WATER OPERATION AND MAINTENANCE BULLETIN

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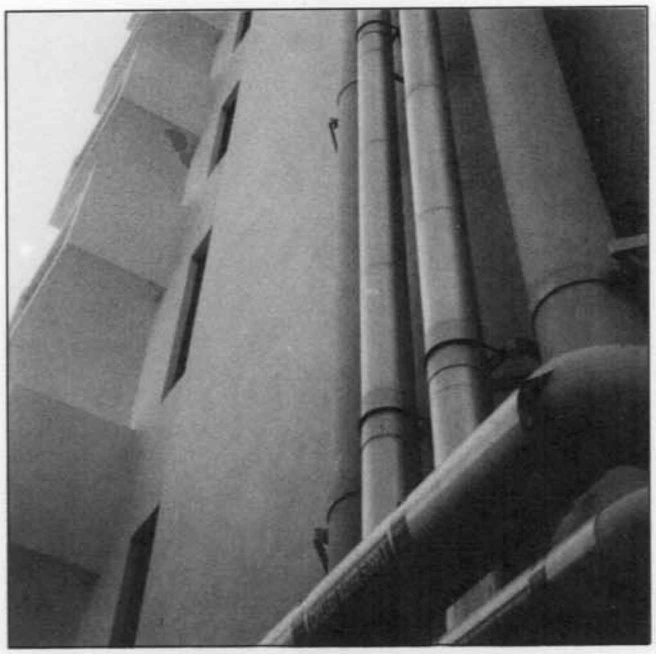

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UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

This *Water Operation and Maintenance Bulletin* is published quarterly for the benefit of water supply system operators. Its principal purpose is to serve as a medium to exchange information for use by Reclamation personnel and water user groups in operating and maintaining project facilities.

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Cover photograph: *Two 12-inch PVC risers carry water 165 feet up and down the side of a Florida hotel.*

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WATER MEASUREMENT PROBLEMS AND RECLAMATION'S NEWLANDS DEMONSTRATION PROJECT

by Kathleen H. Frizell[1], Brent W. Mefford[2], and James Lively[3]

WATER MEASUREMENT PROBLEMS

The need to measure water is driven by different forces: cost accounting, project operations, water conservation, water rights issues, streamflow requirements, etc. Many problems can arise when trying to measure water quantity, particularly when the delivery system is not designed for water measurement devices, as is the case with many older irrigation projects.

The Newlands Project, located east of Reno, Nevada, is a good example of an irrigation project in need of water measurement. Currently, there are a few permanent water measurement devices on the main canals but no devices on small laterals or farm turnouts. Experience of the ditch riders is relied upon to set flows delivered to each user. Attempts to provide water measurement broadly across the project have encountered the following very typical barriers:

- Miles of unlined canal sections with weed and algae growth, sediment problems, and uncharted seepage
- Very low available head throughout the entire system
- Aging system of manually operated wooden head gates on the turnouts
- A large number of unmetered turnouts and short distances between turnouts and farm delivery gates
- Few sites with power and minimal automation
- Limited funding

Many of these problems are encountered on other Bureau of Reclamation (Reclamation) irrigation projects, particularly those constructed early in our history. This article describes a new cooperative program between the project, district, and the Water Resources Research Laboratory (WRRL) working toward breaking the barriers of water measurement at Newlands. This program is jointly funded using Reclamation water measurement research funds for the demonstration of water measurement and recording devices. Perhaps this effort can provide some solutions for your project.

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INTRODUCTION

The Newlands Project, formerly the Truckee-Carson Project, was one of the first Reclamation projects built to stabilize or store, supplement, and distribute the natural flow of the Truckee and Carson Rivers. The project was authorized in 1903 and is located in the high desert of Nevada at an elevation of about 4000 feet. The project began with construction of the Derby Diversion Dam on the Truckee River and grew in scope with the completion of Lahontan Reservoir that impounds the Carson River flow. The project provides irrigation water from the Truckee and Carson Rivers for the lower Carson Valley near Fallon and Truckee River water to the Truckee diversion near Fernley in western Nevada. The drainage basins contain almost 3,400 square miles with total project diversion of about 350,000 acre-feet of water. The only year that the project recorded using the entire allotment of water was in 1989. The project includes major storage reservoirs, diversion dams, and 326 miles of canals of which only 7 percent are lined. The Truckee-Carson Irrigation District (TCID) has operated the project under contract with Reclamation since 1926.

There are approximately 1,500 unmetered irrigation head gates on the Newlands Project. Most of these sites are not well suited for standard water measurement devices. Many require low head, loss measurement devices that will not be easily fouled by filamentous algae, debris, or sediment. The devices must be easily used with farm head gates and simple enough to be maintained and monitored by the local farmers. The devices should be able to be linked to data loggers that at a future date can be incorporated into a telemetry system. There currently are few permanent measurement sites and no actual remote operation capability of gates or telemetry of flow volumes.

Turnouts on the project are similar in design. Most have a concrete head wall with a rectangular opening about 4-feet wide by 3-feet high with a wooden slide gate. During deliveries the gates are usually pulled out of the water. Generally, only one diversion is open on a lateral at a time. Ditch riders try to supply 25 cubic feet per second for a requested duration to the farmers. Through experience, the ditch riders have established how to set flows into the canal laterals to approximate the discharge needed. Spot checks on the flow are made with hand-held velocity meters. However, the extensive lengths of unlined canal sections producing seepage losses and varying canal water elevations often hinder sustained accurate accounting of water supplied to farm turnouts.

NEWLANDS PROJECT OPERATING CRITERIA AND PROCEDURES

Water rights on the Newlands Project are associated with specific parcels of land. Unlike many irrigation projects, Newlands' water users are charged a delivery fee based on a per-acre basis of water-righted land. A court decree specifies the annual acre-feet of water allotted per acre of land as a function of land classification. Water allotments are accounted for based on the water delivered to the farm head gate.

Similar to most irrigation systems, demands on the Carson and Truckee riverflows can quickly outpace available water. As a large diverter, the irrigation project must operate as a partner with several communities and smaller diverters to meet domestic water needs while protecting the rivers and several large wetlands and lakes that are part of the natural river systems.

The operating criteria and procedures (OCAP) were instituted with this water use partnership in mind. OCAP require that annual maximum decreed water entitlements be calculated, and that conservation measures be implemented to improve project efficiency. Incentives and penalties are provided to encourage TCID to achieve efficiency improvements. Efficiency target levels are currently being phased in with the goal of reaching 75-percent efficiency.

COOPERATION

The first phase of determining whether efficiency levels are met is to provide for accurate measurement of the water deliveries. As mentioned, the existing project was not designed with water measurement facilities, and many technical and financial barriers exist to providing adequate measurement.

In 1996, Reclamation's WRRL, along with the Fallon Field Office, entered into a cooperative agreement with TCID to design, install, and test water measurement devices for farm turnouts. Reclamation water measurement research funds are used to partially fund this field demonstration of water measurement technology. Our organizations are collaborating to investigate low cost, low head loss measurement devices that can be used throughout the Project. Farmers at selected sites within the project are also being asked if they would like to participate in the study. As a first step, the study is setting up a field evaluation program of several water measurement devices.

SITE SELECTION

Various sites throughout the project have been visited and information gathered about suitability of water measurement devices. Initially, priority is given to those sites that will provide measurement of several turnouts and those with the greatest available head and freeboard. In general, most of the farm turnouts are closely coupled to field water distribution ditches, have about 0.2 foot to 0.3 foot of head available between the water level upstream of the turnout and flow into the field, and frequently pass filimentatous algae and other weed debris.

Obviously, there are any number of water measurement devices [1] that could be considered at each site. Not all devices are appropriate, however, based upon their expected performance in relation to the design constraints that will be encountered. In addition, each device should be used easily in conjunction with an electronic flow totalizer that will store, and perhaps at a later date, transmit the data to a control center.

Once sites are selected, an important aspect of the project is obtaining the dimensions of the canal sections, including the bottom slope, for selection and design of a water measurement device. A field assessment of the available head is also needed. Therefore, water surfaces upstream and downstream of the potential installation sites for a water measurement device are needed. Measurement of the water surfaces and the top of the canal banks will determine if adequate freeboard is available.

DESIGN AND INSTALLATION OF WATER MEASUREMENT DEVICES

A list of feasible water measurement devices was compiled. Each device was ranked according to how well it would function given the design constraints outlined. The lack of available head, coupled with weed and debris problems and requirements to keep costs low, led to the conclusion to use long-throated flumes wherever possible in the system. These flumes, also referred to as ramp flumes or Replogle flumes, are very easy to install, are accurate, and offer the flexibility of being removable and easily modified to fit the site situations.

Site Description—The first demonstration site is NT22, the 20-second turnout on the N canal. It was chosen because it is a typical site with a concrete-lined trapezoidal canal with 1.25:1 side slopes and a 2-foot bottom width. The canal is 2.5 feet deep and will only require a small flume. Upstream from the turnout is a long unlined section with a 90-degree bend leading to a check structure for an unlined wasteway canal going back to the river. This check gate will allow flexibility in the operation of the flume during the demonstration. Immediately downstream from the turnout is a wooden bridge spanning the farmer's canal. The flume structure is located 20 feet downstream from the turnout in a slightly curved portion of the canal, upstream from any farm turnouts. The upstream geometry is shown in figure 1.

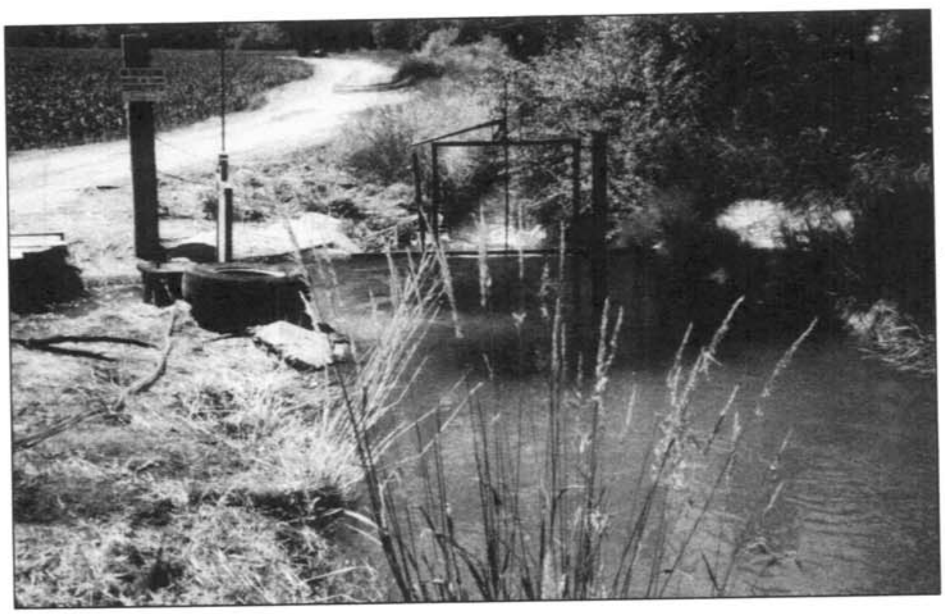

Figure 1.—Geometry upstream from demonstration site NT22 showing the check structure leading to the wasteway back to the river, the turnout, and the bridge over the farmer's canal.

Flume Design—Flume design is based upon the work by the Agricultural Research Service (ARS) and Reclamation [2, 3]. The flumes are critical flow devices, meaning that when critical flow occurs in the throat section of the flume, a unique relationship is established between the upstream head and the discharge. The long-throated flume consists of an approach channel, upstream transition, horizontal throat section, downstream transition, and tailwater channel. The parts of the flume design are shown on figure 2. Any of the flume components may be customized for an individual site. Normally, a rating curve or table can be computed with an error of about 2 percent or less.

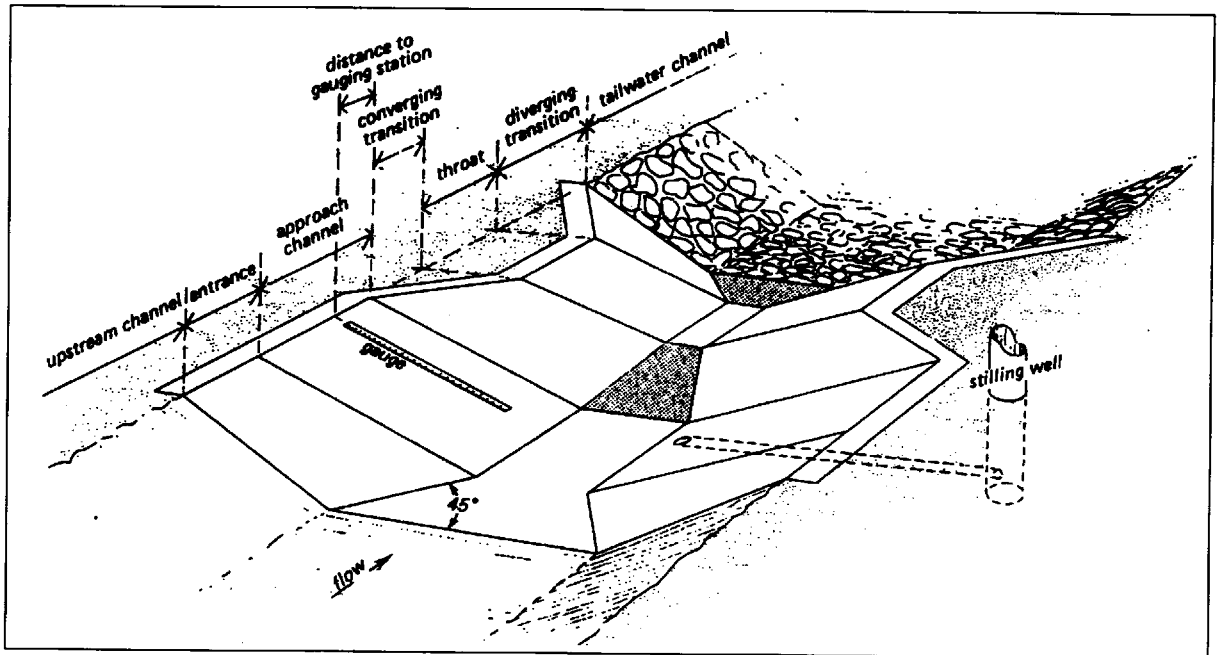

Figure 2.—Components of a general long-throated flume.

A computer program, FLUME, developed by ARS, is being used to design flumes for the Newlands Project [2]. The FLUME program was used to determine the dimensions of the sill in the throat by modifying the sill height and minimizing head loss. No side contractions were used to simplify the construction. Canal geometry and estimates of the water surfaces were used to design a flume for a discharge range of 10 to 30 cubic feet per second, with a target discharge of 25 cubic feet per second.

Freeboard requirements can be varied to minimize or maximize the height of the sill in the throat. Setting the sill height is critical to preventing submergence of the flume and maintaining accuracy. In general, submergence should be limited to 90 percent or less.

A number of sill heights and overall flume lengths could be used for this design. Some flexibility was wanted in the design because of the uncertainty in the canal water surfaces. Therefore, an initial concrete flume section was constructed to a height of 1 foot and two 3/4-inch plywood caps for the sill will be available to be attached on top of the base flume. The flume has a 3:1 upstream slope, or ramp, that transitions up the side slopes to the 2.75-foot-long throat section. The width of the throat sill is 4.5 feet, and the downstream transition slope was omitted. A vertical drop for the downstream transition produces additional head loss but will be cheaper to construct and easier to modify. The head loss produced by flow over the flume for this site is only 0.12 foot. Use of the plywood caps to vary the sill height will allow optimization of the measurement device for this site and information for other canal applications of similar geometry so that additional flumes can be constructed with confidence.

Flume Construction—The flume is shown under final construction in figure 3. This flume is typical of an installation where a bottom sill is added to a lined canal section and is often referred to as a Replogle flume. The flume is 1 foot high with a 3:1 upstream transition and no downstream transition section. The upstream transition and throat follow the 1.25:1 canal side slopes with no side convergence. Two 1-inch diameter polyvinyl chloride pipes were

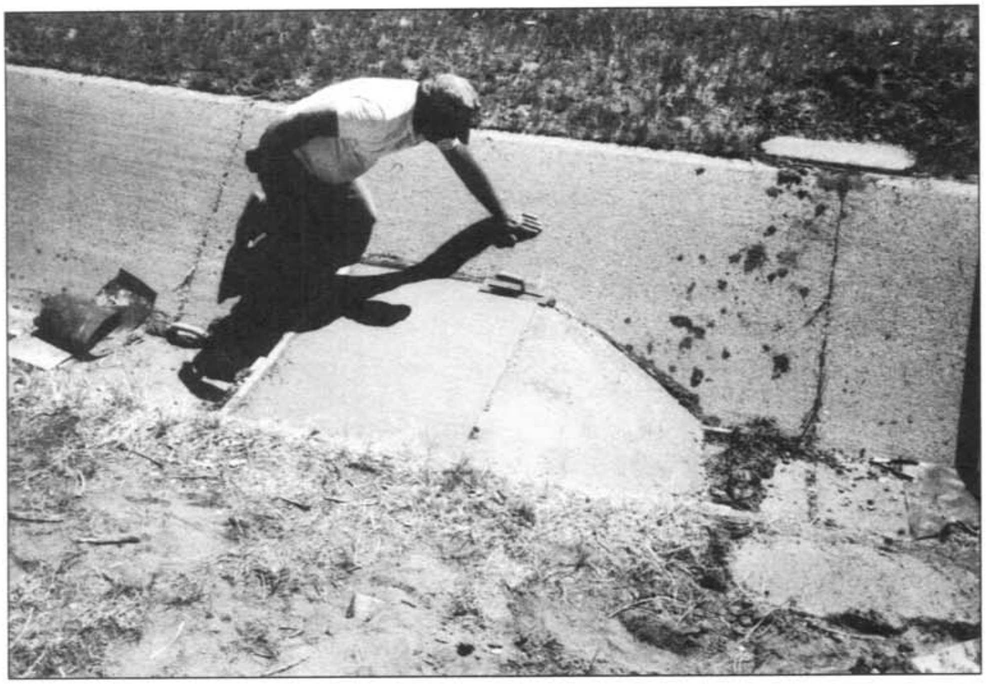

Figure 3.—Flume under construction at demonstration site NT22. The flume is 1 foot high with a 3:1 upstream transition and a 2.75-foot-long throat. The 1.25:1 canal side slopes lead to a 4.5-foot-wide sill from a 2-foot bottom width.

installed underneath the sill to permit drainage of the canal. The length of the throat section was designed to allow attachment of the plywood shims. A 20-mil plastic sheet was laid over the canal liner before placement of the flume to prevent bonding and permit the flume to be lifted out of the canal, if desired. The total weight of the concrete and the low differential head expected across the flume will prevent movement of the flume under flowing water conditions. Flume construction was completed in a day at a total cost of $425.

Instrumentation—Instrumentation is needed to measure the total flow delivered to the farmer. This includes the startup filling of the canal and the decay in delivery as the upstream turnout is closed and the canal downstream drains. To accomplish total flow measurements, an open channel flow meter was purchased. The meter is an electronic instrument, housed in a tough polycarbonate box with a remote ultrasonic transducer and temperature sensor. These are mounted above the water surface at a specific distance upstream of the flume based upon a function of the head. The instrument measures the water surface by transmitting a pulse signal to the transducer which then emits ultrasonic pulses that echo off the water surface. The time for a pulse to echo back from the water surface is temperature compensated and converted into a head measurement. A discharge equation is programmed into the instrument that was developed during the flume design. The instrument then uses this equation to convert the head measurement into flow rate. The flow rate is totalized and stored in a comprehensive data log for manual access, printing, or remote telemetry. The instrument provides continual readout of the actual and totalized flow. Programming is simple with a removable keypad. The cost of this instrument is $2,500.

At our sites there is no electricity, so the unit is powered by a solar panel and a car battery. There is a backup battery inside the electronic box to provide backup power should the power be lost.

A staff gauge has also been installed at the site. The staff gauge reading can then be used to determine the flow rate once the flume is calibrated. This will allow the electronic instrumentation to be moved to another site and used to determine the total flow. The instrumentation and solar power supply are shown in figure 4.

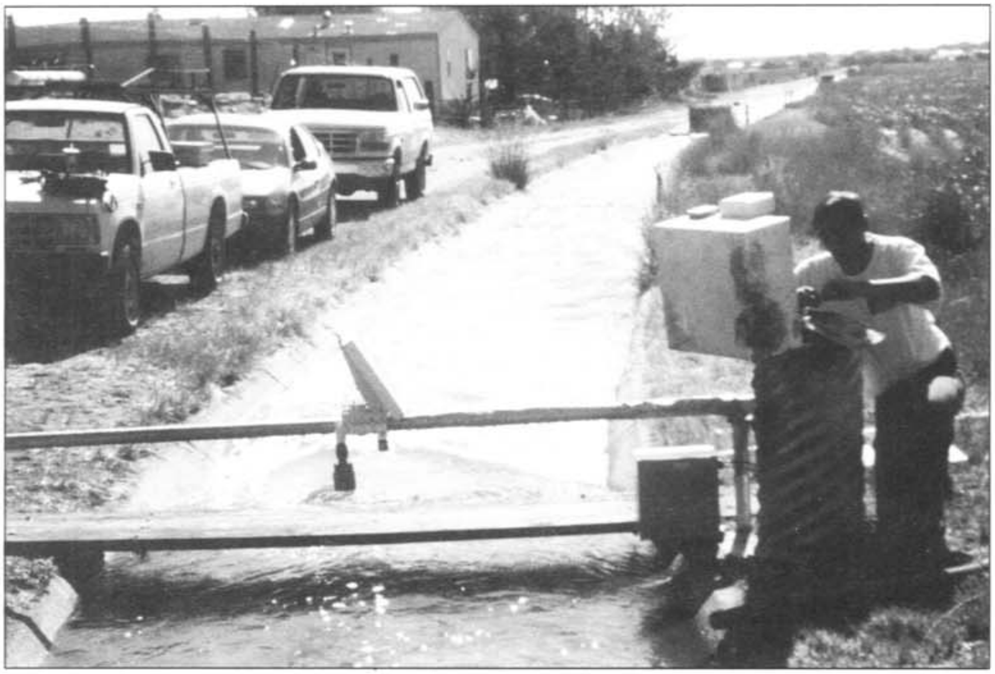

Figure 4.—Flume instrumentation including the transducer and temperature sensor, solar cell and battery, and the electronic flow meter mounted at site NT22.

CONTINUING WORK

The Newlands Project offers many unique and challenging opportunities for water measurement. The combination of unlined and lined canals, weed growth and debris, manually operated gates, and low available head will continue to require careful application of water measurement technology.

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CONFINED SPACE ENTRY PROGRAM

by Steve Engleman[4]

The Occupational Safety and Health Administration (OSHA) issued a general industry standard on permit-required confined spaces on January 14, 1993, which became effective on April 15, 1993. This standard was promulgated in order to address instances of death and injury to employees who entered confined spaces to conduct work activities or attempt rescue of others.

Bureau of Reclamation (Reclamation) power and water facilities have areas which may be classified as confined spaces. Reclamation and water district employees routinely enter these areas in order to conduct operations and maintenance activities.

In order to address the OSHA standard, Reclamation management has issued a directive (SAF 01-02) which states that all provisions of 29 CFR 1910 will be followed. Reclamation is committed to comply with the standards of 29 CFR 1910.146 and 29 CFR 1910.269. Reclamation provides guidance documents through the Safety and Health Services/ Management Services Office at the Reclamation Service Center which suggest means of compliance with these standards.

The OSHA standard regulates entry into confined spaces which are classified as permit-required confined spaces (permit spaces). Permit spaces are spaces which meet both the definition of a confined space and also have an additional hazard potential of an atmospheric or physical nature.

OSHA defines confined spaces as a space which has limited or restricted means of entry or exit. It is large enough for an employee to enter and perform assigned work, but it is not designed for continuous occupancy by the employee. In 29 CFR 1910.120, OSHA identifies spaces such as tanks, vessels, silos, storage bins, hoppers, vaults, and pits as examples of confined spaces. Incidents reported and classified as confined space accidents include spaces such as mixers, sewers, trenches, drums, boilers, crushers, furnaces, presses, drains, and traps. Reclamation facilities including utility manholes, pipelines, penstocks, scroll cases, tunnels, shafts, and siphons are some of the spaces to consider for applying the OSHA standard.

In order for a confined space to be classified as a permit space, it must also have one of the following hazards associated with the space or introduced by an operation to be conducted in the space:

- Atmospheric Hazard

  The space has or has the potential to have an atmospheric hazard which exposes entrants to risk of death, incapacitation, impairment of the entrant to exit the space unaided, injury, or acute illness.

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Some of the conditions which would constitute a hazardous atmosphere are an atmospheric concentration of: a substance exceeding its permissible exposure limit or immediately dangerous to life or health value which could cause at least one of the risks stated; a flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL); an airborne flammable dust in excess of its LFL; or an oxygen concentration below 19.5 percent or above 23.4 percent.

- Engulfment Hazard

  The space has or has the potential to have a means of surrounding and capturing the entrant by a liquid or flowing solid substance that can cause death by strangulation, constriction, or crushing.

- Entrapment Hazard

  The space can trap and/or asphyxiate an entrant by the internal physical configuration of the space.

The first order of business for management is to determine whether there are confined spaces in Reclamation facilities or in facilities controlled by others (i.e., water districts) which Reclamation employees are requested to enter. Once confined spaces are identified, each confined space and the activities to be conducted within the space must be assessed for inherent, as well as introduced hazards. This assessment process is best documented through the establishment of a confined space inventory system which describes the space, location, space/operational hazards, and the classification of the space.

Any facility which contains permit spaces must have a system of notification to restrict unauthorized entry. When facilities have permit spaces, the regulations require that all entries must be controlled, and, if nonfacility personnel are requested or required to enter, that facility management notify the entry personnel of the status and hazards of the space. Confined spaces must be analyzed for inherent and introduced hazards based upon the operations to be conducted in the confined space in order to determine whether they are "permit-required" confined spaces.

Once a space has been determined to be "permit-required," the requirements of 29 CFR 1910.146 and 269 must be implemented. Reclamation guidance suggests that the management requirements of the standard are best met by establishing administrative assignments which authorize specific individuals within specific organizational units to perform the functions necessary to efficiently manage the program.

These assignments include a position (program coordinator) which is authorized to oversee the entire program within a facility or organization. This program coordination position would be responsible for establishing program procedures, as well as monitoring the implementation status of the confined space entry program.

Assignments within the facility or organizational personnel office should be made in order for the training and medical qualification provisions of the standards to be efficiently met. Management is required to provide training to all entry personnel which provides the understanding, knowledge, and skills necessary to safely perform each individual's assigned duties. In addition, all entry personnel will be provided appropriate medical evaluations/clearances determined necessary to protect the safety and health of the employee. If entrants will be required to use respiratory protection, a medical evaluation and respirator fit test must be provided. Also, if entrants are expected to perform duties of a stressful nature, it is suggested that management assess the entrant's health status with a medical evaluation of the employee's capability to conduct the assigned duties safely. The training and medical evaluation provided must be documented.

A permit system must be established for entries into "permit-required" confined spaces. All entries are conducted under the direction of an entry supervisor, who has specific responsibilities required by the regulations. The system or program establishes the means for the preparation, issuance, use, and cancellation of detailed written entry procedures. A management level review must be conducted annually for evaluation of the adequacy of program implementation and the efficacy of each entry permit.

Each entry into a "permit-required" space requires a separate written permit which identifies the hazards and controls for the operation to be conducted. The written permit establishes the procedures to be followed, the equipment to be used, and the responsibilities of all involved individuals. The permit also details the communication and emergency procedures which are to be in place for the entry. Each permit must be signed by management officials given entry supervisory responsibilities. The signed permit attests to the adequacy of the entry procedures and the meeting of preparatory entry conditions.

Entries into spaces with potential atmospheric hazards require testing for oxygen, combustibles, and toxic contaminants to ensure that contaminant concentrations do not exceed established limits. Testing is conducted as often as necessary to assure that conditions are suitable for work within the space. Proper selection and use of the monitoring instrumentation, as well as knowledge of exposure limits of the contaminants, are critical for safe entry into spaces with atmospheric hazards. Air monitoring instruments must be intrinsically safe, portable, reliable, and easy to use. The instruments must be properly maintained and calibrated. Calibrations must be performed prior to and after entry in order to verify the accuracy of the instrument. It is important that adequate calibration records be maintained.

Knowing the capabilities and limitations of the instruments used is important. The person conducting the monitoring should be aware of various factors which may affect instrument readings, such as response time and possible chemical interferences. The monitoring sequence must be appropriate. OSHA specifies that oxygen, combustibles, and toxic testing are sequentially sampled in order to ensure accurate readings. A user must know what conditions may cause instruments to go into an alarm mode, and what may cause false alarms, such as discharged batteries or use in excessive humidity. The majority of these instrument types are sensitive to abuse, which can cause instrument error.

Based upon accident data, OSHA has determined that asphyxiation is the leading cause of death in confined spaces. Several conditions and activities can cause an oxygen-deficient (less than 19.5 percent) atmosphere. An oxygen-deficient atmosphere can be caused by displacement by other atmospheric contaminants such as recirculated diesel exhaust, vaporized solvents, leaking gas cylinders, decomposition of organic materials, combustion, or other chemical reactions. Atmospheric hazards can also be created by welding and grinding operations in the space, which introduce toxic substances from the metals or fluxes used.

A recent incident in Alaska involved a confined space with an operations-based atmospheric hazard. An individual died from asphyxiation upon entering a 30-inch stainless steel pipe which was being installed at Prudhoe Bay. The individual entered to adjust an argon dam constructed of styrofoam and wood. Argon gas is used to displace oxygen around the pipe's seam to allow welding of the stainless steel. According to an expert witness at the trial against the company, argon apparently leaked outside the dam, displacing the oxygen in the space where the individual entered. The company provided no confined space training, had no entry procedures, and no harnessing despite the fact the pipe lay at a sharp angle. The company was charged and convicted under the state's penal statutes.

Atmospheric hazards in the confined space might require the use of respiratory protective equipment. The required equipment could range from an air-purifying respirator to a self-contained breathing apparatus. The proper respiratory protection must be selected on the basis of atmospheric oxygen/contaminant concentrations and characteristics with consideration given to the limitations created by the space to be entered and the operations to be conducted. An industrial hygienist should assist with the selection of a respirator. Personnel using respiratory protection must be provided medical clearance for respirator use and a respirator fit test.

Depending upon the hazards of the confined space, safe entry can be a very complex procedure. The importance of comprehensive hazard assessment of confined spaces and the operations to be conducted in the space can not be overemphasized. It is essential that persons entering all confined spaces, especially permit spaces, exercise caution. Maintaining communication with personnel outside the permit confined space is critical in order to assure timely response or rescue required because of an entrants inability for self exit. Remember—safety first, every job, every time.

RECLAMATION ON THE WORLD WIDE WEB

by James A. Higgs,[5] *P.E., M.S.C.E*

INTRODUCTION

The Bureau of Reclamation is using the World Wide Web (WWW or Web) to inform clients and peers of our capabilities and disseminate pertinent design information and research results. You likely have heard of the Web. You may have seen television and magazine advertisements that reference the Internet and Web pages. So, what is the Internet? What are Web browsers, hypertext, and WWW? How can it help you? How can you get to it? How do you use it?

This article will answer these questions and give examples of how to take advantage of Web resources in the exchange of technical information. Using the Web to assimilate information and facilitate two-way communications, such as the Flow Measurement Technology project discussed herein, will assist people in obtaining design information and resources and will provide contacts to personnel experienced in the area of their interest.

WHAT IS THE INTERNET?

Ask any computer wizard what this Internet is all about and you'll probably get a long and dusty discourse studded with acronyms and technical babble. The Internet is a nice place to visit if you approach it right—that is, after you learn it's idiosyncrasies and find the information centers and resources that serve your needs. Until then, it may seem to be a huge and chaotic place to get lost in, especially for people who don't know its special quirks.

The Internet is a world-wide computer communication system that connects universities, businesses, governments, military groups, laboratories, and individuals. Simply, it is a network of networks. Schematics of the Internet often looks like a spider's web (figure 5). The Internet is made up of small Local Area Networks (LANs), and huge Wide Area Networks (WANs) that connect computers for organizations all over the world. These networks are connected with everything from regular dial-up phone lines to high-speed dedicated leased lines, satellites, microwave links, and fiber optic links. The fact that they are "on" the Internet means that all these networks are interconnected. This network extends all over the world, but trying to describe all of it and how it fits together is a bit like trying to count the grains of sand on a beach. In fact, so many networks are interconnected within the

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Figure 5.—This image represents byte traffic into the Internet backbone (heavy white lines) from its client networks for the Month of December 1994. The virtual connections, grayscaled by traffic level, visualize traffic statistics from point to point communications rather than the physical route.

Internet that it's impossible to show an accurate, up-to-date picture. To complicate matters, new computers and links are being added every day.

Having all these computers connected, in and of itself, does not get anything accomplished. There are several ways to communicate between computers—ways to copy data, programs, news, and other information. One of the easiest and most popular methods of communication uses what is called a Web browser with hypertext documents.

WHAT ARE WEB BROWSERS, HYPERTEXT, AND THE WWW?

A Web browser is a program that allows you to view files from specially configured Internet computers called Web servers. The files can be plain text, or they can be specially formatted for Web browsers and are called hypertext documents. A hypertext document uses the hypertext markup language (HTML) standard. This standard allows for text formatting such as bold and italicized text, varied fonts, and headings. There are millions of HTML documents available for access on the Internet. Some provide basic information such as lists of links to other Internet resources. The links in an HTML document show up as text that is highlighted (often with colored text) and/or underlined. With a point and click of the mouse pointer on the link, the Web browser retrieves the linked resource (such as plain text files, hypertext documents, image files, programs, and data). Since this text can produce activity that conventional text cannot, it is considered to be hyper, and it is called hypertext.

Some HTML documents contain images that might be logos. Some may have photographs of products, maps, or icons to help identify different categories in a document. Sometimes even the graphics are hyper. For example, by clicking on the Upper Colorado Region of the Reclamation map on the hypertext document http://www.usbr.gov/OrgStructure/regional_map.html, the Web browser will retrieve the main hypertext document for the Upper Colorado Region.

If all the hypertext documents on the Internet could be shown in a schematic, the schematic would look like a spider's web that is much more complicated and dense than the previously mentioned spider's web. This is because a Web server can contain thousands of hypertext documents that can reference any of the millions of Internet resources. This is why hypertext documents are also called Web documents or Web pages, and the millions of interlinked Web documents on the Internet are collectively described as the World Wide Web.

By definition, a Web browser can display HTML documents and retrieve them using hypertext transfer protocol (HTTP). You will notice the Web page listed previously uses the HTTP method of retrieval. Many Web browsers can use other methods of retrieval. Most of these have been around much longer than HTTP. File transfer protocol (FTP) and gopher are two examples. To standardize how the different types of links are referenced, a uniform resource locator (URL) standard has been developed. It is a standard for specifying how to retrieve a resource on the Internet, such as hypertext documents, files, and images. The URL is typically specified on a line near the top of of the Web browser.

Knowing how to interpret URLs will help you understand some idiosyncrasies of the Web. The first part of the URL, before the colon, specifies the retrieval method. The part of the URL after the colon is interpreted specific to the retrieval method. In general, two slashes after the colon indicate a computer name. The last part of the URL indicates where on the computer to find the resource. This last part, if present, is usually case sensitive. If a file is not specified, the Web browser either retrieves a directory listing or the default page. See table 1 for examples.

Table 1.—Examples of various URLs

URL	Action
ftp://oak.oakland.edu/pub/simtelnet/win3/graphics/lviewplb.zip	Use file transfer protocol to down load the popular graphic viewer and editing program L View Pro for MS Windows 3.1
http://www.yahoo.com	Use hypertext transfer protocol to browse a popular Web resource and Internet search engine
telnet://donews.do.usbr.gov	Use terminal emulation to a Reclamation computer
news:sci.engr.civil	Retrieve a Usenet discussion news group that has announcements and discussions pertaining to civil engineering
mailto:jhiggs@do.usbr.gov	Send electronic mail (e-mail) to me
wais://wais.free.net	Wide area information search

RECLAMATION ON THE WEB

Reclamation's presence on the Web is increasing (see URL http://www.usbr.gov). There are now links to most types of activities and services that Reclamation performs, ranging from "announcements" to "water uses." The intended clients for these pages are water users, engineering consultants, and the general public. Benefits of interoffice communications and to the international community cannot be ignored.

The Structural Analysis Group and the Waterways and Concrete Dams Group of the Technical Service Center in Denver have coordinated to construct an impressive set of pages on Reclamation concrete dams, including details and photographs at URL http://donews.do.usbr.gov/dams/ConcreteDams.html. While the level of detail (information and images) does not approach that of Reclamation's *Project Data* book, last published in 1981, it is a very good start.

FLOW MEASUREMENT TECHNOLOGY

The Water Resources Research Laboratory (WRRL) of the Technical Service Center in Denver has started an ambitious undertaking in the area of flow measurement technology. Reclamation has flow measurement experts on varying equipment and methods scattered throughout the organization, as well as contacts in other agencies. Reclamation and the irrigation districts have a need to improve flow measurement in the field to conserve water and save money. To bring the two groups together and to assemble comprehensive information pertaining to flow measurement, the WRRL has created a Web structure (figure 6) to be the cornerstone of this project at URL http://ogee.do.usbr.gov/fmt. Besides putting the third edition of the *Water Measurement Manual* on line (after it is published at the end of this fiscal year) with easy access links to various parts of the manual, the site will provide for:

- Current activities in flow measurement
- A discussion forum where anyone may submit questions, problems, or suggest solutions
- Information pertaining to various instrumentation and vendor contacts
- Links to ongoing research and other Internet resources

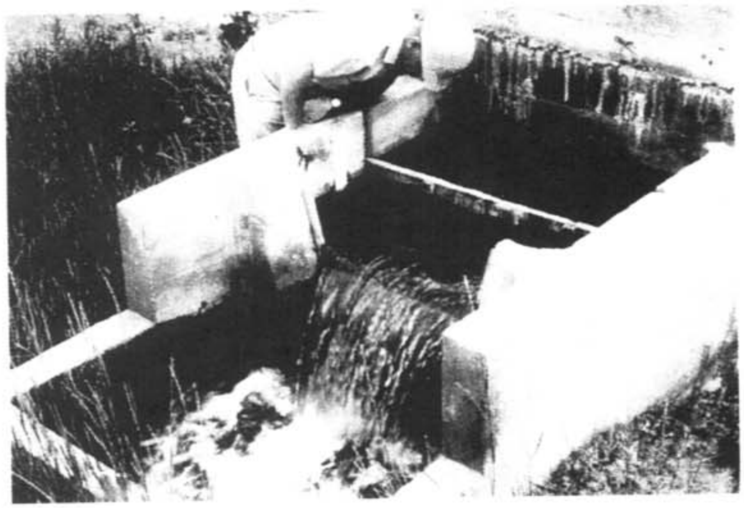
While the Web pages are planned to be the cornerstone of the project, the end goal should not be forgotten, and that is getting the resources and services to the individuals that need to use them. You are invited to visit the Flow Measurement Technology page and send in your comments using the online "Comment Card."

Key things to look for on Reclamation's Web pages are: (1) easy to read documents that have balance in both presentation and content, (2) capabilities of the various entities, (3) current and past projects, (4) who to respond to if you are having problems with the page, and (5) who to respond to if you want more information about that service.

HOW TO ACCESS THE WEB

Most Reclamation computers that are on a LAN server have the hardware they need to access the Internet. Reclamation's Novel Local and Wide Area Networks comprise a small part of the Internet but use a different communications protocol called internetwork packet exchange (IPX). The Internet uses transmissions control protocol/Internet protocol (TCP/IP). The two protocols may reside simultaneously on the same network and even the same computer. Your computer support personnel should be able to set up Internet and Web access with minimal effort, if they have not already done so.

Flow Measurement Technology



Purpose: To provide flow measurement information and a forum for discussing water measurement issues.

- The intent of these pages is to provide a service to individuals offices, etc. that are dealing with water measurement issues.
- We want to get *your* input on what information should be included on these pages.
- We have provided this inital outline of potential topics and links for your consideration.
- Please provide your suggestions and ideas under the Comment Card category.

| CURRENT ACTIVITIES | DISCUSSION ROOM | FLOW MEASUREMENT | COMMENT CARD |

| WATER MEASUREMENT MANUAL | INSTRUMENTATION | TOPIC SEARCH |

CONTRIBUTORS

The following organizations have provided the support that makes these pages and the techncal contacts provided herein possible:
The Water Rescources Research Laboratory
and add the list of others here

You are visitor number 000189 since 4/6/96
For problems concerning these Web Pages, contact the WebMaster
Last Modified: April 6, 1996
Bureau of Reclamation
Department of Interior

Figure 6.—Flow Measurement Technology's main Web page.

To gain access to the Web from other computers, I recommend that your PC be at least a 80486-66 MHz with 16 MB of RAM, 50 MB of free hard disk space, MS Windows 3.1, and a 28.8 kbps modem. You can access the Web with a slower PC, but you will notice an incremental slow-down in performance, whereas a faster PC will give you better response time.

Computers thus equipped may easily connect to the Internet through most commercial online services providers (OSPs) or Internet services providers (ISPs). Online and Internet services all have unique features, capabilities, costs, and ease of use, so take your time investigating them. Some even have the tools for you to create your own Web pages for the entire world to read. The May 1996 *Consumer Reports* compares several more features of Online and Internet services as well as modems.

OSPs are members-only clubs that typically have a local telephone line (to save the expense of long distance phone calls). Most OSPs provide:

- E-mail
- Chat rooms (members-only discussion areas)
- Discussion rooms (members-only, topic-specific discussion areas)
- News services (headlines, weather, sports)
- Services (home shopping, airline and travel reservation, and others)
- Software (freeware, shareware, and to purchase)
- Internet access

The Internet access may be nonexistent, limited, or full access and may have additional fees for each hour of Internet connection. OSPs may provide their own Web browser, Internet e-mail, FTP, gopher, telnet access, and Newsgroups (Usenet, which are topic-specific discussion areas).

Many OSPs will send you a free startup kit. Table 2 lists both telephone numbers and Web sites of some OSPs. These Web sites may have detailed information and startup kits to download. While considering an online service, consider whether you need to have access to the provider while you travel, how much you travel, where you travel, and the location of the phone numbers that are provided.

Table 2.—Online services phone number and Web sites

Online service	Phone number	URL
America Online	(800) 827-6364	http://www.aol.com
Compuserve	(800) 848-8199	http://www.compuserve.com
MSN	(800) 386-5550	http://www.msn.com
Prodigy	(800) 776-3449	http://www.prodigy.com

While ISPs often require more expertise on your part, they may provide you with more efficient and less costly access to the Internet. Most ISPs do not come with the bells and whistles of OSPs. Typically they give you modem access to an Internet computer and a small amount of data storage space. From the ISP Internet computer, you can reach out to the Internet.

Some Internet service providers have local phone numbers only for a small area (for example, a local university), and several have many local phone numbers scattered throughout the United States. While considering an Internet service, again consider the travel and access issues and types of Internet access they provide (such as FTP, gopher, e-mail, and Web).

ASSEMBLING YOUR WEB RESOURCES

Most Web browsers, such as Netscape or Mosaic, have tools to keep track of the Web pages you want to revisit, called bookmarks. Most Web browsers come with default bookmarks to generic resources and at times are a good starting place to find what you want. Table 3 has a list that might help you develop the resources you need in your job. Of particular help are virtual libraries and search engines.

Table 3.—Starting places. This is a list of URLs that you might find useful, along with the other URLs referenced in this article

Topic	URL
Online services	http://www.yahoo.com/Business_and_Economy/Companies/Computers/Networking/Online_Services
Internet access services	http://www.yahoo.com/Business_and_Economy/Companies/Internet_Services/Internet_Access_Providers/National_U_S__/
Main Web page for Reclamation	http://www.usbr.gov
Flow measurement technology	http://ogee.do.usbr.gov/fmt
Water Resource Research Laboratory, Reclamation	http://ogee.do.usbr.gov
Concrete Dams, Reclamation	http://donews.do.usbr.gov/dams/ConcreteDams.html
Reclamation's water conservation pages	http://ogee.hydlab.do.usbr.gov/rwc/rwc.html
American Society of Civil Engineers (ASCE)	http://www.asce.org
American Society of Mechanical Engineers (ASME)	http://www.asme.org
American Society of Agricultural Engineers (ASAE)	http://asae.org/
NCSA Mosaic, a Web browser	http://www.ncsa.uiuc.edu/SDG/Software/Mosaic
Netscape Navigator, another Web browser	http://home.netscape.com
OAK software repository	http://www.acs.oakland.edu/oak/SimTel/SimTel-win3.html
FedWorld information network, civil engineering	http://www.fedworld.gov/civil.htm
Virtual libraries and search engines	http://www.excite.com/
An offical WWW virtual library	http://www.w3.org/vl/
The Water Efficiency Clearninghouse	http://www.waterwiser.org/waterwiser/index.html
WebCrawler search engine	http://www.search.com
Water Resources of the United States, USGS	http://h20.usgs.gov
The U.S. House of Representatives The Legislative Process	http://www.house.gov/legproc.html
U.S. Water News—online	http://www.mother.com/uswaternews/

Virtual libraries are a structure of Web pages that organize other Web pages by subject. Most links in virtual libraries are submitted by the author of the Web page. Search engines search the Web for key words that you submit. There are several different methods of searching, so if the first search engine does not find what you are looking for, try another. If a search finds too many pages, like 40,000 (not uncommon!), use more key words to limit the scope of the search.

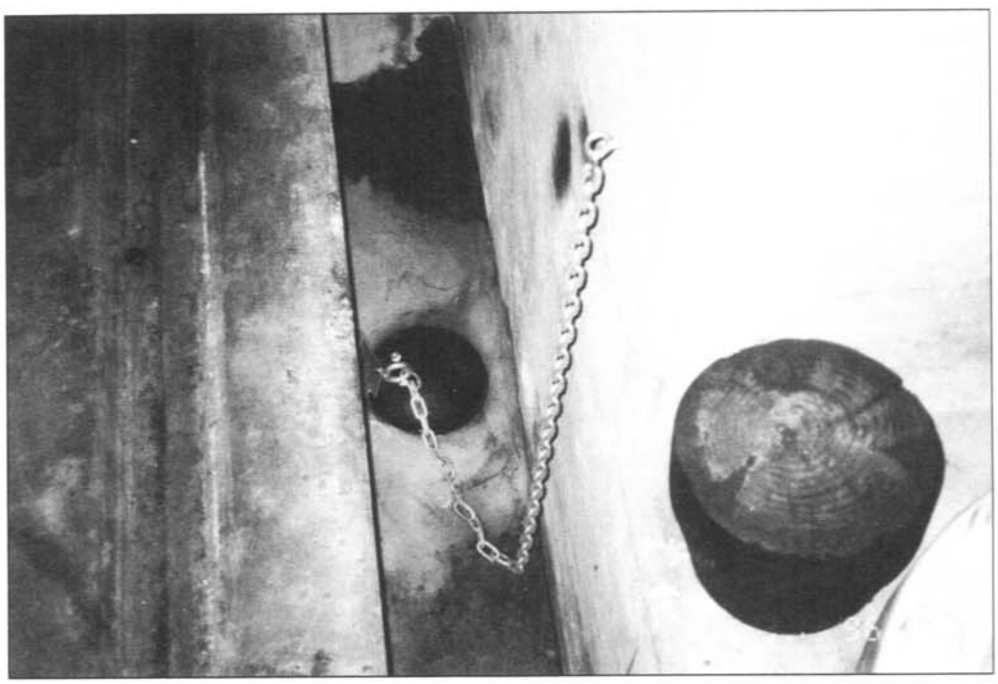
The World Wide Web is a powerful medium that can be exploited in the exchange of important information in the engineering community and the general public. An advantage of publishing on the Web is that documents no longer need to be static; changes can be made as new technologies are developed and as changes are made to Reclamation structures.

AN INNOVATIVE EFFORT TO PREVENT OIL SPILLS

by Mike Stone[6]

The Lower Colorado River Authority (LCRA) is a water conservation district which was created by the State of Texas in 1934 and has contracted with the United States for the operation and maintenance of Marshall Ford (Mansfield) Dam. Mansfield Dam was constructed by the Bureau of Reclamation. The LCRA has a statutory service district of 10 counties in central Texas, covering approximately 10,000 square miles, and operates the major reservoir system called Highland Lakes on the lower Colorado River, which includes Mansfield Dam.

In 1992, the LCRA's Dam and Hydroelectric Division instituted several programs to identify and implement improved maintenance and operation of areas assigned to the division. The programs incorporated a team approach where managers and employees worked together to identify opportunities for improvement and practical solutions.



An innovative way to prevent oil spills.

One notable example of successful teamwork concerns oil spill prevention/containment where an employee's suggestion to effect a practical improvement has been implemented at Mansfield Dam. It was concluded that a hydraulic oil leak from the flood gate operating system within the dam could potentially cause oil contamination of the river below Mansfield. Hydraulic oil from the system, if a system or component failure occurred, would flow unobstructed into the gallery drainage troughs and eventually be pumped out of the dam and into the waterway below the dam.

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[6] Superintendent of Dam and Hydroelectric, Lower Colorado River Authority.

Management had determined that the water drainage trough in the dam's operation gallery could serve as a spill containment basin if an oil leak were to occur. During the preliminary assessment to design the spill containment, an employee suggested that one simple design solution would be to install inflatable plumbing bladders in the piping where the troughs drain into the lower gallery sump. The bladders could be removed if necessary to let water pass and be reinstalled during regularly scheduled gallery inspections. Should an oil leak occur, the bladders would contain the oil within the gallery trough for easy cleanup.

The employee's suggestion was adopted and has proven to be a practical and cost-effective solution to reduce, if not eliminate, environmental damages in the event of a hydraulic oil spill. Regular maintenance of the gates, taking note of potential oil contamination sources, and even minor oil seepage also serve to prevent oil from entering the environment.

IS EXPANSION A PROBLEM IN PLASTIC PIPING?

By Robert C. Wilging, P.E.[7]

To deal with this subject, we will first address these four parts: the coefficient of expansion, the piping systems involved, temperature ranges to be expected, and the devices or design installation provisions that allow for expansion. Throughout this article we will use the term "expansion" to represent both the expansion and the contraction that result from temperature changes. Then we will present information about installations that must be encountering temperature changes and report what we know about their responses to this condition.

COEFFICIENTS OF THERMAL EXPANSION

It has been reported many times that plastic materials have coefficients that are five to 10 times as large as those of metals. The table below presents published values showing the variation among different metals and plastics. As you can see, there are also significant differences with some of the plastic materials. Therefore, subsequent references to these plastics will identify the specific grade or type of material.

Piping material	Coefficient of thermal expansion (in/in/deg. F) ASTM D 696	Expansion (in./100 ft./10 deg. F)
Steel	6.7×10^{-6}	0.08
Cast Iron	5.9×10^{-6}	0.07
Copper	9.3×10^{-6}	0.11
PE 2406 (Type II)	9.0×10^{-5}	1.10
PE 3406 & 3408 (Type III)	9.0×10^{-5}	1.10
PVC 1120 & 1220 (Type I)	3.0×10^{-5}	0.36
PVC 2110 through 2120 (Type II)	5.0×10^{-5}	0.60
CPVC 4120 (Type IV)	3.4×10^{-5}	0.41
ABS 1208 & 1210 (Type 1, Gr. 2)	6.0×10^{-5}	0.72
ABS 1316 (Type 1, Grade 3)	5.2×10^{-5}	0.62
ABS 2112 (Type 2, Grade 1)	6.0×10^{-5}	0.72
PB 2110 (Type 2, Grade 1)	7.2×10^{-5}	0.86

Note: Abbreviations for the plastics are in accordance with ASTM D 883 and D 1600, plastic pipe standards and common usage. They are:

PE - Polyethylene
CPVC - Chlorinated Polyvinyl Chloride
PB - Polybutylene
PVC - Polyvinyl Chloride (Most PVC pipe is Type I material)
ABS - Acrylonitrile-butadiene-styrene

[7] Founded the consulting firm psi(MPa), Inc., in 1992, after 26 years as BFGoodrich's manager of plastic piping testing and standards. He can be contacted at (216) 933-4394.

PIPING SYSTEMS

In this article we will address only those systems or portions thereof that are above ground within buildings. This group divides readily into two parts, pressure and gravity flow systems.

Pressure systems include:

- Hot and cold water distribution.
- Chilled water piping.
- Process piping.
- Fire sprinkler piping.

Gravity flow systems include:

- Sanitary waste and vent systems, commonly referred to as DWV.
- Roof drains.
- Parking garage drains.

In addition to their obviously different configurations, pressure systems and gravity systems can utilize different joining systems.

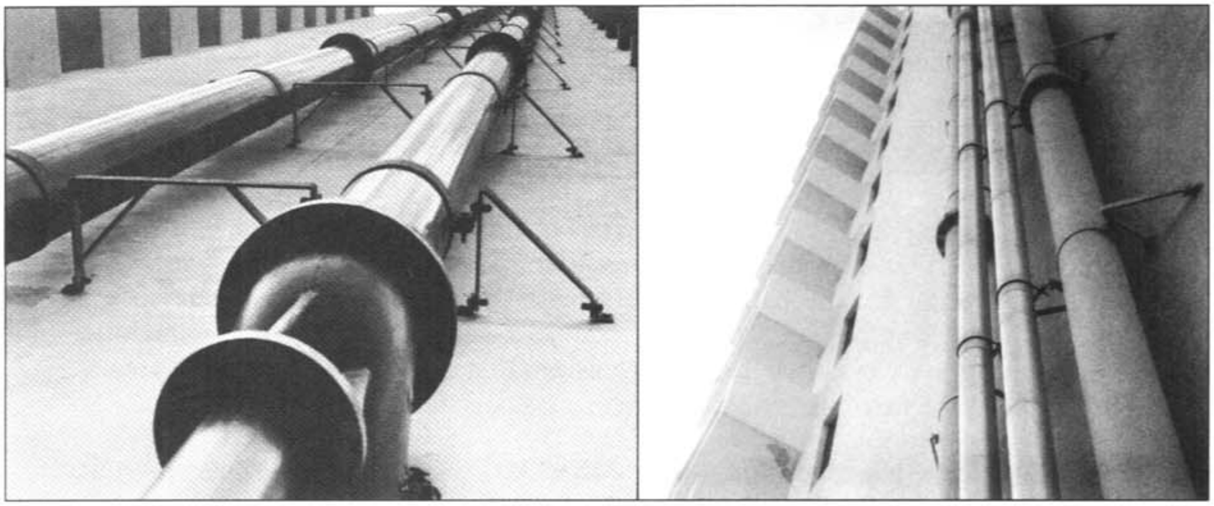
TEMPERATURE

Because expansion and contraction can result from all temperature changes, and because these systems normally have different operating conditions, we offer these thoughts.

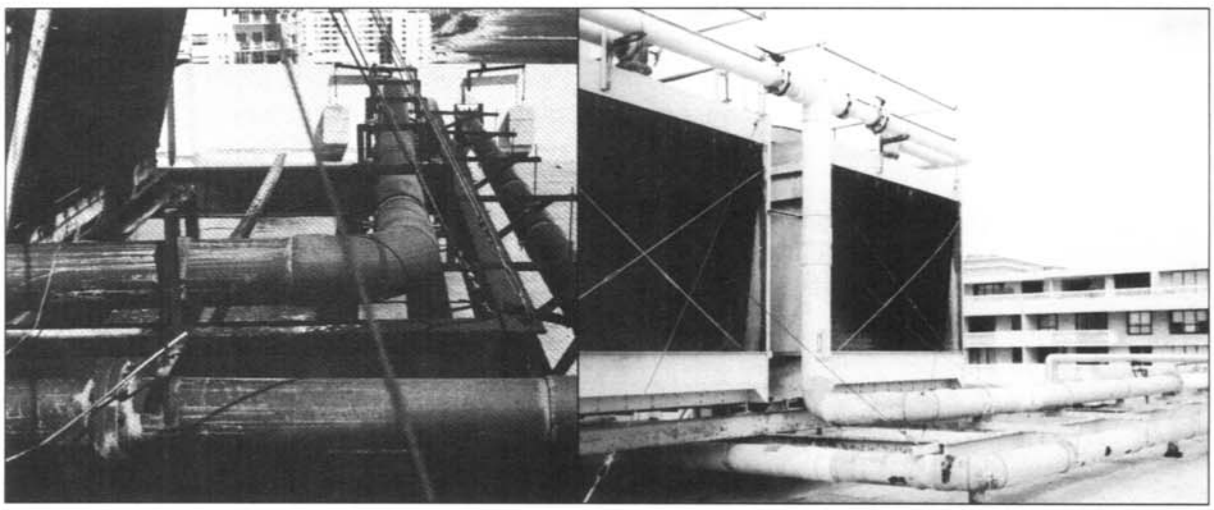
1. Installations of all types of systems can be made under the full range of summer to winter temperatures. We have seen some being made at below zero temperatures and have reports of installation temperatures well above 100 F. When such extremes are encountered, the contractor or installer may need to make adjustments. In addition, there is the possibility of a building shut down that could result in some greater temperature variations.

2. In hot and cold water distribution systems, maximum operating temperatures may be established by a temperature limit set in the code. The cold water temperature is established from local practice and water supply source. For example, with a lake source, winter water temperatures can be quite low. The designer is free to select the temperature range and may prescribe expansion provisions in detail, or he may simply call for the installer to make suitable provisions. Recirculation provisions or insulation will reduce both the frequency and range of temperature cycling.

3. Chilled water systems have in the past operated at minimum temperatures of 40 to 50 F. More recently, "ice storage" systems have come into use and operate at below-freezing temperatures.



These two 12-inch PVC risers, installed about 30 years ago (l.), carry water 165 feet vertically to and from cooling towers on the roof of a Florida hotel. Supplemental piping has been added (r.)



Since the original installation 30 years ago (l.), in a recent photo (r.) it appears that all roof supports have been replaced. While much of the original PVC remains, it appears some pipe has been replaced — the white pipe and molded fittings are new — which may have accompanied the rebuilding of the cooling towers.

4. Process piping systems usually have very specific operating temperature conditions, enabling the designer to prescribe expansion provisions to be made.

5. Fire sprinkler systems normally operate at a building's ambient air temperatures except during fire incidents, which often are localized.

6. In DWV systems, the operating temperature range is a function of the waste water temperature(s), which are variable. The maximum temperatures resulting from hot water flow are moderated as pipe size increases.

7. Roof drain temperatures are controlled by the building air temperature, except when colder storm water flows through the system.

8. In unheated parking garages, drain temperatures are controlled by ambient air and rainfall temperatures and may cover a broad range on a seasonal basis.

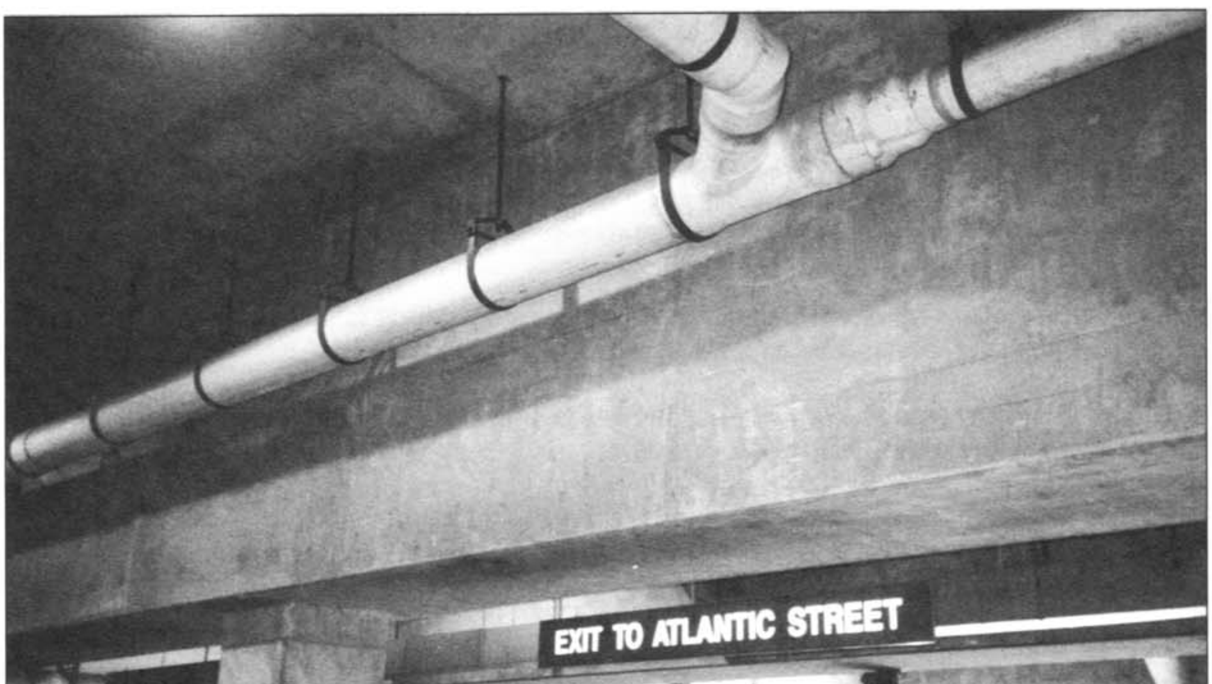
EXPANSION DEVICES OR DESIGN PROVISIONS

Some plastic expansion joints (devices) are available, and in some cases metal expansion devices can be used. If the expansion joint is made of the same material as the plastic pipes, they may be joined without a mechanical joint. Gravity flow system expansion devices may not be suitable for pressure piping. Conversely, devices designed for pressure piping often are not suitable for gravity systems. Design provisions that can be used for both are similar in that they rely on pipe flexibility without increasing stress to unsuitable levels.

Manufacturers of plastic pipe and fittings who also make DWV expansion joints report that sales of these devices are very limited. Most manufacturers make devices for 4-inch and smaller, with a few 6-inch size devices available. One of the oldest manufacturers has on record a recom- mendation letter they have used for years. In this letter, the writer suggests the use of an expansion joint at every floor level in plastic DWV stacks.

Design recommendations for plastic pressure piping expansion provisions are available from many manufacturers. They are based on the same concepts used in metal piping, but because the plastic materials have lower modulus values, the pipe is much more flexible.

Two additional observations are worth stating here. Most expansion devices for pressure piping are metal and require two metal-to-plastic transition joints. And the expansion forces that develop in plastic piping are lower than those in metal pipe when both are subjected to any given temperature change.



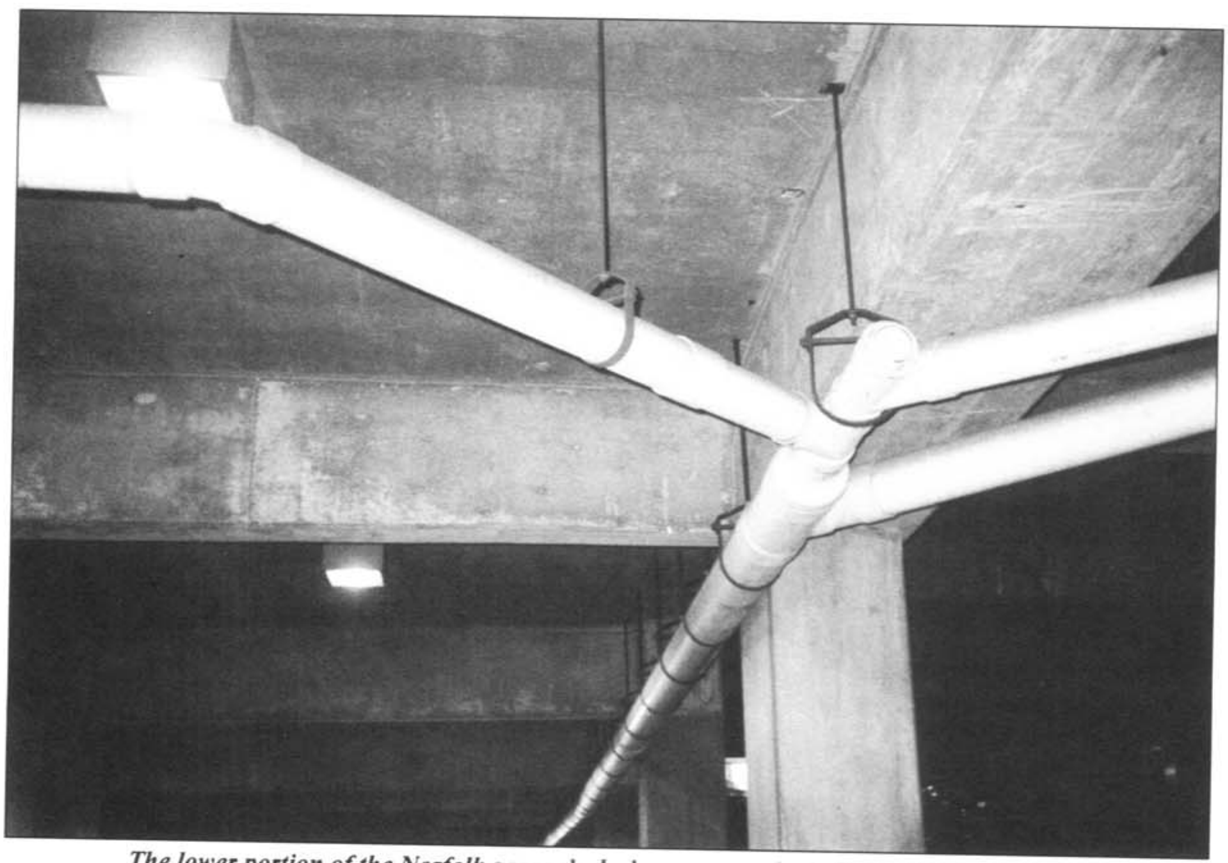
In a Norfolk, Va., parking garage, drainage is provided by this 12-inch PVC cross pipe with 10-inch piping coming from the ramp slope.

SYSTEMS IN SERVICE

Two 12-inch PVC pipes go 165 feet up the side of a Florida hotel to carry water to and from the roof top cooling towers. These were installed about 30 years ago and are still in service. The facility was refurbished, the roofing redone and all the metal piping supports were replaced, but the fully exposed PVC piping on the roof remains. The pipe riser supports are hinged at the wall and at the pipe clamp. Lever arm counterweights are located at the top of each riser. These risers are on the north side of the building and have been painted to match the building exterior.

At another building, in Orlando, some 6-inch cooling tower piping was installed on the roof about 37 years ago. The cooling tower was replaced about 7 years ago, but the rooftop piping and risers within the building are still in service.

A schedule 40 PVC piping system with solvent cemented joints and DWV fittings (4-inch through 12-inch sizes) provides storm water drainage for a nine-story parking garage in Norfolk, Va. The 6-inch drops have some cast iron clean out tees that are joined to the PVC with NoHub couplings. The lower portion of this system includes a 100-foot straight run of 10-inch pipe that is above the sloping entrance ramp. This makes a 90-degree turn at the lower end and connects into a 12-inch horizontal pipe run, which then turns 90 degrees down the ramp. An attendant reported that during heavy rain storms there is considerable movement of these pipe lines and the cast iron manhole lid in the street bounces around.



The lower portion of the Norfolk garage's drainage system includes a 100-foot straight run of 10-inch PVC.

There have been some recent calls about "ice storage" chilled water system problems with PVC piping and contraction stresses may have been a factor. One contractor who designs and installs such systems reports that PVC pipe has given satisfactory service in his installations for several years, but it is necessary to provide for expansion and contraction in these installations because PVC's ductility is reduced as the temperature drops.

WHAT WE CAN TELL YOU ABOUT THIS ISSUE

The Plastic Pipe and Fitting Association, Glen Ellyn, Ill., has a list of more than 100 multi-story buildings using plastic piping systems. These buildings range from five to 25 stories and many have been in service for 10 to 20 years. Most of these are DWV systems, with about 70 percent PVC and 30 percent ABS. Calls to a number of the building managers resulted in reports of "no problems," but none were able to provide details concerning the expansion provisions in their multi-story DWV stacks. We wonder if there are expansion joints or whether they rely on offsets and pipe flexibility.

SOME FINAL QUESTIONS

Have you had expansion problems with PVC piping in DWV stacks or other parts of the systems? If so, how were they resolved? And if not, what provisions were made? Expansion joints, offsets in stacks or design allowances in branch connections?

Have you had expansion problems with plastic pressure piping? What material? What kind of system? How were they resolved? We would be quite interested in learning of others' expansion and contraction experiences in the hope of serving the industry better in the future.

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Mission

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The purpose of this bulletin is to serve as a medium of exchanging operation and maintenance information. Its success depends upon your help in obtaining and submitting new and useful operation and maintenance ideas.

Advertise your district's or project's resourcefulness by having an article published in the bulletin—let us hear from you soon!

Prospective articles should be submitted to one of the Bureau of Reclamation contacts listed below:

Jerry Fischer, Technical Service Center, ATTN: D-8470, PO Box 25007, Denver, Colorado 80225-0007; (303) 236-9000 ext. 230, FAX (303) 236-1070

Vicki Hoffman, Pacific Northwest Region, ATTN: PN-3234, 1150 North Curtis Road, Boise, Idaho 83706-1234; (208) 378-5335, FAX (208) 378-5305.

Dena Uding, Mid-Pacific Region, ATTN: MP-430, 2800 Cottage Way, Sacramento, California 95825-1898; (916) 979-2422, FAX (916) 979-2505.

Ron Smith, Lower Colorado Region, ATTN: LC-4842, PO Box 61470, Boulder City, Nevada 89006-1470; (702) 293-8436, FAX (702) 293-8042.

Don Wintch, Upper Colorado Region, ATTN: UC-258, PO Box 11568, Salt Lake City, Utah 84147-0568; (801) 524-3307, FAX (801) 524-3034.

Tim Flanagan, Great Plains Region, ATTN: GP-2400, PO Box 36900, Billings, Montana 59107-6900; (406) 247-7780, FAX (406) 247-7793.