WATER OPERATION AND MAINTENANCE

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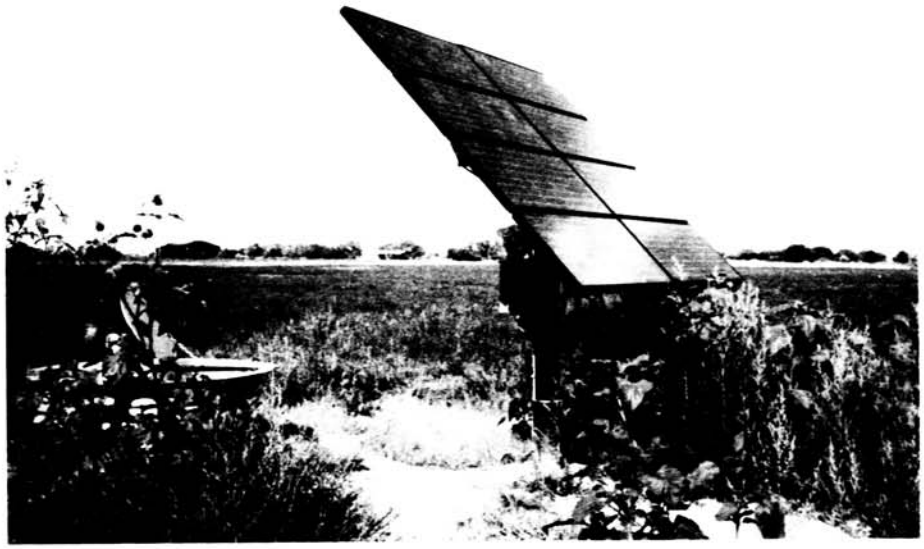

IN THIS ISSUE

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 information for use by Bureau personnel and water user groups for operating and maintaining project facilities.

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Cover photograph:

Las Nutrias Groundwater Project. A PV-power array with battery storage.

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LAS NUTRIAS GROUNDWATER CONTAMINATION STUDY PROJECT

by Mark Lichtwardt[1]

The following article is compiled from a paper authored by Drs. Robert Bowman and Jan Hendrickx, Professors of Hydrology, Geoscience Department, New Mexico Institute of Technology, Socorro, New Mexico; and Stan Bulsterbaum, Coordinator, Jornada RC&D, Las Cruces, New Mexico, for presentation at the New Mexico Conference on the Environment, held in Albuquerque, New Mexico, September 13-15, 1992.

Las Nutrias Groundwater Project is an interdisciplinary, interagency effort to determine the effects of agricultural management practices on shallow groundwater quality. The Project is located on a farm in the Middle Rio Grande Valley, approximately halfway between Albuquerque and Socorro, New Mexico (figure 1). A 60-acre field is equipped with a subsurface tile-drainage system that has been modified to measure groundwater recharge rates and the quality of recharge water below the field. The system allows one to determine water quality responses to changes in irrigation water management and to pesticide and fertilizer applications. The Project provides data on water quality impacts of non-point source pollution relevant to farming along the entire Rio Grande. Federal, State, and local regulatory agencies, as well as landowners, require such data to make meaningful policy decisions. A number of agencies in addition to Reclamation, including the Soil Conservation Service and Sandia National Laboratories, are cooperators in the Las Nutrias Groundwater Project.

Goals and Objectives

To address the needs of the Project, the following goals and related objectives were established.

Goal 1. – Adapt an existing tile-drainage system to allow collection of irrigation return flows from an operating farm.

- Install manholes at the upper and lower ends of a tile-drain lateral.
- Install a photovoltaic (PV) power system to supply power for field instruments and equipment.
- Install automated flow-measuring devices and water sampling equipment in the manholes.
- Install piezometer and neutron probe arrays to monitor groundwater levels and soil-water contents.

Goal 2. – Use the tile-drain sampling system to quantify pesticide and nutrient levels in irrigation return flow.

- Collect water samples on a regular schedule and in coordination with surface water and chemical inputs.
- Analyze samples for inorganic nutrients (particularly nitrates) and pesticides.
- Estimate the total contributions of nutrients and pesticides to shallow groundwater due to farm management.

[1] Mark Lichtwardt is a Mechanical Engineer in the Bureau of Reclamation's Special Technologies Group, Research and Laboratory Services Division, Denver Office.

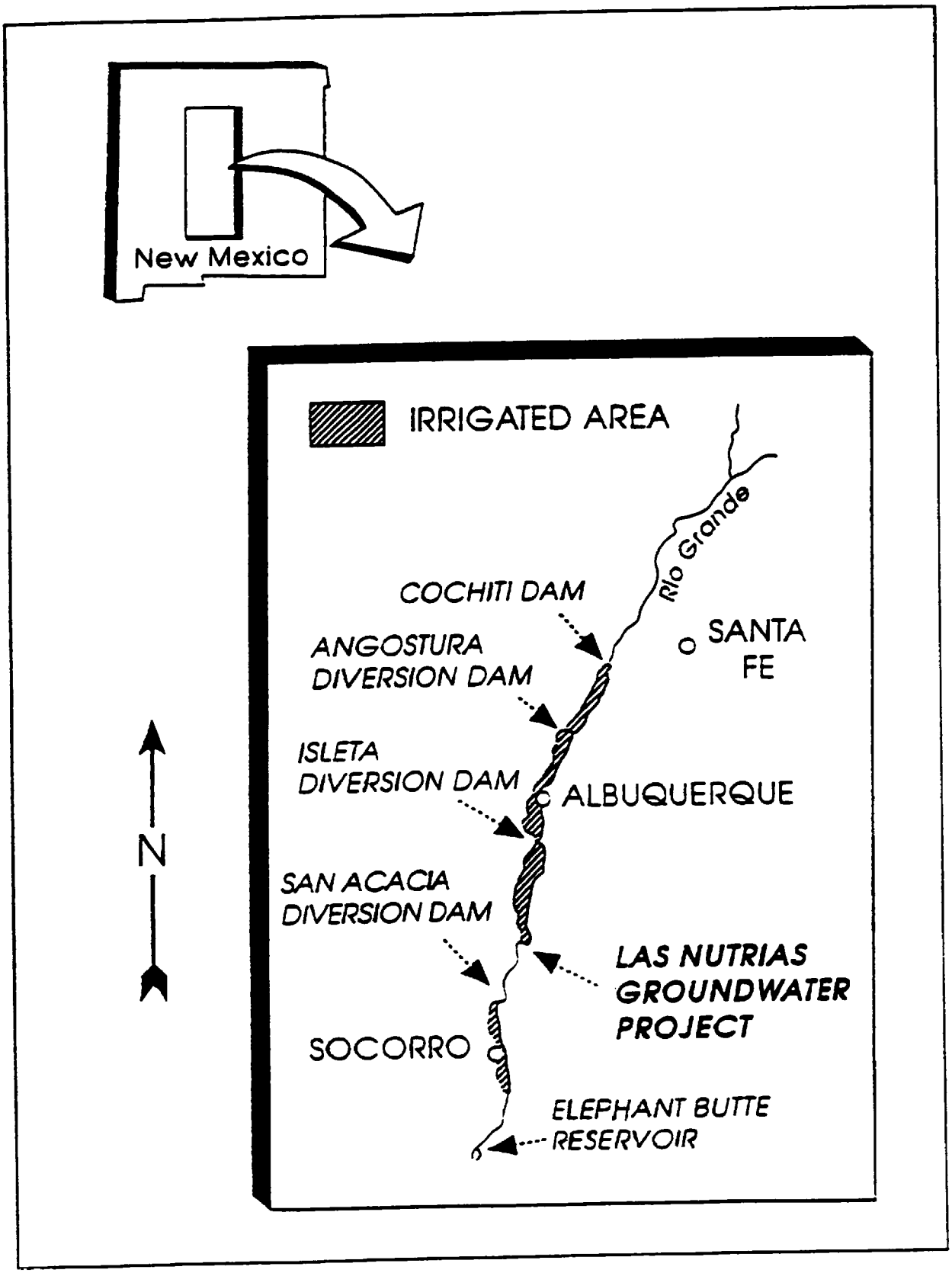

Figure 1. – Location of Las Nutrias Groundwater Project.

Goal 3. – Determine the local hydrology within and around the experimental field.

- Determine the contribution of off-site groundwater flow to observed tile-drainage flow.
- Use estimates of recharge due to field-water inputs to calculate nutrient and pesticide loadings to groundwater on a per-acre basis.
- Determine rates of movement of pesticides and nutrients from the surface to shallow groundwater.

Goal 4. – Develop water quality interpretations for specific soil series.

- Complete detailed soil survey of study field.
- Initiate development of data base for development of soil interpretations related to water quality.
- Present landowner with potential alternatives for changing cultural practices based on monitoring results and soil interpretations.

Field Installation

In 1979, a subsurface drainage system was installed by the landowner to lower the water table below the field which is currently cropped to alfalfa. The system consists of four lateral drain lines of perforated plastic pipe (tiles) which connect to a main line leading to a surface drain (figure 2). The tile drains, installed 4 to 6 feet below the surface, collect irrigation water which drains below the surface as well as shallow groundwater which flows into the area off-site. Such a system is an excellent collector of water and chemicals which move from the surface to the groundwater. Since the system was installed over a decade ago, land disturbance due to the installation has been mitigated by cultivation.

To establish a "control field" for the Project, an 800-foot-long section of the drainage system was isolated in the central portion of the field by installing manholes (figure 3). This allows the quantity and quality of water entering and leaving a single drain line to be sampled. By difference, the inputs of water and chemicals to the shallow groundwater due to management practices specific to this part of the farm can be determined.

A PV power array with battery storage has been installed at each manhole location. The west manhole is equipped with a 500-watt array (figure 4), while the east array produces approximately 240 watts under optimum solar conditions. The power is used to run pumps, water samplers, and dataloggers. These independent power systems were required since the field lies more than a mile from the utility grid.

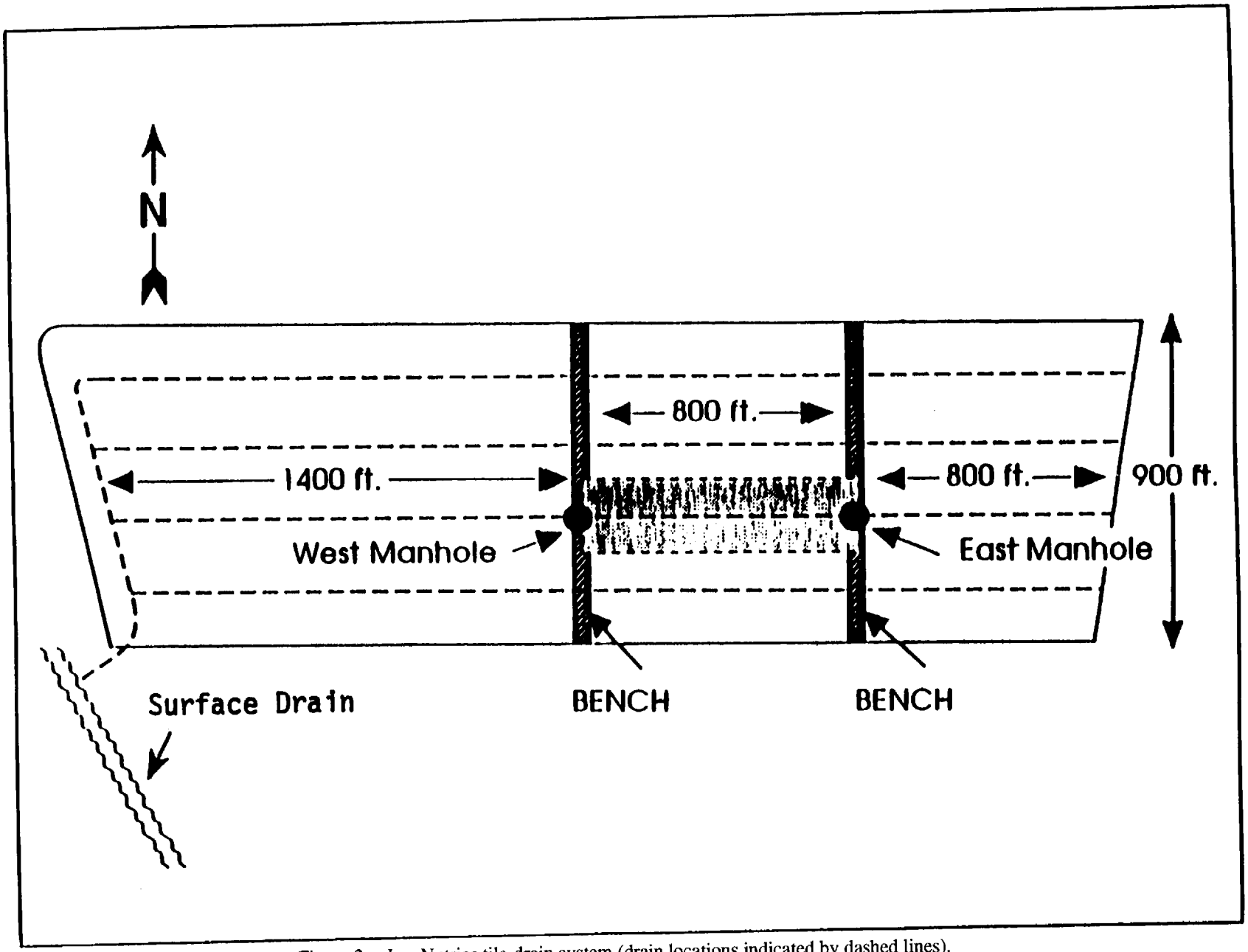

Figure 2. – Las Nutrias tile-drain system (drain locations indicated by dashed lines).

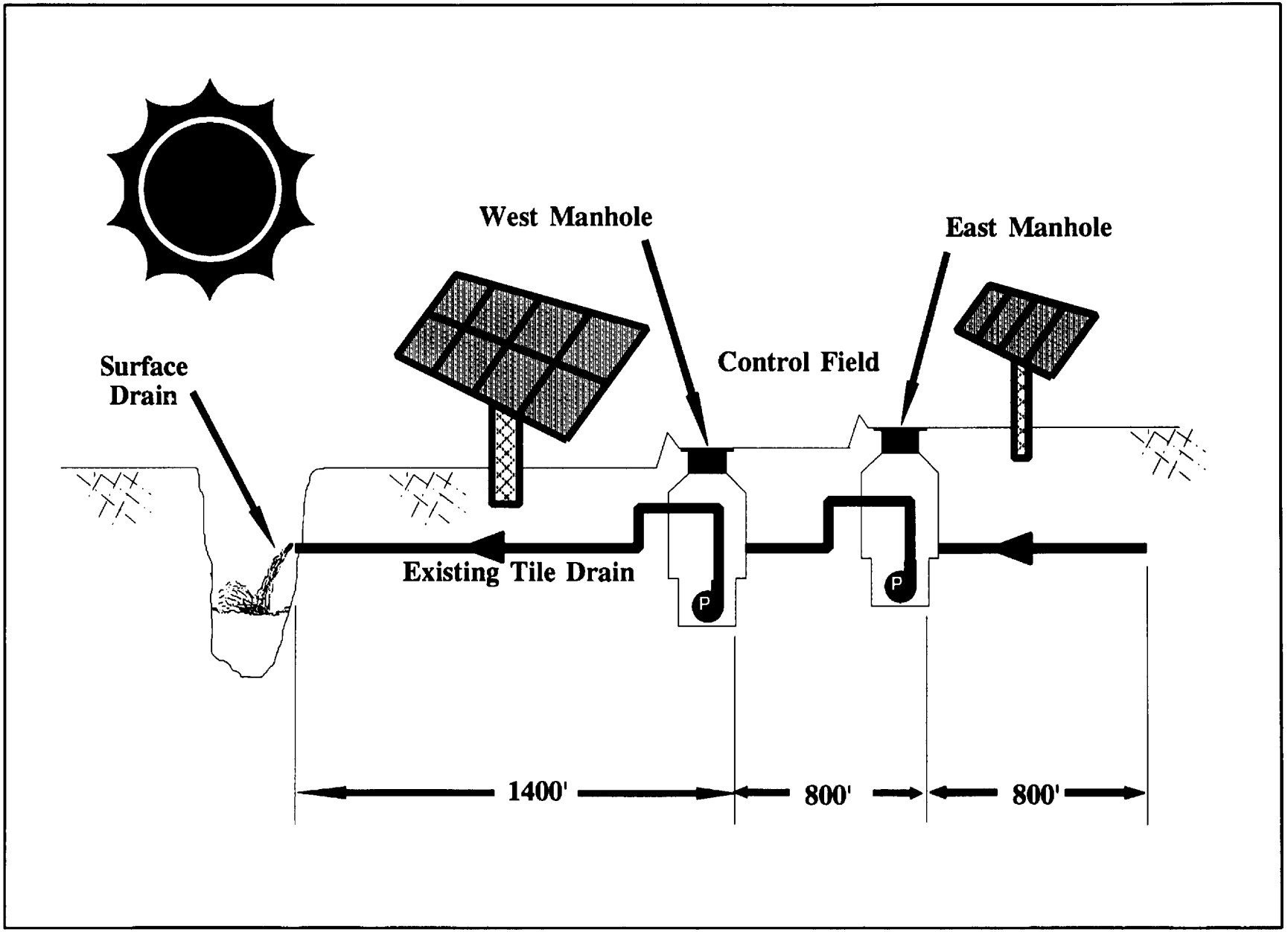

Figure 3. – PV pumping system and manholes installed in existing title drain.

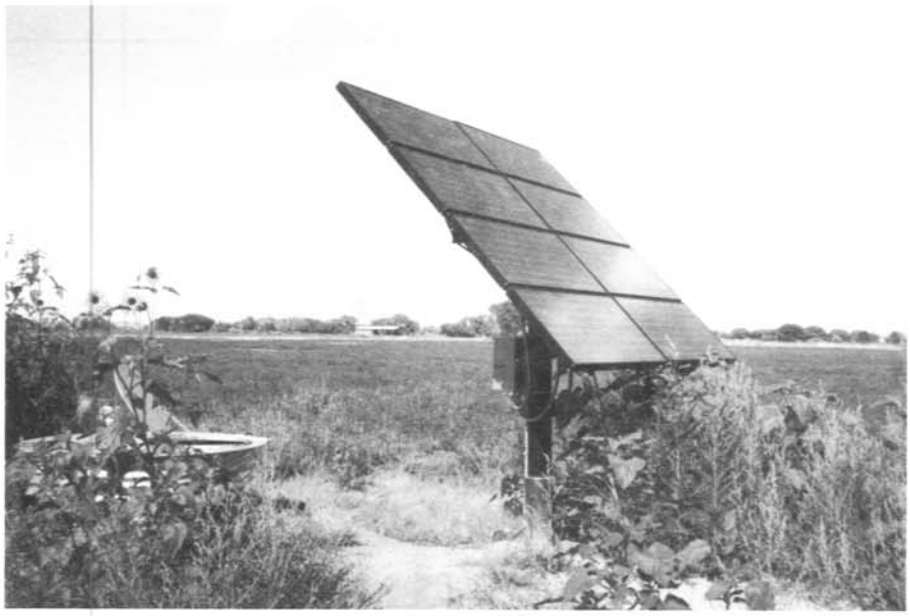

Figure 4. – 500-watt PV array for groundwater pumping at Las Nutrias, New Mexico.

Each manhole is currently equipped with a sump pump, flow meter, and weir for measuring drainage flows (figure 5). Automatic water samplers, programmed to collect samples on a flow-proportional basis, will be added later. A data system for monitoring and recording water levels in the manholes and in piezometers located throughout the field will also be added later.

Progress To Date

The idea for the Las Nutrias Groundwater Project began about a year ago as a result of discussions that Drs. Bowman and Hendrickx had with area farmers and local Soil Conservation Service personnel. Since that time, the focus has been on assembling a group of interested individuals and agencies who will gain from the information generated by the Project and on initial instrumentation of the field as described above. Current participants in the Project include:

- Electric Power Research Institute
- Jornada RC&D
- Landowner
- Middle Rio Grande Conservancy District
- New Mexico Bureau of Mines
- New Mexico Institute of Mining and Technology
- Sandia National Laboratories
- Socorro Soil and Water Conservation District
- Soil Conservation Service (Socorro, Roswell, and Albuquerque)
- U.S. Bureau of Reclamation (Socorro, Albuquerque, and Denver)
- U.S. Department of Energy

All of the participants listed above have provided support to the Project in the form of materials and/or services. The Soil Conservation Service and the Socorro Soil and Water Conservation District helped identify the tile-drained field and enlisted the cooperation of the landowner. New Mexico Tech is providing technical leadership on the Project. Reclamation designed, fabricated, and installed the manholes and the PV-powered pumping system. Funds for the PV system were provided by the Electric

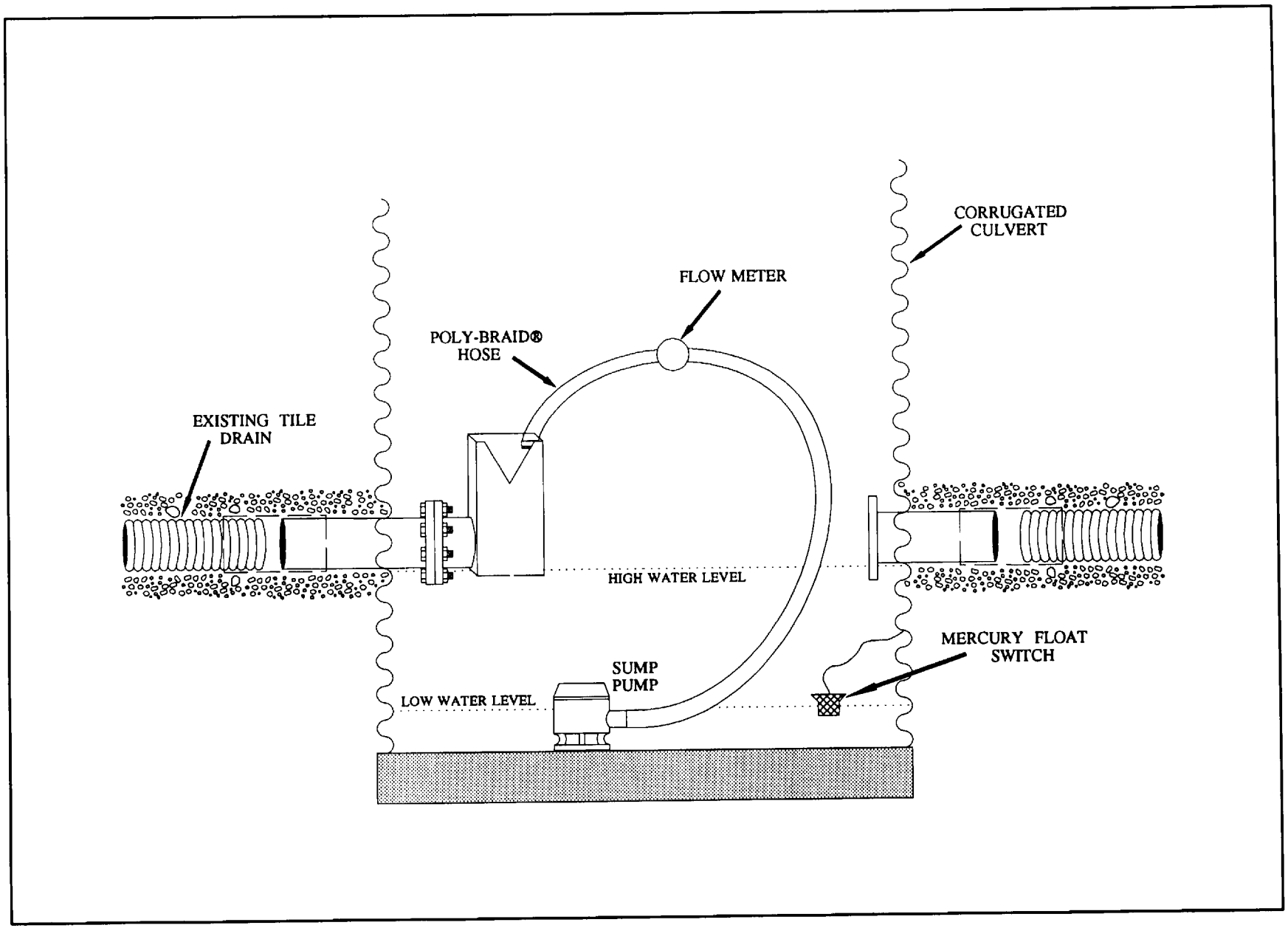

Figure 5. – Manhole schematic showing the water pump and flow-monitoring equipment.

Power Research Institute and U.S. Department of Energy through a grant under Sandia National Laboratories' PV-powered water pumping demonstration program. The Jornada RC&D is providing overall project coordination and is taking the lead in soliciting support for the Project. Participant contributions to date total about $40,000.

In addition to the active participants listed above, a number of other agencies and organizations have expressed their support for the Las Nutrias Groundwater Project. These include the U.S. Geological Survey, the New Mexico Environment Department, the New Mexico Water Quality Control Commission, and the New Mexico Water Resources Institute.

New Mexico Tech has just begun the task of sampling for baseline water quality data and monitoring the levels of nitrate and salinity. Sampling for pesticides will commence when funding and/or cooperative support for pesticide analyses becomes available.

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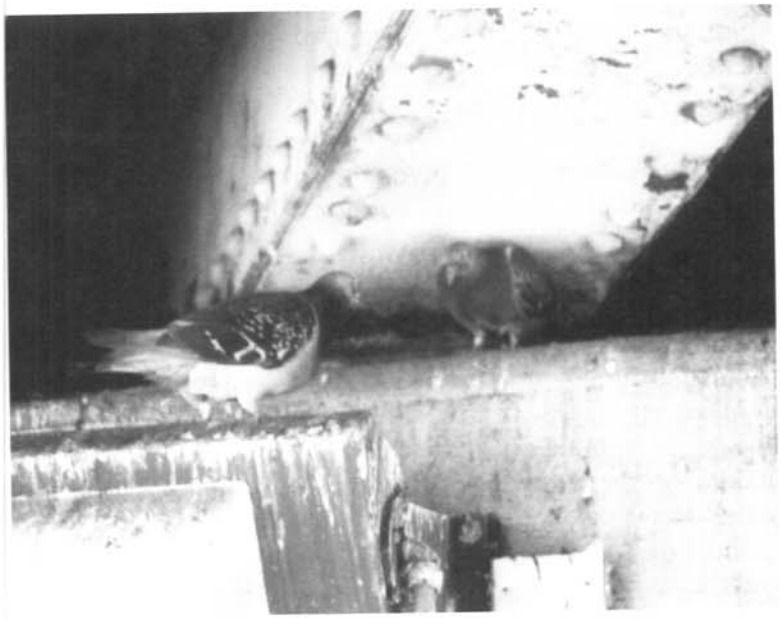
THE ANSWER FOR PESKY PIGEONS[1]

More than an annual migration, it was permanent "squatters' rights" for pigeons in Clearwater, Florida. Glenn Weaver, supervisor of maintenance for the city's 140 traffic signals, decided he had to do something about the infestation of pigeons under the overpass at the intersection of U.S. 19 and State Road 60. The birds were roosting atop ledges along the wall directly above traffic control signal equipment and other electronic equipment boxes. The droppings were creating a mess for Weaver and for Clearwater, a city of more than 100,000 people.

The overrun of unwanted birds had to be stopped. "The droppings were causing concern about the health hazard," Weaver says. He did not want his crews working in an unhealthy environment, which they were forced to do periodically while checking and maintaining traffic equipment.

The health hazard that Weaver sensed was not imaginary. Besides being unsightly, bird droppings often harbor fungi that can trigger serious — even fatal — lung diseases (namely, histoplasmosis and cryptococcosis) when the spores are transmitted to humans who may breathe in the harmful fecal dust.



Sheltered roost beneath overpass attracted pigeons and created a mess below. Many deterrents were used but nothing worked until a gel was applied.

The buildup of bird droppings under the Clearwater overpass covered the concrete walkway almost completely. According to Weaver, "It was a dirty environment. The droppings could contain mites. I didn't want to send people into that mess to service the equipment."

To get rid of the droppings, Weaver's crew used a water truck and hose to blast the mess. The buildup was blown off with a jet stream of high-pressure water. This got rid of the mess, but not the birds. Two months later, it had to be done all over again.

[1] Reprinted with permission from the Editor, Public Works, January 1993 issue.

Driving the Birds Out of Town

The problem with pigeons was old and entrenched. Weaver has worked in city traffic maintenance for 10 years, the past 3 of which have been in his position as Clearwater's Chief Traffic Signal Technician. "We had the problem ever since I'd been with the city," he says. "We tried a number of remedies."

First, Weaver and his crew strung a network of cords, creating a web intended to keep the pigeons off the ledges. No such luck. But there was no positive effect; the birds just flew between the strings.

Next, Weaver tried plastic owls — to no avail. The pigeons would sit right next to them. Weaver ventures a guess that city birds had never seen an owl, explaining why the owls were totally ineffective in scaring away the pigeons.

Then Weaver and his crew tried blaring sound as a deterrent to roosting. They placed a loud timeclock-controlled siren similar to a smoke-alarm horn on the ledge. The siren was programmed to go on at 15-minute intervals for 10-second bursts. The wailing sound was effective only temporarily. The birds got used to it in a couple of weeks and came back to roost again, right next to the siren. Weaver theorizes that the pigeons were so accustomed to the traffic noises of the two highways that the siren was just one more noise component. Furthermore, he says, the birds quickly realized the sound would not hurt them.

The pigeons were not about to give up their cozy, convenient roosting spot under the overpass, sheltered from the weather. But Weaver was not giving up either. He contacted the Florida Department of Transportation, which understood the problem, but offered no solution.

They Went That-Away

About that time, Weaver saw an ad for a product called Bird-Proof, a bird-deterring gel made by Bird-X, Incorporated, Chicago, Illinois. It is a transparent gel that repels bird pests from their normal roosting areas. When applied on ledges, beams, rafters, cornices, ornamental copings, and similar favorite landing sites, the gel compound discourages birds from alighting and nesting — usually for a year or more, even under extreme weather conditions. The gel has a tacky feeling that birds shun; yet it is harmless, odorless, non-poisonous, and environmentally safe. It is easy to apply with any standard caulking gun. Bird-Proof is also available in liquid form for easy spraying on trees and over other large surfaces or less accessible areas.

Here at last was something Weaver had not tried before. He ordered a case of the gel and put it along the ledges on both sides of the overpass and on the street light luminaries — anywhere birds were roosting. It was easily applied using a caulking gun, a two-man crew, and a bucket truck to reach the ledges.

The effect of the gel was instantaneous and total. The compound irritated the birds' feet. As soon as they landed, they were affected. City crews saw no more birds roosting afterwards.

After some months, however, the gel began to lose some of its tackiness. "The area beneath the overpass gets soot, dust, and dirt from the cars whizzing by," Weaver notes. "Birds began returning, so we applied it again and the results were the same."

Birds simply do not appreciate the gel. The tacky substance sticks and they struggle to lift their feet. But there is no indication of it causing them pain; the discomfort keeps the birds away. The city has

also used liquid Bird-Proof, too, on some ledges that were hard to reach, with the same positive results. The liquid version is applied using an ordinary spray bottle.

"Probably every city faces this kind of problem with birds," Weaver notes. He suggests that cities could use the product in parking garages as well, where ledges and rafters are similar to an overpass. "We used it on a service area, where birds were roosting above a retracting metal garage door. We applied Bird-Proof on the seal of the garage door. It worked instantly."

Editor's Note: *This is one method of confronting the problem of lead-based paint. There are other alternatives with different approaches being used for this purpose.*

OVERCOATING BRIDGES CONTAINING LEAD-BASED PAINTS: AN ECONOMICAL ALTERNATIVE[1]

By Carl Angeloff[2]

The following article is based on a paper from the proceedings of the 9th Annual International Bridge Conference, Pittsburgh, Pennsylvania, U.S.A., June 15, 16, and 17, 1992. The conference was sponsored by The Engineers' Society of Western Pennsylvania, Pittsburgh.

Tight bridge maintenance budgets can be stretched by utilizing overcoat technology for repainting steel structures originally coated with lead-based paint. It is estimated that 35 to 40 percent of all existing bridges and industrial steel structures are coated with lead-containing paint.

These structures are coated with hundreds of millions of pounds of lead that represents a potential imminent danger to the environment and worker health upon removal. Total removal is a difficult and expensive proposition. It involves containing and collecting the old paint along with abrasive and other material used in the process, and proper disposal.

These costs have increased so much that on some projects, the facility owner can no longer afford to paint. Thus, some owners have postponed maintenance painting projects indefinitely, anticipating a time when the process is more affordable. However, postponing coating work may take its toll on many structures because significant steel section loss may result from inadequate corrosion protection.(1)[3]

The economics and environmental realities of maintaining today's structures is forcing many decisionmakers to consider marginal surface preparation prior to maintenance painting of steel structures. Power tool cleaning [Steel Structures Painting Council (SSPC) specifications SSPC-SP3 and SSPC-SP11](2) and handtool cleaning (SSPC-P2) may be the only option available to owners and maintenance personnel responsible for painting programs.

Overcoat Concept

On a bridge where a maximum of 25 to 30 percent of its surface is corroded, use of the "overcoat" method is an alternative to full removal and containment. It can be a dramatically cost-effective, as well as an environmentally sensitive way to refinish steel surfaces originally coated with lead-based paints.

The overcoat system is defined as the process of applying a surface tolerant coating to a minimally prepared surface and existing layer of a lead-containing coating. It is not implied that lead particles are neutralized, totally surrounded, or otherwise rendered harmless.

This article describes materials and methods to be used for re-coating bridges and other structures that have suffered minor to moderate damage due to corrosion or weather.

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1 Reprinted with permission from the Editor, Public Works, January 1993 issue.
2 Mr. Angeloff is a Market Development Specialist, Bridge and Architectural Coatings, Miles Inc., Pittsburgh, Pennsylvania.
3 Numbers in parentheses refer to references at end of article.

The Homestead High-Level Bridge near Pittsburgh continues in excellent condition 14 years after repainting over lead-based paint with a three-coat polyurethane system.

The overcoat painting approach calls for thorough cleaning, using a power water wash, of all steel portions of a bridge, including trusses, beams, girders, bearings, railings, and any other exposed structural steel. This removes dirt and some embedded chlorides in the surface.

In isolated areas of corrosion and/or paint breakdown, loose rust and old coatings are removed by a combination of SSPC-SP2, SSPC-SP3, or SSPC-SP11 surface preparation. Project plans must provide for containment and disposal of all generated waste and debris in compliance with applicable environmental regulations.

Overcoating eliminates open air blasting so pollution containment and waste disposal costs are reduced. In addition, non-corroded lead-containing paints are left intact after water-blasting, reducing surface preparation costs and allowing these paints to continue to provide protection.

During the overcoating process, exposed steel surfaces are spot-printed with a surface tolerant one-component moisture-cure polyurethane aluminum primer. A polyurethane intermediate coat that meets VOC (volatile organic compound) requirements then can be applied to the entire bridge surface. The repainting is completed with a VOC-compliant light-stable polyurethane topcoat.

Successful overcoat projects include two Pittsburgh-area steel bridges that were repainted with a similar overcoat system more than 14 years ago. Corrosion has occurred in less than 5 percent of the surfaces.

Important to the success of the overcoat painting method are the special surface wetting, edge sealing, and curing capabilities of the moisture-curing polyurethane aluminum spot primer. The primer's low viscosity enables it to penetrate and wet out the old paint and tightly adhering rust. To cure, the primer scavenges the moisture in the rust, atmosphere, and existing paint.

In addition, the excellent wetting ability of the primer allows it to penetrate under the old paint at the spot-cleaned areas. Upon curing by moisture, this helps seal both the surface and old paint.

The polyurethane primer provides flexibility that helps prevent cracking and stressing of the paint film during freeze-thaw cycles. This important property has contributed to the long-term durability of the coatings used on the Homestead High-Level Bridge, which spans the Monongahela River near Pittsburgh. The bridge had many spot-blasted areas that could have been sources of failure if paint lifting or stress cracking had occurred. Instead, the moisture-cured primer has provided a protective barrier.

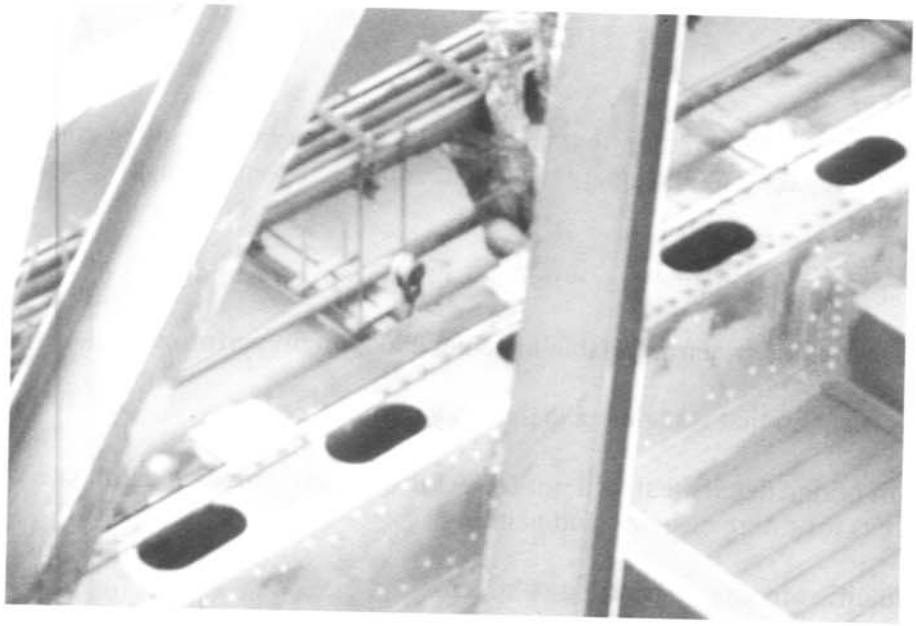
The intermediate coating must provide excellent adhesion to the primer and remaining lead-containing paint, as well as quick re-coat time. It also must reduce the amount of corrosion inducing oxygen and moisture passing through the paint film. It is very important that the intermediate coat will not attack or lift the existing paint.

A high-performance topcoat must provide superior light stability and weather and chemical resistance. Consideration should be given to formulating a durable topcoat that makes it easy to remove graffiti without degrading the paint finish.

The most important factor in determining if a structure is a candidate is to determine if the existing coating system can be overcoated. This evaluation is conducted to assess the condition of the coating and the base metal at representative areas of the structure.

The following factors must be evaluated:

- Approximate percent of rusted areas. At what percentages of rusted areas does the owner specify complete removal of coating system?
- Character of rust areas—light, moderate, or severe corrosion.
- Condition of steel under the coating.
- Adhesion of existing coating to the steel.
- Adhesion between layers of the coating system.
- Serviceability or expected remaining life of the coating and/or repairability of the coating.
- Determination of paint type and dry film thickness of coating. In the case of aluminum pigmented alkyds, it must be determined whether the existing coating, to be painted over, contains leafing or non-leafing aluminum pigments. It may be difficult to develop proper adhesion between leafing pigmented paints and the new coating system.
- Compatibility of the existing coating system/systems (test patch areas).



Rusted sections, including the top chord areas, were spot primed with a durable moisture-curing polyurethane aluminum coating based on polyisocynate.

There are two methods of surface preparation:

Method A – High-Pressure Water Wash. – High-pressure water wash can be used to remove dirt and contaminants from existing sound paint surfaces and corroded areas. There is no SSPC specification reference.

All exposed areas of existing steel members are cleaned by high-pressure water wash to remove chalking, dirt, dust, oil film, or other deleterious material, so that new paint will adhere to the surface. There are several schools of thought regarding water pressure. One calls for hydrant pressures of 80 to 150 lb/in^2 with large volumes of water. Another requires higher pressures (500 to 3,000 lb/in^2) and less water. The sources and types of contaminants and degree of cleanliness will dictate the specification. Also, a non-sudsing, biodegradable detergent may be added to the water to optimize the cleaning operation. However, a rinse operation must follow and various environmental regulations may apply. In general, the purpose of the water wash is to remove loose chalks, paint, rust, and dirt prior to the more extensive final surface preparation necessary to the painting operation. Slight chalking may remain as evidenced by rubbing a hand over the existing coating surface.

Method B – Hand and Power Tool Cleaning. – Another method of surface cleaning is Solvent (SSPC-SP1), Hand Tool (SSPC-SP2), and Power Tool (SSPC-SP3) and Power Tool Cleaning to Bare Metal Cleaning (SSPC-SP11). All exposed areas of existing steel members (the entire exposed steel structure) are cleaned by approved methods, in accordance with SSPC-SP1, to remove dirt, dust, oil film, or other deleterious material, so that new paint will adhere to the surface. Solvent cleaning may be supplemented by scrubbing with water and mild detergent. Small areas of the structure that show pin-hole corrosion, stone damage from traffic, or minor scratches are cleaned in accordance with SSPC-SP2, SSPC-SP3, or SSPC-SP11.

Smaller surface areas where the topcoats are peeling or are badly deteriorated are scraped and cleaned by these methods. It is not the intent that large surfaces of corroded metal be prepared by SSPC-SP2 or SSPC-SP3 cleaning. Small containment areas may be more economical that utilize abrasive blasting.

Critical Variables

A painting project has more variables that are critical to its success than most construction projects. Improper surface preparation, inclement weather, and the wrong choice of materials can have catastrophic results.

There are six steps to obtaining the best possible paint system on a bridge:

- Choose the best paint system available to achieve maximum performance.
- Write a specification that is understandable and enforceable.
- Design clean bridge details that will not collect debris and moisture. Eliminate weld spatter and provide access for future cleaning and painting.
- Choose a qualified reputable painting contractor.
- Provide good construction inspection that is both fair and consistent.
- Follow up with a routine and sound maintenance program to eliminate corrosion problems at the earliest stage in their development.

It is estimated that painting costs can be reduced from 30 to 75 percent using the overcoat method of maintenance painting as compared to full paint removal with no containment and full paint removal with containment. Total estimated costs for the overcoat concept range from \$1.65 to \$2.57/ft^2. Full paint removal with no containment is estimated to cost between \$3.27 and \$4.52/ft^2. Costs per square foot for full paint removal with containment are estimated at \$7.29 to \$9.94.

These estimates included costs for fresh water wash (overcoat system only), surface preparation, three-coat paint system and labor to apply it, pollution containment, waste disposal, mobilization/de-mobilization, and bonding/ insurance.

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HAZARDOUS MATERIALS MANAGEMENT

By Max Haegele[1]

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) which directed the Environmental Protection Agency (EPA) to develop and implement a program to protect human health and the environment from improper hazardous waste management practices. The program is designed to control the management of hazardous waste from its generation to its ultimate disposal.

EPA first focused on large companies which generated the greatest portion of hazardous waste. Business establishments producing less than 1000 kilograms (2,200 pounds) of hazardous waste in a calendar month (known as small-quantity generators) were exempt from most of the hazardous waste management regulations published by EPA in May 1980.

However, public attention since that time has been focused on the potential for environmental and health concerns that may result from mismanaging even small quantities of hazardous waste. Therefore, in November 1984, the Hazardous and Solid Waste Amendments to RCRA were signed into law. With these amendments, Congress directed EPA to establish new regulations that would cover small-quantity generators [100 to 1000 kilograms (220 to 2,200 pounds; 25 to 300 gallons) of hazardous waste per month]. EPA issued final regulation for small-quantity generators on March 24, 1986. Most irrigation districts generating hazardous wastes are regulated at one level or the another.

Hazardous Waste Management

Generators of waste are responsible to determine if waste streams contain hazardous waste.

a. Waste is considered hazardous if it appears on any of the four lists of hazardous wastes contained in the RCRA regulations (40 Code of Federal Regulation 261).

b. In addition, if waste does not appear on one of the lists, it is considered hazardous if it has one or more of the following characteristics:

- Ignitable – is easily combustible or flammable
- Corrosive – dissolves metals, other materials, or burns skin
- Reactive – is unstable or undergoes rapid or violent chemical reaction with water or other materials
- Toxic – shows toxic characteristic leaching procedure toxicity

c. Determine your generator status:

- If you generate 1000 kilograms (about 2,200 pounds or 300 gallons) or more of hazardous waste or more than 1 kilogram (2 pounds or less than 1 gallon) of acutely hazardous waste in any month, you are a large-quantity generator.

[1] Max Haegele is a Hazardous Waste Coordinator for the Bureau of Reclamation, Denver Office.

- If you generate more than 100 and less than 1000 kilograms (between 220 and 2,200 pounds or about 25 to under 300 gallons) of hazardous waste and no more than 1 kilogram (2 pounds or less than 1 gallon) of acutely hazardous waste in any month, you are a small-quantity generator.

- If you generate no more than 100 kilograms (about 220 pounds or 25 gallons) of hazardous waste and no more than 1 kilogram (2 pounds or less than 1 gallon) of acutely hazardous waste in any calendar month, you are a conditional exempt small-quantity generator.

Management of hazardous waste on-site. -

- Clearly mark each container with the words **"HAZARDOUS WASTE."**

- Keep containers in good condition.

- Keep full or empty containers closed.

- Inspect containers weekly.

- Store containers in a safe place.

- Never store wastes that could react together in the same container (causing fires, leaks, or other releases).

- Make certain your hazardous waste is shipped to a treatment storage disposal facility.

- Plan for accidents and emergencies:

  - Have a cleanup kit and equipment available in storage area.

  - Have a contingency plan for handling emergencies.

  - Post emergency telephone numbers near hazardous waste storage room.

  - Train employees how to handle hazardous waste and emergencies.

Ship hazardous wastes off-site. -

- Choose a hauler and facility which have EPA identification numbers.

- Package and label your wastes for shipping in accordance with Department of Transportation regulations.

- Call your State transportation agency if you need assistance.

- Prepare a hazardous waste manifest (shipping papers).

- Conduct a review of the treatment storage disposal facility to ensure wastes are being properly handled:

  - Call State hazardous waste agency to determine last State inspection.

- Call Regional EPA to determine if they have conducted any inspections.

- Call a treatment storage disposal facility and ask for copy of last inspection report and their response.

- If large amounts of hazardous waste are to be shipped, make an on-site inspection of the treatment storage disposal facility.

- Ensure that a copy of the waste manifest, which documents the treatment storage disposal facility's receipt of waste, is returned to you within 30 days:

  - Maintain a copy of all paperwork for at least 3 years (10 years is better).

  - Notify State and EPA if you do not get a receiving manifest copy back in 35 days.

An excellent handbook covering these regulations is "Understanding the Small Quantity Generator Hazardous Waste Rules," U.S. EPA No. 530-SW-86-019. Telephone either the RCRA Hotline [1-800-424-9346] or the National Technical Information Service [1-800-553-6847 or (703) 487-4650].

Underground Storage Tank Management

Underground storage tanks must comply with current regulations. An underground storage tank is any tank, including underground piping connected to the tank, that has at least 10 percent of its volume underground.

Some underground storage tanks are exempt, such as:

- Farm and residential tanks holding 1,100 gallons or less used for noncommercial purposes

- Tanks storing heating oil used on the premises where it is stored

- Tanks on or above the floor of underground areas

- Septic tanks and systems for collecting stormwater and wastewater

- Tanks holding 110 gallons or less

- Emergency spill and overflow tanks

- Flow-through process tanks

Reclamation's policy requires the removal of all pre-1988 underground storage tanks on Reclamation lands, and new underground storage tanks meeting the new standards cannot be installed without the documented approval of the Regional Director having jurisdiction.

New tanks and piping must be certified that they are installed properly according to industry codes. The underground storage tanks must be equipped with devices that prevent spills and overfill. Correct tank filling practices must be followed. Both tank and piping must be equipped with leak detection devices and protected against corrosion.

Underground storage tanks that were installed before 1988 must be equipped with corrosion protection for steel tanks and piping, and devices that prevent spills and overfills by 1988. Leak detection device requirements must be phased in for existing tanks, and require monthly inventory control and annual tightness testing.

Leaking underground storage tanks should be reported within 24 hours to the regulatory authority (usually the State). The site should be investigated as to the extent and nature of the environmental contamination; and all contaminated soil should be removed from the site and disposed of in accordance with State requirements, and the cleanup process coordinated.

If an underground storage tank is to be closed, notify the State regulatory agency 30 days in advance; determine if leaks have occurred from your tanks and contaminated surrounding environment.

An excellent handbook is "Musts for USTs"; A Summary of the Regulations for Underground Storage Tank Systems, U.S. EPA Stock No. 055-000-00294-1. It may be ordered from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; (202) 783-3238 (cost $2.50).

Land Inventories for Hazardous Waste Sites and Hazardous Material Surveys for Land Rights To Be Acquired or for Disposal

All Reclamation lands are required to be inventoried for the presence of hazardous waste sites on a continuing 5-year cycle. Inventories are to list the location of sites and the lands surveyed. Dump sites observed by operations personnel are to be reported to Reclamation project hazardous waste coordinators to evaluate and determine the potential for hazardous materials releases.

All lands are required to be surveyed for the existence of hazardous waste sites before a right to any lands can be acquired or transferred. Surveys are to be conducted within 1 year prior to the transfer of title or interest in the lands.

Surveys can require various levels of evaluation.

- Level 1. – This survey is a checklist for identifying suspected hazardous waste sites. (Can be completed by individuals having minimal hazardous materials recognition.)

- Level 2. – This is a more extensive evaluation of potential sites identified in a Level 1 survey to determine hazardous wastes actually occurring at the site. (This can be conducted only by individuals having extensive training and experience in hazardous materials identification.)

- Level 3. – This is an extensive evaluation of a known hazardous waste site (usually includes sampling of the site and chemical analyses) with emphasis on the cost of cleanup and documentation of who will pay for the remedial activities. Reclamation is not allowed to incur any cost of cleanup of hazardous waste sites on lands to be acquired without written permission.

PCB (Polychlorinated Biphenyl) Management

Reclamation's policy requires the removal of all PCB's from Reclamation lands and facilities. The basic requirements to achieve this goal are to inventory existing transformers, capacitors, and bushings for the presence of PCB's.

- Test transformers for PCB's.

- Determine from manufacturer if capacitors are PCB filled.

- Determine by testing or manufacturer if bushings are PCB filled.

There are different levels of PCB equipment. Less than 50 ppm is considered non-PCB equipment; 50 to 500 ppm is considered contaminated equipment; and 500 ppm and over is considered PCB equipment.

All PCB equipment is required to be inspected monthly and properly labeled. Cleanup of spills and control and disposal of rags are required. PCB labels are required on entrances to all rooms and facilities containing PCB's and on all PCB equipment. Inspections are required to be documented with a complete signature.

If removing PCB equipment from service, the date of removal needs to be documented. Storage of PCB equipment requires secondary containment and protection from the weather. Disposal of PCB equipment is required within 1 year of the out-of-service date.

Asbestos Management

Reclamation policy requires all existing asbestos products and sources be identified and written documented risk evaluations of asbestos exposure be accomplished. In addition, OSHA (Office of Safety and Health Administration) regulations require warning labels be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos, or the containers. Labels require the following information:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

Suitable labels and markers are available commercially. Also, no new asbestos-containing products are to be installed or procured for use within Reclamation facilities.

When removing asbestos, ensure that only trained and State certified employees conduct removal activities; double bag all asbestos removed from service for disposal; and dispose of asbestos at State approved disposal sites. Certified landfills can accept asbestos for disposal in a specified disposal cell.

Title III Community Right-to-Know Responsibilities

The Emergency Planning and Community Right-to-Know Act of 1986 (Title III), promulgated with the Superfund Amendments and Reauthorization Act of 1986 (SARA), was designed to promote emergency planning efforts at the State and local levels, and provide citizens and local governments with information concerning potential chemical hazards in their communities. Title III requires facilities to provide emergency hazardous chemical release notification (40 CFR Part 355.40) and chemical inventory reporting requirements (40 CFR Part 370). Federal agencies are not required by statute to comply with the provisions of Title III, but Reclamation, by Departmental policy, is complying with the intent of the law as it applies to its operations and facilities under its jurisdiction.

Title III includes two basic programs. A general information program that focuses on routine releases of "toxic chemicals," and a program to prepare for and respond to unplanned releases of hazardous

substances. Some facilities which store chlorine gas and large amounts of pesticide, such as Acrolein, have to report storage of such materials to State and local emergency response agencies.

Waste Minimization Responsibilities

The national policy established by Congress in the Hazardous and Solid Waste Amendments of 1984 states that "wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible."

All Federal agencies are required to be in compliance with Executive Order No. 12780 titled "Federal Agency Recycling and the Council on Federal Recycling and Procurement Policy" which requires the development and implementation of a documented hazardous and solid waste minimization plan for all Reclamation facilities; and the monitoring of waste streams and documentation of the reductions achieved by facilities. Also, it requires the procurement of recycled materials whenever possible.

SPCC (Spill Prevention Control and Countermeasure) Plans

SPCC plans are required for Reclamation facilities where oil or hazardous substances may be released into the waters of the United States. Also, it is Reclamation policy to require SPCC plans from all construction contractors where a potential exists for release of oils or hazardous materials into the waters of the United States.

SPCC plans are required to be in place no later than 6 months after startup of the facility, and fully implemented within 12 months after startup. They are required for all facilities having above-ground storage capacity of a single container in excess of 660 gallons, an aggregate of above-ground storage capacity greater than 1,320 gallons, or the total below-ground capacity greater than 40,000 gallons. Also, plans are required for any facility which, due to its location, could reasonably expect spilled oil to reach waters of the United States.

SPCC plans must be certified by a registered professional engineer.

Editor's Note: Anyone interested in updating or establishing a Hazardous Waste Program should contact the Reclamation Regional and/or Project office in his area for assistance. Foreign entities may contact the author, Max Haegele, PO Box 25007, code D-5620, Denver, Colorado 80225 U.S.A. [telephone (303) 236-1061 (extension 249)] for additional information.

AN EXAMINATION OF RECLAMATION CONFINED SPACE WORK

by Jim Oser, PE, CIH[1]

Reclamation has several confined spaces at dams and other project locations requiring entry for occasional inspection or maintenance activities. Unventilated underground facilities always have the potential to trap toxic gases and air contaminants depleting oxygen content and setting up the situation for an employee fatality. Reclamation generally has been lucky but has experienced some close calls. Hydrogen sulfide, an odorous and potentially deadly gas, results from natural organic decay of vegetation and dead animals. This always occurs with the first filling of a reservoir (as dissolved gases) in the water and can be a continuing concern at underground dam facilities.

Water, humidity, and moist surfaces are common to many underground tunnels and conduits, presenting ideal conditions for bacterial and fungal growth. Such growth can produce toxic gases and odors that may result in a hazardous atmosphere. Infectious and hypersensitivity diseases present the more common problem associated with bioaerosols of fungi and bacteria.

There are many underground water metering and instrument vaults at scattered locations throughout Reclamation requiring only minimal attention that are confined and permit spaces according to the Occupational Safety and Health Administration (OSHA) definition.

OSHA Requirements

On January 14, 1993, OSHA published in the *Federal Register* their final rule for **permit-required confined spaces (1910.146)**. A confined space is defined as a space that is large enough and so configured that an employee can bodily enter and perform assigned work, has limited or restricted means for entry or exit, and is not designed for continuous employee occupancy. A permit-required confined space is defined as a confined space having one or more of the following characteristics:

1. Contains or has a potential to contain a hazardous atmosphere.

2. Contains a material that has the potential for engulfing an entrant.

3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.

4. Contains any other recognized serious safety or health hazard.

This rule requires employers to evaluate workplaces for confined spaces and determine if these spaces are permit-required confined spaces (permit spaces). The employer must then decide to either prevent employee entry into the permit spaces or develop and implement a **written permit space program**. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

The question is not only how can Reclamation best comply with this new OSHA rule, but also *how can Reclamation document and best ensure employee safety in these spaces?* To comply with the full

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OSHA requirements for a written permit space program for the limited entry of these locations would be extremely costly in terms of the effort expended to develop and maintain an ongoing program.

Such full-blown permit space program would require provisions for at least one attendant outside the permit space into which entry is authorized for the duration of entry operations (equipped with communication system to maintain voice communications); procedures for summoning rescue and emergency services; development and maintenance of a system for the preparation, issuance, use, and cancellation of entry permits; training activities to maintain certification of training for authorized entrants, attendants, and entry supervisors; and rescue and emergency services teams. For significant ongoing work in confined space locations, this level of program effort is appropriate and should be undertaken. In these circumstances, Reclamation would comply. However, the concern is with the more causal entry into spaces that would fall under the OSHA permit-required confined space definition that presently goes unrecognized and unprotected.

The employer may use the alternate procedures — a continuous forced-air ventilation system sufficient to maintain the permit space safe for entry — when the only hazard posed by the permit space is an actual or potential hazardous atmosphere.

If the employer can demonstrate that the only hazard posed by the permit space is an actual or potential hazardous atmosphere (as is the usual case with Reclamation's instrument vaults), the following procedures would then apply to entry:

1. Any conditions making it unsafe to remove an entrance cover is eliminated before the cover is removed.

2. When entrance covers are removed, the opening shall be promptly guarded by a railing, temporary cover, or other temporary barrier that will prevent an accidental fall through the opening and that will protect each employee working in the space from foreign objects entering the space (CFR 1910.23).

3. Before an employee enters the space, the internal atmosphere shall be tested with a calibrated direct-reading instrument for the following conditions in the order given:

   - Oxygen content
   - Flammable gases and vapors
   - Potential toxic air contaminants

4. There may be no hazardous atmosphere within the space whenever any employee is inside the space.

5. Continuous forced-air ventilation shall be used as follows:

   - An employee may not enter the space until the forced-air ventilation has eliminated any hazardous atmosphere.

   - The forced-air ventilation shall be so directed as to ventilate the immediate areas where an employee is or will be present within the space and shall continue until all employees have left the space.

   - The air supply for the forced-air ventilation shall be from a clean source and may not increase the hazards in the space.

6. The atmosphere within the space is periodically tested as necessary to ensure that the continuous forced-air ventilation is preventing the accumulation of a hazardous atmosphere.

7. If a hazardous atmosphere is detected during entry:

- Each employee will leave the space immediately.
- The space is then evaluated to determine how the hazardous atmosphere developed.
- Measures are implemented to protect employees from the hazardous atmosphere before any subsequent entry takes place.

8. The employer shall verify that the space is safe for entry and certify that the required measures have been taken. A written certification containing the date, location of the space, and the signature of the person providing the certification must be made available to each employee before further entry into the space.

Reclamation Requirements

The OSHA requirements must be understood by employees and supervisors of employees that have responsibilities for frequenting instrument vaults and/or similar Reclamation permit spaces. These requirements mandate air testing before and during entry, and the provision of a forced-air (mechanical) ventilation system. This ventilation system may be portable or preferably a permanent installation. The entrance must be signed and barricaded to prevent unwanted and uninformed entry. The best way to assure that these requirements are developed, documented, and understood by Reclamation employees is to conduct and periodically review a job hazard analysis with all the job participants.

Spaces that are confined spaces under the OSHA rule may often be removed from this category if they are designed for continuous employee occupancy. This can often be accomplished by mechanically ventilating the space.

For a more complete discussion of Reclamation requirements for work in confined spaces, you are directed to Chapter 7, "Occupational Health," of Reclamation's Construction Safety Standards.

All Federal employers are required to follow OSHA regulations. State, city governments, and water district employees may be governed by local state safety and health regulations, which are at least equal to the OSHA regulations.

Air Testing Equipment

Air-testing equipment must include an oxygen meter to assure oxygen content between 19.5 – 22.5 percent; a flammable or explosive gases meter to assure no flammable or explosive gases such as methane or hydrogen are present in excess of 10 percent of the lower explosive limit (LEL) or the lower flammable limit (LFL); and direct reading devices for determining the presence of toxic air contaminants such as carbon monoxide, hydrogen sulfide, sulfur dioxide, carbon dioxide, ozone, oxides of nitrogen, mercury, and oil mist.

Oxygen meters and explosive gas meters can be obtained in a combined unit or as separate instruments. My experience has been better using separate units. Maintenance and care are generally more satisfactory with separate units. For the toxic air contaminants, direct reading detector tubes such as

Draeger, Mine Safety Appliance (MSA), or Gastec can be used. A direct readout hydrogen sulfide meter is available and provides the best method of testing for hydrogen sulfide.

Permit Space Signing

Finally, if workplaces contain permit spaces, then employees must be informed either by posting danger signs or by an equally effective means. The danger sign should read "DANGER—PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER."

Editor's Note: *All Federal employees are required to follow OSHA regulations. State and city governments, and water district employees, may be governed by local State safety and health regulations, which are at least equal to the OSHA regulations.*

WIRECO WR WIRE ROPE

Tech report

WIRE ROPE CORPORATION OF AMERICA, INC., ST. JOSEPH, MO.

REPORT NO. 107

WIRE ROPE INSPECTION

Periodic inspections of wire ropes in use are necessary for one very important reason: Wire rope is a "consumed" item. It is literally "used up" as it is used, and gradually loses strength during its useful life.

The purpose of an inspection, then, is simply to ascertain – insofar as may be possible – whether a wire rope retains sufficient capability to perform the work to be done before the next scheduled inspection.

That regular inspections are required by certain governmental regulations is, in a sense, of secondary importance – since the need to perform such inspections would exist anyway.

But the government does require machine owners and/or users to conduct regular, proper inspections, and to keep written records of such inspections . . . and the burden of this requirement is upon the owner/user.

Probably the primary rule to follow in conducting a wire rope inspection on any typical machine or piece of equipment is that each wire rope must be considered individually.

This individual treatment is particularly important when inspecting so-called "standing" ropes – those which are primarily supporting, or structrual, members. For example, the pendants which support long crane booms are frequently made up of several sections, each of which is an individual rope and must be examined individually.

Because different inspection criteria frequently apply, so-called "standing" ropes should be inspected separately from the "running", or operating, ropes on the same machine or installation. Practicalities may dictate that parts of both running and standing ropes be inspected on the same trip to some high or inconvenient location on an installation – but never-the-less, each rope must be given individual attention, and the pertinent information on each rope must be recorded separately.

It should not be necessary to point out, but it must be emphasized, that a proper inspection cannot be made when a wire rope is supporting a load or is in motion. A rope should be "relaxed and at rest" during the inspection. An exception might be certain types of conveyor and tramway ropes.

Several tools are useful in inspections. These include:

An awl and a marlin spike.
A caliper.
A steel tape.
Two groove gauges.
Chalk.
Wiping cloths.
Pencil, paper and carbon paper.

The manufacturer's handbook or Operator's Manual for the machine involved, and copies of pertinent governmental and other inspection criteria and specifications are also useful.

A proper inspection requires the proper tools, the pertinent criteria for evaluating the rope, and an adequate form for recording the findings to provide a permanent record.

How Often to Inspect

Quite obviously, the greater the usage a rope receives, the more often inspections would be indicated. Typical Occupational Safety and Health Act (OSHA) regulations state:

> "A thorough inspection of all ropes shall be made at least once a month and a full written, dated, and signed report of rope condition kept on file where readily available."

OSHA Specification 1926.602 refers to Power Crane and Excavator Standards for material handling equipment as follows, regarding wire rope inspections (8.2.1.2):

> "All wire ropes in active service should be visually inspected once each working day. A thorough inspection of such ropes should be made at least once a month and dated records kept as to rope conditions."

The OSHA regulations for overhead and gantry cranes states:

> "Inspection procedure for cranes in regular service is divided into two general classifications based upon the intervals at which inspection should be performed . . . designated as 'frequent' and 'periodic' with respective intervals between inspections . . . (a) Frequent inspection – daily to monthly intervals. (b) Periodic inspection – 1 to 12-month intervals."

The foregoing would seem to underscore the wisdom of many machine users who insist on a daily or work-shift, visual inspection of all the elements in a wire rope system. The OSHA Regulations, however, are specific with reference to written and signed reports on thorough, periodic inspections.

'Critical' Points

There are certain points along any given rope which should receive more attention than others, since some areas will usually be subjected to greater internal stresses, or to greater external forces and hazards.

Carefully select the most critical points for close inspection – points where failure would be most likely to occur. The same critical points on each installation should be compared at each succeeding inspection.

Critical points which should be considered for careful inspection on most installations would include the following:

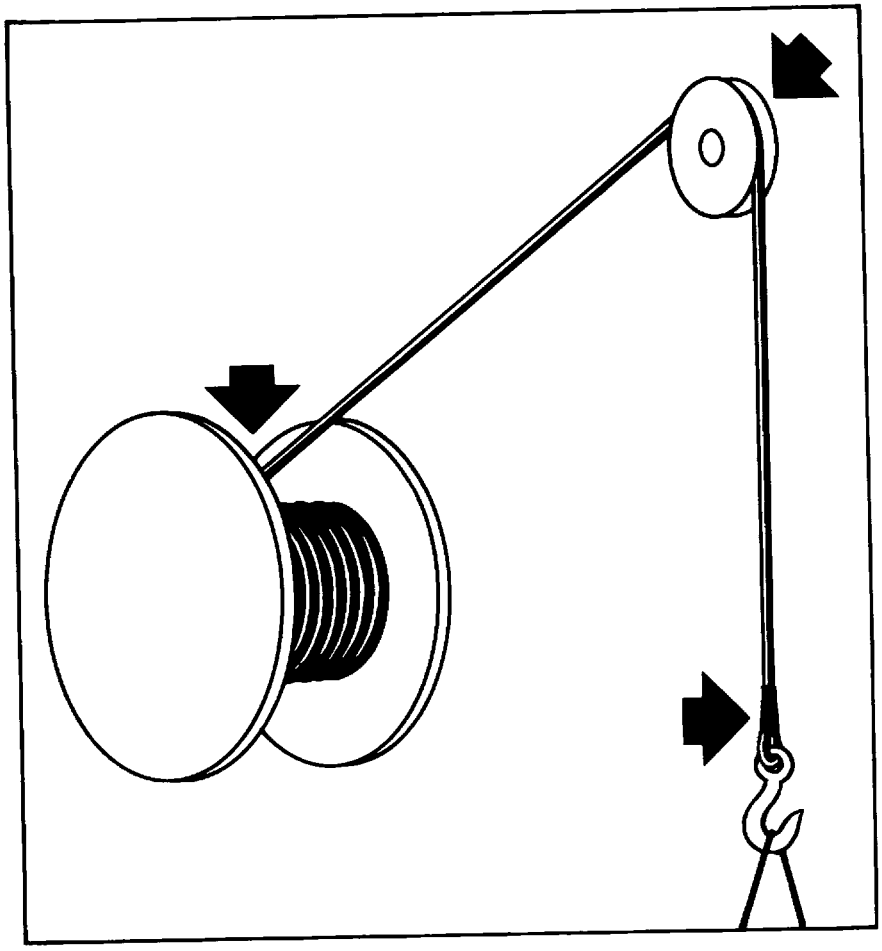
Pick-up Points – These are sections of rope which are repeatedly placed under stress when the initial load of each lift is applied – such as those sections in contact with sheaves.

End Attachments – At each end of the rope, two things must be inspected: the fitting that is attached to the rope, or to which the rope is attached . . . and the condition of the rope itself, where it enters the attachment.

Equalizing Sheaves – The section of a rope which is in contact with and adjacent to such sheaves, as on boom hoist lines, should receive careful inspection.

Drums – The general condition of the drum, and condition of grooves if the drum is grooved, should receive careful inspection – as should the manner in which the rope "spools" onto the drum.

Sheaves – Every sheave in the rope system must be inspected and checked with a groove gauge.

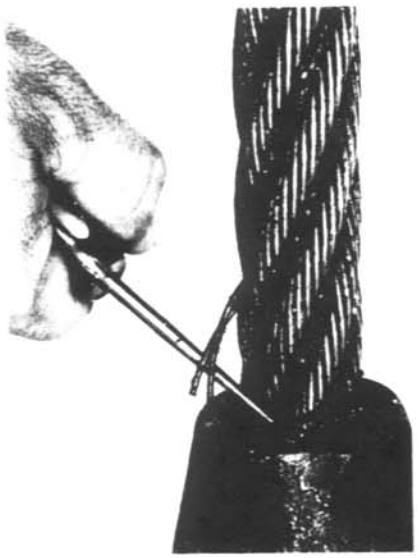


Heat Exposure – Be especially watchful for signs that a rope has been subjected to extreme heat, or to repetitive heat exposure.

Abuse Points – Frequently ropes are subjected to abnormal scuffing and scraping, such as contact with cross-members of a boom. Look for "bright" spots.

It must be kept in mind that minor – and frequently major – differences exist between installations, even on machines of a similar design. Therefore, points on each rope selected for close examination will necessarily require the best judgement of the inspector.

End Attachments



All end attachments have one characteristic in common: all restrict, to some degree, the free movement of wires at the end of the rope. This impairment of the ability of wires to adjust and move at the end can ultimately result in breakage of wires at the point where restriction occurs.

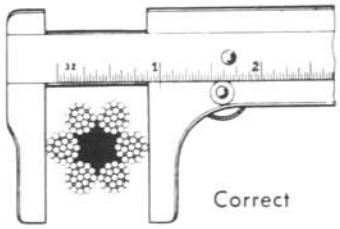
Thus, broken wires are a primary concern when inspecting end attachments on a rope. A single broken wire is usually reason to question continued use of the rope, and more than one is usually sufficient cause for rejection.

Broken wires may be more difficult to locate at end fittings than in other sections of rope. An awl used to pick and probe at the point where strands enter the end attachment can often expose broken wires not otherwise visible.

Another problem frequently encountered at end fittings is corrosion or rust. Such corrosion can easily conceal broken wires, and if left to accumulate can erode the surface of wires to weaken them, or can restrict normal wire movement.

Inspection of rope ends should also include the condition of the actual attachment – worn eyes, missing thimbles, bent or "opened" hooks, worn clevis pins, and so on.

Measuring Diameter



Every periodic inspection must include diameter measurement at critical points – and recording of measurements for future comparsions.

Most inspection standards are specific on permissable reductions in diameter, and the criteria for the installation and industry involved should be known by the inspector before starting to take measurements.

Measurements are proper only when made across the "crowns" of rope strands, so that the true diameter is the widest diameter at any given point on the rope. Always rotate the caliper on the rope – or the rope inside the caliper – to take a measurement.

Reductions in diameter are caused by several factors, including:

Initial "Pull-Down" – All ropes are manufactured larger than nominal diameter. When placed in operation the first time, strands of a new, unused, rope will "seat in", and the diameter will be "pulled down" from its original diameter. Therefore, the first measurements should be made and recorded for future reference after the time of such a rope's initial loading.

Normal Wear – In normal usage, the outer wires, particularly on the crowns of strands, will exhibit wear. Various inspection standards are specific as to the amount of such metal loss permissible.

Internal Rope Damage – When the core of a wire rope has begun to deteriorate, diameter reduction is often the first detectable outward sign. Impending internal breakdown should always be suspected when a sudden or significant diameter reduction is noted, and if possible, an internal rope examination should be made.

Regular Lay

Lang Lay

This picture simulates 6x25 fw construction wire ropes with surface wear (only) of 1/3 the outer wire diameter.

Measuring Rope Lay

One rope lay is the length along the rope which a single strand requires to make one complete spiral, or "turn", around the core. It is an engineering factor in the design of a rope, and is carefully controlled during manufacture.

Since there is often some "adjustment" in rope lay during the initial "break-in" stages of a rope's usage, it is recommended that rope lay measurements should be made after the initial loading, for comparison purposes at succeeding periodic inspections.

One method for measuring rope lay is with ordinary carbon paper, blank white paper and a pencil. Firmly hold the paper and carbon on the rope and

"stroke" with the side of the pencil, so the rope's "print" is made on the paper.
By drawing a line through one strand of the "print", counting off the number of strands in the rope and then drawing another line on the print at the place where the same strand appears again, a measurement is established.
Many inspectors have found that a crayon or marking stick and a roll of adding machine tape are ideal for making a "print" at least three rope lays long – so that an average lay length can be determined.
Changes in length of lay are usually gradual throughout the working life of a rope. It is important to compare current lay measurements with previous inspection results to note any sudden changes – for an abrupt change in the pattern can be the signal of an impending problem.

As a rule, if lengthening of lay is noted WITH loss of rope diameter, internal break-up or core destruction should be suspected.

When lengthening of lay is noted WITHOUT loss of rope diameter, the rope is probably "unlaying" for some reason, and further examination should be made for the cause.

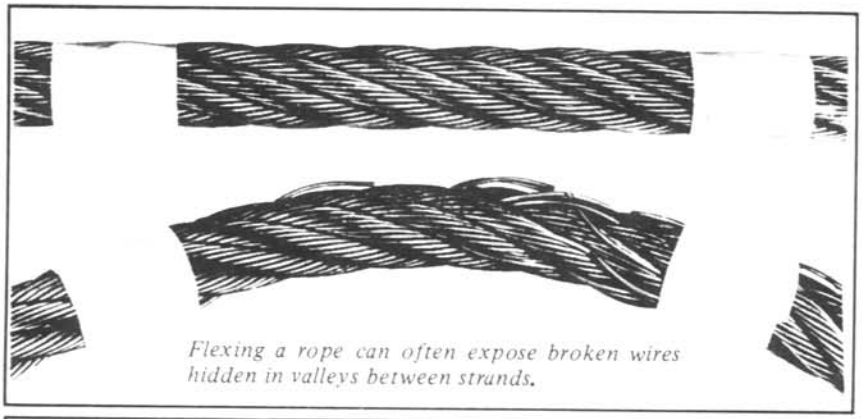
Unlaying sometimes results from operating a rope without having both ends secured to prevent rotation. An end swivel attachment permits such rotation and unlaying.
Another common cause of unlaying is worn sheaves. When the bottom of a sheave groove wears, it can restrict normal movement as the rope enters and leaves the groove; the result can be a build-up of twist which can change the length of lay.
Whatever the cause, unlaying is an abnormality, and should be noted for future reference if the immediate cause cannot be determined.

Finding Broken Wires

Probably the most common sign of rope deterioration and approaching failure is broken wires, and inspection criteria are specific as to the number of broken wires allowable under various circumstances.
It is normal for a properly designed and used "running", or operating, rope to exhibit broken wires as it approaches the end of its useful life. Under ideal conditions, the first wires to break would be the outside wires at the crowns of the strands – where surface wear is expected to occur. On "standing" ropes, wire breakage may not be so easily observed.

It is important that a diligent search be made for broken wires, particularly in critical areas such as "pick-up points" where stresses are concentrated.
The first step in looking for broken wires is to make sure the surface is clean enough that breaks can be seen. Wipe with a cloth. If necessary, scour with a wire brush to clean grease from the valleys between strands.
A thorough search for broken wires cannot be made when a rope is in tension or is supporting a load. Relax the rope, move "pick-up points" off sheaves, and flex the rope as much as possible.

With a sharp awl, pick and probe between wires and strands, lifting any wires which appear loose or move excessively.
If you find a number of broken wires approaching the maximum allowable permitted per strand or per rope lay, extend the search to other sections of the rope, and also take diameter and lay measurements in the area. If internal wire breaks or core damage are suspected, an internal examination should be made, if possible.



Flexing a rope can often expose broken wires hidden in valleys between strands.

One rope lay is the length along the rope which one strand uses to make one complete spiral around the core.

Number of broken wires permitted per strand in one rope lay is specified in inspection criteria for each usage.

Under ideal and normal conditions, wires should break first on the crowns of strands . . . as in this classic example of a worn out rope.

Making an Internal Rope Examination

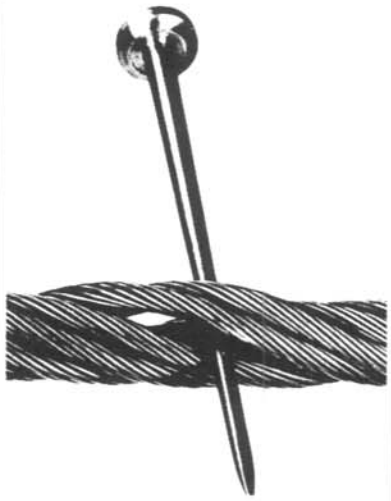
Anytime interior damage, broken wires or core failure may be suspected, a section of rope should be opened for internal examination. This may be accomplished without destroying the rope's future usefulness if due care is exercised and wires are not kinked or notched.

A rope can be opened for internal inspection only when completely relaxed. Using due care, "work" a marlin spike beneath two strands and rotate the spike to expose the core and "under" side of strands. Use an awl to probe for broken wires and examine inner surfaces.

If the rope has an independent wire rope core, look for broken wires on the "under" sides of strands where the strands contact the IWRC. Look for excessive "nicks" or broken wires in the strands caused by contact between adjacent strands or with IWRC. Examine the IWRC for broken wires also.

In the case of fiber core ropes, examine the core for excessive breakage of fibers. If short pieces of fiber – less than 1/4 inch long – sift out of the core, it is breaking up. Such short, broken fibers sometimes indicate the rope is being over-loaded, pinched in tight sheaves, or subjected to other abuse.

If a rope has been opened properly and carefully – and internal condition does not show cause for removal – strands can be returned to their original working positions without distorting the rope or impairing future usefulness.



To open a rope, insert marlin spike beneath two strands and rotate to lift strands and provide view of interior.

Broken wires in the IWRC are not discernable from exterior examination of the rope.

Inspecting Sheaves

Almost every rope installation has one or more sheaves – ranging from traveling blocks with complicated reeving patterns to equalizing sheaves where only minimal rope movement is noticeable. Each sheave should receive an individual examination at periodic inspections.

Each sheave is to be examined for the following:

- Groove depth, width and contour.
- Groove smoothness.
- Broken or chipped flanges.
- Cracks in hubs, spokes, etc.
- Signs of rope contact with guards.
- Sheave bearings and shaft.
- Out-of-round condition.
- Alignment with other sheaves.

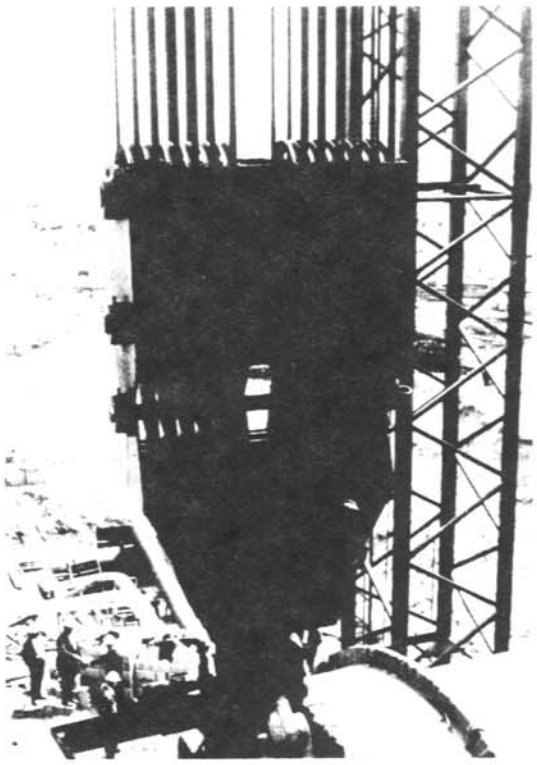
Assessing the general physical condition of a sheave – groove smoothness, freedom from cracks and "knicks", existence of wear on guards, etc. – is a matter of careful, knowledgeable observation.

Properly gauging and evaluating the width, depth and contour of grooves with a groove gauge requires keen observation as well as knowledge of gauge design and use.

A sheave badly corrugated by the rope's "print", a condition which could seriously damage the wire rope.

There are two types of wire rope groove gauges:

1. Those used by manufacturers of sheaves and drums, which make allowance for the maximum allowable oversize for wire rope, and are used to determine the proper contour for NEW grooves.
2. Those used "in the field", which are made to the nominal diameter of the rope PLUS one-half the allowable rope oversize. These are used to determine the MINIMUM condition for WORN grooves.

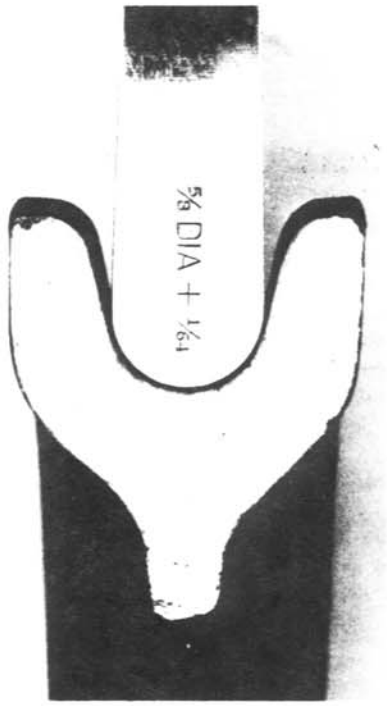


Each sheave in a multiple block is to be examined individually at each periodic inspection.

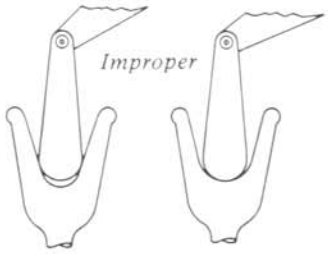
In a field inspection, when the gauge for worn grooves fits perfectly, the groove is at the minimum permissible contour. Anything narrower is unsuitable for use.

It is a good rule to keep in mind that, under normal operating conditions, as a groove wears it tends to become deeper and narrower. Excessive wear in an over-width manner frequently indicates some operating abnormality such as alignment.

Sheave inspection should also include the condition of bearings and shaft. With the rope "relaxed", the sheave should be rotated by hand to determine the "fit" of the bearing and effectiveness of its lubrication . . . whether the sheave runs true, without "wobbling" on its shaft . . . whether the bottom of the groove is still concentric, or "round" in relation to the shaft . . . and whether the sheave and its shaft are in proper alignment with other sheaves or components of the system.

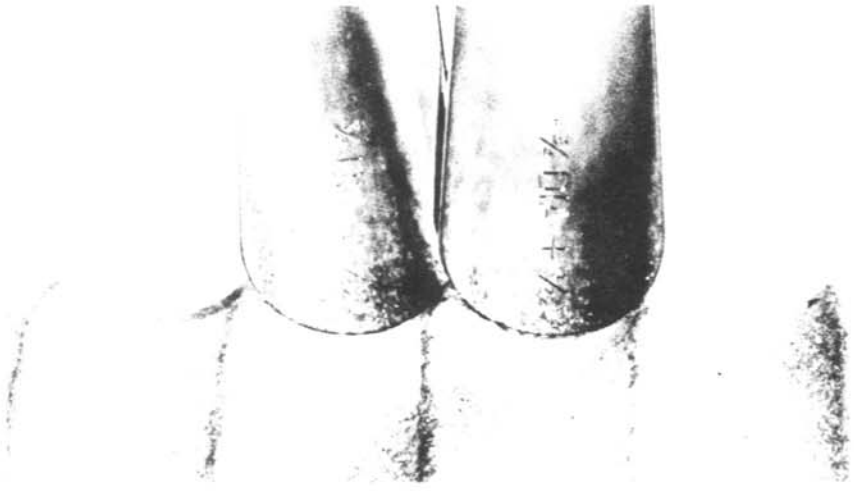


A proper fitting sheave groove should support the rope over 135-150 degrees of rope circumference.



Observe the groove so that it may be clearly seen whether the contour of the gauge matches the contour of the bottom of the groove.

Evaluating Drums



Even though both these gauges properly follow groove contours, when used side-by-side they indicate grooves are too close. Two gauges which overlap in this manner reveal that wraps of rope will scrub when spooling on to or off the drum.

Inspection criteria for drums will usually specify the following:

- Minimum number of dead wraps to remain on the drum.
- Condition of drum grooves, if a grooved drum, and the surface of a smooth drum.
- Condition of flanges at the ends of the drum.
- Rope end attachment.
- Spooling characteristics of the rope.
- Rope condition, particularly at "pick-up points" on the rope.

There is wide acceptance of the following guidelines for checking drums and drum operation.

GROOVES should be of proper contour, and checked with a groove gauge if normal tolerances apply. Bottoms of grooves should be smooth; drums

that become imprinted with the rope's "tread", or excessively roughened, should be corrected or replaced. Grooves should be spaced so one wrap of rope does not "scrub" the next wrap as it spools onto the drum.

SPOOLING is that characteristic of a rope which affects how it wraps onto and off a drum. Spooling is affected by the care and skill with which the first layer of wraps is applied on drums with two or more layers. Wraps should be tight, and a loose condition must be corrected. It is important to examine a rope for kinks or other damage when loose or irregular spooling has been observed.

DRUM CRUSHING is a rope condition sometimes observed which indicates deterioration of the rope. Sometimes crushing is inevitable on a given drum winding, as is deformation of the wires in the rope, usually described as peening. Crushing and peening affect rope performance insofar as these conditions impair adjustment of wires in the rope and damage the wires themselves. When observed, either condition should be noted and careful evaluation of rope made.

How to Use Inspection Forms

These forms were prepared to serve as a guide for making thorough periodic examinations of single wire ropes and serve as a permanent record of the inspection. One form should be used for each rope at each such inspection.

Before beginning an examination of an installation, fill in the blank spaces at the top of the form. These identify the machine or installation, its owner, location, date, etc.

"Rope Application" refers to the specific usage of the rope . . . such as "Main Hoist", or "Boom Pendant", or "Boom Hoist".

After "Rope Description", fill in the diameter, construction, type, etc. . . . such as 1 in. 6x25 FW PRF RLL XIP IWRC.

After "Manufacturer's Ident. No.", insert data which will positively identify this rope . . . preferably the manufacturer's "reel number" which identifies the reel from which the rope was taken. The manufacturer's original purchase invoice or the shipping reel tag

usually carries this number.

The "Applicable Standards" refer to that set of inspection criteria applicable to this installation which can be found in standards and regulations . . . such as ANSI B30.2 for Overhead & Gantry Cranes or Federal Regulations such as OSHA.

It is the inspector's responsibility to obtain the proper inspection criteria for the application to be inspected.

At the column headings to the right of the words "Criteria for Removal", space is provided for the inspector to fill in specific criteria pertaining to each column. Two of these headings are filled in with criteria applicable to all wire rope installations – "1/3 of outside wire diameter" is the maximum wear permissible. One (1) broken wire is the maximum number permissible at end attachments. Fill the other blank spaces with data taken from the proper set of criteria for the machine involved.

A blank column is provided for inspector's use if it is desirable to check any other factor which is not listed on this form.

At the time of each inspection of an installation, refer back to previous inspection records to determine locations on each rope which should be inspected. If the installation has not previously had a thorough inspection, sound judgement should be used in selecting these locations. "Critical Points" should be given first consideration.

The same locations on each rope should be examined carefully at each succeeding inspection so that rope diameter, lay, etc., may be compared to previous measurements in order to detect change in the rope condition. Sudden changes in condition may indicate deterioration.

At each inspection location on a rope, clean the rope sufficiently to be able to find broken wires and to take precise measurements. To be useful, measurements must be accurate.

For each inspection location selected on each rope, describe on the Inspection Report the exact location – such as "Boom point sheave at pick-up". Then, in the order in which columns are established on the Report form, make the indicated observations and write down the information:

1. Measure diameter.
2. Examine for broken wires, (a) in one rope lay, and (b) in one strand of one rope lay. When a broken wire is found, look carefully for others. Record the number of breaks in that rope lay where the most breaks are found.
3. At this same location, inspect for excessive wear.
4. If the examination is being made at a rope dead-end, check for broken wires, corrosion and condition of the fitting.
5. A lay measurement should also be taken at the location selected for inspection.
6. Examine the entire rope end-to-end for evidence of external damage or abuse. Where damage or abuse is noted, proceed to make all the same observations for this location as at any "regular" inspection point. Try to determine the exact cause of any external damage so that "recurring" damage may be prevented.
7. Every sheave should receive a thorough examination and the condition recorded. When the rope "pick-up point" is being examined at a sheave, the data on the sheave can be recorded at that space on the form.
8. Examine and record the drum condition. In a proper inspection, the drum should be observed both in operation and at rest, in order to observe "spooling".

To provide space for all these measurements, five horizontal spaces are provided on each Inspection Report form. Should these not be sufficient for extremely long ropes, or for any other reason, these spaces may be divided with horizontal lines – or a second form used.

When an inspection is completed – or has proceeded far enough for the inspector to decide that rejection is in order – the form should be signed by the inspector. Comments may also be written at the bottom, if desired.

Federal regulations require that signed inspection reports must be maintained on file for all ropes in active service.

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Mission

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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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.