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POWER IN WAR

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POWER IN WAR

A. INTRODUCTION.

1. Due to the universal application of electric power in manufacture, it plays a decisive part in the production of all war materials. During the World War the tremendous industrial activity resulting from war orders, with incident stimulation of commercial activities, caused so complete an exhaustion of surplus power in certain industrial districts that public utility companies were no longer able to honor demands made by their customers. As a consequence, the production of equipment and munitions for both land and sea forces was seriously threatened. The situation became so acute that the Secretary of War appointed Power Administrators who applied relief measures in those localities where war industries were most seriously affected. Following the war, one of the administrators, Brigadier General Charles W. Keller, an engineer officer, made a report which resulted in the Secretary of War directing the Chief of Engineers to furnish information to the Assistant Secretary of War as follows and to keep it up to date:

a. The existing resources of the country in electric power.

b. The probable completion of extensions in process of construction and the increase in electric power which will be effected thereby.

c. The increases in electric power which may be expected to grow out of programs for future development, and the dates when the resulting increases of power are likely to become available.

2. These three provisions constitute the directive to the Chief of Engineers for the power survey which he has been making and reporting on annually since 1921, to the Assistant Secretary of War without the appropriation of any funds for the purpose. The work is extra work for the personnel of the engineer department and of the power companies and associations.

B. GENERAL CHARACTERISTICS OF ELECTRIC POWER GENERATION, TRANSMISSION AND DISTRIBUTION.

3. The major portion of the power used in the United States is generated by water turbines or by steam plants burning coal, oil, or natural gas. Water power is classed as primary power and secondary power, the former being the quantity which any given hydroelectric plant is able to furnish every day throughout the year. Secondary power is the additional quantity which can only

be furnished during periods of greater stream flow. Primary power has the same value as steam power but secondary power sells at a much lower rate because it can only be marketed as a substitute for steam power. In order that the secondary power may be fully utilized, it is usually to the advantage of companies generating large quantities of hydroelectric power to have interchange connections with companies whose main production is from steam.

4. Because of the ease with which alternating current can be stepped up or down, practically all modern plants generate alternating current at voltages varying from 6,600 to 13,200 at the generators. The transmission of power is always accompanied by line losses, which vary directly as the current. For this reason the voltage is stepped up by means of transformers as soon as it leaves the generators, sometimes as high as 220,000 volts. Because of the danger in utilizing power at high voltage, the power must again pass through step-down transformers before reaching the customer.

5. It has become possible to generate electrical energy at a cost of one or two mills per kilowatt hour in very large generating plants. The major part of the cost is found in transmission, distribution and administration, not in generation. There is in many minds a mistaken idea in this regard. People look at the great generating plants and hear the low cost in mills at the switch board, and become incensed at the charges the consumer has to pay. They are not always right, but maybe in some cases they are.

6. There is, of course, a limit to the distance that electrical energy can be transmitted economically, the limit being from 200 to 300 miles, depending on the cost of generation. A steam plant close by may be able to compete with a water power plant far away.

7. The tendency now is to cover the country with interconnected systems. One system can trade power with another if the two are connected in their main transmission lines. But this interchange can naturally be economic for only a fractional part of the load of one district or system, not the whole load.

8. The main feature of an electrical power system that tends toward uneconomic results is the fact that the load is not uniform. At a certain moment in a period, say a day of twenty-four hours, the demand runs sharply to a maximum on a "peak". The peak is of short duration but it must be met. Therefore the capacity of generation at any time must be greatly in excess of the total generation required. The ratio of the actual generation over a period to the ultimate capacity of generation is called the load factor. The load factor is never equal to unity or 100%. The greater the diversity of demand, then the greater the load factor,

and the more economical the system. If the load were constant the load factor might be 100% and economy would be at its height. If manufacturing were done only on off peak loads the economy of power would be increased.

9. The interchange of power between the various companies operating in the United States is controlled by about 20 principal power dispatchers. A power dispatcher supervises the operation of all of the power plants and interconnections over an area having a radius sometimes as great as 500 miles. In order that he may intelligently exercise this control, he must have before him every minute of the day the loads and reserve generating capacity at every plant. He secures the most economical use and production of power throughout the system by ordering the starting or shutting down of generators and by manipulating the connections between transmission lines.

10. The following characteristics of power generation and transmission are especially important when viewing the subject from a war production standpoint.

a. During the past 15 years there has been a tremendous increase in the interconnection of adjacent systems. This change will materially increase the flexibility with which power shortages can be met from surpluses within a range of about 250 miles. However, coincident with this change, the ratio of reserve generating capacity to normal load has been reduced in each system and there is actually less reserve capacity available in any one area under normal business conditions than there was 15 years ago.

b. Since the construction of transmission lines is slow and expensive, and transmission of power for long distances is accompanied by large line losses, little may be expected from construction of new transmission lines in time of war. The most practical method of providing additional power in a given area is to construct new generating capacity in the area.

c. Since the construction of a large hydroelectric plant will require from 4 to 5 years, the main reliance for additionsl power must be placed on new steam plants.

d. Unless prior plans and housing facilities exist, new steam generating equipment cannot be installed in less than 18 months. If such prior arrangements have been made, the new equipment could be built and installed in about 9 months.

C. EXPERIENCE OF THE WORLD WAR

11. When a power shortage became apparent during the war, the Administrators caused the following action to be taken in each critical area:

a. They made a survey to determine the power available and the means of its transmission.

b. They collected information as to the uses to which power was being applied.

c. They collected information as to the requirements for war industries.

d. They then prepared a policy to govern the allocation of power to various needs.

e. Thereafter they exercised a limited control, through cooperation with the power companies.

12. There were difficulties encountered in the administration of power questions that involved differences of cost of production, loss of private interests, shortage of fuel for steam plants, high cost of new facilities, inability of private companies to secure the necessary capital for operation, maintenance and extension. In the Pittsburgh - Ohio Area, there was a shortage of at least 130,000 kilowatts in 1918 with situation becoming steadily worse.

13. As a result of their experiences, the Power Administrators recommended the following measures as desirable in any future emergency of like character and extent:

a. The central government should assume control of power in all districts where the production of war materials is to be allotted.

b. Some regard to the capacity of the power producing agencies must be considered in the allocation of war orders.

c. Where the demand for power is likely to be exceeded, measures must be taken in advance of the needs to increase the supply from adjacent districts and by an increase of generating capacity. This must be done before any shortage appears if delay in manufacture is to be avoided.

D. PLAN FOR MEETING THE POWER SITUATION IN A FUTURE EMERGENCY

14. Of course in the abnormal situation of today there is an excess of power and no new facilities are being provided by private interests. Since the war consolidation of smaller companies and

interconnection of their facilities have been much extended. In this regard the situation is better than was the case during the war. Nevertheless, a shortage of power is sure to develop in districts like Pittsburgh and Niagara during any emergency such as confronted the country during 1917-1919 unless measures are taken early to forestall a shortage.

15. The measures proposed by the Assistant Secretary of War for the handling of the power situation in war are:

a. To increase the production of power to meet all probable needs of industry and the civil population.

b. To secure the most economical use of fuel in the production of power.

c. To conserve transportation in obtaining the fuel supply

d. To distribute power to industrial districts where there is an anticipated shortage.

e. To refrain from interference with power systems not necessary in the production of war materials.

f. To completely control plants wherever their output is necessary for war purposes.

16. Upon approval of the Assistant Secretary of War, the Chief of Engineers has set up an organization, which now collects power data and which will be utilized to control the use of power in time of war. The United States has been divided into four Power Zones, the boundaries of which are identical with those of the four major Procurement Zones. The Power Zones are divided into 12 Power Districts. Suitable officer personnel is assigned to this organization to carry on in event of emergency.

17. The Chief of Engineers makes an annual survey of the power situation and reports the results to the Assistant Secretary of War. In general the purpose of this survey is to forecast the reserve capacities of the major power systems, to determine the industrial areas they serve, and to determine where additional generating capacity will be necessary to meet a war emergency. From this information, plans are made for the rapid installation of additional generating capacity in the areas indicating deficiencies.

18. Thus far there has been no attempt in our procurement planning to adjust the war load allocated to various industrial areas to the power capacities of these areas. Were it possible to

definitely check the power required for our allocations against the power which is surplus to commercial requirements, it no doubt would be found that certain areas will be as grossly overloaded as they were during the World War. For example, it has been found that the Philadelphia Engineer Procurement District, which formerly included the southern states, was placing very few allocations in the Tennessee-Alabama area where a considerable surplus power exists. To correct this situation, a separate engineer procurement district was established for the Birmingham area.

19. It is the opinion of many who have given careful thought to this question that it is impossible to estimate the power load to be placed on any area, first because manufacturers cannot estimate the power required for their allocations and second because any such estimate would not provide for the power required for the manufacture of contributory items which may be produced in an entirely different area. It must be admitted that these are serious difficulties. However, it is certain that some areas, notably in Pennsylvania and Ohio, will be grossly overloaded unless some attempt is made to adjust the war load to the reserve power capacity. It has been suggested that all war planning agencies secure from manufacturers their estimates of the amount of power required for their war allocations and that the sum of these estimates be compared with the reserve power as indicated by the power survey. Neglecting the power requirements for contributary items, we could determine ratios between power required and surplus power for each industrial area. A comparison of these ratios would indicate roughly which areas are being overloaded. If some such scheme is not adopted the next emergency will develop the fact that some areas have been overloaded. Since we cannot increase the power production within 9 to 18 months, much production will be seriously delayed.

E. MEASURES OF POWER CONTROL IN WAR.

20. There will be in a major emergency some individual or commission that will be held responsible directly, under the orders of The President, for the control of power and for insuring that there is enough of it to meet the needs of war and essential civil use.

21. The machinery and policy is simple. First our power control organization, clothed with governmental authority, will be established and acquaint itself with the power situation. It will establish contacts with the directing heads of power companies and place representatives at power dispatcher stations. The policy will be to refrain from unnecessary interference with the power companies but to foresee power shortages and to prepare to meet them.

22. In critical war production areas there must be absolute control of power by the government. This does not mean that existing power organizations will be destroyed or in any way disorganized. But it does mean that they will take and implicitly execute orders received from the proper governmental agency. If they do not do so those in high executive control will be displaced by those who will take and execute orders. Of course, the relations between the power people and the local representatives of the power control agency will be friendly, close, and with mutual understanding, but the grip of the government will be absolutely secure and certain.

23. If an unavoidable shortage can be foreseen at the beginning of the emergency, immediate orders will be placed for boilers and power generating machinery to augment already existing plants. The necessary capital not produced by operation must be supplied by the government.

24. The necessity of the control will begin as soon as the emergency appears imminent, and it must be organized and perfected then. If we had close and powerful enemies the control would be doubtless kept fully organized in peace time, rather than simply planned.