ELECTRIC POWER

Mr. Walker L. Cisler

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Reviewed by: Colonel Thomas C. Keach, USAF

Date: 8 February 1960

INDUSTRIAL COLLEGE OF THE ARMED FORCES

WASHINGTON, D. C.

1959-1960

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GEN. HOUSEMAN: Within the last forty years there has been a tremendous upsurge in the importance of electric power and the use of electric power, particularly here in the United States. It has been one of the prime measures of our economic growth.

It has been during this same time that our speaker has been allying himself as a businessman and as an engineer with the power industry in various facets. He has not only been connected with the power industry in civilian life, which has been the major contribution which he has made; but he has also actively helped the Army, the Navy, and the Air Force and other Government agencies, in both war and peace, to solve our problems. Lately he's been a special consultant to the Department of Defense on the problems of how we are going to organize ourselves militarily and civilianwise as we get into the problems of space in the near and the distant future.

We have a speaker who has been here at the College many times. He is one of our true friends, I am certain. He and his organization gave us tremendous assistance when we went to Detroit last week, when we were traveling around and getting educated in the civilian world.

We are most happy to have with us this morning Mr. Walker L. Cisler, President of Detroit Edison. We are glad to have you with us again, Mr. Cisler.

MR. CISLER: General Houseman, Gentlemen and Friends:

It is a great privilege to be with you again. I always enjoy coming to the Industrial College of the Armed Forces, because I believe very sincerely in the work that you do here; and it's a pleasure to receive many of you in Detroit. I find that I have the opportunity to catch up with old friends when I come here, and to make new ones as well; and I'm sure that this will be another one of those very pleasant occasions.

My subject today will be the present status of electric power in the United States. Also I will give you some personal observations and comments regarding the development of electric power and atomic energy in the Soviet Union.

We have for you copies of what it is I will discuss with you today--in the form of a little booklet which may be useful to you as you carry on your own studies. I believe there are available also some of the other recent power surveys of the Edison Electric Institute. What I have to say today pertains largely to the work of the Edison Electric Institute and other work which is going on around the world.

In fact, this approach to having a status of electric power is being followed by other nations of Western Europe--by the individual nations and by the groups of nations, particularly those in the OEC countries. And it may surprise you to you that Turkey has followed a similar approach. Just yesterday I received in English the latest survey of the Japanese electric power status.

I believe it is axiomatic to state that most of us here today who are vitally concerned with the strength of our country are aware too of

the importance of electric power, both in peacetime and in national emergencies. Electric power is a means to an end, a vital requisite for nearly every aspect of our lives, for economic advancement in peacetime, and especially for the defense of our country.

So that we may understand the electric power situation more fully, I shall first discuss the matter of power supplies, peak loads, and generating capabilities in the United States, and the steps that are being taken to meet future needs. After that I shall discuss nuclear power and its probable role in helping to meet our country's expanding power requirements. Finally, with your agreement, I shall briefly comment concerning electric power in the Soviet Union as compared with the United States.

In beginning this discussion we should have a clear understanding of the role of electricity in our way of life. Our economy demands vast amounts of electric energy for many different purposes, and ever-increasing amounts will be required as our economy grows.

It does not follow, however, that our economy will grow simply because an abundance of electricity is available. Witness the depression years of the 1930's or the recession years of 1957 and 1958, when the electric power industry stood prepared to provide much more power than the consumers used.

At present there is an adequate power supply available in all parts of the United States to meet the requirements of industry, commercial business, farms, and homes. There may be a few minor imbalances,

but they undoubtedly are of minor significance and fewer in number than at any time in recent years.

The Edison Electric Institute, through its Electric Power Survey Committee, provides comprehensive up-to-date data regarding the power situation in the United States on a continuing basis. Representatives of power systems throughout the country prepare the basic information and participate in the compilation of the survey reports. The manufacturers of heavy power equipment provide detailed information concerning equipment for the expansion of generation and transmission facilities. They also provide an evaluation of their total manufacturing capacity for the period ahead over and above their existing commitments; in other words, the unfilled, open-shop capacity. This entire activity, therefore, represents the concerted work of people responsible for the operation of our country's power systems and the manufacture of major equipment--people who are responsible not only for providing power and the necessary generating equipment, but also the planning for the future.

(Chart 1) Figure 1 is a chart taken from the report of the 26th EEI semiannual power survey as of October 1, 1959. It shows the December peak loads and peak generating capabilities available to meet those loads as actually experienced in 1957 and 1958, and as forecast for the years 1959 through 1962. It also shows the gross margins experienced or forecast for those same years.

The EEI surveys cover about 97 percent of the electric power

industry of the country, including both investor-owned systems and those of governmental agencies, Federal and non-Federal. The totals given by those surveys, therefore, differ little from data covering 100 percent of the industry.

Peak capability, as used here, represents the maximum possible kilowatt output with all power sources available. It must, therefore, provide the necessary allowance for maintenance, emergency outages, and system operating requirements. The gross margin is the difference between the peak capability and the peak load; and the numbers on the top of the bars give the gross margin as a percentage of peak load. Obviously, the gross margin includes the provisions for maintenance, unscheduled outages, and system operating requirements. Any remainder, after these needs are met, is available for expected load growth or unforeseen loads.

This chart shows many items of real significance. For example, it was forecast that the December peak load for the country as a whole, excluding the States of Alaska and Hawaii, would increase from 107 million kilowatts in 1957 to nearly 125 million kilowatts in 1959 and 153 million kilowatts for 1962. Similarly, it was forecast that the peak capability to meet these peak loads would increase from nearly 131 million kilowatts in 1957 to 159 million kilowatts in 1959 and 192 million kilowatts in 1962.

The December gross margins, which are a highly significant benchmark, range from 22.2 percent to 27.5 percent.

There is no optimum gross margin applicable to all power systems. Some systems may be satisfactorily operated with gross margins as low as 10 percent; whereas others require much higher gross margins. Much depends upon the character of the load and the nature of the power sources.

Somewhat more generally, 15 percent has been considered to be a reasonable average; but with the recent increase of summer peak loads as compared with December peaks, there is strong indication that the average gross margin should be higher than 15 percent.

It is obvious from the gross margins shown that the power systems of our country are adequately prepared to meet all presently expected power loads.

I should point out here that the actual compilation of the power system data is on the basis of the eight power supply regions of the United States (Chart 2) as established by the Federal Power Commission and shown by Figure 2. The data for each region are included in the power survey reports, and may be used for detailed study.

I should also point out that data concerning both summer and December peak loads are included in the survey reports. In recent years the trend has been for the summer peak loads to approach those of December.

(Chart 3) This is represented by Figure 3, which shows the summer peak loads expressed as a percentage of the peak load for the following December. As can be seen in this slide, the summer peak loads in Region V are well above the December peaks. This is the result of a

very extensive air-conditioning load during the summer months. Little space-heating load has developed in that region, presumably because of the low cost of natural gas. In some of the other regions the summer peak load is either close to or exceeds the December peak load.

(Chart 4) Figure 4 shows the capability, peak load , and gross margin statistics as compiled by the Power Survey Committee for 1947 through 1959--the entire time the survey program has been in existence.

Most startling perhaps is the growth that has occurred during that period of 13 years. Capability has increased from 50,100,000 kilowatts to 159,000,000 kilowatts, and peak loads from 47,400,000 to 122,000,000 kilowatts.

The data shown here for 1959 represent a preliminary determination of the actual results for last December. The peak load of 122 million kilowatts fell about 2,700,000 kilowatts, or 2.2 percent, below the October, 1959, forecast. This resulted largely from after effects of the steel strike and from unseasonably warm weather in many parts of the country. As a consequence, the indicated gross margin was higher than had been expected.

The point which I wish to make with this chart is that over the years the power systems of our country have planned well and adequately to meet the overall requirements of all power consumers. During the years immediately after the war, the situation was tight, due to the curtailment of construction of new generating facilities through the war years. In spite of the low gross margin in 1947 and 1948, however,

there was only minor curtailment in a comparatively few local areas. By 1949 the overall situation was relatively good, and it has remained so since that time.

(Chart 5) Figure 5 shows how the electric power industry is planning for the future. In 1953 the Power Survey Committee made a forecast of the peak loads for the nation as a whole for the years to 1975. This forecast, as shown in figure 5, was expanded to encompass 100 percent of the power supply industry, rather than the 97 percent normally covered in the Committee's regular semiannual survey.

Because it was recognized that many variables are involved, the forecast was made on a maximum-minimum basis. In other words, it was predicted that the peak loads would fall within the dotted lines shown in the slide. It can be seen in Figure 5 that actual December peak loads experienced since 1953 have fallen approximately on the maximum curve of the 1953 long-range forecast.

A similar long-range forecast was made in 1959, extending 25 years ahead, to the year 1985. Like the earlier forecast, this was also made on a maximum-minimum basis, as shown by the solid line in Figure 5. It should be noted that the 1959 forecast predicts higher loads than the 1953 forecast. This appears to be justified on the basis that the actual peak loads since 1953 have been practically coincident with the maximum values predicted at that time.

Looking at the year 1985, the forecast predicts that the peak loads during that year will reach an astounding value of between 550 and 750

million kilowatts. This indeed is a great challenge to the nation's power system. However, it is safe to conclude that the necessary capability will be provided by the industry to meet these loads, as has been done during the past years.

(Chart 6) Figure 6 shows a portion of the same curves shown in Figure 5. Superimposed on these curves and adjusted to the total industry basis are the actual December peak loads and capabilities 1947 through 1959, and those forecast last October for the years 1960 through 1962. This figure demonstrates that generating capabilities have been adequate during the past years to meet the peak demands through 1959. It indicates also that scheduled capabilities through the year 1962 will also be adequate to meet the December peak loads expected during those years.

Data in the hands of the Power Survey Committee show that a very large part of the generating equipment required to provide the capability between now and 1962 is actually on order with the manufacturers, and construction of the projects in question is scheduled for completion at appropriate times. More than 80 percent of the generating equipment required to provide the forecast 1960 capability had been shipped to the plant sites as of January 1, 1960.

Looking ahead, it is evident that very large amounts of new heavy power equipment will be required each year from the manufacturers not only to serve the increases in load, but to replace older equipment as it comes to the end of its useful life.

As a regular matter, at the time of each semiannual power survey,

estimates are made of the potential productive capacity of the domestic equipment manufacturers over and above the commitments already in hand. The basic data supplied by the individual manufacturers are compiled by the Survey Committee to represent the entire domestic industry. These estimates serve to show the adequacy of the nation's equipment-manufacturing facilities to provide the necessary generating equipment to meet the future requirements.

For the longer-range term, manufacturers often make their own predictions; but at all times they work in close cooperation with the power systems, so that there is good agreement as to the long-time needs.

From the foregoing I believe you will agree that the power systems of our country are fully alert to the probable future electric power requirements, and are planning adequately to meet those needs. For our own system in Michigan we have a Load Study Committee, which meets at frequent intervals to review load trends and all available data concerning probable load growth. We have a System Development Department, responsible for planning the broad development of our transmission and power-generation facilities to meet the forecast load. We have a tentative plan for the actual installation of main generating units during the next ten years; and we are acquaring rights of way for new transmission lines that will be needed during that period.

I am sure from my contacts with the responsible power executives throughout the country that all power systems are actively engaged in similar planning. As a strong believer in our American system of competitive

free enterprise, I feel that most of the required expansion can be achieved by private financing.

There are a number of trends in power system practices which are significant in meeting the power needs of our country. Perhaps the most spectacular is the very large sizes of the steam turbine generating units that are being installed. In 1950, units having a capacity of 125,000 kilowatts were considered exceptional. Now some half dozen units with capabilities exceeding 300,000 kilowatts are in operation; and units with capacities up to 600,000 kilowatts are on order. The major part of our new thermal generation is being provided by units with capacities above 200,000 kilowatts. These large units are fully justified because they give a lower capital investment per kilowatt of capacity, a higher thermal efficiency, and a lower operation and maintenance expense.

It is largely through such economies as these that power systems have succeeded in holding the line with respect to power rates, or holding rate increases to a minimum.

Along with the large units, several methods for more effective cooling of the generators have been developed. This results in substantially smaller physical size of units and impressive weight reduction. Though there has been a trend toward higher steam pressures and temperatures over the years, the increases have not been particularly significant in the past three or four years. Several super-critical projects, sponsored by the American Electric Power Corporation, the Philadelphia Electric

Company, and the Cleveland Electric Illuminating Company, are now coming into operation. These projects will be carefully studied, and such advancements as are economically justified unquestionably will be adopted by many systems.

Another important advancement has been the increase of interconnections between power systems, and pooling of operations. These, of course, are economic matters which provide greater reserves and greater economy for the systems that are involved. But it does not follow that interconnections should be made indiscriminately and without economic justification.

The movement toward higher voltage transmission continues, but important questions regarding what the voltage should be remain unanswered. The highest voltage in commercial operation today in the United States is 345,000 volts. European experience seems to prove that somewhat higher voltages, perhaps as much as 500 or 600 kilovolts, or 500,000 or 600,000 volts, are entirely practical. Several test programs and many studies designed to provide further much-needed information are in progress.

Supervisory control systems, actuated by electric computers of various kinds, have made extremely important improvements in power system operation during the past few years. The computers are used to determine on a continuous basis the optimum operation of power systems' generating facilities; and the supervisory system dispatches the proper loading instructions to the various generating plants. The use

of this equipment will increase.

A further development of this kind is a completely automatic control system for a steam turbine generator and related steam boiler. At least one such installation is now under construction, and others are being considered.

Taken all together, it is evident that many improvements in power system practices are under intensive development by the electric power industry in the United States. I believe that in most cases, our technololgy and engineering is equal to or better than that elsewhere.

Atomic power got its real start in 1954, when the Atomic Energy Act was changed to permit industry to engage in its development on an ownership basis. There were high hopes by many, who were not fully aware of the difficult problems involved, that its practical development would be a matter of a few years at most. Those who had studied the problems carefully, however, recognized that many years of intensive and difficult work lay ahead, and that from ten to twenty or more years would elapse before atomic power could be competitive with the existing conventional methods of generation.

Since 1954 approximately 20 power reactor projects have gotten under way. Four of these have been in successful operation for some time. The remainder are in various stages of preliminary operation, construction, and planning.

It has been expressed by some that the development program, as represented by these 20 reactor projects, is lagging and inadequate.

Some of you visited the Enrico Fermi Atomic Power Plant, near Detroit, a few days ago. I am sure that you will agree that work on that project is proceeding in an aggressive manner. We fully expect to have the physical construction of the project essentially completed during the third quarter of this year, and to begin nuclear operation shortly thereafter. It is probable that about one year will elapse before full load operation is achieved, and at least three or more years before significant data concerning the reactor will be available.

I personally know that the other projects are being carried forward with as much vigor as our Fermi project in Michigan. In proper course they will be completed, and their operation will add to the fund of knowledge and experience concerning atomic power.

The point I wish to make is that atomic power development is moving forward on a broad front. The four projects that are operating are contributing much toward needed knowledge and experience. Another project is now in preliminary operation. All of the 15 projects now under construction or in advanced planning stages are expected to be in operation within three years. With the resulting wealth of experience, we will be able to move far toward obtaining truly competitive atomic power.

In Detroit we have made several detailed studies based upon experience in designing and constructing the Fermi plant, to determine what could be accomplished with an advanced design of a breeder reactor that we could build during the next three or four years. We find that

very important reductions in capital investment definitely would be gained. If certain improvements in fuel cycle performance, using plutonium, can be developed, it should be possible to produce power with a large breeder reactor at close to competitive cost.

Such an accomplishment is five years or perhaps more in the future. Similar possibilities seem to be within reason for several other reactor concepts. Taken all together, it seems to me that we do have an adequate atomic power development program under way here in the United States. It includes all of the reactor types that have been sufficiently advanced and have promising technology. Obviously, as new technology becomes available, we should add more projects to the program if it seems that the experience to be gained justifies the expenditures.

Operating results will become available from nearly all of the projects now approved within the next three to five years. I am sure that the electric power industry, equipment manufacturers, operating systems, and engineers are fully prepared to carry on and to utilize these results in the endeavor to achieve genuine economic atomic power.

And now, gentlemen, I would like to take us overseas into the USSR and to discuss with you electric power in the Soviet Union.

I am sure we can agree that electric power in the Union of Soviet Socialist Republics is of great importance to us here in the United States, both from the standpoint of economic growth and defense posture. It is reasonable to presume that the Russians may develop new methods and practices different and perhaps even better than ours, as other coun-

tries have done.

After a long period of negotiation, through personal contacts and with State Department assistance and sponsorship, arrangements were made for a group of ten United States electric power industry executives to visit Russia in August, 1958, and again in August, 1959. These visits were considered by both Russia and the United States as part of the cultural and technical exchange between our countries.

In 1958 the host organization was the USSR Ministry of Power. Between 1958 and 1959 there was a change in the system of administering the electric power industry, and the host organization was the Ministry of Construction of Power Stations.

Both American delegations left the Soviet Union with the impression that their host had been sincerely trying to present the facts about the status of the electric power industry in their country. It was also clear that the Russians were highly desirous to obtain similar facts concerning the United States electric power systems and power equipment manufacturing capability.

To that end the United States did entertain a party of 12 Russian power engineers during October of 1959. The interest of the group lay primarily in thermal power plants; and they were permitted to visit a considerable number of our modern power plants and manufacturing plants during their 30-day visit.

During our two trips we traveled more than 17,000 miles in Russia--from Leningrad in the west to Irkutsk, on Lake Baikal, in eastern

Siberia. We visited five modern thermal power plants, seven hydroelectric plants, and three nuclear power plants. We saw Russia's newest high-voltage transmission facilities and test installations. We visited their experimental laboratories, equipment-manufacturing facilities, and other places of interest. Most importantly, we discussed electric power freely and at length with responsible officials at many points. The Edison Electric Institute is publishing a comprehensive report concerning our visit.

In considering electric power in Russia, we must remember that it is a vast country, about two and a half times the size of the continental United States, with a population of nearly 210 million people, spread over two continents. It has tremendous natural resources, including very large reserves of coal, oil, natural gas, and peat--the fuels needed to build an industrial society. It has very large rivers, with great hydroelectric power potentiality. It is engaged in building and expanding many large industrial complexes in widely separated areas.

In terms of total generating capacity, the Soviet electric industry is second only to the United States. At the end of 1958 they reported a generating capacity of about 53 million kilowatts, and a total generation of 233 billion kilowatt hours for the year. Presumably these figures include self generation of individual industries; and comparable figures for the United States are 160 million kilowatts of capacity and 724 billion kilowatt hours.

And may I tell you at this point that we took with us to the

Soviet Union some of our EEI power survey reports. I had maps of the electric power systems of the United States. I gave many lectures, so to speak, on electric power in far-off places--in a generating plant or in a social center and the like, because I wanted to give them something in return for what we were receiving from them. And they were greatly impressed with this kind of an approach, knowing full well at all times exactly where they stood; and I wouldn't be surprised if one of these days we might find a somewhat similar report on the Soviet Union.

It was surprising to us that 80.5 percent of Russia's generation in 1958 was by thermal plants and 19.5 percent by hydroelectric plants. Although the United States produced almost three times as much electricity in 1958, the ratio of thermal to hydro generation was nearly the same--80.7 percent thermal and 19.3 percent hydro here in the United States.

We discussed this matter at length with our hosts, because we wanted to get a true comparison. We were told that thermal plants could be built with lower capital investment and in a much shorter time than hydro plants. In the interest of providing the greatest amounts of power with the capital available and at the earliest possible time, the maximum effort was being placed on the construction of thermal plants; and hydroelectric plant construction was being deliberately lessened.

This program was made particularly clear by Chairman Khrushchev at the dedication of the 2,300,000-kilowatt Kuibishev plant on August 10, 1958, when he announced that hydroelectric construction was to be lessened and greater emphasis was to be put on the development

of thermal stations.

A short time later, in his presentation of a new Seven Year Plan, the Chairman explained the change of policy this way: "The priority construction of thermal electric power plants will make it possible to increase in the course of the seven-year period the total capacity to be commissioned at electric power stations by approximately 10 million kilowatts,by reducing the capital investment in the construction of hydroelectric plants. If the correlation that had developed in previous years between the capacities of thermal and hydroelectric plants were preserved, it would be necessary either to reduce the planned putting into operation of new stations, or to increase capital investment in the development of the power industry by 23 billion rubles."

Construction of large hydroelectric plants in Siberia is to be continued. The Bratsk (4,500,000 kilowatts), Kremenchug (625,000 kilowatts), Votkinsk (1,000,000 kilowatts), and Bukhtarma (525,000 kilowatts), along with the Stalingrad plant on the Volga (2,530,000 kilowatts) were specifically named by Chairman Khrushchev in his statement.

In Russia, as in the United States, many of the good water power sites are located far from the centers of population where the power is needed. American engineers have learned that, because hydro power must often be transmitted over long distances, and because hydroelectric plants are more expensive per unit of capacity to build than steam plants, steam power, with notable exceptions, is more economical than hydroelectric power. The Russians appear to have arrived at a similar con-

clusion. This I have personally discussed with many of them, including Ministers Mikoyan and Kozlov; and I did so in their own private offices in the Kremlin, as well as when they visited us here in the United States.

With respect to Russian power plants, we did not find that they have equipment or practices that are significantly superior to ours. Their largest thermal units in operation have a rated capacity of 150,000 kilowatts, and we did see two units rated at 200,000 kilowatts being installed. We were informed that 300,000 kilowatt units are being designed, and I have no doubt that they will achieve those. We visited one plant with a total present operating capacity of 600,000 kilowatts, and were told that the ultimate capacity of several thermal plants would be 1,500,000 kilowatts each. As you know, several plants in the United States with capacities in excess of 1,000,000 kilowatts are already operating. Whether we expand those plants or not is strictly an economic matter.

And may I pause to tell you a little story that is not in the text, but it struck me very much so at the time. I have just told you of this plant of 600,000 kilowatts. It's at that plant where they are adding the two 200,000 kilowatts, which will bring the capacity up to 1,000,000 kilowatts. The plant is in the south of the Urals. It's in charge of a White Russian, a man who in his youth lived in the western part of the country, in the Ukraine. He has been in the south of the Urals for many years. He's now a man in his sixties--a tall engineer. He's the father of the Russian

woman high jumper who won the world's championship at Philadelphia in early July. He's very proud of her and told me that she had written back to him while she was over here telling him how wonderfully well she had been treated by the American people that she had met.

It made a great impression on that old gentleman. He couldn't have been more hospitable to us. He took us to their social center, not far away, and outside were thousands of people waiting to greet us--mothers, fathers, children, grandmothers--flowers in hand. They waited outside until we had our dinner. It was a very excellent dinner, well served. And this man brought there some branches from the apple trees--he had been raising apples--branches of cherry trees that he had grown, and other things that he had grown, to show us that in addition to being an engineer and the director of that power plant, he had some other interests.

He gave me a really wonderful piece of handicraft in iron--what I call my iron horse--from the Urals, weighing about fourteen pounds. I was able to get all but its head inside of an S.A.S. flight bag; and so I carried it in my hand all the way back to Detroit, as his gift that he had given me. I had many comments regarding it from people along the way. In Vienna I bought a little hat to put on the horse's head, because I thought he would look even more attractive that way.

I tell you this little story because I think it has a great deal of significance.

We visited factories where turbine-generators and boilers are

being built. While their designs and production methods are good, I believe they are not quite equal to those of our American companies. The reinforced concrete structures of the Russian thermal power plants generally have a somewhat bulky appearance as compared to our own structural steel construction. And I think this is perfectly understandable. However, this is not to imply that it is not satisfactory for their purposes.

On the whole, it was the opinion of our groups that the Russians have done a good job with their thermal plants. Their thermal efficiencies seemed to be somewhat lower than ours for comparable conditions, and the total cost of producing a kilowatt hour seemed to be somewhat higher. Cost comparisons are difficult, because there is no real basis of establishing currency conversion rates. We could not determine fully whether the reliability of their equipment and plants and their maintenance problems are comparable to ours.

The Russian hydroelectric power stations seemed to be well conceived and in most cases, well built. Of course, there is much evidence of the Russian desire to have the world's largest. They have claimed for several years to have developed advanced methods of prefabrication which reduce the time required to build such projects. We could not determine whether these methods, particularly as applied to concrete structures, would meet the design factors applied to similar work in the United States. Kuibishev required seven years for construction to the point where the first unit was ready for operation.

We gained the impression that the Russians have succeeded in

building hydraulic turbines, and associated generators, with larger capacities than we have available for similar hydraulic conditions in the United States.

Transmission of electricity is a highly important matter in Russia because the optimum power plant sites, both thermal and hydraulic, are often far from the population centers. As in the United States, the hydros are mostly far from the large load centers, such as Kuibishev, on the Volga River, which is some 600 miles from Moscow. Many of the thermal plants are located near the center of extensive low-grade coal deposits, distant from the populated cities.

With these conditions, the Russians have built about 2600 miles of 400-kilovolt transmission lines. The longest now in operation is the 600-mile line from Kuibishev to Moscow. Further, they are actively studying much higher alternating current voltages, and plan to convert their 400,000-volt lines to 500,000 volts. They are intensively investigating the possibility of direct current transmission. We saw much of this work and are confident they are making good progress. I personally gained the impression that they believe 600,000-volt AC lines are practical.

The three atomic power plants we visited were interesting. There was nothing to indicate, however, that their technology is superior to ours. They seem to have adopted the attitude that the development of atomic power is not of critical importance, but, rather, is a matter for economic development.

The Russians have prepared extensive plans for the interconnec-

tion of the many power systems that now serve the various industrial areas, particularly in European Russia. We could not determine how carefully the economics of such interconnections have been studied, but we are certain that many years will be required to carry out the programs which were outlined to us.

In summary, all of the 15 men who participated in one or both of our visits believe that the Russians are doing a creditable job of providing electricity for their expanding industrial economy. They are doing it with a philosophy of government greatly different from the philosophy of most of us who accept and admire the freedoms of the United States and the other western world countries.

The members of our group question that the Russians can achieve 110-112 million kilowatts of power capacity by 1965, which Chairman Khrushchev proclaimed in his statement concerning the present Seven Year Plan. There is real question, too, concerning whether any of the various five-year and seven-year plan goals have been met. The economic problems for such accomplishment are difficult indeed.

Even assuming the goal is reached, it is worth remembering that in 1965 the power systems of our country should have a total generating capacity of about 245 million kilowatts.

And may I say that I was concerned with the Soviet Union in the earlier days, the lend-lease days, when I was in the War Production Board as a civilian, and I worked with them in connection with the military government in Germany. I know of the great destruction that

occurred as the German armies marched through the Ukraine and the Don Basin. You know what happened at that rather historic plant, built there in the southern part of Russia, where Colonel Cooper was one of the main engineers. At that time, before hostilities, they had something of the order of 10 million kilowatts. About half of it was destroyed. So you can understand that in the rebuilding they have gone from something like 5 million kilowatts that I knew of to some 53 million kilowatts at the end of 1958. And that I think is really quite a great accomplishment, realizing that there were many things to do. And it's well for us to remember quite well and in proper perspective what the Russians have accomplished in their electric power work. I think they should be given great credit for what they have done.

And so, in closing, gentlemen, I think, as we said earlier, electric power is important. It is a means to an end. Just having capacity in itself means little unless it is utilized for a real and genuine purpose. Therefore it has to be used for productive purposes and to maintain our high standard of living.

It is well to remember that it was the successful accomplishment of Edison in October of 1879, when he perfected the first commercial electric lamp--that it was a piece of utilization equipment that really started the power industry on its great expanding program; that we found the way of using electric power economically and for the benefit of the people.

And so, after the many years since 1879, I feel that the electric power industry of the United States--and I use it in its broad sense--

has done and is prepared to do its part in maintaining our American way of life.

Thank you all very much.

MR. MUNCY: Gentlemen, Mr. Cisler is ready for your questions.

QUESTION: Would you comment on the importation of foreign-made generating equipment, particularly whether the private companies are purchasing any of it?

MR. CISLER: I don't think that the purchase of foreign generating equipment has been done on any substantial basis by the private power systems. You know that there has been the purchase on the part of some of the Federal and non-Federal systems.

May I tell you that in the case of our own company, the Detroit Edison Company, we did purchase a 20,000 kilowatt turbine generator for one of our heating plants from a Swedish manufacturer. It's a small unit. We use it for heat balance purposes, to get some electric power from the higher pressure and temperature steam before exhausting it into our central heating system, which is a very extensive one, probably second in size in the United States, second to that in New York City. And so we're heavily in the steam business, with four steam-heating plants; and we have had previously some electric generation from a similar unit located in this same plant.

The foreign manufacturers--I've seen this quite closely because I lived with it both during the war and since then--the foreign equipment manufacturers have been able to build large-size units, as large as we

are able to build here in the United States. I believe that some manufacturers envisage still larger units. I am sure they do. But the European manufacturers are now able to build the size of units that we need here in the United States, to build them well from a technical and engineering standpoint and that of efficiency, and, of course, at a price that is competitive with those built here.

I think we have to face the fact that the European manufacturers can build comparable equipment to our own. They are no longer restricted because of size. It's only a few years back when the largest machine that you could get in Europe was 100,000 kilowatts, and there were only a few manufacturers who could do that. They caught up awful fast in their technology and engineering and manufacturing practices.

QUESTION: In looking at your chart which presents the increase in capacity and use of electricity from 1947 on, I was kind of startled at being unable to find the emergency of 1953 or the recession of 1958 on that chart. Apparently they had no effect on the continuous expansion. This raises two questions. One is, Why? The other is, What are the central factors that affect demand for electric power?

MR. CISLER: Well, there are a number of factors. Of course your expanding economy is the controlling one. When I say "the expanding economy" I mean that as created by more factories, more homes, more shops, more and more use of electric energy for many, many purposes. That brings about a continuing load growth, which historically has been at the brink of doubling every ten years.

Now, in building generating facilities we must plan far in advance. We have to do our engineering studies of where is the most economic location to add generating capacity--whether in existing plants, in an increment to a plant already built, or whether to start an entirely new installation. Such studies, as I said, are going on continuously.

Then, when we decide where to build, then the detailed design has to be accomplished. All of the equipment has to be selected. Bidding has to occur. And then, of course, the construction is carried out.

So a period as long as six years may be involved. It can be done, of course, in less. The actual field construction may require 36 months to carry out. So when you realize that perhaps 24 months from the time of placing an order for a large turbine generator is required in order to get delivery of that, and then a number of months for its actual field installation, you can see that in carrying out the additions of capability you must do it on an orderly and continuous basis, and you must follow these historic trends.

And therefore, when a recession, such as came about in those years that you mentioned, comes along, power system executives look closely at the picture, at their capital requirements, going out to bring new capital into the business, and it is possible to slow up construction a little or to speed it up, depending upon the conditions. The actual increments of capacity may be delayed a little or may be advanced a little according to the needs, but you will find that the trend upward in the addition of capacity is carried on on a relatively uniform basis. In

1958 I think about 14 million kilowatts of additional capacity were added, and in 1959 about a similar amount. And, as I said, 80 percent of the equipment for 1960 has already been shipped from the factories.

Now, a very significant part of the value of these power surveys is the confidence that it gives people that they have good data to work with. And a power system has a great responsibility in having an adequate supply available to meet all known loads and even unanticipated loads. So the tendency is to be sure that there is enough capacity. That's the policy in the Detroit Edison Company and I'm sure it's true with many others, because we must serve and we must be ready to serve at all times. When the load occurs, capacity must be there to meet it.

QUESTION: Does this also explain the steady line as far as use is concerned?

MR. CISLER: Well, as to the steady line of use, you see, use is made up of many factors--industry, homes, farms, shops, and added uses, and, let me say, more efficient uses. This is very important to understand, because we are finding how to use energy of all kinds more efficiently. It's what's happening now in Western Europe, where they now have an overabundance of coal supply. They have learned to use coal more effectively and efficiently. They, of course, are bringing in more oil from the Middle East in particular. And so here in the United States I spoke about that. I said that we did not reach the peak loads of December to the extent of about 2.2 percent, I think it was.

Well, as you know, with the steel shut-down--and I saw it in our own system--when shut-downs occur, when they come back into operation, they usually come back using a little less proportionately for each unit of output. And they use not only a little less energy, but they use a little less in the way of personnel. That has been my observation. It has been true for shut-downs in automotive production and steel production. When they come back, they have found ways of doing the same thing with a little less.

And so there are these many factors that enter in. What you see is a co mposite, a cross-section, as the result of many components that enter in. If you were to study how the system development people give weight to one component or the other of load growth--many of these things are empirical and they are based upon experience. But this is the actual historical trend, and as we see it for the future.

QUESTION: I noticed that you commented on the large number of interconnections in Russia. Do you feel that the extent of our interconnections and their capacity in this country are adequate to prevent some local demand being cut off by a natural disaster or enemy action?

MR. CISLER: I think our country is well equipped from a defense standpoint. And I think the interspersing of the power systems and the power plants is all very sound and realistic.

I went through the period, as some of you may know, during the war days in the Mediterranean and the European theater. My work had to do with getting these power systems, gas systems, and water supply

systems back into operation. So I have had some experience in that field. And it has been the experience that when destruction occurs, usually the requirements for power go down faster than the ability to supply the power. And so we must keep that in mind.

Take, for example, the case of the State of Michigan. We are all heavily interconnected there. Our own system has three points of interconnection with Consumers Power, two points of interconnection with the Ford Motor Company, one point of interconnection with the City of Detroit, and two points of interconnection with the Province of Ontario. That's a very heavily interconnected area there. And so you can go to other parts of the country.

These power-generating facilities are interspersed, so to speak. I would believe that if any great destruction occurred in an area, the requirements for power would be more severely cut down than would be the ability to supply that power.

QUESTION: I was interested in your growth curve that you projected. You just mentioned that it doubles every ten years. However, if you project this 50 years into the future, you get a phenomenal growth and, of course, you approach infinity in 60 or 70 years from now. What factors particularly prompted your forecasters to come up with this phenomenal increase?

MR. CISLER: It's based upon the experience in the past and the way in which after a recession it seems to resume that same upward trend.

Now, it is hard for me, having been in the industry all my life, to see how this matter of energy consumption can go on--and I speak of it in the broad sense, not just in terms of electric power--how the use per capita can continue to expand and expand. Of course, our resources to meet those indefinitely do not exist unless we find some new sources of energy, such as fission, fusion, and the use of solar energy and the like that all of us are keenly alert to.

How much in the total picture this total energy requirement--I happen to be the U.S. member of the Energy Advisory Commission for Europe in the OEC--and their predictions here are much the same as those over there.

What kind of an economy we are going to have in the year 2000 I don't know. It's certainly going to be far greater than it is today. I have the feeling that the rate is tending to slow up a little. In the experience in our country and in Western Europe and in the Soviet Union they are finding a little less rapid rate. I was inclined to feel until more recently that maybe this doubling was going to occur every 11 to 12 years rather than every 10 years. Those more familiar with the data come back and say, "Well, it looks as though it's picking up the old upward trend."

My personal feeling is that there will tend to be an easing off of the rate of growth, for a number of reasons--more efficient use. Not that there will be an inadequacy for the foreseeable future of electric power, but simply because we will find more efficient and more effective ways of using a given million B.T.U.'s of energy or a given volume of

water.

QUESTION: Sir, you were referring to the interest of the Russians in learning how to transmit power at high D.C. voltages. I wonder if you would elaborate just a bit and tell us what some of the advantages of D.C. are, and also what sort of scheme do they have in mind for getting it back down into the voltages that they can handle for the normal distribution on the distant end.

MR. CISLER: This goes back to the war days. When some of us reached Berlin the first day or two after we were allowed to go in in July of 1945, we found that the Russians had taken the experimental D.C. equipment that was under way to the north of Berlin for a distance of about a hundred miles. We were able to acquire the reports and the like which the Germans had prepared not only for this experimental installation, but also their proposal to develop the hydro resources of Norway, to bring power down from Norway and Sweden underneath the sea and into Germany. They had done a lot of work. They proposed voltages up to 800,000 of D.C.

The advantages that they saw, and the advantages that exist today, are that at high voltages great bulks of power can be transmitted. There is also the ability to put it underground at lower cost. You don't have the problem of the corona that you have from A.C., and the overhead. From a defense standpoint, you have underground rather than overhead.

So the Russians have picked that up, and they now have a similar installation, operating at 200,000 volts D.C. What they really do is to

have 100,000 from one side to ground and then by having another from one side to ground, between the two conductors they get 200,000 volts.

Their next step is to build a long line from the Stalingrad hydro plant, a 2 1/2 million plant, over to an area in the Don Valley, the Don Basin, at 800,000 volts. That they will call an experimental line.

Following their experience with that, they will then start to move into the Siberian area. They will take a big complex of generation there and interconnect it with another big complex by means of high-voltage D.C. or high-voltage A.C. interconnections.

But the reason for the D.C.--and I think there are sound reasons--and I think that we have much to do here in this country in that connection--is the ability to go underground. The conversion and inversion equipment is much superior today, because they don't use the mercury arc rectifiers or converters. They use what they call valves, which are more mechanical devices. That equipment is more reliable. They can get into the higher voltages with it. The Soviets have done quite well with this valve equipment.

So here again technology and engineering are being advanced; and I feel confident that there is going to be an extensive use of direct current in the future. In the past it has been the cost of [redacted] conversion and inversion that has been a limiting factor, but I think that will be brought under economic control.

That is not as complete an answer as perhaps you would like to

have, but I don't want to take too much of your time. I have given you the general principles involved.

MR. MUNCY: Mr. Cisler, all of us are indebted to you for letting us share your wealth of information regarding power and defense. On behalf of the group that had the privilege of going to Detroit last week, may we thank you personally for that wonderful trip through the Detroit Edison plant.

MR. CISLER: We want you to come again.

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