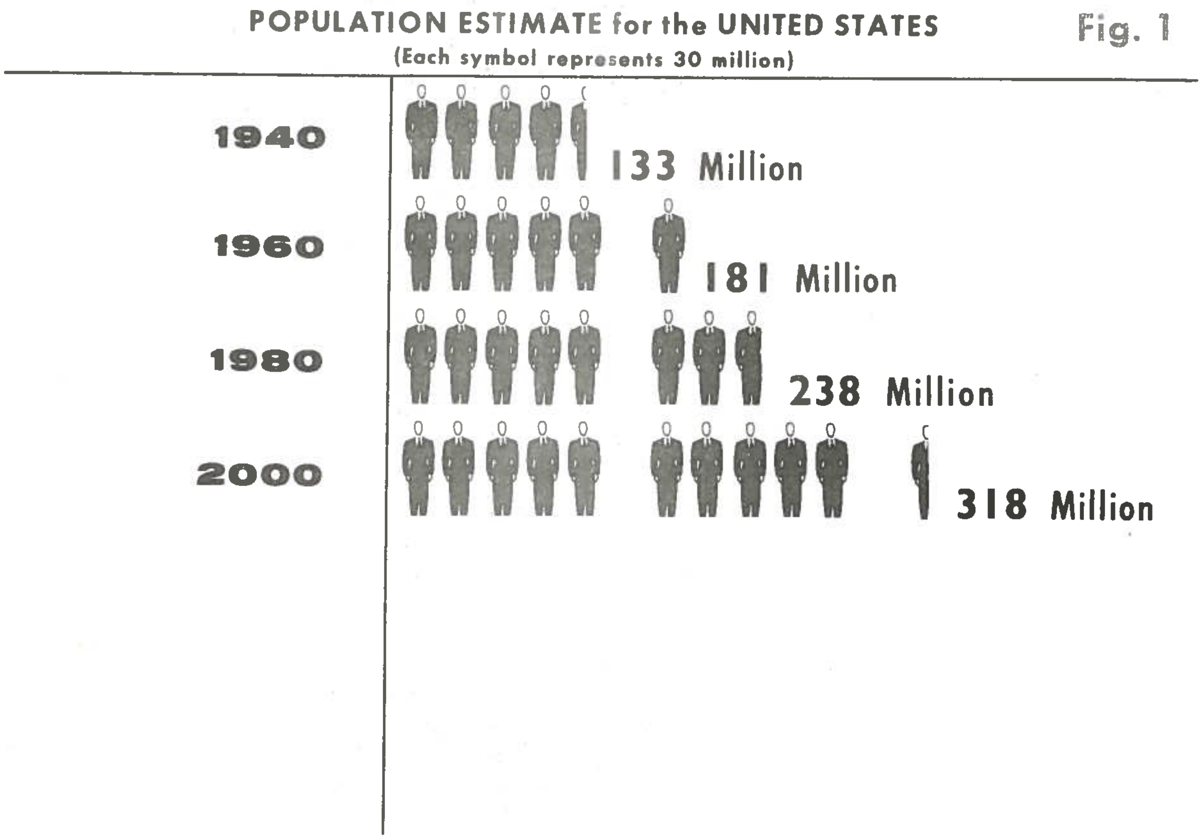
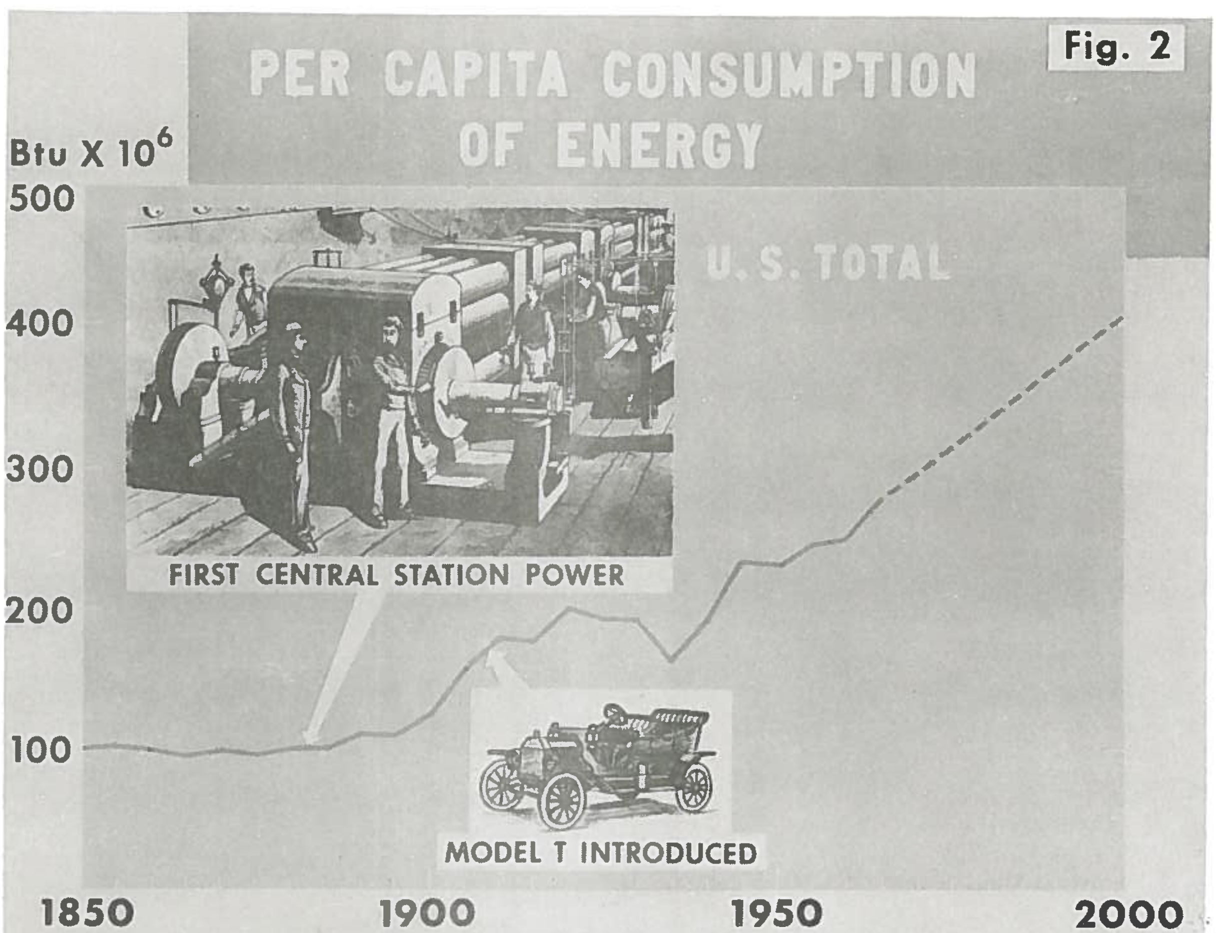


POPULATION ESTIMATE for the UNITED STATES
(Each symbol represents 30 million)
1940
133 Million
1960
181 Million
1980
238 Million
2000
318 Million

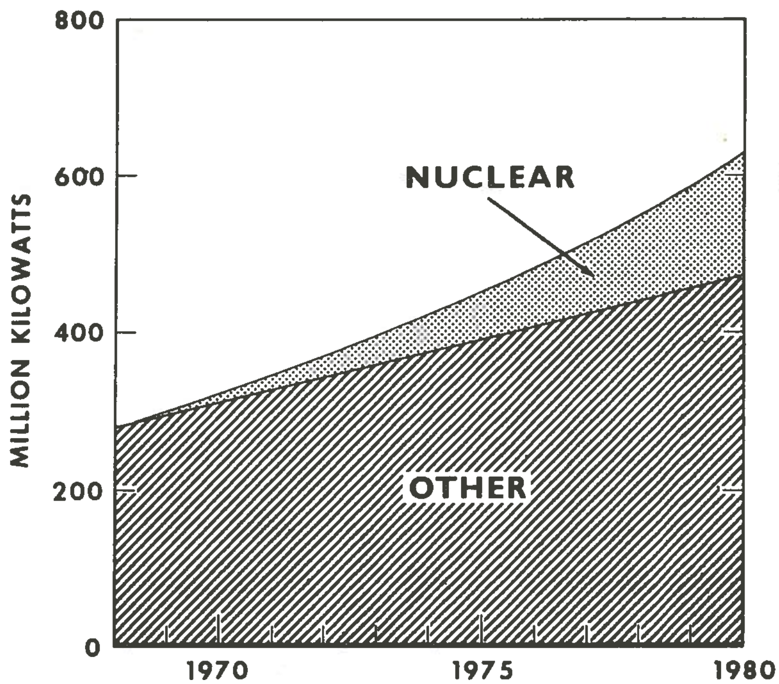
Fig. 1



PER CAPITA CONSUMPTION OF ENERGY
Btu X 10^6
500
400
300
200
100
U.S. TOTAL
FIRST CENTRAL STATION POWER
MODEL T INTRODUCED
1850
1900
1950
2000

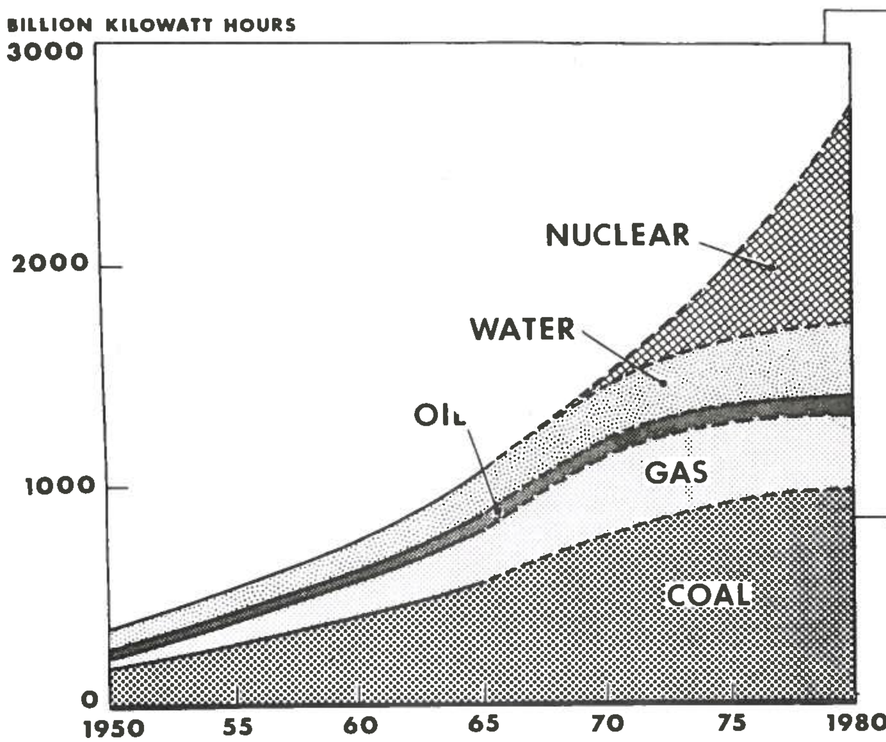
Fig. 2

Fig. 3



ELECTRIC UTILITY GENERATING CAPABILITY AND NUCLEAR POWER GROWTH

Fig. 4



ENERGY SOURCES for ELECTRIC POWER

Fig. 5

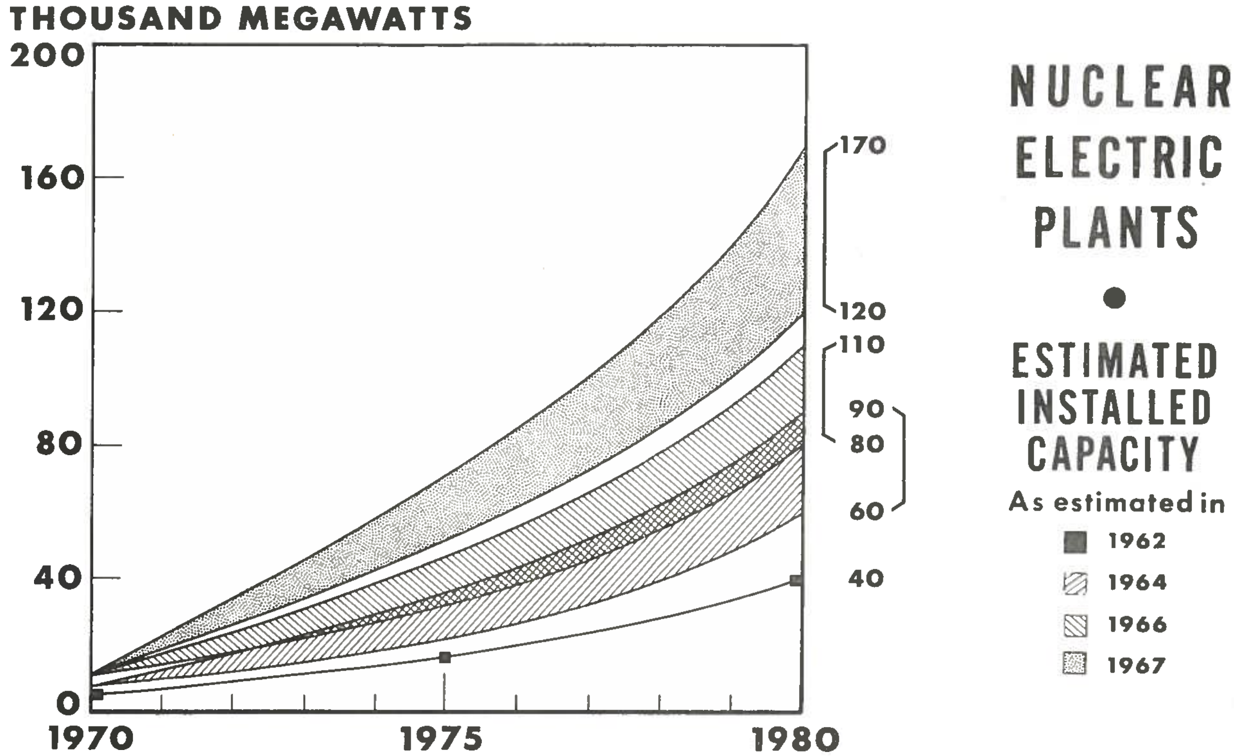

THOUSAND MEGAWATTS
200
160
120
80
40
0
1970
1975
1980
170
120
110
90
80
60
40
NUCLEAR ELECTRIC PLANTS
ESTIMATED INSTALLED CAPACITY
As estimated in
1962
1964
1966
1967

Fig. 6

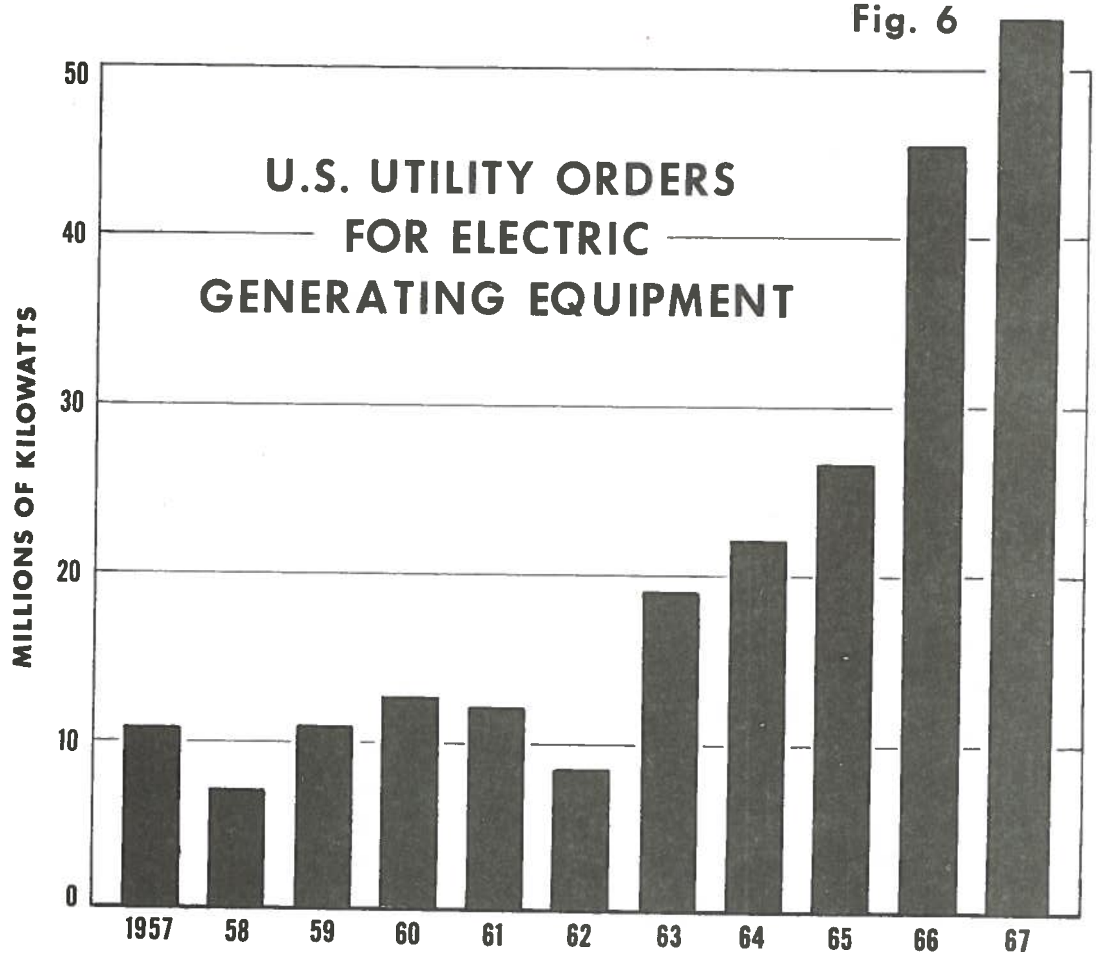

U.S. UTILITY ORDERS FOR ELECTRIC GENERATING EQUIPMENT
MILLIONS OF KILOWATTS
50
40
30
20
10
0
1957
58
59
60
61
62
63
64
65
66
67

Fig. 7

CENTRAL STATION NUCLEAR POWER
REACTOR SALES

	TOTAL TO 9/30/68		
	NO. OF	CAPACITY	
REACTOR SUPPLIERS	UNITS	MWE	%
BABCOCK & WILCOX	11	8,274	14
COMBUSTION ENGINEERING	7	5,175	8
GENERAL ELECTRIC	33	24,679	40
GULF GENERAL ATOMIC	2	370	1
WESTINGHOUSE	31	22,974	37
TOTAL	84	61,422	100

Fig. 8

PROJECTED GROWTH OF NUCLEAR POWER

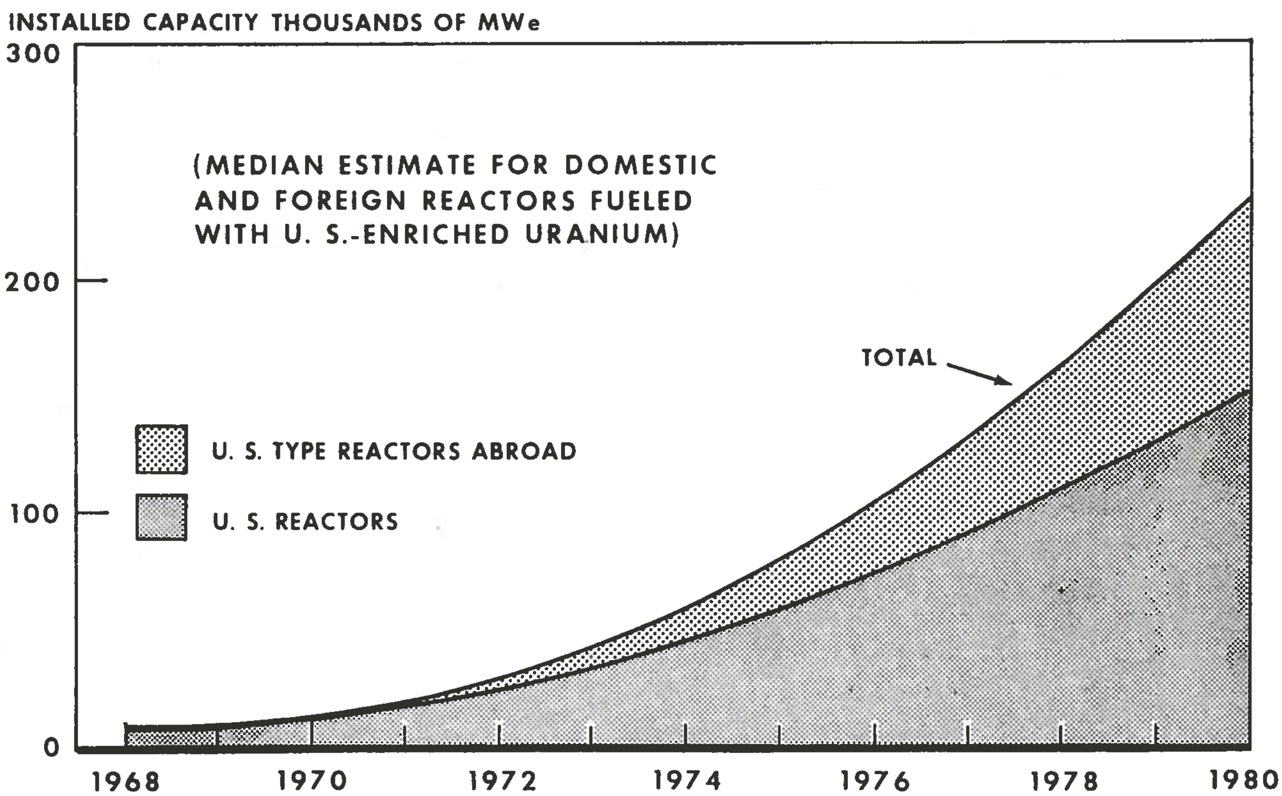


Fig. 9

CONSTRUCTION EXPENDITURES

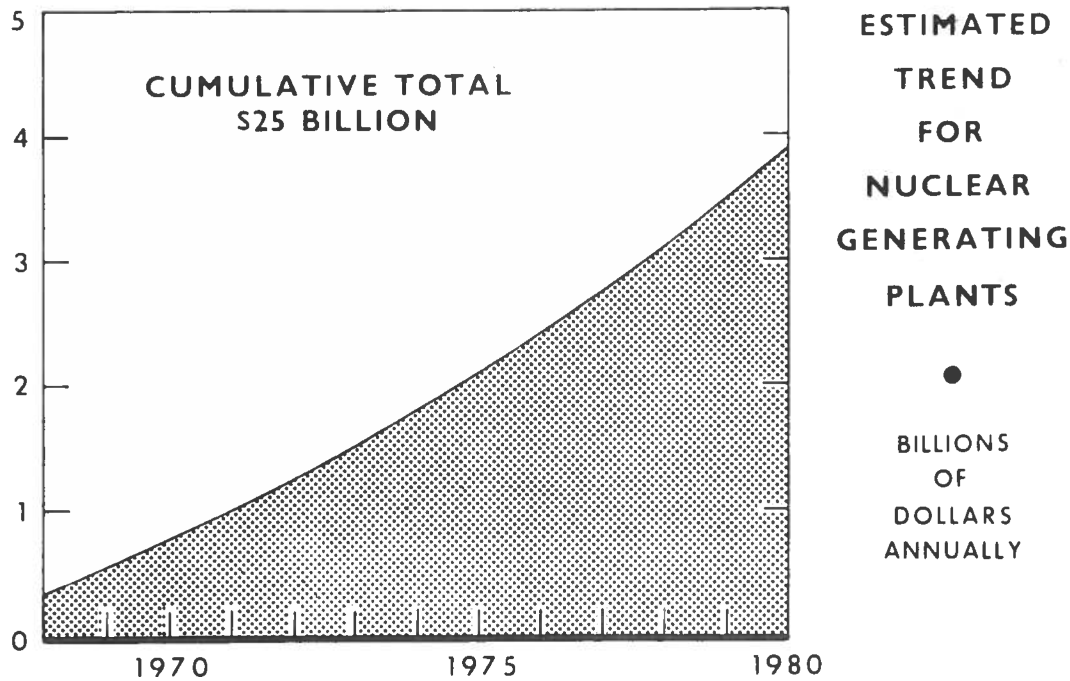


Fig. 10

ESTIMATED ANNUAL URANIUM REQUIREMENTS

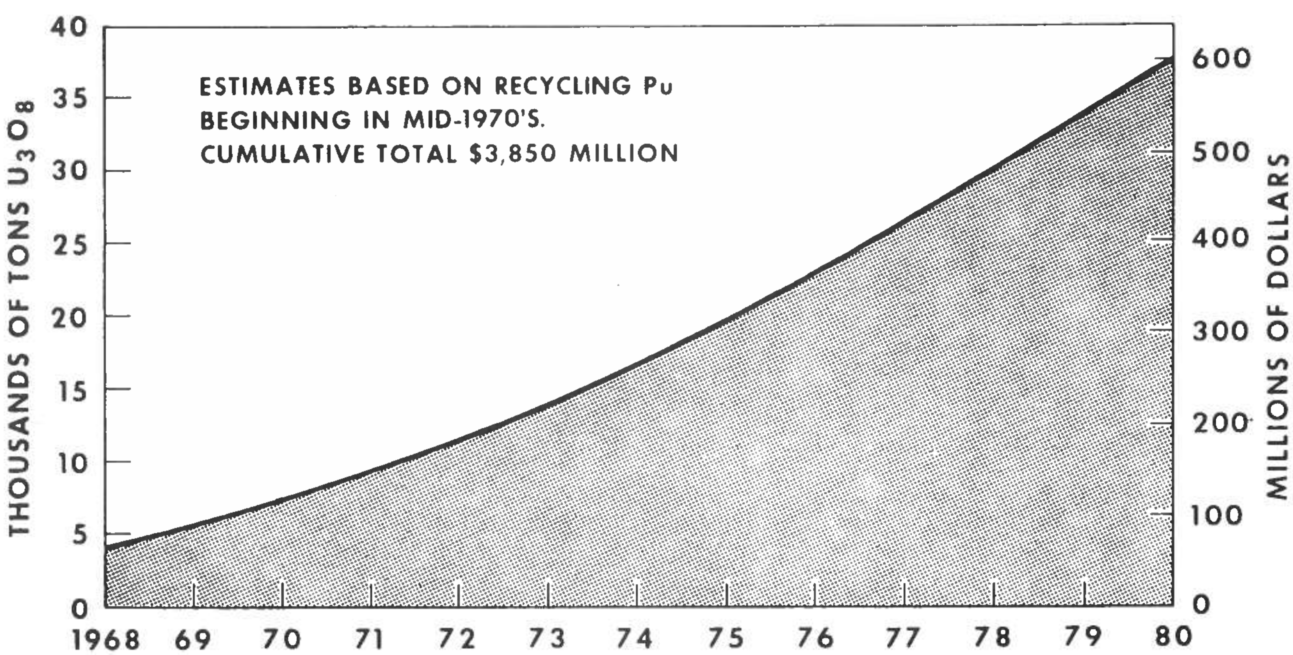


Fig. 11

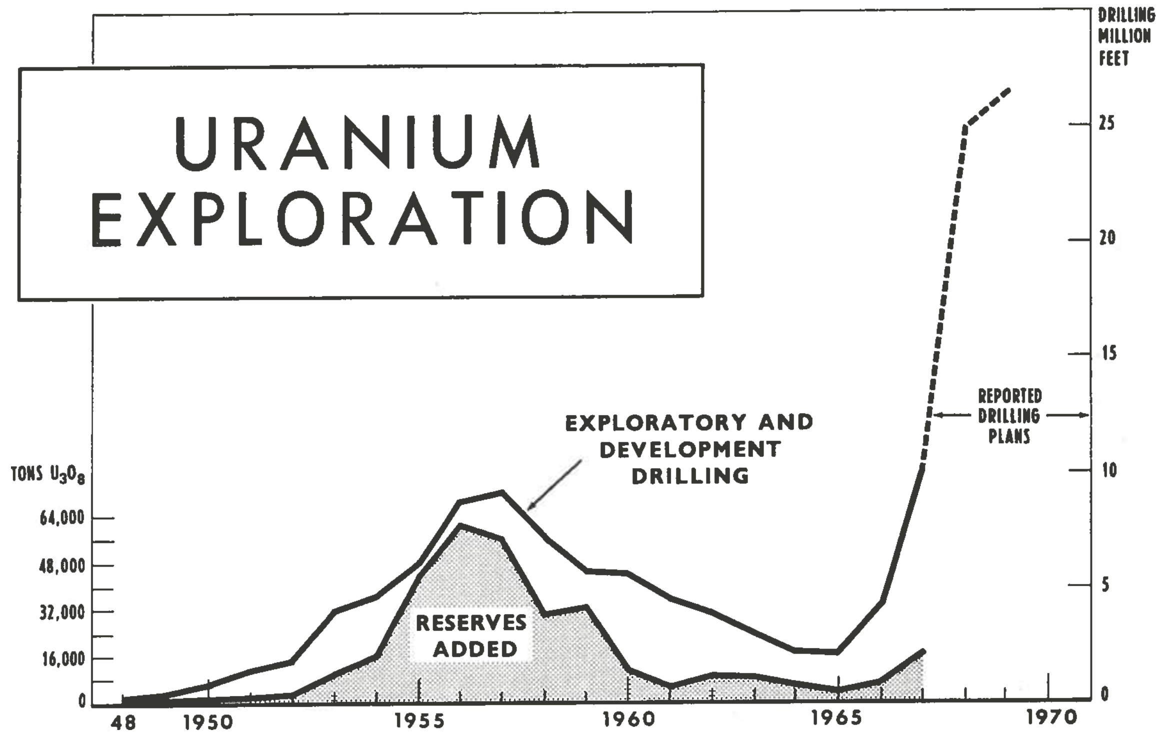

URANIUM EXPLORATION
DRILLING MILLION FEET
25
20
15
10
5
0
REPORTED DRILLING PLANS
EXPLORATORY AND DEVELOPMENT DRILLING
TONS U_3O_8
64,000
48,000
32,000
16,000
0
RESERVES ADDED
48
1950
1955
1960
1965
1970

Fig. 12

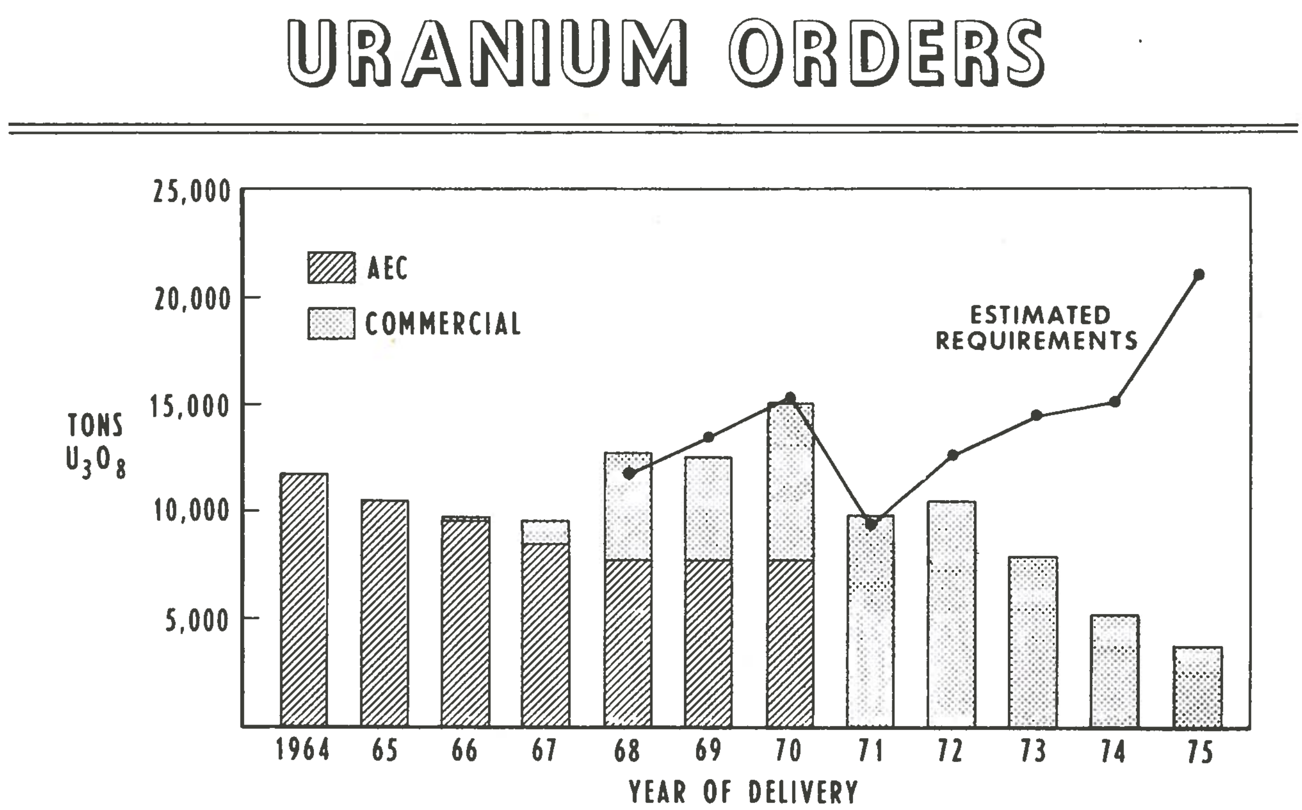
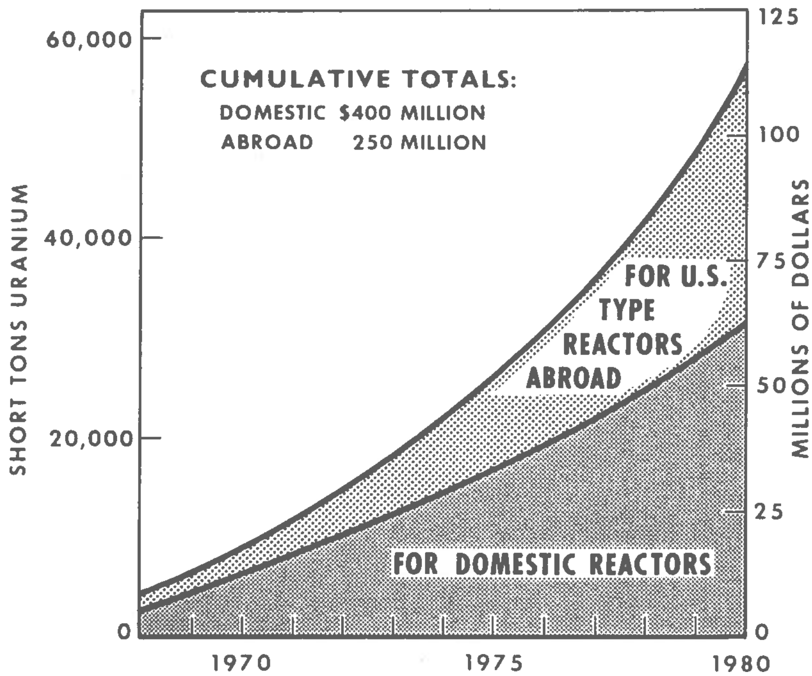

URANIUM ORDERS
25,000
20,000
15,000
10,000
5,000
AEC
COMMERCIAL
ESTIMATED REQUIREMENTS
TONS U_3O_8
1964
65
66
67
68
69
70
71
72
73
74
75
YEAR OF DELIVERY

Fig. 13



CONVERSION OF ORE CONCENTRATES TO UF_6

Fig. 14

URANIUM ENRICHING

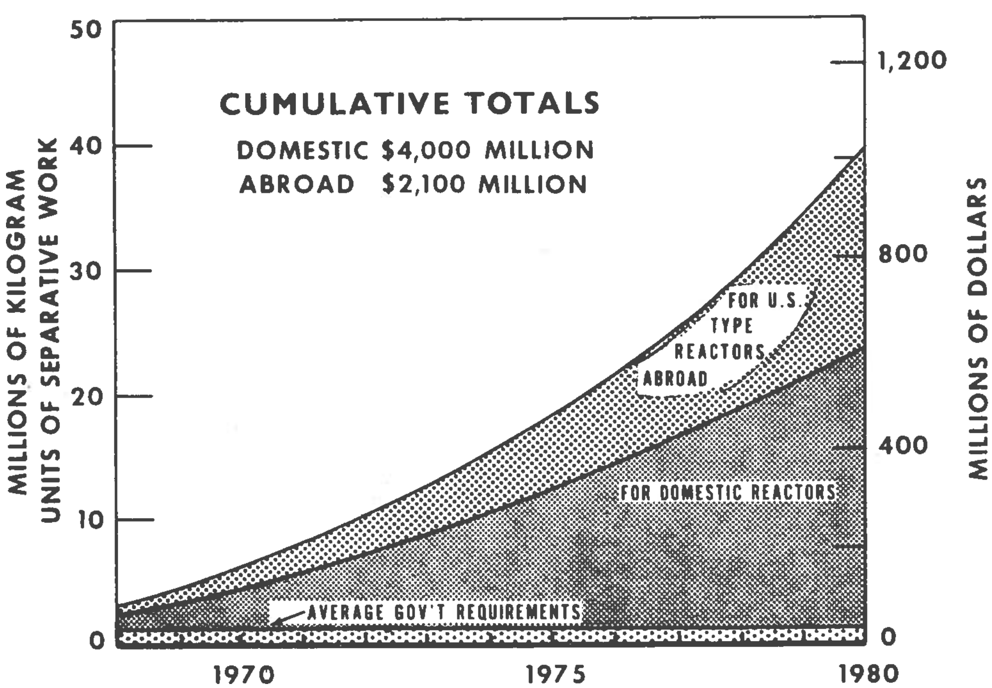


Fig. 15

FUEL FABRICATION

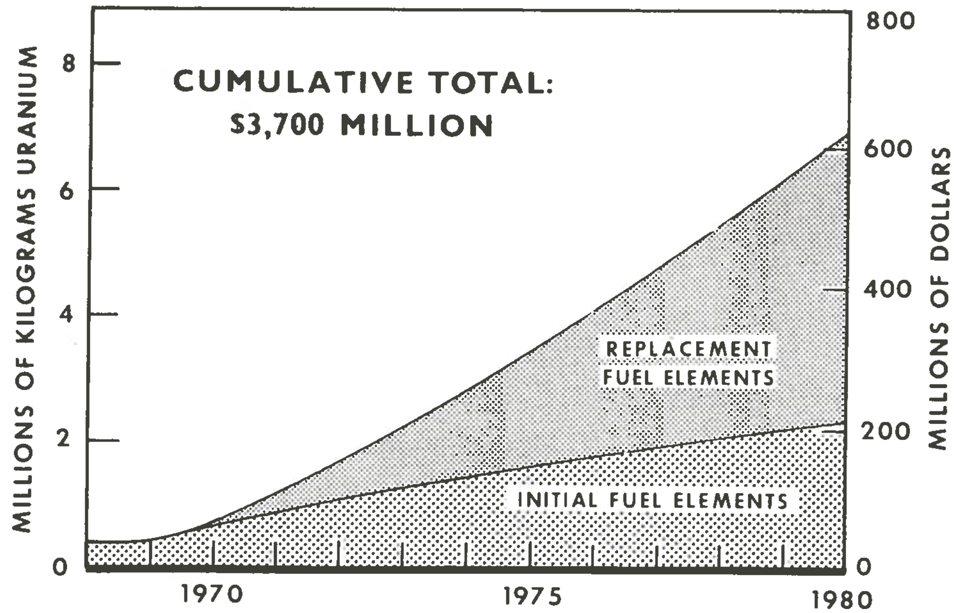


Fig. 16

CHEMICAL REPROCESSING OF FUEL

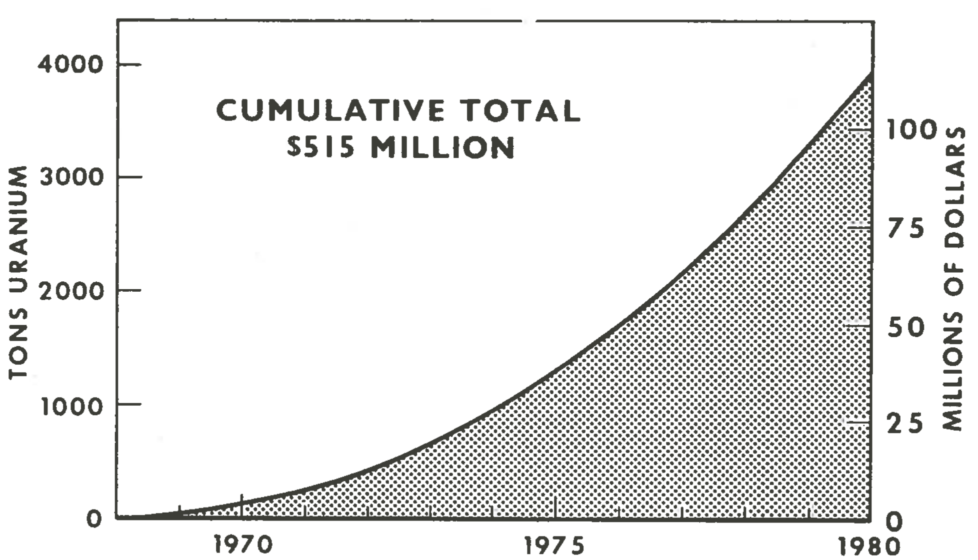
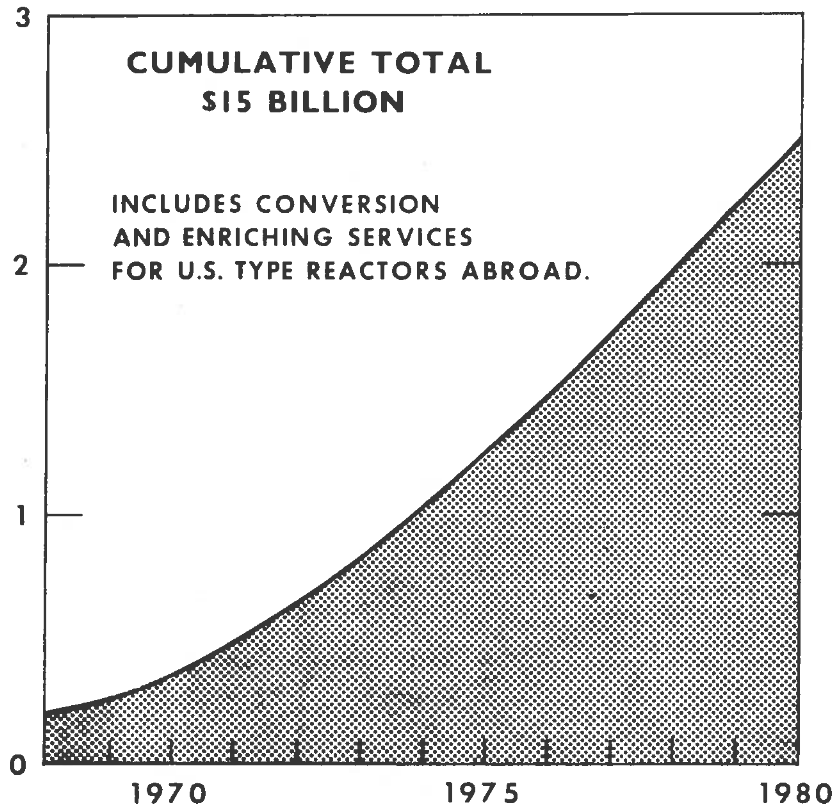


Fig. 17



TOTAL FUEL CYCLE COSTS

●

BILLIONS OF DOLLARS

Fig. 18

NUCLEAR ELECTRIC POWER

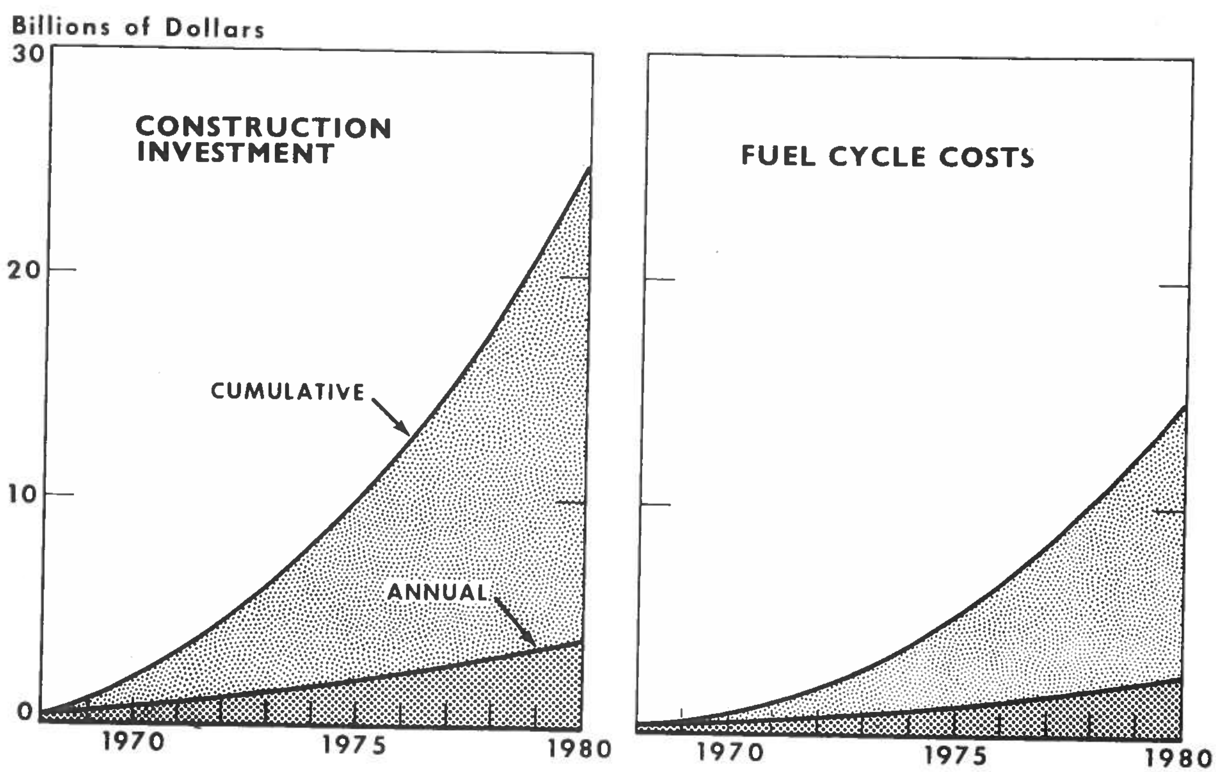


Fig. 19

PROJECT GASBUGGY

DECEMBER 10, 1967

●

EMPLACEMENT OF 26 kt NUCLEAR EXPLOSIVE

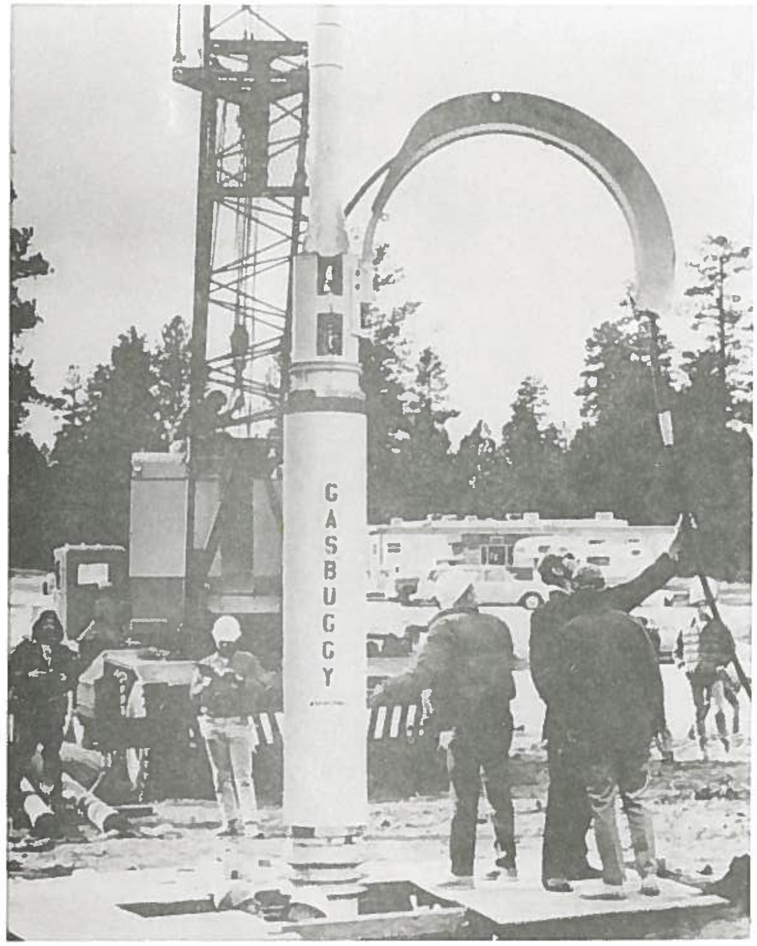


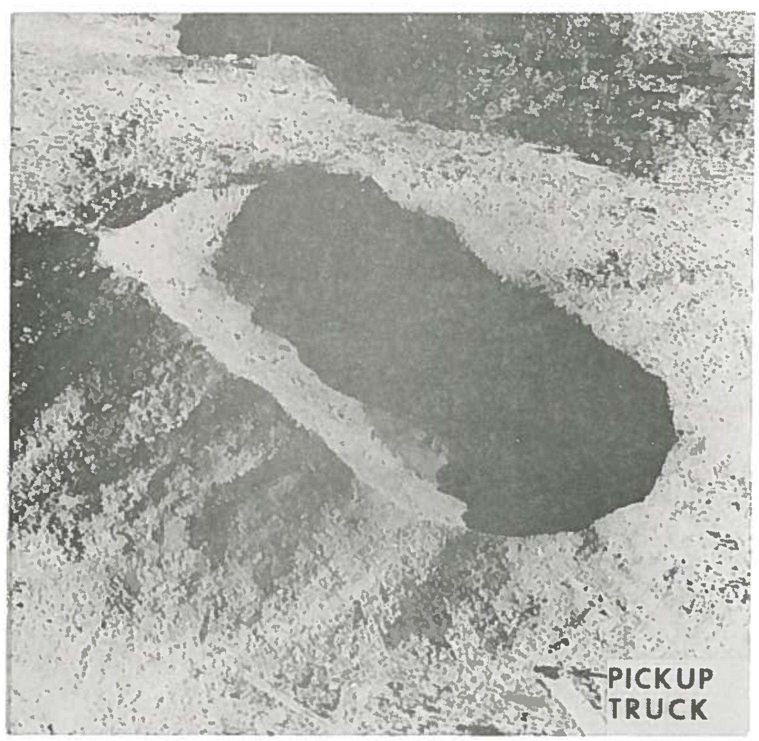
Fig. 20

PROJECT BUGGY

MARCH 12, 1968

●

EXCAVATION BY FIRST NUCLEAR ROW CHARGE EXPERIMENT



UNITED STATES
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NEWS RELEASE

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Tel. 973-3335 or
973-3446

FOR RELEASE AT 4 P.M. EST
SUNDAY, NOVEMBER 10, 1968

Remarks by
Dr. Glenn T. Seaborg, Chairman
U. S. Atomic Energy Commission
and
Honorary Chairman, American Nuclear Society's
International Conference on the
Constructive Uses of Atomic Energy
Washington, D. C.
November 10, 1968

THE PEACEFUL ATOM AS AN INTERNATIONAL BOND

In both of my capacities--as the Honorary Chairman of the American Nuclear Society Winter Meeting and as an official of the United States Government--it's a very great pleasure to welcome you to this International Conference on the Constructive Uses of Atomic Energy sponsored by the Atomic Industrial Forum and the American Nuclear Society. Since I became Chairman of the United States Atomic Energy Commission in 1961, I have attended every one of the joint annual meetings of these two organizations--participating as a speaker every year--and it feels good to be back again. This year the American Nuclear Society and the AIF are holding their joint meeting in the form of an international conference, and it's my privilege to join Walker Cisler, the Honorary Chairman of the Forum's Annual Conference, in extending to all of you the very warmest of welcomes.

This meeting is another important event among the many developments that are promoting international cooperation in nuclear energy. Today international cooperation in nuclear energy builds on the record of the past. People from many nations contributed to the discovery of fission, and the first controlled chain reaction was the result of collaboration

(more)

organizations have developed in other countries. Today the Forum Atomique Europeen, or FORATOM, an international association of AIF counterparts among countries in Western Europe, has a total of 15 members.

The international dimensions of the Atomic Industrial Forum and the American Nuclear Society are also mirrored very clearly by the program of this joint meeting and by the people attending and participating in the panels. I understand that this conference will be attended by over 300 people from about 25 countries. From the roster of very distinguished panelists and other attendees, it is very apparent that this meeting is a gathering-place for outstanding international scientists, technologists, and statesmen of the atom.

We have an opportunity and even a duty during this coming week to use this international conference to promote further cooperation in the constructive uses of nuclear energy. We all share the advantage of being able to meet one another freely and openly on the common ground of science and technology--a common ground that extends far beyond the barriers of national frontiers. We all know full well that the nucleus of the atom recognizes no political boundaries, that the principles of nuclear science and technology have a worldwide applicability, and that the scientific method can be the servant of all mankind. The immutable laws of nature extend across our globe, beyond the earth, and into the farthest realms of the universe.

Almost since its very beginning science has served as a common language among diverse peoples. Scientists and engineers themselves have long recognized the international nature of science and its vital role in world improvement. While science cannot eliminate all the problems and differences, it is an approach that offers very significant results.

Because science springs from a universal heritage and its methods and content are international by nature, science unleashes an irrepressible force that is bound to rise above prejudices and narrow confines of nationalism. Scientists and engineers in their laboratories, regardless of their birthplace or location, work in much the same way. We all have seen how no nation or bloc of nations can long hold proprietary rights to scientific principles or developments. International cooperation in science, today as in the past, expresses this universality of science.

(more)

To a very significant extent, the habits of mind and methods of thinking that science encourages and instills have a common effect on people everywhere. Just as science once exploded the formidable superstitions that stood as barriers stagnating progress, today that spirit of inquiry and reliance on measurement and analysis--which are the essence of science--raise the voice of a common language in opposition to the inflexible dogmas and narrow creeds that now divide men and nations. We must make greater use of this common language of science in strengthening the understanding among our nations that is essential to future world peace and progress.

As Chairman of the United States Atomic Energy Commission, I have had many opportunities to see how international cooperation in nuclear science is contributing to common understanding among the nations of the world. During the last eight years I have been outside the United States 200 days while travelling to more than forty countries. Since I have visited many of the world's leading nuclear laboratories and installations and talked to a great number of scientists, I have already met many of you personally and have some knowledge of your work.

The progress throughout the world in nuclear science and technology has brought us toward the threshold of revolutionary advances in expanding the atom's economic and humanitarian benefits. For example, reactor technology developed by several different nations has already demonstrated the safety, reliability, and economic competitiveness of nuclear power. The task is now to press ahead with developments that will lead to even more far-reaching technological advances, such as breeder reactors that will enable the world to tap the virtually inexhaustible supply of nature's reserves of uranium-238 and thorium-232. And beyond the breeders lies another rich field for research and development: the promise of controlled fusion, which would give us access to the potential energy contained in the heavy hydrogen in the earth's oceans--an amount of energy estimated as the equivalent of 500 Pacific Oceans filled with high-grade petroleum.

Mankind must use its talents for research, development, and highly sophisticated technology to give the world an abundance of low-cost electricity. I believe that in future years nuclear power could be used to desalt seawater and to produce fertilizer on a scale that could transform some coastal desert regions into highly productive farmlands capable of raising enough food to provide an adequate diet for millions of people. Future developments within our capability could lead to low-cost power that would have a fundamental impact on the way we use energy and raw materials throughout much of industry--so great an effect that low-cost nuclear power could bring the world into a new phase of the Industrial Revolution.

Another area of nuclear research and development that I am convinced we can develop to the point of tremendous economic and social benefits is the peaceful application of nuclear explosives. By detonating nuclear devices underground it should be possible to do things that might never be economical by conventional methods, such as to release natural gas locked up in formations of very hard rock, to produce oil from oil shale, and to leach valuable minerals from low-grade ore deposits. Other concepts envision using nuclear explosives to create canals, harbors, mountain passes, lakes, and reservoirs. We must, of course, develop these and other potential applications under an adequate system of international safeguards to open up these great new possibilities.

In addition to these exciting prospects there is that proliferating multitude of beneficial applications based on radioisotopes. The pay-offs for research and development on these versatile servants of progress and humanity are being felt on a worldwide basis in an ever-growing number of uses in research, medical diagnosis and treatment, agriculture, industry, space, and oceanography. Continued work to develop new uses for radioisotopes can give us not only new products and more efficient processes of significant economic value; it can also contribute materially toward alleviating suffering and hardship throughout the world, as the medical uses of cobalt-60 and iodine-131, for example, have so dramatically demonstrated.

Helping to build a better world by developing the peaceful atom will, of course, require effective international safeguards against the unauthorized diversion of nuclear materials for other than peaceful and constructive uses. Adherence to the Non-Proliferation Treaty will assure that end. This is an irreducible and inescapable necessity. A non-proliferation treaty and its accompanying effective safeguards are essential if programs for expanding the peaceful applications of nuclear energy are to be pursued with maximum effectiveness in an atmosphere of mutual trust and confidence where nations can feel assured that other nations are not engaged in nuclear developments that could threaten their security.

The fissionable materials used and produced in nuclear power reactors have a massive potential for good or for evil. We must all assure that the awesome force locked in these nuclear fuels is used only for the good of mankind.

Let us dedicate this conference to making the international atom one of mankind's most important forces for peace. International nuclear cooperation will accelerate those advances that can reduce suffering and misery around the world so that all countries can benefit from the atom and enjoy a more bountiful life.

We must cooperate more so that we can advance together more surely and swiftly than we can alone. The many potential benefits that I have mentioned are examples of what could be developed by pooling international resources in both research and applied technology. The more we can do through international cooperation in science and technology to satisfy basic human wants, the more we can alleviate human conflict. As we go further down the path through the Nuclear Age, let us make the atom a stronger bond between nations.

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AEC

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

No. S-48-68
Tel. 973-3335 or
973-3446

November 22, 1968

Remarks by
Wilfrid E. Johnson, Commissioner
U. S. Atomic Energy Commission
at the
Headliner Awards Dinner
Oklahoma City, Oklahoma
November 22, 1968

Ladies and Gentlemen....................

I have been asked to speak to you about energy, a subject that may sound a little dull but which really is well suited to the circumstances that bring us together and well suited also to your city and your state.

In looking up some of the history of your city, I was reminded of the circumstances under which the Oklahoma City Airport was built some 40 years ago. I am told that after you voters had approved a bond issue to finance the airport, a well known local attorney, Charles Ruth, filed suit on behalf of himself and others to restrain the city from selling the bonds on the grounds that the building of an airport was not a legitimate municipal purpose. The case was heard by Judge J. W. Bird, Special Judge of the District Court of Oklahoma City. In deciding the case, he dismissed the well developed legal arguments of the contesting parties and decided in favor of granting the bond issue. In his opinion, which was notable for its brevity and pithiness, he is reported to have said, "I am going to allow this bond issue because I believe this aviation is the comin' way of goin'."

Of course, my point is that it is people like Judge Bird, your famous Will Rogers, and your distinguished guest of honor who, both in the past and today, have in a very real sense energized Oklahoma - another way of saying that the energy, wit and perspicacity of these people continually serve to keep Oklahoma on the map.

(more)

What is Energy?

So let me get to my subject by first asking the question, what is energy? As a matter of fact, I tried to find a good definition that I could use and must confess that I failed. Technical definitions, of course, are found but they all lead to the same end, the same realization that nature is not about to reveal all of its secrets and that we can never in any physical sense have the ultimate nature of the universe revealed to us.

Nevertheless, energy is such a common and comfortable commodity that it should be possible to have a simple description even though we cannot have an accurate definition. Energy actually manifests itself in many forms, all of which in one way or another will generate heat under certain conditions. Since heat is something that is commonly experienced, it is probably easiest to describe or to define energy in the form of heat. We do this by defining a unit quantity of heat known, in the engineering trade, as the British Thermal Unit, which is that amount of heat which will raise the temperature of one pound of water by one degree Fahrenheit. Another unit for measuring heat is the Calorie which may be more familiar to the ladies in the audience.

Of the various forms of energy, one of the most common is the electromagnetic energy of photons; this includes light, ultraviolet rays, infrared rays, x-rays, gamma rays and radio waves. This form of energy is given off by any hot body such as an oven or a light bulb, and is also generated by various types of atomic excitation. Another form of energy is the electro-chemical form that we find in batteries. Electric energy is also a distinct form, whether produced by battery or by the influence of a magnetic field in an electric generator.

Chemical energy is a very common form. This energy resides in the electron sheaths surrounding the nuclei of atoms or molecules and is either released or absorbed when chemical changes take place. These involve changes of electron orbits as a result of the combination or separation of atoms or molecules.

The energy of motion, or kinetic energy, is a very common manifestation that is widely distributed in nature, since the heat of any material, solid, liquid or gas, is the result of the motion of its constituent molecules. Kinetic energy is also manifested in the motion of celestial bodies and on earth in the movement of automobiles, trucks, airplanes, and other vehicles.

Nuclear energy is unique because it is intrinsically available by virtue of the structure of the nucleus of the atom, whereas the source of most forms of energy that we are familiar with (other than that of the sun) relates in one way or another to the electron shells surrounding the nucleus or to general motion of a body or a particle. In certain types of atoms, particularly the atoms of uranium and plutonium, the nucleus can be split into two or more fragments and in this process a very large amount of energy is released, which gives rise both to kinetic energy in the fragments and in neutrons and electrons as well as energy in the form of electromagnetic radiation (gamma rays).

Energy can also be derived from the nucleus of light atoms such as those of hydrogen and deuterium by creating conditions such that the nuclei of two atoms join together and form helium. While these appear to be opposing processes, both the splitting of a heavy nucleus and the joining of two light nuclei have one thing in common: the mass of the resulting particles is less than the mass of the particules with which we started. This mass defect is a measure of the energy released, and the measure was predicted by Einstein in 1905 as a result of his study of relative motion. It is expressed in the now famous equation which states that the energy content of matter is equal to the mass multiplied by the square of the velocity of light. This is an enormous amount of energy; for example, a pound of any material, if one could release its total energy content, would be sufficient to run a 1000 horsepower motor for about 1500 years.

Practically, of course (with one or two exceptions that take place in the laboratory), we are not able to convert all of any quantity of physical matter into energy, but we can make use of the mass defect that is typical of certain nuclear reactions and we have designed nuclear reactors that permit these sorts of reactions to take place. Despite the fact that only an extremely small amount of mass is consumed, the energy release is very great. To calibrate this for us in a rough way, the nuclear fuel present in a reactor designed for the production of a million kilowatts of electricity weighs about 100 tons and during its lifetime in the reactor, which is about two to three years, will produce the energy equivalent of about seven million tons of coal.

(more)

generating electricity, distilling fresh water, refining aluminum, producing grains, manufacturing proteins, and so on. There is no doubt that the efficiencies which scale produces are real and of themselves can contribute greatly to the well-being of each and every inhabitant of this planet. The more subtle and yet important problem is how great engineering works can be brought into reality in a way that assures that the planned efficiencies and economies are, in fact, available to those human beings who most sorely need them. We must be mindful that if the works of man are not constructed and disposed to the service of individual men, they will, in the long run, be performed in vain. The artifacts of man, including his machines for releasing energy and for using it, should provide for him surroundings of comfort and stature and should enrich his life and broaden his community with his fellows. The instruments of economic advance that we are increasingly able to build do not have purposes of their own apart from the purposes of man. For example, these communities - or agro-industrial complexes - that we talk about cannot be truly beneficial unless the benefits appear in the social and political areas, in human satisfaction, as well as in economics.

I for one am firmly convinced that we will meet the challenge of the future and that we will improve our environment - not merely infest it. Far from being the sorcerer's apprentice, I believe man himself is the ultimate energizer. It is man's vision, man's resolve, man's ingenuity, and man's restlessness and his deep impulse and determination to put reality at the end of the rainbow that is perhaps the abiding human truth. The man we honor tonight is one of these.

#