OPERATION AND MAINTENANCE MANUAL

FOR

WINFIELD LOCKS AND DAM KANAWHA RIVER 14 April, 1999 (Revised April 27, 2000)

U.S. ARMY CORPS OF ENGINEERS HUNTINGTON DISTRICT HUNTINGTON, WEST VIRGINIA

FOREWORD

This manual is prepared in accordance with Chapter 2, “Project Manuals”, of ER 1130-2-500, “Partners and Support”, which directs the preparation and prescribes the coverage of operation and maintenance manuals for completed civil works projects.

This manual has been prepared with two objectives in mind. First and foremost, it will be used as a guide for the operation and maintenance of this project and as an aid in the orientation of employees to Winfield Locks and Dam. Secondly, it furnishes a complete and accurate discussion of the functions of the project operating machinery, including the operating features. Illustrations are included to identify the operating equipment described in the various sections of the manual.

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CHAPTER 1 -PROJECT DESCRIPTION AND HISTORY

A. Authorization and Location.

Winfield Locks & Dam were authorized by the River & Harbor Act of 30 Aug. 1935 to modernize the navigation system on the Kanawha River, WV. Located at River Mile 31.1, Winfield is the downstream project in the system. The navigation pool for the lower reach is maintained by Ohio River backwater from R. C. Byrd Dam.

The construction of an additional lock and gate bay was authorized by the Water Resources Development Act of 1986. Transit time and delays were reduced and the capacity was significantly increased with the opening of the additional lock in Nov. 1997.

B. Description.

1. Locks.

The additional lock is located at a 6 degree skew landward of the original locks. An additional gate bay separates the lock from the original locks. The additional lock chamber is 800 feet long by 110 feet wide. The lift from lower pool to 0upper pool is 28 feet. The original locks consist of two 360 foot long by 56 foot wide chambers.

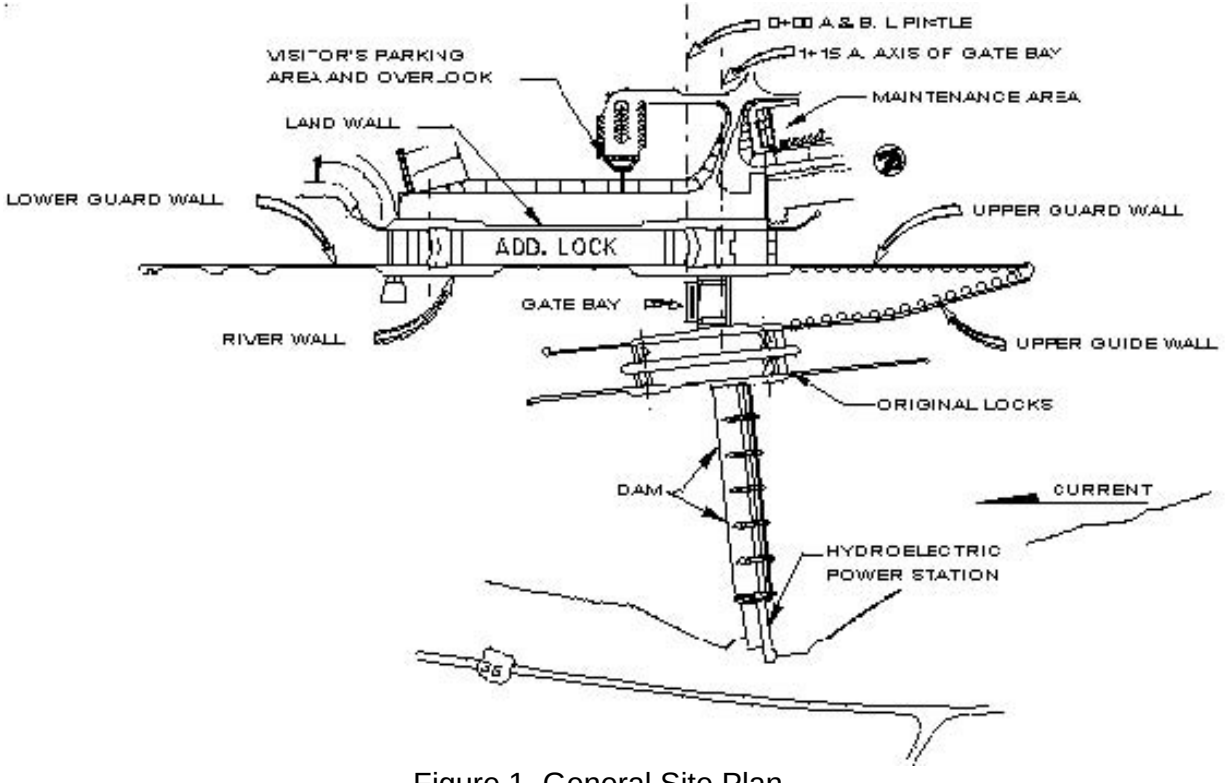


Figure 1, General Site Plan

2. Dam.

The dam is a non-navigable, high-lift structure. It consists of a submerged concrete gate sill with six roller-type crest gates and one tainter gate to control the discharge and maintain the navigation pool. Dam piers are of sufficient height to permit raising the gates above maximum high water.

3. Navigation Pool.

The normal elevation of the navigation pool created by the dam is 566.0 feet above mean sea level, and the pool extends 36.7 miles upstream to the Marmet Locks and Dam on the Kanawha River.

4. History.

Construction of the Winfield project was initiated in 1933 by Dravo Corporation and the original locks were placed in operation on 1 September 1937. The estimated cost of construction was 6.3 million dollars. The project was completed on 20 August 1937.

Phase I of construction of the additional lock and gate bay began in May 1990. Phase IIA of construction began in July 1993. Phase IIB began in August 1994. Phase I and IIA consisted primarily of site work while phase IIB consisted of the construction of the lock and gate bay. The additional lock and gate bay was placed in operation in January 1998.

CHAPTER 2 -REFERENCES

A. Introduction.

The material and information included in this manual are intended as an aid to the operation and maintenance of the Winfield Locks and Dam project. Information that is considered common knowledge to the project personnel, such as the operation of uncomplicated, frequently used equipment, is not included in detail. All operations are to be performed either by or under the supervision of trained personnel. Instructions covering every operating condition and situation cannot be included in a manual of this type, therefore, only the more common operating conditions and situations will be discussed.

B. Regulations.

The operation of this project will be conducted in accordance with the regulations prescribed by the Secretary of the Army for the Ohio River, Mississippi River above Cairo, Ill. and their tributaries; Use, Administration and Navigation. Huntington District Internal Operating Procedures for Navigation Structures supplement these policies. Navigation notices and instructions address particular situations and operating conditions.

C. Reference Material.

1. Design Drawings

A complete set of design drawings is available at the project. As-constructed drawings are available at the District Office in the Design Branch File Room as microfilms mounted on aperture cards.

2. Stored Engineering Data.

Engineering data relating to the project shall be collected and permanently stored in file facilities at the project. The data shall be for the use of authorized personnel only during inspections and emergencies. The data shall be considered as permanent and maintained throughout the life of the project. The Lockmaster shall annually inspect the file to determine that all data are available. The Lockmaster shall release the data only to authorized personnel. When the filed data is to be removed from the project, the responsible person shall be required to complete a hand receipt, ENG Form 3065.

D. Safety.

Safe operating procedures will be practiced at all times. Safety meetings will be held in accordance with procedures established in ORHOP Internal Operations Procedures letter dated 10 August 1972. All applicable provisions of EM 385-1-1 will be strictly adhered to both in day-to-day normal lock and dam operations and maintenance, and during major maintenance work.

E. Preventive Maintenance.

Maintenance will consist of a "Maintenance Control System," which will function as a preventive maintenance program and "Breakdown Maintenance," which will facilitate equipment repairs by use of the various manufacturer's brochures. A record of all equipment on the project and of all repairs will be kept as follows:

"Data Cards" are maintained for each piece of equipment to provide record of pertinent information, including a list and cost of available spare parts.

"Maintenance Inspection Record Cards" are maintained for recording information on the work accomplished for each item of equipment.

"Lubrication Forms" are established for each piece of equipment to show parts to be lubricated, type of lubricant used, service intervals, and employees responsible for lubricating the equipment.

"Maintenance and Repair Records" are maintained for anticipating future maintenance work and provides a basis for determining the performance record of the equipment.

CHAPTER 3 -DAM, EQUIPMENT AND FACILITIES

A. General.

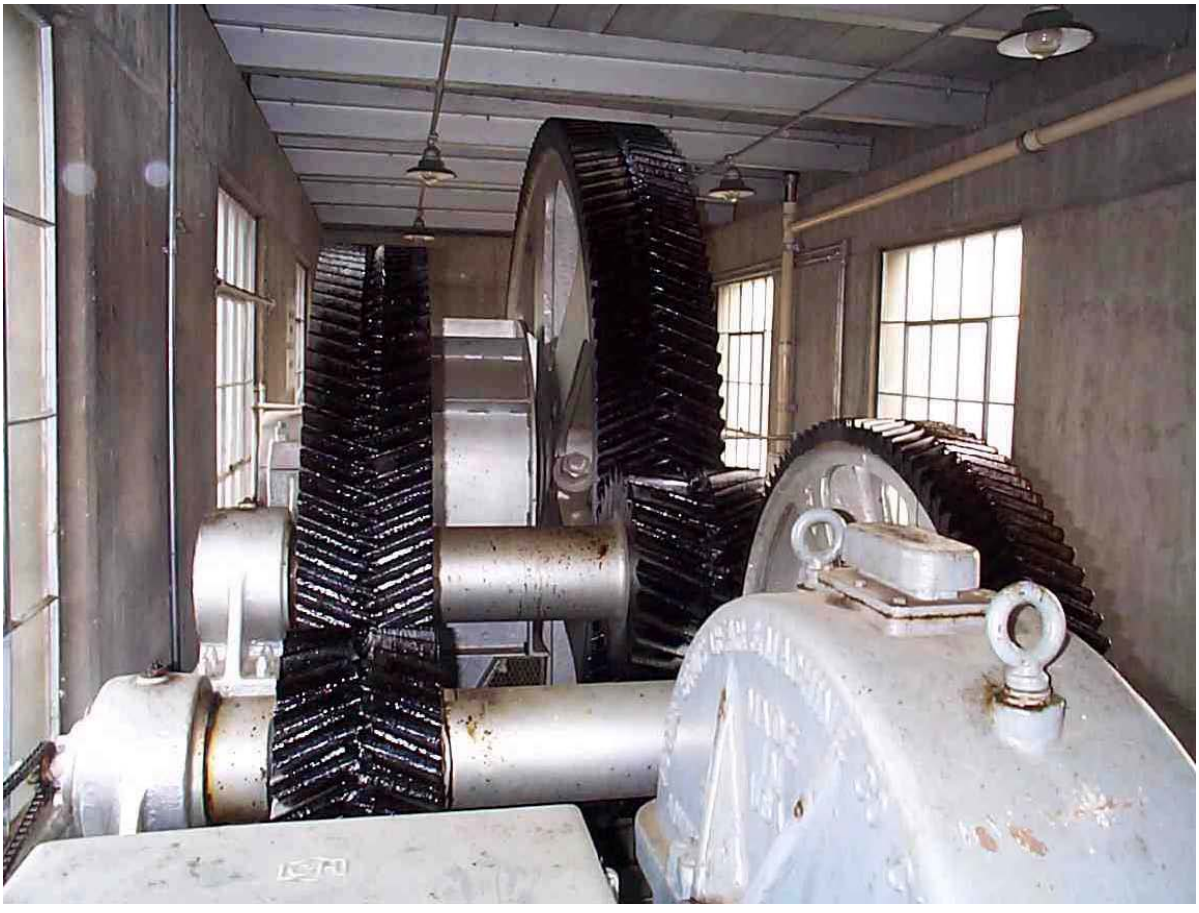
The Winfield Dam extends across the Kanawha River from the riverwall of the original locks to the hydro-electric power plant at the abutment of the dam, which is leased to the Kanawha Valley Power Co (American Electric Power). It consists of seven (7) concrete piers and six (6) steel roller gates. The concrete piers are joined at the top by a steel bridge for access to the operating houses and hoisting machinery on the tops of the piers. Each gate spans the 100-foot 31/2 inch distance between two piers and is supported between load bearing end frames around the perimeter of which are gear segments which operate on sloping tracks in the sides of the piers. The gates are raised and lowered by a hoisting chain. The height of the piers and the track length are sufficient to permit raising the gate clear of any anticipated flood. There are five standard roller gates and one flap type roller gate at Winfield Dam. At normal pool, a gate has sufficient depth to completely block the flow of water between two piers. To maintain a relatively constant pool from Winfield Locks and Dam to Marmet Locks and Dam, the gates are raised to allow water to escape between the gate and the sill. The constancy of the pool is maintained by regulating the sum of the gate openings. Hoist machinery for the gates is located in operating houses on top of the dam piers at the bridge level and is powered by electric motors. Individual controls for each gate are located inside the operating house for the respective gate.

B. Roller Gates.

The standard roller gate is approximately 108 feet long, 19 1/2 feet in diameter with a 6 1/2 foot apron section. The flap type gate is approximately 108 feet long, 14-1/2 feet in diameter and 26 feet high with the flap in the raised position. The flap on the flap-type gate is designed so that it can be lowered to a depth which permits flow at the normal upper pool over the gate. This feature facilitates the skimming of ice and debris from the surface of the upper pool. When the gates are in the lowered position, a seal on the bottom edge of the apron rests on a concrete sill. The gates are also sealed at the sides. The height of the gates is such that at normal upper pool the water level is at the elevation of the top of the gate (Elev. 566.0). The elevation of the gate sill is
540.0.

C. Gate Hoist Machinery.

The hoist for each gate is a flat link pitch chain, sprocket driven, with a drive unit on one side of the gate. The movement of the gate is driven from one end only so that the gate becomes, in effect, a large torque shaft. The drive units are located on the south end of each gate and consist of a 65 horsepower electric motor, brake, worm gear speed reducer, three stages of open gearing, sprocket chain, and chain storage rack.



1. (Roller) Gate Hoist Machinery.

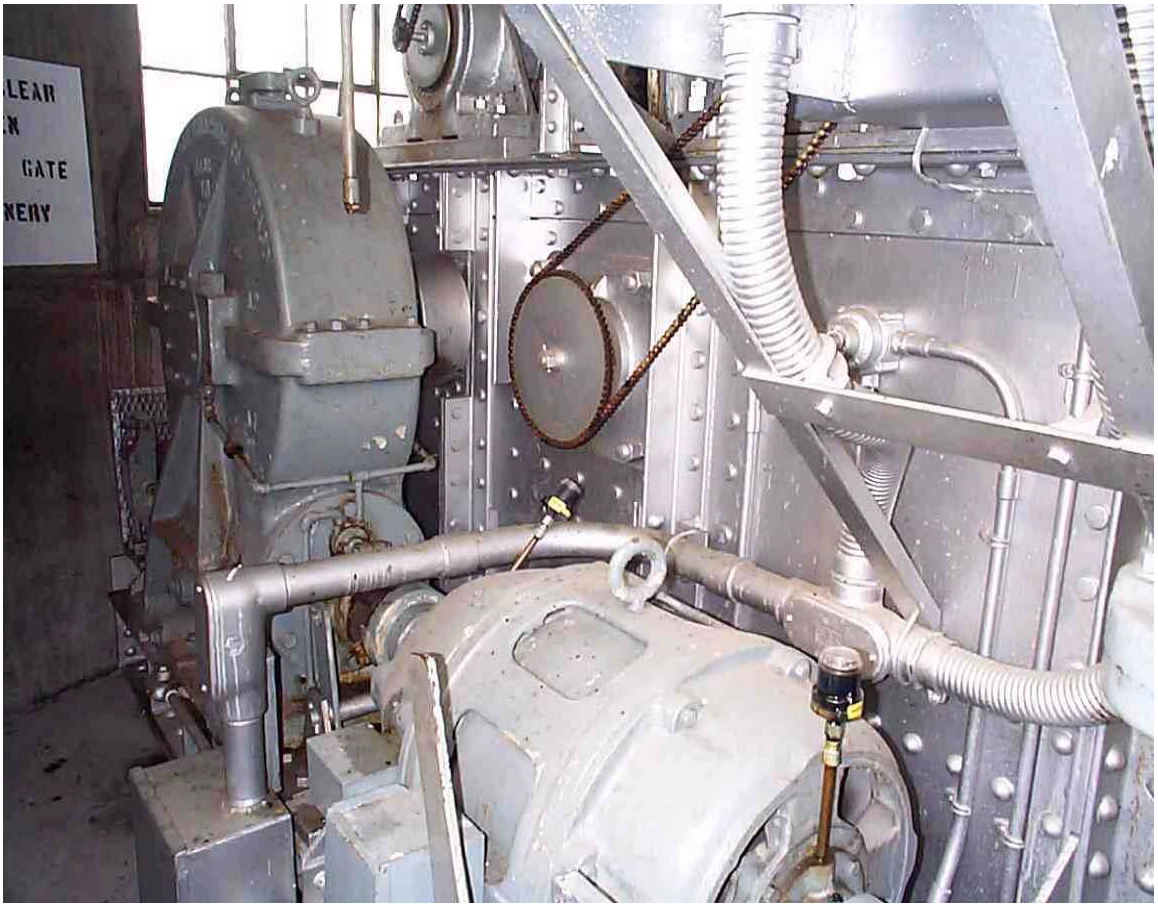
The hoist is an electric motor driven multiple gear reduction machine. Mechanical gear reduction is obtained through a combination of worm gear reducer and multiple open herringbone gear sets. A sprocket on the output shaft winds a chain on the roller. Additional mechanical advantage is obtained by the gear arrangement on each end of the roller riding on the rack embedded in each pier. The machine is fitted with a torque motor type drum brake on the worm gear reducer input shaft. The machine has position indication (local & remote) and limit switches to control motion at both intermediate and extreme points. There is a backup switch to stop the machine when the roller reaches the highest position.



Figure 3, Flap Gate Hoist Machinery

2. (Roller) Flap Gate Hoist Machinery.

The machine on Gate #6 is fitted with an additional hoist for raising the flap which is only on Gate #6. Both hoists are driven by the same electric motor which may be shifted between machines. Mechanical gear reduction is obtained through worm gear reducer and multiple open herringbone gear sets. This machine is fitted with a torque motor type drum brake on the on the worm gear reducer in put shaft. A wire rope drum on the output shaft both winds & unwinds the ropes and depending on direction of rotation either raises or lowers the flap.



3. Gate Hoist Controllers.

The gate hoist controllers are located inside the pierhouses and contain the electrical components necessary to accomplish normal gate operation. These cabinets are located at piers 2 through 7 for operation of gates 1 through 6 respectively. The controller is a multi-step, wound rotor motor controller utilizing timing relays to determine when switching occurs for the next step of external resistance. The resistors were selected to limit the maximum torque produced and the starting current drawn by the motor during starting and acceleration of the gate. The hoist motor is protected from overcurrent by two sets of overload sensing components. A current sensing relay may de-energize the control circuit instantaneously when the current drawn by the hoist motor is higher than it's trip setting. The controller also has a solid state, thermal overload relay that senses motor current and trips if the current drawn by the motor exceeds its trip setting. This overload relay provides inverse time type protection for the motor. If the overload relay is tripped, A MOTOR OVERLOAD light located on the door of the hoist controller will be energized. The controller includes a "Local-Remote" selector switch on the cabinet door to allow initiation of gate operations from the controller door (Local) or from remote stations located in the new lock Operations Building and the Maintenance Building. Local gate operations are made using pushbuttons located on the door of the hoist motor controller enclosure. A dial gage mounted on the gate hoist machinery indicates the amount of gate opening (vertical height above the sill) in feet. When operating the gate from one of the two remote locations, it is necessary that the "LOCAL-REMOTE" selector switch be placed in the "REMOTE" position and that THE "INCREMENTAL BYPASS" switch be placed in the "BYPASS" position. Gate opening in feet and other gate status is displayed at the two remote locations. Gate position for use in the remote control system is sensed by a transducer that is mounted on the hoist machinery

frame and driven by the original gate position dial indicator. See Chapter 9 Project Controls, for details on operating the gates from the new lock Operations Building and the Maintenance Building.

4. Power to Gate Hoist Controllers.

480 volt, 3 phase power is provided to each pier from the dam Operations Building motor control center commercial service through two 480 volt, 3 phase, 3/C #1/0 AWG feeders tapped from two, 3 phase 3/C#400 kcmil dam service feeders.

D. Gate Operating Procedure for Gates Nos. 1 through 5.

1. Raise Gates.

Energize the control panel by throwing the main switch to “ON” position. Press the “Raise” pushbutton. The gate will rise to its extreme upward or maintenance position without interruption. The gate movement may be stopped at any position by pressing the “STOP” pushbutton on the door of the hoist controller. The dial indicator is driven by a chain to the main gear shaft, which allows visual indication of the gate opening while operating the gate from the pierhouse.

2. Close Gates.

From any position two feet or more above the sill, the gate can be closed by pressing the “LOWER” pushbutton which will cause the gate to lower continuously to the limit switch which will stop the gate at 6 inches open. The circuit is re-energized by pressing the “BYPASS” switch. The “LOWER” button must be pressed again to lower the gate to the sill, at which time the stop limit switch will de-energize the control circuit, stop the motor and set the brake. From any position lower than two feet above the sill, it is necessary to raise the gate until it is above two and one-half feet open, then stop the gate and press the “LOWER” pushbutton which will cause the gate to lower until it reaches the stop limit switch. It can be returned to the sill as already described above in this par.

E. Operating Procedure for Flap-Type Gate.

1. Equipment.

Operating equipment is similar to that for the standard gates except that the gate cannot be raised above five feet with the flap in the raised position, except by use of a by-pass circuit whose pushbutton is located on the gate hoist controller door. In addition, a different set of resistors is used in the motor rotor circuit so that the motor speed is slower when operating the flap gate. To operate the flap gate, the operator must move the motor shaft to connect it to the flap hoist machinery. Electrical interlocks require the operator to also select the appropriate set of resistance for the rotor circuit before the control circuit can be energized. The resistance is selected by toggling a 200A, 3pole, double throw switch to the appropriate position ("FLAP").

2. Raise.

From any gate position between closed and five feet, with the flap in the raised position, pressing the "RAISE" pushbutton will cause the gate to rise to the five feet position, where the limit switch will de-energize the circuit, stop the motor and set the brake. The gate should not be raised higher until the flap is lowered.

3. Flap Operating Mechanism.

The flap operating mechanism consists of a worm gear that can be connected to the main hoist motor and a 1-1/2" steel wire cable. This cable extends from the main hoist shaft down through the floor of the pierhouse to a torque tube that is attached to the flap by arms.

a. Raise.

Disconnect motor drive from the gate worm gear and connect to the flap worm gear. Change the resistor switch to the flap position and press the "RAISE" pushbutton. This will cause the flap to raise to the extreme position if the gate is less than five feet above the sill.

b. Lower.

To lower the flap, follow the procedure outlined above except press the "LOWER" pushbutton

F. Gate Operation.

1. Normal Operation.

The roller crest gates are operated to pass the flows in the river and maintain a dependable navigation pool from Winfield Locks and Dam upstream to Marmet Locks. As inflow from upstream fluctuates, the dam is operated to maintain uniform openings on all six gates insofar as practicable in order to equalize discharge across the full width of the dam. Normal upper pool elevation is 566.0 feet above mean sea level, which corresponds to 18.0 feet on the upper gage. Zero of the upper gage is elevation 548.0 feet. Normal lower pool (R.C. Byrd upper pool) elevation is 538.0 feet which is a lower gage reading of 9.0 feet with zero of the lower gage at elevation 529.0 feet.

2. Pool Fluctuation.

Dam operations should be held to a minimum by allowing the pool to fluctuate to a predetermined amount, however, flows should not be allowed to pass over the gates unless directed by the Area Chief or the District Office. The allowable pool fluctuation at Winfield will be dependent on the flow in the river. At extreme low flows the pool fluctuation will be as directed by the District Office. At normal low flows the allowable fluctuation is from 0.2 foot above to 0.2 foot below normal pool elevations. With increasing or high flows the allowable fluctuation is
1.0 foot above to 0.5 foot below normal pool elevations.

3. Gate Operation Schedule.

Start with the tainter gate and continue in the sequence established in Table 1.

4. Flood Operation.

On a rising river, when opening on each gate is 16 feet, more or less, with the total gate opening of about 112 feet, flow in the river will have increased to a point that additional gate operation will not be required to maintain a stage of 18 feet on the upper gage. This occurs at a lower gage reading of approximately
35.5 feet. At this point all gates will be raised to the maximum position. After the crest has passed and continued falling stages are forecast, lower gates in reverse sequence in gate operation schedule in Table 1 to approximate water surface elevation of 18.5 feet on the upper pool gage. The lower pool gage reading will be approximately 36.0 feet. As flows continue to decrease, adjust the gates as required to maintain an upper pool gage reading of 18.0 feet.

5. Skimming Operation.

The removal of floating debris and ice from the surface of the upper pool is accomplished by the operation of the flap gate. The amount of submergence of the flap will be determined on the basis of existing conditions including extent of accumulation and amount of flow. Normally, standard gates will be closed until flow is directed to the flap to facilitate the movement of debris or ice to the flap gate. Skimming should be scheduled to prevent any build-up of debris and ice. Observe the operation closely to detect unusual conditions that require immediate attention.

Table 1: Gate Operation Schedule - Winfield Locks and Dam *Gates to be opened by following alphabetical sequence (Reverse order to close)

GATE NO.	TAINTER	1	2	3	4	5	6	TOTAL OPENING

G. Electrical System-Dam.

GATE NO.	TAINTER	1	2	3	4	5	6	TOTAL OPENG
SEQUENCE *	F	G	D	A	B	C	E	(FEE
1							1	
1			1				2	
1			2				3	
1			2	1			4	
1			2	2			5	
1			2	2	1		6	
1			2	2	2		7	
1		1	2	2	2		8	
1		2	2	2	2		9	
1		2	2	2	2	1	10	
1		2	2	2	2	2	11	
1	1	2	2	2	2	2	12	
2	1	2	2	2	2	2	13	
2	2	2	2	2	2	2	14	
3	3	3	3	3	3	3	21	
4	4	4	4	4	4	4	28	
5	5	5	5	5	5	5	35	
6	6	6	6	6	6	6	42	
8	8	8	8	8	8	8	56	
10	10	10	10	10	10	10	70	
12	12	12	12	12	12	12	84	
14	14	14	14	14	14	14	98	

1. Power Source.

The motor control center in the dam Operations Building contains circuit breakers labeled “Dam Feeder No. 1” “Dam Feeder No. 2” “Reserve Power”, and “Dam Lighting Primary.” The Dam Lighting Primary” circuit supplies 480-volt, single phase power to a transformer in pier no. 4 for 120/240 volt lighting on the dam. The Dam Feeders supply 480-volt, 3-phase power to the dam through three circuits, each consisting of 3/C 400 kcmil conductors. Dam Feeder No. 1 extends to piers 2, 3 and 4 only. Dam Feeder No. 2 extends the length of the dam and enters control cabinets in piers Nos. 5, 6 and 7. The Dam Emergency Feeder extends the length of the dam and enters controller cabinets in piers 2 through 7 inclusive.

2. Lighting Circuits.

The two conductor lighting cable, enclosed in a 1-½ inch conduit, emerges in pier no. 4, at a 15 KVA 480 to 240/120-volt transformer. The transformer secondary is connected to a 2-pole 60 ampere service switch which feeds 120/240 volt lighting service to the dam lighting panels in each pier house. Each roller gate is provided with a flood light over the driven end and receptacles on the upstream side of the pier.

6. Grounding System.

A single bare copper ground conductor, connected to a grounding plate in the base of piers Nos. 1 and 7, extends along the service bridge. All electrical equipment, lighting standards, and metal structural parts are connected to the main grounding bus by smaller, individual ground wires.

H. Upstream Bulkheads.

Winfield Dam is equipped with 6 aluminum alloy, interchangeable bulkheads for use on the upstream side of the gates. Each bulkhead is approximately 100 feet long, 4 feet high and 11 feet wide and is provided with four roller guides at each end. The rollers ride in vertical slots in the pier walls and provide alignment as well as load bearing support. The bulkheads are so designed that a minor caulking operation is required to give a watertight barrier to completely block off one gate on the upstream side. When not in use, each bulkhead section is stored at the bulkhead storage bay provided back of the upper guide wall. The sections are raised from their stored position back of the guide wall, loaded on a barge, moved to the closure site, and raised or lowered in the bulkhead recesses by means of a derrick boat.

CHAPTER 4 -Lock Operations Building

A. General.

The Lock Operations Building is a three story pre-cast concrete structure located adjacent to the land wall at monoliths L-21, L-22, and L-23. The building is approximately 78 feet long, 47 feet wide, and 53 feet high. The first floor is at elevation 573.7, the second floor at elevation 587.2, and the third floor at 600.7. The first floor includes a maintenance, crew, and visitor area. The second floor includes office areas. The third floor includes conference, control, break, and equipment rooms. Equipment in the building includes closed circuit television (CCTV) system equipment, programmable logic controller (PLC) equipment, lock machinery controls, and radio communications equipment.



Figure 5, Operations Building

B. Electrical Equipment.

1. Control Console. See Chapter 9, “Project Controls”, for a description of the Control Console.

2. Lighting and Power Panels.

Lights and receptacles for the first and second floor are fed from panel “H” which is located in the supply room on the second floor. Panel “H” is a 208/120V, 3 phase, 4 wire lighting panel. Lights and receptacles for the third floor are fed from panel “G” which is located in the equipment room on the third floor. Panel “H” is a 208/120V, 3 phase, 4 wire lighting panel. Heat pumps, auxiliary heat, unit heaters, lighting transformer, and the elevator motor are fed from panel “F”. Panel “F” is a 480V, 3 phase, 3 wire power panel, located in the equipment room on the third floor.

3. Intercom System.

The intercom system consists of four master and four slave units. The master units monitor all stations and are capable of selecting which stations receive input from the master unit. The slave units automatically receive input and give output to the master units. The master unit is located on the secretary’s desk, on the lock operator’s desk, and the exterior of both HPU stations. The slave units are located at the visitor’s gate, the delivery gate, the upstream river wall at the nose cell, and the downstream river wall at R-1.

C. Miscellaneous Equipment.

1. Heating and Air Conditioning System.

The building heating and air conditioning system is zoned with a split system Trane heat pump serving each floor. The outdoor units are located on the roof. The air handlers are centrally located in interior rooms. Ductwork extends from the air handlers to the conditioned spaces. Temperature is controlled by wall-mounted thermostats. The three heat pumps separate the building into three zones which are independently controlled. The outdoor units of each heat pump are located on the roof of the Operations Building. The indoor units are located in mechanical rooms on each floor.

2. Communication Service.

The lockmaster's office located in the Operation Building is equipped with the usual telephone service, a two channel FM radio transmitter and receiver for boat and Government traffic, and two-way FM radio equipment assigned to the District network.

a. FM Radio.

The frequency modulated equipment forms a part of the District network which permits direct radio communication with the District Office and with other lock offices. The station call at Winfield L&D is WUE 493.

b. Channel 13 and 14.

Channels 13 and 14 on the FM radio for boat traffic are used for communications between boat pilots and the lockmaster. Initial contact is made on channel 13. For extended conversation channel 14 is used.

c. Channel 16.

Channel 16 is reserved as a Coast Guard emergency channel. No extended conversation is allowed on this channel.

4. Visitor's Gate and Handicap Lift.

Upon notification via the intercom that a visitor desires entry through the visitor's gate, the gate can be opened at the visitor's gate and lift pushbutton station in the control room of the Operations Building. The gate can also be closed and stopped from the local pushbutton station. If a visitor requires the use of the handicap lift for transportation from the parking lot level to the Operations Building level, the lift should be turned on at the visitor's gate and lift pushbutton station. The lift should be left on until the handicap visitor leaves the project. In order to prevent accidental injuries, the handicap lift should only be used with supervision from lock personnel.

CHAPTER 5 -Maintenance Building

A. General.

The Maintenance Building is a single story split block structure located in the maintenance area. The first floor is at elevation 585.5. A basement with floor at elevation 576.67 is located under part of the compressor room. The building includes a workshop with a 2 ton jib crane, a garage, crew area, tool and paint storage rooms, and the compressor room. The compressor room contains two air compressors, the emergency generator, and motor control center 1 (MCC1). The crew room features CCTV and dam gate control equipment. The dam gate control equipment consists of a keypad display module for status information and pushbutton controls for control of the dam gates. The display is the fluorescent scrolling type and includes the position of each of the seven (7) gates and upper and lower gages. See the remote control operating manual for instructions in making dam gate operations from the Maintenance Building.



Figure 6, Maintenance Building

B. Electrical Equipment.

1. Motor Control Center 1.

Motor Control Center 1 is located in the Compressor Room of the Maintenance Building.

a. Automatic Transfer Switch.

The automatic transfer switch (ATS) senses interruption in commercial power, starts the standby generator set and provides emergency power automatically. When commercial power is restored, the ATS will retransfer the load to the commercial power source and stop the generator set, after cool-down, automatically. The ATS is manufactured by Kohler, Model M340, and is microprocessor controlled. Time delays and other settings are adjustable from the keypad and display on the front of the unit. The display also includes a voltmeter, running time meter, and frequency meter. For detailed instructions on settings and operation the operation and maintenance manual for the ATS should be consulted.

2. Diesel Standby Unit.

a. Description.

The diesel engine standby unit is located in the compressor room of the Maintenance Building. The unit is manufactured by Kohler, Model 400ROZD. The generator is rated to provide 400 kW (601 amps) at 0.8 PF, 1800 rpm during the outage (standby rating) or 364kw (547 amps) at 0.8 PF at 1800 rpm continuously (prime power rating). Upon failure of commercial power, the generator set will provide adequate power to operate the electrical equipment under certain restricted emergency conditions.

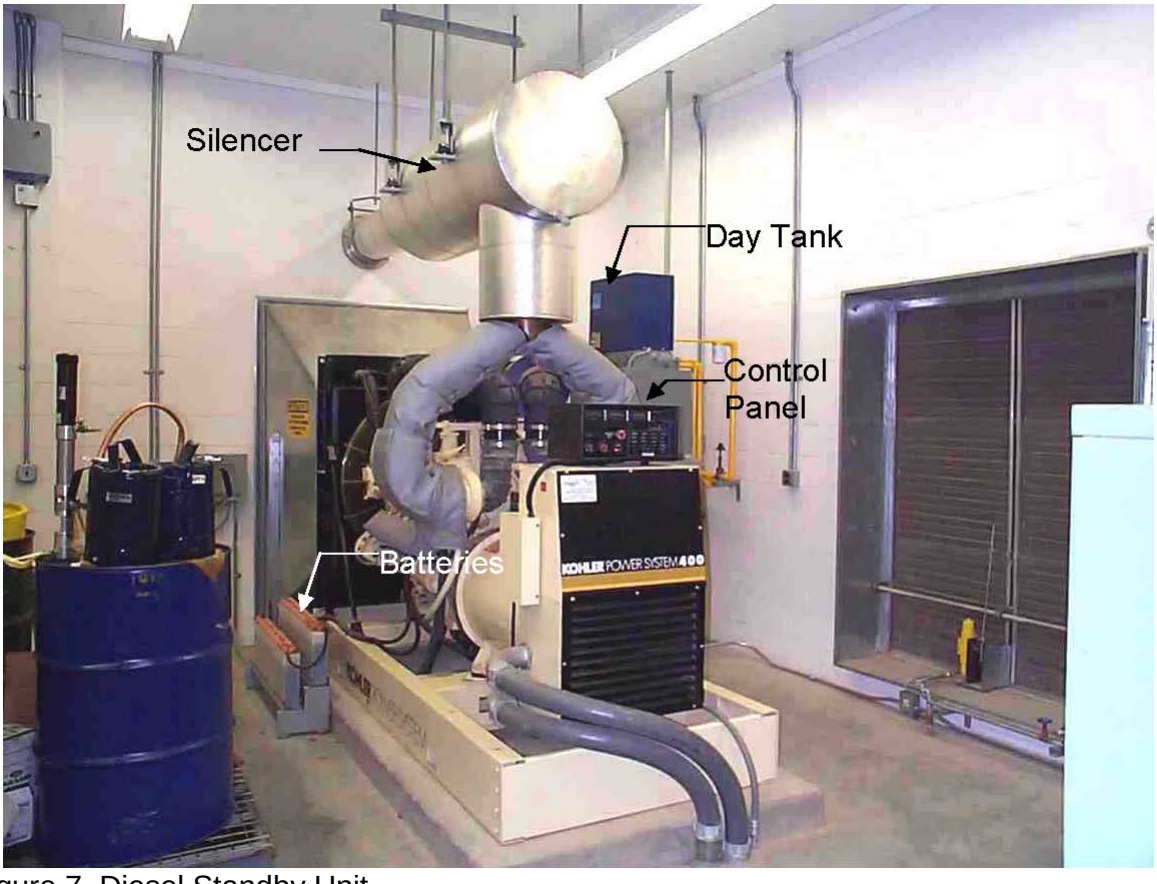


Figure 7, Diesel Standby Unit

b. Starting and Loading Generator Set.

The unit should be cycled under load once a month.

1) Switch the commercial power breaker to the "OFF" position. The generator should start in 35 seconds.

2) Allow the generator to run under load for a minimum of 30 minutes.

3) Turn commercial power breaker to the "ON" position. This will allow the transfer switch to switch back to commercial power after the gen-set has run at least 30 minutes.

4) A retransfer delay bypass switch will transfer the connection of the ATS back to commercial power immediately. The generator will continue to run unloaded for five minutes then shut down. This feature should only be used in an emergency.

c. Scheduled Maintenance For Generator Set.

Scheduled maintenance should be performed in accordance with maintenance manuals included with the unit.

C. Miscellaneous Equipment.

1. Air System.

The compressed air system consists essentially of two motor driven air compressors located in the compressor room in the Maintenance Building. One of the compressors is continuously on-line in order to provide compressed air as needed. The other compressor serves as a backup compressor. In order to equalize running hours, the lead compressor should be switched weekly using the lead/lag switch, located on the wall between the two compressors. A 2-inch pipe line extends from the Maintenance Building to L-29 on the new lock. Air receivers are located in the compressor room of the Maintenance Building and in both Hydraulic Power Unit Stations. One-inch lines are provided for flushing of ice and drift from miter gate, emergency gate, and floating mooring bitt recesses. The air at the miter gates can be directed to the recess, pintle and miter point. Each is controlled by a separate solenoid valve which is controlled from the miter gate control panel. Manual valves in the pipe trenches control the air to the floating mooring bitts. Manual valves in the upstream crossover control the air to the emergency gate. A capped one inch line extends service to



the maintenance area on the first floor of the Operations Buildings.

Figure 8, Air Compressors

a. Air compressor.

The two air compressors are single stage rotary screw, oil cooled, electric motor driven Sullair Model LS 16-60L. They have a capacity of 300 cubic feet per minute at 100 pounds per square inch. The compressors are powered by a 3-phase, 460-volt, 60 horsepower motor and is equipped for manual or automatic operation. Normally, the compressor remains on automatic control mode. In the event of a power failure it will be necessary to reset the air compressor. See the air compressor O&M manual for this procedure.

1. Heating and Air Conditioning System.

The building heating and air conditioning system consists of a split system Trane heat pump with outdoor unit and air handler in the interior mechanical room. Associated ductwork is located in the crew area and restrooms. Temperature is controlled by wall mounted thermostats. The Workshop, Garage, and Compressor room are heated with electric unit heaters and controlled by wall mounted thermostats.

CHAPTER 6 -Lock Equipment And Facilities

A. General.

Three lock chambers are available at Winfield. The additional lock chamber is 800 feet long by 110 feet wide and is located landward of the original locks and additional gate bay. The original two locks, which are 56 feet wide by 360 feet long, now serve as auxiliary locks. The new river wall is approximately 1360 feet long and has guard wall extensions of 825 feet upstream and 827 feet downstream. The new land wall is approximately 1578 feet long. The original land wall is 572 feet long and has guide wall extensions of 486 feet downstream and 511 feet upstream. The original river wall is 572 feet in length with guard wall extensions of 350 feet upstream and 350 feet downstream. The top of the new lock wall is at elevation 573.0. The old lock wall is at elevation 571.0.

B. Additional Lock Equipment.

1. Culverts.

All lock walls have culverts through which water flows into the lock chambers from the upstream pool when the filling valves are open. The water flows from the lock chamber into the lower pool when the emptying valves are open. The level of the water in the lock chamber is controlled by operation of the culvert valves.

2. Culvert Intakes.

The culvert intake manifolds are located inside the land and river walls upstream of the miter gates. Removable trash screens are mounted in front of each manifold opening

3. Culvert Valves.

The new lock is serviced by four valves (2 filling and 2 emptying). Two culverts (one in the river wall and one in the land wall) are used to fill the lock chamber through the filling valves and empty it through the emptying valves. Each valve is the reverse tainter type, hinged on trunnion mounts and installed in the culverts in such a position that, when closed, the flow of water into (or out of) the lock chamber is completely blocked. Force to raise the valve is applied through a system of connecting cables joined to a hydraulic piston cylinder. A four way directional valve selects the flow of oil into either the head or rod end of the cylinder, thereby raising or lower the valve. The weight of the valve lowers itself, controlled by a counterbalance valve.

a. Culvert Bulkheads.

Four culvert bulkheads are provided for use in dewatering the culvert valve recesses. The bulkheads are stored by suspending them with hooks on the bulkheads from pins embedded in the top of the bulkhead recess. When the culvert valve recess is to be dewatered the bulkhead is raised, the hooks are retracted, and the bulkhead is lowered to the culvert. The bulkheads are furnished with small sluice gates for equalizing the hydrostatic pressure on both sides of the bulkhead when rewatering the recess. The sluice gate is operated by attaching a wire rope to the lifting bar on the bulkhead and lifting the sluice gate.

4. Culvert Valve Machinery & Control Manifold.

The culvert valve machinery is a wire rope hoist powered by a hydraulic cylinder. The cylinders action is in the horizontal plane. The hydraulic cylinder piston rod is connected to a multiple wire rope single part line which passes over a multiple groove sheave and is connected to the center of the culvert valve. The sheave is anchored to the lockwall. The lifting action is vertical. The connection between the piston rod end and the wire ropes is a universal joint incorporated in a sliding crosshead. The crosshead rides on a rail which supports the piston rod and crosshead in the horizontal plane. The valve closes under its own weight when hydraulic pressure overpowers the counterbalance valve and the cylinder pays out the rope.

Directional control of the cylinder on the culvert valve machinery is changed by electrical signals to the solenoid valves on the manifold. A change in direction is obtained by energizing a solenoid on the pilot valve, which in turn applies oil pressure or drains the pilot ports on the cartridge valves. There are four cartridge valves controlling the direction. Closing two valves and opening two valves allows oil to flow to and from the cylinder ports and it moves in one direction with return oil leaving the other cylinder port passing through the manifold to the return line; by reversing which ports are pressurized and which are vented then the cylinder may be reversed. A counterbalance valve is used in the rod end of the circuit to hold the hanging load of the tainter valve. In raising the oil flow freely to the rod end of the cylinder. In lowering flow from the cylinder is blocked until its pressure setting is exceeded by pressure produced by applying pressure to the head end of the piston. The speed of the culvert valve is limited by adjustment of the flow restrictors on the manifold.

5. Operation of Culvert Valve.

To operate any culvert valve start both pumps in the hydraulic power unit which services the valve desired to be operated. Hydraulic pressure (1750 psi) is available to operate the culvert valves in the lock walls. The position of the four-way hydraulic valve determines the direction of oil flow applying pressure against the piston of the culvert valve operating cylinder. The position of the valve is selected from the Culvert Valve Control screen on the control console in the Operations Building or at the backup control stations. The culvert valve now starts to open or close. Movement of the valve can be stopped at any time by pushing the stop button, thus cutting off all hydraulic pressure to the hydraulic cylinder. The culvert valves are equipped with two position indicators. One consists of a rod extending vertically through the walkway grating. The height of the indicator rod above the grating provides a visual indication of the valve opening. The other position indicator consists of timing pulleys and timing belt which drive a transmitter whose output (4-20mA) corresponds to the position of the culvert valve. The position is displayed on the various screens of the control console and ranges from 0% to 100% open.

6. Miter Gates.

The lock has two miter gates, one at each end. Each gate consists of two leaves hinged on each side of the lock chamber. Each gate leaf is approximately 61 feet 9 inches long, 53 feet high, and weighs about 200 tons. Because the total gate length exceeds the width of the lock chamber, the closed gate leaves form a miter angle against the flow of water. A head of water on the upstream side of the gates holds the gates in the closed position. These gates move from a mitered or closed position into wall recesses when completely open. The gates are always opened or closed in equalized pools. Each miter leaf is hinged on a gudgeon pin and socket assembly securely anchored in the lock wall.

7. Miter Gate Machinery and Control Manifold.

The machine used to open and close the miter gate consists of a double acting hydraulic cylinder connected at both ends. The barrel is connected to the lockwall and the rod is connected to the miter gate. Both connections are fully articulated. As the cylinder extends the miter gate moves from recess to miter. Speed is automatically controlled when the cylinder is extending to slow the gate as it comes into miter or when retracting to slow the gate as it comes into recess. The hydraulic cylinders, located in machinery recesses in the top of the lockwalls at each gate leaf, are the same for all gates.

Directional and speed control of the cylinder on the miter gate machinery is varied by electrical signals to the solenoid valves on the manifold. A change in direction is obtained by energizing a solenoid on the pilot valve, which in turn either applies oil pressure or drains the pilot port on the cartridge valves.

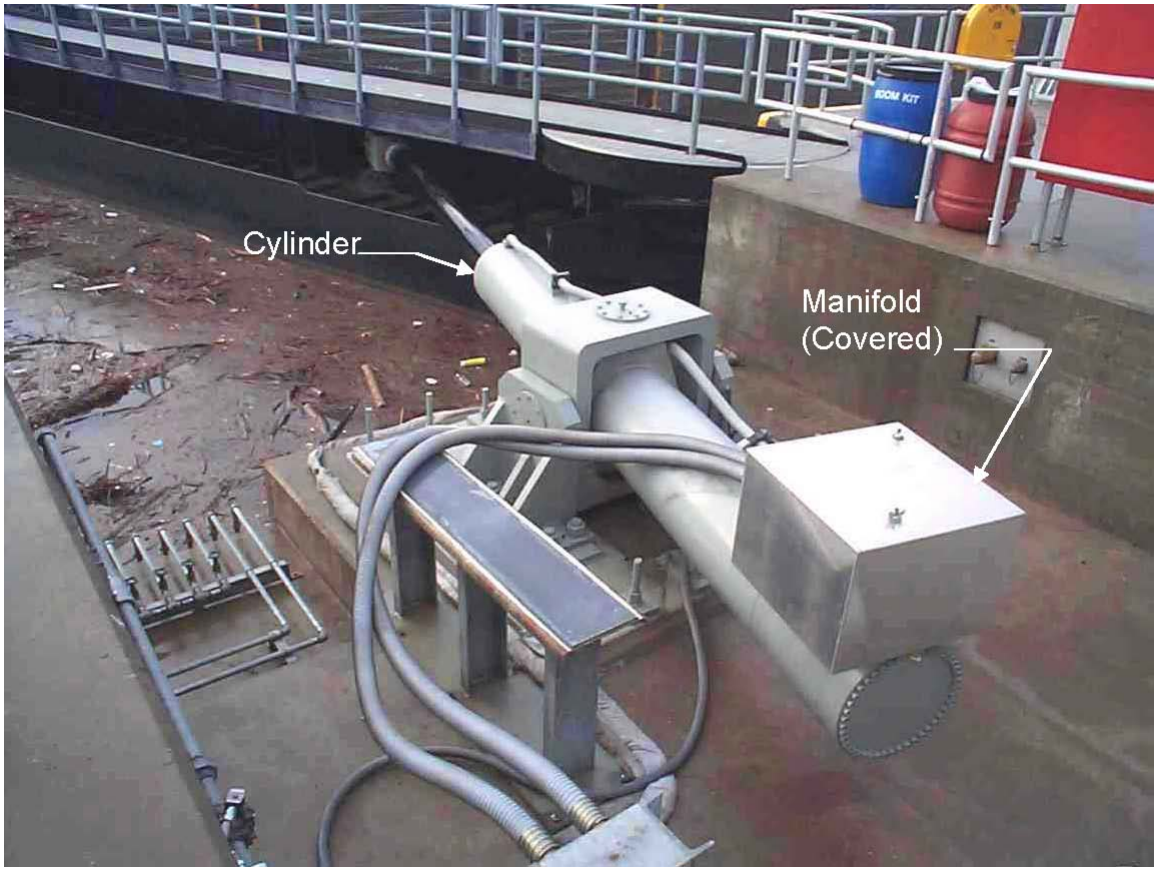
Applying pressure to the pilot port closes the cartridge valve, and venting the port permits the valve to open.

There are four cartridge valves controlling the direction. Closing two and opening two valves allows oil to flow to and from the cylinder ports and it moves in one direction with return flow leaving the other cylinder port passing through the manifold to the return line; by reversing which ports are pressurized and which are vented then the cylinder direction may be reversed. Pressurizing all pilot ports closes all cartridge valves, stops the oil flow and holds the cylinder.

The oil flow or speed of the machine is varied by a throttle valve. The position of the spool is electrically measured and compared to strength of the electrical signal calling for flow, the spool is then automatically adjusted to that proportion. The proportion of maximum signal varies the flow accordingly.

Should the machine be overpowered by external forces, while in motion, the cross-over pressure relief circuit will limit the forces to those for which the machine was designed. This circuit is built into the manifold with a relief valve on each port and a check valve to avoid starving the other end of the cylinder. Pressure relief valves are set at 1650 psi.

Also, built into the manifold is a high pressure relief which is actuated when the gate reaches miter. The design calls for holding against a “temporal head” of 1.25 feet (equivalent of 3,200. psi. in terms of relief pressure) and this circuit carries out that function. When the solenoid on the relief valve is de-energized the oil flows freely through



the cartridge valve.

Figure 9, Miter Gate Machinery

a. Operation.

The operation of the miter gates is controlled from the miter gate control screens on the control console in the Operations Building. Movement of the gate leaves is achieved by actuating “pushbuttons” to open, close, or stop the leaves. A “Normal” or “Slow” pushbutton can be actuated to select the speed of operation. Actuation of the pushbuttons operate a 4-way flow directional valve and a proportional flow control valve to direct and throttle the flow of hydraulic oil to each miter leaf operating cylinder to either open or close the leaf at the speed desired. The speed and direction of the miter gates can also be controlled from the backup control stations.

b. Relief Valve.

To minimize external shock on the machinery at positions other than miter, a cross-over relief system has been included. The relief valves are set to open at 1350 p.s.i on the head end of the cylinder and at 2000 p.s.i. on the rod end of the cylinder.

c. Temporal Relief Valve.

A relief valve, activated only at miter and when the PLC system is operational, is included to resist a temporal head of at most 1.25 feet downstream of the gates. This relief valve is set at 3250 p.s.i.

8. Miter Gate Latching Devices.

Each miter gate leaf is equipped with a latching device that prevents the leaf from moving when in the recessed position. The latches are located on the upper and lower portion of each gate leaf near the miter end. With the gate in the recessed position the latching rods can be extended through the latch. Hydraulic cylinders, located on the lock wall, are used to extend and retract the latching rods. These are controlled by actuating “push-buttons” on the miter gate control screen on the control console or from selector switches on the backup control stations.



Figure 10, Miter Gate Latching Devices

9. Lock Hydraulic Power System.

Separate hydraulic power units serve the upstream and downstream of the lock. Half of the distribution piping serves the upstream end of the lock and the downstream end of the lock is served by the balance of the piping. The distribution piping consists of a “pressure” line and a ”tank” line. Each line has a plug valve (normally closed) which separates the upstream portion of the piping from the downstream portion of the piping. The system is dedicated to the operation of the miter gate machinery, miter gate latches and operation of the culvert valve machinery. In each case branch lines draw the power to operate the individual machine. One power unit located on the landwall at monolith L-6 and the other is at monolith L-30. Each unit has two pumps. Each pump is capable of delivering a maximum of 110 gallons per minute of oil and has a maximum pressure of 2000 psi. Each pump is sufficient capacity to operate the entire lock but at a reduced speed. Each pump is electric motor driven, pressure compensated, and horsepower limiting. The unit includes relief valves, check valves, shut-off valves, supply and return piping, reservoir accessories, a thermostatically controlled heater, high temperature thermostat, filter system, low level switches, filling and draining provision and electrical controls. The relief valves are set at 2100 psi. The pump pressure compensator is set at 2000 psi and the torque limiter is set to limit input horsepower to a maximum of 75 hp. The reservoir capacity is 700 gallons. Float switches are included to indicate when oil should be added and to shut the unit down if oil drops below a certain level. The upstream or downstream service pumps are started at the beginning of a lockage and run continuously until all operations on that end of the lock are completed for that lockage. A 1/3 HP pump is included to recirculate the oil through a filter with an electrical clogging indicator. The pump is set on a timer and it is recommended that it be run 20 minutes of every hour,approximately 8 hours per day. Samples of oil should be taken quarterly to determine if this level of filtering is sufficient.

Figure 11, Hydraulic Power Unit

a. Plug Valves.

Two four inch plug valves are located in the pressure and tank lines at monolith L-11. These valves are normally closed but can be opened to enable operation of the entire lock hydraulic system from one power unit. The valves require periodic lubrication and application of sealant. A maintenance interval and procedure should be established based on recommendations in the manufacturer's maintenance manual.

a. HPU Control.



Red pilot lights are mounted on the control panel at each power unit. The pilot lights are illuminated when the pump motors are in operation. Pilot lights are also included for “Add Oil”, “Low Oil Level”, “High Oil Temperature”, “Oil Heater On”, and “Filter Bypass”. Each pump is started or stopped by push-buttons. The pumps are normally started from the miter gate and culvert valve control screens on the control console in the Operations Building. The status screen on the control console indicates if additional oil is required in the reservoir, if the filter is bypassed, the operational status of the oil heater or if there is high oil temperature. The pumps can also be started from selector switches on the backup control stations.

10. Backup Control Stations.

Backup control stations are mounted on handrail downstream at monolith L-8 and upstream at monolith L-28. The backup control stations contain selector switches and indicators for the miter gate latches and HPU pumps, selector switch control for the culvert valves and a pushbutton for the discharge warning siren (downstream station only). Control of the miter gates is accomplished with joysticks. The backup control stations bypass the PLC system and are to be used when there is a problem in the PLC system or weather conditions require local control. If the backup control stations are not in use, they should be unplugged, removed, and stored.



11. Procedure for Lockage.

a. Normal Operating Conditions.

All operations for locking under normal conditions are accomplished from the control console in the control room on the third floor of the Operations Building. Backup control stations located on the land wall are for emergency use.

b. Flood Conditions.

When the river stage reaches a lower gage reading of about 39.6 feet (Elev. 568.6) it is no longer feasible to operate the locks. When it becomes apparent that the water will rise above the top of the lock walls the Lockmaster will implement the High Water Emergency Plan (Chapter 11, paragraph D) in order to prevent damage to any lock equipment.

c. Air whistle.

The air whistle is located on the roof of Emergency Gate Hoist Structure. This signaling device is controlled from the miter gate control screen on the control console located in the control room of the Operations Building.

d. Locking.

UP BOUND LOCKAGE

FROM OPERATIONS BUILDING CONTROL ROOM

1. BOAT CALLS IN (Either by Radio or by pulling the chain which activates the small craft horn on the Operations Building)

Pass dam conditions and gages
Get data for log book
Tell boat status of locking and position in queue
Remind boat the main chamber is the landward lock

1 Start Hydraulic Power Unit- Use both pumps
2 Turn Lower Approach Amber Traffic Signal Light on to Indicate Lock Preparation
3 Start Both Empty Valves Opening - Do not stop (Let them operate automatically to provide overempty control
4 Start Miter Gate Air if needed
5 Preset the Green Signal Light to activate when Miter Gates are open
6 Unlatch Miter Gate Latches (Status Indicates Unlatched)
7 Select Both Miter Gate Leaves for Operation
8 Select Normal Miter Gate Speed Range
9 When Pool is down (Lower Pool - Lock Chamber Differential Indicates 0), Open Miter Gate leaves until the miter gate leaves are fully recessed
10 Operate the miter gate latches (Status Indicates Latched)
11 Turn Miter Gate Air Off
12 Give Whistle Signal to Enter (New Lock is Two (2) Long Blasts)
13 Watch Entrance of Tow into Lock (Speed of 100 fpm)
14 Turn Point Air On
15 Unlatch and Close Lower Miter Gate when Tow is tied off and wheels stopped (Miter Gate Indicated Fully Closed)
16 Close Empty Valves
17 Start Fill Valves Opening - Do not stop
18 Turn Point Air Off
19 Turn Upstream Pintle Air On
20 Unlatch Upstream Latches (Status Indicates Unlatched)
21 Select Both Upstream Miter Gate Leaves for Operation
22 Select Normal Miter Gate Speed Range
23 When Upper Pool - Lock Chamber Differential indicates 0, Open Gate and Latch Gates (Indicates Latched)
24 Turn Pintle Air Off
25 Check Down Bound Approach for Hazards
26 Give Whistle Signal for Boat in Chamber to Depart (Two Short Blasts)
27 Turn Point Air On
28 When Boat is Clear Unlatch and Close Miter Gate (Miter Gate Indicated Fully Closed)
29 Turn Point Air OFF
30 Close Fill Valve
31 Open Empty Valves and put Head of around five (5) feet on Gate
32 Close Empty Valves
33 Turn off Hydraulic Pumps if no Boats

DOWN BOUND LOCKAGE

FROM OPERATIONS BUILDING CONTROL ROOM

1. BOAT CALLS IN

- Pass dam conditions and gages
- Get data for log book
- Tell boat status of locking and position in queue
- Remind boat the main chamber is the landward lock

1 Start Hydraulic Power Unit- Use both pumps
2 Turn Lower Approach Amber Traffic Signal Light on to Indicate Lock Preparation
3 Start Both Fill Valves Opening - Do not stop (Let them go on their own)
4 Start Miter Gate Air if needed
5 Preset the Green Signal Light to activate when Miter Gates are open
6 Unlatch Upstream Miter Gate Latches (Status Indicates Unlatched)
7 Select Both Upstream Miter Gate Leaves for Operation
8 Select Normal Miter Gate Speed Range
9 When Pool is up (Upper Pool - Lock Chamber Differential Indicates 0), Open Miter Gate (Miter Gate Indicated Fully Recessed)
10 Latch Miter Gate Latches (Status Indicates Latched)
11 Turn Miter Gate Air Off
12 Give Whistle Signal to Enter (Main Lock is Two (2) Long Blasts)
13 Watch Entrance of Tow into Lock (Speed of 100 fpm)
14 Turn Point Air On
15 Unlatch and Close Upper Miter Gate when Tow is tied off and wheels stopped (Miter Gate Indicated Fully Closed)
16 Close Fill Valves
17 Start Emptying Valves Opening - Do not stop
18 Turn Point Air Off
19 Turn Upstream Pintle Air On
20 Unlatch Downstream Latches (Status Indicates Unlatched)
21 Select Both Downstream Miter Gate Leaves for Operation
22 Select Normal Miter Gate Speed Range
23 When Lower Pool - Lock Chamber Differential indicates 0, Open Lower Gate and Latch Gates (Indicates Latched)
24 Turn Pintle Air Off
25 Check Up Bound Approach for Hazards
26 Give Whistle Signal for Boat in Chamber to Depart (Two Short Blasts)
27 Turn Point Air On
28 When Boat is Clear Unlatch and Close Miter Gate (Miter Gate Indicated Fully Closed)
29 Turn Point Air OFF
30 Close Empty Valve
31 Open Fill Valves and put Head of two (2) or three (3) feet on Gate
32 Close Empty Valves
33 Turn off Hydraulic Pumps if no Boats

12. Lighting Procedure.

The navigation lights on ends of guide walls and guard walls are turned on and off by photo-control from the HPU Stations. Manual override of these lights has been provided in Enclosure B in the HPU stations. “Low level” lock lights are turned on at dusk by photo-control and remain on during hours of darkness. Floodlights in the miter gate recesses should be turned on at dusk. Lighting in the Operations Building is used as required. Dusk to dawn lights at the Maintenance Building and Operations Building provide additional outside lighting. High mast lights for the up and downstream approaches are manually controlled from the control console. The lighting and signal control screen on the control console also has “pushbuttons” for the control of floating mooring bitt lights, up and downstream approach wall lights, and the emergency howler. Lock “High Level” lights and approach lights are also manually controlled from the lighting and signal control panel.

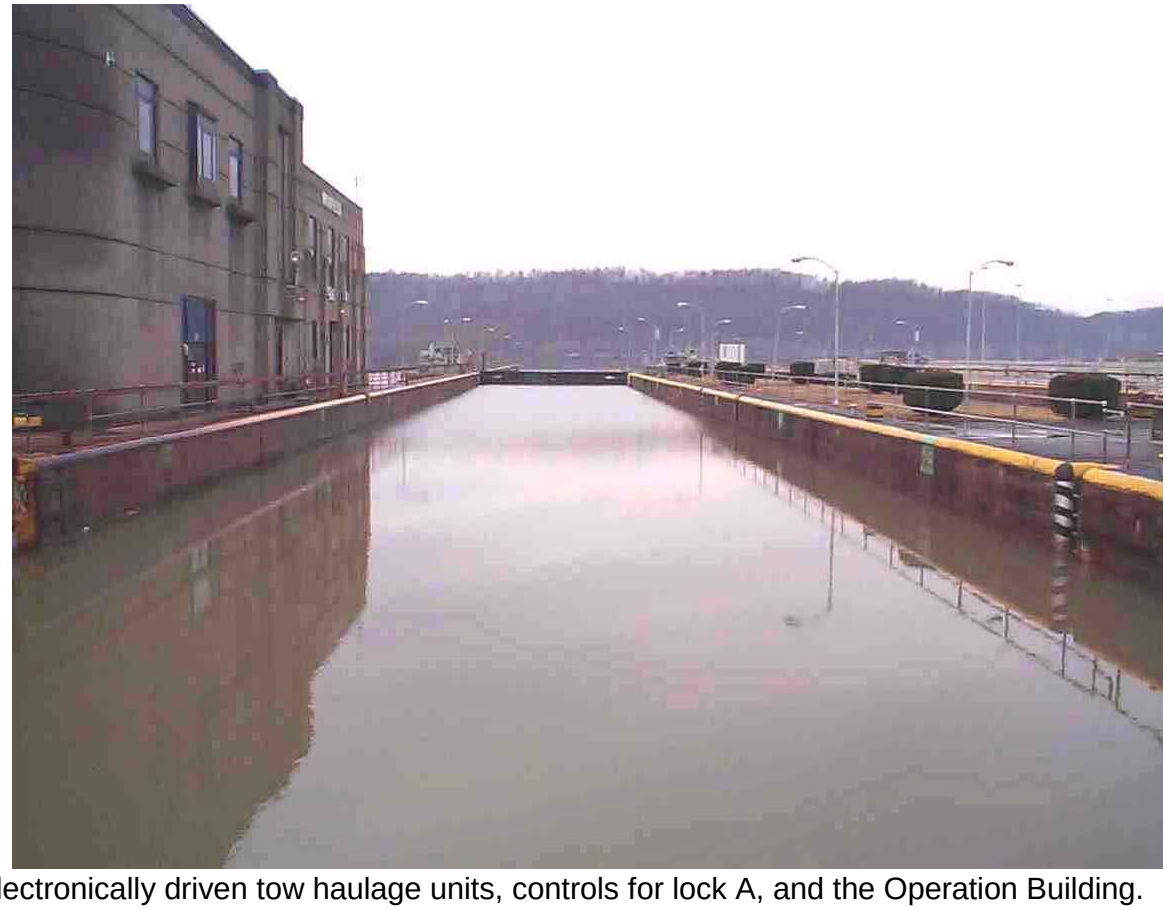
13. Raw Water Supply.

The well for the raw water supply is located approximately 10 feet from monolith L-5. The pump is a 6 stage, 20 hp, 460V/3 phase, submersible pump with 250 gpm capacity at 250 ft. head. The pump does not currently deliver the design capacity and is therefore unusable.

CHAPTER 7 -Original Lock Equipment.

A. General.

The two original lock chambers at Winfield, each 56 feet wide and 360 feet long, are available for backup use. They share a common 604 foot middle wall. Located on the landwall are the controls for lock B along with two electric driven tow haulage units on either end for moving barges out of the lock chamber for boats requiring more than a single lockage. The landwall is 572 feet in length with guide wall extensions of 486 feet downstream and 511 feet upstream. The riverwall is 572 feet in length with guard wall extensions of 350 feet upstream and 350 feet downstream. Located on the riverwall are two



electronically driven tow haulage units, controls for lock A, and the Operation Building.

Figure 13, Dam Operations Building and Lock A

1. Culverts.

All lock walls have culverts through which water flows into the lock chambers from the upstream pool when the filling valves are open. Water flows from the lock chambers into the lower pool when the emptying valves are opened. The discharge ports at this installation are in the lower lock approach for both lock B and lock A. All emptying and filling valves are of

the stoney gate type. The culvert intake manifolds are provided with trash screens and intakes which are sloped for hydraulic efficiency.

2. Miter Gates.

Each lock has two miter gates, one on either end. Each gate consists of two leaves



hinged on opposite sides of the lock chamber. Each leaf for the upper end is 33 inches deep, 33 feet long and 23 feet high. Each upper leaf weighs approximately 67,400 pounds. Each lower leaf is 33 inches thick, 33 feet long and 41 feet high. The lower leaf weighs approximately 147,600 pounds. The upper gates are shorter than the lower because of the built-up upper sill (elevation 548.0 feet M.S.L.). This elevation is 18.0 feet below upper pool elevation. Because the total gate length exceeds the width of the lock chamber, the closed gate leaves form a closure (miter) angle against the flow of water. Keeping a small head against the closed leaves assures the closure.

a. Miter Gate Operating Machinery.

The miter gates are operated by hydraulic cylinders connected directly to the miter gates. The cylinders receive power from individual hydraulic power units located adjacent to the cylinder recesses. Control is provided both at the power units and in the control stations. Controls in the control stations include pushbuttons to stop and start the power units and joysticks to control the speed and direction of the adjacent miter gates leaves. Return of the joystick to the center position stops the movement of the gate. Relief valves are included in each power unit hydraulic circuit to protect against excessive hydraulic and machinery loads.

b. Miter Gate - Culvert Valve Interlock.

The miter gate - culvert valve interlock prohibits both the operation of the upper culvert valve(s) if the lower miter gates are not properly mitered and the operation of the lower culvert valve(s) if the upper miter gates are not properly mitered. The status of the miter gate limit switch is indicated on the interlock panel in the control shelters. If the limit switches is open, the culvert valve will not operate. If the limit switch is closed, then the miter gates are properly mitered and the culvert valve may be opened. If the miter gate limit switch is indicated to be open, after closing the gate, try to put the miter gate in a properly mitered position that will close the limit switch. If this fails, then the interlock can be bypassed. To do this, actuate the “BYPASS” pushbutton on the control panel in the control shelters. When a limit switch is bypassed, a red pilot light for that switch will come on. All maintenance personnel shall be notified immediately of the bypassed limit switch.

WARNING: Extreme caution should be exercised when bypassing a miter gate - culvert valve interlock. Culvert valve operations made with improperly mitered gates can be catastrophic

3. Culvert Valves.

Each culvert valve is of the stoney gate type. They are equipped with seals and installed in the culverts (lock tunnels) in such a position that when closed, the flow of water into (or out of) the lock chamber is completely blocked. Force to raise the valve is applied by an electric motor driven hoist.

4. Operation of Culvert Valves (Emptying and Filling).

The stoney gate type valves in the lock walls (culverts) regulate and control the flow of water from the upper pool into the lock chamber (filling operation) and from the lock chamber into the lower pool (emptying operation). One filling and one emptying valve for the landward lock (lock B) is located in the land wall and one emptying and filling valve is located in the middle wall. The filling and emptying of the riverward lock (lock A) is accomplished by a similar layout with valves in both the middle wall and river wall. It is thus possible to fill or empty either lock chamber in approximately four (4) minutes.All culvert valves are manually controlled.

5. Culvert valve operating machinery.

a. Operating Equipment.

Each set of culvert valve operating machinery contains a 10 HP electric motor and a brake coupled to gear reducer that drives the hoist rope drum. As the valve is raised the hoist rope is wrapped on the hoist drum until operation is stopped. Another gear reducer is coupled to a position indicator and rotating cam limit switch for remote position indication and control. The position indicator is an arm which rotates through 90 degrees from horizontal at closed and vertical at open. Control is accomplished from a control cabinet in the control shelters, where open, stop, and close pushbuttons are located.

b. Filling and Emptying Times.

The filling and emptying times of the lock chambers are left to the judgment of the operator.

A rapid water flow into the lock chamber results in excessive turbulence. To avoid this condition the operator should watch for movement of the barges and strain on the mooring lines. The operator should use caution in the operation of the filling and emptying culvert valves to avoid damage to tows moored in the lock chamber or below the lower miter gates.

6. Culvert valve bulkheads.

a. Culvert.

The culvert valve and culvert can be unwatered for maintenance and inspection. Two steel bulkheads and two wood bulkheads are available for installation in the bulkhead slots, which are provided in all lock walls, above and below each culvert valve. The four bulkheads are stored at Winfield locks. Installation of the bulkheads is accomplished by use of a derrickboat.

b. Unwater Lockchamber.

Before unwatering a lockchamber, bulkheads are place in the bulkhead slots downstream of the two emptying valves so as to prevent leakage due to a reverse head on the emptying valves. Bulkheads are also placed upstream of the two filling valves. While a lockchamber is unwatered, the filling valve operating levers are removed and the hydraulic oil supply is shut off at the control valves.

7. Control stations.

The landwall has two control stations, one near each end, for operating the gates and valves for the lock chamber B. The riverwall, similar in layout to the landwall, has control stations for operation of lock chamber A. Each control station is equipped with controls for the hydraulic pumps, visual traffic signals, and air jets behind the miter gate.

8. Procedure for lockage.

a. Normal operating conditions.

All operations for locking under all conditions are accomplished from control stations on the landward and riverward walls.

b. Flood conditions.

When river stages reach a lower gage reading of 41.0 feet it is no longer feasible to operate the locks and control levers are removed and controls are locked in a neutral position at all stations.

c. Locking.

In making a lockage under normal operating conditions, the operating procedure and sequence of operations are identical for each lock. An example of normal locking operation is as follows:

(1) A tow moving downstream signals for use of the lock. All miter gates are closed.
(2) The operator goes to the upper lock control station and pushes the Control "On" button causing the red traffic signal light for the lock to flash indicating to the tow the receipt of the request for lockage. A flashing red signal light is also automatically activated at the downstream end of the lock to warn approaching vessels downstream that the lock is in use.

(3) The operator starts either hydraulic pump.

(4) Depress the "On-Amber" push button, to change the flashing red signal to flashing amber to show that the lock is being made ready and that the tow may approach under full control. The flashing red downstream warning light continues to flash. At the same time, the "On-Green" push button should be depressed.

(5) The operator should check the positions of the culvert valves by observing indicator rods for each valve. All culvert valves should be closed.

(6) The operator should open the culvert filling valves for the selected lock chamber.

(7) When the level of the water in the lock chamber has raised to the level of the upper pool, the upper miter gate leaves are opened (for the selected lock). Ordinarily both gate leaves are opened simultaneously. WARNING: NEVER OPERATE UPSTREAM MITER GATE UNLESS THE EMPTYING CULVERT VALVES ARE COMPLETELY CLOSED. NEVER OPERATE DOWNSTREAM MITER GATE UNLESS THE FILLING CULVERT VALVES ARE COMPLETELY CLOSED.

(8) As gates are opening, the operator presses the mushroom head push button for the air-jet solenoid-operated valve to clear debris from the gate recesses in the lock walls.

(9) When each gate leaf is completely in its recess, a green "Miter Gates Fully Recessed"

pilot light on the control panel is illuminated to notify the operator that each gate leaf is fully within its recess. When each gate leaf is fully within its recess, the flashing amber traffic signal light changes to flashing green, as preset by the "On-Green" button operation described in paragraph (4). This action notifies the tow that the lock is ready to enter. A whistle signal notifies the tow to proceed into the locks. Two blasts for lock A, one blast for lock B. The operator mush be alert to the position of the miter gates and the operation of the visual and audible signals to assure an orderly lockage.

(10) In the event that the miter gates cannot be fully recessed or clearance in the lock is less than normal. The "On-Amber Green" push button should be depressed, causing an amber and a green traffic signal light to flash, indicating that the tow may enter the lock but with extreme caution.

(11) When the tow is in the lock chamber and clear of the gate swing, the operator closes the upper miter gates, and the flashing green traffic signal light is automatically restored to flashing red. If, however, the tow has entered the chamber on the "Amber-Green" traffic light, the "Off-Amber Green" push button must be depressed to restore the system to a flashing red light.

(12) After the lock gates are closed and mitered, the operator closes the culvert filling valves and signals the operator at the lower end of the lockchamber when the filling valves are closed.

(13) The operator will check to see that the tow is properly secured in the lock chamber as directed by the Lockmaster.

(14) The operator at the lower end of the lockchamber pushes the siren button to warn craft to stay clear of the culvert discharges.

(15) The operator at the lower end of the lockchamber operates the levers to open the culvert valves that empty the lock chamber.

(16) When the water level in the lock chamber has lowered to the level of the lower pool, the operator opens the downstream miter gates.

(17) As the gates are opening, the operator clears drift from the gate recesses by use of air jets.

(18) The operator uses whistle signals to notify the tow to leave the lock. Two blasts for lock A, one blast for lock B.

(19) If no upbound tow has requested use of the lock, or is waiting at the arrival point, the operator closes the lower miter gates, closes the emptying valves, signals operator to open filling valves, opens the culvert filling valves to produce a water level in the chamber that provides a pressure head on both upper and lower miter gates, shuts the filling valves, turns off the hydraulic pump, and de-energizes all traffic signals.
(20) If an upbound tow is waiting, the traffic signal system should by left energized and a flashing red signal will indicate that the lock is being used. When, in the operator's judgment, the departing tow has sufficiently cleared the guard wall and no navigational hazard exists, he changes the traffic signal to amber by depressing the "On-Amber" push button. When it is apparent that the upbound tow has a clear channel into the lock, the traffic signal is changed to flashing green by depressing the "On-Green" push button, and the whistle is sounded to authorize entrance. The locking procedure is similar to that described above in reverse. Note: Emptying valves remain open until the upbound tow is in the lock chamber.

Relief through the emptying system is provided for water trapped ahead of the incoming tow.

(21) If another downbound tow is waiting (no upbound tow), the operator changes the upstream flashing red traffic signal to flashing amber by depressing the "On-Amber" push button at the downstream control station as the tow in the lock departs. He then closes the downstream miter gates and repeats the locking procedure outlined above.

(22) Separate sets of controls enable the use of both locks at the same time. Such use will be at the discretion of the lockmaster depending upon river conditions and other factors. During simultaneous operation of both locks, two service pumps may be used to speed up the operation.

9. Double-locking.

When a tow longer than 360 feet is being locked, it is necessary to make a double lockage. To make a double lockage the tow is brought into the lock chamber and the front section is moored to the lock wall. The coupling between the front section and the rear section is broken and the boat backs the rear section out of the lock chamber. The front section is then locked as described in Paragraph 9 except that the front section is pulled from the lock chamber by a tow haulage unit. When the first section has been locked and moored to the respective guide wall, the second section is locked as described in Paragraph 9 and is lashed to the first section to make the tow complete again. It may be necessary to break the tow into more sections than two to complete the lockage, however, the procedure is the same as for a double lockage.

10. Lighting procedure - night operation.

The navigation lights on ends of guidewalls and guardwalls are turned on and off by manually operated switches in the Operation Building. The U.S. Guide wall lights are powered from MCC2. These lights are controlled from the dam Operations Building MCC. This control action is sent to MCC2 via the PLC system. Therefore, the PLC system must be operational to for this pushbutton to energize the U.S. Guide wall lighting contactor. All lights on the lock wall are turned on at dusk and remain on during hours of darkness. Lights over mooring bitts and miter gates and bridge lights on the dam are on during the hours of darkness. Lighting in the control piers and in the Operation Building is used as required.

11. Danger sign.

At this installation a danger sign is provided to warn pleasure craft that water is being passed through the dam. The word DANGER is outlined both above and below the dam by illuminated lamps. This sign is illuminated both in daylight and darkness. The sign is located on the bridge approximately midway of the dam. Are your sure its not there just because it is a dam and not lock?

12. Needle Dam.

a. General.

Provisions have been made to install a needle dam above the upper miter gates, below the lower miter gates and on the downstream side of roller gates. The needle dam consists of oak timbers, 12" x 12" x 20' long, placed vertically, supported by a sill at the bottom and a steel girder at the top. The steel girder and trestle supports are stored at Winfield Locks. Oak timbers are not kept in storage due to the fact that they are seldom required and timber will warp, crack, and deteriorate. Timbers are procured locally for the specific need and when no longer needed, are used for other purposes.

b. Installation.

When it is necessary to install the needle dam to unwater either of the lock chambers or a crest gate bay, the installation will be made by employees and floating plant under the supervision of the Physical Support Branch, Operations Division, and inspected by the Operations Project Manager or a delegated representative. A diver is required for the installation of the needle dam.

CHAPTER 8 -Emergency Closure System-New Lock

A. General.

The emergency gate is located immediately upstream of the upstream miter gates. The emergency gate is used to pass drift or ice and to form an upstream closure of the lock chamber. It is stored underwater and may be raised under an unbalanced head. Aluminum maintenance bulkhead sections are available to provide closure for dewatering on the downstream side of the miter gates and upstream side of the emergency gate.

B. Lock Emergency Gate.

The lock emergency gate is a single leaf vertical lift type, constructed in one section, or leaf, and is located on the downstream side of a concrete sill on the bottom of the lock approach. The emergency gate sill has a 60 foot notch in the center which normally contains a steel bulkhead. The bulkhead can be removed to allow lockage in the event of pool loss. (See Chapter 11, Paragraph E for Low Water Plan). A system of sheaves, wire rope, and electric, motor-driven, geared drums constitute the hoist equipment to lift the gate leaf into its desired position. The gate is used to completely or partially seal off a lock chamber from any flow of water from the upper pool. Operation of the emergency gate is shown in the following drawings.

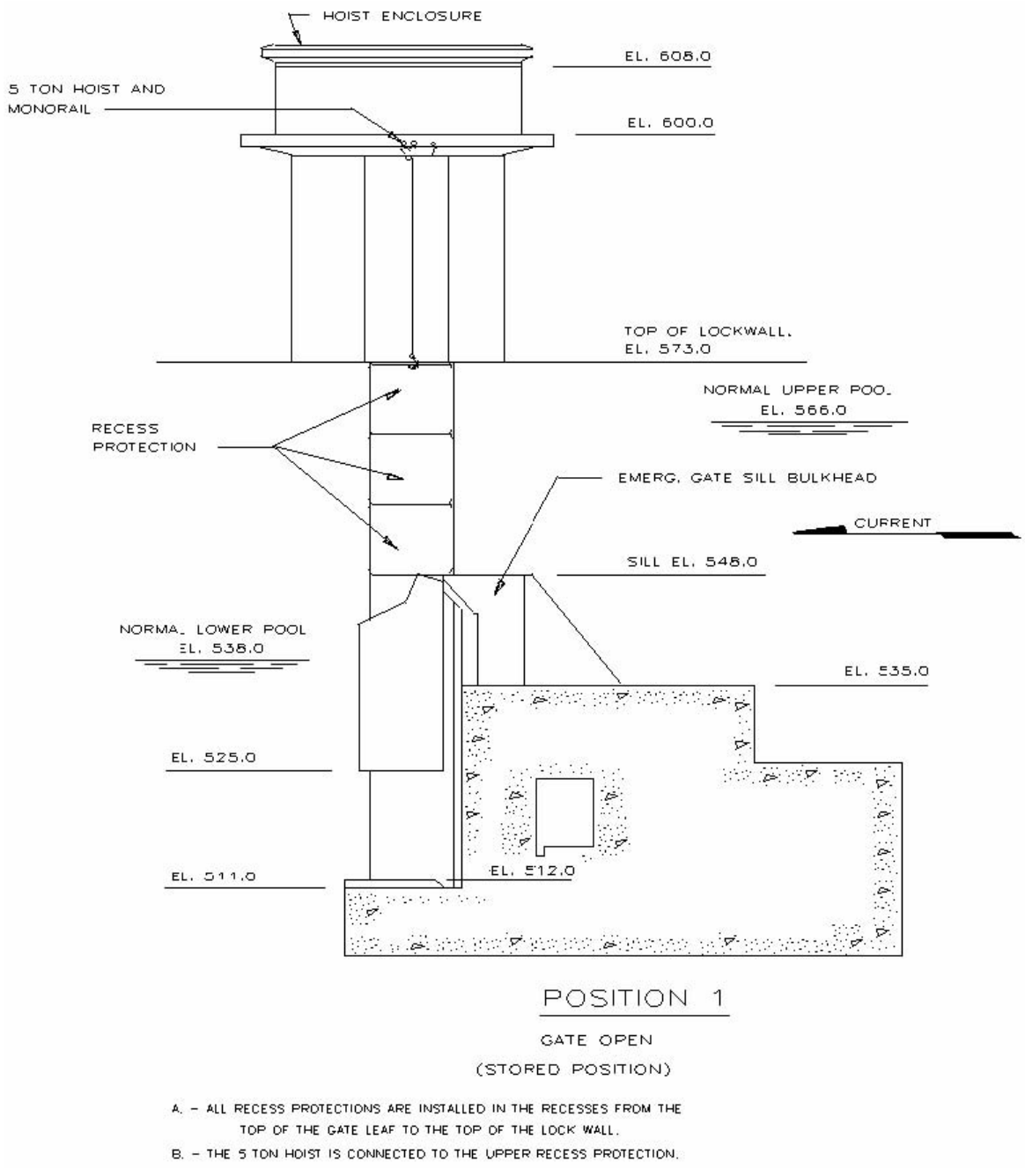
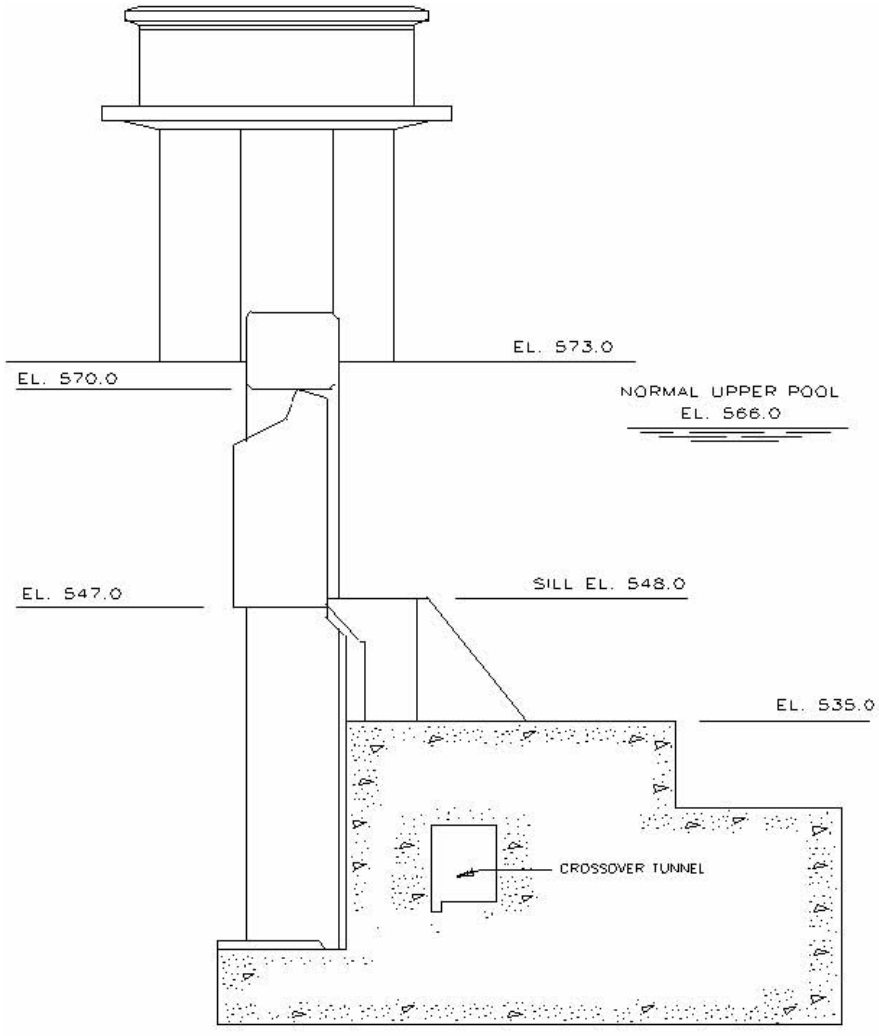


Figure 15, Emergency Gate Operating Positions Figure 16, Emergency Gate Operating Positions, cont'd Figure 17, Emergency Gate Operating Positions, cont'd Figure 18, Emergency Gate Operating Positions, cont'd Figure 19, Emergency Gate Operating Positions, cont'd



POSITION 2

EMERGENCY POSITION OR BULKHEAD POSITION

NORMAL UPPER POOL

A. – REMOVE UPPER RECESS PROTECTION ON GATE LEAF.

B. – LIFT LEAF TO EL. 556.3 AND REMOVE UPPER SECTION OF RECESS PROTECTION.

C. – LIFT LEAF TO EL. 564.5 AND REMOVE MIDDLE SECTION OF RECESS PROTECTION.

D. – LIFT LEAF TO EL. 570.0.

FOR REMOVAL OF TRASH IN LOCK APPROACH

A. – DUPLICATE ABOVE STEPS A., B., C., AND D.

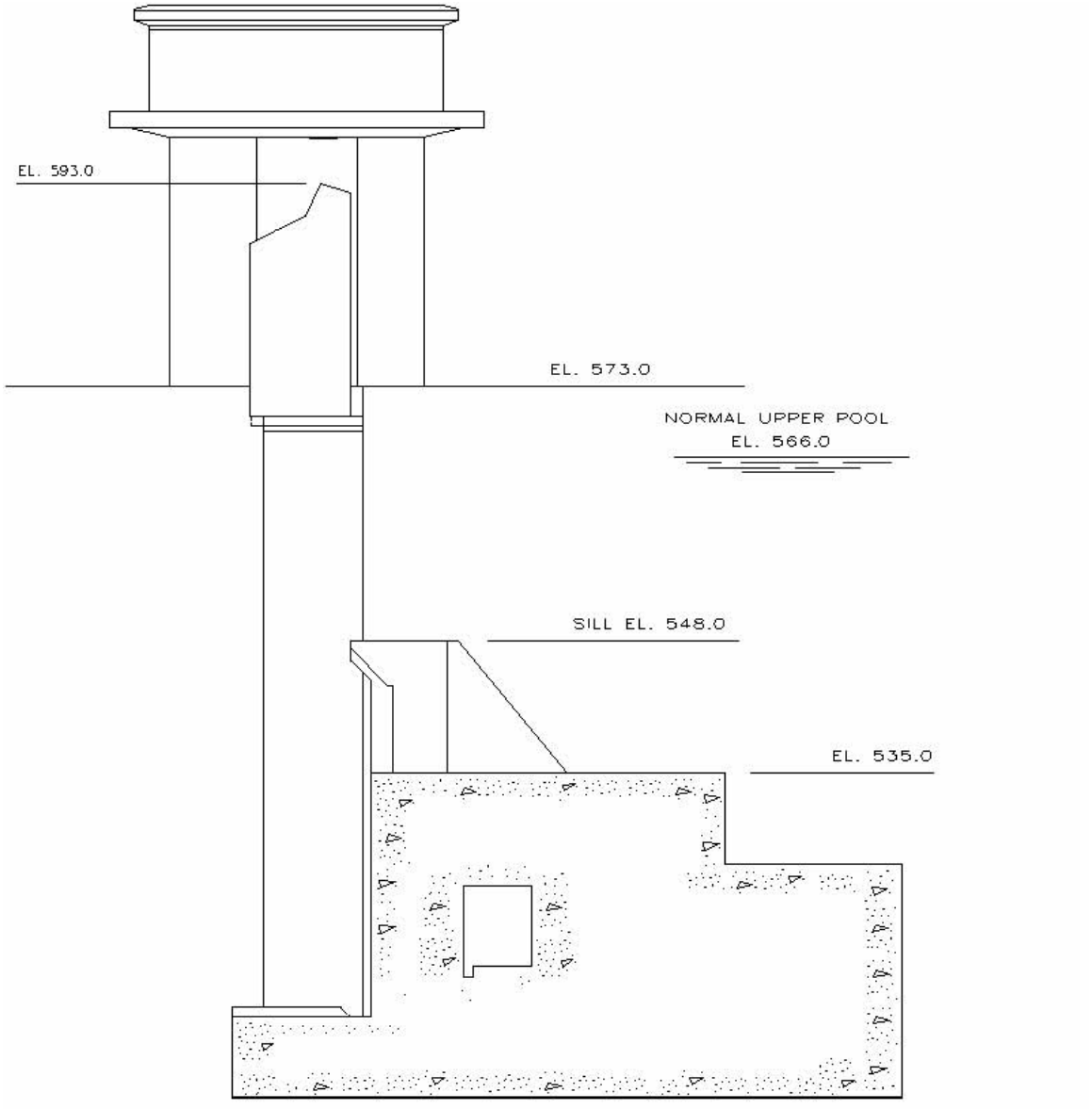
B. – OPEN THE MITER GATES AND ENGAGE LATCHES.

C. – LOWER EMERGENCY GATE SUFFICIENTLY TO ALLOW PASSING OF DEBRIS.

D. – LIFT LEAF TO EL. 570.0.

E. – CLOSE MITER GATES.

BULKHEAD POSITION IS USED FOR UNWATERING THE UPPER MITER GATE.



POSITION 5

MAINTENANCE OR DOGGED POSITION

POSITION 5

A. – AFTER LIFTING LEAF, AS DESCRIBED IN POSITION 4, MOVE DOGGING BEAM UNDER GATE.

B. – LOWER GATE ONTO DOGGING BEAM.

C. Emergency Gate-Operating Characteristics

1. The top of the emergency gate sill and sill bulkhead is at Elev. 548.0. With the bulkhead removed, the top of the sill in the 60 foot notch becomes Elev. 535.

2. The gate is 128 feet long, 23.0 feet high, and designed for overflow. The storage position for the leaf is such that the top of the leaf is at Elev. 548.0 feet. The leaf is supported by lifting wire ropes at each end in the storage position. The minimum upper pool elevation for continued commercial locking is Elev. 557.0. This is based on a maximum vessel draft of 9 feet. If the draft exceeds this depth, then the minimum locking stage should be increased by the amount of increase in draft over 9 feet.

3. If loss of upper pool occurs, limited navigation can take place after the removal of the emergency gate sill bulkhead and the lowering of the leaf to its concrete pedestal at Elev. 512.0. After the leaf is lowered, its top will be at Elev. 535.0. The emergency gate sill bulkhead is 66 feet long and 13 feet high. It weighs approximately 63 tons and is removed utilizing a lifting beam, stored at the project, by the district derrick boat.

1. The ends of the leaf extend into vertical wall recesses and has journal bearing rollers to support the thrust of the water pressure from the upstream pool. It has water seals installed at both ends. The emergency gate sill bulkhead has vertical water seals at the upstream side of the ends, horizontal seals at the top around the ends, a horizontal seal at the top to seal against the emergency gate, and a horizontal seal along the upstream side of the bottom.

2. The wall recesses, the hoisting wire ropes and the leaf sheaves are protected from floating debris by three movable recess protection bulkheads installed in each recess. When a leaf is hoisted, the bulkheads are also raised. A five-ton electric hoist, installed on an overhead monorail at each emergency gate pier, is used to remove the bulkheads as required to storage locations on the emergency pier.

3. The emergency gate hoist machinery piers are located on the lock walls approximately 90 feet upstream of the upper miter gate. Each pier provides an enclosed machinery level at elevation 600.0 feet, which is sufficient clearance to raise the gate out of the water for inspection and is above flood stage.



Figure 20, Emergency Gate Land Wall Pier

□. One drive unit is provided for the hoist machinery. The drive unit is located on the land wall pier. The river wall enclosure carries the sheave installations for hoisting the end of the gate recessed on that wall. The drive unit consists of a 50 HP hoist motor, speed reducer, a divided wire rope drum, direction changing sheaves, limit switches, motor brake and two hoist wire ropes. The leaf is hoisted with two 1-1/2" diameter wire ropes.

□. Two wire ropes are provided for each side of the gate leaf. One end of each wire rope is anchored at the ends of the divided drum. One wire rope passes through the sheaving arrangement and is anchored at the machinery level on the river wall. The other wire rope is anchored on the land wall. As the drum rotates, both wire ropes are shortened (or lengthened) by equal amounts and the leaf remains horizontal in all positions.



Figure 21, Emergency Gate Machinery

9. The gate is supplied with three pushbutton control stations, one located on each of the emergency gate piers and one in the control room in the Operations Building. Control cabinets, located in the machinery enclosures on the land wall emergency gate pier, contain all of the operating controls. It is recommended that a maintenance person be stationed in the machinery enclosure during gate operations to ensure proper wrapping of the wire rope on the drum.

□. Pushbutton control stations are watertight enclosures and provide pushbutton switches for "Raise", "Lower" or "Stop" operation of leaf. Control switches for flood lights and the cabinet light are also available at these stations. The remote pushbutton station located in the Operations Building provides only raise, lower and stop control of the gate. Operation of the gate from this station can be disabled by a selector switch on the door of the gate hoist control cabinet in the machinery enclosure of the land wall pier.

□. A free-standing control cabinet is located in the drive side machinery enclosure on the land wall. The cabinet contains a 100 ampere circuit breaker which supplies 480V, 3-phase, power service to the 50 HP hoist motor and brake. A control transformer provides 120 volt for the gate control circuit. A 20 amp circuit breaker provides 480 volt, 3 phase, power for the 5 ton hoist. A 20

amp circuit breaker provides 480 volt, 3 phase, power service to the sump pump controller. The sump pump is located in the land wall side of the U.S. crossover and is used to drain the upstream crossover tunnel. The sump pump is controlled by float switches and a "HAND-OFF-AUTO" switch located on the front of the sump pump control cabinet. A red pilot light, at the same location, illuminates when the pump is running. An alarm light is provided on the building exterior. NOTE: At a lower gage reading of 40.0 feet, water will begin to flow into the emergency gate sill tunnel. On a rising river, preparations for flooding conditions in the emergency gate sill tunnel should be applied. Prior to stages which cause flooding of the tunnel, the sump pumps must be turned off at the control cabinets in the hoist structure enclosure. A single phase lighting panel and transformer is also located in the machinery enclosure on the land wall. Backout control for the emergency gates is provided by "Backout Raise Overtravel" and "Backout Lower Overtravel" push buttons on the Backout Control Station. These push buttons must be simultaneously depressed with the "RAISE" and "LOWER" push buttons, respectively.

c. Electrical power service for the lock emergency gate is supplied from the MCC1 through a 480 volt, 3-phase, 225 ampere, 3 pole circuit breaker labeled "EMERGENCY GATE".

D. Operation of Emergency Gates.

WARNING: Whenever operating the emergency gate be alert when you press the "Stop" button. If the brake does not immediately set you must push "Lower" at once and lower the gate to its pedestal. Then repair the brake before continuing operation.

1. Momentary pressing of the "Raise" or "Lower" push button switch of any of the control stations causes the leaf to raise or lower, respectively, and provides seal-in operation of the control circuit.

2. Rotating cam limit switches automatically control the sequence and the stopping of operations initiated.

3. Momentary pressing of the "Stop" button of any of the control stations during any operation de-energizes the control circuit, stops the motor and sets the brake.

E. Sequence of Operations.

1. General.

a. The emergency gate has a special top configuration in order to remain stable during overflowing water conditions. Extreme care must be taken to prevent the bottom of the leaf from being raised above the top of the emergency gate sill and sill bulkhead to prevent simultaneous flow over and under the leaf.

b. Refer to design drawing 23/1 for the positions of the leaf for lock closure at different upper pool elevations and the maintenance positions.

Caution: Never operate gate in any positions or conditions other than those shown on drawings 23/1 without prior approval of the Operations Project Manager.

c. As the leaf is raised the sections of recess protection also rise. These sections must be removed and stored by using the 5 ton hoist on the lock wall emergency gate piers.

2. Raising Emergency Gate.

a. If the leaf is in the "Stored" position and the "Raise" pushbutton at any enabled control station is pressed, held momentarily and released, the hoist motor will start and run until the leaf has raised to the "Emergency or Bulkhead" position, where the limit switch shall automatically de-energize the control circuit, stop the motor and set the brake. This places the top of the leaf at Elev. 570.0 which is four foot above normal upper pool (Elev. 566.0).
b. If the leaf is at the "Intermediate" position and the "Raise" button is pushed, held until the leaf has raised at least one-tenth of a foot and released, the gate motor will continue to run until the gate reaches the "Highest" position (Elev. 594.0), where the limit switch shall automatically de-energize the circuit, stop the motor and set the brake. To reach the “Maintenance or Dogged” position from the “Highest” position, move the dogging beam under the gate and push the “Lower” button, holding it momentarily. The gate motor will continue to run until the gate is resting on the dogging beam. At this point the “Low Rope Tension” force control switch will sense low rope tension and will automatically de-energize the circuit, stop the motor, and set the brake.

3. Lowering Emergency Gate.

a. To lower the gate leaf from the "Maintenance or Dogged" position, the leaf must be raised to remove the dogs before lowering. The “Low Rope Tension Override” button must be pressed simultaneously with the “Raise” button. Once the hoist rope load comes within the normal range, the “Low Rope Tension Override” button may be released. Once the gate is raised off the dogging beam it can be stopped, the dogging beam removed, and lowered with the "Lower" pushbutton.

b. To lower the leaf from the highest position, the "Lower" button at any enabled control station is pressed, held momentarily and released. The hoist

motor will start and run until the gate reaches the "Emergency or Bulkhead" position (Elev. 570.0), where the limit switch will automatically de-energize the control circuit, stop the motor and set the brake. From this position, depressing the "Lower" button until the gate has lowered at least one-tenth of a foot shall allow the gate to lower to the "Stored" position (Elev. 548.0), where the limit switch shall automatically de-energize the control circuit, stop the motor and set the brake.

c. To lower the leaf from the “Stored” position to the “Low Sill” position, the “Lower” button at any enabled control station is pressed and held until either the limit switch or the low rope tension force control switch automatically de-energizes the control circuit, stops the motor and sets the brake. In the low sill position, the top of the gate is at Elev. 535.0.

4. Backout From Overtravel.

a. If, during normal operation, the gate should fail to stop after reaching either the "Highest" position, the overtravel limit switch contacts will stop the hoist motor after overtravel by de-energizing the "Main" or "Line" contactor of the controller. If the gate should fail to stop upon reaching the "Overtravel Raised" position, the upper emergency limit switch contacts will stop the hoist motor by de-energizing the "Main" or "Line" contactor.

b. If the gate should fail to stop upon reaching the "Overtravel Raised" position, the upper emergency limit switch contact shall stop the hoist motor by de-energizing the "Main" or "Line" contactor.

c. To operate the gate after an overtravel, the “Backout from Raise Overtravel” pushbutton at the backout control station on the gate hoist controller shall be actuated and held to permit lowering of the gate by actuating the “lower” pushbutton of any enabled control station.

5. Backout From Rope Overload.

If, during normal raising operation, excessive rope tension is reached, force control switch contacts will stop the hoist motor by de-energizing the "Raise" contactor. If the "Raise" contactor should fail to open, rope tension will increase further until the other force control switch contacts will stop the hoist motor by de-energizing the "Main" contactor. To lower the gate after Rope overload the "Backout Raise Overtravel" pushbutton shall be actuated and held to permit lowering of the gate by means of the "Lower" pushbutton on any enabled control station.

6. Low Rope Tension Override.

Anytime the gate is taken to the “Low Sill Position” or placed on the dogging beam the force control switches sensing an abnormally low rope tension will prevent the hoist from running. To raise the gate from either of these positions, the “Low Rope Tension Override” pushbutton must be depressed simultaneously with the “Raise” pushbutton to allow the gate to rise. Once the hoist rope load comes within the normal range, the “Low Rope Tension Override” pushbutton may be released.

7. Backout From Low Sill Position.

To backout from low sill position, the “Backout from Low Sill Position” pushbutton at the backout control station and the “Low Rope Tension Override” pushbutton must be actuated and held, and the “Raise” pushbutton of any enabled control station must be actuated simultaneously, held momentarily and released.

F. Skimming Operations.

Skimming operations refer to the use of controlled flow of water to remove ice or debris from the upper lock approach. CAUTION: Never permit ice or debris to enter gate recesses. Always keep recess protection above water level. Normally, ice removal is performed during low-flow periods and drift removal is required during high-flow periods, particularly at high water stages just prior to taking the lock out of operation.

Caution: During skimming operations and the passage of ice or drift the gates should not be lowered enough to cause scouring of the bottom of the lock chamber.

1. To remove ice or debris proceed as follows:

a. Remove recess protection as required.

b. Raise emergency-gate leaf to elevation 570.0 feet making sure that trash screens are properly positioned in wall recesses at each end of gate leaf.

c. Raise Pool in lock chamber to level of upper pool.

d. Open upper lock gates and latch securely in gate recesses with upper and lower latches. Use air jets to remove ice and debris from recesses as miter gate leaves are opening.

e. Lower water level in lock chamber to level of lower pool.

f. Open lower gates and latch securely with upper and lower latches, in wall recesses, using air jets as required to remove ice and debris while miter gate leaves are opening.

g. Lower the emergency gate leaf sufficiently to pass ice accumulated in upper lock approach. As ice conditions clear in upper approach, lower emergency gate further, if required, to provide flow to wash ice out of lower approach.

h. Raise emergency gate to elevation 570.0 feet.

i. Unlatch and close lower miter lock gate.

j. Raise level of water in lock chamber to elevation of upper pool.

k. Unlatch and close upper miter lock gate.

l. Lower emergency gate to stored position, replacing recess cover plates in proper sequence as the gate is lowered.

G. Use of Emergency Gate to Flush Silt from Under Gate Leaves.

The emergency gate leaf of is raised to Elev. 570.0. Remove upper recess protection as required with the 5 ton hoist. Open the upper miter gate and latch securely. Open the lock emptying valves. Lower the downstream leaf about 2 feet to Elev. 568.0. Operate each compressed air flushing nozzle located under the gate on the downstream side of the sill in turn for several minutes at a time. The air nozzles are controlled with manual valves located in the emergency gate sill tunnel. When flushing is complete, close the lock emptying valves, allow lock chamber to fill to upper pool level, close the upper miter gate, and lower the emergency gate leaf to the stored position. Flushing is recommended quarterly.

H. Aluminum Maintenance Bulkheads.

Bulkhead sections are available for transportation to the project by the District Repair Fleet to the project. Slots are provided in the face of the lockwalls and gate bay piers to facilitate installation of the bulkhead sections by the District Repair Fleet's derrick boat. Five six-foot sections and two four-foot sections are required to provide closure to Elev. 569.0 upstream of the culvert intake manifolds. Five six-foot sections and one four-foot section are required to provide closure to Elev. 569.0 downstream culvert intake manifolds. Five six-foot sections and one four-foot section are required to provide closure to Elev. 554.0 downstream of the upper miter gates, upstream of the lower miter gates, and downstream of the lower miter gates. Five six-foot sections are required to provide closure to Elev. 554.0 downstream of the tainter gate. Five six-foot sections are also required to provide closure to Elev. 566.0 upstream of the tainter gate.

CHAPTER 9 -GATE BAY.

The additional gate bay was located landward of the smaller locks to improve navigation conditions in the additional lock for downbound tows approaching the new lock during high



water. The gate bay is fitted with a 110 ft. wide by 28 ft. high tainter gate and hoist.

Figure 22, Gate Bay

A. Tainter Gate Hoists.

The tainter gate hoist machinery consists of two hydraulic cylinders, two hydraulic power units and synchronizing controls. As the cylinders extend or retract the tainter gate is lowered or raised. Each cylinder extends from a trunnion on each pier & is directly connected to a trunnion arm at each end of the gate. The trunnion is fully articulated and the gate connection is made with a spherical bearing to prevent bending in the cylinder rod.

1. Tainter Gate Hydraulic Power Units.

Each cylinder has a dedicated power unit housed on the adjacent pier. The power units are electric motor driven with flow and directional control for the adjacent cylinder. Manual control, either local or remote, is limited to **stop**, **raise** or **lower**. Devices in the cylinder packing gland housing measure the relative positions of both cylinder rods. The differential is compared electronically. As the difference increases the electrical signal to a proportional valve on the power unit is varied so more oil is diverted from the leading cylinder. The hoists will shut down if the differential exceeds 0.1 feet. When this occurs, lock maintenance

personnel should be called to determine the cause of the actuator position difference and the action to be taken to return the system to normal operation.

Figure 23, Tainter Gate Cylinder





Figure 24, Tainter Gate Hydraulic Power Unit

2. Cylinders.

The hoist cylinders are fitted with an integral position sensing system, known as CIMS. Separate signals are sent to a PLC (Programmable Logic Controller) where they are processed. The detection of any loss of synchronization results in a change in output to a solenoid valve which bleeds off hydraulic oil going to the cylinder which is ahead.

B. Motor Control Center 2.

Motor Control Center 2 is located in the right pier of the gate bay and contains circuits for control of the tainter gate and the guide and guard wall lights.

C. Operation.

See Table 1 for the sequence of operation of the tainter gate in conjunction with the six original roller gates.

D. Service Bridge.

The service bridge spans the gate bay and links the new lock with the old locks and dam. The bridge can be raised during time of flood using fixed electric hoists located at the top of both piers at elevation 603.33. Care must be exercised in raising the bridge to keep it level. During normal conditions, the top of grating is at elevation 573.0. If high water necessitates, the bridge is raised to the platform and secured by engaging the dogging device. Once dogged, the bridge may be used by pedestrians to cross the gate bay.

E. Jib Crane.

For convenience and handling of materials which may have to be transported to the upper level of the pier, jib cranes are located on the downstream side of each pier.

CHAPTER 10 -PROJECT CONTROLS.

A. Control Console.

Operation of all major lock systems and remote control of all dam gates is accomplished from the control console on the third floor of the Operations Building. The control console contains the control computer and monitor along with four CCTV monitors with associated equipment. Control of the hydraulic power units, miter gates, culvert valves, raw water pump, emergency howler, compressed air system, tainter gate, lock lighting, and all dam gates is accomplished through software installed on the control computer. Lock operators manipulate these systems by using a mouse to select the appropriate operation displayed as a button on the control monitor. The control computer is connected to a programmable logic controller (PLC) system that gathers sensor data and issues commands based on ladder logic. The control computer accesses the registers in the PLC in order to display information about the project equipment and send commands to control the various equipment.

A number of screens have been configured in the control computer software. The status and controls shown on the various screens are arranged in terms of function. The screens are as follows:

1. Status Screen
2. Lighting and signal control
3. Upstream Miter Gate Control
4. Downstream Mite Gate Control
5. Culvert Valve Control
6. Dam Gate Control

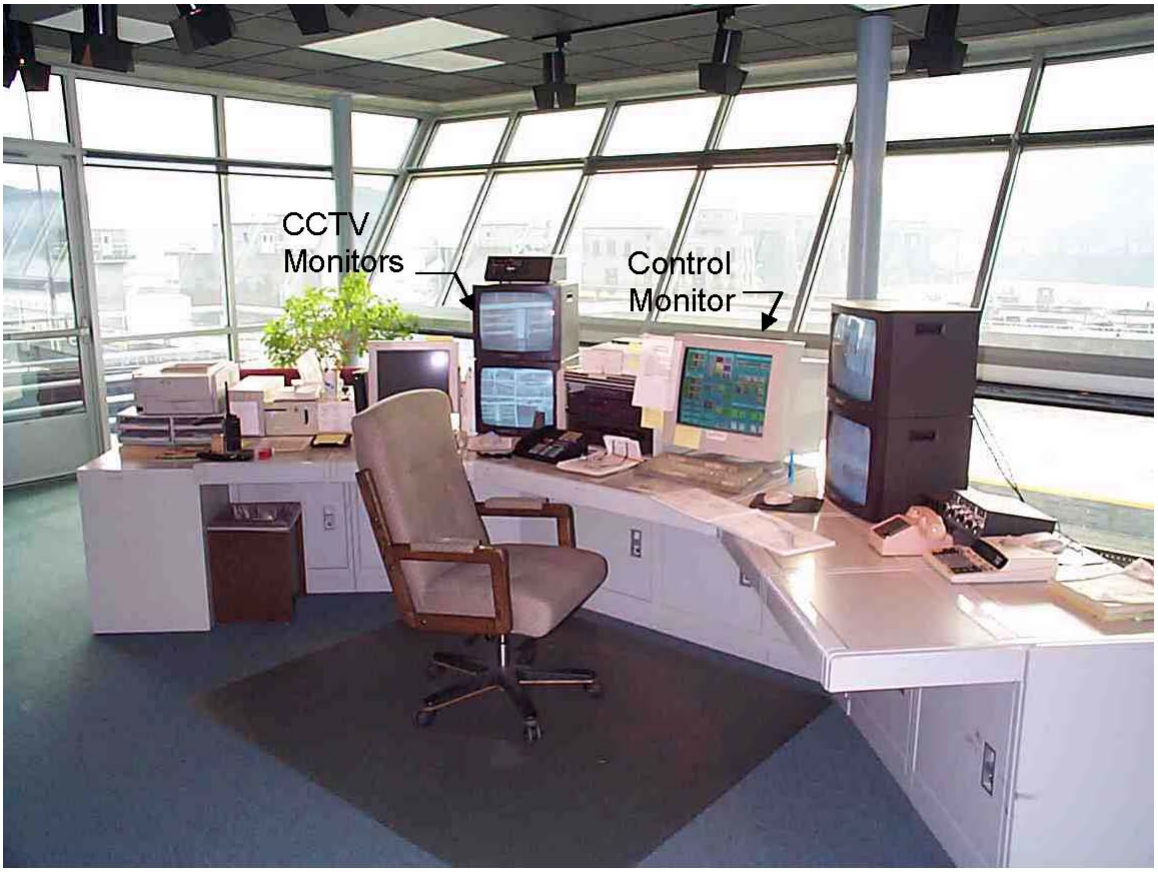
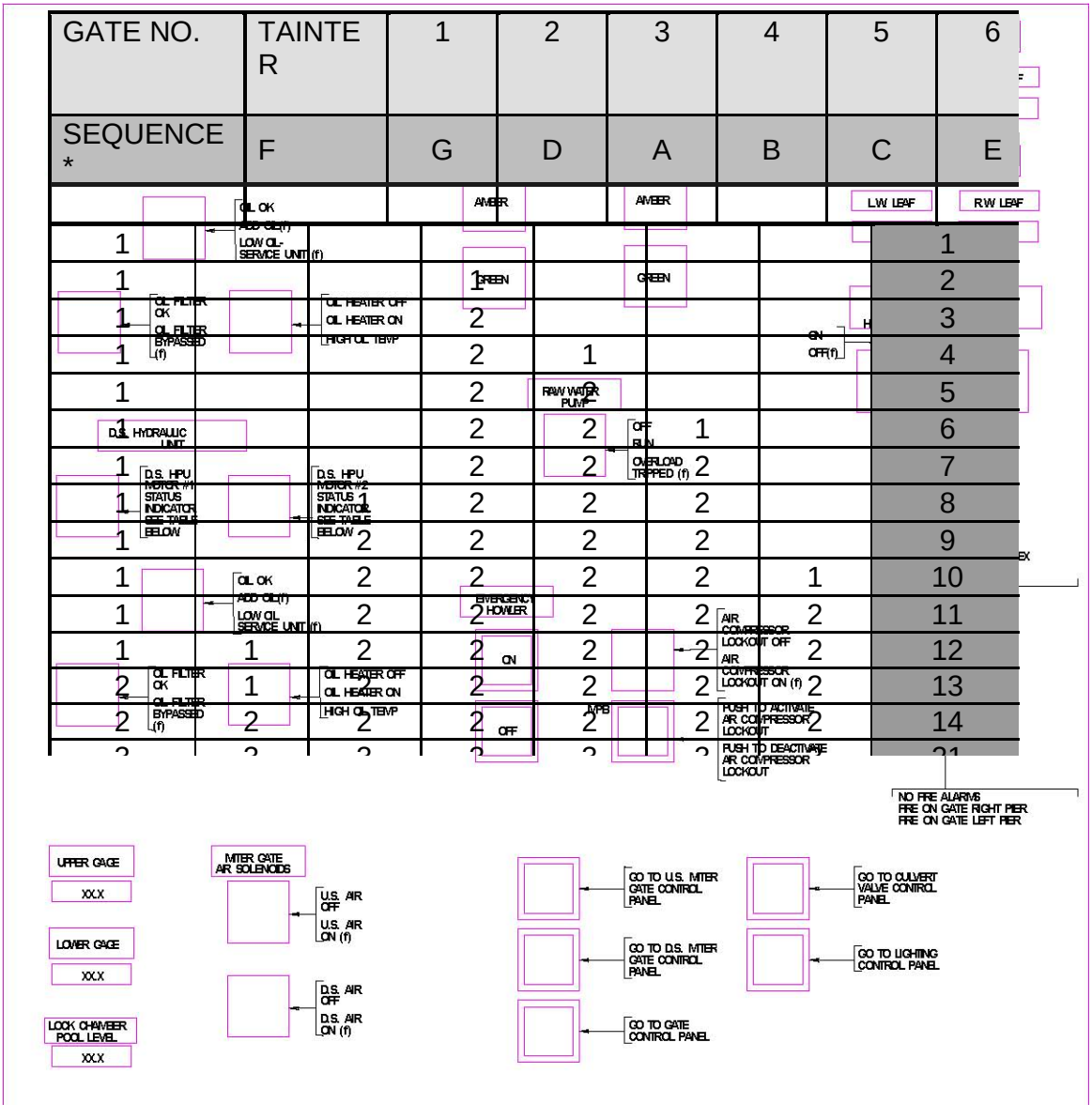


Figure 25, Control Console

1. The Status Screen.

The Status Screen is used to convey information about the entire project at a glance. The status screen is shown in Figure 26. The status of both lock hydraulic power units, traffic signal system, pool level gages, position of both miter gates, opening of tainter gate, fire alarm status, air compressor lockout, miter gate air solenoids and PLC digital output power at the two HPU stations is shown. Control of the emergency howler and the air compressor lockout feature is provided. There are also “GO TO” buttons on all screens to allow movement from one control screen to another. Those screens are described below. The air compressor lockout control is provided to disable operation of the air compressor primarily when the project is being powered by the standby generator set located at the Maintenance Building.



STATUS SCREEN

Figure 26, Status Screen

2. Lighting and Signal Control Screen.

This screen, shown in Figure 27, is used to control the lock lighting. In addition, control of the emergency howler is also provided on this screen. From this screen, high (intensity) level lock lights, upstream and downstream guardwall approach lights, upstream and downstream approach high mast lights, floating mooring bitt lights, miter gate recess lights, and the emergency howler can be controlled by actuating the screen buttons labeled “ON” and “OFF”.

Figure 27, Lighting and Signal Control Screen

a. Lock Lights.

Lock lighting is accomplished using 100 feet tall light poles (High mast) with approximately 6 fixtures on each pole. They are located on the land and river walls and provide two levels of lighting intensity for the lock, high and low level. High level lighting is defined as having all of the fixtures energized that are located on the high mast poles and provides a lighting intensity of approximately
1.25 FC. Low intensity level lighting is defined as having three fixtures energized on each high mast pole and provides approximately 0.5 FC. The low intensity level conserves electrical power consumption and is used for security lighting when lockages are not being made. High intensity level lighting is to be used when making lockages. The low level lock lighting is energized by a photocell and cannot be controlled from the control console in the Operations Building. If the PLC system is not operational, the lights can be controlled from MCC1 at the Maintenance Building where they receive their power.

b. Floating mooring bitt lights.

Floating mooring bitt lights are operated manually, and independently of the lock lights, from the lighting and signal control screen on the control console. The floating mooring bitt lights may also be controlled from HPU stations 1 and 2 where they receive their power.

c. Guard Wall lighting.

Upper and lower approach lights are located on the respective guard (river) walls. The U.S. and D.S. Guard wall approach lights can be controlled from either the lighting and signal control screen or from MCC #2 where they receive their power. The U.S. Guide (land) wall (on old lock side) approach lights can be controlled from either the Dam OB MCC (through the PLC system) or from MCC2 where they receive their power. There are no provisions to control these lights from the control console.

d. Emergency Howler.

The emergency howler is used when it is desired to notify lock personnel that an emergency situation exists. The emergency howler can be controlled from the control console via the LIGHTING AND SIGNAL CONTROL SCREEN or the STATUS SCREEN . It may also be controlled from pushbuttons at HPU stations 1 and 2 through the PLC system. It may be controlled from MCC #1, whether or not the PLC system is operational, where it receives its power.

e. Miter Gate Recess Lights.

Miter gate recess lights are provided to illuminate the recess area of the miter gates. One fixture is provided per gate leaf. They are controlled independently of the lock lights from the LIGHTING AND SIGNAL CONTROL SCREEN on the control console. They may also be controlled from their adjacent HPU station, whether or not the PLC is operational, where they receive their power.

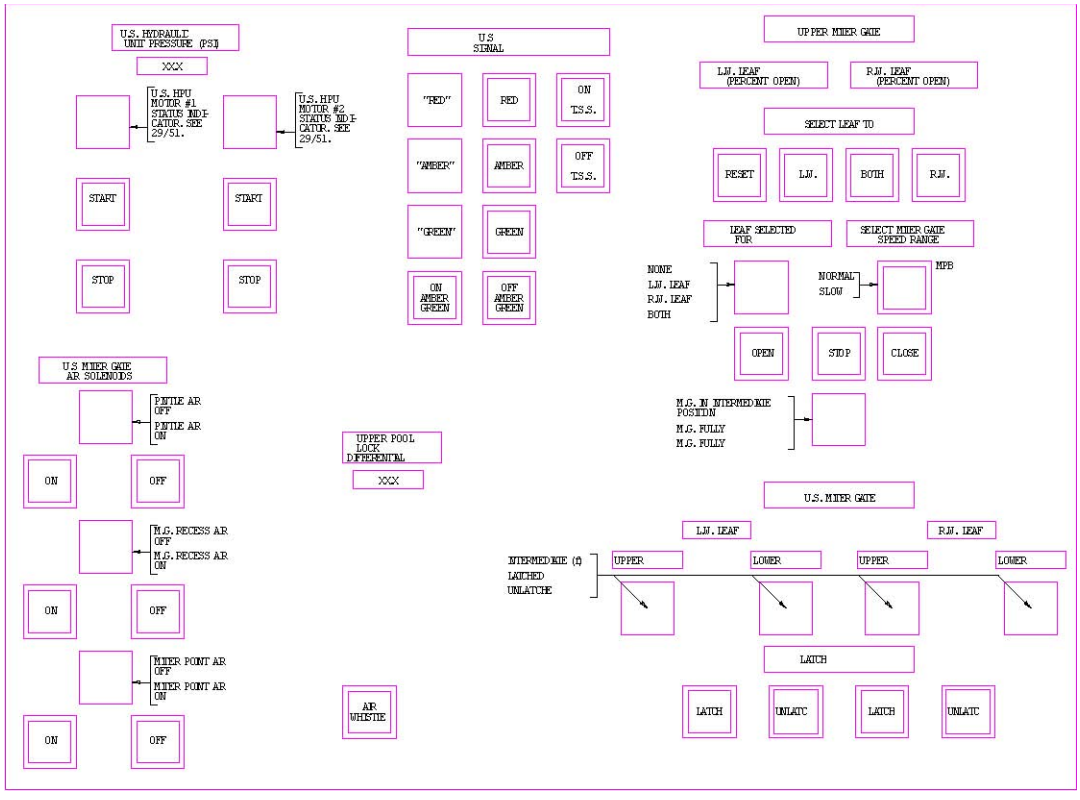
3. Miter Gate Control.

Miter gates are controlled from the U.S. and D.S. MITER GATE CONTROL SCREENS on the control console. The UPPER MITER GATE CONTROL SCREEN is shown in Figure 28. The control panel for the lower miter gates is the same except that designations “U.S.” and “Upper” are changed to “D.S.” “Lower”, respectively. Actuation of the pushbuttons operates a 4-way flow directional valve and a proportional flow control valve to direct and throttle the flow of hydraulic oil to each miter leaf operating cylinder to either open or close the leaf at the speed desired. The speed and direction of the miter gates can also be controlled from the backup control stations. Before the miter gates are operated, the operator should use the appropriate air solenoids to move debris away from the swing path of the miter gates. The pintle, recess and miter point air solenoids can be controlled from the control console or from Enclosure “C” in the adjacent HPU station. There are no provisions to control the air solenoids from the backup control stations. When moving the gate leaves to recess, the pintle and recess air should be energized. When moving the gate leaves to miter, the pintle and miter point air should be energized. When the miter gate operation has been completed, the air solenoids must be de-energized manually. A pilot light on the control screen will start to flash after the solenoids have been energized for 10 minutes and continue to flash until the solenoids are de-energized. Either or both of the miter gate leaves may be selected for control, and the speed and direction of operation may also be selected. There are two speeds available, slow and normal. The speed of the gate leaves is further controlled automatically by the PLC and is based on the position of the gate leaf. The speed is made slow going into miter and recess and made faster through the intermediate positions of travel. The miter gate hydraulic and electrical circuitry is designed to open and close the miter gates in approximately 2 minutes. The percent speed is shown on the screen just below the leaf position and is in terms of normal full speed of the gate. The position of the miter gates is displayed as percent open. Mitered position is considered 0% open, fully

recessed 100% open. From this screen, the corresponding HPU pumps and the miter gate latches can be controlled and monitored. The pool-lock chamber differential is displayed here and the traffic signal lights are displayed and monitored here. For the recommended miter gate control sequence see Chapter 6, Paragraph B.11.d, Procedure for Lockage. When both miter gate leaves are fully recessed (100% open), the “miter gates fully recessed” green light will illuminate. The difference between upper pool and lock chamber water level is displayed on the U.S. MITER GATE CONTROL SCREEN. This information can be used by the operator to determine the optimum time to open the miter gates (as close as practical to when the difference between the lock chamber and upper pool is zero). The difference between the lock chamber water level and lower pool water level is shown on the D.S. MITER GATE CONTROL SCREEN.

UPPER MITER GATE CONTROL PANEL

Figure 28, Miter Gate Control Screen

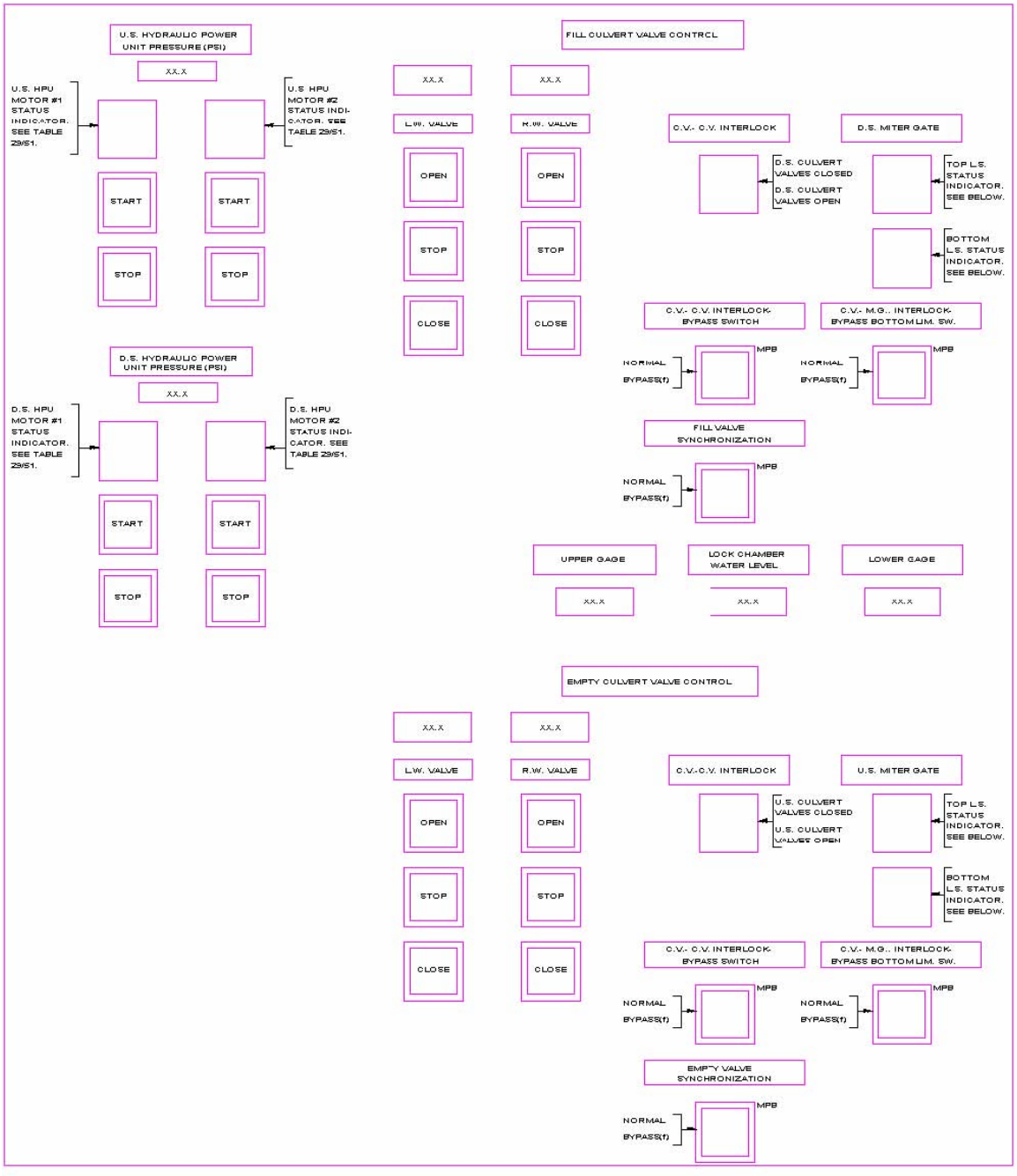


a. Operation of Traffic Signal System.

The system is energized by pressing the “Traffic Signal System (T.S.S.) On” button, causing the red signal lights at both ends of the lock to flash. To change to an amber signal, at either end of the lock, the corresponding “amber” button is pressed. This causes the red signal light to go out and the amber signal light to flash. The red signal light at the other end of the lock continues to flash. To set up for a green signal, with the amber signal light flashing, the “green” button is pressed. The amber signal light will continue to flash until both gate leaves are fully recessed, causing both fully recessed limit switches to close, following which the amber signal light will go out and the green signal light will flash. If either limit switch opens while the green signal light is flashing, the green signal light will go out and the red signal light will start to flash. If both gate leaves cannot be fully placed within their recesses, a combination signal is given by pressing the “Amber-Green On” button. This causes the green and amber lights to flash until the “Amber-Green Off” button is pressed to revert the signal to flashing red. The system is de-energized by pressing the “T.S.S. Off” button. Any signal can be changed to flashing red by pressing the “T.S.S. Off” and “On” buttons in that sequence. When the PLC system is not operational, the traffic signal system is also not operational. During these periods, the operator must use radio communications to signal watercraft into the lock chamber. The operator should inform the vessel captain that the traffic signals are not operational. The operator must ensure the miter gates are fully recessed before allowing boats into the lock chamber.

4. Culvert Valve Control.

Both emptying and filling culvert valves are controlled from one CULVERT VALVE CONTROL SCREEN, Figure 29. The status of the upstream and downstream culvert valves is displayed here along with the status of the miter gate top and bottom limit switches. The miter gate top and bottom limit switches are used as interlocks in the culvert valve control system. If the limit switches on the miter gates do not indicate the miter gates are closed, the opposite end culvert valves cannot be opened. This interlock is called the miter gate - culvert valve interlock. If the fill culvert valves are not closed, the empty valves cannot be opened and vice-versa. This interlock is called the culvert valve – culvert valve interlock. From this screen, the culvert valve-culvert valve interlocks and the culvert valve-miter gate interlocks (bottom limit switch only) can be bypassed. When this is done, a flashing indicator appears on the screen warning that this interlock has been bypassed. The top limit switch on the miter gates cannot be bypassed from the control console in the Operations Building. The operator must travel to the HPU stations and operate a selector switch to bypass the top limit switch**. The operator should use extreme caution before bypassing any interlock.** For example, if the downstream culvert valves cannot be operated because the upper miter gates cannot be mitered, the operator should first walk to the gate to determine why the gates cannot be mitered. If it is determined that the gates are in the proper position for mitering but the limit switch will not close to indicate proper miter, the limit switch may be bypassed**. It is paramount that the equipment be inspected and proper position ensured before bypassing any interlocks.** In the event that the culvert valve – culvert valve interlock cannot be made, the operator must ensure that the fill valves are closed before the empty valves are operated and vice versa. Upper gage, lock chamber water level, and lower gage are displayed on these two screens for general information.



CULVERT VALVE CONTROL PANEL

Figure 29, Culvert Valve Control Screen

5. Tainter Gate Control.

The tainter gate can be controlled from three locations; the pushbutton control station in MCC2, from the control console in the new lock Operations Building and from the keypad display module located in the Maintenance Building. For information on making gate operations from the keypad display module in the Maintenance Building, see page 82. For information on controlling the tainter gate from the Left and right piers of the tainter gate bay, see the Tainter Gate O&M Manual. From the lock Operations Building, the tainter gate is controlled from the TAINTER GATE control screen shown in Figure 30. This screen provides status display and control of the tainter gate only. The heart of the tainter gate control system is a PLC processor and I/O modules PLC racks on the left and right tainter gate piers. The tainter gate PLC processes all control commands, controls all components that operate the two hydraulic actuators, and synchronizes the operation of the two actuators. If the two actuators get out of synchronization by a predetermined amount, the tainter gate PLC automatically stops the gate and de-energizes the hydraulic pump motors and displays error messages at the new Operations Building and at the right pier of the tainter gate bay. The tainter gate hydraulic power units are started and stopped automatically. The operator only has to key in a desired target opening. The PLC automatically performs all required commands after the operator enters this information. Under the Tainter Gate Status section of this screen, the status of the hydraulic power units, the gate PLC, the HPU motors, and the CIMS power supply is displayed. Only HPU general failure messages are displayed to this screen. Pilot lights that describe the particular failure mode of the HPU equipment are located at the respective HPU's on the tainter gate piers. Therefore, the operator must go to the tainter gate HPU to determine the particular fault. This screen also displays whether gate control from the Operations Building is enabled or disabled. Control of the tainter gate is allowed from remote locations by a selector switch located on MCC2 in the right tainter gate pier (beside new lock river wall).



Figure 30, Tainter Gate Control Screen

6. Roller Gate Control.

a. General.

The roller gates (and the tainter gate) can be controlled from three locations: the pushbutton control station at the gate pierhouse, from the control console in the new lock Operations Building and from the keypad display module located in the Maintenance Building. For information on making gate operations from the keypad display module in the Maintenance Building, see page 82. The dam gate can be raised from the remote control locations to a vertical opening of no more than16 feet. Beyond this opening, the gates must be operated from the local pushbutton station.

b. Equipment.

(1) PLC cabinet.

Remote control is accomplished using PLC type equipment whose processor is connected to the network of PLC's at the project. The interface equipment at the remote control points acts to transmit operator data to the controlling PLC that is located at the Dam Operations Building and to display gate status information.

All decisions regarding operation of the dam gates are made by the Dam Operations Building PLC. In addition to the gate hoist controller cabinet at each pierhouse there is a PLC enclosure. This enclosure has pilot lights and one pushbutton mounted on its door. The pilot lights indicate "PLC OPERATIONAL", "HOIST MOTOR OVERLOAD", and "COMMUNICATION FAILURE" conditions. The "MOTOR OVERLOAD TEST" momentary push-button is for testing purposes. The roller gates have been furnished with thermal overload relays whose auxiliary contact closes when the thermal overload relay trips. The message to be displayed to the operator interface screen in the lock Operations Building shall be “HOIST MOTOR OVERLOAD".

(2) Gate Position Sensor.

The position of the gate is sensed by a single turn, resolver-based, absolute shaft position transducer/converter combination. The converter resolves each transducer shaft revolution to 3600 parts. The transducer is mounted on the hoist machinery beam and is driven by a sprocket chain that is driven by the original, single turn dial indicator.

c. Setting up for Gate Operations.

(1) Standard Roller Gates

While the gates are operated from the local pushbutton stations, the operator is required to set a “MASTER-LOCAL” selector switch to the LOCAL position. If it is desired to operate the gate from the two remote stations, the selector switch must be placed in the MASTER position. The openings at which the gates can be controlled using the PLC control system are determined by the lockmaster.

(2) Flap Type Roller Gate

Operation of the flap type gate is similar to the standard roller gates with the following exception.

a. The flap gate must be in the fully raised position. In addition, the three pole double throw switch that selects the appropriate set of resistors (flap or roller) must be in the roller position and the motor must be connected to the set of machinery that operates the roller gate. If these conditions are not satisfied, operation of the gate hoist motor with the PLC system cannot be initiated.

d. Gate Operations

(1) Moving Gates.

i) Gate Move Commands

Once in the ROLLER GATE screen of the lock MMI software, the operator is required to enter data that represents the opening to which the gate is to be moved (in feet) and the direction of the operation to be made (raise or lower). The dam PLC checks to see if conditions will permit the gate movement. If so, the appropriate command to move the gate is automatically sent. The dam PLC automatically stops the gate at the desired opening. The PLC limits the number of gates that can be raised at any given time to two. However, there is no limit on the number of gates that can be closed simultaneously. If the operator

keys in command that should not or cannot be executed, the PLC will not allow the command. For example, if Gate # l is currently being moved, another command to move Gate #1 will be rejected. If a gate is currently in the hoist motor overload status, the PLC will not allow remote control of the gate. The PLC does not allow commands for gate movement if the MASTER-LOCAL switch associated with the gate to be moved is in the "Local" position. In the event that a command cannot be executed because of permissives not being satisfied, the words "INVALID COMMAND" are displayed to the screen for approximately two seconds immediately after the command was entered. The data displayed on the ROLLER GATE control screen is dynamically updated when data, such as gate opening, is changing. A red flashing indicator with text “DAM GATE MOVING” is displayed on the STATUS screen anytime a dam gate is moving.

ii) Audible Warning

The dam PLC has been programmed to energize an audible device at gate #6. This device will be powered for a 15-second period before any gate is to be raised (does not energize on lower). After 15 seconds, the device will de-energize and the gates will start to move. This alarm is provided to signal that the gates are to be raised.

iii) Commands That Won't Execute

The PLC automatically starts a timer after the command is sent to the LTU to move the roller gate. If, after a time delay of approximately 10 seconds after the 15 second warning device has operated, the status report back does indicate that the gate is moving, the command to move the gate is automatically cancelled by the PLC system (unless it is in EGL mode). In addition, the message "COMMAND DID NOT EXECUTE" is displayed on the ROLLER GATE control screen.

iv) Gate Moving Audible

When a roller gate is moving after having been commanded to move by the PLC system, an output at the lock PLC in the Operations Building is energized to provide audible indication. This output is also provided at the dam PLC in the Dam Operations Building.

v) EGL Alarm If a gate is in EGL mode described below, another output in the lock PLC will be energized to power an audible indication and indicate the EGL condition. This audible warning is provided in addition to the audible and visual alarms annunciated on the operator interface screen at the lock operations building.

(2) Gate Stop.

The dam PLC automatically stops the gate(s) at the opening keyed in by the Operator. The gate operating screen also provides the operator with the ability to stop all dam gates simultaneously. This screen button is labeled “STOP ALL DAM GATES”. Gate movement commands are cleared from PLC memory and require re-entry to make another gate movement. A stop button for each gate is also provided. Note that there is one condition where it will not be possible to stop a gate, with the PLC system, that is moving in the close direction. This is called the Emergency gate lower condition and is described later.

(3) Local Gate Operations

Gate operations may be initiated at the push-button control station by selecting the "Local" position of the “MASTER-LOCAL” selector switch located on the gate hoist controller enclosure. The selector switch, when in the "Local" position, disables control of the gate from the remote operating stations and enables control from the control pushbuttons. The LTU and dam PLC send gate position information and other status to the remote operating stations for display regardless of the position of the MASTER-LOCAL selector switch, including transmission and annunciation of alarm conditions.

e. Emergency Gate Lower.

The logic in the PLC at the original Operations Building automatically executes the command to lower the gate to the sill (0.00 feet open) if the machinery brake fails to hold the hoist machinery. It will only do this when the “MASTER-LOCAL” switch is in the "Master" position and within a 60 second period after the gate has come to a stop after a prior operation. An “EGL” alarm condition is a condition of gate movement in the absence of "Raise" and "Lower" status input contacts and will most likely occur as a result of a brake that fails to stop the gate hoist machinery immediately after a gate operation has been made. After a gate has come to a stop after being moved, the dam PLC stores the gate position in memory. If the PLC detects that the gate has moved, it immediately lowers the gate to the sill (0.0 feet open). As a gate is being lowered as a result of an "Emergency Gate Lower" sequence, the dam PLC will not accept any gate control commands. The gate cannot be moved remotely until the MASTERLOCAL switch at the gate with the EGL alarm has been toggled from the MASTER position to LOCAL, then back to the MASTER position. If the gate is not stopped automatically at some point just above the stop limit switch setting, existing limit switches will automatically de-energize the control circuit, stop the motor and set the brake when the gate reaches the sill. The EGL status is sent to the lock PLC for alarm annunciation. A flashing EMERGENCY GATE LOWER alarm message appears on the STATUS screen and the ROLLER GATE control screen. An output on the lock PLC and dam PLC output modules energizes when an EGL alarm occurs and remains on until the alarm has been acknowledged by an operator at the new lock Operations Building. If EGL has not been sensed within 60 seconds after the gate hoist motor has been de-energized, detection of EGL is ceased until the gate is again operated and the hoist motor is then de-energized. The dam PLC neither monitors for nor acts upon an EGL condition if the MASTER-LOCAL switch is in the LOCAL position.

f. Miscellaneous.

(1) Multi-state indicators on the operator interface screen

Multi-state indicators (pilot lights) on the operator interface screen are defined on the project drawings. Multi-state indicator #4 is provided for information about the positions of the safety and transfer switches for the flap gate (gate #6). In order to operate the roller gate locally or remotely, these two switches (safety and transfer) must be in the proper positions so that an interlock relay can be energized. When operating the roller gate, these two switches (safety and transfer) are required to be in the “ROLLER” position. When operating the flap gate (which is mounted on the roller gate), the switches (safety and transfer) are required to be in the “FLAP” position. Note that there are no provisions for operating the flap gate through the remote control system. It must be operated from the local push-button station only. To ensure the transfer switch and safety switch are in the proper positions, an auxiliary contact of the interlock relay and a safety switch auxiliary contact are monitored by the PLC. If the safety switch is not in the roller position (auxiliary contact open), or the interlock relay is not energized (auxiliary contact open), the PLC will not allow remote control.

(2) PLC cabinet door mounted components.

Each PLC equipment enclosure (LTU) at each dam gate has three control pilot lights and one pushbutton mounted on the door as described above. The "PLC OPERATIONAL" light will burn steady when the dam PLC is scanning its ladder logic and otherwise operating properly. It does not directly indicate that the PLC equipment is energized. The "HOIST MOTOR OVERLOAD" light shall flash when this condition exists. Actuation of the “MOTOR OVERLOAD TEST” push-button shall indicate a motor overload condition at the LTU and at the remote operator interfaces. The "COMMUNICATION FAILURE" light shall illuminate when the LTU loses communication with the dam PLC.

(3) Roller Gate Screen Alarm Messages

i) General.

Alarm messages that may be displayed are "HOIST MOTOR OVERLOAD", "COMMUNICATION FAILURE", "EMERGENCY GATE LOWER", “TRANSIENT PROTECTION DEVICE FAILURE” and “LOW BATTERIES".

ii) Hoist Motor Overload

The hoist motor overload message is displayed whenever the solid state motor overload in the gate hoist controller has tripped and de-energized the hoist motor. It is necessary to manually reset the thermal overload before the gate can again be operated. The cause of the overload should be determined before putting the gate back in service.

iii) Communication Failure

When the dam PLC cannot communicate with the remote rack at a particular gate, the remote rack is configured to hold outputs to an inactive state until the communication is reestablished. The PLC has the capability of controlling and monitoring gates that are not in a failure alarm condition.

iv) EGL

EGL is described earlier.

v) Transient Protection Device

A status monitoring wire is provided with the transient protection device and input to the PLC equipment. Should the transient protection device fail, the PLC will automatically display to the screen a message indicating that it has failed. The transient protector should be replaced as soon as practical.

vi) Battery Low

The BATTERY LOW alarm indicates that the battery that backs up the PLC program is low and needs to be replaced. When this alarm occurs, there is approximately 2 weeks of life remaining in the battery currently installed in the dam PLC processor.

B. Dam Gate Control from the Keypad Display Module

1. General.

The six roller gates and the tainter gate can be controlled from keypad display module that is located in the Maintenance Building (MB). Control from this point was provided primarily to put dam gate back into the water after they had been taken all out during flooding conditions when access to the Operations Building was limited due to flooding on the esplanade. Normally control from the Maintenance is disabled. The keypad display module is an operator interface that is located in the office of the MB. It is approximately 10 inches by 10 inches with a two line, fluorescent display, programmable buttons and a numeric keypad.

Small LED type Indicating lights are located beside the function keys.

2. Enabling Control From the Keypad Display Module

In order to operate the dam gates from the Maintenance Building, the operator must enable control from the Maintenance Building by toggling a button on the ROLLER GATE control screen to the enable position.

1. Making Gate Operations

The screen normally displays the upper pool water level in terms of feet of elevation. To display other messages, simply use the down arrow key on the top right of the numeric keypad. You will be able to scroll the following messages: Upper pool level Lock water level Lower pool level Tainter gate opening (in feet) with “MOVE TO” prompt The next 7 messages are the gate openings (in feet) from G1-G6, each with a “MOVE TO” prompt

Continuing to press the down arrow key will allow the operator to cycle through the same screens again.

Once the gate to be controlled is place on the display, the operator must enter the opening to which the gate is to be moved using the numeric keypad. He then must press either the raise, lower or stop key to initiate the operation. The opening displayed on the screen should change as the gate is moving. Should the operator decide to stop the gate, he may depress the programmable button labeled “STOP”. To operate another gate, use the down arrow button to select the gate to be controlled, key in the new opening, press the raise, lower or stop button as appropriate. The gates should stop at the desired opening automatically. Should an alarm occur, the LED pilot light at the bottom of the keypad display module will be illuminated. Provisions have not been made to display the alarm condition on the keypad display module.

C. Overfill/Overempty System.

The lock control system is designed to minimize the overfilling and overemptying of the lock chamber. The overfill/overempty control allows the valves to open and then automatically starts the culvert valves closed at a predetermined time. The time at which the valves start closed automatically is based on the initial lock lift (difference between lock chamber and upper or lower pool level at the time the operation is initiated). In effect, the overfill/overempty control acts to throttle the flow of water into and out of the lock chamber. When the valves are opened, the lock control system selects the two (2) appropriate water level sensor signals, subtracts the lower value from the higher value and uses the result to determine the appropriate time at which to initiate the valve closing operation. The valves are then operated in the close direction and should automatically stop at 40% open. Should there be a need to bypass the overfill/overempty feature, this can be done by actuating the bypass switch for this feature on the respective culvert valve control screen. WARNING: Caution should be exercised when bypassing the overfill/overempty feature. Overemptying or overfilling of the lock chamber could result in higher than normal stresses on hawser lines.

D. Culvert Valve - Culvert Valve Interlock.

The culvert valve - culvert valve interlock prohibits both the operation of the upper culvert valve(s) when the lower culvert valves are not fully closed and vice-versa. If the fill culvert valves cannot be operated and the position transmitter system indicates that the lower culvert valve(s) are closed, then a visual inspection of the lower culvert valve(s) should be made. If the lower valves are closed and the upper valves still cannot be operated, then the lower miter gates should be checked to ensure that they are properly mitered, see Paragraph D below. If the fill valves cannot be operated with properly mitered lower miter gates and fully closed empty valves, the culvert valve - culvert valve interlock can be bypassed. This is done by pressing the C.V.-C.V. Bypass pushbutton on the culvert valve control screen. Bypass of the interlock on the fill valves to allow the empty valves to operate is similar. WARNING: Extreme caution should be exercised when bypassing the culvert valve - culvert valve interlock. Culvert valve operations made without the appropriate interlocks in place can be catastrophic.

E. Miter Gate - Culvert Valve Interlock.

The miter gate - culvert valve interlock prohibits both the operation of the upper culvert valve(s) if the lower miter gates are not properly mitered and the operation of the lower culvert valve(s) if the upper miter gates are not properly mitered. The status of the miter gate limit switches is indicated on the culvert valve control screen on the control console. If either the top or bottom limit switches are open, the opposite end culvert valves will not operate. If both limit switches are closed, then the miter gates are properly mitered and the opposite end culvert valves may be opened. If it is indicated that both limit switches are closed and the culvert still does not operate, check the culvert valve - culvert valve interlock, see Paragraph C above. If the culvert valve – miter gate valve interlock is not activated, try to put the miter gate in a properly mitered position that will close the limit switches. If this fails, then the interlock can be bypassed.

Only the bottom miter gate limit switch can be bypassed from the control console. To do this, actuate the “BYPASS BOTTOM LIMIT SWITCH” “pushbutton” on the culvert valve control screen on the control console. The “pushbutton” will flash when the limit switch is bypassed. The bottom limit switch can also be bypassed from the HPU station. However, the top limit switch on the miter gate can only be bypassed from the HPU Station by toggling the appropriate bypass selector switch from “Normal” to “Bypass”. It is noted that the top limit switch on the downstream gate is bypassed from the upstream HPU station. Similarly, the top limit switch on the upstream gates is bypassed from the downstream HPU station. When a limit switch is bypassed, a red pilot light for that bypass condition will be energized. All personnel, especially maintenance, should be notified immediately of the bypassed limit switch. WARNING: Extreme caution should be exercised when bypassing a miter gate - culvert valve interlock. Culvert valve operations made when miter gates are not properly mitered can be catastrophic. NEVER OPERATE UPSTREAM MITER GATES UNLESS THE EMPTY VALVES ARE COMPLETELY CLOSED. NEVER OPERATE DOWNSTREAM MITER GATES UNLESS THE FILL VALVES ARE COMPLETELY CLOSED.

F. Backup Control Stations.

1. General.

The backup control stations (BUCS) are to be used when there is a problem with the PLC locks control system or when weather conditions require local control as determined by lock personnel. The BUCS are hung on the handrail at monolith L-8 (downstream) and at monolith L-28 (upstream), adjacent to the miter gates. The backup control stations contain selector switches and indicators for the miter gate latches and HPU pumps, joysticks for miter gate control, controls for the culvert valves and a pushbutton for the discharge warning siren (downstream BUCS only). The BUCS’s only allow control of the adjacent set of lock machinery and culvert valves. Fill valve control is accomplished with pushbuttons from the upstream BUCS. Empty valve control is accomplished with selector switches from the downstream BUCS.

When controlling the lock from the BUCS, the operator is required to toggle two selector switches at the adjacent HPU station. To enable miter gate control from the BUCS, the operator must toggle the miter gate control selector switch in the adjacent HPU station from the “PLC” position to the “BACKUP STA.” position. The operator must also toggle the Digital Output Power selector switch to the off position. Power to the digital outputs must be turned off to de-energize the hi pressure relief solenoid valve that is energized by the PLC system when the miter gate culvert valve interlock limit switch is closed. Otherwise, it may not be possible to move the miter gates. When controlling from the Operations Building, these two selector switches must be toggled back to the PLC and on positions, respectively. If the BUCS are not in use, they should be unplugged, removed, and stored in a conditioned space. Affect of the positions of these switches is explained in more detail in the next paragraph.

2. Proper Position of Selector Switches at HPU stations.

NOTE: When the PLC is operational and power to the digital outputs is available, the hi pressure relief solenoid valve will be energized when the miter gates are properly mitered and not allow movement of the miter gates from the joysticks on the BUCS if the limit switch is made and the solenoid valve is operating properly. This is true regardless of whether the miter gates are being operated from the BUCS or from the Operations Building. The hi pressure relief valve holds the miter gate leaves in the mitered position up to a reverse head of 12 inches. When control is again desired from the lock operations building, the switch must be toggled back to the on position. When the PLC is not operational, the hi pressure relief solenoid valve is not energized at the miter position. Therefore, the operator must ensure that the miter gates remain mitered until a head is put on the gates.

3. Availability of Interlocks

NOTE: When operating from the backup control stations, the miter gate – culvert valve interlocks are active. However, the culvert valve – culvert valve interlocks are not active. Therefore, operators should ensure that before operating any lock features that the culvert valves are in their proper positions. When operating the lock from the BUCS, overfill/overempty control is not provided. Therefore, the operator should manually provide this feature by closing the valves early in a fashion similar to that done by the PLC. This can be done by starting the valves closed before the lock chamber water level reaches the target level, i.e., upper or lower pool.

G. Lighting Procedure.

The navigation lights on the ends of guide walls and guard walls are turned on and off by photo-control from the HPU Stations. When work required by the contract for remote control programming services is complete, the navigation lights will be turned on and off manually at the control console. A selector switch in enclosure B of the HPU station allows control of the lights from the control console (remote position) or from the respective HPU station (local position). Currently, manual override of these lights has been provided in Enclosure B in the HPU stations. “Low level” lock lights are turned on at dusk by photo-control and remain on during hours of darkness. Floodlights in the miter gate recesses should be turned on at dusk. Lighting in the Operations Building is used as required. Dusk-to-dawn lights at the Maintenance and Operations Building provide additional site/security type outside lighting. The upstream and downstream high mast approach lights are used to illuminate the vertical faces of the approach walls and are manually controlled from the control console. They may also be controlled from MCC1 where they receive their power. The lighting and signal control screen on the control console also has “pushbuttons” for the control of floating mooring bitt lights, up and downstream approach wall lights, and the emergency howler. Lock “High Level” lights and approach lights are also manually controlled from the lighting and signal control screen.

CHAPTER 11 -OTHER SERVICE FACILITIES.

A. Pool Water Level Pressure Sensors.

Pressure transmitters are located in ladder recesses on the land wall to monitor the lower pool, upper pool and lock chamber water levels . The lower pool pressure transmitter is located at L-5, its lowest point is Elev. 531, and it is rated for 22 psi. The lock chamber pressure transmitter is located at L-9, its lowest point is at Elev. 531, and it is rated for 22 psi. The upper pool pressure transmitter is located at L-30, its lowest point is at Elev. 559, and it is rated for 10 psi. The pressure transmitter signals are inputted into the PLC system and provide indication of the pool levels as well as data for the logic of the lock overfill/overempty system. (See Chapter 9, para. B). Pool levels are read continuously and logged to the control computer hard drive every 15 minutes. The upper gage and lower gage are displayed on digital panel meters on the first floor of the existing Operations Building and on the second floor of the new Operations Building. The lock chamber water level and the upper and lower gages are also displayed on the “Culvert Valve Control Panel” on the control console on the third floor of the Operations Building. It should be noted that the upper and lower pool gage have been displayed because they were available in the lock control system computers. However, they are not intended to be used in lieu of the pool level gages and display(s) provided by Hydraulics. Equipment provided by Hydraulics is marked accordingly and is considered the official pool water level measurement system.

B. Closed Circuit Television (CCTV) System.

A CCTV system consisting of eleven cameras and six 19" monitors provides specific surveillance of the lock approaches, the new and old locks, the operations area, the gate bay area, and the dam. All cameras are equipped with zoom lens and are in weatherproofed housings mounted on pan and tilt units. The following table lists camera locations:

Table 2: Camera Schedule

GATE NO.	TAINTER	1	2	3	4	5	6	TOTAL OPENING
SEQUENCE *	F	G	D	A	B	C	E	(FEET)
1							1	
1			1				2	
1			2				3	
1			2	1			4	
1			2	2			5	
1			2	2	1		6	

10	Roof of the Operations Building
11	Maintenance Area

The cameras can be controlled and monitored from the second or third floor of the Operations Building and from the Maintenance Building. The monitor/control site on the third floor of the operations building includes four monitors, a video cassette recorder, a controller/follower for zoom lens, and pan/tilt control. The monitor/control site on the second floor of the operations building includes one monitor, one 8-position sequential switcher, and one controller/follower.

C. Warning Signs.

Valve discharge warning signs are located on the riverwall in the area of the culvert valve discharge. These signs are to warn boaters of the danger of boating in the area of the discharges. The discharge warning siren, which is also used to warn boaters, automatically sounds for seven seconds upon actuation of the empty valve open “pushbutton”. The siren may also be activated manually from a pushbutton on backup control station no. 2.

D. Sewage Lift Stations.

The new sewage lift station receives sewage from the Operations Building, the Maintenance Building, and the existing sewage lift station on the old locks. Operation and maintenance of the lift stations is according to the manufacturer's recommendations or the District Office. The controller and warning alarm for the new lift station are located adjacent to the lift station. The sewage lift station and controller on the original locks is in the original operations building.

CHAPTER 12 -MISCELLANEOUS

A. Protection of the General Public.

Public visitors that are unescorted shall not be permitted outside of the fenced area around the visitor's parking area. A visitor's overlook is located off the parking area for the use of the general public. Care shall be exercised to remove any hazard that could cause, or contribute to, an accident. On occasions, after proper approval, the public will be permitted to tour the installation, but only under the supervision of the lockmaster, his assistant, or a delegated representative. All visitors participating in such tours will be required to wear life vests while outside of the protected fenced areas. It is the duty of the Lockmaster , his assistant, or delegated representative to protect the public from danger, enforce regulations, maintain security and insure that proper care and attention is given to government property.

B. Periodic Inspection.

In accordance with the provisions of ER 1110-2-100, dated 15 November 1968, entitled Periodic Inspection of Continuing Evaluation of Completed Civil Works Structures, the Robert C. Byrd Locks and Dam project will be inspected after the project is placed into full operation. The inspection and evaluation program is intended to insure the continuing structural stability, safety and operational adequacy of the various projects constructed and operated by the Corps of Engineers. The inspection includes all major components of a lock and dam such as the upper and lower guide wall, upper and lower guard wall, land lock wall, river lock wall, upper and lower miter gate sills, miter gates, roller gates, tainter gate, dam piers, sills, emergency gates, and stilling basin. The inspection will be conducted at frequent intervals to insure the structural stability, safety, and operational adequacy of Winfield Locks and Dam.

C. Stone Slope Protection.

Inspection shall be performed in accordance with Paragraph B above. Settlement or removal of stone protection and evidence of bank slides or erosion will be reported.

D. High Water Emergency Plan.

In the event of unusually high water predictions or water about to come over the walls, this plan will be implemented by the Lockmaster. The purpose of the plan is to prevent water damage to any lock equipment that may be submerged and to prevent damage by floating drift and debris.

1. Lock Hydraulic units are to be removed and placed on higher ground.

2. Lock Hydraulic Unit Removal: Relieve all pressure from hydraulic lines. Shut off power to hydraulic units at motor control center 1. Shut off all valves under hydraulic oil reservoir and in lines. Disconnect power leads and cap ends. Disconnect lights and electric door. Hang HPU power and control cables on brackets provided in hydraulic power unit station. Place pan under pressure and return line flanges. Loosen bolts in flanges and drain oil. When oil stops pull hydraulic unit out of building. Install two blank flanges with gaskets on pressure and return line. The alternative to removing the hydraulic unit is to shut off all valves, unwire and remove drive motor, disconnect and cap the power leads to the hydraulic unit. Close outside doors and fasten. This should only be done as a last resort.

3. Shut off all power receptacles by breaker located in MCC's. The aluminum hold off blocks will be removed to higher ground. The fire extinguishers at wall levels will be removed. Any oil barrels or spill kits will be removed. Weather station will also be removed. Drum pumps are to be removed. Shut off power to mooring bitt lights, miter gate recess lights, and all panels susceptible to flooding.

4. All equipment that has been removed must be re-installed and all disconnected electrical circuits must be reconnected. All drift and mud must be washed from the walls, sector gear pits and gallery.

The lock equipment, walls, roller gates and bridge piers should be checked for damage.

E. Low Water Plan - Bulkhead Sill.

The sill upstream of the emergency gate has a removable steel bulkhead. **In the event of a loss of upstream pool,** this bulkhead might be removed to insure a minimum draft of 5 foot through the lock. The following is the 'Procedure for Removing and Replacing the Sill Bulkhead':

1. The sill bulkhead would only be removed in the event of the loss of upper pool. With the sill bulkhead removed there would be a minimum of a 5-foot draft through the lock.

2. The first step would be to lower the emergency gate to the low sill position (See Position 3, Fig. 17).

3. The second step is to bring the derrick boat into the lock chamber and set the upstream bulkheads.

4. The third step would be to lower the water in the lock chamber to lower pool. This will expose the top of the sill bulkhead.

5. The fourth step is to attach the pickup beam to the sill bulkhead. The head on the sill bulkhead would be balanced by either filling the lock chamber or

dewatering the lock approach between the upstream bulkheads and the sill bulkhead. The sill bulkhead could be lifted by the derrick boat.

6. The last step would be to remove the upstream bulkheads.

1. The installation of the sill bulkhead could take place anytime after normal upper pool is re-established.

2. The first step would be to set the upstream bulkheads and lower the water in the approach below the bulkheads to normal lower pool. This will expose the slots for the sill bulkhead.

3. The second step would to have divers carefully submerged portions of the slots, and pass to assure that they are clear of debris.

4. The third step would be to set the sill bulkhead in place, raise the water level to upper pool and remove the upstream bulkheads.

5. The last step would be to raise the emergency gate from the low sill position. Actuate the compressed air flushing nozzles for several minutes to dislodge any silt which might have accumulated. Raise the emergency gate to the stored position (See Position 1,Fig. 15).