W.E.S.T. USA, Inc. (WEST) is working with clients to get in front of some of these issues. Our approach is in the form of creating a digital, searchable document that details the technical aspects of the facility and merges these details with the institutional knowledge that exists within the employees currently at the facility.

This approach provides a means to capture the knowledge of those who will be retiring or moving into a new role, and an opportunity to provide a resource to new hires. It also provides information required to perform job tasks, ensures consistency of O&M, ensures compliance to prescribed activities (HS&E, organizational guidelines, and regulations), provides an effective training and coaching document, captures the institutional memory of the organization, and provides a platform for job process evaluation and improvement.

A typical document would include a general facility description.

## 0.4 GENERAL FACILITY DESCRIPTION

SAMPLE dam and powerhouse is located at mile 157.3 on the Bad River which merges with the Good River just above Neverville to form the Neutral River. The SAMPLE project was the first of several main river projects constructed by SAMPLE. SAMPLE was the first hydroelectric plant to be automated under the SAMPLE wide automation program and began automated operation in 2020.

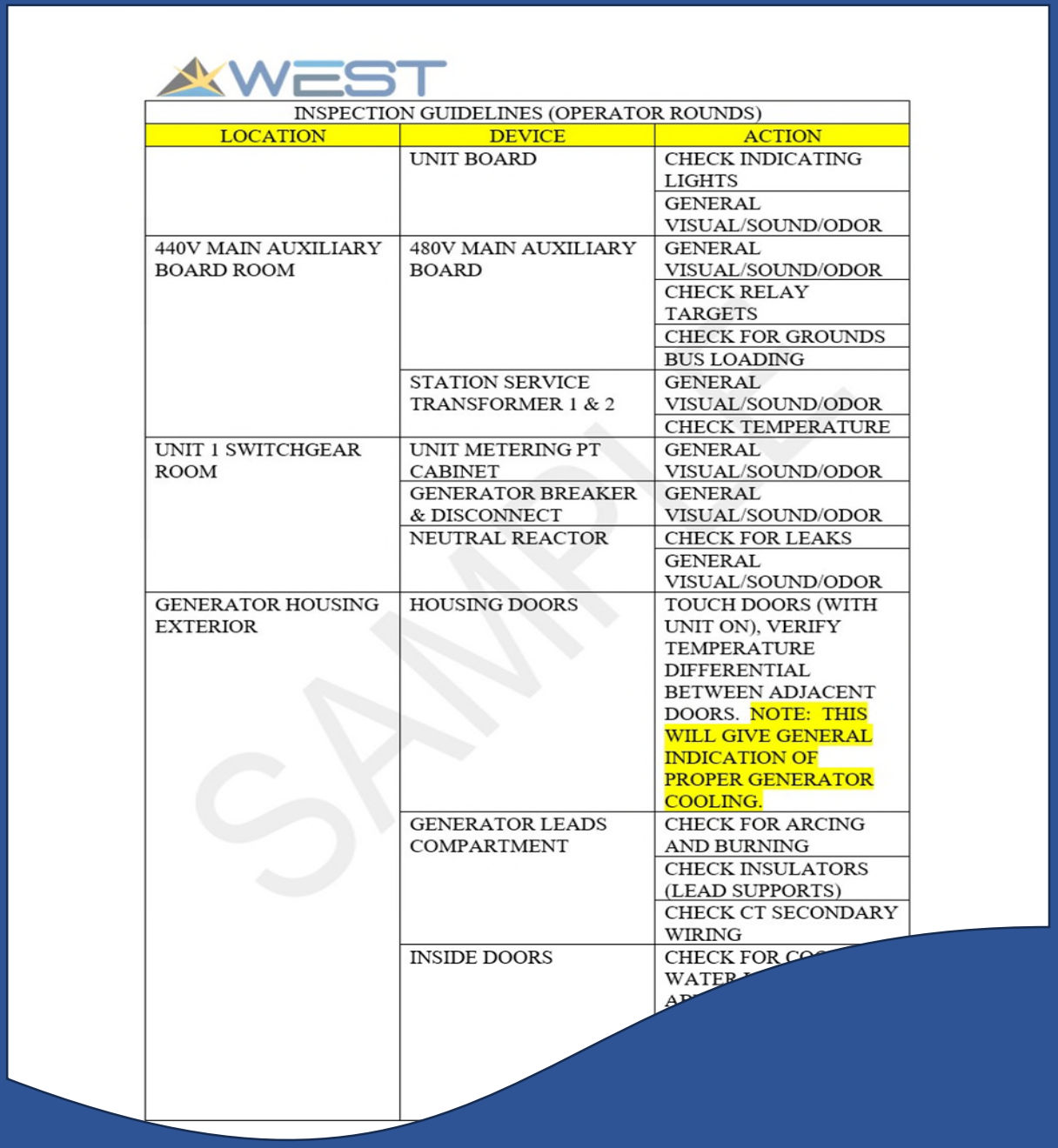
The SAMPLE dam consists of concrete gravity-type spillway, intake, and bulkhead sections flanked by earth embankments on both sides. The total length of the dam is 7,550 feet, exclusive of the saddle dams. The maximum height of the dam from the lower part of the foundation to the spillway deck is 275 feet.

The flow over the spillway, which has a maximum discharge capacity of 345,000 cubic feet per second, is controlled by nine 28 by 40-foot radial gates. The radial gates are operated by two traveling hoists. Eight sluiceways are provided in the spillway for low water releases.

The powerhouse intake section contains the penstocks, trashracks, gates, and gate hoisting equipment. The powerhouse is a reinforced concrete and structural steel structure of the semi-outdoor type with a 250-ton gantry crane mounted on the roof. The draft tube gates are operated with a jib boom hoist on the powerhouse gantry crane. The electrical bay, control room, and office spaces are located upstream from the units and over the toe of the intake blocks.

Each of the four SAMPLE generators is dri
hydraulic turbine. The turbine is rate
full gate, and 100-foot net he
kva, 0.9 power factor, 9

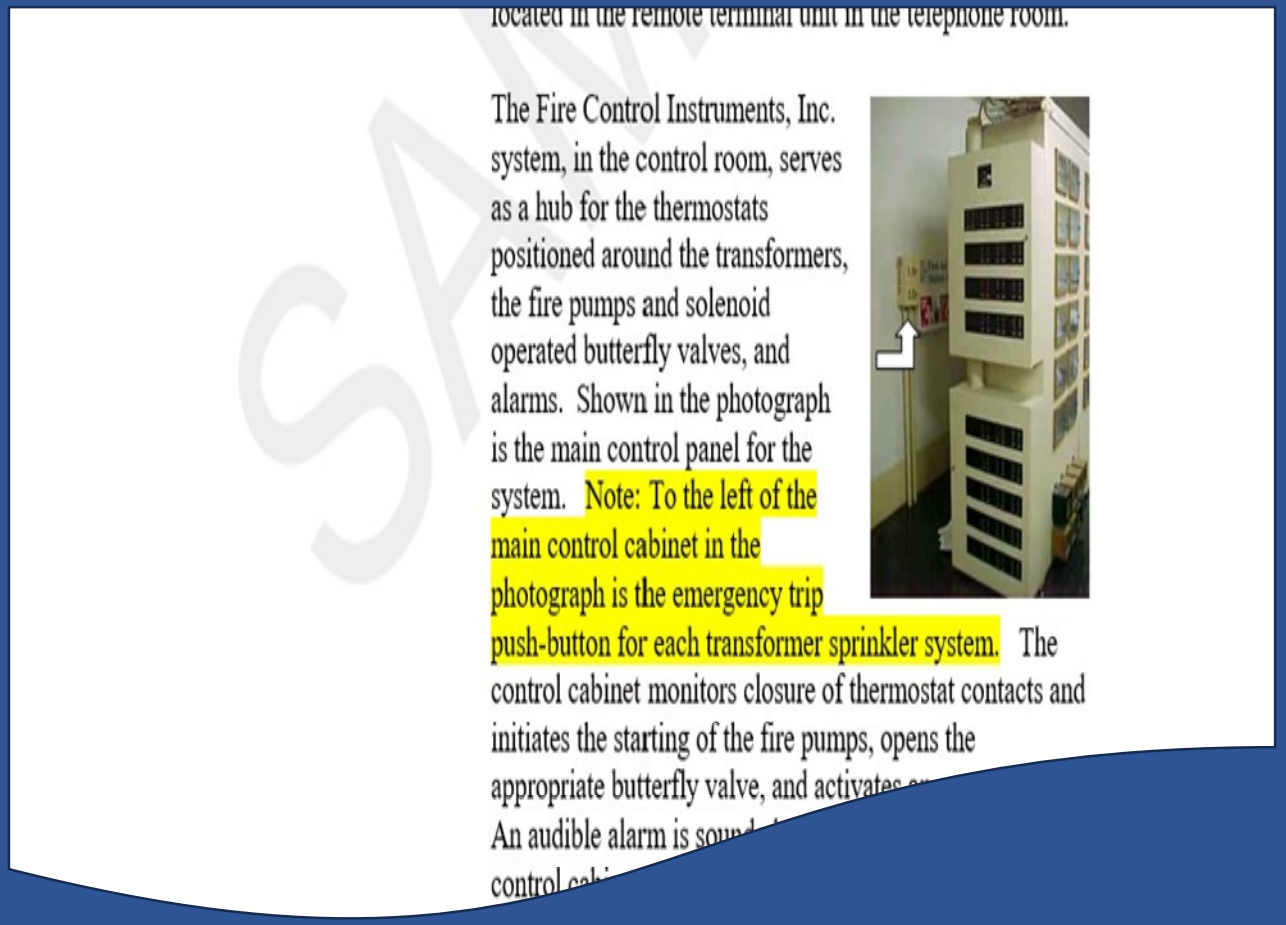
General inspection guidelines and, in some cases, with notes indicating what the actions may indicate.



WEST

| INSPECTION GUIDELINES (OPERATOR ROUNDS) | | |
|---|---|---|
| LOCATION | DEVICE | ACTION |
| | UNIT BOARD | CHECK INDICATING LIGHTS |
| | | GENERAL VISUAL/SOUND/ODOR |
| 440V MAIN AUXILIARY BOARD ROOM | 480V MAIN AUXILIARY BOARD | GENERAL VISUAL/SOUND/ODOR |
| | | CHECK RELAY TARGETS |
| | | CHECK FOR GROUNDS |
| | | BUS LOADING |
| | STATION SERVICE TRANSFORMER 1 & 2 | GENERAL VISUAL/SOUND/ODOR |
| | | CHECK TEMPERATURE |
| UNIT 1 SWITCHGEAR ROOM | UNIT METERING PT CABINET | GENERAL VISUAL/SOUND/ODOR |
| | GENERATOR BREAKER & DISCONNECT | GENERAL VISUAL/SOUND/ODOR |
| | NEUTRAL REACTOR | CHECK FOR LEAKS |
| | | GENERAL VISUAL/SOUND/ODOR |
| GENERATOR HOUSING EXTERIOR | HOUSING DOORS | TOUCH DOORS (WITH UNIT ON), VERIFY TEMPERATURE DIFFERENTIAL BETWEEN ADJACENT DOORS. NOTE: THIS WILL GIVE GENERAL INDICATION OF PROPER GENERATOR COOLING. |
| | GENERATOR LEADS COMPARTMENT | CHECK FOR ARCING AND BURNING |
| | | CHECK INSULATORS (LEAD SUPPORTS) |
| | | CHECK CT SECONDARY WIRING |
| | INSIDE DOORS | CHECK FOR CO... WATER ... AR... |

Additional details with specific locations of devices highlighted in the document text and specific photos of the adjacent equipment to assist in the exact location.



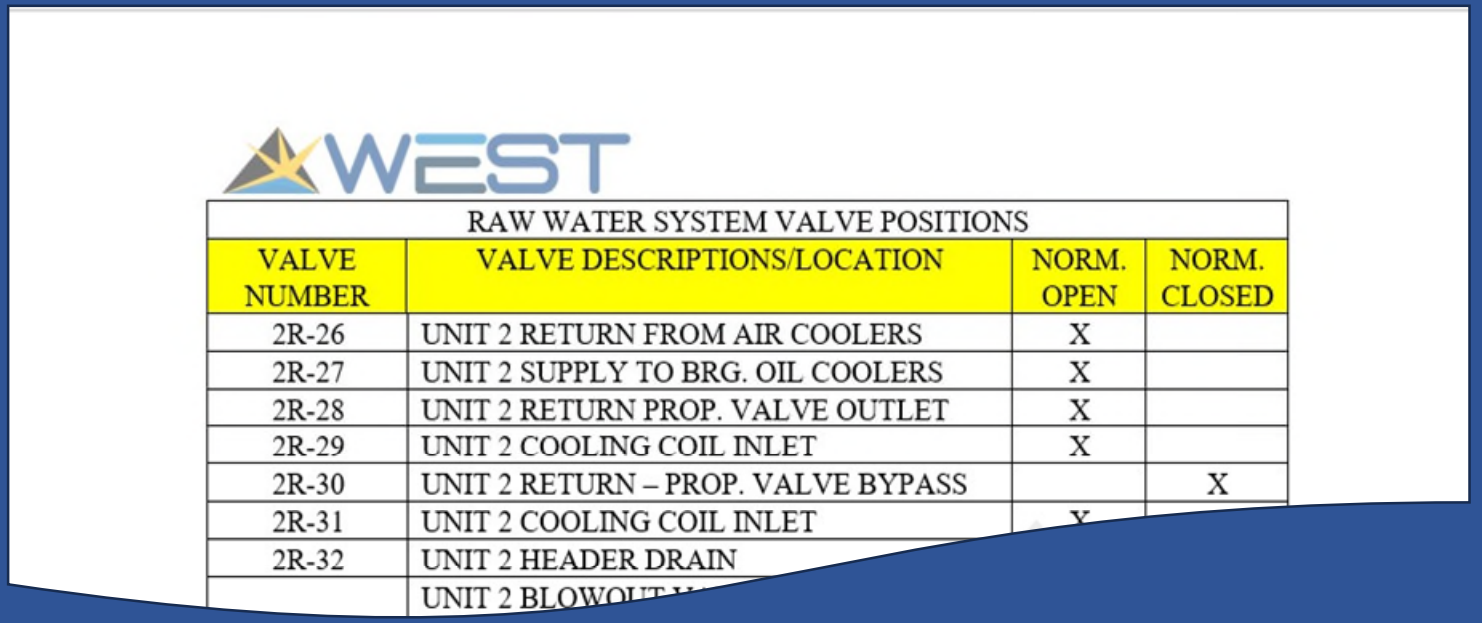
located in the remote terminal unit in the telephone room.

The Fire Control Instruments, Inc. system, in the control room, serves as a hub for the thermostats positioned around the transformers, the fire pumps and solenoid operated butterfly valves, and alarms. Shown in the photograph is the main control panel for the system. Note: To the left of the main control cabinet in the photograph is the emergency trip push-button for each transformer sprinkler system. The control cabinet monitors closure of thermostat contacts and initiates the starting of the fire pumps, opens the appropriate butterfly valve, and activates

An audible alarm is sound

control cab

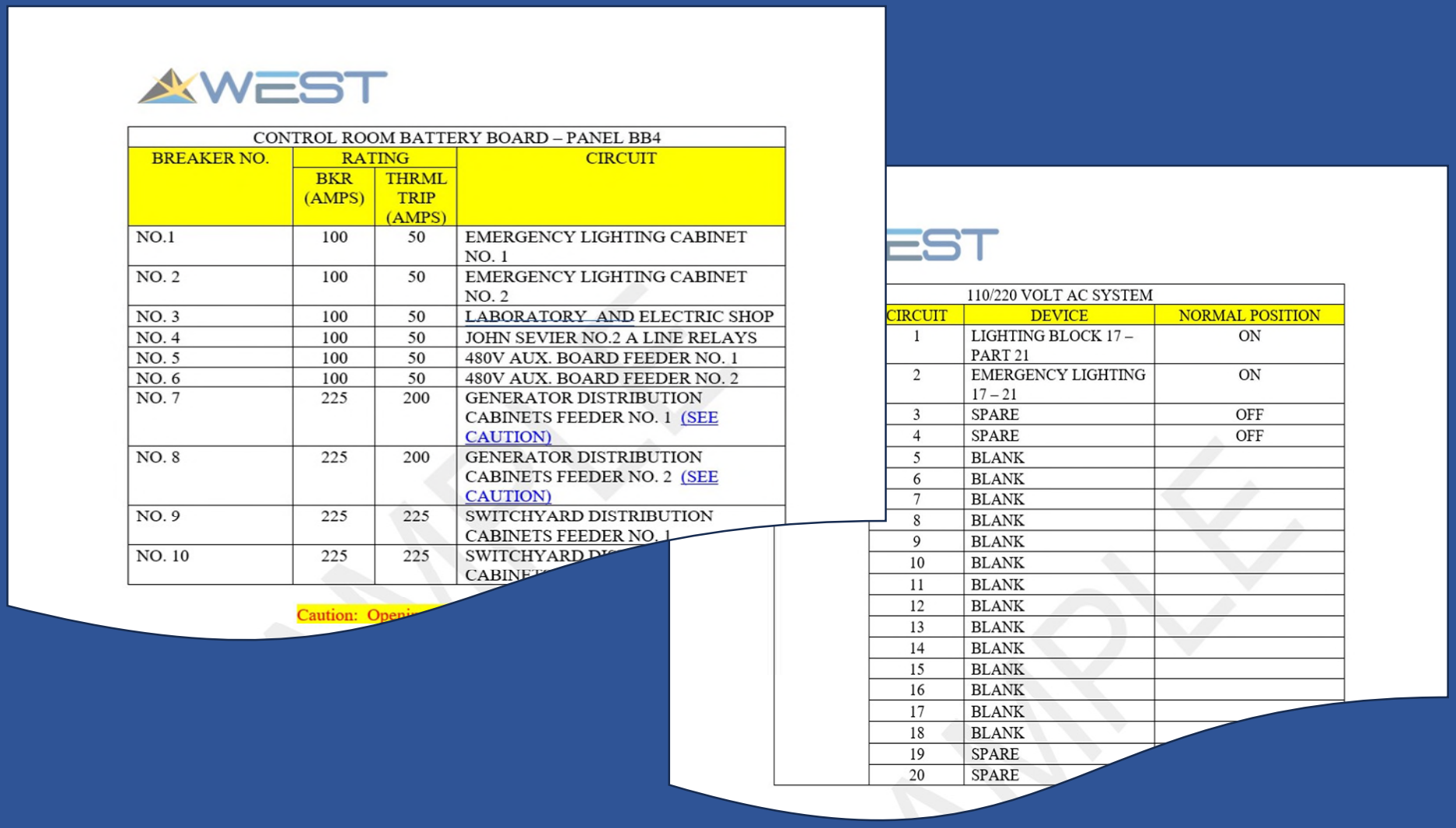
The document is all-inclusive of valves in the powerhouse, valve numbers, description, and normal position.



RAW WATER SYSTEM VALVE POSITIONS

| VALVE NUMBER | VALVE DESCRIPTIONS/LOCATION | NORM. OPEN | NORM. CLOSED |
|---|---|---|---|
| 2R-26 | UNIT 2 RETURN FROM AIR COOLERS | X | |
| 2R-27 | UNIT 2 SUPPLY TO BRG. OIL COOLERS | X | |
| 2R-28 | UNIT 2 RETURN PROP. VALVE OUTLET | X | |
| 2R-29 | UNIT 2 COOLING COIL INLET | X | |
| 2R-30 | UNIT 2 RETURN – PROP. VALVE BYPASS | | X |
| 2R-31 | UNIT 2 COOLING COIL INLET | X | |
| 2R-32 | UNIT 2 HEADER DRAIN | | |
| | UNIT 2 BLOWOUT | | |

Circuit breakers are listed, indicating the breaker number, rating, and circuit served. Cautions are included and highlighted, for example, noting that opening a specific breaker will trip a unit.



WEST

| CONTROL ROOM BATTERY BOARD – PANEL BB4 | | | |
|---|---|---|---|
| BREAKER NO. | RATING | | CIRCUIT |
| | BKR (AMPS) | THRML TRIP (AMPS) | |
| NO.1 | 100 | 50 | EMERGENCY LIGHTING CABINET NO. 1 |
| NO. 2 | 100 | 50 | EMERGENCY LIGHTING CABINET NO. 2 |
| NO. 3 | 100 | 50 | LABORATORY AND ELECTRIC SHOP |
| NO. 4 | 100 | 50 | JOHN SEVIER NO.2 A LINE RELAYS |
| NO. 5 | 100 | 50 | 480V AUX. BOARD FEEDER NO. 1 |
| NO. 6 | 100 | 50 | 480V AUX. BOARD FEEDER NO. 2 |
| NO. 7 | 225 | 200 | GENERATOR DISTRIBUTION CABINETS FEEDER NO. 1 (SEE CAUTION) |
| NO. 8 | 225 | 200 | GENERATOR DISTRIBUTION CABINETS FEEDER NO. 2 (SEE CAUTION) |
| NO. 9 | 225 | 225 | SWITCHYARD DISTRIBUTION CABINETS FEEDER NO. 1 |
| NO. 10 | 225 | 225 | SWITCHYARD DI… CABINE… |

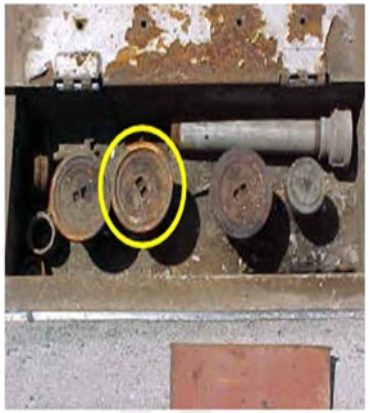
Caution: Openi…

EST

| 110/220 VOLT AC SYSTEM | | |
|---|---|---|
| CIRCUIT | DEVICE | NORMAL POSITION |
| 1 | LIGHTING BLOCK 17 – PART 21 | ON |
| 2 | EMERGENCY LIGHTING 17 – 21 | ON |
| 3 | SPARE | OFF |
| 4 | SPARE | OFF |
| 5 | BLANK | |
| 6 | BLANK | |
| 7 | BLANK | |
| 8 | BLANK | |
| 9 | BLANK | |
| 10 | BLANK | |
| 11 | BLANK | |
| 12 | BLANK | |
| 13 | BLANK | |
| 14 | BLANK | |
| 15 | BLANK | |
| 16 | BLANK | |
| 17 | BLANK | |
| 18 | BLANK | |
| 19 | SPARE | |
| 20 | SPARE | |

Oil handling systems and fill/drain connection locations are detailed.

5.3.2.2 Lubricating and Governor Oil Handling



A 3 inch oil fill connection to receive incoming governor and lubricating oil from a tanker is provided. The connection (Fill and Reject Box) is located at elevation 982 just outside of the main lobby door in the northwest direction approximately 12 foot from the corner of the building. The connection for the lube and governor oil is the one shown in the yellow circle in the photograph above. Oil can be conveyed between the tanker and the governor and lube oil system through this connection.

Note: The connection and vent located on the right side of the Fill and Reject Box, as seen in the phot… the Gas-Electric Generator.

To remove oil f… tank…

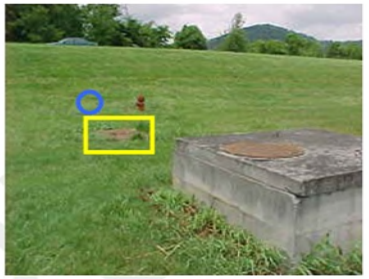
Potable water systems supplying the facility are described in detail with specific equipment locations.

# CHAPTER 105-PLANT SERVICES

## 5.1 SERVICE WATER SUPPLY SYSTEMS

### 5.1.1 GENERAL

#### 5.1.1.1 Treated Water



Treated water for SAMPLE was originally supplied from a spring through a pump house and treatment facility located south of the south embankment. The Sample City Water District now supplies treated water to the facility through a meter pit located in the field approximately 500 feet from the south bank of the Ton River and east of Highway 192. The meter pit is shown in the photograph and outlined in yellow. There is an isolation valve located under a blue cover located in the area of the blue circle shown in the photograph.

A pressure regulator in series with the meter reduces the pressure to 125 PSI. Isolation valves are on the discharge side of the pressure regulat... regulator and isolation valves ... adjacent to the meter pi...

A 6 inch li...

Rotating equipment is included in the document listing the nameplate data of all turbine-generators.

# CHAPTER 102 – MAJOR ROTATING EQUIPMENT

## 2.1 TURBINES

### 2.1.1 GENERAL

The turbine at SAMPLE consists of four Francis-type hydraulic turbines, manufactured by the S. Morgan Smith Company and are direct-connected to the generators. The turbines are rated 41,500 horsepower under a net head of 100 feet and operated at a speed of 94.7 RPM's. The turbines are designed to operate under any head from a minimum of 55 feet to a maximum of 146 feet. They are also designed to withstand a maximum runaway speed of 189 RPM's. At rated conditions the runner is set about 5 feet above normal tailwater elevation.

The runner for each unit is a one-piece casting with 15 blades. The inlet diameter is 165 inches, and the throat diameter is 171 inches. The runner is bolted to a shaft that has a diameter of 33 inches and a length of 12 feet $6^{7}/_{8}$ inches. The main shaft is a mild-steel forging with flanges at both ends. The upper flange is for bolting to the generator coupling and the lower flange for bolting to the runner.

| TURBINE CHARACTERISTICS | |
|---|---|
| DESCRIPTION | RATING |
| NORMAL SPEED | 94.7 RPM |
| RUNAWAY SPEED | 189 RPM |
| SPECIFIC SPEED | 61 RPM |
| DISCHARGE AT GENERATOR RATING (30,000 KW) AND 100 FOOT HEAD | 4,250 CFS |
| TRASHRACK WATER VELOCITY | 2.3 FEET/SECOND |
| INTAKE GATE WATER VELOCITY | 11.9 FEET/SECOND |
| SCROLL CASE ENTRANCE WATER VELOCITY | 15.0 FEET/SECOND |
| DRAFT TUBE EXIT WATER VELOCITY | 7.1 FEET/SECOND |
| TOP SEAL CLEARANCE | 1/32 INCH |
| BOTTOM SEAL CLEARANCE | 5/64 INCH |
| WICKET GATE TOTAL CLEARANCE | 1/16 INCH |

All bearings and support equipment are detailed, including the location and positions of operating control switches.

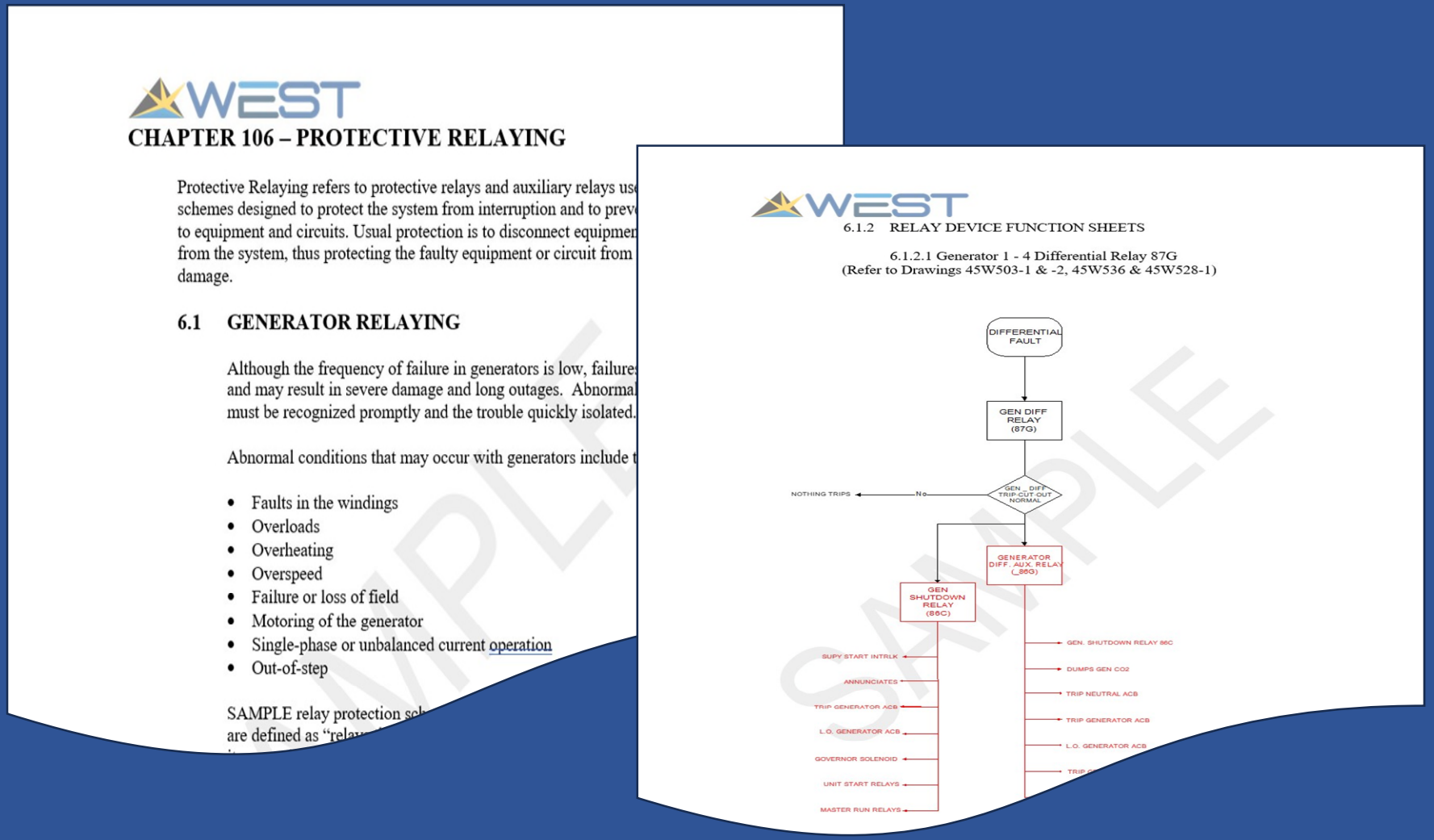
| | |
|---|---|
| CURB RING | 46,500 POUNDS |
| DRAFT TUBE LINER | 17,000 POUNDS |

2.1.2 TURBINE BEARING

The turbine bearing is a babbitt-lined oil-lubricated type having a diameter of 33 ½ inches. A chromium steel corrosion-resistant sleeve, 33 ½ inches in diameter by 11 ½ inches high protects the shaft where the shaft passes through the stuffing box and bearing at the head cover. Normally an AC motor-driven pump circulates the lubricating oil for the turbine bearing. The oil pump is supplied 480VAC from the unit board. The oil pump is rated at 480VAC, 3-phase, ½ HP, 1725 RPM, and normal pressure is approximately 15 pounds. There is also a DC motor-driven pump supplied 250VDC from the unit DC Cabinet. The DC pump is rated at 250VDC, ½ HP, and 1725 RPM. In the event there is a failure of the AC pump, a flow indicator and pressure control device operate. The operation of the flow indicator and pressure device causes an alarm to sound, an annunciator panel window to illuminate, and starts the DC pump. Local controls located at the pumps and outlined in yellow in the photograph are listed in the table.

| TURBINE GUIDE BEARING LUBE OIL PUMP LOCAL CONTROLS & POSITIO | |
|---|---|
| AC LUBE OIL PUMP | DC LUBE O |
| "REMOTE" | |
| "OFF" | |
| "ON" | |

Protective relaying systems are detailed, including settings, locations, etc., as well as device function sheets.



WEST

CHAPTER 106 – PROTECTIVE RELAYING

Protective Relaying refers to protective relays and auxiliary relays us
schemes designed to protect the system from interruption and to prev
to equipment and circuits. Usual protection is to disconnect equipmer
from the system, thus protecting the faulty equipment or circuit from
damage.

6.1 GENERATOR RELAYING

Although the frequency of failure in generators is low, failure
and may result in severe damage and long outages. Abnorma
must be recognized promptly and the trouble quickly isolated.

Abnormal conditions that may occur with generators include t

- Faults in the windings
- Overloads
- Overheating
- Overspeed
- Failure or loss of field
- Motoring of the generator
- Single-phase or unbalanced current operation
- Out-of-step

SAMPLE relay protection sch
are defined as "relay

WEST

6.1.2 RELAY DEVICE FUNCTION SHEETS

6.1.2.1 Generator 1 - 4 Differential Relay 87G
(Refer to Drawings 45W503-1 & -2, 45W536 & 45W528-1)

Specific equipment details are included, as well as notes and cautions highlighted.

the downstream frame when in the closed position, and the 24-inch hydraulic hoist is used for operation of the gate leaf mounted directly above the leaf on the bonnet of the gate. The piston of the hoist is connected to the leaf by a steel stem and is fitted with a stem extension that projects up through the top head of the hydraulic cylinder. The upper end of the extension is fitted with a coned head that engages a suspended semiautomatic gate hanger, or dog when the gate leaf is in the raised position. A hanger is shown in the photograph. The hanger prevents the gate from drifting down to the closed position as a result of possible leakage of oil past the piston rings. The hooks or jaws of the hanger may be released for lowering the gate leaf by a pull chain.

Note: Proper release of the hanger should be to raise the gate a small distance to relieve the pressure on the hanger, then pull the chain down to open the hanger, releasing the coned head.

Caution: Do not pull the chain to
cause the hanger to re

Details of the dam, spillway, and associated equipment are included.

# CHAPTER 107 – DAM EQUIPMENT AND AUXILIARIES

## 7.1 GENERAL

The SAMPLE Dam is a concrete and earthfill gravity type structure. The fundamental principal of this type of structure is to provide as watertight a structure as possible to prevent loss or leakage of water through or around
This is accomplished by making the foundatio
structure. The dam consists of co
original river channel. T

## 7.3 SPILLWAY

### 7.3.1 GENERAL

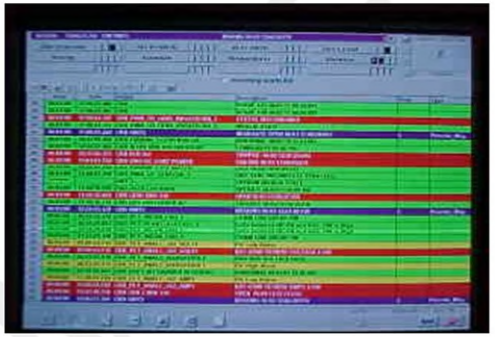
The spillway is located near the south bank of the original river channel. The crest length is 412 feet, consisting of nine openings 40 feet wide, and eight reinforced concrete piers 6 feet 6 inches thick. The spillway is a gravity-type structure separated into blocks, 46 feet 6 inches wide. There are contraction joints at the center of the overfall, midway between the piers. The overfall section of the spillway is an ogee-type overfall. The crest is at elevation 1043, surmounted by nine 40-f
32-foot-high radial gates that control the
1075. The traveling hoists and d
of the radial gates are l
1082. There

The plant and unit control system alarm system is detailed.

## 5.7.3 ALARMS

### 5.7.3.1 General

Alarms are used to keep personnel aware of equipment operation by providing visual and audible indications. The CS is equipped with an alarming function. The alarming function displays alarms on a monitor, and prints the alarms on a printer in the control room. The alarms displayed at SAMPLE are also routed, through the WAN, to the HD, displayed and printed.

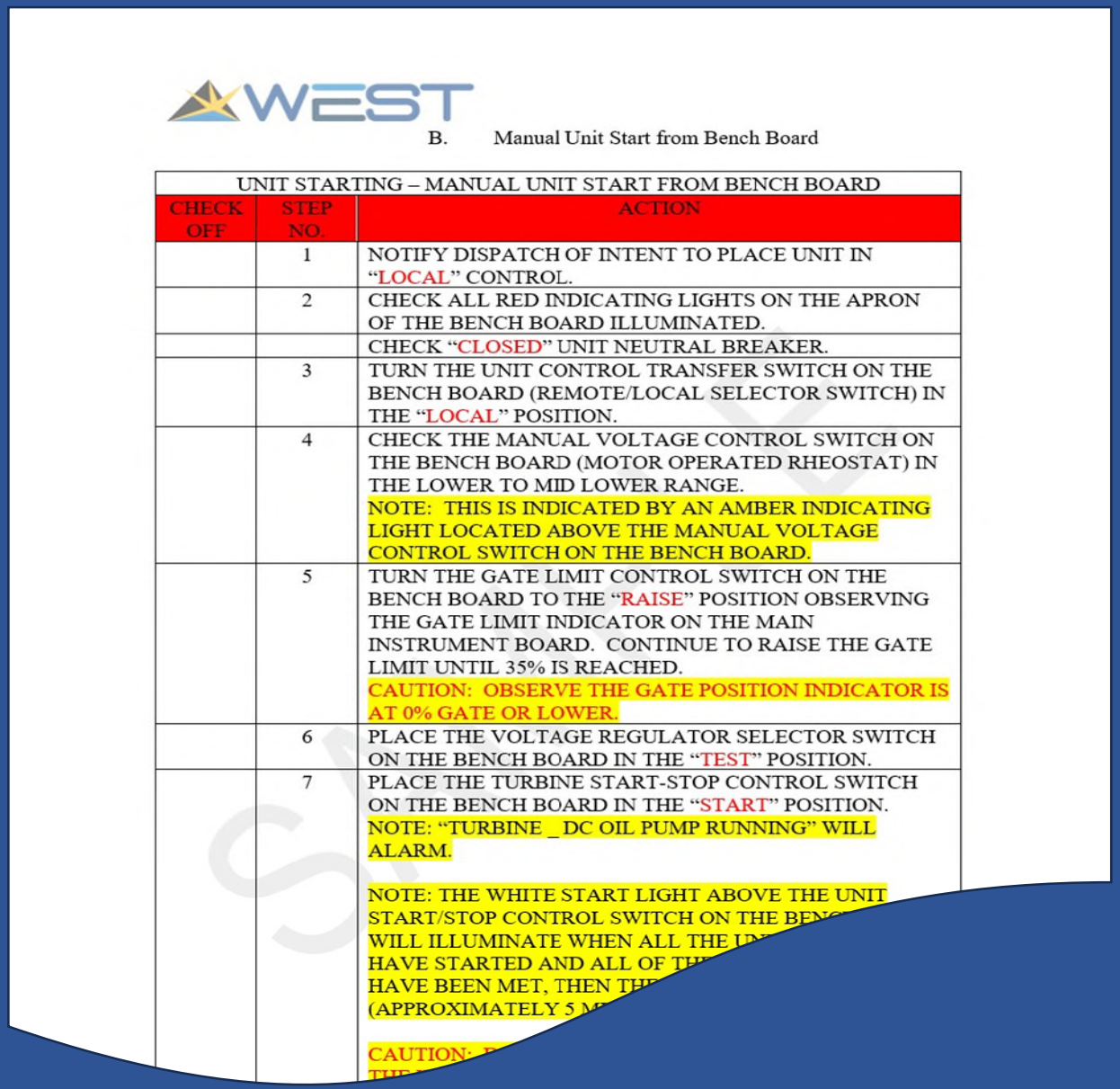


The display that the CS provides is shown in the photograph and is titled "incoming alarm list".

Note the different color lines of text shown in the photograph. The colors represent a specific category of alarms. The categories and description are listed in the following table.

| CS ALARM CATEGORIES | |
|---|---|
| COLOR | DESCRIPTION |
| RED | ALARM |
| PURPLE | PROCESS MESSAGE |
| GREEN | ACKNOWLEDGE |
| YELLOW | WARNING |
| ORANGE | SYSTEM |
| BLACK | FAILURE |

Specific instructions can be included and can be printed if hard copy documentation and check-off are required. Notes and cautions are included and highlighted in the final document.



B. Manual Unit Start from Bench Board

| UNIT STARTING – MANUAL UNIT START FROM BENCH BOARD | | |
|---|---|---|
| CHECK OFF | STEP NO. | ACTION |
| | 1 | NOTIFY DISPATCH OF INTENT TO PLACE UNIT IN "LOCAL" CONTROL. |
| | 2 | CHECK ALL RED INDICATING LIGHTS ON THE APRON OF THE BENCH BOARD ILLUMINATED. |
| | | CHECK "CLOSED" UNIT NEUTRAL BREAKER. |
| | 3 | TURN THE UNIT CONTROL TRANSFER SWITCH ON THE BENCH BOARD (REMOTE/LOCAL SELECTOR SWITCH) IN THE "LOCAL" POSITION. |
| | 4 | CHECK THE MANUAL VOLTAGE CONTROL SWITCH ON THE BENCH BOARD (MOTOR OPERATED RHEOSTAT) IN THE LOWER TO MID LOWER RANGE.<br>NOTE: THIS IS INDICATED BY AN AMBER INDICATING LIGHT LOCATED ABOVE THE MANUAL VOLTAGE CONTROL SWITCH ON THE BENCH BOARD. |
| | 5 | TURN THE GATE LIMIT CONTROL SWITCH ON THE BENCH BOARD TO THE "RAISE" POSITION OBSERVING THE GATE LIMIT INDICATOR ON THE MAIN INSTRUMENT BOARD. CONTINUE TO RAISE THE GATE LIMIT UNTIL 35% IS REACHED.<br>CAUTION: OBSERVE THE GATE POSITION INDICATOR IS AT 0% GATE OR LOWER. |
| | 6 | PLACE THE VOLTAGE REGULATOR SELECTOR SWITCH ON THE BENCH BOARD IN THE "TEST" POSITION. |
| | 7 | PLACE THE TURBINE START-STOP CONTROL SWITCH ON THE BENCH BOARD IN THE "START" POSITION.<br>NOTE: "TURBINE _ DC OIL PUMP RUNNING" WILL ALARM.<br><br>NOTE: THE WHITE START LIGHT ABOVE THE UNIT START/STOP CONTROL SWITCH ON THE BEN<br>WILL ILLUMINATE WHEN ALL THE UN<br>HAVE STARTED AND ALL OF TH<br>HAVE BEEN MET, THEN TH<br>(APPROXIMATELY 5 M<br><br>CAUTION: |

This approach provides a means to capture the knowledge of those who will be retiring and an opportunity to provide a resource to new hires. It also provides information required to perform job tasks, ensures consistency of O&M, ensures compliance with prescribed activities (HS&E, organizational guidelines, and regulations), provides an effective training and coaching document, captures the institutional memory of the organization, and provides a platform for job process evaluation and improvement.

Contact us for more information

https://west-hydrousa.com