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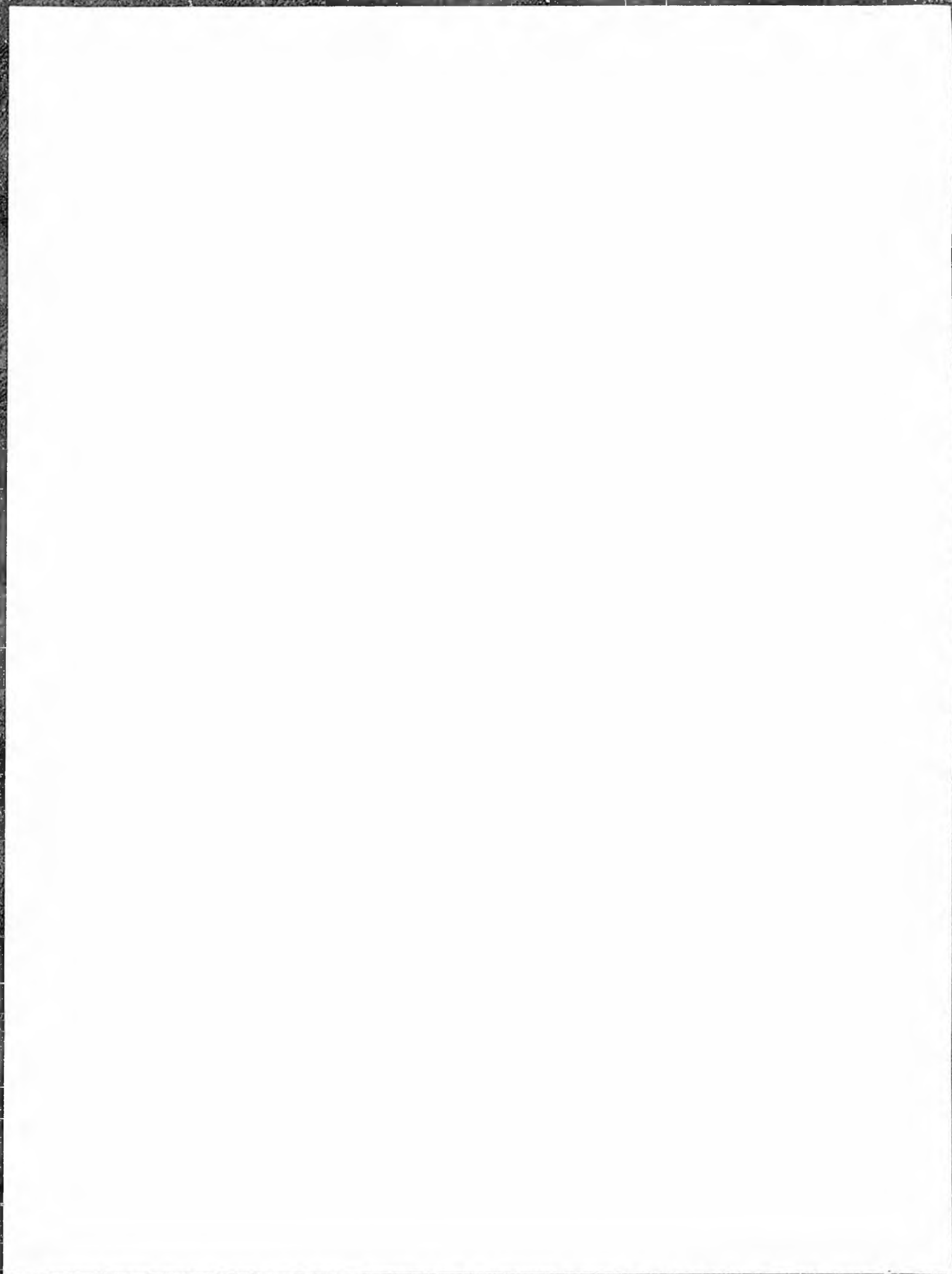
CURRENT AND PROJECTED NUCLEAR ACTIVITIES
IN THE MEMBER WESTERN STATES



June 1971



NUCLEAR ENERGY IN THE WEST



Nuclear Energy in the West

CURRENT AND PROJECTED NUCLEAR ACTIVITIES
IN THE MEMBER WESTERN STATES

JUNE 1971

WESTERN INTERSTATE NUCLEAR BOARD

COVER PHOTO: Model of Diablo Canyon-1
and -2 Nuclear Power Plants on Pacific Coast,
12 miles S.W. of San Luis Obispo, California.

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May 15, 1971

Dr. A. T. Whatley, Executive Director
Western Interstate Nuclear Board
P. O. Box 15038
Lakewood, Colorado 80215

Dear Doctor Whatley:

I am pleased to submit the attached report in fulfillment of our agreement of January 25, 1971. This documentation of the nuclear involvement of the Western states was a healthy exercise. It is recommended that a similar study be conducted in another five years to record progress and refine the state needs.

I believe that the deliberate efforts of the Western Interstate Nuclear Board can significantly affect the nuclear progress in the member states. Since many of the problems and opportunities are characteristic of regions within the West, WINB can address itself to the needs of these regions by use of committees as suggested in Section VII. Although the Board needs to establish the priorities for action, the item of public understanding appears to be a paramount requirement for ready development of nuclear ventures in many of the Western states. The misapprehension regarding nuclear energy will require considerable effort on the part of WINE members and staff to permit the true merits of nuclear progress to be realized.

In conducting this study, I have interviewed over seventy informed persons in the state governments and reviewed many pertinent reports and records. The interviews assisted greatly in learning about previously unpublished plans and of the public apprehension to nuclear developments. It is significant to note that the three states that have participated the most in nuclear energy during its experimental stages are the states most eager to bolster their economy with more nuclear programs. These include California, Idaho and Washington.

I have appreciated the opportunity of conducting this study for you, and will be looking forward to witnessing some planned progress for nuclear energy in the West.

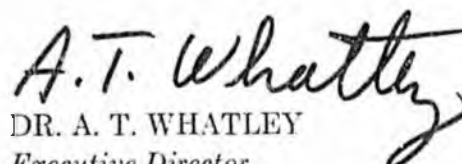
Very sincerely,

Lawrence E. Wilkinson, Director
Nuclear Division

LEW:ac

Acknowledgement

THE WESTERN INTERSTATE NUCLEAR BOARD wishes to acknowledge the assistance of the many state officials that gave freely of their time to produce this original documentation of the current status of the nuclear involvement of their respective states, and for their vision in predicting the progress and related challenges of the future.


DR. A. T. WHATLEY
Executive Director,
Western Interstate Nuclear Board

Foreword

The West is characterized not only by large open spaces, but also by a modern approach to civilization. The people and the state governments in the West are not encumbered by a massive inertia for change but are, instead, challenged with how to build a better America based on technology and natural resources. Therefore, it should be no surprise that nuclear energy should be the choice in the West to utilize the vast resources and to assist in the creation of a quality life. The state governments of the Western states are interested in planning for the development of nuclear energy and regulating its use to be sure that wise stewardship of the state's resources prevail, including the health and safety of the citizens and the protection of the natural environment.

The Western states recognized, at the 1966 Western Governors' Conference, that there would be strength in working collectively on nuclear opportunities and problems. From this Conference, the Western Interstate Nuclear Compact was spawned. In 1968, the Compact was organized; in 1969, an Executive Director was appointed; and in 1970, the Compact was recognized by the U. S. Congress.

This report is a compilation of the nuclear involvement of the member states of the Compact at the beginning of 1971. Within this decade the citizens of the Western states will witness the energy of the atom at work in the West—generating electricity, unlocking underground resources and becoming an even more significant tool for medical diagnosis and therapy. During the 80's, more advanced applications of nuclear energy are expected in the West with multi-purpose applications, including desalinization.

Sound guidance and regulation by the state governments to foster the wise use of the nearly infinite energy of the atom should help to keep the West a place where both man, technology and nature can proceed harmoniously.

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NUCLEAR ENERGY IN THE WEST

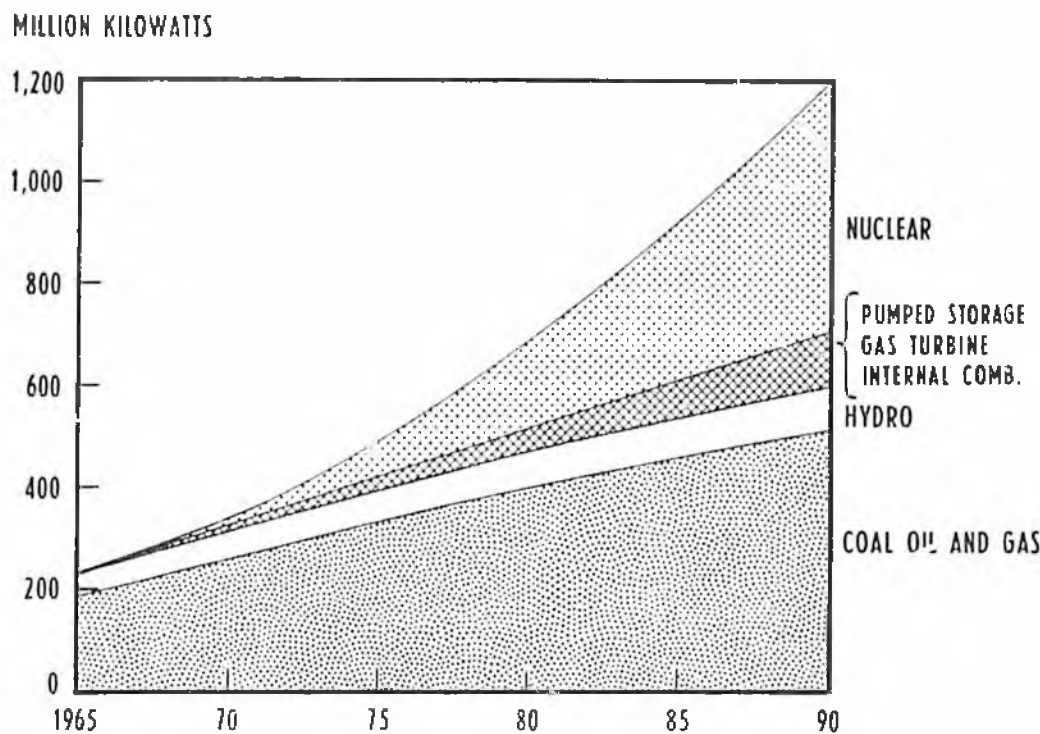
I. INTRODUCTION

Eleven states are joined together in the Western Interstate Nuclear Compact to foster commercial and industrial progress in the West through proper employment of technology in the nuclear field. As provided in the Compact, the Western Interstate Nuclear Board was created to conduct the affairs of the Compact. In order to perform its function in an orderly manner, the Board determined that a study should be conducted to document the nuclear involvement of the member states both now and as they are expected to evolve in the next 5, 10 and 20 years. This report represents the result of the study.

Since use of nuclear energy for the generation of electrical power will be the principal nuclear activity in the West, special emphasis was provided in this

area. Included is consideration for the general growth of nuclear power in the U. S. (*Figure 1*) and how it will affect the Western production of uranium and products containing uranium. Particular emphasis is given to how alternate energy sources such as coal, oil, gas and geothermal will affect the need and location of nuclear power plants. The problems and opportunities associated with nuclear plant siting are covered in some detail since proper siting is so important to public acceptance of this new technology.

Other areas covered in the study are the radiation protection and environmental control programs of the member states. In many cases different approaches have been tried to solve the same problem. The collective force of the Compact is of value in examining



FORECAST ELECTRIC GENERATING CAPACITY IN THE UNITED STATES

Figure 1



NUCLEAR ENERGY IN THE WEST

II. SUMMARY AND CONCLUSIONS

The West has been very much involved in the nuclear energy developments of the United States since 1942. Much of the nuclear industry has located in the West to utilize the uranium resources and others to employ the technologists that have developed nuclear expertise at federal installations in the West. The rapid population growth of the West and the advent of commercial nuclear power plants have brought both problems and opportunities to the state governments of the West. This report has reviewed the needs, desires and actions of the member states in meeting their obligations in the nuclear field. In addition, the report identifies the items that warrant action by the Western Interstate Nuclear Board.

The most significant conclusions from the study are:

1. The development of nuclear energy in the West has matured to a point in which all member states can benefit—each in a different way. The coastal states will benefit from the electrical power that will be generated with a relatively small amount of pollution. The Rocky Mountain states will benefit by the added uranium processing and stimulation of natural gas reserves through underground nuclear detonations. The states that share the desolation of the Great Basin are especially well suited for fuel reprocessing, radioactive waste management, and isotope recovery.

2. Nuclear energy is still mysterious to millions of citizens in the West. The public is eager to become better informed and more involved. A better mechanism is needed for the public to

achieve an understanding and thence enjoy the benefits instead of simply sharing the risks.

3. Standards are not uniform throughout the West. Variations exist on a) permissible radon concentrations for uranium miners, b) burial containers for radioactive waste, c) emergency action response patterns in the event of a nuclear incident, and d) environmental radiological monitoring.

4. Of the states that will not need nuclear power plants for decades due to an abundance of underground resources, Plowshare techniques are of interest for stimulating recovery of these resources.

5. Of the states that will need nuclear power plants within the next two decades, the approach by each to nuclear plant siting is different. A continued close association among these states is desirable to share the strengths and overcome the weaknesses of each approach.

6. Of the states that contemplate utilization of Plowshare techniques, a mastery of several disciplines is necessary within the state governments including a) environmental radiological monitoring for safety assurance, b) social needs of affected communities, and c) economics of early recovery from a large investment. Without a complete understanding of the full benefits and risks, the state governments cannot expect to cope with the emotions that such a sophisticated technology can test.

CORRECTION

**THIS DOCUMENT
HAS BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY**



NUCLEAR ENERGY IN THE WEST

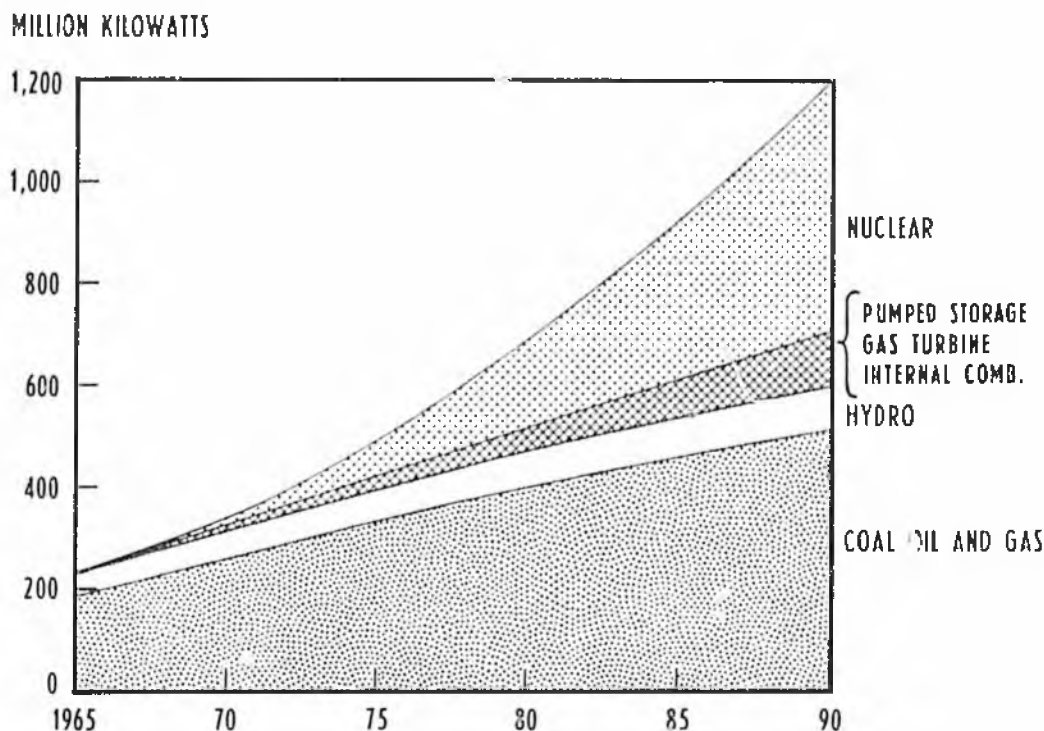
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FORECAST ELECTRIC GENERATING CAPACITY IN THE UNITED STATES

Figure 1

the trials and to summon strength at a federal level if necessary to assist the states to perform their functions in this new field.

The growth rate and resources of the states are presented as background material to prepare the reader on the importance of proceeding with nuclear power plants in some states. Examination of the environmental impact of both the nuclear and fossil fuel plants was in keeping with the national em-

phasis of the seventies.

Finally, the major desires of the member states are expressed in regard to their future nuclear involvement. The problems that need the attention of WINB are tabulated for easy assignment of priorities. Action by the Board can solve many of these problems and can assist the safe and orderly development of nuclear energy in the West.



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The West has been very much involved in the nuclear energy developments of the United States since 1942. Much of the nuclear industry has located in the West to utilize the uranium resources and others to employ the technologists that have developed nuclear expertise at federal installations in the West. The rapid population growth of the West and the advent of commercial nuclear power plants have brought both problems and opportunities to the state governments of the West. This report has reviewed the needs, desires and actions of the member states in meeting their obligations in the nuclear field. In addition, the report identifies the items that warrant action by the Western Interstate Nuclear Board.

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NUCLEAR ENERGY IN THE WEST

III. NUCLEAR ENERGY DEVELOPMENTS AND GROWTH

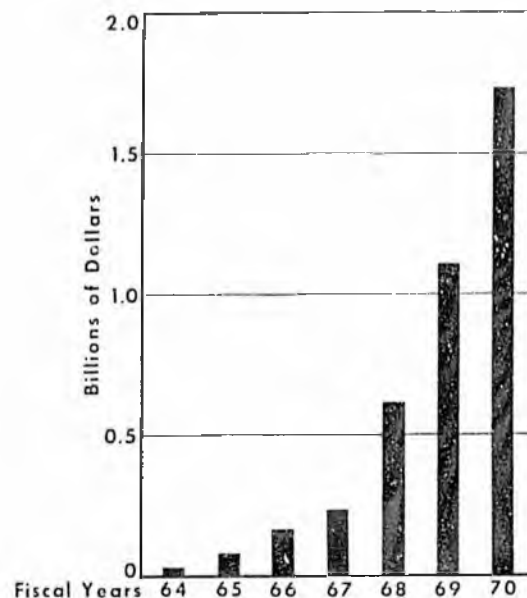
A. National and International Scene

During the past 25-30 years, the United States has been hard at work developing nuclear power into a viable new energy source. The 1960's were marked with a self-sufficient domestic nuclear power industry capable of serving both domestic and international markets. The U.S. nuclear industry is clearly a world leader in the development of safe and reliable central-station nuclear power plants.

Figure 2 displays the growing acceptance of nuclear power by the U.S. utilities. The nuclear industry is already a multi-billion-dollar business. Cumulative orders to June 30, 1970, exceed \$15 billion. In 1970, 54 new central-station nuclear power plants

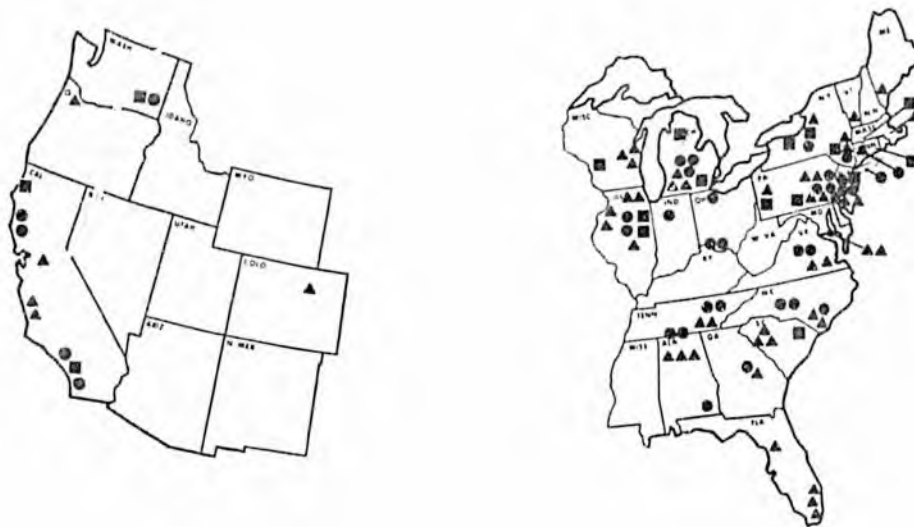
were under construction in the U.S. Figure 3 shows that nuclear power plants are by no means unique to the West. The Northeast and the Southeast are putting the atom to work in a big way. In other industrialized nations such as Great Britain, Germany, France, and Japan, nuclear power is becoming a very acceptable form of electrical generation. Nuclear power plants have been ordered for Belgium, Brazil, India, Italy, South Korea, the Netherlands, Spain, Sweden and Switzerland. Taiwan recently ordered a second nuclear power plant. In total, sales of U.S.-type reactors abroad has amounted to \$5 billion.

Besides the nuclear power for electrical power generation, nuclear energy is being utilized nationally



UTILITY CONSTRUCTION EXPENDITURES FOR NUCLEAR POWER

Figure 2



Legend

| | W.I.N.C. MEMBER STATES (4-30-71) | STATES EAST OF MISS. RIVER (9-30-70) |
|---------------------|----------------------------------|--------------------------------------|
| ☐ Operable . . . | 3 | 14 |
| ▲ Being built . . . | 5 | 44 |
| ● On order . . . | 5 | 32 |

NUCLEAR POWER PLANTS

Figure 3

and internationally in the form of isotopes for medical and industrial uses. Medical uses of isotopes have continued to expand at a steady rate for diagnosis, treatment and research. During 1970 alone, the sale of basic radioisotopes, radiochemicals, sealed sources and radiopharmaceuticals totaled \$59 million. Industrial applications continue to include primarily thickness and density gauges but are now also being extended into gauges for pollution control techniques and medical instrument sterilization. Greater use of isotopes for monomer polymerization, sewage treatment or food preservation could cause the \$300 million industrial isotope industry to take a bold increase.

Another active use of nuclear energy has been in connection with the Plowshare program. Plowshare techniques utilize the energy from nuclear device detonation. Since this is still a new engineering tool, its use has been limited to remote areas—primarily in the West and in parts of Russia. Since domestic supplies of natural gas and oil are of interest nationally, a continuing program has been funded to determine the degree of enhancement attainable from our underground fuel reserves by using Plowshare techniques. The Project Gasbuggy in New Mexico has demonstrated an improvement in natural gas production by a factor of six to seven. The latest detonation was for Project Rulison in Colorado. Improvement factors in natural gas yield are not yet available from Rulison. New projects are planned in Wyoming

gas fields and Utah oil shale fields. If the supply of natural gas continues to decrease and the price of oil continues to increase, large scale use of Plowshare techniques may become necessary and desirable.

B. Western Region Status

The Western states that comprise the Western Interstate Nuclear Compact comprise over 45% of land area of the United States. Within this region, a wide diversity of energy sources prevails. Alaska has yet untapped reserves of hydro power. Nevada and Utah have untapped geothermal power. The Rocky Mountain states have abundant quantities of the least expensive coal in the United States (@ 14¢/million BTU's). The southwestern states have been blessed with oil and natural gas for fuels and the Northwest has a monumental series of hydro power projects on the Columbia River.

Modern industries and a high standard of living in the growing West are compounding the demands for more electrical power. This growth is changing some traditional dependence on district resources. The Northwest is discovering that the hydro projects will not meet all the growth needs of the region and are, consequently, preparing for the addition of thermal power plants.

The Southwest is discovering that their traditional oil is too high in sulfur content and that their supplies of natural gas are only adequate in the summer for

meeting the sustained growth in their region. The vast coal fields in the Rocky Mountains are limited by available cooling water and the long distance for transmission to most of the load centers in the West. The coal-burning utilities in the Four Corners area of New Mexico are finding a new limitation (i.e. the patience of the environmentalists in one of the truly unique geological parts of the West). The ability to continue to build and operate large coal-fired plants in the Four Corners region will depend on technology not yet developed. It may require five or more years to determine how extensive the power production will be in that area.

Meanwhile, nuclear power has been ordered in each of the coastal states to help meet the growing demands for more electrical power. A Washington utility has recently ordered its second nuclear-powered generating station. Oregon's first nuclear power plant is scheduled to start operation in September 1974. California has two nuclear power plants in operation and two more being built and three more on order.

Other Western states are beginning to look beyond their five- and ten-year plans to determine when they will need to be ready for their first nuclear power plant.

With the exception of the coastal states, Colorado is the only other state that is currently constructing a nuclear power plant. However, by the end of the century, Wyoming may be the only state without one. The vast coal fields in Wyoming are nearly beyond belief. And in Wyoming the first dry cooling tower in the Western hemisphere is installed and operating.* Electrical energy should never be short in Wyoming.

It is estimated by the Western Regional Advisory Committee to the Federal Power Commission that the current power load in the West of 54,035 MW will be quadrupled by 1990 to 216,140 MW. Roughly one-half of the new generation could be expected to be nuclear.

This growth of nuclear power in the West together with the fact that over 90% of the U.S. uranium reserves are in the West makes the Western Region very much involved in the nuclear-oriented growth of the United States.

C. Geographic Significance

The Western states represent a region of the United States that is growing in population at a greater rate than any other region. The predominance of the growth is in the Southwest and along the Coast. Interior regions of the West seem to grow most rapidly in urban areas such as the Wasatch Front in Utah, the Front Range in Colorado and the Rio Grande River Basin in New Mexico, and near the metropolitan areas of Phoenix and Las Vegas. With

the continued urbanization of the West, a large fraction of the large land area is available for a multitude of possibilities. None of the possibilities is more real than the need to meet our growing demand for electrical power.

Rather than locate nuclear power plants at random in the large open areas of the West, there are thoughts of locating in areas of special resource significance. These resources could include agricultural lands that could beneficially use heated effluents, proximity to salt water bodies that have a market for desalinized water, labor pools from artificially created "model cities" etc. This is referred to herein as "opportunity siting". By making an overt effort to locate where a multiple use opportunity exists, the nuclear plants can stretch the resources available in the West and help to provide job opportunities in areas of the West that have suffered the most from the mechanization of the western agriculture and mining industries.

Where some resource utilization has been held back simply by lack of a fuel source, the model cities with a nuclear-industrial complex can be created to utilize the area's resources and provide surplus electrical power to distant load centers. The ability to find and utilize such opportunities in the West will help to stem the foreboding trend towards over-urbanization.

Many Western states have a power load of only one or two thousand megawatts for the entire state. The addition of a 1000 MW unit could not be readily accommodated in these states for about 20 to 30 years. Additions of suboptimal units of 300 to 600 MW could possibly be justified within 10 to 20 years if a multi-purpose project is created to compensate for the incremental cost of power.

Many load centers in the West are geographically unsuitable for burning any more fossil fuels. For this reason, California is making a strong move towards nuclear power. Great Britain has demonstrated the ability to use nuclear power to improve on an adverse air quality situation. Since many persons choose to live in the West for reasons of good air quality, the geographic sentiment is expected to be towards nuclear power whenever it can be justified economically.

Finding a "satisfactory" location for a nuclear power plant site in the West is not difficult. Finding the "best" location is the difficulty. Since economics suggest that the plant be located near the load center and emergency planning would suggest a more remote location, the balancing rationale begins to get difficult.

Most Western states have more than an adequate amount of remoteness for the safe location of most any nuclear activities. Each state, however, has its own ideas and qualifications regarding the specific part of the nuclear industry for which it is best suited. These desires and opportunities are more fully

* Nell Simpson plant near Gillette, Wyoming.

discussed in the section on Individual State Actions and Plans.

D. Economic Indicators of Growth

Many parts of the nuclear industry are located in the West. None are more characteristic of the growing need for nuclear power than the uranium industry. A review of the forecasted need* for uranium in its final form shows that a billion dollar market will exist by 1975 and a \$2 billion market by 1980. The production of nuclear power plants and the reprocessing of spent fuel are in addition. The fuel cycle is shown schematically in figure 4.

Ore Production

One of the large contributions made to the nuclear industry by the Western states is the production of uranium ore and the consequent milling to "yellowcake" (U_3O_8). At the end of 1970, the U.S. Government backed out of the market place where it had been the principle buyer since 1942. The government-guaranteed buying price of \$6/lb. was not immediately supported by industry, but the price is expected to increase to \$8/lb. as the power plants start coming on line. Even at \$8/lb., the presently known reserves are inadequate to meet the domestic market needs. The weak reserve situation has made additional exploration necessary. Such an event was

* *The Nuclear Industry—1970*, U.S. Atomic Energy Commission, November 18, 1970.

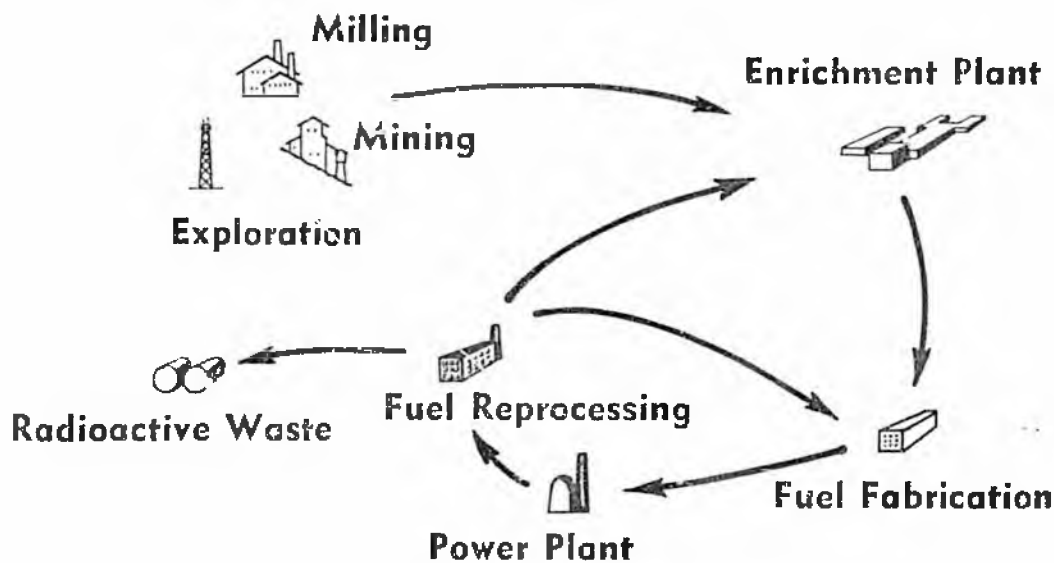
witnessed in 1969 with a record exploration rate of 29.9 million feet of drilling in 76,000 holes. This compares with 23.8 million feet in 58,000 holes in 1968, and 2.1 million feet in 1965.

The uranium milling operations are in the process of being tooled for the future also. Table 1 shows the new additions planned for 1971 and 1972. The temporarily weak market condition that existed in 1970 caused some uranium mining and milling operations to be at partial capacity or on standby conditions. The domestic uranium market is expected to grow in 1972 to exceed 12,000 Tons U_3O_8 /year. By 1980 it should be 34,000 Tons which, at \$8/lb., becomes a \$544,000,000 industry.

Uranium Enrichment

To make the uranium useful in modern power plants, the normal U-235 isotope content in the uranium must be increased severalfold. This is referred to as an enriching process. To accomplish this act, the AEC has traditionally converted the U_3O_8 into a hexafluoride, UF_6 . The hexafluoride is then passed through a gaseous diffusion plant. For power reactors, the enrichment is increased from 0.711% by weight to between 2 and 4%.

Kerr-McGee opened a plant in Sequoyah, Oklahoma, during 1970 that will convert 5,000 Tons/year of uranium to hexafluoride. A doubling of the capacity is expected by Kerr-McGee when the market warrants it. Another plant owned by Allied Chemical



NUCLEAR FUEL CYCLE

Figure 4

Corp. operates south of Chicago. Allied's capacity is already at 10,000 Tons/year. Other U.S. companies are considering entry in to the UF₆ conversion field which will amount to a \$70 million annual market by 1980.

After conversion to UF₆, a much more expensive portion of the enrichment process begins. This is the separative process that increases the U-235 content in some of the feed stock and reduces it to about 0.2% U-235 in the tails. This portion of the enrichment process constitutes one-third of the total fuel costs for a nuclear power plant. The current Free World demand in 1970 is \$130 million but is expected to grow to \$500 million in 1975 and \$1.1 billion in 1980.

Early in the Manhattan project, the U. S. Government built gaseous diffusion plants on a large scale. These plants, though relieved now from weapons production, will not be able to meet the rising demands for separative work after 1978 unless improvements and upratings are made to the existing plants. Even with a \$490 million improvement and a \$129 million uprating, the existing plants will not be able to meet the needs of the nuclear industry after 1980.

Table I

Existing and Scheduled Uranium Milling Companies and Plants in the U.S.

| Company | Plant Location | Nominal Capacity Tons Ore Per Day |
|--|--------------------------|-----------------------------------|
| <i>Existing:</i> | | |
| The Anaconda Company | Bluewater, N. M. | 3,000 |
| Atlas Corporation | Moab, Utah | 1,500 |
| Cottor Corporation | Canon City, Colo. | 450 |
| Dawn Mining Company | Ford, Wash. | 500 |
| Federal-American Partners | Gas Hills, Wyo. | 950 |
| Kerr-McGee Corporation | Grants, N. M. | 7,000 |
| Mines Development, Inc. | Edgemont, S. D. | 650 |
| Petrotomics Company | Shirley Basin, Wyo. | 1,500 |
| Susquehanna-Western, Inc. | Falls City, Texas | 1,000 |
| Susquehanna-Western, Inc. | Ray Point, Texas | 1,000 |
| Union Carbide Corporation | Uravan, Colo. | |
| Union Carbide Corporation | Rifle, Colo. | 2,000 |
| Union Carbide Corporation | Gas Hills, Wyo. | 1,000 |
| United Nuclear-Homestake Partners | Grants, N. M. | 3,500 |
| Utah Construction & Mining Company | Gas Hills, Wyo. | 1,200 |
| Western Nuclear, Inc. | Jeffrey City, Wyo. | 1,200 |
| <i>1971:</i> | | |
| Utah Construction & Mining Company | Shirley Basin, Wyo. | 1,200 |
| <i>1972:</i> | | |
| Continental Oil Company--Pioneer Nuclear, Inc. | Karnes County, Tex. | 1,700 |
| Humble Oil & Refining Co. | Powder River Basin, Wyo. | 2,000 |
| Rio Algom Mines, Ltd. | Near Moab, Utah | 500 |
| Total | | 31,850 |

The federal separation plants are all located in the East in areas of rapidly rising power costs and

an area short of generating resources. The 2,000 MW (e) destined for the separation plants in 1970 needed to be reduced one third to permit New York and other eastern and midwest areas to retain their grid voltages. By 1978, these three separation plants will be seeking 6,000 MW (e).

It has been contemplated for a number of years how private industry and other nations can enter the enrichment portion of the fuel cycle including the expensive separation process. Millions of dollars have been invested internationally on alternate systems for accomplishing the modest enrichment needed for nuclear power plants. These include a jet-nozzle process developed by Professor Becker in Germany and a gas centrifuge under development in a number of countries (including the U. S.). It is possible that a commercial separation plant might use a combination diffusion and then centrifuge system.

It is also likely that a commercial plant would look to an area of the country in which low cost electrical power is available and reliable. The very high capital cost associated with a diffusion plant would necessitate a reliable power supply to maintain the high duty factor required to remain competitive. The current average cost of power for the diffusion plants is now 4 mils/KWH but expected to increase to 5 mils in the foreseeable future. This 25% increase in power cost will constitute a 15% increase in the separation cost.

At the rate of growth in the demand for separation services two to five new separation plants will be needed in the 1980's. Each plant would need a capacity of about 8.75 million separation work units* and would cost approximately \$880 million if the diffusion technique alone was used. If the improvements and upratings of the federal installations were not undertaken, at least one new plant would have been needed at the end of 1978.

Factors that influence the total number of separations plants needed include extent of acceptance of plutonium recycle, advent and growth of breeder reactors and the long-term growth of the electrical energy market.

One issue that needs to be settled is how the federal installations will be turned over to private industry in a fair and equitable manner. This subject is covered in detail in a document entitled "Selected Materials Concerning Future Ownership of the AEC's Gaseous Diffusion Plants", Joint Committee on Atomic Energy, available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402 (@ \$2). When this issue is settled, it may become more clear who would be interested in building the new plants. Locations in energy centers such as Wyoming and other Western states should certainly be considered.

* A separation work unit is a measure used to quantify the product of kilograms of uranium and the degree of separation from the depleted tailings.

Fuel Fabrication

The final step in the processing of uranium for nuclear power plants is fabrication of the fuel into its final form. This step, like the separation phase, is an expensive stage. With fabrication, the cost is primarily due to the labor involved. Many companies have been competing in this field and more are expected to as the orders for reload fuel become a larger fraction of the business. Several Western states would welcome this type of operation since it is a good work base and is a non-polluting industry. Currently there are four fuel element fabrication plants in the West.

Of the four fuel fabricators already in the West, three are located in California. These include Atomics International, General Electric Co. and Gulf Energy and Environmental Systems. The fourth fuel fabricator is Jersey Nuclear Co. currently building as part of the Nuclear Park complex at Richland, Washington. There are 27 locations in the Eastern half of the United States that host fuel fabrication plants.

The market for fuel fabrication is expected to grow from \$74 million in 1970; to \$279 million in 1975; to \$541 million in 1980. In addition to providing a clean manufacturing industry, auxiliary services such as testing laboratories, clad manufacturers etc. can be supportive.

There are many specialty fuels that represent

sizable markets also. These include test reactor fuels, plutonium recycle fuels, fast breeder reactor fuels etc. These and foreign fuel markets were not included in the above amounts.

In summary, the fuel cycle market for central station power plants in the U. S. alone is shown in figure 5 and table 2.

Table 2

Estimated Nuclear Fuels Market in U.S., \$ Millions

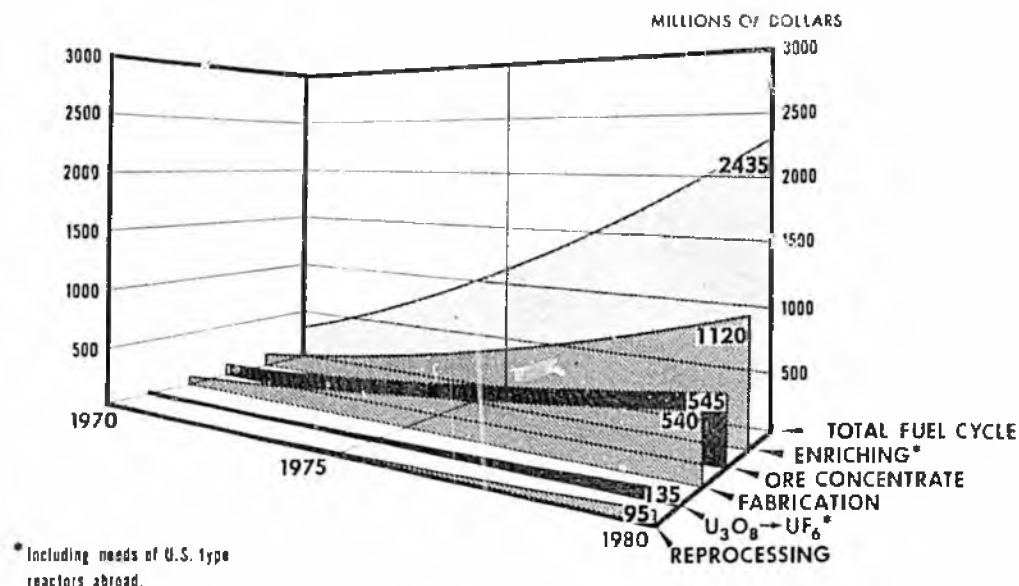
| | 1970 | 1975 | 1980 |
|--|-------------|---------------|---------------|
| Uranium Ore Mining and Milling | 120. | 272. | 544. |
| Ore Concentrates \rightarrow UF_6 | 18. | 33. | 70. |
| UF_6 \rightarrow Enriched Fuel | 130.* | 500.* | 1,100.* |
| Enriched \rightarrow Fabricated Fuel | 74. | 278. | 541. |
| Total | 342. | 1,084. | 2,255. |

* Includes needs in balance of free world which is less than equal to U.S. needs.

The fuels market is clearly a growth industry. Its origin in this nation is in the West. An increasing fraction of the growth is in the West. With the potential of some Western states to deliver nearly unlimited amounts of electrical power, the new diffusion plants should be considered for location in the West.

E. Nuclear Power Plant Safety

The safety record of central-station nuclear power plants in the United States has been outstanding.



NUCLEAR FUEL CYCLE--PREDICTED ANNUAL MARKET

Figure 5

There has never been a radiation injury to either the public or to any worker from a central-station nuclear power plant. The nuclear industry's overall industrial accident experience, including all types of conventional accidents, has been lower (by a factor of three) than the overall rate reported by 41 major industries. The radiation exposure received by the general public as a result of central-station nuclear power plants has been kept to a very small fraction of that allowed by federal regulations. The continued safety of the nuclear programs in the United States will depend on a strong base for design decisions and construction quality. In addition, operational procedures and regulation will need to be based on experience and wisdom.

There has never been an industry in the history of the United States that has been more aware of the necessity for safety planning. From the start of the Manhattan project, safety procedures were instituted and followed. Throughout the development of nuclear power plant concepts the emphasis was on how to reduce the risks to both the plant and to the public. Now with the advent of commercial nuclear power plants, the safety programs are continuing in the form of refinements to compensate for the growing size and number of central-station nuclear plants.

The nuclear safety review begins with:

1. Plant siting to be sure that the designers can adequately cope with the location.

2. Redundancy of vital systems so that the plant can continue to operate as designed despite any single malfunction or be shut down safely.

3. An extensive quality assurance program involving the procurement and fabrication of all vital plant equipment. This program continues throughout the construction of the plant.

4. An extensive in-service testing schedule and inspection program to assure that vital components and systems are operable when needed.

5. Technical specifications governing the reactor operation to assure that safety limits are not exceeded.

The nuclear safety review is a never-ending process in the search for even better engineered safeguards and operating procedures. The AEC currently is funding a \$35 million per year program for the design of better equipment. The nuclear plant manufacturers are in competition to sell plants with the greatest reliability. The utilities that operate the plants are ultra-conscious of their social obligations to operate a plant that will remain a credit to the community in which they serve.

The accident analysis required to obtain an operating license must show that the maximum consequences of an accident will result in less than a lethal exposure to the public even if they were standing at the most unfavorable point on the site boundary. There are accepted routine risks to the public that are of similar consequence e.g. the collapse of bridges, railroad crossings etc.



NUCLEAR ENERGY IN THE WEST

IV. GROWTH PATTERNS IN THE WEST

A. Population

The population of the West is growing at a rate significantly greater than the national growth rate. It is not possible to accurately predict population of the states more than a few years in advance. The most defensible basis for making a ten-year forecast seems to be by observing growth over the past ten years. Table 3 is an historic record of growth of the member states over the past ten years.

Table 3
Population of Western States

| | 1960(a) | 1970(a) | Est. 1980(b) |
|------------------|------------|------------|-----------------------------|
| Alaska | 226,167 | 302,173 | 329,000 to 367,000 |
| Arizona | 1,302,161 | 1,772,482 | 2,244,000 to 2,469,000 |
| California | 15,717,204 | 19,953,134 | 25,343,000 to 27,742,000 |
| Colorado | 1,753,947 | 2,207,259 | 2,404,000 to 2,588,000 |
| Idaho | 677,191 | 713,008 | 767,000 to 827,000 |
| Nevada | 285,278 | 488,738 | 644,000 to 701,000 |
| New Mexico | 951,023 | 1,016,000 | 1,277,000 to 1,384,000 |
| Oregon | 1,768,687 | 2,091,385 | 2,257,000 to 2,414,000 |
| Utah | 890,627 | 1,059,273 | 1,249,000 to 1,351,000 |
| Washington | 2,853,214 | 3,409,169 | 3,366,000 to 3,600,000 |
| Wyoming | 330,066 | 332,416 | 361,000 to 387,000 |

(a) Bureau of the Census Final Population Counts, PC (V 1) 2 February 1971.

(b) U.S. Bureau of the Census Current Population Reports, Series P-25 No. 375 "Revised Projections of the Population of States: 1970 to 1985", U.S. Government Printing Office.

On a percentage basis, Nevada has increased the most. This is recognized as desirable by the current state administration and another comparable increase is sought for the next ten years. With adequate funding of the state's Economic Development Division, another large increase may be possible.

Other states, such as Oregon, have gone on record as not favoring the same growth that beset the state in the past ten years. With a weak economy and massive unemployment, population decrease is entirely possible in Eastern States, but not the West.

Most of the Western states have taken the responsible position of providing at least enough employment for the offspring originating within their own state.

By providing the jobs in the states, the behavior patterns then present a new problem—urbanization. The jobs and the young people all seem to move towards urban areas. Such a trend is apparent in the Puget Sound area; the Front Range near Denver; the Wasatch Front in Utah; the Rio Grande Valley in New Mexico; the Coastal Communities in California and the Willamette Valley in Oregon.

The net effect is that the existing electrical load centers keep increasing in size. The "copper spiderweb" used to transmit power into the metropolitan centers, becomes more obvious, and the smoky 50-year-old power plants that were on the edge of town are suddenly downtown.

The growing West needs to face the future with long-range land use planning. Location of nuclear enterprises in some cases are forms of permanent land use planning. It is fortunate that parts of the West will always be remote enough to cover all aspects of nuclear development and utilization.

B. Economy

The continuing growth economy of the Western states is assumed in all of the load predictions cited herein. An increase in the Gross National Product of 4% per year has been used in most cases.

Some regions of some states are especially affected by the electrical power loads in the U. S. and the West. These areas are the ones that produce the energy sources. Since the extractive industries dominate the economy of many cities in the West, the sensitivity to energy needs is easily felt.

It is shown in Table 4 that the uranium mining is definitely on the upswing. For the past year, government sales have been very low but commercial

Tabel 4
1969 Forecast of U.S. Commercial Requirements

| Year | Tons U ₃ O ₈ in Concentrate | |
|------|---|------------|
| | Annual | Cumulative |
| 1970 | 7,500 | 7,500 |
| 1971 | 7,500 | 15,000 |
| 1972 | 11,000 | 26,000 |
| 1973 | 13,500 | 39,500 |
| 1974 | 15,200 | 54,700 |
| 1975 | 17,200 | 71,900 |
| 1976 | 20,400 | 92,300 |
| 1977 | 23,700 | 116,000 |
| 1978 | 27,300 | 143,300 |
| 1979 | 30,700 | 174,000 |
| 1980 | 34,200 | 208,200 |
| 1981 | 38,000 | 246,200 |
| 1982 | 42,300 | 288,500 |
| 1983 | 46,600 | 335,100 |
| 1984 | 51,700 | 386,800 |
| 1985 | 56,900 | 443,700 |

* Source: U.S. Atomic Energy Commission, "Statistical Data of the Uranium Industry", January 1, 1970, Grand Junction, Colorado Office.

buying is beginning to provide a stable and growing market. The states that will benefit the most are listed in Table 5 in order of known resources. The Colorado Plateau and the Wyoming basins are expected to remain the principal areas for extraction.

Table 5
Distribution of United States \$8 Uranium Reserves
January 1, 1970

| | Tons of Ore* |
|---|-------------------|
| Wyoming | 44,020,039 |
| New Mexico | 34,905,227 |
| Texas | 3,812,529 |
| Utah | 2,952,856 |
| Colorado | 2,550,689 |
| Others: California, Oregon, Washington, Nevada, Idaho, Montana, Alaska, North & South Dakota, Arizona | 8,363,004 |
| Total | 96,604,345 |

* Averaging at least 0.15% U₃O₈.
Source: U.S. Atomic Energy Commission, "Statistical Data of the Uranium Industry", January 1, 1970, Grand Junction, Colorado Office.

Coal mining is less predictable. If nuclear plants continue to have schedule problems, use of coal will continue to grow rapidly. Even with nuclear plants on schedule, the use of coal will increase as the Rocky Mountain states achieve industrial growth. Table 6

Table 6
Coal Production in WINC Member States
1946-1966 (Thousands of Tons)

| Year | Colo. | N.Mex. | Utah | Wash. | Wyo. |
|------|-------|--------|-------|-------|-------|
| 1946 | 5,914 | 1,280 | 5,994 | 991 | 7,635 |
| 1950 | 4,259 | 727 | 6,670 | 874 | 6,348 |
| 1955 | 3,568 | 201 | 6,296 | 610 | 2,927 |
| 1960 | 3,607 | 295 | 4,955 | 228 | 2,024 |
| 1965 | 4,990 | 3,200 | 5,100 | 59 | 3,225 |

Source: U.S. Bureau of Mines—Minerals Handbook—1966.

is an historic record of how coal was displaced as an energy source for a period of two decades. The resurgence of activity in the coal fields is most apparent in New Mexico. The magnitude of the change is expected to be profound in Wyoming, Arizona and New Mexico, where strip mining potential exists.

In general, a 1500 MW (e) power plant consumes about five million tons of coal per year. Therefore, the 3000 MW rating now scheduled for New Mexico would use 10 million tons per year, an increase of three times the 1965 rate. The first significant coal increase for mining in Washington will begin when the 1400 MW Centralia plant is operating in 1972.

The oil and gas production in the member states has been comparatively static. If and when the trans-Alaska pipeline is built, the operational global distribution of energy sources will change. Table 7 is a record of steady production in California and Colorado and a significant growth in the Utah production.

A demonstration of economic feasibility for recovery of oil from shale could have significant economic impact for Utah, Wyoming and Colorado.

Table 7
Estimated Proved Reserves of Crude Petroleum and
Natural Gas Liquids, 1946-66 (million barrels)

| Year | Calif. | Wyo. | Colo. | N.Mex. | Utah | U.S. Total |
|------|--------|-------|-------|--------|------|------------|
| 1946 | 3,602 | 615 | 302 | 617 | 22 | 24,037 |
| 1950 | 4,097 | 890 | 352 | 686 | 22 | 29,536 |
| 1955 | 4,126 | 1,424 | 347 | 1,162 | 37 | 35,451 |
| 1960 | 3,972 | 1,524 | 388 | 1,568 | 259 | 38,429 |
| 1965 | 4,830 | 1,263 | 351 | 1,438 | 248 | 39,376 |

Source: Amer. Gas Assn., Amer. Petr. Inst., Canadian Petr. Assn., Reserves of Crude Oil, Nat. Gas Liquids, and Nat. Gas, Annual.

C. Electrical Loads and Resources

The 1968 National Power Survey has shown that the total energy needs of the West will double between now and 1990 and electric generation will increase by a factor of five. The survey also showed that during the same period electrical generation from thermal plants would need to increase by a factor of ten. This growing demand for energy would require a raw energy input of 22,608 trillion BTU's in 1990 compared with 10,721 trillion BTU's in 1970.

Although coal comprises 56% of the energy reserves in the West, it is slated to provide only 10% of the energy used by 1990. This is primarily due to the remoteness of the coal fields from the load centers. The coastal states, which are the basic load centers in the West, are expected to make increasing use of nuclear power. The mountain states are expected to continue to utilize the coal. Policy determinants such as pricing of natural gas, oil imports, environmental regulations and regulation of nuclear plant siting could influence the coal/nuclear balance and the fraction continuing to use gas and/or oil. These policies

are expected to continue to be in a state of flux for the next few years.

In an industry as traditionally cost sensitive as the utilities, small variations in cost of fuels could influence the energy source selection. In recent years the cost of nuclear power has been rising but the cost of oil and gas is expected to rise even faster. If the minemouth coal-fired generation plants continue to show cost stability, an energy mix fraction greater than 10% should be expected.

Coal production in the West had declined for a number of years. With realization that Western coal is now the least expensive available alternative to meeting the energy needs, western coal production is starting a strong upswing. Coal delivered to the Dave Johnson Generating Plant in Wyoming costs about 14 cents per million BTU's. Even from underground sources in Utah, the delivered cost is 18.2 cents. As shown in table 8, the West contains about one-fourth of the U.S. coal reserves. The geographic location is shown in figure 6. With renewed interest in coal, exploration is resuming, and better information should soon be available. Mechanization has permitted production per man shift to increase both underground (as in Utah) and for strip mining (as in Wyoming, New Mexico, Washington and Arizona). Table 9 shows a tenfold increase in some cases due primarily to mechanization. Indications are that recovery rates per man-shift could double again if all mines were modernized. With the billions of tons of coal available in the West that are economically recoverable, the energy resources of the West are not

Table 8

**Area Underlain By Coal, WINC Member States
1960**

| | Area Underlain (sq. mi.) |
|-------------------------|--------------------------------|
| Wyoming | 40,055 |
| Alaska | 35,000 |
| Colorado | 29,600 |
| Utah | 15,000 |
| New Mexico | 14,650 |
| Arizona | 3,040 |
| Washington | 1,150 |
| Oregon | 600 |
| Idaho | 500 |
| California | 230 |
| Nevada | 50 |
| Total, 11 States | 139,875 |
| 39 Other States | 340,475 |
| U. S. Total | 480,350 |

Source: U.S. Geological Survey, *Coal Reserves of the United States—A Progress Report, January 1, 1960*. Bulletin 1136, p. 27.

Table 9

**Coal Production per Man-day, WINC Member States
1946-1966 (short tons per man-day)**

| Year | Ariz. | Colo. | N. Mex. | Utah | Wash. | U.S. | |
|------|-------|-------|---------|-------|-------|-------|---------|
| | | | | | | Wgo. | Average |
| 1946 | 2.29 | 5.18 | 4.14 | 3.58 | 5.47 | 3.00 | 3.44 |
| 1950 | 2.18 | 5.48 | 5.32 | 7.30 | 3.96 | 8.69 | 6.77 |
| 1955 | 2.78 | 6.32 | 4.28 | 9.75 | 5.24 | 15.34 | 9.84 |
| 1960 | 2.02 | 9.34 | 7.27 | 10.71 | 6.46 | 23.93 | 12.83 |
| 1965 | N.A. | 14.32 | 49.13 | 15.74 | 6.93 | 44.69 | 17.50 |

Source: U.S. Bureau of Mines, *Minerals Yearbook, 1946-66*, and Chapter preprints therefrom.



COAL RESERVES IN W.I.N.C. MEMBER STATES

Figure 6

limiting. The limits are 1) water availability from the Colorado River watershed, 2) economic transmission to load centers, and 3) air quality in the region of the plant. In each case, the limits are not just technical and economic but are environmental as well, thus they are discussed in the next section.

Simply the lack of availability of natural gas will limit its use by plants constructed after the mid-70's. As shown in figure 7, many areas of the West are simply not served with natural gas. Of the existing power plants in the West using the supply of natural gas, many are on an interruptible basis (i.e. when it is totally used for domestic use, none would be delivered to the "interruptible customers"). In some cases this means the utility will then substitute oil for fuel on a temporary basis. In some other cases it means that the generating plant must be shut down until flow is resumed.

Domestic supplies of fuel oil in Southern California are expected to be replaced with low sulfur oils by 1975. The cost and scarcity of the low sulfur oils will assist the emphasis for more nuclear plant construction in California. Oil import control regulation will also limit the availability and use of low sulfur oil at least until the Alaska pipeline is put into operation. All the Alaskan oil is expected to be of low-sulfur quality.

Another energy resource in the West is geothermal power. Currently geothermal power is utilized commercially in California. Efforts to map the geother-

mal fields in the West are only now beginning. Figure 8 displays some indications of how widespread geothermal fields may be according to early work by Blackwell and Hall of Southern Methodist University. It is unlikely that geothermal power will serve a large fraction of the growing base load in the West but it may better serve some regions of the West that are far from other generation resources. If geothermal power is shown to produce low cost electrical power, it may attract heavy industrial power users from metropolitan areas. If geothermal power is engineered to be non-polluting, it may be a favored source of warm water and electrical power within some new or existing towns.

With full knowledge of the problems and limitations of fossil fuel sources, the West Region Task Force on Fuels for the West Regional Advisory Committee of the Federal Power Commission predicted that nuclear energy would be used to deliver 46% of the thermal power plant generation by 1980 and 70% by 1990. The succeeding part of this section will describe how this electrical generation will be required in the future. It is clear that if the Task Force estimate is even reasonably accurate, nuclear power plants will be a large factor in the growth of electrical power in the West.



MAJOR NATURAL GAS FIELDS AND GAS PIPELINES IN W.I.N.C. MEMBER STATES

Figure 7



**POTENTIAL GEOTHERMAL
FIELDS IN THE WEST**

Adapted from Blackwell and Hall, S.M.U.

Figure 8

At the request of the Federal Power Commission, FPC, utilities have prepared estimates* for the areas that they have served in the West for decades. Collectively they have extrapolated into the distant future for planning purposes.

The areas covered in the estimates by the utilities did not always stop at the state lines but instead were more related to the location of their generation resources and their consequent efficiency to cover entire river basins. Therefore the most reliable long-range forecasting available extends beyond state boundaries. An effort has been made here to group the forecasts principally associated with member states. The grouping is not perfect in the following respects.

The area designated:

- Southern California Includes Central Nevada and Ventura
- Northern California Includes Northern Nevada (Reno) and Fresno
- Oregon Includes the Klamath River in California and excludes the Snake River Basin
- Washington Includes the upper Idaho panhandle south to Lewiston and excludes the lower Columbia River Basin
- Arizona Includes Las Vegas
- Utah and Idaho Include the Snake River Basin in Oregon and exclude the Idaho panhandle

* *The Future of Power in the West Region, 1970-1980-1990*, a report to the Federal Power Commission by the West Regional Advisory Committee, June 1969.

- Colorado Includes Colorado only
- New Mexico Includes El Paso and excludes the extreme eastern edge of New Mexico
- Wyoming Excludes the northeast corner of Wyoming
- Alaska Includes Alaska only

Table 10 is a result of the long range utility estimates for the PFC.

Table 10

Estimated Peak Electrical Power Demands in Member States (megawatts)

| | 1970 | 1975 | 1980 | 1990 |
|-----------------|-----------|----------|----------|----------|
| Sou. California | 13,300 W* | 19,400 W | 27,700 W | 55,000 W |
| No. California | 11,200 S* | 16,500 S | 24,100 S | 51,600 S |
| Oregon | 9,470 W | 13,300 W | 18,400 W | 39,900 W |
| Washington | 8,440 W | 11,500 W | 15,530 W | 27,640 W |
| Arizona | 4,490 S | 6,550 S | 9,570 S | 20,600 S |
| Utah-Idaho | 2,840 S | 4,020 S | 5,690 S | 11,460 S |
| Colorado | 2,130 W | 3,020 W | 4,230 W | 8,030 W |
| New Mexico | 1,035 S | 1,520 S | 2,180 S | 4,090 S |
| Wyoming | 715 W | 1,070 W | 1,570 W | 3,150 W |
| Alaska | | 640 W | | |

W—denotes winter is peak season
S—denotes summer is peak season

Table 10 shows that 46% of the load for the member states is located in California and another 33% in the Oregon-Washington bloc. By 1990 this relationship is predicted to be unchanged with 46% in California and 30% in Oregon-Washington. The diversity of loads in the West has made it prudent for

the utilities to exchange power for climatic variations north and south and for time zone variations east and west. The transmission network to accomplish this power exchange is known as the Western Loop. The loop is shown in figure 9 as it exists in 1970 and as it is expected to exist in 1990. A second high voltage DC line from the Northwest to the Southwest has been postponed pending further justification studies. The repeated postponement has caused the Southwest utilities to make other arrangements for generation resources.

The existing load pattern is shown in figure 10. The pattern is not expected to vary greatly from the distribution of loads that now exist. The size of the loads will increase and at a rate that is generally greater than the national average of 6.9%. The average state in the West will experience a four-fold load increase by 1990. Areas in the West that grow less than the national average have been generally overly endowed with low-priced electrical power as a result of federal projects during WW II (e.g. Columbia River Basin in Washington). Table 11 presents the projected growth rate from 1950 to 1990 as a percentage.

It may be significant to note that the growth rate decreases as the load base builds up. If this becomes fact, it could alter the simple exponential growth of electrical power that has been a basis for alarm to some planners and conservationists. The decreased

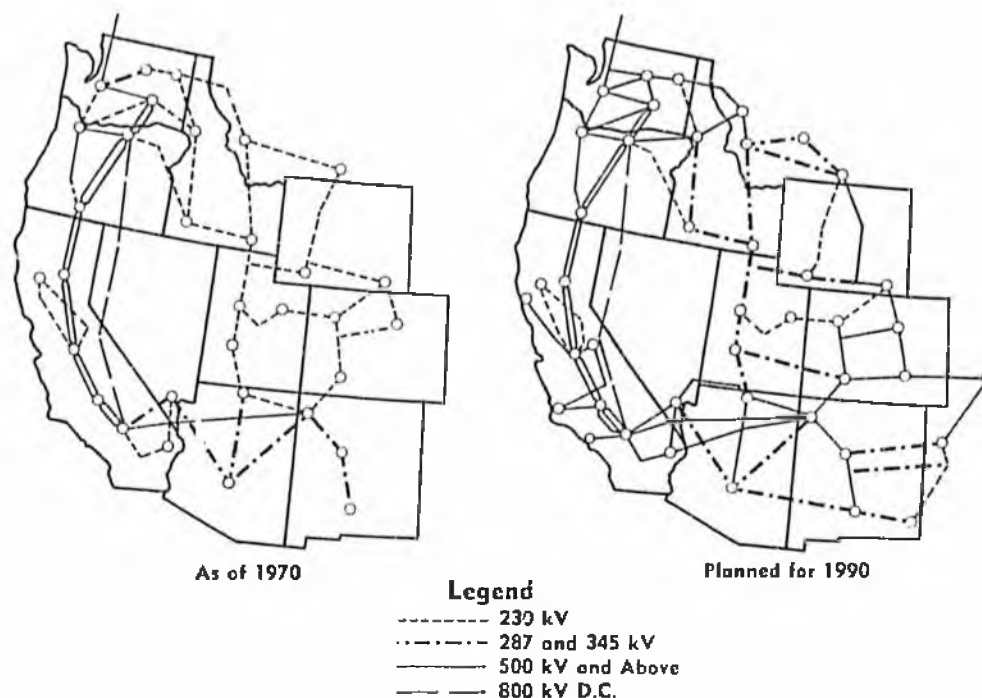
growth rate observed in table 11 could also be associated with the uncertainty of projecting loads twenty years in advance. There may be danger in seeking comfort from the decreasing rate since the rates do not include technological developments that are not only possible but likely in the next twenty years such as the electric auto and widespread use of heat pumps for residential heating and cooling.

Table 11

Estimated Average Compound Growth Rate During 5-Year Periods (per cent)

| | 1950-55* | 1970-75 | 1975-80 | 1980-85 | 1985-90 |
|----------------------|----------|---------|---------|---------|---------|
| So. California | 9.3 | 7.9 | 7.3 | 7.1 | 6.9 |
| No. California | 8.3 | 7.9 | 7.9 | 7.9 | 7.9 |
| Oregon | 8.6 | 7.0 | 6.8 | 6.6 | 6.5 |
| Washington | 11.1 | 5.4 | 5.1 | 4.8 | 4.4 |
| Arizona | 16.4 | 7.8 | 7.9 | 8.0 | 7.9 |
| Utah-Idaho | 12.2 | 7.2 | 7.2 | 7.2 | 7.2 |
| Colorado | 12.2 | 7.5 | 7.2 | 6.9 | 6.7 |
| New Mexico | 13.1 | 8.0 | 7.6 | 7.0 | 6.0 |
| Wyoming | 11.2 | 8.4 | 8.1 | 7.4 | 7.0 |
| Alaska | | | | | |

* actual



ELECTRIC TRANSMISSION IN THE WEST REGION

Figure 9

Another way to analyze electrical load growth is by category such as rural, residential, commercial, industrial and "all other". This is presented in table 12. The "all other" category includes street lighting, municipal services, electrified mass transit etc. Residential use is most predictable since it is based on population growth and the steady growth of electrical energy used per capita. The commercial loads reflect the population trend also but the industrial loads are somewhat independent. In some cases locations for industrial plants are swayed by a source of low-cost electrical power in order to be competitive (e.g. the electroprocess industry in the Columbia River Basin).

The long-range estimate to 1990, although useful for planning purposes, is not justified on the basis of available information but instead is an extension of load growth experience in the past twenty years. Predicting electrical loads are considered "forecasts" if they are for only five years in the future, and "projections" if they are for ten years. A twenty year "estimate" has little value except for general planning functions.

One example of the difficulty with long-range forecasting is the influence of rising power rates from environmental pressures. There is little doubt that environmental pressures are going to increase the cost of producing electrical power. Until the limits of tolerable environmental impact are established in each state, the cost of future power in each state will remain unknown. If, for example, the ratepayers tolerate a 10% increase each year during the seventies for environmental safeguards, aesthetically designed transmission lines, underground transmission, recreation centers etc. etc., the cost of power in those states will rise 250%. Overaccepting the social responsibility of safeguarding the environment could influence the location of industry, the industrial investment and loads to a profound extent.

For example, if the electroprocess industry decided they could be more competitive in Wyoming than in the Northwest, the forecast for Wyoming would be raised drastically and the growth shown for Oregon and Washington tempered. Barring loss of commerce from the West region, the total power forecast, therefore, may be more accurate than the

Table 12
ESTIMATED FUTURE ENERGY REQUIREMENTS BY CLASS, GIGAWATT-HOURS/YR.

| | | Rural and Residential | Commercial | Industrial | All Other |
|---------------------|------|-----------------------|------------|------------|-----------|
| Southern California | 1970 | 19,240 | 19,100 | 20,000 | 6,460 |
| | 1980 | 38,960 | 37,600 | 36,900 | 22,240 |
| | 1990 | 77,710 | 74,000 | 66,500 | 50,190 |
| Northern California | 1970 | 21,765 | 15,400 | 15,800 | 3,135 |
| | 1980 | 46,690 | 29,400 | 38,600 | 7,610 |
| | 1990 | 91,000 | 55,800 | 94,700 | 16,400 |
| Oregon | 1970 | 14,005 | 6,000 | 24,680 | 615 |
| | 1980 | 26,920 | 12,100 | 48,100 | 1,180 |
| | 1990 | 51,850 | 23,500 | 90,000 | 2,150 |
| Washington | 1970 | 14,105 | 5,135 | 18,620 | 1,200 |
| | 1980 | 22,520 | 9,240 | 37,400 | 2,240 |
| | 1990 | 35,465 | 16,400 | 70,950 | 4,355 |
| Arizona | 1970 | 7,515 | 4,610 | 5,080 | 3,995 |
| | 1980 | 14,735 | 9,940 | 11,000 | 9,555 |
| | 1990 | 28,900 | 21,500 | 23,900 | 22,800 |
| Utah-Idaho | 1970 | 5,145 | 2,450 | 5,980 | 295 |
| | 1980 | 9,060 | 5,410 | 12,700 | 630 |
| | 1990 | 16,050 | 11,920 | 26,600 | 1,360 |
| Colorado | 1970 | 4,105 | 3,250 | 2,545 | 500 |
| | 1980 | 9,287 | 6,128 | 5,020 | 790 |
| | 1990 | 18,235 | 12,765 | 9,110 | 1,140 |
| New Mexico | 1970 | 1,744 | 1,347 | 1,200 | 709 |
| | 1980 | 4,322 | 2,440 | 2,708 | 1,160 |
| | 1990 | 9,400 | 4,130 | 4,730 | 1,740 |
| Wyoming | 1970 | 948 | 583 | 1,980 | 200 |
| | 1980 | 2,060 | 1,210 | 4,740 | 315 |
| | 1990 | 4,450 | 2,300 | 9,790 | 460 |
| Alaska | 1965 | 227 | 234 | 75 | 49 |
| | 1975 | 739 | 460 | 350 | 102 |
| | 1985 | 1,735 | 890 | 1,360 | 340 |

class breakdown and the state associated loads pending settlement of the environmental issues to be confronted in the seventies. Capital investments of industries highly sensitive to power cost may be slow pending settlement of some of the environmental issues and stabilization of power rates.

There is no evidence of a direct relationship between the cost of electrical power and its volume of use at the prevailing rate levels for residential and commercial users. Rural users, especially for marginal irrigation projects, may need to close their projects with a significant cost increase. Small increases therefore may not have a large influence on the growth prediction in the member states. When an increase in power rates will have a significant influence on its use is still an open question. It is very likely that the influence will be felt before the cost of power doubles and it could cause a more rapid loss of employment in rural areas unless class preference and priorities are established to protect irrigation projects.

Other influences that significantly affect the rate of electrical load growth are the national programs that affect the Gross National Product. The rates used in the power forecasts herein are 4% per year for the GNP.

The rate of electrical generation in the Four Corners area will affect the rate of generation growth in other regions of the West. The 1500 MW Mohave plant under construction in Southern Nevada uses 5 million tons/year of Arizona coal supplied through a 275-mile 18-inch diameter slurry pipeline. Eighty percent of this energy will be for California. At Page, Arizona, 2300 MW of coal-fired generation are expected by 1976 for Arizona, Nevada and California utilities. Another 1500 MW plant under construction near Farmington, New Mexico, will send about 50% of its generation to California. New Mexico coal producers are attempting to secure water rights for an additional 1500 MW. Twelve miles north of Lake Powell on the Kaiparowitz plateau in Southern Utah. California utilities are considering generation of another 5000 MW. Water rights in Utah for this amount of generation are available if the utilities make use of it within a time limit established by the state of Utah. Added coal-fired generation could be expected in other desert regions of the Southwest if water was available, and if air quality standards can be met.

The low production cost using coal is offset somewhat by the high transmission cost. Figure 11 shows that pipelines even with coal slurries are less expensive than electrical transmission. Electrical transmission is more versatile in that direction of the energy can be switched to follow interplant and inter-regional demands. If high voltage interties are built between the West and the Midwest as proposed,* the

coal fields in the Rocky Mountains would be near the hub of power switching.

Transmission distance cannot be determined by a simple geometric exercise. By displacement techniques, power can be shifted away from areas of power surplus. A good example of this technique will occur in the Northwest when the Bridger plants begin operation in the coal fields near Rock Springs, Wyoming. The power from the Bridger plants will displace the energy previously supplied from the West. Then power derived from the Snake River on the western edge of Idaho will go to the load centers of Oregon. Also, only a fraction of the energy generated at the Four Corners area will actually reach the West Coast since the power from the coastal nuclear plants in California will satisfy coastal needs.

Figures 12, 13 and 14 display the power plants built or under construction in 1970 and a prediction of where the new generation sites will be found in 1980 and 1990. The locations for future plants are not yet known in many cases thus the markers are symbolic of plants in that general area. It becomes abundantly clear that by 1990 nuclear plants will be depended upon to share the load in the West and that coastal sites need to be proven now as an adequate base for plant location.

Growth of generation resources primarily for a secondary purpose such as desalinization could also influence the distribution of new generation facilities. The economics for such projects are not yet known with any degree of accuracy.

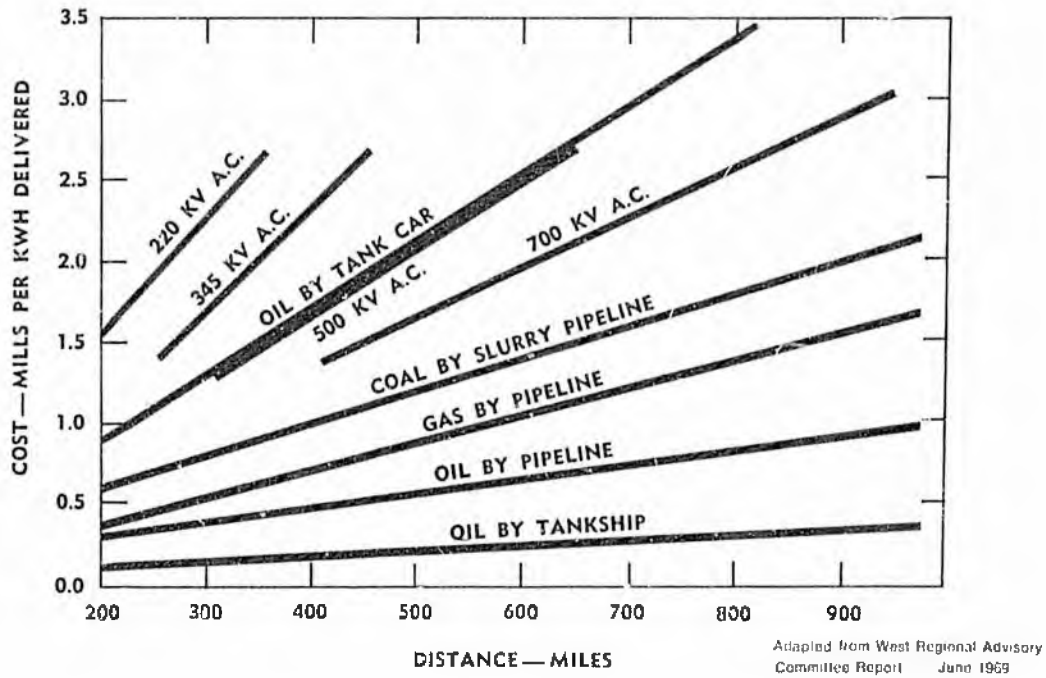
The importation of electrical power from Canada and/or Mexico could influence the timetable and location for new generation facilities especially in the Northwest and the Southwest.

Despite the many influences that affect load growth, there is little doubt that the loads will do anything but double each decade in the foreseeable future. The location of new generation plants will be settled on a project-by-project basis. Each member state should become prepared to evaluate nuclear power plants in the event they are requested to certify the acceptability of a site by one of their utilities or a coalition of utilities. Each state should also investigate how location of a nuclear plant within its borders could be used as a tool to create new opportunities for employment and resource development.

D. Environmental Protection

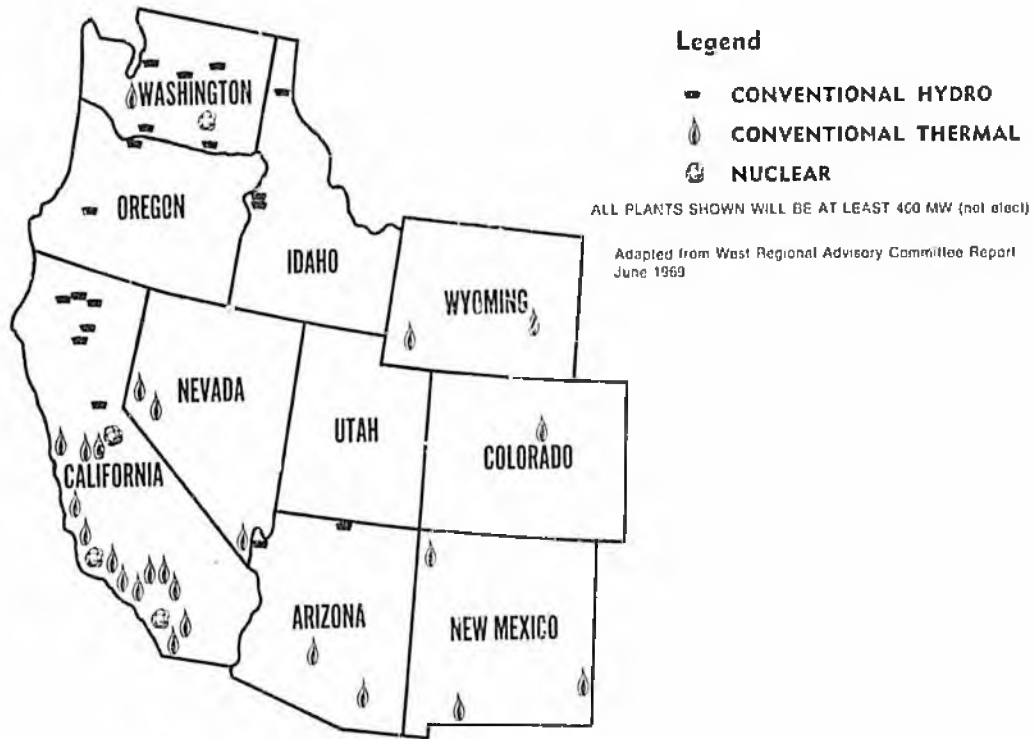
The scope of this study is limited to nuclear involvement of the Western States. To cover the environmental impact of old power generating stations and typical industries would produce an impact statement that would show how delinquent the environmental awareness has been over the past 50 years. Although nuclear power plants have been operating in this country for the past two decades, it is only now that the public has become aware of the needs for

* Transmission Study 190, Office of Chief Engineer, Bureau of Reclamation, Denver, Colorado 80225—Att. D-209, February 1968.



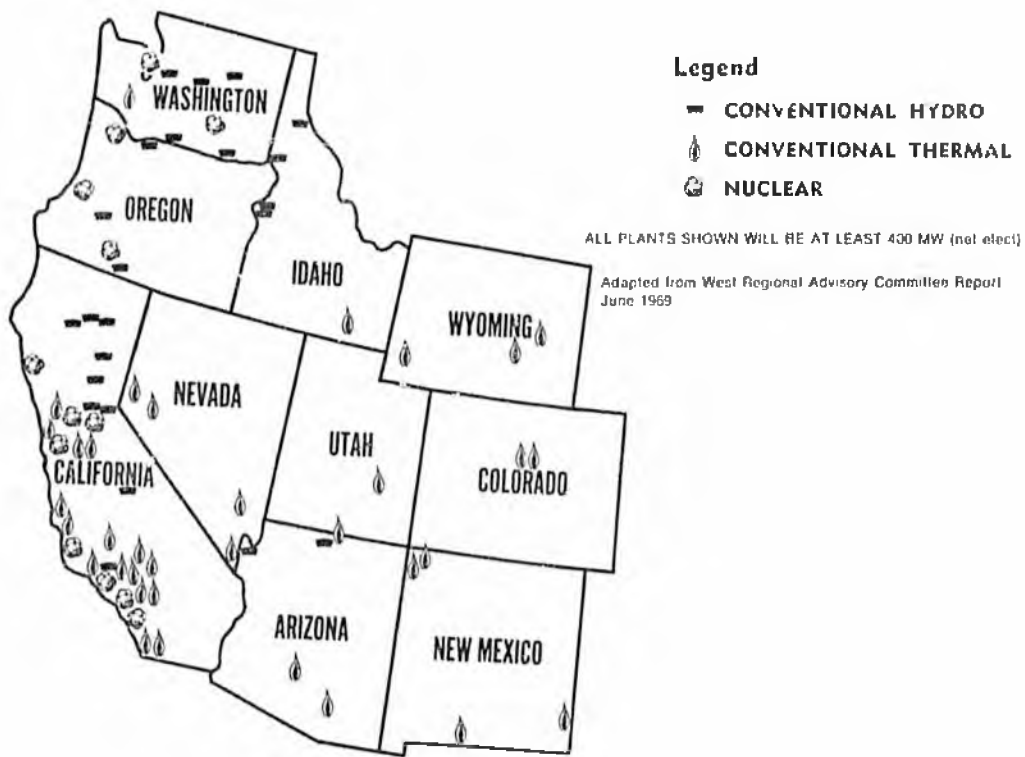
AVERAGE RELATIVE ENERGY TRANSPORTATION COSTS

Figure 11



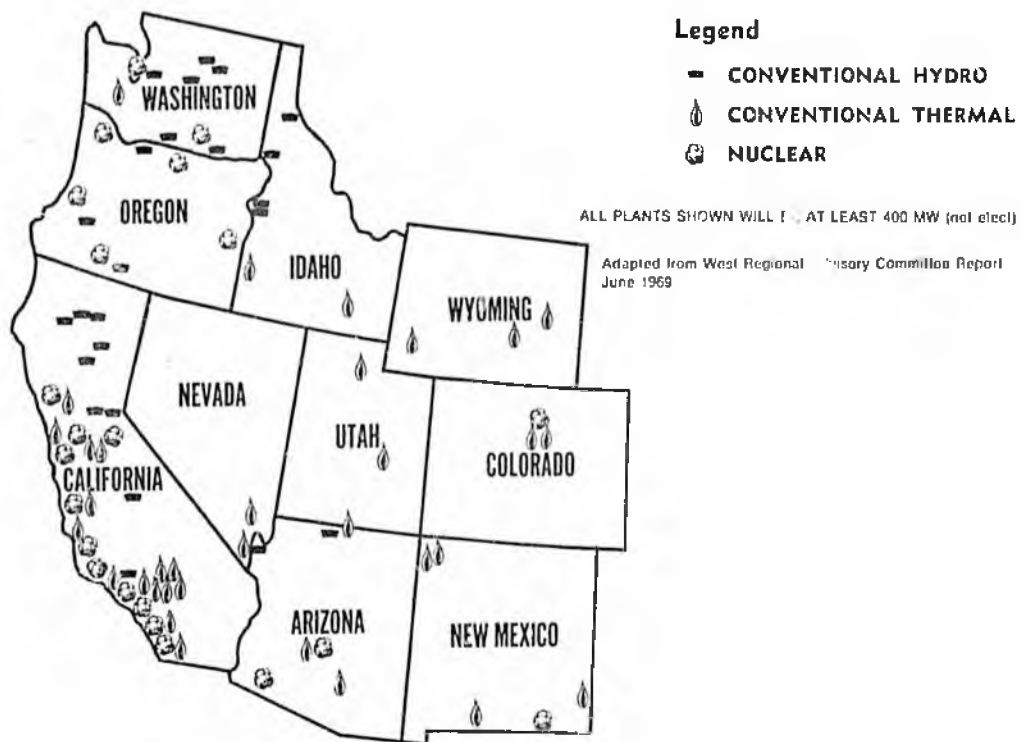
CURRENT ELECTRIC GENERATION PLANTS AS OF 1970

Figure 12



POTENTIAL ELECTRIC GENERATION PLANTS BY 1980

Figure 13



POTENTIAL ELECTRIC GENERATION PLANTS BY 1990

Figure 14

safeguards that have been in existence for many years. With the growing number of power plants in the West there is a need for more safeguards to keep from increasing the risks. It is the purpose of this section to describe briefly the various portions of the nuclear power cycle and indicate where points of control exist or need to be placed.

Uranium Ore Mining and Milling

The uranium mining operations per se have little if any environmental impact. In some cases ventilation in underground mines is inadequate, creating respiratory-oriented radiation hazards to the miners. The location of the tailings piles and sump water discharges have on occasion, caused water contamination as a result of erosion or blowing. Many, but not all, tailings piles have been stabilized to prevent the spread of the uranium, radium, radon and daughter products within the ore.

Conversion and Enrichment Plants

When the yellowcake (U_3O_8) is shipped from the uranium mills to the conversion and enrichment plants, it is in a fairly pure form. The material is handled in the same manner as chemicals and is processed within chemical processing equipment. No unusual environmental hazards are presented from these operations.

Fuel Element Fabrication

When the enriched uranium reaches the fuel element fabrication plant, it is valuable. Accountability for the material is performed to fractions of grams and all residues are reprocessed or packaged and shipped as low-level wastes.

Nuclear Power Plants

As with fossil fueled plants, nuclear power plants emit heated water and gaseous products. Because of the lower temperature steam, the efficiency of most nuclear plants is lower than fossil-fueled plants resulting in the discharge of more BTU's per megawatt of production. Control of the heated discharge is regulated by the states in most cases. The gaseous products are more radioactive but less noxious than most fossil-fueled plants. The type and amount of radioactive products periodically released to the environment are carefully regulated by the AEC and are but a small fraction of the maximum permissible standards set by the Federal Radiation Council, now the Environmental Protection Agency.

In addition, nuclear power plants produce solid and liquid radioactive wastes. The liquid wastes are either diluted and released or concentrated and solidified. The solidification route is preferred since the disposition of the material is then controllable. The solid waste is then shipped to Radioactive Waste Management sites where it is utilized, stored or buried. In either event, the material at a waste management site is removed from the biosphere instead

of added to it as was the practice in early days and still is in some countries. Radioactivity in modern nuclear plants coolant systems can be absorbed by resins (small plastic beads with ionic qualities) and the resins shipped to waste management sites.

The major radioactive constituents of a nuclear plant are within the fuel elements. These are referred to as high level waste. This material is shipped in shielded containers to fuel reprocessing plants.

Shipping of Spent Fuel

Each year a central station nuclear power plant needs to shut down to replace a fraction of its core. The fuel elements that are removed are cooled for a month or more and then shipped to a reprocessing station. In the West there are two reprocessing stations—each located on federal reservations. As the number of commercial nuclear power plants in the West increases, more fuel reprocessing stations will be required. Even with several reprocessing plants in the West, it is reasonable to expect that the spent fuel will need to travel hundreds of miles to reach the reprocessing plants. Because of the large amount of radioactivity present in the spent fuel, the shipments must be performed safely.

This is not a new task. However, since the frequency of the shipments will be increasing, the safety procedures will need to be amplified in order to keep the risk acceptably low. To date the risk accompanying the shipment of spent fuel has been effectively held to zero by:

1. Packaging the fuel in specially designed and tested containers in accordance with DOT and International (IAEA) specifications.
2. Transporting with selected commercial carriers familiar with radioactive materials.
3. Routing around rather than through population centers.
4. Alerting law enforcement agencies prior to entering their areas of jurisdiction.
5. Having standby Radiological Assistance Teams in Idaho and Washington.

In the future there may be additional safeguards that would become feasible. Among these might be the detachment of an armed escort and a Radiological Assistance Team to accompany the shipment. The team would be equipped with survey equipment and have enough markers to isolate a region affected by a shipping accident. The team could be backed up by an airlift of remotely controlled field equipment for decontamination purposes. In addition, more elaborate monitoring equipment such as whole body counters should be available in mobile trailers on a contract basis for use anywhere in the West on a 24-hour notice.

Currently the Civil Defense groups in the Western states are the best equipped to handle the public in the event of a serious shipping accident. The AEC and the contractors involved in the accident would be busy in retsoring safety to within the isolation

zone. In most Western states the local law enforcement agencies already have an established interface with the Civil Defense officials.

The excellent safety record established to date is not accidental. It has been the result of some careful preparation on the part of both industry and government. Shipping is a step in which the radioactive material is out of the custody of skilled technologists. Because of the potential consequences of a shipping accident, neither industry nor the government can be permitted to become complacent. An active effort for evaluating and decreasing risks should continue on a perpetual basis.

Fuel Reprocessing Plants

A used fuel element is still valuable when it is no longer suited to be in a nuclear plant core. The value is in the unused fissionable material and certain fission products. These materials are extracted using established techniques in shielded facilities. The dissolution of the fuel releases radioactive gases from the fuel including the noble gas, krypton. Early reprocessing plants with small lots of fuel to process would release the gases from tall stacks with considerable dilution. The large quantities of fuel to be reprocessed in the future makes it imperative to review the ultimate disposition of the radioactive gases. Considerable research is underway to find a binding agent for the gases in lieu of compression prior to storage.

The mobilization of fission products in a fuel reprocessing plant creates high level and low level liquid and solid wastes. The high level wastes will all be solidified and stored in a federal repository probably in a salt mine in Kansas. The low level wastes will be shipped to radioactive waste management sites. The liquids that cannot be captured are diluted and released at some reprocessing plants.

Radioactive Waste Management Sites

In the fission process hundreds of isotopes are created. Some are in existence for fractions of seconds and some for thousands of years. Industrial and

medical practices have been tremendously improved by utilization of fission products and isotopes created by target irradiation. The value of isotopes in modern civilization can be measured in terms of both millions of dollars and thousands of man years of health and longevity.

Each year new uses of isotopes are found. The isotopes that are stored today in underground tanks may be valuable in coming years for sewage sterilization. The many uses of isotopes are too numerous to mention here.

The radioactive waste management sites serve several functions. They:

1. serve as a depository for low and intermediate level radioactive wastes to permit their ready acceptance from nuclear power plants, universities, hospitals etc.;
2. serve as a sorting station to store or recover potentially valuable isotopes;
3. provide decontamination services to recover valuable equipment that has been contaminated at locations with inadequate facilities for handling resultant cleansing fluids;
4. serve as a control point in which isotopes are under control at all times as contrasted with dilution and release and complete loss of control.

In summary, the nuclear activities associated with nuclear power plants have a variety of interfaces with our environment. As the nuclear power plants become more prevalent, improved techniques will be necessary to keep the radioactivity in our biosphere to a low level. The state radiation control officers are all aware of the potential releases from nuclear plants and the importance of these releases in keeping radiation exposure to the citizens at a low level.



NUCLEAR ENERGY IN THE WEST

V. NUCLEAR PLANT SITING TRENDS

A. Changing Times

Harnessing the atom was a technical problem. Technologists, devotion and dollars were blended together to produce the first few nuclear-power plants. The first nuclear reactor was Chicago Pile-1, built under Stagg Field in Chicago by a team led by Enrico Fermi. Fermi had first split an atom only six years before without knowing for sure that he had done it.

Even ten years later, in 1952, few of the coefficients were well known that contribute to the safety of nuclear plants. Therefore, most of the reactors were built on remote federal reservations where licensing was not necessary.

Gradually private industry chose particular concepts and developed the reactors into product lines. Still the challenges were technical. When the products (reactors) needed to be licensed, design and administrative details began to grow. Standard licensing procedures were established and it appeared that the products could be delivered, ready to operate, in five or six years after the site was proven.

Eventually the technological problems were smaller than the manufacturing problems. Suddenly the public became aware that reactors were a piece of hardware sold on the open market. They began questioning who is in charge and does he have full control of the situation? Housewives and legislators alike have examined the planning and the vested authorities.

The product of the new level of scrutiny is emerging. Although it is not yet clear, it appears that another two or three years will be added to the time it takes to locate and build a nuclear power plant. Figure 15 illustrates the "progress" that has been made. Nuclear power plants that are currently under construction were commonly sited by a decision of the plant owner and the AEC. The future nuclear plants will apparently be more of a joint government-public-utility decision.

The net effect is expected to be a ten-year lead time from the point a need is declared to the time in which it is fulfilled.

B. Regional Importance

In the past, western utilities have planned five years in advance. If this practice continued, no utility would ever find enough time to fill his load needs with a nuclear plant. The Federal Power Commission has recognized this weakness and is requiring 10 and 20 year plans to be submitted.

As pointed out in Section III. A., the population of Western load regions is pure speculation for periods 10 and 20 years in advance. Therefore, it is becoming more clear that nuclear power plant sites need to be located, proven, certified and held in inventory; then used when needed.

The many nuclear plant sites shown in figure 13 should be in the process of being evaluated and proven now. The added sites shown in figure 14 will need to be proven during the next ten years. With the lack of ready acceptance of proposed sites, many more will need to be evaluated than will eventually be used and of those chosen, many will need to support more than one reactor.

The most difficult situation for siting in the West is not the need for isolation but instead the need for a large supply of cooling water. Adequate isolation is available in many areas of the young West. The water not only needs to be available but the return of the water to the environment is carefully regulated. In some states like Oregon, no increase in temperature is the aim. In Washington, some heat dumping is permitted if the water body is cool. In California, a few degrees are permitted. The standards vary but the goal is the same—not to kill or injure indigenous biota.

In some areas of the West heated effluent can be used beneficially for irrigation and aquaculture. Raising shrimp, catfish, crayfish, salmon, oysters etc. can be accelerated with controlled addition of warmed water.

In California, it is important to build plants now with limited biota studies. If significant damage is observed, the intake or outfall lines would be modified. To date, this approach has been shown to be adequate.



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Changing Schedules for Nuclear Plant Construction

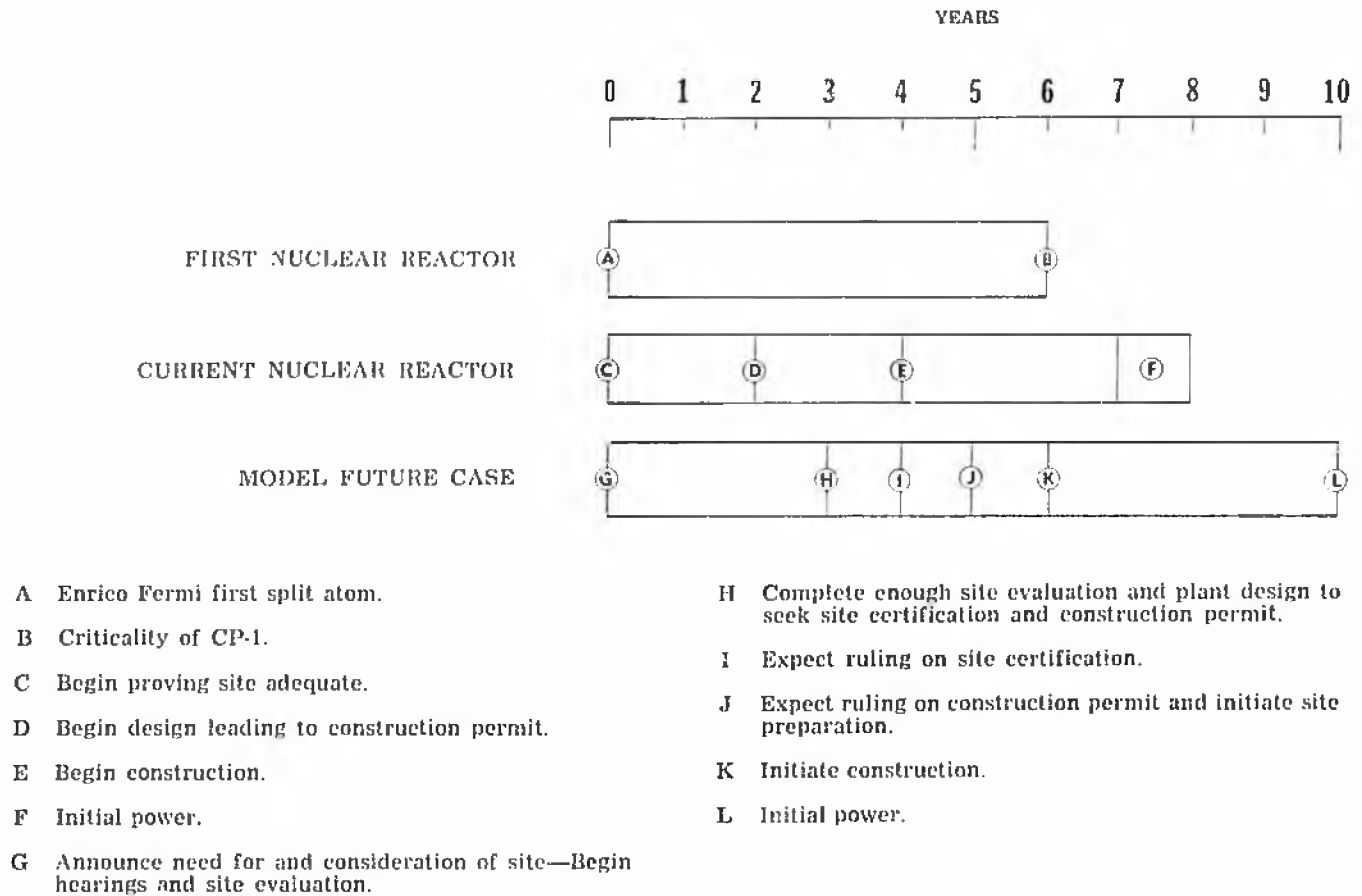


Figure 15

Siting nuclear plants in the West is possible without the constraints found in many parts of the East. A single siting code could not be useful for both regions.

C. State Responsibilities and Opportunities

State governments have a responsibility for health, safety and welfare to their citizens. The health and safety are basic obligations and are well covered in the departments of health, etc. Radiation protection has been provided in most states for many years.

Radiation Control Officers in the Western states generally agree that the environmental radiological surveillance around nuclear activities is a good plan but there are better places to reduce radiation exposure to the public—from excessive medical use of X-rays. The states will continue to participate in the review of nuclear plants and their planned discharges. The engineering of nuclear plants may be complicated but a discharge line and its contents

can be reduced to the same rules that govern other industries. When a nuclear plant is thought to be a hazard, most health departments are empowered to have the operation cease.

Emergency plans are also the responsibility of most health departments. When a nuclear power plant is planned, the state is obligated, by AEC procedures, to develop an emergency plan before the plant is licensed to operate.

The welfare of the citizens is both a state obligation and opportunity. Keeping the electrical power available to every home, shop and street lighting fixture is a basic welfare obligation. This obligation is passed on by the state to the utilities.

Another significant welfare opportunity would be to supply not only the necessary electrical power but to use the waste heat and surplus power to create new recreational and job opportunities. Besides regulating nuclear power plants, each state should have a body ready to observe and implement opportunities for improvement of the social needs of

the state. A few examples would be:

1) To utilize the heated effluent from nuclear plants for community recreation projects such as year-round swimming pools.

2) To utilize the heated effluent to stimulate growth rate in fish hatcheries for producing larger, healthier specimens prior to release.

3) Utilize heated effluents to increase efficiency of sewage treatment plants thereby decreasing the size and numbers of such plants.

4) To restructure power rates to encourage a substitution of off-peak power for peak power and less incentive to waste electrical power.

5) To schedule a phase-out of old generating plants with high environmental impact per megawatt.

6) To encourage interstate connections to permit efficient use of installed resources.

There are countless other opportunities. Individual states each know their own need for heat and power best. The state involvement in siting is, therefore a useful exercise of a state's ability to improve the welfare of its own state.

D. Federal Regulations

Federal regulations now in force have a great influence on siting and procedures related to nuclear plant siting and licensing. New bills signed this last year include:

S. 1075, H.R. 12549

National Environmental Policy Act of 1969—Public Law 91-190. This law establishes a Council on the Environmental Quality. The Council reports to the President on activities of the federal government and recommends national policies.

The National Environmental Policy Act declares a national policy that will encourage protective harmony between man and his environment; to promote efforts that will prevent or eliminate damage to the environment and biosphere, and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the Nation.

S. 7, H.R. 4148

Water Quality Improvement Act—Public Law 91-224. This law requires federal agencies to require applicants for a Federal license to submit a certification by the appropriate state agency that there is reasonable assurance of compliance with applicable water quality standards.

Other bills introduced but not yet passed include:

S. 2752

Intergovernmental Coordination of Power Development and Environmental Protection Act. H.R. 2506

Power Plant Siting

H.R. 7916 H.R. 12595

Electric Power Reliability

S. 4092

National Commission on Fuels and Energy

H.R. 16318

To transfer from AEC to HEW and Interior all responsibilities relating to the effect of atomic energy on the health and safety of the public.

H.R. 17466

Standards for the Discharge of Radioactive Materials

Another bill now being formulated would require state or regional certification of nuclear power plants.

E. Legislation

Six of the eleven member states have signed an agreement with the AEC under Section 274 of the Atomic Energy Act. Becoming an Agreement State permits the state to regulate isotopes previously licensed by the AEC.

The states that are expecting nuclear power plants soon are preparing their own legislation to insure that the siting is done in an acceptable manner. Table 13 shows that only California, Oregon, Washington and Colorado have nuclear plants operating or under construction. By 1980, Arizona will be added to the list. By 1990, possibly New Mexico will be added.

Washington has established, by Senate Bill 49, a Thermal Plant Site Evaluation Council. With the Council's recommendation, the Governor can sign a certificate for use of the site.

California has an established policy that the Public Utility Commission can issue a Certificate of Public Convenience and Necessity for a nuclear power plant site if the Resources Agency has reviewed the site and established an agreement with the utility. The Resources Agency has assembled a Power Plant Siting Committee to review and evaluate the proposed site and establish conditions for its use.

Arizona and Oregon are seeking legislative authority to establish a certifying agency.

Nevada, Utah and New Mexico are seeking authority from the legislature to have their Public Utility Commission become the certifying agency in accordance with recommendations from the National Association of Regulatory Utility Commissioners, NARUC. A copy of the NARUC model bill is presented as Appendix A.

Colorado already does have the Public Service Commission issue the Certificate of Public Convenience and Necessity. Such a procedure appears adequate providing:

1. The jurisdiction of the commission covers all power plants built in the state (public and private; fossil and nuclear, in-state and out-of-state utilities).

2. The review incorporates conditions by the Radiation Control Officer of the State Department of Health.

3. The review includes an evaluation of the environmental protection agencies.

Responsible regulatory action in many cases can preclude the necessity for legislation.

Table 13

RADIATION PROTECTION PROGRAM IN VARIOUS MEMBER STATES

| | <i>Agreement State</i> | <i>Administering Agency</i> | <i>First Nuclear Power Plant</i> | <i>Nuclear Power Plant Siting</i> | <i>Certification</i> |
|------------|------------------------|------------------------------------|---------------------------------------|---|--------------------------------|
| Alaska | Not yet | Dept. of Environmental Affairs | Not foreseeable | N.A. | None |
| Arizona | May 1, 1967 | Arizona Atomic Energy Commission | 1980-85 | SB 98 | None |
| California | Sept. 1, 1962 | Dept. of Public Health | 2 by 1970 10 by 1980 52 by 1990 | PUC with concurrence Resources Agency | Cert. of P.C.&N.* |
| Colorado | Feb. 1, 1960 | Dept. of Health | 1972 | Pub. Serv. Com. | Cert. of P.C.&N.* |
| Idaho | Oct. 1, 1968 | Dept. of Health | Not foreseeable | N.A. | None |
| Nevada | Possibly by 1972 | | 1985 | SB 287 | None |
| New Mexico | Possibly | | 20-30 years | Bill proposed to Pub. Serv. Com. Authority | None |
| Oregon | July 1, 1965 | Board of Health | 1974 | Thermal and Nuclear Energy Council Evaluates | Certificate signed by Governor |
| Utah | Not yet | | 10-20 years | Pub. Serv. Com. has requested legis. permitting issuance of Cert. of P.C. & N.* | None |
| Washington | Dec. 31, 1966 | Dept of Social and Health Services | 1966 | Thermal Plant Site Evaluation Council per SB 49 | Certificate signed by Governor |
| Wyoming | No | | Not foreseeable | N.A. | None |

* Certificate of Public Convenience and Necessity.



NUCLEAR ENERGY IN THE WEST

VI. INDIVIDUAL STATE ACTIONS AND PLANS

A. Alaska

Since 1959, when Alaska became the 49th state to join the union, this state has experienced phenomenal growth. The rapid growth rate is expected to continue through the next decade as well. The most rapid growth sector will be industrial. With the high potential for decreasing rates, the electrical power industry is certain to enjoy rapid growth. None of the new central station power plants is expected to be nuclear.

The nuclear activities in Alaska are expected to be associated with underground nuclear detonations and the routine radiation protection associated with medical and industrial uses of isotopes, and X-ray machines, and uranium mining.

Environmental protection is a watchword associated with the development of Alaska's resources. Any nuclear activities that may be useful in detection and control of oil or sewage pollution, will surely find the interests of the state of Alaska.

Radiation Control Program

Up until mid-1970, the U. S. Public Health Service performed the radiation protection program for the Alaskans. Currently there is no program. If the Radiation Protection Act passes the legislature as proposed, it will invest the needed authority in the Department of Health and Welfare or the new Department of Environmental Affairs to perform a fairly standard program of registering radiation sources and enforcing radiation standards around microwave equipment and lasers.

Alaska is not yet an Agreement State but may become one when it clearly benefits the state. There are many budgets and staff to create first to develop the competence. The first large challenge will be to safeguard the industrial radiographers and their employees on the pipeline project.

Environmental Control Programs

Alaska's Governor William A. Egan is attempting to create a Department of Environmental Affairs. The department would absorb the Division of Environmental Health which currently regulates air and

water quality. Since the new department will be organized along the same lines as NEPA, it will cover radiation safety, air quality, water quality, sanitation and pesticides.

Currently Water Pollution Control is in the Division of Environmental Health per Alaska Statute, Title 46 Water, Chapter 46.05.010-46.05.240. Air Pollution Control is invested in Air Pollution Control Commission, APCC. Their statutory power is listed in Section 18.30.05-250. The APCC is composed of Commissioners of the Departments of Economic Development, Fish and Game, Health and Welfare, Natural Resources plus five persons appointed by the Governor including a physician, a registered professional engineer, a representative of local or regional air pollution control agencies, a representative of industry and one at large.

With citizen participation on commissions such as the APCC, the public viewpoint is expressed but not necessarily controlling. If a segment of the public was permitted to control the growth of Alaska, the acts of preservations would limit the goal of many in state government that want to see Alaska become a self-sufficient state rather than a territory under U.S. domain. The environmental concern in Alaska is justifiably large. There are few places in the world that could match the grandeur of Alaska. The environmental control efforts are being marshalled to preserve parts of the state now, turn some into tourist meccas and permit the rest to be utilized to sustain the prosperity of the region.

Oil will be the resource most likely to be exploited. The water pollution problems with supertankers near Valdez is one that will need to be resolved. A constructive attitude of finding a solution instead of invoking a moratorium seems to prevail.

Natural Resources

Alaska is blessed with a wide variety of mineral resources. The famous Alaskan gold now represents only one percent of the mineral industry. Much of the extractive mining in Alaska will need to await development of land transportation systems. The state has not been thoroughly explored for uranium.

The known deposits are on Prince of Wales Island in Southeastern Alaska. Activities in these mines are expected in 1971. The mining will be done by Canadian Mine Services, Ltd. Extractive mining in Alaska is expected to someday be increased by ten or even one hundred fold. A post of State Mine Inspector to cover the safety of the miners may be needed with the development of uranium mining.

One of the most abundant resources in Alaska is fossil fuel. There are estimated to be about 10 billion tons of coal in Alaska; 10 trillion cubic feet of natural gas (near the Kenai Peninsula); and 26 trillion cubic feet at Prudoe Bay. The oil reserves in the area of the Kenai Peninsula area are estimated to be about 200 million barrels and the Arctic slope is estimated to have over 10 billion barrels. Some geologists claim that the Arctic slope has the greatest petroleum potential in the United States.

Prior to the discovery of oil and natural gas on the Kenai Peninsula, imported oil and coal were the predominant sources of power for electrical generation. By 1985 it is estimated that 74% of the electrical power in Alaska will be generated using natural gas as fuel and only 4% with coal.

The two refineries on the Kenai Peninsula are of limited capacity, thus, it can meet only some of the needs for diesel fuel in Alaska but does meet most of the needs for heating homes. With added refineries and oil flowing from the Arctic slope, Alaska will be a self-sufficient energy state soon. Needless to say it will also be a major energy exporter.

A total natural resource description for Alaska could occupy great volumes. The mere fact that the tourist industry is expected to be the prime employer in Alaska by 1985 should be an indication of the beauty and resources of this state.

Power Needs and Resources

There are 20,000 Eskimos, Aleuts and Indians in 50 villages that are not served with electrical power. An effort by the Rural Electrification Administration will put diesel units in two-thirds of these villages by 1980. These villages are generally separated by many miles of unfavorable terrain and are not very substantial loads which make diesel units an obvious choice.

The interior load is primarily at Fairbanks which is near the Nenana coal fields. Despite the rapid load growths in this university town, the 7 million tons of coal available to the new Golden Valley Electrical Association plant should meet Fairbanks' needs for many years. The major 22MW (e) mine-mouth plant will probably be used to replace many expensive non-utility power sources that serve industrial loads and small communities in the area.

The most rapidly developing loads in Alaska are near Anchorage and the Kenai Peninsula. In 1968 the largest single generating station in Alaska was the Municipal generating plant of Anchorage. The

plant was equipped with three gas turbines and six diesel units of one megawatt each. The gas turbines with a combined output of 48 megawatts will be used to heat a 22 megawatt steam turbine in 1971. The cold weather and low price natural gas make gas turbines a favorable choice in many medium-size Alaskan towns.

Future central station plants appear destined to take advantage of even lower prices (15¢/million BTU's) natural gas by locating large steam electric plants at the source of the gas on the Kenai Peninsula. Transmitting the energy by wire is estimated to be half as expensive as piping the natural gas to Fairbanks.

Large central station power plants and an interconnected grid is expected to cause a 65% reduction in the power costs to 75% of Alaska's population. With the more favorable rates, it is expected that the electrical power will be used more extensively for electric space heating. This will be an environmental asset by eliminating smog and reducing fog ice. Both smog and fog ice have been a problem in Fairbanks.

The interconnection grid will also aid the coordinated use of central station thermal power plants and the hydroelectric installations. By so doing, economies of scale can be achieved and a close margin on reserves to use the hydro power for peak loads.

In 1965 only 17% of the electrical power in Alaska was derived from hydro power. There are at least 76 hydro electric sites remaining in Alaska. They range from 7 to 5,000 Megawatts in capacity. Some sites are located near the Fairbanks-Anchorage transmission corridor. It is reasonable to expect that hydro projects in that area may be developed with federal funds and justified as a multipurpose application.

There are 41 hydro electric developments in Alaska. The largest one in operation is Alaska Power Administration's 30 MW Eklutna plant near Anchorage. Construction has begun on the 46.7 MW Snettisham project 28 miles Southeast of Juneau. Most of the hydro projects are of less than 50 KW and generate power for fish canneries. If growth of Alaska someday demands it, the Rampart site on the Yukon River could be used to produce 5,000 MW.

It is not likely that nuclear power plants will find their way into Alaska's foreseeable future as central station power plants. If technology develops in the next twenty years to permit mass production of low cost small nuclear plants, then a few plants may be useful in interior regions of Alaska remote from fuel supplies. Multiple use of heated effluent for space heating is nothing new in Alaska. It is used in some regions to simply keep the drinking water liquid. In other regions it is used to good advantage in heating the residences in the community. At the Fort Ridge power plant warmed effluent is used in a

fish hatchery to add growth to young salmon. The lower 48 states could probably learn much from the ingenuity of the Alaskans in fully utilizing the available BTU's.

Desired Nuclear Developments

Since central station nuclear power plants are unlikely for Alaska and the nuclear industry is far removed, the applications for nuclear energy in Alaska appear to be related only to underground nuclear detonations. Weapons developments above 1 megaton are clearly not desired (ref. Resolution No. 10 (1971) by Representative Earl Hillstrand).

Geothermal applications of Plowshare may be justified to meet power needs in some remote regions of the state. This most likely would be for non-utility application in a region rich with minerals. There are many geothermal fields in Alaska with the remoteness that makes them a candidate for Plowshare-geothermal.

There is a need for a harbor on the West Coast of Alaska. This is an area of the state rich in extractive minerals but without adequate transport facilities. Due to the long gentle slope of the beaches, a Plowshare-harbor has been considered. Due to the proximity to the Soviet Union and the existence of the Test Ban Treaty, this should be considered a needed but unlikely project.

WINB Assistance

1. WINB assistance in evaluating the economic feasibility of Plowshare geothermal could be useful.

2. WINB assistance to evaluate the schedule and safety for a Plowshare-harbor project might be useful. Whether the Plowshare excavation budget is zero for lack of a mission or lack of feasibility should be determined.

3. Any progress that WINB can make in implementing production of small low-cost nuclear plants for remote applications would have application in some parts of Alaska that can be reached only by air.

4. Alaska could use WINB assistance in developing a radiation control staff to control the use of isotopes, and other ionizing and non-ionizing radiation. The industrial radiography on the trans-Alaska pipeline will probably represent the first large-scale radiation hazard in the state.

B. Arizona

Arizona became an Agreement State on May 1, 1967. In the intervening four years the Arizona Atomic Energy Commission (AAEC) has evolved into a model organization for meeting the state needs for regulation of hazardous forms of radiation and for assisting the state to utilize nuclear techniques. In addition, the Commission has been the focal point for evaluating and encouraging the types of nuclear industry that might become a credit to the state and to establish guidelines for their operation so that

they would always remain a credit.

The Arizona Atomic Energy Commission is funded primarily with state funds in a manner comparable with most state agencies. During the fiscal year 1970-1971, the funding level was \$155,646. This enabled the operation of the following staff:

Executive Director Donald C. Gilbert
Health Physicist II Lynn A. FitzRandolph
Health Physicist I Ralph Ochoa
Radiation Control Technologist I .. Thomas A. Schell
Nuclear Technology Specialist .. Edward C. Johnson
Administrative Assistant Mrs. Polly Gallardo
Accounting Clerk Mrs. Ida E. Hewitt
Clerk-Steno Miss Cindy Geary

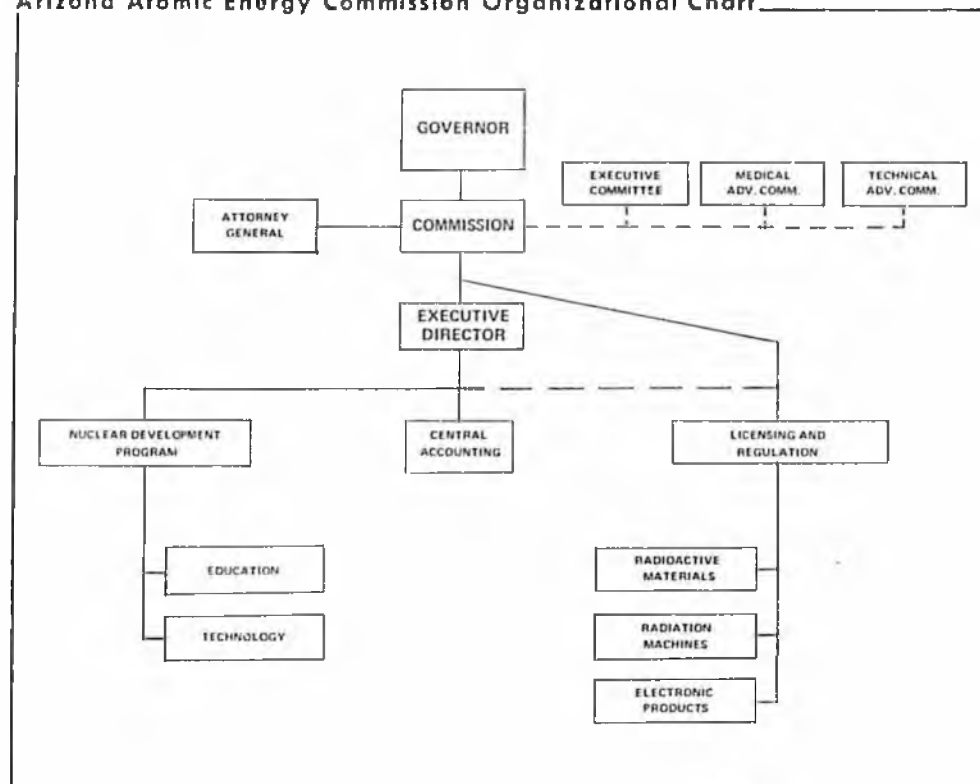
The staff reports to a Commission that is appointed by the Governor with the advice and consent of the Senate except for two positions that are statutory. These two positions being the administrative heads of the State Department of Health and the State Department of Economic Planning and Development. The balance of the Commission is composed of nuclear technologists, business men and educators. They include:

Mr. Harry H. Dooley (*Chairman*), President, American Atomics Corp., Tucson, Arizona
Mr. Hal R. Spragg (*Vice Chairman*), Immediate past President, Unidynamics/Phoenix, Litchfield Park, Arizona
Wesley Fee, M.D., Radiologist, Tucson, Arizona
R. Lee Foster, M.D., Radiologist, Phoenix, Arizona
Mr. Kenneth Geiser, Manager, Exec. Customer Relations, Honeywell Information Systems, Inc., Phoenix, Arizona
Dr. E. O. Hartig, Chief Engineer, Goodyear-Aerospace Corp., Goodyear, Arizona
Louis Kossuth, M.D., Arizona State Commissioner of Health, State Health Department, Phoenix, Arizona
Mr. Tom Morong, Assistant General Manager & Chief Engineer—Power, Salt River Project, Phoenix, Arizona
Dr. Lee P. Thompson, Dean, College of Engineering Sciences, Arizona State University, Tempe, Arizona
Robert Worden, Executive Director, State Dept. of Economic Planning and Development, Phoenix, Arizona
Dr. Norman Hüberr, Professor, Dept. of Nuclear Engineering, University of Arizona, Tucson, Arizona
T. A. Woods, Jr., Vice President—Engineering Services, Arizona Public Service Company, Phoenix, Arizona

Radiation Control Program

The organization of the Commission is shown in Chart 1. The regulatory staff reports directly to the Commission prohibiting any difficulty with a conflict of responsibilities. With such a structure the balance is exercised at the Commission level to provide adequate regulatory funds as the nuclear industry develops. Another clear advantage of such an organizational structure is that the total field of radiation control is invested in one staff so that a balanced program of protection from excessive medical and

Arizona Atomic Energy Commission Organizational Chart



industrial radiation is assured.

The statutory responsibilities of the Commission are for conducting Arizona's Radiation Control Program in accordance with Section 30-654, Arizona Revised Statutes. This responsibility includes regulatory authority over all sources of radiation in Arizona except those located within federal installations and certain quantities of special nuclear materials. The Radiation Control Program is a major and integral part of the Commission's activities and will make use of 53% of its funds in FY 1970-71.

The state has over 200 licensees utilizing nuclear materials and 1950 X-ray machines registered. The Radiation Control Program has recently been expanded to include sources of non-ionizing radiation such as from electronic ovens, lasers etc. This was prompted by passage of the Radiation Control for Health and Safety Act of 1968 as Public Law 90-602 by the 90th Congress of the United States of America. This law gives the U.S. Public Health Service the power to enter into regulatory agreements with the states similar to the AEC's Agreement States contracts. The federal standards for electronic products and possible federal funding for the broadened regulatory responsibilities have not yet been settled. This could become a very expensive program and its significance is yet to be established.

Environmental Control Programs

The Arizona Department of Health has a statutory

responsibility for air and water quality. Discharge of radioactive materials to the air and waterways falls under the surveillance of the AAEC. The Legislature is organizing an Environmental Council that will assist in this area. The current air quality regulations do not have SO₂ limitations. Water quality is difficult to legislate in Arizona because nature has an undeniable role of concentration by evaporation. Environmental control will be difficult in Arizona during the summer months.

The AAEC is establishing a modest environmental monitoring program oriented towards specific geographic areas of the state to establish baseline conditions for future nuclear activities and to provide an early alert in the event of radioactive releases. The USPHS does some environmental monitoring in Arizona—primarily in connection with activities at the Nevada Test Site and with uranium mining activities. With more equipment, the AAEC could assume a more comprehensive role in environmental monitoring. This will probably come in time.

The AAEC has joined with the USAEC in evaluating the establishment of a centralized repository of occupational radiation exposure records. Approximately 200 registrants of various disciplines are currently a part of this study.

Natural Resources

Although some uranium ore is located in northeast Arizona on Indian Reservations, it is not exten-

sively mined.

The Northeast corner of Arizona also has extensive coal deposits at Black Mesa (near Page, Arizona). These deposits can be economically recovered thus they will be used for a mine-mouth electrical power plant. The uncertainty of the future supplies of natural gas and opposition to more hydro-electric projects on the Colorado River has contributed to the decision to build the plant at Page. Prior to that decision, Arizona's dependence was almost entirely on natural gas for central station power plants. The 1970 rating for hydro projects in Arizona represents 25% of the total power production under adverse water conditions. From Hoover Dam a production of 165 MW exists which, together with other hydro projects, totals 904 MW.

There are some underground salt beds north of Kingman that could be utilized for underground gas storage sites if properly cavitated by a Plowshare device. Such an application is achieving higher levels of interest in Arizona as the natural gas peaking demands become more critical.

The water resources are negative (i.e. there is more being pumped from the ground than enters the water table). The ground water is receding at a rate of two to ten feet/year. The natural surface waters are totally inadequate to meet current and future agricultural demands. In this respect, the proximity to the Gulf of California (40 miles) can certainly be rated a natural asset for Arizona. With the growth of this state and the already inadequate water supply, a desalinization plant using water from the Gulf is an ultimate necessity. A variety of locations were considered in the study as shown in figure 16. Such a plant located on the border with Mexico, south of Yuma, could be ducted to Parker Dam and thereby supplement Arizona, California and Mexico's needs for water from the Colorado basin. The quality of the water below Parker Dam is already of marginal quality due to its salt content. A source of distilled water at that point would help to salvage this vital resource. Due to the interstate water entitlements and the international obligations with Mexico, the desalinization project would require federal support. In a study* completed in 1968, a joint study team from the U.S.A., Mexico and the International Atomic Energy Agency concluded that such a project was technically feasible and compiled some cost information. When comparing the costs with other alternatives, the joint study plan appears to be a likely nuclear project in Arizona. In addition to supplying one billion gallons/day of distilled water, it would produce 2000 MW (net elect.) power to the southwest grid. The state's ultimate economic salvation may very well depend on a desalinization project.

Power Needs and Resources

Adequate generation resources are expected to

* *Nuclear Power and Water Desalting Plants for Southwest United States and Northwest Mexico*, TID-24767, September 1968.

be available to meet the electrical power needs in Arizona until at least 1980. After that date and probably before 1985, a nuclear plant will be built. The date will depend on natural gas supplies and the degree of acceptance of large-scale coal burning in the Four Corners area. State control of nuclear plant siting will be exercised by the new Senate Bill 98 (Appendix B).

In a recent analysis by the Arizona Power Authority the energy needs of Arizona were estimated as shown in table 14. The energy in this table is less than Section III-C since the Las Vegas load is not included.

Table 14

| Arizona Electrical Energy Requirements, Millions of KWH | | | |
|--|----------------|-----------------|-----------------|
| | 1960 | 1970 (est.) | 1980 (est.) |
| Residential | 1,354.3 | 3,753.9 | 8,806.3 |
| Commercial | 1,473.2 | 3,734.9 | 8,064.0 |
| Industrial | 1,587.9 | 4,110.7 | 6,415.0 |
| Agricultural | 1,646.2 | 1,748.2 | 1,637.8 |
| Other | 163.5 | 275.0 | 358.0 |
| Losses | 658.1 | 1,360.0 | 2,530.0 |
| Total | 6,883.2 | 14,982.7 | 27,811.1 |

The population growth and dependence on air conditioners constitutes the largest growth segment. This portion can be accurately predicted. Irrigation development is stymied by the water supply and thus shows no load growth in the prediction. With the semi-tropical climate, large agricultural developments will become possible together with attendant employment and power loads when the desalinization project is accomplished.

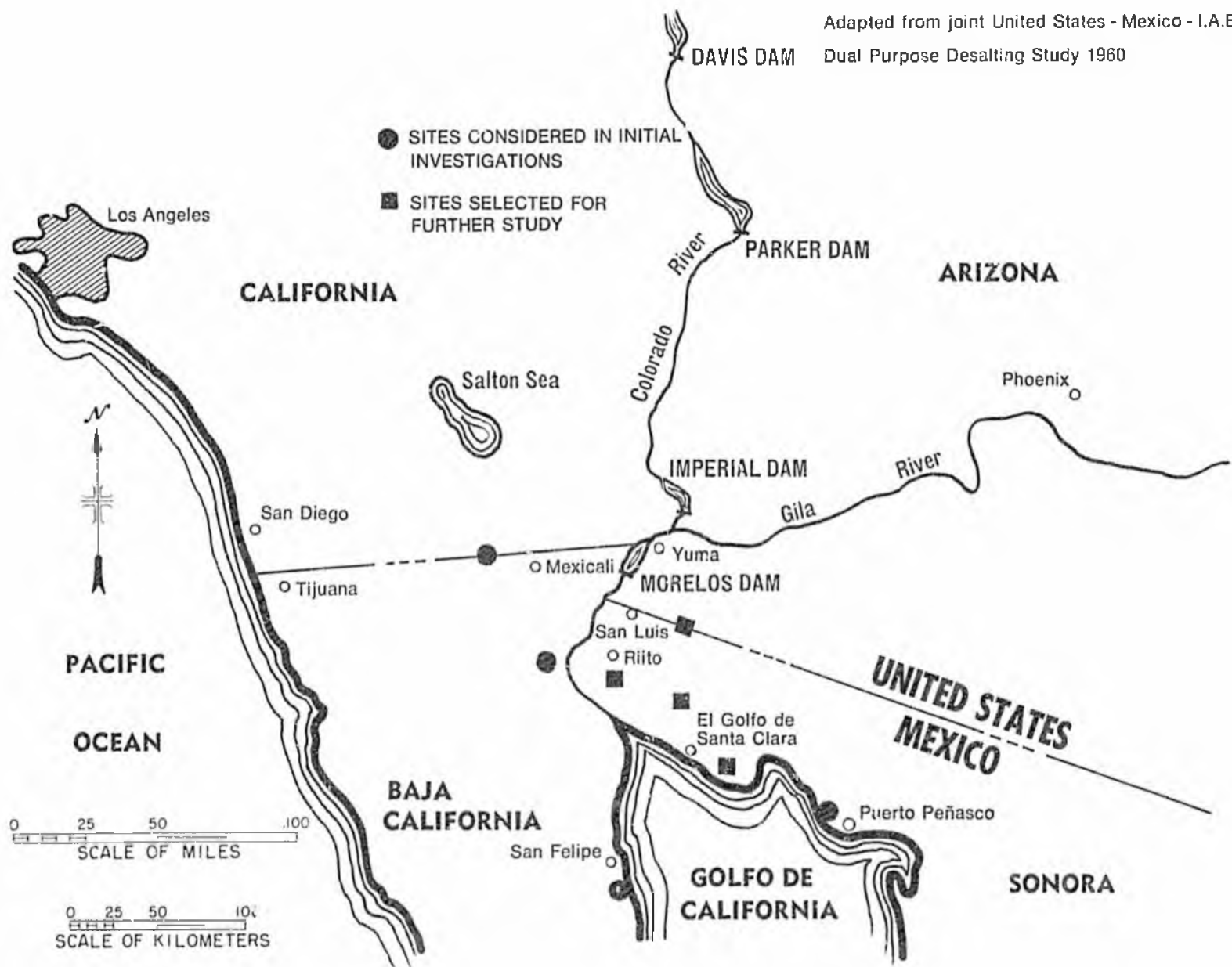
The power resources in Arizona are listed in table 15. The Hoover Dam component is managed by the Arizona Power Authority. About half of the resources are in the hands of investor-owned utilities. The rates for these private utilities in Arizona are controlled by the Corporation Commissioner. It is too early to determine how allowable expenditures for environmental safeguards in Arizona will be.

Desired Nuclear Developments

Arizona has physiographic and geographic advantages which make it a potential center in the Southwest for the rapidly developing nuclear industry. The state is taking an active role in backing up the nuclear industry that will surely develop to meet Southern California's need for electrical power. The state is rapidly becoming a recognized center of nuclear technology. The expertise already available in the state recognizes the following opportunities for Arizona in the nuclear industry.

1. Agri-industrial complex surrounding a nuclear-powered desalinization project.
2. Satellite model cities on the perimeter of commercial and industrial centers such as in item 1.
3. Nuclear fuel fabrication and reprocessing.

Adapted from joint United States - Mexico - I.A.E.A.
Dual Purpose Desalting Study 1960



POTENTIAL DUAL PURPOSE DESALTING PLANT SITES

Figure 16

4. Management systems for utilization of gaseous and other isotopes captured at central station power plants and fuel reprocessing plants.
5. Process radiation for preservation of export food products.
6. Nuclear central station power plants in conjunction with sewage treatment, sterilization and pumped storage for power and irrigation.
7. Nuclear medicine packaging, distribution and utilization for diagnosis, treatment and research.

Many of the above opportunities will require determination to culminate. Others will develop naturally. The central station power and nuclear medicine

developments appear assured. The Model Cities Act is already being implemented in Arizona under their Senate Bill 8 (1970). The first new city is already under construction north of Mesa.

The isotope management effort will be a spinoff from the central station power plants and the fuel reprocessing plants. With technological advances in capturing, rather than releasing, the isotopes, realization of the Arizona goal of isotope utilization will be advanced.

The desalinization project and FDA approval for preservation of foodstuffs will require the most determination, but could mean the most to Arizona. Accomplishment of a desalinization project of the type envisaged could be a significant milestone in utilizing thousands of miles of arid coastline in developing nations. This project would assist all states along the Colorado River watershed in helping to relieve an overburdened resource in the West.

WINB Assistance

1. The U. S. Food and Drug Administration has been slow to act on food preservation by radiation. With the large citrus industry in Arizona and its seasonal nature, approval of fruits preservation by radiation could be a major stride. This could help other member states also (especially California and Hawaii).

2. Constant coaching of congressional delegations on the short supply of Colorado River water could advance the day when the federal government will seek to meet its obligations to the lower states and Mexico with a desalinization plant. This could be a direct benefit to California and a very significant step in locating nuclear plants at points of advantage instead of at load centers.

C. California

During the 1968 session of the California legislature, a bill (ACR 154) was passed instructing the legislature to inform itself of the issues and concerns regarding the developing nuclear industry in California. The legislature thus formed the Joint Committee on Atomic Development and Space. This committee has recognized the need for advanced planning on the siting of nuclear power plants. This has not been an unexpected result considering the expected load growth in California and the importance of maintaining air quality. The difficulty is associated with meeting the many other environmental objectives of the state. Through technology and cooperation by the utilities, the State of California is exploring the impact of nuclear plants along the Pacific Coast. If indications remain favorable, the bulk of the nuclear plants in California can be expected to be found near this planet's largest heat sink.

Table 15

State of Arizona Electric Distributors Power Resources—1970

| Plant | Owner | Dependable Capacity ¹ (MW) ² |
|---------------------------|---------------------------|--|
| <i>Hydro</i> | | |
| Hoover | APA | 165.0 |
| Parker-Davis | USBR | 157.5 |
| Glen Canyon | USBR | 511.0 |
| Roosevelt | Salt River P.D. | 60.0 |
| Horse Mesa | Salt River P.D. | |
| Mormon Flat | Salt River P.D. | |
| Stewart Mountain | Salt River P.D. | |
| South Consolidated | Salt River P.D. | |
| Crosscut | Salt River P.D. | |
| Coolidge | U. S. Indian Service | 5.0 |
| Childs | Arizona Public Service | 3.8 |
| Irving | Arizona Public Service | 1.3 |
| Subtotal—Hydro | | 903.6 |
| <i>Thermal</i> | | |
| Crosscut | Salt River P.D. | 34.4 |
| Agua Fria | Salt River P.D. | 399.8 |
| Kyrene | Salt River P.D. | 104.2 |
| ² Hayden #1 | Salt River P.D. | 74.0 |
| ³ Four Corners | Salt River P.D. | 79.5 |
| Phoenix | Arizona Public Service | 113.3 |
| Ocotillo | Arizona Public Service | 229.4 |
| Saguaro | Arizona Public Service | 198.0 |
| Yucca | Arizona Public Service | 25.0 |
| ³ Four Corners | Arizona Public Service | 691.3 |
| ⁴ Utah Tie | Arizona Public Service | 50.0 |
| Tapeo | Arizona Public Service | 7.0 |
| Cholla | Arizona Public Service | 119.8 |
| Coolidge | U.S. Indian Service | 3.9 |
| Valencia | Citizens Util. Co. | 3.7 |
| Mike Hart | Citizens Util. Co. | 14.0 |
| De Moss Petrie | Tucson G & E | 100.0 |
| Irvington | Tucson G & E | 421.0 |
| ¹ Four Corners | Tucson G & E | 55.6 |
| Apache | Arizona Elec. Power Coop. | 86.5 |
| Safford | The City of Safford | 7.9 |
| Miscellaneous Purchases | | 10.0 |
| Subtotal—Thermal | | 2828.3 |
| TOTAL POWER RESOURCES | | 3731.9 |

¹ Dependable capacity at time of system peak under adverse water conditions.

² Generating station located near Hayden, Colorado.

³ Generating station located near Framington, New Mexico.

⁴ Transmission tie with Utah Power & Light Company.

The state legislature has instructed the Resources Agency to work with the utilities in developing a twenty-year plan. A report* of the initial plan was presented to the Joint Committee on Atomic Development and Space of the California Legislature on February 15, 1970. This report is an excellent demonstration of how state government and the utilities of the state can work together to isolate a problem and chart a course for arriving at a solution before a problem becomes a crisis.

The report points out that the utilities have not always been aware of the desires and needs of various interests at an appropriate time and establishes a procedure and schedule for timely clearance of utility plans through a public agency; namely, the Resources Agency.

The findings and conclusions in the report are especially noteworthy and apply in general to most Western states, particularly the coastal states.

The primary conclusions of the report are:

1. The environment must be protected through an agreement with the State Resources Agency as a condition of constructing any thermal power plant in California.
2. Power plant siting must be compatible with the broader planning and zoning authorities such as a coastal zone authority.

In addition to the above major findings and conclusions, the following additional findings and conclusions were reached:

1. According to present predictions, demand for electricity is expected to continue to double every nine years and by 1990 at least four times the current demand will exist.
2. Most of the good hydroelectric sites have been developed. A significant but not a large fraction of the future capacity will be provided by pumped storage hydroelectric projects.
3. Prudent planning requires that at least two additional sites be acquired in the State, which, together with presently owned sites, will meet the loads forecast for 1980.
4. Ten additional sites will be required by 1990.
5. The major portion of the future electric generating capacity will be supplied by thermal plants located in California. In 1990 the ratio of nuclear to fossil-fired generation is expected to be about two to one. A relatively small portion of the future thermal capacity will be provided by coal plants located outside the State.
6. Because of restrictions on the burning of fossil fuels and also possibly for economic reasons, a major portion of the new capacity required in the future will be nuclear.
7. Inland site locations will be restricted due to lack of inadequate supply of cooling water, unless other acceptable cooling methods are developed.

8. Waste water may find an application for cooling purposes at inland sites.

9. The major portion of the new power capacity required by 1990 and beyond will be plants sited within a reasonable distance of the Pacific Ocean in the coastal zone, and the major source of cooling water will be the Pacific Ocean.

10. Until recently, utilities have been able to find suitable power plant sites to meet the required capacity. However, serious siting problems exist at the present time for a number of reasons, including air pollution from fossil fuel-fired plants, seismic design requirements, and the present required distance from population centers for nuclear plants.

11. Present type commercial nuclear reactors will provide most of the energy for the steam electric generation of power in the immediate future. Commercial breeder reactors will be under construction during the latter part of the 20-year period, but probably will provide little, if any, capacity prior to 1990.

12. Other than the introduction of the breeder reactors, no new developments are likely to significantly change the power generation field by 1990. However, geothermal power has an unknown potential that is presently underdeveloped.

13. There are indications that the discharge of warmed cooling water may have beneficial effects for sport fishing and water-contact sports such as swimming. On the other hand, larger generating plants will increase heat loads and require continued care and attention to prevent adverse ecological effects on receiving waters.

14. By 1990, the maximum installed capacity at any site will probably be on the order of 6,000 megawatts with a maximum unit size of about 1,500 megawatts.

15. Federal legislation should be enacted to complement state legislation to open public lands for the development of geothermal resources with appropriate environmental considerations.

16. An effort should be made to encourage the use of proper terminology such as heat effect, which may be either a benefit or a detriment to the environment, rather than the term thermal pollution for all heat discharges.

17. There is a great need to have an informed public regarding nuclear energy in order to gain public acceptance of nuclear power plants.

18. A greater effort should be made to utilize public lands for power plant sites where compatible with the primary use of such lands.

19. There may be a distinct advantage to combining the desalting of sea water and production of electricity in a dual purpose plant to conserve resources and reduce siting problems.

20. Public and private utilities should continue to cooperate in solving their siting problem by the joint use of facilities when such cooperation is equitable to those involved.

The items relating to power mix and scheduling are expanded below under the section of Power Needs and Resources. The items on siting are further analyzed in the section on Siting Trends. Item 11 which states that "Commercial Breeder Reactors . . . will provide little, if any, capacity prior to 1990," is a significant observation that affects power plan-

* "Siting Thermal Power Plants in California", State of California Resources Agency, February 15, 1970.

ning for California and the other member states.

Since the California report was published in February, 1970, the Bible Bill had not yet passed the U. S. Congress. This bill, signed on December 24, 1970, opened federal lands for geothermal leasing per the suggestion of item 15.

The dual-purpose function of desalting seawater while producing electrical power has remained dormant despite state efforts to date. Although water will not be critical in California again until 1990, the immense job should begin in the 70's. The task will involve drawing together the many organizations and disciplines required, and then finding a market that will pay the full value of the water. The California legislative committee recommendation that a dual-purpose nuclear fueled desalting and power plant be energetically pursued should be heeded by all water planners in the West and in Washington, D. C.

The California legislative committee also supports 1) a study to investigate unique power site concepts such as underground sites, 2) a massive public information program, and 3) a study of the standards and effects of radiation sources utilized in the industrial and medical field.

The California Air Resources Board is a new body but one with considerable charter and authority. The Board is a strong advocate of having all new power plants in California nuclear powered.

Since the Public Utility Commission and the utilities have traditionally selected plants based on economics rather than emissions, the Air Resources Board's desires for all new plants to be nuclear is a new rationale and one that will require some time to be accepted.

Radiation Control Program

California became an Agreement State on September 1, 1962. In California the Department of Public Health is responsible for carrying out the radiation protection provisions of California's radiation control laws (Health and Safety Code Sections 25600-25876) and for enforcing the Radiation Control Regulations (Title 17, CAC, Sections 30100-30397).

The Department licenses and inspects over 1400 users of radioactive materials under terms of their agreement status. Medical, dental, and industrial X-ray machines and other radiation producing equipment are also registered and inspected. Establishing a modern trend, operators and supervisors of medical X-ray machines are certified, and schools teaching radiologic technology are approved, to assure that such persons meet minimum standards of knowledge and competence.

The Department monitors radiation levels in the environment to detect contamination from nuclear weapons testing, nuclear reactor discharges, and other man-made sources, by maintaining sampling stations

and collecting and analyzing samples of environmental media (e.g., air, water, food, milk, marine life). The Department investigates incidents and accidents which could result in excessive exposure; it disseminates technical and informational data relating to radiation safety to users and the public; and it collects information on the health effects of radiation exposure.

Radiation hazards associated with electronic products such as color television receivers and microwave ovens are also investigated, and recommendations are made to minimize radiation exposure from such devices.

The Department is represented on the Power Plant Siting Committee; it maintains close liaison with the U.S. Atomic Energy Commission, the U.S. Public Health Service, and the U.S. Department of Transportation to assure close conformity with federal policies and standards; and it assists and advises local agencies in radiation protection matters.

The Radiological Environmental Surveillance program is carried out by the Bureau of Radiological Health and the Sanitation and Radiation Laboratory. An annual budget of \$100,000 is applied and \$200,000 in equipment is utilized. Since the California surveillance program could be considered a model program, an outline of their program is provided in Appendix C.

Environmental Control Programs

The California environmental programs are many. Most significant for nuclear plant siting are the air and water quality programs. The biota study programs around nuclear plants with ocean sites are basically to document a baseline and observe the result. The confidence needed to proceed with this "wait-and-see" approach is based mainly on the favorable (rather than deleterious) effects observed near the outfall of the San Onofre nuclear plant near San Diego.

The California Air Resources Board is the principal study group and regulatory force for air quality. They have a variety of plans to avoid any further degradation of air quality. Nuclear power plants fit into their plans in more than a simple way. They would like to see the day when there is enough nuclear capacity to operate a grid optimized for minimum emission instead of minimum cost. With enough nuclear power plants, it is expected that the fossil plants with high emission will only need to be used on occasional peaking assignment.

Another situation confronting the Air Resources Board is use of brackish water in a cooling tower. The Board's limit on solid particulates (in this case, salt) rules out the operation of a conventional tower. For the unit in question (Pittsburg No. 7) a 75-acre spray pond appears to be an acceptable alternative.

There appears to be propensity for new R & D projects for improving California air quality. A tax

system for funding these projects based on the volume of fuel burned has been proposed but has met some opposition as evidenced by the battle and defeat of Proposition 18 (November 1970). The advent of nuclear power is one of the few good things that has happened to the Air Resources Board.

Another component of State government that is learning quickly about environmental impact is the California Public Utility Commission (PUC). The PUC has traditionally issued a Certificate of Public Convenience and Necessity for the construction of generating facilities and transmission lines. They have learned that it is imperative that their decision to issue a certificate be backed up with an environmental evaluation. Expenditures needed to avoid an adverse impact then becomes a "social obligation" rather than an unallowable cost. This new social obligation continues to the extent that power rates to the public are not significantly raised. To date, a 10% increase in rates will cover most environmental safeguards with few complaints from the rate-payers. The PUC hearing prior to the issuance of a certificate is a place to balance costs and benefits. In California the Power Plant Siting Committee (via the Resources Agency) comes to an agreement with the utilities prior to the PUC hearing. This has fulfilled the PUC obligation for an environmental review thus far.

In a classic case that started in 1968, the Public Utility Commission issued a Certificate of Public Convenience and Necessity to build two gas-fired power plants with a total value of \$178 million at Huntington Beach in Orange County. After the Certificate was issued, the local enforcement authority for the Air Resources Board refused to issue an operating permit. This case was recently settled by the California Supreme Court in favor of the Air Resources Board. The case is clearly proof that a state government needs to be coordinated on environmental issues in a timely manner. The Air Resources Board is now involved early since they sit on the Power Plant Siting Committee. Before PUC issues certificates of Public Convenience and Necessity, the Siting Committee review is completed. The next test of jurisdiction is a pending request to build Encino No. 2, a gas-fired power plant north of San Diego. This plant is out of the Los Angeles Basin but will use part of the limited supply of gas that might otherwise be used in the Basin instead of oil.

Water quality control is simpler in California than air quality. The policy regarding discharge of heated effluents is presented in Appendix D. In general, some streams and lakes are off limits for receiving heated waters, while some waters (including interstate waters) can be heated 5° F. providing the basic biota are warm water fish. The coastal waters and bays can receive water heated to no more than 20° F. above ambient. Estuaries can receive water heated to no more than 4° F. above ambient. In most all cases

the catch-all clause is: "Additional limitations shall be imposed when necessary to assure protection of beneficial uses."

Natural Resources

The pertinent natural resources in California are mostly related to water. The Cascade and Sierra-Nevada Ranges catch large quantities of water and usher it through gently sloping valleys. The average total runoff in California is 70 million acre-feet/year. The agricultural industry in the valleys (by principally flood irrigation techniques) have produced \$4 billion worth of California's commerce (1969) with products distributed on a nationwide market. Agriculture is still a growth industry in California. Water needs for this second largest industry in California affects the location of the nuclear industry.

Water demands for cooling towers for nuclear plants are not included in the projected demands for water in the 1970 California Water Plan (Bulletin No. 160-70). If cooling towers were used for the entire production in California (78,000 MW by 1990), the added water consumption in California would be 1.5 million acre feet. Although this represents only half of the irrigation water growth needs, it is equivalent to the Mexican entitlement from the Colorado River. This consumptive use is not considered the best use of a vital California resource; consequently, ocean siting is strongly favored by the California Department of Water Resources.

Coal resources do not exist in California. Oil and natural gas are the only fossil fuels recovered and are used as fuels and petrochemicals. Natural gas is used preferentially due to its favorable cost and cleaner burning characteristics. Since some of the gas is imported, and is decreasing in availability, the oil is becoming more commonly used. Since the domestic oil resources in California are too high in sulfur content, some oil must be imported and is subjected to a limited supply.

There are some uranium deposits in Kern County. The deposits are too low in grade to justify for mining uranium alone. California's principal resource is modern technology. Answers now exist in California's scientific community to provide a self-sufficiency of both power and water. Thus the seawater along 1,200 miles of coastline can become a new natural resource as soon as political forces permit progress on desalting plants.

Power Loads and Resources

The first central station electrical power plant in the United States was located in San Francisco. Three years later Thomas Edison constructed the first power plant in New York. California is also a progressive leader in the nuclear field with the first licensed nuclear power reactor (PR-1) at the Vallecitos Nuclear Center six miles from Livermore, California.

Between these two events, hydroelectric power served the predominant electrical needs of California. Today 166 hydroelectric plants produce 7,600 megawatts, most of which are in the Sierra Nevada mountains in Central and Northern California. As Southern California grew after WW II, thermal power plants were necessary to supplant the burden carried by the Northern hydro projects. Since 1948, only one hydro power plant has been built in California. Today there are 40 thermal generating plants with a total capacity of 20,400 megawatts. The two largest plants are near Long Beach and Monterey. Each plant has seven fired units with a total capacity of over 2,000 megawatts.

Even with the large thermal capacity some power is imported on a seasonal basis. On a typical day (February 15, 1970) nearly 2,000 MW was imported. In 1971 nearly 4,000 MW is expected to be imported on an occasional basis. Interregional power transfers are convenient but are often expensive and not always dependable. Large quantities of power might be imported from minemouth coal-fired plants in Arizona, New Mexico and Utah if air quality needs in the Four Corners area can be met. If the Hanford No. 1 power plant is left shut down per Presidential decision, the likelihood of power imports from the Northwest appear unlikely. Previously California imported about 800 MW from the Northwest on a rather steady basis. Now the Northwest will be looking to California for power on an occasional basis.

New thermal power additions are needed in California. The consensus is fairly unanimous that the new plants should use nuclear energy. The basis for this position is, in part, on the requirements for air quality. The safety record established by nuclear power plants in California and the rest of the United States has also assisted in arriving at this charter position. Of the 17 central station nuclear power plants operating in the United States, two are in California. The nuclear power plant at Humbolt Bay has been operating since 1963. The San Onofre plant has been in power operation since 1967. Both use salt water cooling and neither has shown degradation of the biota in the region of the plant.

Currently seven central station nuclear power plants are ordered or under construction in California. These include:

| Plant | Plant Sponsor | Power Operation |
|------------------|-------------------------------------|-----------------|
| Diablo Canyon #1 | Pacific Gas & Electric Co. | 1972 |
| Rancho Seco #1 | Sacramento Municipal Ut. Dist. | 1973 |
| Diablo Canyon #2 | Pacific Gas & Electric Co. | 1974 |
| San Onofre #2 | Southern California Edison | 1976 |
| San Onofre #3 | Southern California Edison | 1977 |
| Mendocino #1 | Pacific Gas & Electric Co. | 1977 |
| Mendocino #2 | Pacific Gas & Electric Co. | 1979 |

Other forms of power generation are being considered in California but not on a large scale. They include geothermal power, pumped storage and gas turbines.

The only commercial geothermal power plant in the United States is in Sonoma County about 70 miles north of San Francisco. Currently 83 megawatts is being produced there. Another 110 MW are scheduled for 1972. Eventually, 1,000 MW might be produced from this same field with a predicted life of over 40 years. Another geothermal field is at the Salton Sea near the Mexican border. Major corrosion and brine disposal problems have forestalled development of this field.

Pumped storage will become more prevalent as the nuclear plants become larger segments of the power resource mix. The low fuel cost in nuclear plants makes it imprudent to operate them at less than full power. Pumped storage makes use of the extra energy available in the system during off-peak hours. The energy stored in the pumped storage reservoirs is then available during daily or seasonal peak demands. With the elevation available, pumped storage projects in California can provide high efficiency energy storage. Such a form of quick peaking energy is far superior to gas turbines with respect to noise and air quality. Both forms of peaking power generators decrease the need for thermal generation plants. Consequently, the number of sites needed for thermal generation is decreased with the advent of pumped storage sites.

Using the load forecasts in California, the required number of new sites can be determined very systematically.

| | 1970 | 1980 | 1990 |
|--|--------|--------|---------|
| Peak load forecast for Calif., *MW | 25,200 | 54,000 | 114,000 |
| Generating requirements, †MW | 30,516 | 62,287 | 128,848 |
| Minus—Imports | 3,742 | 5,060 | 12,185 |
| —Hydro, geothermal and thermal peaking | 7,925 | 13,045 | 26,273 |
| Thermal generating requirements, MW | 18,849 | 42,182 | 90,390 |
| Thermal capacity on existing sites | 18,849 | 24,962 | 33,850 |
| Thermal capacity on approved but undeveloped sites | | 11,000 | 24,660 |
| Thermal capacity with sites under review | | 2,000 | 11,600 |
| Thermal capacity for which new sites are needed | | 4,220 | 20,280 |
| Thermal capacity needed, MW | 18,849 | 42,182 | 90,390 |

From the above, it is clear that as of the study date (February 15, 1970) sufficient sites existed to meet the 18,849 MW thermal generation requirements; by 1980 only 24,962 MW would be generated on existing sites thus 17,220 MW would need to be situated on new sites to meet the 42,182 MW of thermal generation requirements; by 1990 only 33,850 MW would be generated on existing sites, thus 56,540 MW would need to be situated on new sites to meet the forecasted requirement of 90,390 MW. If all generation units on new sites were with 1200 MW

* Excludes some small loads.

† Provides margin for maintenance, forced outages and hydroderating.

plants, then by 1980, 14 plants would need to be situated on new sites; and by 1990, 48 plants would need to be situated on new sites. Of these 48 plants, only 5 are currently scheduled and ordered for delivery as of 1980. Therefore, 43 more plants are awaiting a site and a schedule by 1990. It is apparent that sites chosen should have a capacity for more than one plant.

Desired Nuclear Developments

Technologically astute California companies were early to discover the promise of nuclear energy. The University of California at Berkeley was the headquarters for Dr. Glen Seaborg in 1940 when he discovered plutonium fuel for the breeder reactors. Shell Chemical Company in Richmond owned California Research & Development Company which was the spawning grounds for many accomplished nuclear scientists before the Atomic Energy Act of 1954 was passed. This Act permitted private industry to participate in the development of nuclear energy and to possess fissionable material under AEC license.

In 1954, Atomics International, then a department of North American Aviation, received a contract to build a sodium-cooled reactor in the foothills of the San Fernando Valley. Atomics International is now preparing to offer Liquid Metal Fast Breeder Reactors. Currently they are participating in a consortium bid for a 300 MW (e) prototype breeder reactor.

In 1955, General Electric Co. moved their Nuclear Department from Schenectady, New York, to build a \$25 million Vallecitos Nuclear Center near San Jose. Similarly, in 1956, General Dynamics Corp. moved a department to La Jolla, California, to build the multi-million John Hopkins Research Center which became a base for Gulf General Atomic.

In two years General Electric Co. had a prototype boiling water reactor built and licensed at Vallecitos. By September, 1979, General Electric had brought to power seven central station nuclear power plants in the U.S. and had contracted for an additional 34 Boiling Water Reactors which are currently under construction.

Gulf General Atomic, now a full division of Gulf Oil Co., has delivered 49 TRIGA reactors internationally for training and research. Now known as Gulf Energy and Environmental Systems Division of Gulf Oil Co., this organization is ready to offer 1000 MW (e) High Temperature Gas Reactors (HTGR). The very successful Peachbottom HTGR completed by this group in 1967 is the forerunner to the 330 MW (e) Ft. St. Vrain HTGR now being built in Colorado.

The state's early entry into the nuclear field has permitted successful spinoff for dozens of nuclear industries in California.

The new and the established nuclear orientated enterprises in California control their own destiny. Their continued development is compatible with state

goals.

The state Public Utility Commission charges the utilities with a responsibility to meet electrical generation needs. Table 16 lists the sites in the state in which the state and utilities have agreed can support nuclear power plant developments. The agreement on the part of the state is through the Resources Agency. The Agency has drawn together representatives from the following Departments, Boards and Commissions to review the impact of thermal power plants at various sites. The group is collectively known as the Power Plant Siting Committee.

1. Department of Conservation
2. Department of Fish and Game
3. Department of Navigation and Ocean Resources
4. Department of Parks and Recreation
5. Department of Water Resources
6. Air Resources Board
7. State Water Resources Control Board
8. Department of Public Health
9. State Lands Commission

When the utility agrees with the Committee's conditions for acceptability, a letter of agreement is signed. The next step is for the utility to request a hearing from the Public Utility Commission for a Certificate of Public Convenience and Necessity. The PUC hearing then finds the Resources Agency adequately prepared to accept the site subject to the terms of the agreement.

Table 16
Existing and Proposed California Nuclear
Power Plant Sites

| Site | Utility | 1990 Site Capacity, MW-net elect. |
|-------------------------|---|---|
| 1. Humboldt Bay | Pacific Gas & Electric | 63 |
| 2. Point Arena | Pacific Gas & Electric | 4060 |
| 3. Montezuma | Pacific Gas & Electric | 5280 |
| 4. Santa Cruz | Pacific Gas & Electric | Not established |
| 5. S. Moss Landing ... | Pacific Gas & Electric | 3000 |
| 6. Diablo Canyon ... | Pacific Gas & Electric | |
| 7. Rancho Seco | Sacramento Municipal Utility District | 3000 |
| 8. Point Conception | So. Calif. Edison Co. | 6600 |
| 9. Ormond Beach ... | So. Calif. Edison Co. | 2000 |
| 10. Long Beach | So. Calif. Edison Co. | 3000 |
| 11. Harbor | L.A. Dept of Water & Power | 1000 |
| 12. San Onofre | Southern Calif. Edison Co. San Diego Gas & Electric | 4000 |
| 13. Sorrento Valley ... | San Diego Gas & Electric ... | 3000 |

WINB Assistance

At the November 1970 meeting, a resolution was passed recognizing the need for WINB to press for action on a desalinization project. A request for action on the 1952 Saline Water Act and on the resolu-

tion is renewed here. The resolution reads as follows:

WHEREAS, there will be a continuing demand for additional water development in the Western states; and

WHEREAS, water adequate in both quality and quantity will be required; and

WHEREAS, desalting is receiving widespread attention as a potential economic long-range alternative for supplying water; and

WHEREAS, nuclear energy will be used to supply increasingly greater amounts of electricity in the Western states; and

WHEREAS, there are economic incentives to combining power production and desalting in dual-purpose clean nuclear plants;

NOW THEREFORE, BE IT RESOLVED by the Western Interstate Nuclear Board, that it is the intent of the Board to encourage the use of nuclear energy for desalting; and

THAT, BE IT FURTHER RESOLVED, that the Board does hereby urge that appropriate Federal and state agencies support, and electric utility companies cooperate in the study of prototype desalters with the utilities making steam available from existing or planned nuclear power plants for any desalters being planned or constructed now or in the future.

D. Colorado

The old and the new come together in Colorado. The radiation protection program in Colorado began in the early days of uranium mining—1948-9. The state is now witnessing the advent of an advanced type of power reactor and advanced techniques for recovery of natural gas and oil shale. The Plowshare device that was detonated at Rulison in 1969 was a shock to many that had not been following the Plowshare program. The next planned Plowshare demonstration, at Rio Blanco, is suffering from the overreaction to the Rulison shot.

The maturity of the radiation control program has been a virtue to the citizens of the state and especially to all uranium miners in the West. Persons such as Dr. Duncan Holiday made contributions to the state program and also to the National Cancer Institute.

The Ft. St. Vrain plant will be a 330 MW (net elect.) High Temperature Gas Reactor (HTGR). The reactor will convert fertile material (thorium) into nearly as much fissionable material as it burns. This reactor is an eightfold increase (in power) over the Peachbottom HTGR plant built and operated in Pennsylvania.

The "Front Range" north and south from Denver is undergoing rapid growth. During the past ten years, the population of the state increased 25.8%. From 1970-80 another 26% is expected. The planned electrical power will not be a deterrent to new industries. The Western slope activities are slow. Where nuclear activities can stimulate the state economy, they become desirable providing they do not create an inordinate number of problems. The U mining industry is slow but would be responsive

to a better market. Much of Colorado's underground resources of natural gas and oil are locked in tight rock formations. Plowshare could have a role in releasing this gas and oil but must be pursued with social and political astuteness.

The AEC-Rocky Flats plant is the sixth largest manufacturing plant employer in Colorado. The economy associated with the plant has been beneficial to the economy of the state but the plant has been a problem to monitor. Apparently the plant was located on a formation containing uranium ores. No complete preoperational surveys were made, thus the post operational readings are not necessarily a valid measure of releases from the plant. This is compounded by the releases from the plant from a spill and from the 1969 fire. The Governor appropriated \$90,000 to the radiation control program to get a handle on the situation. This has not been a model operation but the situation is improving.

Radiation Control Program

Colorado became an Agreement State on February 1, 1968. Since that time the staff and budget have continued to be bolstered to where the radiation control staff now numbers twenty and has an annual budget of \$346,000 (including the \$90,000 mentioned above). The Division of Occupational and Radiological Health of the State Department of Health is headed by Dr. P. W. Jacoe. Robert D. Siek is in charge of the radiation control. The Division is guided by a Radiation Advisory Committee which is composed of three members from industry, three members from the healing arts, and three members from institutions of higher learning. The Advisory Committee is appointed by the Governor. The Committee advises both the Governor and the Department of Health on topics of current interest. During 1970 the Committee reported on:

- 1). The indoor radon concentrations in buildings near Grand Junction that have been built on uranium tailings.
- 2). Radium concentrations in deep wells in Southeastern Colorado.
- 3). Licensing and compliance activities of the staff.
- 4). Environmental surveillance around Project Rulison.
- 5). A proposed off-site environmental surveillance program around the Ft. St. Vrain plant.
- 6). Tailings piles stabilization and water sampling.
- 7). Measurements of the Radiation Counting Facility.
- 8). Surveillance activities in relation to the Rocky Flats Plant.
- 9). Proposal to study cesium uptake in fish.
- 10). Proposal to establish a radioactive waste management site; and
- 11). The beginning of educational and regulatory programs on non-ionizing radiation.

The radiological health program has been operating at a high level of efficiency and should be expected to continue at this same pace. It will continue to methodically evaluate problems in radiation control that will assure that development of nuclear industry in Colorado is consistent with safeguarding the public health and protection of the environment. The three areas that will probably attract the most attention in 1971 are: 1) the indoor radon concentration studies, 2) the new control program for non-ionizing radiation (microwave, lasers, etc.), and 3) the licensing of medical radiologic technologists.

The Division has started an inventory of the microwave products in the state. They have performed leakage surveys and made public warnings through the news media. Most background information is obtained from the Southwest Radiological Health Lab.

The third point (licensing) is similar to some proposed federal legislation (HB 1013). Reportedly this bill will require the federal government to license technologists if the state doesn't do it within the next two years. The Division has recognized the need for licensing and has already started efforts in this regard.

The Division of Occupational and Radiological Health has had many years of experience in the field of radiation protection. During this period they have developed a few basic theories that may be of value to other member states now developing radiological programs. They include:

1. The state should know what happens within production facilities in order to know where and when to monitor. The state needs the inside understanding in order to function as a cognizant third party. This practice is now being exercised within the Rocky Flats plant and is expected to be the case with the Ft. St. Vrain power plant.
2. The state needs to establish baseline conditions around zones of expected nuclear projects for establishment of the preoperational conditions. Too much information is far better than not enough. In view of this belief, the state is already establishing background measurements in the proposed region of the Rio Blanco project.
3. The state should have a monitoring network that can be activated quickly in the event a nuclear incident within the state, or outside the state, results in a release. This capability should have enough quantitative determination to make recommendations to the public. The Colorado network was ready for sampling and analysis two hours after the December 18, 1970, venting in Nevada.

During 1970 the Division took 1990 air samples for the Rocky Flats plant surveillance program. Samples were from five stations on-site and sixteen stations off-site. In addition, 256 water samples and 710 soil samples were taken on a routine basis downstream. More accurate dispersion analysis can be made when it is known where radiation releases are made. Therefore, the state is interested in both on-site and off-site surveillance at Rocky Flats and at

the new Ft. St. Vrain generating plant. The AEC is cooperating with this effort.

Through insistence of the state's Department of Health all uranium mill tailing piles were stabilized before the AEC contract was allowed to lapse. The only exception is one in which new milling is expected soon.

The early air surveillance work done by the state on uranium mines was a constructive effort that helped to establish federal occupational standards. Colorado is a good example of how state efforts can sometimes set the pace for federal regulation.

Environmental Control Programs

Air quality and water quality are regulated by the Department of Health. Radiological control of the environment is also administered by a division of the Department of Health pursuant to Chapter 66, Article 26, Colorado Revised Statutes 1963 and as amended in 1965 and 1967.

One new nuclear orientated environmental control bill passed the Colorado legislature in its 1971 session. This is:

SB 208 Radiation Control Act—expands scope of radiation control program to include non-ionizing radiation. This bill is an updating of regulations promulgated by most Western states.

Natural Resources

The geography of Colorado is highly varied. Except for high mountains the state is somewhat arid. The soil on the eastern slope is valuable for agriculture and on the western slope is rich in minerals. Agriculture runs second to manufacturing in the state and mining is third. About one-third of the state is mountainous and forested creating a significant tourist industry. Figure 17 shows the uranium-rich Colorado Plateau and the high-grade Uravan Mineral Belt.

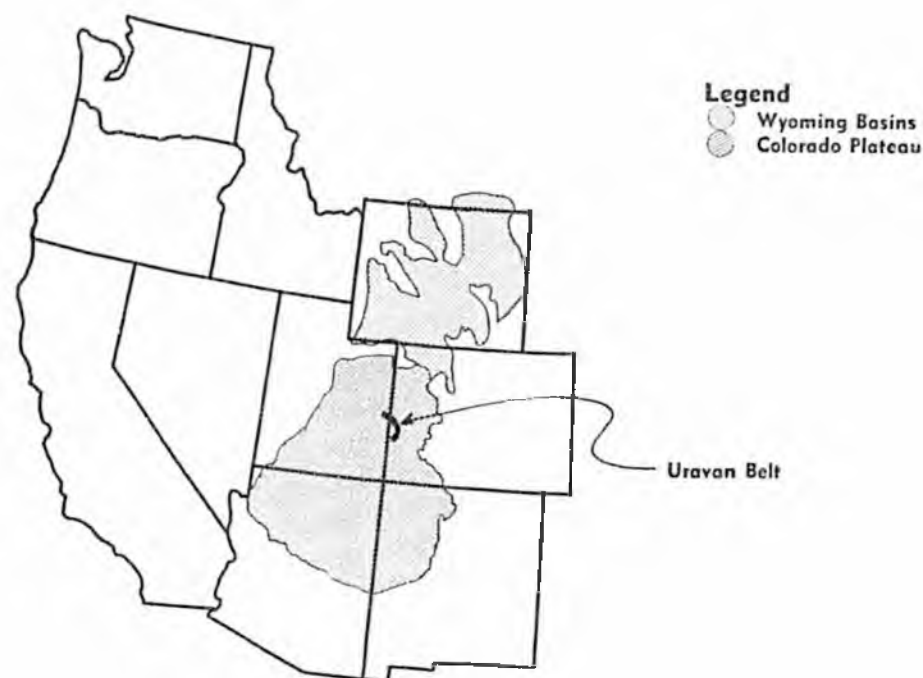
Colorado became one of the first oil producing regions of the West (1862). Now twenty counties produce oil with most of it originating in Rio Blanco County. The oil shale deposits of the Colorado River Valley are estimated to contain 900 billion barrels of oil with some shale richer than 15 barrels per ton. Some of the natural gas found in Colorado is exported to the Northwest.

Much of Colorado is underlain with coal deposits. In the southwest, south central and in the Rio Blanco areas bituminous coal is found. North and east of Denver a large lignite deposit exists.

There are many competing uses for the water that collects in Colorado. With the current growth rate and the growth potential, the water is carefully managed within the state.

Power Needs and Resources

The power needs of Colorado are growing faster than the national average. The Colorado utilities have been able to meet the power needs handily.



URANIUM FIELDS CONSTITUTING 90% OF 1948-1969 PRODUCTION

Figure 17

Even with an 8% annual growth rate, the resource margin for Public Service of Colorado is 28%. When the Ft. St. Vrain generating plant goes on line in 1972, the margin will be even greater. The Ft. St. Vrain plant is shown in figure 18.

The Public Service Co. of Colorado had a rate increase in 1970 for the first time in 15 years. In addition, the rates were restructured to permit metropolitan industrial rates in outlying communities. This is one way in which industrial growth pressure has been relieved from a metropolitan center. The new lower industrial rate was lower in Grand Junction also—an area in which the state is attempting to attract industry and the consequent employment.

The state was very successful in attracting tourist industry. In 1969 an estimated \$36.4 million of new investment was made in winter sports facilities. The number of tourists arriving by plane increased 17.2% in 1969. Industrial development in the state was expected to create 26,000 new jobs in 1970 of which 5,800 would be in manufacturing.

The current estimate for loads and resources in Colorado are tabulated below:

| | 1970 | | 1975 | |
|----------------------------------|---------------|---------------|---------------|---------------|
| | Loads | Resources | Loads | Resources |
| Public Service Co. of Colo. | 1271MW | 1990MW | 2163MW | 2586MW |
| So. Colorado Power.. | 120 | 146 | 158 | 166 |
| City of Colo. Springs | 220 | 226 | 366 | 359 |
| Colorado Utility | 200 | 220 | 250 | 220* |
| Total | 1811MW | 2582MW | 2937MW | 3331MW |

* Plus purchases.

Public Service Co. of Colorado (PSCo) is investor owned and is clearly the leading utility in the state. An addition to the needs of Southern Colorado Power (Division of Central Telephone and Utilities Corp.) in Pueblo will be provided by PSCo. This will be a coal fired 350 MW plant near Pueblo. This will be Comanche No. 1. The plant should begin power deliveries in 1974.

A PSCo project even more noteworthy is the Rocky Mountain's first commercial nuclear power plant, the Ft. St. Vrain Nuclear Generating Station. This plant is scheduled to begin producing 330 MW in 1972. The plant will be a High Temperature Gas Reactor (HTGR) thus it will operate as efficiently as modern fossil fueled power plants.

Later power additions to the Colorado grid are expected to be nuclear if they are in the Denver air shed or coal if they are near Pueblo. There is some natural gas used for power generation. If gas recovery can be stimulated by nuclear detonations such as the Rulison shot, the situation on natural gas reserves would be much brighter.

The Public Utilities Commission of the State of Colorado issues Certificates of Public Convenience and Necessity for power plant locations. There was no opposition at the hearing for this purpose in connection with the coal-fired plant at Pueblo. Lack of opposition was probably due at least in part to the need for an economy stimulus. CF & I Steel Corp. will build an electric steel foundry near the generating station.

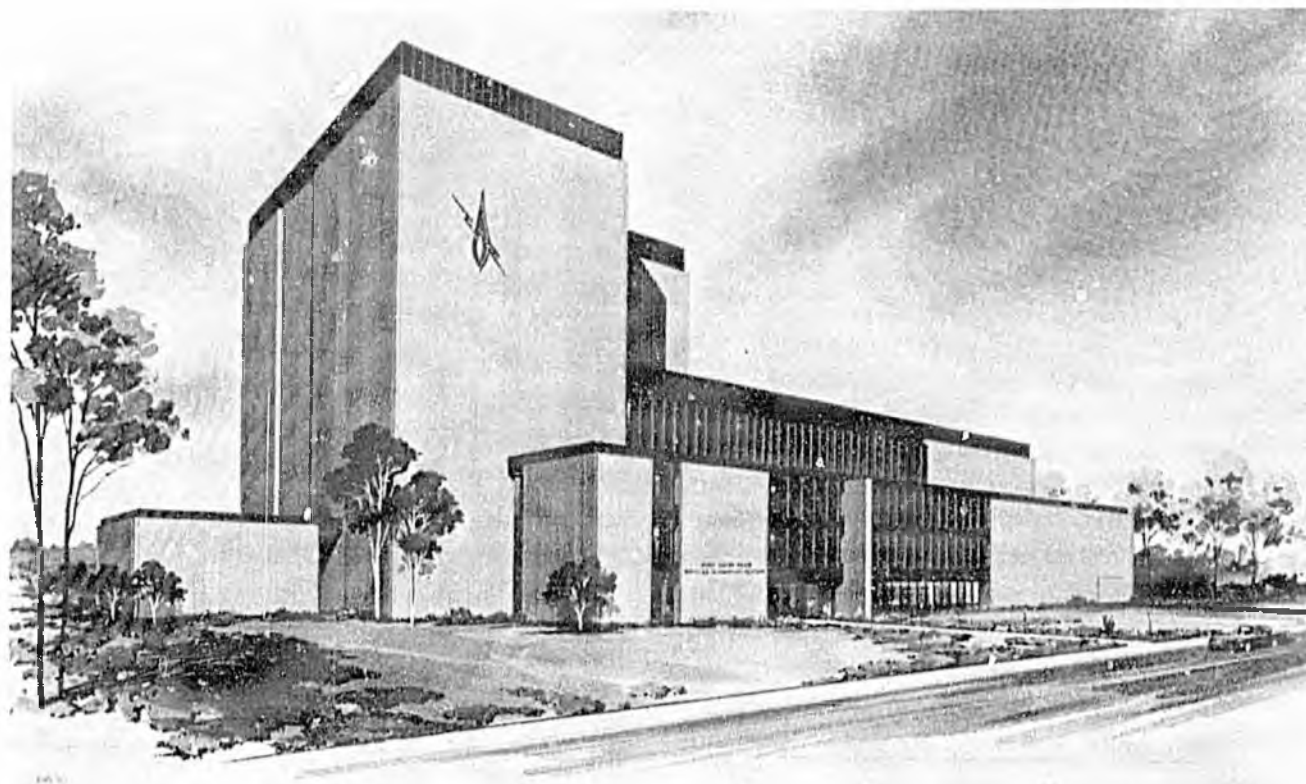


Figure 18
Ft. St. Vrain Nuclear Generating Plant

Desired Nuclear Developments

The Ft. St. Vrain Nuclear Generating Plant will be a welcome alternative to those associated with air quality needs along the Front Range. The high efficiency of this plant and potential for clean operation should make it popular also with those concerned with water management and water quality.

The acceptability of the Rio Blanco Project will be a test of how well the Rulison Project was performed. If the Rulison Project is shown to be adequately beneficial to compensate for the personal disturbances to the citizens then Rio Blanco might be considered a desired nuclear development. If Rio Blanco is simply an underground test creating a disturbing influence with no real benefit then Rio Blanco will not be considered a desirable type of nuclear development in Colorado.

The electronic industry in Colorado could be a contributor to the nuclear industry and should be factored into AEC's procurement system.

Uranium mining activities are sought. The current slow market for uranium affects employment in regions without a diversity of opportunities.

Radioactive waste management is not sought although much of the low level wastes generated in the West originate at the Rocky Flats Plant. The AEC directive regarding where the plutonium wastes should reside is still not clear.

WINB Assistance

1. Attempt to obtain release from the Department of Interior for mining in the uranium-rich Uravan Belt.

2. Attempt to clarify the AEC's position on whether the Rocky Flats Plant plutonium wastes should be sent to Kansas or another location.

3. Conduct a public information program that will assist citizens in member states to become aware of the risks and the benefits of nuclear energy. The good effort by the Public Service Co. of Colorado at the Ft. St. Vrain site is recognized as an excellent information center. Comparable displays regarding Plowshare could be helpful on the Western slope and for those groups involved in Western slope development.

E. Idaho

Idaho entered the nuclear technology field in 1949 when it was selected as site for the National Reactor Test Station (NRTS). The test station is located high on the Snake River Plains 40 miles west of Idaho Falls. The present site covers 571,800 acres. Figure 19 is a 1969 map of NRTS.

During the first 20 years of existence, the NRTS payrolls have totaled over \$500 million. Currently the annual payroll is about \$55 million. In total 48



Figure 19

National Reactor Testing Station

nuclear reactors were built at the NRTS. Many of the reactors were built to demonstrate concept feasibility. Others were built to test beyond the limits of commercial types of reactors. The first breeder reactor and the first submarine reactor were built at NRTS. The breeder reactor, Experimental Breeder No. 1 (EBR-1), was the first reactor used to generate electricity (in 1951) and proved the breeder concept in 1953.

Seven of the 48 reactors are still in operation and two more are under construction. One that is in operation is Experimental Breeder No. 2 (EBR-2). Of the USAEC programs, the breeder reactor system is enjoying top priority. Other important activities at NRTS are at the Naval Reactor Facility with three land-based reactors and at the Test Reactor Area enclosing the Engineering Test Reactor, ETR, and the Advance Test Reactor, ATR.

One reactor that has recently been constructed is the Power Burst Facility, PBF. This reactor as the name implies will test fuel bundles under simulated power excursions. The PBF is a 20 MW light water reactor capable of transient operation after attaining the full power condition. The PBF is due to come to power in the autumn of 1971.

One of the reactors under construction (since 1964) is the Loss-of-Fluid Test (LOFT). The LOFT will be a simulated light water reactor operated under abnormal power and coolant conditions to study causes, mechanisms and effects of simulated reactor

accidents to provide data to the AEC and the nuclear industry.

The other reactor under construction is a critical experiment assembly of a propulsion reactor. The "Cavity Reactor" would utilize gaseous uranium for fuel and heat hydrogen to 100,000° F for propulsion. The experiment is being performed in the same facilities that were built for the Aircraft Nuclear Propulsion (ANP) program in the mid-'50's.

One of the early reactors at NRTS, the Materials Test Reactor (MTR) was directed to be closed down on June 30, 1970. This reactor is fully operable but lacks a sponsor. The USAEC has transferred most of its experiments into the higher powered ETR and ATR. The staff is largely retained pending the outcome of some current efforts to restore the MTR to some duty cycle. The reactor could be useful for 1) university research, 2) protein research, 3) activation analysis (for mercury etc.), 4) neutron radiography, 5) cancer research, and 6) target irradiations.

Spinoff activities from the NRTS have been few in number to date. One that has is an isotopic snow gauge. This involves a gamma source to measure snow pack density for better watershed predictions. Another possible project is an experimental facility for demonstrating the beneficial uses of warm water effluents in horticulture applications.

Idaho has a legislatively constituted body to conduct the nuclear affairs of the state. This body, the Idaho Nuclear Energy Commission, has an appointed

five-member board and an Executive Director. The Commission conducts a public information program, conducts studies and advises the governor on suggested nuclear policies. The advice from the Commission is also available to other state agencies and political subdivisions within the state. The Commission has advanced the interest of industry, agriculturists and educators in the state on many nuclear possibilities.

Despite the fact that NRTS is the largest single employer of engineers in Idaho, the state's growth is most likely to be in agriculture and food processing. The state is already a prime agricultural state and estimates have been made that the irrigated land area could be doubled.

A work force of nearly 6000 persons at the NRTS could assist the growth of the nuclear industry near Idaho Falls and perhaps nationally. The NRTS is an oasis in many respects with a pool of nuclear safety understanding that far exceeds many areas destined to receive a central station nuclear power plant.

Radiation Control Program

Active in radiation control work since the mid-fifties, Idaho became an AEC Agreement State on October 1, 1968. The two-man radiation control budget for this year is \$35,000.

In 1963, the State began a rather comprehensive statewide environmental radiation surveillance network of air, water and milk monitoring for I-131, Sr-90, etc. On August 1, 1969, this network was removed from an "active" status and officially placed on "stand-by". This was due mainly to the very low level of radioactivity being observed in Idaho's environment and the administrative need to channel the staff's talents into more productive areas. These field stations can be reactivated upon short notice. Such was the case in mid-December, 1970, when all samplers were active for a week following an atmospheric venting of radioactivity from AEC underground weapons test in southern Nevada.

Routine environmental radiation monitoring data is shared with the State from daily samples taken by air sampling stations operated by the Environmental Protection Agency (EPA) and weekly samples taken by others operated by NRTS. In cooperation with the EPA's nationwide tritium monitoring network, the State takes a routine quarterly water sample at the discharge point of the aquifer that passes under the NRTS.

The State's main efforts are concerned in the regulation of over 80 firms licensed to use radioactive materials and over 700 facilities registered for use of X-ray equipment. Such an emphasis directly reflects the opinion of state radiation control officers nationally.* As, at the Second National Conference on Radiation Control in April, 1970, the Priorities Committee ranked the importance of medical x-ray and

radioactive material use control first and second, respectively. Environmental radiation surveillance, including monitoring around nuclear plants, was ranked third in control priority. At the same meeting, the Environmental Surveillance Coordinating Committee presented a model state surveillance program. Their report is attached as Appendix E.

The State has become interested in another local industry which, although non-nuclear in purpose, is currently raising the radiation background level throughout southeastern Idaho. The phosphate processing business in Idaho obtains its basic ore from a deposit that is interbedded with uranium ore. During the milling process, it is estimated that around 10 curies/year of an uranium daughter product, polonium-210, is released to the atmosphere from the combined effluents of three phosphate processors. In 1970, a cooperative environmental radiation surveillance study between the State and the NRTS determined the maximum average level of atmospheric polonium-210 to be less than one percent of the State's control limits. Step two of this project will be a cooperative study between the State and the U.S. Public Health Service's Bureau of Occupational Health for a detailed in-plant evaluation of another uranium daughter product: thorium-230. Eventually, two additional aspects will be examined by the state with the aid of the EPA: (a) environmental water study for radioactive contamination of waters in the immediate vicinity of the processing plants; and (b) evaluation of the public health significance associated with agricultural fertilizers containing phosphates that have been mined from geologic strata interlaced with uranium and its daughter products.

Progress has been made reducing the potential risk from radioactive waste at the NRTS. A Task Force organized by the Governor to evaluate NRTS disposal practices concluded that it finds no evidence of any present hazard to the public resultant from the current management of radioactive wastes at the National Reactor Testing Station and, further, believes that no hazard to the public's health will occur in the future provided the plans and programs described in the NRTS' "Special Report to the Governor's Task Force," dated September 1970, are implemented in a timely manner.

The plans and programs described in the AEC's special report include: 1) operation of the improved Waste Calcining Facility heating system previously mentioned and the design and construction of a system to clean up liquid waste that may become accidentally contaminated; 2) establishment of a new solid waste repository (such as that being considered at Lyons, Kan.); 3) improvements in drainage of present waste burial grounds; 4) upgrading of burial packaging procedures; 5) drilling of wells to define the geological structure of the area beneath the burial ground; 6) core hole drilling below the burial ground to check for evidence of contamination below past burial sites; 7) studies of possible recycling of wastes

* HEW-BRH/ORO 70 5 2nd Annual National Conference on Radiation Control. April 26-29, 1970 - Palm Beach, Florida.

to low radioactive concentrations; 8) installation of a sampler on a disposal line running to a low-level radioactive liquid waste disposal well.

It is in the interest of assuring that these changes as planned are carried out and, further, that a direct liaison be established between the State of Idaho and the National Reactor Testing Station that the Task Force strongly recommended the appointment of an advisory committee composed of qualified experts in the field to maintain a continuing check on the management of radioactive wastes at the National Reactor Testing Station.

Environmental Control Programs

Water quality standards are established by the Department of Health. Air quality is under an Air Quality Commission. Without any thermal power plants in Idaho these groups are not much effected by the growing need for electrical power generation.

The northern latitude and the high elevation of the Snake River plain both contribute to a short growing season for much of the agricultural area in Idaho. Therefore, the multi-use of the heated effluent from nuclear plants, hot springs, etc., is of serious interest in Idaho. This is a beneficial form of environmental control available from nuclear plants. Of the markets for BTU's from the low grade steam in the West few could compare with the benefits derivable from a heated greenhouse on an Indian reservation in Idaho. With study and close economic scrutiny it might be shown that the benefits derivable from intensive horticulture could more than pay the price of installing a suboptimal nuclear power plant in this region. Further WINB studies could aid in guiding member states of the redeeming values of suboptimal plants with both economic and social value of using heated effluent therefrom.

While water pollution in Idaho is minimal, strong public, government and industry support has been shown for programs designed to maintain or improve the quality of the lakes, streams and rivers. The adverse effect that the hydroelectric projects have had on migrating fish is likely to force an end to more hydro projects in Idaho especially if the critical nitrogen supersaturation problem is not solved.

Natural Resources

Being the northernmost state on the Western slope of the Rocky Mountains provides Idaho with a preponderous amount of runoff. The Snake River and the Salmon River leave Idaho at 738 feet above mean sea level. Together Idaho has more water dropping a greater distance than any other state in the nation. The hydroelectric potential of 11,729 MW has only been 16% realized. The 1965 Idaho Legislature passed some water resource legislation for the state to plan, design and construct hydroelectric power facilities. The strong conservation movement of the 70's might very well affect the future of this resource.

The broad river valleys are a key resource. Idaho is third in the Pacific Intermountain Region on cash receipts from agriculture. Twice as much land is irrigable than is presently used. Agriculture is clearly a growth industry in Idaho and will account for a growing amount of power for irrigation development.

The minerals in Idaho are of national significance. The state ranks:

- 1st in silver mining
- 2nd in lead mining
- 3rd in zinc mining

One of the world's largest phosphate deposits is near Conda, Idaho. The state also has uranium and thorium deposits although neither have attracted much commercial attention to date. The mining employment has dropped 40% from 1950-1965 due to mechanization, depletion of reserves and foreign competition.

Power Needs and Resources

During 1970 the peak power needs in Idaho were slightly over 1200 MW. The system is expected to grow steadily with a 16% population growth during the next decade and the continued irrigation development. Manufacturing is also expected to continue to grow at a steady pace. Idaho has never been short of electrical power due to the vast amount of hydroelectric power available. It has become customary in Idaho to plan power resources only five (5) years in advance of their need. This time span planning automatically preclude nuclear power since site approval and plant construction cannot be readied in five years. The Federal Power Commission has now requested ten-year plans and twenty-year projections to relieve this very problem. However, even a twenty-year plan would probably not show a nuclear power plant in Idaho if only 1000 MW plants are considered. It is conceivable that suboptimal nuclear plants can be justified at an earlier date if multiple use with agriculture is considered.

Idaho constitutes a basic part of the Pacific Northwest power supply and use. A more in-depth review of the pacific northwest power supply system is presented in Appendix F.

The power generation resources in Idaho are operated by ten organizations. All are hydroelectric. They include:

| | |
|-----------------------------------|-------------------|
| Idaho Power Co. | 1,295.9 MW |
| Washington Water Power Co. | 221.3 |
| Utah Power and Light | 101.3 |
| U. S. Bureau of Reclamation | 163.9 |
| All Others (7) | 89.0 |
| Total | 1,871.4 MW |

Idaho Power Co. has contracted for half of the 1000 MW to be produced by the Bridger No. 1 and No. 2 plants. These plants will be minemouth coal-fired plants located near Rock Springs, Wyoming. This will be the first electrical generation using

fossil fuel by the Idaho Power Co. These plants will be completed in 1974.

Desired Nuclear Developments

Idaho welcomes new industries, nuclear and non-nuclear, that are an asset to the State's environment. Idaho is especially interested in prototype fusion plants and isotope enrichment facilities to supplement the testing, training and processing facilities now at the National Reactor Testing Station.

In an effort to give more attention to spin-off activities, the business community has formed an Eastern Idaho Nuclear Industrial Council.

The Governor of Idaho is anxious to obtain better data on the Idaho snowpack and plans to assist in the funding of the installation of a prototype isotope snow gauge on Mt. Baldy in Sun Valley the winter of 1971-72. The USAEC plans to build three (3) field units and one base station. One field unit will go to Mt. Baldy and the base station will initially go to the scientists at the NRTS. The location of the other two field units has not been determined at this time. The technical details are given in a booklet, *Transactions of the Isotopic Snow Gauge Information Meeting* which was held in Sun Valley on October 28, 1970.

The most desired reactor project in Idaho in many years is restoration of a power cycle on the Materials Testing Reactor. It has been proposed that the MTR be renamed the Western Beam Research Reactor, WBRR, in keeping with a proposed new role. The MTR is well equipped to perform neutron beam research for scientists throughout the world. The desire to see the MTR operable and available for experimental work is backed by:

1. The Federation of Rocky Mountain States.
2. The Western Conference of the Council of State Governments.
3. Western Governors Conference.
4. State of Idaho
5. Associated Western Universities.
6. Idaho Nuclear Energy Commission.

A current study is underway by two scientists from the University of Utah to identify the MTR as a National Neutron Center for Interdisciplinary Research. This study is scheduled to be completed before July 1, 1971.

WINB Assistance

1. To Idaho the Materials Test Reactor is a base for local and regional scientists to make both basic and applied scientific contributions. Any assistance WINB can provide will help to restore this valuable nuclear tool to its rightful place in the scientific community of the West.

2. The industrial diversification efforts in Idaho Falls and other communities adjacent to the NRTS have not been able to effectively take advantage of spin-off industries. WINB is requested to assist the EINIC (Eastern Idaho Nuclear Industrial Council).

3. The predominant type of reactor being built

in the Western states is light water reactors. The increasing number of these reactors has increased the importance of water reactor safety. WINB is encouraged to take a position of supporting the need for water reactor safety programs and in particular the Loss-of-Fluid Test. A program acceleration should be considered.

4. Limitations of uranium deposits in the U.S. and the possible problem of meeting our growing power needs with plutonium breeder reactors seems to make it prudent to occasionally review the status of the thorium cycle. Some basic information needed on the thorium cycle was stopped when the MTR was shut down. To permit meaningful review of the thorium cycle and similar long term needs, WINB should encourage the AEC to temper its priorities to permit a continuation of funding on some basic research programs.

F. Nevada

Nevada is the fastest growing state in the nation. From 275,000 citizens in 1960, Nevada has grown to nearly a half million and is expected to exceed one million before 1980. The principal growth has been in Las Vegas and Reno but future growth would involve new cities also.

Industrial development is welcome in Nevada. A nuclear industry serving Nevada and California would be desirable additions. One of the two licensed radioactive waste burial sites in the West exists near Beatty, Nevada. This site, managed by Nuclear Engineering Co., is fenced, maintained and appears to be an acceptable operation in all respects.

The U.S. Atomic Energy Commission's Nevada Test Site, located 65 miles northwest of Las Vegas, is the nation's outdoor nuclear explosives laboratory. The Test Site was established as the on-continent proving grounds for weapons development testing. Its use has been expanded to include many other programs, most of them related to nuclear detonations. Some programs involve radiation studies which can be best conducted in a remote area.

The site was chosen after an intensive survey of many possible sites throughout the United States. It was determined that under careful control, this area could be used for relatively low yield atmospheric nuclear detonations with safety. The site satisfies best the requirements for a location in an area of low population density, good weather conditions, Government-owned land, accessible labor supply, and security.

Since 1962, all weapons tests at NTS have been conducted underground. Under the terms of the Limited Test Ban Treaty signed in Moscow on August 5, 1963, only underground tests are permissible. A total of 518 nuclear detonations have been announced by the United States. Of these, 405 have been conducted at the Nevada Test Site; 230 since the Limited Test Ban Treaty. The AEC has announced

217 underground tests at the NTS which have been designed to be contained. Of these, 17 released some radiation which was detectable outside the controlled Government area. The latest release was December 18, 1970, and was detectable in several of the Western states. All nuclear tests at the Nevada Test site are conducted under very stringent controls to assure the health and safety of workers on the test site and the public.

The development of nuclear explosives for peaceful uses is one of the major projects at the NTS. Tests have been conducted to develop technology for the use of nuclear explosives to stimulate the production of natural gas from deeply buried, low permeability formations; for excavation; for in-situ leaching of low yield ores; and for possible use in the development of geothermal power. The Plowshare Program has conducted 25 tests at the NTS and at other locations in the United States. The program is conducted in cooperation with American industry and other federal and state government agencies.

Adjacent to the NTS is the Nuclear Rocket Development Station, NRDS. This operation has been funded jointly by AEC and NASA through the Space Nuclear Systems Office (SNSO). The principal contractors have included Westinghouse, Pan Am, and EGG, Catalytic Construction. Los Alamos Scientific Laboratory has been a guiding influence on the program. The Space Nuclear Systems Office, SNSO, has been the object of gross budget cuts in recent years. The cut expected this year will provide for little more than a caretaker action waiting for a mission to use the facilities for nuclear rocket testing. Technical and safety success on the program has been outstanding. In total, over 30 million gallons of liquid hydrogen have been used under test conditions in the past eight years without a single lost-time accident.

The nuclear rockets are being developed to serve space exploration missions that are beyond the capabilities of chemical rockets. It is anticipated that efficiencies are obtainable with nuclear rockets that are twice those attainable using the best chemical rocket engines. Nuclear rockets have been under test in Nevada since 1969. To date, 23 experimental reactor and rocket tests have been conducted at the Nuclear Rocket Development Station (NRDS).

During fiscal year 1971, only the PEWEE 2 nuclear reactor was scheduled for testing. As funding permits, a special critical assembly will be tested. The assembly is referred to as a "Nuclear Furnace." This assembly is intended to permit concentration of the test program on fuel elements. In the "Furnace" the fuel elements are readily replaced but the basic reactor assembly survives.

The peak nuclear rocket power level achieved to date was for 12 minutes in 1968 at 4100 MW (t). The longest test was for one hour in 1967 at 1100 MW (t).

During fiscal year 1971, it was planned to test PEWEE 2 at powers up to 360 MW (t) for short

periods not to exceed two hours over a period of one or two months.

During testing, hydrogen is passed through the reactor core and heated to 4000° F. In the process a fraction of the fission products manage to escape through the fuel element coatings and escape through the nozzle and are burned with the hydrogen. Since the operating time is short, the total fission product release to the atmosphere each year is small. Scrubbers are being developed that will make the release even smaller.

Because of the nature of the testing and to insure public safety in the event of an abnormal action, the tests are conducted on a remote part of the Nevada desert about ninety miles northwest of Las Vegas. During the test firing portion of the program, representatives of the AEC's Nevada Operations Office, the Southwest Radiological Health Laboratory, the U.S. Department of Commerce Air Resource Laboratory and the Chief, Space Nuclear Systems Office-Nevada (SNSO-N) meet jointly to insure that the testing is carried on in such a manner that assures that radiation exposures both on-site and off-site are as low as practical and in any event below the Federal Radiation Council guidelines. The best control available to this group is to wait for favorable meteorological conditions and to be able to interrupt the tests should the weather turn unfavorable. The panel has managed to keep releases within 4 to 5% of the FRC guidelines at the boundary of the test area. Since the population outside the test area is sparse, it is unlikely that any individual received even that exposure. Tests are carried out under meteorological conditions and forecasts most favorable for minimizing any potential off-site exposures. In all tests to date, releases beyond site boundaries have been substantially below Federal Radiation Council guidelines.

Prior to the conduct of a test series, a public announcement is made by SNSO-N. The Southwest Radiological Health Laboratory (SWRHL) provides the monitoring program at the site boundary.

Presence of the large work force in Nevada, trained in nuclear science, creates a potential for growth of nuclear enterprises in the state.

The Public Service Commission has been given legislative authority to rule on the siting of power plants whether fossil or nuclear. They recognize that a balancing effort needs to be invested somewhere in the state government and that they could perform this function well by conducting hearings prior to issuing certification. The authorizing legislation, Senate Bill 287, is presented in Appendix G.

Radiation Control Program

Nevada may become an agreement state as early as 1972. Funds for entering into this accord were in the 1971 Governor's budget request @ \$34,000/year and approved by the legislature.

The state does routine sampling of milk and food.

In the event of an accident, they would also sample the air and water. They are prepared also to do some whole body counting.

Presently the EPA does the radiological surveillance work in Nevada. The same group monitors the radioactive waste management site near Beatty and plays a part in monitoring the perimeter of the AEC's Nevada Test Station. The State Bureau of Environmental Health has registered 300 X-ray machines and has licensed 45 users of radioactive isotopes.

Environmental Control Programs

The State Bureau of Environmental Health controls both air and water pollution. The Mojave coal-fired generators will be tough on both air quality and water quality. The first unit is in operation now. The second will be in late 1972. The water quality is controlled in like manner to other plants upstream on the Colorado (i.e. the plant is cooled by a cooling tower and the blowdown water is drained off into a seepage pond instead of being returned to the Colorado). This is an extra consumptive use but keeps from increasing the concentration of chlorides, sulfates and sodium.

At the Nuclear Rocket Development Station an extensive environmental control program has been underway since 1959. Both air sampling and direct radiation measurement equipment is posted three and fifty miles downwind from the test stand. Data accumulated during the years of operation have been factored into the test planning. Meteorological forecasting around the site is now very sophisticated.

The Southwest Radiological Health Laboratory, SWRHL, now part of EPA, will alert neighboring states if it appears that they will be affected by a release of radioactivity from the site. The SWRHL has an extensive radiological surveillance program. They sample air, water, soil, vegetation, animals and milk. They work in concert with Bureau of Radiological Health and the U.S. Public Health Service. A relationship with WINB apparently is not yet established. The SWRHL alert system should be examined for applicability of WINB needs.

Natural Resources

Historically Nevada has been famous for its extractive mining. Although mining continues to be a healthy industry in Nevada, automation has decreased employment in this field.

The new Nevada has an image of vacationland. Las Vegas continues to be an active convention center. In addition, ski resorts are being established near Reno and other scenic parts of the state. The clean air and open spaces will keep the state popular for sportsmen for decades.

The Colorado is the only river that flows through the state. Other rivers flow into the state and sink into the Great Basin. In White Pine County there are huge deposits of copper that are virtually untapped. A large underground water supply is re-

ported to exist in the area. A new 238 KV transmission line will be the first electrical power available to the area. Previously, the nearest high voltage line had been in Elko about 100 miles north. With power generation and pumped water in the region, the copper resources might be better utilized.

Geothermal fields exist in a number of places in Nevada. With passage of the Bible Bill in 1970, exploration and utilization of these fields has been stimulated. One field 70 miles east of Reno is now being utilized. Where combinations of hot rock formations are found downstream from underground water supplies electrical power can be established in parts of Nevada for creating new mining ventures.

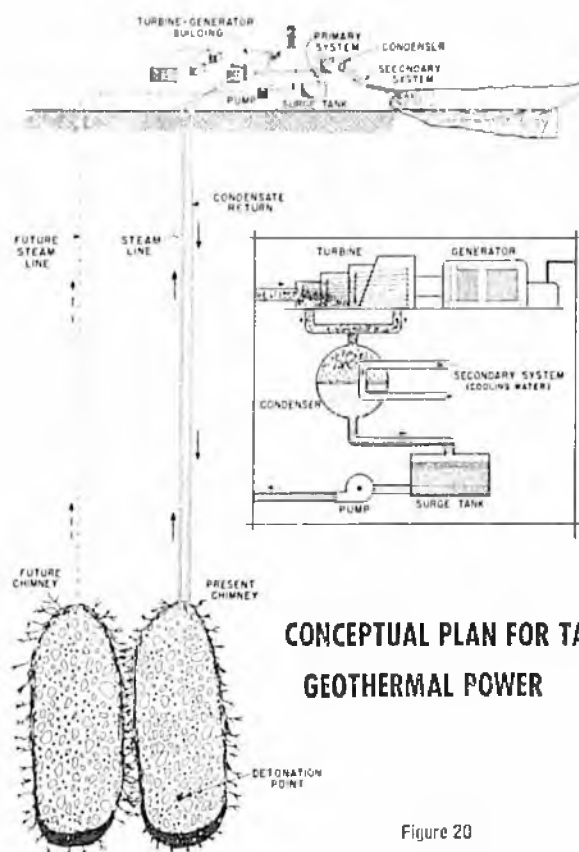
Power Needs and Resources

Nevada's power needs are expanding rapidly with the rise in the state's population. The load growth rate is expected to be at least 8%/year. Although Hoover Dam is within Nevada, only a fraction of the power is left in Nevada—most is sent to California. The principle power loads (Reno and Las Vegas) are near the state borders thus are very involved in interstate power sharing. Besides the new Mohave Power Plant, other fossil fueled plants are planned for Arrow Canyon (northeast of Mead) and near Yerington on the Walker River. This site had previously been considered as a nuclear plant site. The Nevada Power Company owns not only a share of the Mohave plant but also owns a share of the Four Corners plant near Page, Arizona. By 1973 Nevada Power will be able to produce 1000 MW and Sierra Pacific Co. about 800 MW.

Geothermal power enhancement using Plowshare techniques could be a natural for Nevada. The state has:

1. A scarcity of transmission lines and only a few penetrations from the south, west and north. Thus much of the state is without electrical power and needs generation capabilities.
2. Considerable geothermal fields are known to exist in many parts of the state.
3. The citizens and the state government are familiar with underground nuclear detonations.
4. Many of the areas of the state that need new power generation are adequately remote to permit sizeable underground detonations.

The fourth point is important to economic realization of geothermal power. A small device is nearly as expensive as a large device. Where considerably more rubble can be created with a large device at nearly the same costs, the economics favor the largest device that is acceptable by seismic standards. The compound benefit of multiple shots is not yet proven. It is possible that a series of small devices can adequately serve the power needs of a region for many years. A conceptual illustration of a geothermal heat recovery system is shown in figure 20. Capacity of such systems would probably range from 100 to



CONCEPTUAL PLAN FOR TAPPING
GEOHERMAL POWER

Figure 20

500 MW (e). The turbine and generator would most likely be moved by railroad track radially out from the high seismic shock zone during detonations. The principal advantage of geothermal power is the lack of fuel cost. The Bible Bill provides leasing of federal lands for this purpose but does stipulate a 15% royalty charge on power sales. The full extent of Nevada's geothermal potential will probably not be known for several years.

Copper ore leaching is similar to tapping geothermal heat. The principal difference is that sulfuric acid is poured on the rubble instead of water and the product is copper sulfate instead of steam.

Desired Nuclear Developments

Continued funding of the activities at the Nevada Test Station and the Nuclear Rocket Development Station are the most significant needs for continued nuclear activities in Nevada. Even though the nuclear rocket program has no immediate mission, a programmatic interruption could have long-range adverse effects on this nation's most prestigious program—Space Exploration. Continued development even on a limited scale would permit retention of a rare blend of aerospace and nuclear scientists with 10 years of successful experiences.

The facilities at both NTS and NRDS should also be useful for assisting AEC programs in which shielded cells are needed. The hot cells at NRDS are elaborate enough to take a full scale Nerva engine

and reduce it to metallographic specimens. The investments existing at NRDS (i.e. sectioning and metallographic facilities) could aid the fast breeder reactor program.

The large cells could be used to test simulated recovery systems for shipping accidents. The NRDS has been collecting remote controlled equipment from various AEC programs and has developed expertise in this area. Figure 21 is an example of a versatile remotely controlled tool developed at NRDS. This tool has been dubbed SAM. SAM could be easily flown to the scene of a shipping accident. The class of accident in which such equipment might be needed is one in which emergency squads cannot approach the radiation source—such as Co-60 or spent fuel. Comparable equipment is not believed to exist anywhere in the U.S.

The Thresher incident has prompted the U.S. Navy to better prepare in advance for credible accidents. Time required to develop recovery equipment after a spent fuel shipping accident may unnecessarily prolong the cleanup and decontamination for months or even years.

Other nuclear developments desired in Nevada include:

1. Development of satellite industries for the West Coast nuclear power plants—such as fuel reprocessing and radioactive waste management.

2. Nuclear power plant when needed to meet domestic power needs and export potential (probably in the '80's).
3. A demonstration that Plowshare-Geothermal is an economic, safe and useful source of power generation.

WINB Assistance

To secure the nuclear future of Nevada, it is desired for WINB to:

1. Examine the AEC facility needs to determine if the NRDS facilities can be utilized and maintained. (Ref: Remote Systems Topical Meeting in Idaho Falls on Examination of Fast Reactor Fuels 1968).
2. Examine AEC's state of preparedness for coping with serious shipping accidents. Determine what remote equipment would be needed, what is available and who has authority for its use.
3. Encourage the AEC to continue development of cleaner nuclear devices for Plowshare applications such as geothermal. The AEC should also be encouraged to demonstrate the benefits derivable from multiple detonations in the same rock formation.
4. Examine the schedule for future needs related to fuel reprocessing and radioactive waste management.

G. New Mexico

The Nuclear Age was born in New Mexico on July 16, 1945, with the world's first atomic device

was detonated. Since then, New Mexico has been a leader in scientific and technical research. Sixteen major research and scientific centers provide a professional environment in the nuclear, electronics and aerospace fields. The post-war federal funding in New Mexico has created a vigorous and continuing economy.

The population of New Mexico has grown from 951,000 in 1960 to 1,016,000 in 1970, a rate of 6.8%. Over the next decade a growth of 15% is forecast by some state leaders. Success in attracting pollution-free industries to the technologically orientated state has provided a growing job market in an unspoiled part of the West.

Typical of the nuclear oriented industries in New Mexico are:

Sandia Laboratories—a government-owned, company-operated laboratory to provide non-nuclear hardware to weapons laboratories such as Los Alamos Scientific Laboratory and the Lawrence Radiation Laboratory. Sandia is the largest civilian employer in New Mexico with 7,000 employees.

Los Alamos Scientific Laboratory—a government-owned laboratory operated by the University of California. The laboratory is engaged in research on nuclear devices, biophysics, nuclear rocket development and currently is the site of a new meson accelerator. The laboratory employs about 4,000, one-third of which are scientists and engineers.

Lovelace Foundation for Medical Education and



Figure 21

NRDS MOBILE CONTROL UNIT

Research—a research and teaching institution concerned with radiation effects on animals and humans.

USAF Weapons Laboratory—the focal point of Air Force nuclear technology. The laboratory and the Special Weapons Center are major portions of the Kirkland AFB.

Enviroco—designers and manufacturers of laminar flow clean benches, clean rooms, etc. This company is a spin-off industry from Sandia and serves an international market.

Eberline Instrument Corporation—designers and manufacturers of specialized radiation detection instruments providing comprehensive field and laboratory services. Eberline contracts to provide safety assurance around radiation sources for both public and private agencies.

Energy Conversion Systems, Inc.—designers and manufacturers of heat pipes (metal tubes that are equipped internally to provide axial heat flow with practically no temperature gradient). Heat pipes were invented at the Los Alamos Scientific Laboratory.

Similar non-polluting industries are vigorously sought including an expanded tourist industry.

The clean air of New Mexico is now being threatened—much to the chagrin of many that were attracted to the state's blue skies and distant horizons. The new threat is from the burning of coal in gross quantities in the northwest corner of the state. Smoke from the Four Corners area has been reported to be a problem even at the Sacramento Peak Observatory nearly 300 miles distant diagonally across the state. There are five coal-fired units in operation now and three more scheduled. About 150 miles west, near Page, Arizona, another strip mine is scheduled to fuel a minemouth plant and 12 miles north of Lake Powell (on the Kaiparowitz Plateau in Southern Utah) still another. These plants were discussed in more detail in the section Growth Patterns in the West. The point to be made here is that more than adequate power generation is available in New Mexico by virtue of the coal deposits on the Navajo Indian Reservation in the northwest corner of the state. And that with the small fraction of generation already installed in the Four Corners area the populous of the state is already disquieted. New air quality standards may be enacted to tighten air quality more. Already \$4 million of the latest plant cost of \$70 million were invested in air quality equipment.

Radiation Control Program

New Mexico is not yet an Agreement state. Enabling legislation was signed on April 13, 1971. The radiation control staff already has considerable competence. Their many years with uranium mining surveillance has earned the staff a good understanding of how the behavior of miners affects the amount of inhalation and ingestion of radon and its daughters.

The state supplies data to the U.S. Public Health

Service for the epidemiological study on uranium miners. This study is centered in Salt Lake City and involves Wyoming, Colorado and Utah miners also. The mines in New Mexico are under the surveillance of the State Mine Inspectors Office. The Mine Inspector has a two-man staff that makes measurements. Airborne contamination at working stations are the principal measurements. The concentration is expressed in terms of working levels. Using present techniques, the precision of the measurement is 0.25 and variations within the mines are even greater. The U.S. Bureau of Mines current standard of 12 working level months/year is being challenged by the Federal Radiation Council which is recommending 4.0 working level months/year. Currently, most of the Western states are working with different standards. Federal ruling on the 4.0 working level months/year was due to be effective January 1, 1971, but was postponed. WINB should take a position on this vital health issue.

Most miners work under contract rather than as employees. Their pay depends on progress measured in footage and grade. Some miners can earn \$25,000/year if they are not encumbered with respirators etc. Therefore the principal way of reducing exposure is with ventilation techniques. Considerable variation in ventilation provisions exist among companies and between states. For some companies considerable expense is yet to be incurred to provide adequate ventilation. It would seem that some companies would await a determination of the standards before they install any new ventilation equipment. Therefore, expediency in setting a new standard is important.

Development of respiratory protection equipment has been started at the N.M. Dakota mine facilities. More development should be conducted, and on a priority schedule.

Environmental Control Programs

Conservation groups are popular in New Mexico. One of their recent targets is coal burning in the Four Corners area. Both air and water quality control in the state are under the Board of Health and Social Services. The Board regulates both particulate emission and sulfur oxide concentrations. Even though the coal is 20% ash, the particulate emission appears controllable, with hot-side electrostatic precipitators, to 99.5%. By the fall of 1971, flyash compliance is expected on units -1, -2 and -3; by 1973, on units -4 and -5.

Sulfur oxides are limited to 0.03 ppm (tested as sulfur dioxide) as the annual geometric mean and 0.14 ppm as the 24-hour average. Even though the coal is "low-sulfur", the 5 to 10 million tons/year of coal burning in that corner of the state may press this limit. The merit of the low sulfur limit is questioned by a Los Angeles consultant who witnesses a portion of the 10 million people in the South Coast Basin enjoying a healthy life with at least that much

sulfur dioxide regularly. He is reported to believe that even 5 ppm is not unhealthy. Since sources of sulfur dioxide would enter New Mexico from coal-burning plants in Arizona and possibly Utah also, the Board of Health and Social Services is attempting to have the federal government consider the Four Corners area a Federal Air Quality Region. The capacity of the region to receive an "acceptable" amount of gaseous and particulate pollutants will probably take years to determine. Therefore, the nuclear/coal power plant mix in the Southwest will remain a matter of conjecture for several years.

Natural Resources

About one-fourth of New Mexico is mountainous and forested. The northern half of the state is a popular recreation area and the southern half a productive agricultural area with several federal reclamation projects.

Extractive mining accounts for a major share of the state's export commodities. Oil and gas are produced in the southwest corner of the state and coal in the northwest corner. Until recently, natural gas was used to produce 98% of the electrical power production in the state. Coal is now replacing gas to meet the new electrical generation needs.

New Mexico has traditionally produced over half of the uranium ore mined in the U.S. The ore is high grade and is located in Valencia and McKinley counties near Grants, New Mexico. The current uranium production utilizes over 880 miners. Strip mining is most common.

Power Loads and Resources

The principle utility in New Mexico is Public Service Co. of New Mexico. The company is investor-owned which enables it to easily enter into contracts with other private utilities in the West such as Arizona Public Service Co. Arizona Public Service Co. is the owner of the first three coal-fired units in the northwest corner of New Mexico. The largest generating plants to be built in New Mexico are a pair of 755 MW coal-fired plants at Four Corners. These two plants will be equipped with hot-side electrostatic precipitators guaranteed to remove 99.5% of the flyash even on low sulfur fuels. These two plants are owned by:

- Arizona Public Service Co.
- Tucson Gas & Electric
- Salt River Power District
- El Paso Electric
- Southern Calif. Edison, and
- Public Service Co. of New Mexico

Of the 1500 MW from this pair of plants, P. S. Co. of New Mexico will obtain 200 MW; Arizona Public Service Co., 225 MW; and Southern Calif. Edison, 768 MW.

Later, by 1976, Public Service Co. of New Mexico will share with Tucson Gas & Electric half of another

pair of plants totaling 660 MW.

This active construction schedule will easily meet the growth needs of P. S. Co. of New Mexico—even though the growth rate will be higher than the national average of 6.9%. The average annual load growth over recent periods is

| | |
|-----------------|------|
| 1960-1964 | 12% |
| 1964-1965 | 10% |
| 1966-1970 | 7.8% |

The summer peak in 1970 of 403,000 MW was easily met. Industrial development in New Mexico will not be stifled for lack of electrical generation capabilities.

The New Mexico Public Service Commission, PSC, issues certificates of Public Convenience and Necessity for the construction of generation facilities that belong to New Mexico private utilities. In keeping with recommendations of the National Association of Regulatory Utility Commissioners, the PSC is encouraging enactment of SB 323. This bill would provide for environmental judgment to be a factor in plant siting approval. A copy of the NARUC resolution is presented as Appendix A. Even though the PSC is aware that special expertise is needed to make environmental judgments, they feel that they can call on other state agencies to make the determinations. It is likely that passage of SB 323 would precipitate another bill similar to Washington's SB 49 that would form a Power Plant Siting Council to make a formal environmental determination on behalf of the state.

Without need for a nuclear plant in New Mexico for 20 to 30 years, the siting problems are restricted to other thermal plants. Without jurisdiction over out-of-state utilities, it is not clear how PSC can enforce environmental judgments uniformly. It appears that air and water standards, and enforcement thereof by the Board of Health and Social Services, will be the guiding influence in power plant siting and operation in the near future of New Mexico.

Desired Nuclear Developments

A continuation of the federal establishment in New Mexico is desired to provide the base economy. Spinoff industries such as Enviroco, Eberline Instruments and Energy Conversion Systems are desired to provide growth industries.

Providing the air quality degradation at Four Corners does not become too severe, nuclear power plants will not be needed in New Mexico for 20 to 30 years. There is some thought that the first nuclear plant for New Mexico will be a breeder reactor.

El Paso Electric is reportedly interested in considering a nuclear power plant for their next system addition. If siting in Texas or Oklahoma is a problem during the next 10 to 20 years, New Mexico could be chosen. This would be considered a desirable industry addition providing it met the health standards of the state.

The University of New Mexico Medical School and

Graduate School both have outstanding nuclear programs. The medical school curriculum for training nuclear technicians is the first to be approved by the American Medical Association's Committee on curriculum. The state is making an overt effort to remain a leader in the field of nuclear education.

WINB Assistance

1. There appears to be margin for considerable improvement on respiratory protection for uranium miners. WINB should encourage the expenditure of federal research funds to understanding and controlling aerosols that carry radon and its daughter products, the engineering of respiratory protection equipment, etc.

2. The graduate program at the University of New Mexico has an insatiable thirst for technical problems to tackle for the subjects of theses. WINB identification is desired of practical nuclear-oriented problems needing study.

3. A system for stimulating the spinoff of industries from the federal establishment is sought by the Department of Development. The success of such industries is proven in New Mexico but the abundance is not yet enough to stabilize the civilian economy. The Department of Development also wants to be kept advised of potential new nuclear industries seeking a location.

4. Assistance by WINB is desired to help the Public Service Commission develop power plant siting legislation.

H. Oregon

The state of Oregon had an early start on electrical power generation and distribution. The first hydroelectric plant was built near Portland in 1888. In 1889 the world's first direct-current long-distance transmission line was in use to transmit power from Oregon City to Portland. A year later the equipment was converted to alternating-current and became the country's first long-distance alternating-current transmitter. In 1970 the emphasis was back to direct-current. On August 25, 1970, Secretary Hickel of the Department of Interior dedicated the longest direct-current transmission line in the world. This line is 750 KV and crosses Oregon as it stretches from the Columbia River to Los Angeles. This regional intertie helps to satisfy Oregon's peak power needs in the winter and the summer peak in Southern California.

Oregon has not maintained its leadership on electric power production but instead has succumbed to the federal initiative to dam the Columbia. The power production within Oregon is no longer enough to meet even the domestic needs of its citizens. Industrial loads are heavily dependent on federal power projects. The federal power rates have helped to foster industry in the region. The residents of Oregon have also become accustomed to the low price electrical power. In fact, the individual Oregonians

use more than twice as much electrical power for domestic purposes as the average American. In the next twenty years domestic use per capita is expected to nearly double again. The high use of electrical power in Oregon is due in part to the expense of alternative fuels. Oregon must import both natural gas and oil.

Geographically Oregon is a state of topographical contrast. From east to west is found an arid desert, the Cascade Mountains, the Willamette Valley, the Coast Range and the coast. The ocean along the Oregon Coast is normally between 50-55°F throughout the year which helps to create a mild climate in the western part of the state. The coastal range has a high rainfall but is more favorable for steelhead propagation than for hydroelectric power generation. The Willamette Valley, with Portland at the north end, houses 70% of the Oregonians. The Cascade Range is a recreation center and the scene of many multi-purpose hydroelectric projects. East of the Cascades is a vast plateau ranging from a few hundred feet elevation along the Columbia River on the north and 2000 feet along the Snake River on the east to 4000 feet near the Cascades.

As the Columbia River leaves Oregon and enters the ocean, it has an average streamflow of 196 million acre-feet (175 billion gallons per day). In streamflow, the Columbia is second only to the Mississippi. The river is used to convert the interior arid lands of Washington and Oregon into highly productive crop land. The hydroelectric projects on the Columbia permit slack water navigation along the full northern border of Oregon.

Water is the primary resource not only for the production of electricity and navigation but also for commercial fishing and recreation. The commercial fishing in Oregon is over a \$23 million industry. The tourist industry in 1970 amounted to over \$250 million. By 1985 employment in the tourist industry in the Northwest is expected to exceed both the forest and agricultural industries.

Radiation Control Program

Oregon became an Agreement State on July 1, 1965. The Radiation Control staff continues to grow and strengthen its control of radiation within the state. During the next biennium, \$325,000 will be available to a staff of 7½ professionals and 2½ secretaries.

The Radiation Control Program is under the State Board of Health. There is available to the Radiation Control staff a Radiation Advisory Committee composed of:

- 2 — medical doctors
- 2 — radiologists
- 1 — pathologist
- 1 — physicist, and
- 3 — industrial representatives

In addition a Radioisotope Panel is available

which is composed primarily of medical doctors. The Panel assists in determination of acceptable isotope uses for medical applications.

One effort that will be undertaken during the next two years is establishment of a system for registering operators of X-ray and fluoroscopic equipment. If the federal HB-1013 is passed, this task will be greatly simplified.

Nine Oregon counties utilize the Columbia River after it leaves the AEC's Hanford Reservation. Isotope releases from Hanford have been charted over the past eleven years. In addition Zn-65 releases are measurable along the entire Oregon coast. Although no danger is known to exist, this is an interstate matter of special concern to Oregon. The Snake River, which accepts water from the aquifer under the AEC's Idaho site, is a potential threat also but it too does not represent a danger at this time. Oregon has a vested interest in the activities at each of the AEC sites.

The Hanford Reservation is known to be attracting nuclear industries of all types. When another fuel reprocessing plant is added, monitoring stations in northeast Oregon should be expected due, in part, to the predominant northeast wind.

The Radiation Control Staff is working with the Washington Department of Ecology to establish a program for radiological monitoring on both sides of the Columbia River around the Trojan Plant.

Environmental Control Programs

Both air and water quality control is enforced by the Environmental Quality Commission. This Commission is currently composed of five citizens who meet on a monthly basis. The Commission has a professional staff, the Department of Environmental Quality, DEQ. The DEQ is the fastest growing department in Oregon government.

In Oregon the opportunity exists to save many lakes, streams and rivers before their pollution tolerance is exceeded. Thus the Department is funded to the extent necessary to stop any further degradation. The Department also recognizes the need for adequate electrical power to execute environmental control programs. Therefore, nuclear power plants in Oregon are partially justified for environmental reasons. Other nuclear activities such as fuel reprocessing plants would encounter some stiff resistance in Oregon. Even establishment of a remote central location for radioactive waste management has been thwarted in one part of the state.

To date little has been done in Oregon to monitor pollution using radioactive sources. It is doubtful that isotopes in any form will be generally welcomed in Oregon until a larger segment of the public has an opportunity to become better informed.

Natural Resources

Oregon itself is a natural resource to the nation. Much time and effort is spent trying to preserve the

western end of the Oregon Trail. Much of the state is mountainous and forested. The lakes, streams and rivers are generally clear. The forests are harvested on a sustaining yield basis with much of the wood going into plywood. The pulp and paper activities utilizing sawdust are strong and growing.

One of Oregon's most prized resources is its stock of anadromous fish. Both sport and commercial fishing is rated as good. Crabs and shrimp are harvested also.

There is no commercial production of fossil fuels in the state. A heavy runoff in the Northwest has sustained Oregon's energy needs to date. One uranium mine operated in Lake County several years ago.

The state is well suited for agricultural production and tourism. Improved irrigation techniques and frost protection using heated effluent are revolutionizing farm production in Oregon. Emphasis on the pristine environment is having a similar strong influence on the state's tourist industry.

Power Needs and Resources

Oregon residents are highly dependent on electrical power to meet their daily needs. Over 20% of the homes are heated electrically. Over half of the homes are equipped with electric water heaters, electric stoves and automatic dishwashers. A third of the homes have electric clothes dryers. In 1970 domestic use in Oregon was about 14,000 million KW-HR. By 1980 domestic use will amount to about 23,000 million KW-HR.

Commercial loads in Oregon are growing faster than domestic uses. The mechanization of the lumber and paper industries plus the environmental controls built into modern shopping centers are making rapid load expansion. The 6,000 million KW-HR load will grow to about 12,000 KW-HR by 1980.

Industrial loads are expected to continue to grow in Oregon despite the expected increases in power rates. The largest growth rate will be associated with pumped irrigation of previously marginal dryland farms. The 1965 irrigation use of 417 million KW-HR is expected to grow to 4500 million KW-HR by 1985. The basic industrial power user in the area (electroprocess metals) is expected to grow from 28,586 million KW-HR in 1970 to 46,682 million KW-HR in 1980 as shown in Appendix F.

Electrical power is a vital commodity in Oregon. However, the future availability of adequate electrical power is not assured. The Bonneville Power Administration (BPA) markets over half of the power generated in the Northwest. BPA has a preference system which is utilized when insufficient power is generated. The priority system is:

- First — Public Utilities
- Second — Private Utilities
- Third — Interruptible power customers
(generally industrial)

Since Oregon is served predominantly by private

utilities and is highly dependent on the federal generating system, the state is in a vulnerable position unless new generating systems are built on schedule.

Portland General Electric Co. together with Eugene Water and Electric Board and Pacific Power & Light Co. have initiated construction on the 1130 MW(e) Trojan Nuclear Power Plant. This will be the first commercial nuclear power plant in the Northwest. The power from the plant will increase thermal generating capacity in Oregon by 450% and will increase total generating capacity within Oregon by 65%. With the Trojan plant, all domestic power needs in Oregon can be met with power generated from within Oregon. The Trojan plant is scheduled to begin power operation in September 1974. Figure 22 shows the Trojan Plant with its natural draft cooling tower.

Additional nuclear power plants will be needed in Oregon during the next 20 years at a rate of one 1000 MW(e) plant each two years. A second nuclear plant, scheduled to be brought to power in 1976, was delayed by the sponsors of the plant (citizens of Eugene, Oregon) pending further studies. The gap created in the construction schedule based on this indecision has prompted construction of Hanford No. 2 as an alternative nuclear plant.

The next nuclear plant to be scheduled in Oregon will be needed between 1978 and 1980. This plant is expected to be located along the Columbia River

in Eastern Oregon. This could be a multiple-use plant that would demonstrate the workability of agri-nuclear complexes.

Nuclear plants will likely be built on the coast of Oregon also to make use of the dependably cool seawater. Needed biota studies have hardly begun, thus the feasibility and schedule of a coastal plant are unclear at this time.

Desired Nuclear Developments

Oregon is undergoing a transformation of its industrial base of agriculture and forest products to a more diversified manufacturing base. Addition of electronics firms and mobile home manufacturing are examples. There is an inclination towards attracting nuclear businesses to the state but reaction to such propositions from some segments of the public has been adverse.

The state legislature has not decided how nuclear power should be introduced in Oregon. Currently the legislature is considering three bills:

- HB 1065 to create a Nuclear Energy Council.
- HB 1996 to give the Environmental Quality Commission regulatory power over nuclear power plants.
- SB 218 to provide a 5-year moratorium on nuclear power plants.
- SB 705 to ask for a public vote on nuclear plant sites.

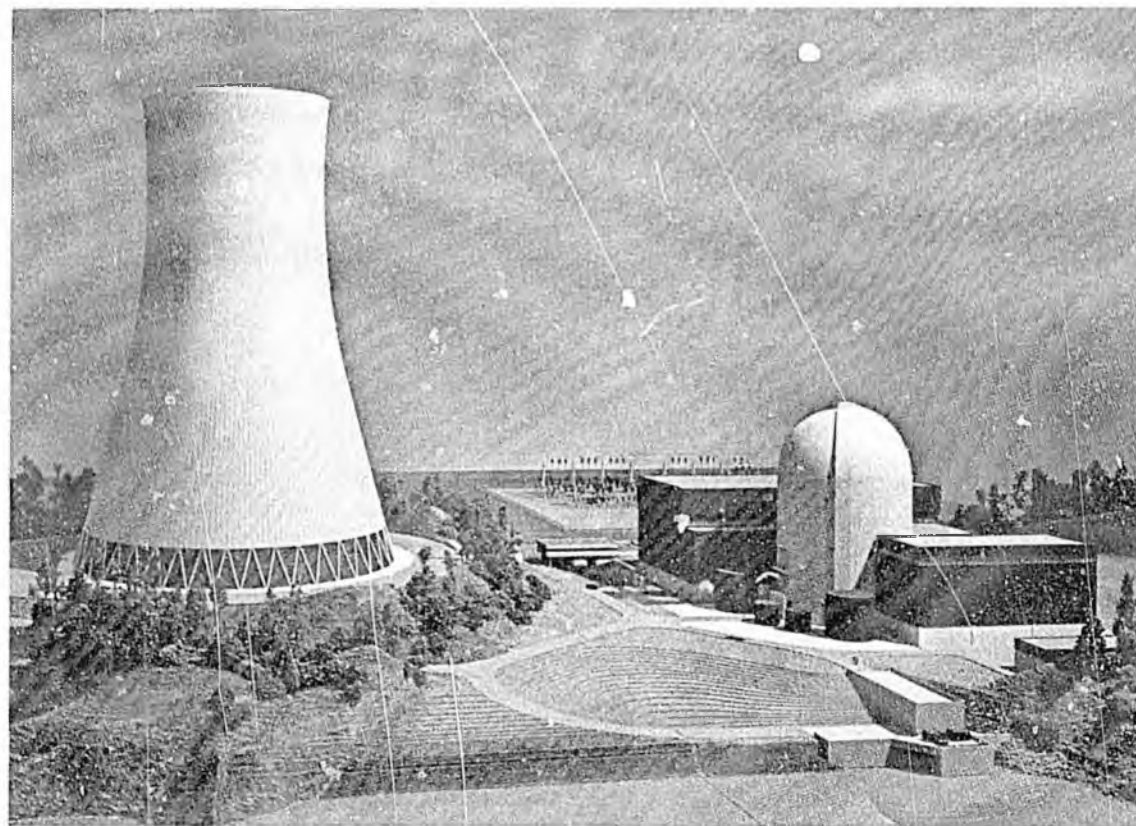


Figure 22

TROJAN NUCLEAR POWER PLANT

The HB 1065 is an attempt to expand upon HB 1695 (that failed to pass the 1969 legislature) to create a state body that would:

- 1) establish nuclear plant siting guidelines and criteria,
- 2) conduct an inventory of potential nuclear sites in the state, and
- 3) approve or reject utility proposals to build on sites located by either the utility or the state.

In addition, the new House bill (as in the attempted HB 1695) would create a Nuclear Energy Council with a staff and budget to administer educational and study programs.

HB 1996 is a new approach. Most states are asking the Public Utility Commission to rule on sites and solicit whatever help they need from state agencies. This bill would put all the power to evaluate and judge in one agency.

The proposed Senate bill calling for a 5-year moratorium appears to be a test of sentiment rather than providing for anything new or constructive for the state. This bill died in committee in the Senate. The bill asking for a public vote on nuclear plant sites has not yet been discussed in open session.

The dominating influence on nuclear matters in the state government is the Governor's Nuclear Development Coordinating Committee. This Committee is composed of Governor-appointed citizens along with four directors of state agencies. This Committee was created by Executive Order in 1967. In 1969, the Governor created, by another Executive Order, a Nuclear Plant Siting Task Force. The Task Force was composed of Directors of nine state agencies:

- 1) Department of Agriculture
- 2) Department of Environmental Quality
- 3) Fish Commission
- 4) Game Commission
- 5) Board of Health
- 6) Public Utility Commissioner
- 7) State Engineer
- 8) State Geologist
- 9) Water Resources Board

The Nuclear Coordinator of the state served as chairman for the Task Force.

The Task Force evaluated one nuclear site and one candidate nuclear park during 1970. Another nuclear site, in southwestern Oregon, was partially reviewed but removed from contention by voter action before the review was complete.

The one site that was evaluated was for the Trojan Nuclear Plant located on the Columbia River 42 miles downstream from Portland. The review and evaluation consisted of:

- 1) utility presentation of site plans;
- 2) public hearing at county seat in the county of the proposed site;
- 3) agency study and establishment of conditions; and
- 4) state recommendation to AEC at time of Construction Permit hearing.

The agencies that were represented on the Task

Force were those that would be most likely to be affected by operation of the plant. Each agency assessed the impact with regard to that portion of the environment it is chartered to protect. The State Board of Health was able to utilize advice from the U. S. Public Health Service. The State Geologist was able to rely on the opinion of the U. S. Geological Survey. Most of the other agencies utilized information and experience developed within their own agencies.

The candidate Nuclear Park reviewed by the Task Force indicated that Northeastern Oregon had a high potential for multiple and beneficial use of water and that new wildlife habitat could be created. The Task Force recommended that the Governor request a similar review by federal agencies in order to identify all problems and recommend conditions or solutions.

Utility interest in the northeastern region has been stimulated. It is expected that Oregon's second nuclear power plant will be located along the Columbia River in the northeastern region of the state.

The only other nuclear development in the state is an attempt on the part of Chem-Nuclear Services Co. to become licensed to bury radioactive wastes. The need for such a facility is expected within the next twenty years.

WINB Assistance

1. Oregon's total nuclear education effort is a traveling van exhibit called *This Atomic World*. Funding for this exhibit is problematical after June 30, 1971. Anything that WINB can do to foster nuclear understanding will help relieve the misapprehension of many Oregon citizens.

2. The deserted uranium mine in southeastern Oregon is suspected of having substandard stabilization. WINB advice on adequacy standards and corrective measures would be useful.

3. Emergency planning efforts related to a nuclear incident has exposed many options. A standardized approach would appear to be in the best interest of the member states and especially those scheduled to be called in the event of a serious accident. An inventory of workable remotely controlled equipment to be used by emergency teams is expected to reveal another area that should attract attention by WINB.

4. Waste burial container standardization may be practical to assure equal safety provisions by all contractors in all member states. WINB investigation of burial practices and safety measures to always insure source control may be appropriate.

I. Utah

Utah is a state of great natural beauty. Rugged mountains and plateaus characterize the eastern portion of the state, whereas the western half is part of the Great Basin. Within an hour's drive from Salt Lake City are countless recreation areas, yet the city is regarded as a center for cultural activities in the Intermountain Area. The majority of the citizens of

the state are characterized as striving for the qualities of life.

The topographical and cultural characteristics of the state have prompted a concentration of the population into an area referred to as the Wasatch Front. This is a four-county area on the western slope of the Rockies. Seventy-five percent of the population lives in these four counties which comprise only 5% of the state's land area. Other counties of the state, particularly in those dependent on coal mining, have witnessed a decrease in the population of up to 26% in the past decade. Regard for the welfare of these counties has prompted the state to provide water rights to a consortium of out-of-state utilities which are considering power generation with the coal on the Kaiparowitz Plateau in southern Utah. The 102,000 acre feet/year allocated is more than half of the water used throughout Utah for municipal and industrial uses. The water would be available in this quantity until the year 2010 when Utah expects to be pressed for water resources. This use of the water was offered with the expectation that 2400 jobs would be created in Kane County. If the intent of the utilities is not demonstrated, the water rights will be withdrawn. Despite the finite water limitations in Utah, the state is very interested in oil shale refining. It is reported that seven barrels of water is used for every barrel of oil that is retorted.

The biggest nuclear venture on the horizon for the state is Project Utah. This will be a Plowshare project detonated in oil shale south of Vernal in Uintah County. In preparation for this and other nuclear opportunities, Utah has created a Nuclear Energy Commission. The Commission will have three primary functions: 1) to assist in utilization of natural resources, 2) to perform a health physics advisory role, and 3) to provide a public information program. The Commission is composed of only two non-scientific individuals. The balance are geophysicists, a radiation ecologist, nuclear engineers, etc. The Chairman is Dr. Alex Oblad, a professor at the University of Utah.

Radiation Control Program

Utah is not yet an Agreement State. Funds have been requested to begin developing the needed expertise but have not yet been granted. There are two radiological control efforts in the state, neither of which provides the needed radiation control for assuring the safety of the citizens. One control point is in the Division of Health's Radiation and Occupational Health Section. Funding for the radiation portion of this effort is \$27,000/year which covers a fraction of the time of one man. At this rate he can assist when requested but cannot muster a regulatory function even on X-ray machines. Thus his time safeguarding uranium miners is inadequate, also. The other control point is in the Department of Radiation Health at the University of Utah. At the University radioecology research programs are conducted

that relate to the current and historical radiation exposure of the state's citizens. Funding at the University is basically federal and is not regulatory.

Historically citizens of Utah have been in the fallout pattern of activities at the Nevada Test Station. In one case (1953) the population of St. George was reportedly subjected to air concentrations of 240,000 picocuries per cubic meter. Since that time 15 air sampling stations have been set up around the state. On December 18, 1970, the Tooele station detected 1,500 picocuries/m³. In 1957, 1962 and 1968 significant fallout was detected, also. The state is serious in questioning the need for any fallout crossing into their state. The smoke from the coal-fired power plants may be laden with radioactive constituents, but these are controllable to some extent and provide something useful to the state.

The U. S. Public Health Service has been helpful in Utah to fill the void created by lack of a solid radiation protection program. The Federal Radiation Council has caught the scorn of some in the state that were advocating a 50% reduction in permissible thyroid exposure. Instead, the FRC increased the allowable exposure by ten times with apparently no new evidence to substantiate the change. The newly permissible levels could provide some damage particularly to the thyroids of grazing animals in the vicinity of nuclear power and fuel reprocessing plants in the West.

Environmental Control Programs

The State Division of Health is responsible for air and water quality standards and regulation. Air quality along the Wasatch Front is a problem in the fall and winter due to temperature inversions.

New power plants are being built away from the urban area. Coal is the standard power plant fuel in Utah. The new Huntington Canyon power plant, 400 MW(e), can probably meet state air and water quality standards but possibly not federal air or water standards. The Public Service Commission is waiting to learn of the expense involved to meet the federal standards before it presses the issue. If rates are raised even a few percent to meet the federal standards, a problem may be created. The Public Service Commission would like to have legislative authority to issue Certificates of Public Convenience and Necessity. They feel that this would aid in the location of power plants at a minimum cost to the ratepayers by the time the necessary environmental control equipment is added.

Natural Resources

Utah has an abundance of natural resources. The most extensive resources are extractive oriented such as copper, coal, uranium, gas and oil. In addition, iron ore, gold, lead, silver and zinc recovery make a substantial contribution to the state's export economy.

The largest, most accessible natural resource is the Great Salt Lake. Long only a dream as a \$100

billion resource, the 70's will record its first actual large scale use. Three firms are investing \$100 million for facilities to annually extract the following quantities of minerals from the lake.

| | Tons | | Tons |
|--------------------|---------|-------------------|---------|
| Magnesium | 45,000 | Lithium Chloride | 5,900 |
| Chlorine | 80,000 | Sodium Sulfate | 150,000 |
| Magnesium Chloride | 400,000 | Potassium Sulfate | 240,000 |

The magnesium chloride will be shipped to other areas of low cost electrical power. One destination will be the new Dow Chemical plant on the Columbia River at Port Washington. If geothermal power could be used to produce low priced electrical power in the Raft River area, the state could become even more prominent as a self-sufficient magnesium producer. Recent higher prices in the aluminum market and technological advances in the magnesium industry are expected to have a large influence on demand for magnesium. The 45,000 tons/year capacity available in the 70's will amount to a \$25 million business for magnesium alone. By the end of this century, the Utah magnesium production is expected to grow by ten times. Such a business offers the state an opportunity to put a high contributed value into the product since most of the power needed for magnesium reduction is based in Utah.

Utah is the only U.S. source of gilsonite, a solid hydrocarbon, like tar. Gilsonite is used as a source of road paving binder, asphalt tiles etc. Utah also has 90% of the U.S. measured reserves of tar sands.

About 3000 square miles in Uinta Basin is underlain by oil shale averaging 15 gallons per ton. In total this field is estimated to contain 320 billion barrels of oil.

Power Needs and Resources

Industrial growth in Utah is not handicapped by lack of ample and dependable electrical power. Utah Power & Light is the principal utility in the state. UP & L rates are very competitive with other utilities in the West.

Natural gas rates in Utah for residential purposes are the lowest in the West. The rate per 100,000 BTU's is less than one half the rate in Oregon.

The total electrical power demands for Utah was about 1000 MW in 1970. Currently the electrical load is growing at a rate of 9%/year. The state is expected to have a 1400 MW peak load in 1975; a 1982 MW in 1980; a 2315 MW load in 1985 and a 3590 MW load in 1990. Commercial and industrial users are expected to use a larger fraction of the power by 1980.

Utah Power & Light has 29 power plants in its system producing a total of 1047 MW. New plant additions are expected to include:

| | | |
|-----------------|----------|------------------------|
| 1. Naughton #3 | — 333 MW | Initial Operation—1971 |
| 2. Undetermined | — 440 | Initial Operation—1973 |
| 3. Undetermined | — 500 | Initial Operation—1978 |
| 4. Undetermined | — 500 | Initial Operation—1982 |
| 5. Undetermined | — 1000 | Initial Operation—1985 |

The fourth and fifth plants might be nuclear if they are the most economic choice. Since the fourth plant is a 500 MW addition and since the chemical industry in Utah is growing, a suboptimal multi-use nuclear plant is of interest in Utah.

Desired Nuclear Developments

The Utah Nuclear Energy Commission was organized early in 1971. Since this body has not had time to determine which nuclear opportunities the state should pursue, it is early to declare how Utah's nuclear involvement will be shaped. However, some of the opportunities that face Utah are:

1. Plowshare Oil Shale—for fracturing oil shale in preparation for in-situ retorting of the shale by ignition and forced injection of air. Such a project is planned as Project Utah scheduled for 1973.
2. Plowshare Natural Gas—to stimulate natural gas recovery from tight rock formations.
3. Plowshare Geothermal—to fragment the hot strata under northwest Utah to provide electrical power without a "fuel cost". The load following characteristics of this type of power source might make it ideal for an electroprocess plant.
4. Nuclear Power Plants—to meet basic load and process steam requirements to serve new industries on the Great Salt Lake and to replace smaller more polluting power plants operating within the Wasatch Range.
5. Uranium mining—to meet domestic and foreign long-range needs on an increased scale.
6. Even with 70,000 students enrolled in Utah colleges and universities, there have been no students graduating in nuclear engineering. Some graduate courses are offered, but more are desired.

WINB Assistance

The new Utah Nuclear Energy Commission is expected to be seeking WINB assistance to:

1. Establish safety assurance programs around Plowshare activities.
2. Become an Agreement State.
3. Help provide needed support to stabilize three old uranium tailings piles.
4. Reduce the possibilities of having another fallout pattern beyond the Nevada Test Station. The Southwest Radiological Health Laboratory could reveal the seriousness of past incidents.

J. Washington

Washington's nuclear history began in 1942 with the formation of the Manhattan Project. Within a short time the town of Richland, Washington, swelled from a tranquil 300 residents to a construction town of 58,000. In time, nine production reactors were built and the project town has stabilized to where the population is now about 30,000. In the Tri-Cities

area around Richland, an "Inland Empire" has been based primarily on agriculture and commerce. The Columbia River that was selected to cool the production reactors is also a vital key to the commerce of the region.

In 1964 nine reactors were still operating in conjunction with AEC production facilities in other parts of the nation, but were producing plutonium at a faster rate than needed by the Department of Defense. Beginning that year, the AEC began a Diversification Program and since that time, eight of the nine reactors have been shut down. The sole surviving reactor, the NPR, is the only one designed to produce power also. Considerable rejustification was required this year for continued operation of the NPR. The Washington Public Power Supply System, WPPSS, has received steam from the NPR since its initial operation at a very nominal cost. New arrangements are being made in which the WPPSS will pay a larger fraction of the actual cost for generating the steam.

The nuclear future for Washington is bright. The Manhattan Project drew together talented scientists from throughout the nation. Since that time, Hanford has been a spawning ground for much of the technology and technologists that have made the U.S. a leader in the nuclear field. The innovative genius of the scientists and residents of Richland has been applied to the AEC's Diversification Program. The net result has been a plan to turn the Hanford Reservation into a full scale Nuclear Park. A description of the Nuclear Park is presented below under Expected Nuclear Developments.

Radiation Control Program

Washington became an Agreement State on December 31, 1966. The radiation control program is in the Division of Health in the Department of Social and Health Services. The annual budget for the ten professionals on the staff is \$140,000/year.

Around nuclear power plants the Radiation Control Section will expect both pre- and post-operational measurements. The monitoring program will be an obligation of the utilities. The adequacy of the procedural program will be a joint determination between the state and the utility.

It is felt that establishment of a radiological monitoring network throughout the nation by the USPHS is a desirable and necessary activity. The AEC practice of asking for state certification of liquid discharge is commended also. The adequacy of the AEC nuclear safety review is apparent from the good operating record established to date. Since routine operation appears to be under control, Washington is directing its attention to the abnormal or emergency situations. The state is in the USPHS Region 6 and the Office of Civil Defense Region 8. In the event of radiological emergency, the AEC's Radiological Assistance team would probably be called. How at least two state agencies, together with the AEC,

USPHS and the Office of Civil Defense would interact is not yet clear.

An extensive radiological surveillance program is in effect in Washington and Oregon to trace the isotopes discharged in the Columbia River at Hanford. The program has not been conclusive and needs more study (esp. on biological buildup). The federal standards may not be adequate in this regard.

Environmental Control Programs

Washington Department of Ecology began functioning on July 1, 1970. The Department is a functional integrated super agency over both air and water quality but is not concerned with radioactivity which is in the province of the Department of Health and Social Services. The name of the Department is not meant to imply that the Department is responsible for all forms of animal life. The temperature standards in Washington permit some river heating providing the temperature never exceeds 68° F. This is different for Oregon in which heating of the river from any temperature is not endorsed. The theory in Washington is that thermal discharge is not a pollutant until undesirable temperatures are achieved. The state further recognizes plumes from wet cooling towers as visible pollution. Dry cooling towers* may become acceptable for use at inland sites in Western Washington, whereas wet cooling towers probably never will be.

It is the consensus in the state that no amount of environmental control equipment can replace a judicious choice for a nuclear power plant site. To this end the state has created, by Senate Bill 49, a Thermal Power Plant Site Evaluation Council. The Chairman of the Council is selected by the Governor. The Council consists of directors, administrators or their designees of the following departments, agencies or commissions.

1. Department of Fisheries
2. Department of Game
3. Department of Parks and Recreation
4. Department of Health
5. Interagency Committee for Outdoor Recreation
6. Department of Commerce and Economic Development
7. Utilities and Transportation Commission
8. Office of Program Planning and Fiscal Management
9. Department of Natural Resources
10. Planning and Community Affairs Agency
11. Department of Civil Defense
12. Department of Agriculture
13. Department of Ecology

* R. W. Beck & Associates, Seattle, Washington, have performed some optimization and economic studies on dry cooling towers for the Federal Water Quality Administration (Contract No. 14-12 823). Their study has shown that dry cooling towers for condenser cooling can be provided to 800 MW (e) power plants for capital costs of \$17 and \$23/KW, for coal and nuclear plants, respectively. For turbines not designed for use with dry cooling systems, operating penalties of \$8 and \$14/KW would be expected for coal and nuclear plants respectively.

In addition, the county legislative authority wherein a site application is filed must appoint a member to the Council for evaluation of the site under review.

The Council has the power to adopt guidelines for plant location, conduct hearings and make a recommendation to the Governor concerning the site applications. The Governor is then the final authority for the state to approve or reject site applications. The Washington Siting Bill is the first of its kind in the U.S. The bill is reprinted as Appendix H.

The first official site application was received on January 28, 1971. The review is to be completed by November 1971. This request was for a light water power reactor at the Hanford Reservation.

The Thermal Plant Site Evaluation Council preempts the actions of other state agencies. For example, if the Council insists on environmental protection equipment, the Washington Utility Commission will need to accept this expense as an allowable cost.

Natural Resources

Washington is blessed with a great diversity of natural resources. About 45% of the land is in farmlands in the eastern part of the state. Puget Sound has some fine deep water harbors making Seattle a busy port for international trade and a base for Alaskan development. Between eastern Washington and Puget Sound the Cascade Range forms a recreational area of rare beauty. The Olympic Peninsula spares Seattle from the precipitation associated with the northern coast. The Puget Sound area has become the urban center of Washington, housing more than two-thirds of the state's population.

Water is Washington's most important resource. Therefore, the Grand Coulee Dam and the other hydro projects on the Columbia River became a storehouse of energy and vitality to the state. Grand Coulee dam is particularly important since it permits water diversion to over a million acres of irrigable farmland.

Only Alaska and Oregon have more than Washington's 24 million acres of timber. The only large coal deposits on the coast are in King and Kittitas Counties.

Power Loads and Resources

The electrical loads and resources of Washington are similar to those of Oregon and Idaho. They are based on a bountiful supply of low cost hydroelectric power as described in Appendix F.

The environmental concerns and a scarcity of meaningful damsites in Washington likewise are foreclosing the advancement of any new hydroprojects. The utilities of the state are working with the Bonneville Power Administration in formulation and execution of the 20-year Hydro-thermal Plan.

One of the first thermal plants in the plan is the Centralia minemouth coal-fired plant. This plant is

being built by Pacific Power and Light and Washington Water Power Co. and will utilize two fired units of 750 MW each. The coal field will not economically support more than these two units.

Subsequent thermal power generation equipment in Washington is most likely to be nuclear. The first commercial nuclear power plant for Washington will be Hanford No. 2; described in the next section.

Future industrial development in Washington is definitely dependent on the state's ability to meet the growing power needs of the region. It is not yet clear that implementation of the nuclear portion of the Hydro-thermal program will be allowed to proceed on schedule in time to meet the increasing demands of a growing population and associated industrial expansion.

Expected Nuclear Developments

The Southeastern corner of the state and of the AEC's Hanford Diversification Program encompass most of the expected nuclear developments in the state. The primary exception to this is the sincere effort on the part of several utilities to locate nuclear power plants closer to the load centers in the Puget Sound area. To date, no utility has shown that a large power plant can be built in the Puget Sound area and survive the environmental impact evaluation by the state. An application for such a review is expected when the necessity for new power plant construction is less critical and can be proven to be more adequate than acceptable distant site possibilities. The AEC Hanford Diversification Program includes the following AEC contractors:

Atlantic Richfield Hanford Company, subsidiary of Atlantic Richfield Company Chemical Division of Atlantic Richfield.

This firm operates the AEC-owned chemical processing facilities. Approximate employment as of December 31, 1970, was 1,450. Funding for FY-1971 was \$34,300,000.

Pacific Northwest Laboratories, a division of Battelle Memorial Institute (Battelle Northwest).

Battelle operates AEC-owned Pacific Northwest Laboratory. Approximate employment as of December 31, 1970, was 934. The budget for laboratory operation for FY-1971 was \$14,900,000.

Douglas United Nuclear, Inc. (DUN)—This firm is jointly owned by McDonnell Douglas Corporation and United Nuclear Corporation.

DUN operates and maintains the AEC owned "N" reactor and fuels fabrication facilities at Hanford. Employment as of December 31, 1970, was approximately 1,311 and the FY-1971 budget was \$34,600,500. The "N" reactor is scheduled to supply steam to Washington Public Power Service System for at least the next three years.

WADCO Corporation, a subsidiary of Westinghouse Electric Corporation.

This firm operates the AEC-owned Hanford Engineering Development Laboratory and is responsible for the design and construction of the High Temperature Sodium Test Facility and the Fast Flux Test Reactor. Approximate employment

as of December 31, 1970, was 1,164. Funding for FY-1971 was \$43,800,000.

Computer Sciences Corporation.

CSC performs data processing services for the entire Hanford Project. The approximate employment as of December 31, 1970, was 168 with funding for FY-1971 at \$4,300,000.

Hanford Environmental Health Foundation, Inc.

This is a nonprofit foundation, providing occupational health services and environmental health sciences studies for Hanford contractors. Employment as of December 31, 1970, was approximately 68 with funding for FY-1971 at \$1,300,000.

J. A. Jones Construction Company

The firm performs onsite cost-type construction work, frequently associated with environmental problems related to radiological conditions. Employment varies considerably due to work flow, but as of December 31, 1970, it was approximately 350. Funding for FY-1971 was \$9,500,000.

Hanford Engineering Services, a division of Vitro Corporation of America.

Hanford Engineering Services performs cost-type, in-plant engineering services. Employment varies with work load and was approximately 184 as of December 31, 1970, with funding for FY-1971 at \$2,400,000.

U.S. Testing Company, Inc., Richland Branch of U.S. Testing Company, Inc.

This firm performs film dosimeter processing, bioassay analysis, and environmental sample analysis for all AEC Hanford contractors. Employment approximated 18 as of December 31, 1970, and funding for FY-1971 was \$420,000.

In addition, private nuclear contractors near the Hanford site include:

Donald W. Douglas Laboratories, a Division of McDonnell Douglas Astronautics Co., has a staff of 138 scientists, engineers and operating personnel at their Hanford laboratory. Over \$4 million has been spent in laboratory activity during the past three years developing a product line of isotopic heat sources for heart pacemakers, space missions, etc.

Jersey-Nuclear, a subsidiary of Standard Oil Co., of New Jersey has built a modern fuel fabrication plant. The \$5 million plant will include facilities to fabricate new and replacement cores for light water reactors. In addition, the plant will include a plutonium fuels laboratory.

Sandvik Special Metals Corp. has a \$5.5 million facility near Hanford to produce zirconium fuel element tubing for light water reactors.

Nuclear Engineering Co. of Walnut Creek, California, utilizes 100 acres of leased land at Hanford for nuclear waste burial and storage.

Washington Public Power Supply System (WPPSS) operates the power generation portion of Hanford No. 1, the first steam producing nuclear plant at Hanford. The plant has been supplying up to 840 MW (net elect.) since 1966. Hanford No. 2 has been ordered for a scheduled start of operation in 1977. WPPSS will own and operate both the steam supply and the electrical generation portions of Hanford No. 2.

Scientific Advances, a subsidiary of Battelle Memorial Institute has created three "spinoff" firms by utilization of ideas and talents at Hanford. These three firms are Automata, Inc.; Nor-tec; and Tyeline Corp.

New facilities under construction at Hanford include:

Fast Flux Test Facility will be an AEC test reactor for conducting research on liquid metal fast breeder reactor fuels, materials and components. The construction of the reactor will be over a \$100 million project with completion expected in 1974.

High Temperature Sodium Facility is a \$6.3 million test facility for engineering development in support of the liquid metal fast breeder reactor program.

Waste concentration and encapsulation facilities will be built at an expense of \$18 million to solidify and seal fission products which have been generated in the production of plutonium at Hanford and are now stored in waste tanks. The facilities will be completed in 1973.

AEC Biology Laboratory was completed this year at a cost of \$5 million. The laboratory will be operated for the AEC by Battelle Northwest. The laboratory has a staff of 130 scientists and a home for 3000 animals.

The Center for Graduate Study at Hanford, constructed at a cost of \$1.5 million, is fulfilling a scientific role of keeping graduate study programs available to the scientists that are in an off-campus area such as Richland.

Other anticipated projects include:

A prototype fast breeder reactor has been proposed for Hanford. This \$400 million facility would be a large-scale demonstration of the liquid metal fast breeder reactor concept.

A fuel reprocessing plant at Hanford is anticipated for serving the nuclear power plants in the West. This plant is not expected until the installed capacity in the West justifies the investment. No organization has yet announced their intent to sponsor the first commercial reprocessing plant at Hanford.

The above facilities are more than adequate to call Hanford the nuclear power center of the West. The Tri-City Nuclear Industrial Council is not yet satisfied with the facilities that have been massed at Hanford. The Council would like to see the full fuel cycle satisfied at Hanford with a product of electricity and with no need to ship spent fuel waste products off-site. When this is accomplished the Council will concede that they have created a Nuclear Park.

A Nuclear Park is well illustrated in figure 23. The fuel is received in yellowcake form from the mining and milling operation. From there it is converted to UF_6 enriched in U-235 and fabricated into fuel elements. To date, Hanford has one commercial facility for fuel fabrication. The next step is use of the fuel in a power reactor. Hanford No. 2 will be the first of possibly several conventional nuclear power plants to be located at Hanford. The next step will be fuel reprocessing. Hanford will need to attract a

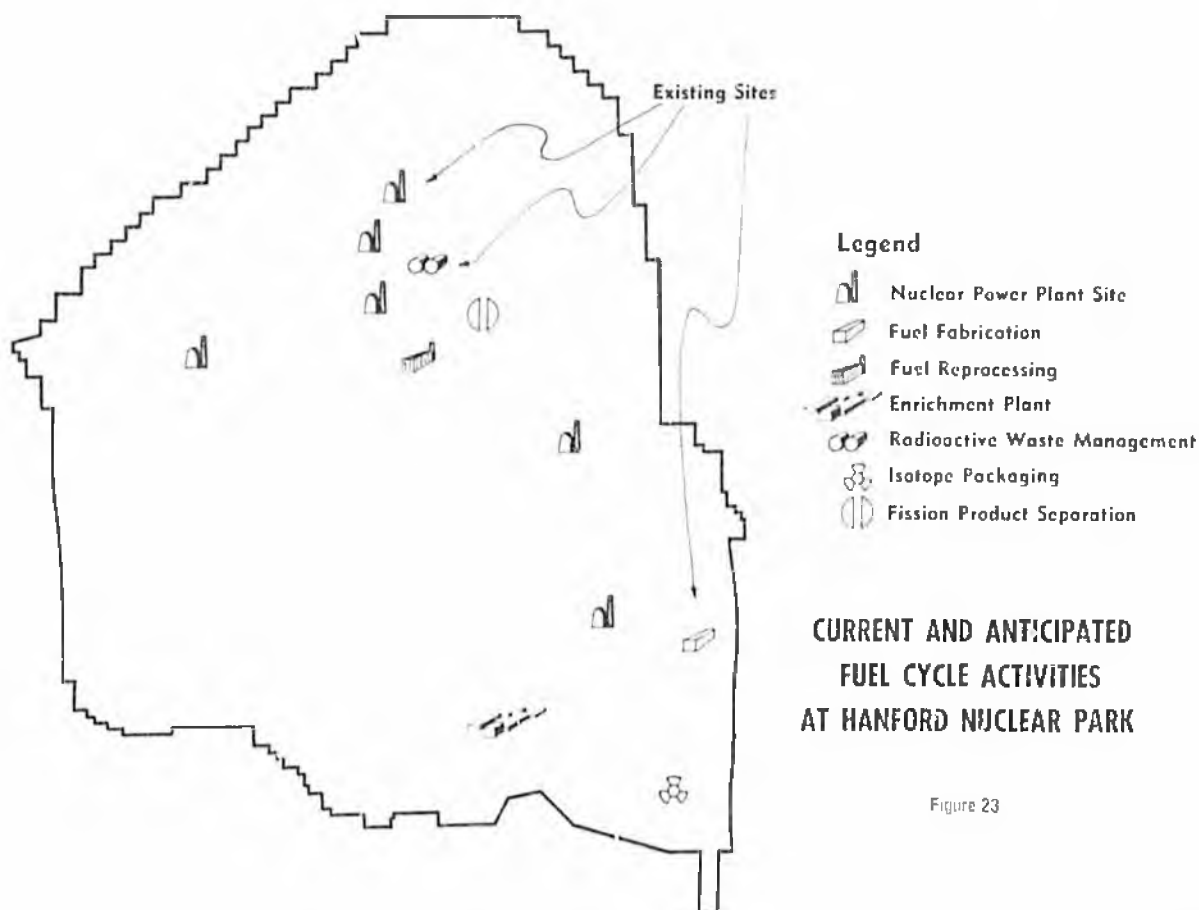


Figure 23

fuel reprocessing operation to complete the cycle. This will be possible when there is enough spent fuel in the region to justify a reprocessing plant. The waste storage capability already exists at Hanford. Thus there is some foundation to the Council's contention that they are well on their way to have the nation's first complete Nuclear Park.

WINB Assistance Desired

WINB is requested to:

1. Critically investigate the adequacy of federal standards with regard to biological buildup.
2. Assist in developing some good public understanding programs on nuclear power plants, and why there is a need for spent fuel reprocessing and proper disposition of associated waste.
3. Assist in allowing the individual states to establish their own standards for nuclear plant site selection and performing their own evaluation and disposition.
4. Impress the federal government with the seriousness of inadequate electrical power for customers depending on the Northwest power grid system.

K. Wyoming

The state of Wyoming is on the threshold of change. New discoveries of coal and oil give a greater meaning to the state known as the Energy Capitol of the World. No state in the union is better suited for

industrial expansion. The state is hopeful of creating enough industry to provide opportunities for the college trained natives that have until now, had to go elsewhere to find adequate challenge. The growing national need for energy and energy sources should fill this self-fulfilling need within the next decade.

The first two growth steps have been taken in the state 1) exploration, and 2) capital investment. The exploration has proven the resources to be available and considerable investment has been scheduled for minemouth coal-fired plants to generate and export electrical power. The next three growth steps will be to 1) accelerate the export of coal and oil, 2) stimulate recovery of more petroleum resources using Plowshare techniques, and 3) invest in coal conversion product plants. The above five steps toward growth are expected during the next five years.

During the seventies, Wyoming is also expected to maintain its prominent position as a producer of uranium ore. Growth of the Wyoming involvement in this field is expected also. Whereas the state's most finished uranium product has been yellowcake, Wyoming is seeking to provide conversion services to uranium hexafluoride and enrichment of uranium in the fissionable isotope—U-235. As the fuel element fabrication business grows and the need for reprocessing develops, Wyoming will be looking at possibilities in these more advanced products and processes also.

The large amount of dependable electrical power that can be generated in Wyoming at a very low cost should make the state uniquely qualified for the location of the next fuel enrichment plant in the U.S. Proximity of the diffusion plant to the uranium mines and mills should be a factor but an even greater influence is the state's willingness to work with prospective plant operators to assist them to become situated including provision for a guaranteed large bloc of electrical energy.

Radiation Control Program

The state of Wyoming has not yet provided either the funds or the enabling legislation to permit the state to become an Agreement State. The total radiation control budget for fiscal year 1970 is \$24,527. For fiscal year 1971, it will be \$39,950. The one-man staff should be doubled or tripled with all the work needed to be done. Most of the radiation protection for the uranium miners has been done by the U.S. Public Health Service's Occupational Health Section in Salt Lake City. The adequacy of this protection is not clear.

The U.S. Public Health Service sampling that followed the December 18, 1970, venting at NTS showed higher concentrations of I-131 in Wyoming milk than in any other state. If the concentration had been high enough to be hazardous, the time required for state action may have been too excessive to be of any value.

Likewise, Wyoming is unable to license X-ray machines and fluoroscopes for lack of funds and legislative authority. Foot fluoroscopes still abound in the state's shoe stores.

Environmental Control Programs

Wyoming is a state proud of its natural beauty and environment. The state has passed many laws relating to environmental protection. Water pollution in the state would be easy to detect and air pollution difficult to achieve. Wyoming provides the headwaters for the Columbia, Colorado and Mississippi Rivers. Meteorologically, Wyoming is among the best ventilated states in the West.

The Department of Public Health establishes the state's water standards and performs the regulation thereof. Chapter II Section 6 of the state's Water Standards reads:

"Radioactive materials of other than natural origin shall not be present in any amount which reflects failure in any case to apply all controls which are physically and economically feasible. In no case shall such materials exceed the limits established in the 1962 Public Health Service Drinking Water Standards of 1/30 (168 hour value) of the values for radioactive substances specified in the National Bureau of Standards Handbook 69."

If Agreement States are given authority by federal legislation to establish their own standards for radioactive discharge from nuclear plants, the above sec-

tion could express the desires of many states anxious to minimize radiation in their water supplies.

Air quality control within the state is also under the purview of the Department of Health. The Air Quality Act enabled the formation of a nine-member Air Resources Council. The Council consists of three state officials and six appointees of the Governor. The Council is chartered to develop and formulate a comprehensive plan for the prevention, control and abatement of air pollution in Wyoming. Paragraph 35-501 of the Air Quality Act exempts from taxation any facilities, installations, machinery or equipment utilized to prevent air pollution. Chapter III Section 12 of the Wyoming Air Quality Standards and Regulations requires that "No person shall cause or permit the installation or use of any device or contrivance which, without resulting in reduction of the total amount of air contaminant released to the atmosphere, shall dilute or conceal an emission from any source."

Natural Resources

Like many of the other Rocky Mountain States, Wyoming industry is heavily related to extraction of minerals. Wyoming has large proven reserves of crude oil, natural gas, oil shale, coal, iron ore, uranium ore, trona bentonite, gypsum etc. Of the \$1.2 billion collected by the U.S. Government under the Minerals Leasing Act, 39% was from Wyoming minerals. Over a billion dollars has been invested in Wyoming during the past decade by private and public sources to increase the exploration and production of natural resources. New investments are expected now to increase the value of the mined products.

New discoveries of oil and gas in the Powder and Wind River Basins may soon warrant refineries and more of the petrochemical industry there. The oil shale in-situ retorting could be of large benefit to Wyoming. Coal production is already being optimized. The modern mining techniques and equipment permit coal to be delivered to the Dave Johnston Generating Plant at only 14 cents per million BTU's. Other coal burning generating plants are being built near Rock Springs to stave off a blackout condition in Oregon and Washington. The uranium ore production can be advanced to a product of enriched uranium and other nuclear products. Energy sources are rampant.

Water resources in the state for industrial purposes are given a preferred classification. There is more that can be done to impound water and for development of underground sources.

The coal reserves are the most outstanding natural resource for Wyoming. The total resources are estimated to be over 120 billion tons by the USGS. The coal underlies over 40% of the state, some of which is under each county. Much of the Wyoming coal is low in both ash and sulfur. Coal production in Wyoming is expected to grow from less than 4 million

tons/year in 1968 to 15 million tons/year in 1972. In addition to its use as fuel, carbonization and hydrogenation of the coal is planned.

The uranium ores are shallow and of high grade. Wyoming should always be competitive in this field. More exploration is needed to learn the full extent of this resource.

Power Needs and Resources

There is now organized in Wyoming a Power Advisory Council. The Council is made up of four persons from private power companies, four from public power companies and four from the state. This group will prepare a 10- and 20-year forecast of the state's power needs. Until now, the individual companies have been able to plan for their own needs with a 5-year forecast. The first forecast from the new group will be completed in August, 1971. Until then the state plans for generating power will not be clear. The expansion rate of the generating facilities in the state has been 10%/year. This rate of increase is expected to continue to provide margin for export.

One limitation to power production in parts of Wyoming is availability of coolant water. The total capturable runoff from the state is 4,000,000 acre-feet. With the limited water development done in the state thusfar, some regions are water short and some have a surplus. The Neil Simpson Plant near Gillette, Wyoming, has sidestepped that limitation. The plant uses a dry cooling tower—the first one used for a central station power plant in the Western Hemisphere.

Present coal-fired electrical generating plants in Wyoming include:

| | |
|--|--------|
| Black Hills P&L Co., Neil Simpson Plant, Gillette..... | 27 MW |
| Black Hills P&L Co., Osage Plant, Osage..... | 34 MW |
| Pacific Power & Light Co., Dave Johnston Plant, Glenrock..... | 420 MW |
| Utah Power&Light C., Naughton Plant, Kemmerer | 163 MW |
| Mont Dakota Utility Co., Acme Plant, Sheridan..... | 12 MW |

Future plants will be:

| | |
|--|---------------|
| Pacific Power & Light Co., Glenrock..... | (1972) 330 MW |
| Pacific Power & Light Co., Rock Springs..... | 500 MW |
| Idaho Power Company, Rock Springs..... | 500 MW |
| Pacific Power & Light Co., Rock Springs..... | 500 MW |
| Utah Power & Light Co., Kemmerer..... | (1971) 330 MW |

The Public Service Commission issues Certificates of Public Convenience and Necessity for both power plant sites and transmission lines. In the future they will hold hearings prior to issuance of the certificates.

Expected Nuclear Developments

Wyoming would like to increase the contributed value of their uranium. The furthest it is now carried in the fuel cycle is into yellowcake. Fuel element fabrication and reprocessing have been considered.

With the least expensive energy in the U.S. located in Wyoming in nearly unlimited quantities, location of the next new diffusion plant in the state appears warranted and logical. Diffusion plants of the type

operated at Paducah, Kentucky, use 2500 MW. Location of such a heavy load in the energy-short regions of the East appears unjustifiable.

Wyoming is the expected location of two nuclear stimulation (Plowshare) projects for natural gas recovery. The most active of the two is Wagonwheel—sponsored by El Paso Gas Co. The second project is called WASP. A suitable well for WASP is yet to be found.

Nuclear power plants are not expected in Wyoming in the foreseeable future. Coal-fired power plants are expected to hold a competitive edge in the state for at least 20-30 years especially if dry cooling towers become routine during that period.

WINB Assistance

It is requested that WINB:

1. Request from the USPHS and the Bureau of Mines a definition of the planned radiation protection program for uranium miners.
2. Query the AEC on their development of respiratory protection equipment for use by uranium miners in especially dusty work stations. Insist on progress or program acceleration.
3. Question the AEC on their policy for stabilizing abandoned uranium mines. An ore pile in Wyoming has exposed selenium also which creates a threat of its own to the cattle.
4. Direct its efforts to having the next diffusion plant in the West.
5. Assist Wyoming in developing expertise required to become an Agreement State.



NUCLEAR ENERGY IN THE WEST

VII. SUMMARY OF STATE PLANS AND WINB NEEDS

A. WINC Charter

The Western Interstate Nuclear Compact charter is best illustrated by the following sections of the federal legislation that established recognition of the Compact by the U. S. Congress.

"ARTICLE I. POLICY AND PURPOSE"

The party states recognize that the proper employment of scientific and technological discoveries and advances in nuclear and related fields and direct and collateral application and adaptation of processes and techniques developed in connection therewith, properly correlated with other resources of the region, can assist substantially in the industrial progress of the West and further development of the economy of the region. They also recognize that optimum benefit from nuclear and related scientific or technological resources, facilities and skills requires systematic encouragement, guidance, assistance, and promotion from the party states on a cooperative basis. It is the policy of the party states to undertake such cooperation on a continuing basis. It is the purpose of this compact to provide the instrument and framework for such a cooperative effort in nuclear and related fields, to enhance the economy of the West and contribute to the individual and community well-being of the region's people.

"ARTICLE V. POWERS"

"The Board shall have power to—

"a) Encourage and promote cooperation among the party states in the development and utilization of nuclear and related technologies and their application to industry and other fields.

"b) Ascertain and analyze on a continuing basis the position of the West with respect to the employment in industry of nuclear and related scientific findings and technologies.

"c) Encourage the development and use of scientific advances and discoveries in nuclear facilities, energy, material, products, by-products, and all other appropriate adaptations of scientific and technological advances and discoveries.

"d) Collect, correlate, and disseminate information relating to the peaceful uses of nuclear energy,

materials, and products, and other products and processes resulting from the application of related science and technology.

"e) Encourage the development and use of nuclear energy, facilities, installations, and products as part of a balanced economy.

"f) Conduct, or cooperate in conducting, programs of training for state and local personnel engaged in any aspects of:

1. Nuclear industry, medicine, or education, or the promotion or regulation thereof.
2. Applying nuclear scientific advances or discoveries, and any industrial, commercial or other processes resulting therefrom.
3. The formulation or administration of measures designed to promote safety in any matter related to the development, use or disposal of nuclear energy, materials, products, by-products, installations, or wastes, or to safety in the production, use and disposal of any other substances peculiarly related thereto.

"g) Organize and conduct, or assist and cooperate in organizing and conducting, demonstrations or research in any of the scientific, technological or industrial fields to which this compact relates.

"h) Undertake such nonregulatory functions with respect to non-nuclear sources of radiation as may promote the economic development and general welfare of the West.

"i) Study industrial, health, safety, and other standards, laws, codes, rules, regulations, and administrative practices in or related to nuclear fields.

"j) Recommend such changes in, or amendments or additions to the laws, codes, rules, regulations, administrative procedures and practices or local laws or ordinances of the party states of their subdivisions in nuclear and related fields, as in its judgment may be appropriate. Any such recommendations shall be made through the appropriate state agency, with due consideration of the desirability of uniformity but shall also give appropriate weight to any special circumstances which may justify variations to meet local conditions.

"k) Consider and make recommendations designed to facilitate the transportation of nuclear

equipment, materials, products, by-products, wastes, and other nuclear or related substances, in such manner and under such conditions as will make their availability or disposal practicable on an economic and efficient basis.

"l) Consider and make recommendations with respect to the assumption of and protection against liability actually or potentially incurred in any phase of operations in nuclear and related fields.

"m) Advise and consult with the federal government concerning the common position of the party states or assist party states with regard to individual problems where appropriate in respect to nuclear and related fields.

"n) Cooperate with the Atomic Energy Commission, the National Aeronautics and Space Administration, the Office of Science and Technology, or any agencies successor thereto, any other officer or agency of the United States, and any other governmental unit or agency or officer thereof, and with any private persons or agencies in any of the fields of its interest.

"o) Act as licensee, contractor or sub-contractor of the United States Government or any party state with respect to the conduct of any research activity requiring such license or contract and operate such research facility or undertake any program pursuant thereto, provided that this power shall be exercised only in connection with the implementation of one or more other powers conferred upon the Board by this Compact.

"p) Prepare, publish and distribute (with or without charge) such reports, bulletins, newsletters or other materials as it deems appropriate.

"q) Ascertain from time to time such methods, practices, circumstances, and conditions as may bring about the prevention and control of nuclear incidents in the area comprising the party states, to coordinate the nuclear incident prevention and control plans and work relating thereto of the appropriate agencies of the party states and to facilitate the rendering of aid by the party states to each other in coping with nuclear incidents.

The Board may formulate and, in accordance with need from time to time, revise a regional plan or regional plans for coping with nuclear incidents within the territory of the party states as a whole or within any subregion or subregions of the geographic area covered by this compact.

Any nuclear incident plan in force pursuant to this paragraph shall designate the official or agency in each party state covered by the plan who shall coordinate requests for aid pursuant to Article VI of this compact and the furnishing of aid in response thereto.

Unless the party states concerned expressly otherwise agree, the Board shall not administer the summoning and dispatching of aid, but this function shall be undertaken directly by the designated agencies and officers of the party states.

However, the plan or plans of the Board in force pursuant to this paragraph shall provide for reports to the Board concerning the occurrence of nuclear incidents and the requests for aid on account thereof, together with summaries of the actual working of effectiveness of mutual aid in particular instances.

From time to time, the Board shall analyze the information gathered from reports of aid pursuant to Article VI and such other instances of mutual aid as may have come to its attention, so that experience in the rendering of such aid may be available.

"r) Prepare, maintain, and implement a regional plan or regional plans for carrying out the duties, powers, or functions conferred upon the Board by this compact.

"s) Undertake responsibilities imposed or necessarily involved with regional participation pursuant to such cooperative programs of the federal government as are useful in connection with the fields covered by this compact.

B. Member State Plans

The nuclear involvement of each state varies to a considerable extent. With time, the variation will become pronounced. California has the greatest need for nuclear power plants and is destined to be foremost by a factor of five over any other state in the West. Oregon and Washington each have a commercial nuclear power plant ordered and expect to have seven nuclear power plants by 1990. Colorado has a nuclear power plant nearing completion and might have another by 1990. By that year, New Mexico may be sharing a plant with Texas and Oklahoma. By 1985, Arizona expects to have its first nuclear power plant. In total, over 75 nuclear plants are expected to be completed in the West by 1990.

Figure 24 shows the distribution of the nuclear power plants and Table 17 lists their approximate power rating and their site location. Load growth may vary the number of plants built but the trend is set. Of the states destined to have nuclear plants, legislation is either in place or being prepared to govern their location and their environment impact.

Each Western state is involved in nuclear power development to some extent and most states would like to become more involved. New Mexico, Wyoming, Colorado, Utah and Arizona have been mining uranium and will begin retooling soon to prepare for a much larger market than served in the past. Alaska is prepared to enter the uranium mining field this year. Idaho, Nevada and Alaska have been hosting AEC test sites. Idaho and Nevada have skilled nuclear manpower pools to build on for spinoff industries. California has been abundantly successful in capturing successful nuclear-oriented industries.

Nevada and Washington have the only commercial radioactive waste storage sites in the West. Nevada would like to add fuel reprocessing plants and