MEASUREMENT OF AIR DEMAND OF 84-INCH JET FLOW GATE IN THE AUXILIARY OUTLET WORKS OF TRINITY DAM AND PREPARATIONS FOR CLEAR CREEK TUNNEL AND SPRING CREEK POWER CONDUIT FRICTIONAL RESISTANCE MEASUREMENTS--TRINITY RIVER DIVISION--CENTRAL VALLEY PROJECT

R. B. DEXTER, HYDRAULIC ENGINEER

TR 2591

Form DFC-11
(12-61)
Bureau of Reclamation

TR 2591

INFORMATIONAL ROUTING

293

Travel Report #2591 May 8, 1963

To: Chief Engineer

Through: Chief Research Scientist
Chief Designing Engineer
Chief, Hydraulics Branch

From: R. B. Dexter, Hydraulic Engineer

Subject: Measurement of air demand of 84-inch jet flow gate in the auxiliary outlet works of Trinity Dam and preparations for Clear Creek tunnel and Spring Creek power conduit frictional resistance measurements--Trinity River Division--Central Valley Project

GPO 852320

Chronology of Travel

I left Denver, Colorado, during the evening of March 8, 1963, and arrived at Redding, California, during the afternoon of the next day. All travel between Redding and the Project Construction Engineer's Office at Lewiston, California, and travel on the Project was accomplished by Government vehicle. On the return portion of the trip, I left Redding during the afternoon of March 19, 1963, and arrived at Denver about noon the next day.

Purposes of the Trip

The primary purpose of the trip was to measure the air demand of the 84-inch jet flow gate in the auxiliary outlet works of Trinity Dam. A secondary purpose was to prepare piezometer facilities in Clear Creek tunnel and Spring Creek power conduit for use during future hydraulic frictional resistance measurements.

Personnel Contacted

The following personnel of the Project Construction Engineer's Office at Lewiston, California, were contacted during performance of duties on the Project:

TR 2591

H. E. McInnis, Project Construction Engineer

Trinity River Construction Division
J. L. Graham, Supervisory Mechanical Engineer
R. W. Tipton, Mechanical Equipment Inspector
T. J. Spicher, Mechanical Engineer

Clear Creek Construction Division
H. A. Jensen, Supervisory Construction Engineer
M. W. Archibald, Supervisory Construction Engineer
A. F. Moore, Supervisory General Engineer

T. W. Merrit, Project Photographer
F. K. Noonan, Photographer

A short time before I left the Project on March 19, 1963, I conferred with Mr. J. L. Kiewit of the Chemical Engineering Branch. He was at the Project to inspect application of an experimental protective coating (Phenoline) in the spiral case and draft tube liners of one turbine in the Spring Creek Powerplant. During application of the protective coating, we discussed methods of providing smooth flow surfaces adjacent to the flowmeter piezometer plugs in the turbine spiral case.

Correspondence References

1. Letter dated April 24, 1962, to Project Construction Engineer, Lewiston, California, from Associate Chief Engineer, subject, "Auxiliary outlet works 84-inch jet flow gate--Trinity Dam--Central Valley Project.

2. Letter dated June 6, 1962, to Project Construction Engineer, Lewiston, California, from Assistant Commissioner and Chief Engineer, subject,same as above.

3. Teletype TLX-DN-46 dated March 6, 1963.

4. Teletype DN-TLX-53 dated March 7, 1963.

5. Letter dated April 2, 1963, to Project Construction Engineer, Lewiston, California, from Chief Engineer, subject, "Change in protective coating application adjacent to piezometer plugs at Spring Creek power conduit, Station 94+51.75, etc."

84-inch Jet Flow Gate Air Demand Measurements

Introduction

Comprehensive studies of a 1:14.87 scale model of the Trinity auxiliary outlet works jet flow gate were made in the Hydraulic Laboratory. The model incorporated the upstream approach conduit, the gate, and a portion of the water and air supply conduits downstream of the gate. Results of the model study are contained in Hydraulic Laboratory Report No. HYD-472. A considerable portion of the model study was devoted to determining the air demand of the gate for various operating heads and gate openings.

In practically all model studies, the laws of similitude for relationships between a hydraulic model and its prototype are well known; there are occasions, however, when these relationships are not definitely known. The latter statement is true when the air demand of large prototype control valves and gates in closed conduits is to be determined from a scale model. It is, therefore, desirable to perform prototype air demand tests to obtain data for comparison with the predictions made from model studies. Such comparisons are valuable for future design studies of large gates and valves.

A plan view and section of the Trinity Dam auxiliary outlet works are shown on Figure 1. Section D-D of Figure 1 shows the cross-sectional shape of the jet flow gate air supply duct. The air duct has its intake end in the crown of the spillway tunnel and its outlet end at the crown of the ovate-shaped conduit 25 inches downstream of the jet flow gate bonnet. Installation of the 84-inch ring-follower guard gate and the jet flow gate in the auxiliary outlet works is shown on Figure 2. Figure 3 is an assembly drawing of the 84-inch jet flow gate. The outlet end of the air duct is shown by the sectional elevation view on Figure 3.

The jet flow gate is characterized by a comparatively long diverging approach flow passage and a short converging section immediately upstream of the gate orifice. The effective percent gate opening is the ratio of the distance of the bottom of the gate leaf (the lowest point adjacent to the orifice) above the orifice invert to the 84-inch diameter of the orifice.

Air Demand Measurements

A 1/2-inch outside-diameter, stainless steel Pitot tube was mounted at the outlet end of the air duct so that the leg of the tube that contained the impact-head and static-head ports extended horizontally into the duct. This leg of the tube was placed at the intersection of the horizontal and vertical centerlines of the duct and rigidly anchored. The impact opening of the Pitot tube extended 13 inches into the duct from the outlet end, and the static-head openings 8-1/2 inches into the duct. Flexible tubes to transmit the impact- and static-head pressures from the Pitot tube were anchored and were then extended to the side of the water conduit, upstream to the jet flow gate bonnet, up through the gate bonnet between the gate leaf and the inside surface of the bonnet, and passed through a hole in the bonnet cover. A threaded hole had previously been provided in the bonnet cover to facilitate passing the tubes from the gate bonnet into the gate chamber. The pressure transmission tubes were connected to U-tube manometers in the gate chamber.

A pressure recorder was connected to one of the vent valves on the bonnet of the ring-follower guard gate to obtain pressure-head measurements immediately upstream of the jet flow gate. A small annular space between the ring-follower gate leaf flow circle and the gate body transmits pressure heads directly into the gate bonnet.

It was necessary to fasten a steel tape, graduated in sixteenths of an inch, to the permanent gate leaf position scale to determine effective percent opening of the gate. The zero of the tape was placed at the elevation of the gate leaf position pointer when the flow control surface on the bottom of the gate leaf was even with the bottom of the gate orifice. Percent gate opening could then be determined by dividing the tape reading at the pointer by the orifice diameter. A table of tape readings and corresponding percent gate openings was prepared prior to the air demand measurements so the desired gate settings could be made rapidly. This auxiliary tape was left fastened to the permanent gate leaf position indicator scale and a copy of the gate opening table was left with Project personnel to aid them in operation of the jet flow gate.

At each gate opening during the air demand measurements, the air velocity-head and static-head at the center of the duct were read on the U-tube manometer in the gate chamber and recorded. Velocity heads were indicated with water columns for all gate openings. At gate openings larger than 40 percent, the negative static heads exceeded the capacity of the longest water-column U-tube on hand, and mercury columns were used. In addition to the manometric data necessary for computation of air velocities and specific weight of the flowing air at the center of the duct, the following data were recorded: percent effective gate opening, temperature of the flowing water, pressure-head immediately upstream of the jet flow gate, temperatures of the manometer fluids, barometric pressures in the gate chamber and at a known elevation on the downstream side of the dam. The latter barometric pressure will be used to compute the gate air demand in terms of weight rate or volume rate of flow of free air that was supplied by the atmospheric reservoir.

Preliminary Results of Air Demand Measurements

Limited air demand measurement results for the 84-inch Trinity jet flow gate are shown on Table 1. During these measurements, the Trinity Dam Reservoir water surface elevation was in the range 2368.16 to 2368.24. The horizontal centerline of the jet flow gate is at elevation 1999.0, and the morning-glory spillway crest is at elevation 2370.0. Thus, the reservoir water surface was about 2 feet below the morning-glory spillway crest which provided a total operating head on the gate of 369 feet.

Since the air duct could not be traversed with the Pitot tube, the relationship of centerline velocity to average velocity is not yet known. Sixteen lineal feet of a 1:4 scale model of the air duct are being built for testing in the Hydraulics Branch to obtain this relationship. The model will be operated on the air test facility in the Hydraulic Laboratory, in which rate of air flow through a supply line ahead of the duct will be measured with a standard ASME square-edged orifice installation. Centerline velocity near the downstream end of the model air duct will be measured with a Pitot tube one-fourth the diameter of the one used for the prototype measurements. Results of this model operation will yield the ratio of average velocity to centerline velocity for a range of air discharges. A range of these ratios will permit conversion of prototype duct centerline air velocities to average velocities for computation of prototype gate air demand.

Jet Flow Gate Operating Characteristics

The pressure-head values at the ring-follower gate, shown in Table 1, reflect a pressure surge or swing in the upstream water conduit for jet flow gate openings between 30 and 80 percent. This pressure swing was caused by an apparent pulsation of flow through the jet flow gate. The pulsating flow was readily audible in the gate chamber as a rhythmic change in the "swishing" sound of water flowing through the system. The pulsations, which occurred at an estimated frequency of 2 to 3 cycles per second, were not severe, and no vibration, rumbling, or movement of the gate or structure could be detected. Pressures transmitted by the Pitot tube in the air duct did not reflect the rhythmic pulsations noted in the upstream water conduit. Instead, random fluctuations occurred in the manometers connected to the Pitot tube, but these fluctuations increased in magnitude as the pressure fluctuations in the water conduit increased. This phenomenon indicated increasing fluctuations in the air duct in direct relation to fluctuations upstream of the jet flow gate. The absence of rhythmic pulsation indications from the air duct could have been due to damping action of the subatmospheric pressures in the lines used to connect the Pitot tube to the manometers and also to the damping action of the liquid columns in the manometers.

The 1:14.87 model study of the jet flow gate (Hydraulic Laboratory Report HYD-472 dated January 6, 1961) indicated a range of unstable water jet configurations and air demand in the conduit downstream of the gate orifice at gate openings between 50 and 70 percent. However, no appreciable pressure variations were detected in the model system upstream from the gate when this occurred, and no rhythmic pattern was observed.

The rhythmic pulsations of flow through the prototype jet flow gate in a relatively large range of gate openings has been discussed with Mr. W. H. Kohler and others in the Large Gates and Valves Section of the Mechanical Branch. The conclusion was made that the frequency, magnitude, and phase relationship of the pressure fluctuations upstream and downstream of the jet flow gate should be more thoroughly investigated with pressure transducers and an electrical recorder. The model studies revealed that for gate openings in the range of 50 to 70 percent the water jet occasionally became relatively smooth downstream of the gate orifice, then broke up to produce a great deal of spray; the air demand was greatest when the spray was the greatest. Simultaneous prototype measurements of air pressure fluctuations in the jet flow gate bonnet and water pressure fluctuations in the ring-follower gate bonnet should reveal whether or not the upstream pressure fluctuations are triggered by the downstream fluctuating air demand. A letter dated April 22, 1963, to the Project Construction Engineer, Lewiston, California, from the Chief Engineer, subject, "Hollow-jet valve outlet works stilling basin and morning-glory spillway," contains a proposal for obtaining the measurements discussed above in connection with performance data and observations of the Trinity Dam hollow-jet valve stilling basin.

Clear Creek Tunnel and Spring Creek Power Conduit Piezometer Installations

Introduction

Piezometer installations have been provided near the upstream and downstream ends of the concrete lining in Clear Creek tunnel for measurement of pressure heads during hydraulic frictional resistance tests. Each installation consists of four stainless steel plates embedded in the concrete lining flow surface, with a piezometer orifice in each plate. The plates are located at each end of the 45° diameters of the tunnel flow circle. The four orifices at each installation are connected to a common line that leads to an access location for pressure-head measurements. Details of the Clear Creek tunnel piezometer installations are shown on Drawing No. 416-D-328. Similar piezometer installations have been provided in the concrete lining of Spring Creek power conduit Tunnel No. 1 and in the steel liner near the upstream end of Rock Creek Siphon. The Spring Creek power conduit piezometer installations are shown on Drawings No. 416-D-619 and 416-D-593.

Inspection of Piezometers and Concrete Lining Flow Surfaces

On March 11, 1963, I joined a Project crew for a round trip through Clear Creek tunnel by means of a diesel-powered jeep with an exhaust filter system. The original purpose of the trip was to probe the openings in the downstream piezometer plates at Station 558+65 to make sure that they were open for pressure measurements during a static test of the tunnel, and to make anemometer measurements of direction and velocity of air movement through the tunnel. These objectives were accomplished and, in addition, the stainless steel plates were cleaned to remove all foreign matter, principally concrete curing compound. The plates were buffed with fine grit abrasive cloth to remove any burrs or projections and were left smooth and clean. While probing the 1/4-inch-diameter holes in the plates at Station 558+65, an apparent obstruction was found in the hole of the lower right-hand plate (looking downstream). A 15/64-inch twist drill would only go 3/4 inch into the hole, and when the drill was bounced on the obstruction it sounded like metal-to-metal contact. It was not possible in the limited time available to determine if this obstruction was foreign material or whether the hole had not been drilled through the stainless steel boss on the back of the plate. Loss of pressure transmission by this piezometer hole would not be a serious problem because all four piezometers are manifolded into one pipe. However, an effort should be made to open the hole before the tunnel is put into service.

The operations described above were repeated at the piezometer installations at Clear Creek tunnel Station 8+56, near the upstream end of the tunnel. All four holes were probed and found to be open. At this station, deposits from ground water inflow had covered most of the areas of the two lower stainless steel plates. The deposits were removed from the plates, and the concrete flow surfaces upstream of the plates, and the plates were left clean and smooth. If these deposits reoccur, they will have to be removed during the final tunnel inspection. Mr. H. A. Jensen, Chief of the Project Tunnels Branch, stated that the final inspection will be made shortly before the tunnel is put into service for generation of power at Clear Creek Powerplant. At the time I left the Project, initial power generation at the plant was scheduled for early June 1963.

In accordance with recommendations in a Travel Report by Mr. John W. Morris dated October 24, 1962, subject, "Spring Creek conduit and Clear Creek Tunnel--Trinity River Division--Central Valley Project, California," mineral deposits have been removed from the concrete lining flow surfaces in Clear Creek tunnel. Judging from observations made during the round trip through nearly the full length of the tunnel on March 11, 1963, nearly all deposits were removed from the tunnel flow surfaces. The only exceptions were a few extremely hard tenaciously bonded white deposits in the reach between Stations 515 and 520. However, these deposits are not large enough to appreciably affect the cross-sectional flow area of the tunnel. Project personnel stated that this cleaning operation was performed during January 1962. The tunnel flow surfaces appeared to be in excellent condition. Mr. H. A. Jensen stated that any additional appreciable deposits that reoccur will be removed during the final inspection of the tunnel.

Concrete lining cleanup operations were in progress in Spring Creek power conduit Tunnel No. 1, and the holes had not been drilled through the stainless steel assemblies at the two piezometer installations in the tunnel. Therefore, preparation of these facilities for use during frictional resistance measurements must be performed at a later date.

I examined the four piezometer plugs installed in the steel liner of Spring Creek power conduit at Station 94+51.75. The liner in the vicinity of the plugs had not been sandblasted for application of coal-tar enamel, and the plugs had not been ground flush with the flow surface of the liner. Therefore, the letter previously cited as Correspondence Reference 5 was sent to the Project to provide flow surfaces adjacent to these piezometer plugs that will not require further preparation after application of protective coatings.

Summary and Conclusions

Jet Flow Gate Air Demand Measurements

Satisfactory air demand measurements were obtained for a complete range of openings of the jet flow gate with nearly maximum operating head on the gate. It will be necessary to operate a model of a portion of the prototype air duct in the laboratory to obtain relationships of duct centerline velocities to average velocities before rates of flow of air in the prototype duct can be computed. The necessary model features are now being fabricated for assembly in the Hydraulics Branch air test facility. The prototype air demand results will provide valuable information for comparison with air demand results obtained from the 1:14.87 scale model of the Trinity Dam jet flow gate and for future design studies.

Pulsations of air and water flows occurred in the Trinity Dam auxiliary outlet works system for jet flow gate openings from 30 to 80 percent. This phenomenon has been discussed with representatives of the Mechanical Branch and the cause and nature of these pulsations will be investigated. A letter has been sent to the Project Construction Engineer, Lewiston, California, in which measurements of the pulsations in the auxiliary outlet works are proposed.

Clear Creek Tunnel and Spring Creek Power Conduit Piezometers

The piezometers in Clear Creek tunnel, installed for future tunnel friction resistance measurements, were inspected and prepared for use. However, there was an obstruction in the pressure transmission hole of one of the piezometer assemblies, at Tunnel Station 558+85, that should be removed.

Mineral deposits have been scraped from the concrete lining of Clear Creek tunnel as previously recommended and the flow surfaces are in excellent condition.

The piezometer installations in the concrete lining of Spring Creek power conduit tunnel No. 1 were not prepared for use, because tunnel lining cleanup operations were still in progress and the holes in the piezometer assemblies had not been drilled through from the tunnel side. Final preparation of these facilities will have to be completed at a later date. Action has been taken to provide special protective coating flow surfaces adjacent to the piezometers in the steel liner at Station 94+51.75 of Spring Creek power conduit.

Recommendations

Trinity Dam Auxiliary Outlet Works Jet Flow Gate

Since action has already been initiated to investigate pulsating flow in the auxiliary outlet works of Trinity Dam, there are no recommendations presented here in regard to the 84-inch jet flow gate in Trinity Dam.

Clear Creek Tunnel and Spring Creek Power Conduit Piezometers

During the final inspection of Clear Creek tunnel, before it is put into service for generation of power at Clear Creek Powerplant, reasonable efforts should be made to remove the obstruction in the piezometer hole located in the lower right-hand quadrant (looking downstream) at Station 558+85. Also, remove with fine grit abrasive cloth any burrs from the stainless steel plate flow surface that might be created by attempts to remove the obstruction. Examine the two lower plates and piezometer holes at Station 8+56 very closely for additional deposits from ground water inflow. If any additional deposits have accumulated on the stainless steel plates at either Station 8+56 or 558+85, remove the deposits and clean the piezometer holes.

Within a reasonably short time before Spring Creek power conduit is put into operation, inspect and clean the four piezometer facilities at Stations 20+45 and 91+90 in Tunnel No. 1 as was done in Clear Creek tunnel.

R. B. Dexter

Copy to: Regional Director, Sacramento, California, Attention: 2-220

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RBDexter:mew-s

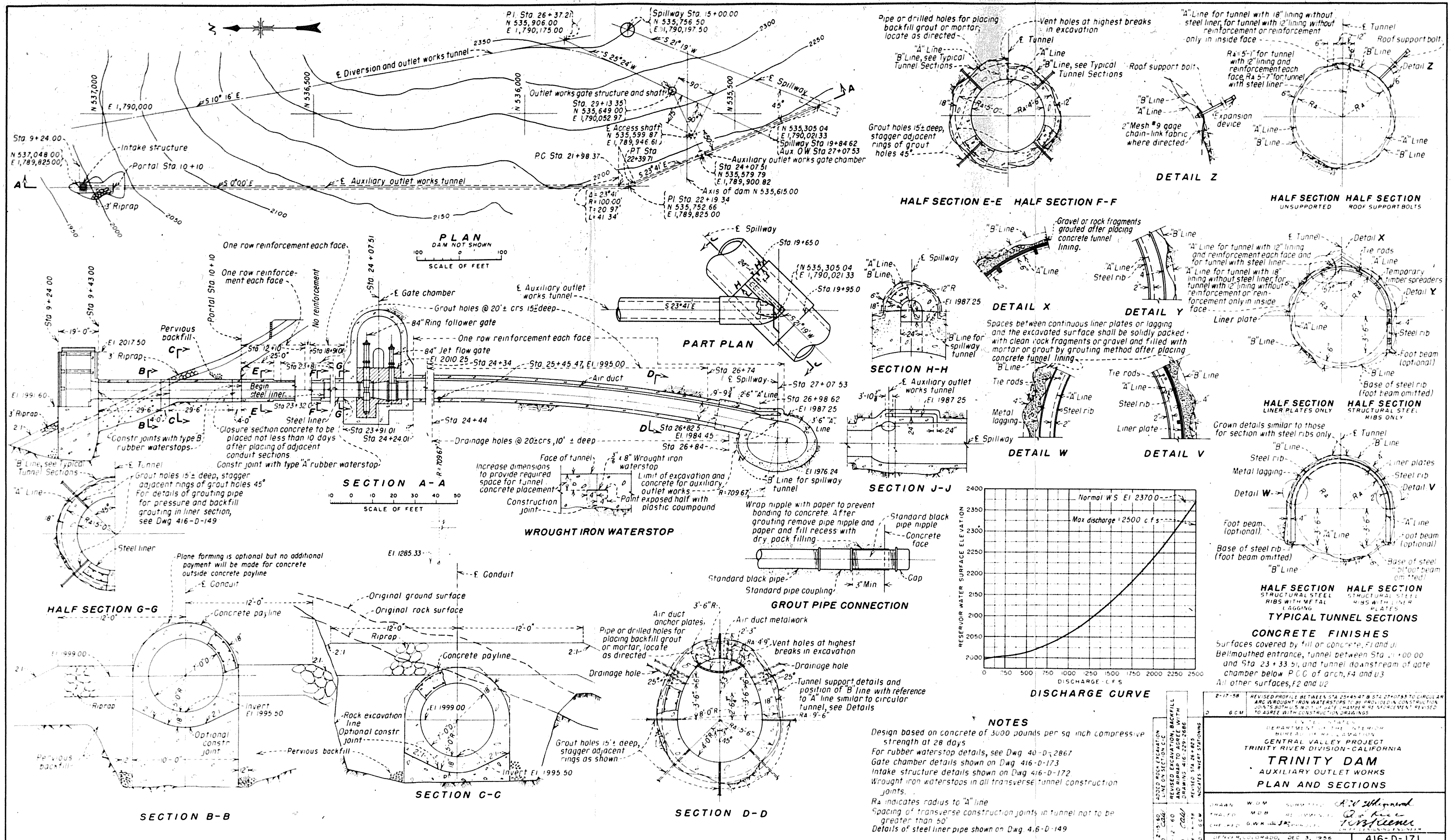
NOTED: MAY 15 1963
B. P. Bellport
Chief Engineer

TABLE 1

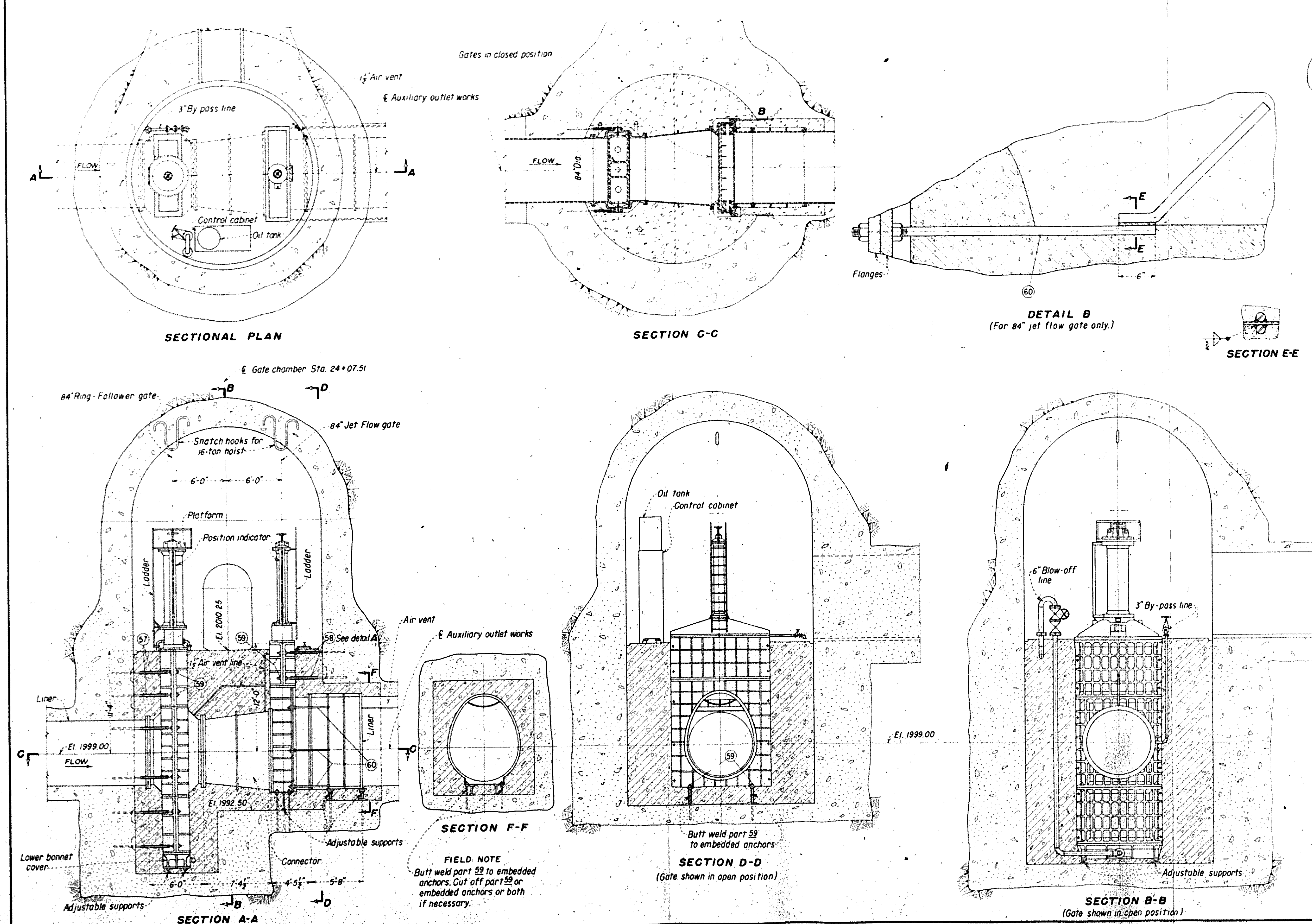
Trinity River Division - CVP
Trinity Dam Auxiliary Outlet Works
84-inch Jet Flow Gate
Preliminary Results of Air Demand Measurements

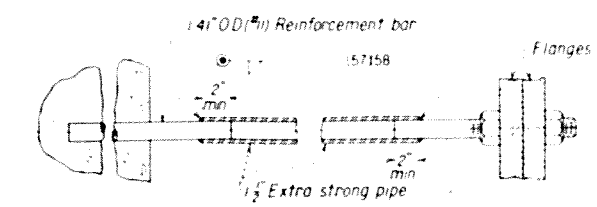
Effective Gate Opening (percent)	At Pitot Tube in Center of Air Duct		Water Press. Head at Ring Follower Gate ‡ (ft. water)
	Air Velocity (ft./sec.)	Negative Static Head* (ft. water)	
0.0	0.0	0.0	369.
4.0	23.5	0.21	368.
6.0	46.9	0.23	367.
7.6	88.0	0.52	365.
10.0	121.	0.74	364.
12.0	123.	0.84	363.
15.0	117.	0.95	359.
20.0	139.	1.38	357.
30.0	152.	2.37	331. to 340.
40.0	235.	4.55	296. to 308.
45.1	269.	5.52	273. to 287.
50.0	288.	6.29	245. to 264.
55.0	292.	6.51	220. to 238.
60.0	294.	6.29	194. to 211.
65.2	292.	6.34	164. to 183.
70.2	271.	5.66	141. to 158.
79.9	248.	4.88	104. to 111.
85.1	238.	4.48	91.
90.1	235.	4.48	72.
95.2	265.	5.22	61.
100.0	303.	6.09	51.

*Referred to barometric pressure in gate chamber at elev. 2014.
‡ Reservoir W.S. elev. was between 2368.16 and 2368.24 during air demand measurements.



PLAN
DAM NOT SHOWN
SCALE OF FEET
£ Diversion and outlet works tunnel
Outlet works gate structure and shaft
£ Auxiliary outlet works tunnel
Intake structure
Portal Sta. 10 + 10
3' Riprap
PART PLAN
SECTION A-A
SCALE OF FEET
HALF SECTION G-G
SECTION B-B
SECTION C-C
SECTION D-D
WROUGHT IRON WATERSTOP
GROUT PIPE CONNECTION
SECTION H-H
SECTION J-J
HALF SECTION E-E HALF SECTION F-F
DETAIL X
DETAIL Y
DETAIL W
DETAIL V
DETAIL Z
HALF SECTION UNSUPPORTED
HALF SECTION ROOF SUPPORT BOLTS
HALF SECTION LINER PLATES ONLY
HALF SECTION STRUCTURAL STEEL RIBS ONLY
HALF SECTION STRUCTURAL STEEL RIBS WITH METAL LAGGING
HALF SECTION STRUCTURAL STEEL RIBS WITH LINER PLATES
TYPICAL TUNNEL SECTIONS
DISCHARGE CURVE
RESERVOIR WATER SURFACE ELEVATION
DISCHARGE - C.F.S.
Normal W.S. El. 2370.0
Max discharge = 2500 c.f.s.
CONCRETE FINISHES
Surfaces covered by fill or concrete, F1 and U1
Bellmouthed entrance, tunnel between Sta 10+00.00 and Sta 23+33.51, and tunnel downstream of gate chamber below P.C.C. of arch, F4 and U3
All other surfaces, F2 and U2
NOTES
Design based on concrete of 3000 pounds per sq inch compressive strength at 28 days
For rubber waterstop details, see Dwg 40-D-2867
Gate chamber details shown on Dwg 416-D-173
Intake structure details shown on Dwg 416-D-172
Wrought iron waterstops in all transverse tunnel construction joints.
RA indicates radius to "A" line
Spacing of transverse construction joints in tunnel not to be greater than 50'
Details of steel liner pipe shown on Dwg 416-D-149
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION - CALIFORNIA
TRINITY DAM
AUXILIARY OUTLET WORKS
PLAN AND SECTIONS
DENVER, COLORADO, DEC. 3, 1956
416-D-171





DETAIL A

NOTE

All 1.41" dia. (#11) reinforcement bar anchors and all adjustable supports shall be furnished by the contractor. Parts 57, 58, 59, and 60 will be furnished with 84" jet flow gate.

INSTALLATION INSTRUTIONS

1. Install the portion of the gates that is to be embedded below elevation 2010.25.
2. The embeded portion of the gates shall be completely assembled except for the gate leaves and hoists.
3. Support the gates and downstream liner on adjustable supports. Bolt up the gates, liners, and connector.
4. Assemble and weld all anchor bolts as shown.
5. Aline the gates by adjusting the nuts on the anchor bolts and the adjustable supports which shall remain embedded.
6. The first concrete lift shall fill the ringfollower blockout to elevation 1992.50. The second lift shall come to 6 inches above the bottom of the jet flow gate. Thereafter the concrete shall be placed around the gate in 3 ft. but not more than 5 foot lifts and the alinement shall be rechecked after each lift.
7. For further instructions for alining and embedding the gates and for fairing the water passageway, see Paragraphs 140 and 142 of Specification No. DC-4824.

LIST OF DRAWINGS

AUXILIARY OUTLET WORKS	
84" RING FOLLOWER AND JET FLOW GATES - INSTALLATION - LIST OF DRAWINGS	416-D-314
84" JET FLOW GATE - ASSEMBLY - LIST OF DRAWINGS	416-D-315
84" RING FOLLOWER GATE - ASSEMBLY - LIST OF DRAWINGS	416-D-74
84" RING FOLLOWER GATE - AUXILIARY PIPING - LIST OF PARTS	416-D-301
84" RING FOLLOWER AND JET FLOW GATES - CONTROLS - INSTALLATION - LIST OF DRAWINGS	416-D-272

REFERENCE DRAWINGS

AUXILIARY OUTLET WORKS	
GATE CHAMBER - CONCRETE DETAILS	416-D-246
84" RING FOLLOWER AND JET FLOW GATES - ALINEMENT ANCHORAGE	416-D-359

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION - CALIFORNIA

TRINITY DAM

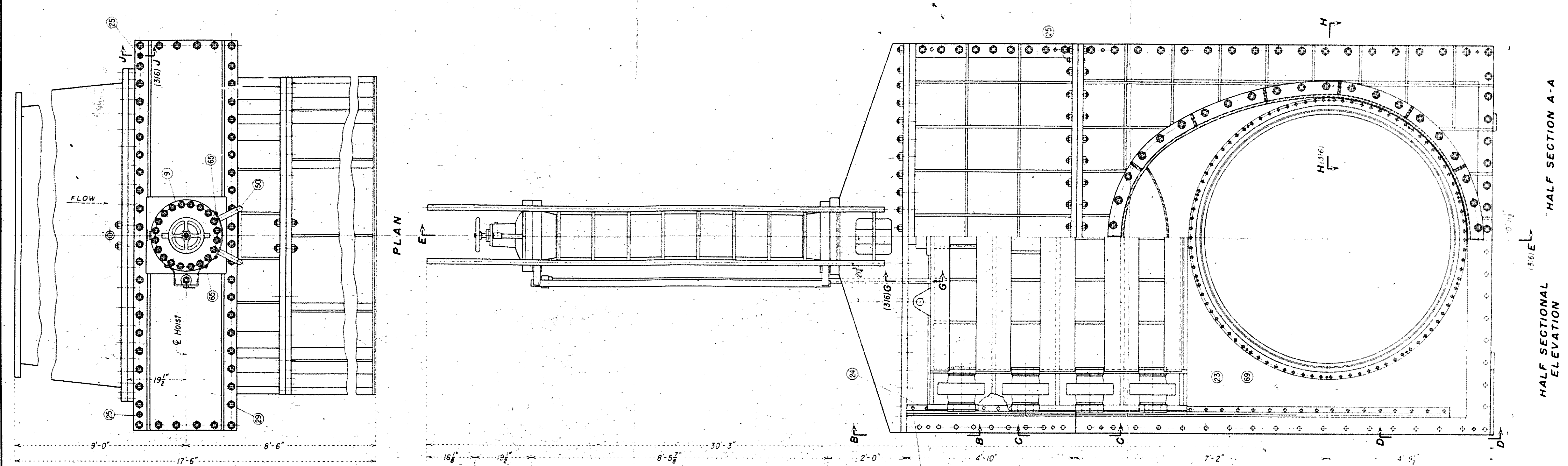
AUXILIARY OUTLET WORKS

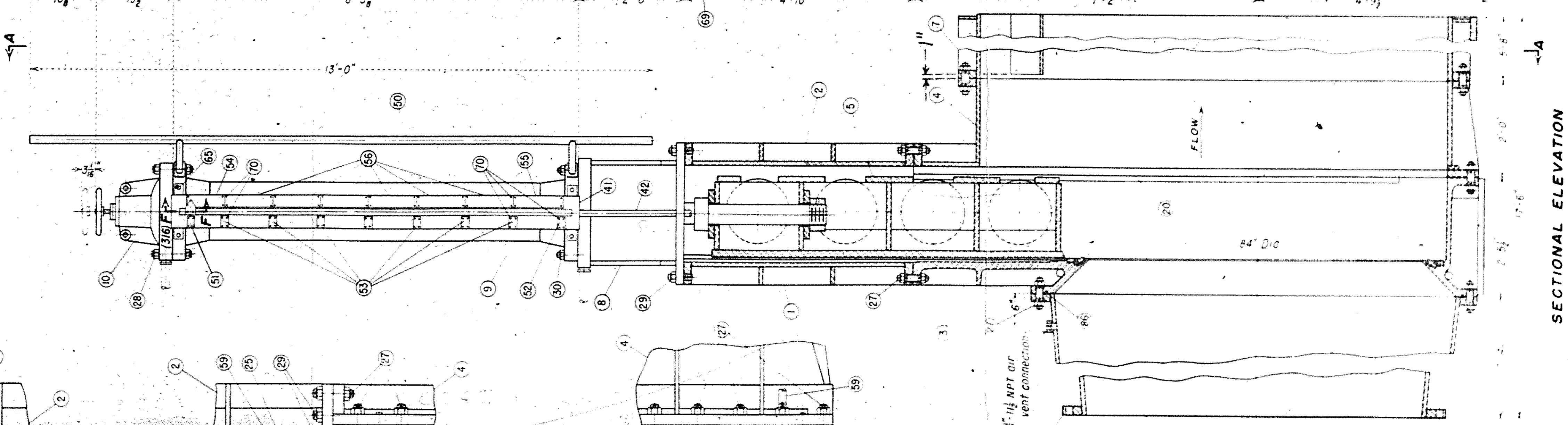
84" RING FOLLOWER AND JET FLOW GATES INSTALLATION - LIST OF DRAWINGS

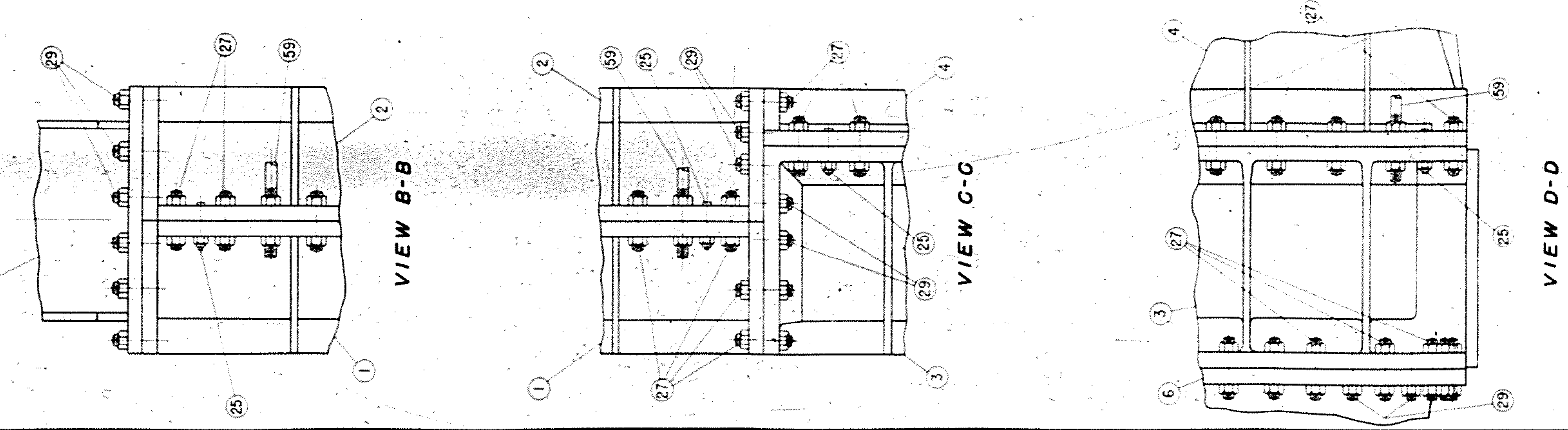
DRAWN H.T.W.-R.L.T. SUBMITTED W.H. Kohler
TRACED J.S.S. RECOMMENDED H.E. Shedo
CHECKED J.A.R.-J.C.G. APPROVED K.B. Keener
CHIEF DESIGNING ENGINEER

DENVER, COLORADO, JAN 31, 1958
SHEET 1 OF 1

416-D-314







LIST OF DRAWINGS

ASSEMBLY - LIST OF DRAWING	416 - D - 315
ASSEMBLY - SECTIONS	416 - D - 316
LIST OF PARTS - MATERIALS	416 - D - 317
BONNETS	416 - D - 318
UPSTREAM BODY	416 - D - 319
DOWNSTREAM BODY	416 - D - 320
LEAF	416 - D - 321
CONNECTOR AND LINER	416 - D - 322
BONNET COVER - CYLINDER - STEM - PISTON	416 - D - 323
WHEEL - AXLE - TRACK - GUIDES	416 - D - 324
SEAL ASSEMBLY AND DETAILS - HANGER PARTS	416 - D - 325
LADDER - INDICATOR PARTS	416 - D - 326

REFERENCE DRAWING

INSTALLATION - LIST OF DRAWINGS	416 - D - 314

DESIGN DATA
Max design head on gate at ℄ conduit = 388 ft of water.
Max. design pressure in hydraulic cylinder = 2000 p.s.i.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION - CALIFORNIA

TRINITY DAM
AUXILIARY OUTLET WORKS
84" JET FLOW GATE
ASSEMBLY - LIST OF DRAWINGS

DRAWN DCF JCW SUBMITTED W.H. Koaler
TRACED CGM RECOMMENDED C.E. Sheln
CHECKED J.A. M.J. APPROVED K.B. Keener
CHIEF DESIGNING ENGINEER

DENVER, COLORADO, APRIL 1958
SHEET 1 OF 2

416 - D - 315