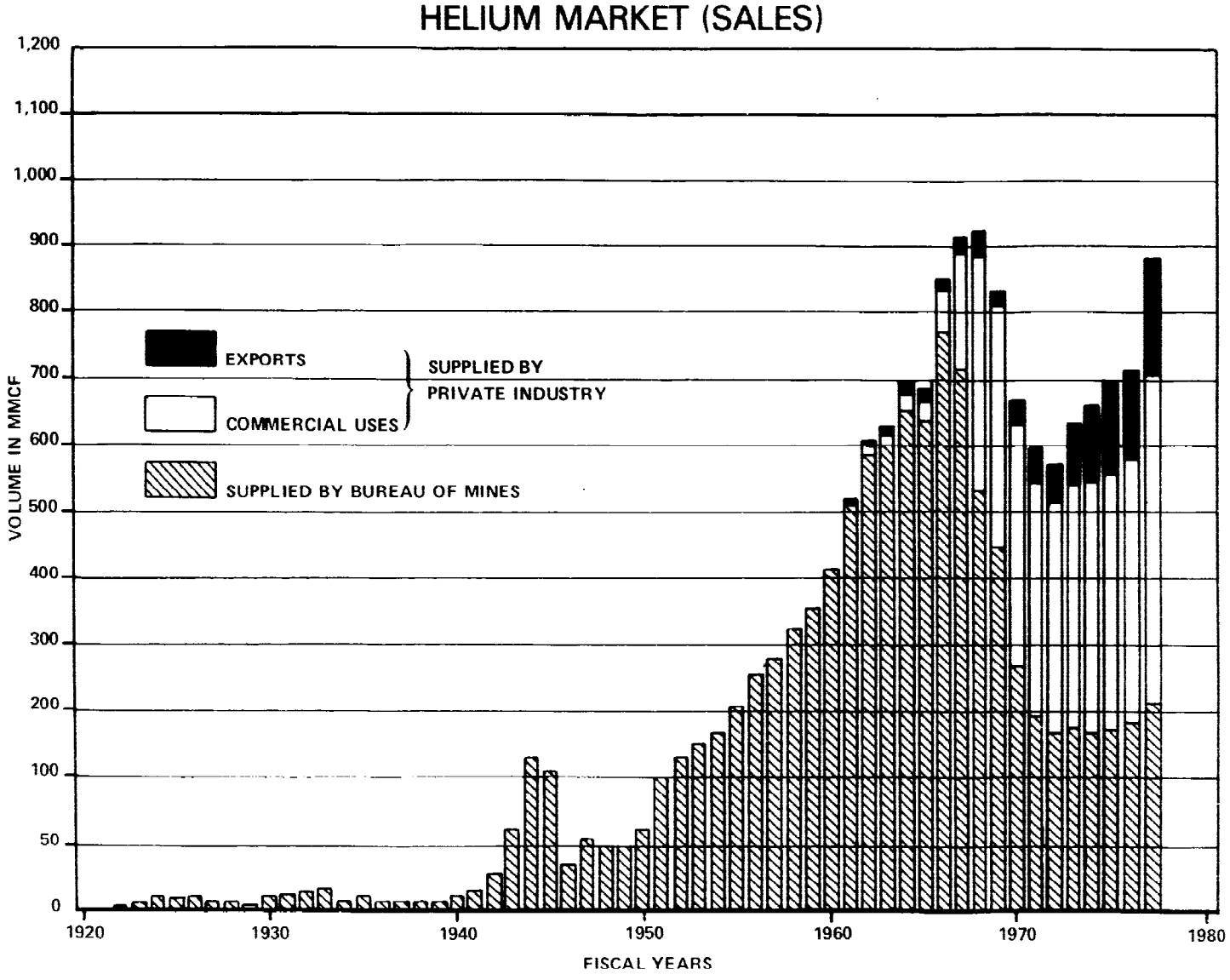
The unique properties of helium create unusual demand characteristics. For many uses, helium has no substitutes.

In a recent survey, 1/ 70 percent of the respondents reported they use helium because no substitutes exist. Another 14 percent use helium because it is technically superior. This survey suggests that price has little influence on demand, i.e., helium demand is relatively inelastic. In 1975, for example, while a slowdown in economic growth caused sharp drops in the consumption of most raw materials, helium demand rose by 5.5 percent.

Since the early 1900s the demand for helium has fluctuated in response to the popularity of various technologies. During World War II the Department of the Navy used helium extensively in lighter-than-air vehicles, increasing demand for helium markedly. This demand for helium declined after the war. The space program, however, requiring significant amounts of helium, caused the annual demand for helium to rise again to about 1 BCF in 1968. The slowdown of the space program and the switch to solid rocket fuel after 1968 had a negative effect on the demand for helium, although the helium demand for aerospace will more than likely increase again through the year 2000. With the advent of cryogenic uses for helium, helium demand once again is rising.

The following chart shows helium demand (consumption) from 1920 to 1977.

1/ "Comprehensive Investigation and Report on Helium Uses," Midwest Research Institute, 1977.


HELIUM MARKET (SALES)
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
50
0
VOLUME IN MMCF
EXPORTS
COMMERCIAL USES
SUPPLIED BY
PRIVATE INDUSTRY
SUPPLIED BY BUREAU OF MINES
1920
1930
1940
1950
1960
1970
1980
FISCAL YEARS
BUREAU OF MINES

DEFINING HELIUM DEMAND TO THE YEAR 2000

The Bureau of Mines Helium Division periodically investigates the Nation's future helium needs. In January 1977, the Bureau issued a report entitled, "A Comprehensive Investigation and Report on Helium Uses." Written by the Midwest Research Institute (MRI) per a contract with the Bureau of Mines, the report was a followup to a 1967 report. Its objectives were to identify current and potential new large volume helium uses and to calculate the total annual volume of helium required to meet demand through 2000. MRI surveyed a large number of potential helium users, including all current large volume helium users, a sample of Government agencies, and a select group of private research centers.

The report concluded that although existing conventional uses of helium will substantially increase demand over the next 25 years, new technologies will not require significant amounts of helium until after the year 2000. According to MRI, helium consumption will almost certainly double to a level of nearly 1.3 BCF per year by 2000. The MRI annual demand forecast for the year 2000 ranges from a low of 652 MMCF (which MRI considers questionable), to a high of 1.87 BCF. MRI estimates that the cumulative demand over the next 25 years will probably require 25 to 30 BCF.

HELIUM DEMAND AFTER THE YEAR 2000

Various studies have attempted to define the long-range demand for helium, and most studies predict a sharp increase in helium demand after the year 2000. ERDA, NSF, and the National Academy of Sciences (NAS) all have reported that helium will be essential to the development and implementation of various energy-related technologies in the next century. The Government will spend over $60 billion on energy research during the next two decades if present funding levels are maintained. According to a NAS report, Government support of research and development of new energy technologies, helium may total $6 billion over the next few years. Over $300 million is planned to be spent in fiscal year 1979 alone. Should these or other, as yet undetermined technologies be implemented, the demand for helium will rise dramatically during the first part of the next century. The Bureau of Mines has generally avoided long-range helium projections as being too speculative, but the Bureau recently made some projections in response to a congressional request.

A summary of all the above efforts to define long-range helium demands is given below.

Promising helium-related technologies identified in the ERDA report

In April 1975, ERDA issued a report entitled, "The Energy Related Applications of Helium." (As of January 1979, this report was being revised.) The report attempted to analyze developing energy technologies that would require substantial amounts of helium in the future.

The report specifically identified fusion power reactors, superconducting power transmission lines, and magnetic energy storage as important energy technologies that could contribute significantly to future electricity supplies and could require substantial amounts of helium--largely in the next century. The report states that the actual helium demand will depend on the Nation's power requirements as well as the extent to which helium-dependent technologies are successfully developed and implemented by industry. Below is a brief description of each of these three technologies.

Fusion power reactors--The ERDA report stated that liquid helium will be required as a refrigerant for superconducting magnetic confinement fusion reactors. The report also states that helium might be used as a heat transfer fluid in fusion reactor schemes. Although fusion reactors are expected to produce helium as a byproduct of nuclear fusion, the total amount produced will be inconsequential.

Department of Energy officials now believe that controlled thermonuclear fusion is one of the most promising energy source technologies under development. The ERDA report, however, states:

> "It must be recognized that the economic and technical feasiblity of commercial fusion power is yet to be demonstrated. Hence the projected helium requirements for fusion power reactors could range from zero to 52 BCF (by 2030) depending on the concept considered. Any near-term decisions regarding helium policy should take cognizance of this large uncertainty in demand attributable to fusion reactors beyond the year 2000."

The United States plans to fund over $300 million for research in this area in fiscal year 1979 and is obviously very committed to developing nuclear fusion technology. Although this technology will have to compete with other technologies such as solar and coal gasification, DOE officials believe that fusion reactors have the potential to provide a significant part of the United States' energy need after the year 2010.

Superconducting power transmission lines--Considerable study has been made of superconducting power transmission systems. The fiscal year 1979 budget for research in this area was over $4 million. It is now planned that a commercial, small scale application will occur between the years 1983 and 1985. Helium will cool superconducting cables able to transmit large amounts of electricity from new large generating plants that are located outside urban areas. Superconducting lines would be used, for example, to carry power through Westchester County to New York City from a new plant of several million kilowatts capacity located 40 to 50 miles up the Hudson River.

ERDA concludes that helium requirements for electrical transmission lines measuring about 50 miles could reach a total of 10 to 20 BCF by the year 2030. The ERDA report also states that although many people consider helium-cooled cables the most efficient and promising technique, liquid nitrogen or water-cooled, gas-insulated cables could also transmit large blocks of power.

Superconducting magnetic energy storage--Between now and the year 2030, a considerable effort will be made to develop effective energy storage devices for electrical peak-shaving purposes. Using large superconducting magnetic energy storage devices for storing electrical energy is one of many storage technologies being developed and present plans include investing $1.8 million for this research in fiscal year 1979. DOE estimates that this device could require a total of 8 to 19 BCF of helium by the year 2030. Unlike conventional electrical conductors, superconducting devices cooled by liquid helium permit efficient long-term energy storage. While the technical feasibility of magnetic storage devices has to a large

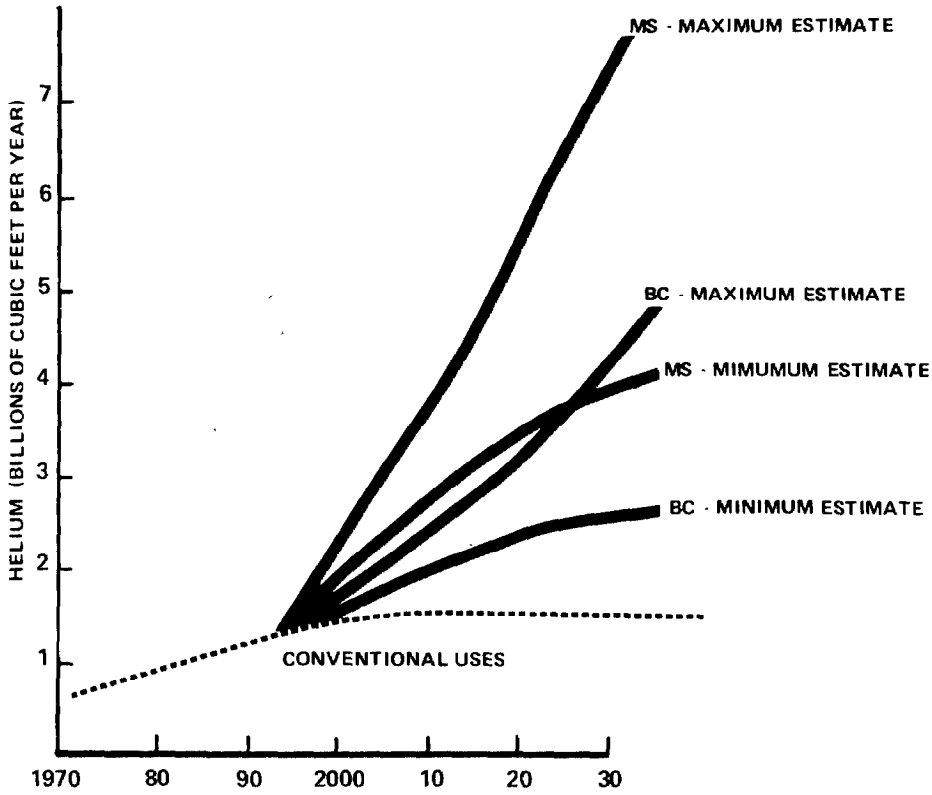
extent been demonstrated and a small scale demonstration project is planned for 1983-1985, the primary difficulty of this storage method is the high cost per kilowatt.

Gas turbines, fuel cells, and batteries are examples of other means of storage competing with the magnetic storage device. DOE believes that although their economic feasibility relative to other devices has not been proven, superconducting energy storage devices are projected to be highly efficient. They also believe the cost will be reduced as energy costs increase.

ERDA demand scenarios--In estimating future helium requirements for energy related technologies, the 1975 ERDA study used two scenarios. Their base case scenario (BC) assumes the annual overall energy growth rate to be 2.5 percent. Their major shift scenario (MS) assumes a massive shift to electrical power, annual energy growth rate of about 1.6 percent, and a reduction of oil and gas usage. For each scenario, ERDA developed maximum and minimum demand estimates through 2030. The graph and table on the following pages reflect the ERDA projected helium demand.

The ERDA study recognized that because of the uncertainty in making annual helium demand projections, its estimates had to be wide-ranging. It estimated, however, that annual helium demand for energy-related technologies could increase from near zero in the year 2000 to between 1 and 5 BCF annually by the year 2030. Cumulative helium requirements could reach 100 BCF to 180 BCF by the year 2030.

ERDA DEMAND PROJECTIONS



ERDA Projected

Annual Helium Demand for Component Technologies

in BCF/Year

Year	Conventional uses	SPTL (note a), BC-Min to Ms-Max	SMES (note b), BC-Min to MS-Max	Fusion, BC-Min to Ms-Max	Other, BC-Min to MS-Max	Total, BC-Min to Ms-Max
1985	1.1	0.00 to 0.00	0.00 to 0.00	0.00 to 0.00	0.0 to 0.0	1.10 to 1.10
1995	1.3	0.02 to 0.03	0.02 to 0.02	0.00 to 0.10	0.3 to 0.0	1.34 to 1.45
2005	1.4	0.16 to 0.38	0.14 to 0.33	0.04 to 0.58	0.3 to 0.3	2.04 to 2.99
2015	1.4	1.32 to 0.75	0.30 to 0.65	0.20 to 1.91	0.3 to 0.3	2.52 to 5.01
2025	1.4	0.39 to 0.94	0.36 to 0.87	0.23 to 3.31	0.3 to 0.3	2.68 to 6.82

a/ SPTL: Superconducting Power Transmission Lines.

b/ SMES: Superconducting Electromagnetic Storage.

Source: "The Energy Related Application of Helium," ERDA, 1975.

Helium substitutes in energy technologies--According to the scientist at the Los Alamos Scientific Laboratory who prepared the ERDA report, scientists expect that helium will be needed for the development and operation of these three technologies. Although this scientist admitted to some speculation regarding high temperature superconductors (30 degrees F. above absolute zero), which could possibly use liquid hydrogen or other elements, no substitutes for helium are presently expected to be technically feasible. Helium also has the advantages of good thermal conductivity and near zero viscosity, that is, it requires very little push to move it. The scientist concluded that although nuclear fusion represents only one possibility for contributing to the Nation's future energy needs and that superconducting power transmission lines and superconducting magnetic energy storage are only two of several possible means to distribute and store that energy, these technologies have a good chance of being implemented.

NSF report

Following the Secretary of the Interior's termination of the helium purchase contracts in 1973 (see ch. 5), a helium study was made by the Argonne National Laboratory. The study was written by Dr. Charles Laverick. Partially funded by the NSF, the report entitled, "Helium--Its Storage and Use in Future Years," was released in November 1974.

The NSF report disagreed with the Department of the Interior's arguments in favor of terminating the contracts. To a large extent, the report summarized the scientific community's concern of a need for a helium conservation program. Dr. Laverick's report predicted (1) substantial helium requirements beyond the year 2000 and (2) emerging energy-related technologies. The principal technologies noted were fusion reactors, superconducting energy storage, and superconducting electrical power transmission. The report estimates cumulative requirements for fusion reactors and superconducting energy storage to be 50 to 100 BCF, and 54 BCF, respectively, through the year 2050. For superconducting electrical transmission lines, the report concluded that there would be potential requirements for 12.5 BCF of helium through the year 2020.

Although the author admits that it is impossible to be precise about future resources, he states that almost certainly not enough helium at acceptable financial and energy costs will be available to meet future demand generated by the many promising technologies now under development.

NAS Helium Forum

As part of the helium study required for the House Committee on Appropriations (see p. 29), the Bureau of Mines contracted NAS to study the present helium situation, to assess the long-term needs for helium, and to describe available options and appropriate policy alternatives. NAS appointed a helium study committee to perform the work. Because committee members were of diverse backgrounds, a public forum was held to give them the maximum exposure in the shortest time. Various experts presented overviews on the major aspects of helium during the public forum.

After conducting the forum and reviewing literature on the subject, the committee wrote its report in January 1978 entitled, "Helium: A Public Policy Problem." In the report, the committee concluded that "the venting of separated helium to the atmosphere * * * should be stopped forthwith." According to the committee, future demand for helium will be substantial and not having cheap helium available to meet this demand could have a major effect on emerging energy technologies. The committee also stated that storing helium now is an obvious way of reducing the effect that higher future helium costs may have on these technologies.

The committee report contained steps the Government might take to increase helium conservation:

--Stop current venting of helium.

--Designate helium stored as a "national strategic reserve."

--Reactivate idle helium separation plants.

--Build new helium separation plants.

--Reserve helium-rich natural gasfields.

Although it did not state which strategy should be adopted or how much helium should be conserved, the committee concluded that

--helium in helium-rich natural gas accessible to the helium pipeline should be conserved,

--Government-owned helium storage should be a strategic reserve, and

--incentives should be provided for private companies to store helium.

The NAS report was provided to the Interagency Helium Committee discussed below. However, the interagency committee in its report did not endorse the recommendations of the NAS report.

Bureau of Mines long-range helium demand projections

As noted above, the Bureau of Mines has been reluctant to project helium demand past the year 2000 because it says that demand projections that far into the future are too speculative to be practical. The Bureau also maintains that its responsiblities are only to insure that Federal needs are met and that most identified potential needs that will possibly be developed after the year 2000 will be national needs.

In projecting long-range helium demand, Bureau officials have stated that estimates and projections to the year 2000 represent the extreme in forecasting. Unlike other studies of helium demand which project substantial helium requirements for new technologies, the Bureau states:

> "It is not reasonable to assume an astronomical growth in helium demand sometime in the 21st century to meet the demands of so-called emerging technologies. In fact, the emerging technologies are so immeshed in the cocoon stage that we have no tangible basis for estimating the year of their metamorphosis."

In 1977, however, the House Committee on Appropriations ordered a joint helium study by the Bureau of Mines and ERDA. The Department of the Interior subsequently led an interagency helium study and released a report in February 1978, entitled, "Future Helium Requirements and Options for Supplying

Projected Demand." The Interagency Helium Committee, responsible for writing the report, did not recommend any specific actions be taken. Instead, the committee only identified areas for needed additional study and evaluation.

In the report the Committee developed mainly from existing studies, three demand scenarios projecting helium demand up to 2030. These scenarios are summarized below:

--Scenario 1, Low Demand, represents a "business as usual" scenario including a slight annual growth rate for Federal agencies and private industry demand.

--Scenario 2, Intermediate Demand, is based on the low demand estimates with increments for (1) space utilization, (2) increases for DOE's and ERDA's helium estimates and (3) a major increase in DOD requirements.

--Scenario 3, High Demand, is based on Scenario 2 plus the helium estimated to be needed to meet either of two energy options including the major shift scenario of the ERDA study.

The following table summarizes the report's demand projections under these scenarios.

The Interagency Helium Committee's Helium Demand Projections
(Annual Demand (BCF))

Year	Low	Intermediate	High
1978	.940	.940	.940
1979	.975	.975	.975
1980	1.010	1.010	1.010
1985	1.180	1.180	1.180
1990	1.350	1.350	1.350
1995	1.520	1.520	1.520
2000	1.690	1.690	1.690
2010	2.030	3.400	6.900
2020	2.370	3.810	7.470
2030	2.700	4.320	8.120

Source: "The Interagency Helium Study," Interagency Helium Committee, February 1978.

In contrast to ERDA's demand analyses, which involved a concentrated effort to define future users of helium, the Committee's low demand projection is a linear extrapolation of the MRI estimate of helium demand for present use through 2000. We consider this projection to be unreliable because historical helium demand patterns are not likely to provide a good indication of future helium uses. For example, most of the uses for helium today have emerged in the last 30 years. In addition, ERDA officials believe that conventional uses will stabilize after the year 2000 because of rising prices. Other reports have also concluded that future helium demand will be based on new technology and not on existing uses.

Without accompanying analyses, the interagency study concludes, that the most probable demand forecast will lie between scenarios 1 and 2. It fails not only to state reasons why this will be the case, but also to consider the consequences of greater helium demand. Even so, the Committee's conclusion implies that annual helium may be between 2.7 and 4.3 BCF at a time when helium resources may be extremely scarce.

OVERVIEW OF HELIUM DEMAND

Although the prediction of long-range future demand for helium is speculative, especially considering the fact that most of the future demand may come from technologies that will not be in place until after the year 2000, the studies discussed above attempted to determine long-range helium demands. These studies indicate that helium demand from new technologies can be expected to increase dramatically after the year 2000. These studies qualify the projections by admitting that error increases as the time frame increases. This accounts in part for the many different demand estimates. In the past the Bureau of Mines has been reluctant to develop such projections because (1) it questions the usefulness of long-range forecasting and (2) it is only responsible for the Federal Government's helium needs. Futher, the Bureau of Mines believes that new large users of helium will be in the private sector.

The following chart summarizes the range of demand estimates for helium in these studies.

Projections of Annual Helium Demand
(BCF per year)

Year	Interagency study			ERDA		MRI	
	Low	Intermediate	High	BC-Min (note a)	MS-Max (note b)	Low	High
1980	1.01	1.01	1.01	-	-	-	-
1985	1.18	1.18	1.18	1.1	1.1	-	-
1990	1.35	1.35	1.35	-	-	-	-
1995	1.52	1.52	1.52	1.34	1.45	-	-
2000	1.69	1.69	1.69	-		c/0.65	d/2.59
2005	-	-	-	2.04	2.99	-	-
2010	2.03	-	6.90	-	-	-	-
2015	-	-	-	2.52	5.01	-	-
2020	2.37	3.81	7.47	-	-	-	-
2025	-	-	-	2.68	6.82	-	-
2030	2.70	4.32	8.12	-	-	-	-

a/ ERDA base case minimum projections.

b/ ERDA major shift case maximum projections.

c/ Estimated by an econometric model using three demand aggregates. MRI finds this estimate questionable.

d/ Estimated by a demand analog model.

Even discounting the perhaps overly optimistic view of scientists and researchers, it appears that energy-related technologies using helium can be expected to heavily influence related helium demands after the year 2000. This factor is not to discredit the possibility of the development of nonenergy technologies that will require helium. Furthermore, these demand projections suggest that because of the rapid depletion of helium-rich gas resources (see ch. 2), present-day conservation is the only feasible way to forestall the need to extract helium from the atmosphere early in the next century.

COSTS AND BENEFITS OF ADDITIONAL HELIUM STORAGE

The Congress enacted the current Federal helium conservation program in 1960 because it believed that the immediate production and storage costs of helium would be more than offset by benefits obtained when the stored helium was used at a lesser cost than it could be acquired from future alternative sources. This assumption provided the economic basis for the program. Since 1960 attempts to quantify the dollar costs and benefits of helium storage generally indicate the additional storage would still be a good investment. The results of these analyses are not totally conclusive, however, because of the input variables.

It appears that presently there are three alternatives available for conserving additional helium: (1) insuring that presently nondepleting resources are conserved; (2) removing existing disincentives to private storage of helium (see ch. 5); and (3) authorizing further measures to conserve helium such as a new purchase program with private producers of helium. Priority consideration needs to be given to means to conserve the helium from the large Tip Top Gasfield. We believe that the first two alternatives are the easiest and least expensive and should be pursued initially (see ch. 6). However, because cost figures for either alternative are indirect or extremely hard to predict and because difficulties may render either or both alternatives insufficient, we selected the third alternative, a new purchase program, for our economic analysis.

In preparing a cost/benefit analysis to aid the evaluation of helium management policies, certain parameters must be considered. Factors crucial to a helium cost/benefit analysis are

--the real costs of conservation and when they are incurred,

--the social discount rate,

--the future cost of extraction,

--the date at which extraction from the air begins, and

--the benefits to society from helium conservation.

Unfortunately, in the case of helium, estimates of the values of these factors vary widely; however, the following sections discuss the various parameters and provide a concluding analysis.

Real costs of conservation

To justify additional storage of helium, the probable future benefits to be received from storage must exceed its current and recurring costs. The cost of conservation from existing plants is the sum of: (1) the cost of separation including capital costs, and transport to Cliffside; and (2) the storage cost including any losses in storage.

Part of the real cost of storing helium is the capital investment for plants and the connecting pipelines to storage facilities. This cost has already been incurred for existing plants and for the pipeline to Cliffside. Cost of extraction from these existing plants is only the operating cost. Storing additional helium in excess of present plant capacity would require investments in both extracting plant facilities and pipelines.

Existing data on the real cost of producing helium from private plants is fragmented and available only through the year 1973. Available data indicates that the initial sale prices (about $11 per MCF) of the original helium sales contracts were considerably higher than the actual costs of production. (See p. 49.) The contractors as late as 1971 offered to lower these prices when it became apparent that the program was running into financial difficulty. Recent data indicates that Tip Top helium may be able to be produced for as low as $4.50 per MCF. Thus, we conservatively estimate that the 1978 cost is approximately $13 per MCF. The maintenance costs at Cliffside are very low, only $0.04 per MCF per year. This estimate assumes that the Government or private producers could buy or produce helium at close to historical costs. Because of existing litigation, however, this may or may not be the case.

The price helium extractors have to pay landowners for helium at the wellhead is the subject of extensive litigation. (See ch. 5.) One Federal District Court determined the price of helium at the wellhead to range from about $0.61 to $0.70 per MCF. Another Federal District Court determined the price to range from $12 to $17 per MCF. Depending on how the helium value cases are ultimately resolved, the cost of producing helium could increase. As a result, the current purchase price of helium cannot be determined with any real certainty for purposes of stringent economic analysis.

Social discount rate

The most important component of cost yet the most difficult to estimate, is the opportunity cost to society for investing now in return for expected future savings or profit. The cost of storing additional helium includes capital, labor, and energy which could be allocated to other purposes in the economy. When helium is withdrawn later, capital, labor, and energy do not have to be expended to obtain helium from other sources. A savings will occur if the cost of extracting and storing helium is less than the cost of obtaining it from other sources, when it is needed at a later date. To measure the real cost of the investment, economists use the social discount rate.

Because of the length of time helium is expected to be held, the choice of an appropriate rate is crucial in evaluating helium storage. Compounding the discount rate causes the differences between rates to become amplified over time. Thus, the results of any analysis may vary depending on the discount rate used.

The Office of Management and Budget (OMB) has stated that almost all Federal investment projects must be measured against a 10 percent real discount rate. Thus, investing Federal funds in helium storage must, by the OMB standard, pay off later at least as well as putting those funds in other investments that return and compound 10 percent (in constant prices) per year.

Future cost of helium

Just as present-day costs are uncertain, estimates of the future costs are even more variable. The helium rich natural gasfields from which helium currently is extracted

will be substantially depleted between the years 1990 and 1995. Alternative sources will then be needed. To meet the demand after the 1990-1995 period, helium could be obtained from stockpiles, and imports, from helium extracted from leaner streams, undiscovered deposits, or the atmosphere. Estimates of the cost of crude helium from non-atmospheric sources other than the producing helium-rich natural gasfields are uncertain for two reasons. First, most of the expected helium resources are as yet unproven. Second, the cost of extracting helium will vary with the amount of helium in the gas stream. Thus, the cost of extracting helium from helium-lean natural gas will be higher because larger amounts of natural gas will have to be processed to produce a given amount of helium. The energy cost of extracting helium from natural gas containing 0.1 percent helium, for example, is expected to be about five times more than for helium extraction from the Hugoton Field.

It is not expected that imports will be adequate to meet this country's helium demand. (See ch. 2.) Further, any imports which become available can be expected to cost much more than present-day costs. Nevertheless, even though the costs of these alternative sources will be higher than the present-day extraction cost, it appears that it would be more economical to use them rather than to extract helium from the atmosphere.

The ultimate source of helium to which all alternative sources must be compared is extraction from the atmosphere. The atmosphere contains about 5,000 cubic miles of helium, but at a very low concentration--five parts per million. This low concentration of helium currently makes recovery from the atmosphere uneconomical because of the large amounts of energy needed for air compression. To extract helium from the atmosphere would cost more than 160 times current helium costs--about $2,000 per MCF. The ERDA report estimates that the atmospheric production of 1 BCF of helium would take the energy equivalent of 18 percent of the current U.S. annual coal production.

While the updated ERDA report estimates that extraction from the atmosphere will cost about $2,000 per MCF, past estimates, including one by the Department of the Interior, indicate the cost will be higher. The Bureau of Mines' environmental impact statement estimates extraction costs from the atmosphere to be from $1,000 to $3,000. We have been

informed that existing technology in this area is highly developed and that improvements are not likely. In addition, because helium is currently available in large quantities, no one is researching cheaper ways to extract it from the air.

Price elasticity of helium--Presently, it is difficult to assess what effect higher prices will have on helium demands because helium is being used where some substitutes do exist. Helium is preferred in most cases because it is technically superior. For example, helium is preferred as a lifting gas because of the danger of explosion with hydrogen. Nitrogen can be substituted for helium as a pressuring medium, but only where weight is not a problem. Because helium is preferred in most applications, it tends to be price inelastic at lower price ranges. Specifically, price changes do not affect demand.

Although helium demand may be inelastic at lower price ranges, little is known about what effects future price increases may have on helium demand. Past history is inconclusive because the Government demand is restricted to Bureau of Mines sales and the price of helium has not changed since November 1961. Moreover, the private sector helium market has been limited since its establishment in 1961. Price for helium has fluctuated between $19.50 and $35 on the private market.

Attempts have been made to estimate the price elasticity of demand for helium by econometric methods. Those studies agree that, within price ranges for which experience exists, the elasticity is about 0.3--a 10-percent rise in the helium price induces about a 3-percent decline in demand. Very large price increases would probably induce larger demand reductions.

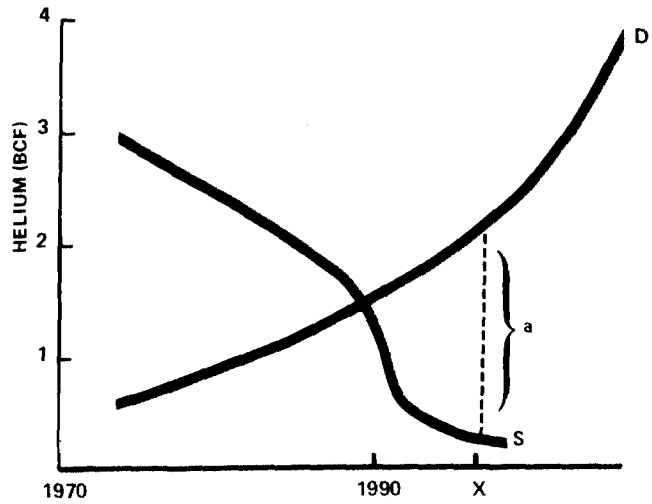
Developments in science and technology at cryogenic temperatures will require helium because no known substitute exists. The unique characteristics of helium will be required in developing superconducting technologies and fusion reactors. The price of helium could be very inelastic for these technologies because helium is a small component of the total investment.

Uncertainty of future atmospheric extraction date

The question of when it will be necessary to extract helium from the atmosphere can only be estimated because of two highly uncertain areas discussed in chapters 3 and 4--future helium resources and future helium demand.

Simplistically, the problem can be described by the following graph:

HELIUM DEMAND AND SUPPLY



The supply curve represents helium that can be supplied from existing facilities. When helium-rich resources that supply existing facilities are substantially depleted (somewhere between 1990 and 1995), demand will be rising while supply sources will be dropping off. The difference (a) will have to be supplied from other sources. Possibilities include:

--Stockpiled helium.

--Imports.

--Helium-lean gas streams.

--Low BTU gas.

--Future discoveries.

If helium-lean natural gas, future discoveries, or low BTU gas are used for helium sources, the date of atmosphere extraction will be postponed. Some limited imports will help meet domestic demand. The size of the helium stockpile and the criteria used to release the helium also affect that inevitable date.

Collectively, the variable nature of these factors prohibit the possibility of identifying with confidence a date when helium will be needed from the atmosphere. The following estimates have been made, however, by ERDA, NSF, and the Bureau of Mines.

ATMOSPHERE EXTRACTION DATES

Source of estimate	Estimated date of extraction
ERDA report	2020 to 2040
Bureau of Mines	(note a) 2016 to 2098
NSF Report	2040

note a: This range of estimates is taken from an August 1976 internal Bureau report which estimated the exhaustion of usable helium supplies under various scenarios. The low estimate scenario assumed that the only helium available after 2000 would be that already stored and what could be stored between 1977 and 2000. The 2016 date also assumed that there would be no new private helium extraction plants built to process helium lean gas or isolated deposits of nondepleted helium-rich gas.

A summary analysis

Assuming a constant discount rate, the accumulated cost of storing 1,000 cubic feet of helium varies with the production cost (or price of available helium) and the length of time stored. Assuming that additional stored helium will be used in the year 2030, and a 10-percent discount rate, the following tables show the range of accumulated costs for 1 MCF of helium when the helium price varies from $10 to $20 and when the actual extraction and storage takes place in 1978, 1988, or 1998.

SUMMARY COST TABLE - PRICE PER MCF IS $10

Price	Stored in year	Extracted from storage for use in year	Accumulated cost
$10	1978	2030	$ 1483
10	1988	2030	571
10	1998	2030	220

SUMMARY COST TABLE - PRICE PER MCF IS $20

Price	Stored in year	Extracted from storage for use in year	Accumulated cost
$20	1978	2030	$ 2903
20	1988	2030	1119
20	1998	2030	431

The accumulated cost must then be compared to the cost of alternative sources of helium to determine which is most economical. As the tables show, by changing one or more variables to the analysis, such as price or number of years stored, helium storage can be shown to change from economical to uneconomical or vice versa, depending on the price for the alternative source of helium.

The following summary analysis, shows that storage is economical in 1978 and each year beyond given certain assumptions. Several assumptions have to be made before even a simple cost benefit analysis of the helium storage question can be attempted. In the following analysis, we make the following assumptions.

1. A 10-percent interest rate is a true reflection of the opportunity cost of investment to society.

2. Inflation and subsequent judicial action will not significantly affect the cost of helium extraction (about $13 per MCF) from existing plants or the cost of storage at Cliffside (about $0.04 per MCF per year).

3. Helium demand will not be satisfied from existing gas streams in the year 2030.

The following table shows in MMCF not only how much helium can be expected from four of the original five extraction plants and the Government's Keyes plant, but what the expected demand will be through the year 1992. As the table shows, demand will exceed supply between the years 1991 and 1992, but approximately 17.5 BCF of helium could be captured and stored before that time.

Amount of Helium Available for Storage

Year	Helium available to be produced at the original contractors' plants	Expected Federal production	Total available	Expected demand	Excess to storage
			(MMCF)		
1978	3,008	334	3,422	737	2,685
1979	2,846	329	3,175	779	2,396
1980	2,694	294	2,988	820	2,168
1981	2,535	256	2,791	861	1,930
1982	2,401	223	2,624	901	1,723
1983	2,234	195	2,429	942	1,487
1984	2,123	171	2,294	982	1,312
1985	1,963	150	2,113	1,023	1,090
1986	1,866	123	1,989	1,069	920
1987	1,769	65	1,834	1,119	715
1988	1,672	-	1,672	1,169	503
1989	1,566	-	1,566	1,221	345
1990	1,461	-	1,461	1,273	188
1991	1,365	-	1,365	1,324	41
1992	1,271	-	1,271	1,376	a/-
				Total:	17,503

a/ The demand exceeds total available during this year and therefore, no excess is available for storage. The difference of 105 MMCF would have to be made up by withdrawals from storage or from other sources.

The ERDA report anticipates that between the years 2020 and 2040 the only source of helium will be the atmosphere. Thus if the 17.5-BCF excess helium produced between the years 1978 and 1991 were stored, it then could be utilized instead of atmospheric sources. ERDA anticipates demand in the year 2030 to be 3.9 BCF for its base case scenario and 7.3 BCF for its major shift scenario. For the purpose of our analysis, we have conservatively assumed demand to be constant after the year 2030.

The necessary calculations required to project the helium prices that would have to be charged by the Government to cover all costs when helium is sold in the year 2030 and subsequent years take into consideration that

--helium is produced and stored in different amounts each year as shown on p. 41,

--production costs are $13 per MCF and storage costs are $0.04 per MCF each year,

--the drawdown rates after 2030 are specified as 3.9 BCF and 7.3 BCF per year, and

--all costs are discounted at 10 percent.

The calculations show that the price needed to cover costs at the high drawdown rate is $1475 per MCF and the necessary price at the lower drawdown rate is $1619 per MCF. Based on our example, if the Government or a private producer were to undertake helium storage in 1978-1990 and if it could sell the helium at a price as great as $1,619 (that is, if alternative sources would cost more than this price), then an investment in helium would have benefited society. If the DOE estimate of $2,000 per MCF of helium extracted from the atmosphere is accurate, then clearly the storage of helium from the helium-rich resources via existing facilities, or any other source where the cost per MCF of helium is less than $13, is advisable, provided the assumptions set forth on p. 40 hold true. The investment would be even more attractive if, as expected, rising energy

costs make atmospheric extraction even more expensive in the future.

Additional analysis of this type needs to be done to evaluate alternative strategies to conserve helium. The analysis should be done on a case-by-case basis to determine where additional extraction plants can be economically located on helium-rich resources and, ultimately on helium-lean resources. In making the analysis, the timing of the extraction plants becoming operational should be such as to maximize the savings from the storage of helium.

Total production and storage costs associated with producing and storing the 17.5 BCF of excess helium through the year 2030 total $261.9 million. Costs would total $35 million in 1978 and decrease yearly as production declines. The present value of the total cost stream discounted at 10 percent is $161.7 million. These figures are substantially less than invested and planned amounts for energy related technologies. (See p. 22).

The cost of such a program could be offset by annual savings of at least $2 million, if Federal agencies were allowed to purchase cheaper helium from private producers. (See p. 77.) Also, annual savings of about $6 to $8 million could accrue if the Government's sales and distribution capabilities were phased out. Also, a substantial amount of money could be recovered by divesting Government helium sales equipment. Discounted over the next 50 years, the present value of these savings conservatively total $80 million--enough to cover about half of the cost of a new purchase program. Thus the net investment required over the period covered by our assumptions would be $80 million. Of course, in the long term, conserved helium will be sold, perhaps at a price sufficient to cover all interim conservation costs, and all funds returned to the Treasury.

We believe that when the annual cost of additional storage is compared to the expenditures being made to develop energy technologies (which, if commercialized will require immense quantities of helium), increased extraction and storage would help protect existing U.S. investments. There is, of course, a risk that some or all of these technologies will not be commercialized or helium substitute breakthroughs will occur. Were that to happen, the Government would incur a financial loss on the helium operation.

On the other hand, if helium requiring methods of energy generation and storage are implemented and no economic source is available, the consequences could be serious.

Another important benefit of additional storage is the possibility of future energy savings. As stated earlier, the process of obtaining helium from the atmosphere is energy intensive because of the necessity to compress large volumes of air.

CONCLUSIONS

Existing studies indicate that helium demand is likely to increase rapidly after the year 2000, even though the degree of increase is uncertain. Also, as discussed in chapter 2, helium resources can be expected to be scarce about the year 2030. The question therefore is: Should the Government store additional helium?

As discussed in this chapter, an economic analysis is clouded by the extremely variable nature of the parameters involved. Past history is relatively meaningless in considering future helium demand and supply scenarios. Also, because the helium price has remained at $35 per MCF or less the effects of high prices have not been demonstrated. Although it is difficult at this point to specify when it will be absolutely necessary to resort to atmospheric extraction, few estimates exceed the year 2050. Some experts believe atmospheric extraction may begin as early as the year 2020. However, for our analysis we used the year 2030. Accepting the assumptions of the analysis on page 40, we conclude that investment in additional storage from four of the original contractors' plants would be a sound investment.

Chapters 4 and 5 show that existing institutional, management and legal problems inhibit additional storage initiatives by the private sector and under the existing helium legislation. We believe, therefore, that the Congress, the Department of Energy, and the Department of the Interior need to consider the significance of potential helium demands and the consequences of not meeting them, as the basis for the development of a new helium conservation policy.

CHAPTER 4

PAST PRODUCTION AND CONSERVATION OF HELIUM RESOURCES

The Government has played an important role in helium production since 1918. (See ch. 1.) In 1960, however, following the rapid buildup in helium demand, the present-day helium program was authorized by Public Law 86-777, the Helium Act of 1960. Under the Helium Act approximately 37 BCF have been conserved by the Government. However, little is being conserved now because the Government believes it has stored all it needs to meet foreseeable Federal needs. The program has also been beset by various legal, financial, and management problems. In 1960 it was assumed that the Government would be the sole supplier of helium in the United States, and the 1960 act required the program to be self-supporting. But with the cutback of the aerospace program in 1967, which started the decline of the Government's need for helium, and with the assumption in fiscal year 1970 by private industry of the production of more than 50 percent of the helium market, the Government's helium program ceased to be self-supporting. Subsequently, the Secretary of the Interior terminated the program on the basis that the needs of the conservation program had been fulfilled. Only a small quantity of helium has been conserved since 1973.

While the legal and financial problems of the existing program drag on, each year as much as 75 percent of the helium available in produced natural gas is being released into the atmosphere. This waste of helium is particularly disturbing since, by the time the various legal and financial problems are resolved, much of the known helium-rich gas resources of the United States may be dissipated into the atmosphere.

This chapter traces the development of the Government's helium conservation program from 1957 to the present and provides the necessary background to the problems discussed in detail in chapter 5. In chapter 6 we discuss our overall conclusions and our recommendations to the Congress.

THE 1960 HELIUM ACT

In 1957 a committee with representatives from the Departments of the Interior, Defense, and Commerce; the Atomic Energy Commission; the Federal Power Commission; the Bureau of the Budget; and the Office of Defense Mobilization studied the helium situation. The committee recommended in a January 1958 report to the President that a new national policy be established for helium conservation. The report noted that large volumes of helium were lost into the atmosphere as helium-bearing natural gas was used as fuel. The report concluded that the only practical method of conserving large volumes of helium would be to extract the helium before marketing the natural gas and to store it in a suitable underground reservoir, such as the Cliffside Gasfield near Amarillo, Texas.

In April 1958, the President approved the recommendations of the committee and on September 13, 1960, the Congress passed the Helium Act which established a long-range helium conservation program and directed the encouragement of private helium production. It specifically authorized the Secretary of the Interior

--to acquire necessary lands,

--to make just and reasonable contracts (not to exceed 25 years); and

--to construct or acquire plants, wells, pipelines, compressor stations, and other facilities for the production, storage, purification, transportation, purchase, and sale of helium.

Under the Helium Act, the Secretary of the Interior assigned program responsibility to the Bureau of Mines. The Chief of the Division of Helium, Bureau of Mines, is responsible for conservation, production, and exploration of helium gas. A general manager located in Amarillo, Texas supervises field activities in Texas, Oklahoma, and Kansas.

Helium Act difficulties

Since 1967 the Helium Act has been beset with two major difficulties. Legal problems have arisen because of differing interpretations of the act's language and unresolved helium entitlements and valuation. Secondly, difficulties have

resulted from the financial management of the conservation program. The Helium Act explicitly states that it is

> "* * *in the national interest to * * * provide within economic limits through the administration of this Act, a sustained supply of helium which, together with supplies available or expected to become available otherwise, will be sufficient to provide for essential Government activities." (Emphasis added.)

The Department of the Interior and the Department of Justice have maintained that the 1960 Federal helium program requires the conservation of enough helium only to meet foreseeable Federal needs. However, this interpretation has been challenged by the Government's helium suppliers in court. (See page 53.)

To finance the program, the Helium Act authorized the Secretary of the Interior to borrow from the Department of the Treasury a maximum annual amount, initially established by an appropriation act to be $47.5 million and changed from time to time. The Helium Act specifies that the conservation program is to be self-supporting and directs the Secretary to establish a helium selling price that will adequately cover all costs, including (1) the operating costs, (2) the cost of the purchased helium, and (3) the compound interest charges on the net capital investment and all Treasury loans. The act also requires the Secretary to pay off the net capital investment within 25 years from the date of the act and all loans from the Treasury within 25 to 35 years.

In 1963 the Bureau of Mines estimated that the $47.5 million annual contractual borrowing authority, plus production from Government plants, would provide for storage of 43 BCF of helium by the year 1986. The Bureau's plan assumed (1) a $35 per MCF selling price which based on a projected demand would cover all costs, (2) a 3.875 percent interest on investment and borrowings would be in effect, and (3) the Bureau would be the sole helium supplier in the United States for the life of the program. However, the actual demand did not meet the projected demand, private industry obtained a significant portion of the helium market, and there was a considerable increase in the interest rate. Subsequently, the plan failed.

Helium purchase contracts

In 1961 the Bureau entered 22-year, fixed-unit-price contracts with four private companies to purchase crude helium extracted from natural gas. The contracts stipulated that the companies finance, construct, and operate five plants. The following table lists the contractors, initial unit prices, maximum annual payments, and Bureau estimates of the total amount to be purchased from each company by the year 1983.

THE HELIUM PURCHASE CONTRACTS

Company (and parent company where applicable)	Contract date	Initial unit price (MCF)	Maximum annual payment (million)	Estimated crude helium purchases thru 1986 (BCF)
Northern Helex Co. (Northern Natural Gas Co.)	Aug. 15, 1961	$11.24	$9.5	13.5
Cities Service Helex, Inc. (Cities Service Co.)	Aug 16, 1961	11.78	9.1	12.2
National Helium Corp. (Panhandle Eastern Pipeline Co. and National Distillers and Chemical Co.)	Oct. 13, 1961	11.78	15.2	21.0
Phillips Petroleum Co. (two plants) (note a)	Nov. 13, 1961	10.30	13.7	15.8
			$47.5	62.5

a/ At one plant the contract would expire in 16 years on October 29, 1977.

Source: "Final Environmental Statement," Department of the Interior, November 1972.

Under the helium purchase contracts, the Bureau constructed pipeline facilities to transport crude helium to storage. Each contract specified a maximum helium quantity the Bureau would purchase and the unit price for each MCF of helium delivered to the pipeline. (See the preceding table.) The unit price would be adjusted annually to reflect changes in the industrial commodities price index and a weighted-average price the companies paid for natural gas delivered to the contractors. The contracts also provided for Government cancellation if, in the opinion of the Secretary of the Interior, the continued purchase of crude helium was unnecessary to accomplish the purposes of the Helium Act because of (1) the discovery of large new natural helium resources, (2) a substantial diminution of helium requirements, or (3) any similar circumstances.

After the purchase contracts were signed, the Bureau selling price was set at $35 per MCF to all Government and private consumers, effective November 18, 1961. The Bureau expected that price to cover all anticipated costs of the conservation program.

From 1960 to about 1968, the program results were those anticipated by the Bureau. The four contractors began delivering crude helium to the conservation pipeline in fiscal year 1963. By the end of FY 1963, they had delivered 318 MMCF. In fiscal year 1968, they delivered 3.6 BCF. Government and private contractors increased helium storage from only 214 MMCF in fiscal year 1960 to 18 BCF in fiscal year 1968.

In fiscal year 1968, however, the program began departing from Bureau expectations. Federal demand declined as a result of cutbacks in the aerospace program. By fiscal year 1970, private industry also had begun producing and selling helium, and acquired about 50 percent of the total helium market, thus eliminating the Government's monopoly. Bureau and private sales from fiscal year 1960 to fiscal year 1976 are shown in the following table.

BUREAU OF MINES AND PRIVATE HELIUM SALES

Fiscal year	Bureau sales	Private domestic sales	Total domestic sales	Exports (private sales)	Total U.S. market
			(MMCF)		
1960	415	-	415	5	420
1961	516	-	516	7	523
1962	591	11	602	9	611
1963	601	20	621	11	632
1964	660	26	686	14	700
1965	640	35	675	16	691
1966	776	61	837	18	855
1967	719	178	897	25	922
1968	534	359	893	36	929
1969	450	360	810	30	840
1970	273	364	637	38	675
1971	193	359	552	50	602
1972	166	351	517	63	580
1973	179	380	559	81	640
1974	168	394	562	103	665
1975	172	393	565	135	700
1976	183	402	585	150	735

Source: Bureau of Mines

Termination of the purchase contracts

In 1961 the Bureau of Mines assumed that (1) the Government would monopolize the helium market by purchasing all U.S. production and selling to all markets and that (2) Federal and private requirements would continue to increase. By fiscal year 1970, however, private companies entering the helium sales market accounted for 57 percent of domestic helium sales. This increase was possible because the private producers' price of $21 per MCF undercut the Federal price by almost 40 percent. In addition, during 1970, Bureau sales were only 20 percent of what had been predicted at the beginning of the program.

In addition to the loss of practically all private helium sales, Federal helium needs were also declining. Although Federal agencies are required to purchase helium from the Bureau, Federal sales fell from a 684 MMCF maximum in fiscal year 1967 to 264 MMCF in fiscal year 1970--a decline of about 52 percent. These declining sales contributed heavily to a $210.9 million helium fund debt by the end of fiscal year 1970.

The Bureau's 1959 estimate assumed cumulative Bureau sales of 9,593 MMCF through fiscal year 1970. Actual sales, however, were only 6,175 MMCF. The 3,418 MMCF difference represented about $120 million less than the revenues expected (3,418 MMCF x $35 per MCF = $120 million). Because of this decline in sales, Bureau of Mines production alone was sufficient to meet all Government demand for helium. None of the helium purchased from the private producers was needed and thus has remained in storage.

In our September 10, 1969 report entitled, "Review of the Government's Program to Supply Current and Future Helium Requirements," (B-114812) we found a significant decrease in Bureau helium sales, and concluded that this reduction in sales may make it impossible to repay the debt within the required time. Therefore, we recommended that the House Committee on Interior and Insular Affairs consider terminating one or more of the helium purchase contracts. Because of our report and congressional interest, the Department of the Interior's borrowing authority was lowered during fiscal year 1969, resulting in late payments to the four contractors.

Because of the fiscal problems of the helium program, the Secretary of the Interior was led to consider whether grounds for termination existed among the contract termination clauses. On January 26, 1971, the Under Secretary of the Interior attempted to terminate the helium purchase contracts because in his view they were unnecessary to achieve the objectives of the Helium Act. According to the Department of the Interior, the objective of the act was to provide, within economic limits, a sustained supply of helium, which together with supplies available (or expected to become available), would be sufficient to provide for essential Government activities. Following various legal procedures, the contracts were effectively terminated by the Secretary of the Interior and the Bureau of Mines ceased accepting helium on November 12, 1973.

The cancellation of the purchase contracts has since involved the helium conservation program in several legal problems. Because of the late payments, one contractor --Northern Helex Company--terminated helium deliveries and in December 1970, sued the Government for breach of contract, asking for $92 million in damages. The three other contractors--National Helium Corporation, Phillips Petroleum Company, and Cities Service Helex Company--

actually delivered 7 BCF of helium to Cliffside between 1971 and 1973. However, with the final contract cancellation in 1973, each filed its own breach of contract suit against the Government, claiming damages for the entire contract term totaling about $375 million.

The termination of these contracts and subsequent statements by the Secretary of the Interior and Bureau of Mines' officials clearly indicate that the Department of the Interior considers the helium program's objective is to meet Government needs only. Indeed, the Under Secretary of the Interior's statement of January 26, 1971, indicates that the Department has concluded that (1) the objectives of the 1960 Helium Act have been accomplished and (2) enough helium has been stored to meet foreseeable Government needs past 2000.

Current Federal helium storage activities

The helium conservation program, established by the 1960 Helium Act has resulted in Government storage of about 37 BCF of helium. However, since November 1973 when the Federal helium purchase contracts' terminations became effective--10 years before they were due to expire--the helium storage program has remained at a virtual standstill. Although excess Federal production has been stored, the amounts have been insignificant. In fiscal year 1977, for example, only about 137 MMCF of federally-produced helium was stored.

Private producers, although offered low-cost storage contracts since 1975, generally have not stored excess helium production. (See ch. 5 for further discussion.) As of October 1, 1977, private firms had stored about 1.6 BCF of helium in Cliffside. The following chart shows total helium storage:

Helium in Cliffside Gasfield as of October 1, 1977

	Billion cubic feet
Purchased under contracts	33.7 (note a)
Produced at Bureau of Mines plants	3.5
Contained in native gas	4.0
Stored for private firms	1.6
Total	42.8

a/ Includes 1.5 BCF accepted under a court order.

The four former contract producers have over 90 percent of the helium production capability in the United States. Of the 1.6 BCF in private storage as of October 1977, 97 percent was produced by one of the former contract producers (Northern Helex Co.). This production was stored by either Northern Helex Co. or its customers. During the subsequent 6 months, private firms stored an additional 0.2 BCF. Of this amount, only 70 percent was produced by Northern Helex Co. The percentage reduction was due to the Phillips Petroleum Co.'s storage of 0.06 BCF which began in December 1977. Of the remaining two former contractors, Cities Service Helex had insignificant storage, and National Helium Corporation had no storage.

CURRENT PRIVATE HELIUM PRODUCTION

Of the approximately 13 to 15 BCF of helium available each year as natural gas is extracted for fuel, eight private companies are capable of extracting 3.2 BCF. The four original Government contractors contain all but 0.3 BCF of this capacity. All but one of the plants are located in Texas, Kansas, or Oklahoma. The following chart shows the fiscal year 1977 production capability, production, and distribution of production for these plants.

U.S. PRIVATE HELIUM PLANTS

Plant	Design capacity	Helium available	Total production	Production			Production vented	Left in fuel
				Transferred	Sold	Stored		
	(volume in MMCF (note c))							
National Helium Corporation (note a)	1,210	1,159	0	0	0	0	0	1,159
Cities Service Helex (note a)	773	700	700	(75)	0	0	625	0
Northern Helex Co. (note a)	798	612	612	(209)	5	398	0	0
Phillips Petroleum Co. (note a):								
Dumas Plant (note b)	656	533	0	0	0	0	0	533
Sherman Plant	607	455	455	70	0	0	385	0
Alamo Chemical Corp.	168	40	40	(70)	110	0	0	0
Cities Service Cryogenics	203	168	168	75	243	0	0	0
Kansas Refined Helium	105	30	30	209	192	47	0	0
Western Helium Corp	71	30	30	0	30	0	0	0
Total	4,591	3,727	2,035	0	580	445	1,010	1,692

a/Formerly under contract with the Bureau of Mines to sell helium to the Government for storage.
b/The Dumas Field was depleted in 1978.
c/Helium bought (or sold) to or from other helium production companies.

Source: The Bureau of Mines.

Although about 3.7 BCF of crude helium were available in fiscal year 1977 for extraction from natural gas, only 1.0 BCF--some 27 percent--was sold to customers or stored in the Cliffside Gasfield. The remaining 2.7 BCF was left in the fuel or released to the atmosphere. The Cities Service Helex and Phillips Petroleum Sherman plants vented about 1 BCF as they were extracting other products from the natural gas. The National Helium Corporation and the Phillips Petroleum Dumas plants left 1.7 BCF in the natural gas fuel stream leaving their plants. (The Dumas field is now depleted, reducing the annual amount of helium available through existing facilities for production from 3.7 BCF to 3.2 BCF since 1977.)

Helium purification activities

Helium produced by the four Government contractors cited above is in a crude form and needs to be further purified for most industrial and scientific uses. (Crude helium is a gas mixture containing 70 percent helium.) Alamo Chemical, Cities Service Cryogenics, Kansas Refined Helium, and Western Helium Corporation, four private firms, and the Bureau of Mines operate the only five helium purification facilities. Union Carbide, however, recently announced plans to build a helium purification plant in Kansas by mid-1979. The Kansas plant will also have the capacity to liquefy 300 MMCF of helium annually making it the world's largest plant.

Although the original extractors under the conservation program do not currently operate helium purification facilities, they are important to the industry because they sell crude helium to some of the small private companies which purify it for sale and distribution.

The Bureau for a fee also plays an important role in the helium industry by assisting small private companies to meet their requirements for pure helium. Two of these companies sell helium even though they have no productive capability of either crude or pure helium. Other companies have part of their crude helium purified by the Bureau. During fiscal year 1977, the Bureau purified 427 MMCF. Of this amount 183 MMCF was for private companies.

As summarized in the following table, the Bureau and private plants purified 937 MMCF of crude helium and sold 887 MMCF for the twelve-month period ending June 30, 1977.

U.S. Helium Sales

July 1, 1976, through June 30, 1977

Private company	Crude helium purified	Sold	Percent of total sales
	(MMCF)		
Northern Helex	-	5	0.6
Alamo Chemical	110	139	15.6
Cities Service Cryogenics	243	243	27.4
Kansas Refined Helium	127	192	21.6
Western Helium Corp.	30	30	3.4
J.B. Kelley Co.	-	22	2.5
Linde Division, Union Carbide	-	62	7.0
Total private	510	693	78.1
Bureau of Mines	427	194	21.9
Total Private and Bureau	937	887	100.0

CHAPTER 5

EXISTING DETERRENTS TO ADDITIONAL HELIUM CONSERVATION

The Federal helium conservation program is presently entangled in litigation and is handicapped by an inadequate financial program. Because of these problems, additional helium conservation would be difficult to accomplish under existing legislation. In addition, private producers are now inhibited from initiating large-scale helium storage efforts because of existing litigation, tax disincentives, and the lack of a definitive Federal helium stockpile release policy. Until these problems are resolved, the storage of significant amounts of additional helium will not take place. In addition, unless these issues are resolved quickly, the low cost helium reserves in the Hugoton and adjacent gasfields will be significantly depleted and wasted.

This chapter examines ways to minimize the adverse effects of these deterrents on helium conservation problems, including (1) expediting the conclusion of helium litigation, (2) resolving the financial problems of the helium program, and (3) eliminating private sector disincentives to helium conservation.

HELIUM LITIGATION

Breach of contract suits

During the early 1970s, as the Congress debated the value of continuing the helium storage program, it was slow to appropriate money for the helium purchase contracts. In December 1970, one of the contractors (Northern Helex Co.) terminated delivery and sued for breach of contract for nonpayment by the Government. The contractor requested $92.3 million in damages--the total amount left to be paid if the contract would have run full term.

Although the U.S. Court of Claims has ruled that the contract was breached, the amount of damages remains to be determined. The damages of $78 million levied by the trial judge were reduced by $43 million by the Court of Claims. The Court of Claims rejected Northern's proposed measure of

damages for the entire contract price and remanded the action to the trial judge prescribing guidelines under which the amount of damages, if any, would be determined. Further reductions or reinstatements will be determined by additional court proceedings, which may take several years.

When the Secretary of the Interior terminated the contracts in 1973, the remaining three companies sued for breach of contract, asking for a total of about $375 million in damages. Cities Service Helex and Phillips Petroleum Co. are asking for the contract price on the remaining amount to be purchased. Because its plant is shut down, National Helium Corp. is asking for the contract price less any operational cost savings. The companies are attempting to prove that helium market conditions in 1970 did not justify termination as specified in the 1960 act and in the original contracts. They also contend that the Secretary of the Interior did not act on his own as required by the law, but rather that the Office of Management and Budget and the President directed his actions.

In these three cases the courts must first determine if liability exists with the Government. One of the basic contentions of the three plaintiffs is that conditions necessary for termination as specified in their contracts had not in fact occurred and, therefore, the Government is liable. The Government denies this contention. If and when liability is shown, the amount of damages will be determined. Final resolution of the cases could take an additional 4 to 6 years.

Helium valuation litigation

When the helium conservation program began in 1961, it was generally assumed that title to the helium contained in the natural gas passed from the landowner-lessors to the producer-lessee extraction companies under the terms of existing gas and oil leases. Title then passed to the extraction companies and ultimately to the Government through its contracts with the extraction companies. The question of ownership and the value of the helium at the wellhead was nevertheless recognized as a potential problem in the helium storage contracts. The helium purchase contracts the Government had with the four extraction companies contain clauses that could

mean that the Federal Government would be subject to claims for payments the helium extractors would have to make to third parties in excess of about $3 per MCF. The Department of Justice maintains, however, that these clauses are void as contrary to statutory proscription against Government indemnification, except where specifically authorized by statute.

A very complex series of legal actions between extraction companies and landowner lessors began in the Tenth Circuit in 1963 contesting the ownership and value of helium. These actions continue. The courts have found that the landowners and gas suppliers are generally entitled to compensation for the value of the helium produced. In subsequent attempts to fix the value, two separate Federal District Court decisions arrived at different valuations for helium. These courts held that the value of the helium at the wellhead ranges from about $0.60 to $17 per MCF. In December 1978, a U.S. District Court, ruling on one of the valuation cases, set the value of helium at the wellhead sold to the Government at $3 per MCF. However, both parties to that particular case are considering appeal. Thus these cases are still a long way from being resolved. A Department of Justice lawyer told us that the ultimate decision probably will be rendered by the Supreme Court. He expects it to be 3 to 5 years before all the appeals and court procedures are completed.

When the final court decision sets the price of a MCF of helium, the Government will be subject to claims for the amount above $3, times the number of thousands of cubic feet purchased under the contracts, less helium volumes produced from the contractor's wells. According to the Bureau of Mines Helium Division, if the Government was held liable and an average value of $15 were adopted by the Court and applied to the entire volume of helium purchased by the Government, this amount would be $386 million. This figure is somewhat exaggerated because some of the helium came from the contractor's own gas wells. However, prejudgement interest at 6 percent compounded annually would double this amount. Based on the Government's obvious financial interest in the outcome of this litigation, the United States has intervened in these cases, favoring the helium extraction companies.

While most existing helium valuation cases concern only the Government-purchased helium under the original contracts, other litigation concerning helium entitlements and valuation is taking place. The Bureau speculates that the wellhead price established by the court for helium might be adopted by all landowners as the appropriate royalty for helium that they should be paid if extraction companies separated helium from leased gas streams. Thus the outcome of these particular cases may affect the entire industry. Until these valuation suits are finally determined, private companies and the Government are reluctant to store helium because they may be required to pay a very high price for it later.

Helium waste is aggravated by continuing litigation

The confusion caused by the helium litigation does not promote conservation. Helium continues to be vented while litigation over breach of contract continues in the Court of Claims. The helium valuation cases also promote waste because of the uncertain value and the potential liability for those who produce helium.

The number of cases and litigants involved have added to litigation problems. The United States is a defendant and/or intervenor in nine helium lawsuits. Five of these lawsuits involve disputes over helium value and involve some 30,000 royalty landowners and a number of lessee-producers. The other four cases were filed against the Government for breach of contract. Until these helium cases are resolved, helium conservation will continue to be discouraged.

THE INADEQUATE HELIUM FUND

The 1959 Bureau program estimate that a $35 per MCF selling price for 36 BCF projected helium sales would liquidate the helium debt did not stand the test of time. (See table on p. 63.) The Bureau believes, however, that the $35 per MCF selling price did serve to meet certain program needs. According to one Bureau official, the relatively high price, compared to the private market, allowed the Bureau to store more helium by eliminating many nonessential helium uses. It also served to meet a requirement of the act to encourage private industry to develop helium production facilities and distribution systems because of high profit potential. Because of these factors the Bureau was able to store enough helium to meet anticipated and essential Government needs much sooner than expected. In meeting those needs however, the Bureau lost almost all of its share of private market sales. The relatively high selling price encouraged private companies to purify and sell helium, thereby undermining Government monopoly of the pure helium sales market and reducing its anticipated sales. Because revenues were less than anticipated, repayments could not be made and a large debt accumulated. According to a National Academy of Sciences' report, the financial burden of this large debt encouraged the Secretary to consider grounds for termination of the helium purchase contracts.

Comparison Between
the 1959 Plan and the Bureau's Actual Helium Sales

Fiscal year	1959 estimate	Cumulative estimate	Actual bureau sales	Cumulative bureau sales
		(MMCF)		
1960	441	441	415	415
1961	512	953	516	931
1962	590	1,543	591	1,522
1963	675	2,218	601	2,123
1964	765	2,983	660	2,783
1965	860	3,843	640	3,423
1966	957	4,800	776	4,199
1967	1,056	5,856	719	4,918
1968	1,153	7,009	534	5,452
1969	1,247	8,256	450	5,902
1970	1,337	9.593	273	6,175
1971	1,421	11,014	193	6,368
1972	1,498	12,512	166	6,534
1973	1,568	14,080	179	6,713
1974	1,631	15,711	168	6,881
1975	1,686	17,397	172	7,053
1976	1,735	19,132	183	7,236

Source: Bureau of Mines

Program costs

The following table shows how the helium fund debt has accumulated from fiscal years 1961 to 1976.

HELIUM PUBLIC ENTERPRISE FUND DEBT FISCAL YEARS 1961-1976

Fiscal year	Debt at start of period	Borrowings (repayments)	Interest	Debt at end of period
		(000 omitted)		
1961 (note a)	$ 39,645 (note b)	$ -	$ 1,220	$ 40,865
1962	40,865	-	1,584	42,449
1963	42,449	(6,000)	1,509	37,958
1964	37,958	2,000	1,485	41,443
1965	41,443	20,000	1,980	63,423
1966	63,423	19,000	2,924	85,347
1967	85,347	23,200	3,916	112,463
1968	112,463	30,000	5,458	147,921
1969	147,921	16,200	7,314	171,435
1970	171,435	29,900	9,530	210,865
1971	210,865	66,300	12,162	289,327
1972	289,327	44,030	15,691	349,048
1973	349,048	1,020	19,233	369,301
1974	369,301	-	20,559	389,860
1975	389,860	-	22,102	441,962
1976	411,962	(1,000)	23,803	434,765

a/Financial obligation began March 1, 1961.
b/Debt arising from the net capital and retained earnings of helium production fund as of September 13, 1960 and certain adjustments thereto (net capital).

Source: Bureau of Mines

As the table on page 64 shows, the Bureau has repaid only $7 million of the debt; $6 million in fiscal year 1963 and $1 million in fiscal year 1976.

The program's cumulative debt as of July 1976 was about $435 million and composed of the following:

HELIUM FUND DEBT

Debt Origin	Principal	Interest	Total
	(millions)		
Net capital less repayments	$ 32.64	$ 31.11	$ 63.75
Borrowings from Treasury	251.65	119.36	371.01
Total	$284.29	$150.47	$434.76

Borrowings from the Treasury were used to purchase helium from the private companies. The actual total amount purchased as of April 4, 1973, cost $385 million, of which $29 million is still owed to the contractors. Of the $356 million ($385 minus $29) which was paid for helium, approximately $104 million were from profits on helium sales and the remaining $252 million came from borrowings.

Repayment unlikely

It is now apparent that the helium conservation program will not pay for itself within the time frame specified in the Helium Act.

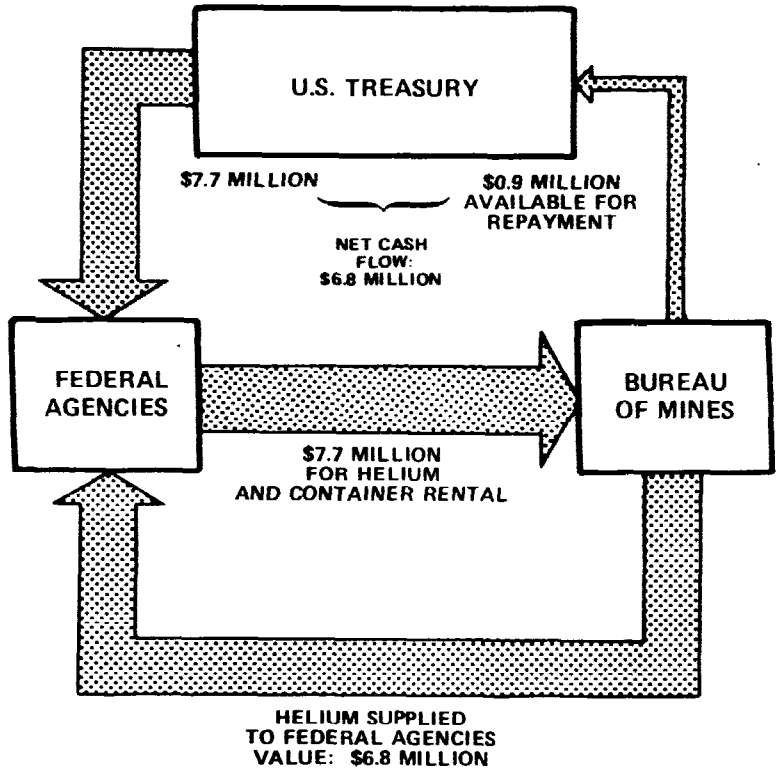
In fiscal year 1976, program revenues exceeded operating costs (excluding interest expense) by $3.7 million. During this same period, the Bureau incurred a $23.8 million interest liability on previous years' cumulative debt (including back interest). When the interest expense of $23.8 million is considered, the Bureau incurred a $20.1-million net loss in fiscal year 1976. During fiscal year 1976 the the debt to the Treasury increased from $412 million to $434.8 million or a net increase of $22.8 million composed

of the $23.8 million interest expense and a $1 million repayment to the Treasury (the first payment since fiscal year 1963). If the Bureau continues to have net losses, it is very unlikely that the debt will be repaid within the time specified in the Helium Act.

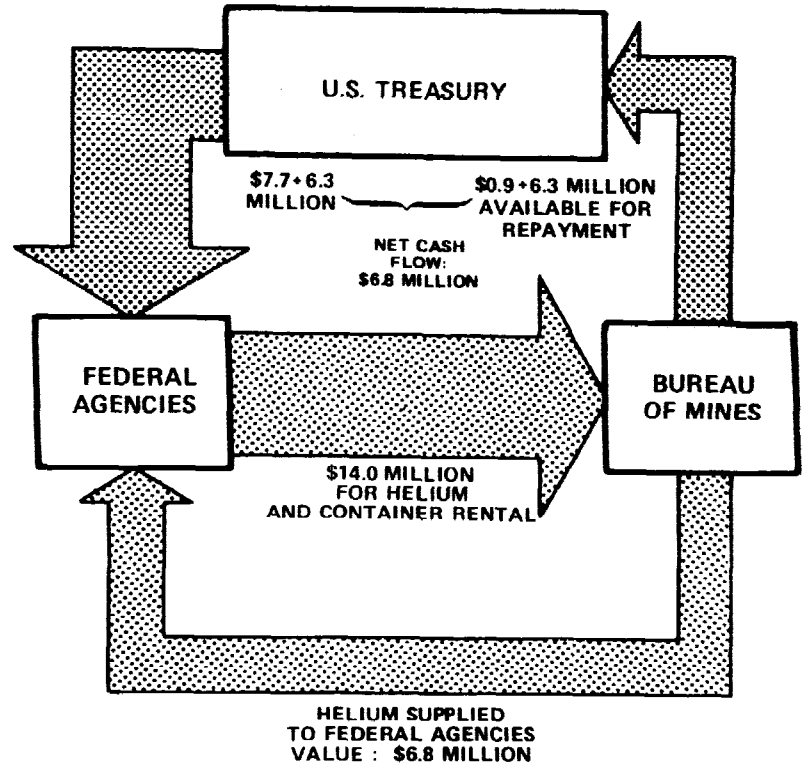
Alternative pricing policies, such as raising the price of helium above $35 per MCF, will have no overall effect. As long as the Bureau supplies only Federal agency requirements, changing the Bureau's price per MCF results in no financial benefit to the Government.

The following graph prepared by the Bureau for example, illustrates the effect of doubling the price (from $35 to $70 per MCF). Regardless of whether the price is $35 or $70, the Treasury's net cash flow remains the same because Federal agencies would have to outlay additional funds to pay for the more expensive helium. Such an arrangement, however, would increase Bureau revenues and make more funds available for payments to the Treasury.

CASH FLOW FOR FEDERAL HELIUM PURCHASES



HELIUM @ $35/MCF.
(CURRENT PRICE, FY - 1978)
NET CASH FLOW $6.8 MILLION



HELIUM @ $70/MCF.
(HYPOTHETICAL NEW PRICE, FY - 1978)
NET CASH FLOW $6.8 MILLION

SOURCE: BUREAU OF MINES

Under these circumstances, we conclude that (1) repayment of the debt is out of the question and (2) changes in pricing would merely be paper transactions designed to administratively erase the debt.

The helium fund problem needs to be resolved. Not only did the conservation program's fiscal problems encourage the Secretary to examine grounds for the contract terminations, but they also inhibit new conservation efforts. The concept of paying for long-term helium conservation out of current helium sales is not a viable one. The idea of making the program self-supporting through an artificially high price only transfers the costs to other Federal agencies.

Therefore, although such a step requires congressional action, we believe that the debt should be excused. Should new conservation efforts be undertaken through the existing or new legislation, appropriations should be made to cover expenses. However, this annual appropriation would be partially offset by the amount Federal agencies would save by buying helium at a cheaper price from private producers. Revenues received when helium is sold from the stockpile should be forwarded to the Treasury.

DETERRENTS TO PRIVATE STORAGE

Currently, private helium production capability far outstrips private helium demand and helium stored now will not be used for 15 to 20 years. Most companies are, therefore, hesitant to invest in the storage of a commodity that will not have a payback for a period that long. Even so, several firms have initiated helium storage contracts not to exceed 25 years with the Bureau of Mines. However, helium litigation as discussed above, tax disincentives, and the lack of a definitive helium stockpile policy have limited the volume of helium stored by private firms.

Tax deterrents discourage private storage

In addition to the litigation and financial problems discussed above, the current Federal tax law inhibits private helium production and storage. Helium is extracted by some natural gas companies as part of an integrated process toward producing a fuel product. Removing helium and other noncombustible gases, such as nitrogen from the gas, increases its fuel value (BTU rating). Of course, some gas is fuel rich and

helium does not have to be extracted to enrich fuel. However, helium left in natural gas is lost to the atmosphere when the gas is burned. If the helium is removed and the producer cannot sell it, he can either vent it or store it. If the producer elects to vent the helium, he can deduct the cost of extracting and venting as part of his cost of fuel production. This procedure provides an immediate cost recovery incentive. But, if he stores it, in effect converting the helium to an asset, he cannot deduct the cost of extraction until he sells it. Under Federal income tax law, the entire cost of producing helium must be capitalized if it is stored as an asset. This tax treatment conforms to normal accounting practice as reflected in the tax code.

The Helium Division has recommended and we concur that the Federal Internal Revenue Code be amended so that the cost of helium produced for conservation need not be capitalized but rather can be immediately written off as a production expense. Of course, when the helium is ultimately sold the costs cannot be claimed a second time.

No stockpile release policy

Private helium producers cite the lack of specified criteria governing the release of the Government's stockpile as a large deterrent to their storing additional helium. These producers fear that if they invest in helium storage, the Government will, at some future time, release large quantities of helium, thus destroying any competitive advantages they might have gained from long-term storage. The business sector, generally short-term, profit-motivated, is reluctant to assume the risk of long-term storage because of this, as well as the litigation and financial factors. As discussed in chapter 6, we believe that the stockpile should be reserved to meet Government and private needs mostly for developing energy technologies. Also, releases should not be made until all other available sources of helium have been depleted short of atmospheric extraction.

The National Academy of Sciences has suggested that the helium reserves held at Cliffside be designated a strategic stockpile. Then releases could only be made from the stockpile if a state of emergency were declared. Although this may be an acceptable way of establishing more

stringent criteria, thus encouraging more private storage, we believe that a new legislative approach to the helium problem, as proposed in chapter 6, could more efficiently and effectively consolidate all such proposals for promoting helium conservation.

CONCLUSIONS

The existing helium conservation program has been at a virtual standstill since the purchase contracts were effectively terminated. Most of the helium that would have been purchased is now vented or allowed to remain in the natural gas. We believe that this wasting of a nonrenewable resource, which could easily be captured, is extremely unfortunate.

The helium litigation and financial problems of the existing program have almost eliminated Government efforts to conserve helium. Until these problems are resolved, helium resources will continue to be depleted.

The outmoded financial structure established by the 1960 Helium Act also needs congressional action. The fiscal problems of the 1960 conservation program probably contributed significantly to the end of the purchase program and have discouraged new conservation efforts. The concept of paying for a long-term conservation program out of present-day sales is not viable for helium. The Congress could alleviate this problem by dismissing the debt of the 1960 program. Future revenues could be forwarded directly to the Treasury.

To encourage private producers to store helium, deterrents presently facing them should be removed. The existing tax law could be amended to allow a much quicker write-off of the cost incurred when separating helium. The Secretary of the Interior could also promote private conservation by establishing a policy regarding the release of the Government stockpile. This policy should recognize that the Government could greatly affect the future market of helium by the way it disperses the stockpile. Private industry will not make new capital investments in helium extraction until it is assured that the Government will not dump stored helium on the market.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

The United States faces a difficult dilemma with respect to management of one of its most unique and nonrenewable resources--helium. On the one hand natural gas, the best source of helium, is rapidly depleting, and some estimates indicate it may be very scarce after the year 2020. At the same time, the United States is investing millions of dollars in energy research-and-development efforts that could require large amounts of helium after the year 2000. On the other hand, long-range resource and demand projections are only estimates and it is possible that additional helium resources may be discovered and/or presently envisioned helium-dependent technologies may not prove viable.

Because of the unique attributes of helium, the large continuing investment in helium dependent energy technologies, and the possibility of as yet unforeseen uses for helium, we believe the Government should act on available alternatives to prevent the loss of helium to the atmosphere. Paramount to the consideration of available alternatives for additional helium conservation is the need for the Congress to develop a new helium policy which would establish within the Federal Government the responsibility for conserving helium for national needs. The existing helium conservation legislation is (1) according to the executive branch, limited to providing for Federal agency needs and (2) hampered by financial and legal problems to the extent that significant additional conservation efforts are unlikely to occur.

THE HELIUM PROBLEM: WASTING RESOURCES AND POTENTIAL NEEDS

Helium, because of its unique characteristics, is currently used for a number of scientific and technical purposes, and may be essential to the future development and implementation of several energy-related technologies presently being researched. However, because of institutional, legal, and management problems, each year large amounts of helium which could be cheaply recovered are lost to the atmosphere.

Helium resources are rapidly decreasing as their most economical source--natural gasfields--are depleted, and uncaptured helium is released to the atmosphere through the burning of natural gas. Of further concern is the fact that the natural gas with the greatest helium content is now being produced and will be substantially depleted within the years 1990-1995.

Government and private helium conservation limited

The Government has been involved with helium production since 1918. In 1960, with helium demand on the rise, primarily in the aerospace industry, the Congress passed the Helium Act. The Helium Act established the Federal helium conservation program and authorized the Secretary of the Interior to acquire lands; to implement helium purchase contracts; and to construct or acquire plants, pipelines, and other facilities for the production, storage, and sale of helium. It also required Federal agencies to purchase their helium needs from the Federal program.

In 1961 the Secretary signed 22-year, helium purchase contracts with four private producers. Under the contracts, the companies financed, constructed, and operated five new helium extraction plants. The Bureau of Mines constructed a commmon collector pipeline to transport the helium to the Government's underground storage facility at Cliffside Gasfield in Texas. All private helium production purchased by the Government has been conserved. Federal needs have been met by production from a Federal extraction plant.

In 1971 the Under Secretary of the Interior determined that the objective of the 1960 Helium Act had been accomplished and continuation of the purchase contracts was unnecessary. The Under Secretary's decision followed a decline in Federal helium demand from a high of 544 MMCF in 1967 to only 264 MMCF in 1970. Also, the 28 BCF in storage as of January 1971 was expected to meet foreseeable Government needs past the year 2000. The termination actions initiated in 1971 and subsequent actions by the Secretary of the Interior clearly indicate that the Department considers the existing conservation program's objective to meet essential Government needs only. However, this interpretation has been the subject of much legal debate since 1971.

Since 1973, when the purchase contracts were effectively terminated, the Government's helium conservation program has virtually stood still. Three of the four private contractors have stored very little helium and have allowed significant amounts of helium to be released to the atmosphere. In fiscal year 1977, for example, of the 3.7 BCF available for extraction at private facilities 2.7 BCF was lost to the atmosphere, 0.6 BCF was used to meet demand, and 0.4 BCF was stored by private contractors. As of October 1977, only a total of about 1.6 BCF had been stored by private producers. Government storage has also been insignificant since the contracts were terminated. Only about 1.6 BCF of Government produced helium has been stored since fiscal year 1973, and only 0.1 BCF was added to storage in fiscal year 1977.

Demand and supply projections

Each year about 13 billion cubic feet of helium escape into the atmosphere as domestic natural gas is produced for fuel and other purposes. The question is: How long will natural gas continue to be produced, and thus insure a relatively cheap supply of helium?

Long-range natural gas projections are only estimates and not surprisingly, a number of studies have reached different conclusions regarding the availability of gas resources in future years, and the desirability of additional helium conservation measures. For example, a 1975 ERDA report concluded that by the year 2020, natural gas production will have depleted gas resources to a great extent and that helium will have to be obtained from other sources. However, the 1978 Interagency Helium Study concluded that substantial domestic helium resources (over 350 billion cubic feet) would remain in natural gas in 2030.

We believe that the interagency study contains serious weaknesses. The Bureau of Mines made the resource projections for the interagency study under the assumption that certain measures would be taken to preserve presently identified nondepleting helium-rich gas resources (over 123 billion cubic feet). The final report, however, did not contain any recommendations towards that end. Some of these fields will likely begin to deplete as the gas becomes economic to produce. Such is the case with the

largest of these, the Tip Top Gasfield in Wyoming. Our opinion of the interagency study is further lessened because the study failed to endorse the recommendations for conservation made by a National Academy of Sciences' Helium Forum commissioned by the Interagency Helium Study Committee.

Conventional helium demands are expected to rise steadily through the year 2000. After 2000, the demand may rise dramatically. According to ERDA (now the Department of Energy) and others, helium may be essential to the future development and implementation of several developing energy-related technologies. Nuclear fusion reactors, superconducting magnetic energy storage devices, and superconducting transmission lines, could require up to 5 billion cubic feet of helium per year by the year 2030. However, the Department of Energy is quick to note that these technologies are in their development phase and, one or all of them may not prove viable or may not ultimately require helium. Presently, the Department views them as very promising, and in fiscal year 1979 alone, plans to spend over $300 million developing these helium-dependent technologies. According to a National Academy of Sciences' report, Federal funding of helium-dependent technologies may be $6 billion over the next several years. By contrast the net investment (not including interest) in the helium program from 1960 through 1973 was about $284 million.

NEED FOR A NEW NATIONAL HELIUM POLICY

We believe that the objective of the helium conservation program must be redefined. So long as the executive branch construes the objective of the existing program as storage of only enough helium to satisfy direct needs of Government agencies, the prospects of significant helium conservation are greatly impaired. Neither the Government nor private industry has assumed the responsibility for meeting the long-range private sector helium demand. Thus large amounts of helium that could be cheaply conserved are lost annually. We find this situation unfortunate. Therefore we believe that a new helium policy needs to be enacted establishing within the Federal Government responsibility for conserving helium for national needs. A new policy is needed to conserve a potentially valuable, nonrenewable resource that has not been conserved adequately either by the private sector or under the existing legislation. Such a policy would allow the Congress, with the aid and advice of the

relevant executive branch agencies, to consider and act on available alternatives for additional conservation. We believe that a new helium conservation policy is justified in that:

--helium gas resources could be scarce when energy-related, helium-dependent technologies or unforeseen technologies requiring the unique attributes of helium, accelerate demand;

--the cost, in terms of dollars and energy, of future extraction, and the continuing investment in energy technologies, will outweigh the cost of extraction and storage for several decades, if certain assumptions are maintained; and

--the largest known helium-rich gasfield, the Hugoton, is rapidly depleting and the Tip Top Gasfield will begin to be produced in the next few years.

It should be the purpose of the new helium policy to fix responsibility in the executive branch to deal with the following problems or issues.

--The amount of helium to be stored for national needs.

--The most efficient ways to accomplish conservation goals.

--The responsibility of the taxpayers and of natural gas consumers for bearing conservation costs.

--Encouraging private industry to undertake conservation to the maximum extent possible.

--Determining the financial conditions and the price under which helium controlled by the Federal Government is made available.

Within the spirit of the new helium policy, the Congress, with the aid and assistance of the Departments of the Interior and Energy, should consider action on the following alternatives for additional conservation:

--Insuring the conservation of potentially large non-depleting helium resources.

--Removing the deterrents to the private storage of helium and eliminating the waste of helium from existing facilities.

--Authorizing additional measures, such as a new purchase program, should the first two approaches prove insufficient.

Priority consideration needs to be given to determining and acting on the most efficient means to conserve the helium from the Tip Top Gasfield.

These alternatives and various actions that could be taken under each alternative are discussed in the following sections.

Insuring conservation from nondepleting helium resources

Substantial amounts of helium resources (about 84 BCF) are presently contained in nondepleting gasfields which lie under Federal land but are leased to gas producers. However, the Government has the right to extract the helium when and if the gasfield is produced. These fields may be produced in the future as the price of natural gas rises and the gas becomes economical to produce. This is the case with the Tip Top field in Wyoming, the largest of these nondepleting fields. No positive steps have been taken to insure the conservation of the helium in these fields.

One way to insure that future discovered Federal gasfields with significant helium content are conserved, would be to include in the original lease a provision which would place responsibility for extraction and storage of any significant helium resources with the gas producer. Existing leases that contain renegotiation clauses could also be examined for such an approach. However, if an existing lease does not contain a renegotiation clause the Government's options for preventing the development of the helium-rich gas resources are limited. The Government must be prepared in these cases to take additional recovery steps, such as constructing an extraction plant on the site. This issue is paramount in the case of Tip Top field which contains about 71 percent of the known nondepleting helium supplies on Federal land, and will begin to be produced in 1982.

Removing the deterrents to private storage and eliminating waste from existing facilities

Existing private helium plants have the capability to produce about 3.2 BCF of helium per year at an average cost of about $13 per thousand cubic feet. Since 1973, however the vast majority of the helium available has not been stored. Of the five privately constructed facilities, only three are presently producing helium. As of October 1977, only 1.6 BCF of helium had been stored over the years by private firms. In contrast, in fiscal year 1977, approximately 2.7 BCF were released to the atmosphere.

The following sections summarize specific actions which the Congress could take or authorize to promote recovery of helium from existing facilities.

The Federal purchase of privately-produced helium and the storage of federally-produced helium--Under the present helium act, Federal agencies must purchase their helium requirements from the Bureau of Mines. However, if Federal agencies could purchase helium from private concerns two benefits would occur. First, this action would encourage private companies to produce helium to meet short-range demands, and thus limit the amount of helium wasted from existing plants. Second, if the private sector met the needs of the agencies, federally-produced helium could then be stored. This procedure would have to be authorized by the Congress. Also, an annual appropriation would be needed to cover costs of Government activities currently being financed by Federal sales. The annual appropriation would be partially offset by about a $2-million annual savings that would result from Federal agencies buying helium at a cheaper price from private producers. Also, the Helium Division's annual $8 million budget could be substantially reduced as its sales and distribution functions were phased out.

Under the new legislation, the Secretary of the Interior could reserve the right to sell helium from the stockpile only in the event that private industry couldn't supply the national requirements of helium at a reasonable price. Adoption of such a policy would eliminate the possibility of the Government dumping helium on the private helium market.

This potential presently discourages private conservation efforts because it undermines the feasibility of private investments. The reasonable price provision would provide leverage against any price gouging by private producers in meeting helium needs.

Eliminating existing tax disincentives--Another initiative the Congress could take to encourage the storage of helium from existing facilities would be to build a positive incentive into the tax code. Existing tax laws discourage private gas producers from storing separated helium. If a producer stores helium, he may not write off separation expenses until the helium is sold, often many years later. However, if the producer vents the helium, he can write off the separation expenses as a cost of preparing higher BTU gas. Therefore, the Congress could promote helium conservation by amending the tax code to permit helium producers to write off separation expenses in the year incurred for helium intended for storage.

To spur private conservation efforts, the Congress could also allow liberal amortization for private investments in new helium separation and storage facilities. It could devise tax amortization provisions to minimize the time required for recovery of capital investments in extraction and storage facilities.

A new financial plan--A new financial plan needs to be formulated. The new plan needs to recognize that future helium sales are not likely to take place for at least two more decades. Since the helium fund debt cannot be paid by the Secretary of the Interior as required by the Helium Act, and continues to discourage conservation, the Congress should enact legislation to write off the debt. This action would alert the Secretary of the Treasury that repayment of the debt is not forthcoming and eliminate the disincentive to new conservation that the rapidly rising debt creates.

Since helium conserved under this program effort would be primarily reserved for future energy applications, funding for the energy portion of the helium conservation program could

be treated as a component of the DOE's energy research and development budget. The Department of the Interior should continue to manage the Government's helium facilities and also manage helium storage and sales for all Government agencies; but the DOE could arrange to transfer appropriations to cover all costs of the helium conservation program except those related to nonenergy applications. Nonenergy applications would be the responsibility of the Department of the Interior.

Authorizing further helium recovery

We recognize that action on the first two options conserving nondepleting resources and eliminating waste from existing facilities, appears to be the most feasible and may offer the most economical means to pursue conservation. For example, under the first alternative, a substantial amount of helium could be conserved in federally owned nondepleting gasfields. Also if steps are taken immediately to maximize helium recovery from existing facilities, an additional 17.5 BCF of helium could be added to storage by 1991-1992 when demand will exceed production.

Without an expansion of helium extraction facilities, a new helium purchase program and/or other efforts, helium available in helium-rich fields without extraction capability will be lost. This is the grave possibility facing the Government in the Tip Top situation. The Tip Top field in Wyoming is presently nondepleting and contains by far the largest amount of nondepleting helium resources (over 42 billion cubic feet). However, production from the field is planned to begin in 1982. Unless the scope of the Federal role is expanded, it is doubtful whether adequate measures will be taken to conserve this most important helium resource.

Under new policy legislation, the Congress could direct new program initiatives toward conserving additional helium. Besides taking the steps outlined under the first two alternatives, the Congress could consider a variety of means for additional recovery. These means could well be the focus of future congressional hearings and congressionally-directed agency analysis. The Congress could:

--Authorize new helium purchase contracts to conserve helium for energy needs.

--Authorize the building of new Federal extraction plants.

Under the new legislation, GAO believes the Congress and the executive branch need to take immediate actions towards conserving helium from nondepleting fields and existing facilities. However, should actions on one or both of the first two alternatives prove insufficient, our economic analysis of helium storage shows that even investment in one option under the third alternative--a new purchase program from existing facilities--would prove to be sound if certain assumptions hold true. (See ch. 3.)

We estimate that a purchase program from existing plants would cost about $260 million over the next 50 years. The present value of this cost stream discounted at 10 percent is about $160 million, about one-half of 1 year's present investment in helium-dependent technologies. The cost of such a program could be offset by annual savings of at least $2 million, if Federal agencies were allowed to purchase cheaper helium from private producers. Also, annual savings of about $6 to $8 million could accrue if the Government's sales and distribution capabilities were phased out, and a substantial amount of money could be recovered by divesting Government helium sales equipment. Discounted over the next 50 years, the present value of these savings conservatively total $80 million--enough to cover about half of the cost of a new purchase program. The net investment required would be $80 million. Of course, in the long term, conserved helium will be sold, perhaps at a price sufficient to cover all conservation costs, and all funds returned to the Treasury.

We believe that investment in such a purchase program would be prudent when compared to the amounts invested in potential helium dependent technologies, and the possibility of new uses for helium resources. We also believe that this analysis goes a long way to dispel concerns about the advisability of additional investment in helium conservation.

RECOMMENDATIONS TO THE CONGRESS

We recommend that the Congress enact new legislation redefining the Nation's helium conservation program. The new legislation should take cognizance of the changing needs for helium which have been identified since the inception of the 1960 program. It should establish the objective of the new helium conservation program to be the conservation of helium resources to meet all national requirements.

Under such a new helium policy, we believe the Department of the Interior should continue to act as the single manager of Federal helium facilities, as well as sales and storage operations. However, the responsibility for determining energy related helium conservation needs should be placed with the Secretary of Energy. Also, authorization should be granted to the Department of Energy, to provide funding to the Department of the Interior for energy related helium conservation activities. These conservation expenditures should be included in Department of Energy appropriations for transfer to the Department of the Interior.

To accomplish helium conservation for national needs the new helium legislation should authorize

--actions needed to conserve helium in present nondepleting resources;

--actions to encourage conservation from existing private facilities; and

--further measures to allow the recovery of helium-rich gasfields.

Under the new policy, immediate attention needs to be given to determining and acting on the most efficient means to conserve the helium in the Tip Top Gasfield, the largest known domestic helium reserve.

Specifically, Congress should take the following steps to conserve helium in present nondepleting resources, and to encourage conservation from existing private facilities.

--Designate the Secretary of the Department of Energy to be responsible for implementing the goals and objectives of the new conservation program as it relates to energy needs.

--Designate the Secretary of the Interior responsible for implementing the nonenergy-related goals and objectives of the new conservation program.

--Allow Federal agencies--to the extent that supplies are readily available at reasonable prices, terms, and conditions--to purchase helium from non-Federal sources. The Secretary of the Interior should then be directed to store and conserve helium produced by the Government-owned Keyes and Exell plants.

--Allow the Secretary to sell such amounts of helium from the Government stockpile as determined necessary for essential national needs.

--Create a positive tax incentive for helium storage by permitting helium producers to deduct extraction costs of helium produced for storage from current income in the year in which extraction occurs.

--Establish a new financial plan under which conservation expenses associated with the storage of helium for energy technologies would be funded by Department of Energy appropriations transferred to the Department of the Interior. Helium conservation for nonenergy applications would be funded by Department of the Interior appropriations. Also, under this new financial plan, borrowings and interest expenses of the previous program should be excused because they cannot be repaid. Revenue from future helium sales should be immediately transferred to the Treasury.

--Require the Secretaries of the Interior and Energy with the advice of the Office of Science and Technology Policy, and other relevant agencies to collaborate on an annual report to the Congress on the activities conducted pursuant to the new legislation. This report should include:

    --A review of the research and development of energy-related applications of helium.

    --Updated estimates of national and international helium reserves.

    --Updated estimates of projected long-range demand for helium.

    --A summary analysis of actions taken toward achieving the purposes of the act.

    --Recommendations for changing or terminating the program.

In order to establish the mechanism to initiate larger-scale helium conservation measures, should they be deemed necessary, the Congress should include in the legislation a provision that authorizes the Secretary of the Interior,

following consultation with the Secretary of Energy, to initiate a new helium purchase program and/or construction of additional Federal helium-extraction facilities for the purpose of storing additional supplies.

We also recommend that if, by the time the new policy legislation is considered, ongoing helium litigation has not been concluded, the appropriate congressional committees should apprise themselves of the status and possible results of the litigation. The outcome of this litigation is likely to have an important impact on the price the Government would pay for helium.

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

While working with the Congress on the development of a new helium policy, and in anticipation of assuming national helium conservation responsibilities, we recommend that the Secretary of the Interior undertake the necessary steps to conserve helium from the Tip Top Gasfield in the most efficient manner. Ultimately, this should include the preparation of a comprehensive conservation plan and related budget requests.

To insure the conservation of nondepleting resources, we also recommend that the Secretary of the Interior include in new Federal land leases, a clause that would place responsibility for extracting helium, when it exists in significant amounts, with the developer or lessee. The Secretary should make storage arrangements when extraction is required. The Secretary should also examine the advantages and potential legal problems of setting aside presently nondepleting helium-rich resources which are already leased.

AGENCY COMMENTS

The Department of Justice

Because of the potential impact our report may have on existing helium litigation, the Department of Justice was asked to comment. The Department has no objection to the issuance of the report.

The Department of the Interior

The Department of the Interior strongly disagreed with our analysis and several of our recommendations. It believes that our report contains two areas of inadequacy; an incomplete and possibly misleading discussion of helium production and consumption rates and an inadequate discussion of the legal ramifications of the recommendations. Interior is also concerned that we do not give adequate consideration to the Interagency Helium Study (IHS) issued in 1978.

We find Interior's strong language unwarranted. As we point out throughout our report, the helium policy issue is controversial and opinions must be formed on the basis of long-term future projections as well as on the need for the Federal Government to meet long-term resource management responsibilities. Thus, there is ample opportunity for a number of supportive arguments to be made on different views on which steps should or shouldn't be pursued. We believe that the tone of Interior's comments, which suggests that its view is the only position with a valid basis, is counterproductive. As amplified below we believe that valid counter arguments can be made against Interior's criticisms.

We also note that Interior's final comments, as contained in appendix I, repeat criticisms of portions of this report which were either deleted or revised as the result of comments received from Interior on an earlier draft of this report. We seriously considered Interior's earlier views in revising our report and can only conclude that the responsible officials did not carefully examine our revised report in providing further comments. The sections of Interior's letter we conclude to be irrelevant are noted in appendix I.

Consumption and supply analysis--The Department of the Interior is concerned about our failure to use the information and analyses of the IHS. In fact we cite the IHS on several occasions (see pp. 13, 29-32, and 73). For example, we depict the IHS demand and supply estimates in chapters 2 and 3, and we show that in fact the IHS demand estimates are not far removed from the previous ERDA study (see p. 32). However, the reason we did not rely further on the IHS is that we continue to believe the helium supply analysis presented in the IHS to be unrealistic. For example, it

projects that 100 percent of Tip Top's reserves, as well as other nondepleting resources, will be available in 2030. It also assumes that steps will be taken to insure the Government's stockpile will be preserved until 2030. (See p. 73.) Even the authors of the IHS acknowledge that these conditions will not exist unless steps such as those we suggest in this report are taken to conserve known helium resources. The IHS does not contain any conclusions and recommendations toward this end and ignores the conservation recommendations made by a National Academy of the Sciences' Helium Forum, commissioned by the Interagency Helium Study Committee.

The IHS was also completed before the recent gas price deregulation legislation was passed. Deregulation will speed up gas production and exploration beyond the rates of recent years and anticipated in the IHS. Thus Interior's estimate of the length of time it may take to deplete remaining gas reserves is very conservative and probably unrealistic. However, their reliance on that estimate led to Interior's unduly harsh criticism of our use of a 2030 date for helium extraction from air in our economic analysis.

The Department of the Interior also criticizes us for using in our helium demand analysis outdated projections of helium that could be used by possible helium consuming technologies. They say that our report gives inadequate attention to the possibilities of substitution or technological progress in helium production. We note that the 1975 ERDA report is being updated by the Los Alamos National Laboratory, with little change expected by them in long-term helium demand projections for energy related technologies. We also acknowledge in our report the possibility of helium substitutes, imports, or gains in helium extraction technology; but as Interior itself suggests, it is impossible to project or predict these developments. Also, we believe that the cost of these alternatives should they become available could be very expensive; another argument for taking prudent actions now. Interior also ignores the distinct possibility of as yet unforeseen technologies which could require the unique properties of helium.

Interior states that we do not provide an adequate time frame in reference for the Tip Top Gasfield situation. It is true that under present drilling and production plans only a small fraction of the helium at Tip Top will be produced annually by 1983. However, one large developer has

planned, given adequate gas prices, the drilling of up to 27 wells in the Tip Top Gasfield perhaps beginning as early as 1985. Again the recent deregulation will provide an impetus for increased gas exploration and production. Interior should act now to determine the most efficient means to conserve the Tip Top helium so that we don't progressively lose this valuable helium reserve. The Government should not wait until high gas production occurs to get the most efficient conservation means in place. To date, Interior has ignored its own Helium Division's recommendations for action in this area.

Legal concerns--The Department of the Interior criticizes our report for not adequately considering the legal ramifications of a number of our specific legislative proposals. Interior's commentary implies that a number of our proposals are already authorized under existing law. This misses the focus of our principal recommendation. Existing authorities can only be used in the context of the limited scope of the Federal Helium Act. The main objective of our report is to emphasize the importance of new policy legislation which would establish responsibility for meeting national needs for helium. Interior fails to comment on this most central issue of our report, but is only concerned about what it erroneously perceives to be an immediate call for action on all fronts to store helium.

An example of this mistaken reaction is Interior's concern about our proposal to include in new Federal leases a provision to place responsibility on the producer for helium extraction should it be deemed necessary. This idea, supported by the Department of Energy, would not require a large Federal exploration program to identify helium resources in advance of lease agreements. This proposal is not meant to be implemented on every Federal land lease to the point where "at least fifty plants would be operating," as Interior supposes, but would only be used in those cases where significant helium reserves are discovered, as determined by the Secretary.

Interior's comments are also critical of our report for failing to give adequate consideration to the Tip Top Gasfield. This criticism is unwarranted in that we

recommend (see p. 81) that the conservation of Tip Top helium resources be given immediate priority under a new national helium policy.

Interior justifiably voices (as does DOE in its comments) concerns over the price of future helium alternatives vis à vis the price that will be needed to be gained from the sale of federally-stored helium. This is a valid concern of the Government and should be continually addressed by both departments as they determine the most efficient way to conserve helium for national needs.

We note, however, that the Government can appropriately expend funds on prudent measures to preserve a potentially valuable, unique resource, even if the public interest can best be served by selling that resource at a later date at a price that would not meet all conservation expenses. Immeasurable benefits may occur, such as energy savings, which could benefit society as a whole.

Finally, Interior, as well as DOE, are concerned about the budget implications of several of our proposals. We recognize that conservation for national needs will involve an expense. In chapter 3 we evaluate the cost of one of the more expensive program options. We also point out that budget requirements are one more good argument to establish a new helium policy which would establish responsibility for determining and acting on the most efficient means to conserve helium.

The Department of Energy

The Department of Energy, while not fundamentally opposed to prudent helium conservation measures, has reservations regarding certain areas of our report. These reservations center on (1) the cost of what it would consider to be the premature separation of helium from natural gas for conservation and (2) the emphasis in our report placed on high cost options of helium purchase or extraction to the exclusion of low cost options. For example, Energy is not opposed to the expenditure of funds to buy back or renegotiate Federal land leases to preserve identified reserves of helium; but it is opposed to any new Government program to purchase or

extract helium from the Tip Top Gasfield. More specifically the DOE does not concur with our recommendation to the Congress to pass legislation which would: (1) authorize the Department of Energy to provide funding to the Department of the Interior for energy-related helium conservation activities; (2) authorize the initiation of a new helium purchase program; or (3) require that specific and immediate consideration be given to authorizing and funding the means to conserve helium from Tip Top Gasfield. (See app. II.)

We agree that the most efficient means to conserve helium ought to be immediately explored and deem this determination to be the responsibility of the Department of Interior. We note that Energy states that recent higher gas prices have incurred an increase in gas production and that the withholding of gasfields for their helium content would be a viable alternative and one that should be explored by the Department of the Interior. (Interior stated in its comments that this may be contrary to the Nation's energy policy.)

We believe, that because of the tremendous reserves of helium in the Tip Top Gasfield, it warrants priority consideration. In this context we agree with the Bureau of Mines' Helium Division which has urged the Department of the Interior to make plans to conserve this most important of helium reserves. The renegotiation or termination of the existing leases may not be a viable option in the case of Tip Top where the developer has invested in exploratory wells and is planning to begin extracting gas in 1982. Termination or renegotiation may lead to years of expensive court proceedings, similar to the current litigation over prior contract termination actions. In any event we believe the DOE and Interior should determine the most efficient means to store from Tip Top and initiate appropriate actions as set forth in our recommendations to insure that Tip Top Gasfield helium reserves are not lost.

We also believe that new helium legislation should authorize purchase or extraction programs should the initially recommended options prove insufficient. Such a provision would not cause immediate expenses--the main concern of the DOE--but only authorize such measures if later found necessary to fulfill national policy.

We address the common concerns of Interior and DOE over budget expenditures and price of helium under our response to Interior's comments. (See p. 87.) Further, we believe that the Department of Energy should be a part of and assume an appropriate responsibility for funding to the extent that additional conservation measures are deemed necessary in support of future energy supply technologies.

APPENDIX I

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

[See GAO note 1, p. 95.]

JAN 2 1979

Mr. J. Dexter Peach
Director, Energy and Minerals Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

The draft of a proposed General Accounting Office report entitled "Unique Helium Resources Are Wasting: A New Conservation Policy Is Needed" has been reviewed within the Department of the Interior. We continue to find this draft report to be seriously flawed. Little attention was given to the comments we provided on the previous draft. We continue to believe that your view of helium policy, particularly the fiscal aspects of a major new government purchase program, should be carefully reconsidered.

As we previously pointed out, we do not concur in your analysis of these issues, and we do not believe it provides a balanced review of the topic. The principal area of inadequacy in the draft is the incomplete and possibly misleading discussion of possible future helium consumption rates and the potential future production of helium and natural gas. The second area of inadequacy is the incomplete and sometimes erroneous discussion of the legal ramifications of the recommendations.

Future Consumption and Supply Analysis

The central thesis of the draft appears to be that storing helium now will be cheaper than extracting it from available sources early in the next century, and that, as a result, the policy should be to immediately take steps to extract helium from all attractive sources. Such a policy design must depend on a reasonably balanced treatment of future helium supply and demand estimates, which is not provided in this draft. We are particularly disturbed that the draft fails to give credence to the Interagency Helium Study (IHS) issued by the Interagency Helium Committee (IHC) in 1978.

Long term market demand estimates are difficult to make at best, and the time spans used in the discussion of helium's future are so long that

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such estimates are seldom attempted. The consumption rates for helium calculated in the studies cited in Chapter 3 are not the estimated amounts of helium that will be bought at some estimated set of prices and industrial growth, but the quantities of helium that could be used in various combinations of possible helium consuming technologies, regardless of future helium prices, the prices of potential substitutes, and the rate of growth of the U.S. economy. Implicit in the use made of the helium scenarios developed by the Energy Research and Development Administration, the National Science Foundation, and others, is the apparent belief that all of the possible future helium using technologies will be successfully developed and applied, and that neither substitution for helium nor technological progress in helium production is likely.

The discussion of the coproduct relationship between helium and fuel natural gas is poor. Neither the potential supplies of helium from all domestic gas resources nor potential helium imports are adequately discussed. The possibility of importing helium is dismissed, on page 22, with the statement that rising worldwide demand will limit our ability to import helium. Little helium is extracted outside of the United States (excluding the USSR). The potential for helium extraction in the Middle East, North Africa, Mexico, the Far East or other potential natural gas producing areas is not well known, but cannot be dismissed.

Both the discussion of the helium resource-reserve relationship and the discussion of possible helium using technologies suffer from a failure to provide a time scale against which change can be measured. This failure, as seen in the suggested leap from Hugoton-Panhandle depletion to air extraction, lends an unwarranted sense of urgency to the draft report. The most obvious example of this is in the discussion of the Tip Top Field on page 16. Neither the Mobil Oil Company's drilling schedule nor potential near-term production rates are mentioned. Present drilling and production plans, given sufficiently high interstate gas prices, will produce approximately 100 MMcf of available helium per year, or less than one quarter of one percent of the estimated helium resources in Tip Top. The Bureau of Mines is studying the helium potential in future gas production from the deep zones in Tip Top.

Although extraction and storage of the helium available to existing plants on the Bureau of Mines pipeline may be intuitively attractive, the analysis presented to justify such storage is flawed. This analysis is intended to justify the purchase of about 17 Bcf of helium from the former contractors even though it is acknowledged that the cost is unknown due to the unresolved helium value lawsuits. In order to justify such action, the authors discount the IHS as to the future supply/demand situation. A good example is the assumption that atmospheric helium will be required in the

year 2030. The IHS indicates that as of 2030 remaining helium resources of the United States will be in the range of 350 Bcf, or about 50 percent of estimated current resources; therefore, the assumption that atmospheric helium will be needed in 2030 is not supported by detailed engineering analysis.

Neither is it supported by the data presented in this draft. For example, it is stated that estimates of future natural gas discoveries in the United States range from 751 Tcf (trillion cubic feet) to 1,412 Tcf (p. 10). The average annual gas discovery rate in the United States for the time period 1946-1976 was about 17 Tcf a year. At that rate, it will take 44 to 83 years to discover the estimated gas resources, let alone develop and produce them to depletion. Such a time frame is reasonable, since GAO points out (p. 9), that only 425 Tcf of gas has been produced in the United States in the past.

If the discovery rate for the time period 1970-1976 (8.8 Tcf a year) is used, the discovery times would be 85 to 160 years. It would seem, therefore, to be physically impossible to discover, develop, and produce all undiscovered natural gas reservoirs in the United States to extinction during the next 52 years as assumed in the draft. The IHS presents a reasonable engineering estimate of future discovery and production rates, and should not be dismissed in this economic analysis.

The analysis also fails to take account of helium resources owned by the Government that may be available in 2030. If GAO's recommendation that the Bureau of Mines terminate helium sales became policy, then both the 37 Bcf of helium in Cliffside, and the probable 44 Bcf of helium in Tip Top will be available in 2030. Before any newly stored helium would be needed, this 81 Bcf would be used, extending the time when newly stored helium could be sold even farther out into the future. Even if no changes are made to the present program, a substantial amount of Government owned helium will remain in 2030.

Legal Analysis

The legal and legislative discussions and proposals in the draft are incomplete, and, in some respects, inaccurate. Three suggestions are made for Congressional action. First, that all or some of the presently nondepleting helium reserves on Federal land be set aside; second, that authority be provided for renegotiation of existing leases on the remaining nondepleting reserves; and, third, that lessees of Federal land be required to extract helium and deliver it to the Government for storage. None of these proposals are presented in sufficient detail to judge their worth, and all may be superfluous. [See GAO note 2, p. 95.]

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If the first recommendation is that Congress set aside nondepleting helium reserves which have not yet been leased, it suffers from two flaws. First, the Department of the Interior has this legal authority under 50 U.S.C. 167a. Second, in order to know which unleased land to set aside, a Federal exploration program would be necessary. Helium on Federal lands is now discovered through private firm natural gas and oil exploration programs, at no expense to the Federal Government. If a Federal exploration program is being suggested in this proposal, that issue should be examined in more detail.

If, on the other hand, the Federal land to be set aside includes reserves not being produced, the proposal raises a serious problem. Precluding a lessee from developing his lease to keep the Government's helium in the ground would probably be seen as taking compensable under the Fifth Amendment. Estimates of the methane content of the Tip Top Field indicate that the market value of that gas is now approximately $2 billion. Even with allowances for production cost savings and discounting the market value to present value terms, the cost of buying back that gas from the lessees would be very large. In addition, locking up fuel natural gas to conserve the helium content, when the helium can be extracted as the gas is produced, is not consistent with our national energy policy goals.

The second recommendation, that Congress authorize the renegotiation of existing leases also suffers from inadequate explanation. The Department of the Interior has the authority to renegotiate leases, if the lessee is willing to do so. If the suggestion is that lessees should be compelled to "renegotiate" their leases, the problem of taking arises again. The taking problem would also arise if the intent of renegotiation is to delay development. [See GAO note 3, p. 95.]

The third recommendation, that the Secretary of the Interior require lessees of Federal land to extract helium and deliver it to the Government for storage, is inadequately presented. The GAO does not seem to understand the scope of the Secretary's authority under the current law for protecting the Government's helium resources, and has apparently devoted little thought to this new proposal. The potential economic and environmental impacts of a blanket requirement such as this are huge. If such a requirement were currently in effect, at least fifty helium plants would be operating to extract helium being produced from Federal lands, and the Government would have had to construct and operate hundreds, if not thousands, of miles of pipelines to transmit the helium to numerous helium storage fields which it would have had to purchase and develop for safe helium storage.

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The draft also suggests that the Department of the Interior enter into "non-prejudicial storage contracts" with the former helium suppliers. This suggestion is unnecessary as such provisions are in current contracts with Cities Service Helex, Inc., Phillips Petroleum Company, and Northern Helex Company, and eight other private companies. The Cities Service contract is typical, and contains the following clause:

> "The making and performance of this contract, the delivery by Company of helium-gas mixtures extracted at Company's Jayhawk Helium Plant for storage, and the acceptance, storage, and redelivery of helium-gas mixtures to Company by United States under this contract shall be without prejudice to the rights, duties, and obligations of either Company or United States under or arising out of that certain contract between Company and United States dated the 22nd day of August, 1961, and entitled "Contract for the Sale and Purchase of a Helium-Gas Mixture."

The Phillips and Northern contracts contain similar clauses. The fees provided for in these long-term (25 year) contracts recover the Bureau of Mines' cost of service. The Bureau cannot charge less than the cost of storage under 31 U.S.C. 483a. However, the contract terms offered by the Bureau include significant inducements for private helium storage. There is no limit to the volume of helium the companies may store. Moreover, the Bureau has, under supplemental agreements, agreed to purify (for an additional fee) the companies' stored helium upon redelivery. As a further inducement to the companies to store helium, the annual storage charges are deferred until the stored helium is redelivered. These contracts are apparently attractive to the private helium industry as eight other firms have requested and obtained identical agreements with the Bureau. [See GAO note 4, p. 95.]

Conclusion

Perhaps a basic shortcoming in the preparation of this draft is failure to use the information and analyses produced among the Federal agencies responsible for developing information and subsequent policy concerning helium. The IHC included representatives from the Bureau of Mines, the Departments of Energy and Defense, and the National Aeronautics and Space Administration. By relying on the estimates made in the 1975 ERDA helium report, the authors have been lead to poorly based assumptions concerning future helium supply and demand. Even in terms of suppositions made in the draft there are questions about the soundness of the recommendations viewed as a program to ensure a future supply of helium.

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A further shortcoming is the inadequate consideration given to the Tip Top Field. Though only a portion of the helium contained in this field is considered proved, the total quantity of helium is thought to be very large. With neither the financial nor legal risks, and at a cost that may be significantly lower than that of helium purchased from the former contractors, this Federally-owned helium could be extracted and stored for future use. Until the current Bureau of Mines study of Tip Top is completed, and until the lease operator has completed the preliminary drilling program, definitive plans for a Federal helium program should not be made. To suggest extensive, and expensive, changes in the helium program now is not reasonable based on the information available.

Finally, we continue to be concerned with GAO's failure to adequately discuss the potential cost to the Treasury of its recommendations. Several recent reports have suggested major expansion of Interior Department programs without considering the multi-year budget impacts. It is precisely for this reason that we believe that decisions on a program of the magnitude of the Helium Storage Program must be based on the best possible analysis.

Sincerely,

Larry Meierotto, Deputy Assistant
Deputy Secretary-Policy, Budget, and
Administration

GAO Note 1: Page references in this appendix refer to the draft report and do not necessarily agree with the page numbers in the final report.

GAO Note 2: The Department of the Interior was given an advance copy of a draft report on helium on which to comment. Following its initial comments GAO revised the report and resubmitted it to the Department for a final review. This letter, received as a response to our final draft, contains criticisms of portions of our report which were not included in the final report on which the Department was to comment. The first two proposals on which the Department is commenting here were deleted or revised substantially in the final draft report sent to the Department of the Interior for comment.

GAO Note 3: This discussion refers to a recommendation not included in the draft report sent to the Department for comment; nor is it included in the final report.

GAO Note 4: This entire discussion on nonprejudicial storage agreements refers to a recommendation in an earlier draft report. It was not included in the final draft on which the Department was to comment.

APPENDIX II

Department of Energy
Washington, D.C. 20545

December 13, 1978

Mr. J. Dexter Peach, Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review and comment on the revised GAO draft report entitled "Unique Helium Resources Are Wasting: A New Conservation Policy Is Needed." The Department of Energy (DOE) continues to have strong reservations regarding certain areas of the draft. Our view with respect to these reported questionable areas and the report recommendation follow:

We believe that the report should emphasize (1) that due to the great uncertainties in future demand, there may be a large ultimate cost in premature separation and storage of helium, particularly if the present costs are appropriately compounded with interest charges to calculate the future user's price. (2) That, since legislative actions are being recommended, it should explicitly propose and describe the lower cost means DOE proferred to arrest dissipation of helium from helium rich government owned natural gas fields. These may include repurchase of production leases on government lands and the necessary rule making to lay the cost of helium separation and storage on the natural gas producer who can recover helium conservation costs from gas revenues rather than laying such costs on the general taxpayer.

We are not fundamentally opposed to the prudent conservation of helium. But any recommendations must be cognizant of the fact that the key to successful stockpiling of any resource in a capitalistic society is to incur only the absolute minimum of interim costs to the time of use. This is particularly true if the deferred use of a stockpile is several cost-doubling generations in the future. Compounded carrying charges should be used to calculate the future price. Thus, at a 10% annual carrying charge (7.2 year doubling time), the $13 separation cost which GAO cites would become a $1300 price in about 45 years, even neglecting charges for storage, surveillance and administration. These should also be compounded into the future price charged.

We noted in our October 18, 1978 comments on the earlier draft that the concept of the government being the compelled buyer, who must pay the conserving costs, is basically wrong. We now reiterate that the government should assert its rule making or legislative powers in such a way as to block the production and dissipation of helium rich natural gas, particularly from government owned lands. Further, consideration should be given to requiring that, above particular concentrations of helium, any producer of natural gas must conserve, separate or reinject the helium at his cost. He may choose to recover such costs from marketing the natural gas products at a higher price. In view of the relatively large supplies of natural gas now being found at higher prices, this policy would postpone the production of helium rich fields without large near term out of pocket costs to either the government or industry. This deferral of helium separation would permit better assessments of ultimate helium demands to be made as new insights are gained into emerging technologies which may use helium.

Separate analyses should be made of whether the significantly large administrative staffs and the existing separation plants should be reduced, sold or eliminated. The criteria for those discrete actions should be when their costs are assessed against the incremental helium to be stockpiled; its future price will be so large as to defer even longer into the future the purchases from the stockpile as those speculative technologies emerge upon which present forecasts of demand are based. If a future helium pricing schedule of present and interim costs including separation, administration, storage and future delivery were to be supplied to those organizations now developing the technologies, they would initiate developments to sharply decrease future uses of helium. Similarly, if proposed GAO options were fully and currently assessed against developmental programs now comprising integral parts of the ultimate "demand", there would be urgent requests to DOI to curtail staffs and minimize all current helium conservation outlays until better downstream assessments of "demands" and of improved separations technology could be formed.

We do not concur in the recommendations to Congress that legislation include (1)"...authorization be granted to the Department of Energy to provide funding to the Department of the Interior for energy related helium conservation activities,' (2) "...a provision that authorizes the Secretary of the Interior, with the advice and consent of the Secretary of Energy, to initiate a new helium purchase program," nor that (3) "...specific and immediate consideration should be given to authorizing and funding the means to conserve helium from Tip Top Gasfield." An interpretation of the latter acceptable to DOE may be funding as required to defer commercial production of helium-rich gas

from Tip Top Gasfield by cancelling and repurchase of gas production leases, so helium recovery may not be necessary. Alternatively, funding and legislation required to renegotiate the Tip Top leases so that the commercial gas producers may separate and reinject helium fractions, at their cost, may be an alternative to be considered by DOE in concert with DOI as program managers.

We would be pleased to provide any additional information you may require in this matter.

Sincerely yours,

Donald C. Gestiehr
Acting Director
GAO Liaison

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