DEFENSE PRODUCTION ACT PROGRESS REPORT—NO. 50

(Volume 2)

POTENTIAL SHORTAGES OF ORES, METALS, MINERALS, AND ENERGY RESOURCES

HEARING

BEFORE THE

JOINT COMMITTEE ON DEFENSE PRODUCTION CONGRESS OF THE UNITED STATES

NINETY-SECOND CONGRESS

FIRST SESSION

ON

POTENTIAL SHORTAGES OF ORES, METALS, AND MINERALS, FUELS AND ENERGY RESOURCES, ESTIMATED FUTURE PRODUCTION AND CONSUMPTION, RECYCLING OF METALS, DEPENDENCE ON FOREIGN SOURCES, RECOMMENDATIONS FOR MEETING DEMAND, AND RELATED MATTERS

SEPTEMBER 22 AND 23, 1971

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WEDNESDAY, SEPTEMBER 22, 1971

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON DEFENSE PRODUCTION,
Washington, D.C.

The committee met, pursuant to call, at 9:30 a.m. in room 2222, Rayburn House Office Building, Hon. Wright Patman (chairman), presiding.

Present: Representatives Patman (presiding), Sullivan, Widnall, and Brown.

Also present: Harold J. Warren, clerk and counsel; Charles S. Brewton, general counsel; George T. Ault, professional staff; and Cary H. Copeland, professional staff.

Chairman PATMAN. We are supposed to start at 9:30 this morning. We could not have one witness unless we started early, because he could not be here. And if the committee will please come to order, I would like to read a statement to kind of give the picture of what we expect this morning. We have a hearing for tomorrow and then after that, we will decide where to go from there.

There are a number of departments and agencies which have responsibilities related to ores, metals, and fuels and energy resources. On August 2, 1971, this committee heard a number of witnesses from the Department of the Interior. Much additional material was submitted for the record, including answers to numerous questions submitted following the testimony. The hearing covering the Department of the Interior has been printed and is available for distribution.

As has been indicated earlier, this committee is interested in our future needs and availability of ores, metals, and energy resources, and whether there may be potential shortages in the years ahead. These questions arise because of greater dependence on foreign sources, lower grades of domestic ores, decreasing reserves, increasing per capita consumption, and increases in population.

It is believed that this situation requires an examination to determine whether our current policies will meet the needs of the future. We are interested in obtaining the views of Government witnesses and outside witnesses.

We will hear two Government witnesses today who have a close relationship to raw materials, and fuels and energy resources. We will also hear Dr. Frederick Wall, executive director of the American Chemical Society.

Our two Government witnesses are Mr. Harold Scott, Acting Assistant Secretary of Commerce for Domestic and International Business; and General George A. Lincoln, Director of the Office of Emergency Preparedness, who has the responsibility for coordinating these resource programs throughout the Federal Government. Mr. Scott has an engagement later this morning, and we have started these hearings at 9:30 in order that we will not delay him.

The Department of Commerce has a direct responsibility for the Nation's productive facilities, and these productive facilities cannot operate without ores, metals, and fuels and energy. The Department of Commerce is in daily contact with industry representatives, and is in a position to maintain constant and direct knowledge of industry problems in this country. The Department of Commerce is also concerned with international trade. The demand for raw materials and energy resources has a direct relationship to our dependence on foreign sources of supply, and our dependence on foreign sources of supply has a direct relationship on our balance of payments. Earlier testimony indicates that our annual consumption of these ores and metals and energy resources is more than $8 billion in excess of our production of these resources, and that the trend is toward larger deficits in domestic supply.

We will now ask Mr. Scott to come around, if he will, please.

Mr. Scott, you may identify anyone who is with you.

STATEMENT OF HAROLD B. SCOTT, ACTING ASSISTANT SECRETARY OF COMMERCE FOR DOMESTIC AND INTERNATIONAL BUSINESS, DEPARTMENT OF COMMERCE; ACCOMPANIED BY STANLEY NEHMER, DEPUTY ASSISTANT SECRETARY IN CHARGE OF IMPORT PROGRAMS; JAMES M. OWENS, DIRECTOR OF MINERALS AND METALS, DIVISION OF THE BUREAU OF DOMESTIC COMMERCE; KENNETH G. CONNER, DIRECTOR, OFFICE OF BUSINESS RESEARCH AND ANALYSIS, BUREAU OF DOMESTIC COMMERCE; HAROLD LYNDE, METAL COMMODITIES SPECIALIST, BUREAU OF DOMESTIC COMMERCE; AND A. A. BERTSCH, DIRECTOR OF THE OFFICE OF INDUSTRIAL MOBILIZATION, BUREAU OF DOMESTIC COMMERCE

Mr. Scott. Before starting, Mr. Chairman, I would like to introduce the experts who have the knowledge and depth in this subject that I lack.

We have with us Mr. Stanley Nehmer, who is the Deputy Assistant Secretary in charge of import programs. We have Mr. Jim Owens with us, who is the Director of Metals and Minerals Division in the Office of Business Research and Analysis of the Bureau of Domestic Commerce; Mr. Ken Conner, who is the Director of the Office of Business Research and Analysis in the Bureau of Domestic Commerce; Mr. Harold Lynde, who is a metal commodities specialist in the Bureau of Domestic Commerce; and we have Mr. Tony Bertsch, who is Director of the Office of Industrial Mobilization in the Bureau of Domestic Commerce.

Chairman Patman. We are glad to have these gentlemen. They will be available to answer any questions that we may ask?

Mr. Scott. Indeed, they will, because the subject in which you are interested is their primary interest.

Chairman Patman. Mr. Scott you may proceed as you desire.

Mr. Scott. Mr. Chairman, with your permission, I would like to read a statement that is not too long, in the hope that by reading, it will get more attention because I share with you the deep interest and concern in the subject in which you are having hearings.

As you pointed out in your opening statement, we wear two hats in this area. In our concern for international trade, we of course, have principal concern with our trade account.

Chairman PATMAN. You mean the balance of payments?

Mr. SCOTT. The trade account is a part of the balance of payments. The trade account being that part of the balance of payments that deals only with the exports of materials and the imports of materials. And as you know, this trade account in all probability will be in deficit for the first time in 78 years, since 1893.

Traditionally, of course, we have easily paid for our imports of raw materials and other products through the surplus we generated in the export of manufacturers. We now see an increasing dependence on these imports of raw materials, and ever increasing demand, and we have real concern as to our ability to generate the foreign exchange to pay for them.

On the other hand, we see the ever-increasing dependence of our domestic industry, which is the concern of the Bureau of Domestic Commerce, for foreign supplies of raw materials. And we have deep concern that there be a continuing flow and assurance of access for these raw materials which are situated in various parts of the world and are controlled by more or less friendly countries.

So we see here a challenge to our diplomacy, a challenge to our ingenuity, that imports will provide the fuel for the furnaces of our economy. And I say, this is an extremely important hearing to us on a subject which we feel should be better understood, not only by our business people, but in effect, by almost all Americans.

With your permission, I would like to run through this statement.

Chairman PATMAN. It may be included in the record at this point and you may elaborate any way that you desire.

(The prepared statement is set forth beginning on page 296.)

Mr. SCOTT. Fine; I hope I won't be too pedestrian in my reading.

We all recognize the vital role that these materials play in economic growth and defense. The intensity of the problem of future supply is compounded by the fact that demand for minerals and energy has been rising at a faster rate abroad than in the United States. This is true especially for Western Europe where there has been a depletion of their own resources and for Japan which must import most of her supplies. As a result, nations of the world will be competing more than ever before for a rising share of the world supply of materials. At the same time the less developed countries that are major sources for new materials are promoting their own industrialization and in supplying the world with raw materials are sensitive to the suggestion that they are being exploited. Therefore, the need for cooperation with other nations of the free world will be even greater in the future, and our materials policy should be increasingly coordinated on an international basis with the policies of other countries.

We are concerned about the long-range adequacy of U.S. supplies of minerals and energy. Congress has also expressed its concern by enacting the National Materials Policy Act of 1970 which established an independent, seven-member National Materials Policy Commission. The Secretaries of Commerce and Interior are the Government members of the Commission, the other members are from the private sector. The Commission has begun a full study of all materials (except food) for the purpose of developing a national materials policy. The study will include such matters as national and international requirements projections, the relationship of materials policy to population

and environmental quality, recycling of materials, research, and education, and Federal agency responsibility and coordination in the minerals field. The Commission held its initial meeting on September 15.

I must pay tribute to the Department of the Interior which has already done so much work which will be of value to the Commission, some of which has been made available in excellent form to your committee.

The Department of Commerce also will make a substantial contribution to the work of the Commission which will submit its findings on or before June 30, 1973. This will be the most comprehensive look at our long-range raw materials outlook since the 1952 report by the Paley commission which was the outgrowth of the Korean emergency.

Assistant Secretary of the Interior for Minerals Resources Hollis Dole pointed out in his testimony before you on August 2 that mineral supply and demand are global in nature, and that we will have to import a higher proportion of our raw materials needs in the future. Mr. Dole also presented to your committee a consistent and rational series of projections of mineral consumption and supply up to the year 2000. These estimates of our rising import need for raw materials have important implications for our future balance of trade and balance of payments.

In our opinion, the overall Interior projections for individual minerals for the year 2000 provide a good starting point for further efforts along this line by the National Materials Policy Commission. We recognize that these projections, as well as those by others, including the National Materials Advisory Board of the National Academy of Sciences, and Resources for the Future, Inc., are extremely valuable in indicating trends and forming a basis for future policy.

If I may add as an aside, there are so many varying assumptions in our need for raw material in the future, that a word of caution is indicated in becoming too dependent upon any series of assumptions we develop now. By this I mean that we are running the continuing risk of losing access to vital raw materials for one or another reason, and therefore that we should not set our policies based solely upon the figures that are developed and published at this time. There is need to develop a flexible approach in what we see as our need and our access to raw materials.

This committee has expressed particular interest in the coordination of interagency responsibilities with respect to raw materials matters. Coordination among Government agencies is supplied by the particular agency which has the legal responsibility for the matter in question. The usual modus operandi is the establishment of either informal or formal committees with members representing diverse interests within Government. The formal committees usually meet when policy formation and/or policy recommendations are needed to resolve an issue, and the agency which has the ultimate authority on these matters heads the committee.

In stockpile matters the Office of Emergency Preparedness has authority for policy decisions and through the Interdepartmental Material Advisory Committee, which it chairs, coordinates recommendations from the other Government agencies, including the Departments of Commerce, Interior, the General Services Administration, and others.

The National Materials Advisory Board (NMAB) of the National Academy of Sciences operates through its Interagency Council for Materials, funded by 11 Government agencies including the Departments of Commerce, Defense, and Interior. The Office of Emergency Preparedness coordinates Federal agency activities in the defense materials area, improving communications to prevent duplication of effort.

In most instances where significant shortages of important raw materials occur or are imminent and may be caused by or aggravated by increased exports, coordination is accomplished through the Department of Commerce's Interagency Advisory Committee on Export Policy structure. Policy is made at the level of the Assistant Secretary in most instances and at the secretarial level in some instances. The effective instrument used in such instances is export control under the authority of the Export Administration Act of 1969 which states:

> It is the policy of the United States to use export controls * * * to the extent necessary to protect the domestic economy from the excessive drain of scarce materials and to reduce the serious inflationary impact of abnormal foreign demand * * *

And here, if I may depart from my text, I may point out we have at the present moment an excellent example of the usefulness of the short supply controls. Under a substantial wage and price freeze, you are developing certain commodity prices which are higher abroad than they are domestically due to the freeze, and there is a strong tendency for exports to drain off commodities and create a short supply situation here. To this end, we have developed what we call an early warning system, or a watch list, where we identify certain commodities that can be in short supply, and at the moment are watching such commodities as scrap metal, coal, coke, and other materials not in the raw material category.

Industrial society depends upon 74 essential metallic and nonmetallic minerals, exclusive of the energy-producing minerals and exclusive of certain gases. In 1969 the United States was self-sufficient or nearly self-sufficient in 32 of them. We were completely dependent, or nearly so on foreign sources for 22. The remaining 20 fell within the 10- to 90-percent foreign dependency range. Our minerals consumption continues to grow, and the general trend is toward further dependence upon foreign sources of supply.

Among the minerals in which the United States is self-sufficient are common minerals such as clays, coal, sulfur, silica, and sodium, less common ones such as molybdenum, magnesium, and lithium, and last, exotic minerals such as the rare earths and rhenium. In the area of total or almost total dependency on imports are some of the more important industrial minerals; among them are: Chromite, columbium, manganese, tin, and the platinum group. If a generally acceptable and relatively weighted rating system could be devised which would measure quantitative and qualitative factors, the U.S. resource base would be deficient on balance.

The table on the following page presents our forecasts for U.S. consumption and imports and world production for six selected mineral commodities representing various degrees of dependency: Fully dependent on imports for manganese ore and chormite; partially dependent for bauxite, alumina, and iron ore; and approaching independence in copper.

It might be interesting for a moment to turn to that table and comment briefly on what we are trying to show.

(The table follows:)

SELECTED RAW MATERIALS PROJECTIONS FOR 1975

[In thousand short tons]

Raw material	U.S. consumption			World production			U.S. imports		
	1970 estimate	1975 estimate	Percent change	1970 estimate	1975 estimate	Percent change	1970 estimate	1975 estimate	Percent change
Manganese ore	2,290	2,420	6.0	20,100	23,620	17.5	1,735	1,840	6.0
Refined copper	2,042	2,810	38.0	6,752	9,400	39.0	[1] 168	[1] 220	30.0
Bauxite	17,500	20,000	15.4	64,000	94,000	47.0	15,500	18,000	16.0
Alumina	8,500	14,000	65.0	23,000	34,000	48.0	2,800	5,000	79.0
Iron ore	138,000	145,000	5.0	741,652	900,000	21.0	50,261	52,000	3.5
Chromite (metallurgical)	912	[2] 1,057	15.9	3,837	4,668	21.6	885	885	([3])

[1] Imports of ores, concentrates, blister, and refined copper minus exports of refined copper.
[2] Includes 172,000 tons from stockpile.
[3] Imports not expected to increase, although United States will retain its position with exporting countries.

In the first set of figures we make certain short-term estimates as to the growth of U.S. consumption of these typical raw materials.

In the second set we show the increase in world production over the next 5 years. Accordingly, in the third set we show the change in imports.

You see, for example, in manganese ore there is virtually no change in dependence. In terms of refined copper, we are becoming less dependent upon imports. In terms of bauxite, we are approximately the same. In terms of alumina, our foreign dependence increases. In terms of iron ore, hopefully it will decrease. And in terms of chromite, for reasons I will explain later, we are becoming increasingly less dependent.

In terms of chrome ore, U.S. consumption is expected to grow at a rate of approximately 3 percent per year. This rate is somewhat higher than for total steel and results from increased production of chrome-bearing alloy steels as a proportion of total steel production and a recovery of stainless steel production to higher levels as imported stainless steels recede in absolute terms. World consumption is expected to grow at a faster rate than United States, at 4 to 4.5 percent per year as the product mix of other developed countries begins to more nearly approach that of the United States.

A technological approach to a difficult dependence problem is illustrated by recent developments in the use of low-chrome content ores. Chromium is essential to the production of all stainless steel.

Prior to the imposition of U.S. economic sanctions on Rhodesia, that country accounted for 45 percent of our imports of metallurgical grade chromite ore, Russia 25 percent and Turkey 22 percent. Now, about 60 percent of it comes from the U.S.S.R. and the rest primarily from Turkey. During this source shift over the past 5 years the price of such ore has risen from $30–$35 to $70–$75 per ton. This dependency has accelerated research toward new technology for using lower grade ores rather than either the higher grade Rhodesian or Russian ores. This research has already resulted in the development of three essentially similar oxygen decarburization processes (two United States and one Swedish). One American process is already well along in commercial development, with several U.S. and foreign stainless steel producers using it. It has been estimated that by 1975 virtually all stainless steel produced in the United States will be made by this new process, and could reduce our dependency upon the U.S.S.R.

The lesson, of course, which we learn here is that necessity is the mother of invention and gives us some hope when our dependence is upon an unreliable source we will develop alternate processes or technology that will reduce such dependency.

Technological progress of this kind in other mineral use must be encouraged and accelerated if the United States is to continue to retain, or regain, its competitive leadership. The cold facts are that the U.S. resource base is declining, and there are only a few ways to improve or stabilize it. These are: New resource discoveries in the United States; development of processes or technology permitting use of smaller quantities of primary materials further along in the production pipeline; development of new offshore resources; increased use of secondary or recycled material and use of substitutes.

Most of the critical raw materials are now found (exclusive of U.S.S.R. and China) in the developing nations, and we find a new situation unfolding. This is the desire of these nations to upgrade their basic raw materials to obtain the benefit of the extra value added. This, in turn, has led to special assistance agreements between these countries and some of the developed countries. A case example is that recently agreed upon between Turkey and Japan. Included in the agreement was financial and technical assistance to Turkey to establish a 50,000-ton-per-year ferrochrome alloy plant; Japan will receive, among other things, 1 million tons of chrome ore over the next 11 years. The United States has for many years been Turkey's principal customer for chrome ore, receiving about 200,000 tons a year. We have been assured that we will continue to receive this same quantity in the future. In this instance our interest appears to be protected but, some other country, or countries, may not fare as well. The next time an agreement of this kind is negotiated, the United States might be the loser.

The lesson here, of course, is there is very severe competition for these raw materials and the traditional prior contract and conditional dependence upon spot contracts may not be all the United States needs to assure itself of adequate supply of raw materials.

The economic cost to the minerals industry of maintaining and expanding production while giving full attention to environmental protection will, of course, affect our efforts to assure adequate supplies of minerals and energy. Some substantial mineral resources will remain unexploited unless we find environmental solutions at reasonable cost.

And here we are talking about our own resources. For example, potential new sources of copper in Washington State and of molybdenum in Idaho have not been developed because of environmental conservation factors. In the processing area we can cite the unsuccessful attempts to locate needed East Coast oil refineries and terminals in Delaware and in Maine.

In the case of emissions from currently operating mineral processing operations, the impact will be huge if companies must attempt to meet very stringent standards quickly; but given proper leadtime to install appropriate controls and given emissions standards consistent with regional air quality standards, the cost can be cut sharply and the efficiency improved. In the environmental area in most cases, we would do well to act only after we understand the economic impact, costs, and alternatives of proposed actions; know the time needed to carry out the action; develop feasible long-range plans; determine how the necessary actions can be financed; and arrange our regulatory and enforcement authorities to assure that similar situations will be treated similarly.

In this regard, the National Industrial Pollution Control Council, an advisory body on industrial policies and progress in improvement of environmental quality, reports through the Secretary of Commerce to the President and the Council on Environmental Quality.

And as an aside, I might say we consider this a very important area of study. We are caught clearly on the horns of a dilemma, whether we develop our domestic resources or whether we conform to the clear demands for environmental control.

There is, we find, a tendency of some companies to site their plants, their processing plants, overseas, so as to avoid the environmental problems that they meet here. Whether or not on a long-term interest this is a correct decision, time alone will tell.

The resources that are not developed because of environmental factors remain locked in the ground as our potential reserves. So this problem is not quite so critical a condition in a period of relative affluence if the raw materials remain to be sold. But this question of siting processing plants, refineries, petrochemical plants, and so forth, outside of the United States is a matter we believe deserves very careful attention.

The Federal Government has supported research and development in extractive metallurgy, the use of secondary materials, and pollution abatement. Where study indicates inability of industry to support indicated research, such Federal efforts should continue to be expanded in scope. The future construction of metal smelters in this country is much in doubt because of environmental considerations; innovative extractive metallurgy study is in order.

Illustrative of current and planned R. & D. efforts are the following:

Federal coal mine health and safety research has expanded from $2 million to $30 million in the past 3 years.

The President has proposed a $30 million per year pilot plant program in coal gasification research, two-thirds of the support to come from the Federal Government.

Creation or expansion of the minerals operations needed to meet our future needs depends on discovery of viable resources and expectation of a suitable rate of return on investment. The investment tax credits proposed under the President's new economic program is a needed stimulant to minerals investment.

The importance of recycling is such that there should be strong consideration given to provision of financial, tax, and regulatory incentives to increase the use of recycled materials and resources. While industrial scrap is recycled rather efficiently, the scrap reservoir of obsolete industrial and consumer products is less well utilized. Junk cars are a major potential source of steel and other materials, and also an eyesore. To the extent that we can expand our capability to recycle materials, our dependence on foreign mineral sources will be lessened.

The Department's Bureau of Domestic Commerce for several years has been documenting the facts on cars, for instance, to give a basis for Government and industry action, cooperating in designing a model law for States for abandoned car problems, establishing an Industry Advisory Committee on Iron and Steel Scrap Problems, cooperating with the Council on Environmental Quality in exploration of incentives to encourage recycling.

We estimate that there are currently 15 million junked, abandoned, or otherwise out-of-service automobiles in the United States (the actual number is presently being quantified by the Environmental

Protection Agency). We must add to this over 6 million cars which are removed from registration each year, of which approximately 15 percent are abandoned. We estimate that approximately 85 percent of these 6 million cars are processed into reusable scrap each year.

A representative junk automobile has the following composition in pounds: steel, 2,532; cast iron, 511; copper, 32; zinc, 54; aluminium, 51; lead, 20; rubber, 145; glass, 87; miscellaneous, 142. All of the metallic values are recoverable resources which could contribute to the conservation of our natural resources. A limited quantity of the rubber and glass are presently recovered for recycling.

Obviously, it would be a national asset if all the scrap in junk cars was recycled. We are considering what action will be required to accomplish this objective of total recycling.

We merely multiply those figures by the figure of 15 million or 6 million per year and you see the resource that can be recovered when we develop the technology and the positioning of that technology to recover these hulks.

Through the trade agreements program or by specific congressional action our tariffs and other trade barriers on raw materials needed by American industry have been progressively lowered or eliminated. Thus, today a long list of raw materials enter this country virtually unimpeded, including copper, natural gas, rubber, iron ore, nickel, and tin.

At the same time, it has not yet been feasible to eliminate tariffs on certain other raw materials which are produced in this country. Many of these products, such as tungsten, fluorspar, lead and zinc, are of critical importance to the industrial capability of this country and the national security interest. Quotas on petroleum imports are also needed for national security reasons.

But the real point here is that on those materials that we have a major need of, and there is no imperative to preserve a domestic source, tariffs are no longer a problem.

The continuing growth of the economies of the developing countries, coupled with their drive toward industrialization, is resulting in a substantially increased demand upon available minerals. While this demand will spur further exploration for new deposits, it will also increase the competition for available supplies.

The two charts on the following pages partially illustrate the problem:

The first reflects some salient facts on U.S. mineral requirements:

With 5 percent of the world's population, the United States is using 30 percent of the world's mineral output;

Presently importing about 15 percent of its minerals requirement, the United States may have to import 30 to 50 percent of its requirements by the year 2000;

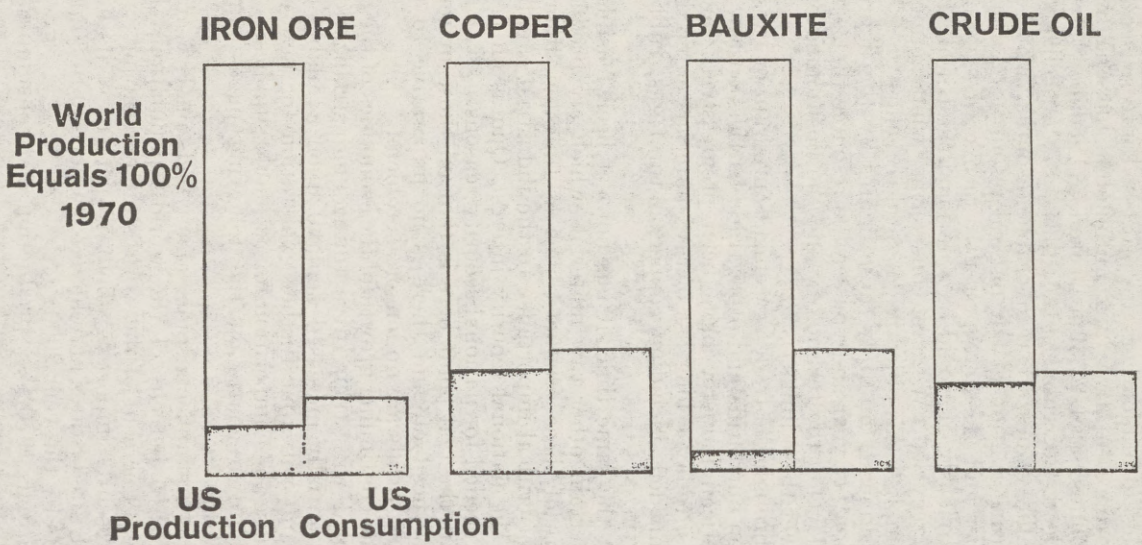
Reveals 1970 U.S. production and consumption as shares of world production for iron ore, copper, bauxite, and crude oil.

I think that chart rather graphically illustrates that our production is always less than our consumption, and that our production is only a fraction of the production in the world.

The second reveals Japan's domestic output and consumption for 1969 and anticipated consumption for 1975 for iron ore, coking coal, copper concentrates, crude oil, and bauxite. Except in bauxite, Japan was the world's largest importer, and in bauxite Japan ranked second after the United States.

As of 1970 the U S had 5% of World Population
7% of World Land Use
But used 30% of World Mineral Output
and Imported 15% of it's Requirements of Minerals

By year 2000 Imports will increase to at least 30% to 50% of requirements



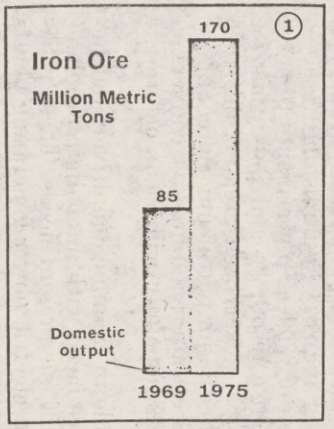
Total requirement definition:
Including domestic production and imports and excluding exports and re-exports

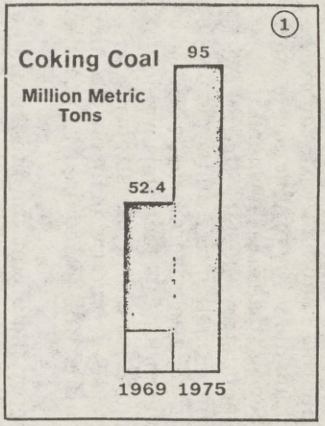
Japan:

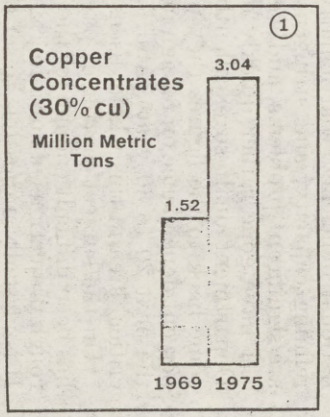
Selected Raw Materials Requirements*

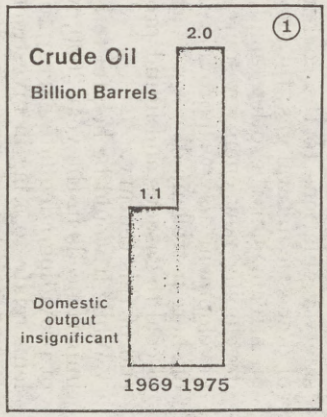
① Rank as world importer 1969

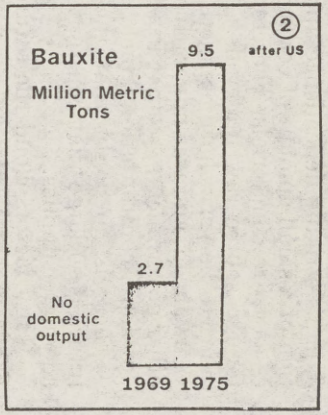
*Domestic output and imports











Also, if you will stop and look at that chart for a minute, you can see Japan's striking dependence upon imports. They had with the exception of a small amount of coking coal, no domestic production of their essential raw materials. Therefore, they have a total dependency upon foreign source raw materials. This points up the fact that there is going to be very sharp competition for available raw materials in the years ahead, and it is imperative that we, as a government, work with other governments, so that in this search for raw materials we do not develop a confrontation which, of course, would be disastrous.

There is no doubt that the increase in energy demand for the future is so large that constant attention will be required to provide adequate supplies.

Many factors cloud the future energy picture at the present time: Environmental demand for "clean" fuels; petroleum concession changes in major petroleum producing countries; increased health and safety regulations to the coal mining industry; diminishing reserves of domestic natural gas; the slowness of nuclear powerplants to come on stream. On the other hand, energy resources and potentials for developing new energy resources have never been greater; oil shale development may well provide another major petroleum source; major offshore petroleum discoveries are accelerated; and massive conversion of coal to gaseous and liquid products hopefully will occur before the end of this century.

While it would be helpful to be able to examine definitively our net import needs in the year 2000, we are faced with immediate problems of providing adequate energy to meet our present needs. These problems relate to a lag in investment in electric power generating plants and equipment, slowness in siting electric power generating facilities, national deficiency (particularly in the east) of planned petroleum refining capacity, and stringent pollution control regulations. These are significant problems, and we must resolve them.

I have gone rather quickly over this section because the Interior Department dealt so excellently with these problems. But I would come back to the figures they use, that we will be moving from a 20 percent dependence on foreign imports to something of 45 percent over the next 20 to 30 years. And, of course, energy is perhaps the most critical area in this whole discussion.

On the subject matter of paying for these imports of materials, it has been difficult enough for the Department of the Interior to develop rough projections of our mineral needs and production in the year 2000. It is virtually impossible to set a price at this time on the likely cost of needed imports. However, in comparison with imports of about $3 billion worth of mineral raw materials in 1969, we estimate that likely imports in 1975 would be about $3.3 billion for such minerals in 1969 prices, based on the trend of the previous 5 years. Total imports of all crude and manufactured mineral, metal, and energy resources are increasing more rapidly, and may reach $9.7 billion by 1975 in comparison with $7.8 billion imports of these materials in 1969. By the time the National Materials Policy Commission completes its study

(June 1973), we should have a more definitive basis on which to estimate imports in the year 2000.

Obviously, in trying to assess what we are going to have to pay for these imports, you have such intangible and almost emotional factors to consider, as the attitude of the OPEC, oil-producing countries as to how they negotiate with the oil-producing companies.

You have for the moment, the question as to how the surcharge will affect the cost of these raw materials, and over the long pull, you have the question of revalued currencies. If we had a major revaluation of some of these currencies involved, we will pay a substantially higher cost for these raw materials.

However, if we are to be able to pay for imports of these minerals at these higher levels in the near future (let alone the higher levels of the distant future) without further damage to our balance of payments position, we must move promptly to improve the scope and structure of our exporting industry.

We can only pay for these materials that we import by those materials that we sell abroad. And at the present, as I mentioned at the outset, our trade balance situation is bad and in recent months has been worsening.

The U.S. merchandise trade balance has moved from substantial surpluses in the first half of the 1960's to an expected deficit of between $1 and $2 billion this year; our export growth rate continues to lag our import growth rate by a substantial margin—currently our exports are increasing at approximately 3 to 4 percent and imports increasing at a rate of 13 percent.

Equally important is the fact that, although our exports continue to expand (but not as fast as our imports), the U.S. share of free world exports to destinations other than the United States had declined significantly, dropping from 21 percent in 1960 to 18.1 percent in 1970.

Nevertheless, I remain confident that this adverse trade situation can be corrected to accommodate our foreseeable needs if effective steps are now taken by the Government and by private industry. Some of these steps have already been undertaken in the President's new economic program which is basically addressed to restoring equilibrium in international trade. Success in the international phases of this program will be most helpful in making U.S. exports more competitive and in improving the environment abroad for exports and investments by U.S. firms.

The President's program also includes the proposed adoption of the important DISC export tax incentive providing for certain export-related profits tax deferral.

Increased emphasis will be needed on matters such as:

Industry-oriented research and development effort in the United States and wider use of existing technology to maintain the United States as the world's technological leader with important consequences for production of advanced technological goods for both domestic utilization and for export;

Encouragement to attract and support introduction of small- and medium-sized firms to the exporting field—both as individual firms and in various types of joint export efforts by such firms;

Fuller utilization of Eximbank financing under the terms of the Export Expansion Finance Act of 1971 to meet competitive financing of foreign firms' exports; and

Support by U.S. embassies and consulates abroad to provide commercial services to U.S. exporters.

Such efforts require a more substantial national recognition of the increasingly important role that exports and exporting must play in maintaining the Nation's overall economic strength in the years ahead.

It is also worth emphasizing that many of our mineral imports play important roles in the production of a wide range of technological goods that this country exports. Our "747" aircraft obviously contains a high percentage of aluminum, for example.

Mr. Chairman, I wish to thank you and the committee for holding this hearing on the supply and demand picture for metals and ores and fuels and energy. It is most timely and worthwhile. We are now living and operating in an international economy in which we are becoming more and more dependent upon others for our mineral needs. Many other countries are also becoming more dependent on foreign supply sources. Essential to our leadership role in the world is using our technology and influences to make certain that ample mineral resources are made commercially available in amounts that can meet the needs of all. I am confident that achievement of this goal lies within the capability of today's world. In helping to meet it, we shall also better assure that our own mineral needs will continue to be met.

Thank you, Mr. Chairman.

Chairman PATMAN. Thank you, Mr. Scott.

Now, I will not ask any questions, but will reserve the right to submit questions to you. And, of course, I believe you have agreed that you would be very glad to answer them for the record.

Mr. SCOTT. Unquestionably.

Chairman PATMAN. We would like the help of you gentlemen. You have the expertise in this field and we are just babes in the woods on this subject, compared to your knowledge. So if you will suggest to us things that should be considered for the record, to make this a good record, it will be appreciated very much.

Although I am not asking any questions, I will yield to either member of the committee who would like to.

Mrs. Sullivan would like to make a statement.

Representative SULLIVAN. Mr. Chairman, I appreciate your yielding to me.

I have an extremely important committee hearing in the Merchant Marine and Fisheries Committee on the sale of U.S. passenger vessels, so I am going to ask to be excused a little before 10:30 o'clock. But I do want to say to Mr. Scott, that this has been a very interesting and informative statement. I think it has given us an insight into the problems of the clamor today for cleaning up pollution and working

on our environment, and why we cannot do it overnight at the expense of our mineral resources.

I frankly do not have any questions to ask, except to say that our minds are wide open for suggestions as to what we can do as a congressional committee to help along what you have suggested here.

I thank you.

Chairman PATMAN. Mr. Widnall, would you like to comment?

Representative WIDNALL. Thank you, Mr. Chairman.

Mr. Scott, I would like to compliment you on your excellent testimony. As Mrs. Sullivan has said, I believe it has been most enlightening to us.

I am particularly interested in your comments on the recycling of materials and the extent to which this could be done in many fields of short supply today from our own domestic production. It seems to me that we are missing a great opportunity to utilize all the resources of this country, by just always seeking the easy way of trying to get the raw material itself, forgetting about what was here already at our doorstep. It can serve a dual purpose, not only providing new materials for new production, but cleaning up a lot of our environmental problems.

I just came back from a short trip overseas. I was interested in the comment that I received from a driver that I had in Germany. He said Germany was making great progress in the pollution field because they were really cracking down on the big manufacturers. And just saying there isn't any excuse; you have got to do it. He said the people themselves have noticed changes, substantial changes, as a result of this, particularly with respect to air and water pollution.

It is going to take some strict administration and toughness on the part of our own people, in order to accomplish the things that have to be accomplished in the environmental field.

Certainly, we are on the horns of a dilemma trying to utilize properly all the resources that we have, and at the same time, appease the environmentalists, who find fault with practically everything we are doing today or what has been done. I am hopeful that we are not going to reach the position where we are going to stand still because of the cries of the environmentalists.

I feel, as Mr. Patman, that this is an extremely important study that we are getting into. The materials that you and other witnesses will submit to this committee should be of inestimable help in stimulating immediate, present, and future policies with respect to the Congress.

I am sure the Congress will want to cooperate with the recommendations that you make, and would very seriously consider all of the testimony that we have.

This is far too important a field for the survival of the United States to play around with it politically. This is something there should be no politics in. I feel that is the way Members of Congress will approach it.

I want to thank you for being here today.

Chairman PATMAN. Mr. Brown?

Representative BROWN. Mr. Chairman, are we going to have an opportunity to pursue these statements later on?

Chairman PATMAN. We will have an opportunity to submit questions and they will answer the questions in the record. They are voluminous, necessarily, we could not do it in a couple of days' hearings. Moreover, the object of this hearing is to incite interest in the subject that is of such tremendous importance, as Mr. Widnall brought out. We will expect to develop a record as full as possible of the basic facts and what should be considered.

Each member will have the right to submit questions. I am going to submit a number myself, but I shall not take the time to ask them now. We have two other witnesses this morning and we would like for the members to make comments if they would like to.

Representative BROWN. Thank you, Mr. Chairman.

I would hope that maybe sometime in the course of these hearings, we would have a chance to have a colloquy on some of the things that are in the statement. Because I think that in a face-to-face confrontation, we oftentimes develop the things that we do not develop in the course of written questions.

Chairman PATMAN. I agree. All of us deserve the right to have a conference after this is over, and if we decide to have a confrontation with the principal witnesses, we shall be very glad to consider it.

Representative BROWN. Very good.

Mr. Chairman, in view of the ground rules which have been laid down for this meeting, I would just like to say to Mr. Scott, I think your statement was very good. I have had occasion to have dealings with you in the past, and I think that you make a tremendous contribution to the Department and in your chosen area.

I thank you very much for being here this morning.

Mr. SCOTT. Thank you ever so much, Mr. Brown.

(The full prepared statement of Mr. Scott follows:)

STATEMENT OF HAROLD B. SCOTT, ACTING ASSISTANT SECRETARY OF COMMERCE FOR DOMESTIC AND INTERNATIONAL BUSINESS BEFORE THE JOINT COMMITTEE ON DEFENSE PRODUCTION, SEPTEMBER 22, 1971

INTRODUCTION

Mr. Chairman and members of the committee, I welcome this opportunity to discuss some of the problems facing the Nation in assuring an adequate supply of minerals and energy in the future. We all recognize the vital role that these materials play in economic growth and defense. The intensity of the problem of future supply is compounded by the fact that demand for minerals and energy has been rising at a faster rate abroad than in the United States. This is true especially for Western Europe where there has been a depletion of their own resources and for Japan which must import most of her supplies. As a result, nations of the world will be competing more than ever before for a rising share of the world supply of materials. At the same time the less developed countries that are major sources for new materials are promoting their own industrialization and in supplying the world with raw materials are sensitive to the suggestion

that they are being exploited. Therefore, the need for cooperation with other nations of the free world will be even greater in the future, and our materials policy should be increasingly coordinated on an international basis with the policies of other countries.

National Materials Policy Act of 1970

We are concerned about the long-range adequacy of U.S. supplies of minerals and energy. Congress has also expressed its concern by enacting the National Materials Policy Act of 1970 which established an independent, seven member National Materials Policy Commission. The Secretaries of Commerce and Interior are the Government members of the Commission, the other members are private. The Commission has begun a full study of all materials (except food) for the purpose of developing a national materials policy. The study will include such matters as national and international requirements projections, the relationship of materials policy to population and environmental quality, recycling of materials, research and education, and Federal agency responsibility and coordination in the minerals field. The Commission held its initial meeting on September 15.

Previous Interior testimony

The Department of the Interior has already done much work which will be of value to the Commission, some of which has been made available to your committee. The Department of Commerce also will make a substantial contribution to the work of the Commission which will submit its findings on or before June 30, 1970. This will be the most comprehensive look at our long range raw materials outlook since the 1952 report by the "Paley Commission" which was the outgrowth of the Korean emergency.

Assistant Secretary of the Interior for Minerals Resources, Hollis Dole, pointed out in his testimony before you on August 2, that mineral supply and demand are global in nature, and that we will have to import a higher proportion of our raw materials needs in the future. Mr. Dole also presented to your committee a consistent and rational series of projections of mineral consumption and supply for the year 2000. These estimates of our rising import need for raw materials have important implications for our future balance of trade and balance of payments.

In our opinion the overall Interior projections for individual minerals for the year 2000 provide a good starting point for further efforts along this line by the National Materials Policy Commission. We recognize that these projections, as well as those by others, including the National Materials Advisory Board of the National Academy of Sciences, and Resources for the Future, Inc., are extremely valuable in indicating trends and forming a basis for future policy.

Mining and Minerals Policy Act

Because the accuracy of any forecast is dependent on the validity of the assumptions on which it is based, and political, technological,

and social factors continue to change rapidly, Congress recognized the dynamic nature of minerals supply and demand by enacting the Mining and Minerals Policy Act which requires the Secretary of the Interior to report annually on the state of the mining industries and to make recommendations to encourage private enterprise to find and develop mineral resources.

COORDINATION OF INTERAGENCY RESPONSIBILITY

This committee has expressed particular interest in the coordination of interagency responsibilities with respect to raw materials matters. Coordination among Government agencies is supplied by the particular agency which has the legal responsibility for the matter in question. The usual modus operandi is the establishment of either informal or formal committees with members representing diverse interests within Government. The formal committees usually meet when policy formation and/or policy recommendations are needed to resolve an issue, and the agency which has the ultimate authority on these matters heads the committee.

In stockpile matters the Office of Emergency Preparedness has authority for policy decisions, and through the Interdepartmental Material Advisory Committee, which it chairs, coordinate recommendations from the other Government agencies, including the Departments of Commerce, Interior, and the General Services Administration, and others.

The National Materials Advisory Board (NMAB) of the National Academy of Sciences through its Interagency Council for Materials, is funded by 11 Government agencies including the Departments of Commerce, Defense, and Interior. The Office of Emergency Preparedness coordinates Federal agency activities in the defense materials area, improving communications to prevent duplication of effort.

In most instances where significant shortages of important raw materials occur or are imminent and may be caused by or aggravated by increased exports, coordination is accomplished through the Department of Commerce's interagency Advisory Committee on Export Policy structure. Policy is made at the level of the Assistant Secretary in most instances and at the secretarial level in some instances. The effective instrument used in such instances is export control under the authority of the Export Administration Act of 1969 which states: "It is the policy of the United States to use export controls * * * to the extent necessary to protect the domestic economy from the excessive drain of scarce materials and to reduce the serious inflationary impact of abnormal foreign demand * * *."

BASIC INDUSTRIAL MATERIALS PROBLEMS

The United States current position

Industrial society depends upon 74 essential metallic and nonmetallic minerals, exclusive of the energy producing minerals and exclusive of certain gases. In 1969 the United States was self-sufficient

or nearly self-sufficient in 32 of them. We were completely dependent, or nearly so, on foreign sources for 22. The remaining 20 fell within the 10 percent to 90 percent foreign-dependency range. Our minerals consumption continues to grow, and the general trend is toward further dependence upon foreign sources of supply.

Among the minerals in which the United States is self-sufficient are common minerals such as clays, coal, sulfur, silica, and sodium; less common ones such as molybdenum, magnesium, and lithium; and, lastly, exotic minerals such as the rare earths and rhenium. In the area of total, or almost total, dependency on imports are some of the more important industrial minerals; among them are: chromite, columbium, manganese, tin, and the platinum group. If a generally acceptable and relatively weighted rating system could be devised which would measure quantitative and qualitative factors, the United States resource base would probably register under 40 percent.

EXAMPLE OF DEPENDENCE

The table on the following page presents our forecasts for U.S. consumption and imports, and world production for six selected mineral commodities representing various degrees of dependency: fully dependent on imports for manganese ore and chromite; partially dependent for bauxite, alumina, and iron ore; and approaching independence in copper.

Manganese ore.—Consumption of manganese ore is expected to increase at a rate slightly greater than the increase in steel consumption owing to an anticipated expansion of manganese in alloys. The United States will remain almost totally dependent on foreign ores, but world supplies of highgrade ores are well distributed geographically; are adequate to supply anticipated world demand; and are inexpensive.

Refined copper.—The rapid increase (38 percent) in U.S. consumption is in large part the result of the cyclically low level in 1970. A more normal 5-year increase would be 25 percent. The 39-percent increase in world production represents planned capacity increases. The net import figure for 1975 represents a continuation of the trend of declining dependency on foreign supplies, principally from Chile.

Bauxite and alumina.—Domestic production of bauxite supplies less than 10 percent of the U.S. industry's requirements and has increased very little, although aluminum production is expected to increase by an average of 6 to 8 percent a year. The trend is toward increasing imports of alumina rather than bauxite in view of new alumina plants constructed abroad. Potential difficulty in maintaining imports from some sources has led to new efforts to stimulate research in the use of domestic nonbauxite ores in place of bauxite.

Iron ore.—The trend is for increasing use of pellet capacity based on domestic ores; increasing ratio of iron scrap to ore; increasing world production of ore and decreasing U.S. dependence on imported ore.

Chrome ore.—U.S. consumption is expected to grow at a rate of approximately 3 percent per year. This rate is somewhat higher than for total steel and results from increased production of chrome-bearing

alloy steels as a proportion of total steel production and a recovery of stainless steel production to higher levels as imported stainless steels recede in absolute terms. World consumption is expected to grow at a faster rate than the United States, at 4 to 4.5 percent per year as the product mix of other developed countries begins to more nearly approach that of the United States.

EXAMPLE OF TECHNOLOGICAL SOLUTION

A technological approach to a difficult dependence problem is illustrated by recent developments in the use of low chrome content ores. Chromium is essential to the production of all stainless steel.

Prior to the imposition of U.N. economic sanctions on Rhodesia, that country accounted for 45 percent of our imports of metallurgical grade chromite ore, Russia, 25 percent, and Turkey, 22 percent. Now, about 60 percent of it comes from the U.S.S.R. and the rest primarily from Turkey. During this source shift over the past 5 years the price of such ore has risen from 30–35 to 70–75 dollars per ton. This dependency has accelerated research toward new technology for using lower grade ores rather than either the higher grade Rhodesian or Russian ores. This research has already resulted in the development of three essentially similar oxygen decarburization processes (two United States and one Swedish). One American process is already well along in commercial development, with several U.S. and foreign stainless steel producers using it. It has been estimated that by 1975 virtually all stainless steel produced in the United States will be made by this new process, and could reduce our dependency upon the U.S.S.R. to nearly zero.

Decline of resource base

Technological progress of this kind in other mineral use must be encouraged and accelerated if the United States is to continue to retain, or regain, its competitive leadership. The cold facts are that the U.S. resource base is declining, and there are only a few ways to improve or stabilize it. These are: new resource discoveries in the United States; development of processes or techniques permitting use of smaller quantities of primary materials further along in the production pipeline; development of new offshore resources; increased use of secondary or recycled material and use of substitutes.

Developing countries desire to upgrade natural resources

Most of the critical raw materials are now found (exclusive of U.S.S.R. and China) in the developing nations, and we find a new situation unfolding. This is the desire of these nations to upgrade their basic raw materials to obtain the benefit of the extra value added. This, in turn, has led to special assistance agreements between these countries and some of the developed countries. A case example is that recently agreed upon between Turkey and Japan. Included in the agreement was financial and technical assistance to Turkey to estab-

lish a 50,000 ton per year ferrochrome alloy plant; Japan will receive, among other things, 1 million tons of chrome ore over the next 11 years. The United States has, for many years, been Turkey's principal customer for chrome ore, receiving about 200,000 tons a year. We have been assured that we will continue to receive this same quantity in the future. In this instance our interest appears to be protected, but some other country, or countries, may not fare as well. The next time an agreement of this kind is negotiated, the United States might be the loser.

Environmental problems

The economic cost to the minerals industry of maintaining and expanding production while giving full attention to environmental protection will, of course, affect our efforts to assure adequate supplies of minerals and energy. Some substantial mineral resources will remain unexploited unless we find environmental solutions at reasonable economic cost. For example, potential new sources of copper in Washington State and of molybdenum in Idaho have not been developed because of environmental conservation factors. In the processing area we can cite the unsuccessful attempts to locate needed east coast oil refineries and terminals in Delaware and in Maine.

In the case of emissions from currently operating mineral processing operations, the impact will be huge if companies must attempt to meet very stringent standards quickly; but given proper leadtime to install appropriate controls and given emission standards consistent with regional air quality standards, the cost can be cut sharply and the efficiency improved. In the environmental area in most cases, we would do well to act only after we understand the economic impact, costs, and alternatives of a proposed action; know the time needed to carry out the action; develop feasible long-range plans; determine how the necessary actions can be financed; and arrange our regulatory and enforcement authorities to assure that similar situations will be treated similarly.

The National Industrial Pollution Control Council, an advisory body on industrial policies and progress in improvement of environmental quality, reports through the Secretary of Commerce to the President and the Council on Environmental Quality.

The Federal function

The Federal Government has supported research and development in extractive metallurgy, the use of secondary materials, and pollution abatement. Where study indicates inability of industry to support indicated research, such Federal efforts should continue to be expanded in scope. The future construction of metal smelters in this country is much in doubt because of environmental considerations; innovative extractive metallurgy study is in order.

Illustrative of current and planned R. & D. efforts are the following:

Federal coal mine health and safety research has expanded from $2 million to $30 million in the past 3 years. The President

has proposed a $30 million per year pilot plant program in coal gasification, two-thirds of the support to come from the Federal Government.

Creation or expansion of the minerals operations needed to meet our future needs depends on discovery of viable resources and expectation of a suitable rate of return on investment. The investment. tax credits proposed under the President's new economic program is a needed stimulant to minerals investment.

Recycling of secondary products

The importance of recycling is such that there should be strong consideration given to provision of financial, tax, and regulatory incentives to increase the use of recycled materials and resources. While industrial scrap is recycled rather efficiently, the scrap reservoir of obsolete industrial and consumer products is less utilized. Junk cars are a major potential source of steel and other materials, and also an eyesore. To the extent that we can expand our capability to recycle materials, our dependence on foreign mineral sources will be lessened.

The Department's Bureau of Domestic Commerce for several years has been documenting the facts on cars, for instance, to give a basis for Government and industry action, cooperating in designing a model law for States for abandoned car problems, establishing an Industry Advisory Committee on Iron and Steel Scrap Problems, cooperating with the Council on Environmental Quality in exploration of incentives to encourage recycling.

We estimate that there are currently 15 million junked, abandoned, or otherwise out-of-service automobiles in the United States. (The actual number is presently being quantified by the Environmental Protection Agency.) We must add to this over 6 million cars which are removed from registration each year, of which approximately 15 percent are abandoned. We estimate that approximately 85 percent of these 6 million cars are processed into reusable scrap each year.

A representative junk automobile has the following composition (in pounds): steel, 2,532; cast iron, 511; copper, 32; zinc, 54; aluminum, 51; lead, 20; rubber, 145; glass, 87; miscellaneous, 142. All of the metallic values are recoverable resources which could contribute to the conservation of our natural resources. A limited quantity of the rubber and glass are presently recovered for recycling.

Obviously it would be a national asset if all the scrap in junk cars was recycled. We are considering what action will be required to accomplish this objective of total recycling.

Removing trade barriers on raw materials

Through the trade agreements program, or by specific congressional action, our tariffs and other trade barriers on raw materials needed by American industry have been progressively lowered or eliminated. Thus, today a long list of raw materials enters this country virtually unimpeded, including copper, natural gas, rubber, iron ore, nickel, and tin.

At the same time, it has not yet been feasible to eliminate tariffs on certain other raw materials which are produced in this country. Many of these products, such as tungsten, fluorspar, lead, and zinc, are of critical importance to the industrial capability of this country and the national security interest. Quotas on petroleum imports are also needed for national security reasons.

COMPETITION FOR RAW MATERIALS

The continuing growth of the economies of the developed countries, coupled with their drive toward industrialization, is resulting in a substantially increased demand upon available minerals. While this demand will spur further exploration for new deposits, it will also increase the competition for available supplies.

The two charts on the following pages partially illustrate the problem:

The first reflects some salient facts on U.S. mineral requirements:

With 5 percent of the world's population, the United States is using 30 percent of the world's mineral output;

Presently importing about 15 percent of its minerals requirement, the United States may have to import 30 to 50 percent of its requirements by the year 2000 A.D.;

Reveals 1970 U.S. production and consumption as shares of world production for iron ore, copper, bauxite, and crude oil.

The second reveals Japan's domestic output and consumption for 1969 and anticipated consumption for 1975 for iron ore, coking coal, copper concentrates, crude oil, and bauxite. Except in bauxite, Japan was the world's largest importer, and in bauxite Japan ranked second after the United States.

"Problems in assuring future adequate supply of energy"

There is no doubt that the increase in energy demand for the future is so large that constant attention will be required to provide adequate supplies.

Many factors cloud the future energy picture at the present time: Environmental demand for "clean" fuels; petroleum concessions changes in major petroleum producing countries; increased health and safety regulations in the coal mining industry; diminishing reserves of domestic natural gas; the slowness of nuclear powerplants to come on stream. On the other hand, energy resources and potentials for developing new energy resources have never been greater: Oil shale development may well provide another major petroleum source; major offshore petroleum discoveries are accelerated; and massive conversion of coal to gaseous and liquid products will occur before the end of this century.

While it would be helpful to be able to examine definitively our net import needs in the year 2000, we are faced with immediate problems of providing adequate energy to meet our present needs. These

problems relate to a lag in investment in electric power generating plants and equipment, slowness in siting electric power generating facilities, national deficiency (particularly in the East) of planned petroleum refining capacity, and stringent pollution control regulations. These are significant problems, and we must resolve them.

Meeting the cost of increased U.S. imports of minerals

It has been difficult enough for the Department of the Interior to develop rough projections of our mineral needs and production in the year 2000 A.D. It is virtually impossible to set a price at this time on the likely cost of needed imports. However, in comparison with imports of about $3 billion worth of mineral raw materials in 1969, we estimate that likely imports in 1975 would be about $3.3 billion for such minerals in 1969 prices, based on the trend of the previous 5 years. Total imports of all crude and manufactured mineral, metal, and energy resources are increasing more rapidly, and may reach $9.7 billion by 1975 in comparison with $7.8 billion imports of these materials in 1969. By the time the National Materials Policy Commission completes its study (June 1973), we should have a more definitive basis on which to estimate imports in the year 2000.

However, if we are to be able to pay for imports of these minerals at these higher levels in the near future (let alone the higher levels of the distant future) without further damage to our balance-of-payments position, we must move promptly to improve the scope and structure of our exporting industry. At present, our trade balance situation is bad and worsening.

> The U.S. merchandise trade balance has moved from substantial surpluses in the first half of the 1960's to an expected deficit of between $1 and $2 billion this year; our export growth rate continues to lag our import growth rate by a substantial margin,
>
> Equally important is the fact that, although our exports continue to expand (but not as fast as our imports), the U.S. share of Free World exports to destinations other than the United States had declined significantly, dropping from 21 percent in 1960 to 18.1 percent in 1970.

Nevertheless, I remain confident that this adverse trade situation can be corrected to accomodate our foreseeable needs if effective steps are now taken by this Government and by private industry. Some of these steps have already been undertaken in the President's new economic program which is basically addressed to restoring equilibrium in international trade. Success in the international phases of this program will be most helpful in making U.S. exports more competitive and in improving the environment abroad for exports and investments by U.S. firms.

The President's program also includes the proposed adoption of the important DISC export tax incentive providing for certain export-related profits tax deferral.

Increased emphasis will be needed on matters such as:

Industry-oriented research and development effort in the United States and wider use of existing technology to maintain the United States as the world's technological leader with important consequences for production of advanced technological goods for both domestic utilization and for export;

Encouragement to attract and support introduction of small and medium-sized firms to the exporting field—both as individual firms and in various types of joint export efforts by such firms;

Fuller utilization of Eximbank financing under the terms of the Export Expansion Finance Act of 1971 to meet competitive financing of foreign firms' exports; and

Support by U.S. embassies and consulates abroad to provide commercial services to U.S. exporters.

Such efforts require a more substantial national recognition of the increasingly important role that exports and exporting must play in maintaining the Nation's overall economic strength in the years ahead.

It is also worth emphasizing that many of our mineral imports play important roles in the production of a wide range of technological goods that this country exports.

Mr. Chairman, I wish to thank you and the commitee for holding this hearing on the supply and demand picture for metals and ores and fuels and energy. It is most timely and worthwhile. We are now living and operating in an international economy in which we are becoming more and more dependent upon others for our mineral needs. Many other countries are also becoming more dependent on foreign supply sources. Essential to our leadership role in the world is using our technology and influence to make certain that ample mineral resources are made commercially available in amounts that can meet the needs of all. I am confident that achievement of this goal lies within the capability of today's world. In helping to meet it, we shall also better assure that our own mineral needs will continue to be met.

Chairman PATMAN. Thank you and your associates very much. We will certainly call on you to answer the questions. We will give consideration to an open discussion as suggested by Mr. Brown. I think that is an excellent idea.

Mr. SCOTT. I want to make fully available to you and the committee all of the resources of our department. Thank you.

Chairman PATMAN. Thank you, sir, for your very fine and splendid cooperation and your good testimony.

(Chairman Patman submitted additional questions to the Department of Commerce, and the answers to these questions were forwarded by Mr. Harold Scott, Assistant Secretary of Commerce for Domestic and International Business, together with a letter dated October 15, 1971. The questions and answers follow the letter.)

DEPARTMENT OF COMMERCE,
THE ASSISTANT SECRETARY OF COMMERCE,
Washington, D.C., October 15, 1971.

Hon. WRIGHT PATMAN,
Chairman, Joint Committee on Defense Production,
Congress of the United States,
Washington, D.C.

DEAR MR. CHAIRMAN: Secretary Stans has asked that I reply to your letter of August 13 and the questions contained therein.

In my appearance before the joint committee on September 22, I stated this Department's concern about the long-range adequacy of U.S. supplies of minerals and energy and the problems posed for the future by our growing dependence on imports. The enclosed answers to the 25 questions posed by the committee supplement my testimony.

Secretary Stans will be working very closely with Secretary of the Interior Morton and other members of the National Commission on Materials Policy in developing recommendations to encourage private enterprise to find and develop mineral resources and increase recycling of scrap and waste materials to conserve primary materials. The Commission's report is due by June 30, 1973, but some interim recommendations will no doubt be made to the Congress in the Secretary of the Interior's annual report on the state of the mining industries which is required by the Mining and Minerals Policy Act of 1970.

The Nation certainly faces serious problems in assuring an adequate supply of minerals and energy in the future. Among the most important of these are the impact of pollution abatement control costs on the mining, metals and other industries and the effect of rising materials imports on our balance of trade and payments. The growing recognition in the Congress and the executive branch of the heavy costs involved in pollution abatement and the possible adverse effects on materials supply is encouraging. A balance must be struck between a cleaner environment and a high level of production and employment.

The President's new economic program to provide more jobs, stabilize the economy and defend the dollar should make our industries more competitive with foreign industries and restore our favorable trade balance. Rising imports of basic materials in the future must be paid for through increased exports. Congressional approval of the President's tax proposals, including the investment tax credit and the deferral of taxes on export earnings (DISC) will contribute toward improving our balance of trade and payments.

Sincerely,

HAROLD B. SCOTT,
Assistant Secretary for Domestic and International Business.

Question 1. Forecasts of the Department of the Interior indicate that the United States is becoming more and more dependent on foreign sources of supply for metals and minerals. What is the reaction of domestic industry to increased dependence on foreign sources for metals and minerals?

Mr. SCOTT. U.S. industry recognizes that the supply of minerals is global in nature, and that total or partial dependence on imports for many minerals will continue and in some cases will increase. Industry is also aware that it will be competing more than ever with the industries of Western Europe and Japan for the limited world supplies of minerals. Generally, U.S. consumers of minerals seek the lowest cost, dependable supply of the required quality of materials. It is more convenient and in many cases less costly for industry to have short supply lines, but for many minerals domestic reserves are unknown, limited or poor grade. Therefore industry must import them from other countries and in some cases over long distances.

Industry certainly would have less concern about dependence on North American sources, or Australian, for example, than it would for dependence on the U.S.S.R., or politically unstable less developed countries where supplies might be interrupted or expropriated as a result of political developments. It also has large investments abroad in subsidiaries, partnerships, and consortiums, sources which it considers more dependable than outside suppliers. Even in the case of captive sources industry is encountering problems such as rising taxes, the desire of foreign countries to upgrade their minerals locally, and nationalization or threats of nationalization.

Nevertheless, for some minerals industry must depend on less reliable and less politically stable sources of minerals and looks to Government for help in promoting a more reliable supply, improving the investment climate abroad, providing incentives or insurance against expropriation, encouraging exploration and development of domestic resources, including those on public lands, and promoting an increase in the recycling of scrap and waste materials.

Question 2. Are present policies adequate for meeting our needs for metals and ores in future years?

Question 3. Are there new policies which should be adopted to assure adequate supplies of raw materials for industrial production?

Mr. SCOTT. Congress and the President have recognized that present policies may not be adequate for meeting our future minerals needs. The National Materials Policy Act of 1970 (Public Law 91–152) established an independent seven member National Commission on Materials Policy. The Secretaries of Commerce and Interior are members of the Commission. The Commission is to develop a "* * * national materials policy to utilize present resources and technology more efficiently, to anticipate the future materials requirements of the Nation and the world, and to make recommendations on the supply, use, recovery, and disposal of materials," no later than June 30, 1973. As part of its work the Commission will examine the adequacy of present programs and policies and will recommend changes where necessary as well as the adoption of new programs and policies needed to assure an adequate future supply of materials. Among the areas to be examined are geologic and geophysical mapping programs, exploration incentives, development of minerals on Fed-

eral lands, tax incentives (including depletion allowances), technological developments and support of research, problems of mine safety, impact of pollution abatement, conservation and the potential of recycling, foreign trade and foreign aid policies.

In addition, Congress last year enacted the Mining and Minerals Policy Act which requires the Secretary of the Interior to report annually on the state of the mining industry and make recommendations to encourage private enterprise to find and develop mineral resources. The Secretary's first report to Congress which will be submitted early in 1972 may contain some interim recommendations before the more comprehensive report of the Commission is made in mid-1973.

Question 4. As dependence on foreign sources increases, will there be a need for stockpiling additional quantities of strategic and critical materials for defense purposes?

Mr. SCOTT. The stockpiling program managed by the Office of Emergency Preparedness under the authority of Executive Order 11051 and the Stockpiling Act of 1946 recognizes the factor of foreign dependence in all stockpile determinations. An increase in foreign dependence could normally be expected to result in increased stockpile objectives. However, this would not be the case if it were determined that suitable substitutes were available whereby nonstrategic materials could take the place of strategic materials. Similarly, increased objectives might not be established if it were determined that conservation programs could eliminate nonessential civilian consumption during an emergency. Another factor that could offset the need for additional stockpiling as foreign dependence increases is the geographical proximity of the foreign sources. Dependence on Canada or Mexico for strategic materials is less dangerous than dependence on distant countries like India or Ceylon. In making such an evaluation, the political stability of the foreign source of supply and the U.S. political relationship with the country would also be considered.

As of June 30, 1971, the total quantities of stockpile grade materials in inventory were in excess or equal to the stockpile objectives for 61 of the 72 basic materials on the List of Strategic and Critical Materials for Stockpiling. These surpluses resulted from changes in conventional and nuclear war concepts which reduced the estimated wartime materials deficits, by purchasing in excess of objectives including the acquisition of materials from other countries by exchange or barter of agricultural commodities. The value of these surpluses approximates $2.5 billion. Congress has authorized the disposal of much of these surpluses. If the stockpile objectives for these commodities were increased, the existing excess inventories would be credited to the new objectives. Depending on the size of the increase, these surpluses (if still available) would moderate or, in some cases, preclude the need for additional stockpile purchases.

It should be noted that, at the present time, nine materials are below their established objectives. The total value of this deficit approximates $0.6 billion. Several contracts now in effect provide for the

acquisition of needed stockpile materials in exchange for surplus stockpile materials. Cash procurement is authorized for only one material (jewel bearings).

In summary, OEP and other Government agencies continually analyze the supply and demand patterns of strategic and critical materials. If these analyses indicate that the factor of foreign dependence outweighs other factors which help to determine the stockpile objective, additional stockpiling might be necessary. However, increased foreign dependence, per se, will not result in a need to stockpile additional quantities of strategic and critical materials. The supply and demand for each material must, and is, continually monitored to determine if a change should be made in the stockpile objective.

Contrasting with metals and minerals, stockpiling fuels in the order of magnitude required by conventional domestic consumption is basically impractical due to order of magnitude and related physical and financial problems.

Question 5. As the demand for materials increases, and our dependence on foreign sources increases, will industries be able to acquire materials to meet their needs for nondefense purposes without carrying additional inventories?

Mr. SCOTT. The carrying of additional inventories would be a costly burden to U.S. consumers of materials. The recent trend has been for lower inventories through computer controlled stocks in order to avoid high interest costs and reduce inventory taxes. Materials consumers regularly review their inventory policies in the light of political and economic developments, and do, at least temporarily, increase their inventories if, for example, dock, rail or other strikes are likely or political developments such as sanctions against Rhodesia threaten the supply of specific materials.

As consumption rises, of course, the quantity of materials stocked would increase. Generally, however, industry cannot be expected to maintain inventories at a higher level in terms of days' supply than at present. There are likely to be some exceptions made by industry for specific minerals if domestic or nearby sources are exhausted or a higher proportion must be imported from long distances. In these cases it will be prudent for industry to carry a somewhat larger inventory in terms of days' supply.

Question 6. What do you consider to be the role of Government and the role of industry in providing adequate quantities of raw materials for industrial production when there are potential shortages?

Mr. SCOTT. Industry has had and should continue to have the primary role in exploring for and developing adequate supplies of raw materials as well as planning ahead to avoid shortages wherever possible. The Government has, of course, taken primary responsibility for assuring an adequate supply of strategic and critical materials in wartime by establishing Government stockpiles. In addition, the Government has supported the efforts of the private sector by means

of exploration, tax and other incentives as well as by helping to finance foreign mineral developments through U.S. or international agencies.

In cases where actual or potential shortages of particular materials have occurred, industry and Government have worked together to alleviate them. The Government in periods of shortage has under authority of the Defense Production Act, assured that defense needs are met, but has also alleviated shortages by disposing of stockpile surpluses for defense and commercial use. Some examples of this activity in recent years are copper, nickel, and molybdenum which were allocated from the stockpile for defense use and the alleviation of hardships. The Government has also utilized the authority to impose quantitative export controls to protect the domestic economy from the excessive drain of scarce materials. Recent examples include limitations on exports of refined copper, copper scrap and nickel-bearing scrap. Moreover, the Government as part of its mobilization planning and annual review of stockpile objectives identifies possible future shortages and works with industry to avoid wherever possible any actual shortages. In this connection, Mr. William N. Lawrence of the Office of Emergency Preparedness in his testimony before the Joint Committee on Defense Production on September 22, 1971, suggested that the Congress take action on the administration's proposed amendments to the Defense Production Act which would increase the funds available for making loans for the expansion of the supply of materials and remove the new contract limitation. Programs undertaken under provisions of the Defense Production Act have resulted in increasing the domestic supply of a number of materials.

Question 7. As the dependence on foreign sources increases, will industry be required to invest larger sums in acquiring materials and carrying larger inventories of materials?

Mr. SCOTT. To meet the much larger materials requirements in the future, industry will have to invest larger sums in both the United States and other countries, particularly in the development of new mineral sources. Moreover, the cost per unit of metal contained in ores will rise because poorer grades of ore must be mined and processed and because other factors including pollution abatement will also add significantly to the costs of mining and metals producing companies. With the rising dependence on foreign sources the cost of freight is likely to be higher. There will no doubt be some technological developments in the mining and processing of minerals and metals and reductions in requirements for some materials by technical changes in metal using industries which will reduce costs; but they are not likely to offset the costs indicated above. Therefore it can be expected that industry will have to invest larger sums and will be faced with an increased cost per unit of metal in ore. Improved Government exploration assistance at home and abroad, priority in foreign aid programs and Export-Import Bank credits for minerals developments would be of great help to the private sector in obtaining the increased investment funds needed.

See the answer to question 5 on industry inventories of materials.

Question 8. Do you consider the present exploration program adequate to meet the requirements for materials?

Question 9. Should the United States carry out an exploration program in foreign countries as well as in this country?

Mr. SCOTT. We agree with Assistant Secretary of Interior Dole's testimony before the joint committee on August 2, 1971, that the tempo of our exploration for new mineral deposits both at home and abroad must be stepped up. The programs of the Geological Survey are a basic element in any program directed at assuring a future supply of minerals. As Mr. Radlinski, Acting Director of the Survey testified, his agency in its research program collects and disseminates basic geological and geophysical data, appraises the mineral and fuel resources of the United States and other countries, and administers the Office of Minerals Exploration loan program. Mr. Radlinski also indicated that because of the limitations of the current exploration loan program industry has not participated as expected, and that ways of correcting the deficiency are under review.

In connection with exploration in foreign countries, U.S. firms are active throughout the world in minerals exploration and development. The U.S. Government has been active in supporting the private sector in foreign resource appraisal and exploration through its foreign aid programs either through the U.S. Agency for International Development (AID) or through international agencies—the United Nations and its subsidiary bodies and the International Bank for Reconstruction and Development, and so forth. The appraisal and exploration of materials resources is an important area of interest in developing country programs for U.S. technical and financial assistance to other countries. Development of foreign minerals resources, especially for export to the United States, is a specific U.S. interest in our foreign economic policy and should have high priority.

Question 10. Since the United States is now importing about $8.4 billion in metals and minerals, how will the balance-of-payments problem be solved as the dependence on foreign sources increases?

Mr. SCOTT. The President's new economic policy, including the freeing of the dollar from gold, the import surcharge, the wage/price controls and the tax proposals, are directed toward increasing economic activity and reducing unemployment in the United States and making U.S. industry more competitive with foreign industries. These new programs should result in a restoration of a surplus of exports over imports and a substantial improvement in our balance of payments.

Rising imports of essential minerals and fuels in the future must be paid for primarily through increased exports from the United States. The United States is, of course, also an important exporter of minerals, fuels and scrap, supplying needed quantities of mainly coal, molybdenum, and ferrous and nonferrous scrap to other countries.

Question 11. To what extent will an increased emphasis on the recycling of materials aid industry in obtaining adequate quantities of materials?

Mr. SCOTT. Recycling of metals, glass, rubber, paper, and other materials already contribute substantially to industry's supply of materials. Adequate data are not now available to measure to what extent an increased emphasis on recycling can contribute to obtaining adequate quantities of materials in the future. The Resource Recovery Act of 1970, passed in October 1970, puts a new emphasis on recycling of solid wastes. It authorizes EPA to publish guidelines for construction and operation of solid waste systems which will be binding on Federal agency operations and federally funded demonstration projects. This act also created the National Commission on Materials Policy which will conduct a broad study of materials including the contribution of recycled materials.

The administration has been exploring ways to use Federal purchasing power to encourage recycling. The first step taken was by the General Services Administration (GSA) which changed its procurement specifications to require that paper purchased by the Federal Government contain a specified percentage of recycled material. Bills have been introduced in the Congress requiring that certain percentages of the procurement funds spent by various Government agencies be for recycled materials. The percentage would be determined by the Environmental Protection Agency. The Council on Environmental Quality is currently conducting a major study of solid waste recycling in cooperation with the Environmental Protection Agency and other agencies. Primary emphasis is on present economic constraints against recycling and on incentives needed to encourage more recycling. Increased recycling could cut both industrial and municipal solid waste disposal costs as well as recover and conserve valuable resources.

Question 12. Do you consider potential energy shortages to be a threat to industrial production?

Mr. SCOTT. Potential energy shortages must be considered a threat to industrial production unless a delicate balance of domestic and foreign oil supply is maintained that will supply U.S. need at lowest costs, at least until the nuclear breeder reactor technology is available. In this connection, a recent survey, reported to the New York Times October 15, 1971, estimates GNP for 1972 will be restricted to $1.1 trillion due to restrictions on the supply of energy caused by the current shortage of all fossil fuels and the slowness in construction and operation of all powerplants, but particularly nuclear.

Question 13. In your view, what is the period when energy shortages are likely to be the most critical?

Mr. SCOTT. 1980–90 is the period when energy shortages are likely to be most critical. First, the nuclear breeder reactor is not expected to be even demonstrated prior to 1980, and is subject to political and budgetary changes. Second, there is the likelihood that

by 1985 imports of Eastern Hemisphere oil will account for at least half of that consumed in the United States. It should be remembered that supply from this source is subject to unknown political contingencies.

Question 14. Do you have any estimates of the amount of energy which may be required to operate new environmental equipment?

Mr. Scott. No estimates are available.

Question 15. To what extent is industry able to shift to different fuels?

Mr. Scott. In case of necessity; that is, without regard to environmental controls or financial impact, industry can readily shift to different fuels—from oil or gas to coal or vice versa. Actual cost would vary substantially, not only by industry but by the location of the actual installation. For example, the electric utility industry, while capable of utilizing various fuels and of installing original equipment suitable for one fuel or transition to another, customarily chooses one on economic bases unique to its physical location and accessibility of one form of fuel or another. Supplemental installations or those capable of ready conversion are considered substantially more costly, although estimates of industrywide cost are not available.

Question 16. What are some of the decisions which must be made to assure industry adequate quantities of energy.

Mr. Scott. Decisions on the establishment of priorities in the allocation of funding for economic, environmental and social programs; establishment of incentives for exploration for gas and oil and for commercial development of both coal gasification and coal liquefaction and possibly energy rationing. Specific questions currently visible relate to: appropriate air pollution standards; Alaskan pipeline completion; offshore terminal facilities for deep water vessesls; resolution of Continental Shelf policies; thermal pollution standards; strip mining and land use laws; siting of utilities, refineries and chemical processing plants.

Question 17. Do you foresee any changes in the role of the Government and the role of industry in assuring adequate quantities of energy for industrial requirements?

Mr. Scott. A more dynamic and aggressive partnership must be forged with industry to expedite solutions in the following problem areas: Sulfur oxide control technology; nuclear breeder reactors; coal gasification; fusion power; magnetohydrodynamics; and underground electric transmission.

Question 18. Since some of the potential sources of energy—including gasification of coal, the breeder reactor, and shale oil—may not be developed for many years, will the United States be able to produce adequate quantities of energy to meet industrial demand in advance of developing these new sources of supply?

Mr. Scott. Yes; predicated on the following assumptions: No aggravated or longtime loss of work due to strikes; no loss in worker

productivity; prudent use of available energy; stable political conditions in supplying nations; appropriate incentives for capital; no restrictive legislation such as prohibiting strip mining of coal, reducing depletion allowances, or excessive and unduly restrictive environmental controls.

Question 19. The average annual demand for natural gas during the next 10 years is estimated to be about 27.5 trillion cubic feet a year, and the United States has been adding only 15.2 trillion cubic feet annually to reserves, oil imports are expected to double in the next 10 years, and nuclear power development is reported to be behind schedule. Should the United States establish energy goals in an effort to eliminate or improve supply-demand imbalances and to focus attention on the seriousness of potential energy shortages for industrial uses and other uses?

Mr. SCOTT. Setting energy goals would focus attention on the seriousness and likelihood of potential energy shortages and the visibility of the problem would imply increasing coordination between Government and industry, pending solutions or improving conditions.

Question 20. What are some of the problems which industry is encountering in meeting environmental standards?

Question 21. Has any industrial production been moved out of the United States because of environmental standards?

Mr. SCOTT. The principal problem facing industry in meeting pollution standards is the high cost of installing and operating pollution abatement equipment. This is especially true for certain industries, such as steel, foundries, nonferrous metals, chemicals, utilities, petroleum, paper, and food products, and the impact is more severe for certain plants or companies and small business. Because of conflicting standards among Federal, State, and local jurisdictions, and the fact that requirements are changed from time to time, it is impossible to make an accurate estimate of the ultimate cost. Pollution controls will demand expensive alterations even in fairly modern plants, and will make some older plants obsolete before their time. Many estimates have been made of capital and operating costs for a number of industries. These estimates vary widely. The Council on Environmental Quality and the Environmental Protection Agency are now giving more emphasis and attention to pollution control costs and their impact on the economy. CEQ, EPA, and Commerce are financing studies on the economic impact of environmental controls of 11 selected industries to be made by various private research firms. The industries included are: automobile, bakeries, steel, cement, fruits and vegetables, gray iron foundries, leather, petroleum refineries, nonferrous metals, pulp and paper, and utilities. The studies are to be submitted to the Government by the end of November 1971. There is also the question of where the necessary funds will come from—some will come from companies' retained earnings if profit levels allow, part will have to be stock offerings. The rapid tax amortization permitted for pollution abatement equipment and

the investment tax credit proposal before Congress will be helpful to industry but for some companies and industries, this will not be adequate since they may not be able to raise prices sufficiently and have to absorb some of the costs because of competitive conditions. Direct Federal financial assistance may be required in some cases.

Other problems industry is encountering which also affect costs include incomplete coordination of the interrelated problems of air and water pollution and solid waste disposal, varying or uneven enforcement of standards, the short time frame in which standards are to be met, lack of knowledge and technology to deal effectively with some of the pollution problems, inability to undertake joint research and development because of anti-trust questions, the availability of clean fuels to meet energy requirements, and the resulting competitive disadvantage of U.S. industry if U.S. pollution abatement standards and costs are more severe than those of other countries.

We know of no cases of production moving outside of the United States solely because of the impact of environmental standards. Undoubtedly, however, those companies and industries facing high pollution control costs are reviewing their investment plans and will postpone or stretch out some projects and consider producing abroad.

Question 22. Would you indicate the extent to which American companies are shifting industrial operations from this country to other countries and the reasons for operating outside the United States?

Mr. SCOTT. We have no information regarding U.S. companies plans to shift industrial operations from this country to other countries. However, the statistics on direct investment indicate the extent to which U.S. industry has invested abroad. Between 1950 and 1969 U.S. direct investments grew 10 percent a year, from $11.8 to $70.8 billion. The largest absolute growth was in Europe, the Middle East and Canada. These investments were mainly in manufacturing, petroleum, and the service industries.

Motives for investing abroad are numerous. Investments in petroleum, extractive and plantation industries are governed by the location of the resources. The bulk of these investments are needed to support the U.S. economy. The motives governing overseas investments in manufacturing are, however, more complex. Typically, offshore investment by U.S. corporations may be explained by the following factors: (1) a need to get behind tariff walls to safeguard existing export markets; (2) greater efficiency in producing for the local market than for export from the United States; (3) the possibility of lower production costs which makes it cheaper to produce abroad; (4) the fear that competitors going abroad may capture a lucrative foreign market or may, by acquiring cheaper sources of supply, threaten the domestic market position of the company; (5) a need to diversify lines to avoid fluctuations in earnings; (6) a desire to assist licensees abroad who may need capital to expand operations;

and (7) a desire to avoid home country regulations, for example, U.S. antitrust laws.

Question 23. What should be done to encourage American industry to operate and expand within the United States?

Mr. SCOTT. The President's new economic policy announced on August 15 to fight inflation, decrease unemployment, and defend the dollar should encourage American industry to operate and expand in the United States. The tax proposals, including the investment tax credit on domestic equipment and the deferral of taxes on export earnings (DISC) will encourage plant expansion in the United States. The President's program as a whole and particularly the floating of the dollar should make U.S. goods more competitive in the United States and foreign markets, thus encouraging exports over production abroad.

In the environmental protection area more consideration should be given to the cost burden on industry and the relative burden being borne by foreign industries.

Question 24. In the event of energy shortages, are industrial users of energy more likely to be curtailed than other users?

Mr. SCOTT. In the event of foreseen energy shortages, it is presumed an order of curtailment priority would be established at a national level. The order of curtailment could be: first, households; second, general business; and last, industrial plants. The foregoing is based on the premise that the well-being of the Nation is based upon continued operation of the industrial plant. In this connection, there is in being at the Office of Emergency Preparedness in the Executive Office of the President a Joint Board for Fuel Supply and Fuel Transport with the mission of evaluating such matters and recommending appropriate action on them.

Question 25. What is the average leadtime for the construction of industrial plants, and what assurance do industrial users require concerning the availability of energy in advance of construction of new facilities?

Mr. SCOTT. The average leadtime for the construction of an industrial plant is between 12 and 18 months, with a much wider overall spread of perhaps 2 months to 4 years. A prudent manufacturer will have arranged contractually for energy, particularly electricity, before committing capital funds.

A small operation utilizing standard manufacturing equipment available out of inventory could be in operation in a few weeks' time. An electroplating shop might fit this description. At the other extreme, large integrated metallurgical operations might require several years to be brought into production because of the need to build some or all of the following: townsite; access roads and railroads; mine shafts and underground workings or removal of large quantities of waste overburden from an orebody; surface facilities such as mills, smelters, and refineries, and powerplants or powerlines.

Chairman PATMAN. General Lincoln is attending a National Security Council meeting this morning. Of course, everything yields to National Security, and also wages and prices right now. So we will not be able to have him this morning. But he has sent us two excellent witnesses, Elmer Bennett, General Counsel, and Special Assistant for Oil and Energy, and William Lawrence, Chief of the Stockpile Policy Division.

If you gentlemen will come around, we would like very much to hear your testimony.

I will insert in the record, without objection, the fine statement by Mr. Elmer F. Bennett on behalf of Gen. George A. Lincoln. He is the Director of the Office of Emergency Preparedness. We appreciate his fine cooperation. If necessary, we will invite him to testify in the future, at least, try for such time for his appearance that would be mutually satisfactory.

(The prepared statement of Mr. Elmer F. Bennett begins on page 322, following the testimony of Mr. Bennett.)

Now, if you will, Mr. Bennett, suppose you identify yourself and then Mr. Lawrence, please.

STATEMENT OF ELMER F. BENNETT, GENERAL COUNSEL AND SPECIAL ASSISTANT (OIL AND ENERGY), OFFICE OF EMERGENCY PREPAREDNESS

Mr. BENNETT. I am Elmer Bennett, General Counsel of the Office of Emergency Preparedness, and I am also a Special Assistant to the Director for Oil and Energy. With me is Mr. William Lawrence, whom I think you have all met before, who is in charge of our stockpiling operations.

Chairman PATMAN. You may proceed. And what you do not put in the record, you may have permission to extend your remarks and insert in the record. We will reserve the right, if it is satisfactory with you gentlemen, to ask our questions in writing and ask you to answer them when you look over your transcript for approval or disapproval.

Mr. BENNETT. That will be fine.

Chairman PATMAN. All right. You may proceed, sir.

Mr. BENNETT. I will respond to those portions of your letter of September 10, 1971, which relate to your committee's interest in fuels and energy. Mr. William Lawrence, Chief, Stockpile Policy Division, Office of Emergency Preparedness, will respond to those portions which relate to the supply of metals, minerals, and ores.

Although I know, Mr. Chairman, that you and the other members of the committee are well informed regarding the responsibility of the Director of OEP in the energy field, I believe a brief review of these responsibilities will be helpful in providing a framework for my remarks this morning particularly with respect to your questions as to how the

decisionmaking process for energy resources is coordinated among the various departments and agencies which have responsibilities in these areas.

The President in his June 4 energy message urged the formation of a new Department of Natural Resources which would "place responsibility for energy questions in a single agency which can execute and modify policies in a comprehensive and unified manner." Until such time as this new department comes into being the President stated that he would "* * * continue to look to the Energy Subcommittee of the Domestic Council for leadership in analyzing and coordinating overall energy policy questions for the executive branch."

The Office of Emergency Preparedness itself has several roles to play in this overall policymaking process.

As the Director of the agency, General Lincoln is a member of the Energy Subcommittee. In addition, the Director serves as Chairman of the Oil Policy Committee created by the President in February 1970. The Director's third hat is that of Chairman of the Joint Board for Fuel Supply and Fuel Transport, created last fall by approval of the President. It should be noted that each of these functions involves interagency effort. In each case the Director's responsibilities are in the nature of policymaking or coordination or both.

OEP is also consulted by other departments and agencies on those energy matters within their direct jurisdiction whenever national security factors are involved, when questions of oil import policy are raised, or when the issue at hand may bear directly on activities of the Joint Board.

In general, I believe the present organization and method of operation of the Federal Government is adequate for providing solutions to potential shortages of fuels and energy, at least in the short run. The Joint Board on Fuel Supply and Fuel Transport has, for example, been quite successful in its roles of identifying short-term emergency fuel problems, coordinating appropriate Federal remedial actions and preparing programs to meet potential problems that may arise in the near term.

The longer term poses a different problem. As the President noted in his June 4 message, the long-run energy outlook dictates further governmental activity. One of the major actions toward this end is the President's proposed Department of Natural Resources, which will provide unified operation and administration in the field of energy.

You asked, Mr. Chairman, a number of questions regarding our future needs for energy and what might be done to meet them. I would like now to address myself to this broad question—meeting our energy needs—in the context of OEP's primary responsibility—the responsibility to look at energy in terms of national security and, particularly, in terms of the mandatory oil import program.

Proclamation 3279, under which President Eisenhower initiated the mandatory oil import program, and the controlling legislation clearly do not limit the concept of national security to current national defense requirements or to future mobilization needs. National security, in this context, relates directly to the indispensability of petroleum to our economy, our way of life and our strength as a nation. To maintain this concept of national security, there are at least four objectives for a viable oil import control program:

(1) Maintain a satisfactory level of domestic reserves of crude oil, supplemented from secure sources of foreign supply;

(2) Maintain spare capacity to produce and deliver crude oil when international factors disrupt supplies from other sources;

(3) Maintain refinery capacity in the United States adequate to meet both defense and essential civilian needs in periods of disruption of normal world oil trade; and

(4) Provide a healthy petroleum industry in the United States with the capacity to meet the Nation's defense and essential civilian needs at all times.

I should add at this point, Mr. Chairman, that the act under which the oil import program was created, specifically establishes the criterion of a healthy petroleum industry as one of the objectives of any program under that act. As you may recall, that is the Trade Agreements Expansion Act of 1962, as amended.

How do we go about meeting these objectives in today's changing world—a changing world which has carried the United States from an energy surplus Nation to an energy deficit Nation.

For many years, the United States not only was the predominant user of the world's petroleum resources, but we also produced the predominant share and held the major proved petroleum reserves of the world. We were even major exporters of oil in those days. This is no longer the case and, although those who forecast supply and demand vary in their projections, all agree that the United States will become steadily more dependent on imports of overseas oil unless a number of steps are taken—and taken soon.

It is clear that the mandatory oil import program, in effect for 12 years, is no longer alone adequate to achieve the national security we need. True energy security must be based more broadly, and our security measures must take account of all our energy resources, and not petroleum alone.

Our proved reserves of crude oil and natural gas are disappointing. The President's June 4 message announces actions to be taken by the Department of the Interior which will accelerate orderly offshore leasing. It also acknowledges the steps being taken by the Federal Power Commission to make interstate natural gas prices more competitive with other fuels.

A large sale of offshore exploration leases took place last December. That was the first substantial sale in 30 months. Experience has demonstrated that the probabilities of large-scale success are greatest on the Outer Continental Shelf and in Alaska. Since the rate of exploration in these areas is under Federal control, it is of vital concern that obstacles to development be removed at an early date. The President's action in regard to offshore leasing is a major step forward in this direction.

I am sure that this committee fully appreciates the interrelationship of crude oil and natural gas at the exploration and production level. Through the oil import program we seek to encourage a vigorous exploration and development effort in the United States. At the same time, Federal regulation of interstate natural gas sales put ceilings on gas prices which have discouraged the production of coal and domestic residual fuel oil which would ordinarily compete with natural gas for use in electric generation and for many industrial markets. The natural gas industry itself has sold large volumes of interruptible natural gas at marginal cost prices which have encouraged profligate use of this very desirable fuel in the years past. For lack of adequate supplies the natural gas industry now is obliged to cut off supplies to many of these industrial customers.

Representative WIDNALL. Mr. Chairman, may I ask a question?

Chairman PATMAN. Certainly.

Representative WIDNALL. How do you define interruptible natural gas?

Mr. BENNETT. That is defined on the basis of a contracting which the supplier agrees at a particularly low price to make gas available to large industrial users on the basis that when the supply is short, he will be the first user to be cut off from supply.

That is the terminology that is used for it, Mr. Widnall.

Representative WIDNALL. Thank you.

Mr. BENNETT. The Federal Power Commission has recognized that natural gas has not been paying its way in our domestic exploration and development effort and last summer approved a price increase for certain contracts, and others are in adjudication. This trend seems realistic. Federal Power Commission data for 1969 shows natural gas supplies 44 percent of the B.t.u.'s (British thermal units) at the wellhead in the United States, but only 25 percent of the revenue. Oil and condensates at the wellhead provide 75 percent of the revenue. To some degree, then, the pricing of natural gas has been a disincentive offsetting the incentive we have sought to achieve with the mandatory oil import program.

In our continuing evaluation of the long-term implications of last fall's crude oil price increases, we considered many of the same economic and resource factors in which your committee is interested. The status of our crude oil reserves, cost trends, investment requirements, surplus production capacity, natural gas pricing and the role

of the independent producer are all important elements in reviewing the crude oil situation in the total national energy perspective.

I realize that the committee has been compiling considerate data from the Federal agencies concerned with fuels and energy. Consequently, I have not attempted to provide that kind of information in detail today.

Nevertheless, there are some salient data which should be kept in proper perspective. The United States has on the order of half of all the low sulfur crude oil found in the world up to this time, even though our total crude oil reserves represent only a small fraction of the world's total.

I emphasize that again because of the pollution aspect. We have nearly half of the low sulfur crude oil in this country that has been found in the world to date.

This presents a challenge to develop policies that will make the best use of these resources, these very valuable and scarce resources.

Another point to be made is that we have vast known reserves of coal—far beyond those of any other single nation in the free world. Even using very conservative measures of technology limitations and economic feasibility, specialists in the Bureau of Mines have told us that the reserves of minable coal available today are the equivalent of three times the entire proved crude oil reserves of the Middle East. With advances in technology we have still further coal resources that could last for hundreds of years.

Using equally conservative assumptions concerning oil shale, we have high quality reserves—and I emphasize high quality reserves—equal to about double our present proved domestic reserves of crude oil from which commercial production could be commenced now.

In other words, a multifuel approach to energy security can still provide us with secure sources of supply of energy fuels. This, however, involves cost and we must not lose sight of the fact that to achieve a given degree of security from this broad scale approach to our total energy resources, will undoubtedly mean a pressure toward a higher cost per energy unit.

I should also comment on the importance of conservation in the use of energy. As our people insist on clean fuels, it is apparent that energy is becoming more expensive as we become more selective in our demands for fuel. If we are to bridge the transition in the next few years, our efforts should turn to informing our citizens of ways they can both reduce their own living costs and help everyone avoid energy supply shortages.

The Joint Board on Fuel Supply and Fuel Transport has taken a number of actions in this area. More will be taken on short-term conservation measures prior to this winter's peak heating season. We hope that various Government agencies will stress the need for long-range conservation measures as well.

I should at this point say we have had the utmost cooperation from the Office of Consumer Affairs, directed by Mrs. Knauer. She has put out brochures regarding public conservation in the use of electricity and heat generally.

I hope that these remarks on fuel and energy have been helpful. I would now like to refer you to Mr. Lawrence with regard to the metals, minerals, and other ores.

(The statement of Mr. Bennett follows:)

PREPARED STATEMENT OF ELMER F. BENNETT, GENERAL COUNSEL AND SPECIAL ASSISTANT (OIL AND ENERGY), OFFICE OF EMERGENCY PREPAREDNESS, BEFORE THE JOINT COMMITTEE ON DEFENSE PRODUCTION

Mr. Chairman and members of the committee, I am sorry General Lincoln cannot be here this morning. I am Elmer Bennett, General Counsel of the Office of Emergency Preparedness and Special Assistant to the Director for Oil and Energy. I will respond to those portions of your letter of September 10, 1971, which relate to your committee's interest in fuels and energy. Mr. William Lawrence, Chief, Stockpile Policy Division, Office of Emergency Preparedness, will respond to those portions which relate to the supply of metals, minerals, and ores.

Although I know, Mr. Chairman, that you and the other members of the committee are well informed regarding the responsibility of the Director of OEP in the energy field, I believe a brief review of these responsibilities will be helpful in providing a framework for my remarks this morning, particularly with respect to your questions as to how the decisionmaking process for energy resources is coordinated among the various departments and agencies which have responsibilities in these areas.

The President in his June 4 energy message urged the formation of a new Department of Natural Resources which would "* * * place responsibility for energy questions in a single agency which can execute and modify policies in a comprehensive and unified manner." Until such time as this new department comes into being, the President stated that he would "* * * continue to look to the Energy Subcommittee of the Domestic Council for leadership in analyzing and coordinating overall energy policy questions for the executive branch."

The Office of Emergency Perparedness itself has several roles to play in this overall policymaking process.

As the Director of the Agency, General Lincoln is a member of the Energy Subcommittee. In addition, the Director serves as Chairman of the Oil Policy Committee created by the President in February 1970. The Director's third hat is that of Chairman of the Joint Board for for Fuel Supply and Fuel Transport, created last fall by approval of the President. It should be noted that each of these functions involves interagency effort. In each case, the Director's responsibilities are in the nature of policymaking or coordination or both.

OEP is also consulted by other departments and agencies on those energy matters within their direct jurisdiction whenever national security factors are involved, when questions of oil import policy are raised, or when the issue at hand may bear directly on activities of the the Joint Board.

In general, I believe the present organization and method of operation of the Federal Government is adequate for providing solutions to potential shortages of fuels and energy, at least in the short run. The Joint Board on Fuel Supply and Fuel Transport has, for example, been quite successful in its roles of identifying short-term emergency fuel problems, coordinating appropriate Federal remedial actions, and preparing programs to meet potential problems that may arise in the near term.

The longer term poses a different problem. As the President noted in his June 4 message, the long-run energy outlook dictates further governmental activity. One of the major actions toward this end is the President's proposed Department of Natural Resources, which will provide unified operation and administration in the field of energy.

You asked, Mr. Chairman, a number of questions regarding our future needs for energy and what might be done to meet them. I would like now to address myself to this broad question—meeting our energy needs—in the context of OEP's primary responsibility—the responsibility to look at energy in terms of national security and, particularly, in terms of the mandatory oil import program.

Proclamation 3279, under which President Eisenhower initiated the mandatory oil import program, and the controlling legislation clearly do not limit the concept of national security to current national defense requirements or to future mobilization needs. National security, in this context, relates directly to the indispensability of petroleum to our economy, our way of life, and our strength as a Nation. To maintain this concept of national security, there are at least four objectives for a viable oil import control program:

(1) Maintain a satisfactory level of domestic reserves of crude oil, supplemented from secure sources of foreign supply;

(2) Maintain space capacity to produce and deliver crude oil when international factors disrupt supplies from other sources;

(3) Maintain refinery capacity in the United States adequate to meet both defense and essential civilian needs in periods of disruption of normal world oil trade; and

(4) Provide a healthy petroleum industry in the United States with the capacity to meet the Nation's defense and essential civilian needs at all times.

How do we go about meeting these objectives in today's changing world—a changing world which has carried the United States from an energy surplus Nation to an energy deficit Nation?

For many years, the United States not only was the predominant user of the world's petroleum resources, but we also produced the predominant share and held the major proved petroleum reserves of the world. We were even major exporters of oil in those days. This is no longer the case, and, although those who forecast supply and demand vary in their projections, all agree that the United States will become steadily more dependent on imports of overseas oil unless a number of steps are taken—and taken soon.

It is clear that the mandatory oil import program, in effect for 12 years, is no longer alone adequate to achieve the national security we need. True energy security must be based more broadly, and our security measures must take account of all our energy resources.

Our proved reserves of crude oil and natural gas are disappointing. The President's June 4 message announces actions to be taken by

the Department of the Interior which will accelerate orderly offshore leasing. It also acknowledges the steps being taken by the Federal Power Commission to make interstate natural gas prices more competitive with other fuels.

A large sale of offshore exploration leases took place last December. That was the first substantial sale in 30 months. Experience has demonstrated that the probabilities of large-scale success are greatest on the Outer Continental Shelf and in Alaska. Since the rate of exploration in these areas is under Federal control, it is of vital concern that obstacles to development be removed at an early date. The President's action in regard to offshore leasing is a major step forward in this direction.

I am sure that this committee fully appreciates the interrelationship of crude oil and natural gas at the exploration and production level. Through the oil import program we seek to encourage a vigorous exploration and development effort in the United States. At the same time, Federal regulation of interstate natural gas sales put ceilings on gas prices which have discouraged the production of coal and domestic residual fuel oil which would ordinarily compete with natural gas for use in electric generation and for many industrial markets. The natural gas industry itself has sold large volumes of interruptible natural gas at marginal cost prices which have encouraged profligate use of this very desirable fuel. For lack of adequate supplies the natural gas industry now is obliged to cut off supplies to many of these industrial customers.

The Federal Power Commission has recognized that natural gas has not been paying its way in our domestic exploration and development effort and last summer approved a price increase for certain contracts, and others are in adjudication. This trend seems realistic. Federal Power Commission data for 1969 shows natural gas supplies 44 percent of the B.t.u.'s at the wellhead in the United States, but only 25 percent of the revenue. Oil and condensates at the wellhead provide 75 percent of the revenue. To some degree, then, the pricing of natural gas has been a disincentive offsetting the incentive we have sought to achieve with the mandatory oil import program.

In our continuing evaluation of the long-term implications of last fall's crude oil price increases, we considered many of the same economic and resource factors in which your committee is interested. The status of our crude oil reserves, cost trends, investment requirements, surplus production capacity, natural gas pricing and the role of the independent producer are all important elements in reviewing the crude oil situation in the total national energy perspective.

I realize that the committee has been compiling considerable data from the Federal agencies concerned with fuels and energy. Consequently, I have not attempted to provide that kind of information in detail today.

Nevertheless, there are some salient data which should be kept in proper perspective. The United States has on the order of half of all the low sulfur crude oil found in the world up to this time, even though our total crude oil reserves represent only a small fraction of the world's total. This presents a challenge to develop policies that will make the best use of these resources.

Another point to be made is that we have vast known reserves of coal—far beyond those of any other single nation in the free world.

Even using very conservative measures of technology limitations and economic feasibility, specialists in the Bureau of Mines have told us that the reserves of minable coal available today are the equivalent of three times the entire proved crude oil reserves of the Middle East. With advances in technology we have still further coal resources that could last for hundreds of years.

Using equally conservative assumptions concerning oil shale, we have high-quality reserves equal to about double our present proved domestic reserves of crude oil from which commercial production could be commenced now.

In other words, a multifuel approach to energy security can still provide us with secure sources of supply of energy fuels.

I should also comment on the importance of conservation in the use of energy. As our people insist on clean fuels, it is apparent that energy is becoming more expensive as we become more selective in our demands for fuel. If we are to bridge the transition in the next few years, our efforts should turn to informing our citizens of ways they can both reduce their own living costs and help everyone avoid energy supply shortages.

The Joint Board on Fuel Supply and Fuel Transport has taken a number of actions in this area. More will be taken on short-term conservation measures prior to this winter's peak heating season. We hope that various Government agencies will stress the need for long-range conservation measures as well.

I hope that these remarks on fuel and energy have been helpful. I would now like to introduce Mr. Lawrence, who will discuss metals, minerals, and ores. We both stand ready to answer any questions you may have when Mr. Lawrence finishes his presentation.

Chairman PATMAN. We will be glad to hear Mr. William N. Lawrence, Chief, Stockpile Policy Division, Office of Emergency Preparedness. Mr. Lawrence, you may proceed in your own way. If you do not wish to read your entire statement, it will be carried in full in the record.

STATEMENT OF WILLIAM N. LAWRENCE, CHIEF, STOCKPILE POLICY DIVISION, OFFICE OF EMERGENCY PREPAREDNESS

Mr. LAWRENCE. The Director, Office of Emergency Preparedness, is responsible for:

(1) Advising and assisting the President in the development of policies and procedures to determine the relationship between available supplies of the Nation's resources and the requirement of military, foreign, and essential civilian programs, including those of civil defense.

(2) The development of policies, programs, and control systems designed to deal with supply deficiencies and to meet effectively the most urgent requirements for those resources in the interests of national defense.

(3) Establishing policies and procedures and directing programs for the stockpiling of strategic and critical materials.

With this background of our responsibilities and our capabilities, I will now discuss the important subjects covered in your letter, Mr. Chairman.

The first involves information relative to the future availability and requirements for metals, minerals, and ores.

This is a broad area, and some of my remarks on it will apply to other areas included in the September 10, 1971, letter.

The Director, Office of Emergency Preparedness, is charged with the responsibility for insuring that in any future national emergency period the United States has an adequate supply of materials to insure that the needs of the emergency period can be met. The two basic Public Laws which provide authorities for carrying out this responsibility are the National Stockpiling Act and the Defense Production Act of 1950, as amended.

In accordance with the provisions of the first act, we are stockpiling sufficient quantities of those materials which have been designated as strategic and critical materials to meet requirements for approved military plans and essential civilian requirements in a possible emergency period that may develop in the next 3 years.

In evaluating the possible requirements for, and the supply of these strategic and critical materials in a future emergency period, we have developed a sophisticated system which utilizes data on past usages of materials; forecasts of the future growth in the gross National Product and interindustry economics to forecast the future situation on metals, minerals, and ores. We believe that these techniques present a new and valuable method for assessing the future situation relative to material resources. Currently, our supply and requirements forecasts cover steel, copper, and aluminum, by form and shape, and the materials which have been designated as strategic and critical. They extend only for 5 years into the future, with the first 2 years being peacetime years and the last 3 a wartime period. Normally, we look to the Departments of the Interior and Commerce to provide us with long-range supply and requirements estimates. We hope to participate in the resource studies to be made by the National Commission on Materials Policy which the Congress authorized in Public Law 91–512. The Director, OEP, has informed the Departments of the Interior and Commerce that OEP is ready to support the Commission in carrying out its assigned functions. This offer includes not only the economic modeling techniques we have developed, but also the use of our computer programers, our modern computer facilities, and our professional experts in the material field.

Second, you requested our views of the dependence of the United States on foreign sources of supply for metals, minerals, and ores.

At present, it appears that the United States will, in the future, become increasingly dependent on foreign sources for its supply of certain raw materials. This conclusion is based on various facts or forecasts.

a. The United States has never had an adequate supply of certain raw materials such as tin, nickel, and chromium.

b. Most of the sources of high grade ores in the United States have already been located and developed. Low grade ore deposits in the United States cannot be economically used when high grade deposits with low labor costs are available to U.S. companies from foreign countries.

c. Because of the profitability of exploiting high grade ores in foreign areas at low costs, U.S. companies are reluctant to invest in explorations in the United States which may result in locating low grade ores which can be developed only at uneconomic costs.

d. Foreign countries are becoming increasingly aware of the potential benefits to them of having basic raw materials upgraded in their country. They are no longer content with exporting basic raw materials. They are exploiting the financial and employment gains achievable by processing raw materials to higher stages—bauxite to alumina, raw copper to refined copper or to copper shapes, et cetera.

These trends will not only affect the imports of raw materials into the United States, but also will decrease the capabilities of U.S. industries involved in the conversion of ores to metals and metals into the forms and shapes needed to produce end items.

Third, you requested our views as to the extent to which the future needs of the United States for metals, minerals, and ores can be met by the recycling of used materials.

OEP has begun to study the possibilities of increased utilization of scrap and waste materials as a means of decreasing our dependency on foreign suppliers, and thus reduce the need for stockpiling many of the materials. This work is being done in conjunction with input-output and econometric studies developed in OEP which are used to forecast the demand for the essential materials in each sector of the economy.

We are also studying the apparent reserves of materials available for recycling as raw materials and the feasibility of using these reserves under emergency conditions. Data on these reserves are not readily available. Inadequate knowledge also exists as to the costs of converting these materials to a form for reuse.

Recycling cannot meet the total metallic needs of this Nation. While it is difficult to state categorically to what extent recycling will meet our metallic requirements, there is information readily available on one element of this total area: iron and steel scrap. At the present time, only about 34–36 million tons of this material are recycled annually back to the steel mills and foundries of the Nation. It is reliably estimated that the inventory of iron and steel scrap available for recycling approximates 750 million tons, and that this inventory is being added to annually. Taking steel production only into account, at a level of say 140 million tons annually, it can be seen that the inventory would last an estimated 5 years. It is the presence of this material incidentially—best exemplified by the junked car—which has prompted much of the discussion about recycling, especially in the field of metallics, our most critical area.

It is this same industry, incidentally, which is largely responsible for recycling most of the estimated 3 million tons of nonferrous metals recycled annually. These areas are perhaps even more critical than iron and steel scrap. The five most important nonferrous metals recycled, excluding gold and silver, are aluminum, copper, lead, nickel, and zinc. About 20 percent of the total market for aluminum comes from secondary sources; in the case of copper, this figure is 35 percent. An estimated 45 percent of our lead used annually is recycled material, while 20 percent of the zinc comes from secondary sources.

Concentration here has been on recycling of metallics rather than the nonmetallics, because these, such as paper, or glass, come from resources which are basically not as critical as the metals. The emphasis on paper recycling, for example, comes from those concerned about sanitary landfill problems, as well as those who see more trees

being cut down to meet paper needs. But in actual fact, trees for paper can be grown readily and are being grown today. Sand, the major constitutent in glass, might be said to be as limitless as the sands of the ocean. Here, the recycling emphasis has come largely from those who are concerned, not with the raw material source, but with the cluttering of the landscape with old glass bottles, et cetera.

There are roadblocks to greater recycling of all secondary metals, but the one area with the greatest problem is iron and steel scrap, where freight rates, restrictive legislation of a local nature, steelmaking technology, and other factors serve to retard greater recycling. For all metals, there is obviously the greater competitive advantage available to mining of new metals through depletion allowances which are not available to the secondary metals industry.

Lack of recycling of metallics will eventually cause serious land pollution problems, as well as the increased reliance on foreign sources for our metallics. To the extent that metals can be recycled, demand on our primary sources could be reduced.

We know that the United States must begin to improve its use of scrap and discarded materials as a substitute for natural resources. We are hesitant, however, to propose plans or incentives to improve scrap recycling, and in turn adversely affect raw material producers to the extent that the potential of these sources is greatly reduced. We also want to make sure that the price paid for materials is not raised by an amount that will adversely affect our economy. Our initial studies, for instance, have shown that scrap prices would have to be raised by a substantial amount in order to have any effect on the amount that is available for recycling today. This, in turn, would raise the total price of raw materials and could adversely affect our economy. I point this out only to show that we must not implement programs without careful study.

Fourth, you requested our opinion as to whether current governmental policies will assure the United States an adequate supply of raw materials and the means for purchasing materials for which the United States is currently dependent on foreign sources.

We believe that current policies are directed primarily toward maintaining and developing domestic sources for raw materials. For example, the Mining and Minerals Policy Act of 1970 (Public Law 91–631) deals only with domestic sources. Inadequate attention has been given to the long-range availability to the United States of ores, minerals, and metals from foreign sources and to the activities beign taken by other countries, such as Japan, to assure themselves of an adequate supply of raw materials for the next 10 or 20 years. This, of course, is one of the major problem areas that the National Commission on Materials Policy will look into.

Next, you requested our opinion on the current status of requirements and availability of raw materials. At present, because of the worldwide slowdown in industries, adequate supplies exist, except in some cases, for all metals and minerals. For example, there is a serious oversupply situation in the aluminum and nickel industries. Copper is in abundant supply, with the London Metal Exchange price running 4 cents to 6 cents per pound below the U.S. price. Shortages exist for some metals or minerals such as fluorspar, and to some extent for chrome ore.

We see no major problems in the near future, but believe that some will develop during the late 1980's, and for some metals and minerals a critical shortage may develop in the 1990's. I have already mentioned the long-range contracts for raw materials being made by some countries which will deny certain sources to the United States. Although new sources may be located, it is estimated, as representatives of the Bureau of Mines have already advised you, that there will be a large increase in the world's requirements for raw materials. This will result from large population increases and increases in the per capita use.

Finally, you requested any recommendations we might have for any changes required to meet U.S. needs for raw materials in the years ahead.

Insofar as domestic sources are concerned, we believe that the objectives stated in the Mining and Minerals Policy Act of 1970, if vigorously pursued, will be of major assistance in increasing future supplies of minerals and metals. We would, however, caution against the rapid imposition of strict antipollution measures to mines, smelters, and refineries. Because of the large costs involved and technological problems, a gradual approach may be necessary.

Currently, there is almost a complete lack of policy with regard to the obtaining of supplies from foreign sources. Since we must rely on foreign sources for raw materials that we do not have or have only in limited quantity, we should adopt policies that will assist U.S. companies to obtain these materials. We also should, if necessary, provide exemptions from general trade regulations or capital flow restrictions if they act to hinder access to these foreign raw materials. There are other problems associated with the development of foreign sources, such as expropriation or nationalization of mines and facilities.

Turning to an area where we have primary responsibility, I would like to suggest that the Congress take action on the proposed amendments to the Defense Production Act which were submitted by the administration to the Congress in January. Programs undertaken since 1950 under this act have resulted in increases in the domestic supply of various materials.

Currently, we are unable to use funds under this act for two reasons:

(1) The funds are almost exhausted.

(2) The 1964 amendments to the act restricted new contracts to $100 million. We have already used about $86 million of this limitation. This was for the Duval Copper Mine.

The proposed amendments would provide for new financing and the removal of the new contract limitation.

Thank you very much, Mr. Chairman.

Chairman PATMAN. Thank you very kindly.

Mr. Bennett, I believe you mentioned about the message of the President June 4?

Mr. BENNETT. Yes.

Chairman PATMAN. Was that the message in which it was mentioned something about exports and it would probably be necessary to cooperate—I don't know that the President mentioned this particular concern—but I refer to what is known as the Domestic International Sales Co. Do you know about that?

Mr. BENNETT. I know something about that. However, that is not the message I had in mind. I was referring to the energy message of June.

Chairman PATMAN. The energy message?

Mr. BENNETT. Yes of June.

Chairman PATMAN. Did he have a message on what I just mentioned about a concern for exports only, including tax deferrals, if necessary, and things like that?

Mr. BENNETT. That was part of his recommendation in connection with the import surcharge and the other steps that he recently took on August 15, I think, Mr. Chairman.

Chairman PATMAN. Would you furnish me, personally, the information you have on that, if you will, please?

Mr. BENNETT. Yes, I will.

Chairman PATMAN. Without reference to the record, and if we think it is important to put in the record, we will.

Mr. BENNETT. All right.

Chairman PATMAN. We appreciate very much the testimony of you gentlemen.

Mr. Brown, would you like to comment before we excuse them?

We have another witness this morning with the Chemical Association.

Representative BROWN. Just one question, if I may, briefly.

You specifically singled out the impact of depletion allowances as having a disadvantageous effect upon the development of secondary sources of metal. Do you want to expand upon that?

Do you want to suggest any corrective measures?

Mr. BENNETT. I believe you mean in connection with our answers to the committee's questions; is that right?

Representative BROWN. Yes.

Mr. BENNETT. What we had commented on in that regard stems back to the study we made of the crude oil price increase of last fall, last November——

Representative BROWN. Your comment to which I referred related to metals, rather than oil, your comment here.

Mr. BENNETT. Oh. Mr. Lawrence, I think, might want to deal with that.

Representative BROWN. Yes, it was Mr. Lawrence's statement, excuse me.

You say for all metals there is obviously a competitive advantage available to mining of new metals because of depletion allowances, which are not available to the secondary metals industry.

Mr. LAWRENCE. That is right. All mining has ability to write off a depletion allowance as they mine ores and minerals. The secondary recovery by the scrap people does not have such an allowance, and therefore, they do not have the ability to make the profits that direct mining would.

Representative BROWN. I have for some time advocated, especially in the paper industry, that some price incentive be provided those industries that are engaged in recycling.

Mr. LAWRENCE. You think this would be to an advantage? I think it would increase the supply to some extent. Although, as I say later in my statement, we have made a study as to the availability of copper scrap. We have not had time to proceed in other directions but

we find that an increase in copper scrap will not increase the supply by any substantial amount, unless you get the price of copper scrap up beyond the prices of new copper.

I do not think—some kind of incentive has got to be there—but I would not want to recommend this morning what type of incentive it would be.

Representative BROWN. Even though there is a present failure to utilize this basic source of metal, is it, in effect, being stockpiled through failure to use?

Mr. LAWRENCE. Certainly we are stockpiling iron and steel scrap all over the country. This points the inability of the steel industry to consume scrap because of changes in methods of steel-making. I think it is something that we are going to have to work out some solution to. Because we could utilize more iron and steel scrap and, of course, this would save on the importation of iron ore, and all the allied materials that go with it.

Representative BROWN. Are we stockpiling the basic raw copper at the present time?

Mr. LAWRENCE. That is right.

Representative BROWN. Is it feasible for the Government in connection with its provision for its own stockpile, to utilize secondary sources?

Mr. LAWRENCE. Stockpiling what?

Representative BROWN. Is it feasible for the Government to utilize secondary sources in its own stockpiling programs?

Mr. LAWRENCE. I don't know that. Most of the things we have in the stockpile have rather rigid specifications on them in order to meet the uses of industry. If we went in another direction, I don't know exactly how we would proceed.

Representative BROWN. Thank you very much.

Thank you, Mr. Chairman.

Representative PATMAN. Thank you very much, gentlemen.

We will be calling on you in the future.

(Statement of William N. Lawrence, and questions and answers:)

STATEMENT OF WILLIAM N. LAWRENCE, CHIEF, STOCKPILE POLICY DIVISION, OFFICE OF EMERGENCY PREPAREDNESS, BEFORE THE JOINT COMMITTEE ON DEFENSE PRODUCTION, SEPTEMBER 22, 1971

Mr. Chairman and members of the committee: I am William N. Lawrence, Chief, Stockpile Policy Division, Office of Emergency Preparedness, and am here today to respond to those portions of your letter of September 10, 1971, which relate to your committee's interest in the availability and supply of metals, minerals, and ores to meet the needs of the United States in the future.

Mr. Chairman, although you and the members of the committee are well aware of the responsibilities assigned to the Director of the Office of Emergency Preparedness relative to the availability of metals, minerals, and ores to meet the needs of the United States in any possible future national emergency, I believe that a brief statement of these responsibilities should be included in the record in order that my responses to your request are placed in proper context.

The Director, Office of Emergency Preparedness, is responsible for:

(1) Advising and assisting the President in the development of

policies and procedures to determine the relationship between available supplies of the Nation's resources and the requirements of military, foreign, and essential civilian programs, including those of civil defense.

(2) The development of policies, programs, and control systems designed to deal with supply deficiencies and to meet effectively the most urgent requirements for those resources in the interests of national defense.

(3) Establishing policies and procedures and directing programs for the stockpiling of strategic and critical materials.

Our responses to your request for information on policies and programs relative to the United States' position on metals, minerals, and ores must be weighed against these assigned responsibilities. Also, because of the additional responsibilities assigned to the Director of the Office of Emergency Preparedness relative to the emergency problems of the Nation and the recently imposed freeze on wages and prices, the manpower resources assigned to the problems on metals, minerals, and ores are extremely limited.

With this background of our responsibilities and our capabilities, I will now discuss the important subjects covered in your letter, Mr. Chairman.

The first involves information relative to the future availability and requirements for metals, minerals, and ores.

This is a broad area, and some of my remarks on it will apply to other areas included in the September 10, 1971, letter.

The Director, Office of Emergency Preparedness, is charged with the responsibility for insuring that in any future national emergency period the United States has an adequate supply of materials to insure that the needs of the emergency period can be met. The two basic public laws which provide authorities for carrying out this responsibility are the National Stock Piling Act and the Defense Production Act of 1950, as amended.

In accordance with the provisions of the first act, we are stockpiling sufficient quantities of those materials which have been designated as strategic and critical materials to meet requirements for approved military plans and essential civilian requirements in a possible emergency period that may develop in the next 3 years.

In evaluating the possible requirements for, and the supply of, these strategic and critical materials in a future emergency period, we have developed a sophisticated system which utilizes data on past usages of materials; forecasts of the future growth in the gross national product and interindustry economics to forecast the future situation on metals, minerals, and ores. We believe that these techniques present a new and valuable method for assessing the future situation relative to material resources. Currently, our supply and requirements forecasts cover steel, copper, and aluminum, by form and shape, and the materials which have been designated as strategic and critical.

They extend only for 5 years into the future, with the first 2 years being peacetime years and the last three a wartime period. Normally, we look to the Departments of the Interior and Commerce to provide us with long-range supply and requirements estimates. We hope to participate in the resource studies to be made by the National Commission on Materials Policy which the Congress authorized in Public Law 91-512. The Director, OEP, has informed the Departments of the

Interior and Commerce that OEP is ready to support the Commission in carrying out its assigned functions. This offer includes not only the economic modeling techniques we have developed, but also the use of our computer programers, our modern computer facilities, and our professional experts in the material field.

Second, you requested our views of the dependence of the United States on foreign sources of supply for metals, minerals, and ores.

At present, it appears that the United States will, in the future, become increasingly dependent on foreign sources for its supply of certain raw materials. This conclusion is based on various facts or forecasts.

(*a*) The United States has never had an adequate supply of certain raw materials such as tin, nickel, and chromium.

(*b*) Most of the sources of high grade ores in the United States have already been located and developed. Low grade ore deposits in the United States can not be economically used when high grade deposits with low labor costs are available to U.S. companies from foreign countries.

(*c*) Because of the profitability of exploiting high grade ores in foreign areas at low costs, U.S. companies are reluctant to invest in explorations in the United States which may result in locating low grade ores which can be developed only at uneconomic costs.

(*d*) Foreign countries are becoming increasingly aware of the potential benefits to them of having basic raw materials upgraded in their country. They are no longer content with exporting basic raw materials. They are exploiting the financial and employment gains achievable by processing raw materials to higher stages: Bauxite to alumina, raw copper to refined copper or to copper shapes, and so forth.

These trends will not only affect the imports of raw materials into the United States, but also will decrease the capabilities of U.S. industries involved in the conversion of ores to metals and metals into the forms and shapes needed to produce end items.

Third, you requested our views as to the extent to which the future needs of the United States for metals, minerals, and ores can be met by the recycling of used materials.

OEP has begun to study the possibilities of increased utilization of scrap and waste materials as a means of decreasing our dependency on foreign suppliers, and thus reduce the need for stockpiling many of the materials. This work is being done in conjunction with input-output and econometric studies developed in OEP, which are used to forecast the demand for the essential materials in each sector of the economy.

We are also studying the apparent reserves of materials available for recycling as raw materials and the feasibility of using these reserves under emergency conditions. Data on these reserves are not readily available. Inadequate knowledge also exists as to the costs of converting these materials to a form for reuse.

Recycling cannot meet the total metallic needs of this Nation. While it is difficult to state categorically to what extent recycling will meet our metallic requirements, there is information readily available on one element of this total area: Iron and steel scrap. At the present time, only about 34 to 36 million tons of this material are recycled annually back to the steelmills and foundries of the Nation. It is reliably estimated that the inventory of iron and steel scrap available for recycling approximates 750 million tons, and that this inventory

is being added to annually. Taking steel production only into account, at a level of, say, 140 million tons annually, it can be seen that the inventory would last an estimated 5 years. It is the presence of this material, incidentally—best exemplified by the junked car—which has prompted much of the discussion about recycling, expecially in the field of metallics, our most critical area.

It is this same industry, incidentally, which is largely responsible for recycling most of the estimated 3 million tons of nonferrous metals recycled annually. These areas are perhaps even more critical than iron and steel scrap. The five most important nonferrous metals recycled, excluding gold and silver, are aluminum, copper, lead, nickel and zinc. About 20 percent of the total market for aluminum comes from secondary sources; in the case of copper, this figure is 35 percent. An estimate l 45 percent of our lead used annually is recycled material, while 20 percent of the zinc comes from secondary sources.

Concentration here has been on recycling of metallics, rather than the nonmetallics, because these, such as paper or glass, come from resources which are basically not as critical as the metals. The emphasis on paper recycling, for example, comes from those concerned about sanitary landfill problems, as well as those who see more trees being cut down to meet paper needs. But in actual fact, trees for paper can be grown readily and are being done today. Sand, the major constituent in glass, might be said to be as limitless as the sands of the ocean. Here, the recycling emphasis has come largely from those who are concerned, not with the raw material source, but with the cluttering of the landscape with old glass bottles and so forth.

There are roadblocks to greater recycling of all secondary metals, but the one area with the greatest problem is iron and steel scrap, where freight rates, restrictive legislation of a local nature, steelmaking technology, and other factors serve to retard greater recycling. For all metals, there is obviously the greater competitive advantage available to mining of new metals through depletion allowances which are not available to the secondary metals industry.

Lack of recycling of metallics will eventually cause serious land pollution problems, as well as the increased reliance on foreign sources for our metallics. To the extent that metals can be recycled, demand on our primary sources could be reduced.

We know that the United States must begin to improve its use of scrap and discarded materials as a substitute for natural resources. We are hesitant, however, to propose plans or incentives to improve scrap recycling, and in turn adversely affect raw material producers to the extent that the potential of these sources is greatly reduced. We also want to make sure that the price paid for materials is not raised by an amount that will adversely affect our economy. Our initial studies, for instance, have shown that scrap prices would have to be raised by a substantial amount in order to have any effect on the amount that is available for recycling today.

This, in turn, would raise the total price of raw materials and could adversely affect our economy. I point this out only to show that we must not implement programs without careful study.

Fourthly, you requested our opinion as to whether current Governmental policies will assure the United States an adequate supply of raw materials and the means for purchasing materials for which the United States is currently dependent on foreign sources.

We believe that current policies are directed primarily towards maintaining and developing domestic sources for raw materials. For example, the Mining and Minerals Policy Act of 1970 (Public Law 91–631) deals only with domestic sources. Inadequate attention has been given to the long range availability to the United States of ores, minerals, and metals from foreign sources and to the activities being taken by other countries, such as Japan, to assure themselves of an adequate supply of raw materials for the next 10 to 20 years. This, of course, is one of the major problem areas that the National Commission on Materials Policy will look into.

Next, you requested our opinion on the current status of requirements and availability of raw materials. At present, because of the worldwide slowdown in industries, adequate supplies exist, except in some cases, for all metals and minerals. For example, there is a serious oversupply situation in the aluminum and nickel industries. Copper is in abundant supply, with the London Metal Exchange price running 4 to 6 cents per pound below the U.S. price. Shortages exist for some metals or minerals such as fluorspar, and to some extent for chrome ore.

We see no major problems in the near future, but believe that some will develop during the late 1980's, and for some metals and minerals a critical shortage may develop in the 1990's. I have already mentioned the long range contracts for raw materials being made by some countries which will deny certain sources to the United States. Although new sources may be located, it is estimated, as representatives of the Bureau of Mines have already advised you, that there will be a large increase in the world's requirements for raw materials. This will result from large population increases and increases in the per capita use.

Finally, you requested any recommendations we might have for any changes required to meet U.S. needs for raw materials in the years ahead.

Insofar as domestic sources are concerned, we believe that the objectives stated in the Mining and Minerals Policy Act of 1970, if vigorously pursued, will be of major assistance in increasing future supplies of minerals and metals. We would, however, caution against the rapid imposition of strict antipollution measures to mines, smelters, and refineries. Because of the large costs involved and technological problems, a gradual approach may be necessary.

Currently, there is almost a complete lack of policy with regard to the obtaining of supplies from foreign sources. Since we must rely on foreign sources for raw materials that we do not have or have only in limited quantity, we should adopt policies that will assist U.S. companies to obtain these materials. We also should, if necessary, provide exemptions from general trade regulations or capital flow restrictions if they act to hinder access to these foreign raw materials. There are other problems associated with the development of foreign sources, such as expropriation or nationalization of mines and facilities.

Turning to an area where we have primary responsibility, I would like to suggest that the Congress take action on the proposed amendments to the Defense Production Act which were submitted by the administration to the Congress in January. Programs undertaken since 1950 under this act have resulted in increases in the domestic supply of various materials.

Currently, we are unable to use funds under this act for two reasons:

(1) The funds are almost exhausted.

(2) The 1964 amendments to the act restricted new contracts to $100 million. We have already used about $86 million of this limitation. The proposed amendments would provide for new financing and the removal of the new contract limitation.

Chairman Patman submitted additional questions to General George A. Lincoln, Director of the Office of Emergency Preparedness. Answers to these questions were submitted for inclusion in the record of the hearing by General Lincoln. The questions and answers are as follows:

QUESTIONS AND ANSWERS

Question 1. The Department of the Interior states that the United States is becoming more and more dependent on foreign sources for minerals and metals (including ores), and forecasts indicate that there will be even greater dependence in future years. Do you agree with this assessment?

General LINCOLN. It is difficult to generalize as to variations in our degree of dependence upon foreign sources of supply for all metals and ores. For example, in the early days of World War II, the United States was almost entirely dependent upon foreign sources for uranium. Today, the United States has a current excess supply of uranium, although it will be necessary to find additional supplies in the future. Domestic mine production of copper has gradually increased over the 20-year period while demand, too, has gradually increased. Zinc data show domestic mine production of zinc has held relatively uniform over the 20-year period while demand has increased. Thus, domestic mine production of the zinc supplies proportionately less of total U.S. demand. In contrast, domestic mine production of lead declined rather steadily from 1950 to about 1964. Since then, domestic mine production of lead has increased steadily as new mines, mainly in Missouri, have opened. Meanwhile, demand for lead has not increased over the 20-year period to the degree that occurred in the case of zinc. Consequently, the proportionate share of the U.S. demand for lead supplied by domestic mines has recently increased.

Domestic bauxite mines have produced bauxite at about a uniform rate over the last 20 years while demand for aluminous materials has greatly increased. Consequently, the proportionate contribution of U.S. bauxite mines to U.S. demand has declined steadily.

Of course, the United States is the No. 1 producer of aluminum metal, using a combination of domestic ores, imported ores, and imported alumina (an intermediate between bauxite and aluminum). For some materials, such as manganese, chrome, and primary tin, the the United States has always relied almost wholly on imports. Comparing value of the United States primary mineral production and demand in 1969 with projected value in the year 2000, Interior data show that there will be increasing dependence on foreign sources of supply for many metals and ores in coming years. This appears to be a valid forecast.

Question 2. Will foreign sources likely become less accessible to the United States because foreign consumption is increasing at a rate greater than that of the United States?

General LINCOLN. Not necessarily. It would depend on the rates of production in foreign countries, the ownership of the foreign sources,

et cetera. The United States is one of the primary markets for the world's metals and minerals.

Question 3. What effect will increased dependence on foreign sources have on the quantity of materials to be carried in the national stockpile?

General LINCOLN. The quantity of materials in the stockpile is governed by the guidance OEP receives from the National Security Council as to the size and type of emergency we need to be prepared to meet. Increased dependence on foreign sources in peacetime would not affect the stockpile objectives because the availability of materials from dependable foreign sources in wartime is included in estimates of the potential supply. The dependence placed on these sources is based on guidance received from the Joint Chiefs of Staff and the Department of State. The effect of increased dependence on foreign sources on the stockpile will be determined by where the sources are located.

Question 4. What consideration is given to the requirements of the civilian economy in arriving at the quantities of materials carried in the national stockpile?

General LINCOLN. Full consideration is given to essential civilian requirements, including nondefense industry, as well as direct military requirements in time of emergency.

Question 5. Is a specific formula used in arriving at quantities of materials which must be available to the civilian economy while providing for military requirements?

General LINCOLN. Civilian-industrial requirements are determined by projecting the actual consumption rate in a specific base period against an estimated GNP for the emergency period. Factors of conservation and substitutability are used, where applicable, in modifying such requirements.

Question 6. Would you set forth the rules and regulations which are followed in making determinations covering the quantities of materials to be carried in the national stockpile?

General LINCOLN. (1) three-year emergency period.

(2) Objectives represent shortfall of requirements as related to supply for the emergency period.

(3) Supply includes domestic and friendly foreign sources (factored for reliability, accessibility, and transportation discounts).

Requirements are calculated by using actual consumption during a historical base and projecting on the basis of an input-output model using an estimated GNP and other factors. Conservation and substitutability considerations are applied to the greatest degree possible, where applicable.

(4) Recommendations on reliability, accessibility, and transportation are made by the Departments of Defense and State. Conservation and substitutability recommendations are made by the Departments of Commerce and the Interior, the Atomic Energy Commission, and others.

Question 7. Would you set forth the exceptions to the rules and regulations covering the quantities of materials to be carried in the national stockpile?

General LINCOLN. There are no exceptions except where excesses declared for disposal consideration are carried in stockpile inventory until legislation is approved and actual disposal is made.

Question 8. When shortages of strategic and critical materials are indicated, what is the responsibility of the Office of Emergency Preparedness for avoiding such shortages?

General LINCOLN. The Office of Emergency Preparedness maintains constant surveillance of stockpile supply-requirements positions to determine areas of possible shortages. In event of shortages (objective deficits), steps are taken to fulfill objectives as expeditiously as possible by cash procurement, surplus transfers, or exchange for other surplus materials. If indicated shortages are likely to occur because of deficiencies in domestic production or processing, provisions may be made to aid in correcting the deficiencies by use of Government contracts (use of DPA funds and other) for increasing production and developing greater production, thereby enabling fulfillment of objectives and maintenance of the mobilization base.

Question 9. How do you interpret your responsibility as between defense requirements and nondefense requirements for strategic and critical materials?

General LINCOLN. Determinations of stockpile objectives are made on the basis of both defense and nondefense needs. Although a considerable part of the stockpile materials would go into defense needs in an extensive wartime emergency, the nondefense (civilian) sector would also be provided for by stockpile plans.

Question 10. How do you interpret your responsibility as between domestic sources and foreign sources of strategic and critical materials?

General LINCOLN. OEP's responsibility is to maintain a mobilization base (that is, stockpile inventory plus domestic productive processing capacity) in all materials for which there are stockpile objectives. If there is not ample production or processing capability but there are sufficient domestic resources, it is incumbent on OEP to assure retention of the mobilization base by use of incentives in the form of development and expansion contracts. Where the United States has a paucity in strategic and critical materials, and hence must rely on imports for all, or the substantial part of, its supply, it is incumbent on stockpile management to fulfill deficits from foreign sources.

Question 11. The Assistant Secretary of the Interior for Mineral Resources, in testifying before this committee, made reference to the many fragmented policies that are in effect today and administered by numerous agencies of the Government. Are current policies adequate for providing solutions to the indicated shortages of strategic and critical materials now being forecast for future years?

General LINCOLN: The National Materials Policy Act of 1970 (Public Law 91–512, October 26, 1970) and the Mining and Minerals Policy Act of 1970 (Public Law 91–631, December 31, 1970) require reports to the Congress concerning supplies and uses of materials, together with recommendations necessary for meeting the needs of the years ahead. Any critique of the inadequacies of present policies and programs (noted by studies and recommendations in following this legislation) should also indicate solutions for overcoming such inadequacies.

Question 12. What future period do you consider most critical in terms of an imbalance in the supply and demand for materials?

General LINCOLN. Given a continuation of the rapid industrial development and increasing consumer demands in various countries (especially in Japan and in some of the underdeveloped nations), it appears that the most critical period will be in the last 20 years of this century. The imbalance will possibly be critical in the 1990's.

Question 13. Does the Export-Import Bank consult with the Office of Emergency Preparedness when loans and guarantees are made for financing the production of metals and minerals in foreign countries?

General LINCOLN. The Export-Import Bank does not currently consult with OEP when it is making loans and guarantees for financing the production of metals and minerals in foreign countries. However, OEP is aware of these programs through public announcements in newspapers and trade journals and by perusal of published congressional hearings.

Question 14. Has the Agency for International Development, or the Overseas Private Investment Corporation, consulted with the Office of Emergency Preparedness when making loans and guaranteeing loans for the production of metals and minerals in foreign countries?

General LINCOLN. Neither the Agency for International Development nor the Overseas Private Investment Corporation consult with OEP. Information on these programs is obtained from newspapers, trade periodicals, press releases, and published reports.

Question 15. Does the Office of Emergency Preparedness maintain records of long-term contracts for metals and minerals signed by other nations, such as Japan, including foreign and domestic sources?

General LINCOLN. OEP does not maintain records on these long-term contracts. Necessary information on them is obtained from newspapers and trade periodicals.

Question 16. Do you have a list of materials which are most likely to present shortage problems in the next 10 years?

General LINCOLN. OEP maintains a continuing surveillance over those materials that have been designated as strategic and critical and over other materials that may qualify for such a designation. OEP relies on analyses made by the Departments of Commerce and the Interior and contract studies with the National Academy of Sciences to indicate future probable shortages.

With the exception of metallurgical fluorspar, OEP does not foresee any major shortages of strategic or critical materials in the next 10 years—1970–80 A.D.

Question 17. On the basis of the forecasts of shortages in supply for strategic and critical materials, is the current exploration program adequate?

General LINCOLN. Given current NSC guidance, OEP considers the current Government-supported exploration programs to be inadequate to meet the future needs for strategic and critical materials in the period 1980–2000 A.D. Also, because of the decreasing grade of newly discovered domestic mineral sources, U.S. companies tend to explore for minerals in foreign countries where the potential for locating high-grade ores is higher and operating costs are often less.

Question 18. Should exploration be carried out by this country in foreign countries?

General LINCOLN. This question is interpreted to mean should the Government carry out foreign exploration. OEP considers that the Government should assist in selective exploration, as it is doing, through agencies such as the Export-Import Bank, the Agency for International Development, and guarantees by the Overseas Private Investment Corporation of U.S. investments. OEP believes that overseas investment in foreign minerals and mining projects by U.S. companies is adequate to meet our future needs for primary metals and minerals.

Question 19. The National Academy of Sciences made a report in 1969, which indicated there had been a decline in fundamental research and education in the mineral field in the United States. There appears to have been little, if any, improvement since 1969. Can you tell us why such a low priority is being placed on mineral science and technology?

General LINCOLN. OEP feels that the low priority which has been placed on mineral science and technology by U.S. colleges and universities is due to a lack of interest by the oncoming generations in the metals and mining fields. Jobs in these areas do not possess the glamor or compensation necessary to attract students.

Insufficient funds may also have been a contributing factor to this decline. However, recent amendments to the Mining and Minerals Act of 1970, which have been passed by the U.S. Senate, but not by the House of Representatives, should provide the necessary funds to eliminate any financial problems.

Question 20. As the demand for materials increases, and our dependence on foreign sources increases, will industries be able to acquire materials to meet their needs for nondefense purposes without carrying additional inventories?

General LINCOLN. To the extent that industries rely on foreign sources for their raw materials, they will have to maintain larger inventories than would be needed if the materials were available from domestic sources. The amount will be dependent on the location of the foreign source, transportation problems, costs, and other factors.

Question 21. Will improved technology lower the cost and increase the available supply of marginal and submarginal resources?

General LINCOLN. The history of the mining and metallurgical industry in the United States indicates that this has been true in the past. There is, however, little incentive for U.S. companies to invest in such improved processes if high-grade materials are readily available from foreign sources. It is considered that the Government should, as it now does to some extent, engage directly in the development of such processes or assist industry in doing so.

Question 22. Since the United States is now importing about $8.4 billion more in metals and minerals than is being produced in metals and minerals, what will be the solution to the trade balance problem for metals and minerals?

General LINCOLN. There is no ready solution to the problem of metals and minerals imports exceeding exports because the United States is deficient in a considerable number of metals and minerals, and these imports are vital for U.S. industry.

The answer lies in increasing exports of finished products, for example, the United States must import almost all of its nickel supplies; but it exports the nickel in the finished form of a jet aircraft. Sizable increases in finished products exports would help achieve a favorable trade balance.

Question 23. Would you indicate whether the Department of Defense has made improvements in its methods for making determinations for the military requirements for strategic and critical materials?

General LINCOLN. The Department of Defense is carrying out a major reorientation of its industrial preparedness programs. OEP and the Department of Commerce are participating in this effort. When completed, this will provide an improvement in methods for determining requirements.

It should be noted that because of the scope of military mobilization plans and the increased usage in the United States of most strategic and critical materials, the percentage of the available supply that would be needed for military programs in a future emergency will be less than the percentage required in World War II and in subsequent military actions.

Question 24. What is the responsibility of the Office of Emergency Preparedness for fuels and energy?

General LINCOLN. The Director of the Office of Emergency Preparedness has five principal roles within the overall body of Federal energy policy formulation and implementation—responsibility for policy direction, coordination, and surveillance of the oil import program; chairman of the Oil Policy Committee; chairman of the Joint Board on Fuel Supply and Fuel Transport; member, Domestic Council Subcommittee on the National Energy Situation; and member of the National Security Council. In time of war, the Director of OEP has direct responsibilities for the mobilization of resources, including energy resources.

Question 25. Would you outline the responsibility of the departments and agencies which report to the Office of Emergency Preparedness for fuels and energy?

General LINCOLN. There are no departments or agencies which "report" to the Office of Emergency Preparedness for fuels and energy except through the medium of formal interdepartmental committees. The Oil Policy Committee provides advice on oil policy matters. The committee is chaired by the Director of OEP. Members include the Secretaries of State, the Treasury, Defense, the Interior, and Commerce, the Attorney General, and the Chairman of the Council of Economic Advisers. The committee is assisted by a working group consisting of key members of the agencies represented on the committee and headed by the OEP representative. The Joint Board on Fuel Supply and Fuel Transport has concerned itself with short-term situations, identifying emergency problems in fuel and supply and fuel transport and coordinating appropriate remedial actions by responsible Federal agencies. The Board is chaired by the Director of OEP. Members include the Secretaries of the Interior and Commerce and the Chairmen of the Council of Economic Advisers, the Council on Environmental Quality, the Interstate Commerce Commission, and the Federal Power Commission. Others are invited to participate as appropriate. This Board is also assisted by a Working Group headed by the OEP representative and consisting of representatives of agencies concerned with the particular problems under consideration.

Question 26. Is the organizational structure of the Government, as it relates to fuels and energy, adequate for providing solutions to potential shortages of fuels and energy?

General LINCOLN. The Government organizational structure is adequate for providing solutions to potential shortages of fuels and energy, at least in the short run. However, the longer run energy outlook dictates further governmental activity. One of the major actions toward this end is the President's proposed Department of Natural Resources, which will provide unified operation and administration in the field of energy. The Joint Board on Fuel Supply and Fuel Transport has been quite successful in its roles of identifying emergency fuel problems and coordinating appropriate Federal remedial actions and also of preparing programs to meet potential problems that may arise in the near term.

Question 27. What actions must be taken to avoid fuel and energy shortages in the next 5 years?

General LINCOLN. To provide adequate quantities of energy for the next 5 years, decisions must be made concerning: (1) what constitutes an acceptable level of dependence on foreign energy sources, (2) national policies which will induce the development of domestic energy supplies sufficient to limit foreign dependence to that acceptable level, and (3) a balancing of national energy and environmental objectives.

Some specific issues which must be resolved include: (1) offshore oil and gas leasing and development policies and procedures, (2) acceptable development and distribution procedures for Arctic oil and gas, (3) optimum use of naval petroleum reserves, (4) recasting of the oil import program to coincide with the changing conditions of the next 5 years and to promote a stable investment planning base, (5) development of technologies to permit the clean combusion of domestic coal, (6) location problems for power plants, refinery distribution systems and deepwater terminals, and (7) objectives and practices in the regulation of natural gas prices.

Question 28. Will it be necessary to develop new sources of energy—such as the gasification of coal, the breeder reactor, and shale oil—in order to provide adequate quantities of energy in future years?

General LINCOLN. Yes, it will, given our growing appetite for all forms of energy. Shale oil development is now in the pilot stage. Demonstration-scale plants are expected to be in operation by the late 1970's. Progress in developing commercial shale oil production facilities is expected to be slow at first with a significant impact on domestic oil supply from this source not expected before the mid-1980's.

Breeder reactor technology is also presently in the pilot plant stage. The only U.S. fast breeder reactor for power generation, the Fermi plant, in Michigan, has suffered severe technological and economic setbacks. The AEC breeder program anticipates successful demonstration scale prototype operation by the mid-1980's. If so, significant impact on power generation by breeder reactors may be felt by 1990, and by 2000, or soon thereafter, this could become the dominant source of electrical power. Details on trends in breeder reactor technology should be solicited from the AEC.

An accelerated development program, including several pilot plants and at least one demonstration plant, should lead to the commercial availability of pipeline gas from coal in the latter 1970's. There have already been some announcements by industry that some commercial synthetic producing plants based on naphtha or on coal gasification will be in production prior to 1980, and it is predicted that by 1980 significant gas will be produced from such sources.

Question 29. What is the planning program of the Office of Emergency Preparedness for future requirements for energy?

General LINCOLN. Implementation of the long-range programs outlined in the President's energy message of June 4, 1971, is not directly in the purview of the Director of the OEP nor in that of the Oil Policy Committee. The direct responsibility of the Director is for the policy direction, coordination and surveillance of the oil import program, with the advice of an Oil Policy Committee.

OEP does, however, conduct a continuing planning program

designed to assist the Government in achieving our national security objectives, the reason for the oil import program. This planning program takes four basic forms: a formal research program, interdepartmental study groups or task forces convened to address specific problems, in-house planning and study efforts, and coordination within Government and with industry and the public.

Question 30. Since some of the potential sources of energy—including the gasification of coal, the breeder reactor, and shale oil—may not be developed for many years, will the United States be able to produce adequate quantities of energy to meet demand in advance of developing these new sources of supply?

General LINCOLN. Although the United States has a tremendous potential in undeveloped energy resources, it does not appear that we can avoid increasing our foreign dependency, at least not in the short term (see 28). The courses of action available to us are, broadly, to continue existent measures and institute new measures to reduce that dependency which will otherwise exist in the mid-term and the longer-term future. Such courses of action can be placed in broad categories which encourage: (1) exploitation of conventional gas and oil resources, and (2) use of other energy sources—coal, nuclear power, energy conservation—thereby reducing potential demand for imported oil and gas. Related considerations, perhaps more qualitative than quantitative, include development and location of new refining capacity, security of transportation arrangements, diversification among sources of supply, and generally prudent oil import policies. The last is a particularly difficult objective because of the frequent conflict between short-term and local needs and the guards against longer-run energy security hazards.

Question 31. The average annual demand for natural gas during the next 10 years is estimated to be about 27.5 trillion cubic feet a year and the United States has been adding only 15.2 trillion cubic feet annually to reserves, oil imports are expected to double in the next 10 years, and nuclear power development is reported to be behind schedule. Should energy goals be established in an effort to eliminate or improve supply-demand imbalances and to focus attention on the seriousness of potential energy shortages?

General LINCOLN. Actions proposed in the President's energy message of June 4, 1971, are designed to meet both the present and future energy needs.

Question 32. Has the Office of Emergency Preparedness been called upon to make any decisions relating to environmental problems?

General LINCOLN. No, not directly. Although OEP is interested in decisions on environmental problems as they may react on basic raw materials industries, it has not been called upon to make any decisions on these problems.

Question 33. Have any problems come to your attention in connection with the relocation of industries outside of this country due to environmental regulations?

General LINCOLN. OEP is not aware of any basic industries relocating outside of this country due to environmental regulations. Some ores have been shipped to foreign countries for processing to avoid environmental restrictions. OEP believes this may be a temporary situation.

Question 34. Since the sale of energy in the United States has grown faster than the gross national product for the past five years, do you forecast a continuation of this growth trend?

General LINCOLN. The ratio of U.S. energy consumption to real GNP has been on a long-term downward trend since the end of World War II until 1966 when it took a sharp upward direction. Reasons underlying these trends are numerous and complex. There is no single basic relationship between GNP and energy.

Underlying the current upward trend are such factors as the growth in industrial output, the increased demand for air-conditioning and the general trend toward electricity (a less efficient form of energy utilization). With a continuation of these factors and with increasing emphasis on air quality control, it is difficult to foresee energy growth trends reverting to their earlier relationships and to GNP.

Question 35. Are there any estimates on the amount of energy which will be required to operate new equipment which will be installed to meet environmental problems?

General LINCOLN. OEP has not attempted to make such an estimate. The Environmental Protection Agency has commissioned a number of research studies of environmental problems and they may be able to provide a projection based on an in-depth review.

OEP anticipates that there will be five areas where changes resulting from environmental considerations may increase energy requirements. The most significant area concerns auto emission controls. To meet emission standards may require lowering engine efficiency, which industry estimates indicate could increase fuel requirements by as much as 15 percent. A 15-precent increase in gasoline consumption will increase total energy requirements by approximately 2½ percent.

Additional energy will also be required (1) to clean stack gases (by electrical precipitators or combustion controls), (2) to operate downstream refinery facilities to increase clear octane (lead removal), (3) for sulfur removal from fuels, and (4) for conversion of coal, oil shale and tar sands to synthetic fuels. Of these, the increased downstream refinery requirements will be the most significant. In 1970, U.S. refineries consumed approximately 700,000 B.t.u.'s energy for every barrel throughput. By 1975, depending on changes required in downstream processing to yield additional clear octane, the refinery energy requirements could increase to 800,000 B.t.u. or 900,000 B.t.u. per barrel throughputs. An increase to the higher amount would increase total U.S. energy requirements just over 1 percent. Processes to remove sulfur from crude oil also require significant energy. Coal gasification projects to obtain usable energy from high sulfur coals, and other conversion projects, could consume considerable energy in the long term. However, they likely will not significantly increase energy requirements during the next 10 years. Most conversion processes to obtain sythetic fuels will be instituted to replace diminishing natural fuel supplies, rather than as a result of environmental considerations. Processes to treat stack gas and industrial waters and wastes likely will not consume large volumes of energy.

Question 36. What is the role of Government and what is the role of industry in taking actions to avoid shortages in energy supplies in future years?

General LINCOLN. The role of Government and industry in taking actions to avoid shortages in energy supplies in future years must be one of close cooperation. In the short term, the operations of the Joint Board on Fuel Supply and Fuel Transport provide a working

mechanism for some aspects of this type of cooperation. As the President stated in his Energy Message of June 4, 1971, private industry "will still play the major role in providing our energy but Government can do a great deal to help in meeting this challenge." On the Government's side, the President urged the formation of a new Department of Natural Resources which would "place responsibility for energy questions in a single agency which can execute and modify policies in a comprehensive and unified manner." The President added, "Until such time as this new department comes into being, I will continue to look to the Energy Subcommittee of the Domestic Council for leadership in analyzing and coordinating overall energy policy questions for the Executive Branch."

Question 37. Have any actions been taken by the Office of Emergency Preparedness in connection with the recycling of metals?

General LINCOLN. OEP has been looking into the problems of recycling materials, but personnel working in this area have been diverted to assist in the administration of the price-wage freeze. OEP has traditionally been interested in the recycling of materials (normal scrap operations) since this constitutes part of the available supply.

Chairman PATMAN. As I indicated earlier, we welcome the testimony of witnesses outside of the Government as well as Government witnesses. We are glad to have Dr. Frederick Wall, executive director of the American Chemical Society, meet with us today, and give us the benefit of his views on the availability and demand for resources in future years, and any recommendations he wishes to make on finding solutions to problems related to potential shortages in supply and dependence on foreign sources.

Dr. Wall is a physical chemist and a member of the National Academy of Sciences. Dr. Wall has served as vice chancellor of graduate studies and research at the University of California in San Diego.

Dr. Wall, you may take your seat over here at the witness chair, please. We appreciate your accepting our invitation to appear and testify. We are delighted to have you come. We shall be very glad to hear your testimony.

You may proceed in your own way, sir.

STATEMENT OF FREDERICK T. WALL, EXECUTIVE DIRECTOR, AMERICAN CHEMICAL SOCIETY

Mr. WALL. Thank you, Mr. Chairman. I appreciate very much the chance to come here to offer a statement. I do so as an individual physical chemist, for my comments do not necessarily represent an official position of the American Chemical Society.

I want to discuss certain energy use practices, the importance of which is not fully recognized by the public, but which I think should be called to the attention of the Congress in considering possible legislation.

My remarks today will be limited to some basic considerations concerning heat, with particular reference to efficient utilization of fossil fuels. I propose to show that certain practices, which are becoming increasingly widespread, are wasteful of our irreplaceable fuels and that measures should be taken to stop such waste.

A significant waste of fossil fuels arises from the use of electricity for heating purposes. Specifically, I am concerned about electricity generated by steam plants and then used to produce heat through electrical resistors. The most serious example of such waste is that of electrical space heating, although electric hot water heaters, clothes driers, ovens, and stoves are likewise offenders to varying degrees. All over the country, especially here in Washington, one sees "all electric" buildings, the operations of which can have a serious impact on our fuel supplies. Not only is electric heating wasteful of fuel but, as I shall also show, it contributes unnecessarily to thermal pollution which can upset the environment.

The specific arguments supporting my assertions follow. Suppose a certain amount of combustible gas would serve to heat a building; then in accordance with basic laws of thermodynamics, a much greater quantity of gas or equivalent fuel would have to be burned to produce the electrical energy required to heat the same building by the same amount. (Actually, about 2.5 times as much fuel is required for electrical resistance heating.) This follows because no heat engine, however perfect, can convert more than a fraction of the heat supplied into electrical energy.

The most efficient fossil-fueled steamplants convert about 40 percent of the heat of combustion of the fuel into electricity and the nationwide average is less than 33 percent. The substantial amount of heat (about two-thirds of the total) not converted into electricity at the powerplant must be discharged into the surroundings, often a lake or river. This is wasted heat and a source of thermal pollution, which in many instances has serious consequences depending upon where and how the waste heat is discharged.

Now, if I may digress from my written statement, let me elaborate a little bit. I don't want to suggest we not heat our houses or our buildings; what I am really concerned about is how best to heat them with the fuel we have. When two-thirds of the potential heat from burning a fuel is put into a river, thereby endangering fish and plantlife, and only one-third comes to heat our buildings, we had better ask "isn't there a better way of doing it?"

Let me continue with my prepared statement. On the basis of fundamental principles, it is definitely more efficient to burn gas in a space heating furnace than to burn gas to generate steam to make electricity to heat the same building space. I use gas as an example, but the argument is valid irrespective of the kind of fuel employed as long as one deals with thermal equivalents. (Through gasification of coal, for example, one could use gas in a home without depending on natural gas alone.)

It is interesting to note that waste of fuel, like other kinds of waste, and thermal pollution, like other kinds of pollution, correlate rather directly with degree of affluence. Even though electric heat is more costly, an affluent society has no compunctions about using electrical heating devices because of the immediate convenience and apparent local cleanliness. Since, however, a modern electric building is in fact coupled with a powerplant located elsewhere, it is the combination that must be judged; unhappily that combination gives rise to serious waste and to more, not less, undesirable effects on our total environment than would direct combustion in a properly designed heating device.

If we burn 2½ times as much fuel out in the country, just to keep

it away from our immediate location, we still contribute more to the total pollution; hence there is the question of how this might be avoided.

What can be done about this? In the first place, the use of electrical resistance heating should be severely restricted wherever electrical energy is generated by steam plants. Prompt action might give us enough time to determine more precisely what further measures, if any, must be taken to avoid serious, irreversible consequences. The development of means for the direct conversion of nuclear energy into electrical energy might, of course, provide a solution. On the other hand, steam plants with nuclear sources for heat, will not solve the problems.

The thermal pollution from nuclear steamplants is terrific, although one can get electrical heat that way. A return to individual coal-burning furnaces is not advocated; certainly our people won't accept such. This can be avoided by gasification of coal, which would make available a convenient, not too costly, and relatively nonpolluting fuel for small heating units. Actually, it is easier to clean up gas, prior to distributing it, than it is to clean up coal. We can prepare gas that will be free of sulfur and other objectionable materials. You can burn it directly, derive full heat benefits and not waste a precious commodity. And gas is our best and most convenient kind of fuel, whether it be natural or made from coal.

Accordingly, I would recommend an intensive research and development program on coal gasification, which could go far toward promoting efficient use of our fossil fuels. I understand that some legislation in support of such is under consideration, and I hope that proper measures will be enacted.

It should be emphasized that I am not suggesting the elimination of electric lights, minor heating appliances, or electric motors that perform work. Electric motors are essential and the only practical way presently in view for supplying power to them is the method now employed. I do want to focus attention on space and water heating, since the energy required for such can be very large, with a correspondingly large wasteful thermal discharge in the neighborhood of the powerplant. Our Nation can ill afford to waste precious fuels when means are available to realize greater efficiency. Proper usage of our resources will, of course, aid our overall economy and, in the long run, our national defense.

Chairman PATMAN. Thank you very much, Doctor. Will it be satisfactory if the members of the committee desire to ask you further questions in writing, that you would cooperate with us by answering them when you approve or look over your transcript of this testimony?

Mr. WALL. Certainly.

Chairman PATMAN. Thank you, sir.

Mr. Brown, would you like to comment or ask any questions?

Representative BROWN. Dr. Wall, in your analysis of this question, have you taken into consideration the energy utilization, the energy loss in connection with the transmission of the energy?

Dr. WALL. That is another factor which would militate against electrical heating because, on the average, you lose about 10 percent of the energy in transmitting it from the powerplant to the city.

Representative BROWN. And that exceeds the cost of transmission of oil and other things?

Dr. WALL. I would say that the possible added cost of transporting gas or any fuel is not a serious matter, because it has to be transported to powerplants from the original source in any case. It is a question of what the difference might be. A direct user of gas might be a little farther, or might be a little closer to the gas field.

Representative BROWN. In theory I suppose your ultimate solution, if we are going to utilize our sources to the fullest, would be to have nuclear powerplants in the central cities, and have them on a slow-down basis during the warm season. Then we could probably utilize all of the heat. Right? And we wouldn't have the problem of thermopollution.

Dr. WALL. Certainly, there are ways in which we could recover some of the heat that is presently being wasted, but if the powerplants are far out in the country, it is difficult to do. The past practice has been to distribute the heat in an easy way, which usually means putting it into a lake or a river, which causes problems.

There are efforts being made to require the power companies to discharge the heat to the atmosphere by use of cooling towers. It is more costly, but it does protect lakes and streams.

Representative BROWN. But even this poses a problem, does it not, because I happen to know in Michigan where the fruitgrowers were a little bit concerned about disposing of the heat in the atmosphere because of its impact upon the fruit production.

Dr. WALL. Indeed, it could do that.

The essence of my message is that there are two things involved: We waste heat and then cause a problem with that waste.

Representative BROWN. Wouldn't you agree then, again in the theory, that nuclear powerplants in central cities, would make much heat available for heating purposes. You would utilize the heat which today you have some trouble disposing of?

Dr. WALL. You might argue with some validity that the powerplant should be located in the centers of our cities, whatever the source of heat, to facilitate utilization of what might otherwise be wasted.

There are problems, of course. I am not fully qualified to comment on this but I suspect there are individuals who might question the desirability of having a large nuclear establishment right in the center of an urban community.

Representative BROWN. There is no question about that.

Thank you very much.

Chairman PATMAN. Thank you very much, sir. We will submit questions to you to complete the record. Any suggestions you desire to make voluntarily and expand your remarks and insert them, it will be appreciated.

Dr. WALL. Thank you. I appreciate the opportunity.

Chairman PATMAN. Tomorrow morning we will have Mr. Wilfrid E. Johnson, Commissioner of the Atomic Energy Commission, as a witness. Also, Mr. John N. Nassikas, Chairman of the Federal Power Commission.

With that understanding, we have heard the witnesses we were to hear this morning. We will recess until 10 o'clock in the morning in this room. We appreciate the attendance of all of the witnesses.

So, without objection, we will stand at recess until 10 o'clock in the morning.

(Whereupon, at 11:15 a.m., the committee adjourned to reconvene at 10 a.m. on Thursday, September 23, 1971.)

POTENTIAL SHORTAGES OF ORES, METALS, AND MINERALS AND ENERGY RESOURCES

THURSDAY, SEPTEMBER 23, 1971

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON DEFENSE PRODUCTION,
Washington, D.C.

The joint committee met, pursuant to recess, at 10:05 a.m., in room 2222, Rayburn House Office Building, Hon. Wright Patman (chairman) presiding.

Present: Representatives Patman (presiding), Sullivan, and Brown.

Also present: Harold J. Warren, clerk and counsel; Charles S. Brewton, general counsel; George T. Ault, professional staff; and Cary H. Copeland, professional staff.

Chairman PATMAN. The committee will please come to order.

The Joint Committee on Defense Production is continuing with hearings this morning on the availability of raw materials and energy resources, potential shortages in the future, and dependence on foreign sources of supply.

Our witnesses are Mr. Wilfrid E. Johnson, Commissioner of the Atomic Energy Commission; and Mr. John N. Nassikas, Chairman of the Federal Power Commission.

The Atomic Energy Commission is concerned with the production of adequate supplies of uranium and is also working toward developing new sources of energy which will utilize lower grades of uranium in the future.

All estimates which we have seen indicate that atomic energy will be of increasing importance in the future. The development of the breeder reactor is frequently mentioned as one of the new sources of energy supply. We are interested in obtaining the views of the Atomic Energy Commission concerning the estimated supply of atomic energy in advance of the development of new sources of supply, the progress which is being made in developing new sources of supply, and recommendations which may be made in connection with meeting the demand for energy for defense and nondefense uses.

Mr. Johnson, of course, after I get through reading this statement, I will ask if you will identify yourself and any members of your staff who may be with you for the record, and then we will proceed with your testimony, which will be followed by the testimony of our other witness this morning, Mr. John N. Nassikas, Chairman of the Federal Power Commission. Then, we will interrogate the two of you.

So, you may proceed, Mr. Johnson in your own way. You are recognized.

STATEMENT OF WILFRID E. JOHNSON, COMMISSIONER, U.S. ATOMIC ENERGY COMMISSION; ACCOMPANIED BY VICTOR CORSO, DEPUTY CONTROLLER; CHRISTOPHER L. HENDERSON, ASSISTANT DIRECTOR OF REGULATION; WILLIAM J. MINSCH, JR., ASSISTANT GENERAL COUNSEL; MERRILL J. WHITMAN, ASSISTANT DIRECTOR, REACTOR DEVELOPMENT AND TECHNOLOGY; WILLIAM L. OAKLEY, ASSISTANT DIRECTOR, PEACEFUL NUCLEAR EXPLOSIVES; MARCUS A. ROWDEN, SOLICITOR; STAUNTON E. MILLER, REACTOR DEVELOPMENT AND TECHNOLOGY DIVISION; AND FRANK P. BARANOWSKI, DIRECTOR, PRODUCTION DIVISION, U.S. ATOMIC ENERGY COMMISSION

Commissioner JOHNSON. Thank you, Mr. Chairman.

My name is Wilfrid E. Johnson, Commissioner of the Atomic Energy Commission. I am pleased to appear before the Joint Committee on Defense Production to discuss the availability and requirements for fuel and energy and atomic energy's role in helping to meet this Nation's future energy needs.

I am accompanied this morning by several senior members of the Atomic Energy Commission staff. They are: Victor Corso, Deputy Controller; Chris Henderson, Assistant Director of Regulation; Bill Minsch, Assistant General Counsel; Merrill Whitman, Assistant Director, Reactor Development and Technology, Bill Oakley, Assistant Director, Peaceful Nuclear Explosives Division; Marc Rowden, Solicitor; Ed Miller of the Reactor Development and Technology Division, and Frank Baranowski, Director, Production Division.

My remarks will of necessity be of a summary nature; we are providing additional information to the committee in response to the chairman's letter of August 13, 1971 forwarding a list of questions on nuclear matters. I would like to present our answers to the committee at this time for inclusion in the record.

If that has your permission, Mr. Chairman?

Chairman PATMAN. Without objection, it is so ordered, sir.

(The questions and answers referred to above and the answers to additional questions submitted following the hearing are set forth beginning on page 371.)

Chairman PATMAN. And in presenting your testimony, if you desire to leave out something from your original statement, you may insert the whole statement in the record.

Commissioner JOHNSON. Thank you.

Chairman PATMAN. And also you have permission to extend your remarks to include anything that you have overlooked.

Commissioner JOHNSON. Thank you very much.

Chairman PATMAN. Anything that you would like to include.

Commissioner JOHNSON. We will, of course, also be pleased to provide any other material the committee may identify in the course of our discussions.

In my remarks today, I would like to concentrate on three areas in which the Atomic Energy Commission (AEC) has had a continuing responsibility in the general field of minerals and energy resources. These areas include:

First, the mining and beneficiation of the uranium raw material and the evaluation of uranium availability; the product of the mills, which is sold on the basis of its U_3O_8 content, is known as yellowcake.

Second, the enrichment of the uranium contained in yellowcake in the uranium-235 isotope; this involves two steps: (1) the conversion of the yellowcake to a product called uranium hexafluoride (2) enrichment in the U–235 isotope [1] in gaseous diffusion plants.

Third, the conversion through nuclear fission in nuclear reactors of the potential energy of the enriched material to heat and the heat into electricity; this area of the Commission's activity has included the encouragement of the private development of nuclear powerplants and their installation by electric utilities.

I plan to devote most of my time to discussing each of these three areas in turn. I would also like to briefly discuss two other promising applications of nuclear energy—the controlled thermonuclear program and the plowshare program—as well as to make a few comments on several other potential energy sources. I don't intend to discuss extensively the need for energy, the projections of future demand, or the future outlook for fossil fuels since these matters were discussed at some length by representatives of the Department of the Interior at your earlier hearings on August 2, 1971, and I assume, Mr. Chairman, that Mr. Nassikas will also touch on that subject. We have reviewed this information on energy furnished the committee by the Department of the Interior. We are generally in accord with their presentation as to the availability and requirements for fossil fuels and other sources of energy.

In reviewing energy requirements, we find that the average annual increase in the rate of energy consumption was 3.4 percent for the 30-year period ending in 1970; 3.6 percent between 1960 and 1965, and a surprising 5 percent for the 5-year period between 1965 and 1970.

The increase in energy consumption since 1965 has not yet been fully explained. Growth of air conditioning; expanded use of home appliances in general, particularly electric space heating; and more intensive processing of our industrial raw materials such as aluminum may be contributing factors. Bearing on this point is the trend of energy use in relation to gross national product. For example, in the decade beginning in 1956 there was a progressive and rather substantial decrease in the ratio of energy to gross national product. However, beginning in 1966 this ratio has gone sharply upward and presently is above the 1956 level. The important question is whether this increase in the energy consumption rate represents a long-term historic trend, which will be reflected in higher growth rates over the future. Obviously, if this higher rate persists then all energy requirements would have to be adjusted dramatically upward.

I will now proceed with a discussion of nuclear energy beginning with the production of the raw material.

PRODUCTION OF RAW FUEL (YELLOWCAKE)

Prior to the establishment of the Atomic Energy Commission on January 1, 1947, uranium procurement was in the hands of the Manhattan Engineer District which had the sole responsibility of develop-

[1] Almost all (99.28%) of natural uranium is the Uranium–238 isotope; the U–235 in natural uranium only constitutes a small part (0.71 percent).

ing nuclear weapons. About 85 percent of the uranium acquired for this purpose was obtained from foreign sources.

The Commission first approved plans to expand uranium production in 1948, during which year U.S. production amounted to only about 100 tons. Over the past two decades, nearly 200,000 tons of yellowcake were produced. Most of this has been for defense purposes. However, some of this production was being diverted to commercial use in power reactors by 1960. Initially, the technology and fuel for all nuclear reactors was controlled by the Government. The civilian application of nuclear technology was greatly stimulated by a major revision to the Atomic Energy Act which occurred in 1954, which permitted private industry to own and operate nuclear reactors both for research and for the commercial production of electric power.

The act was again modified in 1964 to permit private ownership of nuclear fuel.

In the early 1960's defense needs for enriched uranium were tapering off rapidly. While it was clear that the uranium requirements for nuclear powerplants were increasing, there was still a significant gap between total requirements and production capacity because of the timespan required for the buildup of commercial nuclear power.

The Atomic Energy Commission took a major action in late 1962 which helped to preserve viability of the uranium mining and milling industry by stretching out its remaining contracts for the procurement of yellowcake. This policy worked out extremely well and, while production capability still exceeds requirements, resulting in a soft market for uranium, the mining business is reasonably healthy. The last procurement contract expired in December 1970. Since then, all mining and milling of uranium has been for the private sector of the economy.

The Atomic Energy Commission's actions in stretching out its contracts, which was intended to bring procurement more nearly into balance with requirements, also served to help protect the large investment in mines and mills. Subsequent reductions in AEC requirements resulted in a substantial inventory of yellowcake being accumulated by the Commission. This inventory amounts to about 50,000 tons—approximately $600 million of value at current commercial prices.

A further step taken to assist the American mining and milling industry through this transition was the imposition of a restriction on enriching of uranium from foreign sources if the enriched material were to be utilized in the United States. The performance of enrichment services on foreign uranium when the enriched product is to be used in foreign countries was not prohibited.

The industry today is more than capable of meeting today's needs. Known reserves calculated on the basis of a price of $8 per pound of yellowcake amount to 245,000 tons, about a 10-year forward requirement. Known reserves calculated at $10 per pound of U_3O_8 are 390,000 tons including 90,000 tons potential production as a by-product of copper and phosphate processing. We presently estimate that additional resources which may remain to be discovered, largely in the presently producing areas, may amount to about 680,000 tons at $10 or less per pound.

Foreign uranium reserves at $10 per pound are estimated to be about 700,000 tons of yellowcake. Since foreign demand is projected at 475,000 tons through 1985, excess foreign supplies may be available during the next 15 years.

The central problem now and in the future is how to meet the needs of the 1980's and 1990's. Two specific Government policies are directly pertinent: (1) the removal of restrictions on enriching foreign uranium for domestic use; and (2) the disposal of excess AEC uranium stocks owned by the Commission. It is our present opinion that it will be necessary to dispose of the stockpile over an extended period of years and to control the disposition in relation to the size of the market and also in relation to market growth. With respect to foreign imports, it would seem to be in our country's long-range advantage if we met a portion of our needs with uranium of foreign origin; of course, this must be accomplished in a manner which maintains the viability of our domestic industry. I will go on now to enrichment of uranium.

ENRICHMENT OF URANIUM

The second subject I will discuss is uranium enrichment. This operation is presently performed in three Government-owned plants. Two of the plants are operated by Union Carbide, one at Oak Ridge, Tenn., and the other at Paducah, Ky. A third plant is operated by Goodyear Atomic Corp. at Portsmouth, Ohio. When operating at full capacity, these plants require about 6,100 megawatts of electric power.

The current domestic and foreign requirements for enriching services amount to about 35 percent of capacity of the three plants. These requirements are expected to grow to 100 percent of capacity by 1975. The AEC has projected that in 1980 there will be 150,000 MWE of domestic nuclear capacity and 75,000 MWE of foreign capacity using U.S. enriching services.

The AEC expects to meet the uranium requirements for this rapidly growing capacity through several actions. The operating levels of the diffusion plants will be increased. Production and stockpiling of enriched uranium will be continued. In addition, there are plans to improve the plant efficiency through technological advancements. The Cascade Improvement program (CIP) will increase the output of the plant by about 4.8 million units of separative work[1] per year with no increase in electric power requirements and no increase in operating costs. Following the CIP, the plant electrical equipment can be uprated to increase power input. An increase in the power level of 1,300 MWE to a total nominal level of 7,400 MWE will result in additional separative work production of 4.5 million units of separative work per year.

I should add to the text here that our present capacity is approximately 17 million separative work units. So, we are talking about the adding of about nine to that for a total of about 26 million units per year.

[1] A "separative work unit" is a measure of the effort expended in the plants to separate a quantity of uranium into a portion depleted in uranium-235 and a portion enriched in that isotope. The number of separative work units required to produce enriched uranium for fuel for any specific nuclear powerplant is related to the concentration of uranium-235 required, the concentration of the feed material, and the waste (tails) concentration.

The programed utilization of the full present plant capacity with the improvement and uprating programs and the preproduction of enriched uranium should meet the forecasted foreign and domestic requirements for about the next decade. We expect that new enriching capacity will be required in the United States in 1982.

The worldwide production of refined uranium ore and the increasing market for it in the United States, Europe, and Japan make it inevitable that other countries besides the United States will seek national ownership and control of at least some portion of the enrichment capacity to meet their requirements. The AEC is therefore considering helping foreign governments to become at least partially self-sufficient by sharing with them our gaseous diffusion enriching technology in return for suitable royalties or other payments.

The Commission has also invited American industry to have access to the Commission's gaseous diffusion and gas centrifuge technologies. The promise of this action is that private industry will be able to provide most of the new enriching capacity when it is required.

CONVERSION OF NUCLEAR ENERGY INTO A CONTROLLABLE SOURCE OF HEAT

Nuclear reactors can be used for the production of various elements (such as different isotopes of plutonium) with heat being merely a byproduct. However, by far the predominant use of nuclear energy today is for the production of heat for steam-electric powerplants with residual isotopes being the byproducts. The initial design and construction of experimental reactors was performed by Commission contractors in Commission-owned laboratories such as the Oak Ridge, Argonne, and Brookhaven national laboratories. Reactors for naval propulsion were also developed in the Commission-owned Knolls Atomic Power Laboratory and the Bettis Laboratory. The early experimental nuclear reactors which were operating in the early 1950's gave rise to the full-scale development of today's light water power reactors. These are of three kinds: naval propulsion reactors, which use highly enriched fuel, and two kinds of reactors for the production of electric power, one using pressurized water as the coolant, the other using boiling water as the coolant.

The Atomic Energy Act of 1954 greatly stimulated private research and development which ultimately resulted in the commercial application of the light water reactors for power production purposes. As I indicated earlier, we expect about 150,000 megawatts of nuclear electric powerplants to be in place by the end of 1980, and about double that amount by 1985. At the end of this century, we anticipate that over half of all of the electricity produced in this country will be from nuclear powerplants. It is also anticipated that by that time approximately half of the total energy consumed will be for the production of electricity. If these growth rates are realized, about one-fourth of the total energy supply in the United States will be produced from nuclear fuel.

The Atomic Energy Commission still faces the major tasks of assuring the improvement of the nonbreeder type of reactors and developing and achieving commercial acceptance of the breeder reactor.

The breeder reactor is expected to utilize 60 percent or more of the potentially available energy in nuclear fuel whereas the light water

reactors utilize only 1 to 2 percent. The light water reactors are economic because of the relatively low cost of uranium. While the initial experimental breeder operated and produced electric power in 1951, the major effort in the United States leading toward commercialization of the breeder began about 1965. Today we are developing major industrial competence and arranging for a cooperative effort among the manufacturers, utilities and the Commission for the design, development, construction and operation of a breeder reactor that will be cooled by liquid sodium.

The development and commercial utilization of breeder reactors is widely recognized as essential if this country's energy requirements are to be met. We are expecting commercial acceptance of breeder reactors to take place in the mid-1980's.

As you know, on June 4 of this year, President Nixon sent to the U.S. Congress, a comprehensive energy message which proposed a program to insure an adequate supply of clean energy for the years ahead. Very importantly, the message clearly stated that "Our best hope today for meeting the Nation's growing demand for economical clean energy lies with the fast breeder reactor." To realize the immense potential of the fast breeder, the President provided augmented funding for the LMFBR and related programs and a charter for concentrated followup action by establishing a commitment to complete its successful demonstration by 1980.

As a result of the President's message and the recent actions by the Congress, an additional $50 million for the demonstration plant has been authorized bringing the total direct cash contribution by the Government up to $100 million. Also, the level and type of support to be provided by the LMFBR (liquid metal fast breeder reactor) base program has been increased significantly. These actions, along with the favorable results obtained from the increased participation by the utilities, provide a firm basis for expectation that the United States will enter into a definitive cooperative arrangement for the first LMFBR demonstration plant by the end of this year.

Another reactor concept deserving mention is the high temperature gas-cooled reactor. Although not a breeder, the HTGR has a potential for achieving higher fuel utilization, lower fuel cost, improved thermal efficiency, and reduced environmental impact when compared with water reactors—although these advantages remain to be demonstrated in plants of commercial size. The utility acceptance of this type of reactor may provide a powerful stimulus to the water reactor manufacturers to make the fast breeder reactor available on an accelerated schedule. Interest in this type of reactor, whose large-scale demonstration in the Fort St. Vrain plant is now scheduled to begin in early 1972, received an important boost by the recent announcement by the Philadelphia Electric Co., of its entering into negotiations for the purchase of two 1160 megawatts electrical HTGR plants. Moreover, the gas-cooling technology developed in these HTGR plants will contribute to the technology of the gas-cooled fast breeder reactor. This is a second type of breeder.

Now, Mr. Chairman, I would like to discuss briefly the controlled thermonuclear program:

As I indicated at the beginning, there are two other promising applications of nuclear energy which I will discuss briefly today. The

first of these is the creation of a major new source of energy from nuclear fusion.

Nuclear fusion is the opposite of nuclear fission. Instead of splitting large atoms such as uranium (fission) low mass elements such as deuterium are made to collide with each other and fuse (fusion). A very high temperature ionized gas, or plasma, must be produced and contained long enough for energy to be released. The AEC did not begin research on this task until 1952, but already the basic hurdles of making and heating plasmas have been cleared.

As the President's energy message indicates, recent progress in this program suggests that the scientific feasibility of fusion may be demonstrated in the 1970's. The potential advantages of fusion power in terms of fuel reserves, compatibility with environmental quality, and technological applications are so impressive that the CTR program should be accelerated and proceed as rapidly as technology permits. Some specific potential advantages are: The fuel is inexpensive and very plentiful; such reactors should be inherently safe; effects on the environment could be minimal; high thermal efficiencies are possible, and direct conversion of nuclear energy to electrical energy also may be achieved.

As a result of successes of the past few years, scientists are now quite confident about their ability to achieve adequate confinement of the hot, dense plasmas. Plans are now being laid for experiments which, if successful, would extrapolate the presently attainable plasma conditions very significantly—possibly to "break-even" conditions. Such experiments will, of necessity, operate at a higher power level and require larger subsystems than those now used.

I believe that it will be sometime past the turn of the century before fusion power becomes available commercially. I think in terms of 10 years to demonstrate scientific feasibility, another 10 years for the development of engineering feasibility, and an additional 10 years for the demonstration of economic feasibility.

PLOWSHARE

The second additional nuclear application I wish to discuss is the use of nuclear explosives for peaceful purposes, or the Plowshare program.

As the President stated in his energy message, "additional supplies of gas will * * * be one of our most urgent needs in the next few years." Recognizing this fact, the AEC has been concentrating in its Plowshare program on developing nuclear gas stimulation technology which would permit the Nation to tap the 317 trillion cubic feet of gas estimated by the Bureau of Mines to be potentially available from the tight gas formations of the Rocky Mountain area. This is an amount greater that the Nation's current reserves of natural gas.

Projects Gasbuggy and Rulison, the two nuclear gas stimulation experiments conducted to date, demonstrated that nuclear explosions can significantly stimulate the flow of natural gas which is conventionally unattainable. The results of the 29 kiloton Gasbuggy nuclear detonation have indicated that projected total production would be five to eightfold more than that from a conventionally stimulated well in the same area. Preliminary data from production testing on the Rulison well show that significant stimulation has been achieved.

The first 70 days of flow from the Rulison well produced 400 million cubic feet of natural gas, more than the first 5 years of production from nearby conventionally stimulated wells. Thus, we know that, technically, gas stimulation works.

Based on our experience to date, we have developed a proposed 4-year program to answer the remaining questions regarding practical application of this technology. The program consists essentially of 4 tests to develop a small-diameter, low-tritium, temperature-resistant explosive in the 100 kiloton yield range, and five to six production experiments to be carried out jointly with industry.

While gas stimulation is the near term goal of the Plowshare program, other applications of underground nuclear explosions appear promising over a longer period. These include in situ retorting of oil shale, stimulation of geothermal heat and the in-place recovery of certain mineral resources, principally copper.

Ultimately, legislation will be required amending the Atomic Energy Act to permit the provision of nuclear explosions to industry on a commercial basis. State and local governments will have a major practical role to play in that procedure, as they are invited to do today wherever a Plowshare experiment is undertaken.

OTHER ENERGY SOURCES

In viewing the Nation's energy needs, we have also examined the potential of several other sources of energy in addition to nuclear and fossil. In the judgment of most experts, other sources of energy are either insufficient to contribute to present needs on a broad scale or are too far in the future.

The world's potential tidal power, for instance, is estimated to amount to only 1 to 2 percent of the world's potential waterpower. The economics of developing suitable sites so greatly reduces even this limited potential that only one major tidal-electric plant is in operation today, that at La Rance Estuary, France, presently rated at 240 MW. The maximum generating capacity that might be developed using geothermal power is estimated as approximately equal to that of tidal power.

Hydroelectric power at present represents only about 4 percent of the Nation's overall consumption of energy, and there are relatively few acceptable sites left for hydro plants.

Solar energy, on the other hand, is virtually unlimited, but its intensity at the earth's surface is so small that its utilization for bulk power production is impractical. In a National Academy of Sciences report, for instance, it is estimated that a 1,000 Mwe solar electric plant would require an area of approximately 16 square miles of the earth's surface to collect the necessary solar energy. Very advanced concepts, incorporating immense solar screens on satellites and laser beams for transmitting the power to earth have been proposed but are not to be considered a serious means at present for supplanting energy from fuels.

Magnetohydrodynamics—MHD—and the fuel cell are two developments whose technologies are sufficiently far advanced to be considered possible electric energy producers before the end of the century. These are power conversion devices, however, and not sources of energy. Their attractiveness lies in potentially higher cycle efficiencies for converting the energy of fossil fuels—and possibly heat from nuclear

reactors in the case of MHD—into electricity. Serious materials and engineering problems remain to be solved before the technical and economic feasibility of MHD is demonstrated. Fuel cell applications so far have been mostly for space missions, but systems for civilian applications are under development. The lifetime of fuel cells needs to be greatly lengthened and their unit costs lowered by an order of magnitude before they would seem competitive. This plus the fact that extensive use of house-size units would involve a restructuring of the Nation's power system makes wide-scale use of fuel cells problematic.

CONCLUSION

In closing, I would like to emphasize our conviction that nuclear energy has an important—indeed vital role in meeting this country's need for a continuing supply of clean energy. It is axiomatic that such a supply is essential to this Nation's economic growth, national defense, and environmental quality.

It is also the AEC view—many times expressed—that in the years ahead this Nation will need to use, in the most efficient manner possible, all of the practicable energy sources available to us—fossil, nuclear, and hydro—if future energy demands are to be met.

As we survey the prospects and problems for meeting our energy needs, it is evident that Government must prescribe the basic framework within which the energy industries carry out their tasks of insuring adequate and secure supplies at reasonable competitive costs. There has to be a continued dependence upon effective performance by sound and viable industrial firms. Government, through a combination of incentives, regulations, and direct support, must assure that the energy sector develops in a way that meets social, environmental, economic, and defense requirements.

Major undertakings such as those necessary to prove out a new technology may require Government sponsorship. Government will need to assist when the undertaking exceeds industry's capability and resources, when the probable benefits are widely dispersed throughout society, when the welfare of future generations is involved, when the country's national defense is involved, or when necessary to maintain effective competition among and between energy resources.

This completes my prepared statement. I will be glad to answer any further questions or provide additional information for the record.

Chairman PATMAN. Thank you very much, sir, for your very fine statement. I assume it will be all right for members of the committee to submit questions to you in writing and you will answer them when you look over your testimony for approval or disapproval?

Commissioner JOHNSON. Yes, sir.

Chairman PATMAN. Thank you, sir.

Now, you know, in the last few years we have been talking about something to take the place of gold or to supplement gold in the use of bank reserves and similar uses. Would uranium fit into that category for consideration?

Now, we have about $10 billion worth of gold. About how much uranium do we have now in your stockpile?

Commissioner JOHNSON. Mr. Chairman, we are talking now about the uranium–235 isotope, which is about seven-tenths of 1 percent of the total. I think it is just about the same amount, about $10 billion

worth in known reserves. The value of our stockpile is about $650 million at current prices.

Chairman PATMAN. In other words, if we were to——

Commissioner JOHNSON. In the United States.

Chairman PATMAN (continuing). If the Congress would look upon that favorably and give it the same standing and prestige as gold, it would be tantamount to doubling the reserve requirements of banks, for instance, that use gold, or for reserve requirements. We have $10 billion worth of gold now, and if you have about $10 billion worth of uranium, would it be imposing upon you too much to enlarge upon that suggestion as a possibility of being considered?

Commissioner JOHNSON. No. I think, Mr. Chairman, we probably would have to differentiate between the value of uranium which, commercially, of course, is usable. We can pay bills with it just as well as with anything else in the commercial sense, but it would be the commercial value that we would be dealing with, and this is the fuel value. To monetize it would be a somewhat different situation.

Chairman PATMAN. Different approach?

Commissioner JOHNSON. Different problem. That was studied some years ago in the sense of making a gold-uranium alloy that would be, presumably, not corrodible, and there would be no risk of it exploding, and, presumably, hopefully, it would not contaminate things too much, but you have to be a little bit careful about uranium, and getting into contamination problems.

Chairman PATMAN. If you have any papers on that subject that you would care to submit, I wish you would, because the subject is rather fascinating.

Commissioner JOHNSON. Mr. Chairman, I think it is a very good subject. I would, of course, like to look at uranium as an asset and think of it in that way.

Chairman PATMAN. You know, now we have this gold question up, and it is pretty big. South Africa and Russia are the principal gold producers. We do not know how much gold they have in South Africa and we do not know how much gold and what the potential is in Russia. But if we were to agree on something now and neither one of the countries would show up with a large amount of gold, it would probably be upsetting.

Another thing that disturbs me is the fact that in Russia, I think from a hearing before the Joint Economic Committee it was disclosed that Russia mines their gold with slave labor, and we are in competition with gold mining by slave labor in Russia. I do not know what the situation is in South Africa. Therefore, of course, anything that could be used to take the place of gold, or partially take the place, would be very interesting; and anything along that line that you can contribute to our hearings would be very much appreciated, sir. [See letter of Sept. 30, 1971, from Commissioner Johnson to Chairman Patman, p. 369.]

Commissioner JOHNSON. Mr. Chairman, the value of uranium, the 235 isotope, is about 10 times the value of gold.

Chairman PATMAN. About 10 times the value of gold.

Mrs. Sullivan, would you like to comment or ask questions?

Representative SULLIVAN. I would. I have gotten a very intense education this morning in listening to you, Mr. Johnson, and I am extremely interested because I know what the needs, the growing

needs, are for producing energy of some kind. I do not know that you would be able to answer the question that comes to my mind, but we have been reading of the dangers—and safety—in the disposal of atomic waste. In your capacity or in your work, are you making studies of how we can dispose of this?

Commissioner JOHNSON. Yes, Mrs. Sullivan. As a matter of fact, we have been studying that intensely for about 15 years now and have obtained the help of the National Academy of Sciences and their committees they have assigned to the work, and the general plan has been scoped, the general plan which envisions taking the waste product from the chemical separation plants and letting them reside at the plants just temporarily, and taking the most active waste, the most dangerous waste, such as strontium 90 and others, and extract those separately and then put those more intensely active wastes with the long half lives into containers, stainless steel or something like that, and bury them in a salt formation. There is a very large——

Representative SULLIVAN. What could the salt formation do to it?

Commissioner JOHNSON. Mainly, the salt formation just gives you geological evidence that there is no water or the salt would not be there if there was water flowing through it. So, you know it is quite safe in the sense that you do not get water going into any other water supply. It is safe in that sense, and these layers of salt are quite deep, several hundred feet deep, and extend for some hundreds of miles. So, it is a good place to put something like this that will adequately dissipate the heat that is generated and will presumably be safe for over many thousands of years.

Now, the other waste, the less dangerous waste, that of a shorter half life and those that are not so active, can be solidified and perhaps kept in tanks at the chemical processing plant. That is not completely settled yet, but it looks as though the solidification is a good way to handle those. That simply immobilizes the wastes, and they would be solidified in a form that would not be soluble.

Representative SULLIVAN. As this process is growing to the extent you hope it to grow in the next 20, 30 years, or more, it is going to be a more difficult problem, is it not, to find enough space to either bury it or do away with it?

Commissioner JOHNSON. No, not too much. There might be some problem in shipping because of the number of shipments, or something like that.

Representative SULLIVAN. Danger of explosions?

Commissioner JOHNSON. But the space would not be very much. You see, all of these nuclear things are all relatively small and quite intense.

Representative SULLIVAN. Well, this seems to be a fear that we have read about—also in having the atomic energy plant built in certain areas. The people in the area object because of the possible dangers, not only of explosion of the plant, but of the waste that comes from it.

Commissioner JOHNSON. Yes. Back in 1890 or thereabouts, when the central electricity was being developed for the purpose of running streetcars and things of that sort, people were very afraid of it and grossly alarmed, unreasonably alarmed, about it. And when the industry switched from direct current to alternating current, there was great alarm again. And I think a lot of the concern now about atomic energy is very much the same; it is more emotional than

rational. Granted, you do not want to let fission products get out and get loose or you would have trouble, but the facts are that we have now been some 25 years operating reactors, and there has not been a single accident to anyone in the public in all of that time.

Representative SULLIVAN. Well, I do believe people need to be better informed about what might happen, because, as I do, they probably have very false or inadequate knowledge of what might happen and how to get rid of the waste matter safely.

Commissioner JOHNSON. But today there is about, I think, every year, a thousand people killed by electrocution, and there is no fuss about it. There has not been a single person killed by atomic radiation in 25 years that I know of—a member of the public. Now, there have been a few accidents. I am not saying there are no accidents. But I think of only two or three deaths of people working around in laboratories.

Representative SULLIVAN. Would be contaminated. Thank you very much.

Chairman PATMAN. Mr. Brown?

Representative BROWN. I have no questions at this time, Mr. Chairman.

Chairman PATMAN. All right, Mr. Johnson. We certainly appreciate your testimony. I know you are a very busy man, but if you would like to stay with us we would be glad to have you; however, if you have other things you would like to do——

Commissioner JOHNSON. With your permission, Mr. Chairman, I think we will stay and hear what Mr. Nassikas has to say.

Chairman PATMAN. Now, that would be wonderful, sir.

STATEMENT OF WILFRID E. JOHNSON, COMMISSIONER, U.S. ATOMIC ENERGY COMMISSION, BEFORE JOINT COMMITTEE ON DEFENSE PRODUCTION HEARINGS ON AVAILABILITY AND REQUIREMENTS FOR FUELS AND ENERGY, CURRENT POLICIES AND FUTURE NEEDS—SEPTEMBER 23, 1971

I am pleased to appear before the Joint Committee on Defense Production to discuss the availability and requirements for fuel and energy and atomic energy's role in helping to meet this Nation's future energy needs. I am accompanied this morning by several senior members of the AEC staff.

My remarks will of necessity be of a summary nature; we are providing additional information to the committee in response to the chairman's letter of August 13, 1971, forwarding a list of questions on nuclear matters. I would like to present our answers to the committee at this time for inclusion in the record. We will, of course, also be pleased to provide any other material the committee may identify in the course of our discussions.

In my remarks today, I would like to concentrate on three areas in which the Atomic Energy Commission (AEC) has had a continuing responsibility in the general field of minerals and energy resources. These areas include:

First, the mining and beneficiation of the uranium raw material and the evaluation of uranium availability; the product of the mills, which is sold on the basis of its U^{308} content, is known as yellowcake.

Second, the enrichment of the uranium contained in yellowcake in the uranium-235 isotope; this involves two steps: (1) The conversion

of the yellowcake to a product called uranium hexafluoride (UF_6,) and (2) the enrichment of the hexafluoride in the U^{235} isotope [1] in gaseous diffusion plants.

Third, the conversion through nuclear fission in nuclear reactors of the potential energy of the enriched material to heat and the heat into electricity; this area of the Commission's activity has included the encouragement of the private development of nuclear powerplants and their installation by electric utilities.

I plan to devote most of my time to discussing each of these three areas in turn. I would also like to briefly discuss two other promising applications of nuclear energy—the controlled thermonuclear program and the Plowshare program—as well as to make a few comments on several other potential energy sources. I don't intend to discuss extensively the need for energy, the projections of future demand, or the future outlook for fossil fuels since these matters were discussed at some length by representatives of the Department of the Interior at your earlier hearings on August 2, 1971. We have reviewed this information on energy furnished the committee by the Department of the Interior. We are generally in accord with their presentation as to the availability and requirements for fossil fuels and other sources of energy.

In reviewing energy requirements, we find that the average annual increase rate of energy consumption was 3.4 percent for the 30-year period ending in 1970; 3.6 percent between 1960 and 1965, and a surprising 5 percent for the 5-year period between 1965 and 1970.

The increase in energy consumption since 1965 has not yet been fully explained. Growth of air-conditioning; expanded use of home appliances in general, particularly electric space heating; and more intensive processing of our industrial raw materials such as aluminum may be contributing factors. Bearing on this point is the trend of energy use in relation to gross national product. For example, in the decade beginning in 1956 there was a progressive and rather substantial decrease in the ratio of energy to gross national product. However, beginning in 1966 this ratio has gone sharply upward and presently is above the 1956 level. The important question is whether this increase in the energy consumption rate represents a long-term historic trend, which will be reflected in higher growth rates over the future. Obviously, if this higher rate persists then all energy requirements would have to be adjusted dramatically upward.

I will now proceed with a discussion of nuclear energy beginning with the production of the raw material.

PRODUCTION OF RAW FUEL (YELLOWCAKE)

Prior to the establishment of the Atomic Energy Commission on January 1, 1947, uranium procurement was in the hands of the Manhattan Engineer District which had the sole responsibility of developing nuclear weapons. About 85 percent of the uranium acquired for this purpose was obtained from foreign sources.

The Commission first approved plans to expand uranium production in 1948, during which year U.S. production amounted to only about 100 tons. Over the past two decades, nearly 200,000 tons of yellowcake were produced. Most of this has been for defense purposes. However,

[1] Almost all (99.28%) of natural uranium is the Uranium-238 isotope; the U^{235} in natural uranium only constitutes a small part (0.71 percent).

some of this production was being diverted to commercial use in power reactors by 1960. Initially, the technology and fuel for all nuclear reactors was controlled by the Government. The civilian application of nuclear technology was greatly stimulated by a major revision to the Atomic Energy Act which occurred in 1954, which permitted private industry to own and operate nuclear reactors both for research and for the commercial production of electric power.

The act was again modified in 1964 to permit private ownership of nuclear fuel.

In the period 1964–65, defense needs for enriched uranium were tapering off rapidly. While it was clear that the uranium requirements for nuclear powerplants were increasing, there was still a significant gap between total requirements and production capacity because of the time span required for the buildup of commercial nuclear power.

The Atomic Energy Commission took a major action in late 1962 to preserve viability of the uranium mining and milling industry by stretching out its remaining contracts for the procurement of yellowcake. This policy worked out extremely well and, while production capability still exceeds requirements, resulting in a soft market for uranium, the mining and milling business is reasonably healthy. The last procurement contract expired in December 1970. Since then, all mining and milling of uranium has been for the private sector of the economy.

The Atomic Energy Commission's actions in stretching out its contracts, which was intended to bring procurement more nearly into balance with requirements, also served to protect the large investment in mines and mills. Subsequent reductions in AEC requirements resulted in a substantial inventory of yellowcake being accumulated by the Commission. This inventory amounts to about 50,000 tons (over $600 million at current commercial prices).

A further step taken to assist the American mining and milling industry through this transition was the imposition of a restriction on enriching of uranium from foreign sources if the enriched material were to be utilized in the United States. The performance of enrichment services on foreign uranium when the enriched product is to be used in foreign countries was not prohibited.

The industry is more than capable of meeting today's needs. Known reserves calculated on the basis of a price of $8 per pound of yellowcake amount to 245,000 tons—about a 10-year forward requirement. Known reserves calculated at $10 per pound of U_3O_8 are 390,000 tons, including 90,000 tons potential production as a byproduct of copper and phosphate processing. We presently estimate that additional resources which may remain to be discovered, largely in the presently producing areas, may amount to about 680,000 tons at $10 or less per pound.

Foreign uranium reserves at $10 per pound are estimated to be about 700,000 tons of yellowcake. Since foreign demand is projected at 475,000 tons through 1985, excess foreign supplies may be available during the next 15 years.

The central problem now and in the future is how to meet the needs of the 1980's and 1990's. Two specific Government policies are directly pertinent: (1) The removal of restrictions on enriching foreign uranium for domestic use, and (2) the disposal of excess AEC uranium stocks. It is our present opinion that it will be necessary to dispose of the stockpile over an extended period of years and to control the dis-

position in relation to the size of the market and also in relation to market growth. With respect to foreign imports, it would seem to be in our country's long-range advantage if we met a portion of our needs with uranium of foreign origin; of course, this must be accomplished in a manner which maintains the viability of our domestic industry.

ENRICHMENT OF URANIUM

The second subject I will discuss is uranium enrichment. This operation is presently performed in three Government-owned plants. Two of the plants are operated by Union Carbide—one at Oak Ridge, Tenn. and the other at Paducah, Ky. A third plant is operated by Goodyear Atomic Corporation at Portsmouth, Ohio. When operating at full capacity, these plants require about 6,100 megawatts of electric power.

The current domestic and foreign requirements for enriching services amount to about 35 percent of capacity of the three plants. These requirements are expected to grow to 100 percent of capacity by 1975. The AEC has projected that in 1980 there will be 150,000 megawatts electrical of domestic nuclear capacity and 75,000 megawatts electrical of foreign capacity using U.S. enriching services.

The AEC expects to meet the uranium requirements for this rapidly growing capacity through several actions. The operating levels of the diffusion plants will be increased. Production and stockpiling of enriched uranium will be continued. In addition, there are plans to improve the plant efficiency through technological advancements. The Cascade improvement program (CIP) will increase the output of the plant by about 4.8 million units of separative work [1] per year with no increase in electric power requirements and no increase in operating costs. Following the CIP, the plant electrical equipment can be uprated to increase power input. An increase in the power level of 1,300 megawatts electrical to a total nominal level of 7,400 megawatts electrical will result in additional separative work production of 4.5 million units of separative work per year.

The programed utilization of the full present plant capacity with the improvement and uprating programs and the preproduction of enriched uranium should meet the forecast foreign and domestic requirements for about the next decade. We expect that new enriching capacity will be required in 1982.

The worldwide production of refined uranium ore and the increasing market for it in the United States, Europe, and Japan make it inevitable that other countries besides the United States will seek national ownership and control of at least some portion of their production capacity. The AEC is therefore considering helping foreign governments to become at least partially self-sufficient by sharing with them our gaseous diffusion enriching technology in return for suitable royalties or other payments.

The Commission has also invited American industry to have access to the Commission's gaseous diffusion and gas centrifuge technologies. The promise of this action is that private industry will be able to provide most of the new enriching capacity when it is required.

[1] A "separative work unit" is a measure of the effort expended in the plants to separate a quantity of uranium into a portion enriched in uranium-235 and a portion depleted in uranium-235. The number of separative work units required to produce enriched uranium for fuel for any specific nuclear powerplant is related to the concentration of uranium-235 required, the concentration of the feed material, and the waste (tails) concentration.

CONVERSION OF NUCLEAR ENERGY INTO A CONTROLLABLE SOURCE OF HEAT

Nuclear reactors can be used for the production of various elements (such as different isotopes of plutonium) with heat being merely a byproduct. However, by far the predominant use of nuclear energy today is for the production of heat for steam-electric powerplants with residual isotopes being the byproducts. The initial design and construction of experimental reactors was performed by Commission contractors in Commission-owned laboratories such as the Oak Ridge, Argonne, and Brookhaven National Laboratories. Reactors for naval propulsion were also developed in the Commission-owned Knolls Atomic Power Laboratory and the Bettis Laboratory. The early experimental nuclear reactors which were operating in the early 1950's gave rise to the full-scale development of today's light water power reactors. These are of three kinds: Naval propulsion reactors, which use highly enriched fuel; and two kinds of reactors for the production of electric power, one using pressurized water as the coolant, the other using boiling water as the coolant.

The Atomic Energy Act of 1954 greatly stimulated private research and development, which ultimately resulted in the commercial application of the light water reactors for power production purposes. As I indicated earlier, we expect about 150,000 megawatts of nuclear electric powerplants to be in place by the end of 1980 and about double that amount by 1985. At the end of this century, we anticipate that over half of all of the electricity produced in this country will be from nuclear powerplants. It is also anticipated that by that time approximately half of the total energy consumed will be for the production of electricity. If these growth rates are realized, about one-fourth of the energy supply in the United States will be produced from nuclear fuel.

The Atomic Energy Commission still faces the major tasks of assuring the improvement of the nonbreeder type of reactors and developing and achieving commercial acceptance of the breeder reactor.

The breeder reactor is expected to utilize 60 percent or more of the potentially available energy in nuclear fuel, whereas the light water reactors utilize only 1 to 2 percent. The light water reactors are economic because of the relatively low cost of uranium. While the initial experimental breeder operated and produced electric power in 1951, the major effort in the United States leading toward commercialization of the breeder began about 1965. Today we are developing major industrial competence and arranging for a cooperative effort among the manufacturers, utilities, and the Commission for the design, development, construction, and operation of a breeder reactor that will be cooled by liquid sodium.

The development and commercial utilization of breeder reactors are widely recognized as essential if this country's energy requirements are to be met. We are expecting commercial acceptance of breeder reactors to take place in the mid 1980's.

As you know, on June 4 of this year, President Nixon sent to the U.S. Congress a comprehensive energy message which proposed a program to insure an adequate supply of clean energy for the years ahead. Very importantly, the message clearly stated that: "Our best hope today for meeting the Nation's growing demand for economical clean energy lies with the fast breeder reactor." To realize the immense

potential of the fast breeder, the President provided augmented funding for the LMFBR and related programs, and a charter for concentrated followup action by establishing a commitment to complete its successful demonstration by 1980.

As a result of the President's message and the recent actions by the Congress, an additional $50 million for the demonstration plant has been authorized, bringing the total direct cash contribution by the Government up to $100 million. Also, the level and type of support to be provided by the LMFBR base program has been increased significantly. These actions, along with the favorable results obtained from increased participation by the utilities, provide a firm basis for expectation that the United States will enter into a definitive cooperative arrangement for the first LMFBR demonstration plant by the end of this year.

Another reactor concept deserving mention is the high temperature gas-cooled reactor. Although not a breeder, the HTGR has a potential for achieving higher fuel utilization, lower fuel cost, improved thermal efficiency, and reduced environmental impact when compared with water reactors—although these advantages remain to be demonstrated in plants of commercial size. The utility acceptance of this type of reactor may provide a powerful stimulus to the water reactor manufacturers to make the fast breeder reactor available on an accelerated schedule. Interest in this type of reactor, whose large-scale demonstration in the Fort St. Vrain plant is now scheduled to begin in early 1972, received an important boost by the recent announcement by the Philadelphia Electric Co., of its entering into negotiations for the purchase of two 1,160 megawatt electrical HTGR plants. Moreover, the gas cooling technology developed in these HTGR plants will contribute to the technology of the gas-cooled fast breeder reactor.

CONTROLLED THERMONUCLEAR PROGRAM

As I indicated at the beginning, there are two other promising applications of nuclear energy which I will discuss briefly today. The first of these is the creation of a major new source of energy from nuclear fusion.

Nuclear fusion is the opposite of nuclear fission. Instead of splitting large atoms such as uranium (fission) low-mass elements such as deuterium are made to collide with each other and fuse (fusion). A very high temperature ionized gas, or plasma, must be produced and contained long enough for energy to be released. The AEC did not begin research on this task until 1952, but already the basic hurdles of making and heating plasmas have been cleared.

As the President's energy message indicates, recent progress in this program suggests that the scientific feasibility of fusion may be demonstrated in the 1970's. The potential advantages of fusion power in terms of fuel reserves, compatibility with environmental quality, and technological applications are so impressive that the CTR program should be accelerated. Some specific potential advantages are: the fuel is inexpensive and very plentiful; such reactors should be inherently safe; effects on the environment could be minimal; high thermal efficiencies are possible, and direct conversion of nuclear energy to electrical energy also may be achieved.

As a result of successes of the past few years, scientists are now quite confident about their ability to achieve adequate confinement of the hot, dense plasmas. Plans are now being laid for experiments which, if successful, would extrapolate the presently attainable plasma conditions very significantly—possibly to "break-even" conditions. Such experiments will, of necessity, operate at a higher power level and require larger subsystems than those now used.

I believe that it will be sometime past the turn of the century before fusion power becomes available commercially. I think in terms of 10 years to demonstrate scientific feasibility, another 10 years for the development of engineering capability and an additional 10 years for the demonstration of economic capability.

PLOWSHARE

The second additional nuclear application I wish to discuss is the use of nuclear explosives for peaceful purposes, or the Plowshare program.

As the President stated in his energy message, "additional supplies of gas will * * * be one of our most urgent needs in the next few years." Recognizing this fact, the AEC has been concentrating in its Plowshare program on developing nuclear gas stimulation technology which would permit the Nation to tap the 317 trillion cubic feet of gas estimated by the Bureau of Mines to be potentially available from the tight gas formations of the Rocky Mountain area. This is an amount greater than the Nation's current reserves of natural gas.

Projects Gasbuggy and Rulison, the two nuclear gas stimulation experiments conducted to date, demonstrated that nuclear explosions can significantly stimulate the flow of natural gas which is conventionally unattainable. The results of the 29 kiloton Gasbuggy nuclear detonation have indicated that projected total production would be five to eightfold more than that from a conventionally stimulated well in the same area. Preliminary data from production testing on the Rulison well show that significant stimulation has been achieved. The first 70 days of flow from the Rulison well produced 400 million cubic feet of natural gas, more than the first 5 years of production from nearby conventionally stimulated wells. Thus, we know that, technically, gas stimulation works.

Based on our experience to date, we have developed a proposed 4-year program to answer the remaining questions regarding practical application of this technology. The program consists essentially of four tests to develop a small-diameter, low-tritium, temperature-resistant explosive in the 100 kiloton yield range, and five to six production experiments to be carried out jointly with industry.

While gas stimulation is the near-term goal of the Plowshare program, other applications of underground nuclear explosions appear promising over a longer period. These include in situ retorting of oil shale, stimulation of geothermal heat, and the in-place recovery of certain mineral resources, principally copper.

Ultimately, legislation will be required amending the Atomic Energy Act to permit the provision of nuclear explosions to industry on a commercial basis. State and local governments will have a major practical role to play in that procedure, as they are invited to do today wherever a Plowshare experiment is undertaken.

OTHER ENERGY SOURCES

In viewing the Nation's energy needs, we have also examined the potential of several other sources of energy in addition to nuclear and fossil. In the judgment of most experts, other sources of energy are either insufficient to contribute to present needs on a broad scale or are too far in the future.

The world's potential tidal power, for instance, is estimated to amount to only 1 to 2 percent of the world's potential water power. The economics of developing suitable sites so greatly reduces even this limited potential that only one major tidal-electric plant is in operation today, that at La Rance Estuary, France, presently rated at 240 megawatts. The maximum generating capacity that might be developed using geothermal power is estimated as approximately equal to that of tidal power.

Hydroelectric power at present represents only about 4 percent of the Nation's overall consumption of energy, and there are relatively few acceptable sites left for hydroplants.

Solar energy, on the other hand, is virtually unlimited, but its intensity at the earth's surface is so small that its utilization for bulk power production is impractical. In a National Academy of Sciences report, for instance, it is estimated that a 1,000-megawatt electrical solar electric powerplant would require an area of approximately 16 square miles of the earth's surface to collect the necessary solar energy. Very advanced concepts, incorporating immense solar screens on satellites and laser beams for transmitting the power to earth have been proposed but are not to be considered a serious means at present for supplanting energy from fuels.

Magnetohydrodynamics (MHD) and the fuel cell are two developments whose technologies are sufficiently far advanced to be considered possible electric producers before the end of the century. These are power conversion devices, however, and not sources of energy. Their attractiveness lies in potentially higher cycle efficiencies for converting the energy of fossil fuels (and possibly heat from nuclear reactors in the case of MHD) into electricity. Serious materials and engineering problems remain to be solved before the technical and economic feasibility of MHD is demonstrated. Fuel cell applications so far have been mostly for space missions, but systems for civilian applications are under development. The lifetime of fuel cells needs to be greatly lengthened and their unit costs lowered by an order of magnitude before they would seem competitive. This plus the fact that extensive use of house-size units would involve a restructuring of the Nation's power system makes wide-scale use of fuel cells problematic.

CONCLUSION

In closing, I would like to emphasize our conviction that nuclear energy has an important, indeed vital, role in meeting this country's need for a continuing supply of clean energy. It is axiomatic that such a supply is essential to this Nation's economic growth, national defense, and environmental quality.

It is also the AEC view—many times expressed—that in the years ahead this Nation will need to use, in the most efficient manner possible, all of the practicable energy sources available to us—fossil, nuclear, and hydro—if future energy demands are to be met.

As we survey the prospects and problems for meeting our energy needs, it is evident that Government must prescribe the basic framework within which the energy industries carry out their tasks of insuring adequate and secure supplies at reasonable competitive costs. There has to be a continued dependence upon effective performance by sound and viable industrial firms. Government, through a combination of incentives, regulations, and direct support, must assure that the energy sector develops in a way that meet social, environmental, economic and defense requirements.

Major undertakings such as those necessary to prove out a new technology may require Government sponsorship. Government may well need to assist when the undertaking exceeds industry's capability and resources, when the probable benefits are widely dispersed throughout society, when the welfare of future generations is involved, when the country's national defense is involved, or when necessary to maintain effective competition among and between energy sources.

This completes my prepared statement. I will be glad to answer any further questions or provide additional information for the record.

A letter dated September 30, 1971, was received by the Chairman of the Joint Committee on Defense Production from Mr. Wilfrid E. Johnson, Commissioner, Atomic Energy Commission, relating to his testimony before this committee on September 23, 1971. The letter follows:

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., September 30, 1971.

Hon. WRIGHT PATMAN,
Chairman, Joint Committee on Defense Production, Congress of the United States.

DEAR MR. PATMAN: During the course of my testimony before the Joint Committee on Defense Production on Thursday, September 23, you asked for any thoughts I might have on the possibility of utilizing uranium as a supplementary basis for international liquidity to ease the pressures on gold reserves.

Our uranium represents a national asset that can be estimated at various values depending upon the assumptions one makes as to the availability and cost of extraction from our reserves. For example, the Atomic Energy Commission has a stockpile of about 50,000 tons of U_3O_8 equivalent which at a market price today of $6.50 per pound represents a value of $650 million. A reasonable estimate of our probable reserves of uranium at a price of $8 to $10 per pound amounts to about 1 million tons which represents a value on the order of $20 billion.

This is an asset which can have a substantial and favorable impact on our balance of payments, both as a source of foreign exchange through sales of uranium abroad and as a domestic energy source which can substitute for and therefore reduce our dependency on the importation of foreign fuels. Either of these uses would improve our balance of payments.

One of the important differences between uranium and gold lies in the fact that the value of uranium has historically been determined by its energy potential. Unlike gold, it has no intrinsic value other than

this. Initially and during the early days when uranium was relatively scarce, the principal application for this energy potential was in nuclear weapons and the price per pound of uranium was very high. Over the last decade with the extensive additions to uranium reserves that have come about as a result of Government support for an expanded exploration effort, together with the fulfillment of our uranium requirements for military purposes, the value of uranium has come to be defined as its fuel value in nuclear powerplants. Thus, unlike gold, which historically has been used directly as a medium of exchange, uranium's value in the marketplace has been established by its value as a consumable commodity.

What may not be appreciated at first blush is that when uranium is consumed in a nuclear reactor, it is destroyed as an element and the total quantity of the metal which exists on the planet is reduced by the amount consumed in the nuclear reaction. The uranium which is burned cannot be subsequently recycled or recovered.

It is for this reason that we are pursuing the breeder reactor which is so designed that for every gram of burnable uranium that is consumed more than a gram of recoverable plutonium is produced which in turn can be burned in a reactor. If it were not for the potential availability of the breeder reactor, our economically recoverable uranium reserves, even as extensive as they are, would be consumed in a matter of decades by the growing nuclear power industry. Because of the efficiency of the breeder in using our uranium fuel, the practical success of this machine will extend our uranium fuel reserves for hundreds of years. It will permit economic use of uranium recoverable at prices up to $50 per pound or more and thus make economically recoverable the uranium which occurs in very low grade ores. The advent of the breeder will also permit the use as fuel of our large stockpile of uranium depleted in its fissionable isotope which today has no practical fuel value for use in light water reactors. The value of uranium used in breeders will ultimately be independent of its isotopic content and will tend to approximate the cost of extraction.

In light of the foregoing, I believe that the monetization of uranium would involve some serious and probably insuperable practical problems.

First, over the next 20 years, we shall need uranium as a fuel and its price will rise—perhaps doubling in real terms. The price of a monetary metal should be reasonably stable.

Second, the world's supply of uranium will be reduced in absolute terms by the amount consumed by the nuclear power industry. The supply of a monetary metal on the other hand, should grow at a stable rate in order to provide for the expansion of reserves and the growth of trade.

Third, the demand curve for uranium in the United States to fuel our burgeoning electrical power industry will precede a parallel demand elsewhere in the world, so that, if we are to use our domestic uranium reserves to meet our energy requirements, surplus uranium for monetization is more likely to be available to the Canadians, South Africans, Australians and other foreign producing nations (including the Soviets) than to ourselves.

Fourth, if uranium were to be monetized, it would be necessary to establish a dual pricing system; one price being held relatively stable

at a level slightly above or equal to the fuel price and used for settling international accounts and the other fluctuating as the requirements for and supply of uranium as a fuel varied in relation to international energy needs and changing technologies of fuel use and economics. The fluctuations in uranium pricing that seem likely over the next two or three decades would put sharp pressures on the pegged price and have the effect of promoting uncertainty and instability in the international monetary system.

Finally, uranium has a strategic value in the fabrication of nuclear weapons and one could conceive of substantial international uneasiness should an accumulation of uranium by a nation through the settlement of accounts appear to be dedicated to supplying a nuclear weapons program.

It is for the foregoing reasons that I do not believe that the monetization of uranium would be in our national interest. Nevertheless, our uranium reserves constitute an important national asset which over time will have a favorable effect on our balance of payments.

Perhaps the most dramatic sector of the uranium market, insofar as its near-term potential for a favorable effect on the balance of payments is concerned, lies in the enriching business. "Enriching" refers to the industrial process performed now only in the Commission's gaseous diffusion plants whereby the ratio of fissionable uranium to fertile uranium as it exists in nature is upgraded preferentially in fissionable uranium so as to produce a more useful and efficient fuel for the present generation of light-water-cooled and moderated nuclear power generators. The United States today is virtually the sole supplier of this vital service to the free world and, although (for understandable reasons) we anticipate that the Europeans and Japanese will wish to have some alternative enriching capacity within the next 10 to 15 years, we estimate that by 1985 we will still be furnishing about two-thirds of the enriching services requirements of the free world outside the United States. This will represent a business with revenues in the early eighties of about $500 million per year and a cumulative contribution to our balance of payments of about $6 billion by 1985.

I hope the foregoing thoughts are useful to you and your committee and I would, of course, be pleased to furnish any further information you might desire.

Sincerely,

WILFRID E. JOHNSON,
Commissioner.

Chairman Patman submitted additional questions to Commissioner Wilfrid E. Johnson of the Atomic Energy Commission. Answers to these questions were submitted for inclusion in the record by Commissioner Johnson. The questions and answers are as follows:

Question 1. How many nuclear-fueled generating plants are in operation in the United States?

Commissioner JOHNSON. As of September 1, 1971, there were 22 nuclear-fueled central station generating units operable (achieved initial criticality) in the United States, including the N reactor, amounting to a total generating capacity of 9,132 net electrical megawatts (MWE). Of these 22 units, 3 units, including the Enrico Fermi No. 1 fast breeder unit, are not yet in full commercial operation.

Question 2. How many additional nuclear-fueled generating plants are under construction in the United States?

Commissioner JOHNSON. As of September 1, 1971, there were 55 nuclear-fueled generating units under construction (construction permit issued but the unit not yet having achieved initial criticality), amounting to a total generating capacity of 46,605 MWE.

Question 3. How does the capacity of the nuclear-fueled generating plants now in operation compare with the capacity of the nuclear-fueled generating plants under construction?

Commissioner JOHNSON. The capacity of the nuclear generating units operable is 19.6 percent of the capacity of nuclear-fueled generating units under construction as of September 1, 1971.

Question 4. Has the licensing and operation of nuclear-fueled generating plants lagged far behind earlier expectations?

Commissioner JOHNSON. As of September 1, 1971, there were 57 civilian nuclear-fueled generating units under construction or in the process of being started up (not yet in commercial operation), excluding the Enrico Fermi fast breeder plant. Recent reports from the electric utility owners show that 41 of these units have had their initial commercial operation dates rescheduled by the utilities to later than their originally announced dates. The total schedule slippage of the 41 units amounts to 555 months (46.3 years), which represents an average of 9.7 months slippage for the 57 units under construction or in startup.

Question 5. Is it impossible for an explosion to take place in a nuclear powerplant reactor?

Commissioner JOHNSON: It is impossible for a nuclear powerplant reactor to explode like an atomic bomb. An atomic bomb is designed to achieve the fastest possible rate of reaction—an uncontrolled or explosive reaction rate—once the bomb is triggered. To this end, materials highly enriched in fissionable isotopes are arranged in the bomb in such a way as to minimize the escape of the neutrons necessary to sustain an explosive chain reaction. Further, the reaction depends almost exclusively on the production of nuclear fission "prompt" neutrons, since the explosive energy is released in the very short time before the bomb literally blows itself apart. The safety features in a bomb are designed to prevent the bomb from being triggered, not to control the reaction once it is initiated.

A nuclear power reactor, on the other hand, is designed with exactly the opposite in mind—that is, to produce energy in the most carefully controlled way. Materials are arranged in the reactor to optimize these control functions. Coolant, structural materials, and control rods all serve to enhance control. Also the fissionable material in a reactor is only a small percentage of the total material involved, in contrast to the nuclear assembly in a bomb.

Despite the inability for a reactor to explode like an atomic bomb, this is not to say that under certain highly unlikely conditions, a substantial rapid energy release from a nuclear reactor could not occur. The safety reviews of nuclear reactors by the AEC include considerations of just such a potential event. The energy releases that would be involved, even in the unlikely event of all control rods failing, would range from a few pounds to less than a ton of equivalent TNT, rather than the thousands and millions of tons of equivalent TNT generated by a properly functioning atomic bomb.

Question 6. On the basis of future projections for nuclear energy, how many years will the known uranium reserves last?

Commissioner JOHNSON: Known reserves in the United States of U_3O_8 at $10 per pound at the beginning of 1971 were 390,000 tons, an amount equal to projected requirements through about 1983. There are estimated additional resources of 680,000 tons in presumed extensions of known deposits and ore trends in the known uranium districts. Together these resources would equal requirements projected to the early 1990's. Higher cost resources are also known to exist. At $15 per pound, estimated resources are 1,620,000 tons of U_3O_8. These resources are about equal to projected requirements through the end of the century. With introduction of the breeder reactor during the 1980's, higher cost resources will be economically usable, providing resources which should be adequate to last for centuries.

Question 7. Have our goals been met on the development of the breeder reactor?

Commissioner JOHNSON. The overall objective of the liquid metal fast breeder reactor (LMFBR) program is to achieve the early establishment of a self-sustaining, competitive LMFBR industrial economy.

The achievement of this objective requires the successful accomplishment of three phases of work: (1) a research and development (R&D) phase to confirm the technical aspects of the concept, (2) an engineering and manufacturing phase to provide for the development of a broad industrial base, and (3) a utility commitment phase to purchase, build, and operate commercial LMFBR's.

To accomplish the breeder objective, we are proceeding along two essential and complementary lines—the technology effort and the demonstration plant program—coupled together by the vital engineering development, manufacturing and proof testing activities.

The technology effort involves R&D on fuels and materials, control instrumentation design, the determination of physics and heat transfer data, basic engineering to provide the data for component design, and the construction and operation of facilities to provide facility design information.

The engineering and manufacturing phase involves the manufacture and testing of fuels, cladding and core hardware, the design, fabrication, and testing of components and systems, the fabrication and testing of reliable instrumentation, the conduct of proof testing and quality assurance programs, and the development and application of codes and standards.

The utility commitment phase is designed to enable utilities to be prepared to accept the financial risks resulting from the uncertain costs, schedules, and plant factors associated with demonstration plants and first-of-a-kind power plants, and to become knowledgeable in the purchase, management of construction, operation, and maintenance of commercial LMFBR's.

Question 8. What are the future projections as to the year the breeder reactor will be operating on a commercial basis?

Commissioner JOHNSON: The commercial introduction of the LMFBR is presently projected to occur in the mid-1980's. This projection is based upon the assumption that the Government will support an LMFBR program of about $2.4 billion (in 1970 dollars) through the fiscal years 1972–88.

Commercial introduction is defined as taking place over the time period during which the transition of a workable, demonstrable, technical concept to a commercially available, operationally reliable power plant occurs. The LMFBR concept will have been introduced in the year in which a significant number of commercial-sized LMFBR's are placed into operation.

Question 9. Would the breeder reactor use lower grades of uranium?

Commissioner JOHNSON. The fast breeder reactor (FBR) employs plutonium as "fissile" material in its fuel and uranium as "fertile" material that is converted into plutonium during the irradiation of the fuel. Low grade uranium, which has a preponderance of the fertile uranium-238 isotope and less of the uranium-235 fissile isotope than is the case of fuel for converter reactors, is the ideal fertile material for the FBR. Vast amounts of depleted (low grade) uranium which would be useless otherwise will be employed gainfully in the FBR as fertile material for conversion into plutonium for new breeder fuel. This depleted uranium comes from the reprocessing of the spent fuels of the present light water reactors (LWR), and from the residue or "tails" of uranium left over from the separative process in the Government's nuclear fuel enrichment plants. The amounts of low grade uranium available from these two sources will be sufficient for fast breeder plant use well into the next century without having to resort to the mining of new uranium ore for use in breeder reactors. This employment of depleted uranium is another instance of the FBR being the natural advanced reactor development to follow the commitment to the present LWR plants.

Question 10. What would be the estimated number of years the lower grades of uranium in the United States suitable for the breeder reactor would supply our needs?

Commissioner JOHNSON. It has been estimated that with appropriate exploration at least 2,400,000 tons of U_3O_8 would be available in the United States at $30 per pound. If we assume that between 400 to 600 fast breeder reactors of 1,000 megawatts (MW) capacity will be in service about the year 2000, they would require between 800 to 1,200 tons of U_3O_8 annually. Thus, $30 uranium would be adequate to operate that capacity for many hundreds of years. Much more costly uranium can also be used in breeder reactors with minor effect on the cost of power. At $50 per pound, resources are estimated at 8 million tons and at $100 more than 17 million tons. This is adequate to fuel a breeder reactor economy many times the capacity indicated for many hundreds if not thousands of years.

Question 11. To what extent should other sources of energy be developed as an alternative to the breeder reactor?

Commissioner JOHNSON. There are no sources of energy other than full utilization of fission energy by means of the breeder reactor that can be expected to be developed in time to meet the need to supplement the energy resources on which the Nation has been relying. Development of this breeder reactor will enable nuclear powerplants to assume the greater part of base-load electrical generation for many years and permit best use of the Nation's irreplaceable fossil fuel reserves. This will allow adequate time for work on other long-range concepts, such as fusion power.

In accordance with the President's energy message of June 4, 1971 to the Congress, the Atomic Energy Commission is continuing high

priority efforts for the success of the FBR program. The successful demonstration of the LMFBR plant by 1980 is a key element in that program.

The need for the timely introduction of the breeder reactor is evident from a brief examination of the Nation's energy situation. Although all feasible energy resources will have to be utilized to meet burgeoning energy requirements over the next few decades, by the year 2000 over one half of the Nation's electrical energy requirements are projected to be generated in nuclear powerplants. In order for nuclear power to assume this task successfully, it is planned that the current LWR plants will be joined by the more efficient fast reactor plants. Although presently competitive economically and environmentally with fossil-fueled plants, LWR plants extract only 1 to 2 percent of the energy available from their uranium fuel. Each FBR plant, however, will produce more fissionable material than it consumes. Introduction of the FBR will extend the use of our uranium resources from decades to centuries. Also, since the FBR uses the uranium cycle, it complements the present LWR plants that predominate in the United States, which also employ this cycle. The transition from LWR plants to fast breeder plants is seen as an orderly process in which the plutonium produced by the former will supply the fissile material for the latter until the fast breeder plants have operated long enough to be completely self-sufficient in producing their own plutonium. Furthermore, because of its superior economics, the gross benefit in electrical energy costs to the Nation from commercial introduction of the FBR in the mid-eighties could be more than $350 billion in terms of today's dollars over the following 35-year period.

Despite the rapidly increasing contribution by nuclear power, fossil fuels will still be called on to supply the greater part of the Nation's overall energy requirements for the remainder of this century. Natural gas is already in short supply, with U.S. reserves presently being proved in at less than consumption rates. Proven oil reserves in the United States, aside from Alaska, are sufficient for less than 10 years at present consumption rates. The Alaskan find adds several years to U.S. reserves. Oil is imported from foreign sources but petroleum production is due to decline worldwide after the turn of the century. Thus, conventional petroleum resources cannot be considered truly long range. The measures for coal gasification development and investigation of our shale oil resources included in the President's energy message are recognition of the need to insure that energy will be available in the fossil fuel forms required for utilization.

Although coal is the only fossil fuel available in the United States of long range significance, its exhaustion would be hastened if it were to serve as the main energy source once natural petroleum resources are no longer economically available. Also, fossil fuels are an irreplaceable treasure for mankind that should be utilized to maximum advantage. In this respect, the industrial demand for fossil fuels as raw materials for manufacture is continually increasing. For instance, in 1969 16 percent of the coal mined in the United States went to produce coke for domestic metallurgical use. The petrochemical and chemical industries are large consumers of petroleum. In order to preserve this irreplaceable resource for better uses than burning, mankind must take advantage of suitable alternatives for the production of energy.

Through the development of the breeder reactor, nuclear power from the fissioning of the atom will serve as the necessary complement to the other available sources of energy for many centuries. As already discussed, fossil fuels, including coal, do not constitute an energy resource of comparable magnitude. Available resources of fossil fuels will be needed to meet such continuing demands as raw materials for manufacturing, fuel for intermediate and peaking electric generating units, and fuel for certain modes of transportation and heating. Hydroelectric power at present serves only about 4 percent of the Nation's overall consumption of energy, and there are relatively few economical sites left for hydro plants.

The AEC is conducting controlled thermonuclear research (CTR). The objective of the CTR program is to create a major new source of energy from nuclear fusion. As the President's message indicates, recent progress in this program suggests that the scientific feasibility of CTR may be demonstrated in the 1970's. The potential advantages of fusion power in terms of fuel reserves, compatibility with environmental quality, and technological applications are so impressive that the CTR program should proceed as rapidly as technological progress permits. Some specific potential advantages are: the fuel is inexpensive and very plentiful; such reactors should be inherently safe; effects on the environment could be minimal; high thermal efficiencies are possible, and direct conversion of nuclear energy to electrical energy also may be achieved.

A realistic appraisal of the role that fusion power may play in meeting energy requirements must take into account the present status of its development and the time that would be needed to bring such a concept to fruition. It takes 30 to 50 years to bring a new technology from its initial developmental phase to that stage where it plays a major role in the economy. In the case of fission reactors an early event in this time scale was the demonstration of a controlled fission chain reaction at Stagg Field in December 1942. An equivalent demonstration of the scientific feasibility of fusion power has not been achieved as yet.

The harnessing of fusion power could solve man's energy needs for millennia. However, commercial realization of its potential, if successful, is not likely to be achieved until the 21st century. Meanwhile, the technology of the nuclear fission breeder reactor is already in hand.

Other sources of energy, in the judgment of most experts, are either insufficient to contribute to present needs on a broad scale or are too far in the future to substitute for the breeder reactor. The world's potential tidal power, for instance, is estimated to amount to only 1 to 2 percent of the world's potential waterpower. The economics of developing suitable sites so greatly reduces even this limited potential that only one major tidal-electric plant is in operation today, that at laRance Estuary, France, presently rated at 240 MW. The maximum generating capacity that might be developed using geothermal power is estimated as approximately equal to that of tidal power.

Solar energy, on the other hand, is virtually unlimited, but its intensity at the earth's surface is so small that its utilization for bulk power production is impractical. In a National Academy of Sciences report, for instance, it is estimated that a 1,000 MWe solar electric powerplant would require an area of approximately 16 square miles

of the earth's surface to collect the necessary solar energy. Very advanced concepts, incorporating immense solar screens on satellites and laser beams for transmitting the power to earth have been mentioned but are not to be considered a serious means at present for supplanting energy from fuels.

Magnetohydrodynamics (MHD) and the fuel cell are two developments whose technologies are sufficiently far advanced to be considered possible electric energy producers before the end of the century. These are power conversion devices, however, and not sources of energy. Their attractiveness lies in potentially higher cycle efficiencies for converting the energy of fossil fuels (and possibly heat from nuclear reactors in the case of MHD) into electricity. Serious materials and engineering problems remain before the technical and economic feasibility of MHD is demonstrated. Fuel cell applications so far have been mostly for space missions, but utility use is under development. The lifetime of fuel cells needs to be greatly lengthened and their unit costs lowered by an order of magnitude before they would seem competitive. This plus the fact that extensive use of house-size units would involve a restructuring of the Nation's power system make wide scale use of fuel cells problematic.

Question 12. Does a nuclear reactor add minute amounts of radiation?

Commissioner JOHNSON. During regular operation a nuclear powerplant does add minute amounts of radioactive products to its surrounding environment. These are wastes of low radioactivity level that are released to the air and to the cooling water discharge strictly in accordance with AEC regulations. As discussed further in the answer to question 17, the radioactivity in these nuclear powerplant effluents is at levels that keep resultant radiation exposures of persons living near the plant to only a few percent of the average natural background radiation.

Accidental emissions to the environment are guarded against by defenses in depth, also subject to AEC regulation, which include reactor and fuel design margins, multiple fission product barriers such as fuel cladding and reactor coolant pressure boundaries, engineered safety features, and containment structures, The effectiveness of this protection is evidenced by the fact that no member of the public has been subjected to radiation from a nuclear powerplant in the United States in excess of Federal Standards.

Question 13. Is there any reason for limiting the number of nuclear power plants because of radiation?

Commissioner JOHNSON. The AEC's regulation of nuclear power facilities and its joint efforts with industry in the development of nuclear waste management systems are directed to making the benefits of nuclear plants' power available without their number being limited because of radioactivity.

As discussed in the answers to questions 12 and 17, the low-level radioactive waste releases of nuclear powerplants themselves are minute. The already permissible concentrations of these releases are rapidly dispersed beyond the limits of the powerplant sites, so that even in the case of several nuclear plants being located within fairly close proximity to each other the radiation exposure to the general public in the area would be very low compared to the standards established in accordance with the recommendations of national and international standards groups.

The nuclear fuel containing the high-level radioactive products of nuclear powerplants is shipped in accordance with strict AEC and Department of Transportation regulations to fuel reprocessing plants. Here the high-level wastes are treated and temporarily stored for eventual conversion to solid form and permanent storage in a Federal repository. The AEC proposes to demonstrate the suitability of such permanent storage in salt mines near Lyons, Kans.

The environmental aspects of natural and man-made radioactivity are discussed quite thoroughly in the publication of the Hearings before the Joint Committee on Atomic Energy in October and November of 1969 and January and February of 1970. Special waste management considerations are described therein, including the disposal of krypton 85 and tritium.

Krypton 85 is a radioactive noble gas produced in fission, with a half-life of 10.8 years. Release of krypton 85, which occurs mainly during fuel reprocessing, but also to a small extent from nuclear power reactors, will increase in proportion to the amount of electrical power provided by nuclear reactors. The AEC and the U.S. Public Health Service have recently completed studies on the worldwide effects of the release of this noble gas to the environment. Their findings indicate that even though present plant design and operating methods are used through the year 2000, radiation exposures to the general public resulting from the release and worldwide dispersion of krypton will not exceed approximately 1 percent of the radiation protection guides recommended by national and international standards groups. As larger fuel reprocessing plants are built, it may become necessary to remove krypton from gaseous effluents in order to maintain local exposure limits within applicable radiation guides. This possibility is recognized and R. & D. on advanced systems for noble gas removal is now being done in the Commission's R. & D. program and by industrial firms.

Tritium, an isotope of hydrogen having a half life of 12.3 years, also is not separated by present waste-handling techniques because its chemical behavior is very similar to that of ordinary hydrogen. Its distribution throughout the biosphere from nuclear powerplants and reprocessing plants would increase for some time as generation of power in nuclear plants increased. With the present mix of LWR plants the tritium activity in the environment from nuclear power production could reach that of the residual tritium from the hydrogen weapons tests. However, even then the radiation exposure to the public from all sources of tritium would be orders of magnitude less than the Federal standards. R. & D. in support of effluent control includes investigation of deep well injection of tritium into a suitable geologic formation as a means of reducing the introduction of this nuclide into the biosphere. Also, the commercial introduction of the LMFBR powerplant expected in the mid-1980's offers the potential for less production of tritium and more complete control of its release to the environment.

Although we confidently expect releases from power reactors will continue to be low, releases from the total numbers of reactors which are projected for certain geographical areas 15 to 20 years from now will continue to be examined. For example, we are planning to examine the potential levels of tritium in a large river resulting from tritium releases from the projected number of nuclear facilities—say in 1985—

in a river drainage basin. We are also planning to examine the cumulative effects from releases of noble gases in a given area and the cumulative effects in an estuary where food taken from the water is the important pathway of exposure. Regulatory requirements will continue to be reviewed to provide assurance of their adequacy in light of the results of such studies.

Question 14. To what extent have there been objections to the construction of new nuclear plants?

Commissioner JOHNSON. That public opinion has been influenced against nuclear power in recent years is evidenced by national public opinion surveys conducted for the electric companies public information program (PIP). Asked whether they would support or oppose a nuclear powerplant in their town, in 1967 62 percent of the respondents expressed "favor," 17 percent "opposed," and 21 percent "no opinion." In 1970, 43 percent of 1,200 respondents said "favor," 30 percent "oppose" and 27 percent "no opinion."

Despite this concern about nuclear power, active opposition to new nuclear plants had been limited until recently to relatively few projects (although AEC operating licenses for nuclear plants already constructed are being contested in about a half-dozen cases). However, one recent action on the part of a group critical of implied effects of nuclear plant operation on the environment has had a widespread effect on nuclear powerplant licensing. On July 23, 1971, the Court of Appeals for the District of Columbia Circuit decided in the Calvert Cliffs litigation that under the provisions of the National Environmental Policy Act of 1969 (NEPA) the AEC had to revise its rules governing consideration of nonradiological environmental issues in the licensing of nuclear facilities. Based on present AEC estimates, the court's decision will directly affect 63 license applications involving 91 nuclear power units, representing more than 80 million kilowatts of generating capacity. Delays on the order of 6 months are estimated in decisions on issuance of operating licenses and construction permits that were near the decision point last July.

Question 15. What is the leadtime for the construction of a nuclear powerplant?

Commissioner JOHNSON. As of June 1971 the average time from order of the nuclear steam supply system (NSSS) to initial commercial operation scheduled by utilities for nuclear powerplant units ordered in 1970 and 1971 was approximately 6 years. If 6 months is added to the front end of this period for preparing the specifications, receiving the bids and awarding the order for the NSSS, the construction leadtime in the broad sense for a nuclear unit ordered today can be considered as 6½ to 7 years. If a second unit is ordered concurrently with the first one, the second unit generally will lag the first by several months.

This 6½- to 7-year period commonly is broken down into 6 months for specification, bidding, and awarding the order for the NSSS (and often the turbine-generator concurrently); 6 months or longer for preparation of the preliminary safety analysis report (PSAR) and utility environmental report; 18 months for receipt of a construction permit from the AEC, with the tendency for this time to be prolonged recently by additional consideration of environmental factors in the licensing procedure; 42 to 46 months for actual construction and some preoperational testing; and 6 to 8 months or longer for fuel loading and operational testing.

Question 16. Has the leadtime for the construction of nuclear powerplants increased substantially as a result of objections from the public?

Commissioner JOHNSON. Leadtime allowed for the construction of a nuclear powerplant undoubtedly has been influenced recently by objections from specific public groups. However, it is still early to judge the overall effect of this opposition in quantitative terms on project schedules. It is likely that utilities may add some months to both the front and rear ends of the project schedule to account for additional environmental licensing requirements stemming from the recent court of appeals decision in the Calvert Cliffs litigation and for intervention of public groups opposing the construction and operation of nuclear powerplants.

As yet, these objections have not been reflected in the utility schedules of the majority of the nuclear units presently under construction, although some of those close to the point of receiving operating licenses may soon extend their schedules as the result of additional environmental reviews resulting from the Calvert Cliffs decision.

Question 17. Have the emission limits for nuclear powerplants been redefined recently?

Commissioner JOHNSON. Although the National Council on Radiation Protection and Measurements (NCRP) reaffirmed in January 1971 the overall basic standards that apply to all radiation sources other than those for medical uses and from natural sources, the AEC has reemphasized the importance of nuclear powerplants emitting the lowest levels of radioactivity to the envionment practicable with the latest technology for LWR nuclear powerplants.

On December 3, 1970, the AEC announced its policy of keeping radioactivity in effluents and resultant radiation exposures to levels which are "as low as practicable." At that time, the Commission said it would consider providing more definitive guidance at a later date. On June 7, 1971, the Commission announced proposed guidance on design objectives for LWR nuclear powerplants which would carry out the policy announced December 3, 1970. At present, comments or suggestions are being entertained from the public in connection with these proposed amendments.

The numerical guidance is in terms of emission limits on quantities and concentrations of radioactivity in plant effluents. Under the proposed guidelines, nuclear powerplants would be designed to limit radioactivity in effluents to levels that would keep resultant radiation exposures of persons living near the plants to less than 5 percent of the average natural background radiation in the United States. Such exposures would be about 1 percent or less of the Federal radiation protection guides for individual members of the public.

Question 18. Are there limits as to the number of nuclear powerplants which could be constructed in this country because of requirements for cooling water or other factors?

Commissioner JOHNSON. Cooling water requirements will not be a limiting factor in the total number of nuclear powerplants that could be constructed in the United States. In those sections where sufficient cooling water for once-through operation is not available, present alternatives such as closed-cycle cooling water systems employing cooling ponds or evaporative type (wet) cooling towers can be employed. Future plants can even be expected to use still other alterna-

tives such as dry-type cooling towers or offshore plant siting (on barges or artificial islands).

Question 19. How does the cost of electricity produced in nuclear powerplants compare with the cost of electricity produced in fossil-fueled plants?

Commissioner JOHNSON. The cost of electricity produced in the larger, more recent nuclear powerplants compares favorably with that of fossil-fueled plants. For instance, on the basis of common evaluation parameters [1] the average generating cost of electricity in 1970 of the Haddam Neck (575 MW), San Onofre (430 MW), Oyster Creek (560 MW), Nine Mile Point (625 MW) and R. E. Ginna (420 MW) nuclear powerplants was 6.72 mills per kilowatt hour (kw.-hr.). The comparable cost of five modern fossil-fueled generating stations, Ravenswood, Eddystone, Keystone, Kincaid, and station No. 7 (of the Rochester Gas & Electric Co.), on the same basis is 7.59 mills per kw.-hr.

A very important factor to bear in mind in comparing the costs above, however, is that four out of five of the nuclear plants mentioned were built under turnkey contracts where the suppliers (the Westinghouse and General Electric Cos.) bore the financial risks. The unit capital cost reported by the utility for the Nine Mile Point plant was significantly higher than that for the other nuclear plants, so that it is a good assumption that the suppliers absorbed some capital costs in the case of at least some of the turnkey plants. This would tend to make the average generating cost for the five nuclear plants somewhat higher on the basis of nonturnkey construction.

The nuclear plants mentioned were ordered in the 1962–65 period. The capital costs of both nuclear and fossil-fueled plants and fossil-fuel costs have risen considerably since that time. Also, nuclear plants are no longer being ordered on a turnkey basis in the United States. Therefore, the choice between nuclear and fossil-fueled units today is not affected by the average costs indicated except to the extent that the practicality of nuclear power has been proven. Nevertheless, on a case-by-case basis, nuclear powerplants are being chosen over fossil-fueled units in numerous instances, based on superior projected economics, satisfactory reliability, and uncertainity of fossil fuel supplies over plant lifetimes. As of September 1, 14 nuclear power units totaling 13,616 MWE had been ordered in 1971. During the first 6 months of 1971 nuclear powerplants represented about one-half of all steam-electric powerplant capacity ordered in the United States.

Question 20. Is the comparative cost of electricity produced in nuclear plants becoming more favorable as more nuclear plants are constructed?

Commissioner JOHNSON. Although nuclear powerplants are more capital intensive than fossil-fuel plants for equivalent baseload service and nuclear plants experienced somewhat higher capital cost trends in the late 1960's, the comparative cost of electricity produced in nuclear plants should become more favorable as more of them are constructed in this decade. Experience in manufacturing, standardization of design, and resulting better management of construction at the site should cut the capital costs of nuclear plants. Also, nuclear units are susceptible to greater economy of scale and appear to maintain this advantage in unit capital costs over fossil-fueled units even as individual ratings move out beyond 1200 MWe.

[1] Unit capital carrying charges for generation costs based on an assumed 14 percent annual capital carrying charge and correction of actual plant capacity factors to 80 percent. Data taken from that submitted by the utilities to the Federal Power Commission (FPC) for calendar year 1970.

The greatest advantage of nuclear powerplants lies in fuel costs, however. LWR plants recently put in service are already experiencing fuel cycle costs of about 1.80 mills per KW. By 1980 this level is expected to decrease to 1.5 to 1.7 mills, going to 1.4 to 1.6 mills by 1985 (in terms of 1970 dollars). These reductions are based on expected improvements in the efficiency of using nuclear fuels and in nuclear fuel processing costs, particularly due to greater volume production in the fabrication and reprocessing stages of the nuclear fuel cycle.

Fossil fuel costs, on the other hand, have risen sharply in the last 2 years. In 1968 the average long-term price of coal for powerplants was projected to be $6 per ton. By mid-1970 this value had increased to $8 per ton. Oil prices have increased even more than coal prices. In 1968 residual oil prices without sulfur content specification were about $1.80 per barrel. Late 1970 east coast, low sulfur, residual oil prices were about $3 per barrel. Natural gas is already in short supply for generating station use. Due to rising production and transportation costs, fossil fuel prices are expected to continue to rise, although probably not so sharply as over the past 2 years. The opposite trends of nuclear and fossil fuel costs are expected to improve the future competitive position of nuclear power.

Question 21. Is there an estimate of the cost of electricity to be produced from breeder reactors.

Commissioner JOHNSON. It was estimated in the April 1969 Cost-Benefit Analysis of the U.S. Breeder Reactor Program (WASH 1126) that an LMFBR plant would deliver energy in 1990 for about 4.1 mills per kw.-hr. in 1969 dollars. The current estimate is 4.8 mills per kw.-hr. in 2000 in 1970 dollars. The report of the Edison Electric Institute (EEI) Reactor Assessment Panel, EEI Publication No. 70–30, forecasts LMFBR energy costs to be 5.5 to 6.5 mills per kw.-hr. in 1985; 4.5 to 5.5 in 1990; and 3.9 to 4.7 in 2000.

Question 22. What percentage of uranium used currently is from domestic sources?

Commissioner JOHNSON. All uranium currently used in U.S. reactors is from domestic sources. Restrictions on enrichment of foreign uranium for domestic use effectively prevent foreign sales in the U.S. market. The possibility of modifying restrictions on enrichment of imported uranium for domestic use is under review.

Question 23. To what extent are we dependent on foreign sources for the construction and operation of nuclear plants?

Commissioner JOHNSON. The United States is not dependent on foreign sources for the construction and operation of nuclear powerplants. Four U.S. manufacturers, the General Electric Co., the Westinghouse Electric Corp., the Babcock and Wilcox Co., and Combustion Engineering Inc. supply complete nuclear steam supply systems (NSSS) for the LWR units that comprise the great majority of nuclear powerplants in operation or on order in the United States today. The Gulf General Atomic Co. supplies the NSSS for the High Temperature Gas Reactor (HTGR) type of plant. The General Electric Co., Westinghouse Electric Corp. and Atomics International Division of the North American Rockwell Corp. have indicated to the AEC their willingness to build nuclear steam supply systems for an LMFBR powerplant.

As far as nuclear fuel materials mining, processing, and fabrication are concerned, there is ample domestic capability present or planned

in all aspects of the nuclear fuel cycle. In 1970 the domestic uranium industry's milling capability was about 15,000 tons of uranium concentrate (U_3O_8) annually in 17 mills. By 1972–73 this capability is planned for expansion to 20 mills having an annual capacity of about 19,000 tons. All of the reactor system suppliers mentioned previously are capable of designing and fabricating nuclear fuel for their reactor systems. There are also several independent U.S. companies with present or planned capacity for fabricating nuclear fuel. Except for the enriching and reprocessing of irradiated (spent) fuel, capability presently exists with at least two U.S. companies for each of the remaining steps in the LWR nuclear fuel cycle. In the case of reprocessing, the Nuclear Fuel Services, Inc. plant is the only U.S. commercial facility in operation. However, the General Electric Co. will begin to provide fuel reprocessing next year, to be joined later by the Allied-Gulf Nuclear Services Co.

Domestic manufacturing capacity of nuclear materials and components is also adequate for domestic requirements. In the case of several major components in the LWR nuclear steam supply system, foreign sources of supply have been evident primarily from an economics rather than capacity point of view. In the area of reactor pressure vessels, foreign involvement was first established when six out of 14 vessels were transferred out of the Babcock & Wilcox Mount Vernon plant in 1969 to foreign companies for completion of work. Since that time an additional 10 orders were let to offshore suppliers of this major component, representing in total 16 vessels or about 16 percent of the market since 1966. Turbine-generators is another area where foreign entry has been successful to some extent, in both nuclear and fossil-fueled electric powerplants. Here again, however, domestic capability and capacity are sufficient to meet requirements for some years to come.

There is importation from Australia of a sizeable portion of the zircon used in this country for manufacture of the zirconium used for the cladding of LWR fuel, but zircon ($ZrSiO_4$) is found in beach sands throughout the world, with most American zircon coming from Florida beaches. Zirconium metal requirements account for only a small portion (less than 5 percent) of the zircon consumed in this country.

The domestic supply of equipment for the more conventional part of nuclear powerplants, including items such as turbine-generators, electrical apparatus, condensers, heat exchangers, pumps and piping, is more than adequate. American architect engineers and construction firms are not only designing and building the majority of the 100 odd nuclear powerplants presently under construction or on order in the United States but are involved in nuclear projects overseas also.

Finally, there has been no shortage of personnel for operation of nuclear powerplants to date, although the AEC has been engaged actively during the last few years in cautioning the industry on personnel needs and in fostering the orientation and training of utility personnel for this purpose. Two nuclear plant control room simulators are now in service for training of nuclear plant operators, one operated by the General Electric Co. and the other by the Babcock & Wilcox Co., with a third inaugurated this year by Westinghouse. A number of nuclear consulting firms and universities are also engaged in all phases of nuclear power education and training, accommodating foreign as well as American citizens.

Question 24. Are there estimates on the amount of energy which will be required to operate environmental equipment?

Commissioner JOHNSON. To our knowledge no estimates have been published as yet as to the overall amount of energy that will be required to operate environmental equipment in the United States. However, some idea of the magnitude of the energy requirements for routine environmental cleanup is had from the fact that one of the two largest loads on New York City's Consolidated Edison system is that for sewage treatment.

There are examples of individual environmental equipment requirements for energy. For instance, electrically powered machines for shredding, baling and compressing old auto bodies require up to 7,500 kilowatts each. The EEI reports that five paper mills on one electric utility's system will add about 30,000 kilowatts of load by mid-1972 for operation of equipment to enable the mills to meet the State's environmental standards.

A fact sometimes overlooked (although not by utilities) is that environmental equipment in steam-electric generating stations not only consumes electric energy for its operation but also can reduce the useful output of the station. The capitalized additional operating costs and capability penalty of a closed-cycle cooling tower system for a large LWR nuclear plant can amount to well over a million dollars, not counting the first cost of the cooling tower system itself.

Question 25. Will the cost of equipment for meeting environmental standards be less for nuclear powerplants than fossil-fueled powerplants?

Commissioner JOHNSON. It is difficult to say which type of steam-electric generating plant, the fossil-fueled or the nuclear-fueled, will be more affected by the economics of meeting environmental standards. The best that can be estimated at this time is that the overall environmental costs associated with nuclear powerplants should not be more than those of coal or oil-fired powerplants. Other factors such as future fuel availabilities and prices are likely to be more influential in the selection of a fossil-fueled or nuclear-fueled unit for each generating addition. This selection will continue to be on a case-by-case basis, depending on the conditions peculiar to each site and system.

A brief comparison of the capitalized costs associated with the recent environmental requirements for new generating powerplants reveals why no clear-cut advantage for either type of plant is apparent at present. Environmental costs for steam-electric generating plants correspond to three main categories: thermal effects, air pollution, and waste management. Cooling towers increasingly are being selected to meet thermal effects requirements on new steam powerplants. Capitalized costs for presently available towers run about $10 to $15 per kilowatt of capacity for fossil-fuel plants and about $15 to $22 for equivalently rated LWR nuclear powerplants. (Cooling ponds and other means are also used to minimize thermal effects where possible and are generally less expensive.) Capitalized costs for equipment at coal-fired powerplants to remove particulates and sulfur dioxide from their stack gases are about $15 per kilowatt and up. Augmented waste management equipment at nuclear powerplants to meet the most stringent radioactivity emission requirements is estimated at $1 to $4 per kilowatt (added waste management costs are associated with some stack gas cleanup processes for fossil-fuel plants also—additional ash disposal, for instance—but is not counted here). The assumption

that all the equipment mentioned would be needed at a given plant site means a total added cost of $25 to $30 for a coal fired plant and $16 to $26 for an equivalently sized nuclear plant.

The environmental costs of nuclear power will be lowered with the introduction of new reactor types. Both the HTGR and LMFBR nuclear powerplants will have plant thermal efficiencies as high as those of large, modern fossil-fueled plants and will reject equivalent amounts of waste heat to condenser cooling water. Accordingly, costs associated with cooling towers or cooling ponds for HTGR and LMFBR plants will be no greater than with equivalently rated fossil-fueled plants.

Question 26. Are the newer nuclear plants more efficient than the earlier nuclear plants?

Commissioner JOHNSON. Newer nuclear plants are more efficient than earlier ones. The net plant thermal efficiency, which is the ratio expressed as a percent of the electrical megawatts output of the plant to the thermal megawatts produced by its reactor, is a parameter for measuring this improvement. The net plant thermal efficiencies of the Dresden No. 1 and Yankee (Rowe) LWR plants, which went into service in 1960 and 1961 respectively, are less than 30 percent. The net plant thermal efficiencies of LWR plants now going into operation are about 32 percent and those of LWR plants recently ordered are projected to be between 33 and 34 percent.

The net plant thermal efficiencies of the advanced converter HTGR nuclear plants are projected to be 39 percent to 40 percent. For instance, it is reported the 330 MW Fort St. Vrain HTGR plant scheduled to start commercial operation in 1972 will have a net plant efficiency of 39.2 percent. The net plant efficiency of the two new 1150 MW HTGR units recently announced by the Philadelphia Electric Company is reported as 39 percent.

The net plant efficiencies of the FBR plants are expected to be even better. Studies done by various reactor system suppliers of conceptual 1000 mw LMFBR plants projected to enter commercial operation by the mid-1980's indicate net plant efficiencies of 40.2 percent to 41.7 percent. A benefit of such higher plant efficiencies is the rejection of less waste heat to the environment per unit of useful output, which will result principally in thermal effects from advanced type nuclear plants being no greater and sometimes less than those of the most modern fossil-fueled power plants.

Question 27. What are the projected expenditures on the development of the breeder reactor from year to year in the foreseeable future, by Government and by private industry?

Commissioner JOHNSON: The total principal LMFBR costs to the Government are anticipated to be about $2.4 billion. Expenditures of about $200 million per year are expected for the 5 years starting in fiscal year 1972, then decreasing to about $65 million in the year 1968. Industrial and utility investments are expected to be more oriented toward the design construction and operation of early demonstration LMFBR's and first commercial LMFBR's than toward development as such. The utilities play their part in the developmental process through the investment of "risk capital" in demonstration plants on first-of-a-kind power plant installations, the related proof-testing and follow-on-investments in unproven plants. Industrial costs for the large numbers (about 90) of commercial-sized LMFBR's

expected to be committed between 1972 and 1988 are anticipated to be over $9 billion dollars.

Question 28. It is understood that the total capacity of nuclear plants is estimated to be 59,000 mw in 1975; 150,000 mw in 1980; 300,000 mw in 1985; 500,000 mw in 1990; 770,000 mw in 1995; and 1,100,000 mw in the year 2000. Would you indicate the amount of this capacity which is estimated to be produced from breeder reactors?

Commissioner JOHNSON: The values of nuclear power plant generating capacity mentioned in the question for the years 1975, 1980, and 1985 accord with those published by the AEC in January 1971. The figures indicated for 1990, 1995, and 2000 are also currently in use although they are subject to error in proportion to their projection into the future.

The commercial introduction of the LMFBR type of nuclear powerplant is projected for the mid-1980's. By 1990 it will constitute only a small percentage of the Nation's operable nuclear power generating capacity, perhaps 5 to 10 percent. By 1995, however, it is estimated that roughly one-quarter of U.S. nuclear plant capacity will be incorporated in FBR plants and that they will compose almost one-half of U.S. nuclear power generating capacity by the year 2000.

Question 29. Do you have projections for the total capacity of nonnuclear powerplants as well as nuclear powerplants for 1975, 1980, 1985, 1990, 1995, and the year 2000?

Commissioner JOHNSON. Projections of nuclear, nonnuclear, and the total U.S. electric utility generating capacity in electrical megawatts are as follows:

	Nuclear [1]	Nonnuclear [2]	Total
1980	150,000	515,000	[3] 665,000
1985	300,000	630,000	930,000
1990	500,000	760,000	[3] 1,260,000
2000	800,000–1,200,000	900,000–1,000,000	1,800,000–2,100,000

[1] AEC projections.
[2] The nonnuclear values are not independent projections but are the difference between nuclear and total projections for the corresponding years.
[3] FPC values given in testimony on May 1971 to Subcommittee on Communications and Power Committee on Interstate and Foreign Commerce, by Chairman Nassikas, FPC.

Question 30. What period is considered to be most critical for meeting the energy requirements of the United States?

Commissioner JOHNSON. The next 20 to 30 years can be considered the most critical period for meeting U.S. energy requirements. There are two major concerns in supplying the electric energy requirements: installing sufficient generating capacity, a present concern, and assuring adequate fuel resources, a longer term challenge.

Delays in installing new generating capacity have resulted in local brownouts and blackouts during peakload periods, notably in the Northeastern U.S. during the past few summers. These delays are the consequence of digestion of new or extrapolated technology and the increasing intervention of environmental considerations.

The delays in actual construction and running in of individual nuclear and fossil-fueled plants should trend downward in the coming years, both because present scheduling is more realistic and because

experience is being accumulated in the construction and operation of these large units.

Delays due to environmental considerations appear likely to continue, however, until there is general agreement on the requirements to be met by bulk power facilities for their compatibility with the environment. Legislation, judicial interpretation, licensing procedures, industry investigations and reporting, the formulation and implementation of guidelines and standards, and, most importantly, the cooperation of the public are all ingredients in the solution of this problem. The sooner these factors contribute constructively to a satisfactory framework for treating with the environmental aspects of bulk power facilities the sooner will the Nation's energy supply be assured.

The assurance of adequate fuel resources is a challenge that will require concerted efforts over the next two, and possibly three, decades. The various programs to achieve this goal are listed in the President's energy message of June 4, 1971, to the Congress. These programs will require years before the technologies involved reach significant commercial realization. The successful demonstration of the LMFBR is to be achieved by 1980 but commercial introduction is expected in the mid-1980's. Conversion of coal to pipeline gas has just entered the pilot plant stage, and will have to be demonstrated in large-scale production prior to commercial introduction. Magnetohydrodynamics is at a similar stage of development, with serious technical problems to be surmounted. The latter examples may not require the 20 years to progress from the experimental to commercial introduction stage true of current nuclear power systems, but the order of magnitude promises to be similar.

The success of a sufficient number of the approaches included in the President's energy message will assure an adequate supply of energy in the forms needed for utilization and with increased environmental compatibility in their use. In the coming years, the fast breeder reactor will be brought to commercial realization and by the year 2000, nuclear powerplants are expected to be supplying well over half the Nation's electric energy and more than one-fourth of its overall energy requirements. Because of the high utilization of the potential energy in our uranium resources made possible by the fast breeder reactor, nuclear power will be capable of meeting U.S. energy requirements for centuries. This will permit subsequent conservation of our fossil-fuel resources for their optimum uses.

Fusion power is a prospect for the virtually unlimited supply of energy. It cannot be counted on as a power source before the 21st century, however. In the event that the scientific feasibility of fusion power is proven in the next decade or two, its development to demonstration of technical and economic feasibility and eventually to commercial introduction is still likely to require several additional decades. Thus, the realization of the full potential of nuclear power through the development of the FBR, whose technology is already in hand, is needed to bridge the gap from the present time of incipient shortcomings in some fossil fuels to the full utilization of a virtually unlimited source of energy.

Question 31. You indicated that the dollar amount of uranium now carried in inventory by the United States now amounts to $10 billion.

Would you list the countries other than the United States which now maintain inventories of uranium?

Commissioner JOHNSON. I should distinguish between the Commission's stockpile of uranium on the one hand and the known and estimated additional reserves of the United States on the other. The AEC's surplus natural uranium inventory or stockpile has a value at current concentrate (yellowcake) prices of about $650 million. As enriched uranium, its value would be about $1.5 billion. These stocks, together with current U.S. uranium reserves not a part of the AEC's stockpile and producible by the mining industry at a price of up to $8 per pound of U_3O_8, have an aggregate potential value as enriched uranium of about $10 billion. As noted in my letter of September 30, the value of current reserves and estimated additional resources producible by the mining industry at an $8–$10 price would be worth, as yellowcake, about $20 billion.

Other free world countries besides the United States having inventories of uranium, are France, Canada, South Africa, and Australia.

Question 32. What is the estimated dollar value of uranium carried in inventories by countries other than the United States?

Commissioner JOHNSON. The total inventory held by the free world countries specified in question 31 is probably about 37,000 tons of U_3O_8. At a market price of $6.50 per pound, these inventories would be worth about $480 million.

Question 33. Would you list the countries other than the United States which have known reserves of uranium?

Commissioner JOHNSON. The attached table I lists the free world countries other than the United States with known reserves of uranium. In addition, some Communist countries, for which data are not available, are also known to have uranium reserves. These would include Russia, Czechoslovakia, Hungary, East Germany, Rumania, and mainland China.

Question 34. What is the estimated value of uranium reserves located in countries other than the United States?

Commissioner JOHNSON. The value of reserves in foreign non-Communist countries at the price of $10 per pound which has been used for estimating their resources, would be about $14.4 billion.

Question 35. Would you indicate the dollar value of uranium produced in the United States during the latest year for which figures are available?

Commissioner JOHNSON. In 1970 about 12,900 tons of U_3O_8 in concentrate was produced in the United States. At a price of $6.50 per pound of U_3O_8, this production would be worth $168 million.

Question 36. What is the dollar value for uranium consumed in the United States for the latest year for which figures are available?

Commissioner JONHSON. It is estimated that U_3O_8 consumption, defined as the requirements to fuel nuclear powerplants in 1970, in the United States was 5,700 tons. At $6.50 per pound, this would be worth $74 million.

Question 37. Would you indicate the estimated annual increases for uranium production in the United States for future years?

Commissioner JOHNSON. Production is expected to increase substantially in future years to meet requirements for fueling nuclear reactors. If domestic requirements are met entirely from domestic

resources, production would increase from 12,900 tons in 1970 to about 20,000 tons in 1975, 37,000 tons in 1980, and 65,000 tons in 1985.

Question 38. Would you indicate the estimated annual increases for uranium consumption in the United States for future years?

Commissioner JOHNSON. The attached table II presents the AEC estimate of domestic uranium requirements through 1985. (See page 390).

Question 39. Would you indicate the dollar value of uranium produced in countries outside of the United States during the latest year for which figures are available?

Commissioner JOHNSON. Foreign non-Communist uranium production in 1970 was about 11,400 tons of U_3O_8. At $6.50 per pound, this production would be worth $148 million.

Question 40. Would you indicate the dollar value of uranium consumed in countries outside of the United States during the latest year for which figures are available?

Commissioner JOHNSON. Precise data on uranium consumption (defined as the requirements to fuel nuclear powerplants) in foreign countries are not available. It has been estimated, however, that in 1971 foreign non-Communist uranium requirements for nuclear power will aggregate about 7,400 tons U_3O_8. At $6.50 per pound, this would have a value of about $96 million.

Question 41. Would you indicate the estimated annual increase in the production of uranium for countries other than the United States in future years?

Commissioner JOHNSON. In order to meet projected uranium requirements foreign uranium production would have to increase from the 11,400 tons produced in 1970 to about 17,000 tons in 1975, 37,000 tons in 1980, and 65,000 tons in 1985.

Question 42. Would you indicate the estimated annual increases in consumption of uranium for countries other than the United States in future years?

Commissioner JOHNSON. The AEC estimate of foreign uranium requirements is given in table II. (see page 390).

Question 43. Would you indicate the kind of storage facilities required for uranium, the form in which it is stored, the unit of measurement, and whether there is any deterioration or special treatment required to prevent deterioration?

Commissioner JOHNSON. Natural uranium in the form of concentrate or yellowcake is usually stored in metal drums of about 55 gallons capacity. When in the form of UF_6, it is usually stored in heavy steel cylinders of several tons capacity. Enriched uranium is stored in steel cylinders of various sizes depending on the enrichment. Uranium is commonly measured in terms of pounds U_3O_8 content when in the form of concentrates, or in pounds or kilograms of elemental uranium when in the form of UF_4 or UF_6. After enrichment, the enriched uranium is measured in kilograms and percent content of the U^{235} isotope. Uranium when stored in the manner described needs no further special treatment.

TABLE I.—FREE WORLD URANIUM RESERVES AND PRODUCTION

Country	Uranium reserves Jan. 1, 1971, price of $10 per pound of U_3O_8 tons U_3O_8	1970 Concentrate produced tons U_3O_8
Canada	232,000	4,580
South Africa and Southwest Africa	300,000	4,110
France	41,000	1,680
Niger	26,000	(1)
Gabon	19,500	520
Spain	11,000	60
Central African Republic	10,400	
Argentina	10,000	55
Portugal	9,600	100
Others, foreign [2]	60,000	300
Total, foreign	720,000	11,400
United States (including 90,000 byproduct)	390,000	12,900
Total, world	1,110,000	24,300

[1] Production started in 1971.
[2] Australia, Brazil, Italy, Japan, Mexico, Turkey, and Yugoslavia.

TABLE II.—AEC FORECAST OF NUCLEAR U_3O_8 REQUIREMENTS WITH PLUTONIUM RECYCLE

[In tons of U_3O_8]

Calendar year	United States		Foreign (non-Communist) [1]		World (non-Communist)	
	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
1971	6,900	6,900	7,400	7,400	14,300	14,300
1972	10,200	17,100	8,300	15,700	18,500	32,800
1973	14,700	31,800	11,200	26,900	25,900	58,700
1974	18,200	50,000	14,600	41,500	32,800	91,500
1975	20,100	70,100	17,400	58,900	37,500	129,000
1976	23,000	93,100	22,200	81,100	45,200	174,200
1977	26,600	119,700	26,100	107,200	52,600	226,900
1978	21,200	150,900	28,300	135,500	59,500	286,400
1979	34,600	185,500	30,700	166,200	65,300	351,700
1980	37,300	222,800	37,100	203,300	74,400	426,100
1981	42,800	265,500	42,800	246,100	85,600	511,700
1982	48,300	313,900	48,500	294,600	96,800	608,500
1983	53,500	367,400	53,600	348,200	107,100	715,600
1984	58,800	426,200	61,800	410,000	120,600	836,200
1985	64,600	490,800	65,200	475,200	129,800	966,000

[1] Foreign requirements includes enriched and natural uranium requirements.

Note: Enriched requirements are based on a toll enrichment tails assay of 0.20 percent U:235 for 1971, 1972, and the first half of 1973 and then increased to 0.25 percent for the last half of 1973 through 1985.

Chairman PATMAN. We are glad to have Mr. John N. Nassikas, Chairman of the Federal Power Commission, meet with us today, too.

The Federal Power Commission has important responsibilities relating to electric power and natural gas. The growth in the use of electric power has been exceeding the rate of growth of the gross national product in recent years. Our known reserves of natural gas are said to be adequate for only about 12 years, which is a substantial reduction in reserves in the past few years.

We are interested in having the views of the Federal Power Commission relating to potential shortages of electric power and natural gas, and to have the benefit of any recommendations which will assure adequate supplies of energy for defense and non-defense purposes.

We are also interested in whether the present organizational structure of the Government adequately provides for the coordination

of the functions of the various departments and agencies concerned with energy resources.

Mr. Nassikas, if you will identify yourself for the record, and any members of your staff, we will proceed with your statement.

You are recognized, and you may present your statement in any way that you choose.

STATEMENT OF JOHN N. NASSIKAS, CHAIRMAN, FEDERAL POWER COMMISSION, ACCOMPANIED BY GORDON GOOCH, GENERAL COUNSEL; DREXEL JOURNEY, DEPUTY GENERAL COUNSEL; DANIEL GOLDSTEIN, ASSISTANT GENERAL COUNSEL; FRANKLIN P. GOULD, LEGISLATIVE ATTORNEY; T. A. PHILLIPS, CHIEF, BUREAU OF POWER; STEWART CRUM, DEPUTY CHIEF, BUREAU OF POWER; ROBERT BOYD, CHIEF, DIVISION OF ELECTRIC RESOURCES AND REQUIREMENTS, BUREAU OF POWER; HASKELL P. WALD, CHIEF, OFFICE OF ECONOMICS; THOMAS J. JOYCE, CHIEF, BUREAU OF NATURAL GAS; EDWARD A. ALBARES, HEAD, GAS SUPPLY SECTION (ANALYSIS AND PROCEDURES DIVISION) BUREAU OF NATURAL GAS; GORDON K. ZARESKI, HEAD, NATIONAL SUPPLY AND DEMAND ESTIMATES SECTION (ANALYSIS AND PROCEDURES DIVISION) BUREAU OF NATURAL GAS; WILLIAM WEBB, DIRECTOR, OFFICE OF PUBLIC INFORMATION; AND HARRY H. VOIGT, ASSISTANT TO THE CHAIRMAN, FEDERAL POWER COMMISSION

Mr. NASSIKAS. Thank you, Mr. Chairman.

I would like to introduce a list of the Federal Power Commission attendees, the names of whom I have given to the stenographer.

I am John N. Nassikas, Chairman of the Federal Power Commission. To my right is Gordon Gooch, who is General Counsel of the FPC. To my left is Drexel Journey, who is Deputy General Counsel. Mr. Journey concentrates primarily in power matters.

I also have Mr. Daniel Goldstein, Assistant General Counsel, in the back of the room; Mr. Franklin P. Gould, Legislative Attorney; T. A. Phillips, Chief of our Bureau of Power; Stewart Crum, Deputy Chief of our Bureau of Power; Mr. Robert Boyd, Chief of our Division of Electric Resources and Requirements in the Bureau of Power; Mr. Haskell P. Wald, Chief of our Office of Economics; Thomas J. Joyce, Chief of our Bureau of Natural Gas; Edward A. Albares, Head of Gas Supply Section, Analysis and Procedures Division of the Bureau of Natural Gas; Gordon K. Zareski, Head of the National Supply and Demand Estimates Section, Analysis and Procedures Division of the Bureau of Natural Gas; Mr. William Webb, Director of the Office of Public Information, and Mr. Harry H. Voigt, Assistant to the Chairman.

While I have a comprehensive statement to present to you, Mr. Chairman, Mrs. Sullivan and Mr. Brown, I will attempt to summarize certain sections as I go along, so, please, do not be disturbed by the length of what you see before you.

Chairman PATMAN. Well, without objection, the entire statement will be inserted in the record at this point.

(The prepared statement and appendices submitted by Mr. Nassikas are set forth beginning on page 409).

Mr. NASSIKAS. Thank you kindly.

Chairman PATMAN. And after the hearing today, we will present to you, in writing, certain questions that members of the committee would like for you to answer when you look over the transcript for approval or disapproval.

Mr. NASSIKAS. We will be very pleased to answer any questions.

Chairman PATMAN. Thank you, sir.

You may proceed as you desire.

Mr. NASSIKAS. Yes.

My remarks are directed to both of the industries which the Federal Power Commission regulates, the electric power industry and the natural gas industry. Both industries have great demands to satisfy over the foreseeable future. There are problems. Some are being handled administratively under existing authority, others, undoubtedly, will be solved through additional legislative action.

On July 22, 1971, I appeared before the Subcommittee on Special Small Business Problems, Select Committee on Small Business, House of Representatives, and testified in respect to energy policy.

On May 6, 1971, I appeared before the Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives, and there discussed electric power requirements and supply. And as of Tuesday of this week, I again appeared before this House committee discussing general energy matters. The hearings before the Subcommittee on Communications and Power of May 1971, have now been printed.

In my testimony I shall discuss the factual situation in the gas industry, particularly as it relates to gas supply. I shall also consider the electric utility industry. In the next pages, I discuss our generalized powers under the Natural Gas Act and the Federal Power Act and some of our defense related activities. Our broad powers under the acts are really more significant than the specific powers in the defense-oriented activities.

Also, I describe some basic factual background.

Within the United States we now have approximately 150,000 miles of natural gas pipeline facilities and 12,586,000 compressor horsepower under Federal Power Commission certification pursuant to the requirements of the Natural Gas Act.

Total electric utility generating facilities in existence in the United States include approximately 340,350 megawatts. Incidentally, on that point I was recently in England and discussed various matters concerning power reliability in England and in the United States with the Electricity Council, and it is quite surprising, in preparing for those discussions that England, including Wales and Scotland, has a total capacity of about 40,000 megawatts, about 10 percent—or a bit more than 10 percent—of our total supply. England's power supply would fit into the northeastern part of the United States, parts of New York and New England. To use another analogy, it would be about one and one-half times the loads in parts of Pennsylvania, New Jersey, and Maryland.

Now, there are about 3,400 generating stations in the United States, 302,000 circuit miles of transmission facilities and about 3.5 million miles of electric distribution facilities.

In the United States today, there are some 3,440 different electric supply systems—not a centralized system like England—2,000 State or municipal electric systems, 1,000 cooperatively-owned systems, 400 investor-owned systems and 40 federally owned systems. In terms of generating capacity, investor-owned systems own 77.2 percent, Federal systems like TVA 11.4 percent, State and municipals 10 percent, and cooperatives 1.4 percent.

National energy policies is one topic that your forwarding letter to me indicated to me you would like to have me discuss, Mr. Chairman. I will briefly address that issue.

To meet our forecasted national and regional energy requirements, it is necessary to pursue policies which will enable the natural gas and electric utility industries to develop on a long-range basis adequate supplies of natural gas and electric energy and to construct the associated physical facilities on a timely basis to meet scheduled requirements. These policies must, of course, recognize that both our environment and our resources are finite and essential for quality of life. As I see our national objectives in the energy field, they are to preserve and enhance our environment and utilize and conserve our resources as the essential foundation for meeting our national, defense, economic, and social goals. I include within these goals full employment, stable prices, and a productive society. Also, I believe that in the execution of governmental policy we must preserve the operation of the free enterprise system.

It is evident that past patterns of energy utilization have caused significant problems. We have imbalances in demand and supply of fuel resources. Under current technologies we have produced in the production of energy and all fields, greater environmental effects than the Nation is willing to tolerate. There has been congressional action to establish policies, which I salute and which we are attempting to execute, hard as it may be to meet the environmental goals and also meet the absolute necessity of having enough energy resources to meet our economic goals and, if you please, our social goals, because I happen to believe that unless we have the resources to fund programs and priorities, we will not be abe to accomplish these.

Now, we have been pursuing patterns of use of our mineral fuels which may be sustainable to the end of the century at the rate at which we expect energy to be needed, only if: (*a*) we increase the trend rate of exploration and development of assured reserves of oil and gas, and create new technologies for developing existing, as well as supplementary energy resources; (*b*) only if there is adequate technical effort to make our longest-term fossil fuel (coal) adequately usable with acceptable environmental effects, or to gasify coal or to synthesize gas from various hydrocarbon sources; and (*c*) only if our nuclear power needs of the future—which Commissioner Johnson expressed this morning—which are critically dependent on successful development of a fast breeder reactor program, are vigorously pursued on a time schedule which assures bringing this vital technology to a state of commercial readiness in the early 1980's.

In your letter of September 10, 1971, Mr. Chairman, you specifically asked for an expression of views "as to whether energy goals should be established in order to focus attention on potential energy shortages and provide the means for finding solutions to supply problems." I think this is a significant question. I believe that the establishment of

supply goals is important—imperative, if you wish—if we are to assure this Nation an adequate energy supply.

The Commission has done this—that is, set the goals—both in the electric and natural gas areas. I refer to our nationwide program of electric power supply adequacy and reliability under 202(a) of the Federal Power Act, the National Power Survey which we are now completing for publication later in 1971. I have reference also to our parallel National Gas Survey initiated this year which we should complete—my present target is—about spring, March–April of 1973. We started this based on congressional funding which was approved finally, with presidential approval, in December of 1970. Additionally, I refer to Commission action in evaluating the natural gas rates set in southern Louisiana and Texas gulf areas.

By way of summary, we have almost completed our initial price review of all areas in the lower 48 States of the United States. There are several cases, of course, that are at the appellate stage, and other cases may be awaiting rehearing, but the Commission has completed virtually all of its initial pricefixing, as we have been delegated the responsibility by Congress.

It is from the southern Louisiana area that we reasonably can expect the greater portion of total demand for jurisdictional gas to be satisfied in the next few years. In the southern Louisiana area proceeding, we concluded that a reasonable target level of service for jurisdictional sales is between 45 and 50 trillion cubic feet for the 1971–75 period. To achieve this level, while maintaining deliverability, will require dedications of new gas reserves to the interstate market of approximately 60 trillion cubic feet for the same period. Remember that our annual consumption of gas in 1970 was about 22 to 22.5 trillion cubic feet, including intrastate and interstate gas.

With respect to the Texas gulf area, we concluded that if demands from this area are to be satisfied during the next 5 years, it is essential that jurisdictional sales from this area increase from present volumes of 8 trillion cubic feet for a 5-year period to 12.5 trillion cubic feet cumulatively for the period 1971–75. In order to achieve this desired level, while maintaining deliverability, our goal for dedications of new reserves from the Texas gulf coast to the interstate market will be 20 trillion cubic feet during that period. It should be emphasized that these goals must be reviewed on an empirical basis to determine whether they can be realistically attained under our established regulatory policies.

ENERGY OVERALL

Our relative use of energy sources in the past 21 years is shown in table I following. It indicates our energized society is reliant on oil and gas, these fossil fuels, for 76 percent of its energy requirements. Though, as I will discuss very briefly, the nuclear power program will take over a substantial, relative share of our energy burden over the course of the next 20 to 30 years, nevertheless, the overall quantity of fossil fuels, whether it is coal, gas or petroleum will still increase to meet our requirements. The nuclear program, in my opinion, has to stay on schedule because, by reference, we get increasing demands on our finite fossil fuel resources.

Table II, the next page beyond, shows that over the next 20 years oil and gas requirements will account for over 60 percent of projected

energy use. If nuclear technology does not fulfill its promise on schedule we may continue to be significantly more dependent on oil, gas, and coal resources than anticipated into the 21st century and beyond.

NATURAL GAS

In the area of natural gas supply, the Commission's analyses of discernible demand/supply trends indicate a present and future shortage of deliverable reserves to service consumer demand. Natural gas is an important part of electric utilities' fuel also. In 1970, 29.7 percent of the fuel used for power generation was natural gas. Limitation of gas supplies must result either in limiting the productive capacity of gas-fueled plants, or a switch to alternate fuels. The problem of reduced reserves in relation to supply developed during the decade of the 1960's when the ratio of proved gas reserves to annual production dropped steadily. Essentially, the facts are that since the mid-1950's the number of wells drilled per year has dropped from 57,111 in 1956 to 28,008 in 1970.

With the declining effort to provide additions to reserves in the last 15 years, the lower 48 States' reserve-to-production ratio slid from a 1946 high of 32.6 to 11.9 by yearend 1970, according to American Gas Association statistics. In other words, an 11.9-year supply, according to the American Gas Association statistics. Reserve additions in the lower 48 States fell short of production; that is, we used more than we found by 7.3 trillion cubic feet in 1968, by 12.3 trillion cubic feet in 1969, and by 10.7 trillion cubic feet in 1970.

Our continuous observation and analysis of the oil and gas industry's efforts to discover and produce gas indicates that the adverse trends in the Nation's natural gas supply/demand balance have not yet been reversed. The gas energy gap between demand and supply continues to widen. The annual form 15 reports, submitted by interstate pipeline companies to FPC regarding natural gas reserves and deliverability, indicate that the declining trend of owned or controlled reserves which began in 1968 has worsened.

I do not have to review the table at the bottom of page 13, which is natural gas reserves and reserves to production ratio, data reported to us by the American Gas Association and reported by the pipeline companies on form 15. The figures generally parallel each other. They both show declining trends, and it would indicate, on a national basis, of course, that our reserves are getting thin.

More than 50 percent of the 1969 gas consumption went to industrial use, residential usage required 21 percent, 8 percent went to commercial enterprises, and 19 percent was consumed in the field and in other uses.

Now, the Future Requirements Committee, which is an industry committee with Government observers, as I detail in footnote 10, estimates the total regional demand for natural gas in the lower 48 States, excluding field use, will grow from approximately 21.4 trillion cubic feet in 1970 to 54.9 trillion cubic feet in 1995. The projected average annual compounded growth rate during the 1970–95 period is about 3.8 percent. The historical growth rate for the period 1950 to 1970 was about 6.7 percent.

Of course, if we had the gas on a projected basis, the compounded growth rate of 3-plus percent would increase, but the Future Require-

ments Committee takes into account realistically all likely sources of supply—as to whether you will have the gas from the Lower 48 States, from Alaska, from supplementary sources, from technologies, or whatever the other sources might be.

On September 3, 1971, the Future Requirements Committee announced its latest projection of anticipated natural gas requirements for the United States. In addition to its usual forecast of future gas requirements under conditions of an adequacy of supply, the committee estimated the requirements that can be met between now and 1975 from presently contracted or assured supplies. These data indicate that by 1975 only 86.3 percent of the total regional requirements for 28.5 trillion cubic feet of gas, or 24.6 trillion cubic feet, can be met with contracted or assured supplies. A summary of this forecast is shown in table IV.

Looking to the time period beyond 1975, with the probable rate of development of natural gas reserves, coupled with reasonable expectations of supplemental supplies, it appears that the problem of balancing supply and demand will be with us for many years.

In the illustrative supply-demand balance given in table V—and I emphasize "the illustrative"—which has been prepared by the Federal Power Commission staff, a gas supply deficiency is shown beginning in 1972. Because the data in this table is national in character, regional supply problems cannot be shown. As a result, surpluses and deficiencies which may tend to offset each other on a national basis may have a quite different effect in a given consuming area. In other words, you could have a national average which might indicate a better situation than you actually have because of the logistics of transmission, distribution, and demand, and where the gas is. As has already become apparent, supply problems have developed on a localized and regional basis prior to a projected national deficiency.

Liquefied natural gas (LNG) shipped from Algeria to the Boston Gas Co. in 1968 was the first instance of LNG imported into the United States and was used to alleviate an emergency situation. I am well aware of that one, because I happened to be in New England—in Manchester, N.H., which is my home—at the time that that part of New England did not have enough gas to keep people warm. There are no current baseload marine imports into the United States, but several major projects are planned.

A listing and status of currently proposed LNG imports is attached in appendix A. Perhaps the most important aspects of the developments in LNG technology is the advantage it makes available to distributors in LNG technology for peak shaving, satellite facilities, remote and emergency deliveries, and potential for making new worldwide sources of natural gas technically available to U.S. consumers. I want to emphasize that liquefied natural gas is purely a supplemental source for gas and cannot be considered as the type of source of supply which the United States will rely on for meeting its long-range requirements for natural gas. Taking all of the applications that we have currently before us and without indicating—because I cannot—what action the Commission is going to take on these, these are pending cases—but just taking what the records show as to the number of applications for gas, from Algeria and other sources, you could round the figures off to about a trillion cubic feet annually as a maximum,

and deliveries not projected, under the most optimistic calculations, before 1975 to 1976. By that time, of course, the growth of our gas requirements will be approximating upward of 25 trillion cubic feet annually.

From the standpoint of electric power, which is another important responsibility of the Federal Power Commission, we project that there were about 342,000 megawatts of net dependable capacity this summer, with an estimated peakload of 296,000 megawatts. So, we had about 15 percent reserves for the Nation as a whole. These projections, made in May and reported to the Subcommittee on Communications and Power Hearings, page 446, have been shown to be substantially correct based upon more recent data and staff analyses. My testimony before that committee analyzes the power supply conditions of the Nation by geographic areas and in substantial detail.

Currently, a number of systems are projecting reserve ratios of 15 to 20 percent of peakload to compensate for forced outages, required maintenance, uncertainties in load forecasting, and other reasonably foreseeable contingencies. I am not satisfied that these ratios are yet high enough, but efforts are being made to improve them.

The concept of interconnecting various systems and relying on smaller reserve ratios is a salutary objective, but it does not practicably meet the power requirements that we need. We need to have higher reserves as well as better interconnections, and higher reserves than were forecast in 1964 by that national power survey. I do not think we will make the same error. We have the benefit, of course, of their experience.

COORDINATED GOVERNMENTAL ACTIONS

On June 4, 1971, the President announced, in his energy message to the Congress and the people of the United States, that a "sufficient supply of clean energy is essential if we are to sustain healthy economic growth and improve the quality of our national life." The President's message is relevant to environmental and social costs involved in the current energy issues confronting all technologically advanced nations in the world. The President stated "that the various elements of our society will be able to work together to meet our clean energy needs. And I am confident that we can therefore continue to know the blessings of both a high-energy civilization and a beautiful and healthy environment."

IMMEDIATE STEPS

Under near-term conditions, the immediate and short-range solutions to our gas and electric energy problems are and must be to insure the most efficient utilization of available natural gas supplies and electric generating capacity, wherever located and by whomever owned, to meet consumer demands at a reasonable price—I might add—and reliably. The Commission and its staff, in coordination with other Federal Government departments or agencies, State utility commission personnel, and representatives of the operating system, are working throughout the Nation to accomplish needed natural gas and electric power transfers to serve local areas of shortage or anticipated shortages.

There has been a coordinated effort by the administration, through the Office of Emergency Preparedness, to coordinate the efforts of all energy agencies like the Federal Power Commission, the Atomic Energy Commission, the Department of the Interior, and, insofar as transportation affects energy, the Interstate Commerce Commission, and others. The idea is that we all have our separate responsibilities, we all have the same objective of meeting the needs of the Nation and that administratively, this is what the administration decided to do. There is no central coordination by statute of these activities. And, of course, I endorse this. I have worked personally—as well as assigned staff to all meetings of the Energy Subcommittee of the Domestic Council and the Joint Board on Fuels and Transport which was convened by the President, and also on which I served.

I have summarized various actions which the Federal Power Commission has taken in respect to natural gas supply. I do not have to repeat these—they are set forth on those pages—actions we have taken in order to try to stimulate further exploration and development, to try to establish a healthy regulatory climate for the required investment in needed facilities, and at the same time to serve the consumers' interest in a reasonably priced supply.

Now, I happen to believe that the interest of the consumers and the interest of the industry in supplying the needs of those consumers, insofar as the element of a stable, reliable supply of energy is concerned, that they are identical. There is no division of interest between the consumers' demand for electric service and the consumers' demand for gas supply and industry desires to serve those needs.

Now, obviously, we have to have the necessary regulatory constraint, and this is what we are charged with doing, and this is what I am doing as chairman. Also we have the overriding national policy of the United States in our antitrust laws which must be enforced to assure that industries are operating within an adequate competitive structure.

Now, I have summarized several pages there. I would like to pause for a moment, on table VI. This is a forecast, taking required fossil fuel resources that we need for electric power generation. We indicate what the breakdown is there between the various fossil resources. You will note that under our forecast coal by 1990, will have a higher relative share than it enjoys now; that gas will go down rather substantially in its relative share, although in quantity it increases, as I said earlier, and oil will increase its relative share by 1990.

We have had fuel shortages in the last 18 months, some this past winter. The Republic survived adequately, I believe, in meeting the energy needs of the Nation. I am not satisfied, of course. I would like to have a great deal more gas to meet incremental demands that industry requires in all parts of the United States, to meet some further interruptible demands, or boiler fuel for electric power generators to meet some of our environmental objectives. But that is wishful thinking because we do not presently have it.

Table VII, Sources of Generation, there is a summarization in kilowatt hours indicating the breakdown between nuclear, internal combustion and gas turbines, and fossil fuel resources, again. Here, you will note, of course, that the nuclear increase is dramatic, increasing from some 22 billion kilowatt hours in 1970, or 1.4 percent of the

total, to 2,913 billion kilowatt hours, or almost 50 percent of the total in 1990.

Table VIII, this is just a question of degree, and it depends on the assumptions in our figures.

Commissioner Johnson stated that the Atomic Energy Commission forecast for 1980 in megawatts for nuclear power was 150,000. Our table and forecast for the National Power Survey is 140,000. I say that this is simply a difference in the assumptions underlying the figures. We, of course, are in full agreement that the nuclear part will increase. And I personally hope that Commissioner Johnson is conservative in his forecast and that the nuclear proportion is going to be even greater because that will mean less demand on fossil fuel resources.

In my statement, I summarize research and the relationship of research and development and the importance of research and development in meeting our energy needs. So did Commissioner Johnson. I am not going to repeat anything he said. I have part of this in my statement—MHD and fusion and this kind of thing will come along for posterity. In the meantime we are living now, we have got to take care of posterity, too, and the unborn generation, but we also have to take care of this generation from now until the end of the century at least. And, too, I want to be sure that we have realistic research programs to meet the energy resource requirements of this day and age through the end of the century.

I endorse wholeheartedly, as I have said today and before, the absolute necessity of developing the fast breeder nuclear reactor. Currently, the liquid metal fast breeder reactor is the one AEC is concentrating on. There are others, as Commissioner Johnson said, which also have promise that may not be quite termed as breeder reactors, but they are advanced reactors which will assist in meeting our power needs.

I inserted the *Calvert Cliffs Coordinating Committee, Inc., et al.* v. *U.S. Atomic Energy Commission, et al.* case which was decided on July 23, 1971. Because this is a landmark case interpreting the application of the Environmental Policy Act of 1969, to the actions of various regulatory agencies, the decision is a very important policy decision.

I have not attempted to analyze this in detail.

I will state to you, Mr. Chairman, Mrs. Sullivan, and Mr. Brown, that we are working in close cooperation with the Atomic Energy Commission. We are in constant communication, our staffs work together, not against each other. I am working with the new Chairman of the Commission, as I did with Mr. Seaborg, the past Chairman. We have a joint goal to reach; we have got to find a way to put it in very simple terms, to resolve within the requirements of the National Environmental Policy Act of 1969 the need for building on a transitional basis the required nuclear plants, provided that the environmental safeguards, by a scientific consensus of the Atomic Energy Commission and others, indicate that this can be done. I am confident that this can be resolved, but I want to emphasize as clearly as I can that we cannot afford, as a Nation, if we are to accomplish our economic and social objectives, any delay that is undue on these plants. because they are part of the system of planning of the generating system to meet loads this coming winter, next spring and on to the end of the next decade. They are not plants that I am talking about

which are projected in the 1980's. These are plants that are completed, ready for operation, or almost completed and will be ready for operation under the standards as they have existed, of the AEC, to meet these demands this winter and next summer.

In conclusion, the crucial question is how to formulate and apply national energy policies without extremism in support of numerous important but conflicting goals in national energy, whether it is in support of more energy or more environment, and I think we all want more environment. I think, also, we need more energy. In my judgment there needs to be a deliberate balancing—national energy, economic, social and environmental values as a basis for determining the public interest.

To arrive at intelligent decisions in matters of natural gas and electric energy supplies, we require fundamental knowledge of the impact of a proposed course of action on our national objectives—to preserve and enhance our environment, utilize and conserve our resources as the essential foundation for meeting our national defense, economic and social goals. We must be able to forecast a predictable result in advance of an irretrievable commitment.

I might state, if it might be of interest to you, that I have tried to have some of the utilities, some of the larger companies with expertise in computer technology as well as the National Science Foundation, to try to reduce to data processing a plan for a region which includes everything in the nature of what is being used to produce energy for that region, not just power, not just electric power, but everything; coal, oil that may be burned directly for homes, or gas, or electric power, and, then, of course, the fuels they burn for this, to take a regional plan and try to forecast what the result will be of the different alternatives of the type of fuel or the type of plant that may be built in that region. If this can be done—and I do not see why it cannot be done, in time at least—then, we can truly say that we will be able to forecast a predictable result in advance of an irretrievable commitment. We also require a scientific definition of the parameters of irreparable injury to human health or safety or a necessary ecological system, if we are to enjoin actions threatening our survival and yet prevent the intolerable state of our society or economy slipping into limbo.

If the Congress authorizes the creation of the Department of Natural Resources, proposed by the President, this will not answer all of our problems, but will help in meeting some of these problems, and it would be a logical and beneficial step if responsibility were centered in that department or such other agency as Congress may designate for setting fossil fuel and basic energy goals and, to be sure that the policies are implemented once they are established, followed through.

And in my judgment that action would not impair the integrity or the jurisdiction and responsibilities conferred by the Congress upon the Federal Power Commission under the Federal Power or Natural Gas Acts. We would endeavor to establish coordinate procedures to attain the objectives of an adequate energy supply compatible with environmental standards.

And I would finally state in conclusion that in the event the Nation's interest requires more coordination than is contemplated in the Department of Natural Resources, which does not include the Federal

Power Commission as part of that organization, I say, if it is found that the Nation's interest requires this, then I certainly will endorse that objective also, because I happen to believe, as I know you do, that the Nation's interest is paramount and agencies in serving the public interest must recognize the national interest.

Thank you.

Chairman PATMAN. Thank you very much for a very interesting statement, sir.

Mrs. Sullivan, would you like to comment or ask questions?

Representative SULLIVAN. Only that, again, I think it is an excellent statement in giving us the background of present conditions, our hopes and needs to find new sources of energy and the extreme needs that we have. Of course, I was thinking, as you were talking, too, sir, that the urge today concerning pollution and all of the things that happen when we gather in the gas, the coal, and all the other elements to produce the energy—the demand by the public to protect the environment—protection of pollution and environment must be a part of our plan. There is a great need to stop the pollution in this field and stop the ruination of the area.

I am thinking of an article that I read just a month or so ago about the new plans and the geology finding and proposals for stripping the Rocky Mountain States for coal. I think this is good if they absolutely do not ruin the area as they strip it.

I live in an area of the country, near Illinois, where they have strip mines that have just ruined the countryside and made it impossible for anyone to live there. If they are made to put the area back into some kind of a condition after they have stripped it, then I think it could be a good thing to do.

Mr. NASSIKAS. I am in full accord with you, Mrs. Sullivan. In fact, on the southwest project, which you mention, the Department of the Interior has organized a task force which will review all impacts of that project, including the strip-mining effects and what environmental protection will be given to the area, what the need for the power is, what alternatives there are.

My staff is serving on that committee. We have assigned our chief engineer as the liaison, and I am participating and will continue to participate in it.

In your region of the country, just for the sake of an example only, there are studies which are being conducted on demonstration projects of the effects of emissions of fossil fuel plants to meet air standards, air quality standards as promulgated, and water quality standards as promulgated by the Environmental Protection Agency. We are personally studying this matter ourselves through our Environmental Quality Office. We have an office of the advisor on environmental quality which I established about 2 months after I became chairman. We now have six members in that office. some extremely competent people. We also have throughout our Bureau of Power and our Bureau of Natural Gas and our line organization approximately 20 others who are competent either in the environmental area, whether they are biologists or whether they are specialized engineers, or whatever they may be.

This is the big issue—and the big issue is what you say: Can you accomplish what we need in each region of the country without really doing any harm?

Representative SULLIVAN. Yes; but as new proposals come in, I think we have to give more thought to this than was given before, and in the testimony that we heard yesterday, with all of these new things coming into being, it is going to disturb the area where we live and the environment. The American public must be better informed of our national needs for these ores, minerals, and so forth. But, again I think you have got to think not just of the resources that we need from the ground, and in the mining and so forth that is going to be done, but of how do we protect the area once this is extracted from the earth.

Mr. NASSIKAS. It might be an interesting observation on what you mentioned earlier when you said something to the effect that we should educate and inform the public, as all of us want to do, but at a panel in Geneva that I attended recently there happened to be seven scientists on the panel, one academician and one public information director from India, and the public information director's observation I think was quite well taken, that he thought there was an imbalance in the emphasis on the panel, because the scientists, of course, are in a realm which just ordinary people do not understand.

We do require an educational process in simple terms, and I would like to just add finally to that, too, that because you have scientists who may disagree on a result, they disagree in relative terms. But the disagreement is expressed out of context when it is communicated and you therefore get the impression of a range of scientific consequences, and then people become alarmed. And I do not blame them.

Representative SULLIVAN. Well, just as a short example, we have some plants in our area that are polluting the air without any doubt and people are clamoring: "Make them close down."

Well, my answer to them has been that I recognize it and I hope we can stop it, and find the means to stop it, but if they close down how are you going to live, because you are working and earning your salary from these plants that are polluting both the air and the water.

What we have got to do is to get across to them that this cannot be cured overnight without wrecking the institution, and I think that we have got to encourage these production areas to use every means they have as quickly as they can to find ways to stop the pollution.

Mr. NASSIKAS. Like power. While it, of course, discharges heat and has an effect on the environment, a degrading effect when it is being produced, and, also, we have to have transmission lines which, esthetically, for what we like to look at, they are not as pretty as we would like to have it, at the same time I do not think that we should fail to recognize the contribution that electric power, as we market it in this country, makes an effective contribution to clean up the environment, because you cannot purify water, under any means that I know of; and you cannot have sewage disposal systems, you cannot have rapid urban transit that would be environmentally clean, so to speak, electrified urban transit, to meet some of these problems in your major urban areas, unless you have the power resources to do these things, as well as the underlying and more fundamental points that you raise: "What is the relationship between our energy and our economy?" It would be an entirely different kind of an economy without our having an abundant energy resource base. This is our big problem today, that we are accustomed, as Americans, to having plenty of

everything, and we finally have realized that we do not have plenty of energy in the developed form that we need it to meet our national priorities. This is what we are all trying to work out, Congress, the executive department, independent regulatory agencies like the Federal Power Commission and others, the AEC.

Representative SULLIVAN. Well, I think, as we are searching for new ways and new methods we also must search for better communications so that people understand what is happening, and then try to find ways to produce without all of the pollution that was so wantonly done before.

That is all, Mr. Chairman.

Thank you.

Chairman PATMAN. Mr. Brown?

Representative BROWN. Thank you, Mr. Chairman, and thank you, Mr. Nassikas, for your fine statement.

It seems to me that your remarks are primarily related to improvement in the technology and development of production. Has there been much study and is there not need for further study in the area of research into the technology of usage?

Mr. NASSIKAS. Yes, sir.

Representative BROWN. For instance, I just heard the other day—I think it was a Lear jet—that they had produced an engine which can go from coast to coast practically with the same fuel supply that formerly would only go one-third the distance.

Mr. NASSIKAS, Yes, sir.

Representative BROWN. Then, I would compound that question by adding: in your statistics for need for the future, is there an input of possible improvement in the usage of our present energy supplies?

Mr. NASSIKAS. Yes; I think each question that you have asked here and observation that you have made, I am in full agreement with.

Broadly, I think what you are saying is: Should we not have research and technology with reference to the conservation of our resources to stretch them out further, to have them not only more efficiently utilized, those resources, but also to research into the usage so that the use itself will not create more environmental destruction or economic destruction. I mean, I think, broadly, that is what you are saying.

Representative BROWN. I was not thinking of the environmental aspects so much as of basically more effective utilization of our energy.

Mr. NASSIKAS. Yes; could I give you one example, just one example, which I think is directly in point?

The gas fuel cell which is being developed by the gas industry through a prototype program with the Pratt-Whitney Division of the United Aircraft Corp., in East Hartford, Conn.

This program has now reached the stage where it is technically feasible. The big question under this program is whether it is economical. The gas fuel cell would, in effect, convert gas energy to electricity and utilize those gas resources at about 30 percent to 40 percent greater efficiency than a conversion of such gas resources in a conventional, current generator.

Now, automatically, if this turns out to be economically feasible, and has some broad applications, you can stretch out the supply that you have of the existing resource. That is one example.

Mr. BROWN. Well, when you say feasible, is that not kind of a many-faceted question?

Mr. NASSIKAS. Yes; it is.

Mr. BROWN. For instance, in order to utilize gas, et cetera, or aircraft fuels and so on, as I understand it, the development of metals, the metallurgy involved, is tremendous to get the pressure, the heat, et cetera, in order to be able to get the efficiency out of your fuel. But, since it is cheaper to use present methods rather than go into the expensive metallurgy that is involved in there, it is more economically feasible than to continue to have your less efficient use of fuels.

Mr. NASSIKAS. This can happen, and undoubtedly when you have an economic system of the kind that we have it will continue to happen. What I am saying is that recognizing that you do have these built-in pressures against the economic feasibility, that they are almost at the stage, considering all of these factors, where this is commercially feasible and competitive with other types of powerplants and small utilizations for residences, for apartment dwellings, and this kind of thing, and it is very interesting as a supplemental stretch out of our existing resources with the lowest pollution index of any system that we know of.

Mr. BROWN. Is this not quite analogous to the recycling of solid waste and stretching out the available supplies of ores and minerals, et cetera?

Mr. NASSIKAS. Yes, sir; coming from New England I am entirely in favor of stretching out as much as you can the limited resources you have.

Mr. BROWN. One further thing. You have touched upon and discussed the environmental impact. Is there not a great need for research into the real environmental impact of many of those things that we think are quite adverse to our environment, such as thermal pollution? Can anyone state today at what level it is a tolerable level, et cetera?

Mr. NASSIKAS. This is one, I think one of the great issues involved in all industrial development and powerplant development too. I have seen and studied this myself. I am a layman, as you must know from the way I talk. I am a lawyer, not a technician, so I have to learn and rely on the technicians and try to——

Mr. BROWN. You are a technician, but a technician in the law. At least I like to think of myself as such.

Mr. NASSIKAS. I would hope I am. I have worked hard enough at it. But, the primary point is that some of the environmental impact is not known. Under the National Environmental Policy Act, as I read it as a lawyer, the burden of proving that there is no environmental detriment is upon the proponent of the proposed project, which is the same as the *Scenic Hudson* case before Congress adopted that particular statute. And contrary to the generalized burden of proof in any other legal proceeding, in most other legal proceedings the burden of proof usually would be on an opponent of the proposed actions to show that there are going to be some environmental problems involved. Now, this is more important than just semantics. It is a conscious policy and, therefore, as regulators, we have to show that there will not be a tendency to environmental degradation by the proposed action before the plant is licensed, yet, we know, there is a gray area where you do

not know what the impact is. You cannot prove the point, you cannot prove there will not be environmental degradation or that there will be. Well, what do you do in a case like that? You still have to rely on the most reasonable evidence you have, and you could decide that you will monitor that plant, but you will have constant surveillance of that plant, and conduct tests as to what the thermal discharge effects are, and the effect on human health and the ecology.

Remember that I said destruction of the necessary ecological system is one standard which you would use to determine whether or not a plant should be built or not. Now, to determine the destruction to a necessary ecological system, you may have to watch that plant in operation for a number of years to see what the effects are and then make your determination.

Now, if it is true that the continuance of that operation is going to destroy a necessary ecological system, including the health and welfare of ourselves as human beings as a part of that system, then at that stage it ought to be closed down until it is improved so that we will not cause that kind of destruction.

So, I am in agreement with you, Mr. Brown, on your observation.

Mr. BROWN. You have interpreted the legislation though, I think, with much greater concreteness than the Congress contemplated when it passed it. I do not believe the Congress was thinking about the necessity of the burden of proof, that is, when environmental considerations had to be taken into account, in connection with any regulatory or licensing action. At least I do not recall much attention being paid to this question of who has to carry the burden of proof. It is one thing to say that Federal agencies must determine or consider the environmental impact. But, it is another thing to get into the particular areas we are getting into now, when not just the areas of substance, but the areas of procedure become pertinent.

Mr. NASSIKAS. Yes, sir.

Mr. BROWN. And they are, I think, a little less than fully discussed.

Mr. NASSIKAS. Yes, sir.

Mr. BROWN. Again I wish to thank you for your very comprehensive statement.

Mr. NASSIKAS. Thank you, Mr. Brown.

Mr. BROWN. I have no further questions.

Mrs. SULLIVAN (presiding). I just have one other question. Is the use of natural gas for producing electric power an inefficient use of natural gas?

Mr. NASSIKAS. Yes. However, the efficiency for the use in electric power, subject to correction by my staff, might be 35 to 40 percent efficiency compared to, as you used in a boiler, compared to the use of that gas let us say in a residence, to heat a residence, compared to maybe 60 to 70 percent efficiency there. We are currently reviewing nationally under our rulemaking proceeding order No. 431 the curtailment responses by all major pipeline companies under our jurisdiction to determine whether there may be some alternate, and also in conjunction with the electric utilities, I should say, through another proceeding rulemaking R–405, to determine whether there are ultimate uses or alternate fuels available other than natural gas that will still meet environmental standards. And there is a conscious effort on the

part of the electric utility industry, and the gas industry to attempt to utilize the resource in its most effective manner if you can.

Now, if there is no substitute, take this case, there is no substitute, there is no alternate fuel, there should be a practicable transition to meet the needs of society. Before compelling a theoretically more efficient use, you have to wait until some alternate is available, whether it is a nuclear facility or whether it is coal of the right sulfur content or whether it is residual fuel oil with the required sulfur quantity, or clean fuel characteristics compatible with environmental standards.

Now, some very well intentioned people have advocated, that you should divert natural gas from boiler fuel use. This, they consider is a secondary use. It is a secondary use, it is a waste of assets. That is easy to say, but you cannot decree that kind of end use without assessing the consequences to our industrial economy. To execute that policy you have to consider it on a plant-by-plant basis, a system-by-system basis and consider all of the factors that go into the decision economically and environmentally, before you make your decision to say: Let us not use this any longer as boiler fuel because it is inefficient. We must constantly inquire: What is the practical consequence of our action? Can it be done? How? When?

And another point I would like to make is that of course it may depend in some instances on where you are. In the Southwestern part of the United States, in Texas, in Louisiana and Oklahoma and in other parts gas is used directly as boiler fuel.

The Federal Power Commission has no jurisdiction over the intrastate sale of gas. This is controlled by the States themselves, so gas can be used intrastate for any uses without any control by the Federal Power Commission. Nor am I suggesting that the Federal Power Commission should be granted the authority at the present time to divert those fuel uses to other uses, because we do have a transmission capability, we do have long-term contracts, we have equitable and legal considerations that are involved in any allocation or end use control policy. Also the questions of price and of development of regional economies are by no means peripheral issues.

Now, in the northeastern part of the United States where I come from it would be advantageous to the national interest, in my opinion, if we were to be able to develop some Outer Continental Shelf gas and petroleum resources, taking our east coast and selecting areas from it, from Maine right down to Florida, and this would have to be done, of course, under the supervision and direction of the Department of the Interior under their leasing program with environmental safeguards, just as that Department conducts general lease sales and other sales in California and in the Gulf of Mexico. It may be sound national policy to broaden our resource base geographically to serve the needs of the urban areas, to meet environmental concerns where you might have more supplies that could be used as boiler fuel until we get to this marvelous era of the nuclear age with adequate protection to everyone concerned. And then once we get fusion, maybe my grandchildren will enjoy that.

Mrs. SULLIVAN. Well, is the natural gas a cleaner fuel than coal would be?

Mr. NASSIKAS. Yes.

Mrs. SULLIVAN. To produce this power?

Mr. NASSIKAS. Yes; in generalized terms. We are told again by engineers and scientists that you can clean up coal, you can gasify coal, and you have gas that is just as clean as natural gas. But, even apart from that, just taking coal and burning it as coal, there are processes which can reduce the sulfur dioxide emissions and control fly ash and particulates. Emissions are controlled as part of the technology in the plant but the burning of the coal itself, the emissions of the gases by the coal, and the emission of undesirable noxious elements into the atmosphere can be controlled. There are improvements that are currently being made in that technology, although it is too slow and the research and development effort should be accelerated. More money has got to be invested in the technology and commercial production of gasified coal—to put it in a nutshell.

Mrs. SULLIVAN. Well, thank you very much.

Mr. BROWN. I have one final question that occurred to me, and I will not ask you to answer it beyond what you care to. In your statement you pointed out that although nationwide there may be an adequacy of energy supplies, certain regions are disproportionately disadvantaged. I recall a Dear Colleague letter which came across my desk with respect to the Alaskan pipeline, the argument being made that basically the Midwest and even the East are areas which are much more disadvantaged than is the west coast, and yet the Alaska pipeline would tend to benefit the west coast rather than the Midwest or the East. Would you care to comment on that?

Mr. NASSIKAS. Yes; I think that is another very good question. The west coast also has a critical, gas supply problem. There is a gasification project——

Mr. BROWN. In this letter there was also a breakdown of fuel costs for the different areas, the assumption being that this cost was directly related to supply and that, therefore, the conclusion you should reach is that the supply is much greater on the west coast at the present time than it is in the Midwest and East.

Mr. NASSIKAS. Like many theories, it would seem to work out that way, but if you count the numbers it does not work out that way.

Mr. BROWN. I would be happy to receive the clarification.

Mr. NASSIKAS. Let me say this, on the west coast, just taking a projected requirement for the electric utilities industry particularly in the Los Angeles area which is, or course, the one where the largest air quality problems exist, there is a critical shortage of all kinds of fuel, not just gas, but also oil of the right quality to meet projected air quality standards. Now, consider the proposed gasification project of El Paso, and that is this Four Corners area again. They would propose to gasify coal to produce several billion cubic feet of gas annually at the site which, of course, creates environmental problems at the site and in areas near the site. The question is if the gas were available, nevertheless, just speculating for the moment, then this would, of course, contribute immeasurably to cleaning up the air and still meet the energy requirements of the Los Angeles area. All right, there is a tradeoff which might be considered. How it is resolved, I do not know.

Alaska, I spent 2 days there within the past 3 weeks. I finally got up there, I have been wanting to do it for 2 years, and I went over, by air, most of the route of the TAPS, the so-called hot oil lines, and most of the route of the generalized route of the proposed gas pipeline

project down from Prudhoe Bay, Alaska, generally speaking, in the direction of MacKenzie River area of Canada, proposed as an area connecting with three projects. There are three projects already, all of which are being fully examined and evaluated, and someday may be formally presented to have gas come down from not only from Alaska but also down through Canada with lines feeding into that pipeline in Canada, and then other lines fanning out to the west coast to serve that area, and other lines fanning out toward the Chicago area to serve the Midwest. The resource, of course, it is almost, well it is almost incredibly located is the only way I can describe it at Prudhoe Bay. This particular gas resource at Prudhoe Bay is at least not under the Arctic Ocean. At least you can get there once they build a road, as they have in parts of that area about 8 to 10 feet of gravel base. The course of the proposed oil pipeline and gas pipeline is across rough, rugged, mountainous country.

Getting to the cost factor is very rough, and we do not have any project before us at this time, but we will have, I am sure, some time to get that gas down, but a generalized estimate would indicate that for each cubic foot daily of gas that you would expect to bring down from Prudhoe Bay or the Canadian MacKenzie River region, would be in the area of a dollar of investment for each cubic foot daily. So, for each billion cubic feet daily that you bring down, it is a billion dollars of investment, so that for a trillion cubic feet annually you would have an investment of some place around $2½ billion. So, some gigantic projects are planned.

On liquefied projects for gas, here I cannot tell you the cost because we have cases pending before us and we cannot yet review these, which are dealing in staggering figures as projected without critical analysis. Even if the price of a supplemental import from Alaska via Canada, or possibly by Alaska to Valdez, gas in liquified form, and then transported by LNG ships down to the west coast, these costs are going to represent substantially higher costs than the cost of exploration and development in the lower 48 States. And all of the supplemental sources, at that higher cost, at a higher price, probably will be required over the course of the next two to three decades in this country, in addition to the gas that you have in the lower 48. By the way, if TAPS is certified, then you can start getting your gas down. Until TAPS, the hot oil line is certified, your gas being in solution, cannot be produced and transmitted down by pipeline. There is some free gas up there, which could be transported down independently of TAPS, but again, economic feasibility probably would prohibit this kind of a development. The gas is not projected to come down even if you were to certify TAPS today—you might figure 5 years before there is gas flowing to the Midwest and to the far West.

Mr. BROWN. As I recall this proposition, and I am sure Mrs. Sullivan received it, too, it related to both oil and gas. Therefore, I would appreciate receiving a further summary of what you see as the meat of the argument between the Canadian pipeline approach and the Alaskan pipeline.

Mr. NASSIKAS. I would be very happy to. Actually, I think all alternatives——

Mr. BROWN. I consider myself a total neophyte in this area.

Mr. NASSIKAS (continuing). Mr. Brown, all alternatives I know are being carefully explored. If the geologists are right—and, you know,

after all, geologists are not always right either. If they were, they would be rich, I guess; but if the geologists are right, you know on the Canadian Arctic and our own Arctic, and if the technologists claim the technology is there, as they do, I think some day you could see oil pipelines that may be coming down from there, and gas pipelines coming down from that region, in addition to TAPS, if it is certified. What I am saying is that the quantity apparently is very large, and we know the demand is equally large.

Mr. BROWN. Thank you very much.

Mrs. SULLIVAN. Thank you very much, Mr. Nassikas, and we appreciate your very informative testimony as well as answers.

The committee will stand adjourned until the call of the Chair.

(Whereupon, at 12:05 p.m., the hearing was adjourned subject to the call of the Chair.)

(The statement, and additional information from the Federal Power Commission, follow:)

STATEMENT OF JOHN N. NASSIKAS, CHAIRMAN, FEDERAL POWER COMMISSION, BEFORE THE JOINT COMMITTEE ON DEFENSE PRODUCTION

Mr. Chairman, I appreciate this opportunity to appear before this committee in response to your letter of September 10, 1971. My remarks are directed to both of the industries which the Federal Power Commission regulates, the electric power industry and the natural gas industry. Both industries have great demands to satisfy over the foreseeable future. There are problems. Some are being handled administratively under existing authority, others will be solved through additional legislative action. On July 22, 1971, I appeared before the Subcommittee on Special Small Business Problems, Select Committee on Small Business, House of Representatives, and testified in respect to energy policy. On May 6, 1971, I appeared before the Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives, and there discussed electric power requirements and supply. The hearings before the Subcommittee on Communications and Power are now printed.

I shall discuss the factual situation in the gas industry, particularly as it relates to gas supply. I shall also consider the electric utility industry. But, before I do, let me note briefly what our regulatory jurisdiction is and how these two industries are comprised.

Under Part I of the Federal Power Act, (16 U.S.C. 792–823) the Commission issues licenses to non-Federal interests authorizing the construction, operation and maintenance of waterpower projects on Government lands and on streams over which the Congress has jurisdiction. These licenses are issued for fixed periods not exceeding 50 years and contain terms and conditions which are designed to protect both the public interest and the licensee. Among these conditions are the right of takeover in the United States of projects needed for war or defense purposes, 16 U.S.C. 809. The Commission, in those instances, is authorized to fix the compensation to the owner of the project taken over. The right of takeover in the United States was exercised during the Second World War, Project No. 1494, Grand River Dam Authority. It was returned to the licensee under act of July 31, 1946, 60 Stat. 743.

The Commission, under parts II and III of the Federal Power act (16 U.S.C. 824–825r), exercises broad responsibilities with respect to the regulation of the electric utility industry. As conferred by the Congress, the Commission has jurisdiction over the interstate transmission of electric energy and its sale at wholesale in interstate commerce by public utilities, 16 U.S.C. 824. This regulation at the wholesale for resale level is designed to insure just, reasonable and nondiscriminatory rates and services throughout the United States, 16 U.S.C. 824d, 824e.

To assure an abundant supply of electric energy throughout the Nation with the greatest possible economy and with regard to the proper utilization and conservation of natural resources, the Commission is empowered and directed, under section 202(a) of the act, to encourage voluntary interconnection and coordination of facilities for the generation, transmission and sale of electric energy, 16 U.S.C. 824a(a). This authority is implemented in Commission Docket No. R–362, Statement of Policy, Reliability, and Adequacy of Electric Service, Reporting of Data, Participation of Regulatory Personnel in Regional Councils, order issued April 10, 1970, 43 FPC 515. Under section 202(c) of the act, 16 U.S.C. 824a(c), the Commission is authorized to act in war or emergency conditions to meet electric power requirements throughout the Nation.[1] During the Second World War and thereafter, numerous orders were issued by the Commission in the exercise of this defense related responsibility.

Under existing statutory and delegated Executive authority, the Commission and its staff participate in defense preparedness measures. See Defense Production Act of 1950, 50 U.S.C. App. 2061, et seq., and Executive Order No. 10480. The Commission acts in a support role to the Office of Emergency Preparedness and the Department of the Interior. See Executive Order No. 11490.

Under section 202(e) of the Federal Power Act, the Commission controls the exportation of power from the United States, 16 U.S.C. 824a(e). Under Executive Order No. 10485, the Commission, upon the favorable recommendations of the Secretary of Defense and the Secretary of State, issues executive permits for the construction, operation, maintenance and connection of facilities at the international borders for the transmission of electric energy or natural gas.

Coincident with its regulation of the electric power industry, the Commission also regulates the interstate aspects of the natural gas industry under the Natural Gas Act, 15 U.S.C. 717–717w. Pursuant to this legislation, the Commission issues certificates authorizing natural gas companies to construct, extend, acquire or operate facilities for the transportation and sale of natural gas in interstate commerce for resale, 15 U.S.C. 717f(c). Under that same section, the Commission issues certificates authorizing producers to sell gas to natural gas

[1] That section provides:
"During the continuance of any war in which the United States is engaged, or whenever the Commission determines that an emergency exists by reason of a sudden increase in the demand for electric energy, or a shortage of electric energy or of facilities for the generation or transmission of electric energy, or of fuel or water for generating facilities, or other causes, the Commission shall have authority, either upon its own motion or upon complaint, with or without notice, hearing, or report, to require by order such temporary connections of facilities and such generation, delivery, interchange, or transmission of electric energy as in its judgment will best meet the emergency and serve the public interest. If the parties affected by such order fail to agree upon the terms of any arrangement between them in carrying out such order, the Commission, after hearing held either before or after such order takes effect, may prescribe by supplemental order such terms as it finds to be just and reasonable, including the compensation or reimbursement which should be paid to or by any such party."

transmission companies subject to this Commission's jurisdiction. Rate jurisdiction is also conferred on this Commission by other provisions of the Natural Gas Act. It investigates the need for, and, when appropriate, directs, natural gas transmission companies holding certificates to establish physical connections with, and to sell natural gas to, local distributors, 15 U.S.C. 717f(a). The abandonment of facilities or the discontinuance of service subject to Commission jurisdiction requires Commission authorization, 15 U.S.C. 717f(b). The Commission regulates the exportation and importation of natural gas from the United States, 15 U.S.C. 717b.

At present, there are 113 interstate natural gas pipeline companies, approximately 4,500 independent natural gas producers supplying the interstate market and almost 1,700 natural gas distributors serving approximately 18,000 communities.

Within the United States we now have approximately 150,000 miles of natural gas pipeline facilities and 12,586,000 compressor horsepower under Federal Power Commission certification pursuant to the requirements of the Natural Gas Act.

Total electric utility generating facilities in existence in the United States include approximately 340,350 megawatts, located in approximately 3,400 generating stations. There are about 302,000 circuit-miles of transmission facilities and about 3.5 million miles of electric distribution facilities. In the United States today, there are some 3,440 different electric supply systems, 2,000 State or municipal electric systems, 1,000 cooperatively owned systems, 400 investor-owned systems, and 40 federally owned systems. In terms of generating capacity, investor-owned systems own 77.2 percent, Federal systems 11.4 percent, State and municipals 10 percent, and cooperatives 1.4 percent.

NATIONAL ENERGY POLICIES

To meet our forecasted national and regional energy requirements it is necessary to pursue policies which will enable the natural ga and electric utility industries to develop on a long-range basis adequate supplies of natural gas and electric energy and to construct the associated physical facilities on a timely basis to meet scheduled requirements. These policies must recognize that both our environment and our resources are finite and essential for quality of life. As I see our national objectives, they are to preserve and enhance our environment and utilize and conserve our resources as the essential foundation for meeting our national defense, economic, and social goals. I include within these full employment, stable prices, and a productive society. Also, I believe that in the execution of governmental policy we must preserve the operation of the free enterprise system.

It is evident that past patterns of energy utilization have caused significant problems. As a Nation, we are continuing to develop imbalances between the demand and the supply of fuel resources, reducing our capacity to meet unexpected changes in the availability of particular fuels. Our use and consumption of fuel resources under current technologies has produced greater environmental effects than the Nation is willing to tolerate. Beyond this, we have been pursuing patterns of use of our mineral fuels which may be sustainable to the end of the century at the rate at which we expect energy to be needed, only if—

(*a*) We increase the trend rate of exploration and development of assured reserves of oil and gas, and create new technologies for developing existing, as well as supplementary, energy resources: (*b*) there is adequate technical effort to make our longest term fossil fuel (coal) adequately usable with acceptable environmental effects, or to gasify coal or to synthesize gas from various hydrocarbon sources; and (*c*) our nuclear power needs of the future, which are critically dependent on successful development of a fast breeder reactor program, are vigorously pursued on a time schedule which assures bringing this vital technology to a state of commercial readiness in the early 1980's.[2]

In your letter of September 10, 1971, you specifically asked for an expression of views "as to whether energy goals should be established in order to focus attention on potential energy shortages and provide the means for finding solutions to supply problems." I believe that the establishment of supply goals is important if we are to assure this Nation an adequate energy supply.

The Commission has done this both in the electric and natural gas areas. I refer to our nationwide program of electric power supply adequacy and reliability under 202(a) of the Federal Power Act, the national power survey which we are now completing for publication in 1971. I have reference also to our parallel national gas survey initiated this year. Additionally, I refer to Commission action in evaluating the natural gas rates set in southern Louisiana and Texas gulf areas. It is from the southern Louisiana area that we reasonably can expect the greater portion of total demand for jurisdictional gas to be satisfied in the next few years. In the southern Louisiana area proceeding,[3] we concluded that a reasonable target level of service for jurisdictional sales is between 45 and 50 trillion cubic feet for the 1971–75 period. To achieve this level, while maintaining deliverability, will require dedications of new gas reserves to the interstate market of approximately 60 trillion cubic feet for the same period.[4]

With respect to the Texas gulf area, we concluded that if demands from this area are to be satisfied during the next 5 years, it is essential that jurisdictional sales from this area increase from present volumes of 8 trillion cubic feet for a 5-year period to 12.5 trillion cubic feet cumulatively for the period of 1971–75. In order to achieve this desired level, while maintaining deliverability, our goal for dedications of new reserves from the Texas gulf coast to the interstate market will be 20 trillion cubic feet during that period.[5] It should be emphasized that these goals must be reviewed on an empirical basis to determine whether they can be realistically attained under our established regulatory policies.

ENERGY OVERALL

Our relative use of energy sources in the past 21 years is shown in table I following. It indicates our energized society is reliant on oil and gas for 76 percent of its energy requirements.

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[2] Testimony of John N. Nassikas, Subcommittee on Communications and Power, May 6, 1971, hearings, p. 469.

[3] Area Rate Proceeding, *et al.* (southern Louisiana area), Dockets Nos. AR61–2 *et al.*, AR69–1, Opinion No. 598, issued July 16, 1971, mimeo ed. p. 39. The order denying rehearing was issued on Sept. 9, 1971.

[4] Gross additions to reserves in trillions of cubic feet from Southern Louisiana have been 7.8 TCF in 1965, 5.5 TCF in 1966, 8.2 TCF in 1967, 8.0 TCF in 1968, and 4.2 TCF in 1969.

[5] Area Rate Proceeding *et al.* (Texas gulf coast area), Docket No. AR64–2 *et al.*, Opinion No. 595, issued May 6, 1971, mimeo. ed. p. 13.

As table II following shows, over the next 20 years, oil and gas requirements will account for over 60 percent of projected energy use. If nuclear technology does not fulfill its promise on schedule, we may continue to be significantly more dependent on oil, gas, and coal resources than anticipated into the 21st century and beyond.

TABLE I.—RELATIVE CONSUMPTION OF MAJOR ENERGY FORMS, 1950–70

[Percent of total]

Year	Anthracite	Bituminous and lignite	Natural Gas, dry	Petroleum [1]	Hydropower	Nuclear power	Total gross energy input
1950	3.0	34.8	18.0	39.5	4.7	----------	100.0
1951	2.6	33.3	19.6	40.2	4.3	----------	100.0
1952	2.5	30.0	21.2	41.9	4.4	----------	100.0
1953	1.9	29.7	21.6	42.7	4.1	----------	100.0
1954	1.9	26.2	23.5	44.3	4.1	----------	100.0
1955	1.5	27.8	23.1	43.9	3.7	----------	100.0
1956	1.5	27.0	23.4	44.2	3.8	----------	100.0
1957	1.3	25.9	24.8	44.3	3.7	0	100.0
1958	1.1	22.9	26.2	45.7	4.1	0	100.0
1959	1.1	22.1	27.6	45.3	3.9	0	100.0
1960	1.0	22.2	28.3	44.6	3.9	0	100.0
1961	.9	21.5	29.0	45.0	3.6	0	100.0
1962	.8	21.3	29.6	44.6	3.7	0	100.0
1963	.7	21.6	29.9	44.2	3.5	0	100.0
1964	.7	21.9	30.2	43.5	3.6	0.1	100.0
1965	.6	22.3	29.8	43.4	3.8	.1	100.0
1966	.5	22.3	30.3	43.2	3.6	.1	100.0
1967	.5	21.3	31.0	43.2	3.9	.1	100.0
1968	.4	20.9	31.3	43.4	3.8	.2	100.0
1969	.3	20.2	32.1	43.1	4.1	.2	100.0
1970	.3	19.7	32.5	43.4	3.8	.3	100.0

[1] Includes natural gas liquids.

Source: 1950–63—Bureau of Mines Information Circular 8384, p. 60. 1964—Minerals Yearbook–1967. 1965–69—Bureau of Mines, Mineral Industry Surveys, Petroleum Statement, Annual, Dec. 15, 1970, p. 32. 1970 (preliminary)—Bureau of Mines, Mineral Industry Surveys, Petroleum Statement, Monthly, December 1970, p. 37.

TABLE II.—PROJECTED GROSS CONSUMPTION OF ENERGY IN THE UNITED STATES, 1980 and 1990

[Quadrillion B.t.u.]

Energy source	1970 (preliminary)		Projected			
			1980		1990	
	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total
Coal [1]	13.8	20.0	18.0	18.9	18.5	13.2
Gas [2]	22.4	32.5	26.5	27.9	35.7	25.5
Oil	29.8	43.4	38.0	40.0	50.0	35.7
Hydro	2.6	3.8	3.0	3.2	3.6	2.6
Nuclear	.2	.3	9.5	10.0	32.2	23.0
Total	68.8	100.0	95.0	100.0	140.0	100.0

[1] Anthracite coal and bituminous coal and lignite.

[2] A more rapid growth in gas requirements is indicated by the announcement of the gas industry's Future Requirements Committee, September 1971. The Committee's projections show gas requirements of 38.5 in 1980 and 50.1 in 1990 (in quadrillion Btu).

Source: 1970: Bureau of Mines, Mineral Industry Surveys, Petroleum Statement Monthly, December 1970, p. 37. Projections: Bureau of Mines Information Circular 8384, p. 114, given for 1980 and as implied for 1990, adjusted by FPC estimated heat rates and revisions due to expected changes in pattern of fuel use by electric utilities.

NATURAL GAS

In the area of natural gas supply, the Commission's analyses of discernible demand-supply trends indicates a present and future shortage of deliverable reserves to service consumer demand. Natural

gas is an important part of electric utilities fuel—in 1970, 29.7 percent of the fuel used for power generation was natural gas. Limitation of gas supplies must result either in limiting the productive capacity of gas fueled plants, or a switch to alternate fuels. The problem of reduced reserves in relation to supply developed during the decade of the 1960's when the ratio of proved gas reserves to annual production dropped steadily. Essentially, the facts are that since the mid-1950's the number of wells drilled per year has dropped from 57,111 in 1956 to 28,008 in 1970.[6]

This 51 percent decrease in total drilling activity has been accompanied by a concurrent decline in exploratory drilling of approximately the same magnitude. Preliminary data relative to drilling activity during the first 6 months of 1971 indicates that total wells drilled are running almost 10 percent below the pace of 1970. Total exploratory wells drilled have fallen almost 17 percent below the rate of the like period of 1970.

With the declining effort to provide additions to reserves in the last 15 years, the lower 48 reserve to production ratio slid from a 1946 high of 32.6 to 11.9 by year-end 1970, according to American Gas Association statistics. Reserve additions in the lower 48 States fell short of production by 7.3 trillion cubic feet in 1968, by 12.3 trillion cubic feet in 1969 and by 10.7 trillion cubic feet in 1970.

Our continuous observation and analysis of the oil and gas industry's efforts to discover and produce gas indicates that the adverse trends in the Nation's natural gas supply/demand balance have not yet been reversed. The gas energy gap between demand and supply continues to widen. The annual form 15 reports, submitted by interstate pipeline companies regarding natural gas reserves and deliverability, indicate that the declining trend of owned or controlled reserves which began in 1968 has worsened. National reserve data published annually by the American Gas Association includes information on both interstate and intrastate companies and on a nationwide basis parallels the trends indicated by form 15 data as shown on the following table:

TABLE III.—NATURAL GAS RESERVES AND RESERVES TO PRODUCTION RATIO [1]

[Volumes in trillions of cubic feet]

	End of year reserves		Reserve to production ratio	
	A.G.A. [2]	Form 15 [3]	A.G.A.	Form 15
1963	274.5	188.5	18.9	20.2
1964	279.4	189.2	18.3	18.9
1965	284.5	192.1	17.5	18.5
1966	286.4	195.1	16.4	17.5
1967	289.3	198.1	15.7	16.8
1968	282.1	195.0	14.6	15.5
1969	269.9	187.6	13.1	14.0
1970	259.6	173.7	11.9	12.3

[1] Excludes Alaska.
[2] Reserves of crude oil, natural gas liquids, and natural gas in the United States and Canada and United States productive capacity as of Dec 31, 1970, volume 25, May 1971.
[3] Federal Power Commission Report, "The Gas Supplies of Interstate Natural Gas Pipeline Companies—1969" Preliminary figures for 1970.

[6] Source: 1955–65 Oil and Gas Journal, 1966–69 American Association of Petroleum Geologists, 1970–71 American Petroleum Institute.

In the United States, natural gas comprises approximately one-third of the total energy consumed. More than 50 percent of the 1969 gas consumption went to industrial use, residential usage required 21 percent, 8 percent went to commercial enterprises, and 19 percent was consumed in the field and in other uses.[7] Based on the most recent estimate of the Future Requirements Committee, the total regional demand for natural gas in the lower 48 States, excluding field use, will grow from approximately 21.4 trillion cubic feet in 1970 to 54.9 trillion cubic feet in 1995. The projected average annual compounded growth rate during the 1970–95 period is about 3.8 percent. The historical growth rate for the period 1950–70 was about 6.7 percent.

On September 3, 1971, the Future Requirements Committee announced its latest projection of anticipated natural gas requirements for the United States. In addition to its usual forecast of future gas requirements under conditions of an adequacy of supply, the committee estimated the requirements that can be met between now and 1975 from presently contracted or assured supplies. These data indicate that by 1975 only 86 percent of the total regional requirements for 28.5 trillion cubic feet of gas, or 24.6 trillion cubic feet, can be met with contracted or assured supplies. A summary of this forecast is shown in table IV.

TABLE IV.—U.S. GAS REQUIREMENTS [1]

SUMMARY OF FUTURE REQUIREMENTS COMMITTEE PROJECTIONS, 1971–1975

[Gas volumes in trillions of cubic feet]

Year	Total regional requirements including field use	Total regional requirements [2]	Total regional usage	Percent of requirements met	Deficiency in trillions of cubic feet of gas	Deficiency in equivalent barrels of residual oil [3] (millions)	Deficiency in equivalent tons bituminous coal [4] (millions)
1971	28.2	23.3	22.4	96.1	0 9	143	34
1972	29.9	24.7	22 9	92.7	1.8	286	69
1973	31.7	26.2	23.5	89.7	2.7	429	103
1974	32 9	27.3	23.9	97.6	3.4	451	130
1975	33.9	28.5	24.6	86.3	3.9	620	149
Cumulative 1971:75	156.6	130.0	117.3	90.3	12.7	2,019	485

[1] Gas at 1,000 B.t.u. per cubic foot.
[2] Field use not included.
[3] Residual oil heating value, 6,287,000,000 B.t.u. per barrel.
[4] Coal heating value, 26,200,000,000 B.t.u. short ton.

Looking to the time period beyond 1975, with the probable rate of development of natural gas reserves, coupled with reasonable expectations of supplemental supplies, it appears that the problem of balancing supply and demand will be with us for many years.

In the illustrative supply-demand balance given in table V which has been prepared by the Federal Power Commission staff, a gas supply deficiency is shown beginning in 1972. Because the data in this table is national in character, regional supply problems cannot be shown. As a result, surpluses and deficiencies which may tend to

[7] Market division estimated by the Future Requirements Committee. The Future Requirements Committee is sponsored by the Future Requirements Agency, Denver Research Institute, University of Denver and is composed of members from the gas producing, pipeline, and distribution industry, observers from State and Federal regulatory bodies, American Gas Association, American Petroleum Institute, Independent Natural Gas Association of America, and the National Association of Regulatory Utility Commissioners.

offset each other on a national basis may have a quite different effect in a given consuming area. As has already become apparent, supply problems have developed on a localized and regional basis prior to a projected national deficiency. While pipeline supply may be in balance on a broad national basis, deficiencies in supply are already manifest in various parts of the United States for firm contract demand, interruptible demand, and incremental demands. It should be pointed out that this projection for the period 1971–75 assumes a rate of reserve additions well above the average of the past 3 years, although below the average of historical levels of reserve additions.

TABLE V.—ILLUSTRATIVE U.S. GAS SUPPLY-DEMAND BALANCE, 1970-90

[All volumes in trillions of cubic feet at 14.73 p.s.i.a. and 60° F.]

	1970	1971	1972	1973	1974	1975	1980	1985	1990
Reserve additions [1 2]	11.1	12.0	13.0	14.0	15.0	16.0	17.0	17.0	17.0
Yearend reserves [1]	255.6	244.1	232.7	223.4	216.1	210.5	194.0	184.3	178.6
Domestic production [1 3]	12.8	23.5	24.4	23.3	22.3	21.6	19.7	18.6	17.9
Total supplemental supply	.8	.9	1.1	1.1	1.2	1.6	4.7	7.7	11.6
Net pipeline imports	.9	.9	1.1	1.1	1.2	1.3	1.7	2.0	1.9
LNG imports	(4)	(4)	(4)	(4)	(4)	.3	2.0	3.0	4.0
Gas from coal							.3	1.4	3.4
Gas from Alaska							.7	1.3	2.3
Total supply available	22.6	24.4	25.5	25.4	23.5	23.2	24.4	26.3	29.5
Annual demand [1 5]	22.6	24.4	25.9	27.4	28.5	29.3	33.3	37.7	43.3
Supply deficit			.4	3.0	5.0	6.1	8.9	11.4	13.8

[1] Contiguous 48 states.
[4] Very small volumes.
[2] Assumed rate of reserve additions, excluding full impact of recent area rate proceedings.
[3] Estimated by holding reserve to production ratio at 10 or above.
[5] Based on growth rates derived from Furture Requirements Committee press release dated Sept. 3, 1971.

Source: Prepared by the Federal Power Commission Bureau of Natural Gas.

Liquefied natural gas (LNG) shipped from Algeria to the Boston Gas Co. in 1968 was the first instance of LNG imported into the United States and was used to alleviate an emergency situation. There are no current baseload marine imports into the United States but several major projects are planned. A listing and status of currently proposed LNG imports is attached in appendix A. Perhaps the most important aspects of the developments in LNG technology is the advantage it makes available to distributors for peak shaving, satellite facilities, remote and emergency deliveries, and potential for making new worldwide sources of natural gas technically available to U.S. consumers.

ELECTRIC

On a nationwide basis, electric utilities were projected to have 342,279 megawatts of net dependable capacity this summer, with an estimated peak load of 296,791 megawatts. The resulting capacity available for reserves totals 45,488 megawatts, or 15.3 percent for the Nation as a whole. These projections, made in May and reported to the Subcommittee on Communications and Power Hearings (p. 446), have been shown to be substantially correct based upon more recent data and staff analyses. My testimony before that committee analyzes the power supply conditions of the Nation by geographic areas and in substantial detail.

Currently, a number of systems are projecting reserve ratios of 15 to 20 percent of peak load to compensate for forced outages, required

maintenance, uncertainties in load forecasting, and other reasonably foreseeable contingencies. I am not satisfied that these ratios are yet high enough, but efforts are being made to improve them.

COORDINATED GOVERNMENTAL ACTIONS

On June 4, 1971, the President announced, in his energy message to the Congress and the people of the United States, that a "sufficient supply of clean energy is essential if we are to sustain healthy economic growth and improve the quality of our national life." The President's message is relevant to environmental and social costs involved in the current energy issues confronting all technologically advanced nations in the world. The President stated "that the various elements of our society will be able to work together to meet our clean energy needs. And I am confident that we can therefore continue to know the blessings of both a high-energy civilization and a beautiful and healthy environment."

IMMEDIATE STEPS

Under near term conditions, the immediate and short-range solutions to our gas and electric energy problems are to insure the most efficient utilization of available natural gas supplies and electric generating capacity, wherever located and by whomever owned, to meet consumer demands at a reasonable price. The Commission and its staff, in coordination with other Federal Government departments or agencies, State utility commission personnel and representatives of the operating systems, are working throughout the Nation to accomplish needed natural gas and electric power transfers to serve local areas of shortage or anticipated shortages.

The Commission has coordinated its activities with the actions of other Federal agencies through the Interagency Power and Energy Committee [8] convened by the Office of Emergency Preparedness. I have served personally on this committee along with members of the Commission's staff.

On September 29, 1970, Dr. Paul W. McCracken, Chairman of the Council of Economic Advisers, and Gen. George A. Lincoln, Director of the Office of Emergency Preparedness, jointly outlined steps which the members of the Interagency Committee, and other offices of the Federal Government, have taken to meet electric power and fuel needs of the Nation. That statement provides, in part, the following:

> We will continue to work closely with the electric power industry through the Federal Power Power Commission along the lines of our program for the summer to assure that interruptions in electric service are minimized. We urge the state and local governments to meet with the utilities in their respective service areas to review contingency plans for meeting loads this winter in those areas of tight supply * * *.
>
> We are establishing a Joint Board [9] composed of the Director of the Office of

[8] The committee is comprised of representatives of the Department of Health, Education, and Welfare; the Department of the Interior; the Office of Emergency Preparedness; the Office of Science and Technology; the Atomic Energy Commission; the Interstate Commerce Commission; and, the Federal Power Commission.

[9] I have assigned George E. Tomlinson, Chief Engineer, and Thomas J. Joyce, Chief, Bureau of Natural Gas, to be FPC staff members of the Working Group to assist the Joint Board in identifying emergency problems in fuel supply and fuel transport and coordinating prompt and appropriate remedial action by the responsible Federal agencies. The Working Group is composed of representatives designated by the Secretaries of the Departments of the Interior and Commerce, the Chairmen of the Interstate Commerce Commission and the Federal Power Commission, and the Director of the Office of Emergency Preparedness.

Emergency Preparedness (Chairman), the Secretaries of Interior and Commerce, and the Chairman of the Council of Economic Advisors, the Council on Environmental Quality, the Interstate Commerce Commission, and the Federal Power Commission to identify emergency problems in fuel supply and fuel transport and coordinate prompt and appropriate remedial action by the responsible Federal agencies.

These steps are in addition to a number of measures already taken, or in the process of being prepared for implementation, to use the transportation and power systems more efficiently and respond to local shortages.

Field boards on fuel and energy problems which are counterparts of the joint board at the national level have been established by the Office of Emergency Preparedness in its eight regions throughout the country. The commission staff has actively participated in the work of these boards in pursuing specific problems of fuel shortages during the past year in addition to their longer range activities related to future energy needs.

At the request of the President, the Domestic Council, through its Energy Subcommittee [10] studied the national energy situation to develop for the President new or revised energy policies; and recommended to the President Federal actions which may be taken to alleviate the immediate shortages of clean fuels and to insure an adequate fuel supply over the next 5 years.

ADDITIONAL FPC ADMINISTRATIVE ACTIONS IN RESPECT TO NATURAL GAS SUPPLY

The Federal Power Commission has taken full cognizance of the existing imbalance between natural gas supply and demand and has taken a number of actions aimed toward restoring the balance. The commission's multifaceted actions have been undertaken for the purpose of easing the administrative burden on the regulated industry, to aid rapid development of new gas supplies, and to assure the long-range strength and viability of the natural gas industry. A detailed explanation of the actions taken by the commission to resolve gas supply problems is set forth as appendix B to this statement. Among the actions which have been taken are the following:

(1) A nationwide investigation to review existing rates and determine whether higher rates should be estabished for future supplies of natural gas dedicated to the interstate market.

(2) Review and completion of area rate proceedings in important gas producing areas.

(3) Institution of rulemaking procedures designed to stimulate the search for natural gas by independent producers and pipeline companies.

(4) Change of small independent producers price regulation by means of blanket certification and commission review of gas purchase costs in its pipeline regulation.

(5) Nationwide investigation of the reliability of electric and natural gas service.

(6) Establishment of producer rates by rulemaking proceedings.

[10] Members of the Energy Subcommittee which conducted this study included the Secretary of State; the Secretary of the Interior; the Secretary of Health, Education, and Welfare; the Secretary of Commerce; the director of the Office of Science and Technology; the chairman of the Council on Environmental Quality; the director of the Office of Emergency Preparedness; the chairman of the Federal Power Commission; the chairman of the Atomic Energy Commission; the special assistant to the President for Consumer Affairs; the director of the Office of Management and Budget; and the chairman of the Council of Economic Advisors who served as chairman of the committee.

(7) Accepting for consideration applications by independent producers requesting issuance of a certificate for sales of natural gas notwithstanding that the proposed rates may be in excess of the ceiling or guideline rates.

(8) Authorization of importation of liquefied natural gas to meet emergency needs.

(9) Establishment of accounting rules for advance payments and loans to producers by pipelines to stimulate further exploration and development and to increase pipeline responsibility for gas supply.

(10) Review of pipeline company curtailment plans and policies.

(11) Overall rate review to attract required investment in facilities to provide consumer service.

(12) The Federal Power Commission has undertaken with approval from the Congress an independent investigation of natural gas reserves in the United States and an overall evaluation of the role of natural gas in meeting energy requirements of the United States.

The National Gas Survey is intended to enhance the Commission's ability to regulate effectively through policies to provide a continuing, reliable supply of gas to meet consumer needs. To obtain an overview of gas supplies, an extensive reserve analysis will be conducted. This study will provide detailed geological evaluations of a broad sample of reserve estimates made by natural gas companies. In the conduct of this study, geological and geophysical data will be reviewed to develop individual estimates of reserves in the reservoirs which will be examined. Some of the important questions to be examined in depth by the survey are—

(*a*) the precise dimensions of the gas supply problem;

(*b*) the extent to which pipeline expansion of facilties is threatened by inflation and uncertainty of new gas supplies;

(*c*) the role of natural gas in air pollution control;

(*d*) the supply-price-demand relationship;

(*e*) the potential impact of interfuel competition;

(*f*) import-export policies;

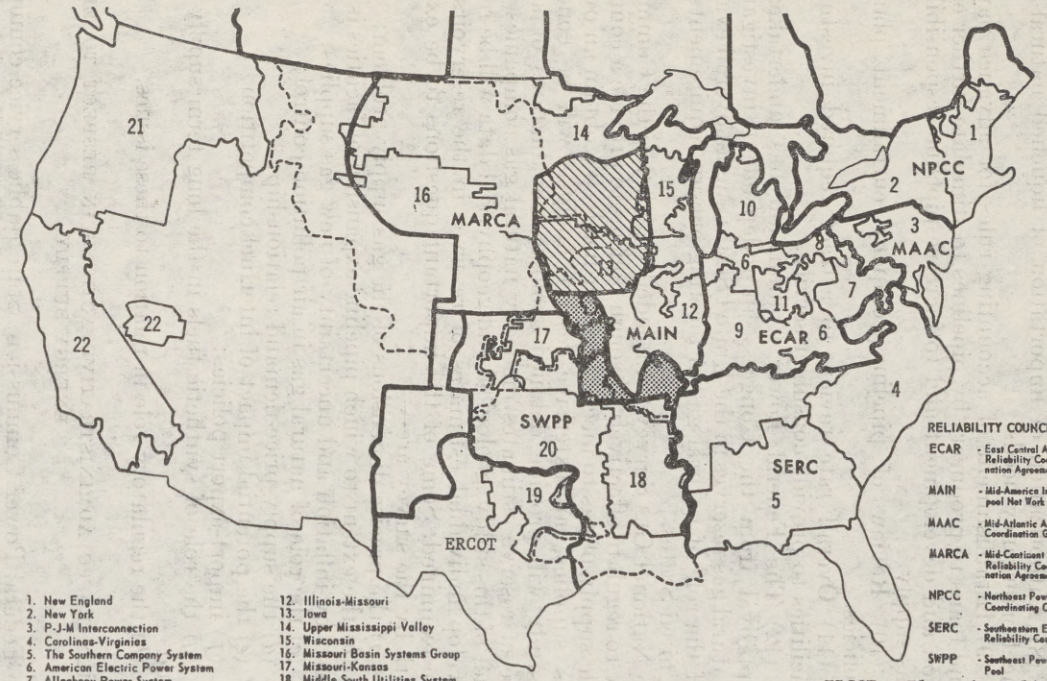
(*g*) the role of synthetic fuels in the long term supply of gas, and

(*h*) the regulatory role in relation to these issues.

ADDITIONAL FPC ADMINISTRATIVE ACTIONS IN RESPECT TO ELECTRIC ENERGY SUPPLY

The Federal Power Commission, State public service commissions, and the major operating utilities, through the established nationwide network of nine electric reliability councils and 22 power pools, are acting to coordinate electric utility system planning and operation. Also, affected systems are developing nationwide contingency programs in order to maximize the capacity of all utilities to render emergency, standby, and reserve services among systems. These councils and pools are identifiable on the map which follows:

GEOGRAPHIC AREAS ENCOMPASSED BY FORMAL POWER POOLS AND REGIONAL RELIABILITY COUNCILS



1. New England
2. New York
3. P-J-M Interconnection
4. Carolinas-Virginias
5. The Southern Company System
6. American Electric Power System
7. Allegheny Power System
8. Central Area Power Coordination
9. Kentucky-Indiana
10. Michigan
11. Cincinnati, Columbus, Dayton
12. Illinois-Missouri
13. Iowa
14. Upper Mississippi Valley
15. Wisconsin
16. Missouri Basin Systems Group
17. Missouri-Kansas
18. Middle South Utilities System
19. Texas Utilities
20. South Central Electric Companies
21. Pacific Northwest Coordination
22. California

RELIABILITY COUNCILS

- ECAR - East Central Area Reliability Coordination Agreement
- MAIN - Mid-America Interpool Net Work
- MAAC - Mid-Atlantic Area Coordination Group
- MARCA - Mid-Continent Area Reliability Coordination Agreement
- NPCC - Northeast Power Coordinating Council
- SERC - Southeastern Electric Reliability Council
- SWPP - Southwest Power Pool
- ERCOT - Electric Reliability Council of Texas
- WSCC - Western Systems Coordinating Council

Operating utilities have now substantially completed their actions to implement the 11 principal recommendations which the Federal Power Commission made in respect to adequacy and reliability of power supply, as a part of its three-volume report to the President on the prevention of power failures, July 1967. I set forth the factual details of these recommendations and actions in my testimony before the Subcommittee on Communications and Power on May 6, 1971, Hearings p. 446 and appendix N thereto (not printed, but reproduced and annexed thereto as appendix C).

In addition, through our general rulemaking procedures, we are in the process of evaluating establishment of a schedule of plans and procedures which major utility systems would follow to effect all possible needed electric power transfers between utilities or areas to meet electric shortages, whether arising from equipment breakdown, fuel or water shortages, equipment maintenance requirements, or other emergency conditions. The formulation of load relief or load curtailment procedures which may be required to avert widespread service interruptions in the event of severe capacity-load imbalances in any given locality, area, or region are also included in this rulemaking which is under consideration: docket No. R–405, "Policy Statement Notice of Investigation and Proposed Rulemaking With Respect To Developing Emergency Plans," issued November 4, 1970. At p. 466 and following of the printed hearings containing my testimony before the Subcommittee on Communications and Power (May 6, 1971), I discuss the details of this rulemaking which covers both the electric power and natural gas industries.

With respect to the supply and availability of fossil fuels specifically for electric utility use, we are working with other agencies of Government, as well as industry, in order to help stimulate the production of all types of fuels, to insure their delivery at needed points of consumption, and to encourage the full utilization of storage facilities to meet future needs.

The following tabulation, prepared by the Commission staff, shows the relative percentages of fossil fired fuel electric generation at 5-year intervals from 1970–90:

TABLE VI.—PERCENTAGE BREAKDOWN OF TOTAL FOSSIL FUEL GENERATION

	1970	1975	1980	1985	1990
Coal	55.1	56.0	59.4	62.1	63.3
Gas	29.7	24.0	20.1	17.6	17.1
Oil	15.2	20.0	20.5	20.3	19.6
Total	100.0	100.0	100.0	100 0	100.0

Based upon what we know now, the next few years may represent the period of the greatest difficulty for electric utilities in securing adequate fuel supplies. In the past 18 months, scattered fuel shortages have been experienced by the electric utilities. Fuel stocks, delivery methods, and air quality regulations all must be considered. By order issued September 17, 1971, the Commission prescribed report forms for all types of electric utilities—investor owned, publicly owned, and cooperatively owned—to report on a weekly basis when emergency conditions exist in respect to coal and oil stocks for electric utility

generation, order No. 438, "Reliability of Electric Service," docket No. R–415.

In the Commission's 1971 national power survey covering the period 1970–90, and in working with the Nation's 22 powerpools in the course of our day-to-day regulation of the electic utility industry, we are taking steps to stimulate increases in reserve ratios through increased capacity additions and better load forecasting techniques. This is being done through appropriate ratemaking allowances in the discharge of our rate regulatory activity, in studies made in our interconnection and coordination work, and in general reports and studies which are being prepared by the Commission and its staff. My current judgment is that average installed generating reserve ratios should be at least 20 percent of the loads served. Necessarily, the specific amount varies between utilities and regions, depending upon physical equipment and the nature of connected loads.

At page 447 and following, including appendixes L, P, and P–1 thereto (not printed), of the printed record of my testimony before the Subcommittee on Communications and Power on May 6, 1971, I reviewed the electric power supply conditions throughout the Nation for 1971 summer period and for the winter period 1971–72. Since that date, the Commission's staff, as a part of its continuing work schedule on electric power reliability matters, has completed a reassessment of electric load and supply conditions as projected by the nine regional electric reliability councils (summer season and winter season) on a comparative basis, 1970 (actual) and 1971–73 (projected). This reassessment is set forth in appendix D hereto. The overall conclusion to be drawn is one of gradual improvement in respect of the Nation's bulk power supply arrangements, although there have and will continue to be disturbances. Since January 1, 1971, 25 power interruptions have been reported to the Federal Power Commission under its order No. 331–1. A number of these involved power outages of more than 200,000 kilowatts, including three which affected relatively large areas. A brief summary of these three incidents appears in appendix E.

On September 9, 1971, the Commission released its staff report comparing actual 1970 and 1971 summer conditions. The Commission's release (appendix F hereto) states:

> The Federal Power Commission today released a staff report which shows that the Nation's electric power system conditions improved this summer as compared to the summer of 1970.
>
> The report shows that 40 voltage reductions were reported during the period June 21 to September 7, 1970, compared to only nine this year, between June 1 and September 6. Voltage reductions occurred on 15 days last year and on 5 days this year.
>
> There have been no reports of appeals for load curtailment so far this summer, compared to eight such appeals last year.

I believe the present policies and programs of the Federal Power Commission will contribute to meeting the energy needs of the future under our assigned responsibilities by Congress. But, it should be emphasized that some shortages are inevitable over the course of the next 3 to 5 years. There will be a definite lag in supply to meet demands due to the time required for resource development.

The Commission regularly analyzes the load capacity situation of each major electric utility supplier in the contiguous 48 States, under projected summer and winter conditions. Also, as a part of the Com-

mission's continuing work in the area of electric power adequacy and reliability, analyses are prepared of the annual reports of the Nation's major electric utility suppliers, submitted through the nine electric reliability councils. These reports project ahead up to 10 years. Appendix G hereto sets forth the Commission's release of that report dated August 30, 1971. The release notes:

For the 1972–76 period there are only a few instances in which projected reserves are less than 18 percent at the time of winter or summer peaks. Average reserve margins of about 20 percent of expected peak load demands generally are considered necessary to compensate for forced outages, required maintenance, uncertainties in load forecasting, and other reasonable contingencies.

Projecting farther into the future (1970–1990) ,the Federal Power Commission, in completing its National Power Survey to be released during 1971, is studying electric utility growth and demands in coordination with industry advisory committees. We may expect the growth in electric power use to continue at a rate which will result in an approximate doubling of consumption in each 10 years, at least for the next two decades. In 1970, the total electric utility generation in the United States was about 1,541 billion kilowatt hours. For purposes of the National Power Survey, we have made projections for 1980 and 1990 of 3,113 billion and 5,922 billion kilowatt hours, respectively. Based on these projections and interpolating for the intermediate points, the electric power generation for 1975 and 1985, from all fuel sources, would be about 2,160 billion and 4,240 billion kilowatt hours, respectively.

The sources of generation for the years 1970, 1980 and 1900, for all types of fuels, are shown in the following tabulation:

TABLE VII.—ELECTRIC UTILITY GENERATION

[In billions of kilowatt-hours]

Sources of generation	1970		1980		1990	
	Kilowatt-hour times 10^9	Percent of total	Kilowatt-hour times 10^9	Percent of total	Kilowatt-hour times 10^9	Percent of total
Water:						
Conventional hydro	253	16.4	292	9.3	319	5.4
Pumped Storage hydro	4	.3	25	.8	62	1.0
Fossil fuel (coal, oil, gas): Fossil fueled steam	1,241	80.5	1,895	60.9	2,579	43.6
Internal combustion and gas turbines	21	1.4	27	.9	49	.8
Nuclear	22	1.4	874	28.1	2,913	49.2
Total	1,541	100.0	3,113	100.0	5,922	100.0

As shown in table VI tabulation above, staff projections of the percentages of coal, gas and oil used to produce the kilowatt hours generated by fossil fuels have been made for 5 year intervals, 1970–1990. Your letter of August 19, 1971, requests these data estimates as set forth above.

The hardware and sites needed to meet the future demands of electric utilities may be summarized as follows:[11]

Current projections call for 300 new thermal plant sites by 1990 and the utilization of approximately 7 million acres of land for transmission

[11] Testimony of Chairman John N. Nassikas before the Subcommittee on Communications and Power May 6, 1971. Hearings pp. 439–442.

rights-of-way as compared with the 4 million acres now in use for this purpose. The various types of basic generation in this long-term picture are:

TABLE VIII

	1970		1980		1990	
	Megawatts	Percent	Megawatts	Percent	Megawatts	Percent
Conventional hydro	51,600	15.2	68,000	10.4	82,000	6.5
Pumped storage hydro	3,600	1.1	27,000	4.0	70,000	5.6
Fossil steam	259,100	76.1	390,000	58.6	558,000	44.3
Internal combustion and gas turbine	19,200	5.7	40,000	6.0	75,000	5.9
Nuclear	6,500	1.9	140,000	21.0	475,000	37.7
Total	340,000	100.0	665,000	100.0	1,260,000	100.0

In respect to increased and strengthened transmission ties between utilities and regions, the Commission and its staff are continuing to use all available means to ensure the early construction of needed lines. Heavy ties are necessary for reasons of reliability and economy of service. Moreover, they are indispensable to the accomplishment of large emergency power transfers between systems or regions. At p. 433 and following of hearings before the Subcommittee on Communications and Power, I summarize these actions by geographic area.

RESEARCH AND DEVELOPMENT

As a part of this look to the future, I believe there must also be a greatly expanded effort to stimulate research and development and formulate new concepts for utility systems analysis and design on regional and vastly improved interconnected bases. The 1971 National Power Survey and the National Gas Survey should do much in both areas. In the utility sector of our economy, the regulator and regulated must effectively contribute to a resolution of the pending problems. I called attention to the urgency of this matter in my May 6, 1971 testimony before the Subcommittee on Communications and Power, Hearings p. 455 and Appendix Q thereto (not printed). That Appendix summarizes recent regulatory actions which the Federal Power Commission has taken in an effort to stimulate advance planning and research and development activities. It appears as Appendix H hereto. [12]

In my judgment, we must develop the technology to economically gasify coal or synthesize gas from other hydrocarbon sources, such as oil shale and tar sands. In addition nuclear power needs of the future, which are critically dependent upon successful development of a fast breeder reactor program, must be vigorously pursued on a time schedule which assures bringing this vital technology to a state of commercial readiness in the early 1980's. These are absolutely essential priorities.

[12] The basic materials discussed in the Appendix were presented to the National Academy of Sciences–National Academy of Engineering Environmental Studies Board on February 11, 1971, Remarks of John N. Nassikas, "National Energy and Environmental Policy".

Among the promising programs undertaken by a number of gas utilities is participation in an intensive research effort to develop a commercially feasible fuel cell. Other programs requiring commitment by the gas industry and the energy interests are the establishment of expanded pilot projects for coal gasification [13] and the initiation of new projects for oil shale gasification, improvement of storage and transportation facilities for both natural and liquefied natural gas, and further investment in nuclear or other methods of stimulating tight reservoirs of gas.

The electric utility industry must also embark on unprecedented programs of research and development to find new commercially feasible energy sources, and improved technology for the production, transmission, and consumption of electricity consistent with preservation of and reduced impact on the environment.

Over the past 4 years, it is estimated that an average of about $100 million has been spent annually on liquid metal fast breeder reactor research. Of this total, the Atomic Energy Commission has spent about $75 million per year, manufacturers about $25 million, and electric utilities about $5 million, or about 5 percent of the total. The electric utility industry should bear a substantially greater proportion of funding and consequent responsibility for this program to accelerate the development of vitally needed nuclear facilities to reduce environmental impact and meet power demand during the remainder of the 20th century. In the President's message of June 4, 1971, the President increased funding for the liquid metal fast breeder program and stated that our "best hope today for meeting the Nation's growing demand for economical clean energy lies with the fast breeder reactor." In addition to the liquid metal fast breeder reactor program, the technology of a gas-cooled fast breeder reactor should be developed.

Breeder reactor development on a commercially feasible scale by mid-1980's should not only greatly extend our nuclear fuel resources but also conserve our other energy resources, contribute to an ultimate solution of air pollution problems as well as reduce thermal pollution problems, and develop energy at a social and economic cost competitive with conventional thermal steam generating plants of the next generation.

The recent decision by the U.S. Court of Appeals for the District of Columbia Circuit in *Calvert Cliffs' Coordinating Committee, Inc., et al.* v. *U.S. Atomic Energy Commission, et al.*, Nos. 24839 and 24871, decided July 23, 1971, underscores this need for research. The court found inter alia that the Atomic Energy Commission's procedural rules do not comply with the congressional policy as set forth in the National Environmental Policy Act. There are electric supply consequences.

The Atomic Energy Commission has approved interim procedures for NEPA implementation in the AEC licensing process. It is my

[13] A large part of the budget of the Office of Coal Research of the Department of the Interior is devoted to gasification projects. The Office's fiscal 1972 budget is $21 million, of which nearly $4 million is for the expansion of pilot plant construction and operation for conversion of coal to fuel gas, and for research in magnetohydrodynamics. See "Budget of the U.S. Government, Fiscal Year 1972," p. 348.

find 11 units, totaling almost 7.5 million kilowatts of electrical capacity which vary from 87 percent to 100 percent physical completion. In applying requirements of the Environmental Policy Act to the licensing requirements of the Atomic Energy Commission, the question of delay and operation of needed units arises. Chairman understanding, based upon our staff's analysis that 33 nuclear plants are being given "highest priority" attention by the Atomic Energy Commission as to implementation of the Environmental Policy Act in relation to that agency's licensing actions. Within this list of 33 we Schlesinger and I and our respective staffs are maintaining continuing communications so as to discharge our respective responsibilities. In my judgment, it is essential that environmental procedures reflect not only the state of the air, land, and water, but needs of the Nation for continued electric power supply. A balancing requirement must obtain. Among other things, nuclear facilities should comply with radiological health and safety standards, not result in a significant irreversible long-term adverse effect on the environment and yet contribute to an adequate and reliable supply of electric power to avoid adverse economic, environmental, and defense impacts of conditions which may obtain in power shortage situations.

The Federal Power Commission has developed and issued pertinent guidelines and other related orders as listed in appendix I hereto, to assure employment of the best principles of environmental protection. The Commission is participating actively with the Electric Power Council on Environment, the Electric Research Council, the National Association of Regulatory Utility Commissioners, the Environmental Protection Agency, and with a variety of State and regional organizations to foster communication, coordination, and improvement of technical data and policies related to environmental practice. Environmental factors formed a large part of the subjects considered in my testimony before the Subcommittee on Communications and Power. Also, I discussed this subject at length in hearings before the Subcommittee on Fisheries and Wildlife Conservation, Committee on Merchant Marine and Fisheries, House of Representatives, December 9, 1970. Hearings, page 215 and following.

CONCLUSIONS

The crucial question is how to formulate and apply national energy policies without extremism in support of numerous important but conflicting goals. In my judgment, there needs to be a deliberate balancing—national energy, economic, social, and environmental values as a basis for determining the public interest.

To arrive at intelligent decisions in matters of natural gas and electric energy supplies, we require fundamental knowledge of the impact of a proposed course of action on our national objectives—to preserve and enhance our environment, utilize and conserve our resources as the essential foundation for meeting our national defense, economic, and social goals. We must be able to forecast a predictable result in advance of an irretrievable commitment. We require a scien-

tific definition of the parameters of irreparable injury to human health or safety or a necessary ecological system, if we are to enjoin actions threatening our survival and yet prevent the intolerable state of our society or economy slipping into limbo.[14]

If the Congress authorizes the creation of the Department of Natural Resources, proposed by the President, it would be logical and beneficial if responsibility were centered in that Department or such other agency as Congress may designate for setting fossil fuel and basic energy goals. In my judgment, that action would not impair the integrity or the jurisdiction and responsibilities conferred by the Congress upon the Federal Power Commission under the Federal Power or Natural Gas Acts. We would endeavor to establish coordinate procedures to attain the objectives of an adequate energy supply compatible with environmental standards.

[14] Testimony of Chairman John N. Nassikas, hearings before the Subcommittee on Communication and Power; hearings, pp. 469–470, May 6, 1971, committee print.

APPENDIX A

TABLE 2.—FEDERAL POWER COMMISSION LIQUEFIED NATURAL GAS IMPORT APPLICATIONS (SEPT. 15, 1971)

Number and applicant	Docket No.	Source	Delivery point	Mode of transport	Estimated volume and price [1]		Date of authorization
					MMcf	Amount per thousand cubic feet	
CANADA							
Short term [2]							
1. Wilbros Terminal Co	CP70-194	Canada	Boston, Mass	Truck	[3] 266	$2.20	Feb. 13, 1970 and May 12, 1970.
2. Fall River Gas Co	CP70-305	do	Fall River, Mass	do	[4] 150	$1.12	July 2, 1970, July 17, 1970 and Sept. 22, 1970.
3. Lowell Gas Co	CP71-9	do	Tewksbury, Mass	do	630	$1.25 delivered by Oct. 7, 1970; 1.94 delivered by Oct. 7, 1970 to Apr. 30, 1971.	Aug. 28, 1970 and Mar. 15, 1971.
4. Boston Gas Co	CP71-61	do	Boston, Mass	do	220	$1.25 delivered by Oct. 19, 1970 to Nov. 1, 1970; 2.00 delivered by Nov. 1, 1970 to Apr. 2, 1971.	Nov. 4, 1970.
5. Boston Gas Co	CP71-247	do	do	do	[5] 714	$1.30 delivered by Apr. 1, 1971 to Sept. 1, 1971 [5]; 1.45 delivered by Sept. 1, 1971 to Nov. 1, 1971 [5]; $1.92 delivered by Nov. 1, 1971 to Apr. 1, 1972.	June 4, 1971.
6. Lowell Gas Co	CP72-10	do	Tewksbury, Mass	do	[5] 696	$1.30–1.45 delivered by Apr. 1, 1971 to Oct. 31, 1971 [5]; $1.92 delivered by Nov. 1, 1971 to Apr. 1, 1972 [5].	Aug. 5, 1971.
7. Fall River Gas Co	CP72-16	do	Fall River, Mass	do	[5] 120	$1.30 delivered by Aug. 31, 1971 [5], 1.45 delivered by Oct. 31, 1971 [5].	Sept. 8, 1971.

ALGERIA

8. Boston Gas Co	CP69–112	Algeria	Boston, Mass	Ship	200	$1.14	Oct. 25, 1968.
9. Lowell Gas Co	CP7 –143	do	do	do	[6] 374	$1.52	Dec. 17, 1969 and Jan. 16, 1970.
10. Texas Eastern Transmission Corp.	CP70–208	do	Staten Isl., N.Y.	do	2,600	$1.37	Mar. 16, 1970 and Apr. 8, 1970.
11. Boston Gas Co	CP70–291	do	Boston, Mass	do	1,600	$1.70	July 14, 1970 and Nov. 16, 1970.
12. Boston Gas Co	CP71–248	do	do	do	1,250	$1.66	June 4, 1971.
Long term:							
13. Distrigas Corp	CP70–196	do	Everett, Mass and Staten Island, N.Y.	do	[5] [7] [8] 6,600	$0.68 delivered by April 1 to November 1 [5], start-up 1971; full operation 1974; $0.70 delivered by November 1 to December 1 [5]; $0.85 delivered by January 1 to March 1 [5]; $0.71 delivered by March 1 to April 1, [5];	Pending.
					[5] [8] 8,800	$0.68	
Distrigas total					[5] [8] 15,400		
14. Columbia LNG Corp	CP71–68, et al [9].	Algeria	Cove Point, Md., and Savannah, Ga.	Ship	[5] [8] [10] 390,000	$0.64 [5] to 68 [5] start-up 1975; full operation 1967–77.	Do.
15. Columbia LNG Corp	CP71–69	Venezuela	Cove Point, Md	do	[5] [8] [11] 175,000	$0.54 [5] start-up 1975–78	

[1] Volumes and prices rounded to the nearest MMcf and cents per Mcf; B.t.u. content not stated; delivery at shiprail or truckside.
[2] 1 year or less.
[3] Estimated from reported volumes delivered.
[4] Estimated from the original filing on basis of 83.3 cf. per gallon.
[5] Volume is billion B.t.u. and price is dollar per million B.t.u.
[6] Estimated from the original filing on basis of 52 Mcf per metric ton.
[7] For 20 years; annual price escalation of 0.6/MMB.t.u.; seasonal deliveries not related to any 1 year.
[8] Per year.
[9] Lead docket no.; consoidated with Southern Energy Co. CP71–151, CP71–264 and Consolidated System LNG Co CP71–153, CP71–290 and Southern Natural Gas Co. CP71–276 and Columbia LNG Co. Consolidated System LNG Co CP71–289.
[10] For 25 years; prices are based on 1971 construction and operating costs, subject to revision based on actual costs; volumes rounded to nearest MMMcf.
[11] For 20 years; prices subject to various adjustments to reflect changes in estimated costs; testimony in Docket No. CP71–68 et al., indicated completion of this project as applied for is not probable.

APPENDIX B

Actions by the Federal Power Commission To Increase Explorations and Development of Natural Gas Supplies

I. On October 3, 1969, in opinion No. 567, the Commission revised its area rate policy to encourage the search for gas in reservoirs which underlie acreage already committed to the interstate market. Potential gas-bearing sedimentary rocks up to 40,000 feet in thickness occur in the deepest basins. A large portion of the sediments below 5,000 feet remain untested. The new policy provides that under the two-price system, with higher rates for new gas-well gas to encourage exploration, production from newly discovered reservoirs on previously dedicated acreage would be allowed the price it would have if the contract had been dated coincident with discovery.

II. On October 7, 1969, in opinion No. 568, the Commission applied the area rate principle to pipeline company producers of natural gas. The new policy placed pipeline producers on a parity with independent producers by pricing, in future pipeline rate proceedings, gas produced by pipelines or by their affiliates from leases acquired after October 7, 1969, at the just and reasonable rate applicable to gas of a vintage corresponding to the date of completion of the first well on the lease. Natural gas reserves owned by jurisdictional pipelines have declined in recent years when Commission policy was to price their gas on an individual company cost-of-service methods.

This new policy should encourage greater natural gas exploration and development by interstate pipelines so as to provide additional gas supplies to their own customers or to other pipelines. From the records of the Department of the Interior, it is clear that there has been increased gas exploration activity on the part of pipelines. This was evidenced by the participation of Consolidated Gas Supply, Texas Eastern Exploration Corp., a unit of Pennzoil United Inc. (Pennzoil Offshore Gas Operators Inc.), and a unit of Tenneco (Tenneco Oil Co.), among others, in the latest Louisiana offshore lease auction.

III. The Commission has moved to clarify the status of research and development expenses in an effort to stimulate technological developments in the natural gas industry. The Commission issued on August 26, 1970, in docket No. R–381, new regulations which revise and clarify the Commission's accounting treatment of research and development expenditures. These changes allow the regulated companies to recover legitimate research costs. This rulemaking resulted from the analysis of responses to the Commission's order No. 322 which required annual reporting of research and development expenditures. These responses showed minimal research and development activity in the natural gas industry at a time when major supply problems and environmental concerns affect the industry.

To provide impetus for a much needed comprehensive natural gas research effort an industry sponsored Gas Research Council has been proposed. Such an organization, drawn from all segments of the natural gas industry, could aid immeasurably in coordinating a research and development program which would benefit the entire industry. An industry sponsored Electric Research Council has been actively engaged in promoting research and development programs of benefit to

the electric power industry and has effectively promoted international exchanges of research and development information of benefit to all countries.

The Commission is currently taking action to provide utility companies with a more informed basis for planning ways to meet their ever increasing operating and financial needs by reducing regulatory uncertainty and providing consistency between accounting and rate-making wherever possible and by clarifying the existing policies in these areas, as required. For example, see Commission Order No. 420 issued January 7, 1971 (36 F.R. 507) prescribing the accounting treatment of land held for future use.

IV. The Commission set just and reasonable rates for production from southern Louisiana, our most prolific gas producing area, by Opinions Nos. 546 and 546–A, issued on September 30, 1968, and March 20, 1969, respectively, in docket Nos. AR61–2, et al. Concurrently with the latter opinion, the Commission initiated in docket No. AR69–1 a limited investigation into future sales of natural gas from offshore southern Louisiana. On December 15, 1969, the Commission enlarged that proceeding to include all gas regardless of contract date produced both onshore and offshore in the southern Louisiana area and called for evidence with respect to the adequacy of gas supply and adequacy of service to consumers, the demand for gas, and the cause of a gas shortage, if any.

On March 19, 1970, the U.S. Court of Appeals for the Fifth Circuit sustained the orders of the Commission in Opinions Nos. 546 and 546–A but explicitly provided that this mandate should not be interpreted to interfere with Commission action that would change the rates approved. The court expressed concern over strong evidence that a supply deficiency is imminent. *Southern Louisiana Area Rate Cases* v. *FPC*, 482 F. 2d 407 (5th Cir. 1970), cert. denied, *Municipal Distributors Group et al.* v. *FPC* ——— U.S. ———, 27 L. Ed. 2d 257, 91 S. Ct. 241 (1970). On petition for rehearing, the Fifth Circuit on June 16, 1970, affirmed its grant of authority to the Commission to reopen any part of its orders, including those affecting revenues from gas already delivered.

In light of these actions by the courts, on December 24, 1970, the Commission reopened the proceedings in docket Nos. AR61–2, et al. and consolidated them with the proceedings in docket No. AR69–1 so that parties might be given an opportunity to submit, if they so desired, relevant evidence concerning whether the rates established in Opinion Nos. 546 and 546–A should be changed in the light of the Fifth Circuit's decision.

By Opinion No. 598 issued July 16, 1971, the Commission set new, higher ceiling rates for the southern Louisiana area and provided a system of incentives to promote dedication of gas reserves to the interstate market. *Area Rate Porceedings, (Southern Louisiana Area)*, docket Nos. AR61–2, et al., and AR69–1. The order denying rehearing was issued on September 9, 1971.

V. On January 23, 1970, the Commission gave notice in docket No. R–380 of a proposed rulemaking to amend its regulations to provide for accounting and rate treatment of advance payments made to suppliers by pipelines for gas to be delivered at a future date. The receipt of such advance payments by producers is intended to en-

courage acquisition, exploration, and development of gas producing properties.

Subsequent to receipt of comments, on October 2, 1970, in order No. 410 the Commission amended its Uniform System of Accounts to permit unrecovered advance payments to be included by pipelines in their rate base as part of working capital. In the Commission's view, it was not at the present time in the public interest for pipeline companies to bear the cost of assuring themselves and their customers of a future supply of natural gas.

On January 8, 1971, in response to applications for rehearing, the Commission issued order No. 410–A and a notice of proposed rulemaking in docket No. R–411 to permit further comments on proposed modification, but stressed that order No. 410 treatment applied in the interim except as to advances made to affiliates for lease acquisition and exploration costs.

VI. On February 25, 1970, in order No. 395, the Commission revised its regulations and rules under the Natural Gas Act to allow increased expenditures for budget-type gas purchase facilities. The purpose of the budget rule is to expedite numerous minor projects. The increase in allowable expenditures gives companies added flexibility and results in a decrease in the lag in deliverability time between the discovery of gas and its flow to interstate pipelines.

VII. On June 17, 1970, the Commission in docket No. R–389 instituted an investigation and proposed rulemaking to consider the terms and conditions under which it will issue permanent certificates for, and otherwise regulate, new sales of natural gas subject to the Commission's jurisdiction in the Permian Basin area of southwestern Texas and southeastern New Mexico. On July 17, 1970, in docket No. R–389A, the Commission expanded the scope of this investigation and proposed rulemaking to cover certificates for new sales of natural gas subject to the Commission's jurisdiction nationwide (except Alaska and Hawaii). The Commission stated it would accept for consideration applications by independent producers requesting issuance of a certificate for sales of natural gas notwithstanding that the proposed rates may be in excess of the ceiling or guideline rates.

Numerous applications for certificates have been filed pursuant to this statement by the Commission. These applications represent sizable volumes of natural gas potentially available to interstate pipelines. Several of the applicants have already received permanent certificates permitting sales of natural gas in interstate commerce in proceedings in which no petitions to intervene were filed. On February 22, 1971, the Commission ordered consolidation of 55 applications for such certificates for a public hearing to allow the presentation, cross-examination and rebuttal of evidence concerning whether the present or future public convenience and necessity requires issuance of a permanent certificate on the terms proposed in each individual application. That hearing commenced on April 6, 1971.

VIII. On June 17, 1970, in docket No. AR70–1 the Commission instituted a second area rate proceeding in the Permian Basin area to review the just and reasonable rates established by the Commission in 1965. In order to induce producers to dedicate supplies to the interstate market without waiting for the final price determination of the proceedings, the Commission stated that contracts dated after June 17, 1970, would have the same price ceilings as contracts entered into

subsequent to a final order. A prehearing conference was held on February 23, 1971, cost questionnaires have been submitted to producers, noncost evidence is to be filed by June 11, 1971, and hearings for purposes of cross-examination of the direct evidence will commence on July 27, 1971. In order to expedite the proceedings, the Commission incorporated, by reference, all relevant evidence filed and subjected to cross-examination and rebuttal in the southern Louisiana area rate proceedings. (See IV above). The Commission stated that there should be no repetition of this testimony.

IX. On July 30, 1970, the Commission gave notice of a proposed rulemaking in docket No. R–394 which would terminate the existing moratorium prohibitions against rate increase filings by natural gas producers in the southern Louisiana area. Data available to the Commission indicated that circumstances had changed since the establishment of the moratoria. It was proposed that such a termination would encourage increased exploration and development efforts for natural gas and the dedication of greater volumes of gas from that area to the interstate market.

The moratorium provisions were terminated by order No. 413 on October 27, 1970, thus permitting offshore and onshore gas producers in the south Louisiana area to file for gas price increases in excess of ceiling prices, although such rate increases would be collected subject to refund. By subsequent order of December 25, 1970, the Commission limited rate increase filings made prior to June 30, 1971, to the levels set forth in the settlement proposal filed in docket Nos. AR61–2 et al. and AR69–1 on November 6, 1970. By order of February 10, 1971, the Commission denied motions for a rehearing of the December 24, 1970, order and denied a request for a stay of the December 24, 1970, order. By further order of April 13, 1971, the Commission denied an application for rehearing on the Commission's February 10, 1971, order.

X. On October 16, 1969, the Commission issued a Notice of Proposed Rulemaking in docket No. R–371, proposing to determine just and reasonable area rates for the Appalachian and Illinois Basins through rulemaking procedures rather than the lengthy area-rate hearings which had been conducted in the major producing areas, thus hoping to assure rapid disposition of the matter and insure continued stability in the area. On October 2, 1970, the Commission, relying on written comments and reports which had been filed and on an oral conference, rather than a full-blown evidentiary hearing, issued order No. 411 establishing area rates for these basins.

XI. By letter dated July 9, 1970, the Commission urged the Secretary of the Interior to conduct a general oil and gas lease-sale in the Gulf of Mexico. The Commission, by letter dated August 18, 1969, had previously urged that steps necessary to the orderly marketing of Outer Continental Shelf leaseholds be accomplished at the earliest practicable time. Public hearings were held on July 14, 1970, in New Orleans, and the Chief of the Bureau of Natural Gas presented detailed testimony in further support of the sale at that hearing. The importance of the Louisiana lease-sale cannot be overemphasized since the geological evidence would seem to indicate that this area is one of the most prolific potential sources of natural gas. Gas from Federal domain lands on the Outer Continental Shelf offshore Louisiana may then be available for dedication to the interstate market. The offshore Louisiana area is capable of rapid development and may

be connected with existing pipeline systems to meet the threat of near term gas shortage in the Northeast and Great Lakes marketing areas. The oil and gas lease-sale was held on December 15, 1970. Involved were 1,043 bids and bonuses to the Federal Government from 116 winners totaling a record $845.8 million. Eleven high bids were rejected. The average sale price per acre was $1,434. An all-time high of $12,874.79 per acre was received for tract No. 2153 from Pennzoil Offshore Gas Operators, Mesa Petroleum, Texas Production, and Mobil. The next highest bid was $7,636.87 per acre for tract No. 2213 by the Trans Ocean group. By letter dated September 8, 1971, to Secretary of the Interior, Rogers C. B. Morton, the Federal Power Commission expressed the belief that the public interest can best be served if the proposed general lease-sale of Outer Continental Shelf tracts is held as proposed in December 1971. The Chief of the Bureau of Natural Gas also testified in favor of the proposed lease-sale at public hearings held in New Orleans on September 8, 1971.

XII. In order that the Commission may improve its capability in the measurement of supply and demand and thereby enhance its ability to effectively regulate and provide a continuing reliable supply of gas to meet consumer demands, the Congress approved the Commission recommendation to undertake a national gas survey by providing funds for the Agency's fiscal year 1971 budget. Some of the more important questions to be examined in depth by the survey are (*a*) the precise dimensions of the gas supply problems, (*b*) the extent to which pipeline expansion of facilities is threatened by inflation and uncertainty of new gas supplies, (*c*) the role of natural gas in air pollution control, (*d*) the supply-price-demand relationship, (*e*) the potential impact of interfuel competition, (*f*) import-export policies, (*g*) the role of synthetic fuels in the long-term supply of gas, and (*h*) the regulatory role in relation to these issues.

XIII. The Commission was advised that natural gas distributing companies, which are exempt from the provisions of the Natural Gas Act under section 1(c) thereof, have received an increasing number of requests from distributors located in other States and interstate pipeline companies for short-term supplies of gas to meet temporary emergencies caused by weather conditions, acts of God, breakdown of facilities or other unforeseen situations, or to replenish depleted storage reservoirs in order to meet consumer needs in a forthcoming heating season.

In order to facilitate responses to such requests, the Commission indicated by statements of policy issued May 6 and June 3, 1970, order Nos. 402 and 402–A, that the recipients of such requests would not jeopardize their exempt status under the act by making short-term sales or deliveries of natural gas in interstate commerce to the extent that such transactions enabled those companies confronted with emergencies to meet their system requirements, subject to reporting provisions and prior Commission approval in emergencies exceeding 60 days. By order No. 418 issued December 10, 1970, in docket No. R–404 the Commission amended its regulations under the Natural Gas Act to permit independent producers to sell natural gas to pipelines for emergency purchases for periods up to 60 days without first obtaining certificate authorization from the Commission. A tabulation of the short-term purchases requested to date under the terms of these orders is given in appendix A.

XIV. The Commission on September 18, 1970, in opinion No. 586, adopted a settlement proposal submitted by a majority of the parties to the Hugoton-Anadarko Area Rate Proceeding, docket No. AR64–1, et al., thus establishing just and reasonable rates for the area. The Commission found that the proposed settlement was fair to the consuming public and would promote certainty and stability and contribute to obtaining additional supplies of gas from this crucial area.

XV. The Commission on February 18, 1971, issued Order No. 423 in Docket No. R–407 establishing as a matter of general policy a suspension period of one day from the proposed effective date of a rate change filing made by an independent producer unless the Commission imposes a longer suspension period. The former 5-month suspension period which had generally been applied to producers placed them at a disadvantage because they also were limited by contract as to when an increase might be made effective. A 5-month suspension period also deprives a producer of revenues to which it would otherwise be entitled in the event the proposed rate is found to be just and reasonable.

XVI. On March 18, 1971, in Order No. 428 issued in Docket No. 393 the Commission amended its regulations covering natural gas sales by small producers, which are defined as independent producers with annual total nationwide jurisdictional sales not in excess of 10 million Mcf. Although only accounting for about 15 percent of the total volumes of interstate gas sales, small producers comprise all except about 70 of the over 4,700 natural gas producers in the United States. Their exploratory efforts are extremely valuable to the discovery of new sources of gas.

Under the new provisions, small producers may apply for a blanket certificate to cover all existing and all future jurisdictional sales. Those receiving such certificates are authorized to make small producer sales pursuant to existing and future contracts at the price specified in each such contract. Thereafter, so long as the holder of the certificate qualifies as a small producer and complies with its terms, the only filings required by the Commission are an annual statement of total jurisdictional sales and applications for abandonment of facilities or service. The Commission's purpose in thus classifying small producers was to facilitate their entry into the interstate market and to stimulate competition among producers to sell in interstate commerce as well as to encourage their exploratory efforts. Assurance is given small producers that the provisions of their contracts for the interstate sale of gas will not be subject to change. A further purpose is to relieve the small producer of the expenses and burdens relating to regulatory matters.

The Commission's action did not constitute deregulation of sales by small producers. Such sales will be regulated in pipeline rate and pipeline certificate proceedings by Commission review of the purchased gas costs of each pipeline with respect to small producer sales. The Commission's order assures adequate protection for the consumer by providing certain other safeguards against unreasonably high small producer prices.

XVII. The Commission has authorized increased imports of gas by pipeline from Canada. The net import of natural gas from Canada in 1970 was approximately 767.8 million Mcf, which was an annual percentage increase of 19 percent over the 1969 figure. During 1970 net Canadian imports accounted for 3.4 percent of U.S. consumption.

The 1969 figure was 3 percent. If U.S. companies take advantage of all present Commission authorizations to import gas from Canada the net import could go to approximately 1 billion Mcf in 1971.

XVIII. As of September 15, 1971, the Commission authorized the importation of the equivalent of 8,820,000 Mcf of liquefied natural gas, LNG, on a short-term basis from Canada and Algeria.

XIX. On April 15, 1971, in order No. 431, the Commission promulgated as a new section of its General Policy and Interpretations section 2.70, entitled "Measures for the Protection of Reliable and Adequate Natural Gas Service." The statement of general policy provides that jurisdictional pipeline companies shall take all steps necessary for the protection of as reliable and adequate service as present supplies and capacities will permit during the 1971–72 heating season and thereafter. In order to effectuate this, the Commission:

(*a*) Encouraged companies to fill all storage fields;

(*b*) Required the filing of curtailment plans as an amendment to existing tariffs by jurisdictional companies which intended to curtail service;

(*c*) Indicated that additional short-term gas purchases may still be necessary to meet the 1972 demands and indicated the procedure under which this could be done;

(*d*) Stated that where emergency gas purchases are made and/or curtailment program is instituted, volumetric limitations should be set on sales at current levels;

(*e*) Indicated that the Commission will reexamine existing commodity rate levels and may redesign existing commodity demand rate relationships;

(*f*) Encouraged pipelines to enter into exchange arrangements with other pipelines.

XX. The Commission on May 6, 1971, in Opinion No. 595 set just and reasonable rates for sales of gas in interstate commerce from the Texas Gulf Coast, Docket Nos. AR64–2, et al. The Commission set a ceiling of 24 cents per thousand cubic feet for gas sales made under contracts dated on or after October 1, 1968, whether within the tax jurisdiction of the State of Texas or the offshore Federal domain. Rates for gas sold in interstate commerce under contracts dated prior to October 1, 1968, were established at varying levels with the ultimate rate of 19 cents established as of October 1, 1968, for all such contracts. In addition, the Commission offered incentives to producers to stimulate exploration and production by permitting credits to refund obligations through dedication of new supplies, and increased rates if new dedications reached the levels set forth in the opinion. The Texas Gulf Coast is the Nation's second largest producing area.

XXI. On July 15, 1971, the Commission by Order No. 435 in Docket Nos. R–389 and R–389A, established initial rates at which sales of natural gas in the Rocky Mountain area are to be certificated, without refund obligation, for sales made under contracts dated aftet June 17, 1970. The rates which the Commission established represenr the area rate levels for the areas involved until such time as just and reasonable rates are promulgated for the area.

Concurrently, the Commission, in Docket No. R–425, gave notice instituting a proposed rulemaking to issue rules fixing the just and reasonable rates and otherwise regulating jurisdictional sales in the Rocky Mountain area and to determine whether the initial rates

established by Order No. 435 shall apply to contracts dated on or after October 1, 1968. The just and reasonable rates to be determined pursuant to this proceeding shall be for all jurisdictional sales of natural gas made under contracts dated before October 1, 1968. These procedures of setting area rates by rulemaking were previously used in the Appalachian and Illinois Basin areas and found successful in sharply reducing the protracted regulatory lag heretofore associated with area rate proceedings.

APPENDIX C

Federal Power Commission, Bureau of Power

INDUSTRY RESPONSE TO COMMISSION RECOMMENDATIONS ON PREVENTION OF POWER FAILURES

The Bureau of Power has reviewed the response of the electric utility industry to the 12 principal recommendations of the Commission regarding prevention of power failures.[1] This review indicates that the utility industry has substantially complied with six of the recommendations and substantial progress has been made with respect to five others. One (recommendation No. 11) is directed to "all levels of government" and is not the responsibility of the electric utilities.

On October 2, 1970, comments were solicited from the National Electric Reliability Council (NERC) and its constituent regional councils regarding those five of the Commission's recommendations which we believe deserve additional consideration by the electric utilities. We encourage the reliability councils to establish permanent mechanisms at the national and regional levels for dealing with specific or continuing problems affecting reliability of bulk power supply. These mechanisms would facilitate identification of new interregional transmission facilities needed for improving reliability, assist in refinement of the accuracy of load forecasting techniques, assist utility systems in resolving problems related to the location of new facilities (and their environmental effects), and encourage member utilities to cooperate with public officials and customers in arranging for standby facilities to assure uninterrupted service to critical loads.

The 12 recommendations referred to, and the present status of industry action in compliance are discussed below:

1. FPC recommendation

To the extent they do not now exist, strong regional organizations be established throughout the Nation, for coordinating the planning, construction, operation, and maintenance of individual bulk power supply systems; and that representation of systems be by groups, where feasible, to facilitate progressive improvements in coordination.

Industry action in compliance

Nine regional reliability councils which represent most of the utilities of the United States have been organized to coordinate the planning and operation of the interconnected bulk power supply systems. The councils vary considerably in experience at this time from the Northeast Power Coordinating Council formed early in 1966 to the Electric Reliability Council of Texas formed in July, 1970.

[1] Prevention of Power Failures. A Report to the President by the Federal Power Commission, 1967; vol. 1, pp. 4-5.

2. FPC recommendation

A council on power coordination be established, made up of representatives from each of the Nation's regional coordinating organizations to exchange and disseminate information on regional coordinating practices to all of the regional organizations, and to review, discuss and assist in resolving matters affecting interregional coordination.

Industry action in compliance

A National Electric Reliability Council, composed of representatives from each of the regional reliability councils, was formed in June, 1968, to encourage and assist the development of interregional reliability arrangements, to facilitate exchange and dissemination of regional coordination practices, and to review and assist in resolving matters affecting interregional coordination.

NERC's Technical Advisory Committee established on October 30, 1970, an Interregional Review Subcommittee which is to review on a continuing basis the overall adequacy and reliability of the North American bulk power systems as existing and planned among and within the NERC regions. This subcommittee has already reviewed the 10-year projected planning of several regional reliability councils; this work is continuing.

3. FPC recommendation

A central study group or committee should be established to coordinate industry efforts in investigating some of the more challenging problems of interconnected system development.

Industry action in compliance

The responses in general indicate a preference for coordination regionally rather than nationally, in this area. Interregional coordination is feasible, it is claimed, where it takes place among systems at the geographic borders of regions. It is noted that for certain matters of national overview and interregional effect, activity would be appropriate on the part of the NERC Technical Advisory Committee (NERC/TAC).

4. FPC recommendation

Early action be taken to strengthen transmission systems serving the Northeast.

Industry action in compliance

Completed improvements and plans to strengthen the transmission systems serving the Northeast have not accomplished the amount of strengthening that is needed; however, planning and construction of extensive new facilities are time consuming. Although announced transmission system expansions are not as extensive as FPC has suggested, the Big Eleven Loop and associated connections from the New England area and New York State will greatly improve transmission capabilities and the recently announced 345 kilovolt connection from the New Brunswick Electric Power Commission to the Maine Public Service Co. will provide an additional source of supplemental power. The proposed New England operating and planning pool will strengthen the area. Import capability into the New York City area is still quite limited and even when completed, the planned transmission system additions will not provide as much transmission capability as has been recommended by the Commission.

Legal proceedings by environmental groups have delayed completion of vital elements of the transmission system linking New York with the Pennsylvania-New Jersey-Maryland (PJM) pool. Nevertheless, the additions will provide for significant improvements over the conditions which existed in 1965.

5. FPC recommendation

Transmission facilities should be critically reviewed throughout the Nation, and planning and construction of needed additions should be accelerated on schedules which will provide ample transmission capacity to meet a broad range of potential needs for both reliability and economy as they occur.

Industry action in compliance

The councils advise that regional review and coordination are practiced and strongly recommend that major emphasis be maintained at regional levels with NERC/TAC overview only where pertinent.

6. FPC recommendation

In estimating future loads, full attention should be given to economic trends, potential weather extremes and growth in special uses of electricity in each load area.

Industry action in compliance

The councils believe that the factors to be considered in estimating future loads differ so greatly among regions and systems that they are best considered at the level of the individual utility system. Some NERC overview may be appropriate for coordination of effort.

7. FPC recommendation

Utilities should solicit the participation of interested parties at an early date in the resolution of problems relating to the location and environmental effects of new facilities.

Industry action in compliance

The responses point out that the annual planning reports to be filed under the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (order No. 383–2 issued Apr. 10, 1970) will do much to fulfill this recommendation. The thought was also expressed that this matter is best implemented at the local level, although some consideration is being given to action on a regional basis.

8. FPC recommendation

Utilities intensify the pursuit of all opportunities to expand the effective use of computers in power system planning and operation.

Industry action in compliance

Computers are being used extensively in power system planning and operation, although this is probably not an indication particularly of compliance with the Commission's suggestions. The complicated calculations involved in the solution of large network problems make it virtually impossible to solve these problems without the use of large-scale computers. At least two councils are actively working on common data formats for their members, and the establishment of regional data banks to facilitate regionwide intersystem studies. Such activity may

not be spectacular, but is vital to more thorough analysis and planning of large-scale systems.

9. FPC recommendation

Coordinated programs of automatic load shedding be established and maintained in areas not so equipped, to prevent the total loss of power in an area that has been separated from the main network and is deficient in generation. Load shedding should be regarded as an insurance program and should not be used as a substitute for adequate system design.

Industry action in compliance

Automatic load shedding has been generally accepted by all of the regional reliability councils. There are variations in its application, and there may be a need for greater interregional coordination, but the concept of automatic load shedding and its usefulness in limiting cascading power failures seems no longer to be a question. A large portion of the major utilities now have in service the equipment needed to perform the load-shedding function, and others are following suit.

10. FPC recommendation

Utilities complete a thorough reassessment of their needs for emergency power for system operation.

Industry action in compliance

Most utilities have examined their needs for emergency power for essential system services during disturbances and restoration following an interruption. A complete list of the emergency power sources is not available at this time, but many gas turbines, diesel-driven generators, and emergency connections to firm sources of power are known to have been added since the Northeast blackout. Progress in compliance with this recommendation is satisfactory. The addition of gas turbines for providing peaking capacity increases the emergency-start capability of many systems.

11. FPC recommendation

All levels of Government appropriately establish requirements for emergency power sources for services essential to the safety and welfare of the public, and insure the availability of such facilities.

Industry action in compliance

Some Government agencies have established requirements for emergency power sources for services essential to the safety and welfare of the public. However, we believe that the extent of such actions is probably limited.

12. FPC recommendation

Utilities should cooperate with appropriate public officials and customers in planning and maintaining customer standby facilities to assure service to critical loads in the event of emergency.

Industry action in compliance

The councils believe this to represent an individual utility-customer relationship, since it is most intimately related to retail electric distribution systems. Six councils state that cooperation in this regard between public officials, critical service customers, and the utilities has long been observed.

Staff comment

The electric utility industry has made substantial progress in self-organization since the Northeast blackout of November 1965. By the end of 1967, utilities voluntarily established five regional councils to improve power supply reliability and adequacy within their respective regions. In June 1968, 1 year after the publication of the Commission's report to the President, the industry formed the National Electric Reliability Council to encourage improvement of coordination at both the regional and national levels. The goals initially established by NERC are reappraised periodically, and activities are expanded as required to be responsive to the needs of the councils, Governmental agencies, and the general public. There is no doubt that NERC has become the central industry forum where the more challenging problems of interconnected system development are investigated.

Following the formation of NERC, industry efforts to form new reliability councils and to expand membership in existing councils intensified. By the end of 1970, nine regional councils were formed, comprising all electric utilities in the 48 contiguous States which make a signficant contribution to each region's bulk power supply reliability. Staff members of the Commission, in meetings with each of the councils, have urged that smaller systems be given the opportunity to participate in council activities. At the present time, every council but Mid-Atlantic Area Coordination Group (MAAC) provides for participation by the smaller electric utilities. The provisions relating to such participation are summarized in attachment A. Representatives of MAAC have informed Commission staff that procedures for small system participation are under development.

All of the councils have taken steps to improve the quality of power supply in their regions by strengthening existing organizational structures and expanding their reliability functions. Transmission facilities have been constructed and projected by regional council members, which will provide power transfer capability to meet a broad range of potential needs for both reliability and economy. Moreover, committees have been established within each council and NERC to identify those additional interregional and intraregional transmission facilities needed to improve reliability.

The industry has addressed itself to the problem of estimating loads more accurately at the subregional and regional levels. Also, an industry committee on load forecasting has made an important contribution in its October 1969 report [2] to the Commission, by summarizing existing techniques and suggesting improvements. Mr. Floyd L. Goss, past NERC chairman, states that NERC can supplement the work being carried on by the regions and could coordinate the studies being performed by other organizations. We agree.

Many utilities throughout the country solicit the participation of interested parties in the resolution ot problems relating to the environmental effects of new facilities. The number of such utilities is increasing. Commission order No. 383–2 is accelerating this trend and also encourages participation by the regional councils. Most of the regional councils are already involved in providing aid and guidance to utilities within their geographic boundaries.

[2] "The Methodology of Load Forecasting." A report to the Federal Power Commission, prepared by the Technical Advisory Committee on Load Forecasting Methodology for the National Power Survey.

Cooperation with public officials and customers in providing standby facilities for essential loads is the responsibility of each individual electric utility. The regional councils do not wish to upset the long established utility-customer relationship by expanding their activities into this area, especially since their member systems have developed procedures for working with appropriate public officials and customers in the planning and installation of standby facilities for essential services.

Conclusions

Based on our review of industry activities, the Bureau of Power concludes that the 11 principal Commission recommendations directed toward the electric utility industry have been largely implemented. The other principal recommendation (No. 11) in the June 1969 report to the President was directed toward all levels of Government. Although some Government agencies have established requirements for alternate power sources to facilities essential to the safety and welfare of the public, the extent of such action is probably limited.

Appendix D

Federal Power Commission—Bureau of Power, Comparison of Summer and Winter Electric Load-Supply Conditions by Seasons Through Winter 1972–73[1]

This report presents an analysis of the generating capability, peakload, and reserve margin projections prepared by the nine regional electric reliability councils and submitted by letter of June 7, 1971, from Walter D. Brown, administrative manager, National Electric Reliability Council.

The projections cover the peakload periods for the summer of 1972 and the winter of 1972–73. Earlier estimates, supplied by Mr. Brown on April 29, 1971, covered the summer of 1971 and the winter of 1971–72. All of these have been combined with other data for the summer of 1970 and the winter of 1970–71 in formulating a picture of comparative load, supply, and reserve margin conditions for the total period.

The data has been arrayed in the attached tabulation in a manner which permits reasonably easy comparison of the conditions by summer and winter seasons. Also the load growth, generating capability, and reserve margin trends are easily discernible from the tabulation.

The general conclusion to be drawn from the information presented is that a gradual improvement in the overall situation may be expected. This, of course, is contingent upon the utilities being able to put new facilities in service as planned. An examination of the tabulation shows some variations in the trends in the different reliability Council regions but it is generally true that significant improvements are anticipated in the areas where the most serious shortages have prevailed in recent years. The notable exception is the midatlantic (MAAC) area which does not show much change over the 3-yeai period of this analysis. At the same time, the peakload in that area so

[1] Compiled by Bureau of Power, T. A. Phillips, Chief.

far this year (1971) has been below the estimated value and no severe problems of meeting peak demands have been experienced. Information available at present indicates that favorable weather conditions and reduced industrial activity are the primary factors which have resulted in lower than expected peak demands.

The specific percentages of reserve margins for the different periods and various regions do not constitute a good measure of relative reliability and should not be interpreted as such. The improved margins projected for most of the regions do indicate, however, an expected slight easing of overall deficiencies. As you are well aware, an adequate regional reserve margin does not guarantee freedom from problems in particular areas. Consolidated Edison is a good example of the condition where mathematical system reserves have appeared to be adequate but actual conditions have been very strenuous. Prior to the summer of 1970, the theoretical reserve margin was 23.2 percent but many problems were encountered in meeting essential load requirements. Consequently, the total situation through 1972–73 should not engender any great optimism but conditions should be slightly better if schedules for new capacity can be met.

COMPARISON OF ELECTRIC LOAD-SUPPLY CONDITIONS—BASED ON RELIABILITY COUNCIL ESTIMATES

Reliability council	Projected capability (megawatts)			Projected load (megawatts)			Reserve margin					
							Megawatts			Percent of peak		
	1970	1971	1972	1970	1971	1972	1970	1971	1972	1970	1971	1972
Summer season conditions:												
NPCC	43,085	49,102	55,053	36,067	38,603	41,429	7,018	10,499	13,624	19.5	27.2	32.9
MACC	28,722	31,499	34,559	24,900	27,285	29,840	3,822	4,214	4,719	15.3	15.4	15.8
SERC	59,407	65,832	76,836	53,078	58,492	65,646	6,329	7,340	11,190	11.9	12.5	17.0
ECAR	48,870	53,572	59,055	42,302	47,125	49,332	6,568	6,447	9,723	15.5	13.7	19.7
MAIN	26,847	28,180	34,507	22,991	24,892	27,885	3,856	3,288	6,622	16.8	13.1	23.7
SPP	25,763	29,694	32,585	22,374	25,288	26,524	3,389	4,406	6,061	15.1	17.4	22.9
ERCOT	19,253	22,146	25,448	16,347	19,118	20,802	2,906	3,028	4,646	17.8	15.8	22.3
MARCA	12,535	13,560	14,422	10,954	11,243	12,150	1,581	2,317	2,272	14.4	20.6	18.7
WSCC	64,378	69,620	74,430	51,329	54,626	58,684	13,049	14,994	15,746	25.4	27.5	26.8
	1970–71	1971–72	1972–73	1970–71	1971–72	1972–73	1970–71	1971–72	1972–73	1970–71	1971–72	1972–73
Winter season conditions:												
NPCC	49,369	53,407	57,862	39,704	42,297	45,426	9,665	11,110	12,436	24.3	26.3	27.4
MAAC	29,440	32,849	35,310	22,057	23,520	25,445	7,383	9,329	9,865	33.5	39.7	38.8
SERC	64,361	68,830	78,757	53,863	56,394	63,966	10,498	12,436	14,791	19.5	22.1	23.1
ECAR	51,783	56,459	61,460	42,447	45,421	48,505	9,336	11,038	12,955	22.0	24.3	26.7
MAIN	28,157	30,136	35,345	20,822	22,253	23,777	7,335	8,207	11,568	35.2	35.5	48.7
SPP	24,005	27,908	32,217	16,453	19,923	20,884	7,552	7,985	11,333	45.9	40.1	54.3
ERCOT	20,003	23,487	25,994	10,597	12,392	13,495	9,406	11,095	12,499	88.8	89.5	92.6
MARCA	13,438	13,503	15,024	10,318	10,827	11,608	3,120	2,676	3,416	30.0	24.7	29.4
WSCC	66,392	72,251	76,098	55,092	59,187	63,323	11,300	13,064	12,775	20.5	22.1	20.2

Appendix E

Federal Power Commission—Bureau of Power Report, Disturbances of February 9, July 6, and August 18, 1971

On February 9, 1971, a severe earthquake in the Los Angeles, Calif., area caused transmission and distribution outages which interrupted service to an estimated 950,000 customers with a total load of 1,000 megawatts on the systems of two relatively large utilities and three smaller municipal systems serving Los Angeles and surrounding areas. A limited amount of generating capacity tripped out due to earthquake shock and most transmission and distribution line faults were of a temporary nature, thus permitting a large part of the load to be restored within a matter of minutes.

On July 6, 1971, a system disturbance on the U.S. Bureau of Reclamation's Missouri River Basin division affected a large area of North Dakota. Although a final report has not been submitted, it is generally understood that an operating error occurred during attempts to reduce system oscillations. The problem, however, is more than one of operating procedure, for the North Dakota system is an area of heavy generation and is inherently susceptible to severe oscillations under changing load conditions.

On August 18, 1971, a large area of the Northeast, which included New York State from Syracuse eastward and all of New England, became isolated from the rest of the North American interconnected systems. The disturbance and the resulting system separation were caused by a flashover from a 345-kilovolt transmission line to a nearby tree and the subsequent loss of this line at a time when a parallel transmission line was out of service for maintenance. Studies of the combination of events which occurred after the initial fault are not yet completed. During the sequence of events, the Nine-Mile Point nuclear plant of Consolidated Edison Co. tripped off adding to the deficiency in generating capacity of the affected area and further tripping of transmission ties split the isolated area into several sections. Operation of automatic load-shedding devices in the areas of deficient capacity reduced the loads sufficiently to permit recovery without any long-term interruption of extensive areas such as was experienced at the time of the November 9, 1965, Northeast power failure.

Appendix F

FPC Staff Report Shows Electric Power System Conditions in U.S. Improved Over Last Year

The Federal Power Commission today released a staff report which shows that the Nation's electric power system conditions improved this summer as compared to the summer of 1970.

The report shows that 40 voltage reductions were reported during the period June 21–September 7, 1970, compared to only nine this year, between June 1 and September 6. Voltage reductions occurred on 15 days last year and on 5 days this year.

There have been no reports of appeals for load curtailment so far this summer compared to eight such appeals last year. The staff report, signed by T. A. Phillips, Chief of the FPC's Bureau of Power, said that while specific reasons for the differences between the two periods cannot be identified, weather and economic conditions may

have contributed. More importantly, the report says there has been improvement in the equipment forced outage rate in 1971 over 1970, which in essence has made more generating capacity available.

The staff report is attached.

Federal Power Commission—Bureau of Power, Comparison of Load Conditions, Summer 1970 and 1971

Since June 21, 1970, utilities have been required to report, under FPG order 331–1, in addition to certain interruptions of electric power service and unusual hazards to the bulk power supply system, measures that are taken to reduce loads, either by voltage reductions, requests to the public for voluntary reductions in electricity use, or other load curtailments. The following table compares the reports received by FPC during the specified summer periods of 1970 and 1971:

	June 21–Sept. 7, 1970	June 1–Sept. 6, 1971
Reports of voltage reductions	40	9
Number of days	15	5
Reports of appeals for load curtailment	8	0
Affected areas	(1)	(2)

[1] New England, New York, Mid-Atlantic, Midwest and upper Midwest.
[2] New England, New York, Mid-Atlantic, parts of North and South Carolina.

The comparative numbers of voltage reductions and other load relief actions reported during the summers of 1970 and 1971 point up a substantial difference in the 2 years. Although some of the information needed to identify the specific reasons for the differences observed is not yet available, it appears that weather and economic conditions may have contributed to the improved system conditions. However, more importantly, there has been improvement in the equipment forced outage rate in 1971 over 1970 which in essence has made more generating capacity available to meet the summer loads.

Electric utilities attempt to provide sufficient generating capacity to meet usual outage contingencies and still have enough capacity available for maximum load requirements. In addition, virtually all have transmission interconnections which permit exchange of supplemental power for emergency and also under normal circumstances when there are economies of operation that can be realized through such exchanges. During the last several years, however, there have been numerous delays in the planned availabilities of new equipment, particularly large nuclear units, which have created deficiencies in generating capability in many areas of the Nation.

T. A. Phillips,
Chief, Bureau of Power.

Appendix G

FPC Releases Staff Report Summarizing Electric Utility Industry Expansion Plans

The Federal Power Commission has released a staff summary of industry reports which indicates that significant expansion of electric utility generating is planned for the next decade, with more than 1,100 units totaling about 460,423 megawatts scheduled to be added to the national generating total by 1980.

The staff summary, prepared by the FPC's Bureau of Power, is based on reports submitted to the commission by the Nation's nine regional electric reliability councils, showing information as of April 1, 1971, and projecting plans 10 years ahead.

The reports were made in response to the commission's April 1970, statement of policy on adequacy and reliability of electric service (order No. 383–2).

The FPC's 1970 policy statement was based on cooperative procedures and voluntary action in a move to promote reliability and adequacy of service throughout the Nation. The policy statement established the system of voluntary reporting by all segments of the industry on coordinated regional bulk power supply programs.

The policy statement noted that under the Federal Power Act the FPC is charged with responsibilities and duties to promote and encourage the voluntary interconnection and coordination of the Nation's electric power systems in the interests of assuring an abundant supply of electric energy throughout the United States with the greatest possible economy and with regard to the proper utilization and conservation of natural resources.

The staff report points out that the trend of electric power reserves over the next 5 years is generally one of improvement.

For the 1972–76 period there are only a few instances in which projected reserves are less than 18 percent at the time of winter or summer peaks. Average reserve margins of about 20 percent of expected peak load demands generally are considered necessary to compensate for forced outages, required maintenance, uncertainties in load forecasting, and other reasonable contingencies.

While generation reserves cannot be considered in a vacuum, they can respresent a valuable measurement if used with caution in analyzing capability to meet demands. Reserves must be viewed in terms of the various unpredictable conditions which may affect the power supply.

The voluntary reporting system provides for data to be coordinated and reported by the regional councils. The repoi ts, covering a 10-year period, are due each year by April 1. Copies are sent to State commissions, and are available for public inspection in the FPC's Office of Public Information.

The staff summary points out that ways must be found to permit accomplishment of the planned capacity expansion programs if the improvement trend is to be realized and difficult power shortage problems are to be avoided over the next 5 years.

The staff summary shows that much of the capacity to be added over the next decade will be in units of 300 megawatts and larger. The staff noted that 262 of these larger size units are now under construction or scheduled to be started within the next 2 years. Their capacity totals 182,143 megawatts.

Concern for mitigation of the undesirable environmental effects of generating plants is evident in the plans for cooling water systems and stack emission reductions of large steam units, the staff said. About 87 of the units, 300 megawatts and larger, will use cooling towers, and 58 will use cooling lakes, canals, or other means to avoid or reduce the amount of heat added to rivers and natural bodies of water.

Coal will be the primary fuel in 88 of the large units and 84 electrostatic precipitators will be installed to remove particulate matter from

the exhaust gases. The report notes that little air pollution is expected from the 31 projected plants in which natural gas is planned as the primary fuel.

Most of the transmission expansion for the 1972–76 period is expected to be at the 345-kilovolt level. Some will be at 500 kilovolts, but only two regions expect construction of 765-kilovolt lines.

A copy of the staff summary, signed by T. A. Phillips, chief of the FPC's Bureau of Power, is attached.

FEDERAL POWER COMMISSION—BUREAU OF POWER, BULK POWER SUPPLY INFORMATION REPORTED APRIL 1, 1971, BY REGIONAL RELIABILITY COUNCILS IN RESPONSE TO APPENDIX A OF ORDER 383–2

This report summarizes pertinent data reported by the nine Regional Electric Reliability Councils as of April 1, 1971, in response to the Commission's statement of policy on adequacy and reliability of electric service, order No. 383–2. These reports provide a comprehensive survey of regional bulk power supply programs projected for the 10-year period 1971–80.

The procedure incorporated in commission order No. 383–2 for updating and reporting power supply programs is expected to:

(1) facilitate the timely construction of needed bulk power facilities;

(2) document the growth of regionally coordinated practices on a continuing basis; and

(3) identify posssible power supply problem areas particularly during the first 5 years of each annual projection when short lead time capacity additions would be needed for avoiding possible power supply shortages attributable to delays in the installation of new base-load generating units.

Power supply planning is a dynamic facet of the electric utility industry since plans for bulk power facilities must be modified periodically to reflect changing conditions. At this time, commitments for the installation of large, base-load generating units generally are made 5 to 7 years in advance to provide the lead-time currently required to get new units in service by the time they are needed.

The nine Regional Reliability Councils are in different stages of development, and each has its own approach to regional coordination for improved reliability and adequacy of power supply. The request for information enumerated in appendix A of order No. 383–2 is conceptually phrased so that each council can reflect its own unique situation. Accordingly, the nine reports are dissimilar in some respects. The attached tables summarize some of the bulk power supply data reported by the councils in April 1971. Tables A, B, and C deal with existing and proposed generating capability and expected 1971 loads; table D projects summer and winter reserves for each of the years 1972–76; tables E and F present data on cooling plans and stack emission control; table G projects extra high voltage transmission (345 kv. and above) for each of the years 1972–76.

There are a number of considerations which sometimes produce differences in estimates of future loads and generating capacities from different sources. Such differences include variations in assumptions concerning capabilities of generating units depending upon assumed cooling conditions, particular fuels in use at a given time, amounts of water available in the case of hydroelectric facilities, short term over-

load capabilities, interchange power availabilities, and treatment of reserves particularly with respect to those available to an individual utility member of a power pool or other coordinated operating group. Also, there is the question of dependability of immature units.

Projected installed reserves for the 1971 summer range from 13.6 percent to 27.5 percent of load responsibility. The projections for winter 1971–72 range from 21.0 percent to 89.5 percent. The probability that some generating capacity may be out of service for maintenance when the seasonal peaks occur will reduce the expected reserves somewhat. Regionwide reserve figures are large-scale averages, of course, and individual systems, pools or subregions may have reserves that differ markedly from the regional average. One function of the transmission system is to provide a means of spreading available generation over a region to alleviate local shortages.

The trend of the reserves over the next 5 years is generally one of improvement. It is important to point out however, that ways must be found to permit accomplishment of the capacity expansion programs planned and scheduled by the utilities if the improvement trend is to be realized and difficult power shortage problems are to be avoided. Installed generating reserves are different for the nine councils, reflecting a diversity of regional and subregional characteristics and differing concepts of system planning. Likewise, the planning of additions to generating plant and transmission lines is not uniform among the different councils.

For the 1972–1976 period there are only a few instances in which projected reserves are less than 18 percent at the time of the winter or summer peaks. Southeastern Electric Reliability Council (SERC) and Mid-Atlantic Area Coordination Group (MAAC) have relatively low summer reserves in 1971 and 1972, but project significant increases by 1976.

All of the regional reports show that significant expansion of generating capability is planned for the next decade. Over 1,100 units, aggregating some 460,423 megawatts, are expected to be added to the national generating total by 1980. Much of the added capacity will be in units of 300 megawatts and larger size. Some 262 such units are under construction now or are presently scheduled to begin within the next two years; their capacity totals 182,143 megawatts.

Concern for mitigation of the undesirable environmental effects of generating plants is evident in the plans for cooling water systems and stack emission reductions of large steam units. Some 87 of the units 300 megawatts and larger will use cooling towers, and 58 will use cooling lakes, canals, or other means to avoid or reduce the amounts of heat added to rivers and natural bodies of water. Coal will be the primary fuel in 88 of the large units and 84 electrostatic precipitators will be installed to remove particulate matter from the exhaust gases; the method of stack emission control was not reported for a few of the units. Natural gas is planned as the primary fuel in 31 of the projected plants; little air pollution is expected from these.

Most of the transmission expansion for the period 1972–76 is expected to be at the 345-kilovolt level; some will be 500 kilovolts. Only two regions expect to construct 765-kilovolt lines. Some transmission planning is fixed by the requirements of generation, and must cover the same timespan as that of generating units. The technical details of planning and the construction of transmission lines and associated facilities usually require less time than for generation.

However, right-of-way acquisition unless completed before initiation of construction may prolong significantly the time when a transmission line goes into operation.

This report does not attempt to summarize the large amount of other valuable information related to coordinated bulk power supply programs set forth in the council reports. Staff analyses are continuing, and it is expected that evaluations of the reported data will be discussed at appropriate times with representatives of the councils.

T. A. PHILLIPS,
Chief, Bureau of Power.

TABLE A. PROJECTED LOADS AND CAPABILITY REPORTED APR. 1, 1971, BY REGIONAL RELIABILITY COUNCILS IN RESPONSE TO APPENDIX A OF ORDER NO. 383-2 (CONTIGUOUS UNITED STATES ONLY)

[Megawatts]

Council	Annual peak-load, [1] 1971	Installed generating capability [2] at time of 1971 peakload
WSCC [3]	55,927	67,619
SERC	56,438	68,892
ECAR [4]	46,204	55,056
NPCC	30,840	39,799
MAAC	27,285	31,499
MAIN [5]	26,057	28,126
SPP	25,851	30,434
ERCOT	19,118	[6] 22,146
MARCA [7]	11,954	13,876

[1] Native load plus interruptible load. All regional annual peaks occur in summer except for NPCC, SERC, AND WSCC SERC expects a winter annual peak for 1971–74 and a summer annual peak 1975–80.
[2] Installed owned generation only; excludes interregional transactions.
[3] U.S. portion of WSCC after exclusion of estimated loans and resources of the Canadian members of WSCC (British Columbia Hydro and Power Authority and West Kootenay Power & Light Co.).
[4] ECAR members only.
[5] Only MAIN region systems in Wisconsin, Missouri, and Illinois. Iowa members of MAIN report through MARCA and are included in the MARCA data in this table.
[6] Includes firm purchases, the magnitudes of which are not stated in the Apr. 1, 1971, response to order No. 383-2.
[7] Includes data for 43 municipal systems in the MARCA region; the remaining 223 municipal systems did not report.

TABLE B.—1971 LOAD-CAPACITY SUMMARY BASED ON DATA REPORTED BY REGIONAL COUNCILS IN RESPONSE TO APP. A OF ORDER 383-2 ON APR. 1, 1971

Council	Resources [1] (megawatts)	Peak load responsibility [2] (megawatts)	Margin	
			megawatts [3]	Percent [4]
Summer 1971:				
WSCC [5]	69,620	54,626	14,994	27.5
SERC	66,437	58,472	7,965	13.6
ECAR	52,603	46,204	6,399	13.9
NPCC [5]	49,102	38,603	10,499	27.2
MAAC	31,499	27,285	4,214	15.4
MAIN	29,439	24,892	4,547	18.3
SPP	29,694	24,835	4,859	19.6
ERCOT	22,146	19,118	3,028	15.8
MARCA [6]	13,560	11,243	2,317	20.6
Winter 1971–72:				
WSCC [5]	72,251	59,187	13,064	22.1
SERC	68,892	56,394	12,498	22.2
ECAR	56,618	45,805	10,813	23.6
NPCC [5]	53,407	42,297	11,110	26.3
MAAC	32,849	23,520	9,329	39.7
MAIN	30,529	22,322	8,207	36.8
SPP	29,768	19,923	9,845	49.4
ERCOT	23,487	12,392	11,095	89.5
MARCA [6]	13,503	11,162	2,341	21.0

[1] Owned generating capability adjusted by nonfirm purchases and sales, before any deduction for scheduled maintenance.
[2] Native load (including interruptible) adjusted by firm purchases and sales.
[3] Resources less peak load responsibility, in Megawatts.
[4] Megawatts margin as a percentage of peak load responsibility.
[5] Includes Canadian members of the council.
[6] The data furnished do not include the Canadian member.

Note: Resources are those expected to be available at the time of the estimated peak loads.

PROJECTED GENERATING CAPACITY ADDITIONS 1971–80 REPORTED APR. 1, 1971, BY REGIONAL RELIABILITY COUNCILS IN RESPONSE TO APPENDIX A OF ORDER 383–2

Council	Fossil		Nuclear		Hydro and pumped storage		Diesel and gas turbines		Unspecified	
	No.	Total MW	No.	Total MW	No.	Total MW	No.	Total MW	No.	Total MW
WSCC	91	25,615	18	17,043	96	13,715	39	1,442	4	900
SERC	59	34,443	38	36,164	42	6,393	72	41,813	23	18,842
ECAR	57	37,706	10	8,510	4	4,422	(1)	1,439	12	10,020
NPCC	27	13,813	19	16,816	13	4,625	22	2,674	2	1,800
MAAC	31	14,689	20	20,914	2	1,300	77	5,016	5	2,850
MAIN	36	15,777	14	12,823	0	0	22	3,489	0	0
SPP	69	24,454	8	7,645	32	987	21	1,668	2	4,865
ERCOT	64	27,888	0	0	0	0	4	353	2	2,100
MARCA	16	7,883	8	4,746	0	0	16	1,925	0	0
Total	[2] 450	[2] 202,268	135	124,661	189	[3] 31,442	273	[4] 59,819	50	41,377

[1] Number of units not stated.

[2] Includes 3 combined-cycle (steam turbine-gas turbine) units totaling 1,000 MW and 25 geothermal units totaling 1,310 MW.

[3] Includes 3,042 MW for which the number of units is not stated.

[4] Includes 6,076 MW for which the number of units is not stated and 2,555 MW of peaking capacity not otherwise identified as to type or number of units.

TABLE D.—PROJECTED REGIONAL COUNCIL INSTALLED RESERVES 1972–76, BASED ON DATA SUBMITTED APR. 1, 1971 IN RESPONSE TO APP. A OF ORDER NO. 383–2 RESERVES [1] AS PERCENTAGE OF PEAKLOAD RESPONSIBILITY [2]

Council	1972	1973	1974	1975	1976
Summer:					
WSCC [3]	26.9	27.8	29.7	31.8	30.4
NPCC [4]	34.6	35.6	38.9	38.8	35.4
ERCOT	21.6	16.3	19.3	19.1	17.9
MARCA [5]	20.0	24.0	24.0	21.0	24.0
MAIN [6]	23.9	24.8	19.6	17.5	18.4
SERC	17.0	19.6	23.1	22.8	21.4
MAAC	15.8	18.3	22.2	25.4	24.9
SPP	22.4	20.0	21.4	20.4	19.8
ECAR	18.0	19.3	20.1	23.6	24.9
Winter:					
WSCC [3]	20.2	20.5	23.3	24.3	22.0
NPCC [4]	28.8	30.7	33.3	30.3	30.3
ERCOT	92.6	90.4	91.9	93.8	93.4
MARCA [5]	26.0	30.0	28.0	32.0	29.0
MAIN [6]	48.0	52.0	44.8	48.1	49.4
SERC	23.1	25.6	31.3	30.4	28.1
MAAC	38.8	48.3	52.6	55.6	57.3
SPP	55.2	63.5	63.5	64.0	65.9
ECAR	24.2	26.8	27.7	30.7	30.3

[1] Reserves before deduction for scheduled maintenance; capability adjusted for nonfirm transactions.

[2] Load responsibility is defined as the sum of native load (including interruptible load) plus firm power sales less firm power purchases.

[3] Includes British Columbia Hydro and Power Authority and West Kootenay Power & Light Co.

[4] Includes New York, New England, and Ontario.

[5] Excludes Manitoba (Canada) Hydro Electric Board, an associate member of MARCA. No data on Manitoba are contained in the MARCA report.

[6] Reflects revised capability data received from MAIN, dated Apr. 28, 1971.

TABLE E.—COOLING PLANS FOR PROJECTED STEAM UNITS 300 MW. AND LARGER [1] [2] REPORTED APR. 1, 1971 BY REGIONAL RELIABILITY COUNCILS IN RESPONSE TO APPENDIX A OF ORDER 383–2 (Contiguous United States only)

Size range (megawatts)	Total units	Once-through	Cooling towers	Other [2]	Not specified	Total capability (megawatts)
300 to 399	25	8	8	9	0	8,717
400 to 499	37	17	8	8	4	15,859
500 to 599	46	18	16	10	2	25,148
600 to 699	22	10	6	5	1	13,797
700 to 799	35	15	15	5	0	26,463
800 to 899	55	20	20	14	1	45,888
900 to 999	3	1	2	0	0	2,828
1,000 to 1,099	12	6	2	4	0	12,715
1,100 to 1,199	24	11	9	3	1	26,878
1,200 to 1,299	2	2	0	0	0	2,550
1,300 to 1,399	1	0	1	0	0	1,300
Total	262	108	87	58	9	182,143

[1] Units for which construction has begun or is scheduled to begin within 2 years.

[2] Includes cooling lakes, cooling canals, and 2-pass condensers.

TABLE F.—TYPE OF FUEL AND CONTROL OF STACK EMISSIONS PROJECTED STEAM UNITS 300 MW AND LARGER [1] REPORTED APR. 1, 1971, BY REGIONAL RELIABILITY COUNCILS IN RESPONSE TO APP. A OF ORDER 383–2

[Contiguous United States only]

Unit size MW	Total units	Fuel					Stack emission control			
		Coal	Oil	Gas	Multi-fueled	Nuclear	Electro-static precip-itators	Other [1]	Low sulfur coal or oil	Not specified
300 to 399	25	11	3	8	1	1	8	11	4	3
400 to 499	[3] 37	9	13	8	3	3	13	13	7	6
500 to 599	[4] 46	24	2	6	4	6	25	13	3	9
600 to 699	[3] 22	11	8	0	0	2	9	5	2	4
700 to 799	35	17	0	9	6	3	15	14	8	5
800 to 899	55	11	7	0	2	35	9	18	6	25
900 to 999	3	0	0	0	0	3	0	2	0	1
1,000 to 1,099	12	2	0	0	0	10	2	4	2	6
1,100 to 1,199	24	0	0	0	0	24	0	15	0	9
1,200 to 1,299	2	2	0	0	0	0	2	0	0	0
1,300 to 1,399	1	1	0	0	0	0	1	0	1	0
Total	262	88	33	31	16	87	84	95	33	68

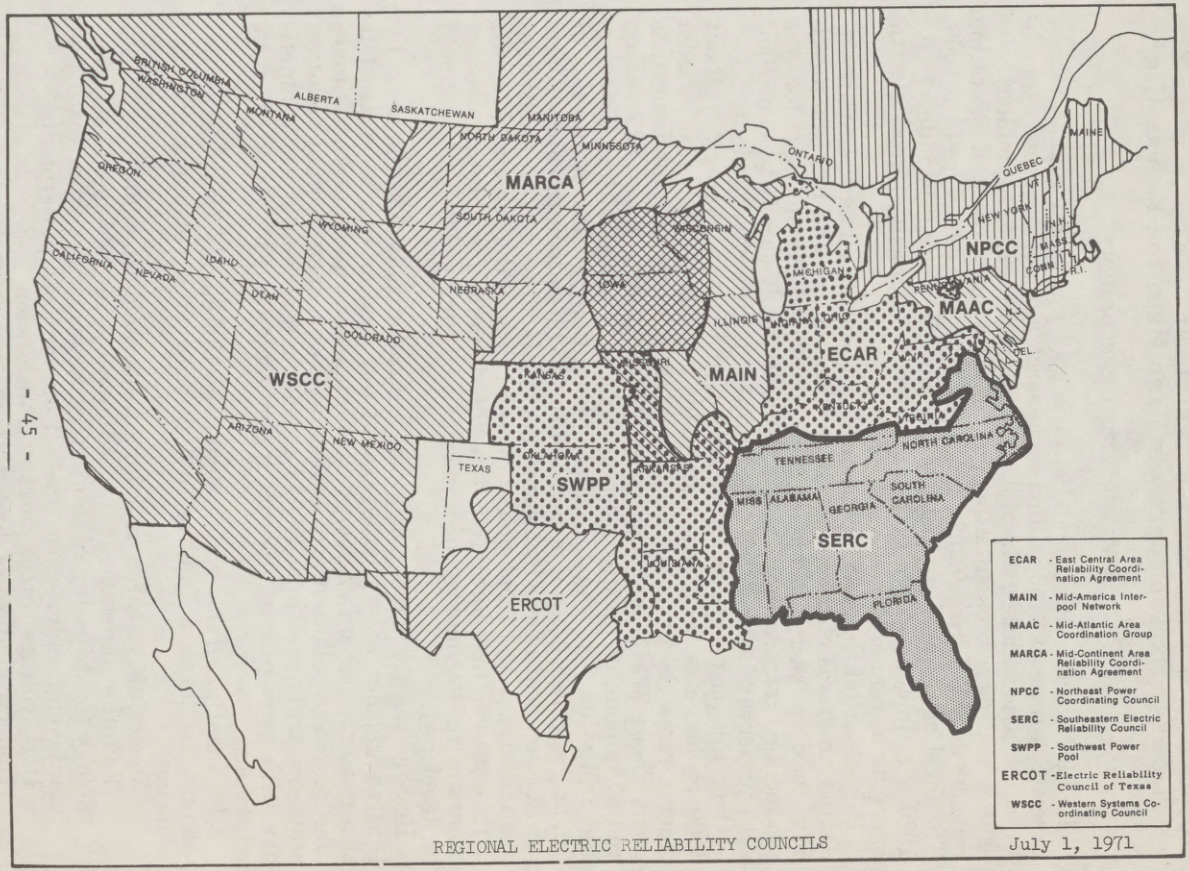
[1] Units for which construction has begun or is scheduled to begin within 2 years.
[2] Includes use of natural gas, nuclear fuel, mechanical collectors, wet scrubbers, gas holdup facilities, stoichiometric combustion, and limestone injections into boilers.
[3] Type of fuel not specified for 1 unit.
[4] Type of fuel not specified for 4 units.

TABLE G.—PROJECTED EHV TRANSMISSION ADDITIONS 1972–76 REPORTED APR. 1, 1971 BY REGIONAL RELIABILITY COUNCILS IN RESPONSE TO APPENDIX A OF ORDER 383–2 (Contiguous United States Only)

CIRCUIT MILES OF TRANSMISSION LINE

Council	1972	1973	1974	1975	1976
345 kilovolts					
ECAR	1830	970	960	700	303
MAIN	853	587	259	290	365
NPCC	384	275	274	253	165
MARCA	61	0	66	700	54
WSCC [3]	0	345	410	237	391
MAAC [3]	10	0	0	0	0
SPP [3]	150	30	257	72	462
ERCOT [3]	53	433	358	449	([4])
SERC [2]					
500 kilovolts					
ECAR	70	85	130	0	16
NPCC	5	0	0	0	0
WSCC [3]	691	152	1016	156	583
MAAC [3]	193	87	68	102	0
SPP [1]	0	48	0	70	0
SERC [3]	703	400	302	295	([4])
MAIN [2]					
ERCOT [2]					
MARCA [2]					
765 kilovolts:					
ECAR	0	134	216	0	0
MAIN	0	0	40	0	0
WSCC [2]					
SERC [2]					
MAAC [2]					
NPCC [2]					
SPP [2]					
ERCOT [2]					
MARCA [2]					

[1] Transmission at this voltage level is shown but the mileage is not stated.
[2] No transmission is shown at this voltage level.
[3] Mileage data furnished by FPC regional engineer.
[4] Not available.



REGIONAL ELECTRIC RELIABILITY COUNCILS

July 1, 1971

Appendix H

Accounting and Ratemaking Treatment of Research and Development Expenditures and Land Held for Future Use [1]

A. RESEARCH AND DEVELOPMENT

In 1969 electric utilities and electric utility industry manufacturers invested a total of $150 million in research and development expenditures (electric utilities, $40 million; manufacturers, $110 million). Research and development expenditures as a proportion of operating revenue declined from 0.269 percent in 1966 to 0.226 percent in 1969. The level of research expenditures in the electric power industry for 1970 is estimated at less than a quarter of 1 percent of gross electric operating revenue.

It is essential that the electric utility industry embark on unprecedented programs of research and development to find new commercially feasible energy sources, and improved technology for the production, transmission, and consumption of electricity consistent with preservation of and reduced impact on the environment.

Over the past 4 years, it is estimated that an average of about $100 million has been spent annually on liquid metal fast breeder reactor research. Of this total the Atomic Energy Commission has spent about $75 million per year, manufacturers about $25 million and $5 million, or about 5 percent, by the private utilities. The electric utility industry should bear a substantially greater proportion of funding and consequent responsibility for this program to accelerate the development of vitally needed nuclear facilities to reduce environmental impact and meet power demand during the remainder of the 20th century. In addition to the liquid metal fast breeder reactor program, the technology of a gas-cooled fast breeder reactor should be developed.

Breeder reactor development on a commercially feasible scale by 1984 should not only greatly extend our nuclear fuel resources but also conserve our other energy resources, contribute to an ultimate solution of air pollution problems as well as reduce thermal pollution problems, and develop energy at a social and economic cost competitive with conventional thermal steam generating plants of the next generation.

Additional programs which should be thoroughly reviewed to determine the level of funding and priority of development are the following:

Basic fuel research to minimize air pollutant effects.

Pollution abatement procedures by improvement of technology for disposing of solid and gaseous wastes from fossil fuel plants and radioactive waste from nuclear powerplants.

High voltage direct current transmission.

Undergrounding of high-voltage transmission lines.

Fuel cell research.

Solar energy research.

Magnetohydrodynamics (MHD) or other methods for converting heat energy directly into electrical energy without the need for conventional turbines and generators.

[1] Compiled by Bureau of Power, T. A. Phillips, Chief.

Development of automatic data-processing techniques and methods for making regional and national electric load forecasts and analyzing the environmental effects of planned systems.

Study of long-term effects on human health and other forms from effluents from nuclear and fossil-fueled powerplants.

Basic research in ecology and the life sciences with respect to air and thermal pollution effects.

During the past few years a number of members of the Federal Power Commission including the present Chairman and other present members of the present Commission, have spoken out in an effort to encourage a higher level of expenditures for research and development by electric utilities particularly with respect to environmental matters. Such efforts to encourage research and development have, from time to time, met with the response by the industry that regulation tends to discourage research and development expenditures on the part of various elements of the industry. In particular, the argument is made that regulated systems are uncertain of the extent to which they will be permitted to recover, by way of rates, expenditures made for research and development, especially where such research and development has been unsuccessful.

A careful examination of the ratemaking process at the Federal Power Commission and a review of electric utility rate cases before State regulatory commissions provides little support for this contention on the part of the industry. In its regulation of rates for electric service at wholesale in interstate commerce, research and development expenditures have generally been included as a part of the cost of service by the Federal Power Commission. Our review also indicates that State commissions have generally included research and development expenditures as a part of the cost of service for ratemaking purposes. For example, in a recent case before the Michigan commission, that commission's staff had argued that research and development expenditures relating to a nuclear reactor that had been constructed mainly as a research project should not be allowed, partly because the reactor was inoperable during the test period due to material failures. In its order the commission in allowing these research and development expenditures made the following statement:

> With respect to research and development expenses incurred by Edison in 1968, we must admit that this commission in its order in Case No. U-1444 in 1963 strongly encouraged the company to carry on the research and development discussed here. Since that time the electric industry has been subjected to criticism for its failure to devote sufficient resources to research and development. The research and development expenses involved here by Edison are less than 1 percent of the company's gross revenues in 1968. If this amount is to be regarded as excessive because it is four times the level of performance on research and development of comparison companies, then we can only conclude that the comparison companies' efforts regarding research and development are indeed dismal. The problem here is with the use by staff of the wrong standard without any effort to learn whether performance of the industry in general regarding research and development is a reasonable yardstick by which to measure Edison's performance in such a potentially vital field as the development of a fast breeder reactor.[1]

The Federal Power Commission has taken steps recently to further clarify the manner in which research and development expenses will be treated both for accounting and ratemaking purposes. On December 19, 1968, the Commission authorized Northern States Power

[1] Michigan Public Service Commission, opinion and order, Case No. U-3189, April 22, 1970, p. 10.

Co. to amoritize a $9.5 million loss on its experimental Pathfinder muclear plant over a 10-year period by charges to operating expenses.[2] In announcing this decision the Commission stated that "these expenses are treated as above-the-line items and presumably would be allowed as operating expenses for ratemaking purposes in Federal Power Commission rate proceedings." The Commission further stated that "electric and gas utilities normally will be permitted to charge off as operating expenses for accounting purposes costs resulting from the research and development activities reasonably entered into for the benefit of their utility operations."

On January 27, 1970 the Federal Power Commission issued a proposed rulemaking in docket No. R-381: "Notice of Proposed Amendments of the Uniform System of Accounts under the Federal Power Commission Act and of the Natural Gas Act to Reflect Changes in Accounting Treatment of Research and Development Expenditures." In initiating this proposed rulemaking, the Commission recognized that misunderstanding of its present accounting treatment of unsuccessful research and development costs may tend to inhibit research and development activity. The Commission stated:

> While strict accounting principles may dictate that research expenditures be charged off in the year incurred, the Commission believes a more flexible approach may meet the regulatory need to stimulate such research and development expenditures, and yet remain within the boundaries of sound regulatory accounting. The Commission believes it to be beneficial to both the consumer and the industry that research and development expenditures should be treated whereby (1) the expenditures will be fully recovered through charges to operating expense either currently or over a period of years, and (2) the utility will be able to earn a return on unrecovered expenditures.

The Commission went on to state its policy "that the accounting and ratemaking treatment of research and development expenditures should be consistent, providing that such treatment is consistent with the evidence developed in the individual cases." These principles were affirmed by the Commission in its final order No. 408 in this rulemaking docket issued August 26, 1970.

B. LAND HELD FOR FUTURE USE

There has been considerable variation in the past in the ratemaking treatment accorded to the cost of land held for future use by regulatory agencies. Most State regulatory commissions have not permitted land held for future use to be included in the rate base for ratemaking purposes until it actually becomes a part of electric plant in service. A few, including the Federal Power Commission, have permitted the inclusion of land held for future use where there is a definite plan for its use in the reasonably near future.

The systems of accounts of the National Association of Regulatory Utility Commissioners and the Federal Power Commission provide that account 105—electric plant held for future use "shall include the original cost of electric plant owned and held for future use in electric service under a definite plan for such use . . ." Where no such plan exists, property is to be included in account 121—nonutility property. This treatment has the effect of segregating the accounts in such a way that individual commissions are able to utilize such ratemaking treatment as seems appropriate to them.

[2] Letter from Gordon Grant to Northern States Power Company, dated December 19, 1968, by direction of the Commission.

The Federal Power Commission audit program for public utilities and licensees contains the following instruction:

> No limitation is placed on a number of years between the acquisition of land or other property and the date of its planned use in order to have the property considered as plant held for future use. However, any period extended beyond ten years would raise a serious question as to the definiteness as to the plans involved.

On January 22, 1970, the Federal Power Commission issued a notice of proposed rulemaking in docket No. R–379: Accounting treatment for land held for future utility use and for profits or losses realized through sales of those lands. The Commission noted that:

> . . . under the current economic conditions, we believe that our present accounting and ratemaking policies may be inadequate to meet the future public interest needs of the utility companies and of their consumers. Accordingly, we are proposing to revise those policies, to the extent possible, in order to encourage utility management to acquire land for long range utility needs.

Specifically, the rule proposed to delete from account 105—plant held for future use, any requirement pertaining to a definite plan. This would permit the recording in account 105 of land acquired under long range planning. With respect to ratemaking the Commission stated:

> In general, it will be our policy to allow the ratemaking treatment of land held for future use to track the accounting treatment prescribed therefore, insofar as such treatment is consistent with the evidence developed in individual cases. It is our intention in following such policy to provide impetus to utility management for prudent acquisition of land for utility purposes well in advance of specific construction needs. . . . We believe this policy will best serve the public interest as electric utilities and natural gas companies acquire land with a view toward preserving environmental quality.

On January 7, 1971, the Commssion issued its order No. 420 in this rulemaking docket No. R–379. This provides, *inter alia*, for the segregation of account 105—electric plant held for future use as between (1) land and land rights and (2) other electric plant. With respect to land and land rights, such property may now be included in account 105 without there being a definite plan for its future use. In addition, gains and losses from disposition of such land would pass to ratepayers.

Appendix I

FPC Guidelines and Related Orders and Rules on Environmental Matters

1. Order No. 407, issued July 10, 1970, set forth guidelines which should be followed by natural gas pipeline companies in the planning, locating, clearing, and maintenance of rights-of-way and the construction of aboveground facilities.

2. Order No. 408, issued August 26, 1970, amended Commission accounting and ratemaking policies to encourage more extensive research and development activities by electric and gas utilities.

3. Order No. 412, issued October 22, 1970, in cooperation with the Federal Water Quality Administration and the National Air Pollution Control Administration, amended Commission rules to require electric utilities to annually submit air and water quality control data to help develop and evaluate effective environmental quality control programs.

4. Order No. 414, issued November 27, 1970, implemented procedures for the protection and enhancement of natural, historic, and

scenic values in the design, location, construction and operation of hydroelectric project works.

5. Order No. 415, issued December 4, 1970. Implementation of the National Environmental Policy Act of 1969.

6. Order No. 420, adopted January 7, 1971, pursuant to notice of proposed rulemaking issued in docket No. R–379 on January 22, 1970, revised FPC's accounting procedures to encourage utility management to acquire land for long-range utility needs by amending the Uniform System of Accounts to permit a return on investment in plant sites.

On September 30, 1971, Chairman Wright Patman submitted additional questions to Mr. John N. Nassikas, Chairman of the Federal Power Commission. By letter dated October 14, 1971, Mr. Nassikas furnished this information for inclusion in the record, together with additional information covering questions raised during the hearing. The letter follows:

FEDERAL POWER COMMISSION,
Washington, D.C., October 14, 1971.

Hon. WRIGHT PATMAN,
Chairman, Joint Committee on Defense Production, Room 459, Old Senate Office Building, Washington, D.C.

DEAR MR. CHAIRMAN: I transmit herewith responses to the questions transmitted by your letter of September 30, 1971, following my appearance September 23, 1971, before the Joint Committee on Defense Production, and data in response to an inquiry of Congressman Brown relating to Alaskan and Canadian Arctic natural gas (page 408). I request that this material be included in the hearing record.

A. Reference, Inquiry of Congressman Brown, page 408.

Various projects have been proposed for the movement of gas from the Prudhoe Bay field on the North Slope of Alaska and the gas being developed in the Canadian Arctic to markets in the Lower 48 States and southern Canada.[1] If the trans-Alaska pipeline (TAPS) is certified, then you can start getting your gas down. Until TAPS, the hot oil line is certified, your gas being in solution cannot be produced and transmitted down by pipelines. There is some free gas up there, which could be transported down independently of TAPS, but again, economic feasibility probably would prohibit this kind of a development.

Three of the projects are discussed below. The Federal Power Commission has no jurisdiction over the construction of oil pipelines or over the construction of natural gas pipelines outside the United States. The information about these proposed natural gas pipeline projects is not based on filings pending before the Commission; rather it has been compiled by the FPC staff from trade sources which have not been independently verified but which the FPC staff believes are reliable. Activity and interest in Alaskan and Canadian Arctic gas reserves is increasing at an ever-accelerating rate as evidenced in the attached recent account from the Wall

[1] See attached map.

Street Journal of October 6, 1971, pp. 34 and 22, in which staff reporter Roger W. Benedict identifies and describes the proposals of the principal industrial consortiums for developing and transporting these natural gas reserves.

Alberta Gas Trunk Group (also known as Gas Arctic Systems Study Group).

In mid-1970, Alberta Gas Trunk Line Co. proposed the construction of a large-diameter gas pipeline across the Northwest and Yukon Territories into the Prudhoe Bay area of Alaska and the connection of this line to their existing pipeline system in Alberta. In December of 1970, Alberta Gas Trunk Line was joined in its study by the Columbia Gas System, Northern Natural Gas Co., and Texas Eastern Transmission Corp. This consortium is also known as the Gas Arctic Systems Study Group.

The proposed 1,550-mile, 48-inch system would consist of three principal segments: A 300-mile Alaskan portion to be U.S. owned and operated, a 900-mile segment across the Yukon and Northwest Territories to be financed and constructed by a Canadian company, and a 350-mile extension of the present Alberta gas trunk to be operated by Alberta Gas Trunk. The cost of the entire system is estimated between $1.5 billion and $2 billion. A feature of this proposal is that it utilizes the existing system to the fullest extent possible. This utilization of anticipated spare capacity would result in a relatively low incremental cost for substantial additional capacity

Gas transported through the proposed system would be available to U.S. Northwest and California markets through connections in Idaho and Montana, and would also be available to the Midwest of the United States via Trans-Canada Pipe Lines Ltd.'s facilities which transport gas to eastern Canada and also into the U.S. Midwest through a connection at the international border in Minnesota.

The group has thus far announced the location of two Arctic pipeline test-loop facilities. One is located at Prudhoe Bay, and the other is at Norman Wells, about halfway up the Mackenzie River. Alberta Gas Trunk was the first to install 42-inch high-pressure pipeline in Canada. Included in the installed pipeline is a special 1-mile test segment involving a special installation method considered applicable to conditions which will be encountered in portions of the proposed line.

The group indicated in the latter half of 1970 that a tentative project schedule would allow startup of the system in mid-1974. Delays in the development of a transport capability for North Slope oil will, of course, delay startup of a gas pipeline as well. It is assumed that the group could meet a startup date of early 1976 to coincide with the currently anticipated production of North Slope oil at that time.

The group recently announced that a study of possible means of moving gas to market from Canada's Arctic islands was also being undertaken. One possible route for this gas is a pipeline extending southward along the Boothia Peninsula to the Canadian mainland and thence to the Great Lakes area. A possible pipeline link between the Boothia line and the North Slope line will also be studied.

THE MOUNTAIN PACIFIC PROJECT

The proposed Mountain Pacific system would originate on the North Slope and extend southeast to the Fort Liard region of the Northwest Territories where it would divide into two lines, one extending southward and the other eastward. Ultimate capacity of this initial 1,100-mile, 48-inch segment would be 3.2 billion cubic feet daily. Additional reserves are anticipated to become available in the Fort Liard area. About one-half of the total Alaskan and Fort Liard gas would be shipped eastward and delivered to Canadian and U.S. Midwestern markets by interests not affiliated with the Mountain Pacific project. The remaining half would travel some 950 miles through a 40-inch line to the international border near Kingsgate, British Columbia (Eastport, Idaho). Delivery of the gas to U.S. Pacific coast markets in Seattle, San Francisco, and Los Angeles would be accomplished by way of a new corporation, Pacific States Pipeline Co.

The Alaskan segment of the line would be owned and operated by Arctic and Western Pipeline Corp. The Yukon and Northwest Territories portion would be owned and operated by Arctic and Western Gas Co. Ltd., and the segment through British Columbia would be owned by Mountain Pacific Pipeline Ltd. These three components would comprise the Mountain Pacific system. The project is sponsored by Westcoast Transmission Co. Ltd., Canadian Bechtel Ltd., El Paso Natural Gas Co., Southern California Edison Co., and Pacific Lighting Corp.

The ultimate capital cost of the system is estimated at $1.8 billion, excluding the eastern line and the Pacific States line in the United States. A projected schedule for the undertaking indicates that initial operation could begin in late 1975. Initial delivery rates to the west coast are estimated at about 365 billion cubic feet annually, and are expected to increase to approximately 750 billion cubic feet per year in 1980 when the anticipated North Slope and Fort Liard gas has all come onto the line. An equal quantity of gas will move through the eastern portion of the system, but no breakdown between expected Canadian and U.S. volumes is available. If one-half of the gas moving east went to U.S. markets, the total U.S. annual rates could be about 0.54 trillion cubic feet in 1975 and 1.15 trillion cubic feet in 1980.

NORTHWEST PROJECT STUDY GROUP

In July of 1970, the Northwest Study Group was formed to conduct a joint research and feasibility study of a pipeline project to transport natural gas from the North Slope and northern Canada to eastern Canadian and U.S. Midwest markets. Three oil companies holding major interests on the North Slope, and three pipeline companies are participating in the study. They are Atlantic Richfield Co., Standard Oil Co. (Ohio), Humble Oil and Refining Co., Trans-Canada Pipe Lines Ltd., Michigan Wisconsin Pipe Line Co., and Natural Gas Pipeline Co. of America.

The proposed line would be about 2,500 miles in length and would involve pipe diameters up to 48 inches. The northernmost end of the line would originate in the Prudhoe Bay area of the North Slope. From there the line would travel southeastward across the Yukon and

Northwest Territories, Alberta, and Saskatchewan and intersect the international boundary at Emerson, Manitoba. From that point to the Midwest of the United States and eastern Canadian markets, service could be rendered through pipeline interconnections with Trans-Canada, Great Lakes Gas Transmission, and Midwestern Gas Transmission. The line is estimated to cost about $2.5 billion to construct and would handle about 3 billion cubic feet per day (1.1 trillion cubic feet annually) when fully powered.

The study group has established an Arctic test facility at the San Sault Rapids of the Mackenzie River in northern Canada. This facility will provide the means to evaluate and determine the stability of lines in permafrost, the stability of various foundation types for aboveground structures, pipeline effects on surface cover, Arctic drainage problems, and study construction methods, materials, and equipment which might be used in an Arctic system. Work at the Arctic test facility will cost about $3.5 million of the total $12 million which will be expended on the feasibility study. Construction of the facility has been completed, and startup of tests has begun. A number of consultants in specialized fields relating to the study have been retained. A liaison and data-sharing arrangement relating to route selection studies has also been established between the Northwest Project Group and the Mackenzie Valley Pipe Line Research organization. The Mackenzie Valley group is studying the feasibility of an oil line from the Prudhoe Bay area to possible inteconnections in the Edmonton, Alberta area, and is operating an Artic oil line test facility near Inuvik in the Northwest Territories. A tentative startup date for the Northwest project is generally regarded as 1976.

B. Reference, response to questions submitted to the Federal Power Commission, September 30, 1971, by Chairman Wright Patman.

1. What are the estimates of the amount of electric power, or energy, which will be required to operate environmental equipment?

The Federal Power Commission staff has made estimates of the 1990 electric power demand of environmental and pollution control equipment needed to meet air and water quality objectives. The type of equipment involved includes soot and sulfur oxide removal systems for industrial furnaces, smelters, steel plants, and powerplants; pumps for industrial water reuse, municipal sewage plants and powerplant cooling systems; and equipment for new processes employed to minimize pollution, such as coal cleaning, induction heating of steel, and treatment of solid wastes.

The estimated power requirement for these environmental uses of electricity is 44,000 MW in 1990, or about 3.5 percent of the projected 1990 capacity of 1,260,000 MW. This does not include the potential demands of electric automobiles and mass transit systems which could become important factors in alleviating urban pollution.

2. Would you compare the cost of electric energy obtained from sources other than nuclear plants with the cost of electric energy obtained from nuclear plants?

In all types of plants generation represents about one-half the total cost of electricity as delivered to the consumer. Thus, a 10 percent change in generation costs represents about a 5-percent change in

the cost of electricity to the consumer. Generation costs are affected by many variables besides the type of fuel. These variables include plant size, hours per year plant is in use, mode of ownership (public or private), and local availability of fuels. Consequently, it is not possible to present a definitive comparison of the costs of generating electric energy from different fuel sources. However, an approximation, shown in the following table, can be made by averaging generation costs of plants of different sizes and ownerships.

APPROXIMATE 1970 NATIONAL AVERAGE GENERATION COSTS

[Mills per kw,-hr,]

Source	Direct production cost	Indirect costs	Total generation cost
Nuclear	3	5	8
Fossil (coal, oil, gas)	4	4	8
Hydroelectric	½	6	6½

Generation costs at specific plants vary widely from the average The hydroelectric plant average generation cost shown reflects the lower fixed charges of public ownership for much hydroelectric capacity. New hydroelectric plants will be used chiefly for peaking and will tend to have higher generation costs per kw.-hr. than the present national average. However, some existing baseloaded hydroelectric plants have total generation costs as low as 3 mills per kw.-hr. Generation costs of fossil fuel plants are especially sensitive to fluctuations in the cost of fuel. For example, some utilities have recently experienced fuel cost increases of over 50 percent, resulting in increases of 25 percent or more in the total cost of generation.

3. Are studies being conducted for the purpose of making determinations relating to the most efficient use of energy resources?

The Federal Power Commission's national power survey, now being updated, and its national gas survey, currently in progress, will contain data and projections relating to the reliability, adequacy, economy, and efficiency of electric power and natural gas in meeting the Nation's future energy needs.

In addition, a variety of groups in industry, government, the universities and the foundations are engaged in continuing studies directed toward determining the most efficient and economic use of energy resources. As a result of technological advances produced by the industry's research and development efforts, the amount of fuel used to generate a kilowatt-hour of electricity was reduced by one-third during the 25 years from 1938 to 1963. Recent studies have focused on national energy needs and the role of nuclear power in the national energy picture, including the development of a faster breeder reactor which will increase by 30 times the energy extracted from each pound of uranium.

Combined research studies by the natural gas industry and equipment manufacturers are aimed at developing an economic fuel cell using natural gas. If successful, the fuel cell could provide about 50 percent more electricity from the same amount of natural gas than is presently possible with conventional powerplants.

Long-range research exploring ways of obtaining large amounts of electricity from solar energy and examining such concepts as magneto-

hydrodynamics to increase the efficiency of converting thermal energy to electricity is also currently in progress.

4. Would you indicate the estimated savings which would result if we were able to obtain the most efficient use of energy resources?

The "most efficient use of energy resources" is a relative concept which reflects at any given point in time the state of technological development in the energy industry, the availability of new energy sources such as fusion power, national policy concerning such matters as the environment, the economy, conservation of natural resources, national defense, public transportation, to name a few, and variations in the energy needs of large and small, industrial and residential consumers. For example, replacement of older steam electric plants by more modern units would result in a 20 percent reduction in the amount of fuel used to generate electricity and a consequent improvement in the efficient use of energy resources. Similarly by making advantageous use of the relatively high degree of interchangeability among different forms of energy for different uses, efficiency might be improved by changing the type and proportion of energy resources committed to various end uses. Over the long run there are opportunities for improvements in the design of industrial, commercial, and residential buildings which would help to conserve the use of energy for heating and lighting.

5. Since the use of natural gas for the production of electric power is said to be an inefficient use, would you indicate whether utilities find natural gas to be more economic or whether environmental factors are controlling?

Electric utilities use natural gas as a boiler fuel for both economic and environmental reasons. In the gas-producing regions of the Southwest, natural gas has been the least expensive fuel available. In urban areas with pollution problems, utilities sometimes use clean-burning gas to meet emission standards even though the gas is more costly than other fuels. Where large amounts of energy are needed in the form of electricity, not heat, the use of natural gas as a powerplant fuel is no less efficient than the use of other fossil fuels. However, where heat is the desired end use, intermediate conversion of gas energy to electricity is clearly less efficient than direct use of gas heat.

6. In the event of the curtailment of natural gas and electricity, when there are shortages in supply, how are determinations made as to the manner in which sales will be curtailed?

Under our Federal system, jurisdiction to curtail retail sales of natural gas and electricity during periods of short supply rests with the State public utility commissions. In carrying out its responsibility to protect the public interest under the provisions of the Natural Gas Act, the Federal Power Commission, on April 15, 1971, in order No. 431 promulgated a new section 2.70 of its general policy and interpretations entitled "Measures for the Protection of Reliable and Adequate Natural Gas Service." This statement of policy provides that natural gas pipeline companies subject to the jurisdiction of the Federal Power Commission shall take all steps necessary for the protection of as reliable and adequate service as present supplies and capacities will permit during and after the 1971–72 heating season. To effectuate this policy, the Commission in order No. 431:

(*a*) Encouraged jurisdictional natural gas pipeline companies to fill all storage fields;

(*b*) Required jurisdictional companies which intended to curtail service to file curtailment plans as an amendment to existing tariffs;

(*c*) Indicated that additional short-term gas purchases may still be necessary to meet the 1972 demands and indicated the procedure under which this could be done;

(*d*) Stated that where emergency gas purchases are made and/or a curtailment program is instituted, volumetric limitations should be set on sales at current levels;

(*e*) Indicated that the Commission will reexamine existing commodity rate levels and may redesign existing commodity demand rate relationships; and

(*f*) Encouraged pipeline companies to enter into exchange arrangements with other pipeline companies.

Consonant with the directives of the Federal Power Act that the Commission encourage the voluntary interconnection and coordination of facilities for the generation, transmission, and sale of electric energy for the "purpose of assuring an abundant supply of electric energy throughout the United States with the greatest possible economy and with regard to the proper utilization and conservation of natural resources," the Commission has encouraged the National Electric Reliability Council to formulate guidelines to be followed by electric utilities in responding to an electric energy shortage. According to the National Electric Reliability Council, electric utilities experiencing power shortages are generally prepared to take the following steps:

(*a*) Make maximum use of the available interconnection capacity within and without the region to deliver all available power to the affected system or systems;

(*b*) Reduce the use of electricty by:

(1) Dropping interruptible loads in accordance with contract provisions;

(2) Requesting large industrial customers to reduce unessential loads to the extent possible;

(3) Reducing voltage, but only insofar as this will have no detrimental impact on customers' equipment;

(4) Dropping load of particular customers or of particular service areas on an alternate basis for short periods of time. In this contingency, however, every effort is made to supply power for essential public services such as the police, fire stations, hospitals, etc.

7. Do you have estimates of the quantity of natural gas in the United States which has not yet been included in reserves?

According to the latest estimate of the Potential Gas Committee,[1] the United States possesses substantial undiscovered natural gas resources. The committee has estimated that as of January 1, 1971, the potential supply, that is, the supply which remains to be found and developed and which includes Alaskan resources, was 1,178 trillion cubic feet. The U.S. Geological Survey has estimated the potential gas supply as 2,061 trillion cubic feet. These estimates of potential gas supply do not include the January 1, 1971, inventory of 290.7 trillion cubic feet of proved natural gas reserves (also inclusive of Alaska).

[1] The Potential Gas Committee is sponsored by the Potential Gas Agency, Mineral Resources Institute, Colorado School of Mines, and is composed of members from the gas producing, pipeline, and distribution industry, observers from State and Federal regulatory bodies, American Gas Association, American Petroleum Institute, Independent Natural Gas Association of America, and National Association of Regulatory Utility Commissioners.

In spite of the presence of these vast undeveloped resources, the Nation still faces serious problems in finding and developing these reserves and effectively transferring them from the potential to the proved category. This is because much of our potential lies deep in the ground, beneath the oceans on the Continental Shelf or in areas otherwise hostile to exploration eflorts. For example, about 20 percent of the total potential is attributed to our lower 48 offshore areas, 28 percent to Alaska, and 14 percent to onshore areas at depths below 15,000 feet. Cumulatively, the potential in these technically, environmentally and economically difficult areas comprises almost 62 percent of the estimated total potential. The timely development of this potential will thus require policies which will provide the necessary incentives for industry to undertake this difficult development effort.

8. Since reserves of natural gas have been decreasing for many years, what actions could be taken to reverse this trend?

The level of natural gas exploration and development is responsive to many factors and diverse actions will therefore be required to reverse the recent downward trends in natural gas supplies. Appendix B of my testimony presented on September 23, 1971, summarized many of the actions taken by the Commission in discharging its own regulatory responsibilities to foster and facilitate an improvement in the exploration and development of natural gas supplies. Foremost among the actions taken by the Commission have been the setting of new higher ceiling rates for the very important southern Louisiana supply area, the establishment of area rates in the Appalachian and Illinois Basins, the adoption of a settlement proposal establishing just and reasonable rates for the Hugoton-Anadarko area, the determination of rates for the sale of gas in interstate commerce in the Texas gulf coast area and the establishment of initial rates for sales of natural gas in the Rocky Mountain area. These and the other actions listed in appendix B of my testimony are each intended to provide a regulatory atmosphere in which development of gas supplies adequate to meet the Nation's needs will take place at the lowest cost consistent with the public interest.

Other factors outside the Commission's jurisdiction also exert a substantial influence on the natural gas supply picture. Of particular importance are tax policies, specifically the depletion allowance, and leasing policies relating to Federal domain lands. These factors require extensive analysis and review to determine whether changes in present policies are needed in order to promote the timely development of the Nation's natural gas resources.

9. What will be the estimated cost of natural gas to the consumer during the next 5 years as compared to the current cost?

The price of natural gas paid by the ultimate consumer in the typical situation is dependent upon three separate components: the wellhead price received by the producer for its contractual sale to a pipeline, the city-gate price which the pipeline charges to a distributor, and the retail rate which the distributor charges to its customers. If the gas is in interstate commerce, the Federal Power Commission establishes the maximum rates which the producers may receive by contract and sets rates charged by pipelines for their wholesale sales. The retail component received by the distributor, however, which may account for around 50 percent of the ultimate price paid by the consumer, is not within the rate jurisdiction of the FPC. These rates, which are generally set by State or local regulatory agencies, may

vary widely between jurisdictions and among different classifications of customers through applications of local rate designs. Because of these diversities, a reasonable prediction as to the distributing component cannot be made.

The transmission component of the ultimate price is established in FPC pipeline rate proceedings on a cost of service basis. Although a number of factors are involved in establishing these rates, perhaps the most important factors in estimating the transmission costs 5 years hence are general inflation and the cost of financing, both debt and equity. If these continue their upward trends, transmission costs almost certainly will be higher.

Wellhead prices received by producers also are set by the FPC. Recent Commission decisions have established just and reasonable area rates for the first time in several areas of the country. These decisions provide for periodic and incentive escalations which will tend to cause increases in wellhead prices over the next 5 years. Since the Commission's first area rate opinion in 1965, all decisions have adopted a vintaging system of pricing gas for incentive purposes. Under this system, gas dedicated to interstate commerce prior to a certain date may be sold for one price and gas dedicated after that date may be sold for a higher price. As larger percentages of the total gas sold are produced from reserves dedicated in the more recent vintage, the average wellhead price increases. However, without knowing the volumes to be dedicated over the next 5 years, it is not possible to quantify the amount of that increase. Another factor which will exert upward pressure upon the consumer's cost of natural gas in the next 5 years will be the increased reliance upon supplemental sources, such as liquefied natural gas. Again, since neither the volumes nor the prices of these supplemental sources are known, quantification of the increased costs is not susceptible to an accurate estimate.

10. Would you indicate the lead time required for bringing new sources of natural gas into the pipelines, including exploration?

The lead time required from the commencement of exploratory activity to the commencement of production from a natural gas lease is difficult to quantify and varies significantly from lease to lease. The elapsed time from lease acquisition to date of initial production is heavily influenced by the proximity of the acreage under lease to existing production and to readily available pipeline connections. For example, the lead time for a lease acquired in an offshore drainage lease sale would be very much shorter than the lead time for leases on the Alaskan North Slope where geological information is more sparse and transport capability is not yet available. Shorter lead times would also be encountered in onshore areas which have experienced a high level of development activity and lie in close proximity to pipeline transportation.

In the southern Louisiana area rate proceeding, FPC Docket No. AR69–1, lead time estimates applicable to gas wells located in that area of the continental United States including the Federal offshore domain, were developed by the Commission staff from data gathered on more than 7,000 gas wells and 3,000 leases on which gas and gas-condensate wells were completed during the 6 calendar years from 1963 through 1968. These estimates indicated a composited elapsed time of almost 83 months (6.9 years) from the date of lease acquisition

to the date of initial delivery of gas from the leases. For this same group of wells, the composited elapsed time from the date of well completion to the date of initial delivery was just over 11 months. While comparable data are not available for wells and leases which have come into production since 1968, the current high levels of gas demand relative to supply can be expected to result in significantly shorter lead times.

11. Would you compare the quality of gas obtained through the gasification of coal with the quality of natural gas?

All coal gasification processes currently being investigated would produce synthetic gas comparable in quality to pipeline quality natural gas. In synthetic gas produced from coal, the fractions of inert gases, such as $C0_2$ and N_2, would fall within the limits for these components found in pipeline quality natural gas, while in each type of gas the sulphur content would be negligible. Rated at approximately 1,000 B.t.u. per cubic foot, the heat content of synthetic gas produced from coal would be comparable to the heat content of pipeline quality natural gas. Thus, with respect to quality, pipeline quality natural gas and synthetic gas produced from coal are fully interchangeable.

12. Would you compare the uses of natural gas with the uses of gas obtained from coal?

Successful commercialization of current coal gasification processes will result in a synthetic product which is interchangeable in every respect, including type of use, with natural gas. Despite this complete interchangeability, however, economic considerations of using what is presently a more expensive gas, will limit the kinds of uses to which synthetic gas produced from coal is put.

13. How will total expenditures for acquiring natural gas in the future compare with current expenditures?

Although exact figures cannot be supplied, staff anticipates that expenditures directed toward the acquisition of new gas supplies will probably have to be increased beyond 1970 levels if increasing future demands for natural gas are to be met. The principal factors to which these increased expenditures may be attributed are: (1) inflationary forces, which affect almost every phase of gas exploration and development; (2) location of a large portion of the potential gas supply in areas, offshore, in Alaska and at great depths, which will be expensive to develop; and (3) since the most easily developed reserves are exploited first with the passage of time, increasing reliance must be placed on developing the remaining less economical reserves.

14. Has there been any change in the quality of natural gas produced as reserves have decreased?

Despite declining natural gas reserves, there has been no discernible change in the average quality of natural gas being produced.

15. In connection with the coordination of the responsibilities of departments and agencies, would you distinguish between the functions of the Joint Board, the Interagency Power and Energy Committee, the Energy Subcommittee of the Domestic Council, and any other body within the Government having responsibility related to energy supply?

On August 6, 1970, the President appointed an Energy Subcommittee of the Domestic Council, headed by the Chairman of the Council of Economic Advisers, to undertake a study of the national energy situation and to develop proposals for new or revised Federal actions for consideration by the President.

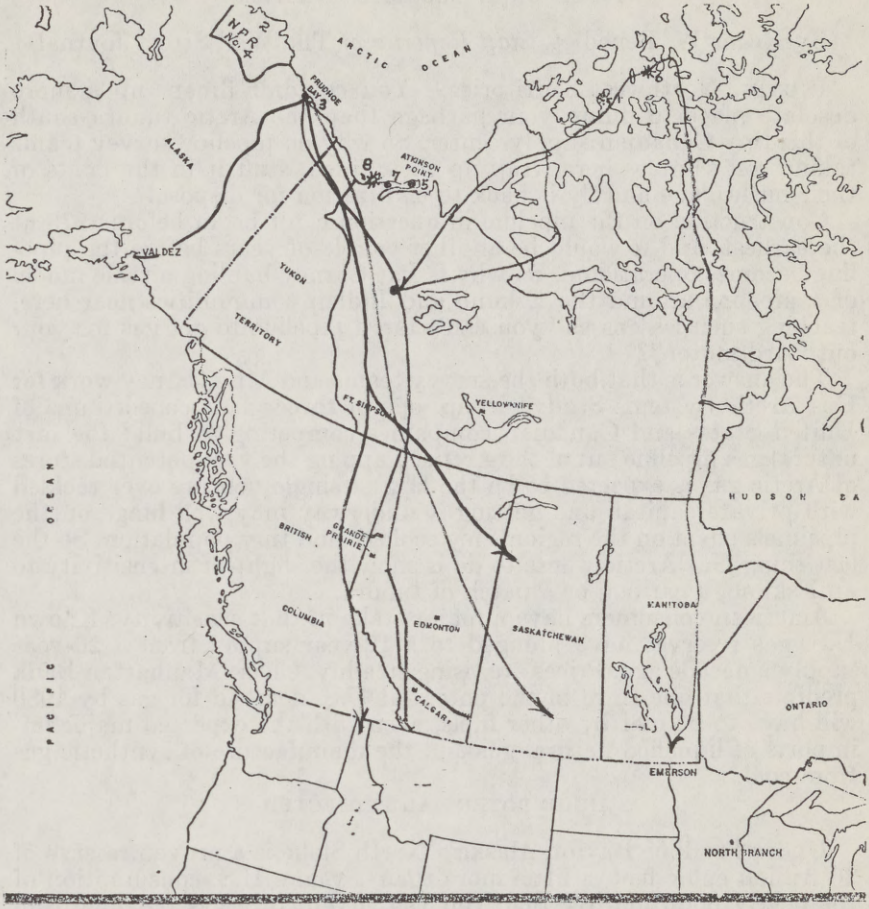
On June 4, 1971, the President sent a message on Energy Resources to the Congress. This message was based on the work of the Energy Subcommittee. In this message, the President proposed that "all of our important Federal energy resource development programs be consolidated within the new Department of Natural Resources. . . . Until such time as the new Department comes into being, I will continue to look to the Energy Subcommittee of the Domestic Council for leadership in analyzing and coordinating overall energy policy questions for the executive branch."

On September 28, 1970, the President established a Joint Board on Fuel Supply and Fuel Transport chaired by the Director of the Office of Emergency Preparedness. The Joint Board is charged with identifying emergency problems in fuel supply and fuel transport and coordinating prompt and appropriate remedial actions by the responsible Federal agencies. In addition, the Board is developing energy conservation measures for industry, Government, and the general public to help reduce energy use in times of shortage and during pollution crises.

The Joint Board on Fuel Supply and Fuel Transport has assumed responsibility for the activities conducted by the Interagency Power and Energy Committee, which was established in the spring of 1970 by the Office of Emergency Preparedness, but is now no longer active.

Sincerely,

JOHN N. NASSIKAS, *Chairman.*



GAS AND OIL PIPE LINE PROPOSALS

LEGEND

——— EXISTING ALBERTA GAS TRUNK LINE SYSTEM
——— PROPOSED ROUTE-ALBERTA GAS TRUNK LINE GROUP
——— PROPOSED ROUTE-NORTHWEST PROJECT STUDY GROUP
——— PROPOSED ROUTE-MOUNTAIN PACIFIC PROJECT
——— PROPOSED ROUTE-TRANS ALASKA OIL PIPELINE SYSTEM

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Far-North Treasure

Firms Seek Ways To Tap Arctic Natural Gas Without Running Afoul of Ecologists, Natives

(By Roger W. Benedict, *Staff Reporter of* The Wall Street Journal)

Inuvik, Northwest Territories.—You couldn't dream up a more desolate place to dump your garbage than the Arctic tundra south of this tiny Canadian supply center. So why do pipeline survey teams taking soil samples here wrap up their trash, stuff it in the floats of their bush plane and fly it back to civilization for disposal?

Construction on the pipeline in question can't begin before 1973 at the earliest, and it would be another couple of years before the pipeline becomes operational. So why is Pat Carney hauling a scale model of a pipeline around the Eskimo and Indian communities near here, teaching such lessons as "you can't tap a pipeline to get gas for your outboard motor"?

The answer is that both the survey teams and Miss Carney work for Gas Arctic Systems Study Group, one of three giant consortiums of United States and Canadian companies competing to build the first natural gas pipeline out of the Arctic. Tapping the vast potential stores of Arctic gas is expected to be the largest single venture ever tackled with private capital, and getting it underway may well hinge on the pipeline's effect on the region's icy ecology and tiny population. So the last thing Gas Arctic wants to do is show the slightest insensitivity to an Eskimo, a caribou or a patch of tundra.

American consumers have a major stake in that sensitivity. Known U.S. gas reserves have plunged to a 12-year supply from a 20-year supply a decade ago. Prices are rising steadily. Chase Manhattan Bank predicts that one third of the potential U.S. demand for gas by 1980 will have to be met by other fuels, even with the expected major imimports of liquefied natural gas and the manufacture of synthetic gas from coal.

HUGE POTENTIAL PROJECTED

Under Prudhoe Bay on Alaska's North Slope is a proven reserve of 26 trillion cubic feet, a little more than 1 year's U.S. consumption of the nearly pollution-free fuel. But the advent of a gas pipeline from Prudhoe Bay through Canada to the United States is expected to accelerate the search for gas across the Canadian as well as Alaskan Arctic. Several promising discoveries have already been made, and geologists estimate as much as 750 trillion cubic feet may remain to be found. That's two and one-half times the present proven U.S. reserves and nearly equal to the amount of undiscovered gas that is estimated to lie under the 48 lower States.

The Prudhoe-U.S. pipeline alone is expected to cost up to $3 billion, with hundreds of millions more to be spent on connecting links within the United States. Those figures could double within a decade as discoveries and developments lead to additional lines.

To further understand Arctic gas pipeline planners' concern over ecological and native claims issues, one has only to fly the 350 miles northwest to Prudhoe Bay. There sits row on row of idle vehicles, deserted and semideserted base camps and supply dumps and a massive stockpile of 173 miles of rusting pipeline pipe.

The pipe is destined for use in an oil pipeline that ultimately is supposed to carry North Slope crude oil across Alaska to the ice-free port of Valdez. But the project, to be built by a consortium called Alyeska Pipeline Service Co., remains indefinitely delayed by environmental court suits and pending native claims legislation in Congress. Drilling activity in the area has dwindled to three rigs from 23, 2 years ago; the work force has shrunk to 900 from 4,500, air activity is a shadow of the freight movement that once exceeded the Berlin airlift, and only one of Prudhoe's 42 completed wells is producing—for a local fuel oil facility.

CONSERVATIONIST'S DAY IN COURT

An Arctic gas system isn't possible until Alyeska is built, because gas is a byproduct of oil production and can't flow until the oil does. But the gas pipeline consortiums hope they can avoid Alyeska's woes and begin construction as soon as 1973 on the presumption that construction of the Alyeska line will have begun by then.

"The conservationist will have his day in court, and these hearings could last up to a year, but we hope to have all the answers for him," says Douglas A. Simpson, manager of administration for Northwest Project Study Group, another of the three consortiums. He reports Northwest will likely ask for hearings soon before Canada's National Energy Board on the environmental issues connected with the line.

"We can safely build a gas pipeline to Prudhoe right now," asserts Robin J. Abercrombie, manager of special studies for Alberta Gas Trunk Line Co. and coordinator of much of the Gas Arctic group's research. Competing groups agree the toughest ecological problems appear to have been licked, thanks in part to an estimated $25 million or more in research on gas pipelines underway in the far north.

For one thing, Mr. Abercrombie explains, the pipeline won't unnaturally thaw the permanently frozen ground through which it will be laid. Gas flows naturally at temperatures well below freezing, so the latest plans call for simply chilling the gas to the temperature of the ground around it. Heavy construction equipment will move only in winter over ice roads that won't damage the tundra, he says, adding that these techniques are now being proven at Arctic test stations.

The pipeline must cross about 1,000 miles of "permafrost," a permanently frozen and sometimes unstable mixture of ice, rock and earth up to 1,200 feet thick, of which only the top 2 or 3 feet thaw each summer. Researchers are finding only about a fourth of the permafrost contains so much ice that it can become unstable, and they say much of this can be avoided by careful route planning that combines new aerial photography techniques and ground soil survey parties.

THREE ROUTES IN SOUTH

The initial pipeline from Prudhoe Bay, by direction of the Canadian Government, must follow the Mackenzie River Valley through most of northern Canada. The three competing consortiums, however, have put forth three different routes through southern Canada that reflect roughly the distribution areas of their U.S. gas company members.

The Northwest group has proposed the longest pipeline, a $3 billion, 2,500-mile route ending in the Great Lakes area. The group is made up of Trans Canada Pipelines Ltd., Canada's largest gas pipeline system; units of two major U.S. suppliers of Midwest markets, American Natural Gas Co. and People's Gas Co.; and the three major holders of North Slope oil and gas leases, Atlantic Richfield Co., Standard Oil Co. (New Jersey) and Standard Oil Co. (Ohio).

A $1.8 billion, 2,050-mile pipeline to the west coast is proposed by the Mountain Pacific group, a venture formed by Bechtel Corp., the large construction company; Westcoast Transmission Co., which operates the Canadian gas pipeline that already extends to the Northwest Territories; El Paso Natural Gas Co., the biggest supplier of the Western U.S.; and two large California utilities, Pacific Lighting Corp. and Southern California Edison Co. (Pacific Lighting, however, recently joined the Gas Arctic group and presumably will drop out of the Mountain Pacific group.)

Gas Arctic's 2,500-mile proposed route would cost $1.5 billion and run into the U.S. Great Plains. It would distribute gas throughout the United States and Canada by way of Alberta Gas Trunk's existing pipeline system. Other members include the government-owned Canadian National Railway Co. and three major U.S. pipelines, Columbia Gas System Inc., Texas Eastern Transmission Corp. and Northern Natural Gas Co. Columbia serves the East, Texas Eastern the East and West, and Northern Natural the Great Plains.

TENNECO A LIKELY ENTRANT

These three entrants in the pipeline derby are likely to be joined by others, most notably Tenneco, Inc., which says it is negotiating to form a consortium of its own and which is doing research on arctic pipelines.

Tenneco has another stake in arctic gas through its relationship with the other major figure in gas development here, Panarctic Oils Ltd., a venture of the Canadian Government and 19 private companies, that is doing much of the exploration for gas in the Canadian Arctic. In July, Tenneco agreed to finance half of up to $75 million in exploration by Panarctic in return for rights to buy half the gas discovered.

The other half of the money was put up by three members of the Gas Arctic group, Columbia Gas, Texas Eastern, and Northern Natural, who hold the rights to the other half of any discoveries. Panarctic has already made two major discoveries on Melville and King Christian Islands, respectively 650 and 750 miles northeast of here. Just last month, Panarctic confirmed via a second well that the King Christian discovery is a major natural gas field with exceptionally high flow potential, but says still further drilling is required to evaluate the finds.

As a result of these finds, Gas Arctic set up on Vanier Island a camp to study ways to cross the deep, ice-choked arctic channels with a pipeline. If built, such a pipeline would either run southwest to join the Prudhoe pipeline or due south alongside Hudson Bay to the Great Lakes region. The latter route, while longer, would have the advantage of lying on a rock shelf rather than permafrost.

Imperial Oil Ltd., 70 percent owned by Jersey Standard, has promising gas finds about 75 miles north of here at its Mayogiak and Taglu wells in the Mackenzie River Delta. So far Imperial hasn't said much about its discoveries, but it has built up a sizable supply base at the nearby Eskimo community of Tuktoyaktuk, and industry sources say the Mackenzie discoveries are important ones.

ALLOCATION SYSTEM SEEN

It's believed by many that the competition among the consortiums will result in allocation of the gas to nearly all those who seek it through a single giant project. The competition, in this light, is chiefly to determine who will get what share of the gas and the project.

Gas Arctic believes it has an edge here, because it proposes majority Canadian ownership of all sections of the line built in Canada, and it notes the Canadian Government would have an indirect stake in the project through its ownership of Canadian National Railway, which is a member of Gas Arctic. The railway, though, says it's more interested in the $200 million movement of supplies and equipment the project will entail.

Considering the staggering costs of finding and transporting Arctic gas, it won't be much of a bargain for American consumers. The delivered cost of gas from the Southwestern fields that supply 90 percent of present U.S. consumption averages about 43 cents per 1,000 cubic feet. Mountain Pacific estimates transportation costs alone from Prudhoe to Los Angeles will come to about 54 cents per 1,000 cubic feet. Nationally, the total cost of Arctic gas is expected to run between 70 cents and $1 per 1,000 cubic feet. However, with the worsening gas shortage, Arctic gas increasingly will be competing with imported liquified natural gas and synthetic gas manufactured from coal. Gas prices and capital investments for these three appear about equal.

In the context, payments to settle Native claims don't bulk large. Gordon Walker, vice president of Alberta Gas Trunk, says Native claims would affect only the price paid for right-of-way along the line, and he reports those payments are only a fraction of 1 percent of total pipeline construction costs even in heavily settled areas of Canada.

That's not much, but it's important to areas like this one, where up to 90 percent of the inhabitants of some villages are unemployed. George Clark, geologist, restaurant owner and head of the chamber of commerce here in Inuvik, says Native claims payments would provide the most important potential benefits of the pipline project to the far north's economy, though he concedes the exploration boom is also boosting local business.

The consortiums say the Canadian Government will make all decisions on environmental and Native claims issues. Canada hasn't

even conceded at this point that the Native groups have any claims such as those Congress is considering in Alaska. But it's expected that Native groups will seek to pursue such claims in the courts.

The consortiums estimate the pipeline will create about 150 permanent jobs for northern Natives, whose main source of income has traditionally been the bleak, risky life of trapping fur animals. Actually, the key Native claims issue is whether a pipeline will affect the normal migratory habits of such animals, especially the huge herds of caribou on which the Indians and Eskimos also depend for food.

The pipeline planners say they will go to whatever lengths are necessary to insure caribou will cross the line at their regular migration points. Gas Arctic, for one, reports caribou frequently cross test pipelines at its Prudhoe Bay research station and sometimes even lie down on top of them.

Wayne Hansen, a Colorado State University scientist performing ecological studies on the North Slope, continues to be concerned that pipelines could create a serious "optical barrier" to caribou. But only minutes after he explained how caribou won't climb the 6-foot-high gravel roads at Prudhoe, a reporter photographed several caribou climbing across one of those roads. They looked quite casual about it.

APPENDIX

AEC

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

No. S-18-71
Tel. 973-3446

FOR RELEASE AT 9 A.M. EDT
FRIDAY, SEPTEMBER 24, 1971

Remarks by Wilfrid E. Johnson
Commissioner, U. S. Atomic Energy Commission
National Energy Forum
Washington, D. C.

September 24, 1971

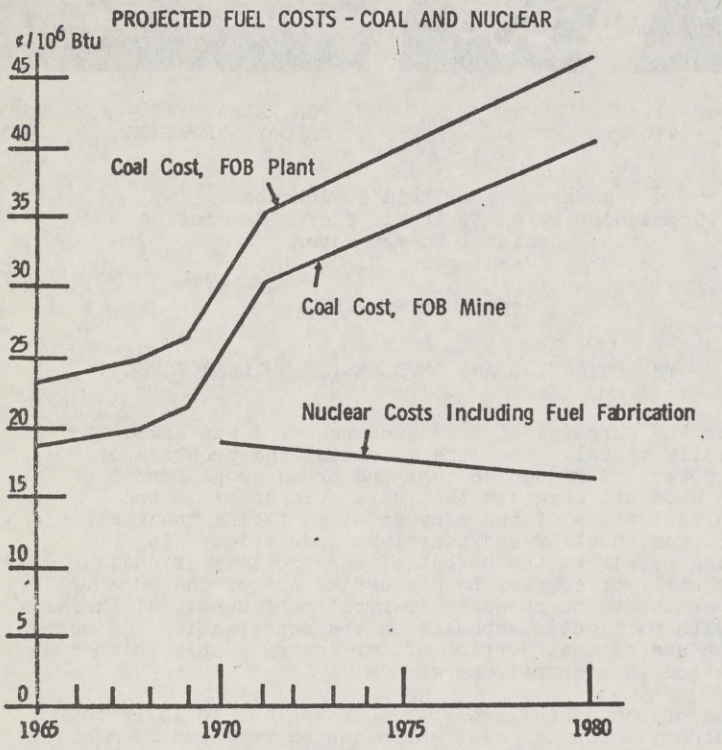
THE POTENTIAL AND PROBLEMS OF NUCLEAR POWER

For the purposes of this conference, I was asked specifically to talk about the potential and problems of nuclear power. I recognize that the broad scope stated by Chairman Woodruff suggests that we should speak to the potential solutions of the many problems facing the coal, electric, gas, nuclear and petroleum industries. In addressing myself to the potential and problems of nuclear power, I will, of course, be discussing one of the more obvious solutions to the overall problem of supply of thermal energy with particular emphasis on the conservation and more efficient use of that portion of our energy supply which must be converted to electric energy.

One of the unique properties of nuclear fuels is the extraordinary amount of heat which can be released from a very small amount of material. The advantage of nuclear fuels over coal, for example, in terms of potential energy per unit of weight is about 3 million to one. In today's nuclear power systems, up to about two percent of this potential may be realized eventually with plutonium recycle. Breeder reactor systems are expected to increase this figure to 60 percent or more. Current commercial light water nuclear reactors even without plutonium recycle, produce energy from each pound of uranium equivalent to that available from about 10 tons of coal. This characteristic of a highly concentrated energy source in turn has two implications which I consider of special significance.

First, as nuclear power takes on a larger share of the electric generating market, regional differences in power generation costs will tend to disappear.

Second, nuclear fuels are considerably less affected by price escalation attributable to rising transportation costs. So while the capital costs of nuclear plants are higher than those of fossil fueled plants, once the capital investment is made, the cost of producing nuclear power from a particular plant tends to be more stable.



Nuclear power will probably account for about one-fourth of the Nation's generating capacity by 1980 and about one-half of our generating capacity by the year 2000. This degree of market penetration in an electric power generation industry which is itself growing at a rate of 7 or 8 percent per year implies an enormous growth rate for the nuclear power industry. It is the challenge of this projected rate of growth which I would like to focus on today.

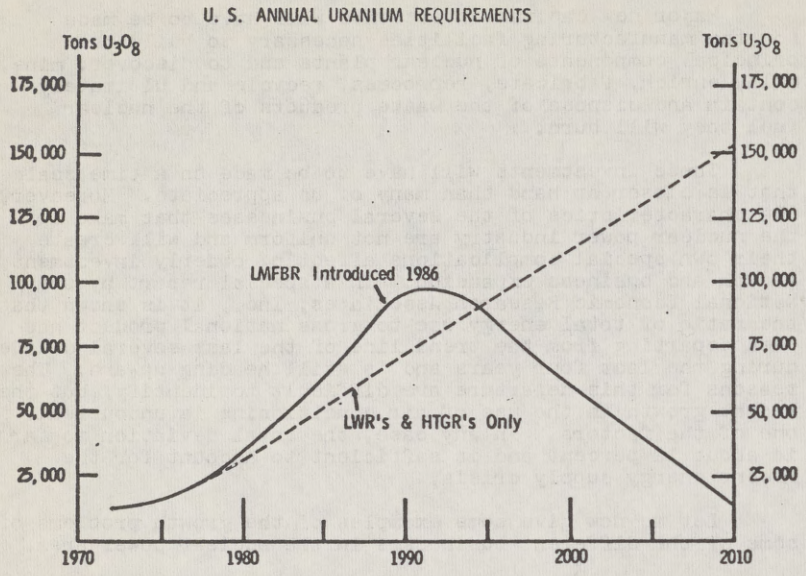
Major new capital investments will have to be made for the manufacturing facilities necessary to build the principal components of nuclear plants and to discover, mine, mill, enrich, fabricate, reprocess, recycle and ultimately contain and dispose of the waste products of the nuclear fuel they will burn.

These investments will have to be made on a time scale that is closer at hand than many of us appreciate. Moreover, the characteristics of the several businesses that make up the nuclear power industry are not uniform and will create their own special complications affecting orderly investment growth and business expansion. In a special report by the National Economic Research Associates, Inc., it is shown that the ratio of total energy use to gross national product has been departing from the trend line of the last several decades during the last four years and is still heading upward. The reasons for this departure are difficult to identify, but the recent growth in the use of air conditioning is undoubtedly one of the factors. In any case, the total deviation so far is about 12 percent and is sufficient to account for the recent energy supply crisis.

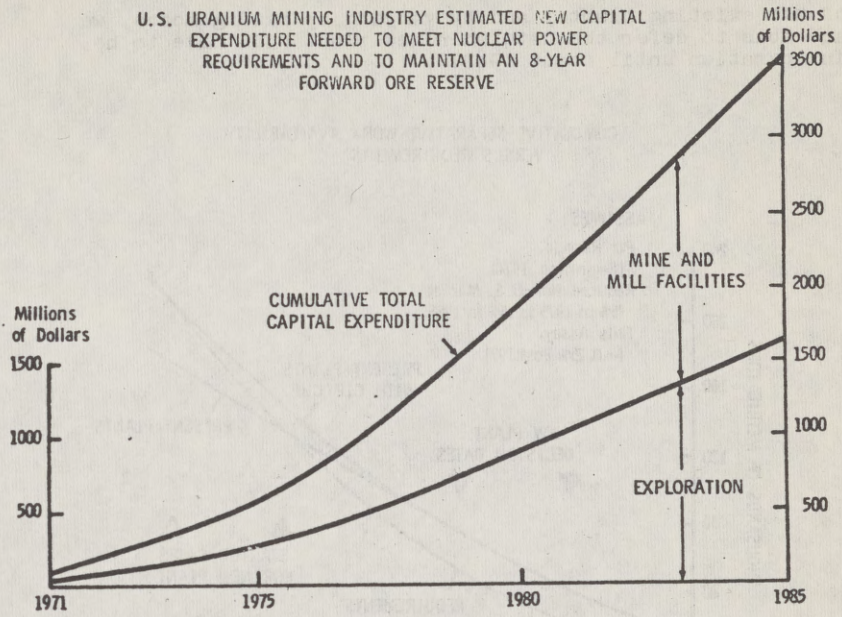
Let me now give some examples of the growth problems of some of the different businesses in the nuclear power area.

The Yellow Cake Market

This is the first year that the market for natural uranium or yellow cake (U_3O_8), as I will call it, is completely in the private sector. The Commission's long term purchasing contracts are completed and the government has a stockpile of some 50,000 tons of uranium excess to its needs. The utility market for yellow cake is soft today and will probably continue to be soft until the late 1970's. Thereafter, however, it will increase very rapidly and remain high through the decade of the nineties when, presumably, the advent of the fast breeder reactor will cause the market to taper off and by the early part of the next century to come to a lower level.



A major problem facing the raw materials industry today arises because revenues from sales in the current soft market are insufficient to finance expansion in exploration and in mining and milling facilities on the scale needed to meet projected requirements and maintain an adequate forward reserve. The magnitude of this investment through 1985 may be on the order of $3.5 billion. Failure to make this investment on a timely basis will impact principally on the utility industry in the form of price instability and reduction in their sources of supply through a tendency toward the elimination from competition of the small and medium sized producers who lack the capital resources to weather the slack years. Through long-term contracting, the utilities can probably mitigate these effects and contribute to the viability of the uranium industry.

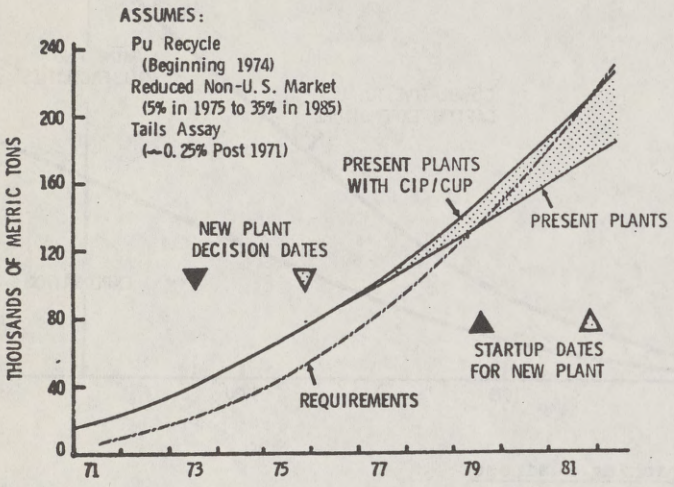


The Enriching Business

Today the Atomic Energy Commission is the sole domestic supplier of enriching services. This is done in three large plants built for military purposes at an acquisition cost of $2.3 billion. I should interject here that while these plants were built some time ago and construction costs have escalated substantially in the intervening years, the improvements in technology have just about matched the escalation rate so that we believe we could build equivalent new plant capacity today at about the same cost. Today these plants are operating at about 40 percent capacity, but by about 1976, domestic and foreign requirements for enriching services will equal their full capacity production and provide a business with revenues in excess of a half billion dollars annually. However, preproducing enriched material now and in the years before our capacity is fully committed, and with a program of plant improvement which will increase the capacity

of the existing plants, and by varying operating modes, we are able to defer the date when new plant will have to be in operation until about 1982.

CUMULATIVE SEPARATIVE WORK AVAILABILITY
VERSUS REQUIREMENTS

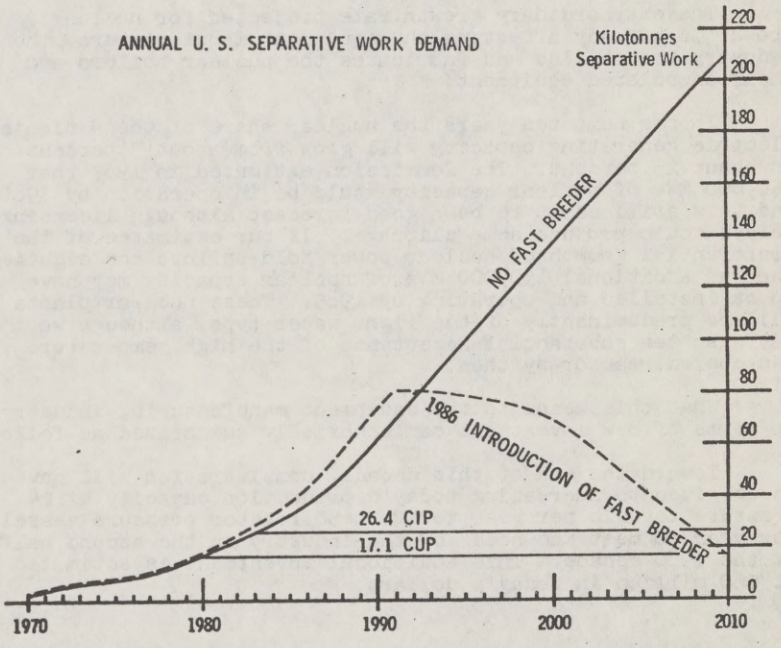


The major problem in the enriching industry is whether private industry can marshall the resources to build the new capacity that will be required or whether this commercial service will have to be performed by the government. There are those who favor one solution or the other largely on ideological grounds. As a matter of policy, however, the President has decided that the government's role as the sole supplier of enriching services should eventually be ended.

The Commission recently established a program for permitting a limited number of private companies access to our separations process technologies which remain secret. We expect through this program that industry will become familiar with the technologies and develop and improve upon them so that they can take the steps necessary, on a timely

basis, to provide enrichment services when substantial new plant capacity is needed in the early eighties.

The investment in new enriching capacity will be substantial. The projected peak in annual domestic separative work demand (assuming 1986 introduction of commercial breeder reactors) is some 50,000 metric tons of separative work more than the capacity of our present plants even when modified to operate with improved efficiency and to provide increased capacity. The shape of the projected domestic requirements curves suggest that plant capacity actually added may be in the range of 25 to 40 thousand metric tons of separative work and that enriched fuel requirements will be met by making use of operating flexibility regarding preproduction and choice of tails assay.



When one considers that an investment of about $100 per Kg unit of separative work capacity per year is required to put these plants in place, it becomes clear that an investment of 2.5 to 5 billion dollars will be required for enriching plants alone. Electric power generating plants to power gaseous diffusion plants would require an additional investment roughly comparable in magnitude.

A final complication in this picture arises when the breeder reactor comes along to compete with, and eventually to replace, the uranium converters. Though the phasing will not be abrupt, by the nineties enriching requirements look as though they may start to peak out and slowly decline over the ensuing 20 to 30 years or more to a point where ultimately they will approach zero. The predictable rise and fall of the projected requirements curve is a very unusual feature in a highly capital intensive business, and poses a problem unique to this business.

The Equipment Manufacturing Business

The extraordinary growth rate projected for nuclear power is already affecting the equipment manufacturers, the industry that builds and fabricates the nuclear boilers and their associated equipment.

In the next ten years the nuclear share of the Nation's electric generating capacity will grow from about 3 percent to about 25 percent. The Commission estimated in 1967 that 150,000 MWe of nuclear capacity would be in operation by 1980 and this still seems to be a good forecast although licensing delays could produce some slippage. If our estimates of the preferential growth of nuclear power hold up into the eighties, then an additional 150,000 MWe of nuclear capacity may have to be installed and operating by 1985. These nuclear plants will be predominantly of the light water type, although we may also see substantial acceptance of the high temperature gas cooled reactor by then.

What this means to the equipment manufacturing industry in terms of new investment can be briefly summarized as follows:

Toward the end of this decade, consideration will have to be given to increasing today's production capacity of 24 pressure vessels per year to 40 to 50 reactor pressure vessels per year to meet the needs of the industry in the second half of the 1980 decade. This additional investment is estimated at $60 million in today's dollars.

Today we have the capacity to produce some 60 steam generators per year. This capacity also should be sufficient to supply the needs for nuclear power for about the next 10 years. By the early 1980's, however, it is expected that this capacity will have to be approximately doubled. This will mean that an investment in additional facilities on the order of about $60 million will have to be committed - probably before the end of this decade.

The turbine generator business will continue to grow over this period but its rate will match that of the utility industry generally. Capital requirements here will nevertheless be substantial, involving investment commitments at the end of the decade totalling perhaps $400 million.

The Impact of the Breeders

The growth challenges that I have been describing to this point are those confronting the light water reactor industry. There is no debate within the nuclear industry that the breeder reactors will ultimately penetrate and take over the major portion of the heat source market for the generation of electricity. The date of major market penetration is uncertain although it is generally concluded that a significant beginning will occur in the mid eighties. Our studies indicate that by 1990 some 20,000 to 30,000 megawatts of breeder capacity may be available. By the year 2000, this could have increased to several hundred thousand megawatts.

I have noted earlier the long-term impact of the breeder on the uranium and enriching industries. In the near term, development of the breeder to the point of commercialization confronts the government, the utility industry and the equipment manufacturers with a major challenge in the research and development area.

The initial breeder demonstration plant will be an expensive project costing in the range of $400 to $500 million. Much of these costs are attributable to research and development in direct support of the plant, first of a kind items, contingency, and open-ended risk. We are evolving with the utilities and manufacturers a plan for equitably sharing these costs with the government. However, to have built and successfully operated a 300 to 500 MWe liquid metal fast breeder plant is only the first step in the introduction of a commercial breeder business. A continuing significant research and development effort is planned. Also, several plants of increasingly larger sizes will have to be built; manufacturers will have to develop cost experience for the new components and

systems and invest in the manufacturing facilities needed to support what is expected to become a rapidly expanding market.

Financial Problems

Needless to say, the equipment manufacturers, who have just within the last year or two turned the profit corner on the light water reactors, are not eager from a business standpoint to undertake a new and perhaps greater investment commitment for the breeders and they have said so. It is becoming recognized increasingly that the traditional relationship between the equipment manufacturers and the utilities with respect to the funding of research and development for generating equipment will have to change, and the utility industry is preparing to assume a much heavier share of the burden. The recently reported preliminary results of the fund raising efforts of utilities for design and development and construction of a liquid metal fast breeder demonstration plant is a major step forward.

The growth rates and scale of the nuclear power industry are, of course, framed by the growth rate and scale of the electric utility industry itself. In 1971, the utility industry is expected to order about 36,000 MWe of generating facilities of all types. This represents a commitment of about $9 billion for generating facilities alone to which an additional $7 billion will probably be added for associated transmission and distribution facilities. These large capital investments in utility plants naturally require that large capital investments also be made to provide the equipment, fuel and services which these plants require. While there is a several year interval between ordering new facilities and going to the capital markets to finance them, the utility industry as a whole has the unique problem of raising new capital at an annual rate which approaches one half of its revenues. This problem will be compounded if inflation continues in the construction industry as it has in the last few years.

Moreover, rapid increase in the use of electricity has been a vital factor in our ability to maintain continuing improvement in the productivity of our economy. If the growth sectors of the economy have their supply of electric power curtailed or its cost increased exhorbitantly, economic development could be seriously disrupted.

Recently, the utility industry has faced extremely rapid escalation in costs of plant and equipment, financing costs, and costs of fossil fuel. It seems clear that the inflationary effects on the costs of capital and operation of

facilities must be brought under control or the electric utility industry will be unable to provide the power required to meet the demands for renewed expansion of the economy.

Other Problems

I thought it best to give you this morning a brief outline of some of the problems incident to the prospective growth of the nuclear power business. There are, of course, many other problem areas and while I do not have time to discuss them all, I can mention a few.

One unique problem is that pertaining to insurance to cover liability to the public and provision for governmental indemnity beyond the limits of available insurance. Like any other piece of equipment, nuclear reactors and the machinery that goes with them can have minor malfunctions from time to time and, generally speaking, these have zero effect on the environment and on the health and safety of the public. In fact, there has been almost zero effect so far as we can determine on either employees or public with respect to nuclear power plants.

Of course, one can imagine somewhat more severe accidents occurring with extremely low probability. Again, the environmental costs or damage would be very low, but one could theoretically compute an estimated damage level over a period of years that might be substantial enough to exhaust available insurance.

In 1957, the Congress initially enacted legislation, the Price-Anderson Act, which provided Government indemnity in excess of available private insurance. In the fourteen years since we have had this program, no claim involving licensee indemnity has ever been received and most of the premium amounts for private insurance that have been held as reserves for ten years are being refunded.

Despite this very excellent safety record, one can still make a hypothetical, even though highly improbable case, for a major nuclear accident. Because of the possible magnitude of damage from such an accident and the resulting number of claimants, it has been felt advisable to channel the public liability through the plant owner and to provide indemnity coverage above available insurance to assure compensation to persons who may suffer damage. A limit of Government indemnification of $500 million was originally established. This is gradually being reduced as experience is gained and the amount of available private insurance increases. This sort of indemnity protection is very similar to the kind of action taken

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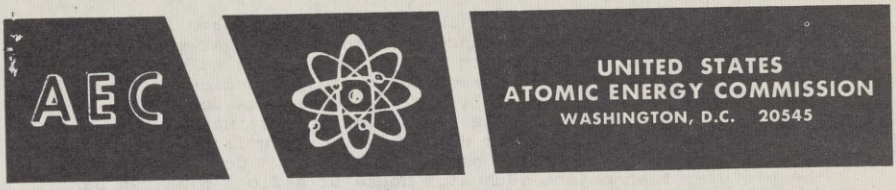
by the Government in the case of natural disasters such as earthquakes and floods. The major difference in this case is that the provisions are made in advance. The Price-Anderson Act, of course, has to be reviewed from time to time to determine what changes, if any, are warranted. As the Act now stands, it will continue into 1977 and it will be necessary to make another review in the near future.

A separate and distinctive problem of the nuclear power business is that of obtaining public confidence in, and acceptance of, long-term radioactive waste storage. The Commission is proposing to retain the responsibility for safe storage of high level and other dangerous waste and the Commission is exploring the feasibility of storage in salt mines. However, there are some problems of public acceptance even though this method has been fully endorsed by a committee of the National Academy of Sciences after prolonged investigation.

The last problem I will mention is that of the potential delays in the licensing of nuclear power plants as a result of the expanded environmental review in non-radiological areas required by the recent decision of the Court of Appeals for the District of Columbia Circuit in the Calvert Cliffs case. In addition to the immediate delays, the industry will continue to face the problem of dual or multiple licensing and regulation in non-radiological matters since it presumably will still be necessary for states, regions, and other government entities to make decisions relating to environmental impact even though the Atomic Energy Commission will have to make a complete review itself. It will take time to bring some order to this area, but we are hopeful that this will prove possible within a reasonable time. Certainly, the Commission will do its utmost in this area.

Conclusions

The ultimate importance of nuclear fuel as the principal source of electrical energy generation in this country seems pre-ordained. But it will require an almost unprecedented growth rate. Although we have begun to see this process, it will accelerate sharply in the latter part of this decade. The challenge of energy supply is real and upon us; it will demand wisdom and courage on the part of leaders in government and industry alike to develop the technologies, commit the funds, build the facilities, control the costs, maintain safety and cleanliness in the production of electricity, and furnish the electric energy that is an essential part of a flourishing society.



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June 3, 1971

Remarks by
Wilfrid E. Johnson, Commissioner
U. S. Atomic Energy Commission
before the
31st Annual Membership Meeting
of the
Northwest Public Power Association
Eugene, Oregon
June 3, 1971

PEOPLE, THE ENVIRONMENT, AND POWER

Ladies and Gentlemen:

The title of my remarks tonight as it appears on your program is "People, The Environment, and Power." Frankly, this title will probably tip you off that I am more a lecturer than a speaker - particularly an after-dinner speaker. I thought about this and wondered about changing the title to "More Power to the People." Really this is what I am going to talk about, but such a title, as you well know, could create a vision of blue jeans, beads and sandals all wrapped up in revolutionary fervor. While I believe in change and progress and relevance, just as much as anybody else, I don't think I am quite the type to go forward under a revolutionary banner or in the currently fashionable costume of the advocates of instant solutions.

Nevertheless, I am hoping that I can communicate well enough this evening to achieve some measure of understanding so that we can all focus on what some of our real problems are and perhaps stop worrying about some of the phony problems.

Communicating, of course, is not easy, but I have learned through a good deal of experience over the years that some things are almost impossible to communicate - such as a particular odor unless one has experienced it (you ladies in the audience may be able to do it), but I am at a loss for words when trying to describe Arpege perfume or to distinguish it verbally from Chanel #5. Nor do I think, if you'll excuse the pun, that this deficiency is peculiarly My Sin. Communicating the picture of an object such as a house or a floor plan can be difficult, but it generally can be accomplished. The communication of thoughts and ideas can be relatively easy and satisfying if there is a communion of the spirit between two people or in a group. On the other hand, it can be extremely difficult to have a dialogue when each of the two persons is interested only in his own point of view and his own ideas.

Talking about power and the need for it in the Northwest with an Oregonian - particularly an environmentalist - can sometimes be less than satisfying. One might like to think about spending a pleasant evening at the beach near a campfire sitting on a log with oneself at one end of the log and perhaps an environmentalist at the other, and having an interesting and fruitful exchange of ideas. Too often, however, the dialogue is not in tune and one ends up wanting to sit on the environmentalist and talk to the log, and I'm sure the environmentalist can have a corresponding urge. People in the Northwest often assume that people from the East just don't have any conception of how people in the Northwest want to live and, of course, this can be true. In my own case, however, I have lived in the Northwest for over 25 years and in Astoria, Oregon, for some ten years - and I think I do have a highly attuned sympathy for how Oregonians feel about their environment. As a matter of fact, I can still recite for you the Oregon State song.

Many Oregonians, I believe, just don't want industry, or if they want it, they want only the very light industry. Fortunately for Oregonians, up to this point in history, they can do this in their State while driving Detroit's automobiles, using gasoline refined in New Jersey or California, derived from oil wells that are drilled and operating in Texas - this because Oregon's resources do not happen to include iron ore, oil, natural gas and similar materials.

But now, it seems that some of the people in the Northwest would go so far as to do without electric power or at least propose to use much less than will be necessary in the future because they appear to think there must be a choice between electric power and the clean air, the green grass, the hemlock and the pine, and the beaches along the seashore, which I understand are still public property. While I do understand and can sympathize with these very deep-seated feelings, I find them short of logical justification.

Despite how I feel or anyone else feels, events will overtake Oregon and the major event is the growth of population which we are not able as yet to control. As people surrounding Oregon get into more congested circumstances or have to live in a more and more polluted environment, they will want to come and live in Oregon and there is no legal way of keeping them out. Then you will find that your taxes begin to increase because of unemployment payments and because larger schools are required and there will be no practical way to balance the budget without excessive taxes unless more industry is established to provide employment. This has happened in many other States and probably is unavoidable here in the long term.

This is all part of the people problem. World population growth is inevitable at least through the next 50 to 100 years and we had better prepare for it rather than just lament the circumstances in which we are going to find ourselves. Even if we Americans should limit ourselves to two children per family for the next 50 years or so (which I am willing to do), the longevity patterns would redistribute the age groups so as to substantially increase our population through the next 30 years or so. On a worldwide basis, we probably will have to accommodate 6 billion people by the year 2000 and 10 billion by the year 2050.

Obviously, the population explosion must come to an end. Either we bring it to an end intelligently and willingly, or we and our offspring will no longer inhabit the earth - we will merely infest it and sink to a low order to existence. Population control, however, is not a technological problem, although people sometimes think it is. It is a political and moral problem which reflects both very personal decisions as well as social customs and deeply imbedded cultural legacies. The population problem does, however, give rise to a large number of technological problems of which the production of power is one.

In the coming years we must use all our resources - spiritual, human, biological and material to bring about and maintain a balance between man and his environment which will not only permit us to exist but continue to give all the people the benefits of a healthful and rewarding life - and let me emphasize this cannot be merely a national objective. I am wholly convinced that this great country, the United States of America, cannot survive even if it adequately supports 300 million people in the year 2000, unless we share our means of production and distribution with all the peoples of the world who live under inferior conditions. In the last analysis, we will have to give up some of what we produce here for the benefit of others and in the interest of world peace which is, of course, in our own overriding self interest. This is a challenge which has moral and political, as well as technological and economic aspects.

Now let me talk a bit about the balancing of our own needs so that we can have what we really want and yet appreciate fully what this will require of us. Perhaps we should first of all understand that the population explosion has already taken us beyond the point of no return in this country. Despite what anyone may tell you, it is no longer possible to go back to the "good old days." If we tried to live again as the people of this country lived 200 years ago, putting a horse to the plow, raising our own produce, picking cotton and shearing sheep to obtain the fibers for clothing - carding these fibers, spinning them to make yearn or threads and processing the threads into cloth on a handloom - slaughtering the home grown cattle occasionally, saving and curing the hide, making our own shoes, and so on, we might possibly support 50 or 60 million people, As I recall there were 90 million people in this country when I came here in 1920.

When I say that we are beyond the point of no return, I mean that we cannot go back to a type of environment in which man produced his needs from the earth with a few simple, rudimentary tools and the help of animals. To do that, we would need to reduce our population by some 150 million people, and there is no way to do this without truly catastrophic social and political consequences. Most of those who long sentimentally for the return to yesteryear don't understand, I am sure, that their nostalgic longings, if fulfilled, would literally entail the price of genocide. So I think you will agree this is not a feasible approach. We will find it difficult enough to keep our population within some limit such as 300 million and to have a well balanced, rewarding type of society at that level of population. We will need appreciably more electric power than we have today - partly to provide for the increased population, partly to accommodate the anticipated improvements in living conditions that people want, and partly to clean up the environment - a subject I will stress later.

Interesting examples that demonstrate the basic need for more energy and its human significance can be visualized perhaps if I can use the concept of energy slaves. (The definition of an energy slave is the amount of energy that would be contributed by a human being used as a slave.) Even in countries that do not have as much electric power as we do, it is interesting to note that the number of energy slaves as I have defined them is about 80 per person or 400 per family in Europe, about the same as the number in the United States, whereas in Asia it is only three and in Africa only ten. This point is emphasized in a book called The Future of the Future by John McHale. Now, to consider the dimensions of the problem

we would face in going back to primitive times, assume that building an Egyptian pyramid required the work of 50 thousand slaves for 20 years, and compare this to the building of a skyscraper by 5000 people in six months (these numbers of course may not be exact). The ratio of the number of workers at a given point in construction is 10 to 1. But if the time element it taken into account, the ratio is 400 to 1. This means that it took about 400 times the amount of food to generate the manpower to build the pyramid as it took to feed the workers who built the skyscraper. This doesn't mean that we work harder today, but we do produce more with less human work, and the social and political reality is that those people who today are trapped in the cycle of boneweary drudgery will not be content until they have their own energy slaves.

Now we in the United States, being in some ways a gullible people, are apt to accept criticisms to the effect that we are extravagant in our use of power. This is not really the case. Actually, we use less power per unit of gross national product than many other industrialized countries of the world. In fact, we just about match the world average. It is true that we use more electric power than any other country - about 30 percent of the world's production of electric power even though we have only 6 percent of the people - but the secret of our success is that we have been able through ingenuity and motivation to make this power work for us very efficiently. We might note at this point that only one-fourth of the total energy consumed in this country goes to the generation of electricity, whereas many countries, including those as diverse as Japan, the United Kingdom, the Federal Republic of Germany, Australia and Brazil, to mention a few, use a much higher percentage. The significant fact is that we produce more gross national product per unit of electric energy than any other nation in the world. Every dollar spent for electric power supports, in one way or another, about $40 worth of gross national product. Many of our people seem to think that our utilization of electric power is somehow a luxury that we can do without, and the rhetoric of their argument almost always turns to minor appliances which they personally would give up - the electric toothbrush, or an extra hairdryer for the new son-in-law or a new electric guitar amplifier for the boy next door. While I am personally sympathetic to some of these rhetorical examples, we need to keep in mind that most of our electric power goes for the purpose of making aluminum, manufacturing chemicals, manufacturing high grade crucible steels, manufacturing automobiles, bicycles, refrigerators, motors, clothing, shoes, bottles, sheet steel - almost anything you can name.

Some proportion of our electric power, of course, does go for personalized consumption; electric lights, running a television set, and a large and increasing amount for air-conditioning which I can assure you is almost a necessity of life in the semi-tropical summer climate of that other Washington from which I have just come. But we should not forget that without electric power, we should not be able to go to the store and buy a suit of clothes, a pair of shoes, or for that matter, packaged food. In fact, a newspaper might be a luxury.

Beyond all this, we are getting into a situation where we badly need more electric power to clean up our environment. Apparently, many of our sewage processing plants are not doing an adequate job now and with more people the problem will not diminish; so they will need more equipment and better processing to dispose of sewage in a sanitary way. Before too long, we will be running short of potable fresh water and will have to consider recycling the water that we normally flush away as waste. In addition, we may very likely be forced into recovering fresh water from sea water. Each of these processes requires enormous amounts of energy - both thermal energy and electric energy or power. The reprocessing of solid wastes into forms that can be readily disposed of also requires energy. If we want to clean up the environment, we must consider producing steel without burning sulphur-laden coal, and there are many other processes such as the production of pulp for the paper industry that will need cleaning up. We are going to need more power, not less, to do all of this and it clearly must be done.

On top of it all, we have the problem of what to do about conserving our coal and oil for those applications such as aircraft propulsion in which no other fuel is satisfactory or for that matter conserving it for use in the production of other chemical materials such as plastics. By the way, some cleaning of the environment can be accomplished by converting coal to a gaseous fuel and we have nuclear reactors coming along (the high temperature gas-cooled reactor which your Byron Price is very familiar with) that can do this job as well as producing power without pollution. The net of this is that we can, in the next few decades, greatly improve our environment by the application of more energy and electric power in the right places and by doing such things as resorting to electric automobiles for city use with their battery power supplied by central power plants.

Of course, I would like to tell you that we should use nothing but nuclear plants in order to keep pollution down to a minimum. Frankly, there is no use in saying this because even though we bring nuclear plants on the line as rapidly as we can, it will still be necessary to double the amount of fossil fuels used for electric power by the end of this century. But there are enormous environmental incentives for going to nuclear power as much as we can. Glenn Seaborg illustrated this point by noting that under present estimates for the year 2000, if we had to rely entirely on coal for electric power, we would need 100 thousand railroad cars daily dumping coal into billions of cubic feet of storage space in order to keep the boilers fired. By way of contrast, if all the power plants were nuclear, they would burn only three tons of nuclear fuel per day (a fraction of a carload) and the individual power stations would only need refueling every one to three years.

Assuming that we can get by for the next 30 years by using resources carefully and by doing all we can to keep the environment as clean as possible, we still have to ask "what about the next 100 years?" At that time it seems that nuclear energy is the inevitable answer. Either we use nuclear energy or we go backwards, and going backwards means cataclysmic social and political upheaval around the world, not a romantic return to village life, the plow and the stars and the quilting bee. We simply cannot dismantle an industrial society and eliminate the increased population it supports for want of adequate energy supplies. This is why I can say with some confidence that the use of nuclear energy is inevitable.

Fortunately we know that the so-called breeder type of reactor is feasible and that its use can extend our energy resources for hundreds - perhaps thousands of years.

A breeding reactor is one that converts a potential atomic fuel (usually ordinary uranium) into a highly efficient atomic fuel (such as plutonium) that will burn directly in an atomic reactor. This conversion of one element into another takes place in all the nuclear reactors, but in reactors we use today the amount of new fuel that is produced by conversion is less than the amount of the original fuel that is burned while the conversion process is going on. In the breeder reactor, the amount of new fuel produced is greater than the amount of original fuel consumed, so that over a period of time, a given reactor will not only produce enough fuel to fuel itself, but enough to also fuel another reactor. This period of time is called the doubling time. If the doubling time is short enough to match, or be less than, the doubling time for the demand of electric energy capability, the breeder reactor could keep pace with the total energy demands of society.

However, it will not have to do this immediately after its introduction, because when it comes into commercial use (around 1985) there will still be a large number of light water reactors producing plutonium which can be used as fuel in the breeders.

Beyond the breeders, there is the fusion reactor which we are not likely to see in any commercial sense for the next 30 years or so. But it will come. It's fuel (deuterium) is present in abundance in the oceans of the world; so if we can succeed in making use of this process in a controlled and reasonably efficient way, energy supplies will be available to man for thousands of years.

The availability of unlimited energy supplies means that for the first time in the history of this planet, every man and woman can have slaves - energy slaves - almost without limit. The wars and social disruptions mankind has endured have all too often been struggles to possess the larger share of a limited abundance. The glory of Athens, and the freedom of the elite members of its population, were purchased by the labor of thousands of slaves. We stand on the threshold of a change in this dreary cycle. With an abundance of energy within man's grasp over the next hundred years, the physical and material basis for a world of peace is presumably in sight. "Power to the People," in the true sense of representing the dominion of every man over the supply of his own wants, is a slogan foreshadowing reality. But whether it shall do so is of course up to us today. We must choose either to increase our energy supply to satisfy the growing human family, or we can limit our energy supply and accept the privation this will entail. The issue is at last a moral one.

If we choose wisely and I believe we shall, it would be folly to suggest that material abundance - an army of energy slaves - will constitute a return to the Garden of Eden - that most nostalgic vision of Western man. For in the final sense even then, the challenge will be as it is now, a moral and political one. In an age of plenty, men will still be obliged to contribute from themselves to one another those qualities of spirit, of art, of generosity, and of intuition that make the human environment prized beyond its material conveniences and treasures.

Let us remember that the abiding truth of creation is that man, and all life, is fundamentally spiritual in nature. The material aspect of man vanishes under the electron microscope, and as we search ever deeper into the structure of our own being, we find less and less that can, in even a remote sense, be called material. We are, in fact, spirits in a real and measurable sense. There is less than one cubic inch of identifiable matter in all the people in New York City - yet we feel so solid, so serene, until that last moment when perhaps we know that we are mortal and we feel the presence of a supreme being.

What then is our problem? How are we to live together in these beautiful green spaces, between the snow capped mountains, along the streams, and on the ocean shore? In my view, we must begin to reconcile our material lives - governed largely by technology - with our spiritual lives - and we simply must do a better job of it than we have been doing lately.

STATEMENT SUBMITTED TO THE JOINT COMMITTEE ON DEFENSE PRODUCTION BY JOHN CIBORSKI, PRESIDENT OF TITANIUM METALS CORP., SEPTEMBER 21, 1971

The titanium industry of the United States is in dire straits, and if appropriate action is not taken, we may find ourselves totally dependent upon Russia and Japan which may not then desire to sell to the United States. The total domestic capacity for titanium sponge is approximately 48 million pounds per year. This capacity is distributed as follows:

TMCA (Titanium Metals Corp., New York, N.Y.), 28 million.
RMI (Reactive Metals, Inc., Niles, Ohio), 15 million.
ORMET (Oregon Metallurgical, Albany, Oreg.), 5 million.

Of the above, TMCA and ORMET have already shut down sponge production facilities. RMI is operating on a reduced schedule, and unless the situation improves drastically, it is also scheduled for shutdown in January 1972.

The financial losses for all companies for the past 4 years threaten permanent shut down of the entire industry. The continued losses have proven too much for the sponsor parent companies, which have subsidized the industry through its development stages for many years. In 1966, under the encouragement of the aircraft industry, the Department of Defense, the Federal Aviation Administration, and the Materials Advisory Board, plus the benefits of industry's own forecast, the industry expanded from 30 million pounds of sponge a year to 48 million, using private capital. However, increased utilization of the material has not taken place, and instead, consumption has been reduced to 1965 levels. The chief factors responsible for this are: the cancellation of the SST, the low level of commercial aircraft purchases, the low level of military aircraft procurement, and the importation of Japanese and Russian sponge for domestic consumption. Thirty percent of the sponge utilized in this country is of foreign origin. The industry has only operated at less than 43 percent capacity, which is uneconomical.

The defense aircraft titanium requirements have actually increased on a unit consumption basis. For example, current aircraft, such as the F–105, F–8, and F–100, each use approximately 8- to 10-percent airframe weight of titanium.

In contrast, the newer aircraft will use substantially greater quantities of titanium. For example, 25 percent of the airframe weight of each Grumman F–14 is titanium, representing a purchased weight of 40,800 pounds of titanium mill productions per aircraft. Thirty-one percent of the airframe weight of each McDonnell-Douglas F–15 is titanium, representing a weight of 56,700 pounds of mill productions per aircraft. Twenty percent of the airframe weight of each North American Rockwell B–1 is titanium, representing a byweight of 128,500 pounds mill productions per aircraft. In addition, 6,000 pounds of titanium productions are used in each defense aircraft engine associated with these airplanes. The actual military requirement per unit is, therefore, increasing rather than decreasing.

Unless some help is forthcoming in the near future, the industry may be forced to shut down, resulting in future military requirements being furnished by imported Japanese and Russian sponge, if available.

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