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Remarks by
Dr. Glenn T. Seaborg, Chairman
U. S. Atomic Energy Commission
at a celebration commemorating
25 years of progress at
the Hanford Works and the City of Richland
Richland, Washington
June 7, 1968

LARGE-SCALE ALCHEMY - 25TH ANNIVERSARY AT HANFORD-RICHLAND

In celebrating the 25th anniversary of Hanford I am especially pleased and honored to be sharing the platform this evening with General Leslie R. Groves. It was suggested, when this evening was planned, that General Groves' remarks look back to Hanford's history and that mine concentrate on the future which might grow from all that has taken place here over the years. But I hope you will not mind if our remarks overlap somewhat. It is hard to resist the temptation to indulge in some reminiscences on an occasion such as this.

Although this is Hanford's 25th anniversary year it is hard to peg the birth of this great complex to any one day or week. But in looking over the record I noted that today, June 7, was the day in 1943 that construction was begun on the first Hanford pile, so I believe we have chosen an appropriate time for this celebration.

My own association with the site of the Hanford Engineer Works - and ''Site W'' as it was called at that time - dates back to ~~the spring of 1943.~~ early 1944.

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One of the considerations for choosing this site for the Hanford operation was its remoteness from centers of population. And my first impression of the area led me to agree with the selection on this account. I recall looking over some of the flattest, most lonesome territory I had ever seen. Of course there were other important factors involved in the selection. There was the mighty Columbia River to provide the necessary amounts of low-temperature water to cool the chain-reacting piles. And flanking the area at convenient distances were the Grand Coulee and Bonneville power networks.

From many standpoints it was apparent that General Groves and his staff and Crawford H. Greenewalt and his Du Pont engineers had chosen well in the matter of a site. But in addition, it was apparent that they were wasting no time in turning this lonesome expanse into a beehive of special activity. At the Hanford camp rows of barracks, tents and trailers stretched in all directions. Tons of materials and construction equipment, ordinarily scarce during the war, were pouring into the area. And even at this early stage I recall eating in the largest mess hall I had ever seen - a sea of faces all being well fed. Certainly I was impressed with the scope of the project, and it was all the more amazing when one considered its purpose - to conduct large-scale alchemy. Here we were going to produce kilogram amounts of a new element which only a few months before we had just been able to isolate in a weighable quantity. This first weighable amount was only 2.77 micrograms. As many of you may recall, that first weighing took place in Room 405, Jones Laboratory, at the University of Chicago on September 10, 1942. It was carried out on a specially constructed balance using an extremely thin quartz fibre and the sample was so small that some people still say our experiment consisted of weighing an invisible amount on an invisible balance. Incidentally, last fall we reenacted the first weighing of plutonium at a reunion in Chicago commemorating the 25th anniversary of the original event.

Looking back on the history of Hanford there is so much to indicate that in a sense it was a remarkable act of faith and a result of the determination and courage of many men - and I wish there were time to mention all their names and give each the individual credit he deserves.

The Hanford project represented the largest scale-up of industrial production ever attempted by man. From the ultramicrochemical experiments we had performed in Chicago to the final Hanford plant production the amounts of plutonium handled would represent a scale-up by a factor of 10^9. Of course, that is only one phase of the large-scale alchemy of plutonium production. If we consider the future production of this element, and compare these projected amounts with those involved in the very first tracer studies of the chemistry of plutonium, the scale-up becomes all the more incredible. We are then considering an escalation from picogram amounts (10^{-12} gram) to quantities measured in hundreds of metric tons. The scale-up thus will amount to about 10^{20}, a number more meaningful to astrophysicists than to chemists!

Of course this scale-up possibility is due to plutonium's unique promise of service to mankind. As used in breeder reactors, it will be the fuel of the future. And it will serve as an energy source in devices ranging from a surgically implanted artificial heart to scientific and life-supporting units in deep space. In fact, there has been some talk that the future value of plutonium may someday make it a logical contender to replace gold as the standard of our monetary system. However, not being an economist I will not try at this time to predict how we would operate on this new ''plutonium standard.''

But going from the speculative future back to the interesting past and looking at the original Hanford Project another way, Fermi's first reactor in Chicago produced less than a single watt of thermal power. The reactors built here at Hanford were designed to generate 200,000 kilowatts. If Fermi's pile were to have operated continuously for millions of years it would not produce the plutonium made in one year in one Hanford reactor. And perhaps even more remarkable at the time was the fact that construction on the reactor plant was begun on June 7, 1943, when just six days earlier, on June 1, 1943, we had decided that the Bismuth Phosphate Process, which Stanley G. Thompson had developed, should be the method for chemical separation of the plutonium that would be made in these reactors. Thus we have passed another important 25th anniversary just last Saturday, another indication that we have chosen an appropriate time for this celebration.

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That decision to use the Bismuth Phosphate Process was made in an important all-day meeting in Chicago, and, as some of you may recall, it was a difficult one to make. Attending the meeting were representatives of the DuPont Company and the Metallurgical Laboratory, together with the chemists and engineers who had been most closely associated with the development of chemical processes. We summarized all the available information relative to the Bismuth Phosphate Process and the Lanthanum Fluoride Process, which was the other leading contender at the time. Even with all the available data we had on these two processes there remained uncertainties as to the final choice. For example, there were the corrosion problems associated with the Lanthanum Fluoride Process, and there was the possible failure of complete coprecipitation of plutonium with bismuth phosphate at high concentrations of plutonium. In fact, it was not even certain that precipitation processes would necessarily prove superior to methods based on solvent extraction, adsorption, volatility or other phenomena. But the Bismuth Phosphate Process won out, largely due to my guarantee of at least a 50 per cent yield of chemically extracted plutonium and because of Crawford Greenewalt's preference for a process that would minimize possible early equipment failures even at the expense of possible decreased yields; the potential of corrosion of equipment with the Lanthanum Fluoride Process presented the possibility of complete failure.

In retrospect it is somewhat amazing that this deliberation took place only a week before actual construction began on the Hanford reactors.

I recall that during my second trip out here, in December 1944, I was asked to sign the numerous specifications for the Bismuth Phosphate Process to be operated in the just completed first Chemical Separation Plant. This was, amazingly, only 18 months after the historic June 1 decision. Equally amazing was the rate at which the Chemical Separation Plant went into operation. We received the operating standards on December 15, 1944. The first production run of Hanford material in this Chemical Separation Plant began nine days later (December 26, 1944), and in less than two months (February 2, 1945) the first delivery of plutonium was made from Hanford to the Los Alamos Laboratory.

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As I think back to the Hanford-Richland area of 25 years ago, and compare it to what we see here today, I am reminded of changes in things other than the plutonium production facilities. For one thing - if I might digress from nuclear matters - there is quite an improvement over the transportation I encountered on my first visit here, early in 1944. As I recall, John Willard and I had as our host and personal guide on that visit, Walter O. Simon. Walter was one of Hanford's leading citizens having the double honor of being plant manager as well as the Mayor of Hanford. However - and I hope Walter will bear me out on this - one trip he took us on showed that his auto driving did not quite match his managerial talents. It was the evening that he drove us from the site back to the guest house in Richland. Being impatient with the secondary road in the area (there were no other kind anyway) he decided to take a shortcut straight across the desert.

Sure enough, in an area where one might expect to come across a cattle skull or Gabby Hayes, the wheels of Walter's car got trapped in loose sand. Fortunately, we discovered a water hole nearby, and John and I carried water over to pack down the sand, hoping to create a little better traction. But then we also discovered that Walter was somewhat of an expert at spinning his wheels. And he impatiently dug the car in deeper and deeper before we could finish our compaction of the sand. With a great deal of persuasion and some restraint John and I finally succeeded in slowing Walter down and we managed to get free and make our way back to town - but not before there were a few buzzards circling overhead, or so we imagined. They tell me Walter's driving has improved since then, and so have the roads in and out of Richland.

Richland, of course, has changed in a great many ways since that time. And it is particularly appropriate to take note of its progress during this anniversary year. Richland is a community that grew naturally from the needs of the scientists, engineers and administrators who created and operated the Hanford Works. It is also an example of community growth based on the diversity that springs from a great scientific and technical enterprise and is nurtured and encouraged by a progressive, energetic citizenry.

Some people might say that today's Richland is representative of ''the town that science built.'' I would go one step

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further and say it represents the human bonus that results from our Nuclear Age endeavors - a type of spin-off for people which goes with our technological progress. I am pleased to say that the atom has been responsible for some healthy and happy communities and Richland is certainly among the foremost of them. Of course, no small credit for this is due to your enlightened and enterprising community leaders, your Mayor and public officials, your regional organizations - such as the Tri-Cities Nuclear Council - and certainly your fine Senators Warren Magnuson and Henry Jackson and outstanding Congresswoman, Mrs. Catherine May, who have always worked so hard in your behalf.

All their efforts in cooperation with private industry and the Federal Government have set the pattern for making Richland a city of the future. And I believe that the changes which have been fostered here are the results of the kind of thinking and long-range planning that is going to be essential in our country in the coming years, when rapid economic and social change must take place to meet new national goals.

But returning to the broader aspects of our celebration today, what have all these pioneering years of Hanford and Richland seen - to what overall effort have they contributed? They have contributed far more than the massive production of a new chemical element and the technologies and spin-off associated with it. I believe they have seen the evolution of a new age, the full possibilities of which we are now only beginning to realize. The great potential power stoked forth from the nuclear furnaces of Hanford is now becoming the fire of the future. And it is a type of fire that will bring more people not only physical comforts - through heat, light, power, water and food - but a large measure of added knowledge and understanding. The greater significance behind the large-scale alchemy which has taken place at Hanford is that of being able to bring forth changes in the lives of people and the healthy growth of their communities through scientific and technological changes. It also involves the future production of energy on such a grand scale, and so cheaply, that we may well see, as I will point out in a moment, an era when such a material as plutonium will radically change our relationship to almost all other materials - to our production of food and the use we make of our water, air minerals and other natural resources. Let me spend the next few

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minutes, therefore, exploring the role that nuclear energy might play during the next 25 years and perhaps well into the next century in changing our lives and advancing the lives of our children.

I will not go into the statistics of today's nuclear power growth, mainly because they change almost as fast as I can report them. (Back at AEC headquarters we have a map which one might call our ''nuclear power box score,'' and I can tell you it is usually much more encouraging to follow than the standing of our Washington baseball team.)

There is no doubt that nuclear power as a means of generating electricity has reached, and passed, what some economists call ''the take-off point.'' It is being accepted for economic reasons. It is being accepted for environmental reasons. And it is being accepted for aesthetic as well as for practical reasons. The time is not far off when clean, compact, competitive nuclear plants will be the ''conventional'' power plants of the day.

But being ''conventional'' is not the goal of most of us interested in nuclear power - far from it. We look forward - and are working and planning accordingly - to the day when abundant, versatile and very economic nuclear power, together with other technological advances taking place, will make possible a new era of human progress. This can take place on many levels and in many ways.

The changes that will be wrought by nuclear power are, of course, dependent on farsighted economic and environmental thinking, and in this respect we in the Nuclear Age have a decided advantage over previous generations. This is an age when we have the ability, the tools and the wisdom to look ahead and plan wisely for the future. Prior to this our use of energy resources has been rather haphazard. We have used our natural fuels - wood, coal, gas and oil - as we have discovered them and needed them, without much in the way of long-range thinking and planning. Fortunately, our Nuclear Age is one of foresight as well as power and therefore we are thinking in terms of conserving our energy resources, of using them as efficiently and economically as possible, and of their relationship with all our other resources and our total environment. This new level of thinking is perhaps the most significant phenomenon that has taken place paralleling our current technological revolution. As a result, in the nuclear field we are not content to sit back and watch the growing use of our present range of nuclear power stations, no matter how safe, reliable and economically competitive they may be today and for the coming decade or so. We are already very hard at work developing the more efficient converter reactors and the breeder reactors of the future which will allow us to make far more efficient and economic use of our natural nuclear resources.

Richland, of course, will be highly involved in the development of an important kind of breeder reactor, the fast breeder, as the Fast Flux Test Facility (FFTF) will be located here. And this facility, which will play a vital role in the development of the fast breeder through the testing of its fuels and materials, is an example of how nuclear development can bring additional growth to a community.

Now, to what extent and in what ways might the growth of nuclear power affect our total progress - at first through the fullest use of our current reactors and eventually through that of reactors such as the fast breeder? The secret lies not just in producing abundant, cheap energy but in thinking of it and using it as a raw material to affect our use of other materials and the environment.

Energy has always played this role to some extent; this is one reason why our cities and industrial centers have grown and prospered on the large waterways and at the rail centers where they could be supplied easily with fuel. But we have nuclear energy at a time when we also benefit from a new level of sophistication in chemical and industrial engineering, in agricultural development and in environmental planning. Therefore, we can work toward using nuclear energy in combination with these other factors to perform some momentous tasks.

At the same time the possibilities ahead give us enormous incentive to reduce the cost of nuclear power to levels where it will greatly increase its use and effectiveness. For example, we know that at a certain cost nuclear power makes it economical to desalt large amounts of seawater in conjunction with generating substantial amounts of electricity. At a similar cost range the economic production of large amounts of fertilizer becomes feasible and can be used in combination with fresh water and electricity. In still other ranges of reduced costs a cumulative number of industrial processes becomes possible, ranging from the making of steel by electric furnace methods, through the manufacture of magnesium at today's cost of aluminum, down to the production of pipeline gas from coal. At the very low end of this decreasing cost scale we may someday see the use of nuclear power for general purpose industrial heat or uses such as the manufacture of gasoline from coal. In this range, for which the cost of power would have to come down to one mil per kilowatt hour or cheaper, all sorts of industrial miracles become possible.

But let us project some of the possibilities which nuclear energy offers at various economic levels if we dare to be bold, imaginative and forward-thinking in its behalf. Let me briefly sketch out a few development schemes based on the availability of nuclear power and other factors. While some of these ideas may seem in the realm of fantasy at the moment, most of them are based on technologies and concepts which are in existence today or being seriously studied and developed.

The first plan is based on the work of Professor Perry R. Stout of the Department of Soil and Plant Nutrition of the University of California (at Davis, California). This plan envisions the construction of a large nuclear complex in the Indo-Gangetic Plain in India, an area which lies over a huge reservoir of groundwater but which currently is dependent on unreliable monsoon rains for the success of its crop. Farmers in this area are beginning to have great success in raising a dwarfed variety of wheat which, when properly watered and fertilized, can produce yields as high as seven times that of the previously grown local crop. But fertilizer, particularly if it has to be imported or shipped great distances, is expensive. And water, particularly if its source must be a monsoon, is not always available at the right time or in the right amounts. This is where the nuclear complex comes to the rescue - and in substantial as well as dramatic fashion.

The plan involves the following: A large nuclear power station would be built in this area and its extensive electric grid system is used to operate thousands of tube-well pumps to bring up fresh water from the underground source - water which can be used scientifically to best grow these new crops. In addition, the power from the nuclear plant would be used to produce the needed fertilizer for this region. This combination of resources could all but guarantee an abundant crop regularly in this area which previously was at the mercy of nature's whims. It might someday mean the difference between a country that always lived on the edge of famine and one that could be assured of feeding its people.

This alone would make such a costly venture worthwhile, but there are other benefits that could accrue. There are a multitude of modernizing effects which could come from the power such plants would produce. What if, in addition to the fertilizer plant, there was sufficient power to support a small steel mill and some subsidiary light manufacturing such as the production of steel plows, bicycles or eventually small tractors? There is also the general uplifting effect of electricity on the farms and in the villages where such things as electric lights, small power tools and modern communications could generally raise living standards. Most economists agree on the importance of fostering a development situation in which agriculture and industry grow hand-in-hand, and nuclear power, supplied in an area where there is presently little or no power available and used in conjunction with other production technologies, might be the winning combination to start some areas of the world on the road to more rapid development.

Let's see how a similar combination might affect other areas of the world. In this case I refer to the coastal desert areas, large regions located on tropical seacosts in several parts of the world. These areas, for the most part unpopulated and unproductive today, might prove to be valuable sources of food and other products if the right combination of nuclear energy and human ingenuity were brought to bear. From studies that were originated by Dr. R. Philip Hammond of Oak Ridge National Laboratory and vigorously advanced by Dr. Alvin Weinberg, director of the laboratory, has come the idea of constructing large nuclear-powered agro-industrial complexes on such desert coasts. These complexes, using large reactors, even of the types currently under construction today, would be used to desalt seawater, in quantities of several hundred million gallons per day, and to provide the power to produce large quantities of ammonia and phosphorous fertilizers as well as all other electricity to operate the complex and its community. This power, water and fertilizer would support the operation of a large highly scientific farm - a ''food factory'' growing very high yield crops specially bred for the area's soil and climatic conditions.

An extensive study has been made of this concept by a team comprised of outstanding scientists, engineers and other experts in various disciplines, and their findings indicate that such agro-industrial complexes could produce tremendous quantities of food on hitherto unproductive land. The results of this study will soon be released by Oak Ridge National Laboratory, so I will not go into detail on its findings. But I would like to point out other ramifications of this plan. This, again, involves extending the use of the technology you have helped bring into being and putting it to work for maximum development.

For example, the nuclear plant of this complex could produce many other chemical by-products from the brine resulting from its distillation of seawater. A fishing industry might be started off the coast with its catches either being preserved by irradiation or other methods, or being processed into the ''fish flour'' concentrate which could act as a high protein supplement to the grain produced by the agricultural center.

Naturally, an undertaking of this scope is a mammoth one requiring extensive financing and probably significant international cooperation. And perhaps these centers could be focal points of such cooperation operated under the aegis of an organization such as the International Atomic Energy Agency and financed by the World Bank. (Incidentally, both of these organizations have examined this concept and expressed some interest in it, even at this early stage.)

The third idea involving the future application of nuclear power on a large scale is one which I have spoken about in several talks. It is cast a little further into the future than the two previous ideas as it is dependent on the very cheap nuclear power that might be available from very large breeder reactors - probably in the multi-thousand-megawatt range. Also this concept would be most applicable to more heavily industrialized countries such as the U. S.

Essentially, it is the concept of basing heavy industry around a very large nuclear power facility which would act as the complex's energy heart. This processing and manufacturing center would become a nuclear-powered industrial complex or, as we have been referring to it, a Nuplex. There are substantial economic and environmental advantages to be

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gained from the Nuplex concept - particularly if the cost of your nuclear power is low enough to produce large amounts of electricity and process heat very cheaply and put them to a variety of uses.

In addition to processing many conventional resources by new methods which would reduce their cost, and being able to produce new and more exotic materials - different new metal alloys, ceramics, plastics and even transuranium elements in large amounts - the Nuplex would give us the advantage of being able to recycle most of our waste on an economic basis. This is becoming increasingly important when the disposal of our output of junk and garbage is becoming a problem of major proportions. When the economic recycle of most waste becomes possible we will alleviate the problems involved in burning trash, flushing industrial waste into our waterways or finding adequate sites for land-fill operations. There is also the added factor that these recycled materials will become more and more valuable as our industrial civilization expands and we must search farther and dig deeper for new natural resources.

Of course, the Nuplex concept has the additional feature of radically improving our urban development. Not only would it give us a literally ''junkless'' society, but it would allow us to separate our heavy industry from the cities so that we could plan and build cities designed for the ultimate in healthy living. The Nuplex would be the source of our power and products. The city would once again become a place primarily for people.

These three concepts based on the extensive use of nuclear power are, of course, only a part of our possible nuclear future. The role of nuclear energy on and under the sea, its use as a source of power in remote, inhospitable areas of the earth, its varied applications in space - both in satellites that will give us greater knowledge about the earth and in nuclear-powered projects that will see us colonize the moon and explore the distant planets - all these are among the other possibilities which are evolving in part from the large-scale alchemy that was begun here 25 years ago. There is the expanding role of radioisotopes in medicine, agriculture and industry. There is also an entire new range of knowledge - about man, his origins, his history and his environment - that is growing from the use of the atom as an investigative tool. And still we continue to explore the atom itself and learn more about the structure of its nucleus - giving us clues to the structure of our universe.

Perhaps 25 years from now we will be able to gather here to look back over half a century of progress of the Nuclear Age. By then Richland, together with the Tri-Cities Area, will probably be a large metropolis thriving on its growing science-based industries. Perhaps Hanford will be its Nuplex, able to preserve the surrounding vast and majestic area close to the way nature created it. And we will be able to reminisce about the beginning of the Nuclear Age while we see all about us many of the wonders that it has brought and continues to unfold. In the meantime, I think that all the citizens of Richland and those who helped to make history at Hanford can be justifiably proud today.

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