Erection experiences, unusual problems, and their solutions encountered in the installation of major heavy hydroelectric equipment
by Donald C Beckman

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the professional degree in Mechanical Engineering at Montana State College
Montana State University

Abstract:
The installation of a third generating unit and all associated equipment in the Fort Peck Power Plant at Fort Peck Dam, Fort Peck, Montana, presented a number of unusual erection problems and necessitated immediate and correct solutions to insure the proper installation of the heavy hydroelectric equipment, A satisfactory Construction Progress Schedule, taking into consideration all possible reasons for delay, had first to be prepared to insure that the work was completed in the allotted time. When the actual erection of the penstock was started, difficulties were encountered in obtaining "tight" rivets. It was necessary also to analyze the penstock stresses to determine the best joint for the closure section.

The placement of the immense 82 ton butterfly valve was accomplished after considerable planning. Turbine erection problems included the proper alignment of the curb ring, the speed ring and the shaft.

The assembly of the rotor laminations, the installation of the keys, the assembly of the thrust collar assembly on the drive shaft, and the assembly of the rotor on the thrust collar all present problems that had to be satisfactorily solved during the process of the assembly and erection of the generator.

When the work was completed an overspeed and turbine efficiency test was performed. The satisfactory results obtained indicate that the erection problems encountered were solved satisfactorily.

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ABSTRACT

The installation of a third generating unit and all associated equipment in the Fort Peck Power Plant at Fort Peck Dam, Fort Peck, Montana, presented a number of unusual erection problems and necessitated immediate and correct solutions to insure the proper installation of the heavy hydroelectric equipment.

A satisfactory Construction Progress Schedule, taking into consideration all possible reasons for delay, had first to be prepared to insure that the work was completed in the allotted time. When the actual erection of the penstock was started, difficulties were encountered in obtaining "tight" rivets. It was necessary also to analyze the penstock stresses to determine the best joint for the closure section.

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INTRODUCTION

The problems presented in this treatise are unusual to those which normally occur in the erection of heavy hydroelectric equipment, and they are also distinctive because their solutions were primarily dependent upon the successful application of sound engineering knowledge and practices. All of the problems discussed in this thesis actually occurred during the installation of a 50,000 horsepower Francis type turbine, a 16-foot diameter butterfly valve, and a 35,000 kilowatt capacity generator, with the associated equipment, in the Fort Peck Power Plant. The writer was intimately associated in the problems and their solutions.

The Fort Peck Power Plant is located near the right abutment of the Fort Peck Dam. This dam is the largest hydraulic earth fill dam in existence in the world today, and may always be so, since the advent of improved heavy duty earth moving equipment makes hydraulic placement methods uneconomical. The Fort Peck Dam is located across the Missouri River at River Mile 1868.7, which is 1868.7 miles above its point of confluence with the Mississippi River, according to the 1941 adjusted river mileage established by the U. S. Coast and Geodedic Survey. The resultant impoundment created by this dam has a shoreline of approximately 1600 miles, is 189 miles long, has a maximum capacity of 19,412,000 acre-feet of water when filled to the elevation of 2250 mean sea level, and develops a total head for power generation of 210 feet at this elevation. As is commonly known, the power development of this project was accomplished with Federal funds, authorized by Act of Congress dated 18 May 1938, with the Corps of Engineers designated as the constructing

agency. While the power development of this project is of major importance, other multiple purposes of this project are concerned with flood control, navigation, irrigation and recreation features.

The work of installing the hydroelectric equipment mentioned above began in June of 1950, by means of a construction contract issued by the Department of the Army, Corps of Engineers. The successful bidder to the contract was the E. V. Lane Company, Engineers and Contractors, of Palo Alto, California.

THE FORMATION OF A CONSTRUCTION PROGRESS SCHEDULE

Since the terms of the contract required all of the work to be completed by 15 December 1952, and because that firm date had been established with the power marketing agency as the date upon which the production of power from the newly installed unit would be available, it was necessary that a carefully prepared installation schedule be established. The preparation of this schedule, while in outward appearances was simple, was full of troublesome problems. Unexpected work conditions and erection difficulties with resultant delays required consideration in the formulation of an accurate construction schedule. The problem was approached by considering all of the salient features of the work, and those mentioned above, and allowing for reasonable contingencies, then plotting the order of work on a graph. The greatest difficulty encountered was the bewildering number of nebulous variables introduced when the considerations stated above were tabulated, and the estimated working times were computed for each item of the contract. The sequence of the work was perhaps the easiest determination to make in the preparation of the schedule. The consolidated results of the estimates appear as Plate I, titled CONSTRUCTION PROGRESS CHART. The estimated scheduled progress of the entire amount of the work under the contract is plotted on the chart in a solid heavy line, and the actual progress of the work is plotted on the chart with a heavy broken line. It can be seen from the chart that the contract was successfully completed within the specified time. It is considered that this success was due to a carefully prepared schedule, and the diligent efforts of the contractor and the