WATER OPERATION AND MAINTENANCE

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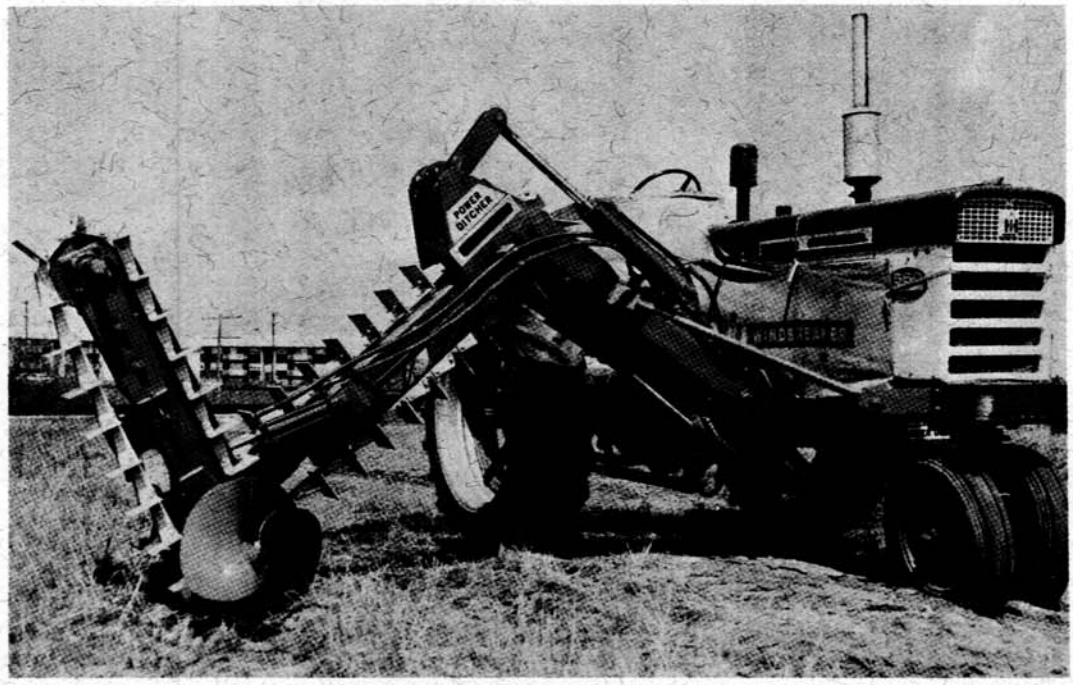

IN THIS ISSUE

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 Suggestions Award Committee when a suggestion is adopted.

Any information combined in this bulletin regarding commercial products may not be used for advertising or promotional purposes and is not to be construed as an endorsement of any product by the Bureau of Reclamation.

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Division of Water Operation
and Maintenance
Engineering and Research Center
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COVER PHOTOGRAPH:

This unique machine is used by the Burley Irrigation District, Burley, Idaho, for cleaning vegetation and silt from drainage and irrigation ditches. It is also used for construction and maintenance of ditches, levees, landscape contours and road bed ditches. The auger which runs in the bottom of the ditch, eliminates any side draft on the tractor. Photo P1095-D-74802

UNITED STATES DEPARTMENT OF THE INTERIOR
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Secretary

BUREAU OF RECLAMATION
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WATER OPERATION AND MAINTENANCE
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INTRODUCTION

The proper selection, procurement and use of mobile equipment is most essential for the successful operation of any water supply system, as described in the first article on page 1.

Table saws can be very dangerous if not properly used as the article from the "Industrial Supervisor," a National Safety Council publication, on page 11 points out.

"New Standard Adopted on Irrigation Machines," and "Irrigation Line of Corrugated Steel Pipe," are the titles of two short articles on page 13.

A suggestion from an employee of the Navajo Indian Irrigation project for a modified version of the old barbed wire carrier, can be found on page 15.

Information provided by an Earth Resources Technology Satellite described on page 17, supplements the information needed to develop water management policies for the most efficient use of water resources.

Scheduling irrigation during offpeak periods has resulted in power savings as related in the article on page 18.

A short article on page 19, describes the importance of regular tune-ups for tractors and automobiles to conserve fuel consumption.

An electric motor is a valuable piece of equipment and here on page 20 are some valuable tips on how to keep it running.

Special precautions should be observed at all times when using a grinding wheel, as the safety article on page 21 indicates.

MANAGEMENT OF MOBILE EQUIPMENT[1]

Selection, Procurement and Use

Some of the most important decisions that can be made by an irrigation district or canal company are those that have to do with equipment selection, procurement and use. These are decisions that the irrigation manager, board members, and staff must make on a recurring basis, frequently, or at least as often as annually at budget time.

Equipment requirements are determined by the size of the project, type of water delivery, facilities, terrain, climate, and to some extent, available personnel. Only people thoroughly familiar with these facts can intelligently make the proper equipment requirement determinations. Work requirements on an irrigation district change, new equipment becomes available, and the proper mating of these two things is what determines the value of the decisions involving equipment needed.

One of the most difficult decisions to make is that of determining when the remaining life of a piece of equipment can no longer justify additional repairs. In reaching this decision, some of the factors to be considered are undepreciated value, cost of repairs, estimated remaining hours of use, and future maintenance and rehabilitation programs. There are other considerations to weigh before replacing equipment. Whether or not similar or adequate equipment is available under equipment rental is one of the considerations. Whether or not the work can be economically performed by contract is another consideration. In some areas, equipment rental is not practical either because the particular piece of equipment is not available or because it may not be available in cases of emergency. Many pieces of equipment which managers once thought had to be owned by the project can now be obtained by equipment rental. Some of these pieces of equipment are concrete mixers, road graders, scrapers, and compressors. There is always the question of when ownership is more economical than equipment rental. Many operators feel that 300 hours of annual use is the approximate point where ownership is more economical.

There are certain points to consider in equipment rental. Some of these are:

1. With or without operator
2. Who furnishes fuel and lubrication
3. Cost per hour of operating
4. Operating time per week or day
5. Cost per hour of standby time
6. Transporting equipment to and from jobsite

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[1] Reprinted from Water Systems Management Workshop--Lecture Notes, 1973. Written by Mr. T. A. Gulley, General Engineer, U.S.B.R., Minidoka Project Office, Burley, Idaho.

Another means of getting certain types of maintenance work done that is closely related to equipment rental is by contract. The major difference between the two is the unit of measure. The contractor under a contract bids so much a yard for riprap placed in a lateral or yard of gravel placed on an operating road. With all contracts it is very important to have positive control of the unit of measure, whether it is lineal feet, cubic yards, or miles.

In all cases, it is good management to have a complete inventory of contract services and equipment available for rent in your area. Utilizing these services can result in reducing your fleet and staff while properly maintaining your project at less cost. On occasion there has been an exchange of men and equipment between entities as Bureau of Reclamation, Forest Service, Bureau of Land Management, irrigation districts, and highway districts. A cooperative spirit of "you scratch my back and I will scratch yours."

Under certain programs such as a small rehabilitation program or a program where the hours of annual use are close to the breakpoint of equipment rental, it may be more economical to purchase used equipment. Here you need the assistance of your mechanic and operator as well as the services of a good, reliable dealer. It will be worthwhile to consult with the original owner of the used equipment if this is at all possible.

Let us now consider some of the factors in the selection of the various categories of equipment. When we consider the selection of vehicles, we cover a wide range of equipment ranging through cars, trucks, and heavy equipment.

Many utility companies are replacing a large part of their standard passenger cars and light pickups with the compact-size vehicles. These vehicles are used mostly in supervisory or light maintenance work. Recent survey by these companies revealed that the changes most desired in compact vehicles include:

1. Larger wheels and tires
2. Increased durability
3. Higher horsepower
4. More durability in brakes, clutches, engines, front ends, and transmissions

All of these additions mean that the compacts stand to lose or at least lessen their cost advantage. A cost comparison by one large company showed a cost per mile of the standard car to average $0.0336 against $0.0283 per mile for the compact car and $0.0801 per mile cost of a standard pickup versus $0.0706 for a compact pickup. These costs include fixed costs as well as operating costs. The consensus of these companies was that as long as the vehicles are not subjected to rugged use, the lower initial cost and lower operating cost of a compact make

it an economical vehicle to own. Applying the experience of these utility companies to water projects indicates that the compact is suitable for operation and supervisory purposes. Where these vehicles are used for both operation and maintenance, the 1/2-ton and 3/4-ton sizes are probably more economical because of reduced maintenance costs. The extras available on these pickups (fleetwing body, heavier spring, 4-speed transmission, and positraction rear end) are worth considering because of the reduction of maintenance costs and increased flexibility. A few years ago there was a great deal of driver resistance to the 3/4-ton pickup. The manufacturers have eliminated much of the hard riding and difficult steering that were the main objections to this size of vehicle. Another feature in this class vehicle is the 6-man cab. This cab is ideal for the average maintenance crew. This cab costs approximately $500 and can easily pay for itself by eliminating the need for additional vehicles for the purpose of transporting men to the job. Too many times these additional vehicles are large trucks.

A few years ago the basic truck on water projects was the 1-1/2-ton flatbed or dump. Many projects are replacing these with the 2-ton dump or flatbed. They are purchasing a truck with heavier front springs, 2-speed axles, and power steering. These larger units have the ruggedness to economically perform maintenance work with less maintenance cost than the old 1-1/2-ton unit. Some projects have used the side-dump flatbed rather than the rear-dump flatbed. They have found that extra care has to be used in balancing the load, particularly if there is only one hydraulic ram. Those who have used the side dump recommend two hoists. This will eliminate the twist in the flatbed resulting from an unbalanced load. Four-yard trucks, that side-dump, are about a maximum size for irrigation district use.

The need for the larger trucks will vary among projects. Unfortunately many projects are severely limited in the size of equipment they can operate because of poor O&M roads. In the selection of larger units it is important to become familiar with the many extras available and with the relationship of the additional costs of these extras to the increased performance and the reduced maintenance. There is nothing more important in the selection of your truck than the proper balance of all the components in your vehicles. The larger the unit, the more important this becomes.

Let us now consider some of these components. Of first consideration is the engine - should it be gasoline or diesel. The diesel engine will save up to 50 percent on fuel and 30 percent on maintenance. Therefore, the more miles and more capacity loads, the less operating cost per mile. Diesels will also idle on about one-fourth the fuel used by gasoline engines. The diesel has been particularly successful with such applications as transit-mix trucks and garbage collection units. But this type of use adds up to miles. There is no question

but the diesel is most practical in operations above 40,000-50,000 miles per year. With less miles per year, the gasoline-powered truck becomes more economical. A gasoline-powered truck will cost you approximately $2,000-$3,500 less than a comparable diesel model. In addition there are savings in interest, insurance, and license fees. Other advantages in the gasoline engine are:

1. Lighter weight
2. Lower overhaul costs
3. More optimistic resale price

The clutch is dependent on four major components; namely, the engine, transmission, rear axle, and tires. It is a standard practice in the clutch business to predicate the clutch size on engine torque. In selecting a clutch, consideration should be given to a two-plate clutch rather than a larger single plate for the following reasons:

1. Provide increased area of frictional surface for longer life
2. Minimize diameter of bell housing, clutch housing, and flywheel
3. Reduce inertia of clutch-driven disc assembly
4. Minimize clutch release effort

The most common transmission and axle combination in the 1-1/2-ton truck is the 5-speed transmission with the single-speed axle. In the 2-ton size, the 5-speed transmission is in combination with the 2-speed axle. As your truck sizes increase to the larger 3- to 5-ton trucks, the 5-speed transmission is joined with 3-, 4-, or 5-speed auxiliary transmission and a single-speed axle to give you the necessary steps and power to handle the loads.

At some point when your purchase the larger units, because of highway restrictions, you will be forced to consider tandem axles. There are three different designs of the single-speed tandem axle.

1. Both axles geared to drive.

2. One axle geared to drive with sheaves mounted next to wheels which, through belts, drive a following set of wheels. (It appears that the trucking industry prefers the "geared" axle to be in the rearward position in order to obtain a longer drive shaft, thus reducing the critical nature of the angle caused by short ones.)

3. One axle geared to drive, with the second axle employed as a weight-carrying member only.

In addition, there are important advantages inherent in the tandem axle design:

1. Greater Safety. There are six wheels on which brakes are mounted instead of four wheels on a two-axle tractor. This feature provides 28 percent more brake lining area on the tractor.

2. The suspension is usually of the "walking beam" type, which either utilizes a nonflexible member or a spring as the equalizing beam; reduces road shock by 50 percent.

In these heavy duty units, it may be best to go to the larger front axle. The small axles are not as safe and the extra wear on bearings, bushings, kingpins, and tierods under overload conditions could prove more expensive than that of the heavier axle.

Power steering on trucks should be considered, particularly on the larger trucks. This item is no longer considered a luxury item on front-axle loadings of 7,000 pounds or more. Power steering adds to cost, the weight, and the maintenance but should be considered in light of additional safety due to driver fatigue and considering the road conditions encountered on most irrigation districts. Canals, laterals, and drain bank roads, as a rule, are not noted for their fine condition and safety factors. Power steering is available for most trucks and tractors and is a valuable asset where there is a lot of low-speed maneuvering. Power steering offers a safety advantage of controllability under emergency situations, regardless of the load. One common mistake made in the selection of trucks equipped with automatic transmissions, power steering, and power brakes is buying the unit with insufficient horsepower. Economy in horsepower is false economy in this instance.

The brake safety and performance requirements as established by Federal, state and municipal authorities should also be reviewed in detail. Individual states have important specific brake regulations. The principal components to be considered in a brake selection are:

1. Brake system
2. Foundation brakes
3. Brake drums
4. Parking brake
5. Safety brakes
6. Retarders

The vacuum booster-hydraulic brake system is a type of operation combining manual or physical power and engine manifold power, an "assistor"-type system. A full power system for brake operation is conventionally an air system. This full power system has found almost complete acceptance on diesel-powered straight trucks and combination vehicles.

Development of brakes with automatic lining-drum clearance mechanism is an accomplished design and these are being marketed for brakes on both light- and heavy-duty vehicles. In addition to eliminating the

service operations, the automatic adjustment maintains a constancy of clearance which assures uniform brake timing and power, thereby providing the economies in brake operation obtained through good brake balance. Safety devices such as "springset" units can be added.

Item 3 touches on a component offering the advantage of light weight with the accompanying disadvantage of either high initial cost for an aluminum drum or higher brake operating temperature which invariably results in lower lining mileage.

For Item 4, the choice on light trucks is between a transmission-mounted propeller shaft brake and a mechanical pickup of the brakes at the rear wheels. Both systems are widely used. The transmission mounting enjoys the power advantage of the rear-axle ratio and simplicity of hookup. It also provides a completely independent secondary brake system which is not affected in its performance by the variable lining-drum clearance of the service brakes.

Regulations in most states forbid the use of other than mechanical power to apply the rear brakes for parking purposes because of "leakoff" possibilities. Most use rear brakes for both "parking" purposes and "emergency" stopping requirements. This trend has resulted in the adoption of so-called safety brakes or "springset" brakes, which are Item 5. These devices are applicable to full-powered, air-operated brakes and function to remain in a released or inactive position while air pressure to the spring compressing mechanism results in a brake application by spring force.

Automatic brake adjuster to insure uniform lining-drum clearance are therefore a prime requisite for optimum performance of rear-wheel parking brakes, either spring or mechanically operated.

Item 6 indicates a consideration of "retarders" for vehicle braking. The increasing use of automatic transmissions in light trucks makes a retarder consideration a reality by the introduction of this device in the torque converter section. The weight and cost penalties are minimized in such a construction and the unit will be found adequate and effective for brake requirements in traffic as well as downhill.

The trend in heavy-duty trucks toward the use of brake retarders has been in the area of exhaust and engine brakes. Although these enjoy a weight advantage over other types, they are also somewhat limited in the braking capacity when compared with fluid or electric retarders.

Certainly they should be of the self-adjusting type to reduce maintenance labor. The very fact that the lining-to-drum clearance remains constant throughout the lining life will result in minimum air usage and better brake timing.

When one starts thinking about the electrical system, alternating-current-type generators should be considered in all vehicle specifications because of their capability to deliver a charge rate at engine idle speed and also to perform well in the higher speed ranges. To complement the long-life design alternators, full transistor regulators are recommended. These do not contain any moving parts that deteriorate, such as contact points, have no conventional source for radio interference, and thereby improve the range and quality of two-way communications and are not affected by ambient temperature.

From the economic standpoint, the cost of tires represents close to 10 percent of the total cost of a new vehicle. This is true both for a small delivery truck and for a large over-the-highway tractor-trailer rig. Furthermore, throughout the life of the vehicle, tire cost will represent approximately 10 percent of vehicle operating expense.

The starting point in new tire selection should be the operators' tire records. Are the present tires delivering good original tread mileage and good retread mileage? Are most of the tires retreadable, with few failures due to impact or heat?

1. Tire size and ply rating
2. Tread design
3. Tyrex or nylon
4. Tubed or tubeless

The selection of optimum size and ply requires:

1. Determining maximum tire loads on each position of the vehicle
2. Considering available tire capacities based on tire and rim association load inflation tables
3. Selecting size and ply which will offer suitable capacity as well as economical interchangeability within the fleet

Tubeless tires have several advantages over tubed type:

1. A large reduction in road delays due to punctures
2. Up to 136 pounds per axle weight savings
3. Elimination of tube and flap problems
4. Elimination of lock-ring safety hazard
5. Require fewer man-hours for mounting and less shop space

Primary disadvantages of tubeless tires are lack of high-quality standards from one brand to the next and failure of retread and personnel to follow recommended tubeless repair procedures.

Much of the maintenance work on the canals, laterals, and drains on a water project is done by draglines, yumbos, backhoes, Gradalls, etc. These are very important pieces of equipment on a water project. The

size of this equipment is based upon the size of the canal or drains to be cleaned and the necessary reach to do this job. Often there is a tendency to purchase a larger piece of equipment than is necessary because of the greater earth-handling capacity. If you are involved in long-range construction or rehabilitation, the greater earth-handling capacity should be considered; but, this does not necessarily hold true on normal maintenance. Even with smaller machines you will notice that the buckets are seldom filled. In additional, particularly in the maintenance of drains, the larger machines and buckets over-excavate which results in reduced water velocities which tend to build up deposits of silt and encourage growth of weeds.

Dragline buckets are manufactured in the light-, medium-, and heavy-duty weights. In normal maintenance the light or medium-weight bucket will provide many years of satisfactory service. There are also perforated buckets that are highly desirable for maintaining canals and drains. The condition of your maintenance roads and bridges as well as state highway weight restrictions may limit the size of the machines. The size of your hauling equipment or the cost of renting heavy hauling equipment imposes a limitation on the size of the machine. Hauling equipment is usually available that will handle the 1- to 1-1/2-yard machine. Machines above this size are difficult to justify because of the high moving costs.

Closely related to the dragline is the hydraulic-controlled excavator such as the Gradall. These machines have positive control booms and buckets. There are numerous types and sizes that can be purchased for specific jobs. Another good type of similar machine is like the Drott Yumbo, Hop To, etc., which due to the type boom (not telescoping) can excavate with more latitude in the placing of the carrier. These machines are not a high-production piece of equipment in terms of cubic yards moved per hour. Their value lies where positive control of the bucket is needed, such as in cleaning a lined lateral or canal, cleaning around structures, or for fine grading in placing structures. When this machine is to be used to clean canals or laterals, 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 and release the clutch three or four times a minute. For a cleaning job that is more or less continuous, both a truck driver and an operator are required. This will require some type of communication between the truck driver and operator to coordinate the moving with the operating. If a lot of your work is spotty or in short stretches, consideration should be given to a remote control unit where the operator controls the truck from the machine cab. This unit is also available for draglines.

There is a group of machines that in the last few years has been used on nearly every project. These are the loader-backhoe combinations.

They are a highly mobile unit with many uses. The loader and backhoe unit is hydraulically controlled and mounted on an industrial farm tractor. The larger units approach the Gradall in performance and are considerably less expensive and also more versatile. If you are planning on using the loader unit to excavate and load material lying in its natural state, the loader capacity should be at least 1-1/2 cubic yards. Another attachment for this machine is the 4-in-1 front-mounted bucket. This bucket serves as a shovel-dozer-scraper or clamshell.

Another basic unit on a water project is the crawler-tractor. On most projects it is used for bulldozer work, leveling spoil, building roads, and repairing canal breaks. It is also used for operating the side sloper or pulling heavy-duty brush cutters. If the tractor is to be used for operating the side sloper, it is important to have the proper size tractor for the sloper. Many improvements have been made by the manufacturers to reduce daily servicing time costs in these units. Some of these improvements are electric starting, sealed track rollers and idlers, and hydraulic-type track adjusters. However, even this unit is being challenged by smaller rubber-mounted units stressing mobility.

Properly maintained O&M roads are very important to the operation and maintenance of the project. This maintenance can best be done by a motor grader. It is very difficult to justify the ownership of this equipment on small projects. Justification is made easier if some of the lateral and canal cleaning can be done with the sloper attachment to the grader. Equipment rental or contract is probably the most economical way of maintaining these roads on the smaller project.

Do not overlook office equipment when reviewing equipment requirements and replacements. Many administrative costs can be sharply reduced by replacing obsolete and worn-out office equipment. There have been many improvements in billing and cost account machines, duplicating and reproduction equipment, addressograph machines, self-answering and recording telephones, and other office equipment that will increase the efficiency of the administrative section.

Mobile radio equipment is being used on an ever-increasing number of projects. Improvements in these radios have greatly reduced the unit maintenance costs. Increased efficiency in operation, water utilization, maintenance, and the correlation of all project programs with the use of this piece of equipment have certainly removed it from the class of an expensive toy. Closely related to the communication equipment are the new developments of supervisory radio controls. Some projects are now dispatching water and providing additional protection to their projects with this equipment. Supervisory radio control can provide additional safety to your system, increased efficiency in water

utilization, and decreased cost of operation. Project managers should consider this type of equipment to determine whether or not it can be efficiently used on their projects.

Some project, no doubt, will want to consider the practicability of snow machines and motorcycles. These machines have been perfected and can be depended on to provide cheap, quick transportation where roads may not be usable or nonexistent in the gathering of watershed data and operation duties in remote areas. Planes or helicopters, usually on a charter basis, may also fill a requirement in this regard.

There are many other pieces of equipment necessary for the proper operation of a water project. Whether the piece of equipment costs $40 or $40,000, the same factors should be considered. These factors are repair versus a new replacement; equipment rental versus ownership.

Most projects purchase equipment by preparing and issuing specifications covering the general size and type of equipment that they wish to buy. This can result in a lower initial cost of the equipment. Specifications should list basic requirements of components and the general performance required. The type of specifications that will permit at least four to six bidders will generally make it possible to purchase a satisfactory piece of equipment at the most economical cost. This does not mean that the least expensive piece of equipment has to be or should be selected. However, this will provide the project manager with a basis for comparing comparable equipment offered by various manufacturers. Project managers should not overlook adequate warranties on new equipment and they should insist on as much protection as possible.

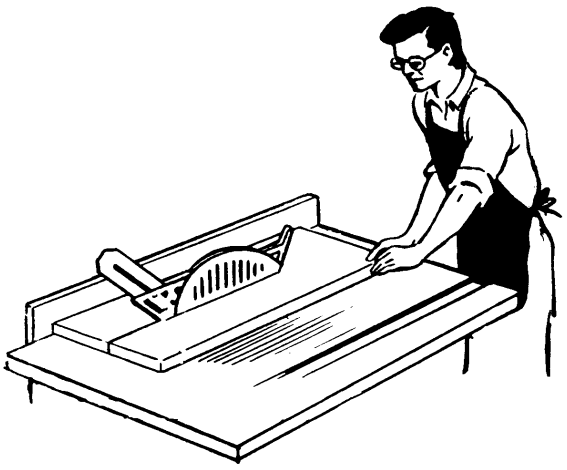
* * * * *

TABLE SAWS[1]

It's just about impossible to make a guard for a table saw that will absolutely prevent the operator from getting a finger into the blade. Guards can save a lot of fingers, but if the wood can get to the blade, so can the hand.

Some people think that's an excuse for not using the guards. Of course it isn't. Guards give a lot of protection and should always be used--but we still need to use our heads to save our hands.

So, on all table saws, no matter how well guarded, always keep your hands out of the line of the saw blade. On lots of sawing, this can be done without any special devices. But sometimes the work does call for special handling.



For instance, if you are ripping with the fence close to the saw, it's never safe to squeeze your hand between the fence and the saw. Always use a push stick long enough to keep your fingers out of range.

On cutting jobs, always use a gauge. Never try to saw free hand. That's bound to endanger your hands, and it may cause the work to get out of line, bind on the saw, and kickback.

When you're ripping with narrow clearance on the fence side, you may have found you had no room for the hood guard. And you may have been tempted to remove the guard so you could do the job.

That's just asking for trouble, because it leaves the blade wide open to tear your hand if you should slip or get absentminded. What's more, the procedure isn't necessary--not ever.

If there isn't room for the guard on close work, you can make room for it by clamping a filler piece to the table between the fence and the saw. This can be one inch stock the length of the fence and wide enough to give you plenty of room. Then you guide the work against the filler piece, and the hood guard stays in place to protect you.

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[1] Reprinted from the March 1974 issue of the "Industrial Supervisor," by special permission of the Editor, a National Safety Council, publication.

As most of you know, another danger of table saw work is kickbacks. So, keep your body out of line with the stock. A heavy leather apron is also some protection against getting a piece of stock knocked into your gut.

The higher the blade above the table, the greater the danger of kickbacks. So keep is as low as you can. There ought to be no more than three teeth showing above the stock being cut--or another good rule is to have the teeth show no more than 1/8th inch above the work.

Don't use a crosscut saw for ripping, and don't use a ripsaw for crosscutting. It makes the job harder, take more pressure, and increases the risk of accidents.

Sometimes it's better not to use a table saw. Long boards can be cut better and more safely on a swing saw or pull saw and lots of ripping jobs should be done on a power feed ripsaw.

If you've got special equipment handy to do special jobs, don't try to use the all-purpose table saw for these jobs. The right tool for the right job is always better and safer.

Don't ever try to remove or adjust either the saw guard or the fence when the saw is running--not unless you've got a couple of extra fingers you want to get rid of. And don't try to clean off sawdust and slivers with your hands. Always use a brush or stick--and that, only when the saw is stopped.

I want to say a word about shutting off the machine. Sometimes a man will get through with a saw, turn off the switch, and then walk away. Just then another man comes along, sees the saw is free, and assumes that it has stopped. So he starts to adjust it for another job--and then the idling sawblade cuts deep and fast.

Stay with your saw until the blade has stopped turning. If you're in a hurry you can stop it by sawing into a piece of scrap after the power is off. That's the one way to stop that kind of accident I've just described. It's a small thing to ask and to do for the protection of the guys who work with you.

A table saw properly used is a good safe tool. But wrongly used it is a real source of trouble and grief. So follow these tips I've given you, and if you have any doubts about how to handle something on the saw, check with one of the older hands before you try to figure out things for yourself.

A table saw is one thing you can't afford to work with unless you really know what you're doing.

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NEW STANDARD ADOPTED ON IRRIGATION MACHINES[1]

"Wiring and Equipment for Electrically Driven or Controlled Irrigation Machines" has been formally adopted as ASAE Standard S362. The purpose of the standard is to improve the degree of personal safety in operation of irrigation machines and application of products and materials under a reasonable range of conditions. It was developed by a subcommittee of the ASAE Agricultural Wiring and Utilization Committee with broad representation from center pivot irrigation system manufacturers. S362 provides detailed information for the application of electrical apparatus to electrically driven or controlled irrigation machines.

Standard S362 also includes specifications on disconnects, enclosures, interlocks, automatic or remote starting, grounding, main control panels, auxiliary panels, motors and motor controllers, conductors, collector rings, and safety signs. Although the safety records on irrigation machines is considered to be quite good, electrical safety is a major consideration in design and operation.

Copies of the new Standard will be available from the American Society of Agricultural Engineers Headquarters, 2950 Niles Road, St. Joseph, Michigan 49085, in early November 1974.

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IRRIGATION LINE OF CORRUGATED STEEL PIPE[1]

Pecan trees in northern Texas require 60 inches of rainfall a year for optimum production. In a normal year, however, the area only receives 30 inches. To supplement the natural rainfall, one northern Texas orchard recently installed an 11,000-foot steel irrigation pipe.

"We needed an asphalt-coated pipe to give us the corrosion protection we felt was required," the orchard manager explained. "We also wanted long lengths that were relatively light weight for easy installation. We used our own crews and equipment, so we also needed a pipe that wasn't too difficult to install."

The water comes from a nearby lake from which it is pumped into reservoirs on the orchard. The supply line, fed by gravity, delivers water at 15 PSI pressure to a small diameter plastic pipe distribution system.

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[1] Reprinted by special permission of the Editor, from the Irrigation Journal dated January/February 1974.

In the total some 19,000 gallons of water per minute are handled by the total irrigation system. The newly installed pipe carries some 13,000 gallons per minute.

As the 11,000 foot pipe line makes its way around the orchard, it changes diameter as it gets progressively further away from the reservoir. Starting at 420 inch diameter, the pipe goes down to 30-inch diameter at the end of the line.

* * * * *

ANCIENT WATER PROBLEMS

In the past, problems of water supply and management were the same as those of the 20th century; modern man, like his ancient forebearers, still is plagued by such problems as insufficient or excess water, water at an undersired place or time; poor chemical quality, erosion and sedimentation, and soil salinity.

The earliest beginnings of water management, and for several thousand years thereafter, were linked primarily to food production. Many archeological data and published accounts disclose a great antiquity of water management, of disputes over water use, and even wars fought for water rights.

By about 5,000 BC, irrigation was practiced in a few areas, but irrigation agriculture did not become extensive until about 3,500 BC. This occurred simultaneously in the Tigris-Euphrates Valley in Mesopotamia and the Nile Valley of Egypt, and somewhat later in the Indus Valley of Pakistan. Ancient irrigation systems were established also in China and Armenia.

The earliest large-scale management of water was for irrigation in lower Mesopotamia. A great deal of labor was expended in building and repairing canals along the Tigris and Euphrates Rivers, which had violent and unpredictable flooding. Some of the canals were in use for a thousand years before they had to be replaced.

Soil and water salinity have been persistent problems throughout the 6,000 year history of irrigation in Mesopotamia. Ancient attempts to control waterlogging and soil salinity were based on avoidance of over-irrigation, and on weed-fallowing in alternate years. Nevertheless, salinity gradually increased, expanding northward; crop production fell off and prosperity decreased.

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BARBED WIRE CARRIER MODIFICATION
(Suggestion SW-NIIP-74S-1)

A rather simple modification to the standard barbed wire carrier as suggested by James Ray of the Land Division, Land Classification and Drain Branch, Navajo Indian Irrigation Project, Farmington, New Mexico, offers a reasonable and economical solution to a very real safety hazard. Mr. Ray's idea was used when the project decided to fence off a section of a canal to keep out vandals. It was reported to have prevented some nasty barbed wire injuries and reduced construction time by maintaining the spool of wire in the center position, eliminating the necessity for repositioning of the spool on the carrier.

As a general rule when constructing barbed wire fences the wire is unrolled from a spool, using a steel pipe carried by two men, similar to that shown in Figure 1 below. This method allows the spool of wire to slide sideways coming frequently into contact with hands and/or arms of persons carrying the spool of barbed wire. The spool continually has to be repositioned in the center of the steel bar to prevent possible cutting of hands or arms by the barbs. Both repositioning of the spool and treatment of injuries causes unnecessary delays in work process.

Figure 1 Photo P809-D-74799

The barbed wire carrier designed by Mr. Ray and fabricated by field personnel is shown in Figure 2 at left. It consists of two steel pipes, one small enough to fit inside the second pipe, and handles are welded on each end and steel discs welded seven and one-half (7-1/2) inches in from the handles. The larger pipe (with the handles), is fitted with a nut and bolt to prevent the handles from sliding off the smaller pipe; see Figure 3 on the next page.

Figure 2 Photo P809-D-74800

The steel discs as shown will prevent any side movement of

spool on the carrier. This unique barbed wire carrier can be used to unroll spools of wire rapidly and safely by two employees.

If further information is desired regarding this suggestion, please contact the Regional Director, U.S. Bureau of Reclamation, Southwest Region, Post Office Box H-4377, Amarillo, Texas 79101.

Figure 3 Photo P809-D-74801

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The Senior Park Manager for Colorado's Division of Parks and Outdoor Recreation at Bonney Dam State Recreation Area, found a use for those little sacks of silica gel which are often packed in crates of new equipment and machinery. Ditto for those moisture absorbing cards which come with new film. He uses them to hold down moisture in tool boxes and first aid kits, or for equipment being put away for the off-season. The reuse of these moisture-absorbing freebies prolongs the life of tools by reducing moisture content and thus inhibiting rust.

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EARTH RESOURCES TECHNOLOGY SATELLITE[1]

Pictures provided by the ERTS-1 satellite can be a powerful tool in managing the state's water resources, according to a speaker at the recent Nebraska Water Conference.

"ERTS-1 (Earth Resources Technology Satellite), orbiting 565 miles above the earth, provides scientists with detailed pictures of the earth's vegetation, landscape and surface water," said Dr. James V. Drew, associate dean for graduate studies and research at the University of Nebraska in Lincoln, Nebraska.

At 18-day intervals, NU scientists are provided images of the entire state of Nebraska. Since the satellite passes over the same spot every 18 days, it is possible to determine how seasonal changes affect resources.

ERTS-1 images are produced by a method called remote sensing. A scanner aboard the satellite picks up images in four wavelengths, each showing something different. For example, one image will show density of vegetation while another will show the distribution of surface water.

Interpreting these images will provide facts about relationships between crops and water, the relative amounts of available water and the location and acreage of irrigated crops. With these facts scientists can predict patterns of water use in the state more accurately and with less time and cost.

This information is needed to develop water management policies, to determine the consequences of water projects and to improve water use efficiency.

Images of the Sand Hills region are being used to locate and measure areas of severe wind erosion and the area of surface water. Research currently in progress is aimed at interpreting the animal-carrying capacity of specific sites within the region.

Other scientists are measuring the acreage of irrigated land in central and western Nebraska and monitoring soil and water management under irrigated conditions. Images of reservoir surfaces can be used to determine water quality; and the thermal images can be used to calculate water lost through evaporation and plants.

Pictures from ERTS-1 are supplemented by infrared photography from high-altitude aircraft. A Follow-up satellite, ERTS-B, is scheduled to be launched in 1976.

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[1] Reprinted by special permission of the Editor, from Irrigation Age, dated February 1974. The practical magazine for Irrigation Farming.

REDUCED POWER[1]

An experiment in reducing a Nebraska power district's peak electricity load, by cooperation of irrigationists and power district officials in scheduling irrigation, produced some interesting results. The experiment involved restricting hours of pumping and using a moisture depletion program for scheduling irrigations. The Custer Public Power District joined with local farms to experiment with schedules involving 20 center pivot systems and six gravity systems.

Irrigation farming in Custer County depends heavily on electricity to power pumps on deep wells. Since farmers have been accustomed to irrigating during the summer at the same time demand for air conditioning is greatest, the Custer Public Power District's summer peak power demand was high in comparison to the rest of the year. As a result, the district, which buys its power and pays for unused power up to 65 percent of the peak, paid $29,000 for power not used in 1972.

The experiment was designed to reduce peak power demand by adjusting irrigation power demands so that they complemented rather than conflicted with the demand of the rest of the district's customers. John H. Evans, district manager, estimates that the district will pay only $11,000 to $12,000 (saving $17,000 to $18,000) for unused power this year, as a result of the experiment. The cost of the experiment last summer was $15,000 to $16,000. $1.50 an acre was granted to cooperating farmers for inconvenience and for the services of a technician to schedule irrigation.

In addition to rescheduling irrigations, the farmers used a program of soil moisture depletion which cut down on the total amount of water needed by the crops. Programmed soil moisture depletion works on fine to medium textured soils at least five feet deep. It involves applying water only as needed by the crop, leaving room in the soil profile for a rain that may fall after irrigation and relying on soil moisture to bring the crop to maturity late in the season.

When district officials decided to try the experiment last year, they needed an expert to help farmers schedule their irrigation properly. So they hired Agricultural Technology Company of McCook, Nebraska. Fred Corey, president of the company, lined up 14 farmers with 26 irrigation systems for the experiment. Helping him was John H. Evans and Darrel Watts, district extension irrigationist at the University of Nebraska's North Platte Station. William R. Pederson, Custer County extension agent, joined to help. They included in the test 20 center pivot and six gravity irrigation systems watering a total acreage of 3,330 and using name plate horsepower of 2,120.

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[1] This article was written by Mr. Grant I. Johnson, University of Nebraska, Lincoln, Nebraska, and reprinted here by special permission of the Editor, from Irrigation Age, dated February 1974.

Farmers with proper size systems irrigated between the hours of 10 p.m. and 2 p.m., shutting down during the peak power load time of day (2 p.m. to 10 p.m.). Farmers whose systems were too small to permit shutting down for that length of time had their hours adjusted to the capacity of their systems. Mr. LaVerne Stetson, a USDA agricultural engineer stationed at the University of Nebraska, helped coordinate the schedules. The district installed radio operated controls on most of the systems and a time clock on one dozen.

The results of the experiment satisfied both the power district officials and the farmers. Many farmers have said that they will voluntarily continue the practice of cutting back irrigation during peak load periods. They have contracted with Agricultural Technology Company for a full time irrigation specialist. He is now on the job in Broken Bow, Nebraska. The district plans to start moving toward making the controlled irrigation arrangement permanent next year, although they will continue to experiment. Other Nebraska power districts have shown interest in the Custer County experiment.

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TRACTOR TUNING SAVES FUEL[1]

University agricultural researchers are examining farm operations in a search for ways to conserve fuel. Mr. Robert (Bob) Durland, extension agricultural engineer at South Dakota State University, claims that improper engine adjustment and neglected maintenance waste at least 10 percent of all petroleum fuels consumed in tractor and automobile engines. To avoid such wastes, Durland suggests giving your engines regular tune-ups, changing fouled spark plugs, oil and filters regularly. Changing spark plugs can increase engine performance four to six horsepower and decrease fuel consumption by six percent. On a tractor, spark plugs should be checked every 250 hours. Durland warns that pumps or injectors on diesel engines should be cared for by your dealer.

Kansas Experiment Station researchers checked carburetor adjustment as a potential cause of inefficient fuel use. Forty-six percent of the tractors studied had improperly adjusted carburetors. This lowered fuel consumption efficiency 9.5 percent. This study also showed that black smoke emission indicates air shortage, overfueling, faulty fueling, faulty fuel injection or overloaded engine.

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[1] Reprinted by special permission of the Editor, from Irrigation Age, Dated February 1974.

CUT DOWN ON MOTOR FAILURE![1]

Here Are Some Helpful Hints

Anyone who has just burned out an expensive electric motor can be hard to reason with. And a man who just burned out more than one motor can be worse. Solution?--Be familiar with most of the main causes of motor failure so that the correct steps can be taken!

Here is a list of some (but not all) causes of electric motor failure. Check it over, and then get with the Electrical Engineer in charge and nip your problems in the bud!

1. Voltage unbalance in three phase supply.
2. Single phase operation of three phase motors.
3. Lightning and other surge voltages.
4. Overload.
5. Short cycling.
6. Restricted ventilation.
7. Improper lubrication.
8. Certain ungrounded electrical system condition.
9. Insects or rodents destroying motor insulation.
10. Moisture.
11. Improper belt tension.
12. Vibration.
13. Misalignment.
14. Loose electrical connections.
15. Age.
16. Low voltage.
17. High voltage.
18. Incorrect type of motor for that particular application.

For more information on the wise and efficient use of electric power, contact your local Electrical Engineer.

* * * * *

According to a recent study by the U. S. Department of Agriculture--
If pesticides were withdrawn from agricultural production, farm exports would be eliminated. The number of agricultural workers currently on farms would have to doubled. Instead of spending 17% of family income on food, we would spend 30 to 40 percent of our income to provide current food needs. Without increasing the amount of land in farm crops, we could not provide food for more than 40% of our present population.

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[1] Provided by the Petroleum Electric Power Association. P.E.P.A. is a group of investor-owned taxpaying electric power companies providing dependable electric service to the petroleum industry.

GRINDING WHEEL SAFETY[1]

"DON'T play roulette with any work tools," warns the Grinding Wheel Institute (GWI). It is vitally important to keep the guards in place on grinding wheels. If the wheel should shatter the guard will stop the pieces before they hit YOU.

Always turn the wheel off before changing or adjusting the work rest. If the work rest should hit a running wheel while you were adjusting it, the wheel could shatter in your face.

The gap between the work rest and the wheel should be between 1/32 and 1/8 of an inch. When turning on a wheel stand to one side. If a wheel is going to shatter it will usually shatter a few seconds after it is turned on according to the Grinding Wheel Institute.

Grinding wheels are fragile and must be treated gently. If they are dropped, hairline fractures may form which will cause the wheel to shatter when it is turned on. Make sure the replacement wheel is the correct diameter, and has the proper RPM rating for your equipment. Check the governor on air operated grinders to insure that the shaft is not turning too fast.

Never, under any circumstances, alter the arbor hole of a grinding wheel to make it fit on an oversized shaft. Doing this can affect the balance of the wheel and shatter it.

The arbor flanges support and drive the wheel. If you lose an arbor flange always replace it with the correct flange. Makeshift flanges made from old nuts and washers can kill you.

Even pressure must be exerted by the flanges on the grinding wheel maintains the Grinding Wheel Institute. Dirt under the flanges is hazardous because it can cause uneven pressure which can cause wheel failure. Be careful when you tighten the flanges. Too much pressure can shatter the wheel and too little pressure can cause wheel slippage.

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Near the southwestern corner of the Arabian Peninsula, a large dam was built at Ma'rib by the Sabaean Kings, who reached their prime about 500 BC. This dam was used to impound irrigation water for almost a thousand years before a great flood broke it up.

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[1] This article is presented here by special permission of the Editor, from the Arizona Farmer-Ranchman, April 1974 edition.

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

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

Prospective material should be submitted through your Bureau of Reclamation Regional office.

GPO 855-514