GUAM WATERWORKS AUTHORITY	STANDARD OPERATING PROCEDURE	No.	SOP-1500-WD-003
	Operation and Maintenance for Booster Pump Stations	Effective Date	11/20/2025
		Final Approver	Miguel C. Bordallo, P.E. General Manager
		Revision Letter	A

1.0 Purpose

This Standard Operating Procedure (SOP) is intended to provide guidelines for operating and maintaining the Guam Waterworks Authority's (GWA) Booster Pump Stations (BPS). Booster pumps increase pressure and flow in the distribution system to push water through the system when existing pressure is insufficient to effectively manage peak flow demands. This SOP covers guidelines for operating, inspecting, and maintaining a booster pump station and all its related components, as well as troubleshooting issues and necessary actions to remedy the situation.

2.0 Scope

This SOP applies to all GWA personnel assigned to the Water Distribution section responsible for operating and maintaining the BPS.

3.0 Policy

It is the policy of GWA to optimize system performance through regular maintenance and prompt response to operational issues. GWA is committed to ensuring high-quality, reliable, and safe drinking water in compliance with the Safe Drinking Water Act of 1974 (SDWA).

4.0 Definitions

4.1. **Booster Pump:** A pump that increases water pressure and flow in a distribution system.

4.2. **Call Out:** A request for immediate presence or assistance to address an urgent operational issue in the BPS.

4.3. **Centrifugal Pump:** A pump that uses an impeller to move water or other fluids.

4.4. **Distribution System:** A network designed to deliver potable water from a treatment plant, wells, or reservoirs to its consumers, including residential, commercial, industrial, and public users.

4.5. **JD Edwards EnterpriseOne Capital Asset Management (CAM):** A tool used to manage GWA's Operation and Maintenance Program. CAM tracks the full lifecycle of assets—from acquisition to retirement—including asset performance, and schedules both preventive and corrective maintenance activities[1].

4.6. **Valve:** Regulates and controls flow and pressure in pumping systems.

4.7. **Variable Frequency Drive:** An electric device that controls the speed and torque of an AC (alternating current) motor by adjusting the frequency and voltage of the power supply.

4.8. **Vertical Turbine Pump:** A type of centrifugal pump used to lift water/fluids from deep underground pits or wells.

[1] JD Edwards EnterpriseOne Capital Asset Management Data Sheet (oracle.com)

4.9. **Water / Wastewater System Control Center (SCC):** GWA's primary control/communications hub connecting field personnel and system operators with Operations Supervisors or Managers and executive management. SCC Dispatchers send and receive data to and from field personnel/operators providing critical asset information, additional support, or equipment needed. SCC is also responsible for documenting all transactions between SCC the relevant Operations Supervisor or Manager, and the responding field personnel/operators.

5.0 Roles and Responsibilities

5.1.	General Manager	Approves this SOP and all its subsequent changes.
5.2.	Assistant General Manager for Operations (AGM-O)	Oversees the development, revision, and implementation of this SOP as the Policy Owner.
5.3.	Operations & Maintenance (O&M) Manager, Water Distribution	Reviews this SOP annually and makes necessary changes to be presented to the AGM-O for consideration. Ensures that proper training and/or training guidelines are provided to the affected employees to ensure proper compliance with this SOP.
5.4.	Supervisor, Operation & Maintenance (O&M)	Monitors personnel to ensure compliance with this SOP and provides guidance if needed.
5.5.	Water / Wastewater System Control Center (SCC)	Receives critical report or information from GWA field personnel about the operation of GWA facility. Creates and assigns WO requests as needed. Relays the report or information received, and updates and logs all communications received in the SCC records for its reference.
5.6.	Personnel Services Administrator (PSA)	Works with the Policy Owner and Authors to establish a training module and track compliance of employees involved in the activities of this SOP.
5.7.	Operators	Strictly abide by the contents of this SOP and conduct activities accordingly. When confronted by a situation not covered by this SOP or requiring clarification, seek the manager's or supervisor's assistance.

6.0 Procedure Description

6.1. **Pump Safety:** Specific hazards related to operating and servicing pumps include rotating equipment, lifting heavy machinery, using hand tools, working with electrical devices, and fires. Operators must use appropriate personal protective equipment (PPE) needed to perform the required work. See *Safety Equipment and Supply* **(Attachment 1)**.

6.1.1. **Lock-out/Tag-out (LOTO):** Before performing maintenance or repair activities, follow LOTO procedures[2] to isolate energy sources and prevent accidental start-up.

6.1.2. **Motor and Engine Safety:** Follow special precautions[3] when dealing with motors and engines.

6.1.3. **Electrical Safety:** Operators are advised to adhere to electrical safety procedures[4] and use extreme care when working around transformer installations, or other electrical equipment or systems to prevent electrical shocks or hazards.

6.1.4. **Equipment Check:** Operators must ensure that their vehicles are fully equipped with all necessary equipment, tools, and supplies to perform their duties effectively. See *Tools and Equipment List* **(Attachment 2)**.

6.2. **Pumps:** GWA's booster pump facilities use centrifugal and vertical turbine pumps. Operators shall operate the pumps and all mechanical equipment in accordance with the manufacturer's instructions.

6.3. **Schedule and Assignment:** Preventive maintenance (PM) is performed based on various factors, including the manufacturer's recommendations, regulatory requirements, and historical data. The recommended PM is added and entered into the Capital Asset Management (CAM) system to generate a Work Order (WO). The Maintenance Supervisor shall use the CAM to assign, track, and manage all PM activity[5].

6.4. **General Operating Procedures for Pumps:** The general operating procedures for the pumps are listed below. For detailed operating procedures, consult the manufacturer's manual.

6.4.1. **Pre-Start Checks:** Before starting the pump, operators shall perform several checks and preparations to ensure smooth and proper operation.

6.4.1.1. Verify the power supply is off.

6.4.1.2. Verify suction and discharge valves are in the open position. For multiple pumps, confirm each valve is in the desired (open/closed) position.

Note: If the pump uses a water-cooled packing or a mechanical seal, open the valve to the liquid cooling supply line.

6.4.1.3. Confirm the pump is primed (filled and vented).

6.4.1.4. Remove the coupling guard and rotate the pump shaft by hand to make sure it turns freely.

6.4.1.5. Check for leaks, particularly at the shaft seal, then reinstall the coupling guard.

6.4.1.6. Ensure the interior of the motor is clean and free of dirt, oil, grease, water, or other debris. Keep ventilation openings clear to prevent overheating and motor failure.

[2] Refer to *SOP L.104 Lock-out / Tag-out (Energy Hazard Control)*.
[3] Refer to manufacturer's maintenance manual for safety warnings.
[4] See *SOP E.101 Electrical Safety*.
[5] See *SOP GM-062 Preventive Maintenance Scheduling & Assignment.*

6.4.1.7. Turn on the power supply and verify operation controls, alarms, and voltages.

6.4.2. **Starting the Pump:** Always start the pump according to the manufacturer's instructions. Proper start-up procedures are critical for avoiding damage and ensuring the pump operates within its design parameters.

6.4.2.1. Ensure all personnel are clear of dangerous areas.

6.4.2.2. Switch to hand or auto on the control panel.

6.4.3. **Routine Data Collection:** Record pump readings in the *Water Distribution Daily Route Sheet*[6] **(Attachment 3)** and document any issues encountered (e.g., noisy bearings, leaks, corrosion, broken flow meters, pressure gauges, etc.) in the remarks section. Compare these readings to the ones recorded from the previous shift. If there is a significant change, troubleshoot the issue using **Attachment 4** and **Attachment 5**.

6.4.3.1. **Suction and Discharge Readings:** Record the suction and discharge readings. Compare these readings with "normal" values. Make sure valves are set as required. Check shaft packing. Check discharge rate. Check driving equipment.

6.4.3.2. **Flow Meter Readings:** Record the flow rate in gallons per minute (gpm).

6.4.3.3. **Water Meter Readings:** Record the water meter readings for total flow usage.

6.4.3.4. **Power Meter Readings:** Record the power meter readings.

6.4.3.5. **Pump Hours:** Record the number of hours the pump has been running.

6.4.3.6. **Pump Status:** Verify if the pump is on or off.

6.4.3.7. **Variable Frequency Drive (VFD):** Record the frequency in Hertz (Hz) at which the pump is operating.

6.4.4. **Stopping the Pump:** Always review instructions for disconnecting and securing the drive and rotating equipment.

6.4.4.1. **Valves:** As a rule, there is a check valve in the discharge line close to the pump. In such cases, follow these steps:

a. Shut down the pump by stopping the driver according to the manufacturer's manual.

b. Then close all valves, except the check valve, in this order: discharge, suction, pump cooling water supply, and other connections leading to the pump or system.

c. In some instances, however, using a check valve is not feasible because the sudden closing of the valve under high discharge pressure might create pressure surges or a water hammer. In such cases, close the discharge valve slowly to avoid water hammer.

[6] Divided into three forms based on location (north, central, and south).

6.4.5. **Monitoring Operations for Unusual Sounds:** Operators need to recognize normal and abnormal sounds during inspections and document any abnormalities in the remarks section of **Attachment 3**.

6.5. **Maintenance Procedures for Pumps:** General maintenance procedures for all horizontal and vertical centrifugal multi-stage pumps include regular pump inspection and motor performance monitoring. Operators should consult the manufacturer's manual for detailed procedures that apply specifically to volute, diffuser, regenerative-turbine, split-case, and multistage design.

6.5.1. **Lubrication:** The manufacturer's manual provides general lubrication instructions and frequency for special cases, but the following generally applies:

6.5.1.1. To avoid errors, establish a marking system to ensure that the proper lubricant is used. Avoid over-lubrication as it can cause antifriction bearings to overheat and may damage the grease seals and electric motor windings. Simplify operation by using the same type of grease gun fitting (zerk) at all points. This reduces the likelihood of improper grease being used.

6.5.1.2. The recommended lubrication schedule is listed in the *Lubrication Schedule for Pumps* **(Attachment 6)** which may be modified as warranted.

6.5.2. **Packing:** The packing selection is usually done in accordance with the manufacturer's recommendations. For pumping water, packing types include non-reinforced woven or braided cotton packing rope, semi-metallic plastic, or mechanical seals.

6.5.3. **Maintenance During Prolonged Shutdowns:** Pumps shall be maintained during extended shutdown periods to ensure they may be operated at any time. Ensure that the motor is kept dry, and the pump is operated at least once a month whenever possible.

6.6. **Sealing Water System:** Perform daily checks on the sealing water system. If the leakage cannot be adjusted properly, replace the mechanical seal or the packing rope.

6.7. **Rotary Seals:** If a pump has seals that do not have the conventional follower and pliable, replaceable packing, consult the manufacturer's manual for detailed instructions.

6.8. **Shafts and Shaft Sleeves:** When the pump is dismantled each year, examine the shaft carefully at the impeller hub, under the shaft sleeves, and at the bearings.

6.8.1. **Shafts:** Replace any shaft that is bent or distorted. After the shaft has been replaced, check it for possible run out. The maximum allowable is 0.002 inches (51 microns µ).

6.8.2. **Shaft Sleeves:** Inspect shaft sleeves each year. When the sleeve has become appreciably worn, the packing cannot be adjusted to prevent leakage and the sleeve should be replaced.

6.8.3. **Bearings:** Check bearing temperature and lubrication as recommended in the *Maintenance Checklist for Bearings* **(Attachment 7)**, which may be modified as warranted. Follow the manufacturer's manual where petroleum-based lubricants are used.

6.9. **Wearing or Sealing Rings:** Inspect the wear of mechanical seals each year. Do not allow excessive leakage due to worn mechanical seals, or the pump's efficiency will be impaired.

6.9.1. Cartridge mechanical seals do not require any adjustment. The seal type is set to the shaft after the pump lateral is set and must be un-set before any adjustment[7].

6.10. **Impeller:** Each year, remove the rotating element and thoroughly inspect it for wear.

6.10.1. Remove any deposits or scaling.

6.10.2. Check for erosion and cavitations effects. Cavitation causes severe pitting and a spongy appearance in the metal.

6.10.3. If cavitation effects are severe, some changes in pump design or use may be necessary. Report the matter to the supervisor.

6.11. **Casing Maintenance:** Keep the waterways clean and clear of rust. When the unit is dismantled, clean and paint the waterway using a coating certified to NSF/ANSI Standard 61 for potable water contact surfaces. Ensure it is applied and cured in accordance with the manufacturer's guidelines to prevent the introduction of contaminants into the water supply.

6.12. **Pump Shutdown:**

6.12.1. **Shutdown Procedures for General Inspection and Maintenance:**

6.12.1.1. Isolate the pump controls in the control room.

6.12.1.2. Isolate the power and lock-out/tag-out all instruments so others won't re-energize the controls.

6.12.1.3. Once the power is isolated and equipment is locked and tagged, operators shall perform inspection and maintenance activities.

6.12.2. **Shutdown for an Extended Period:** When a pump is shut down for an extended period, the following steps shall be taken:

6.12.2.1. Contact SCC to request assistance from the Electricians who will ensure that all electrical power has been isolated, all instruments are tagged with the circuit breaker number, and any open switches are locked using fully enclosed shockproof panels.

6.12.2.2. Once the power has been isolated, operators shall shut off all the valves on the suction discharge, water seal, and priming lines. Then, drain the pump completely by removing the vent and drain plugs until the water has run off. This operation protects against corrosion and sedimentation.

6.13. **Overhaul Procedures:** The frequency of complete overhaul depends on the pump's operating hours, service conditions, construction material, and maintenance. Pump designs vary so operators should always consult the manufacturer's manual for guidance.

6.13.1. Use extreme care in dismantling the pump to avoid damaging internal parts. For convenience in reassembly, lay out all parts in the order they are removed. Protect all machined faces against metal-to-metal contact and corrosion. Do not remove ball bearings unless absolutely necessary.

[7] Refer to the Mechanical Seal Instruction Manual for further guidance.

6.13.2. While the pump is dismantled, examine the foot and check valves to make sure they are seating and functioning properly.

6.13.3. To assemble the pump, reverse the dismantling procedure. Follow the manufacturer's manual explicitly.

6.13.4. Check the pump and motor alignment after reassembly.

6.14. **Couplings:** Check the alignment of the equipment to prevent outages and the expense of installing replacement parts.

6.14.1. **Checking Coupling Alignment:** Realign when necessary, using a straight edge and thickness gauge or wedge to ensure satisfactory operation.

6.14.2. **Lubrication:** Use lubrication procedures and lubricants recommended by the manufacturer.

6.15. **Repairs:** Repairs may be necessary to address significant damage or malfunctions beyond routine maintenance, which includes replacing major components. Operators should follow the manufacturer's guidelines to ensure proper repair and pump operation.

6.16. **Emergency Call-Outs:** In the event of an equipment failure or malfunction or other troubleshooting issues, swift action must be taken to mitigate risks and ensure uninterrupted operations.

6.16.1. **Notification and Assignment:** When equipment failures or malfunctions are reported to SCC, the Control Dispatcher will create a WO request and assign it to the operator who will respond to the call-out.

6.16.2. **Response Procedures:** Operators must record details of the work performed, including the scope, materials used, date and time the work was completed (if applicable), and the name of the operator performing the work.

6.16.2.1. Upon arrival, operators shall conduct a visual inspection to identify the source of the problem.

6.16.2.2. Use effective troubleshooting techniques to determine the cause of the issue.

6.16.2.3. Use the comprehensive troubleshooting checklists **(Attachments 4 & 5)** to address and resolve the identified problem.

6.16.2.4. Make necessary repairs.

6.16.2.5. Contact SCC and the Supervisor to request additional support if needed or if the problem cannot be resolved within 30 minutes. SCC should be updated every hour during long call-out procedures.

6.16.2.6. Notify SCC when the work is complete and close out the WO. Operators must ensure all required fields are accurate and complete before closing the WO.

6.17. **Documentation and Reporting:** Equipment and maintenance records must be kept for each pump and drive assembly in CAM. Since a pump's condition is best evaluated by comparing

its current performance to its original performance, a record of flow, pressure, pump speed, amperage, and other test data determined immediately following installation is recommended.

6.18. **Training:** The O&M Manager should conduct training for the operation and maintenance of the Booster Pump Station when needed. New or relevant employees must receive training and sign the *Employee's Acknowledgment Receipt* **(Attachment 8)** to confirm their understanding and compliance with the procedures outlined in this SOP.

6.18.1. The Personnel Services Administrator (PSA) will work with the Policy Owner and Authors to establish a training module and track compliance of employees involved in the activities of this SOP.

6.19. **Non-Compliance to this SOP:**

6.19.1. **Employees:** Failure of the employee to adhere and comply with any of the guidelines, policies, and procedures stated herein may result in progressive or adverse disciplinary action, including but not limited to suspension, demotion or termination of employment as provided by GWA Personnel Rules and Regulations (PR&R).

6.19.2. **Supervisors and Managers:** Failure of the Manager or Supervisor to report and enforce all the guidelines, policies, and procedures stated herein may result in progressive or adverse disciplinary action, including but not limited to suspension, demotion, or termination of employment as provided by GWA PR&R.

7.0 Document Approvals

Role	Position	Name of Approver	Approval Signature	Date Approved
Authors	O&M Manager, Water Distribution Management Analyst II	Vincent Pangelinan Antonette Dione Gutierrez	Approval on File	On File
Policy Owner	Assistant General Manager for Operations (AGM-O)	Thomas A. Cruz, P.E.	Approval on File	On File
Final Approver	General Manager	Miguel C. Bordallo, P.E.	Page 1	Page 1

By existing Guam and Federal laws, the contents of this SOP were reviewed thoroughly by its Policy Owner and was found to be:

☒ appropriate for publication on the GWA website without compromising the security of GWA's system or the public's health and safety.

☐ not appropriate for publication on the GWA website because it might jeopardize the security of GWA's system or the public's health and safety.

8.0 Records of Revisions

All suggestions for improvement shall be directed to the Policy Owner indicated below. The Policy Owner will consider input received, develop recommendations on how to address the suggestions and obtain authorization to make the recommended changes. Updates, revisions, corrections, and waivers to this SOP shall be made in writing and be approved by the GM.

8.1. Policy Owner: Assistant General Manager of Operations

8.2. Authorization: General Manager

Effective Date	Revision Letter	Document Authors	Description of Change
Page 1	A	Vincent Pangelinan Antonette Dione Gutierrez	Initial Release of SOP

9.0 References

9.1. GWA Employee Safety Handbook.

9.2. SOP L. 104, *Lock-Out / Tag-Out (Energy Hazard Control).*

9.3. SOP E.101, *Electrical Safety*.

9.4. SOP GM-062, *Preventive Maintenance Scheduling and Assignment*.

Attachment 1: Safety Equipment and Supply

GUAM WATERWORKS AUTHORITY

Gloria B. Nelson Public Service Building
688 Route 15
Mangilao, Guam 96913
vpangelinan@guamwaterworks.org

OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
SAFETY EQUIPMENT AND SUPPLY

- Lock-out / Tag-out kits
- Hard hat
- Safety glasses
- Ear protection
- Eye protection
- Safety vest
- Rubber gloves
- Safety shoes
- Portable blower
- Air monitor

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Attachment 2: Tools and Equipment List

GUAM WATERWORKS AUTHORITY
Gloria B. Nelson Public Service Building
688 Route 15
Mangilao, Guam 96913
vpangelinan@guamwaterworks.org

OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
TOOLS AND EQUIPMENT LIST

- General basic hand tools
- Voltage meter
- Vibration analyzer
- Lifting equipment (chain hoist, jacks, shoring jacks, dolly, straps, etc.)
- Grinders
- Saws
- Portable flowmeter
- Various gauges
- Lubrication equipment (grease guns, spray lubricants, rust inhibitors, WD40, etc.)
- Corrosion control tools (chippers, scrapers, paints, etc.)

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Attachment 3: Water Distribution Daily Route Sheet

GUAM WATERWORKS AUTHORITY

Gloria B. Nelson Public Service Building
688 Route 15
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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
WATER DISTRIBUTION DAILY ROUTE SHEET (NORTH)

Employee Name: _____ Shift: _____
Received By: _____ Date: _____

NIMITZ HILL	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

ADAWAG	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

ULLOA UNTALAN	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

PALE KIERIN	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

ACCESS	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

Attachment 3: Water Distribution Daily Route Sheet (Cont.)

AGANA HEIGHTS	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

ASAN	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

RESERVOIR READINGS

SITE	TIME	LEVEL	REMARKS
NIMITZ			
AGANA HEIGHTS			
CHAOT			
MANGILAO			
MANENGON			

Attachment 3: Water Distribution Daily Route Sheet (Cont.)

GUAM WATERWORKS AUTHORITY

Gloria B. Nelson Public Service Building
688 Route 15
Mangilao, Guam 96913
vpangelinan@guamwaterworks.org

OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
WATER DISTRIBUTION DAILY ROUTE SHEET (CENTRAL)

Employee Name: _____ Shift: _____
Received By: _____ Date: _____

WBP-18 PAGO BAY	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

WBP-05 BRIGADE	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

WBP-25 WWH	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

CAMACHO	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

MAN TENORIO	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

Attachment 3: Water Distribution Daily Route Sheet (Cont.)

WBP-20 SR SPRINGS	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

SANTA ANA	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

SR MASTER METER	Time	GPM	READING	REMARKS

RESERVOIR READINGS

SITE	TIME	LEVEL	REMARKS
WWH			
SINIFA			
SPRINGS			
SR. RES.			
SAN. ANA LOW			
SAN. ANA UP			

Attachment 3: Water Distribution Daily Route Sheet (Cont.)

GUAM WATERWORKS AUTHORITY

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688 Route 15
Mangilao, Guam 96913
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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
WATER DISTRIBUTION DAILY ROUTE SHEET (SOUTH)

Employee Name: _____ Shift: _____
Received By: _____ Date: _____

WBP-12 MALOJLOJ LINE	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

MALOJLOJ ELEVATED	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

IJA	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

WBP-14 GEUS	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	
PUMP # 3								on / off	

REMARKS: _____

PIGUA	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

Attachment 3: Water Distribution Daily Route Sheet (Cont.)

WBP-15 TOGUAN	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	
PUMP # 2								on / off	

REMARKS: _____

WBP-02	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

WBP-01	Time	SUC	DIS	GPM	Water Meter	Power Meter	Hourly RDG	Status	VFD Hz
PUMP # 1								on / off	

REMARKS: _____

RESERVOIR READINGS

SITE	TIME	LEVEL	REMARKS
MALOJLOJ			
PIGUA			
UMATAC SUB.			
AGAT-UMATAC			

Attachment 4: Troubleshooting Checklist for Centrifugal Pumps

GUAM WATERWORKS AUTHORITY
Gloria B. Nelson Public Service Building
688 Route 15
Mangilao, Guam 96913
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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
TROUBLESHOOTING CHECKLIST FOR CENTRIFUGAL PUMPS

CONDITION	PROBABLE CAUSE	REMEDY
Zero Flow after Startup	1. Air in pump or suction pipework. 2. Suction lift too high. 3. Insufficient Manometric Head. 4. Operation is reversed. 5. Speed incorrect. 6. Impeller, strainer or check valve clogged.	1. Ensure Pump and Pipework are Completely Filled with Liquid. Pump cannot prime with air in suction line. 2. Check the Inlet for obstruction. - If there is not an obstruction, calculate friction losses. - If static lift is too high, the liquid in the suction tank must be raised or pump lowered. 3. Actual head with friction losses is higher than pump design. Calculate head and friction losses in discharge. - Check all valves are open. - To correct, increase pipe diameter, motor power or pump. 4. Check motor direction of rotation is in the direction of arrow on pump casing. 5. Check supply voltage and frequency. Motor may also have open phase. 6. Clean impeller, valve, and strainer.
Flow Decreases or None at All	1. Air ingress through shaft seal, suction piping, suction port. Pump lifts liquid with air. 2. Air pocket in suction pipe. 3. Increase of Manometric Head. 4. Impeller, strainer or check valve clogged	1. Check the following: - Suction pipework for leaks, including all joints and fittings. - Shaft seal and if necessary, increase pressure of sealing liquid. - Depth of suction pipework or valve in liquid and deepen if required. - Check inlet tank for vortexing. 2. Check the angle of suction line and ensure there is no possibility for an air pocket. If so, ensure air eliminator valves are fitted. 3. Check valves are fully open and there are no obstructions in discharge pipe. 4. Clean impeller, valve, and strainer.

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Attachment 4: Troubleshooting Checklist for Centrifugal Pumps (Cont.)

CONDITION	PROBABLE CAUSE	REMEDY
Driver Overloaded	1. Pump operating at lower manometric head. 2. Speed too high. 3. Mechanical friction inside pump. 4. Packing wound too tight. 5. Coupling alignment. 6. Density or viscosity of the liquid pumped is higher than originally advised. 7. Motor defects.	1. The actual head is lower than originally specified. - Reduce impeller size to diameter advised by supplier or utilize an inverter to reduce pump speed. 2. Decrease pump rotational speed or trim impeller to required size. 3. Check pump rotor for any obstruction or deflection. 4. Loosen nuts on packing gland. 5. Check coupling rubber and realign pump and coupling. 6. Increase motor size. 7. Check for motor defects. - May not be ventilated correctly and be in a poor location.
Bearings Overheating	1. Poor couplings alignment. 2. Bearing Covers too tight. 3. Pumped flow is less than minimum safe continuous flow. 4. Too much grease. 5. Insufficient lubrication or lubricating oil / grease dirty or contaminated.	1. Check coupling rubber and realign pump and coupling. 2. Check and loosen if necessary, bearing cover. 3. Increase flow. If necessary, use a bypass recirculating valve or line. 4. Remove excess grease. 5. Check the amount of oil/grease. - Clean the bearings, bearing housing and lubricate.
Vibration	1. Partially clogged impeller. 2. Worn or defective impeller. 3. Poor coupling alignment. 4. Oblique shaft. 5. Unbalanced parts.	1. Clean impeller. 2. Replace impeller. 3. Check coupling rubber and realign pump and coupling. 4. Check shaft and replace if required. 5. Check and rebalance parts if required.
Noise Level High	1. Air in liquid. 2. Pump working in cavitation area. 3. Pump operating outside of duty range.	1. Suction pipe needs to be submerged to ensure vortexes are not created on the surface of the liquid. - Check liquid level in suction pipe or increase depth of suction pipe. 2. NPSH is too low. - Check liquid level in suction tank, check suction losses. - Check valve in suction line and ensure fully open. - Increase suction head by lowering pump. 3. Check duty point.

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Attachment 5: Troubleshooting Checklist for Vertical Turbine Pumps

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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
TROUBLESHOOTING CHECKLIST FOR VERTICAL TURBINE PUMPS

CONDITION	PROBABLE CAUSE	REMEDY
Pump will not run	1. Motor overload protection contacts open: - Incorrect control box - Incorrect connections - Faulty overloads - Low voltage - Ambient temperature of control box or starter too high 2. Blown fuse, broken or loose electric connection. 3. Defective motor. 4. Faulty control equipment. 5. Faulty switch. 6. Pump binding.	1. Check the following: - Check nameplate for horsepower and voltage. - Check wiring diagram furnished with starter. - Replace. - Check voltage at pump side of control box. - Use ambient compensated relays. 2. Check fuses, relays or heater elements for correct size and all electrical connections. 3. Repair or replace. 4. Check all circuits and repair. 5. Repair or replace. 6. Pull master switch, rotate pump by hand to check. - Check impeller adjustment or disassemble unit to determine cause.
Pump runs, but no water delivered	1. Line check valve backward. 2. Line check valve stuck. 3. Unit running backwards. 4. Lift too high for pump. 5. Pump not submerged. 6. Excessive amounts of air or gas. 7. Impeller plugged or pumped in mud or sand. 8. Impeller loose on shaft.	1. Reverse check valve. 2. Free the valve. 3. Consult manufacturer's manual on installing hollow shaft driver and installing solid shaft driver. 4. Check with performance curve. 5. Lower pump if possible or add fluid to system. 6. Correct conditions. 7. Start and stop pump several times or use line pressure if available to back flush. - Pull pump and clean. 8. Pull unit and repair.
Reduced capacity	1. Bypass open. 2. Lift too high for pump. 3. Motor not coming up to speed. 4. Impeller partly plugged. 5. Scaled or corroded discharge pipe or leaks anywhere in system. 6. Excessive amounts of air or gas. 7. Excess war due to abrasives. 8. Impeller not properly adjusted. 9. Impeller loose on shaft.	1. Check bypass valving. 2. Check performance curve. 3. Check voltage while unit is running. 4. Start and stop pump several times or use line pressure if available to back flush. Pull pump and clean. 5. Replace pepe or repair leaks. 6. Correct conditions. 7. Replace worn parts. 8. See manufacturer's manual for guidance on installing solid shaft driver. 9. Pull unit and repair.

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Attachment 5: Troubleshooting Checklist for Vertical Turbine Pumps (Cont.)

CONDITION	PROBABLE CAUSE	REMEDY
Reduced capacity (cont.)	10. Wrong rotation.	10. Correct. Consult manufacturer's manual for installing hollow shaft and installing solid shaft driver.
Motor overloaded	1. Line voltage not correct. 2. Faulty Equipment used to check. 3. Specific gravity higher than design. 4. Operation at point on pump curve other than design. 5. Motor speed too high. 6. Impeller dragging. 7. Pump in bind.	1. Check and correct. 2. Check equipment. 3. Correct specific gravity or re-evaluate system. 4. Check performance curve. 5. Line voltage too high or incorrect frequency. 6. Readjust. 7. Pull master switch, rotate pump by hand to check. - Disassemble unit to determine cause.
Pump vibration excessive and noisy	1. Unit running backwards. 2. Pump breaking suction and pumping air. 3. Loose fasteners. 4. Badly worn motor or pump bearings. 5. Impeller loose on shaft. 6. Pump and motor shafts misaligned. 7. Stress due to piping misalignment.	1. Consult manufacturer's manual for initial start-up procedures and, installing hollow shaft driver and installing solid shaft driver. 2. Lower pump or reduce capacity. 3. Check all bolts, nuts, etc. 4-7. Pull unit and repair.
Excess wear	1. Abrasives. 2. Pump in bind. 3. Vibration.	1. Change to harder materials. 2. Pull paster switch, rotate pump by hand to check. 3. Disassemble unit to determine cause.
Corrosion	1. Impurities. 2. Corrosive liquid.	1. Analyze fluid. 2. Change to corrosion resistant materials.
Pumped liquid in enclosing tube	1. Insufficient pressure and flow lubricating system. 2. Worn bowl bearings. 3. Defective enclosing tube or connector bearing thread.	1. Adjust pressure/flow. Check for blockage. 2. Replace bearings. 3. Check and replace if necessary.
Excessive packing box leakage	1. Gland not properly tightened. 2. Ends of packing not staggered. 3. Worn packing or sleeve.	1. Adjust as necessary. 2. Replace in accordance with the manufacturer's manual. 3. Replace worn parts.
Overheating	1. Bearings. - Shaft bent. - Rotating element binds. - Pipe strain. - Insufficient bearing lubrication. - Incorrect type grease or oil. - Flushing water not circulating through enclosing tube. 2. Packing Box. - Packing gland too tight. - Water flush line plugged.	1. Bearings. - Remove and straighten or replace. - Check for bent shaft. - Correct. - Increase lubrication. - Correct. - Check for blockage or insufficient pressure. 2. Packing Box. - Loosen gland. - Correct.

Attachment 6: Lubrication Schedule for Pumps

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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
LUBRICATION SCHEDULE FOR PUMPS

Lubrication Item	Action	Frequency
Antifriction bearing	Check temperature (with thermometer); if running hot, bearing is probably over lubricated; remove excess lubricant.	Monthly
	Drain lubricant: flush lubricant wells and bearings with kerosene; add clean fresh lubricant.	Quarterly
Ball-thrust bearing	Add fresh grease to grease cups, but do not attempt to keep grease from coming out around the collar seal.	Monthly
	Change the grease in the grease cup if the pump operates more than 50 times a day; change yearly.	Quarterly
Bearing housing	Check oil level in oil hosing; do not add oil with pump running; remove oil vent plug when adding oil.	Daily
	Open housing; flush with kerosene; add clean fresh lubricant.	Quarterly
Enclosed shaft type bearing	Check oil cup; add lubricant as necessary.	Weekly
Greased sealed packing gland	Check spring-loaded grease cup; refill as necessary; adjust spring tension to maintain grease discharge through packing at approximately 1 ounce per day.	Daily
Guide bearing	Add grease through fittings provided.	Monthly
Sealing water system	Check packing gland assembly; adjust packing if excessive seal-water leakage is noticed, allow 60 drops per minute with pump running.	Daily
Sleeve bearing	Check bearing temperature; if too hot, add lubricant.	Monthly
Universal joint coupling	Lubricate coupling and slip splines with fresh grease.	Semi-Annually

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Attachment 7: Maintenance Checklist for Bearings

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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
MAINTENANCE CHECKLIST FOR BEARINGS

Inspection	Action	Frequency
Antifriction bearings		
Check bearing temperature	Check with a standard thermometer. Antifriction bearings that are running too hot probably have too much lubricant.	Monthly
Change lubricant	Change lubricant according to **Attachment 5**. If lubricant change does not prevent overheating, disassemble and inspect the bearing. If nothing appears to be wrong, check the pump and motor.	Quarterly
Check clearances	During the quarterly lubrication change, check the clearances. Recommended clearance is 0.002 inch (51 µ), plus 0.001 inch (25 µ) for each inch (25 mm) of the shaft-journal diameter.	Quarterly
Check bearing condition	Each year, when the pump is dismantled, check the condition of the bearings and the bearing race; replace as necessary.	Annually
Sleeve bearings	Check with a standard thermometer. Sleeve bearings that are running too hot probably have too much lubricant.	Monthly
Change lubricant	Change lubricant according to **Attachment 5**. If lubricant change does not solve the overheating problem, disassemble, and inspect the bearing. If the bearing is in good condition, check the pump and motor alignment.	Quarterly
Check clearances	During the quarterly lubrication change, check the clearances. Normal clearance is 0.002 inch (51 µ), plus 0.001 inch (25 µ) for each inch (25 mm) of the shaft-journal diameter. Make sure that oil rings are free to turn with the shaft. Repair or replace oil rings when necessary.	Quarterly
Check bearing condition	When the pump is dismantled, check the condition of the bearings and the bearing race; replace as necessary. Sleeve bearings are usually split-type and can be easily removed and installed. Rotation of the bearing is prevented by a pin in the top half of the bearing housing.	Annually

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Attachment 8: Employee's Acknowledgement Receipt

GUAM WATERWORKS AUTHORITY

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OPERATION AND MAINTENANCE FOR BOOSTER PUMP STATIONS
EMPLOYEE'S ACKNOWLEDGMENT RECEIPT

I, the undersigned, an employee of the Guam Waterworks Authority, hereby acknowledge receipt of SOP-1500-WD-003 entitled "*Operation and Maintenance for Booster Pump Stations*" this _____ day of _____, 20____.

Employee's Name/Badge No.:	Employee's Signature:	Date:

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