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THE COOPERATIVE HYDRAULIC MACHINERY LABORATORY

OF THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

AND THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Origin of Laboratory:

The Cooperative Hydraulic Machinery Laboratory is, as the name implies, a joint enterprise of the California Institute of Technology and the Metropolitan Water District of Southern California. In November, 1933, a three year agreement was signed by the two organizations, and the design of the laboratory was begun. Construction was completed by the end of August, 1934, and since that time this laboratory has been in continuous operation.

Need for Laboratory:

The need for the laboratory arose principally from the extraordinarily severe problems that faced the District engineers in connection with the pumping plants for the Colorado River Aqueduct. This aqueduct will have a capacity of 1600 cubic feet of water per second, and in bringing it the 300 miles from the Colorado River to Los Angeles and the other Southern California municipalities which have united to form the Metropolitan Water District, it is necessary to lift it a total of nearly 1700 feet. To do this will require about 350,000 horsepower, which classes it as the largest pumping project in existence. The location finally selected divides this lift between five pumping stations, working against average heads of from 146 feet for the lowest one to 444 feet for the highest. Very little precedent was available for plants of such size, to assist the engineers of the District in answering questions concerning maximum permissible head per stage, single or double

suction pumps, optimum speeds, attainable efficiencies, and desirable operating characteristics. It was felt that a properly equipped laboratory would be of great assistance in studying such problems, and would amply justify the expense required, both by savings expected and by the insurance of obtaining the most satisfactory type of equipment.

Supervision and Activities of Laboratory:

The responsibility of supervising the design, construction and operation of the laboratory was placed in the hands of a group consisting of Professors Th. von Kármán, R. L. Daugherty, and R. T. Knapp for the Institute, and Mr. J. M. Gaylord, Chief Electrical Engineer, and Mr. R. M. Peabody, Senior Mechanical Engineer, for the District. In the two years since the construction was completed, the laboratory has been engaged in working on the following problems:-

1. A comprehensive study of a group of pumps of varying specific speeds and other operating characteristics for the purpose of selecting the proper specifications for the pumps in the different stations.
2. Precision acceptance tests of both Bidders' and Contractors' Model Pumps.
3. A study of the transient flow characteristics of the Contractors' Model Pumps in order to ascertain their behavior during emergency conditions such as power failure, shaft breakage, etc.
4. Special internal surveys of the hydraulic conditions existing within the case, as they affect either structural design or operating efficiency of the unit.

5. Study of control valve characteristics throughout the operating range from closed to full open.

6. Metering investigations.

Object of this Paper:

The purpose of this paper, however, is not to discuss any of the details of the work of the laboratory, but is rather to give a description of the laboratory itself, its equipment and instrumentation, and thus furnish a foundation for subsequent reports dealing with the various investigations that have been undertaken.

General Description of Laboratory Circuits:

(A) Main Circuit. The equipment in the laboratory is arranged in a series of closed hydraulic circuits, to increase its convenience and usefulness. The main circuit is shown in Fig. 1 and consists essentially of

Fig. 1.

Hair Circuit

(Fig. 4 of District report with title and arrows removed.)

Change "pump" to "machine" and "suction" to "low pressure".

the low pressure regulating tank, the machine under test connected to the dynammeter, the venturi meters, and the high pressure service pumps. This circuit can be utilized with flow in either direction through the test machine, for by means of interconnections the suction and discharge connections of the service pumps may be reversed. Also parts of the circuit not needed can be bypassed. An example of this is shown in Fig. 2,