Memorandum

To: Chief, Office of Drainage and Groundwater Engineering

From: Acting Chief, Division of Engineering Laboratories

Date: May 23, 1956

Subject: Calibration of flow meter and Bourdon pressure gage--Shoshoni, Wyoming, Municipal Water Supply--Boysen Dam Project

Calibration of the 3-inch Sparling (main line) meter and pressure gage requested in your memorandum of April 27, 1956, in preparation for a 30-day performance test of a 6-inch deep well turbine pump has been completed. The meter, associated piping, and pressure gage were received in the laboratory on April 25 from Shoshoni, Wyoming, and were returned on May 1 by Mr. W. N. Tapp.

The meter and piping were installed in the laboratory to duplicate as nearly as possible the pump piping that exists in the Shoshoni Municipal Water Supply (Figure 1). A 6-inch, long radius elbow, gate valve and riser pipe from a 12-inch supply line (under the grating in the photograph) were used to represent the pump (Figure 2). The use of the piping assumed an essentially uniform velocity distribution to the pump elbow from the casing. A 6- to 4-inch reducer, 12-1/4 inches long between the elbow and 4-inch swing check valve, was slightly longer than the one installed in the field. The 7-5/8-inch length of pipe from the valve to the elbow was fabricated to complete the laboratory piping. The 4-inch long radius elbow, a 16-3/4-inch length of 4-inch pipe, a 4- to 3-inch reducer upstream, and 3- to 4-inch expander downstream of the 3-inch Sparling meter were received from the field. A 4-inch return line downstream of the reducer was straight for a distance of 10 feet to return the water to the main supply line through a 90° elbow and appropriate fittings, including a regulating valve. The pipe downstream of the meter did not contain the 90° angle valve of the field installation. The flow through the meter bypassed a closed 12-inch valve in the supply line to be discharged into the laboratory volumetric calibration tank.

A brief inspection before installation and calibration disclosed the meter body and piping to be clean with only a slight degree of rusting. The rotation of the meter propeller was sluggish but there was no evidence of binding or stoppage at any particular point of rotation.

The 3-inch Sparling meter has been designed to measure the volume of water with an accuracy of ± 2 percent between 30 gpm and 200 gpm. For the proposed pump performance and well drawdown

tests that use a rate of flow, the meter was calibrated by comparing the meter flow rate with that obtained by the volumetric tank. A straight reading totalizer head with indicator needle in units of 10 gallons per revolution was counted and recorded with time to obtain the meter flow rate. The water from the meter was discharged into an 88-cubic-foot volumetric tank through a swing spout and timed automatically by an electronic counter to obtain the actual flow rate for comparison with the meter. Two flow rate measurements were made for each discharge unless there was an unreasonable variance between the readings. When this occurred a third and at times a fourth reading were made for check purposes. The minimum tank filling time was approximately 186 seconds and the maximum 732 seconds. The volume of water measured per reading averaged approximately 650 gallons through the meter and 85 cubic feet in the volumetric tank. The 6-inch gate valve in the meter approach piping was fully opened during the calibration. A gate valve approximately 13.5 feet downstream of the meter controlled the flow through the meter.

The results of the calibration of the meter as received from the field appear in Table I and Figure 3. The meter over registered the volumetric tank by approximately 2 percent at a discharge of 200 gpm. At a discharge of approximately 150 gpm the meter and tank indicated the same rate but the meter efficiency decreased rapidly as the discharge was reduced to 100 gpm. The meter under registered the tank by approximately 8 percent at 100 gpm. As the discharge was decreased to approximately 70 gpm the accuracy of the meter increased, under registering the tank by approximately 4 percent. From 70 to 50 gpm the meter efficiency sharply decreased and evidently would continue to decrease until a stoppage occurred.

The irregularity of the accuracy curve did not follow the uniform curve predicted by the manufacturer's rating. Corrective measures were applied to the piping system at the suggestion of the manufacturer's representative in Denver, Colorado, in an attempt to provide uniform flow conditions upstream of the meter. The change in piping consisted of moving the 4- to 3-inch reducer from the upstream end of the meter to the downstream end of the 4-inch long radius elbow (Figure 4). A 3-inch pipe 16-3/4 inches long fabricated by the meter representative was attached between the reducer and meter to replace the 4-inch pipe of the field installation. The 3-inch pipe provided approximately 5 diameters of straight pipe

upstream of the meter. The meter was thoroughly cleaned of small deposits of very fine rust and sand particles in the bearings and gears. All parts requiring grease were thinly coated with ball bearing "Lubriplate." The meter was reassembled and installed in the piping system.

The results of a second calibration of the meter are contained in Table II and Figure 3. The curve obtained from the first calibration was essentially repeated in the second calibration in the discharge range from 100 gpm to 200 gpm. For discharges between 50 gpm to 100 gpm, the meter efficiency was improved over the first calibration. This improvement may be attributed to the cleaning of the meter because the greatest efficiency increase occurred in the low range of discharge where friction effects would be higher in proportion to the power available from the propeller. Because of the press of time it was not possible to evaluate the separate effects of cleaning and the change of piping by installation of the clean meter in the pipe system received from the field. Nevertheless, it was believed that the irregularity in the calibration curve between 50 and 150 gpm discharge was a characteristic of the pipe system and not one of the meter. Thus the meter could be used to obtain the rate of flow for pump performance and well drawdown tests. The meter would not accurately measure the volume of flow over long periods unless the rate remained constant over the period of measurement. The meter does not record the time over which a particular volume was obtained or the variation of rate during that time. Therefore, it becomes impossible to accurately apply a corrective factor to obtain the true volume of water. If at some future date the meter again becomes available for calibration, flow straightening vanes could be installed in either the 4- or 3-inch straight pipes upstream of the meter to obtain a more constant relationship between the meter and volumetric rate of flow. The meter accuracy could also be checked with a long straight run of pipe upstream of the meter.

The Bourdon pressure gage that accompanied the meter was calibrated with a dead weight tester. The results of the calibration are contained in Table III.

Conclusions

From the limited studies made on one meter in the laboratory, it may be concluded:

1. The accuracy curve Figure 3B for Meter No. 30829 with the 3-inch pipe immediately upstream can be used to correct the discharge for short periods of time for constant or nearly constant pumping rates.

2. The accuracy curve cannot be used to correct the volume of flow over long periods because the meter does not record the time over which a volume was obtained or the variation of rate during that time.

3. If the irregularity of the accuracy curve of Meter No. 30829 is due to the piping arrangements, the second meter of the Shoshoni Municipal Water Supply may be similarly affected because the systems are nearly identical.

4. Measures should be taken to modify the installation to obtain a more constant relationship between the indicated meter rate and the volumetric rate of flow.

A. C. Barnett

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W H Price 1
H M Martin 1
C W Thomas 1
J. C. Schuster 1
Hyd. Lab Files (2)

Table I

CALIBRATION OF 3-INCH SPARLING (MAIN LINE) METER
NO. 30829 AS RECEIVED FROM FIELD INSTALLATION
SHOSHONI, WYOMING, MUNICIPAL WATER SUPPLY

DISCHARGE, GPM		ACCURACY
Volumetric tank	Meter	Meter discharge divided by volumetric discharge
186.0	190.7	1.025
185.6	189.0	1.018
189.7	193.7	1.021
175.9	179.6	1.021
176.1	179.6	1.019
151.5	151.2	0.998
151.5	151.6	1.001
151.4	151.5	1.001
143.5	142.5	0.993
143.9	141.9	0.986
126.0	115.7	0.918
122.5	115.0	0.939
122.6	115.3	0.940
97.9	91.1	0.930
97.8	91.2	0.932
79.8	76.1	0.954
79.7	75.8	0.951
53.5	47.9	0.895
53.4	47.4	0.888

Table II

CALIBRATION OF 3-INCH SPARLING (MAIN LINE) METER
NO. 30829 WITH 3-INCH PIPE UPSTREAM OF METER
SHOSHONI, WYOMING, MUNICIPAL WATER SUPPLY

DISCHARGE, GPM		ACCURACY
Volumetric tank	Meter	Meter discharge divided by volumetric discharge
204.2	210.3	1.030
204.6	210.3	1.028
177.0	180.7	1.021
177.0	181.0	1.023
150.2	150.3	1.001
150.4	150.6	1.001
136.1	133.8	0.983
136.5	134.2	0.983
122.6	116.4	0.949
122.5	116.8	0.953
111.5	103.6	0.929
111.5	104.3	0.935
103.5	96.6	0.933
96.4	91.2	0.946
96.3	91.4	0.949
81.2	79.5	0.979
81.2	79.3	0.977
68.1	67.4	0.990
68.1	67.4	0.990
52.1	51.6	0.990
52.1	51.5	0.988

Meter indicator needle movement was erratic at flow rate of 9.6 gpm.

Table III

CALIBRATION OF DIAL PRESSURE GAGE USED IN PREVIOUS TESTS SHOSHONI, WYOMING, MUNICIPAL WATER SUPPLY PUMP TEST EQUIPMENT

Note: Gage calibrated as received from field (gage glass broken--sand in and around gage face). Gage nomenclature--0-300 psi, U. S. Gage Co. No. 108941

Pressures (psi)*							
Up scale		Down scale		Up scale		Down scale	
Tester	Gage	Tester	Gage	Tester	Gage	Tester	Gage
0	0	300	283	0	0	300	283
25	29	275	265	50	55	250	245
50	51	250	245	100	102	200	198
75	75	225	221	150	150	150	150
100	100	200	198	200	198	100	102
125	124	175	174	250	245	50	55
150	148	150	150	300	283	25	30
175	172	125	125	315	300	0	0
200	194	100	102				
225	217	75	79				
250	238	50	55				
275	262	25	30				
300	280	0	0				
325	300						

Could not duplicate these gage readings either up scale or down scale

Satisfactory duplication

*Copied from original calibration sheet--dead weight tester used for calibration.

"Satisfactory duplication" obtained without gage adjustment after testing from 0 to 300 and back to 0 psi (first 4 columns).

Figure 1

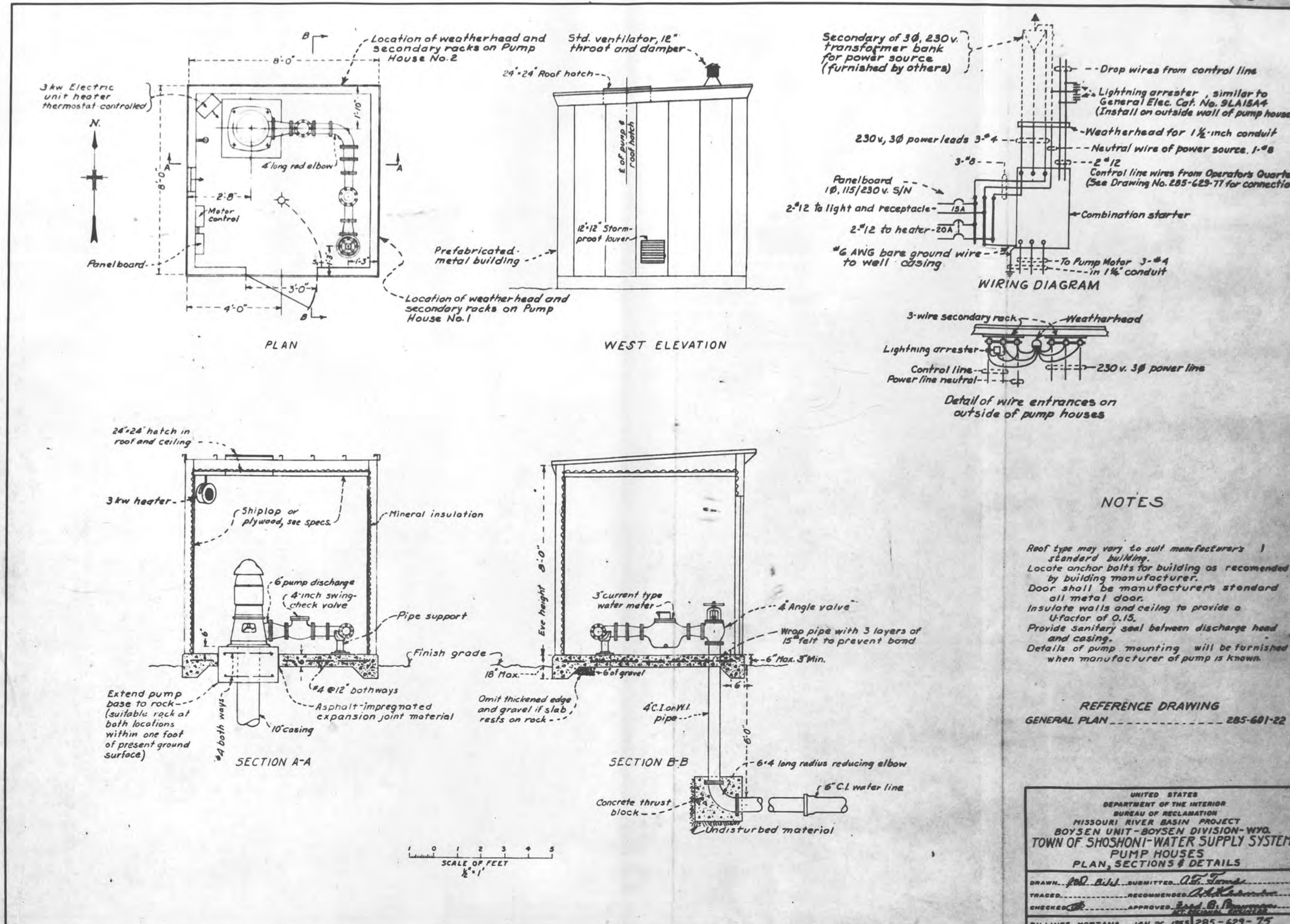
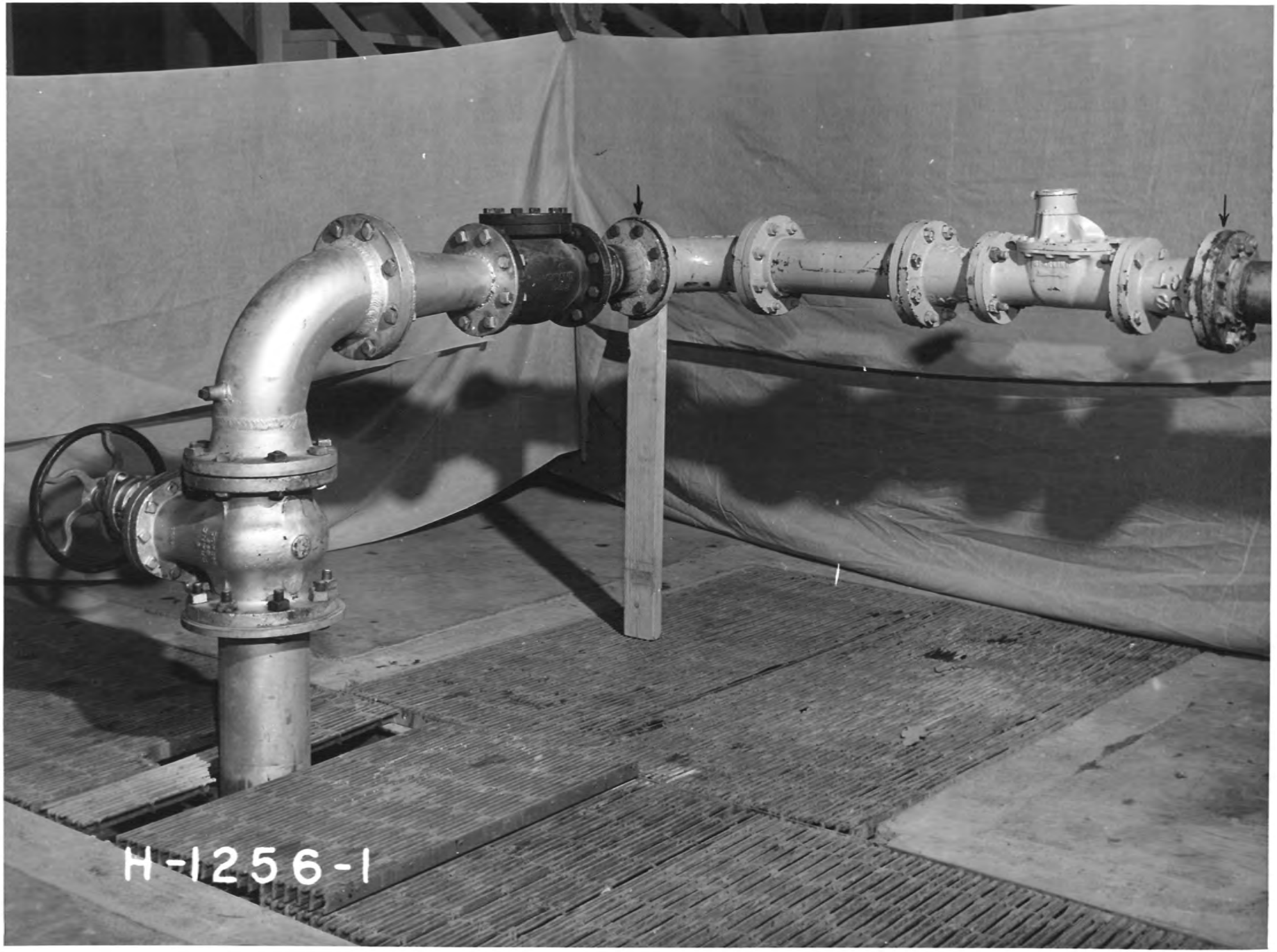

Location of weatherhead and secondary racks on Pump House No. 2
Std. ventilator, 12" throat and damper
24"×24" Roof hatch
3 kw Electric unit heater thermostat controlled
4" long rad elbow
Motor control
Panelboard
Location of weatherhead and secondary racks on Pump House No. 1
12"×12" Storm-proof louver
Prefabricated metal building
PLAN
WEST ELEVATION
Secondary of 3Ø, 230 v. transformer bank for power source (furnished by others)
Drop wires from control line
Lightning arrester, similar to General Elec. Cat. No. 9LA15A4 (Install on outside wall of pump house)
Weatherhead for 1½-inch conduit
230 v, 3Ø power leads 3-#4
Neutral wire of power source, 1-#8
2-#12 Control line wires from Operators Quarters (See Drawing No. 285-629-77 for connection)
Panelboard 1Ø, 115/230 v. S/N
2-#12 to light and receptacle
2-#12 to heater
Combination starter
#6 AWG bare ground wire to well casing
To Pump Motor 3-#4 in 1½" conduit
WIRING DIAGRAM
3-wire secondary rack
Weatherhead
Lightning arrester
Control line
Power line neutral
230 v. 3Ø power line
Detail of wire entrances on outside of pump houses
24"×24" hatch in roof and ceiling
3 kw heater
Shiplap or plywood, see specs.
Mineral insulation
6" pump discharge
4-inch swing-check valve
Pipe support
Finish grade
#4 @12" bothways
Asphalt-impregnated expansion joint material
Extend pump base to rock (suitable rock at both locations within one foot of present ground surface)
10" casing
#4 both ways
SECTION A-A
Eve height 8'-0"
3" current type water meter
4" Angle valve
Wrap pipe with 3 layers of 15# felt to prevent bond
6" Max. 3" Min.
18" Max.
6" of gravel
Omit thickened edge and gravel if slab rests on rock
4" C.I. or W.I. pipe
6×4 long radius reducing elbow
6" C.I. water line
Concrete thrust block
Undisturbed material
SECTION B-B
SCALE OF FEET ½"=1'
NOTES
Roof type may vary to suit manufacturer's standard building.
Locate anchor bolts for building as recomended by building manufacturer.
Door shall be manufacturer's standard all metal door.
Insulate walls and ceiling to provide a U-factor of 0.15.
Provide sanitary seal between discharge head and casing.
Details of pump mounting will be furnished when manufacturer of pump is known.
REFERENCE DRAWING
GENERAL PLAN 285-601-22
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
BOYSEN UNIT - BOYSEN DIVISION - WYO.
TOWN OF SHOSHONI - WATER SUPPLY SYSTEM
PUMP HOUSES
PLAN, SECTIONS & DETAILS
DRAWN
SUBMITTED
TRACED
RECOMMENDED
CHECKED
APPROVED
BILLINGS, MONTANA JAN. 26, 1955
285-629-75

FIGURE 2

Laboratory installation of 3-inch Sparling meter and pipe as received from Shoshoni, Wyoming, Municipal Water Supply--Boysen Dam Project.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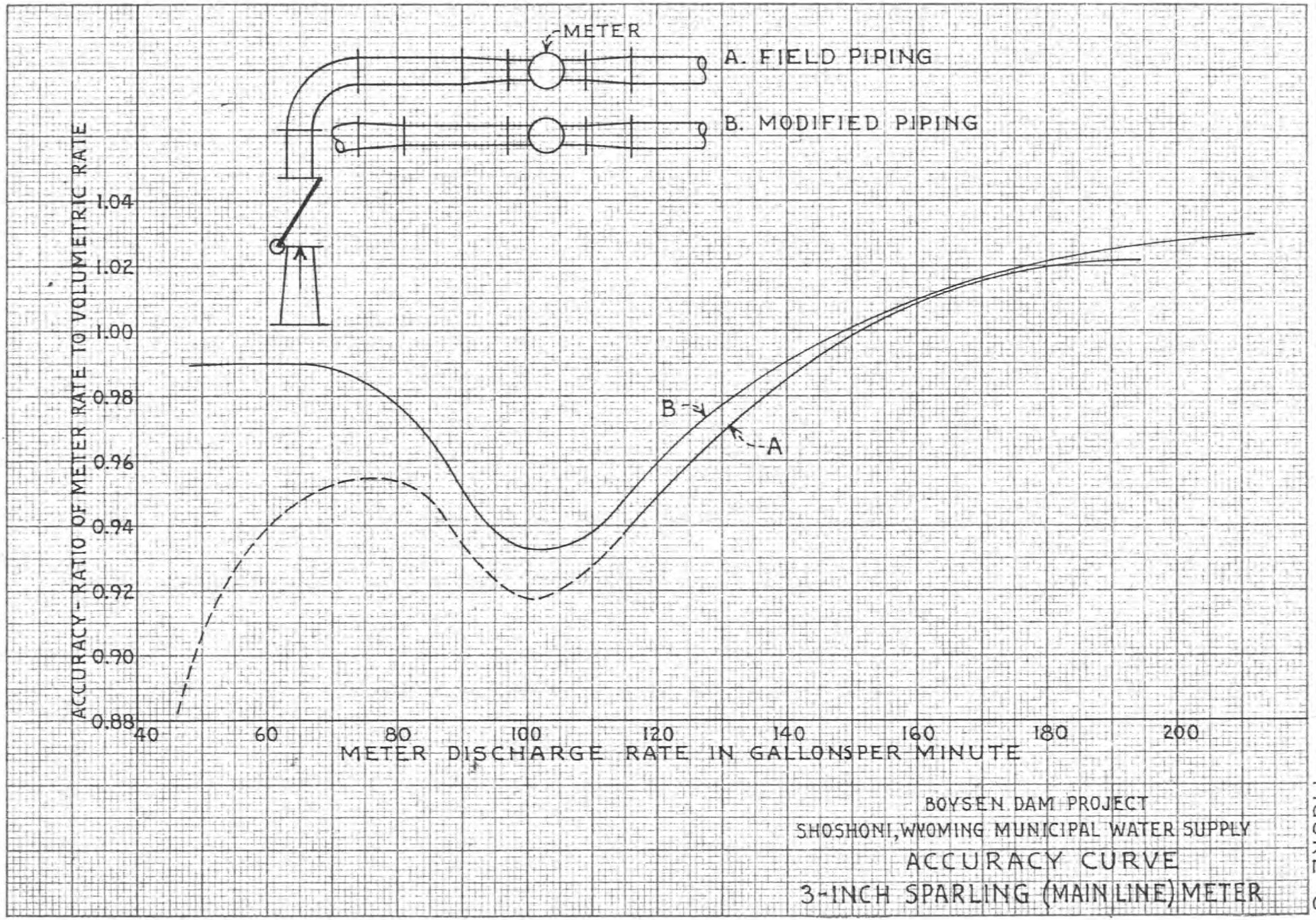
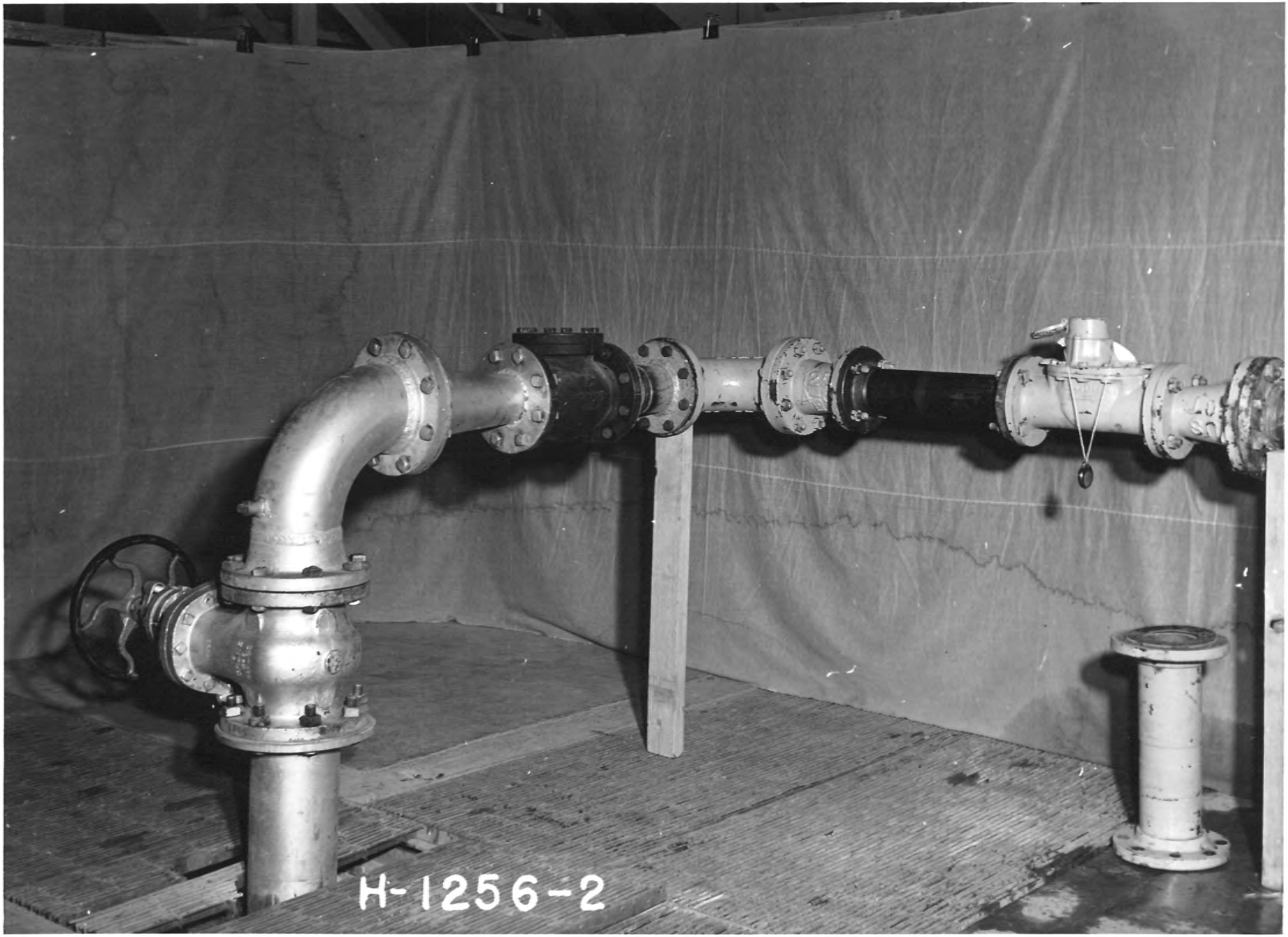


BOYSEN DAM PROJECT
SHOSHONI, WYOMING MUNICIPAL WATER SUPPLY
ACCURACY CURVE
3-INCH SPARLING (MAIN LINE) METER

FIGURE 3

FIGURE 4

Modified piping--3-inch pipe, 16-3/4 inches long upstream of 3-inch Sparling meter--Shoshoni, Wyoming, Municipal Water Supply.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