WATER OPERATION AND MAINTENANCE

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UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the reports herein concerning laborsaving devices and less costly equipment and procedures will result in improved efficiency and reduced costs of the systems for those operators adapting these ideas to their needs.

To assure proper recognition of those individuals whose suggestions are published in the bulletins, the suggestion number as well as the person's name is given. All Bureau offices are reminded to notify their Suggestions Award Committee when a suggestion is adopted.

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Cover photograph:

Musk thistle.

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INTRODUCTION

Musk thistles can get so thick that they crowd out perennial grasses. The article beginning on page 1 tells why you should mount an all-out attack on this noxious weed.

The article beginning on page 3 gives you five steps to help you get top performance from your pesticide sprayer.

Some valuable information, as well as advantages and disadvantages, on a new surface irrigation method called surge irrigation is given in the article beginning on page 5.

See page 11 for an article that may help you decide whether a projectile cleaning device would be suitable for cleaning your water distribution system.

Documentation of flooding of the tunnel and control house at Currant Creek Dam begins on page 18.

CONTROL THISTLES THIS FALL

The race is on now to catch up with the fast-spreading musk thistle. From mid-October (after the first frost) until the ground freezes this winter is the best time to attack this noxious weed. And it's important to mount an all-out attack.

Musk thistles can get so thick that they crowd out perennial grasses in pastures and roadsides, says William Greenwood, noxious weed law administrator for the Kansas State Board of Agriculture. Two musk thistles per square foot can reduce pasture yield by 50 percent.

Seeds from musk thistle plants can spread up to 5 miles and last 8-10 years in the soil. Seeds also are spreading in Kansas through brome or native grass hay and on machinery.

To effectively control musk thistle, over 95 percent of the stand has to be killed in a treated area, Greenwood explains. If as few as 5 percent of the plants survive and bolt the following spring and summer, musk thistle will perpetuate itself.

Musk thistle

To control musk thistle, farmers can use 2,4-D amine, 2,4-D LV ester, dicamba (Banvel) or Tordon 22K. 2,4-D and Banvel will provide good kill of musk thistle in the rosette stage. They have relatively short residual activity. 2,4-D alone can be applied in fall or spring. Banvel or Banvel/2,4-D tank mixes are labeled for spring application only.

Tordon provides excellent musk thistle control, says Greenwood. The advantage of this recently labeled herbicide is that when applied in the fall, it gives residual control of thistles through the next spring.

Tordon is a restricted use herbicide. It cannot be applied to cropland. It should be kept out of water supplies, both human and livestock. Soil treated with Tordon cannot be moved. Pastures treated with the herbicide can be grazed with no waiting period.

Certain trees may be damaged by Tordon. In Lincoln County, an old homesite has been sprayed with the herbicide after leaf drop in the fall to test for damage. Mulberries, Siberian elm, and osage orange showed some injury; mulberries most severely. Trees unaffected by the spray in this test include walnut,

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willow, pine, cedar, oak, ash and peach species, says Lester Pinkerton, Kansas State University Extension forester.

Pinkerton advises spraying Tordon in the fall only after leaf drop, if possible. Tordon cannot be applied to wooded sites in the spring. Also, it can be applied to the same land only 2 years in a row.

Cost-sharing money is available in various amounts in most Kansas counties for musk thistle control. Greenwood urges farmers and county weed control personnel to get a control program started soon.

"Fall is the best time to control musk thistle for several reasons," he explains. "In fall, there's more time to work on control than in the spring, the weather isn't as windy and rainy, there's less risk to nontarget plants and musk thistle control is much better then." Tordon can be applied aerially in the fall and by ground only in spring.

Musk thistle problems in Kansas are most severe roughly east of a line from Phillipsburg to Great Bend and north of a line from Great Bend to Ft. Scott.

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SPRAYER CALIBRATION IS KEY TO GOOD PESTICIDE RESULTS

Getting top performance from a sprayer is a continuous process, according to an Iowa State University Extension agricultural engineer. Sprayers must be calibrated each spring to ensure sprayer accuracy. And they may need recalibration in the same season if the sprayer is used extensively.

"Just because you calibrated your sprayer properly last year does not mean you will obtain satisfactory results in 1985," Erdal Ozkan says."Several factors that influence the effectiveness of your sprayer change with use.

"For example, the flow rate of a brass nozzle can increase by 15 percent after 25 hours of use. Nozzles will wear out even faster with chemicals containing wettable powders and other adhesive materials."

Other variables that can affect sprayer accuracy include shape and size of nozzle orifice, pressure at the nozzle, nozzle spacing, travel speed, concentration of active ingredients in the spray solution and uniformity of distribution.

"Field calibration helps maintain a satisfying relationship among these changing variables, so you don't over- or under-apply," Ozkan says. "Nine out of 10 sprayers calibrated at sprayer clinics last year either applied too much or too little pesticides because they weren't calibrated correctly."

Accurate field calibration of a sprayer requires a measuring tape, a watch with a second hand, and a measuring jar graduated in ounces. With that equipment, calibration can be done, following these steps:

– First, fill the sprayer tank with water.

– Second, determine the nozzle spacing in inches and measure an appropriate travel distance in the field, according to the nozzle spacing. For a nozzle spacing of 20 inches, mark off a travel distance of 224 feet; for 30 inches, 136 feet; 36 inches, 113 feet; 38 inches, 107 feet; and 40 inches, 102 feet.

– Third, drive the designated distance in the field at the normal spraying speed. Use a watch with a second hand to record travel time in seconds.

– Fourth, with the sprayer parked, set the desired pressure on the sprayer. Collect the output from each nozzle for the recorded travel time, and separately record the output (in ounces) in each nozzle.

– Fifth, calculate the average nozzle output. If any samples collected from the nozzles are more than 10 percent below or above the average, replace those tips and repeat steps four and five until the variation in discharge rate of each nozzle is within 10 percent of the average rate.

"The average discharge rate of all nozzles in ounces equals the gallons per acre application rate of the sprayer," Ozkan says. "If the gallonage figured is not within 5 percent of the desired rate, adjust the pressure or travel speed.

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"If these changes do not bring the application rate to an acceptable level, then select a new set of nozzles with smaller or larger orifices and recalibrate."

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SURGE IRRIGATION:
A New Approach to Cutting Costs

After just a few short years of development in Utah and Texas, a new surface irrigation method has arrived in Kansas. And by and large, the new method, called surge irrigation, has convinced skeptics that the equipment will work under Kansas conditions.

Problems with surge valves and their timing controllers plagued some farmers early in the season last year, but most of these problems now seem to be resolved. Farmers who have tried it report that surge irrigation equipment is reasonably dependable now, and likely to get better this year.

The purpose behind surge irrigation is twofold, explains Mark Hooker, research agronomist at the Garden City Experiment Station. One is to cut back on water use during pre- or the first in-season irrigations and on coarse soils. The other is to get more uniform distribution of water into the root zone up and down the rows.

Under continuous flow irrigation, the end of the field closest to the gated pipe typically gets too much water while the far end gets shortchanged. Water often goes down substantially below the root zone in the top of the field during preirrigation, Hooker says.

By installing a surge valve in the middle of the field, the irrigator can change this watering pattern. He can turn the water onto one half of the set for 2 hours, then water the other half for the following 2 hours, then come back to the first half again for 2 hours, and so on until each half of the field is fully watered (normally in 12 or 24 hours).

The advantage of this is that it makes good use of the soil's natural sealing capacity, Hooker says.

"After the water soaks into the soil, the soil surface will seal over," he explains. "So when the water is applied again, it moves more rapidly over the furrow in the top of the field instead of soaking in.

"This improves the advance time, the time it takes water to reach the end of the field. It also keeps the top of the field from taking in too much water and allows more water to soak into the ends of the rows."

This tends to even out the distribution of water and improves yields on the down side of the field.

In practice, it's not always so easy to cash in on these theoretical benefits, although it can and has been done in Kansas. To get the most benefit from a surge valve system, the irrigator should experiment with different cycle times (such as 30 minutes, 60 minutes, or 2 hours) to find the ideal program for his fields. One-hour cycles are what Lindy Cooper uses in Stanton County on about a 2 percent slope. This time seems to work well in many situations in southwestern Kansas.

Optimum cycle times vary with soil type, slope and slope variations within the field, well capacity, the number of rows being watered, the crop being grown and possibly other factors, Hooker says.

Reprinted, with permission, from the March 2, 1985 issue of Kansas Farmer.

Alternating the flow of water between two sets of furrows in short intervals is the key to surge irrigation. This experimental system used last year by Kansas State University irrigation engineers used two timing controllers, one for each valve. Commercial systems now use just one controller for both valves.

Some irrigators may benefit most by varying the cycle time in the set. For example, he could start out with 1-hour cycles, then go to 2-hour cycles for the rest of the set.

Also, different cycle times are often advised for preirrigation and in-season irrigation, Hooker adds. Generally, preirrigation requires longer cycle times. The newer timing controllers on the market are more able to vary cycle times within a set than the older models.

Irrigators typically get too busy once the irrigation season begins to fiddle around with varying cycle times to find the pattern that would suit their soil best. But some answers may come from the Soil Conservation Service target team in Garden City this summer.

The SCS scientists plan to study surge irrigation in detail on farms in Finney and Haskell counties this year. Cooperating with them will be Hooker and Harry Manges, Kansas State University irrigation engineer, and his graduate students. They hope to find out how to adjust surge valves best under various Kansas field conditions.

Up to now it's been a case of technology galloping ahead of our capability to use and understand it, Manges says. Advanced controllers now allow the irrigator to set several cycle patterns for his surge valves. But making the right selection can be a difficult, or impossible, task.

The irrigator buying a surge valve system is faced with several choices. The first choice is type of valve: water-driven (diaphragm) or mechanical. Costs of surge valve systems sold by Teeter Irrigation in Johnson range from $990 to $1550 for 10-inch valves. For 8-inch valves, prices range from $880 to $1450.

Commonly available diaphragm valves include Hastings and Fresno. Until this year, these type valves were almost the only types available in Kansas.

Mechanical valves now available in Kansas include the P&R, Waterman and Boss, among others.

The diaphragm valves operate on water pressure. It takes 2-1/2 pounds of pressure to activate the Hastings valve, says Dan Plagge of Teeter Irrigation. Irrigators with shallow wells sometimes have had a hard time getting enough pressure in the line to operate these valves, Plagge says. "I had to rig up a restrictor to put into some of the Hastings valves to help increase the pressure. That helped solve the problem," Plagge explains.

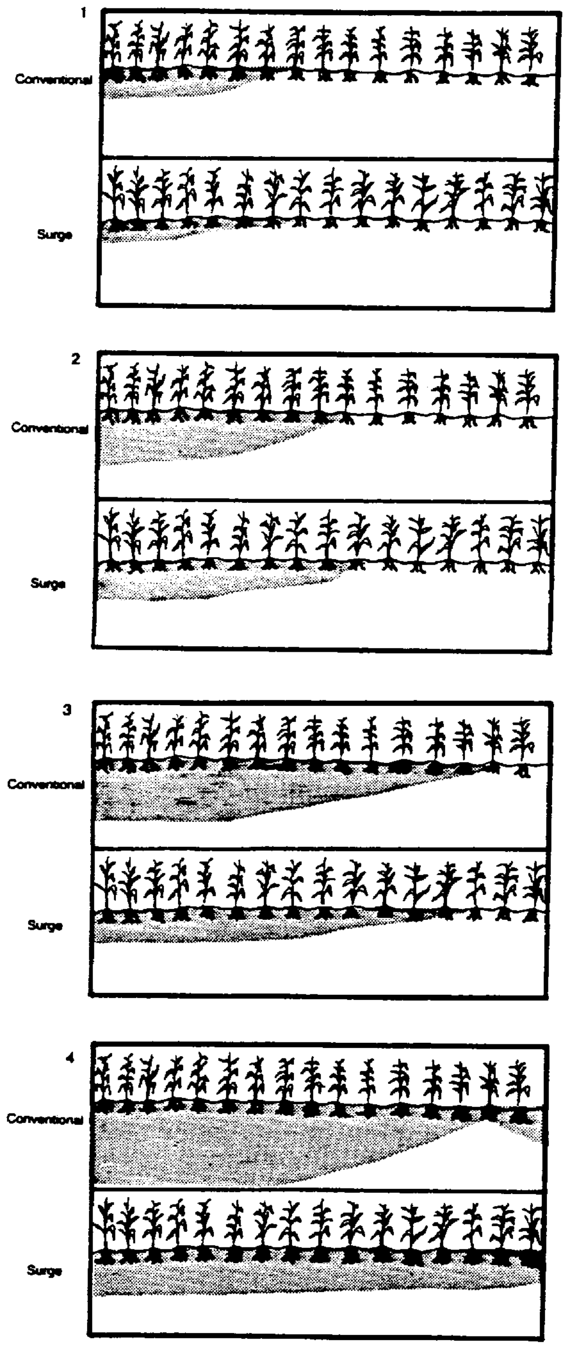
Also, irrigators may have to water fewer rows than they'd like at a time in order to keep water pressure high enough to activate the diaphragm valves, he adds.

Mechanical valves with positive action can offer more reliability than diaphragm valves in many situations, Mark Hooker says. But mechanical valves could pose a problem to irrigators with high-pressure systems and old or weak concrete pipe.

"The P&R, for instance, switches in about 7 seconds as opposed to 2-1/2 minutes for the Hastings valve," Plagge says. "We're concerned this could cause some back pressure and hammering that could damage old concrete pipe."

COMPARISON OF WETTING PATTERNS IN CONVENTIONAL IRRIGATION AND SURGE IRRIGATION

Time Sequence of Irrigation Sets



While water may sink far beyond the root zone in the top of the field under continuous irrigation, distribution across the field may be improved by surge flow valves. The kind of difference depicted above is most likely to occur during preirrigation or on coarse textured soils.

Plagge tested the mechanical valve last year and saw very little damage, so he's marketing it this year. Still, he plans to caution potential buyers about this possibility.

"If you have old concrete or have had problems with it, you may want to consider a diaphragm surge valve instead," he explains.

The potential for hammering can be avoided, says Patricia Bruno of P&R Surge Systems. "If you put a dead load on the flap on the low-pressure side of the valve, then try to move the dead load by introducing new water into that static pipe full of water, that could create hammering," she says. A dead load would be created if all the gates along several joints of pipe were closed as the valve switched.

"We recommend you crack the first gate so the water will drain out of there."

To avoid the possibility of collapsing the pipe, P&R includes a 2-inch vacuum release port on the system. But Bruno adds that the irrigator may help avoid the problem by rolling one of the lengths of the gate to just above horizontal so that those gates are higher than the rest of the gates. This will draw in air and keep the pipe from collapsing.

Despite these concerns, interest seems high this winter in the positive action mechanical valves, Plagge reports. They could prove somewhat more reliable than diaphragm valves, especially for irrigators with low-volume wells, say Plagge and Hooker.

The P&R and Waterman valves should be available in several locations in Kansas this year. One thing to consider in buying a Waterman valve is that all service calls are handled only by a specialist out of their Garden City office.

After selecting a valve, the irrigator then will probably have a choice of controllers available to go with the valve. The most basic and inexpensive controllers allow the irrigator to choose just one cycle time per set.

More advanced controllers offer the option of changing cycle times within a given set.

The mechanical valve systems commonly available have their own controllers. With a Hastings valve, however, the buyer has a choice of controllers, Plagge says. Teeter offers the Brandon & Clark and Geoponics. A controller from Lubbock Electric also is available.

"The Brandon & Clark controller will take a higher pressure (about 1-1/2 pounds more) than the Geoponics. It has a digital readout and can tell you how long the set has been on. The valves in it are small, though, and can have problems with sand," Plagge says.

"The Geoponics is less expensive and can take lower pressures. It's not as fancy, but, overall, it doesn't have as many problems," he adds.

Once the valve and controller are selected, the buyer may have the option of getting a solar-powered system rather than battery powered. This can overcome the problem of the occasional dead battery, but it's a convenience that costs. By replacing or recharging the battery every 2-3 weeks during the irrigation season, the farmer would never have problems with a battery-powered system, Plagge says.

Problems did occur in some surge systems last year, and many of them were battery related, Plagge says.

"We were having controller problems and motors burning out. The intermittent surges in the 6-volt batteries they put in caused a lot of this. We switched them over to 12-volt wet cell batteries and that solved it," Plagge says.

Lindy Cooper was one of the farmers who had trouble with his controller at first. He lost 5,000 bushels of corn on one 100-acre field because the valves failed to switch when they should.

But as the season progressed and the problems got solved, Cooper became more satisfied with his surge system. He plans to switch to a mechanical valve this year.

"If they work dependably, I'll probably go with surge on all my furrow-irrigated fields," he says.

He also likes the idea of having a solar-powered controller. "They'd be more dependable than those batteries," he explains.

Cooper says he saves a lot of tailwater by using surge irrigation. "And I loved it for prewatering." He uses 1-hour cycles in a 24-hour set.

There are still many unknown factors in surge irrigation. Many farmers aren't waiting for all the answers, though. So far, they appear to be making a wise move.

Surge Irrigation

Advantages: Irrigators can save up to 50 percent of their water on prewatering application, especially on high-infiltration soils. Then during the season, surge can help distribute the water more uniformly. Irrigators with low-volume wells may find it easier to get water across their fields. Overall pumping costs may go down by 20 percent or more.

Disadvantages: The main disadvantage of surge irrigation is that the irrigator has to be very careful to put on enough water for the crop. It's easy to cut back on water use so much that the crop suffers. Also, some irrigators won't find it worth their time to string out the extra pipe necessary to get water to the surge valves in the middle of the set. The cost savings may not be great enough.

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CLEANING WATER DISTRIBUTION SYSTEMS WITH POLYURETHANE FOAM PIGS

The polyurethane foam pipeline cleaner, called a foam pig, is a projectile cleaning device propelled through a pipeline either by water or by air pressure applied to the rear seal.

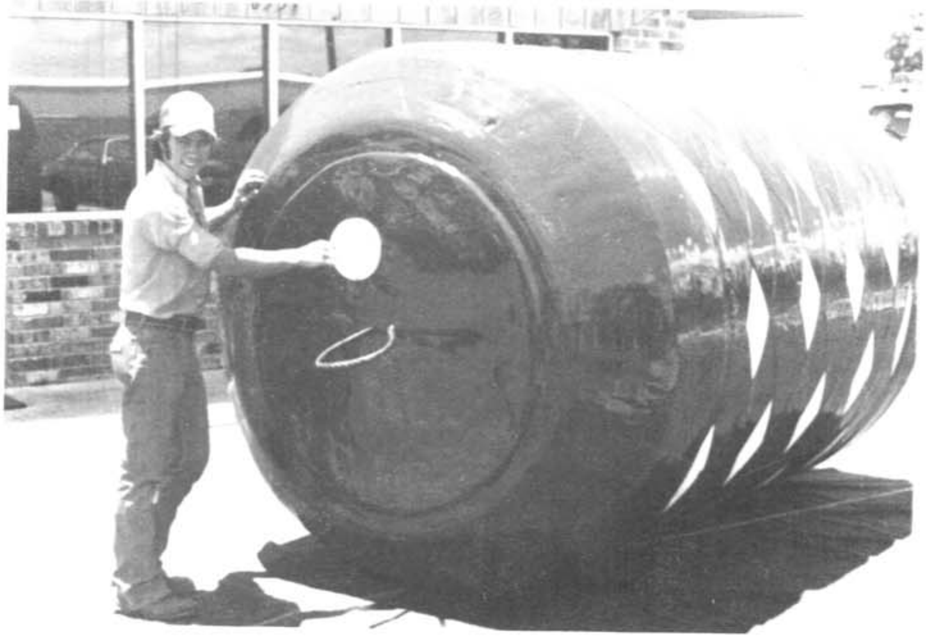
On pipelines 4 inches and larger, existing water pressure and volume are utilized as the means of propulsion, if the volumes are adequate. Cleaning is accomplished, according to Poisson's Law, by the friction drag on the front of the pig and the pressure being applied to the rear of the pig. These two opposing forces then meet and turn outward, causing the middle portion to scrape or rub against the pipe walls. With pressure being applied to the rear, a high-velocity bypass of water moves past the pig at the interface between the pig and the pipe wall. This high velocity ensures that the area ahead of the pig will be purged of loose debris that is in the pipe and has been scraped or broken loose. The importance of the bypass is apparent on viewing the large amount of debris coming out of the line ahead of the pig.

Under normal conditions, the foam pig is designed 2 percent over the size of the inside diameter of the pipe. Pressure, volume, type of pipe, purpose of the pig, and type of material to be removed all have a bearing on the size and type of pig. Most foam pigs are made in three densities of foam—2 lb/cu ft, 5 lb/cu ft, and 8 lb/cu ft.

There are also four basic types of pig. The 2-, 5-, and 8-lb/cu ft sizes are made for the type 1 pig, which is bare without any coating on the body, but with a coating of high-density urethane coating on the rear to create a pressure plate and seal. The type 2 pig is a criss-cross type, with the high-density urethane applied in a manner similar to Kellums Anchor (that is, criss-crossed bands that allow expansion and contraction without tearing the bands). It allows the expansion and contraction of the pig, plus provides scraping and heavy wiping action.

The other two types are abrasive. Type 3 is made with a carbide strap. This pig type is constructed on the same body and has high-density urethane criss-cross wrap with heavy grit silicone carbide applied on one of the spirals. The best application for this pig is in very hard deposits or where polishing the interior of the pipe is desired. The most effective abrasive foam pig is the wire brush, type 4. It is also constructed like the criss-cross type, but has fine flame-hardened wire bristles with cloth backing embedded in the high-density urethane. All pigs have the pressure seal on the rear. Types 2 through 4 come in all sizes.

Foam pigs have several important advantages. They are compressible, expandable, and flexible, which permits them to travel multidimensional pipelines and clean each pipe. They will go around bends as sharp as a two-section mitered bend, short-radius 90-degree bends, and make abrupt turns in tees so that lateral lines can also be cleaned. They will also travel through gate valves, ball valves, plug valves, and swing check valves with as little as a 65 percent opening. It is virtually impossible for the foam pigs to become stuck when they are used properly.



Foam pigs can be molded to any size; this model's diameter is 6 feet.

When heavy, thick deposits are a problem, the foam pigs have proven successful when the progressive pigging method is applied. This method allows the user to start with a small pig and progress with larger sizes until the deposits are removed. Progressive pigging also permits controlled cleaning when the pipe is not in sufficient condition to withstand excessive pressures. The user can halt the progress of the pig at any given point to avoid overcleaning or pressurizing, thereby preventing red water or pipe rupture.

Foam pigs are light in weight. For example, a 30-inch pig weighs less than 125 pounds, so on lines less than 30 inches in diameter, such lifting devices as cranes, backhoes, and hoists are unnecessary. Because of its light weight, the pig actually becomes a part of the flow and will exit in the water stream, thereby avoiding the danger of projectile exit posed by heavier-model pigs.

Long distances are no problem for foam pigs. Line lengths of 50, 500, 5,000 feet, and longer can be cleaned with openings at only the launch and retrieval sites. With careful planning, grid sections of a potable water system can be cleaned with minimal entry and exit points.

Foam pigs offer significant costs advantages; compared to other pipeline cleaning methods, it is very inexpensive.

A few limitations on the use of foam pigs should be considered for optimum performance. The pig is a one-time use product; it cannot be reconstructed or rebuilt once it is worn out. High concentrations of some acids will shorten the life of the pig. Another limitation common to all pressure-propelled projectile pipeline cleaners is that it cannot be used to clean totally plugged lines.

Excavations are usually needed only at the launch and retrieval sites. The size of excavation is dependent on pipe size and burial depth. Usually, the launch point and retrieval site are brought to the surface so as to facilitate easy access.

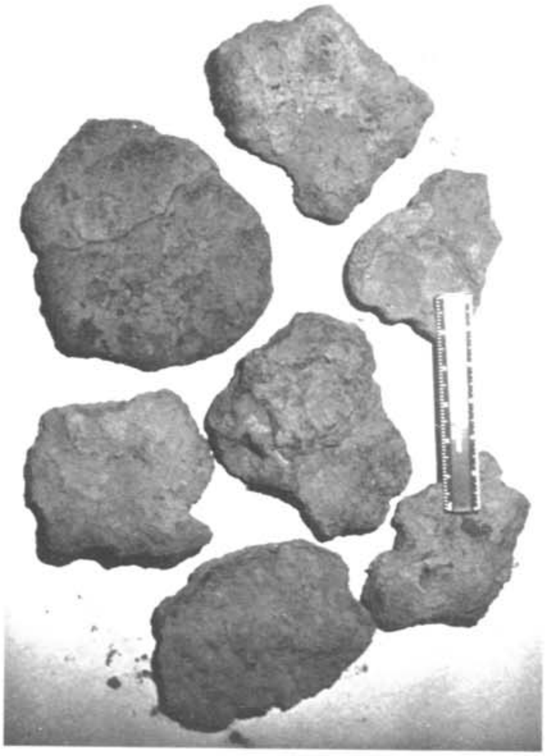
Pig being launched into a fire hydrant.

Pig being recovered from a fire hydrant.

The equipment needed is also dependent on line size and location. A job requiring excavation also entails use of a backhoe and operator. Usually a launcher is also needed. Typically, a launcher consists of a section of pipe one size larger than the pipe to be cleaned which reduces down to the pipe's diameter. A closure or cap is affixed to the rear end so volume and pressure can be applied to move the pig into the main line. Usually, at this point, the main-line volume and pressure are applied, enabling the launcher to be isolated and opened to receive another pig. Many times, however, the launcher and launch water and pressure are utilized to propel the pig the full length of the run.

It is convenient to have some other equipment on the job, such as a pressure recorder, pressure gauges, fire hose, standard wrenches, two-way radios, pipe cutters, and the like. The pressure recorder is very important; it is used to record runs, pressures, and location of the pig as well as to provide evidence of cleaning. Pressure gauges give instant information on the current cleaning conditions. Observation of pressure gauge and pressure recorder can often pinpoint problems as soon as they occur.

Sophisticated receivers (or pig catchers that allow retrieval of a pig in a closed system) are not usually needed for distribution mains or raw water lines. However, when sewage lines are cleaned, the receiver functions as a reversed version of the launcher, with a valved outlet to enable the discharge ahead of the pig to continue to its destination as well as to allow the bypassing of the pressure. When the pig enters the receiver barrel, the flow then goes around the pig to the bypass line. A stopple, basked, or barred section must be put into the receiver to prevent the pig from also going down the bypass line.



These larger tubercles were removed by pigging.

After the pig enters the receiver, the main line is opened and the receiver valve and bypass valve are closed. This isolates the pig in the receiver. The drain valve should then be opened to relieve fluid and pressure. The door may then be opened to remove the pig. The system is then returned to pigging condition.

When a receiver is used, it is advisable that a rope be built into the pig for easier handling.

Normally, a bypass service is not necessary when pipe is cleaned with foam pigs, because the service to residents can be controlled by each pig run. On exit of each pig, the service can be restored to residents within a few minutes. Of course, for an extended downtime, the method explained here would entail use of auxiliary piping.

For best cleaning, flow should be maintained at between 2.5 and 5 ft/second, which ensures pig velocity at approximately 95 percent of the rate of flow. When flow falls below 2 ft/second, water volume tends to bypass the pig. If the velocity exceeds 15 ft/second, the pig has a tendency to hydroplane.

Pressure requirements are probably the most difficult aspect of pipe cleaning to ascertain. Volume, friction loss in the pipe, deposit thickness, type of deposit, pipe material, length, and many other factors need to be evaluated when pressure requirements are set. Guidelines from Girard Industries, Inc., should be followed in determining pressure. Furthermore, it is important to ensure safe operation at the required pressure by use of pressure gauges, recorders, and pressure-relief valves.

The rate of cleaning is determined by the location of the pipeline and the surrounding terrain; the pipeline depth; the length and diameter of the pipeline; the deposit thickness and hardness; the volume and pressures available; the type of prime mover (pumps or gravity); and the type of launching and receiving facilities. Many variables affect the rate; thus, it is important to gather data for each variable in order to make an accurate estimate of the time needed. For each pig run, it is also necessary to calculate a velocity that gives an approximate time for a pig run. Fifteen to 30 minutes should be allowed between runs for loading and fastening the launcher. These calculations plus the planned number of pig runs can be used to estimate a total time to completion.

Prior to any pipe cleaning job, disposal or removal of water and deposits must be considered. The Environmental Protection Agency, property owners, and other authorities need to be consulted before the job is begun. If the water is allowed to exit onto a street or to the ground, care must be taken to ensure that drainage is proper and adequate. If water must be contained, as with sewage lines, the quantity of water and sludge in the pipeline needs to be calculated. A full 20 percent or more volume should be available in the storage area or tanker.

Distribution lines can normally be emptied onto the street. It is suggested that sandbags or a screened barrier be placed downstream to catch the solids and allow excessive water to pass down storm drains.

Raw water lines can usually be emptied into the treatment plant retaining ponds, with the solids to be settled out as normal water solids are settled. This enables the treatment system to be used continually while cleaning work is going on.

Sewage force mains present a greater disposal problem. These lines are normally cleaned in the direction of flow; thus, the water and sludge can ultimately be disposed into the retention ponds.

For force mains that become gravity mains into a lift station, care must be taken to ensure that the wet well or pump capacity is not overloaded. If this type of cleaning is required, it is recommended that cleaning begin at the lift station nearest the treating plant and progress away from the plant with each line that is cleaned. This allows for constant disposal through lines capable of carrying the maximum capacity.

Should water and solids be required to be trucked to another location for disposal, two valved discharge lines should be provided, so that as one tanker is filled simple valve switching can provide for uninterrupted flow. A sufficient quantity of tankers should be on hand, of course.

At least two workmen should always be on hand to open and close the launcher and operate the valves. Many industrial plants insist that an authorized party from the plant activate the valves. If this is the case, the responsibility is not borne by the cleaning service company.

Every job should be supervised, and the supervisor should have an assistant. The supervisor will be in charge of the physical cleaning operation. It is the supervisor's responsibility to select the proper type and style of pig for each phase of the operation. This is done by reading the pressure gauge, pressure recorder, and the discharge, selecting the proper flow and pig. On exit, the pig's condition will inform the supervisor as to whether to increase the pig size, change the pig type, or continue with the originally selected pig.

Above, pig exiting.

The assistant supervisor will be present at the opposite end of the pipeline to relay information back to the supervisor.

Other personnel on hand will include backhoe operators, truck drivers, pipe fitters, and so on, as required for each individual job.

After cleaning, the line should be flushed until the discharge runs clear. This can be accelerated by running a swab type pig once or twice through the line. When the discharge begins to run clear, it is advisable to use 70 percent granulated chlorine crystals in slug form and begin pumping down the line. After about 5 minutes, a swab should be inserted to make a final sweep and to keep the chlorine in slug form for removal out of the pipeline.

If the lines are to be cleaned to improve flow, decrease pump pressure, and increase discharge pressure, then it is only necessary to clean the wall of the pipe. It is not necessary to remove every tubercle.

Above, flushing the line after pigging.

If cleaning is undertaken to meet a predetermined C factor, then the orignal C factor when the pipe was new must be considered. Care must be taken when the objective is to reach a predetermined C factor on unlined pipe. If it is overcleaned, all the black iron oxide will be removed, and the bare pipe is then exposed to water, causing red water to appear and entailing further chemical cleaning.

Experience has shown it is better to set out to meet desired flow and pressure requirements than a given C factor requirement. Sometimes twice as many pigs are needed to clean to the latter than to clean the former.

When the objective is to meet a relining requirement, it is often necessary to use chemicals in conjunction with projectile type cleaning to remove any deposits that will prevent the lining material from adhering in the proper manner.

After cleaning with foam pigs, it is not unusual for the C factor to be increased from 30 or 40 to as much as 130 to 135. It is also not unusual for flows to be double, triple, and even quadruple; pumping pressure can decrease by the same magnitudes. The cost of the cleaning job can be recaptured in six months to a year through decreased power consumption and chemical feed, reduced line breaks and fire insurance premiums, and improved water quality. Above all, these benefits mean satisfied customers.

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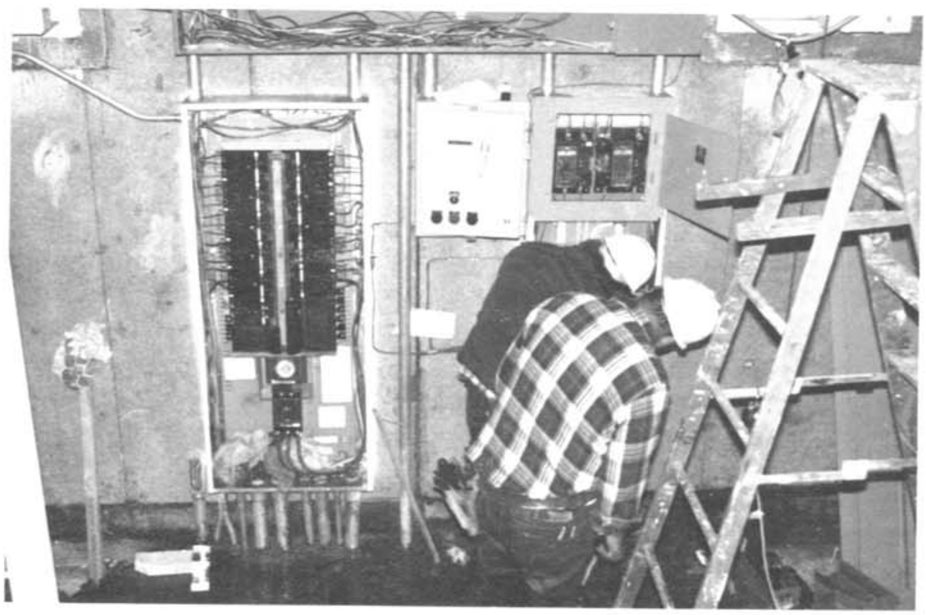
FLOODING OF TUNNEL AND CONTROL HOUSE AT CURRANT CREEK DAM

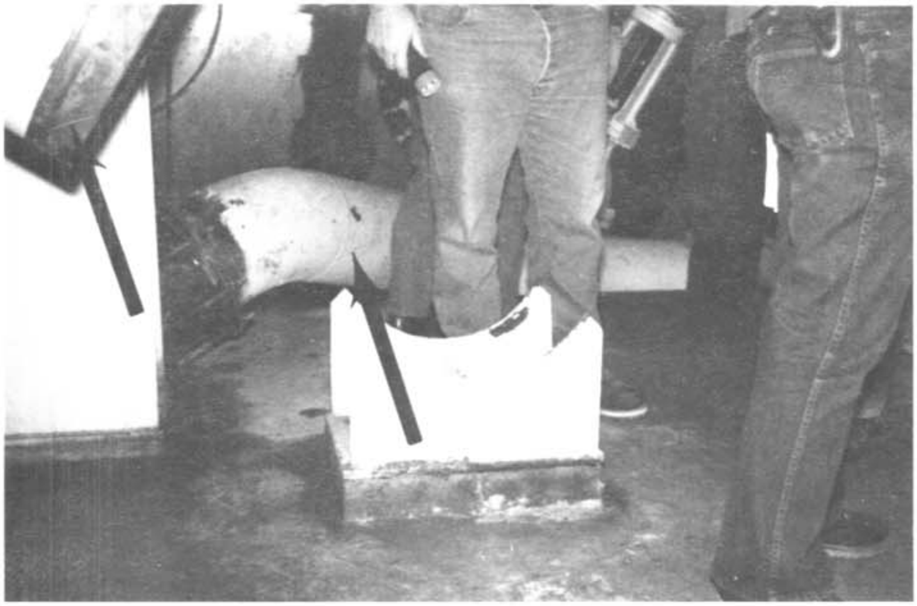
On April 9, 1985, L. J. Yocom of the Water O&M Branch and D. W. Beard of the Mechanical Branch, E&R Center, Denver, traveled to Currant Creek Dam to inspect damage to the outlet works from flooding that occurred on April 6, 1985.

When Messrs. Yocom and Beard arrived, work was well underway by Utah Projects Office personnel in drying out electrical equipment, replacing switches and breakers, and assessing other damaged equipment. All electrical devices in the control cabinets were found inoperable and required replacement. A section of the ventilation duct in the access tunnel from the control house to the outlet works tunnel had collapsed from external pressure of flooding. The downstream section of 12-inch filling/bypass pipe had separated from the 20-inch bypass line at the entrance to the gate chamber access tunnel, which provided the source of water for flooding. Displacement of the pipe occurred at sleeve type couplings, which were unsupported for thrust loading.

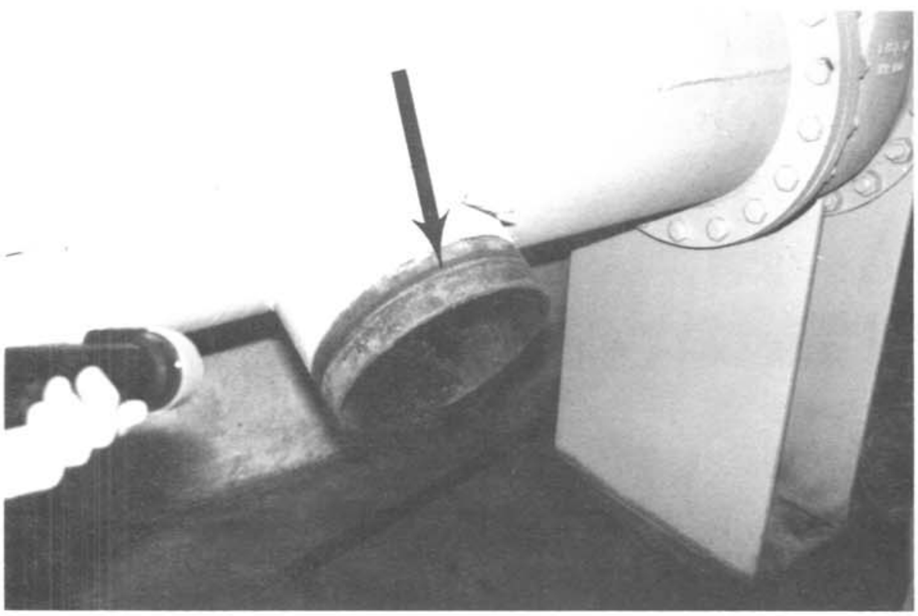


Electrical equipment in the control house at Current Creek Dam which was essentially destroyed by flooding.

This article was written based on the travel report dated April 16, 1985, by L. J. Yocom, Water O&M Branch, and D. W. Beard, Mechanical Branch, E&R Center, Denver.



Seperation of coupling flooded entire outlet works access shaft. The 12-inch filling/bypass pipe that blew apart is in the background.



The 12-inch filling/bypass connection to the 20-inch bypass pipe. The connection separated due to unsupported dresser coupling for thrust loading.

Emergency generator transfer switch located in the access tunnel was flooded. Note collapsed ventiliation duct from external pressure.

Example of dresser-style coupling unsupported for thrust load.

Class E type flange which will replace the sleeve-type couplings.

Following is an incident report documenting the sequence of events involved in the flooding of the outlet works.

On Friday, April 5, 1985, around 6 p.m. Utah Projects Office O&M personnel left the Currant Creek Dam outlet works area and stated everything was functioning okay. When they returned about 6:30 a.m. on Saturday, April 6, 1985, they reported the emergency generator was running which indicated to them that something was wrong. When they opened the control house door and stepped on to the stairway landing, which is about 12 feet above the floor, they discovered water flowing inside the control house approximately 10 feet deep.

At first they thought a sleeve-type coupling on the 12-foot-diameter outlet pipe had worked loose and was the source of the water flow. Practically all of the control panels were under water. The auto transformer trip panel for the emergency generator was also submerged.

The 9- by 12-foot high-pressure gate was closed from the gate chamber control deck on the crest of the dam; however, this did not stop the waterflow in the control house.

An assumption was then made that the water was flowing out of the 12-foot-diameter pipe, through the 20-inch bypass pipe, and there was a real danger that the 12-foot-diameter pipe may float from its supports. They opened the access cover over the 20-inch guard valve on the bypass pipe which connects to the main outlet pipe. The purpose of this pipe is to provide minimum flow to the river below the dam. The chain operator was not completely submerged and they were able to catch hold of the chain with the use of a step ladder and close this valve.

A slight reduction in flow from the tunnel was observed, however, waterflow continued. It was then suspected that flow was coming from the 12-inch filling/bypass pipe which must have separated or ruptured. This pipe connects upstream from the 9- by 12-foot high-pressure gate at the gate chamber. There is a guard valve in this line in the tunnel near the gate chamber. Returning to the crest of the dam, Frank Dimick and Marvin Bird went down the access shaft ladder to the tunnel. Water was waist deep and there was considerable smoke in the tunnel and control house. The 12-inch filling/bypass line and guard valve are located on the opposite side of the 12-foot-diameter outlet pipe. Marvin Bird climbed over the pipe using a sleeve-type coupling on the outlet pipe as a ladder only to find the 14-inch ventilation duct between the concrete tunnel roof and the top of the outlet pipe blocked his way. However, he managed to squeeze through the narrow opening and down the other side and found the filling/bypass guard valve handwheel in waist deep water and was able to close the valve. The water flow stopped and began to drain out of the tunnel and control house.

Following the draining operation they returned to the access way along the 20-inch bypass pipe and found that the 12-inch filling/bypass line which connects to the 20-inch line at this point had separated at the sleeve-type coupling at the connection. It had also pulled free at the next upstream coupling length of pipe about 10 feet further upstream. The coupling was on the floor near the wall and the 12-inch pipe and valve also was on the floor rotated 180 degrees from its installed position.

The cause of the failure was due to the fact that the sleeve-type coupling had no thrust protection and the force due to internal pressure had overcome the friction force of the coupling on the pipe causing it to separate. It did so with such force that it bent a portion of the 12-inch valve support and its anchor bolts.

It was agreed, by field and E&R Center personnel, to replace four 12-inch sleeve-type couplings which are not protected from thrust loading with flange joints. Class E flanges will be used because their hub design allows sufficient movement of the flange to compensate for the gap between the ends of the pipe inside the sleeve-type couplings.

The 12-inch pipe will be placed in its installed position and flanges will be tack welded in place so the correct flange location can be determined before they are welded to the pipe. Finally the coal-tar epoxy lining will be repaired at each weld and the pipe assembled.

Flooding of the control house and access tunnel inundated essentially all of the electrical controls including the emergency engine generator automatic transfer switch. Replacement of most of this equipment will be required to return the outlet works to service.

The flooding event and subsequent damage could have been substantially worse if it were not for the immediate action and excellent knowledge of the system displayed by Utah Projects Office personnel, in particular Frank Dimick and Marvin Bird. Failure to analyze the situation properly, or misoperating the outlet gates under the flooded condition of the access tunnel, could have resulted in floating the 12-foot-diameter pipe. This condition could have caused severe damage to the steel pipe and threatened the evacuation and operating capability of the dam.

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GPO 847-647

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