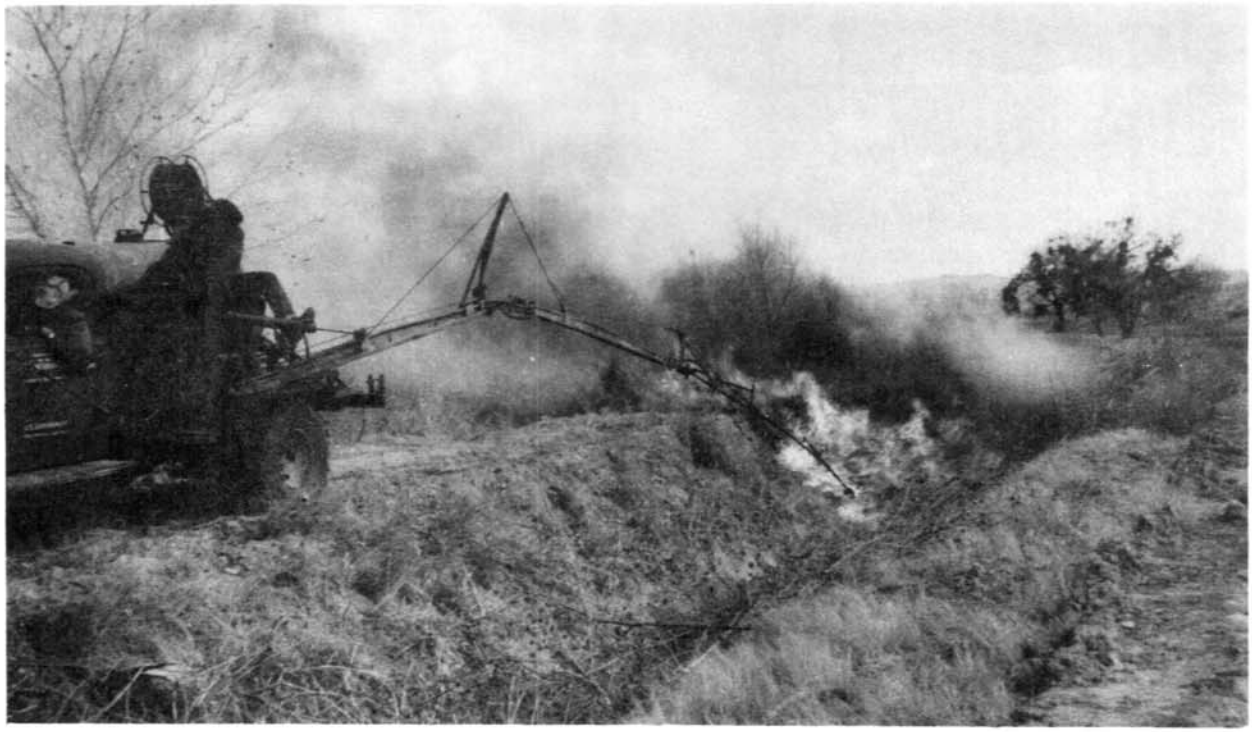
Department of the Interior

Bureau of Reclamation

OPERATION AND MAINTENANCE EQUIPMENT AND PROCEDURES

RELEASE NO. 24

April, May and June 1958



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OPERATION AND MAINTENANCE

EQUIPMENT AND PROCEDURES

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INTRODUCTION

This bulletin, published quarterly, is circulated 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. Reference to a trade name does not constitute the endorsement of a particular product, and omission of any commercially available item does not imply discrimination against any manufacturer. It is hoped that the labor-saving devices or less costly equipment 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.

Better ways of doing things and the saving of time and money are the purposes of this bulletin. If you have any ideas, shop made devices of your own design to do a job easier and better, or equipment modifications, they may be of value to other irrigation projects. Send in your ideas--a descriptive article with photographs and sketches to put the idea across--to the Assistant Commissioner and Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver 2, Colorado, Attention: D-400.

In order to insure proper recognition to those individuals whose suggestions are published in this and subsequent bulletins, the suggestion number as well as the person's name will be shown. All Bureau offices are also reminded to notify their Suggestion Awards Committee when a suggestion is adopted.

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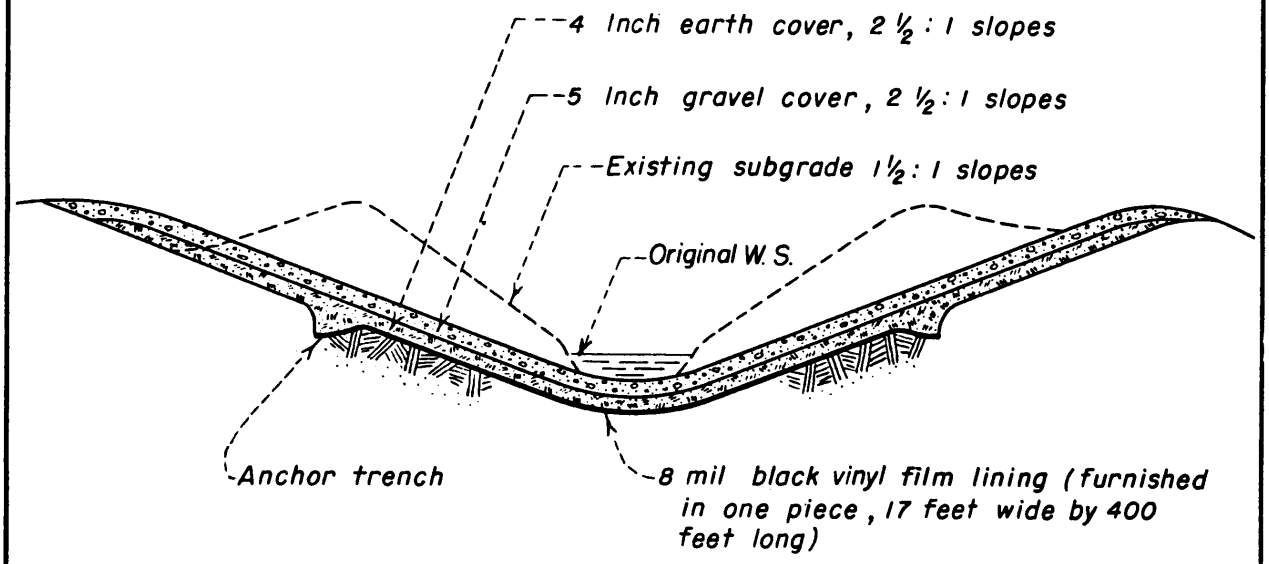
Division of Irrigation Operations
Commissioner's Office
Denver, Colorado

PLASTIC CANAL LININGS

As a part of the continuing search for satisfactory and low-cost linings for irrigation canals that can be installed by project forces, using a minimum of equipment normally available on an irrigation project, an experimental test section of buried plastic membrane lining was constructed on a lateral of the Heart Mountain Division, Shoshone Project, Wyoming. The work was accomplished in the fall of 1957 and a prefabricated, black, vinyl plastic material 8-mils in thickness was used for the 400-foot long experimental installation.

Preparation of the lateral subgrade and installation of the plastic lining were performed by project forces, using project equipment. The lining material was donated by the Bakelite Company of New York. The black, 8-mil thick vinyl film was furnished in one piece 17 feet wide and 400 feet long. The weight of the plastic lining material was approximately 350 pounds. The film was packaged at the factory, accordian-folded into a cardboard box about 4-feet long by 1-foot thick. The Bakelite Company is currently wholesaling this material at about 40¢ per square yard, according to R. H. Kennedy, Chief, Operation and Maintenance Branch, and W. H. Swenson, Head, Materials Section, who reported the installation work.

The condition of the lateral before lining is shown in the upper photograph at left. A typical cross-section of the lined lateral is shown, and its size and hydraulic characteristics are given on



R-9N Lateral, Heart Mountain Division
Lining installation Sta. 202+06 to Sta. 206+06
Hydraulic properties of original lateral

Q = 10 sec.-ft.
V = 1.8 ft./sec.
Side slopes = 1 ½ : 1
Bottom width = 4 feet (approx.)

TYPICAL CROSS-SECTION OF EXPERIMENTAL BURIED PLASTIC LINING INSTALLATION

the facing page. Preparation of the subgrade for the lining is shown in the lower photograph on page 1. The work was initiated October 22, 1957, and completed October 23, 1957.

The lateral was overexcavated to provide for 9 inches of combined earth and gravel cover over the lining after placement. The slopes were flattened to $2\frac{1}{2}$:1, and where sandstone was encountered, the subgrade was excavated slightly below grade and refilled with earth material to provide a cushion to prevent possible puncture of the film. The rough excavation was made with a dragline and fine-grading was accomplished with hand shovels, rakes and a lightweight lawn roller. Trenches were cut into the slope at the elevation of the top of the lining, as shown in the photograph at left, to anchor the film and to prevent surface water from seeping under the lining. Cutoff trenches 18-inches in depth were excavated at both inlet and outlet transitions to prevent water from getting under and displacing the lining.

Placing of the lining was easily accomplished by using a two-wheel trailer in the bottom of the lateral to carry the box containing the plastic. The lining was first unfolded in the bottom of the canal and then unfolded again toward each side slope as shown in the photograph at left. A minimum amount of earth material was placed in the trench at the top of the lining by hand methods to hold the plastic in place while the cover was being placed by the dragline. Placement of the lining for the entire 400-foot reach was completed without difficulty in about one hour. The

plastic remained soft and pliable even though the temperature was only slightly above freezing during placement.

The earth cover was silty sand material obtained from over-excavating the canal section. A template was constructed and pulled along the bottom and side slopes of the canal to level the earth cover prior to placing the gravel cover. No particular difficulty was experienced in placing the earth cover. The plastic apparently withstood the impact of the material dropping from the dragline bucket without any noticeable tearing of the lining. No doubt the excellent condition of the canal subgrade contributed to the successful application of the cover without damage to the membrane.

The gravel cover was hauled to the site in dump trucks and picked out directly from the truck with a clam shell bucket and placed in the canal section in one operation, as shown in the photograph at left.

In order to secure comparative costs which could be used for estimating the cost of similar work on other projects, labor and equipment costs were kept on the installation. These are given below. A minimum of supervision normally would be required for installation of this type of lining and the costs would be reduced materially on a larger installation using experienced personnel. Accordingly, costs somewhat lower than shown would normally result.

Dragline, excavation	$216.00
Dragline, placing earth and gravel cover	204.00
Loader, loading gravel trucks	36.00
Patrol, cleanup work	88.00
Labor, fine grading subgrade	168.55
Labor, smoothing earth cover	164.80
Labor, smoothing gravel cover	69.01
Transportation	43.74
Engineering and Supervision (Field Costs)	206.17
Total installation cost	$1,196.27
Installation cost per square yard (756 square yards)	$1.58

Approximately the same amount of subgrade preparation would be required for any type of membrane lining. The ease and time required to install this plastic membrane was a large factor in reducing the costs.

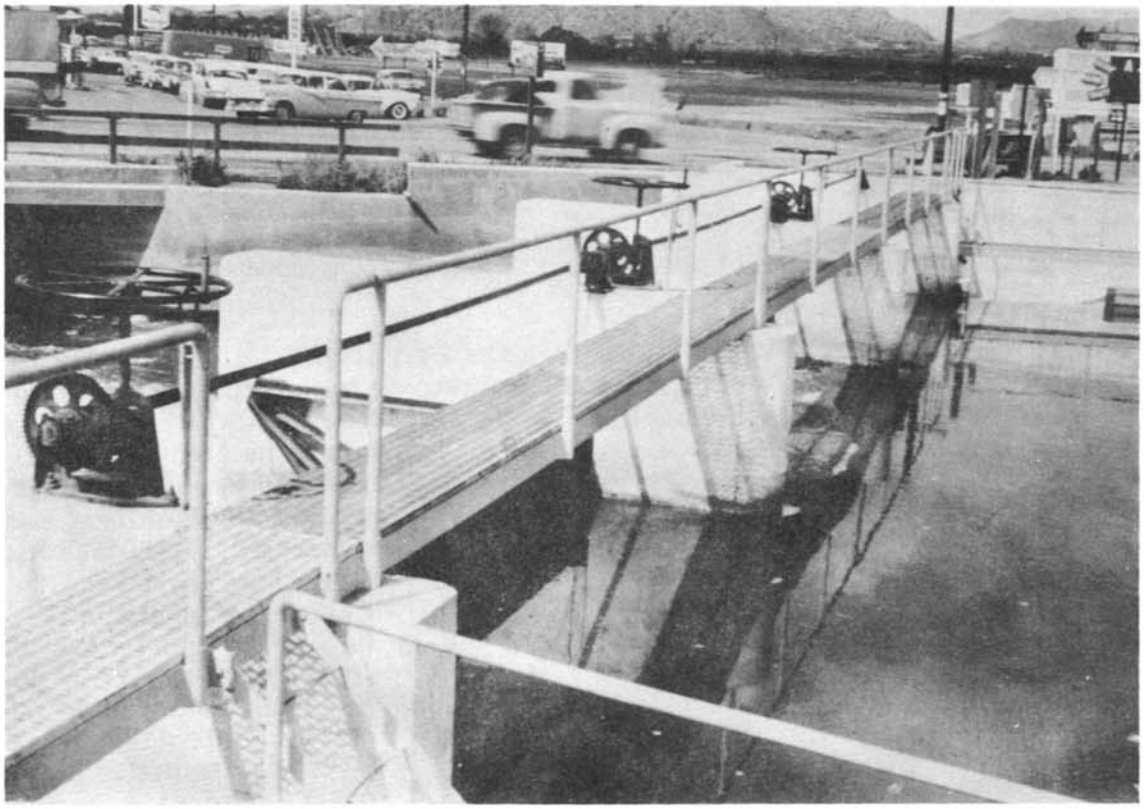
The above photograph shows the completed lining installation looking downstream. Where the canal prism is more than 20 feet and the length to be lined more than 400 feet, additional lengths of the plastic could be joined in the field to reduce the weight for handling conveniently. The Bakelite Company advises, however, that practically any width and length of film can be supplied and handling in the field will be the controlling factor on the size of sheet to be used. The ease in making field splices between two sheets of the vinyl plastic film was illustrated during the installation where it became necessary to patch a tear in the film which occurred during the unfolding process,

as shown in the lower photograph on the previous page. The repair was made without difficulty and without delay to the work using solvents and materials furnished by the manufacturer. The manufacturer reports that field splices made in this manner can be expected to develop at least 80 percent of the tensile strength of the material.

* * * * *

EXPANDED METAL WALKWAY

The expanded metal walkway shown below is located on a check of a lateral on the Arizona Canal, Salt River Project, Arizona, and is typical of many such installations on the project. This type of walkway is much preferred by the project forces to cast-in-place concrete walkways and is less expensive. The project forces feel that the expanded metal provides a safer operating deck in that it is skidproof. The walkways of this type are made in the project shops from purchased stock materials.



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SPRAY UNIT CONVERTED TO BURNER

There are approximately 350 miles of large riverside and interior drains and 200 miles of relatively large main canals on the Middle Rio Grande Project in New Mexico. As a rule, these waterways and drains are 8 to 12 feet in depth with comparatively long side slopes. Willows, salt cedar and other native vegetation grow profusely on these side slopes.

The weed control procedure in the past had included chemical spraying of this vegetative area using a 33-foot hydraulically operated spray boom. After the brush had been killed or controlled, the next step consisted of mowing with a heavy duty mower leaving the tops of the dead vegetation and other debris in place until it had dried sufficiently and could be burned. Burning of the vegetation and tumble weeds that accumulate throughout the perimeter of the drains and waterways was accomplished largely by the use of propane-butane burners mounted on trailers pulled behind trucks or tractors.

Unfortunately, the length of the boom used was limited to about 10 to 15 feet of area; the radius of the boom from the edge of the trailer. Accordingly, this limited the burned area to only part of the canal and drain slopes. To complete the job, it was necessary to use laborers and hand burners to extend the burning to the bottom of the canals, to the water surface in the drains, and to the tumble weeds generally located near the water's edge.

The project was well equipped with chemical spray equipment, which included a 33-foot hydraulically operated sectional spray boom. E. W. Elliott, Operation and Maintenance Supervisor on the project, reports that this boom was utilized with an adapter to spray a burner oil or a like material and accomplish the job more effectively and economically. A photograph of the unit in operation is shown on the cover of this issue of the Bulletin.

The spray equipment, all mounted on a one-ton, 4 by 4 Power Wagon, consists of a Peerless Model TVB 56 turbine pump, direct connected to a Wisconsin Engine No. AHH. A 4-foot extension was added to the end of the spray boom, and with a tee and two sections of pipe, provided for the mounting of three 6502 tee jets at 20-inch spacings. The tee jets were drilled out to enlarge the holes and make it possible to apply approximately 100 gallons per hour of diesel oil in small droplets at an approximate pressure of 25 psi. The more detail view of the burner in operation on the following page shows the 4-foot extension, burner tip and bracing of the burner tee to the extension pipe.

With the 33-foot boom and extension, and pumping facilities on the spray truck, it is now possible to completely cover the entire perimeter of the drains and large canals with a minimum of effort. While the use of oil as a catalyst for burning debris and willows is no innovation, this burner constructed by the Middle Rio Grande Project

forces is accomplishing a far better job than formerly accomplished by the use of a propane burner. The modified burner has improved the efficiency of the operation by 20 to 30 percent, and, although the greatest improvement has been on the drains and larger canals, some further savings are being realized by being able to burn the entire section of smaller canals. The photograph below shows a lateral after the diesel burning operation. Brush has been cut along the sides of the bank prior to burning.

For further information regarding the conversion of the chemical spray unit to a weed and brush burner, write the Regional Director, U. S. Bureau of Reclamation, Amarillo, Texas, or the Project Manager, Middle Rio Grande Project, U. S. Bureau of Reclamation, Albuquerque, New Mexico.

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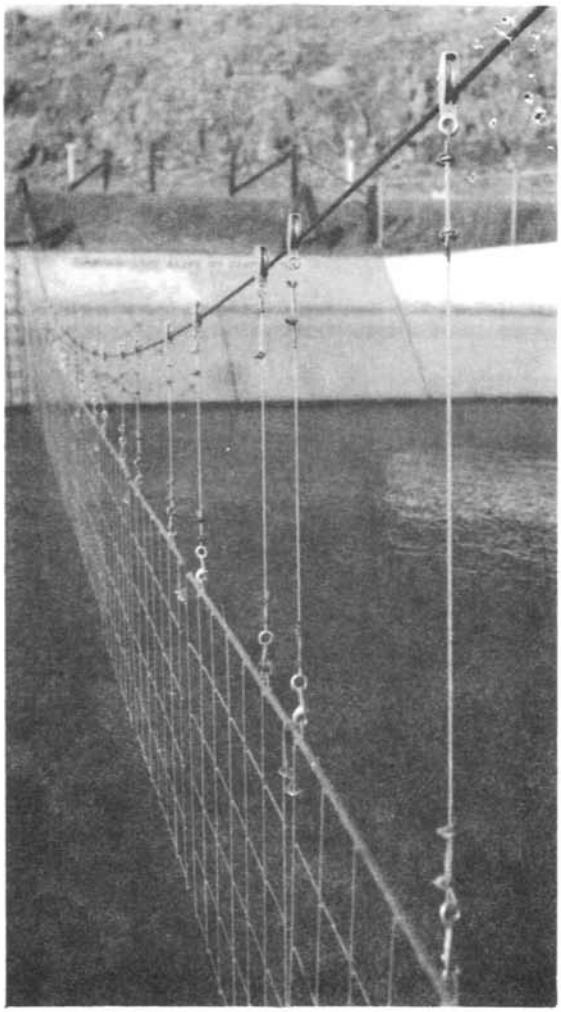
SUSPENSION OF SAFETY NETS ACROSS CANALS
(Suggestion R2-58-114)

Safety nets are installed across the Friant-Kern Canal of the Central Valley Project, California, above all siphon inlets and some other canal structures. The safety devices consist of wire netting suspended from a cable. The nets become clogged with debris and require cleaning about once a month during the midsummer season.



The cleaning operation was formerly accomplished by men in a boat. It was a dangerous undertaking as the men were working immediately upstream from siphons and check gates, some of which were of large capacity.

Jeff Neilsen, Fresno, California, a project employee suggested the idea depicted in the photograph at left, to overcome some of the hazards as well as to speed the cleaning operation with a reduced number of men. Sections of the netting are suspended from easily obtainable and inexpensive pulleys which ride the cable as shown. By hooking the netting sections together with harness snaps, they all may be pulled to one side of the canal, disconnected and cleaned without anyone having to enter the canal.

The device works as simply as reeling in the dry clothes on an endless clothes line from the steps of the back porch. Further information may be secured by writing the Regional Director, U. S. Bureau of Reclamation, Sacramento, California.

* * * * *

BASIC FACTS ABOUT DIESEL FUELS

Just what is diesel fuel? What properties should the best grades possess? Does the color of fuel mean anything? These questions about diesel fuels are among those asked frequently. The field engineers of the Standard Oil Company of Ohio answer these and other questions in an article in the January 1958 issue of Construction Methods and Equipment. The article, presented in nontechnical language, stresses many points that are of interest to all operators of diesel equipment.

What is Diesel Fuel?

Diesel fuel comes from the part of crude oil that evaporates less quickly than gasoline, but more quickly than lubricating oil. Crude oil consists of hundreds of compounds called hydrocarbons which are "boiled off" the crude at various temperatures. At about 90°, gasoline begins to boil from crude; at about 600°, lubricating oil begins to accumulate. Between these two extremes are found the distillates--furnace oil, kerosenes, and diesel fuels--which begin to boil off at approximately 300°.

What Does Color Indicate?

Nothing. At one time, color was a fair indication of the quality of diesel fuel, but advances in refining have made color a completely irrelevant factor today, except for showing up unusual and obvious cases of contamination.

What Does Smoky Exhaust Indicate?

If diesel fuel is of high quality and of the type recommended by the engine manufacturer, smoke from a diesel exhaust may indicate some type of misadjustment. A great deal can be learned from the color of the smoke. Blue smoke indicates that lubricating oil is being burned. White smoke means that the engine is operating at too low a temperature. Black smoke, most visible at full throttle, indicates that there is not enough air present to support complete combustion. (It's time to check air filters.)

Must Fuels Have High "Lubricity"?

It is true that, to some small degree, the fuel tends to lubricate the injectors, but cleanliness is a much more important quality, because most injector problems are caused by dirt or water. Under no circumstances should motor oil be added to diesel fuel. Diesel fuel must fall within a minimum and maximum viscosity range. If it is too viscous, it will not atomize properly as it is sprayed into the combustion chamber.

This means that the fuel will not burn completely. If the proper fuel is used, there is no need to add a lubricant.

Should Anti-Freeze be Added?

No. Anti-freeze tends to disperse water throughout the diesel fuel. This can easily build up rust on check valves, springs, plungers, and bushings in the injectors. In a short time, rust can lead to scoring of these parts.

What Properties do Good Fuels Have?

Cleanliness--Because the diesel engine injection system is a precision instrument, diesel fuel must be free from dirt, water, and other contaminants. In a relatively short time, dirt and water will score or rust check valves, springs, plungers, and bushings in the injectors.

Low sulphur content--All fuels contain varying amounts of sulphur. In some forms it is inactive and harmless, but in other forms it can contribute to corrosive engine wear.

Proper pour point--The pour point indicates the fuel's ability to flow through the fuel system at low temperatures. The pour point should be low enough so that fuel will flow properly at the lowest ambient temperatures expected during the engine's operation.

Volatility--The ability to change from liquid to vapor is called volatility. Because diesel fuels burn only in a vaporized state, volatility influences combustion and is responsible for the amounts of smoke, odor, and harmful deposits that an engine develops.

Ignition quality--The cetane number is a yardstick of how quickly a diesel fuel will ignite after it is injected into the combustion chamber. Fuels with high cetane numbers ignite quickly, which means the engine starts easily and runs smoothly. The American Society for Testing Materials (ASTM) recommends a minimum cetane number of 40, except for application under certain weather conditions when a higher cetane number may be desirable.

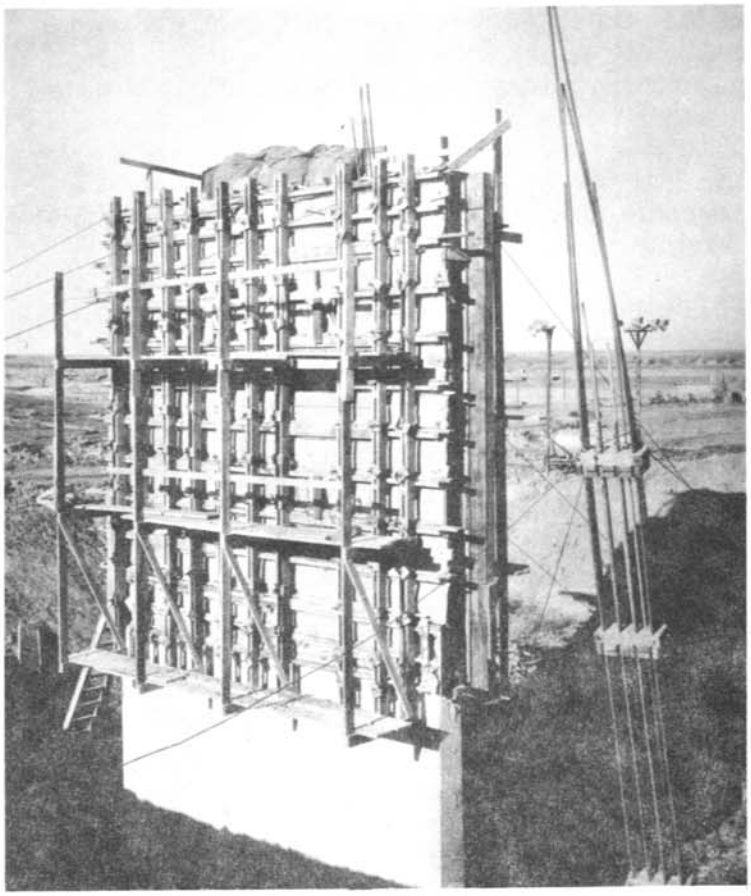
How Should Diesel Fuels be Stored?

Because the diesel injection system is susceptible to rust and scoring, great care must be exercised to keep fuel as clean as it is when delivered from the refinery. It is a dangerous practice to pump storage tanks completely dry, because water and sediment settle to the bottom. When new fuel is pumped into the tank, it stirs up sediment. For this reason, fuel should not be used immediately after it is delivered; it should be allowed to stand in storage for at least 24 hours. Care should be taken to see that the storage tanks are tightly sealed.

* * * * *

INSULATION FACILITATES WINTER CONCRETING

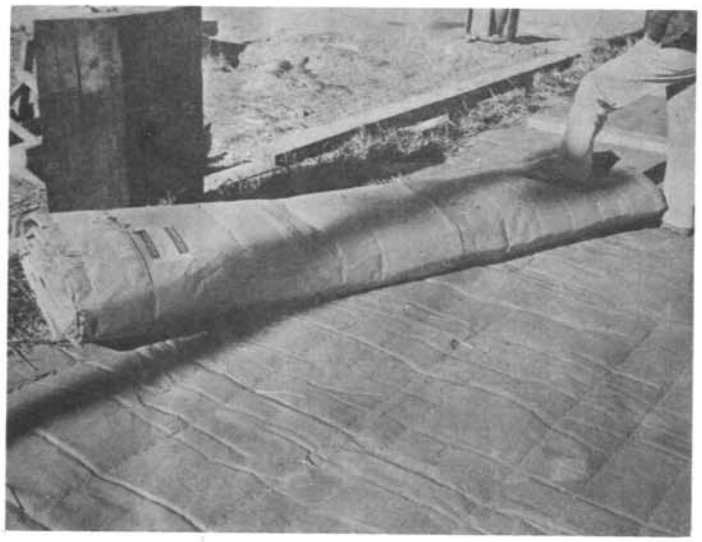
The practice of covering concrete with tarpaulins and heating by various methods to retain heat and moisture in concrete during freezing weather is expensive, inconvenient, and sometimes harmful to concrete. The use of insulation to provide the needed protection offers many advantages and the practicality of using insulating materials on forms and on unformed concrete surfaces to retain the heat and moisture was the subject of a study by the Bureau of Reclamation. Results of the laboratory and field investigations are summarized in the Bureau publication, Engineering Monograph No. 22, which reported the studies made and demonstrated the feasibility of protecting freshly placed concrete from freezing and loss of moisture by the use of insulation of several types.

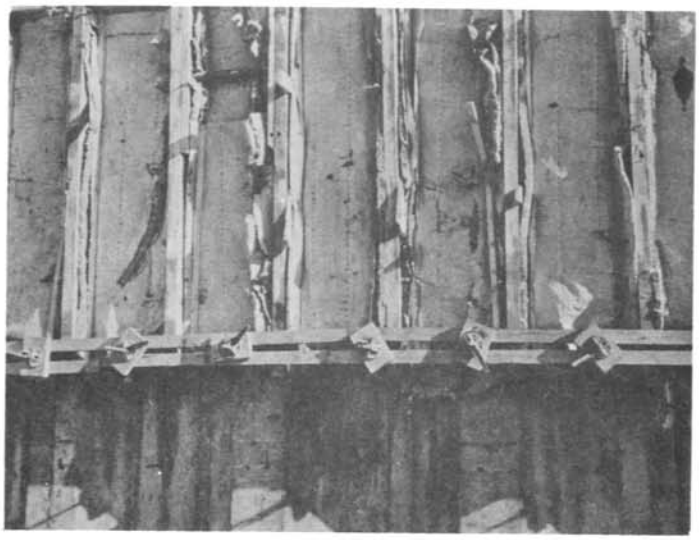


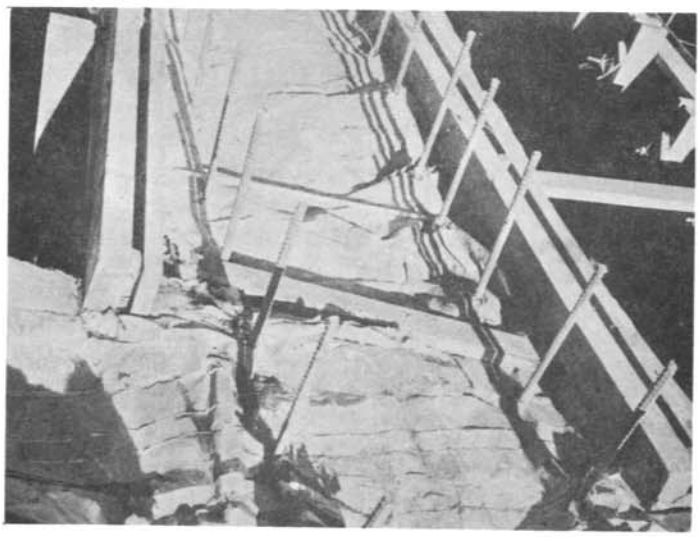
Insulation materials successfully used include spun glass and rock-wool bats and blankets and fiberboard. Spun glass insulation attached to the outside sheathing of the form at left provided very satisfactory protection during construction in Kansas during the winter of 1953-54. Encased in tough, water-resistant Sisal-kraft, the spun glass blankets are very durable and weigh but 0.24 pounds per square foot.

Spun glass insulation blankets supplied in rolls 10 feet wide, 25 feet long, 1 inch thick, and weighing 60 pounds per roll, as shown in the upper photograph on the following page, were placed directly on unformed concrete surfaces in the same area. The blanket was obtained at a cost of about 11¢ per square foot. The light weight of the rolls makes handling convenient. One workman can carry a roll of the material to a concrete placement and cover the surface of the concrete as placing operations proceed.

Spun glass insulation blankets cut to stud spacing and fastened to the outside of the form sheathing by 1- by 2-inch wood strips nailed to the forms are shown in the middle photograph on the following page. The form had been reused seven times.





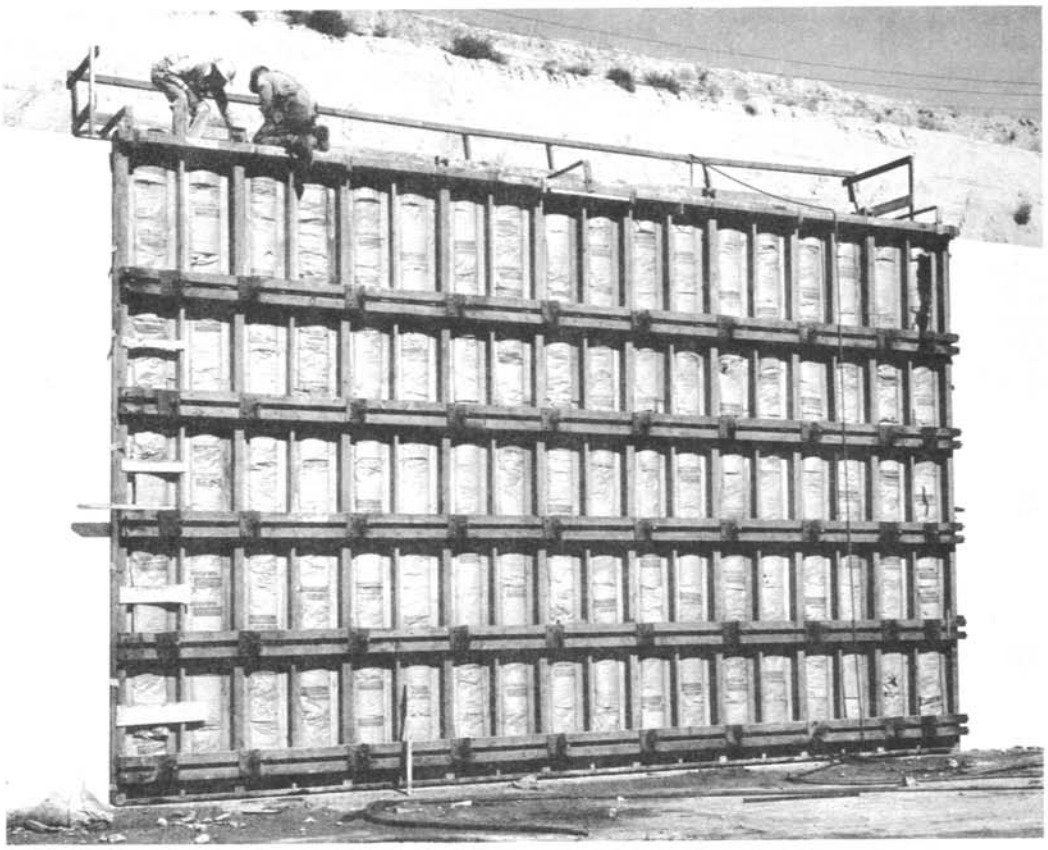


When applied to forms, the blankets are cut to the stud spacing and secured between the studs to the outside sheathing. The tops of walls are protected by placing a strip of blanket over the concrete surface and securing the strip to the sides of the forms either by tacking or weighting down with boards.

The blankets should be in direct contact with the top concrete surface. If reinforcing or dowel steel extends through the top of a wall placement, it may be punched through the blanket, or the blanket may be slotted and fitted snugly around the bars, as shown in the lower photograph. When an air space exists between the blanket and the concrete surface, small holes in the insulation permit cold, dry air to enter below the insulation which seriously detracts from the beneficial effect of the blanket.

Rock-wool bats 2 inches thick with black building paper encasement were also used in the Kansas-Nebraska area to protect freshly placed concrete from freezing and loss of moisture. The bats were obtained at a cost of about 44¢ per square foot. Bats of this type of material may also be obtained in $1\frac{1}{2}$- and 4-inch thicknesses and with special reflective encasements if desired.

The use of rock-wool bats on the form for one structure is shown in the photograph at the top of the following page.



The bats were placed between studs spaced 18 inches on centers and fastened to the outside of the form sheathing by battens along the edges. The forms were of extra sturdy construction designed for numerous reuses. The tops of the walls were protected by a double thickness of the blanketing material. Each blanket was composed of 2 inches of rock wool held together with a burlap covering.

The rock-wool bats covered with building paper were less durable than the spun glass blankets covered with Sisalkraft paper. The building paper covering deteriorated quite rapidly when exposed to wet weather, and it is recommended that bats of this type be covered with chicken wire or water-resistant paper for prolonged use. However, the rock-wool bats shown were used for 6 weeks, while each set of forms was used to place 9 wall panels.

Job-made rock-wool blankets were used during the winter in the Superior, Nebraska, area to protect concrete in siphon barrels. The blankets were constructed by the local construction forces at a cost of 30¢ per square foot. A 13- by 17-foot piece of canvas was laid out on sawdust on a wood platform and mopped with hot tar. A 2-inch layer of rock-wool insulation was placed on the canvas while the tar was still hot. Following this, more hot tar was mopped on the rock-wool and a layer of burlap covered the treated rock-wool. The canvas was lapped 6 inches around the edges of the blanket and mopped onto the burlap with tar. The resulting blanket was 12 feet wide, 16 feet long, and nearly 2-inches thick. However, the rock-wool soon consolidated to a thickness of slightly less than 1 inch.

The blankets were used to protect the concrete before and after the forms were stripped, as shown in the photographs above, and to protect the subgrade of future placements. During extremely cold weather, small butane burners inside the barrel provided supplementary heat prior to stripping forms. Also the subgrades were protected by placing the burners under the insulation while it was draped over the reinforcing steel cages. As soon as the forms were stripped, blankets were placed in direct contact with the outside concrete surface and weighted down, when necessary, to prevent circulation of air under the blankets.

The job-made rock-wool blankets were very durable and a blanket of this kind with proper care and handling should be quite serviceable. The greatest disadvantage of the job-made blankets was the rapid consolidation from 2-inch to 1-inch thickness and the accompanying loss of protective efficiency because of the consolidation.

Fiber insulation board has also been used to protect formed concrete surfaces on the Colorado-Big Thompson Project in Colorado. Panels of 1/2-inch fiberboard were fitted between the form studding and separated from the sheathing by 1-inch furring strips, thus forming a 3/4-inch dead air space. A variety of insulating boards in various panel sizes is available. Asphalt impregnated or coated fiberboard is also available and is designed for outdoor use, while the uncoated board is not.

Balsam-wool bats were used to protect concrete in bridge piers in South Dakota, where the work was performed during January and February. These bats sell for approximately 9¢ per square foot for double bats 2-inches thick and 6¢ per square foot for standard bats 1-inch thick, in the area in which they were used.

From the study made it may be concluded that concrete can be satisfactorily protected from freezing temperatures and dry winter winds by the use of insulated forms and surface blankets. This type of protection is considerably less expensive and is more uniform and

reliable than utilizing heated enclosures. Field performance records show that top surfaces, edges, and corners of walls are critical points and that considerable more insulation should be provided at these points than for adjacent surfaces. The study indicated that for locations with climates similar to that of southern Nebraska or northern Kansas, 1-inch of commercial insulation blanket or bat on 2-inch sheathing or its equivalent will usually be adequate for protecting formed surfaces of walls 12-inches or more thick; 2 inches of commercial insulation blanket or bat or its equivalent will usually be adequate for tops of walls or floor slabs; and 1 inch of commercial insulation blanket or bat or its equivalent will usually be adequate to protect unformed surfaces of mass concrete.

The large number of continually changing conditions that affect the generation and retention of heat in concrete make it advisable to check the temperature of the concrete at regular intervals during the first 3 days after placing. One important advantage of insulation is that the residual heat does not dissipate rapidly. If the temperature of the concrete is measured twice daily, there is little danger that the temperature will drop to the critical point without ample time to secure additional protection.

Bureau specifications have been revised to make winter concreting more practicable. The use of 1 percent calcium chloride, by weight of cement, is required when the mean daily temperature at the site of the work falls below 40° F. For concrete curing by sealing compounds, protection is required at 50° F for only 72 hours if the protection is obtained by means of adequate insulation in contact with forms or concrete surfaces. If insulation is not used, protection against freezing is required for an additional 72 hours.

The quoted Engineering Monograph was prepared by George B. Wallace, Canals Branch, Division of Design, Commissioner's Office, Denver, Colorado, from data obtained in the Denver Laboratories, and supplied by field forces. Engineering Monographs are published in limited editions for the technical staff of the Bureau of Reclamation and interested technical circles in government and private agencies. Their purpose is to record development, innovations, and progress in the engineering and scientific techniques and practices that are employed in planning, design, construction, and operation and maintenance of Reclamation structures and equipment. Copies may be obtained from the Bureau of Reclamation, Denver Federal Center, Denver 2, Colorado, and Washington, D. C., Engineering Monograph No. 22, published under date of October 1955, is obtainable at a cost of 55¢.

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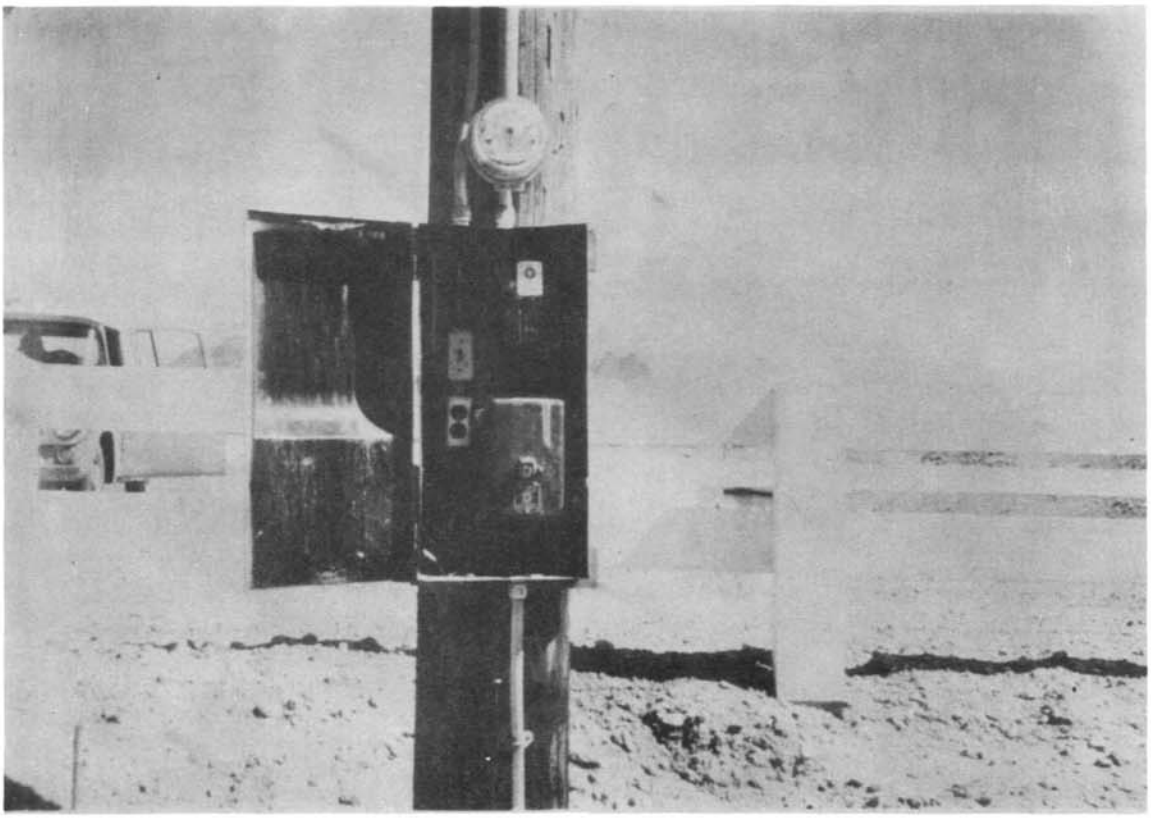
A CONVENIENT CONVENIENCE OUTLET

The control box at the Dome Turnout on the Wellton-Mohawk Canal, Gila Project, Arizona, as shown below, includes the usual electrical equipment necessary to operate the turnout gates and a switch for controlling the flood lights for the headworks. In addition, a convenience outlet to supply current for power tools used in maintaining the works has been provided by O&M forces. This has proved to be a useful addition.



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PAINTING "CYCLONE" TYPE FENCING

The Consumers Power Company, Saginaw, Michigan, has developed a new technique in the maintenance of "cyclone" type fencing used to protect many structures including, substations, pumping plants, material yards and other facilities.

Periodic painting and maintenance of this type of fencing material is often neglected because ordinary methods using hand brushes or spray equipment are time consuming and costly. The power company uses ordinary sweeper's brooms as applicators and report the method to be fast, thorough and economical.

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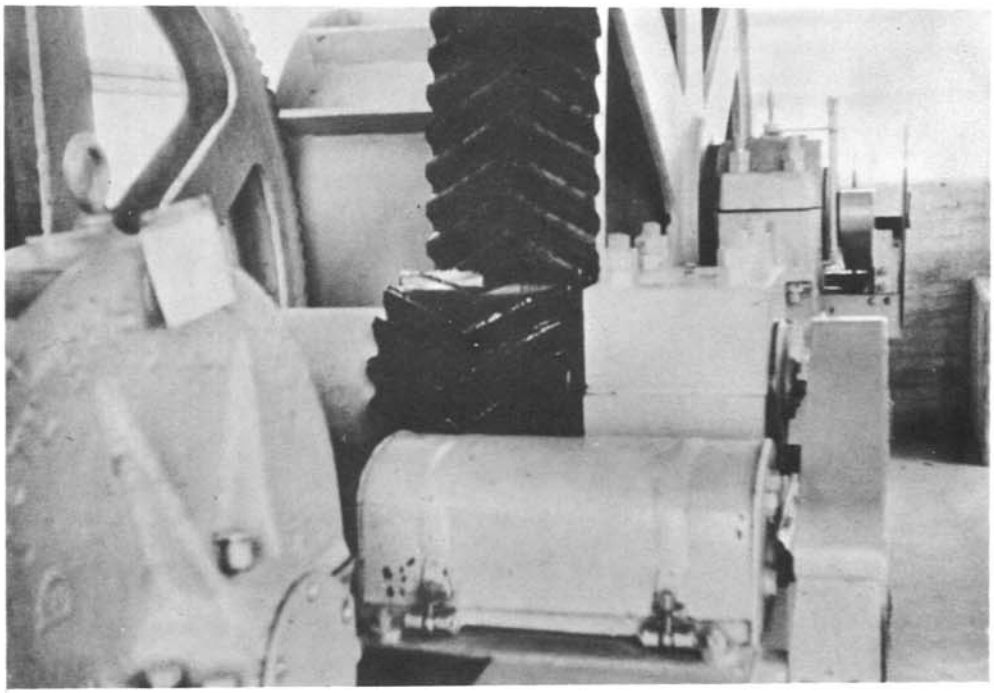
A GOOD GEAR AND PINION LUBRICANT

The gear and pinion of the Imperial Dam roller gate hoist shown below is coated with Keystone 29 Lt. lubricant. This lubricant is used on all roller gate hoist gears at the dam and on the hoisting chain pins. It remains in place very well and is quite effective. Additional information may be obtained from Imperial Irrigation District, Imperial, California.



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READY-MIXED CONCRETE

Ready-mixed concrete is being used more and more in the maintenance and repair of irrigation structures and facilities. A recent booklet published by the Portland Cement Association "Ready-Mixed Concrete for the Farm," although directed to the farmer as the title implies, has some useful and informative suggestions for maintenance forces. The booklet is written to help the user of ready-mixed concrete and information is given on:

How to order the right quality of concrete for your job.
How to estimate the amount of concrete needed.
How to organize the job so that construction runs smoothly.
How to place, finish and cure concrete for the best results.

Copies of the booklet can be obtained by writing the Portland Cement Association, 33 West Grand Ave., Chicago 10, Illinois, or your local Portland Cement Association representative.

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CANAL LININGS

Two publications that may be of interest to you on the subject of canal linings are: (1) Lining Irrigation Canals, and (2) USBR's Lower-cost Canal Lining Program.

The Portland Cement Association's illustrated, 32 page booklet "Lining Irrigation Canals," discusses the need for canal linings, the economics of lining, general design considerations and describes the types of linings that can be constructed with portland cement. Included are concrete, plastic soil-cement, compacted soil-cement, and shotcrete linings: precast lining units and pipe; and cast-in-place concrete pipe. Copies of the Portland Cement Association booklet can be obtained by writing the Association at 33 West Grand Ave., Chicago 10, Illinois.

The "USBR's Lower-cost Canal Lining Program," is a paper prepared by a member of the Bureau of Reclamation's Lower-cost Canal Lining Committee recently published by the Irrigation and Drainage Division of the American Society of Civil Engineers. It is a summary of the Bureau's program since it was initiated in 1946. Copies of the paper, published in the Journal of the Irrigation and Drainage Division of the ASCE as Paper 1589, may be obtained by writing American Society of Civil Engineers, Publication Office, 2500 South State Street, Ann Arbor, Michigan.

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