BUREAU OF RECLAMATION
Technical Service Center
Denver, Colorado

TRAVEL REPORT

Code: 86-68560 Date: June 28, 2006

To: Manager, Water Resources Research Laboratory

From: Tracy B. Vermeyen, 86-68560

Subject: Controlotron Flowmeter, Big Thompson Powerplant, near Loveland, Colorado.

1. Travel period: June 14, 2006.

2. Places or offices visited: Big Thompson Powerplant (BTPP) near Loveland, Colorado.

3. Purpose of trip: Review To service and troubleshoot the Controlotron flowmeter at Big Thompson Powerplant (Colorado-Big Thompson Project.)

4. Synopsis of trip: I traveled to Loveland, Colorado on the morning of Wednesday June 14, 2006. I arrived at the BTPP at 9:30 am where I met Phil Gregory, EC-6000. Phil and I discussed the problems with the flowmeter installation. The BTPP flowmeter consists of a single acoustic path mounted in reflect mode (transducers positioned on the same side of the pipe-figure 1). Size five transducers are used on this 67-inch outside diameter (OD) penstock. The wall thickness was 0.375 inches and the penstock has a 0.125 inch thick coal tar epoxy liner.

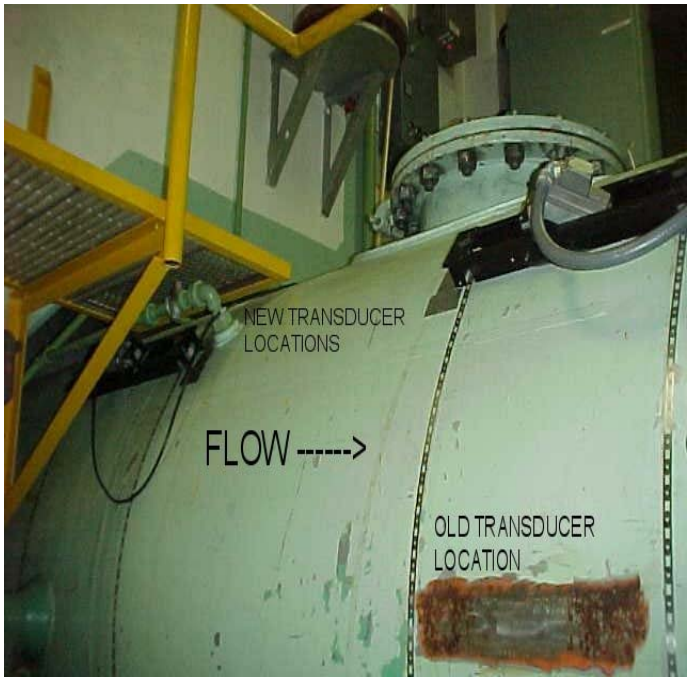

Figure 1. Photograph (taken in 2000) of the Controlotron flowmeter installation. The old transducer location is also shown. The pipe has since been re-painted to cover the old transducer locations.

The purpose of this field visit was to inspect the flowmeter to determine why the flows are increasing to an unreasonably high value. At about 11:00 a.m. I turned off the power to the flowmeter and the flow was about 310 ft^3/sec. This flow agreed closely to the BT Plant MW vs. Flowrate table displayed in the flowmeter enclosure.

I removed the transducers from their tracks and inspected the condition of the acoustic couplant. The downstream transducer was in good condition and the upstream transducer was in poor condition, i.e. the couplant was dried out. I cleaned the transducers and the pipe and re-applied a thin-layer of a long-lasting acoustic couplant. I left a tube of the couplant in the flowmeter

enclosure for future use. I re-installed the transducers in their original locations. I checked the transducer spacing which was 49.50 inches.

By 12:55 p.m. the installation was complete and the flowmeter was re-started. All the setup parameters were checked and no errors were found. The signal strength parameters were very good (Valc=75 and Vaer=8) which is an indication of the quality of the installation. However, when I turned on the flowmeter it came up with a flow of 570 ft^3/sec which was consistent with the erroneous flows the project operators had been observing.

At this point, I performed a new transducer installation (makeup) which included a "reversamatic" flow zero procedure since an actual zero offset procedure could not be performed. Again, when the flowmeter was enabled a flow of 570 ft^3/sec was reported. After several makeup procedures the flowmeter reported a flow of 310 ft^3/sec. At this point, I began outputting the flowmeter data to a thermal printer to monitor the activity. After a few minutes, the flowmeter went through an In-process Makeup procedure, after which the flowmeter began reporting a flow of 570 ft^3/sec. The reason for the In-process Makeup is likely caused by turbulence or excessive aeration in the flow. The printout of flowmeter data showed an increase in V_{AER} from a value of 12 to 22 during the In-process Makeup incident. I checked with Controlotron technical support and they confirmed this diagnosis. Apparently, a disturbance in the flow causes the In-process Makeup routine to run and the flowmeter returns to operation in a "Mis-registered" state. This condition is indicated by an apparent Zero Offset equal to +/- Vf max, which in this case was +264 ft^3/sec. For example, the actual flow was 310 ft^3/sec with an additional 264 ft^3/sec which resulted in an apparent flow equal to 574 ft^3/sec. The simplest way to correct for this error is to subtract 264 ft^3/sec from the high discharge reported by the flowmeter.

According to section 7.5 in the Controlotron 990 Portable Flowmeter manual, the reason the flowmeter switches from an accurate flow measurement to a "Mis-registered" state is because the poor flow conditions in the penstock can cause the flowmeter to go through an In-process Makeup which results in the flowmeter fixing on a secondary peak in the acoustic signal, rather than the primary peak. The next time the flowmeter goes through an In-process makeup it may or may not detect the primary peak. Eventually, it will re-acquire the primary peak and begin reporting the "true" discharge value.

The only changes that were made to the flowmeter installation were re-applying acoustic couplant to the transducer orientation from direct to reflect mode which required changing the transducer spacing. Note: I positioned the tracks so that the transducers could be mounted with a spacing of 49.56 inches which corresponds to placing pins in locations C-11 for a *reflect* track system. However, the tracks are for *direct* mount and they were positioned such that pin locations B-15 provided the correct transducer spacing. In order to get the transducer spacing close to the actual 49.5 inches I had to change the index from C-11 to D-10. For some reason I could not change the number index from 10 to 11. A possible fix to this is to reinstall the transducers and pick a different size transducer, say a size 4, then change it back to a size 5. This should reset the track index values to C-11. A print out of the site setup parameters is included in an appendix to this travel report.

After installation was complete, I collected data for a couple of minutes at a fifteen second interval, and the measured flowrate was very stable but was reading 560 ft^3/sec. While I was packing up my equipment, Phil

kept cycling the power to the flowmeter until it re-registered to the correct flowrate. Then we left the plant, around 2:00 p.m.

I found this phone call record from 5/21/2003 which describes this same problem: Tim Walenter EC-electrician called with a flowmeter problem. The flow in the penstock was 330 ft^3/sec which exceeds Vfmax=262 ft^3/sec which leads to a re-register which causes the flow to be increased by Vfmax. I called Controlotron and talked to Jim Robertson and he said you can fix the problem in the Diagnostic menu using the Re-Register < Decrease Flow> , but this fix only lasts until the next time the unit In-process Makeup (power outage, disable channel, transducer cleaning, low signal, etc..). A permanent fix would be to reinstall the transducers in DIRECT mode which should double the Vfmax value. However, this will result in a reduction in flowmeter accuracy. To improve accuracy a second pair of transducers can be installed to correct for cross flow errors. Cross flow errors are corrected by using REFLECT mode for a single pair of transducers.

Miscellaneous Comments:

- According to Controlotron, upgrading the 990 flowmeter to their 1010 line of flowmeters will eliminate this problem, because they have improved their signal processing routines in their latest generation of flowmeter. The existing transducers would NOT have to be replaced, only the electronics.

- The ECAO flowmeter was configured to store a discharge measurement in the internal datalogger every 4 hours, with a circular memory setting, which means the oldest data will be overwritten by new data once the memory is full. There is enough memory to collect about 10 weeks of data. This data storage may be useful as a backup if the Sutron system were to go down for a period of time. Note: this stored data must be retrieved within a few weeks or the data may be overwritten by new data.

- The signal strength (Valc) was very strong for after the new couplant was applied. Valc provides an indication of the condition of the acoustic couplant. If the strength drops below 60, fresh acoustic couplant should be applied. Valc was about 60 when I re-applied couplant on 6/14/2006.

- A copy of this travel report should be kept in the flowmeters instrumentation cabinet for future reference.

- The physical transducer spacing should be should be changed to 48 inches from the current LTN value of 49.6 inches because the flowmeter is programmed for a LTN value of 48 inches. I can assist with this process if needed. An alternative to this would be to re-install the transducers and see if the C-11 index can be selected, then finish the installation process.

Previous related reports:

- Water Resources Research Laboratory Travel Report, TR-98-18, *Controlotron Flowmeter Evaluation, Big Thompson Powerplant near Loveland Colorado,* dated August 12 and 19, 1998.

- Water Resources Research Laboratory Travel Report, TR-00-12, *Controlotron Flowmeter Evaluation, Big Thompson Powerplant near Loveland Colorado*, dated August 30, 2000.

5. Conclusions: The current Controlotron flowmeter installation at the Big Thompson Powerplant is periodically producing erroneous discharge readings because the flow conditions are causing the flowmeter to mis-register and produce a discharge that is offset by the value of Vfmax, 264 ft^3/sec. This problem comes and goes depending on the flow conditions in the penstock. To correct this problem you can subtract 264 ft^3/sec should produce the most accurate flow measurement possible for this instrument considering the site limitations mentioned above.

6. Action correspondence initiated or required: None.

cc: Area Manager, ECAO, Loveland, CO, Attention: EC-1000
Area Manager, ECAO, Loveland, CO, Attention: EC-6000 (Gregory, 2 copies)
Area Manager, ECAO, Loveland, CO, Attention: EC-1800 (Peterson, Conger)

bc: 86-68560 (Vermeyen)
86-68560 (*Travel Report file*)
86-68500

SIGNATURES AND SURNAMES FOR:

Travel to: Big Thompson Powerplant, near Loveland, Colorado

Date or Dates of Travel: June 14, 2006

Names and Codes of Travelers: Tracy B. Vermeyen, 86-68560

Traveler	**Date**
_____	_____
_____	_____
_____	_____

Noted and Dated by:

NOTED: _____
(Date)

_____
Manager, Water Resources Research Laboratory

Appendix - Controlotron Flowmeter Settings

RE INSTALLED XDCRS

Print Date	06.14.06 12.55	
Site Load	Channel Disable	No
	Site	BTPWR
Pipe Data	Units	Inches
	Pipe OD	67.000
	Pipe Material	Steel
	Estimate Vps I/S	126000.020
	Wall Thickness	0.375
	Liner Material	Coal Tar
	Liner Thickness	0.125
Liquid Data	Liquid Type	Water 20C/68F
	Estimated Vs M/S	1447.000
	Viscosity (CS)	1.000
	Density (SG)	1.000
Flow Rate Units	Units (Vol/Mass)	Cubic Feet
	Time Units	SEC
	Display Range	Autorange
	Display Scaling	CU FT/SEC
Flow Total Setup	Units (Vol/Mass)	Cubic Feet
	Resolution	000x0000
	Totalizer Mode	NETFLOW
	Batch/Sample Tot	0.000
	Display Scaling	MCU FT
Analog Span	Max Flow Rate	500.000
	Min Flow Rate	0.000
	Max Vs (M/S)	1729.000
	Min Vs (M/S)	1300.000
Alarm Set	High Flow Alarm	960.231
	Low Flow Alarm	-960.231
	Interface Vs M/S	2099.998
	Aeration Alarm	50
Stripchart Setup	Data Selected	Vo
	Scale Units	Percent of Span
	Time Interval	1 second
Datalogger Setup	Datalogger Mode	Off
	Data Selected	Site Id
		Date
		Time
		Average Flow
		Flow
		Total
		Vs
		Valc
		Aeration
		Alarms
		Analog Inputs
	Event Selected	None
	Log Interval Set	1 Min.
Analog Inputs	Aux 1 Enab	No
	Aux 1 High	4000.000
	Aux 1 Low	0.000
	Aux 2 Enab	No
	Aux 2 High	4000.000
	Aux 2 Low	0.000
	Aux 3 Enab	No
	Aux 3 High	4000.000
	Aux 3 Low	0.000
	Aux 4 Enab	No
	Aux 4 High	4000.000
	Aux 4 Low	0.000

	Io/Psen/V2	Vo
	V3	Vo
	V4	Vo
Relay Setup	Relay 1	Off
	Relay 2	Off
	Relay 3	Off
	Relay 4	Off
Xdcr Mount	Xdcr Type	5
	Xdcr Size	Reflect
	Spacing	D10
Site Adjustment	Empty Pipe Set	60.025
	Zero Flow Set	0.000
	Damping Set	15.000
	Slew Rate(F/S/S)	0.000
	Deadband Set	0.000
	Memory or Fault	Fault
	Memory Interval	60
Flow Calibration	Calibration Type	Intrinsic
	Calibrate Kc	0.000
Diagnostics	Flow Rate	313.000
	Flow Total	88.558
	Alarm Status	---------
	Vs	1449.372
	Valc	74.600
	Vaer	8
	AUX1	0.000
	AUX2	0.000
	AUX3	0.000
	AUX4	0.000
	fx	45
	N	37
	n	13
	x	16
	Vfmax	264.056
	Vs max (M/S)	1618.321
	Vs min (M/S)	1281.300
	TN	2537.654
	TL	2466.678
	Ltn	47.960
	Sp. Gr.	1.000
	Contour	0.988
	Reynolds #	7015476.072
	Delta T (uSECS)	4.922
	Checksum	296C93F
	Code	042194-0921
	Version	2.30
	Upper Flow Limit	950.332
	Lower Flow Limit	-950.332
	ANCAL	0.000
	Empty Set	60.025