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DISCUSSION AT MEETING ON OPERATION TECHNIQUES OF HYDROELECTRIC STATIONS AND DESIGN OF ELECTRICAL DEVICES

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ABSTRACT: In November, 1964, the Chinese Electrical Engineering Society and the Chinese Hydraulics Society met at Chengtu, Szechwan, to discuss problems of hydroelectric stations all over the country. Four specific areas were covered:

1. Gas corrosion and soil sand abrasion of hydroelectric turbines.
2. The areas of safeguard adjustment calculations and speed adjusting systems in hydroelectric turbines.
3. The areas of the techniques of ventilation and flood prevention at hydroelectric stations.
4. The automation of hydroelectric stations and the automation and mechanization of terrace-type hydroelectric stations.

DISCUSSION AT MEETING ON OPERATION TECHNIQUES OF HYDROELECTRIC STATIONS AND DESIGN OF ELECTRICAL DEVICES

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C. S. Chao

On November 15-23 1964 the Chinese Hydraulics Society and the Chinese Electrical Engineering Society called a meeting to discuss techniques of operating hydroelectric stations and the design of engines at Chengtu, Szechwan. Participants in the meeting came from various provinces, cities and autonomy regions all over the country. There were 80 representatives representing 57 units connected with production, design, manufacturing, technology, scientific research and institutes of high learning. Eighty-six papers were received, and of those read, all possessed definite technical and academic levels that were closely related to actual production and practice. They represented the incessant upgrading of the operation and the design of hydroelectric stations in our

country. It is the final result of the fulfillment of production and the experience of scientific experimentation. Through an exchange of technical discussions on research results and experience, we have proposed many useful conditions that are particularly suited to the technology of our country based on the foundation of systematic findings from experiences both here and abroad. The problems discussed at this meeting covered four specific areas, and several important proposals were made. The discussion is summarized as follows.

(1) Gas corrosion and soil and sand abrasion of hydroelectric turbines.

Through an original investigation of the gas corrosion of hydroelectric turbines, the rules of the occurrence and development of certain gas corrosion conditions of the hydroelectric turbines in our country were advanced. There are six specific gas-corrosion areas in the mixed-flow type of hydroelectric turbines, each having its characteristics of formation. However, the main location of the occurrence of gas corrosion is on the back of the blades appearing above the water surface and also on the back of the blades in the vicinity of the vertical surface between the lower ring and the inside of the lower ring. The former is considered to be gas corrosion of the blade type and cavity which could be corrected by an accurate and reasonable choice of the parameters of the blade type; the latter is one of local corrosion, it could be reduced or eliminated under proper blade conditions. In order to reduce the damage by gas corrosion, it was concluded that research work and improvement must be made in the choice of blade parameters, the quality of production work and the operation conditions. Considering the installation of large-scale turbine systems, this should be determined by an evaluation of the results on experimental models and also on the basis of the summary actual gas corrosion conditions of the original hydroelectric turbine, plus the production technique of the manufacturing plant and the design department, and also the actual operating conditions. The techniques and manufacture of the blade types are closely related to the development of gas corrosion. It is necessary, therefore, to try to

conform to the original design and to consider that it is essential that the surface smoothness should at least attain the level of grade 6 or grade 7. In addition, discussions were also carried out on the workmanship and material of arc and butt welding used in the repair of gas-corroded turbines. Domestically produced No. 1 corrosion resistant and No. 1 abrasion resistant welding solders, were both considered to have relatively high gas-corrosion resistant properties. Also, the workmanship involved in welding can definitely have a great effect on resistance to gas corrosion. Emphasis must be placed on this research. The selection of a gas-corrosion index to determine the degree of corrosion that a certain turbine has suffered was also discussed, and in addition, a standard of examining and repairing gas-corroded turbines proposed.

The problem of soil and sand abrasion on hydroelectric turbines in our northwestern and southwestern regions was also discussed. This problem was considered to be more complicated than that of gas corrosion. At the various hydroelectric stations, the contents of sand, its composition, size of the granules, its class distribution and shape in the water current, are different from locality to locality. Although the appearance of the abraded water turbine may have the same fish-scalelike effect, the degree of abrasion, however, may still differ, in addition to the fact that normally a sand and soil abraded turbine may also be suffering the simultaneous actions of gas corrosion and water erosion, and hence damage was accelerated. It was concluded that to solve this problem of abrasion, it is necessary to carry out combined model experimentation at the hydroelectric station, and at the same time to take combined effective steps in preventing abrasion. In the research on antiabrading materials, an evaluation was made on the chromium-copper system which has had some success. In addition, a comparative analysis was made on the relative merits of using water or oil in the lubrication of the turbine axle, based on fifteen years of experience. The decision was that thin lubricating oils have relatively better application properties.

(2) The areas of safeguard adjustment calculations and speed adjusting systems on hydroelectric turbines.

The meeting discussed calculation formulas on safeguard adjustment. The Hydroelectric Department of the Changsha Surveying and Designing Institute has proposed a new formula after having completed research on the correction of the effective efficiency of hydroelectric turbines, the influence of the increase in pressure and the time delay and the three-step computation of the cutting off of the relay instrument. The formula is one step further in theory and its calculated results are closer to the actual determined values at the hydroelectric stations. With regard to the use of GD^2 value in the calculations involving the increase in velocity, it was agreed that for axial-flow type hydroelectric turbines and the high-speed ratio mixed-flow type hydroelectric turbines, the effect of the inertia of the water current must also be taken into consideration. The Research Institute of Hydraulics Hydroelectric Science has already obtained definite results in their work on theoretical analysis and treatment of the instability in the speed- adjusting instruments in certain hydroelectric stations and the defects of the low quality of the adjustment. The meeting also discussed the determination of the parameters in the adjustment system and practical methods of their solution. Other problems related to the design and operation of a hydroelectric whirlpool machine for reducing the sand content of the water supply were also discussed.

(3) The areas of the techniques of ventilation and flood prevention at hydroelectric stations.

It was considered that the mode of ventilation in the hydroelectric plant should be determined by the type of construction of the station, its total arrangement, and the local weather conditions. It should vary according to the location of the plant. Natural ventilation should be the main set-up for surface plants and generator housing. In the case of underground plants, [illegible] should be made according to the combined characteristics of the water power, generator and construction techniques. If the station

requires the use of warm water, the installation of air conditioning is reasonable. In the design of ventilation systems, the connection of the ventilator, the arrangement of the wind tunnel, wind pressure, and the problems of calculations involved in the wind tunnel were discussed respectively. The Hydraulics Hydroelectric Designing and Surveying Institute of Shanghai, has rederived the formulas for calculating the equivalent diameter of a rectangular wind tunnel and its peripheral abrasion resistance. With reference to the flood-prevention problem, it was concluded that all plants should eliminate leakage and water accumulation in all departments and reduce the surface evaporation of water. In the underground parts, floow-prevention double-layer construction should be made to prevent the exposure of all kinds of conduits. In addition, problems related to the proper choice of parameters of air inside and outside of the room to reduce the noise level of the ventilation system were also discussed.

(4) The automation of hydroelectric stations and the automation and mechanization of terrace-type hydroelectric stations.

The working experience of self-adjusting systems, and the frequency and effective efficiency of hydroelectric stations was exchanged at the meeting. The one-time and two-time adjustment plans were analyzed and compared. In the discussion, it was believed that the two-time adjustment should be used at stations of relatively large capacity; the one-time technique is more suitable to simpler structure, low investment, small- and medium-type plants. Concerning the economical operation of hydroelectric plants, two plans were thoroughly discussed: 1) on the terrace method; and 2) on the dynamic regulation method of hydroelectric stations with the load of the economic distribution of terrace-type plants. With regard to the problems of the automation and mechanization of terrace-type hydroelectric plants, and other types, the research plan on the automation of high-voltage electric systems and the automatic frequency and effective efficiency adjustments was also discussed. A general discussion was made

of the rules of frequency regulation in the plan, and principles of adjustment and practical rules were proposed. At the same time, measures on the transition to techniques of control without regular staff on certain hydroelectric stations were also considered.

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