Flow Accuracy Certificate for Teledyne Isco LaserFlow™

TELEDYNE ISCO
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Expertise in Flow
Flow Accuracy Lab Test

The Teledyne Isco LaserFlow flow meter was tested over the course of five days at the Alden Research Laboratory, Inc. (Alden). It was verified calibrated using standard test procedures in QMSM-01 Revision 5. The flow meters performance is presented in graphical format in this document.

Brand:	Teledyne Isco		
Type:	2160 LaserFlow Module with LaserFlow sensor		
Serial #:	215C01491		
Model:	LaserFlow		
Round Pipe Size:	36 in		
Measured Range:	Level inch: 6.4-33.0	Velocity fps: 0.3-4.9	Flow GPM: 517-13,000
Description:	Independent flow measurement verification testing on a LaserFlow measurement system.		
For:	Teledyne Isco		
Tested By:	Data collection witnessed by Alden research Laboratory Representative.		
Certification Date:	21-July-16		

Over the course of five days the LaserFlow was tested at Alden Research Laboratory. The Teledyne Isco LaserFlow Flow Meter was installed in a round pipe near a tee in the piping. The combination of upstream and downstream control valves were used to set the desired flow rates and water levels. The flow in the pipe was measured using Alden's 21" Master Venturi meter installed in the 40" supply penstock. An 8" Venturi was used in a similar manner when flow rates were less than 2,000 GPM. Analysis indicates that the flow measurement uncertainty is within 0.5% of the true value for each test run using the 21" Venturi and within 0.25% of the true value for each test run using the 8" Venturi meter. The data reported on herein was obtained by measuring equipment the calibration of which is traceable to NIST, following the installation and test procedures referenced in the Alden Report (No. 2161TIOO1-R1.3).

Conclusions:
The LaserFlow performed well and measured flow accurately. The average error for the LaserFlow throughout the test periods was 2.7%.

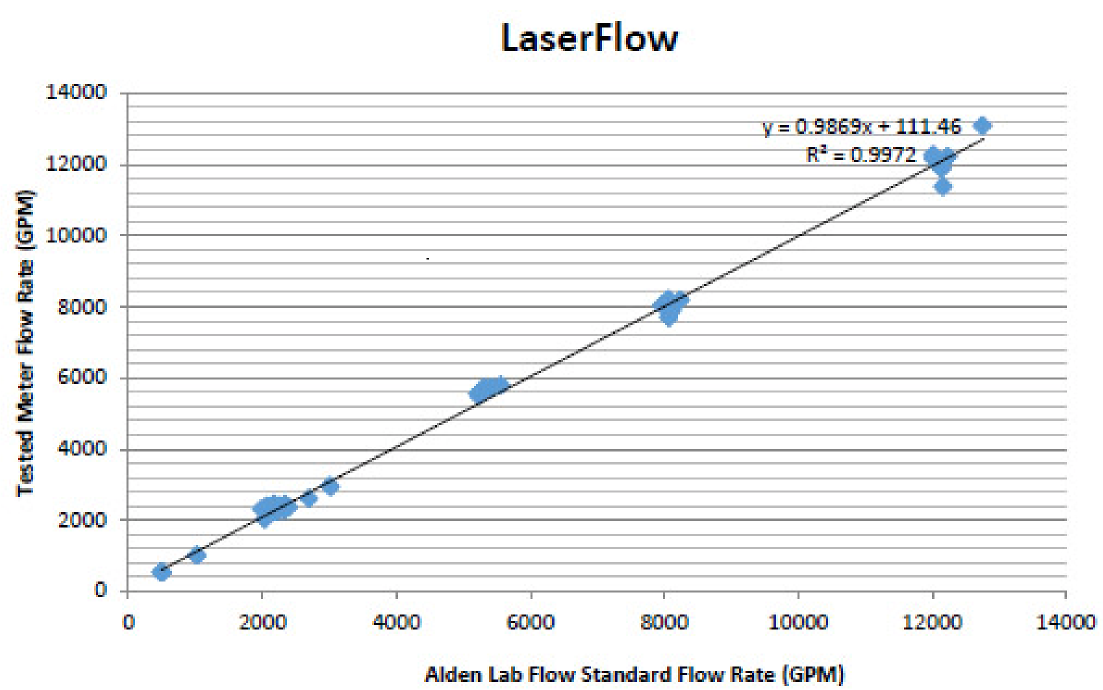

Figure 1: Graph of results

Flow Element Installation

Each meter under test (MUT) was installed in one of the four test lines in the Hooper Low Reynolds Number Facility, which is shown in Figures 1 and 2. Water is provided from a 40" penstock from the laboratory head pond at a head of about 18 feet. Electrically driven centrifugal pumps provide a maximum head of about 140 ft and a maximum flow of 6,000 GPM in Lines 1 and 2. Centrifugal pumps provide a maximum head of about 170 ft and a maximum flow of 1,200 GPM in Line 4. The Gravimetric Method is used to measure flow in Lines 1, 2 and 4. In Line 3 the penstock from the main laboratory pond provides a gross gravity head of approximately 28 feet and a Master Venturi is used to measure flow with maximum flow of 35,000 GPM. When flows need to be lower than 2,000 GPM in Line 3, an 8" Venturi is installed in Line 1 and then piped into line 3.

The detailed piping arrangement, immediately upstream and downstream of the flow element, including all significant fittings and pipe lengths, is shown in Figures 1 and 2. Careful attention was given to align the flow element with the test line piping and to assure no gaskets between flanged sections protruded into the flow. Vents were provided at critical locations of the test line to purge the system of air.

Test Procedure

Teledyne Isco's personnel installed the equipment using a tee in the piping for access. A combination of the upstream and downstream control valves were used to set the desired flow rates and water levels. For accuracy testing, after the system was allowed to stabilize, typically two to five average readings with a two minute duration were recorded by a computer based data acquisition system to determine flow and level for Alden's data. The test equipment was set to log averages of depth and flow with a time stamp. Alden's time of day was provided to the manufacturers so that the data was correlated correctly. The average Master Venturi flow, water level, and water temperature were recorded on a data sheet. The control valves were then adjusted to the next flow and the procedure repeated.

Flow Measurement Method

In Test Line 3, flow was measured using Alden's 36" by 21" Master Venturi in the 40" supply penstock, which is periodically calibrated using the Gravimetric Method (50,000 lb weigh tank) and a transfer standard Venturi. The Master Venturi performance is characterized by plotting the discharge coefficient versus pipe Reynolds number. Flow is calculated by the following equation:

$$q_a = C_{MV} K_M \sqrt{\Delta h_M}$$

Where:

q_a = actual flow, ft^3/ sec

C_{MV} = Master Venturi discharge coefficient, dimensionless

K_{MV} = Master Venturi constant, 20.6091 ft$^{2.5}$/ sec

Δh_M Master Venturi differential head, ft

The effect of fluid properties, viscosity and density, on the discharge coefficient is determined by Reynolds number, the ratio of inertia to viscous forces. Pipe Reynolds number, R_D, is determined by the following equation:

$$R_D = \frac{q_a D}{a_p \gamma}$$

Where:

D = Pipe diameter, ft

a_p= Pipe area, $\pi D^2/4$, ft^2

γ = Kinematic viscosity, ft^2/ sec

A computer is used to calculate flow rate from the raw data to assure consistency. Data was recorded manually and copied onto disk file for later review and reporting. As an option, flow may be expressed in many different units as required by the application of standard conversions.

An 8" Venturi was used in a similar manner when the flow rate was lower than 2,000 GPM. Prior to use, the 8" Venturi was calibrated in Line 1 of the Hooper Low Reynolds Number Facility using the gravimetric flow measurement method that complies with ASME/ ANSI MFC-9M-1988 Measurement of Liquid Flow in Closed Conduits by Weighing Method.

Flow Meter Signal Recording

The Master Venturi and 8" by 4" Venturi flow meter output was recorded by one of several "Smart" differential pressure transmitters having ranges of 25" Water Column (WC), 250" WC, and 1000" WC. Each transmitter was calibrated with a pneumatic or a hydraulic dead weight tester having an accuracy of 0.02% of reading. Transmitter signals were recorded by a PC based data acquisition system having a 16 bit A to D board. Transmitter calibrations were conducted with the PC system such that an end to end calibration was achieved. Transmitter output was read at a rate of about 34 Hz for each test run (flow) and averaged to obtain a precise differential head. Similar transmitters with a ranges of 25" and 250" WC was used to measure the water level in the pipe using a pressure tap at the bottom of the pipe just upstream of the tee and a reference water level. The level and Venturi meter outputs were measured and averaged simultaneously.

Test Results

Teledyne Isco provided averaged flow meter data logged outputs of level and flow. The data was averaged over the same time period Alden averaged flow and depth. The Alden data, including the time of day, measured flow, line temperature, and the water level are shown in individual tables. For evaluation, Teledyne Isco's average data was entered into the Alden's data table and used to calculate a deviation of the test equipment.

For each test meter, test results are shown as Alden flow, depth, and the flow meter averaged outputs for depth and flow. The deviations of depth and flow from the Alden data are shown as a percent of reading in each table.

Analysis indicates that the flow measurement uncertainty is within 0.5% of the true value for each test run using the 36" Master Venturi and within 0.25% of the true value for each test run using the 8" Venturi. Calibrations of the test instrumentation (temperature, time, weight, and length measurements) are traceable to the National Institute of Standards and Technology (formerly the National Bureau of Standards) and Alden's Quality Assurance Program is designed to meet ANSIINCSL Z540-1-1994 "Calibration Laboratories and Test Equipment-General Requirements" (supersedes MIL-STD-45662A).

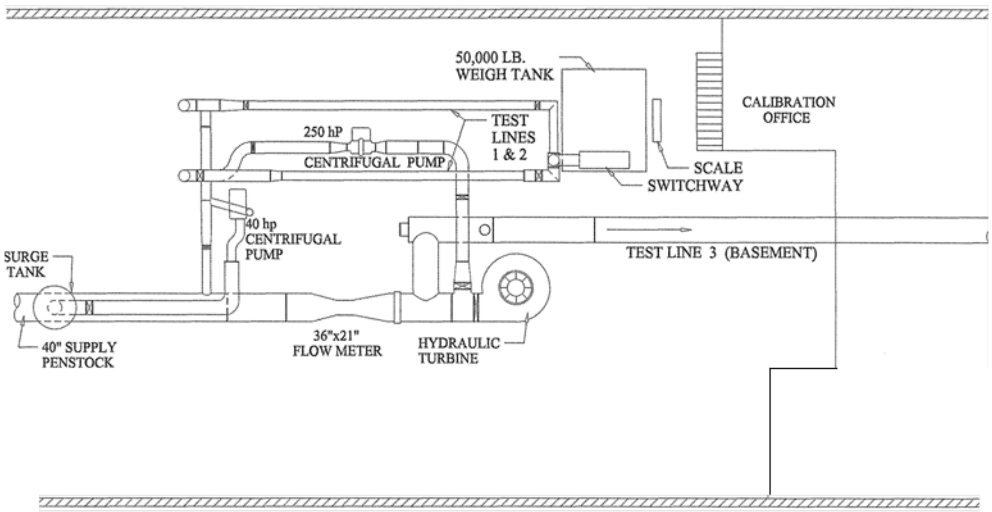

Figure 2: Drawing of Test Lines 1,2, and 3

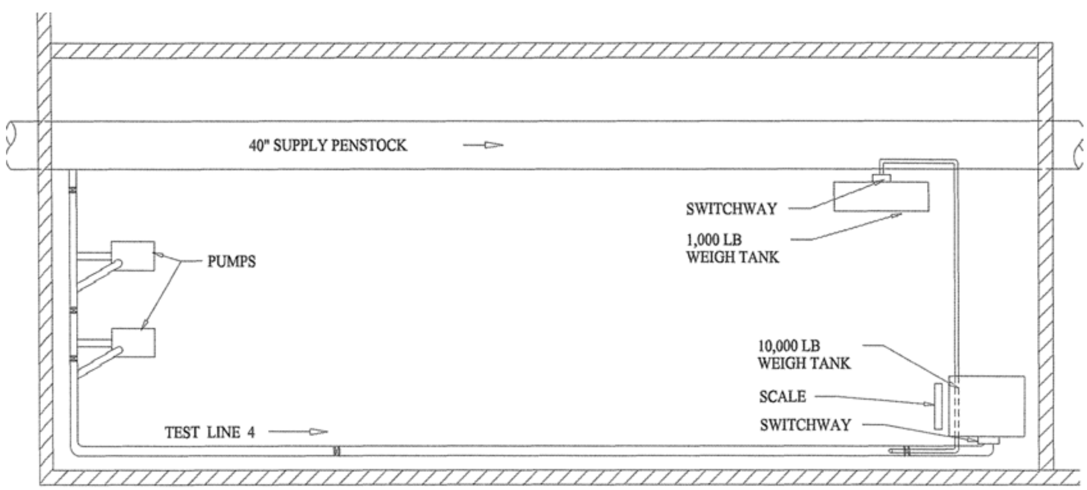

Figure 3: Drawing of Test Line 4

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