

Department of the Interior
Bureau of Reclamation

OPERATION AND MAINTENANCE EQUIPMENT AND PROCEDURES RELEASE NO. 48

APRIL, MAY AND JUNE 1964

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CONTENTS

Director and Manager Teammates (Okanogan Irrigation District)
How Wire Rope Lubrication Pays
Equipment Management
Metal Pipe Band Clamp
Project Operation by Boards of Control
Small Winches Bind Loads
Growth of Algae on Measuring Devices
Prestressed Concrete Bridges

Cover Sheet. Photograph shows erection of shade over the throat
of a Parshall flume on the Madera Canal, Central Valley Project.
The shade inhibits the growth of algae on measuring devices.
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OPERATION AND MAINTENANCE
EQUIPMENT AND PROCEDURES
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INTRODUCTION

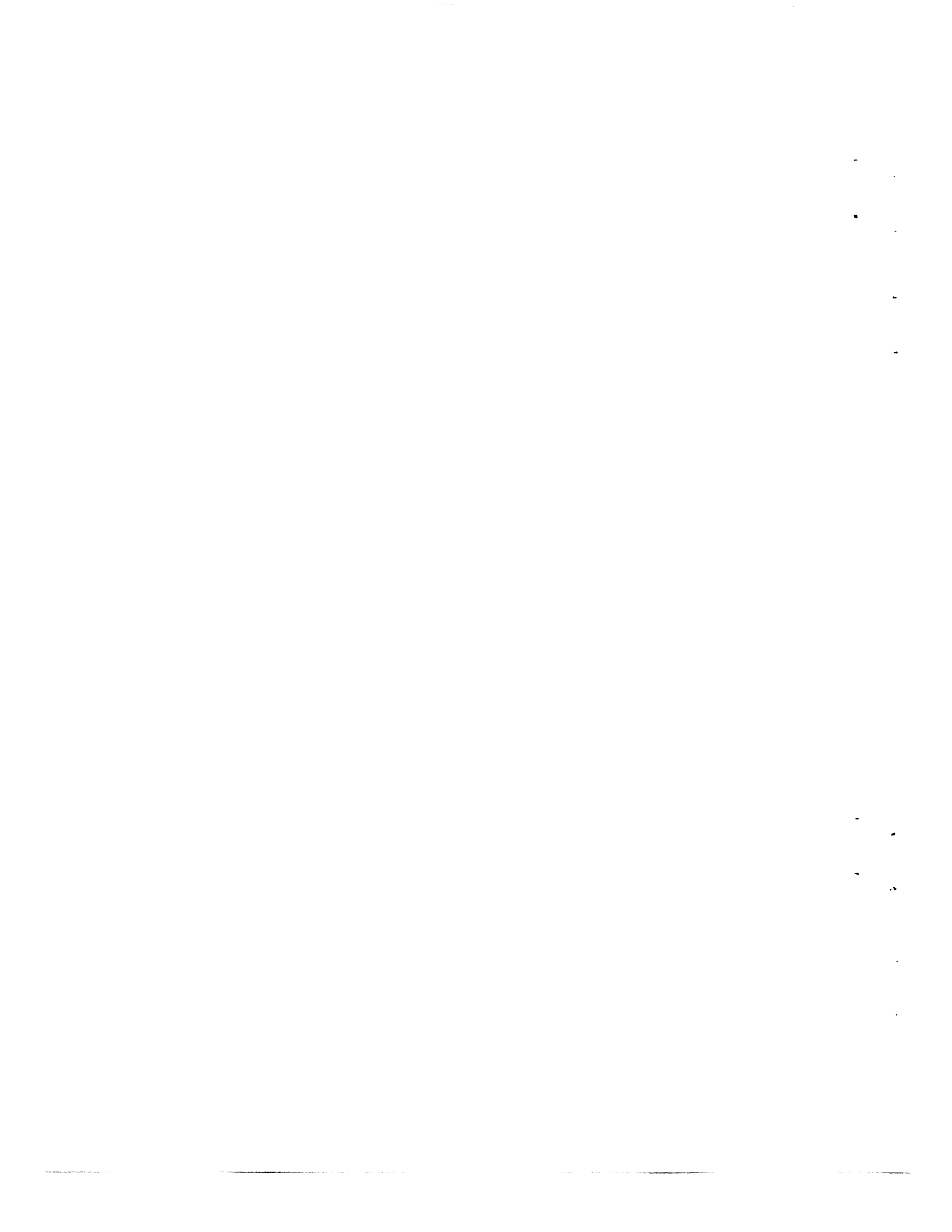
The Operation and Maintenance Equipment and Procedures bulletin is published quarterly, for the benefit of irrigation project operation and maintenance people. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the labor-saving devices or less costly equipment and procedures developed by the resourceful water users will be a step toward commercial development of equipment for use on irrigation projects in a continued effort to reduce costs and increase operating efficiency.

On page 1 there is an article written by R. W. Hendrick, President, Okanogan Irrigation District, Okanogan, Washington, on the relationship between director and managers; page 4 carries an article reprinted from WESTERN CONSTRUCTION with the permission of the editor on "How Wire Rope Lubrication Pays," and on page 9 is a talk given at the Irrigation Operators' Workshop in 1962 on the use and selection of equipment.

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.

* * * * *

Division of Irrigation Operations
Office of Chief Engineer
Denver, Colorado



DIRECTOR AND MANAGER TEAMMATES

By

R. W. Hendrick, President, Okanogan
Irrigation District, Okanogan, Wash.*

It couldn't be

If I were to read the minutes of a meeting of the Board of Directors from one of the irrigation districts represented here today, would they read like this? "The meeting was called to order at 1:00 p. m. by the Chairman of the Board with all members and the Secretary present. Minutes of the last meeting were read and approved. Vouchers were signed and after some discussion the meeting adjourned at 2:00 p. m."

I am sure these are not the minutes of any of your Boards of Directors, for the very fact that you are attending this Conference indicates that you have more of an interest in the welfare of your District than is apparent in the District I just suggested. Now then, admitting these minutes are rather ridiculous and assuring ourselves they are not at all like our own, let's take a little closer look and see if our own operations parallel in any way those of the District I suggested. As I read these minutes, undoubtedly each of you formed in your own minds a mental image of the operations of such a District, just as I did as I wrote them.

I arrived at two possible conclusions as to the operations of such a District. I am sure there are many other possibilities, but the two possibilities as I see them are:

- (1) The Manager of the District is such a capable person, doing such a fine job of operating the District that every one is perfectly happy and therefore there is no need of the directors doing anything but signing vouchers.
- (2) The second possibility that came to my mind was that each of the directors has a personal friend, or a brother-in-law employed by the District and is therefore kept well informed about the operation of the District.

In accordance with the conclusions, the directors do not have to take up a lot of time during their meetings discussing problems with their Manager, for after all, they have a direct line of communication straight through to the employee. There is no need of my going into any detail as to the weakness of such an operation under either possibility I suggested. The problems involved here are very apparent and I suggested them, only, to stimulate your thinking as to the problems you might have with your Director-Manager relationship. I

*Presented at the 13th Annual Irrigation Operators' Conference, Boise, Idaho, January 21, 1964.

think at times we need to take a look at ourselves through the back door, so to speak, for a glimpse as to the way we really operate.

Let's be serious

So far I have taken a rather negative approach to this subject, sort of backed into it. Now, I would like to take the straight forward, positive approach, and suggest some things I think are essential to a well-organized district operation.

The success or failure of a district is generally believed to be related to management. This is true in a sense of the word for when we think of management we must remember that the Board of Directors has the sole responsibility of the successful operation of an irrigation district in that it is responsible to the water users for the kind of management that has been provided the district.

With emphasis then on the Board of Directors, who in turn provides good management, we need to add just one thing - the proper relationship between the two. Let us define then the respective duties of the Board of Directors and the management and see how they can work together for the best interest of the water user.

Policy formulation

It is my opinion that foremost in importance is the establishment of a clear understanding between the Board of Directors and the Manager as to precisely the functions which are to be carried out by each. If not clearly defined, this can be one of the weakest areas of an organization's operation. Generally speaking, a Board of Directors is recognized as the policy making body of any organization. However, one of management's primary functions is to aid in the development of policies and operating procedures. Management then can recommend such items to the policy making body without any hesitation. A Board of Directors by its very make-up has every right to disagree with policies made by the Manager and develop policies of their own.

Policy making is a vital function of any organization and should be a two way street whereon the Board and Manager have an opportunity for free exchange of ideas which may eventually merge into sound and workable policies. At the time policies are being made, individual board members and the manager should express their ideas frankly and openly. But once a decision has been made by a majority vote, then individual board members and the manager should abide by this decision and not air their differences in public. At no time should we ever let prejudice or special privileges influence our better judgment.

Daily operations

So far, I have discussed policy making and the relationship between the Board and its Manager. But what about the daily operations of a

District? This is where board members can function best by simply going home and taking care of their own operations. After all, most board members have full-time businesses of their own to operate.

At the time of policy making the description of the functions of the Manager should have been sufficiently broad enough to allow him the full use of his own judgment as to the business and administrative operations of the District. When a Board hires a Manager, they must allow him the freedom that is necessary to handle the district's business in a professional and efficient manner. If the manager is not capable of doing this, then you must let him go and find some one that is capable. This much authority placed upon a man requires an equal amount of responsibility from the man who accepts that authority. Perhaps there are those of you that would disagree with me on the amount of authority your Manager should be allowed, but I believe it is necessary. For if you place full authority and responsibility on the Manager for carrying out the programs and procedures of the Board and then he fails, you only have to point your finger at one man.

It is only human to make mistakes, this applies to directors and managers alike. When a manager errs, he will have to correct the error to the satisfaction of the board. However, if the Board of Directors, by a majority vote, makes a decision that is contrary to the philosophy of the Manager, he will have to abide by that decision or vacate the position he holds.

Now this seems like a rather unilateral arrangement but we must not lose sight of the fact that it is the director who is responsible to the water user for the best operation possible.

Responsibility to water users

I have discussed at some length now the relationship of the Board and Manager, policy making, authority, and responsibility to the water user. Responsibility to the water user has been discussed the least and in my opinion it is the most important. For, after all, the only reason the positions of director, manager, or ditchdigger, even exist is to serve the water users. I would like to summarize then, by suggesting some of the most important ways in which a director can meet the responsibility he has to the water user.

1. Provide a sound fiscal policy, one that is consistent with adequate and dependable irrigation services.
2. Provide these services at the lowest possible cost to the water user and still provide adequate reserves.
3. Make all decisions, such as water use and deliveries, with fairness and impartiality.

4. Provide the District with a Manager that is capable of administering the affairs of the district, and then let him do this without interference.

Operating rules or regulations

I have made four suggestions in summarizing, and I have just one more. First, let me say that the purpose of this Conference is to give to each of you something that you can take home to your own District, and put to use in such a way as to improve your program. If I have made some suggestions so far that are of a benefit to you, this is wonderful. I think, though, that any of you here could sit down with your own boards, make an analytical study of your program and come up with things more pertinent to your operations. Now then, suggestion Number 5, the very last one and by far the most important one is this.

Provide yourselves with a set of rules to follow in the operation of your District. Now you can take these rules and call them By-Laws, rules and regulations, operating procedures, or any other thing you want. But get them down in black and white. Why is this so important? Here is why. If you take ideas you have garnered from this Conference or ideas of your own and formulate them into operating policies of your District without writing them down on paper, they are not policies at all but just hear-say.

I believe you will find many advantages in having the policies governing the operation of your District included in some way in your By-Laws. Each year then, as your new Board of Directors is organized, they can look at what has been the policy in the past, decide what their policy will be in the future and in this way lend some continuity between one board and the next. If you have done this, a Director or Manager will never have to say, "I think the policy is," when asked a question by one of the water users.

I have attempted discussing this subject in general terms only, leaving out details of operation. If I have given you anything that will improve the operation of your District, the pleasure was mine.

* * * * *

HOW WIRE ROPE LUBRICATION PAYS

(Reprinted from the September 1963 issue of WESTERN CONSTRUCTION with the permission of the Editor)

The dividends that come from good wire rope lubrication are often overlooked. Too often we put up with frequent replacements and even

costly down-time rather than take the trouble to maintain and lubricate wire rope properly. Helpful information on this subject comes from E. S. Reynolds, senior engineer, of a major oil company, and is presented in the following:

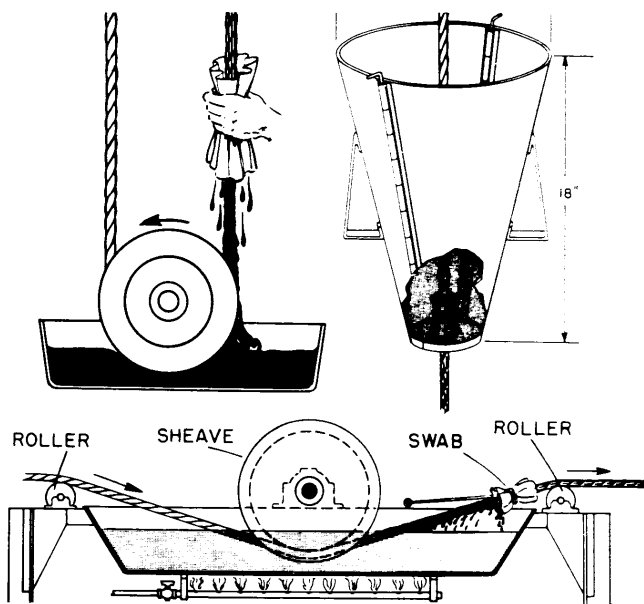
Wire rope can be considered as a machine with many moving parts. To get the most out of it, careful lubrication is essential.

A lubricant especially formulated for wire rope will provide the longest rope life with the fewest applications, but engineers setting up equipment lubrication programs do not always recommend a special wire rope lubricant. Where only a few wire ropes are involved, it is often preferable to use one of the greases or oils used for other applications. There are many oils and greases that can approximate the performance of a special wire rope lubricant if applied more frequently. More frequent application may be simpler and more economical than ordering, storing, handling and dispensing a special lubricant.

A wire rope consists of wire strands laid evenly around a core--usually made of hemp or other fiber, but, in some cases, also of wire. Each strand consists of several wires laid--or helically bent, not twisted--around a core.

Like any moving part it is subject to frictional wear where it bears against its surroundings--rollers, sheaves, drums, and not infrequently rubbing against rock, grit, etc. But, even more important is internal wear as the rope's many parts bear on and move with or against each other continuously.

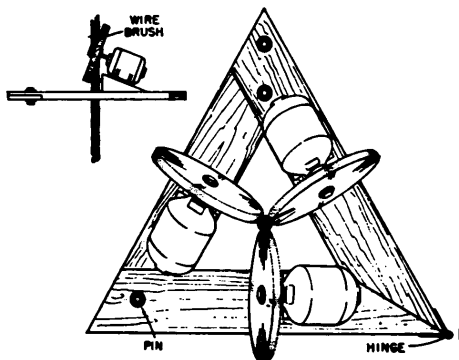
Each wire of a rope can be in contact with three or more wires over its entire length. Actually, the line of contact widens to a band because of deformation under load. As a result, the total bearing area in a wire rope is relatively large--probably greater than in any other piece of machinery of equal weight.



The sketch at left shows trough application which is particularly appropriate where lubricant must be heated to be applied. In any of these methods the swab helps to remove excess.

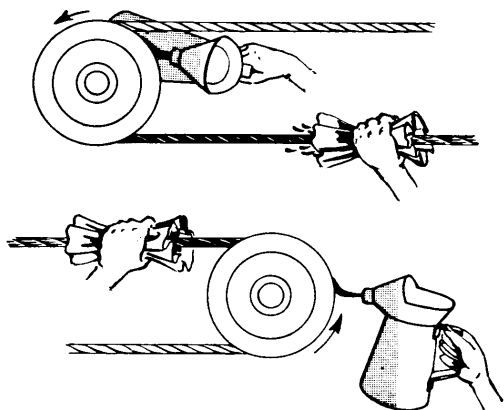
Metal fatigue is a main cause of wire rope failure. Bending and tension stresses, repeated over and over again,

cause fatigue. When lubrication is inadequate, the stresses in a rope are increased by the high frictional resistance to the movement of wires over each other and fatigue failures occur more quickly. Corrosion is also a principal cause of wire rope failure. Though lubricants for other services may not even be expected to provide corrosion resistance, wire rope lubricants are normally formulated to provide resistance to rust and other corrosive attacks. Surprising to many is the large area open to such attack. For example, for every 100 feet of length, a 1-inch-diameter 6x7 rope has 110 square feet of wire surface.



The sketch at left shows motor-driven wire brushes that can be used to clean off hard, built-up dirt from wire rope. The brushes, as shown, are set in line with the helix angle of the strands and the rope runs downward past the brushes.

Another principal threat to wire rope life that lubrication is called upon to lessen is deterioration of the fiber core. Wear, deterioration by water or dripping can all cause the core diameter to shrink and reduce its support of surrounding strands. Strands then tend to overlap and severe cutting or nicking may occur. The lubricant can minimize friction and wear at the core surface, seal it against water, and prevent drying.



When lubricating wire rope by pouring, it should be applied while the rope is moving slowly and as it touches the sheave. This is illustrated by the drawing at left. The contact with the sheave and the resulting bending will distribute the lubricant. The swab also helps to distribute the lubricant and removes excess.

Lubricant requirements

To do its job, then, wire rope lubricant should:

1. provide lubrication between pulleys or sheaves and the wire rope
2. penetrate between adjacent wires to lubricate them, protect them against wear, and keep the core from drying out
3. protect against rust or corrosion from the atmosphere, acid, alkaline or saline surroundings.

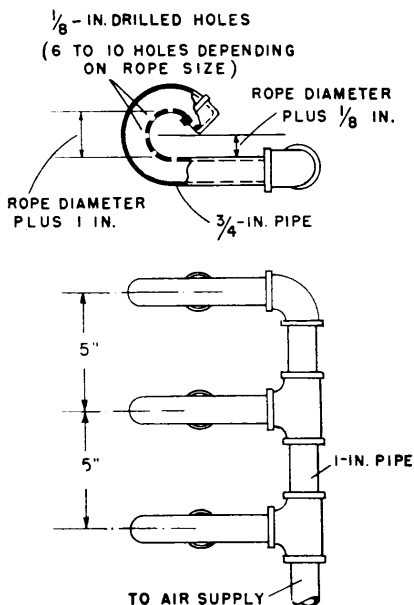
To do this job for an extended period of time the lubricant should:

1. form a coating that does not throw or wipe off
2. resist being washed off
3. remain pliable and resist stripping at the lowest temperature of operation
4. resist softening or thinning at high temperatures so that it is not thrown off and doesn't drip.

From a practical operating standpoint, some additional characteristics should be considered, and in many cases, these additional characteristics are the more important insofar as selection of a wire rope lubricant is concerned.

Thus, a good wire rope lubricant should:

1. form a light colored transparent film so that wear, corrosion, or broken wires can be readily detected
2. form non-sticky films so that dust and dirt will not build up
3. be capable of easy application.



The illustration at left shows how to clean wire rope with compressed air. This can be done with this simple, multi-jet device. Such cleaning should be done after the rope has been soaked with penetrating oil. This same device can be used for steam cleaning which must be followed with compressed air for drying.

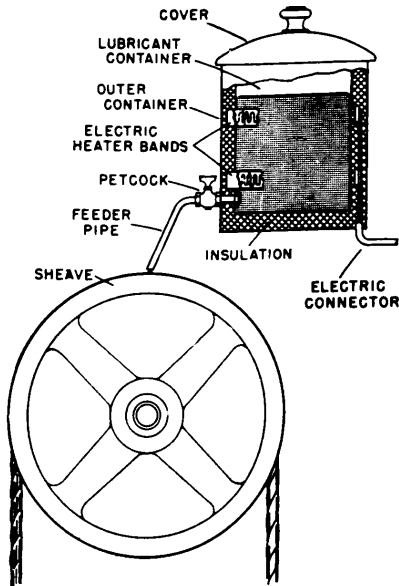
Stationary ropes

For stays and guys exposed to all kinds of weather and wide variations in temperature, the critical requirement is protection against rusting and corrosion. A coating is required that will resist the washing effect of driving rain or salt spray and that will protect against rust and corrosion. The lubricant must not drip off during application or as a result of softening under high summer temperatures and must re-

main pliable--not crack or peel off--under low winter temperatures.

Tramways and carrier ropes are stationary ropes subject to the same conditions as stays and guys. However, it is not practical to apply

lubricant to these ropes by hand, and they are usually relubricated by means of a mechanical force-feed device. These devices cannot handle lubricant that forms the heavy coatings used to protect stays and a less viscous lubricant must be applied.



At left is an illustration, showing drop-feed lubricator which provides continuous lubrication, with many advantages. The use of heat and insulation of the reservoir as indicated, are required only with the more viscous lubricants.

Earth handling equipment

Wire ropes in this service operate in dirt and dust that adhere to the rope lubricant and tend to form an abrasive compound. Exposed to the extremes of weather, the lubricant must resist being washed off by rain and protect the wires from rusting. Nor should it become brittle and strip off at low temperatures.

Drippage after application generally is of little concern. A lubricant similar to that used for wire ropes in vertical-shaft mines and for under water service will provide the rust protection needed and, if applied in relatively thin films, dust and dirt do not tend to form a grinding compound with it. Some operators even prefer to use a relatively light lubricant applied at more frequent intervals to wash off dirt accumulations.

Obviously, some of wire rope lubricant requirements are conflicting and probably no single lubricant will be developed to meet them all. However, recent formulations are very effective, and are designed to have the important characteristics listed above.

Methods of applications are relatively standard. The accompanying drawings show techniques for cleaning and applying lubricants. Whatever lubricant and method of application is chosen, the single most important point in any wire rope lubricant program is frequency. Lubricants should be used regularly. It is the simplest way to cut rope maintenance costs.

* * * * *

EQUIPMENT MANAGEMENT

Use and Selection

by
William L. McCaig*

INTRODUCTION

All irrigation projects, or even parts of projects, although similar in many respects, have unique differences. It is these differences that make it almost impossible to set down a list of equipment that is necessary for the operation and maintenance of an irrigation project. Equipment requirements are determined by the size of the project, the type of construction, whether the delivery system is concrete lined or unlined, the type soil that predominates, along with many other characteristics of the areas, such as climate and crops, and even to some extent by the type of personnel that is available to operate the equipment.

Various types of work will be handled in just about as many different ways as there are people to do the work, so I am not going to attempt to tell you what kind of equipment should be selected for your irrigation project. I would rather take the units of equipment that are more or less common to all projects and discuss the features of these units that make them more adaptable to particular types of work.

DRAGLINES

A necessary part of all irrigation projects is the drainage system and most drainage systems consist of open drainage channels. The maintenance work on drains usually calls for dragline work. The size of the dragline depends upon the size of the drain or canal to be cleaned and the reach necessary. Often there is a tendency to purchase larger oversize equipment because it has a greater earth handling capacity and you find yourselves overexcavating the drains both in depth and width. This destroys the designed hydraulic properties of the drains and makes for nonuniform flows which tend to build up deposits of sediment and encourages growth of aquatic weeds.

A 2-cubic-yard dragline bucket is approximately 51 inches wide, 38 inches high, and 54 inches long. Good dragline operating procedure is to set the bucket down and pull it not more than 2 lengths of the bucket, then pick it up, swing and dump. You therefore must have a drain with sufficient bottom width to accommodate this operation to justify using this size of bucket and the depth of cut would have to be at least 2 feet. Otherwise the bucket would not be filled

*Chief, Irrigation Division, Rio Grande Project, El Paso, Texas, given at the Irrigation Operators' Workshop, Denver, Colorado, 1962

in the 2 lengths of the bucket and the operator would have a tendency to keep on pulling it up to the machine to get it full. He would end up with it too close to the machine where it takes additional power to lift it. The use of this additional power for lifting not only costs money, but it uses power that should be available for faster swinging. This additional pulling of the bucket takes time and slows down the cycling of the machine.

Dragline buckets are manufactured in three weights, for light, medium, or heavy duty. Perforated buckets are also available and are very desirable for drain cleaning work. As the bucket is picked up, the water runs out through the perforations rather than around the front of the bucket. This has a tendency of drawing the weeds and other lightweight material into the back of the bucket instead of losing them around the front edge.

When the size of the bucket has been determined, an estimate of the weight of the material is made and a size of machine is selected that will handle this weight without exceeding 75 percent of the tipping load at a working angle and boom length that will reach the maximum size canal or drain to be cleaned.

State highway weight restrictions also limit the size of machines. The size of your hauling equipment or the cost of renting heavy hauling equipment likewise imposes a limitation on the size of a machine and it becomes hard to justify a 2-cubic-yard dragline that will weigh around 130,000 pounds. A 1-1/2-cubic-yard machine usually weighs about 100,000 pounds and can be moved on a 50-ton trailer. Hauling equipment of this size is not so unusual. Therefore, depending on your requirements, a machine in the range of 1- to 1-1/2-cubic-yard capacity would seem to be the best size.

Although these machines are usually purchased for dragline work, the basic machine is made so that various attachments can be applied or changed to facilitate or perform other operations carried on in our maintenance programs. Basically, the machine is a shovel, hoe, crane, dragline, or clamshell. The last three of these are all used with the same lattice-type boom and the same drum arrangement for winding the cable. Draglines usually have a smaller lagging for a larger size cable on the haulback line. So with a few additional considerations we are able to select a dragline that could also be used to do crane work or clamshell work or to drive piling. Unless there is a considerable amount of rock loading or trenching to do, it would be hard to justify the purchase of a shovel front or backhoe attachment, so let us go back to the basic dragline and see what it takes to make it a crane, clamshell, and pilehammer.

First of all we have to have at least more than one sheave in the crown block and it would be better to have three which would cost about \$185 extra. We would need a tagline winder for clamshell work

at a cost of about \$245. For good crane work we need an independent boom hoist, that is, independent of the swing arrangement and equipped with power boom lowering, preferable through a self-locking worm drive. This feature will cost about \$960.

Another good feature for crane work is the power load lowering attachment. This device would cost about \$1,165. To do crane work we would also need a weighted crane hook with at least two sheaves and a hook of the same capacity as the crane.

Pile driving can be accomplished by attaching the top of the pile leads to the boom. With the lines from both drums over the crown blocks, use one for the hammer, and the other to handle piling. If the machine is to be used mostly for pile driving, it would be preferable to have three active drums and use the third drum to handle free swinging leads.

Last, but probably the most important decision to make, is whether to buy a truck-mounted dragline or one on crawlers. In selecting a crawler-mounted machine it is also necessary to consider hauling equipment. Either a trailer and truck tractor will have to be purchased, or this equipment will have to be rented for each move. The rented equipment is seldom immediately available in an emergency, so we lose some time getting to the emergency. If a truck and trailer are purchased only for moving heavy equipment, the cost per mile can be extremely high because we have high annual depreciation charges to write off on a comparatively small number of miles of operation each year.

A 50-ton-capacity low-bed trailer with a truck tractor to handle it will cost in the neighborhood of \$29,000 and a considerable portion of the cost of this equipment will be charged off to moving your dragline if you are going to have a 50-ton machine. Your next heaviest piece of equipment is usually a crawler tractor which will weigh only about 30 tons with a dozer. In other words, if you did not have the dragline you could get by with a 30-ton tractor truck and trailer. So the difference in cost between a 30- and 50-ton trailer all should be charged off to your dragline. When you consider the cost of the crawler-mounted machine, plus the additional cost of the trailer and tractor, the truck-mounted machine appears to be more feasible and much easier to justify on an investment basis. The greater efficiency of the truck-mounted machine is also to be considered, as it is more readily available at various sites for emergency work.

The increased use of precast and prestressed concrete structures, makes it desirable to have a good lifting crane and if it is readily portable the efficiency is greatly increased. In a structure replacement program, the mobility of a truck crane greatly speeds up the work. Old structures can be removed with the crane and a wrecking ball. Smaller structures can be precast and hauled to the site and

set into position with a crane after the excavation work has been completed. In some instances the concrete forms can be built and assembled in a central shop area and the reinforcing steel can be placed in the forms before hauling to the jobsite. These are loaded with the crane and after delivery to the construction site also set into place usually by the same truck crane. We use this system on our lateral check replacement program. The crane is also used to place concrete with the concrete bucket.

When all of the advantages are properly considered, I feel it is difficult to justify the purchase of a crawler-mounted dragline unless the machine is required to handle a bucket larger than 1 cubic yard, or unless crawlers are necessary because of unstable ground conditions.

HYDRAULIC-CONTROLLED EXCAVATOR

Another of our most used pieces of excavating equipment is a hydraulic-controlled excavator. This machine comes with numerous attachments and is therefore quite versatile and can be adapted to many of your jobs. Excavation for structures can be practically completed with such a machine and a good operator leaves only a small amount of this work to be performed by hand. The digging buckets come in several widths and the machine can excavate and cast or load trucks. It takes a good operator to get more than three buckets per minute and about the maximum is four. This and the bucket size limit the production of these machines.

When these machines are used to clean canals or laterals, it is necessary for the operator and the truck driver to coordinate their operations as it is often necessary to move the machine with each bucketful taken. When the machine is to be used for this type of work, it is preferable to purchase the equipment with a torque converter in the truck drive. This is of great assistance to the truck driver, otherwise he would have to press down on the clutch pedal and release it on an average of three to four times each minute throughout the working shift. The heavy spring in the clutch makes this almost impossible. (With the torque converter he has to depress the clutch once and put the transmission in gear, release the clutch and from then on he has only to step on the foot throttle and, usually, the brake.) When the truck driver and the operator properly coordinate their work the driver moves the truck while the operator is swinging and dumping the bucket. Inasmuch as it is often necessary to make more than one bucketful before moving, it is a good idea to have some means of communication between the operator and the truck driver, such as a horn or bell signal so the operator can signal when to move. The manufacturers build several attachments for this type of machine, all of which are well tested and proven to be adequate for the work intended. In addition to these, various users have built their own

tools or attachments. For example, on the Rio Grande Project we built a special 8-inch-wide bucket to dig cutoff walls for structures, 8 inches wide and 4 feet deep. Also we made a vibrating screed attachment to screed off concrete on 1:1 slope paving on check structures or short pieces of concrete canal paving. The screed is about 12 feet long and is vibrated by two pneumatic bin shaker-type vibrators. Screed forms are set across the canal or check lining. The vibrating screed is drawn along the screed forms, striking off the concrete to grade and compacting the concrete on slopes as steep as 1:1. The concrete is well compacted on the slopes and the work of the concrete finishers is reduced considerably. Perhaps many of you have developed similar uses or your own shop built attachments and it would be well to discuss these later so all could take advantage of the experience gained on various projects.

CRAWLER TRACTORS

The crawler tractor is said to be the most basic and versatile machine in the construction industry and it also plays an important role in our maintenance work. It serves as a prime mover for pulling or pushing loads, a power unit for winches and hoists, and a moving mount for bulldozers, side slopers, side booms, and front-end bucket loaders. On most maintenance projects the primary use for the tractor is for bulldozer work, leveling spoil piles, building roads, repairing canal breaks, and the like. Particularly in the case of the canal breaks where the area is usually wet the crawler tractor is well adapted to handle the situation. In addition to the dozer work the tractor can also be used extensively for operating the side sloper or for pulling the radial blade type of brush cutter. A Class VI crawler tractor with a 225-horsepower engine handles the side sloper without much difficulty. A Class V tractor with a horsepower of 185 can also handle this same sloper and do a satisfactory job, but the side draft on the machine causes the steering clutches to take considerable abuse. It is apparent that the heavier machine with the additional power handles the sloper better.

Either machine can handle the medium weight radial blade type of brush cutter alone along the bank of a canal or drain, but it takes two tractors, one on each side, to pull the brush cutter in the bottom of the drains, particularly when there is much water present.

Normally in maintenance work there is not much use for scrapers. When dirt moving is necessary these small volumes can usually be handled with trucks and loading equipment.

In selecting the power control unit for your tractors, I believe it is best to pick the cable type rather than the hydraulic control as this unit is more readily adapted for use with our type of equipment. The

double-drum type mounted on the rear of the tractor can provide power for the dozer blade and have a spare drum for other uses such as a towing line for the weed cutter. Both drums are needed for scraper work and the side sloper also requires two drums. The hydraulic-controlled power unit is usually restricted to use with a dozer. About the only instance I can think of where the hydraulic dozer has an advantage over the cable type is in blading a rocky or extremely hard surface where positive down pressure is required. This makes the dozer more adaptable to pick out rock or other hard material that the cable-type dozer will sometimes skim over.

SHOVEL LOADERS

The rubber-tired front-end loader is a very practical piece of equipment for use on maintenance work. Not only is it an excellent dirt loader, but also its mobility makes it extremely handy for use in repairing canal breaks or other emergency work. However, I believe the front loader should have a bucket capacity of not less than 1-1/2 yards. Sometimes this large a bucket is not needed, but a smaller machine is often too light to dig into hard spoil banks.

In selecting a front loader, it is a good idea to consider the purchase of a forklift attachment so that it can be substituted for the bucket. The unit can then be used in your warehouse or outdoor storage area to stack materials or load them onto trucks. If such a unit is available, and the warehoused materials are stacked on pallets or in such a manner that the forklift can get at the material, the cost of handling can be greatly reduced and more use made of the equipment. This unit can also handle a concrete bucket in placing concrete into forms that are too high for the mixer truck to discharge into. A standard concrete bucket can be set on the forks and attached to the frame. In this manner the unit can often release a crane for other work or eliminate man-hours or hard work shoveling concrete into the forms.

MOTORGRADERS

The selection of a motorgrader is often influenced by the condition of the roadway on which it will have to travel. Narrow bank roads may lead you to decide to purchase a medium-sized grader or smaller grader. However it is difficult to do a good job with equipment that is too small. A complete analysis of the specifications on motorgraders will indicate that there are comparatively small differences in the actual length and width of the larger model and one of medium class. The main difference is in the weight and horsepower and it is these two features that are most necessary for accomplishing the work with a motorgrader. Usually a roadway that is too narrow to accommodate a good sized motorgrader is also too narrow to carry on even

the routine operation and maintenance work. The larger motor-graders can also be used to handle the side slopers if it is desired. If the motorgrader is to be used with the sloper it is necessary to get the lifting device for the scarifier attachment since this device is needed to pick up the front end of the sloper blade.

TRUCKS

In the selection of trucks, let us start with the pickups. Under hard and continuous use there is no doubt that the 3/4-ton models stand up better than the 1/2-ton trucks. The employees used to object to the 3/4-ton models because they were hard to steer and the heavier springs caused them to be hard riding. The new 3/4-ton models, however, are as easy to handle and ride in as the 1/2-ton trucks. The larger units have a longer life with less maintenance work so the only other consideration is the additional original cost. The best estimate that I can get indicates that the 1/2-ton model would cost the Government about \$1,640, while cost of a 3/4-ton pickup is about \$110 more. It does not take very many repair jobs to equal this additional cost.

A desirable feature that is rather new in pickups, and larger trucks also, is the six-man cab. A 3/4-ton pickup with a six-man cab would provide an excellent crew truck for a small work crew. Six men can ride in the cab and there is plenty of space in the pickup bed for hauling tools. A rack can be built extending over the cab to haul ladders, long-handled tools, and lighter pieces of building materials. A six-man cab, 3/4-ton pickup will cost about \$500 more than a regular 3/4-ton pickup. If you are using several crews in the field and are now providing each with a heavier truck to haul men and material, it would be a good idea to consider these smaller faster units for transporting the crews and probably one heavier truck for hauling materials to all the crews.

In the matter of heavier trucks, most projects would have a requirement for both flatbed trucks and dump trucks. Flatbed trucks are used to haul materials and, with recent development in precasting and prestressing concrete structures, it would be well to consider trucks of sufficient capacity to haul these structures as well as other materials required in maintenance work. For example, an 18,200 pound GVW truck, properly equipped will cost about \$2,900, while a larger 27,500 pound GVW truck costs \$4,800. This increases your cost \$1,900, but you have a truck that will handle precast structures or other loads up to 9 tons without overloading instead of 5-1/2 tons. Unless you have a requirement for several flatbed trucks in this range, the larger of the two trucks will be much more versatile.

Another thing to consider in the selection of trucks is the extras. For instance an oversize clutch on either of these two trucks would

cost only about \$12. A heavier front axle on the smaller of the two trucks would cost about \$41, but it would increase the loading capacity on the front end from 3,500 pounds to 5,000 pounds. On the larger truck a heavier front end would cost \$175, but would increase the loading capacity from 7,000 pounds to 9,000 pounds. A heavy-duty rear axle would cost \$75 for the smaller truck and \$280 for the larger truck but it would increase the capacity about 13 percent. Heavy-duty front and rear springs do not cost much extra and perhaps should be considered. Actually, you should consider your use for the truck and compare the cost of the extras with the benefits to determine the best equipment for cost.

In considering dump trucks, there is always a question of how large a truck you should buy. During the last year or so, we have bought four dump trucks, ranging in size from 4 cubic yards to 8 cubic yards. The 4-yard truck with dual rear wheels costs \$4,500; a 6-yard truck with tandem rear drive costs \$8,400; while two 8-cubic-yard trucks with tandem rear drive and auxiliary transmission cost \$10,500 each. This will give you some idea of the range in cost for various sizes of dump trucks. There are advantages to small trucks and advantages to larger trucks, but due to the variety of work on the O&M jobs it is probably advisable to have some range in sizes. However, the larger trucks experience little difficulty in delivering loads to most any location on the project. For example, a contractor delivering transit-mix concrete for our rehabilitation program uses 7-cubic-yard mixer trucks and successfully delivers concrete to all construction sites in the area.

Computations can be made to determine the most effective truck size and matching loading unit, but these determinations, although they work fine on some construction jobs, seldom fit in maintenance work. In maintenance work, the amount of fill in any one location is usually small and borrow sites change often; consequently the hauling distance is always changing. Even the material hauled changes constantly. The trucks are used to haul muck, dirt, concrete aggregates, and even rock for riprap. Another feature that makes your dump truck more versatile is the double hinged end gate, that is, hinged at both the top and bottom. For ordinary dumping you would use the top hinge. The bottom hinge will allow the end gate to be laid down level with the floor of the truck thereby providing a longer bed for hauling lumber or other materials. Because of the type and variety of work it is difficult to decide what size dump truck would be most ideal.

WEED BURNERS

Weed control work is to be treated as a separate subject at another time, but it would be well to consider some of the equipment used in this work. The first burners used extensively in weed control work

consisted of a high-pressure pump that forced the oil through nozzles on the boom where it was atomized and burned. This operation usually resulted in a lot of black smoke and even unburned oil left on the vegetation. These units could burn from 1,200 to 1,800 gallons of oil per shift. Since oil presently costs about 12 cents per gallon, the cost for fuel alone would vary from \$144 to \$216 per day. On the Yuma Project a burner was developed that uses an air compressor to force air along with the burner oil into two suction atomizer torches. Two of these torches were mounted on a hydraulic-controlled 30-foot boom. This type of burner reduced the oil consumption to less than 50 gallons per hour as compared with 170 to 250 gallons per hour without the air and produces a flame temperature of 2,700° F. On this project contaminated JP-4 jet fuel is available from the Air Force or the Marines at little or no cost. Latest information indicates this machine will use 47 gallons of JP-4 jet fuel per hour, averages 1.1 miles per hour which is also 1.1 acres per hour, and averages 43 gallons per acre of area burned. The jet fuel produces considerably more heat than ordinary burner oil and is not dangerous to use. Recently, new torches have been built in the shop to spread the flame to cover a wider area.

On another project where liquified petroleum gas is used in the burners, a machine is used that has six burner heads, three for each bank and both banks of small laterals are burned at the same time. This requires about 165 gallons of fuel per mile with the fuel costing about 8 cents per gallon.

WEED MOWERS

You are all familiar with the sickle type of mower so we can skip that. However, in recent years a newer rotary type of mower has been developed that performs well on irrigation works. It consists of one, two, or three synchronized rotating heavy cutting blades that are powered from the power takeoff on the tractor. They do an excellent job of mowing and handle fairly large brush. The three cutter units fit our purpose best as one set of blades can be hung over the inside or outside slope of the canal bank and, it not only cuts off the brush and weeds, but it will throw most of the cuttings up the bank, out of the water. Weed cuttings from the sickle type of mower fall into the canal water and usually create trash problems in the ditch. Altogether, the rotary mower will cut a 15-foot swath.

The main limitation is that the outside units cannot be lowered as much as we would like. By modifying the machine and cutting away some of the deck plate, however, we are able to lower it to about 30° below the horizontal.

JUSTIFICATION OF EQUIPMENT PURCHASES

There are several different ways of justifying the purchase of new equipment. The one most common is the replacement of old or worn out equipment. Although proper maintenance will increase the life of equipment, eventually the repair costs become too high and the equipment has to be replaced. Downtime, or time lost from production also has to be considered, particularly if the piece of equipment is vital to the maintenance program or if it is used in conjunction with other equipment. An example of this would be a loader used for loading trucks. If it breaks down, the trucks are idle too unless they can be diverted elsewhere.

In replacing used equipment, we usually have previous operating costs. It is a matter of determining when a piece of equipment has outlived its usefulness and can be replaced with new equipment that can be operated at less cost.

In purchasing any equipment, whether it is a replacement or a new type of machine, not only the cost of operating the machine but also the cost of just owning the equipment must be considered. The depreciation and some of the other costs of ownership go on whether the machine is used or not. Some pieces of equipment need careful study to determine if their usefulness will outweigh the cost of ownership and operation. Many projects have probably found themselves owning equipment on which they will never recover the original cost. In selecting any new equipment, and especially when the new equipment will make a change in your methods of maintenance, it is a good practice to estimate the number of hours the equipment will be used annually and predetermine as closely as possible the depreciation and other costs of ownership right down to an hourly basis. To this, add the cost of operation and maintenance to determine if it is feasible to purchase the equipment or whether it would be better to rent it.

Depreciation on equipment can be figured several ways. The Bureau of Reclamation uses a straight line method and depreciates cars, pickups, and other automotive equipment up to 1 ton in 7 years, 1-1/2- to 2-1/2-ton trucks 8 years, 3- to 10-ton trucks in 10 years, and over 10-ton in 12 years. Other mobile equipment, such as construction machinery, usually is depreciated as it is used at a rate sufficient to equal the total depreciable value of the equipment during the expected useful life. Another method of depreciating equipment is to take a certain percent of the undepreciated value of the equipment each year. Using this method the depreciation is high when the equipment is new and it gets less each year. There always remains some depreciation charges and there is also some value in the equipment. As the depreciation decreases each year, the maintenance and repair costs increase so that the total operating cost seems to level out over a period of years.

The question of rental or ownership of equipment depends on several considerations: How much of the time the equipment can be kept

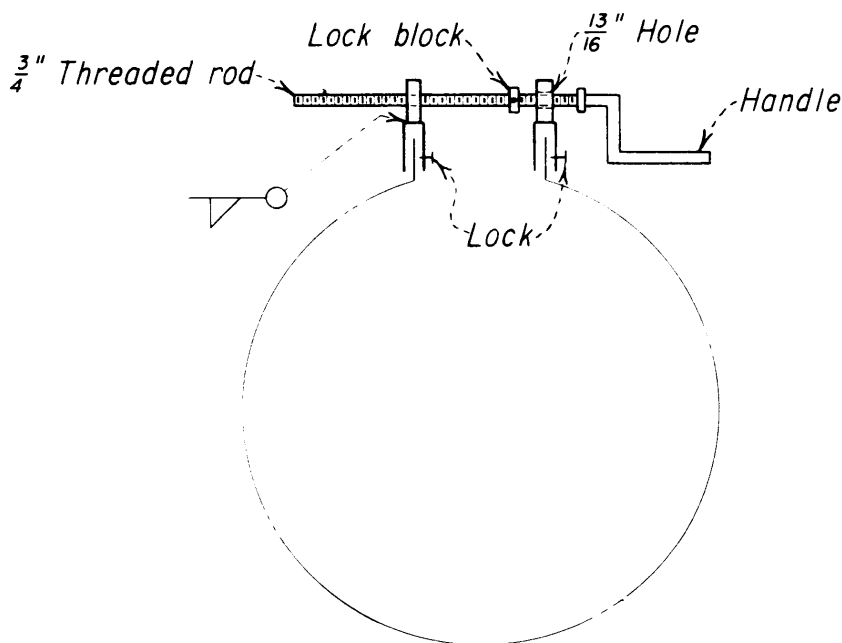
working, how vital it is in case of emergency, and the cost and availability of rental equipment? Some types of equipment must be immediately available in case of emergencies. If this equipment can also be utilized enough in the normal maintenance program, it will undoubtedly be wise to own the equipment. Rental companies intend to make a profit on their operations, and this profit could be converted to a savings to the irrigation district. Equipment needed for emergencies must be purchased if it is not always immediately available on a rental basis.

All projects should be continually searching for newer and more efficient ways to handle maintenance work, and this usually involves new machinery. The use of new machines should not only speed up the work, but should also reduce the number of employees required. This single development has probably been responsible for keeping O&M costs somewhat in line in spite of the continual increases in wages and other costs.

* * * * *

METAL PIPE BAND CLAMP (Suggestion R5RG-62-7)

The sketch below is a suggestion by Robert P. Marin, Machinist, Rio Grande Project, Texas, for a tool to install corrugated steel pipe couplings, safely and easily. This tool has been used to advantage in closing and expanding the collar by merely turning the crank handle.



* * * * *

PROJECT OPERATION BY BOARDS OF CONTROL

Boards of Control were developed to serve water users most equitably and economically from common and interrelated irrigation facilities. The merits of the Board of Control type operation, where joint storage, carriage and other related features are used to serve contiguous individual irrigation districts has been discussed in several of the annual conferences held by irrigation districts and has received special attention in the Bureau of Reclamation's Irrigation Operators' Workshop held in 1961, 1962, and 1963 in the Office of the Chief Engineer, Denver, Colorado.

It has been maintained that the Board of Control type operation has many advantages and an attempt has been made in the Pacific northwest to evaluate those opinions, where three boards of control are operating project facilities. One board represents five irrigation districts with a total irrigable area of approximately 165,000 acres, and has been responsible for operation since 1926; another represents seven irrigation districts with a total irrigable area of 65,500 acres; and a third represents two irrigation districts with a total irrigable area of 39,600 acres. The latter two have been responsible for irrigation system operations since 1956 and for operation of a reservoir and related works common to both, since 1958.

There is considerable variation in the size of the individual irrigation districts comprising the three boards of control. This is recognized in that representation on the boards is on the basis of irrigable acreage. In order to obtain an evaluation of the operations, a questionnaire was mailed to 44 directors of the 14 individual irrigation districts involved, several of whom were members of one of the boards of control. Eight specific questions were asked. In addition voluntary comments were included on many of the questionnaires upon their return. Like polls of this type, no response was received from some directors, but the overwhelming opinion of those answering, as discussed below, was favorable to the board of control approach to operation. It also should be remembered that some of the districts replying have operated by both board of control and individual district-type operations.

Question 1--Has joint operation of your district's irrigation facilities made it (more difficult or less difficult) for a water user to contact the right people for corrective action on a problem?

More difficult	21 percent
Less difficult	74 percent
No difference	5 percent

Question 2--Has distribution of project water supply been equitable and satisfactory under joint operation?

Yes	100 percent
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Question 3--Do you feel that joint operation of your district has had an adverse, a favorable, or no effect on the operation and maintenance costs you are paying?

Favorable effect 95 percent
No effect 5 percent

Question 4--Do you feel that distribution facilities for your district have been maintained as well under joint operations as they would have been under separate district operations?

Yes 100 percent

Question 5--Do you feel that joint use of managerial, technical, and clerical personnel, and of equipment has proved to be advantageous, disadvantageous, or no difference?

Advantageous 100 percent

Question 6--Has joint operation given you an operating financial reserve at a lesser cost than what you would have had under separate operations?

Yes 100 percent

Question 7--Has a joint board of control made it easier to resolve problems that arise between your district and the other districts in the board of control, than it would have been had you been operating under a separate operating organization?

Yes 100 percent

Question 8--Do you feel that joint operation has been an advantage to your district?

Yes 100 percent

The voluntary comments from the directors covered personnel, water-control, maintenance, administration, equipment, and costs involved in project operation. Advantages cited were the centralization of advisory, operation and maintenance responsibility, and the fact that assistance was more easily and quickly obtained; that better use was being made of personnel and equipment, therefore, better equipment and personnel can be afforded; that this utilization of personnel and equipment includes office accounting, records, and other administrative and clerical activities.

Costwise the directors claimed that there was no question but what joint operation was less costly. The joint operation avoids duplication, overhead expenses were smaller, fixed costs are spread over a larger average and it is possible under the joint ownership of special

equipment to maintain and operate more economically with such specialized equipment that could not be afforded by a smaller operating unit.

Emphasis was given the need for cooperation between the directors of the different districts, the manager, and the watermasters, if board of control operation is to succeed. Also stressed was the opinion that operation under a board of control is desirable only as long as the project has an efficient operating organization.

* * * * *

SMALL WINCHES BIND LOADS (Suggestion R5-MR6-64-1)

A good practical scheme for binding loads on a trailer by the use of cables and small ratchet-type winches has been used to advantage on the Middle Rio Grande Project, New Mexico.

The suggestion by Eugenio Marquez, Belen Field Branch, of the Irrigation Division, is shown in use in photographs below and on the following page.

Figure 1 shows two of the winches welded to the side of the frame of a project trailer. Figure 2, below, and Figure 3 on the following page are more detailed views of the winches and method of mounting.

As shown in Figures 4 and 5, the winches also can be used for loading some rather heavy and unwieldy materials. The metal pipe shown in Figure 6, was loaded by use of the small winches by one man utilizing the two winches alternately. After loading the pipe, the winches

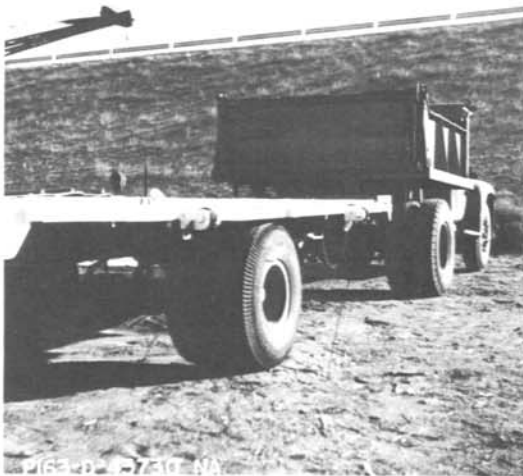


Figure 1

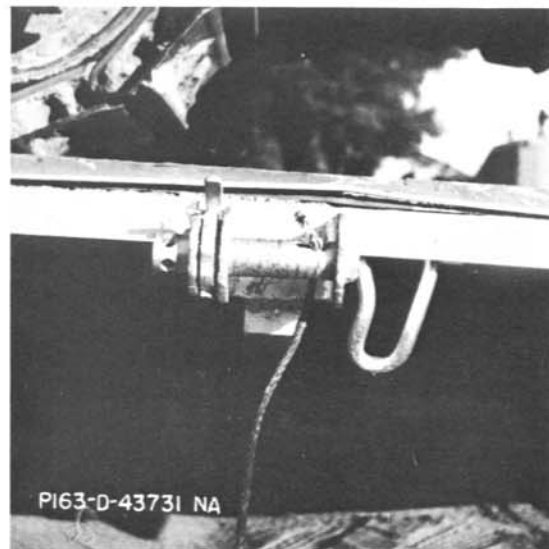


Figure 2

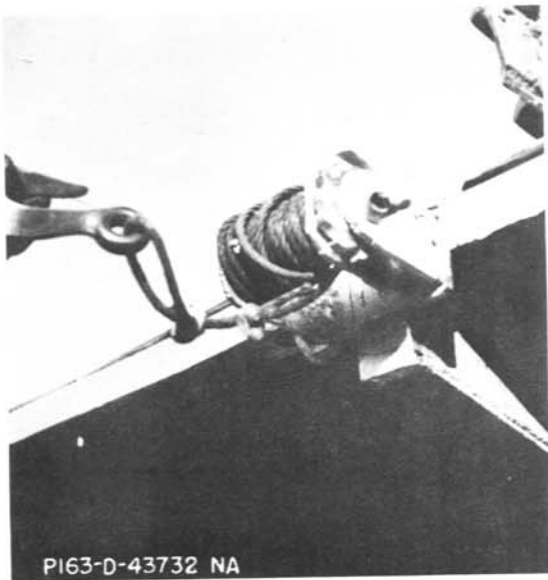


Figure 3



Figure 4



Figure 5



Figure 6

of course, are utilized to tighten the cables sufficiently to bind the load to the trailer.

The winches and cable eliminate the need for the conventional chains and "boomers" that are frequently utilized for binding loads. Actually this has resulted in a savings in cost since discarded cable from draglines or other pieces of similar equipment can be utilized. The winches shown were made in the project shops. Similar winches are available commercially.

* * * * *

GROWTH OF ALGAE ON MEASURING DEVICES
(Suggestion R2-64-42)

The growth of algae in measuring devices has long been a problem on canals. Mr. Arthur W. Thomas, Fresno Field Division, Central Valley Project, California, suggested the erection of a shade over the throat of a Parshall flume for Lateral 6.1 of the Madera Canal.

In past years, it had been impossible to obtain a stable discharge rating, due to varying algae growth which affected the velocity through



Photo No. 1



Photo No. 2

the turnout. As the throat of the flume is only 12' wide, ten 2"x12"x14' planks were laid across the top of the vertical walls and scabbed together, see Photographs No. 1 and 2 on the preceding page. This provided suitable shade, and during the 1963 season the rating has remained constant.

The shading has effectively controlled the previous fluctuations in the rating curve for this station and algae growth has now become negligible. The cover is strong enough for occasional foot traffic, yet heavy enough that it is not likely to be disturbed. This method of shading may be applied to other weirs or flumes where algae growth is a problem.

* * * * *

PRESTRESSED CONCRETE BRIDGES

Prestressed concrete sections are being used on the Bureau of Reclamation constructed and operated Rio Grande Project, in Texas and New Mexico, over project canals and laterals. The drawing on the following page gives the general design details and construction cost figures for three typical bridges. These have been supplied by Project Manager, W. F. Resch, El Paso, Texas, from whom additional information can be obtained if desired.

Design Details

The bridges consist of six prestressed concrete channel girders, each section being 2 feet 9 inches in width, to make up a total width of 16 feet 6 inches. The abutments are constructed of precast-concrete piling with a combination reinforced cast-in-place concrete cap and abutment block. The drawing also gives a bar list and bending diagram for reinforcement required. The overall design is based upon an H-20-44 single lane loading. It has been suggested that angle iron placed on the ends of the channel girders at the abutments would prevent damage to the girder edges.

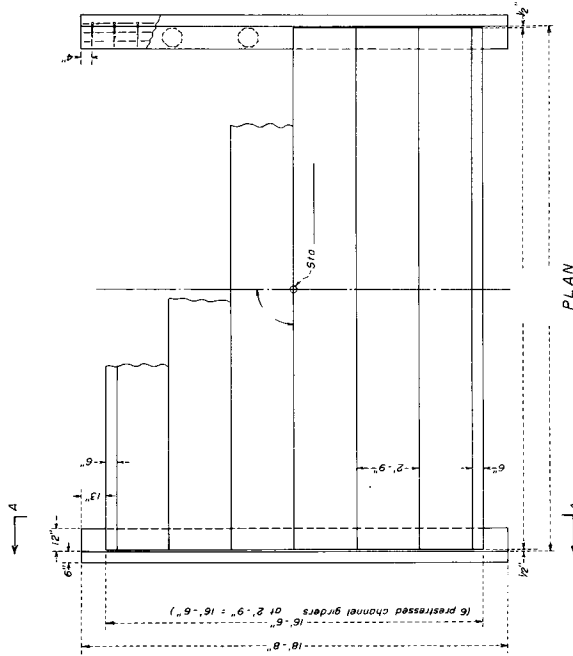
It will be noted from the drawing that steel sillplates, bearing plates and nylon bearing pads for the bridge are provided and also that 6- by 6-inch precast curbs along the outer girder have been provided with attachment of the curbs to the girders being accomplished with epoxy bonding compounds.

Bridge Construction Costs

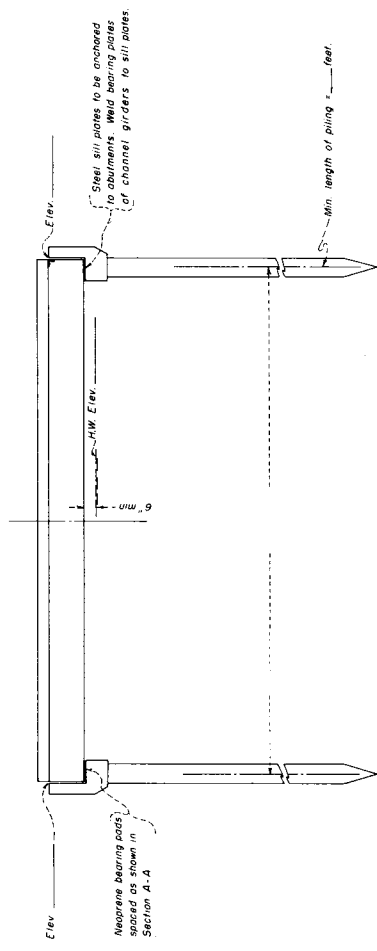
The cost figures cover all field costs of construction, including supervision and warehousing, but not the cost of design and general overhead expense. The materials cost designated by an asterisk (*), includes labor and materials for precast-concrete piling and curbs; and all other materials except for the prestressed sections; and a 12 percent warehousing charge.

<u>Location</u>	<u>Franklin Canal</u>	<u>Hansen Lateral</u>	<u>San Elizario Lateral</u>
	Sta 1165+78	Sta 15+01	Sta 52+44
Width	16'-6"	16'-6"	16'-6"
Length	34'-0"	25'-0"	21'-0"
Loading	H-20	H-20	H-20
Cost:			
*Materials	\$ 884.96	\$ 611.95	\$ 602.45
Prestressed sections	1,530.00	1,065.90	928.20
Labor at bridge site	767.76	595.60	647.92
Equipment:			
Jet pump	5.00	4.00	6.00
Trucks	84.00	351.00	40.11
Truck-crane	297.00	84.00	135.00
Total	3,568.72	2,971.10	2,566.94
Per square foot	6.60	7.20	7.45

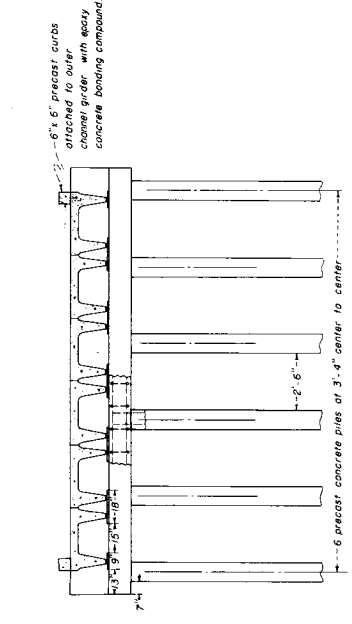
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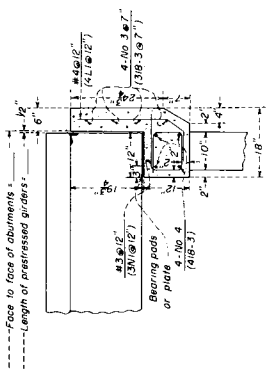
PLAN



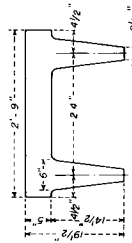
LONGITUDINAL ELEVATION



SECTION A - A



DETAIL (Piling Cap)



END SECTION CHANNEL GIRDER

BAR LIST AND REINFORCING DIAGRAM			
For Two Piling Caps			
Mark	Size	Qty	Notes
3/8-3	3	16-3"	8
4/8-3	4	18-3"	8

Bent Bars			
Mark	Size	Total Length	No. Bars
4/1	4	3'-0"	3
3/1	3	4'-1"	3

Bending Diagrams for Reinforcing Bars			
Mark	Size	Total Length	No. Bars
4/1	4	3'-0"	3
3/1	3	4'-1"	3

NOTES

UNLESS OTHERWISE SHOWN, PLACE REINFORCEMENT AS NOTED. CLEAR DISTANCE BETWEEN FACE OF CONCRETE AND NEAREST REINFORCEMENT IS 1 1/2" FOR FORMED SURFACES. LAP ALL BARS 24 DIAMETERS AT JOINTS, UNLESS OTHERWISE SHOWN. CONCRETE DESIGN BASED ON A COMPRESSIVE STRENGTH OF 3,000 P.S.I. DESIGN IS BASED UPON H20-44 SINGLE LANE LOADING. CONSTRUCTION B.M. Elev. _____

Total Quantities

- Superstructure
 - 6'-____ ft. prestressed channel girders
 - ____ in feet 6 x 6 precast concrete curbs
- Piling Caps
 - 31 cy concrete
 - 1 1/2 # reinforcement, No. 3 bars
 - 174 # reinforcement, No. 4 bars
 - ____ # steel bearing plates
 - ____ # 8" x 8" x 8" corrugated bearing pad
- Piling
 - 12'-10" octagonal x ____ ft. precast concrete piling

REINFORCED STEEL
 FABRICATED BY
 HUNTER & COMPANY
 1000 W. 10TH ST., NEW BRUNSWICK, TEXAS

PRESTRESSED CONCRETE BRIDGE

DRAWN: _____ SUBMITTED: _____
 TRACED: _____ RECOMMENDED: _____
 CHECKED: _____ APPROVED: _____

J. L. PASCO, TEXAS

Cost code