INSTRUCTIONS FOR OPERATION AND MAINTENANCE

KAJAKAI DAM, ARGHANDAB DAM

AND

DIVERSION DAM AND HEADWORKS

FOR BOGHRA CANAL INTAKE

Prepared by

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INSTRUCTIONS FOR OPERATION AND MAINTENANCE

KAJAKAI DAM, ARGHANDAB DAM

AND

DIVERSION DAM AND HEADWORKS

FOR BOGHRA CANAL INTAKE

FOREWORD

These instructions, supplemented with manufacturer's drawings, pamphlets, photographs, etc., are prepared as a general guidance for normal operation and maintenance of the three projects which have been completed for the first stage of construction. Future additions and improvement of the pertinent features of the projects may alter a part or the whole of these instructions.

Special circumstances and unusual difficulties may arise from time to time. They should be brought to the attention of the supervisory engineer at once. Special investigation and expert advice may be required to deal with such occasions.

Kajakai Reservoir

At this stage there is no need of a strict schedule of reservoir operations. As water supply exceeds present irrigation demand, water can be released whenever it is required. Release of water should be controlled by decisions to be made from time to time by the President of the Helmand Valley Authority.

Arghandab Reservoir

The extremely low water year just passed (October 1954 to October 1955) makes evident the need for a strict schedule of reservoir operation. Water should be released only as it is needed for irrigation and to reduce spill when it is quite evident that the reservoir will be filled during a runoff season.

PART I. GENERAL INSTRUCTIONS

IA. DAMS

IA-1. Maintenance and Inspection

The earth dams will require little maintenance, but necessary work should be performed promptly because delay usually adds to the expense, Systematic inspection of the dams will seldom be required because conditions that call for correction are usually apparent at once and are not likely to be overlooked. The area immediately below the downstream toe of the dam should be examined at intervals for "boils", "piping", deposits of fine sediment and unusually large or muddy seepage flow.

IA-2. Leakage

Minor leakage is evident in nearly every dam. Small localized flows of clear water should be examined from time to time to determine whether flow is increasing or becoming muddy. A sunken place or wave in the surface of an earth dam, suggesting possible local settlement, should be investigated at once. The appearance of "boils" or "piping" in the area downstream from the dam and an increasing volume of seepage at the downstream toe are danger signals and should be reported without delay.

IA-3. Cracks

Cracks in the concrete are often caused by temperature changes and shrinkage and are usually of no consequence, but they should be observed to determine if they are increasing in size. It is good practice to photograph severe cracks and to record their measurements for future reference. Large leaks in a chute or stilling pool should be sealed promptly.

In times of long drought, deep cracks may develop in the surface of the earth dams. These cracks should be filled with puddled clay or grout.

IA-4. Erosion

Any erosion on the upstream face of dams, such as occasionally results from strong wave action, should be reported at once and corrective measures taken as soon as the water level is low enough to permit it.

IA-5. Visitors

Controlled observation points should be provided for the public and visitors should not be allowed within the operating areas except when accompanied by official guides.

IB. TUNNELS AND CONDUITS

IB-1. General

In normal operation, the rate of flow through the intake tunnel and conduits is regulated by the valves at the conduit outlets. The upstream valves and intake gates ordinarily are left wide open when water is being released and are kept closed when the system is shut down. Except in emergencies, the flow of water into the tunnel must not be stopped abruptly, because negative pressure will occur and the tunnel walls may crumble. Similarly, a large flow at high velocity must not be admitted to an empty tunnel, because the violent turbulence and high pressure will erode the walls.

Good practice dictates that the flow in a tunnel below an intake gate should be stopped before closing the gate. This avoids the danger of negative pressure in the tunnel and also neutralizes the pressure against the gate, greatly reducing wear of the gate wheels. In general, the discharge valves at the outlet ends of the conduits should be closed first, followed if necessary by the valves farther upstream. It is considered good practice to close the upstream valve whenever the discharge valve is closed, unless the discharge valve is to be closed for only an hour or two. This practice provides a working test of the upstream valve which otherwise may seldom be operated through the full cycle.

To fill the tunnel with water, the discharge and upstream conduit valves should first be closed. The intake gate should then be cracked by raising it about 6 inches. The gate must not be opened wider, even momentarily, until the tunnel has been filled.

IC. MECHANICAL EQUIPMENT

IC-1. Inspection

Mechanical equipment must be inspected at intervals as specified by the manufacturers or as dictated by good practice. In no instance shall inspections be made less frequently than once a month. A fixed routine should be followed in all regular inspections, and specific days of the month or week designated in a schedule of inspection.

Each piece of equipment should be checked for breakage, wear, malfunction and cleanliness. Where visual inspection is insufficient or is impossible, tests to check the equipment shall be made by other means.

Records of all inspection and maintenance work are desirable as an aid to systematic maintenance and for use in determining quantity of spare parts and supplies to be stocked.

IC-2. Cleaning

As part of the regular inspection, all parts of the mechanical equipment should be thoroughly cleaned. Dirt, excess grease and foreign material should be carefully wiped off using kerosene or other non-corrosive cleaning fluid. Care must be taken to avoid damage to painted and machined surfaces through rough handling. Internal parts may be blown out with an air blast and outside installations, except machined and lubricated surfaces, may be washed with water from a hose.

The service and emergency generating units require daily checking and cleaning when in operation. The valve operating mechanisms and pressure sets should be checked and cleaned at intervals, depending upon their frequency of operation.

IC-3. Painting

Systematic re-painting should be performed as often as necessary to maintain a good protective coat. It is important to re-touch all damaged paint-work promptly. All oil, grease and dirt should be removed from the surfaces by the use of clean mineral spirits, white gasoline or xylol and clean wiping material. After cleaning with the solvent, surfaces to be painted should be cleaned of all loose rust, loose mill scale, dirt and other foreign substances by scraping, sand blasting, wire brushing or other effective means. Stainless steel, bronze and machined surfaces should be protected by effective masking during the cleaning and painting of adjacent metal work.

Paint and coating materials should be thoroughly mixed before being applied. If necessary, for smooth application, the paint may be heated by a hot water bath to temperatures not exceeding 38° C (100° F). Priming paint may be thinned as necessary with mineral spirits not exceeding 1 liter of thinner to 8 liters of paint (1 pint thinner to one gallon of paint). All other paints should be applied as furnished. Painting should

not be done when the temperature of the metal or of the surrounding air is below 7° C (45° F), and the surface to be painted must be dry. The first coat should be applied immediately after cleaning. Each coat must be allowed to dry or harden thoroughly before the succeeding coat is applied.

Bare surfaces should be given a first coat of red lead primer. Otherwise paint shall be of the same enamel, lacquer or similar coating used previously on the equipment.

IC-4. Protection of Exposed Machined Surfaces

Exposed machined surfaces should be protected from rust with a coating of machine oil, or, if exposed to the weather, by frequent applications of lime base grease.

IC-5. Lubrication

All sliding and rotating parts must be well lubricated. The bearings of the service and emergency generating units should be checked every day when the units are in operation. Other mechanical devices should be given periodic lubrication as specified by the manufacturers. Some equipment should be lubricated either before or after each use as specified (rotovalves, cranes, wheel gates) but not less than once a month.

The type of lubricant used shall be as specified by the manufacturers. Before lubrication, the area around the filler hole or the grease fitting should be wiped clean. Most ball bearings and roller bearings have seals that prevent the leakage of grease. Only a few "shots" of grease shall be applied, using a low pressure gun, unless the bearing is vented. Forcing the grease until it appears around the shaft may break the seals. High pressure guns may be used with hydraulic (Alemite) fittings if the bearings are vented. Oil lubricated bearings shall be filled, not flooded, from one quarter to one half full or as recommended by the manufacturer.

Oil level in tanks should be checked frequently and fresh oil added as necessary. The use of a rust inhibitor is advisable. Oil tanks and oil reservoirs should be drained at least once a year, cleaned of sludge, sediment and dirt and filled with oil.

Lubricants shall be changed at intervals specified in lubrication schedule.

After lubrication equipment shall be wiped clean.

IC-6. Replacing Packings and Seals

Packing or seals which show wear should be replaced to avoid contaminating the lubricant with packing material. Catalog cuts and/or drawings of the equipment should be used as a guide for disassembly of machine parts holding packing in place. Worn packing or seals should be completely removed and the machine parts thoroughly cleaned and inspected for defects. Scratched or abraded bearing surfaces must be repaired or parts replaced.

New packing used for replacement should be inspected for defects and should not be used unless in good condition. Sharp tools should not be used on packing; a wooden tool with rounded edges may be used to advantage. Shim stock should be used to protect packing to be installed over sharp edges. Tighten glands evenly and only enough to prevent leakage.

When installing "V" or "U" type packing:

a) Install each ring separately.
b) Set the split rings 180° apart.
c) Seat each ring properly.
d) Adjust the gland nut until the stock is firmly set but not squeezed. Then loosen the gland nut not more than one-sixth turn and secure it.

When installing "O" type packing:

a) Push "O" rings over sharp openings with care to avoid cutting.

b) No adjustment of these rings is required upon installation.
c) Ring must be of correct size to give a "squeeze" in the installed position.

After assembly, whenever possible, move the unit by hand to check for free operation before starting under power.

IC-7. Servicing Engines

Clean all dirt and grease from the outside of the engine before removing any parts. For easy identification use separate containers for bolts, nuts and other small parts removed from the various assemblies. While an engine is disassembled keep it covered with heavy paper or other suitable material to keep out dirt.

Spare parts lists should be reviewed prior to disassembly and replacement gaskets procured to be available at time of reassembly.

When assembling parts, care should be exercised to tighten the retaining nuts evenly and firmly. Do not use extensions of any type or handles of wrenches. Overtightening may cause failure of the bolts or studs.

IC-8. Test Operation

All mechanical equipment not in continuous operation should be tested periodically.

Once a week the emergency generating units should be started and operated for 15 minutes.

Once a month the valves (rotovalves, hollow jet valves, ring follower gates, and Howell-Bunger valves) shall be operated through a complete cycle. The hoists and cranes shall also be test operated under load once a month.

PART II. SPECIFIC INSTRUCTIONS

IIA. KAJAKAI DAM

IIA-1. Description

Kajakai Dam is a rock-fill dam with an ungated open channel spillway about 1/2 km from the right abutment. The irrigation intake structure consists of a concrete tower with imbedded metal guides for one wheel gate, one concrete sliding bulkhead and a set of sliding trash racks. There is an electrically-operated movable bridge crane on top of the intake tower.

The trash racks cover the entire intake portal. Immediately behind the trash racks are two rectangular openings into the tunnel. One of these is closed by the wheel gate and the other by the bulkhead.

A lifting mechanism is used to connect the hoist block to the gate or to the bulkhead. This device has counterweighted latches for automatically engaging and releasing the load. Two wheeled guide beams are provided for centering the lifting mechanism between the guides. One of these is used for operating the gate and the other the bulkhead. The trash racks are raised and lowered by chains. A hook on the hoist block is used to engage the chains.

The tunnel is plugged near the downstream end and transition is made to three circular conduits. The penstock for the service hydroelectric unit also starts in the upstream face of the plug and passes through it into the valve house. Each of the three main conduits is controlled by a rotovalve in the tunnel valve chamber and extends to the river bank, where it is controlled at its outlet by a hollow-jet discharge valve.

A diesel-powered emergency generating unit is provided for use in the case of failure of the service unit or when the tunnel is closed.

IIA-2. Irrigation Tunnel

a. Unwatering - The general rules applying to the intake tunnel have already been stated. The procedure for unwatering the tunnel at Kajakai Dam is as follows:

1. Start the emergency generating unit and shut down the service hydroelectric unit.
2. Close the hollow-jet valves.
3. Lower the bulkhead to closed position.
4. Lower the wheel gate to closed position.
5. Open the hollow-jet valves.

6. Allow the tunnel and conduits to drain through the hollow-jet valves to the level of the outlets or of the tailwater.

7. If the tailwater is higher than the bottom of the outlets, close the hollow-jet valves.

8. Open the valves in the conduit drains. The remaining water will be discharged into the sumps and will be ejected by the unwatering pump.

b. Filling - To fill the tunnel and conduits, the procedure is as follows:

1. Close the hollow-jet valves, conduit drain valves and the valve to the service hydroelectric unit.

2. "Crack" the wheel gate by raising it 15 cm. Leave the gate cracked until the escape of air from the tunnel vents in the intake structure has stopped, indicating that the tunnel has filled. This should take from three to four hours, or longer when reservoir water level is low.

3. Raise the wheel gate to "open" position. Raise the bulkhead to "open" position.

4. Start the service hydroelectric unit and shut down the emergency generating unit.

5. Open the hollow-jet valves as required.

IIA-3. Wheel Gate

a. Closing the Wheel Gate - The hollow-jet valves or rotovalves should be closed before lowering the wheel gate. The procedure for lowering the gate is as follows:

1. Attach the lifting mechanism to the hoist block.

2. Attach the wheel gate guide beam to the lifting mechanism.

3. Move the crane so that the hoist block is over the center of the gate slot.

4. Swing the assembly into position so that the wheels of the guide beam are aligned with the guide channels for the gate. Lower and raise assembly and adjust alignment as necessary.

5. Place the counterweight of the lifting mechanism in the "engage" position. (Make sure that the mechanism operates freely in both the engage and release position with counterwieght forces only.)

6. Lower the lifting assembly into the guides until it engages the gate automatically.

7. Hoist the gate slightly to free the dogging arms. Rotate the dogging arms to the disengaged position.

8. Place the counterweight of the lifting mechanism in the "release" position.

9. Lower the gate until it comes to rest at the bottom; the lifting mechanism will disengage automatically when the load is removed from it.

10. Hoist the lifting assembly.

b. Opening the Wheel Gate - The procedure for raising the gate is as follows:

1 to 5. Same as in closing the gate (IIA-3a).

6. Ensure the dogging arms are disengaged.

7. Lower the lifting assembly into the guides until it engages the gate automatically.

8. Hoist the gate sufficiently to allow the dogging arms on upper deck to be rotated to engaged position.

9. Place the counterweight of the lifting mechanism in the "release" position and lower the gate until it barely touches the dogging arms.

10. Inspect the position of the wheel hubs and dogging arms to insure safe storage of the gate.

11. Resume lowering until the gate weight is carried by the dogging arms and the lifting mechanism has automatically disengaged.

12. Hoist the lifting assembly.

c. Maintenance of the Wheel Gate - The wheel gate should be inspected at least once a year for corrosion, condition of paint, wear of wheels and damage to seals. If the gate is removed from the gate slots for maintenance, timbers must be placed on the deck to spread the load of the gate, otherwise the concrete may be cracked or broken.

Three grease fittings should be left permanently in the outer cover of each wheel. All wheels should be lubricated with lime-base grease after each use of the gate. Lubricate wheels as follows:

1. Wipe all dirt from the grease fittings.

2. Apply a grease gun to the three fittings in turn (see section IC-5).

IIA-4. Bulkhead

a. Operation and Maintenance - Before raising or lowering the bulkhead the tunnel should be full of water, but not flowing, and the wheel gate should be open to insure that the water pressure against the bulkhead is balanced. The bulkhead cannot be lowered if more than one conduit is flowing.

Since the bulkhead is wider than the gate, the longer of the two guide beams must be attached to the lifting device. Otherwise, the method of manipulating the bulkhead is identical with that already described for the wheel gate.

The bulkhead should be inspected at least once a year for possible corrosion of metal parts.

IIA-5. Trash Racks

a. Operation and Maintenance - The trash racks should be raised only as often as may be required for inspection, painting and repairs. The bulkhead and wheel gate must always be closed before the racks are raised. If the water level in the reservoir is below or just above, the top of the racks, special care must be taken to remove floating trash or to keep it well away from the intake structure.

The trash racks are raised and lowered by chains made in lengths of 5-1/2 meters each, with a hoisting ring and a dogging link at one end and a clevis at the other. A chain bridle about 3 meters long, with a hoisting ring at the top is permanently attached to each rack. As a rack is lowered, successive lengths of chain are attached by pinning the clevis of each into the hoisting ring of the preceding length. When the rack is being raised, the lengths of chain are detached in succession. The chain is dogged by resting a dogging link across the top of the two-bladed movable dogging arm through which the chain passes.

The procedure for raising trash racks is as follows:

1. Remove the gate-lifting device from the hoist block of the crane and attach the hook.

2. Position the crane so that the hoist block is centered directly over the trash rack chain.

3. Engage the hook into the hoisting ring at the end of the trash rack chain.

4. Hoist the chain slightly and rotate the dogging arm to disengaged position.

5. Hoist the chain (5-1/2 meters) until another dogging link is above the dogging arm.

6. Dog and uncouple the chain above the dogged link.

7. Lower the hook and repeat (3) above.

8. Repeat the lifting and dogging operation until the trash rack has been raised as high as may be required. In lowering a trash rack, the operation is reversed.

IIA-6. Lifting and Dogging Equipment

The manner of operating the lifting mechanism, guide beams and dogging arms has already been described. Non-moving parts of these devices should be kept painted. Moving parts, bearings and sliding surfaces should be greased after each use and kept coated with grease to protect them against corrosion. Scratches and abrasions of the painted surfaces should be repainted without delay.

IIA-7. Intake Crane

a. Operation - The crane is the overhead traveling type and is used for operating the wheel gate, bulkhead and trash rack panels of the irrigation tunnel intake structure. It is also used to hoist heavy items from barges on the lake because the footbridge to the crane tower is not strong enough to take a load any heavier than can be carried by hand. The crane's rated capacity is 75 tons.

The bridge travel drive is a 5 horsepower electric motor, 400 volts, 3 phase, 50 cycles. Bridge travel is controlled from the push-button station mounted above the walk way, having three buttons marked "Forward", "Stop" and "Reverse". The trolley travel drive is a hand-operated gear reduction unit. The hand crank should be locked when the crane is not in use.

The hoist drive is a 20 horsepower electric motor, 400 volts, 3 phase, 50 cycles, controlled from a push-button station mounted on the trolley. There are three buttons marked "Raise", "Stop" and "Lower". Each motor has a built-in, electrically-released, spring-set brake to permit accurate positioning of the hoist. A mechanical load brake is provided to stop and hold the load in any position. See Appendix "A" for "Installation and Operating Instructions for Western Gear Load Brakes", and "Maintenance and Operating Instructions" for the crane.

b. Maintenance - The following work should be performed before each use of the bridge crane, and at least once a month if crane is not being used:

1. Apply a lime-base grease at all grease fittings.

2. Check the oil level in the gear reduction unit. Replenish it as necessary, with SAE Type "A" Transmission oil.

3. Check the oil level in the load brake oil cooler. Replenish it as necessary, with the same transmission oil used in the reduction unit.

4. Open the hatches and slowly pour heavy lubricating oil on the exposed gearing while it is rotating.

5. Brush the wire rope with lubricant.

The following work should be performed every 6 months:

1. Inspect the wheel flanges. If the wheels are mis-shapen or the bridge is out of alignment it will be apparent by wear on the wheel flanges.

2. Check the alignment of the drive-shaft couplings.

3. Check the condition of the bearings and oil seals.

4. Check the connections between the load brake housing and oil cooler.

5. Carefully inspect the hoisting cables. Replace them if they are not in first-class condition.

6. Check the alignment and span of the runway rails. These should be maintained within a tolerance of 1/4".

7. Remove the inspection cover of the load brake and check the friction plates for clearance. Rotate the high-speed shaft clockwise until the gear hub has tightened against the friction plates. Loosen the set-screw in the adjusting nut that holds the gear hub tightly against the friction surfaces. Insert a feeler gage between the gear hub and the adjusting nut until the required clearance (.010 - .015 inch or .25 - .38 millimeter) is attained. Tighten the set-screw.

8. Check the distance between the inner surfaces of the load-brake gear hub and the outer brake disc. When it has decreased 46 millimeters (1-13/16 inch) the friction lining must be replaced.

9. Check all movable and stationary contact tips in both the power circuit and the control circuit.

10. Ensure the commutator brushes in electric motors are free to move in their holders and that there is enough carbon remaining for at least another six months service. The correct pressure is .15 to .20 kg/sq cm for metallic brushes.

11. Dress the commutators and slip rings if necessary.

12. Inspect all wiring and replace or repair any damaged insulation.

13. Use a megohmmeter to check the entire crane for high-resistance ground faults.

Records of all inspection and maintenance work on the crane should be kept.

See Appendix "A" for "Renewal Parts Data" for Westinghouse equipment and "Berger Intake Crane".

IIA-8. Rotovalves

a. Operation - For method of operating rotovalves refer to "Operation and Maintenance Instructions", Appendix "B".

The rotovalves are designed for emergency closure only and are not provided with by-passes and air vents. They are not regulating valves and should be fully opened or closed under balanced head during normal operation.

b. Maintenance - Prior to each and every operation of the rotovalves they should be lubricated in accordance with the applicable provisions of the "Operation and Maintenance Instructions", Appendix "B". It is especially important to lubricate the trunnions.

IIA-9. Hollow-Jet Valves

a. Operation - For method of operating the hollow-jet valves under various conditions refer to the Westinghouse "Instruction Book", Appendix "C".

b. Maintenance - Prior to each and every operation of the hollow-jet valves they should be lubricated. As a guide in lubricating refer to the drawings and instructions in the "Instruction Book", Appendix "C".

IIA-10. Service Generating Unit

a. Operation - For method of operating the service generating unit (turbine) refer to the S. Morgan Smith Company, "Operation, Instructions, and Suggestions", Appendix "D".

b. Maintenance - Prior to starting the unit, and also once a day when unit is operating, the oil in the governor and in oil lubricated bearings should be checked and all parts requiring it should be greased. Bearing temperatures should be checked a minimum of every four hours.

If foreign material entering the scroll case is audible, shut down the unit and remove the material.

At 6-month intervals the unit should be given a general inspection as specified in the "Operation, Instructions, and Suggestions", Appendix "D".

IIa-11. Emergency Generating Unit

a. Operation - The diesel generator should be started as follows:

1. Open the large switch panel on the wall.
2. Turn the White switch (valve house feeder) to "OFF".
3. Turn the Yellow switch (battery charger) to "OFF".
4. Pull the Black handle on the diesel engine half way.
5. Pull up on the Brown handle and the small Black handle at the same time, until the diesel engine starts.
6. Push the Black handle all the way to "Full Open".
7. In the switch panel on the wall, turn the large Blue switch to "ON".
8. Turn the small Blue switch to "ON".
9. Turn the Green switch to "ON".
10. Turn the Pink switch to "ON".
11. DO NOT turn the White switch "ON" while the diesel engine is running.
12. DO NOT turn the Yellow switch "ON" while the diesel engine is running.

The diesel generator is stopped as follows:

1. In the large switch panel on the wall, turn the Pink switch to "OFF".
2. Turn the large Blue switch to "OFF".
3. Turn the small Blue switch to "OFF".
4. Pull the Black handle on the diesel engine all the way up and wait until the engine stops.
5. In the large switch panel on the wall, turn the Yellow switch to "ON".
6. Turn the White switch to "ON".

b. Maintenance - The diesel generator should be maintained in accordance with the instructions in "Instructions for Operation, Maintenance, and Repair of Murphy Diesel Engines" and "The EM 'Packaged' Synchronous Generator", see Appendix "E". The unit must be maintained in good condition at all times for immediate use in emergencies.

IIA-12. Piezometers

The piezometers are used to measure pore-water pressures in the embankment and foundation of the dam to determine the extent of saturation, percolation flow lines, and uplift pressures that affect stability. There are sixteen piezometer tips embedded in the foundation and embankment of the dam. Each tip is connected by two plastic tubes to a pair of pressure gages in the piezometer gage cabinet, there being for each tip a pair of gages connected to a manifold. (The cabinet is on the left bank of the river at the downstream toe of the dam, just above the service road). The manifold supplies water for flushing trapped air from the individual piezometer lines, and the system is provided with a pump, an air trap, and a master pressure gage for checking the calibration of the piezometer inlet and outlet gages. For additional detail refer to Piezometer Installation Drawings 11-F-3 and 11-F-4, Appendix "G".

Pore-water pressures are transmitted through the water-filled tubes to the piezometer inlet and outlet gages in the cabinet. The readings of the two gages for each piezometer are averaged and adjusted to the elevation of the piezometer tip to obtain the actual pressure at that point. Twice each year, and more often if necessary, readings are made with the master gage to check the calibration of the piezometer gages.

a. Reading the Piezometers - Piezometer readings are made as follows:

1. Close the piezometer inlet and outlet valves. This isolates the piezometer from the water manifold.

2. Read the pressures in feet of water as indicated by the inlet and outlet gages. Record the pressures on the form provided for piezometer observations.

3. Compute the mean of the two readings and convert to meters.

4. The difference in meters between the elevation of the gage and that of the piezometer is the "tip constant". If the tip is lower than the gages, the tip constant must be added to the mean gage pressure. If the tip is higher than the gages, the tip constant must be subtracted from the mean gage pressure. The result is the pore-water pressure at the piezometer tip.

5. If the readings of the inlet and outlet gages for the same piezometer do not agree within 5 feet, flush the piezometer and then check the individual gages against the master gage (see Section b and e below).

b. Flushing the Piezometers, Usual Procedure - The line from the inlet gage to the piezometer tip and back to the outlet gage is flushed as follows:

1. Open the piezometer inlet and outlet valves, the manifold inlet valve, the outlet flushing valve, and the pressure check valve. All other valves should be closed. Operate the pump with moderate pressure until no bubbles appear in the air trap. Close all valves.

2. If the piezometer line has been drained, it should be flushed repeatedly in alternate directions of flow. Circulation is reversed by closing the manifold inlet valve and outlet flushing valve and opening the manifold outlet valve and inlet flushing valve. Operate the pump as in (1).

c. Flushing the Piezometers in Porous Fill - If the earth material at the piezometer tip is highly porous, it may be found that the application of pressure to one tube of the pair will not produce a return flow in the other. When this occurs, each tube must be flushed independently, the air being removed by forcing it out through the tip into the earth. The method is as follows:

1. Compute the internal volume of the inlet and outlet tubes between the gage cabinet and the piezometer tip in terms of the change in water level in the air trap. For this purpose, assume that the capacity of the tubing is equivalent to 2-1/2 millimeters of height on the air-trap gage glass for each meter of length of tube.

2. Open the pressure check valve, the manifold inlet valve, the air-trap bleeder valve, the safety valve, and the piezometer inlet valve. The other valves should be closed.

3. Pump into the inlet line a volume of water equivalent to the full capacity of the line from the cabinet to the piezometer tip, as measured on the air-trap gage glass. Close the piezometer inlet valve.

4. Open the water-supply valve and refill the air trap to within 15 centimeters of the top. Close the water-supply valve.

5. Open the piezometer outlet valve and the manifold outlet valve. Pump into the outlet line a volume of water

equivalent to the full capacity of the line. Close the piezometer outlet valve.

6. Open the water-supply valve and refill the air trap to within 15 centimeters of the top. Close the water-supply valve and the bleeder valve.

d. Filling the Piezometer Manifold - If the pumping and manifold system has been drained, it should be refilled with water as follows:

1. Close all valves.

2. Open the bleeder valve. With the water-supply valve, fill the air trap with water to within 15 centimeters of the top. Close the water-supply valve and the bleeder valve.

3. Open the inlet flushing valve, the manifold flushing valve, the manifold outlet valve, the safety valve, and the pressure check valve.

4. Operate the pump, keeping the pressure as low as practicable, and circulate water until no more bubbles are observed at the air trap.

5. Open the outlet flushing valve and close the inlet flushing valve. Continue pumping for a few strokes.

6. Open the manifold inlet valve and close the manifold outlet valve. This will reverse the direction of flow through the manifold. Continue pumping until no more bubbles are observed, reversing the flow as necessary.

e. Checking Piezometer Readings with the Master Gage - Pressure readings to check the calibration of the piezometer inlet and outlet gages are made as follows:

1. Close all valves.

2. Open the bleeder valve, the outlet flushing valve, the pressure check valve, the manifold inlet valve, the manifold flushing valve, and the safety valve.

3. With the pump, circulate water until no bubbles appear at the air trap.

4. If the water level in the air trap is more than 15 centimeters below the top, open the water-supply valve and raise the level. Close the water-supply valve.

5. Close the outlet flushing valve. Resume pumping and build up the pressure until the needle of the master gage

is about at mid-point of the dial. Close the pressure check valve and the bleeder valve.

6. Observe the gage to ensure pressure is being maintained. If there are leaks in the manifold piping or valves they must be repaired before accurate readings can be made.

7. Adjust the pressure of the master gage to within 5 feet of the pressure recorded on the inlet gage of the first piezometer. To increase the pressure, open the pressure check valve and operate the pump. To reduce the pressure, open the bleeder valve and "crack" the outlet flushing valve momentarily. For a vacuum reading, close the bleeder valve, open the outlet flushing valve, apply a suction stroke with the pump, and close the outlet flushing valve.

8. Read and record the pressures indicated on the piezometer inlet and outlet gages.

9. Close all valves except the manifold inlet valve and the safety valve. Open the piezometer inlet valve, read the master gage, and close the valve again. Record the reading.

10. Close the manifold inlet valve and open the manifold outlet valve. Open the piezometer outlet valve, read the master gage, and close the valve again. Record the reading.

11. To check the inlet and outlet gages of each of the other piezometers in turn, close the manifold outlet valve. Open the manifold inlet valve, the manifold flushing valve, the pressure check valve, and the bleeder valve. Perform operations (5) to (10), above. After four or five piezometers have been checked, flush the manifold circuit as described in (1) and (4), above. Repeat the flushing operation after each additional four or five piezometers have been checked.

IIB. ARGHANDAB DAM

IIB-1. Description

Arghandab Dam is an earth-fill dam, protected by two ungated spillways located apart from the dam area. The intake portal of the tunnel has inclined trashracks. The intake gate is located in the tunnel about 90 meters downstream from the portal. A vertical shaft at this location extends to ground level and is surmounted by the intake gate superstructure. A stationary hoist in the superstructure is permanently coupled to the wheel gate.

At the downstream end of the tunnel, a steel liner extends beyond the portal and is sealed by a steel bulkhead welded in place. Two conduits and the penstock for the service hydroelectric unit are connected into the side of the liner. Each conduit is controlled by a ring-follower gate near the upstream end and by a Howell-Bunger valve at the outlet.

A diesel-powered emergency generating unit is provided for use in case of failure of the service unit or when the tunnel is closed.

IIB-2. Tunnel

a. Unwatering - No provision is made for unwatering the upstream portion of the tunnel between the trashrack and the intake gate. The main portion of the tunnel and the conduits are unwatered as follows:

1. Start the emergency generating unit and shut down the service hydroelectric unit.
2. Close the Howell-Bunger valves.
3. Lower the wheel gate to closed position.
4. Open the Howell-Bunger valves.
5. Allow the tunnel and conduits to drain through the Howell-Bunger valves to the level of the outlets or of the tailwater.
6. If the tailwater is higher than the bottom of the outlets, close the Howell-Bunger valves.
7. Open the valve in the tunnel drain. The remaining water will be discharged by gravity.

b. Filling - The procedure for filling the tunnel and conduit is as follows:

1. Close the Howell-Bunger valves and the ring-follower gates.

Close the valves to the service hydroelectric unit, on the tunnel drain and in the by-passes around the ring-follower gates.

2. "Crack" the wheel gate by hoisting it 15 cm. The hoist controls are designed to do this automatically. The indicator lights on the control boxes will light when the gate is "cracked" and will go out automatically when the tunnel is full. This should take from 5 to 20 minutes, depending upon the reservoir level.

3. Hoist the wheel gate to "open" position.

4. Start the service hydroelectric unit and shut down the emergency generating unit.

5. Open the valves in the by-passes around the ring-follower gates and allow the conduits to fill.

6. Open the ring-follower gates.

7. Open the Howell-Bunger valves as required.

IIB-3. Wheel Gate

a. Closing the Wheel Gate - The intake wheel gate is normally attached permanently to the hoist block, which is aligned permanently with the path of the gate.

The procedure for closing the gate is as follows:

1. Close the Howell-Bunger valves, tunnel drain valve and the penstock valve. (Note: about one hour and 23 minutes is required to close the gate from "normal open" position.) If necessary, the discharge valves may be left open for one hour after lowering has begun. The gate should then be stopped, the emergency generator started and the valves closed before lowering the gate the distance remaining.

2. Start the emergency electric generating unit and shut down the service unit. Close the power circuit breaker in the Intake Gate Tower distribution panel.

3. Press the "lower" push button at either of the two control stations. (In case of power failure the gate can be lowered by tripping the hand release on the motor shaft brake.)

4. The automatic switch will stop the hoist when the gate has closed.

5. Open the power circuit breaker.

b. Opening the Wheel Gate - The procedure for raising the gate is as follows:

1. If the tunnel is empty, close the Howell-Bunger valves, penstock and drain valves, and the ring-follower gates.

2. Close the power circuit-breaker.

3. Press the "raise" push button at either control station.

4. When the gate reaches "cracked" position it will stop automatically and the tunnel indicators will light.

5. When the tunnel is filled the indicator lights will go out. Press the "raise" push button again.

6. The automatic switch will stop the gate at "normal open" position.

7. If it is desired to raise the gate higher for maintenance purposes, hold the "raise" button closed. The gate will then rise to "maintenance" position.

c. Maintenance - Maintenance shall be the same as described in Section IIA-3c of these instructions.

IIB-4. Trashracks

The trashracks should be raised only as often as may be required for inspection, cleaning, painting and repairs. The wheel gate must always be closed before the racks are raised. If the water level is below, or just above, the top of the racks, special care must be taken to remove floating trash or to keep it well away from the trashrack structure.

The two racks are hoisted up the incline by chains, which are passed over curved steel plates at the top of the incline so that the pull can be applied horizontally by any convenient means. At the end of each plate there is a stopping pawl for the chain by which it can be dogged at any link desired.

IIB-5. Hoist

a. Operation - Power to operate the hoist is normally supplied by the emergency diesel generator, but for routine tests of operation power from the hydroelectric generator can be used. For hoist operation procedure refer to the "Maintenance Manual", Appendix "F". When lowering, the hoist stops as soon as the gate is seated. When raising, it stops at "cracked" position 15 cm above the invert of the tunnel; at "normal open" position 30 cm above the gate maintenance deck and at "maintenance" position above the tops of the guide channels.

b. Maintenance - The following work should be performed before each use of the hoist and at least once a month when hoist is not being used.

1. Apply a lime-base grease at all grease fittings.

2. Check the oil level in the gear reduction unit. Replenish it as necessary with SAE 90 oil.

3. Check the oil level in the electric motor brake. Replenish it as necessary with hydraulic brake fluid.

4. Open the hatch on the cover of the center drum gear and slowly pour heavy lubricating oil on the exposed gearing while it is rotating.

5. Brush the wire rope with lubricant.

The following work should be performed every six months:

1. Check the condition of the bearings and oil seals.

2. Carefully inspect the hoisting cables. Replace them if they are not in first-class condition.

3. Check the brake-shoe linings on the electric motor brake for excessive wear. Simultaneously, apply a small amount of oil on the bearing pins without dropping oil or grease on the brake-shoe surfaces.

4. Check all movable and stationary contact tips in both the power circuit and the control circuit.

5. Ensure the commutator brushes in electric motors are free to move in their holders and that there is enough carbon remaining for at least another six months service. The correct pressure is .15 to .20 kg 1 sq. cm for carbon or graphite brushes and .20 to .35 kg 1 sq. cm for metallic brushes.

6. Dress commutators and slip rings if necessary.

7. Inspect all wiring and replace or repair damaged insulation.

8. Use a megohmmeter to check the entire crane for high-resistance ground faults.

Records of all inspection and maintenance work on the hoist should be kept.

IIB-6. ~~IIB-6~~. Ring-Follower Gates

The ring-follower gates should be either fully open or fully closed. They should not be cracked when filling unwatered conduits. By-passes are provided for that purpose. All throttling to adjust the rates of flow in the conduits should be done with the Howell-Bunger discharge valves.

a. Closing the Gates - The procedure for closing the ring-follower gates is as follows:

1. Close the discharge valve (Howell-Bunger) in the same conduit.

2. Connect the hanger chain by engaging the ring in the hook on the cylinder head.

3. Set the operating levers of both 4-way valves at the "neutral" position.

4. Start the motor.

5. Move the operating lever for the gate to be closed to the "open" position, to raise the gate until the hanger disengages automatically.

6. When the hanger has disengaged, move the operating lever to the "close" position to close the gate.

7. When the gate is fully closed, set the operating lever at the "neutral" position, stop the motor and disconnect the hanger chain from the hook.

b. Opening the Gates - The procedure for opening the ring-follower gates is as follows:

1. Close the discharge valve (Howell-Bunger) in the same conduit.

2. Open the water by-pass valve and allow the conduit between the ring-follower gate and the discharge valve to fill with water.

3. Set the operating levers of both 4-way valves in the "neutral" position.

4. Disconnect the hanger chain from the hook on the cylinder head.

5. When the conduit is full, start the motor.

6. Lower the operating lever of the gate to be opened to "Open" position.

7. When the gate is fully open and the hanger has engaged, move the operating lever to "neutral" position and stop the motor.

c. Hydraulic System - The normal settings of the valves are as follows:

Drain valves - closed
By-pass valve (oil) - fully open for normal operation.
By-pass valve (oil) - fully closed for emergency operation.
By-pass valve (water) - open when raising gate.
By-pass valve (water) - open or closed when lowering gate.
Four-way valves - neutral.
Relief valve setting - 850 pounds per square inch.
Free-flow and throttling valves - set so that pressure gage reads 50 pounds per square inch while closing gate.
Blow-off valves - open.

The entire hydraulic system contains approximately 105 U. S. gallons of SAE 10 oil. The oil tank should be kept about one-quarter full (15 U.S. gallons). The oil should be checked or replenished only when both gates are open. The method of filling the system is as follows:

1. Close the drain valves; open the oil by-pass valve; and place the 4-way valves in "neutral" position.

2. Fill the tank with oil.

3. Start the motor and adjust the setting of the relief valve to 850 pounds per square inch. The oil by-pass valve can be used to vary the oil pressure for the purpose of adjusting the valve.

4. Open Gate No. 1, adding oil to keep the tank full.

5. Close Gate No. 1, setting the free-flow and throttling valve so that the oil pressure is 50 pounds per square inch.

6. Open Gate No. 1. When it is open add oil to fill the tank 1/4 full.

7. Open Gate No. 2 and follow the same procedure as with Gate No. 1. (Instructions 4, 5 and 6.)

8. Operate both gates and add enough oil to fill the tank 1/4 full.

IIB-7. Howell-Bunger Valves

a. Operation - The Howell-Bunger valves are used to control the discharge rate at the outlet ends of the conduits. Each valve is operated by an electric motor through a mechanical linkage and is controlled from the push-button station. The operation is as follows:

1. To open a valve fully or to close it entirely, press the "Open" or "Close" button. The motor will operate until the operation is complete and then stop automatically.

2. If an intermediate setting is desired, press the "Stop" button as soon as the indicator reaches the desired position.

3. If a foreign object should lodge in the outlet while the cylinder gate is closing the overload relay will stop the motor automatically. The valve should then be opened and the obstruction removed.

4. In case of failure of the electric power supply, the valve can be operated manually by means of the hand wheel. As a safety measure the electrical connection is broken automatically when the safety cover is removed from the hand-wheel shaft extension and the motor cannot be operated until the cover is replaced.

For additional details refer to S. Morgan Smith Company "Bulletin No. 156" and "General Arrangement Dwg. #5355-JG-2", Appendix "H".

b. Maintenance - For smooth operation of the valves, the gear units, operating screws, and bearings should be well lubricated. The operating parts should be inspected and lubricated once a week when the valves are in frequent operation. If valves have not been operated for a month or longer, they should be lubricated prior to use. Correct adjustment of the packing gland is important and it should not be tightened more than is necessary to stop the leakage. If the valves are kept either closed or dry for long periods, it is advisable to coat the bronze sleeve with grease occasionally. When the valve is operated frequently that is done automatically by the packing box.

To repack the packing gland: remove old packing, clean, put in three rings of graphite packing, the "H" ring and another ring of graphite packing. Insert the packing gland and draw it down completely. Remove the packing gland and insert a ring of babbit foil-packing. Again insert the packing gland and draw it down tight enough to prevent leakage.

For additional details refer also to S. Morgan Smith Company, "Lubrication Chart, Drawing #5355-DU-3", Appendix "H".

IIB-8. Service Generating Unit

a. Operation - The service generating unit is started as follows:

1. Open the by-pass valve on the turbine penstock valve.

2. When the penstock and scroll case have filled, open the turbine penstock valve.

3. Release the governor gate lock.

4. Close the emergency shut-down valve.

5. Set the gate-limit knob to "Full Load--Full Speed" position.

6. With the lever provided, open the turbine gates until the turbine starts rotating.

7. Turn the speed-adjustment knob until the frequency meter on the switchboard panel indicates 50 cycles.

8. Close the main switch.

The service generating unit is shut down as follows:

1. Open the main switch.

2. Set the gate-limit knob to "0".

3. When the unit has slowed down and the governor piston is all the way in, set the gate lock.

4. Close the turbine penstock valve and then the by-pass valve.

To stop the unit in an emergency open the emergency shut-down valve on the governor by turning the hand wheel in a counter-clockwise direction.

When the unit is to be shut down for longer than a brief period, remove the scroll-case drain plug. Replace the plug after the scroll case has drained.

b. Maintenance - Prior to starting the unit and also once a day when unit is operating, the oil in the governor and in oil lubricated bearings should be checked and all parts requiring it should be greased. Bearing temperatures should be checked a minimum of every four hours.

If foreign material entering the scroll case is audible, shut down the unit and remove the material.

At 6-month intervals the unit should be given a complete inspection and repaired as necessary.

Refer also to The James Leffel and Company, "Instructions for Erecting One-Horizontal Globe Case Turbine", Appendix "I".

IIB-9. Emergency Generating Unit

a. Operation - Refer to Section IIA-11a of these instructions

b. Maintenance - Refer to Section IIA-11b of these instructions.

IIC. BOGHRA CANAL INTAKE

IIC-1. Description

The diversion and intake works consist of a rock weir and a concrete weir (with provision for flashboards) across the river, a sluiceway along the right bank, and a gated weir at the side of the sluiceway. There are three sluice gates (wheel gates) at the lower end of the sluiceway. These gates are operated by a gantry crane. The intake weir has four radial gates which are operated by means of stationary hoists on the bridge deck.

IIC-2. Sluice Gates

There are three pairs of gate slots in the sluiceway. Each pair consists of a service and an emergency slot. The emergency slot is immediately downstream from the service slot. The three gates must be kept at nearly equal height to maintain symmetry of flow. The gates should be opened at least every two weeks for a sufficient length of time to sluice out the sand and silt which might otherwise enter the canal.

a. Operation - The procedure for opening a gate is as follows:

1. Pick up the lifting beam with the hoisting hook of the gantry crane. Hoist it into the positioning guides under the transverse H-beams in the portals of the crane.

2. Crank the crane along the track until it is over the gate slot. The positioning pin on the driving platform will drop into the socket in the bridge deck at the location.

3. Turn the dogging arms in the gate slot to the raised position and secure them by hooking the lower rings of the latch chains.

4. With the differential hoist, lower the lifting beam, guiding it so that the wheels are aligned with the rails in the gate slot. Continue lowering until the beam rests on the gate. Slack the tiller cable so that the hooks of the lifting beam will engage the gate, and hoist the beam slightly to lock the hooks in the engaged position.

5. Hoist the lifting beam and gate until either the top or bottom wheels are just above the dogging arms.

6. Unhook the latch chains and turn the arms down to the dogging position.

7. Lower the beam and gate until part of the load is resting on the dogging arms.

8. Inspect the gate wheels and dogging arms to make certain they are correctly engaged.

9. If the bottom wheels are being dogged, remove the gate-brace locking pins, swing the gate braces out from the gate and slide the free ends into the gate-brace sockets (these are embedded in the concrete just below the top of the gate-slots).

10. Lower the beam until the hoisting chain is slack. The tension in the tiller cable should then disengage the hooks of the lifting beam automatically and release it from the gate. Hoist the lifting beam into the positioning guides attached to the crane.

To close a sluice gate, proceed as follows:

1. With the lifting beam carried in the positioning guides, position the crane over the gate. The positioning pin on the operating platform will drop into the socket in the bridge deck at that location.

2. Lower the lifting beam and guide it so that the hooks enter the slots in the gate. Rest the lifting beam on the gate.

3. Slack the tiller cable to permit the hooks to engage the gate. At the same time, hoist the beam until it is carrying part of the weight of the gate. This will lock the hooks in the engaged position.

4. If the gate braces are in use, disengage them from the sockets, swing them into the disengaged position on the gate and secure them with the locking pins.

5. Hoist the beam and gate until the dogging arms can be turned up to clear the gate. Secure the arms by hooking the lower rings of the latch chains.

6. Lower the beam and gate to the bottom of the slot. When the hoisting chain becomes slack, the lifting beam will disengage itself from the gate automatically.

7. Hoist the lifting beam into the positioning guides on the crane.

To transport a gate along the bridge, first hoist it until the lifting beam enters the positioning guides on the crane. The crane can then be moved along the track, carrying the gate without damage.

b. Maintenance - The wheels of the sluice gates should be lubricated with lime-base grease whenever the gates are raised (see IC-5). A grease fitting is attached to each wheel for that purpose. At the time the wheels are lubricated the gate seals and paint should be examined, and repairs made as necessary.

IIC-3. Gantry Crane

a. Operation - The crane is propelled along the track by means of a hand crank on the operating platform, and when positioned over a gate slot it is held in place by a positioning pin that drops into a socket in the bridge deck. The hoist is a differential block and is hand-operated by means of an endless chain, as is also a cog-wheel drive used to shift the hoist laterally within the frame of the crane. The tiller cable that releases the hooks on the lifting beam operates over a small idler sheave attached to the housing of the hoist. The free end is counterweighted to maintain tension in the cable.

b. Maintenance - All of the bearings in the crane are self-lubricating except those of the four track wheels. Each track wheel is provided with a grease fitting mounted on the outer end of the axle. The wheels should be lubricated with a grease gun once a week if crane is being used frequently. If crane has not been operated for a month or more, the wheels should be lubricated before use. Bearings on the lifting beam should be greased after each use and kept coated with grease to prevent corrosion. Non-moving parts should be repainted as necessary.

IIC-4. Intake Gates and Hoists

a. Operation - The radial gates are operated in pairs by means of two stationary hand-operated hoists. It is important to maintain symmetry of water flow to prevent cross-currents that would produce undue turbulence in the canal. All of the gates must be kept at nearly equal height. This can be accomplished either by operating two hand wheels at the same time, or by turning each wheel only a few times before turning the other a similar amount.

When opening the gates, great care must be taken to avoid a large hydraulic jump in the canal downstream from the spillway, or a flow of high velocity extending beyond the concrete stilling pool. If the canal is empty or nearly so, the gates must be opened approximately one foot to allow the canal to fill to a level such that the hydraulic jump is confined to the stilling pool. Then the gates should be opened slowly, keeping the hydraulic jump above the lower end of the stilling pool. One pair of gates should not be opened much wider than the other pair at any time.

b. Maintenance - The hoist bearings and gearing should be lubricated once a week if used frequently and prior to each use if operated once a month or longer. Hoist cables should be inspected and lubricated at least once every three months.

IIC-5. Concrete Weir

The concrete weir adjacent to the sluiceway is equipped with sockets for flashboards. If it is desired to raise the level of the lake, flashboards may be put in, but they should be designed to fail when the water has risen one meter above the concrete weir. For rare flood conditions, at which time the water level is higher, the rock weir adjacent to the concrete weir is designed to fail in part in order to save the weir, sluiceway and canal intake.

INSTRUCTIONS FOR OPERATION AND MAINTENANCE

KAJAKAI DAM, ARGHANDAB DAM

AND

DIVERSION DAM AND HEADWORKS

FOR BOGHRA CANAL INTAKE

FOREWORD

These instructions, supplemented with manufacturer's drawings, pamphlets, photographs, etc., are prepared as a general guidance for normal operation and maintenance of the three projects which have been completed for the first stage of construction. Future additions and improvement of the pertinent features of the projects may alter a part or the whole of these instructions.

Special circumstances and unusual difficulties may arise from time to time. They should be brought to the attention of the supervisory engineer at once. Special investigation and expert advice may be required to deal with such occasions.

Kajakai Reservoir

At this stage there is no need of a strict schedule of reservoir operations. As water supply exceeds present irrigation demand, water can be released whenever it is required. Release of water should be controlled by decisions to be made from time to time by the President of the Helmand Valley Authority.

Arghandab Reservoir

The extremely low water year just passed (October 1954 to October 1955) makes evident the need for a strict schedule of reservoir operation. Water should be released only as it is needed for irrigation and to reduce spill when it is quite evident that the reservoir will be filled during a runoff season.