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POWER IN WAR

by

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A. INTRODUCTION

1. Due to the universal application of electric power in manufacture, it plays a decisive part in the production of all manufactured articles in time of war. Its sufficiency to meet the demands of any additional load of manufacture imposed by war conditions is a question of some importance to those who are concerned with the preparation for war. Accordingly, in 1921, as a result of reports made to The War Department through the Chief of Engineers, that officer was directed 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. If the data is useful to The Assistant Secretary of War, or likely to be useful in the preparation for war, the survey will doubtless be continued. If we go on the theory that what we do not know does not hurt us, then the recommendations of some gentlemen that the power survey be discontinued may be adopted.

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

3. Electric power is generated from the energy stored in fuel or a hydrostatic head. The fuel may be used to generate steam or to produce gas for use in internal combustion engines. The motion of a conductor across a magnetic field creates electro-motive force. Power of some kind has to be applied to effect this motion. The great

English experimentor, Michael Farady (1791-1867) discovered the above-named principle of the electric generator. It is amusing now to read that Faraday, as a witness, explained his discovery to a committee of the House of Commons, and that one member asked "Now that you have found this thing, what good is it?" Farady's answer was, "Maybe some day you gentlemen can tax it."

4. A hundred years has seen the great development from Farady's experiment. Electric power can now be transmitted economically 200 to 300 miles. This was made possible by the successful handling of alternating current in years beginning in this century. It has been possible to transform currents of relatively low voltage to those of very high voltage, transmit them over high resistance in small wires and then at the points of distribution to transform them down to low and safe voltages without great loss in transmission or transforming.

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, but the distance is, as stated, considerable, 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. Since electric current is of such wide application in domestic affairs for heat, light, and power, a great curtailment in available current for such purposes is quite difficult, and will be found so in emergency.

10. The construction of large generating plants is a task that requires time. In the case of steam the time may be taken as not less than 18 months. In the case of water power the time will run to four or five years. In any emergency installations only steam or internal combustion engines could be considered, and the need of them must be seen in advance to secure their use in emergency.

11. The practice in business is to build plants only up to demand. The line of demand is projected into the future from definite knowledge of the past and present. In any case of abnormal increase in demand, such as may be brought about in any district by war needs, there is sure to be found a deficiency in power. The deficiency can be met by interchange between that district and those not over-burdened, by a curtailment of non-essential uses, and last by new installations if made with great promptness on plans already formed for the occasion.

C. GENERAL EXPERIENCE AS TO POWER IN THE UNITED STATES DURING THE LAST YEAR.

12. Due to the three years war in Europe from 1914 to 1917, industrial activity in the United States was stimulated and in 1917 the great needs of the United States for war materials of every description, and on an unprecedented scale, increased the demand on American industry to a point where a shortage in all facilities became apparent. As great as was the power of American production, it was over taxed. There was a shortage in ships most marked and also in railway equipment that continued to be felt through 1920, though all roads were under consolidated management. Of course, there was felt a shortage of power in the most active industrial centers such as Pittsburgh and the Lake region.

13. The power companies are in private or municipal ownership, management and control during ordinary times. The power producing capacity is accurately adjusted to the normal demand. Idle plants in reserve are kept to a minimum through forecasts as to demand. New plants are built only as the probability of demand indicates as advisable. The market is so protected and is at its best when the demand is ahead of the supply. Such a condition is pleasing to power interests.

14. During the war the value of interconnected systems of power became apparent from the standpoints of both security of supply and economy of operation. The diversity factor of the demand is greater in a far flung system than in a small one. In a vast interconnected system it is possible to relieve a shortage in one district with a surplus from an adjacent one, and this process may be operated over much longer distances by steps than is possible by continuous transmission. The value of interconnected systems, or the so-called super power systems became apparent to everybody during the war and has been applied to a considerable extent since the war. In the south there are four companies operating under one holding company, they are all inter-connected and the general policy is governed by the holding company.

15. During the war when power shortage became apparent, the Administration caused the following action to be taken:

a. Collection of information, or a survey to determine the power available and the means of its transmission.

b. Collection of information as to the uses to which power was being applied.

c. Collection of information as to the requirements of power for the war industries.

d. Preparation of policy to govern the allocation of power to various needs.

e. A limited control of power was established.

16. There were difficulties encountered in the administration of power questions that involved differences of cost of production, loss to 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.

17. The experience of the World War with the power question indicated 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 from increase of generating capacity. This must be done before any shortage appears if delay in manufacture is to be avoided.

D. POWER SITUATION TODAY.

18. Of course in the abnormal situation of today there is an excess of power and no new facilities are being provided. 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 1917-19 unless measures are taken early to forestall a shortage.

19. 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. Refrain from interference with power systems not necessary in the production of war materials.

f. The complete control of plants wherever their output is necessary for war purposes.

E. RECOMMENDED PREPARATORY MEASURES

20. In addition to the survey which merely determines the amount of power existing in any power zone, the amount that might be considered as surplus should be estimated in each year.

21. The Chief of Engineers should be informed of the anticipated orders to be placed in each power zone and be required to report an estimate of the power shortage that may appear there as a result of the added load, together with measures that should be taken, and when, to increase the amount of power to a sufficiency. Such would be real and definite preparatory work.

22. Responsibility should be placed on the Chief of Engineers for preparing plans and securing personnel for the organization of such power control as may be deemed necessary under the conditions as forecast. Such plans would be subject to the approval of The Assistant Secretary of War, as a matter of course. Individual responsibility for results must be clearly fixed if results are to be obtained. Approval is a matter of study and advice by the staff, and action by The Assistant Secretary is approval or further instructions.

F. MEASURES OF POWER CONTROL IN WAR.

23. There will be in a major emergency some individual 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.

24. The machinery and policy of control is simple.

25. 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.

26. The necessary capital not produced by operation must be supplied by the government.

27. In each organization, and in contact with the directing powers of each company at all points of control, there must be representatives of the military and naval services thoroughly acquainted with military and naval requirements, clothed with the authority of the governmental control agency, and belonging to it. They will acquaint power agencies of the needs of the services, and if these needs are not met at once, without hesitation, then report will be immediately made to the high governmental authority of the situation with all its attendant circumstances and the suggested remedy.

28. 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.

29. 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 fully planned.