

## INTRODUCTION

Canal automation is becoming widely used to improve the operation of canal systems and to conserve water. Most new canals have an automatic control system. Additionally, many older canals are being modernized with data collection, telemetry, and control equipment that helps canal operators better manage their water.

The Bureau of Reclamation Hydraulics Laboratory offers a 5-day course on canal operation and control that covers modern methods to upgrade the operations of existing canals, including canal automation techniques and equipment.

The curriculum includes a combination of classroom discussions, equipment demonstrations, and laboratory workshops that target canal operators, water masters, engineers, and other technical staff. Course topics include:

### Canal Hydraulics

- Terminology
- Open channel flow principles
- Structure hydraulics

### Canal Operation

- Delivery concepts
- Operation and control concepts
- Methods of canal pool operation
- Natural tendencies
- Check gate operating techniques

### Flow Measurement

- Weirs
- Submerged orifices
- Flow measurement flumes
- Pipe flow measurement
- Acoustic velocity measurement
- Rated sections, gaging
- Undershot and overshot gate flow
- Free and submerged flow
- Aerated and non-aerated flow
- Program WinFlume (Windows software for design and calibration of long-throated flumes)
- Program WinGate (Radial gate flow algorithm)

## Instrumentation Systems

- Water level measurement
- Gate/valve position measurement
- Alarm sensors
- Equipment status
- Selection factors

## Automatic Control

- Feedback controllers
- Basic characteristics of automatic control
- Canal system control methods
- Automatic control components
- Local control algorithms
- Local automatic gate control
- Supervisory control

## Communication Systems

- Communication system design
- Cable communication systems (wire and optical fiber)
- Radio systems
- Configurations
- Types of communications channels

## Canal Automation Equipment

- Local control systems
- Telemetry systems (monitoring)
- SCADA software and hardware
- Alarm systems
- Lightning protection
- Failure considerations

## Software

- Local control software
- SCADA software / Human-Machine Interfaces
- Design and analysis programs
- Numerical simulation

## Case Studies

- Small and large-scale modernization projects

A model canal facility located in Reclamation's hydraulics laboratory is the central focus of the course. This model is a 300-foot-long canal made from clear

acrylic Plexiglas<sup>7</sup> and aluminum with motorized control gates, turnouts, a long-throated flow measurement flume, and an inverted siphon. It is fully instrumented to remotely monitor and control water levels, gate positions, and flows with both manual and automatic control features. The model canal was designed specifically to provide training through "hands-on" workshops where students experience different canal operating techniques and control methods. This model canal facility has many of the modern control features used on actual canals.

## WHO SHOULD ATTEND

The course is designed for canal operators, engineers, and managers interested in modern methods of canal operation and control. This course covers methods to upgrade the operations of existing canals using canal automation techniques and equipment, with "hands-on" workshop sessions that use the model canal facility.

## SCHEDULE

### Monday

- Welcome and Course Introduction
- Tour of Reclamation's hydraulics laboratory
- Basic hydraulics
- Canal hydraulics lab demonstration
- Conventional canal operations
- Canal operation lab

### Tuesday

- Modern canal operations
- Canal operation lab workshops
- Fundamentals of automatic control
- Feedback controllers
- Local automatic control computer workshop
- Local automatic control lab demonstration

### Wednesday

- Flow measurement
- Flow measurement lab workshops
- Long-throated flume design
- Instrumentation systems

### Thursday

- Instrumentation lab workshops
- Communication systems
- Canal automation equipment
- SCADA system software demonstration
- Canal Olympics (canal control competition)

## Friday

- Results of Canal Olympics
- Specific modernization projects/case studies
- Miscellaneous questions and discussion

The workshop will conclude at about 11:00 a.m.

## TRAINING STAFF

Workshop instructors are engineers and scientists with extensive experience and knowledge in the areas of canal automation, operation and control. Most instructors are employees of the Bureau of Reclamation.

## PUBLICATIONS

Outlines and summaries of presentations and other materials will be compiled into a notebook and distributed to all participants at the start of the Workshop. Participants will also receive the 2-volume *Canal Systems Automation Manual* and the *Water Measurement Manual*.

## REGISTRATION & COST

Participants should register using the enclosed registration form. Course tuition for each participant is \$1100. Fee payment should accompany the registration form. Payment by VISA or MasterCard credit card is accepted. Checks should be made payable to "Canal Automation Workshops". Reclamation employees may pay with an internal funds transfer by providing their cost center and a 19-digit cost authority number.

To maximize the benefit for each student, each workshop session is limited to 15 participants. *The first 15 registrations received with payment will be accepted.* Tuition will be charged to all registrants unless cancellation is made a minimum of 15 days prior to scheduled class. A substitute will be accepted to attend in place of a paid student

## TRANSPORTATION & LODGING

Course participants are responsible for their own transportation and lodging arrangements and costs. The workshop is held in Building 56 at the Denver Federal Center, on the west side of the Denver metropolitan area. Several hotels are located nearby; some of these have complementary van service to the Federal Center. Taxis or shuttle service from Denver International Airport (DIA) to hotels can be arranged at DIA. Please visit our web site for more details.

## CLIMATE/CLOTHING SUGGESTIONS

All workshop activities will take place indoors in the classroom or the heated laboratory. Outdoors, winter weather can be unpredictable in Denver. Participants should be prepared for cold, snowy, wet weather, or bright, cool sunshine. Warm jackets, hats, and gloves are recommended. Denver is at an altitude of 5280 ft (1610 m). The normal high and low temperatures in late January are 43°F and 17°F (6°C and -8°C), respectively, but much warmer or colder weather is also possible.

## CONFIRMATION

A confirmation package will be sent upon receipt of the registration form and payment. This package will include information on local transportation and lodging. If necessary, details will be communicated by fax or e-mail.

## ADDITIONAL INFORMATION

For more information contact:

Susie Leidholdt  
Hydraulic Investigations and Laboratory Services Group  
Bureau of Reclamation  
P.O. Box 25007, 86-68460  
Denver, Colorado 80225

Telephone: 303-445-2828  
Fax: 303-445-6324  
E-mail: [sleidholdt@do.usbr.gov](mailto:sleidholdt@do.usbr.gov)

Additional information, registration forms, and photos from past classes are available from the *Workshops* link on our web site at: [www.usbr.gov/pmts/hydraulics\\_lab/](http://www.usbr.gov/pmts/hydraulics_lab/)

## Department of the Interior Mission

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

## Bureau of Reclamation Mission

To manage, develop, and protect water and related resources in an environmentally and economically sound manner.

**RECLAMATION**  
*Managing Water in the West*

# Modern Methods in Canal Operation and Control

## A Water Resources Technical Workshop

January 26-30, 2009  
Denver, Colorado



U.S. Department of the Interior  
Bureau of Reclamation