HYD-116

HYD 116

Engineering and Geological Control and Research Division
Field Trip Report No. 28

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Customhouse
Denver, Colorado October 24, 1942.

From Engineer J. E. Warnock

To Chief Engineer

Subject: Inspection of turbine-driven pumping units in the Thomas Point Pumping Plant - Lower Yellowstone Project.

1. In accordance with office letter of September 25, 1942, to Mr. Axel Persson, Project Manager, Board of Control, Sidney, Montana, efficiency tests were made and the direct-connected turbine-pump units in the Thomas Point Pumping Plant were inspected during the period from October 5 to 9, 1942.

2. The output of both units, as indicated by the curves on figure 1 in color, during the tests on October 7 and 8, 1942, was considerably under that indicated during the acceptance tests on July 14, 1922. This reduction in output can be charged to three factors:

(a) The collection of debris in the passages of the turbine runners.

(b) The condition of the turbine vanes particularly in the curved portion at the bottom of the runner due to excessive welding required every season to maintain the runner against severe scouring by the silt in the water and to the worn condition of the turbine wicket gates.

(c) The excessive rust scale in both the turbine and pump scroll cases.

3. The speed, power water, pumped water, efficiency and operating heads as obtained from measurements made during the recent tests have been plotted on figure 1 to compare them with the performance curves for Unit B during the acceptance tests on July 14, 1922. As shown on figure 2, in the case of Unit A, the flow through the turbine was 53 to 73 percent of the original; the pumped water showed a deficit of approximately 30 percent and the speed of the unit was from 87 to 94 percent of the original. In the case of Unit B, the power water showed a shortage of from 21 to 30 percent; the pumped water, from 10 to 18 percent; and the speed, about 5 percent. The head on the turbines during the recent tests were practically the same as during the original tests, while the head on the pumps was somewhat less. There are indications of errors in the computation of the pump head during the original tests.

4. At the conclusion of the hydraulic tests, the units were completely dismantled for a physical inspection. The turbine in Unit A had nine sticks of wood from 4 to 6 inches long and 1½ to 2 inches in

diameter wedged in the passages between the vanes of the runner. Two pieces were found in Unit B, one in the upper part and one in the curved portion. Both turbine runners are severely scoured by the silt in the water as shown in figure 3. The interior of the pump and turbine scroll cases was deeply pocked by rusting. The wicket gates in the turbine were badly worn on the outside, nearest the draft tube.

5. To correct these conditions several remedial measures should be taken:

(a) A hand hole should be cut in the right side of each draft tube elbow with quick-removable, air-tight, cover plates similar in design to the inspection ports on the scroll case of the turbine and the pump. Sticks of wood which have lodged in the turbine runner passages can then be removed while the turbine is idle without dismantling the turbine. These hand holes must be in the right or downstream side of the elbow so that in raking the sticks forward toward the draft tube the force of gravity will keep them from falling back into the scroll case.

(b) As a means of determining the need of closing down a unit to remove debris, the speed of the unit can be used as a criterion. A speed indicator is available in the pumping plant. By using the second hand on a watch, the speed of the turbine can be determined. If it is decidedly less than the value given on figure 1 for a given gate opening in the original tests, the cause of the underspeed will probably be debris in the turbine runner passages.

(c) The wicket gates in the turbine should be restored to their original shape by building up the corners which are now worn away. The original dimensions of those gates are shown on drawings in the project office.

(d) The interior of the turbine and pump scroll cases should be cleaned by sand-blasting and painted with three coats of cold-application coal-tar protective paint (CA-50) which can be cold-applied without using skilled workmen. Copies of the Denver office specifications covering the purchase of CA-50 and instructions for its application are attached.

(e) The condition of the turbines due to the severe scour caused by the silt in the water is serious. The manganese bronze in these runners is not sufficiently resistant to scour whereas the cast iron in the pump runners appears to be withstanding the abuse to which they are subjected. Since pump and turbine operate at the same speed and handle the same silt, it indicates the desirability of replacing the present manganese bronze runners with new ones using grade 2 mild cast steel. If that were done, future repairs could be made by welding the scoured spots using a more resistant material, possibly 18-8 stainless steel, which would increase the resistance of the turbines to scour. It is the opinion of engineers in the mechanical section that turbines of mild cast steel can be obtained at the present time. If that course is considered favorably, the manufacturer should be requested to furnish a set of templets of the turbine runner vanes and instructions for their use so the project would have a specific guide for future maintenance. These templets and instructions can then be used to restore one of the present runners to a condition whereby it would serve as a spare unit for use in emergency only. In the past, the natural tendency has been to apply extra metal to the points of scour. As can be seen in figure 3, the original shape of the buckets with a refined leading edge have been destroyed. Instead it is now a blunt, inefficient shape. The objection to the restoration of the present runners is that it will produce the original hydraulic shape which is too susceptible to scour. If a more resistant material could be used in rebuilding the shape in the bronze runner, such as is suggested in the previous item where 18-8 stainless steel can be applied to mild cast steel, that objection could be removed.

6. The penstocks to the turbines and pumps are in excellent condition as is the pump discharge conduits. In 1937, the 36-inch lap-riveted pump discharge conduit was replaced from the east side of the main canal to the outlet. The pipe was painted at that time and has been kept in excellent shape by retouching each year. Blisters and rust spots are cleaned and repainted. The draft tube cones below normal tailwater surface were covered both inside and outside with a heavy coat of scale and rust, but examination with a hammer and knife blade revealed no indication of leakage. Above the tailwater on the outside of the cone, the original paint was 50 percent intact. The inside and outside of the draft tube should be thoroughly cleaned and painted in the same manner as recommended for the interior of the scroll cases.

7. The thrust bearings were in reasonably good condition. Trouble has been experienced in the past with heating but two streams of water from the water-lubrication supply line flowing over the bearing housing has served as a remedy. The thrust bearing on Unit B showed some grabbing on the inner surface. It has been in service two seasons but should be repoured this year.

8. The packing gland surfaces on the pump shafts as shown in figures 5A and 5B are a source of constant trouble, particularly where the original bronze sleeve is used. The grinding due to silt in the water cuts the packing and sleeve very rapidly. Some conception of the silt content can be realized from the fact that it is necessary to drain the pressure settling tank twice a day to provide clear water to the water-lubricated bearings. The shaft surface in Unit A (figure 5A) is bronze and the wear of the packing is so rapid as to require repacking at least twice each month. In Unit B (figure 5B), the bronze sleeve has been replaced by an iron pipe sleeve coated with stellite. The results appear to be entirely satisfactory, as the original packing placed in the spring has lasted throughout the season. It is recommended that the sleeve on Unit A be given similar treatment. It is probably impossible to obtain stellite at this time, but there are a number of other materials which may serve the same purpose, such as General Electric O or I welding rod, Lincoln Abrasoweld or Stoodyte from the Stoody Company, Whittier, California.

9. Piezometer taps were installed prior to the testing: (1) in the turbine intake penstock (2) in the pump intake penstock, and (3) in the discharge side of the pump. The latter was in the hole provided by the pump manufacturer and the results obtained from it were so much in error as to make it necessary to compute the head losses in the pump discharge line. The tap was placed in a converging section and the surface around the hole was coated with scale impossible to remove by access through the inspection port. In completing the

maintenance this season, it is suggested that all of the pressure taps be installed more firmly than was possible by working from the outside and that the pump discharge tap be installed in a straight section of the penstock beyond the pump. The taps should be flush with the inside of the penstock in every case to prevent cavitation below the tap. In preparing for these tests, the measurement of pressures was considered to be of paramount importance due to the part they play in the computation of the efficiency. As the program developed and subsequent inspection revealed the excellent state of repair of the penstocks, the measurement of the flows and speed became more pertinent. In the future, the project manager by measuring the flows in the canals and determining the speed of the individual units can maintain a check on the output of the plant. This is on the assumption that the penstocks are maintained in their present state of repair. Staff gages in the main canal, the turbine discharge canal and in the pump canal—installed temporarily for these tests—should be installed permanently and referenced periodically to the center-line of the turbine-pumping units.

10. Since copies of the "Report of Test of Thomas Point Pumping Plant," by C. M. Day on July14, 1922, were not available in the project office, a copy is included as part of this report.

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J. E. Warnock.

Encl.

Approved

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Chief Engineer.

CC-Mr. Axel Persson,Mgr.,
Board of Control,
Sidney,Mont.(In dupl.)
Field Sup.,Great Falls,Mont.
General Supervisor
J. E. Warnock

Report of Test of Thomas Point Pumping Plant,

Lower Yellowstone Project

July 14, 1922 C. M. Day

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One of the direct pumping units (Unit B) furnished by Wellman-Seaver-Morgan Co. on Specifications No. 400 for Thomas Point Pumping Plant, Lower Yellowstone Project, was tested on July 14, 1922.

The power water was measured by a current meter in K. K. canal about 100 yds. below the plant, two and three measurements being taken at each turbine gate opening. The canal was clean and smooth, having been cleaned with a Ruth dredger a few days previous to test.

The pumped water was measured by a Cipolletti weir, 10 ft. crest length, placed in the concrete outlet structure, a stilling box being placed 3 ft. above the crest, with a fall of from 0.5 to 0.8 ft. to the water surface below.

All elevations were carefully checked with a level before the test. The pressure gauge for the turbine was connected to the top of the scroll case, there being no tap provided at the inlet connection as required by the specifications. The area of the scroll case at the point where the gauge was connected was measured by planimeter from contractor's detail drawing, and, assuming that one-third of the water was passing this point, the velocity was higher than at the turbine inlet, which is improbable. Therefore, in the computations for velocity head, the velocity at the turbine inlet has been used.

The pressure head on the turbine was measured by a calibrated pressure gauge, having both pound and foot scale, to which was added 4.24 ft., the distance from the center of the gauge to the center of the turbine shaft.

The suction and pressure heads on the pump were measured by a calibrated pressure gage, 2.15 ft. being added to the pressure head, and 1.0 ft. deducted from the suction head, these being the distances from the center of the gauges to the center of the pump shaft. The draft head, from the center of the turbine shaft to water surface in the tail race, was the actual difference in elevation. The head on the unit was approximately 9% greater than called for in the contract, the increased head on the pump being due to the weir in the outlet, and on the turbine because the nearest check in K. K. canal was so far below the plant that it was not effective with the quantity of water discharged through the turbine.

The curves on drawing 14-B-30 show the performance of the unit from 4/10 to 10/10 gate opening. The maximum over-all efficiency of both pump and turbine is 64.4%. The maximum over-all efficiency guaranteed by the contractor is 68%.

The operation of the unit was very satisfactory. The operation of the pressure settling tank for furnishing clear water to the stuffing boxes seems to be satisfactory, although the units have been operated too short a time to be certain on this point. The steel penstocks and discharge pipe leaked in a number of the joints, but these seem to be silting up, and will probably close completely in a short time. The general construction has been very good, and costs to date indicate that the completed cost will be several thousand dollars less than the estimate of $60,000. The check in the main canal, and the wasteway to Lateral K K operate satisfactorily.

The detailed computations and performance curves are attached.

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SPECIFICATIONS June 1942

COLD-APPLICATION COAL-TAR PAINT C.A.-50 GRADE

1. The requirement. It is required that there be furnished and delivered f.o.b. cars in accordance with these specifications the cold-application coal-tar paint called for in the accompanying schedule.

2. Data and samples to be furnished by bidders. Each bidder shall submit with his bid his own detailed specifications covering the material to be furnished.

3. Inspection and tests. Samples will be taken at random from the material as received at destination. Any material represented by these samples which does not conform to the specifications will be rejected and the contractor shall furnish and deliver, at his expense, material to replace that which is rejected.

4. Packing and marking. The coal-tar paint, CA-50 grade, shall be packed in steel drums of approximately 55 gallons capacity, which containers shall become the property of the Government. Each container shall be plainly marked with the brand, the name of the manufacturer, the kind and quantity of materials, and the number of the contract or order.

5. Coal-tar paint. Composition: The coal-tar paint shall consist of coke oven coal-tar pitches and coal-tar naphtha together with an inert inorganic filler, suitably processed and blended to produce a smooth liquid coating which will comply with the detail requirements set forth in this specification. The paint shall be free from water, ammonia, pyridine, pyridine bases, tar acids, oil gas tar, asphalt and petroleum derivities, and shall conform to the following detail physical requirements.

		Minimum	Maximum
(a)	Distillation - initial drop	300° F.	
	Total distillate to 455° F. by weight	20%	30%
(b)	Softening point of residue of distillation	205° F.	240° F.
(c)	Penetration of residue of distillation	5	15 (1/100 cm.
(d)	Ash-percent of residue by weight	20%	30%

6. Performance requirements. (a) The paint as furnished and without thinning or other preparation other than adequate stirring shall be of such a consistency and characteristic as will permit it to be easily applied on a clean metal surface by brushing when both the air and metal temperatures are as low as 40 degrees F. The stirring shall be readily accomplished by hand and without the use of a power-driven mixer. After the stirring is completed the paint shall exhibit very little brush drag even at the 40 degrees F. temperature.

(b) The sample of paint to be tested together with four sandblasted 4" x 12" 26-gage steel panels shall be stored in a 40 degrees F. room 24 hours before application is performed. After the 24 hours at 40 degrees F. the paint is to be stirred and applied to the test panels at a coverage of 150 to 180 square feet per gallon by hand brushing.

(c) The panels prepared as described in the previous paragraph shall be allowed to dry in a vertical position, two in the 40 degrees F. atmosphere and two in a 160 degrees F. atmosphere. None of the paint films shall show evidence of having sagged or run when dry to firm film. The paint on the panels stored in the 40 degrees F. room shall attain a skin dryness in twelve hours and a complete film dryness in six days. The panel stored in the 160 degrees F. atmosphere shall attain complete film dryness in 24 hours.

(d) After the first coat of paint has dried the minimum specified period for complete dryness, a second coat of paint shall be applied at 100 to 120 square feet per gallon. The panels shall continue to be stored in the original 40 degrees and 160 degrees F. Atmospheres and the second coat shall dry without sagging in the same manner as described for the first coat in the previous paragraph, (c).

(e) The test panels as prepared in accordance with paragraphs (b), (c), and (d), shall have a good bond to the metal and shall show no tendency to check, crack, or loosen from the metal when stirred in a temperature-controlled compartment and the temperature lowered from room temperature to -40 degrees F. at the rate of 20 degrees F. per hour, held at this temperature one hour, then returned to room temperature at the rate of 20 degrees F. per hour. The panels are to be inspected after the compartment has returned to room temperature.

7. Method of tests.

(a) Distillation - A.S.T.M. D-20-30.

(b) Softening point - A.S.T.M. D-36-26.

(c) Penetration - A.S.T.M. D-5-25, 100 grams, 5 second, 77 degrees F.

(d) Ash - A.S.T.M. D-271-37.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Instructions Governing Preparation of Surfaces, Application and Inspection of Cold-Application Coal-Tar Protective Paint (CA-50 Grade)

1. Introduction. On continuously submerged metalwork which is seldom uncovered for a sufficient length of time to permit inspection or maintenance painting, it is advisable to provide more protection than is afforded by three or four coats of the CTP-2 and/or CTP-3 grades of coal-tar paint. For this purpose, therefore, a jell-like cold-applied coal-tar pitch is furnished under number CA-50 grade. This material has a peculiar characteristic which is described as "false body." In the container it appears to have the consistency of soft mush and might appear to be so heavy-bodied that it could not readily be applied. It can be applied by brushing, however, with no more effort than required for the application of ordinary paint. It can be applied in two or three coats to produce any desired thickness up to 1/32 inch. With care, this thickness can be produced on vertical surfaces without encountering running or sagging of the paint while wet or dry.

2. Preparation of metal surfaces. The CA-50 grade paint is to be applied directly to the surfaces of the bare metal, and no attempt should be made to apply it over any other type of paint. The surfaces to be coated shall be cleaned to bright metal by sandblasting. Oil and grease shall be removed by washing with coal-tar naphtha, or lead-free high-test gasoline. The use of kerosene or low-grade gasoline must not be permitted, as these leave an oily film on the metal which prevents the coal-tar paint from correctly bonding to the metal.

3. Preparation of paint for application. The CA-50 grade of paint conforming to Bureau of Reclamation specifications is prepared by the manufacturer to the correct consistency for brush application providing the temperature of the paint is above 60° F. The addition of solvents or thinners to the paint is not necessary and must not be permitted. If the temperature of the paint is lower than 60° F. it will be necessary to warm the paint to a temperature of not greater than 100° F., which should be done by placing the container in a water bath. The heating must not be continued for more than one hour. Heating the paint over a direct flame is dangerous to life and will ruin the paint

and must not be permitted. The container in which the material is heated should not be more than three-quarters full and if covered should be vented to allow for expansion. While 100° F. is a higher temperature than is needed for application, it allows some margin to compensate for cooling of the compound during the period of application. The CA-50 grade of paint will require some stirring or mechanical agitation prior to use as this material contains an inert filler which, even though finely divided, has some tendency to settle and form a stratification of the paint.

4. Application of CA-50 paint. The first coat of CA-50 grade paint is to be carefully brushed out to a coverage of 150 to 175 square feet per gallon. The second and third coats are to be applied at 100 to 120 square feet per gallon. Each coat of paint shall be allowed to dry thoroughly and shall be inspected and approved before the following coat is applied. Twenty-four hours shall be considered as the minimum drying time for the first coat of paint and, unless the paint is drying under ideal conditions of well circulated warm air, more time may be required before the following coat is applied. In like manner, 48 hours shall be considered as the minimum drying time for the second coat before the third coat is applied. The inspection of the painting shall include determination of drying time to be allowed each coat. Application of this paint is difficult to perform in a satisfactory manner when the air or metal temperature is below 50° F.

5. Inspection. Each shipment of coal-tar paint which is to be furnished by the Government will have been sampled by a representative of the Government and the samples forwarded to Denver, tested, and approved before the material is furnished to the contractor. When the material is supplied by the contractor, samples shall be taken by the inspector at the contractor's shop and forwarded to Denver for approval and shall be approved before being applied. Materials received at the project which have not been tested before shipment or do not bear the Bureau's acceptance identification are to be sampled at the project. The sampling shall be performed in accordance with General Order No. 896, December 31, 1936: "Instructions governing procedure to be followed in securing field samples of paint materials, and preparation of same for shipment." One sample shall be taken to represent each 50 drums of paint or fraction thereof. Each sample shall be shipped in a one-quart container and shall be approximately equal to but not greater than 0.85 of a quart in volume.

All areas to be painted shall be carefully inspected to insure that they are cleaned in accordance with foregoing instructions. If the metalwork has previously been shop-primed and the primer material has not been previously approved, or if there is doubt as to the quality of the primer used, the primer on the metal shall be sampled as hereinafter outlined and the samples forwarded to the Denver office for test.

The sample shall be secured by removing paint from 8 to 10 square feet of painted area. The primer on this area should first be softened by washing with coal-tar naphtha and then removing as much as can be by scraping and carefully placing such scrapings into a sample can. After this, the surface should be rubbed with coal-tar-naphtha-saturated cloths to remove most of the paint left after the scraping operations, and the cloths wrung into the sample can. Washing with the naphtha-saturated cloths should be repeated several times.

The inspector shall determine by test whether or not each coat of paint is thoroughly dry before the next coat is applied. If the paint film is dry to a firm, hard film which cannot be dislodged or wrinkled under moderate pressure of the thumb, it can be considered as sufficiently dry to permit application of the following coat. Allowances must be made, of course, for the temperature of the metal and the paint. The above test is based upon the paint having a temperature of 60° to 80° F. Temperatures above 80° F. tend to cause the paint film to be soft and plastic, even though thoroughly dry, and temperatures below 60° F. will solidify the paint film, creating a false dryness. Under the wide variation of field conditions, experience is the best guide in determining dryness of coal-tar paint.

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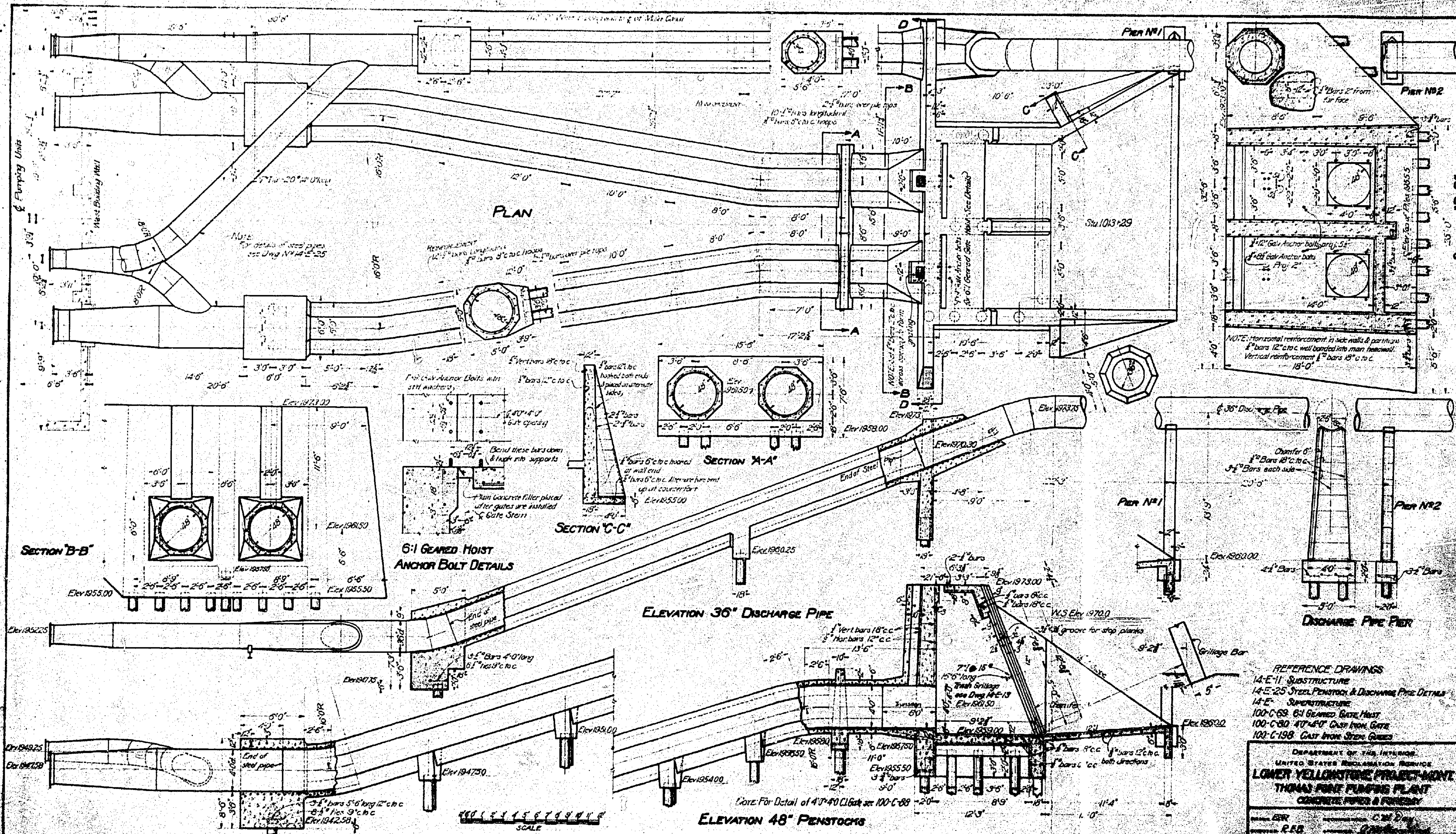
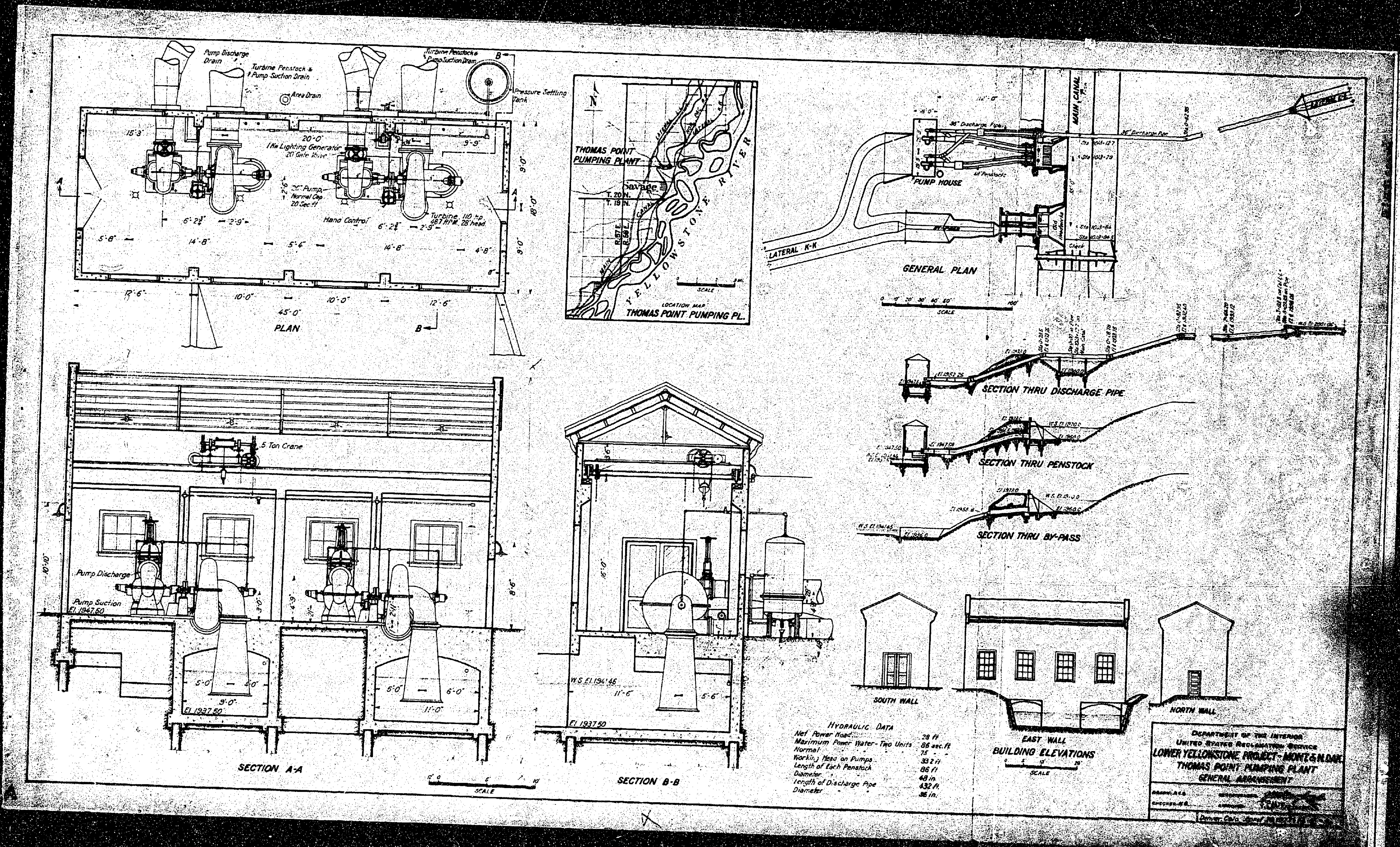

Plan
Section "B-B"
6:1 Geared Hoist Anchor Bolt Details
Section "C-C"
Section "A-A"
Pier No 1
Pier No 2
Discharge Pipe Pier
Elevation 36" Discharge Pipe
Elevation 48" Penstocks
Scale
Reference Drawings
14-E-11 Substructure
14-E-25 Steel Penstock & Discharge Pipe Details
14-E- Superstructure
100-C-69 6:1 Geared Gate Hoist
100-C-80 4'0"x4'0" Cast Iron Gate
100-C-198 Cast Iron Stem Guides
Department of the Interior
United States Reclamation Service
Lower Yellowstone Project-Mont.
Thomas Point Pumping Plant
Concrete Pipes & Forebay


Pump Discharge Drain
Turbine Penstock & Pump Suction Drain
Area Drain
Pressure Settling Tank
1 Kw Lighting Generator
20" Gate Valve
20" Pump, Normal Cap. 20 Sec. ft
Hand Control
Turbine, 110 h.p. 287 R.P.M. 28' head
PLAN
THOMAS POINT PUMPING PLANT
Savage
YELLOWSTONE RIVER
LOCATION MAP
THOMAS POINT PUMPING PL.
PUMP HOUSE
MAIN CANAL
LATERAL K-K
GENERAL PLAN
SECTION THRU DISCHARGE PIPE
SECTION THRU PENSTOCK
SECTION THRU BY-PASS
5 Ton Crane
Pump Discharge
Pump Suction El. 1947.50
El. 1937.50
SECTION A-A
SECTION B-B
SOUTH WALL
EAST WALL
NORTH WALL
BUILDING ELEVATIONS
SCALE
HYDRAULIC DATA
Net Power Head 28 ft
Maximum Power Water - Two Units 86 sec.ft
Normal 75
Working Head on Pumps 33.2 ft
Length of Each Penstock 86 ft
Diameter 48 in.
Length of Discharge Pipe 432 ft.
Diameter 36 in.
DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
LOWER YELLOWSTONE PROJECT - MONT & N. DAK.
THOMAS POINT PUMPING PLANT
GENERAL ARRANGEMENT
Denver, Colo.

A - Leading edge of vanes in turbine runner of Unit A showing severe erosion and excessive thickness of metal

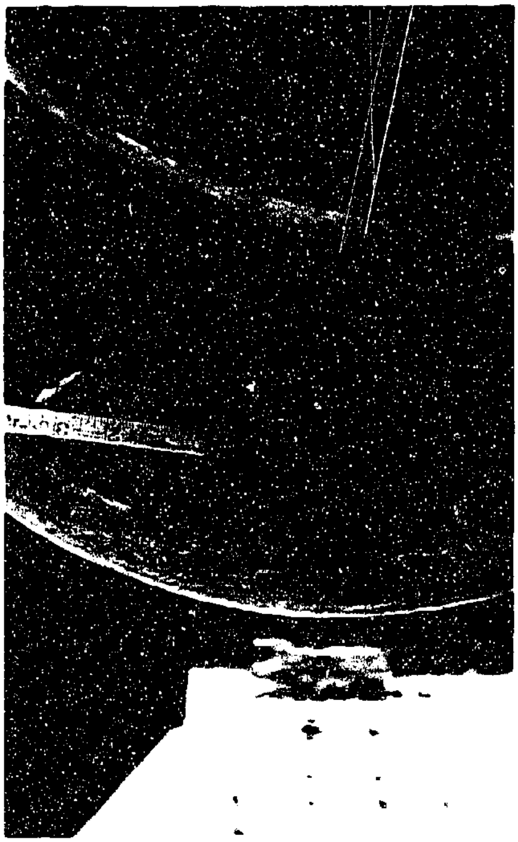
B - Erosion pockets on bottom of buckets in turbine runner of Unit A.

C - Excessive thickness of leading edge and scour pockets on inside surface of turbine runner vanes of Unit B.

D - Scour pockets on trailing edge of vanes in Unit B turbine.

THOMAS POINT PUMPING PLANT - LOWER YELLOWSTONE PROJECT

A - Excess metal and severe scour on leading edge of vanes in turbine runner of Unit B.



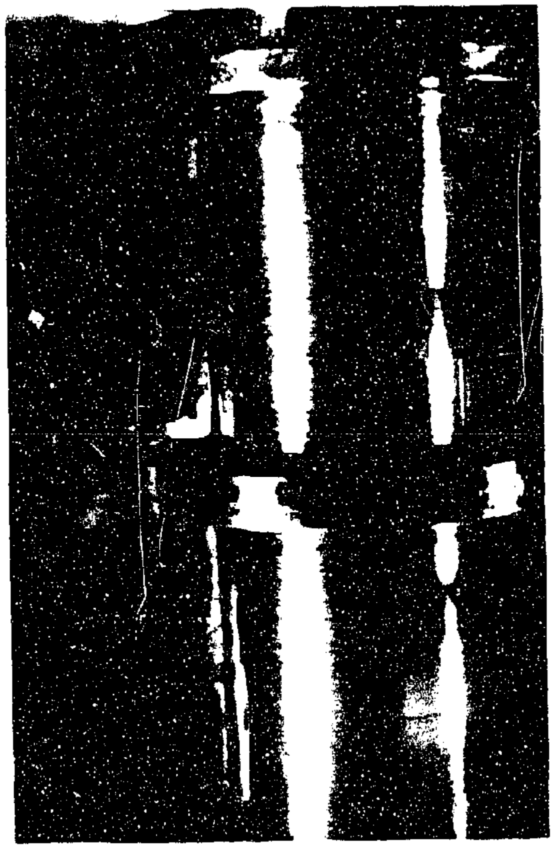
B - Spare bronze turbine runner showing repairs to vanes at entrance to buckets.

C - Welding on sealing ring of spare turbine runner.

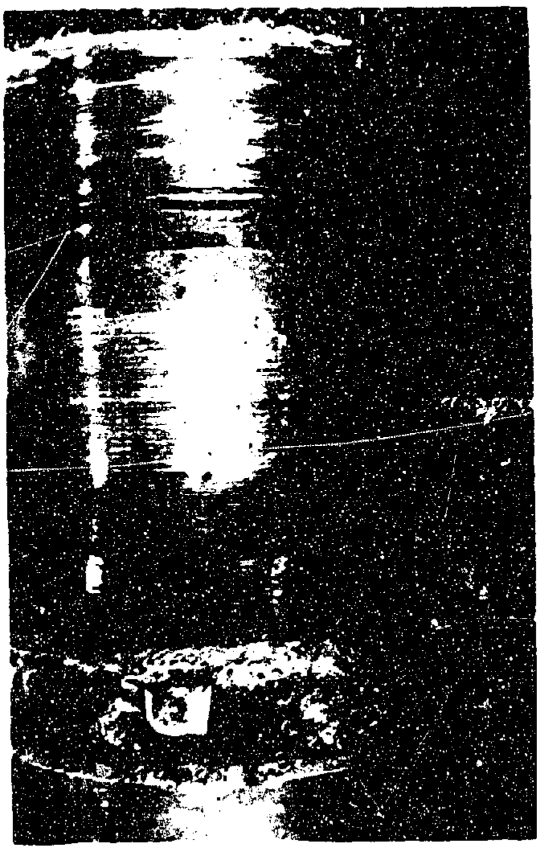
D - Roughness on trailing edge of vanes in spare turbine runner.

THOMAS POINT PUMPING PLANT - LOWER YELLOWSTONE PROJECT

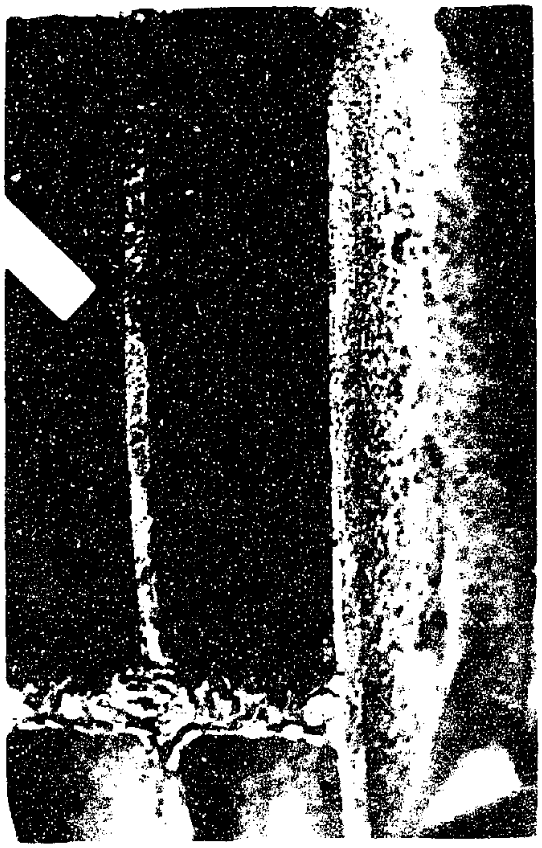
B - Stellite-coated iron pipe sleeve packing gland at outer end of pump in Unit B after one season of operation.



D - [illegible]



A - Badly cut bronze packing gland surface at outer end end of pump in Unit A after one season of operation.



C - Trailing edge of vanes in cast iron spare pump runner.