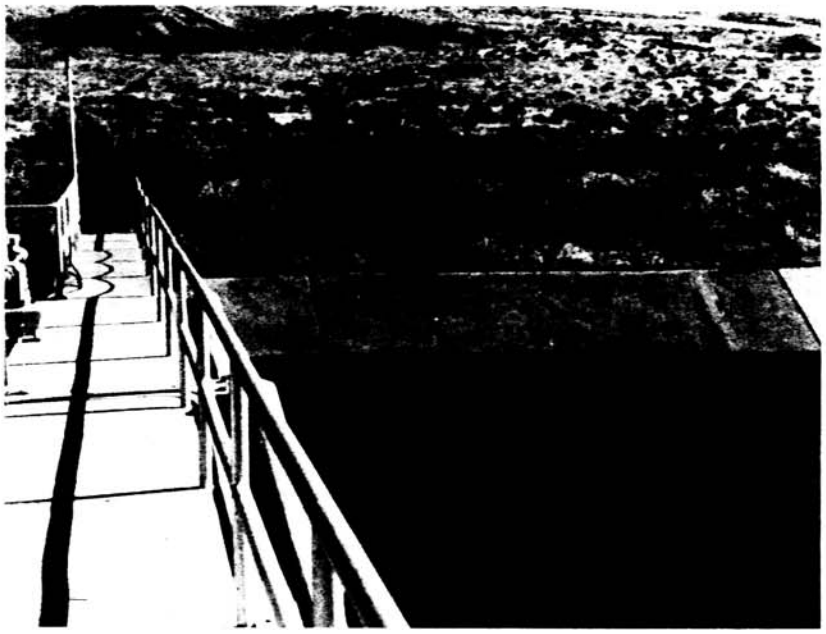
WATER OPERATION AND MAINTENANCE

BULLETIN NO. 131

MARCH 1985



IN THIS ISSUE

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 Suggestion Award Committee when a suggestion is adopted.

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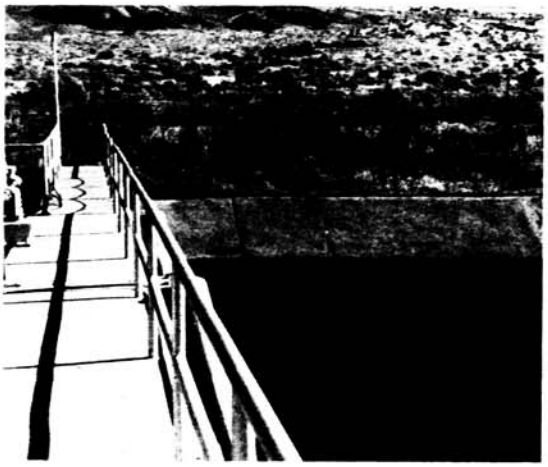

Cover photograph:

Target installed on the High Hill Check, Quincy-Columbia Basin Irrigation District, Washington, in an attempt to alleviate vandalism.

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INTRODUCTION

Vandalism is one of the most persistent problems that irrigation districts face. The article on page 1 shows how the Quincy-Columbia Basin District has dealt with that problem.

The article on page 3 tells how you can avoid pump strain.

Guidelines for the removal of trees and other vegetative growth from earth dams, dikes, and other conveyance features are on page 5.

See page 7 to learn how the Farmer's Irrigation District cut electrical costs and gained some income from their allotment of irrigation water.

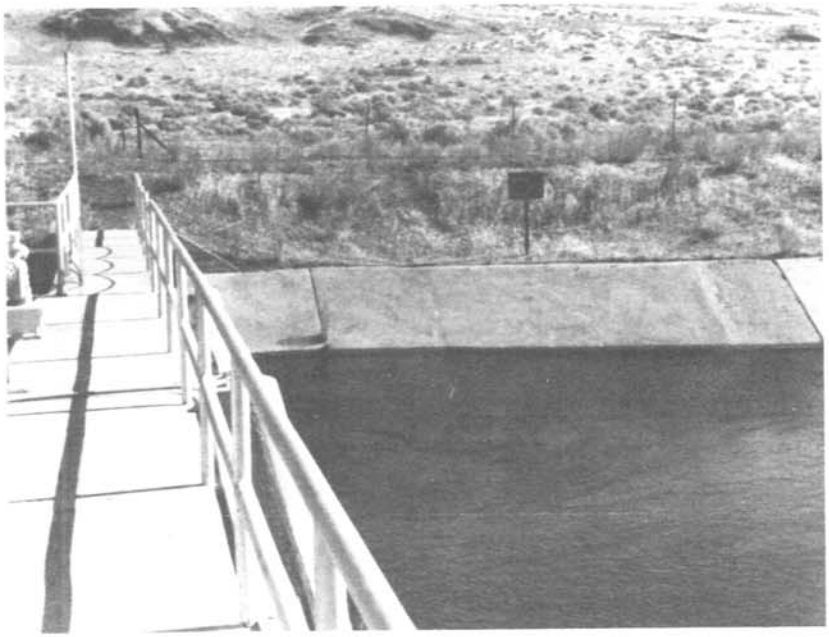
The article beginning on page 12 tells why many experienced and new irrigators are looking toward the most fuel efficient internal combustion engine, the diesel.

First aid kits come in many types, shapes, and sizes. The right first aid kit is a vital part of your overall first aid training program. See page 16.

ALLEVIATE TEMPTATION

Are your windows, light standards, control panels, and other equipment being used for target practice? If so, you may want to consider two ideas used by the Quincy-Columbia Basin Irrigation District, Washington.

As shown in photograph 1, in an attempt to prevent vandalism the District installed a target upstream from this check structure on the far side of the canal. This has somewhat alleviated the problem, as it appears that the target rather than the structure equipment now receives the major portion of the bullet holes.



Window panes at Quincy-Columbia Basin Irrigation District pumping plants were continuously being broken by rocks or bullets. Rather than replace the windows with glass, the District now covers them with galvanized sheet metal.

The building extension, shown in photograph 2, contains switchgear equipment for pumps. In the past people have shot through the windows and bullets have penetrated the switchgear. Serious problems can occur if switchgear panels are not protected.

These items were extracted from the 1984 Review of Operation and Maintenance Examination report of the Quincy-Columbia Basin Irrigation District by Virgil Temple and Gene Sell. Virgil Temple is an Irrigation Systems Specialist in the Pacific Northwest Regional Office and Gene Sell is a Hydraulic Engineer in the Columbia Basin Project Office.

The District feels that if riflemen cannot see into the buildings, they are less likely to shoot into them.

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HOW YOU CAN AVOID PUMP STRAIN

So you've installed a centrifugal pump for an important application. You've taken steps to avoid problems with drainage, lighting, alignment, and lubrication. But have you taken care to minimize pipe strain?

Pipe strain interferes with pump performance and may cause internal metal failure. Problems can spring from a variety of causes, including misalignment, temperature changes, pressure deformation, foundation movement, improper flange alignment, and inadequate pipe support. Preventing these problems requires an understanding of the forces at work in a pump.

A centrifugal pump is more than an object; it is a system made up of both moving and stationary parts. Because the rotating element is designed to perform with minimum wear, any contact or friction caused by binding of moving parts must be avoided. Internal forces can cause misalignment of seals. In addition, an entire pump can easily be pulled from proper position if bolts in the pump flanges are drawn to piping flanges that are not properly aligned.

Strain caused by initial misalignment is probably the most common cause of pump damage. At the time of installation, the suction and discharge piping and all associated valves, strainers, etc., should be supported and anchored near to, but independent of, the pump. This will keep strain from being transmitted to the pump casing. Don't overlook using pipe hangers or other supports at necessary intervals as well.

Another source of undue force is large temperature variations. Resulting expansion of the connected piping may subject the pump nozzles to substantial forces. Although such changes in the metal cannot be prevented, their effects can be minimized. Pumps designed specifically for high temperatures normally have a centerline mounting to minimize the effects of temperature changes. However, it is not usually practical to build a pump casing or baseplate to resist dimensional changes in the piping itself. Pipe strain due to pressure deformation at the pump casing can be reduced only by proper engineering.

Foundation shifting may be anticipated, but is hard to predict. The cost of designing strength into the pump and base is prohibitive compared to the cost of building adequate flexibility into the pipe system. However, the piping must be supported so that the resulting stresses cannot act on the pump.

Expansion joints are often used in the discharge and suction lines to help avoid transmitting pipe strains. Various joint types are used, such as those formed by looping the pipe (which is customary in steam piping) and the more common slip joint or corrugated diaphragm types.

Although expansion joints eliminate pipe stress when properly used, they often introduce an entirely new problem: transfer of high forces and torque on the pump and its foundations. Unless they are properly anchored and supported, expansion joints can cause more problems than they can cure.

It is not good practice to install expansion joints in the piping between the pump and the nearest point of anchor in the piping. A force equal to the area of the expansion joint (which may be considerably

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larger than the normal pipe size) times the pressure in the pipe will be transmitted to the pump. For example, if an expansion joint is located vertically ahead of the suction elbow, and if an 8-inch pipe is involved, the downward force is the product of the pressure (30 pounds per square inch) and the area of the expansion joint, resulting in a force of over 1600 pounds. This force can move a pump from its foundation, leading to substantial misalignment of the pump and driver.

Therefore, the expansion joint must be properly restrained to avoid undue forces being transmitted to the pump. Expansion joints can be properly installed on the upstream and downstream sides of the pipe anchor, although this may be impractical in many cases. Pipe couplings with slip fits that do not provide an axially rigid connection can cause the same problems as expansion joints, and must be similarly anchored.

Generally, expansion joints are not recommended for high-head pump installations. Illustrating the rapid rise of reaction forces with increased sizes and pressures, a 24-inch pipe and 160 lb/in^2 will produce a 70,000 pound, or 35-ton, reaction force. The casing would have to be almost entirely sunk in concrete to hold it in place, but no pump could withstand such forces.

Similar conditions can occur in vertical pumps. For example, in a pump discharging 20 lb/in^2 through a 30-inch pipe, an approximate force of 18,000 pounds exists at the below-ground discharge point. This is enough to cause complete failure of the unit if the flexible joint is not restrained with tie bolts.

Expansion joints are also not recommended for use on pumps that produce low-frequency pressure pulsation, such as slow-rotating sewage pumps or process pumps. The frequency of pressure pulsation normally equals the operating speed of the pump times the number of blades in the impeller. Strong forces can be developed that may cause the pump and piping structure to move if a near-resonant condition exists.

This recommendation applies to expansion joints even when supplied with tie bolts. Experience has shown that tie bolts are elastic and respond as springs to the forcing frequency of the pressure pulse, particularly with low-frequency pulses. The amplitude of a normal pressure pulse is about 3 percent of the total head of the pump. This causes disturbing vibrations to be transmitted to the pump, pressures that may damage the entire system.

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REMOVAL OF TREES AND OTHER VEGETATIVE GROWTH FROM EARTH DAMS, DIKES, AND CONVEYANCE FEATURES–GUIDELINES

Establishment of trees and other undesirable vegetative growth on earth dams, dikes, and conveyance features should be prevented by controlling the early stage growth. However, when undesirable growth occurs, proper maintenance of earth embankment dams, dikes, and conveyance features requires discriminate removal of trees and vegetative growth. The effect of this growth on safe operation of these features is judgmental; opinions vary widely as to practical and proper management procedures. Generally, tree growth on earth dams and dikes is undesirable and can lead to eventual dam failure by causing seepage paths to develop in the embankment. Decaying and rotted roots are hazardous. Old or large trees are susceptible to falling and the resultant uprooting may lead to the beginning of voids, weakness, and shortened seepage paths in the embankment. Shallow-rooted brush inhibits proper facility surveillance–from the standpoint of seepage, settlement, cracking, etc.–and provides habitat and food for rodents. All noxious weeds should be removed, regardless of the effect on the operation and maintenance of the facility.

The following guidelines should be used for all Bureau earth dams, dikes, and conveyance features. They are not "cast-in-concrete" rather, they should be used with reasonable judgment and practicality.

1. All trees and deep-rooted woody growth should be removed from earth dam embankments and dikes. Removal should be beyond 50 feet upstream and downstream from the toe of these structures.

2. Upstream and downstream groin areas should be free of trees and deep-rooted woody growth within 25 feet beyond each contact.

3. Earth dams and dikes having large tree growth or stumps from previously cut trees on or near them–based on above criteria–should be evaluated by an experienced engineer for future action; i.e., monitor, excavation and backfill, rebuild, etc. Generally, old root systems of large trees should be grubbed out and the embankment replaced and compacted to prevent the development of piping action.

4. Spillway inlet and outlet channels should be free of vegetative growth that could significantly impede water flow. Large, deep-rooted growth adjacent to the spillway, outlet, and other structures should be removed within 25 feet to prevent damage to them.

5. Judgment should be used to remove brush and small growth from earth dams and dikes. Usually, shallow-rooted brush and growth are not potentially hazardous to the facility as to creating seepage paths that could cause failure. This kind of growth should be removed when it hinders examination of the facility for seepage, settlement, cracking, etc. Growth also encourages rodent activity. Rodents are attributed to the formation of seepage paths and resulting failure. Removal of large vegetative growth or rodents from earth embankments may be by mechanical or chemical means; however, it

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These Guidelines were developed by Jerry Schaack, Division of Water and Land Technical Services, E&R Center, Denver. These Guidelines have been reviewed by the seven regional offices of the Bureau of Reclamation and are included in the forthcoming SOP Guidelines which are being published as a water resources technical publication.

should be done after consulting with experienced personnel or with a pest management specialist. The downstream face of dams which are susceptible to erosion damage may require grass cover. Periodically, it may be desirable to mow the grass to ensure proper surveillance and rodent observation.

6. Similarly, for open canals, laterals, and drains, the guidelines should be applied except the minimum distance beyond the outside toe of the banks should be 15 feet.

7. Likewise, for pipe conveyance systems, to provide operation and maintenance access and to prevent root encroachment, the clearance distance should be 15 feet from each side of the pipeline.

* * * * *

OREGON IRRIGATION DISTRICT FINANCES IMPROVEMENTS WITH HYDRO POWER

by

Ron Larsen
Editor

From about any angle it looks like a typical pump house. A neat, well-kept building nestled against a wooded-embankment with water pouring into a canal just below the building.

The key to the secret of the building is that the water is spilling into the canal, not being drawn from it. The centrifugal pump is, in fact, also a hydro turbine which is generating electricity as irrigation water drops some 512 feet in an enclosed pipe, through the turbine, and out into the canal. It's Farmers Irrigation District's way of cutting electrical costs, and gaining some income from its allotment of irrigation water.

"This is the most worthwhile project we've ever done," said Ladd Henderson, District Manager. In March 1984 the initial generation project was paid for, and work has begun on a second generation unit which will be 10 times the size of the Reed Road generation unit. "While the Reed Road project generates perhaps 600,000 kwh per year, this second unit will generate 600,000 to 1 million kwh per month," Henderson explained. The second unit which is being built on the nearby Hood River is scheduled to be operating in October of this year.

A third unit also is planned which will have both turbines and pumps for pumping water back up in to the upper reaches of the district.

For about two months of each year the district will be buying electricity for its irrigation pumping, Henderson explained, but the rest of the year its system will be generating profits for the district. The money will be used for an enclosed pipeline system which will replace the less efficient open canals.

"We're a relatively small district, with about 6,000 acres served and a budget of about $200,000 a year," Henderson explained. "We could not have undertaken these improvements (the enclosed pipeline) without our hydro generation." Even if the district were to double its levy, it could not make the system improvements that will be possible from the proceeds of power generation.

Henderson began work on the idea in 1977, and the Reed Road unit began generating power in 1981. In between, there were a lot of headaches, Henderson said. "You have to keep a lot of balls in the air to get a project like this . There's the federal licensing and state regulations, getting the project financed and getting the utility to buy your power. You can't get financing unless you're licensed, and you have to meet certain requirements to get the licensing."

This article appeared in the January 1985 issue of Irrigation Age and is reprinted with permission from the Editor.

One of the disappointments was the contract offered by Pacific Power & Light Company, the utility that serves that Hood River area.

"The hydro generation unit we got from the Cornell Pump Company (Milwaukie, Oregon) was rated at about 160 kw. We found we could generate 185 kw, but we found that we would be paid $3,000 to $4,000 less by PP&L than if we produced only 100 kwh," Henderson explained. So the answer was obvious. Henderson had the unit modified, throttled back if you will, so that it only produced about 100 kwh.

With the greater generation capacity of the new units, however, that will change and Henderson anticipates a payment of up to 7.2 cents a kwh over the 25-year period of the contract.

The Cornell unit at Reed Road is designed to work both as a hydro turbine and a pump, but Henderson said it has never had to be used as a pump. "There are some tradeoffs that have to be made if you're going to use it both ways," Henderson noted. "You lose some efficiency as a pump and as a hydro turbine, and that may make some differences as power costs continue to rise."

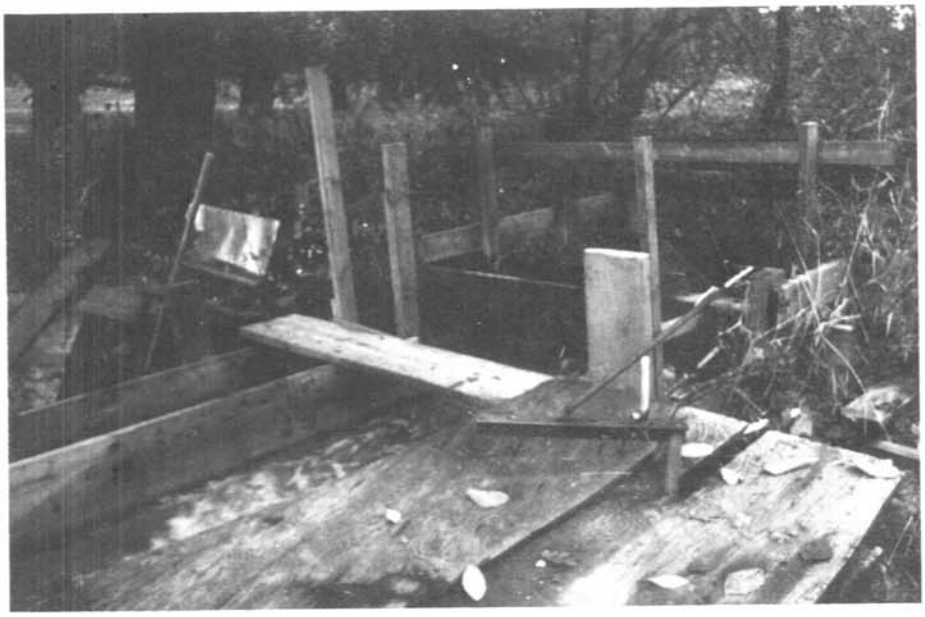
The Reed Road unit which is used about 9 months a year for generation will be replaced by the newer generation units, Henderson explained, but it has worked so well that he is thinking of having it moved to another area in the district.

While the units are being installed, Henderson is accomplishing part of the district's goal of having an efficient pressurized pipeline system throughout the district. A total of 28,000 feet of pipeline is being installed along with the three generation units.

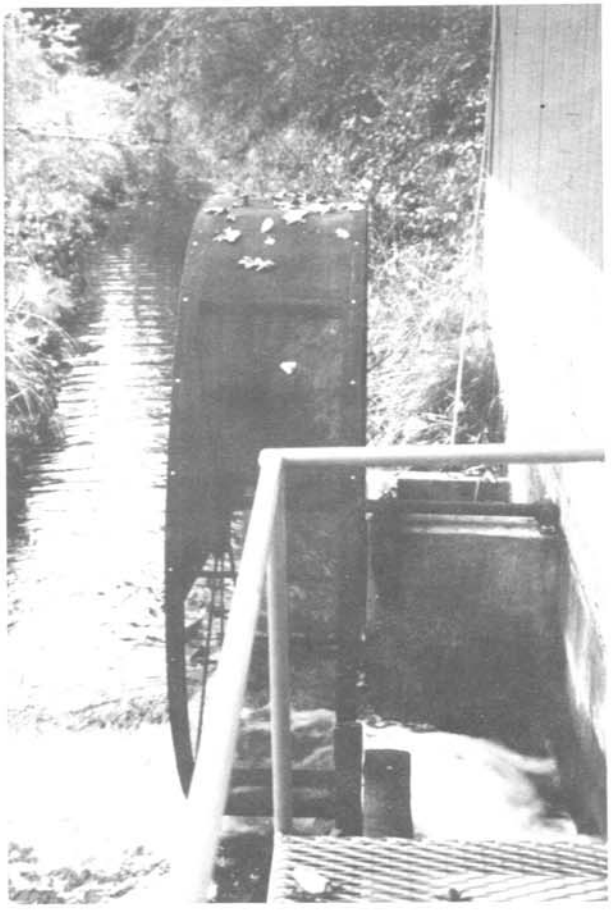
"There probably aren't two irrigation districts that are alike," Henderson noted, "but I think anyone who can should take a look at it (hydro generation)."

For Cornell Pump, the Hood River project is one of 40 hydro projects the firm has been involved in. At the time that the Reed road unit was built, Cornell also was involved in the design of the project.

"We don't do that anymore," said Glenn Tribe, Cornell's President and General Manager. "We leave that to others and just supply the necessary equipment." Of the 40 projects about a half dozen involve irrigation. The others are mostly non-agriculture projects including one in which a hydro turbine helps offset electrical costs for a hot-water heating system in a Chicago high-rise apartment complex.



A simple turn gate, located at the bottom of the upper photo, directs water from the upper canal into the pipe which feeds the Reed Road generation unit. The water (lower photo) then flows from the turbine into the lower canal.



For Cornell, the hydro turbine system is developing into a separate profit center for the company. "We're concentrating on the 50- to 300-kwh market," Tribe explained, "leaving the larger generation projects to General Electric and others."

The hydro turbine market even means a new set of terms for the long-time pump manufacturer. As an example, as Max Frey, Vice President for Engineering, pointed out, a pump impeller is no longer an impeller when you're talking hydro; it's a runner.

And, while Cornell's engineering department can design a more efficient runner for hydro generation, it's no good if you want to pump water with it, as well. That's where the compromise comes into play, and that's why Cornell recommends that your unit be designed to one or the other, but not both. Still, there are situations where the compromise must be made, Frey said.

The Cornell package includes an induction generator, and a flywheel is sometimes used to prevent a "runaway," Frey explained. As the turbine speeds up, water flow reduces rapidly if a flywheel isn't used.

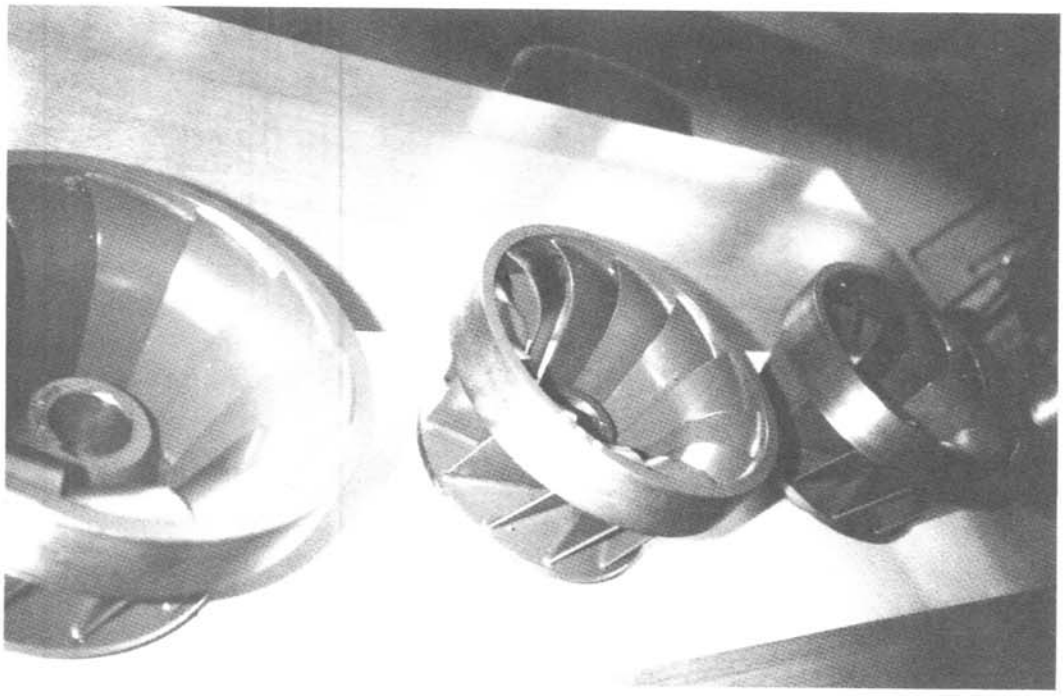
Okay, how do you decide whether your situation might qualify for hydro generation? Frey offers these suggestions:

The first step is to make an appraisal of potential water power. This, Frey said, is best done over several years. You need to determine the flow rate and the head drop available. Rainy season isn't always the best time to check either, Frey explained, because more flow usually means less head. However, you can compensate for erratic flows by using off-on multiple units which Frey feels is practical for small projects.

Another factor is that someone considering a hydro project should look at it as a high-risk venture and look for a quick payback. Frey said a long-term payback on a small hydro system just isn't practical.

Well, let's say you have an open stream, and you want to determine the potential water power. How do you go about it? You can either build a small weir, or "section" the stream, estimating the width and the depth and float a bottle through the section to measure velocity. Then, a transit can be used to determine the drop.

Entrance and exit losses are important considerations when designing a hydro system, Frey said. Sometimes the hydro outlet is 5 feet or more above the outlet stream. Frey said that is a loss of generation head which can affect the efficiency of your generation system. The hydro unit should be located as near the level of the outlet stream as is physically possible.



In this photo, an example of the hydro turbine's runners is set up for display.

Operating several hydro turbines in tandem makes sense for the small operator, Frey said, because if you have a breakdown in a unit you don't have to shut down the entire system. Also, big units take special components which may not be readily available. Smaller units have more readily available components which shortens down time.

However, putting together too many units may result in reduced efficiency because you reach a point of diminishing returns, Frey said. Friction loss through the units decreases the efficiency.

Above all else, the key phrase, according to Frey, is "keep it simple."

* * * * *

TRENDS FAVOR SMALLER, MORE FUEL EFFICIENT DIESEL ENGINES

One thing never varies among the philosophically opposed: energy costs aren't going down in the long run.

Another constant, and one that is adhered to more and more in the humid areas, is that crops grow best when water is applied when the crop most needs it.

Those two inter-related variables – water and energy – are leading to an interesting scramble for irrigators' dollars. Many power companies, which supply two-thirds of the irrigation water used in this country, are intensely advancing new, innovative programs to reduce power bills, in the face of growing non-agricultural competition for the power surge.

Energy audits, peak and off-peak load irrigation, satellite aided irrigation scheduling, well efficiency testing, peak season power transfers with other nations (Mandan), and Bureau of Reclamation aided storage and tunneling are a few such programs.

Still, many experienced and new irrigators are looking away from an uncertain cost-and-need electrical supply, and toward the most fuel efficient internal combustion engine, the diesel.

The demand favors quiet, fuel efficient engines that are smaller and more powerful than their predecessors.

On the upper end of the scale Caterpillar, Ford, White Engines, Cummins and others are engineering for durability as well as fuel efficiency.

"Fuel economy and power performance have to be the major consideration of any technology changes," said Bob Beckenbaugh of Caterpillar. The company recently announced an Extended Service Coverage program available on engines delivered after August 1, 1984, for one to four years past the one-year standard warranty.

"Service and ease of service are very important to the packages we offer," he said. "We consider ourselves premier in the business for farmers who work on the engines themselves. Our kits are complete with instructions for in-frame and out-of-frame overhauls.

He feels the American-based companies have and will have a competitive advantage because of service.

"The key, though, is the fuel efficiency out of the factory. Higher performance. Engines today are doing jobs with less horsepower than their predecessors. We have increased the injection pressures up to 44 percent, the rate of injection timing by 33 percent. With these better volume combustion characteristics we're looking at a 3 to 10 percent better fuel efficiency. That's good for the large irrigation engines," he said.

Reprinted with special permission from the October 1984 issue of Irrigation Age.

Fred Hess, of Cummins, said standards are getting tougher "because farmers have the micro computers and know their costs for running an irrigation system, matching yields, cost of the crop, etc. Everyone is looking for greater horsepower for less and less price."

Servicing is key at Cummins, too. Engines are designed so no special tools are required for servicing. "They're built with an enterprise concept in mind. Not a lot of hang-on parts. For instance, the water pump has but three or four parts. Just easier for servicing."

Hess said diesel will play an increasingly important role as "sprinkler irrigation grows. There is an uncertainity with electric power, and many hidden costs. Power rates are going up. In the Mississippi Delta area, for instance, rates will jump 20 percent in a year's time. This causes people to analyze their choice."

And that, said Brooks Harryman, White Engines, Inc., will lead to even more improvements. "Particularly with fuel injected, turbocharged engines with electronic ignitions. Things you press a button with and forget.

"But I expect even more changes in the upper horsepower ranges. The foreign competition, because of OPEC and resulting high energy prices, have built tremendous efficiencies into their engines which are just now coming into our market. They're beating us to death with these efficiencies, especially in the smaller horsepower ranges."

"Farmers are definitely looking for quieter, more efficient engines. They are just more fuel conscious than they were four to six years ago. They want to know the pumping costs, gallons per minute, cost per acre, rather than coming in and saying I want an engine," said distributor Mack Massey, Lubbock, Texas.

Massey ships engines nationwide, and certainly sees the trend toward diesel engines. "I have never seen so much comparison shopping. We have to be better prepared to answer questions about products than we ever were before."

In St. Paul, Minnesota, distributor Dave Norland said "the large stuff isn't priced competitively. That will be changing very rapidly, particularly with the larger engines coming in from Europe and Japan."

Norland said the irrigation market has matured. "There is a trend toward lower horsepower engines. But a greater trend than engine design is the bottom line on power costs: what's it going to cost me to get a gallon of water on the ground."

He said most people don't really analyze the total cost of electricity versus diesel. "What does it cost to run the wire to the pump? What are the start up or line charges annually? Are there higher charges for peakload use? There is more than the simplicity of just going out and turning on the motor.

"But I find that most farmers fail to get the full use out of a diesel. They are losing 60 to 70 percent of its capability. I have seen only one farmer who used his irrigation engine for purposes other than irrigation."

Norland said the leading engine in his part of the country is Deutz. "Nissan has a good engine, and goes up to 500 horsepower, but they don't have much experience and aren't priced competitively."

So where does Deutz fit in the market? Many insiders say the heat of the competitition is between Deutz and Deere in the 70 to 250 hp range.

"Deutz is a bigger, air-cooled engine, which has 40 percent less maintenance than a water-cooled simply because there isn't a water cooling jacket around it to cause problems," said Norland.

David Jackson, Deere and Co., said, "Of course we feel the foreign competition, but we're going to be competitive with Japan and European countries. There are a lot of evolutionary changes. We're now experimenting with a rotary engine. But, those things, like adiabatic engines and/or parts, will have to come."

Adiabatic engines, which most companies have in research and development phases, are basically a highly insulated engine that uses ceramic, high energy parts such as piston heads. Most likely, because of price, these parts will be integrated gradually into current generation-style engines.

"These things will revolutionize the industry," said Jackson. He said that Deere has been in the irrigation business about 12 years "and from our perspective the growth has been phenomenal." Their engines range from 3 to 8 cylinders.

Walter Steinbuchel, Deutz, said fuel efficiency and horsepower are the two key issues. "Since our fuel costs in Germany have been historically higher compared to this country, our engines are designed to be the most fuel efficient.

"A lot of this is due to the cooling system. An air-cooled system requires less horsepower, because whatever horsepower is required to drive the cooling system isn't available at the rear end of the engine," he said.

Air cooling, along with the shape and form of the combustion system, gives his engine a fuel efficiency rating 8 to 10 percent higher than most liquid cooled engines, he added.

Irrigators are also concerned about noise, which is an inherent trait to diesel engines. But, said Tony Woodward, Lister Diesel, it is a problem diesel manufacturers are working on.

"There is a lot of interest now in the silencing of engines. It has been quite strong in Europe, where there is a heavier density of population, and it is now coming here. They want something in the 85 decibel level or below," he said. That is about the noise level found inside a tractor cab.

He said the English company is working with metals to solve the problem. "You will see general engine noise dropping in the next few years," said Woodward.

Adiabatic engines are often thought of as the next diesel generation. Nearly every company here and abroad has some form of adiabatic research in the works.

Cummins and Caterpillar claim to be the leaders nationally. Steinbuchel and his colleagues tend to believe that fully adiabatic engines are "wishful thinking. Everyone talks about the engine that doesn't need any cooling at all, but they forget that while ceramics are a beautiful material when it comes to heat, it is not so beautiful when it comes to stress and pressure.

"That's why we see the use of ceramics in certain areas of the cylinder head area. From a practical standpoint that will come first, possibly by the end of the decade," he said.

Just that addition of ceramics should improve fuel efficiency by as much as 10 percent, depending on the informational source.

"Adiabatics will certainly be evolutionary," agreed Jackson, "But, you're looking at something that is at least five years in the making."

Cummins' Hess said because of price, that adiabatics will be seen in the higher horsepower ranges. "It just wouldn't be cost effective in engines below 250 hp."

Diesel engines have been improved considerably in the past five years, and it is a lively field of action as new technology and competition grow. For repowering or new installations, there has never been a more efficient lineup of engines available. It is a trend most certain to continue.

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FIRST AID PROGRAM: WHAT'S NEEDED

A first aid "kit" is as effective as what is placed into it.

This is just another way of saying that although the actual equipment and supplies in a kit are of great importance, there is more to be considered.

What may be often forgotten is that a first aid kit is really part of an overall program. The first aid program should be designed to ameliorate quickly the effects of any accident that is liable to happen in a particular plant.

It's becoming increasingly apparent that proper first aid training is a *vital* part of the package.

In fact, a study conducted in England indicated that first aid training reduced the injury accident rate of a problem group.

The experiment used a group of workers who had experienced high accident rates. They volunteered to take first aid training as an experimental group. A control group was matched to the experimental group for type of job, experience at that type of job, age (because of a consistent accident curve according to age), and nationality because of possible ethnic differences in reporting habits.

The experiment was complex and, in some respects, inconclusive, but one conclusion was:

> *Following the course, the experimental subjects' injury accident rates improved relative to the injury accident rates of the control subjects. Evidence from interviews held before and after the first aid courses suggested that this occurred despite the fact that the experimental subjects became more willing to report their minor injuries.*

A fully rounded program will also tap employee resources to get the right supplies into the first aid kit.

Supervisors, for example, can provide information on which jobs cause finger cuts and abrasions and which of these can prove greater infection risk.

In smaller companies where a high percentage of employees are office workers, a supervisor can tell which workers are stress prone. The supervisor will know which employees alternately cram sandwiches into their stomachs while working through lunch and other times "relax" by stuffing the same stomach with rich restaurant foods while talking business.

Such employees are prime candidates for cardiac arrest or some other sudden illness. A first aid "package" for them would include cardiopulmonary resuscitation equipment and a wellness program.

Once needs are determined, selecting the kit and its contents should not be difficult, because there is a wide variety of supplies to pick from.

Reprinted from NATIONAL SAFETY NEWS, December 1984.

First aid kits come in many types, shapes, and sizes. They range from the small pocket kits in zippered plastic bags to cabinets large enough to hold a stretcher and oxygen units, as well as first aid supplies.

Kits themselves come in three basic formats: unit kits, bulk kits, and more recently developed combination kits.

The compact *unit kit* is designed to be carried in trucks, utility vehicles, school buses, etc. Its contents are usually designed to deal with major traumatic injuries. They customarily contain splints, compresses, tourniquets, and triangular bandages.

Another feature of unit first aid kits is that the individual packages (units) are color-coded and sealed. The color-coding is for quick identification of contents in an emergency, and the plastic wrap seal is designed to let people know at a glance whether a package has been opened. One company's color-code is as follows: yellow, bandages; blue, antiseptics; red, burn treatments; green, special (such as ammonia inhalant ampoule) or miscellaneous.

Units are designed to be interchangeable, in the sense that if compress bandages are preferred over adhesive bandages in a particular kit, either will fit into the space provided.

Bulk kits are so named because they often carry supplies in bulk lots, such as bulk cotton gauze, rather than in individual units. They may carry items such as adhesive tape in rolls and individual plastic and elastic bandages.

Combination or bulk/unit kits contain a variety of smaller quantities of both the unit and bulk kits, in addition to specialty items, such as burn and antiseptic sprays, eye solutions, and bandages for hard-to-cover areas, such as the knuckles and the fingertips.

Some kits even contain non-prescription drug items, such as aspirin products, antacids, cold tablets, and throat lozenges. One manufacturer will include items such as scissors, tweezers, and a first aid booklet in such kits.

A major manufacturer of bulk/unit kits has developed a system that provides kits designed for various environments with kits for worker populations of from 5 to 100. Such an approach indicates the flexibility of such kits.

Kits and supplies are also available in special formats and for special jobs.

One such kit is a trauma kit, such as those used by ambulance and rescue squads. Other examples include a cloth type with pockets that is worn like a vest, glove compartment kits, vehicle-visor kits, pocket kits, snake bite kits, boat kits, bus kits, eye care kits, poison ivy treatment kits, welder's kits, and more.

Special supplies for kits can include tubular bandages, finger ring cutters, emergency blankets, small magnets for removing bits of ferrous metal from eyes, blister treatment materials, bee and wasp killers, and more.

Thus, in both kit format and supplies, there is plenty to choose from.

What is important is that the first aid kit selected contains the right kind of correct quantities for its location in the plant. For example, a welder's first aid kit in the office area is not the optimal selection. Also, a 50-person plant with widely separated production and office areas, probably should have something besides one 50-person general kit.

Check with distributors and manufacturers about the possibility of an individually tailored kit (or kits) for the operation in question.

Check also with the consulting physician before deciding on the contents and placement of the first aid kit or kits.

For a first aid kit filled for a work environment with many hazards, one manufacturer offers the following guidelines:

Burns–burn spray, ointment, and cold pack;

Cuts–gauze, tape, bandages, cut cleaners, gauze pads, antiseptics, items to stop bleeding, and items to prevent infection;

Eye injuries–eye washes, neutralizers, eye drops, magnets for removing metal particles, eye pads, and dressing sets;

Shocks or fainting–ammonia inhalants;

Fractures–splints, triangular bandages, air splints;

Contusions–cold pack, bandages;

Bee stings–bee sting relief swabs;

Splinters–splinter forceps;

Heart attacks–oxygen, airway.

All of the listed accidents–particularly the last one–point up the need for the other ingredient in the first aid kit–*training.*

Ideally, all employees should be trained. If that is impossible, at least foremen, supervisors, and people whose talents and background indicate capability should be trained in first aid and cardiopulmonary resuscitation (CPR) techniques.

Plants with a training department can use their own facilities. But smaller organizations and perhaps even larger ones might find it more cost-beneficial to have it done by an outside agency.

The prime supplier of first aid, CPR, and related courses is the American Red Cross. One user says that such training in some form is available for a donation or a small fee.

There are several ways the courses can be obtained. They can usually be arranged during the day or evening. If there are enough participants, classes can be conducted by a Red Cross instructor at the plant site. Alternatively, the classes may be coordinated with other such classes in the community. Another alternative is to have one key "first aider" trained by the Red Cross to be a qualified instructor. This person, in turn, can give classes at the plant.

Still another alternative is suppliers of first aid equipment. Some charge fees while others will provide the service for free.

A good guideline for how many employees to train is one trainer for every 100 employees.

More information on what is available in the community or area is to contact local chapters of the Red Cross or American Heart Association, which offers classes in CPR.

Some of the courses available from the Red Cross include Nutrition for Better Living; A Wellness Course; High Blood Pressure Control; How To Measure the Vital Signs of Body Temperature, Pulse, and Respiration; Basic First Aid; First Aid Modular System; Emergency Extrication; several varieties of standard first aid; several advanced first aid courses; some courses in CPR; and an instructor training program.

Other courses, with a less direct bearing on on-the-job safety and health, but important off-the-job, include swimming and life-saving, boating safety, family health, and various courses for young people.

There is plenty to choose from in first aid programs – enough variety to fit any plant's needs, regardless of size.

So there's no excuse, because *first aid is vital, not a last resort.*

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-922, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.