# **Operational Issues Checklist – Water-Cooled (Submerged) Screw Chiller**

## Introduction

This manual serves as a comprehensive diagnostic and troubleshooting guide tailored specifically for operational issues encountered in water-cooled screw chiller systems. Each entry provides:

* A detailed description of the problem
* Operational priority rating
* Root causes
* Recommended corrective actions
* Key performance indicators (KPIs)
* Necessary instruments for field verification

The summary table facilitates rapid reference, while the detailed sections offer in-depth guidance for effective problem resolution.

## Summary Table of Operational Issues

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| **Problem Statement** | **Priority** | **Indicating Parameter / Symptom** |
| Condenser heat-transfer loss (fouling/scaling) | High (Energy + Performance) | Condenser approach temperature rise (>3–5 °C); ΔT across condenser decreases; compressor amps increase |
| Cooling tower performance degradation | High (Energy + Trips) | Cooling water (CW) supply temperature rises above design; tower approach >5–6 °C |
| Insufficient condenser water flow | High (Trips risk) | ΔP across condenser decreases; condenser ΔT increases; abnormal pump amps |
| Refrigerant under/over charge | High (Capacity + Environmental) | Suction superheat unstable; sight glass bubbles; suction/discharge pressures abnormal |
| Refrigerant leaks (water–refrigerant contamination) | High (Environmental + Safety) | Pressure decay in tests; refrigerant detected in water stream |
| Oil management problems | Medium | Oil level fluctuates; oil temperature rises; evaporator approach temperature rises |
| Compressor mechanical wear / vibration | High (Failure risk) | Vibration >4–6 mm/s; bearing temperature rises; abnormal noise/current |
| Electrical supply & motor issues | High (Trips + Damage) | Motor current imbalance >10%; winding temperature rises; overload trips |
| Control system/PLC faults | Medium | Frequent cycling in logs; unexpected trips; wrong setpoints |
| Faulty / drifted sensors | Medium | Parameter jumps; mismatch with handheld gauge; no response to load |
| Expansion valve malfunction | High (Liquid slugging risk) | Superheat erratic; suction pressure oscillates; ΔT unstable |
| Filter drier / strainer blockages | Medium | High ΔP across filter; suction pressure decreases; sight glass frosting |
| Non-condensables / air in circuit | High (Efficiency loss) | Condensing pressure rises despite low CW temperature; condenser approach temperature rises |
| Chiller short-cycling | Medium | Increased starts per hour; runtime logs; average kW/ton increase |
| Evaporator freezing | High (Tube rupture risk) | Leaving water temperature <2 °C; flow alarms; ice on tubes/piping |
| Water chemistry induced corrosion | High (Leak risk) | Unexpected tube leaks; high Fe/Cu in water test; coupon loss increases |
| Biofouling in cooling tower | High (Performance + Health risk) | CW ΔT decreases; slime/algae in basin; bacterial counts increase |
| Pump cavitation | Medium | Gravel-like noise; suction pressure fluctuates; vibration increases |
| Oil/refrigerant migration on shutdown | Medium | Hard start current increases; oil level low on restart; crankcase pressure abnormal |
| Environmental compliance issues | High (Legal/Environmental) | Leak detector alarms; refrigerant log losses; pressure test fails |

# **Detailed Issue Descriptions**

**1. Condenser Heat-Transfer Loss (Fouling / Scaling)**

1.1 **Priority**: High (Energy + Performance)  
1.2 **Probable Reasons**: Scaling, fouling, or biofilm accumulation in condenser tubes due to inadequate water treatment.  
1.3 **How to Fix**:  
 1.3.1 Improve water treatment regime (chemical dosing, filtration, biocide program).  
 1.3.2 Implement periodic mechanical or chemical cleaning of condenser tubes.  
 1.3.3 Continuously monitor condenser approach temperature to detect early fouling.  
1.4 **Indicating Parameters / Symptoms**:  
 1.4.1 Condenser approach temperature rises (>3–5 °C).  
 1.4.2 Decrease in temperature difference (ΔT) across condenser.  
 1.4.3 Increase in compressor current draw (amps).  
1.5 **Field Measurement Tag / Instruments**:  
 1.5.1 Condenser Inlet/Outlet Temperature Sensors.  
 1.5.2 Compressor Amp Meter.

**2. Cooling Tower Performance Degradation**

2.1 **Priority**: High (Energy + Trips)  
2.2 **Probable Reasons**: Cooling tower fan failure, clogged spray nozzles, fouled fill media, or poor make-up water quality.  
2.3 **How to Fix**:  
 2.3.1 Inspect and repair or replace faulty fans.  
 2.3.2 Clean or replace fill media.  
 2.3.3 Repair or replace blocked nozzles.  
 2.3.4 Maintain proper tower water treatment and filtration.  
2.4 **Indicating Parameters / Symptoms**:  
 2.4.1 CW (condenser water) supply temperature rises above design limits.  
 2.4.2 Tower approach temperature exceeds 5–6 °C.  
2.5 **Field Measurement Tag / Instruments**:  
 2.5.1 Cooling Tower Water Temperature Sensors.  
 2.5.2 Tower Fan Status Indicator.

**3. Insufficient Condenser Water Flow**

3.1 **Priority**: High (Trips Risk)  
3.2 **Probable Reasons**: Pump failure, blocked strainers, closed valves, or cavitation in the pump.  
3.3 **How to Fix**:  
 3.3.1 Inspect and repair or replace pumps and valves.  
 3.3.2 Clean or replace blocked strainers.  
 3.3.3 Address NPSH (Net Positive Suction Head) issues to eliminate cavitation.  
3.4 **Indicating Parameters / Symptoms**:  
 3.4.1 Reduced pressure differential (ΔP) across condenser.  
 3.4.2 Increased ΔT across condenser.  
 3.4.3 Abnormal pump current readings.  
3.5 **Field Measurement Tag / Instruments**:  
 3.5.1 Condenser Water Flow Meter.  
 3.5.2 Pump Suction and Discharge Pressure Gauges.

**4. Refrigerant Undercharge / Overcharge**

4.1 **Priority**: High (Capacity + Environmental Impact)  
4.2 **Probable Reasons**: Refrigerant leaks, improper charging procedures, refrigerant trapped in oil.  
4.3 **How to Fix**:  
 4.3.1 Perform leak tests and repair identified leaks.  
 4.3.2 Recharge system to OEM specifications.  
 4.3.3 Maintain accurate refrigerant usage logs.  
4.4 **Indicating Parameters / Symptoms**:  
 4.4.1 Unstable suction superheat values.  
 4.4.2 Bubbles visible in sight glass.  
 4.4.3 Abnormal suction and discharge pressures.  
4.5 **Field Measurement Tag / Instruments**:  
 4.5.1 Evaporator Temperature Sensors.  
 4.5.2 Refrigerant Pressure Gauges.  
 4.5.3 Sight Glass.

**5. Refrigerant Leaks (Water–Refrigerant Contamination)**

5.1 **Priority**: High (Environmental + Safety Risk)  
5.2 **Probable Reasons**: Corrosion or pitting of tubes, vibration fatigue, or failed brazed/welded joints.  
5.3 **How to Fix**:  
 5.3.1 Conduct pressure testing of suspected areas.  
 5.3.2 Plug or replace leaking tubes.  
 5.3.3 Address root cause of corrosion (e.g., chemical treatment).  
5.4 **Indicating Parameters / Symptoms**:  
 5.4.1 Pressure decay during static tests.  
 5.4.2 Detection of refrigerant in chilled/condenser water streams.  
5.5 **Field Measurement Tag / Instruments**:  
 5.5.1 Pressure Test Kit.  
 5.5.2 Water Sampling Port.

**6. Oil Management Problems**

6.1 **Priority**: Medium  
6.2 **Probable Reasons**: Faulty oil separator, incorrect oil charge/type, or internal compressor wear.  
6.3 **How to Fix**:  
 6.3.1 Inspect and replace oil separator if faulty.  
 6.3.2 Ensure correct oil type and level are maintained.  
 6.3.3 Service or overhaul compressor if wear is evident.  
6.4 **Indicating Parameters / Symptoms**:  
 6.4.1 Oil level fluctuates abnormally.  
 6.4.2 Oil temperature increases beyond normal.  
 6.4.3 Increased evaporator approach temperature.  
6.5 **Field Measurement Tag / Instruments**:  
 6.5.1 Oil Sight Glass.  
 6.5.2 Oil Temperature Sensor.  
 6.5.3 Evaporator Temperature Sensors.

**7. Compressor Mechanical Wear / Vibration**

7.1 **Priority**: High (Failure Risk)  
7.2 **Probable Reasons**: Misalignment of components, bearing wear, rotor imbalance, or frequent start-stop cycling.  
7.3 **How to Fix**:  
 7.3.1 Conduct vibration analysis and trending.  
 7.3.2 Replace worn bearings and balance rotating components.  
 7.3.3 Align shafts and couplings correctly.  
 7.3.4 Install anti-short-cycle timers in the control system.  
7.4 **Indicating Parameters / Symptoms**:  
 7.4.1 Vibration levels exceed 4–6 mm/s RMS.  
 7.4.2 Bearing temperatures increase.  
 7.4.3 Audible abnormal noise or fluctuating motor current.  
7.5 **Field Measurement Tag / Instruments**:  
 7.5.1 Vibration Sensor.  
 7.5.2 Bearing Temperature Sensor.  
 7.5.3 Motor Current Meter.

**8. Electrical Supply & Motor Issues**

8.1 **Priority**: High (Trips + Equipment Damage)  
8.2 **Probable Reasons**: Phase imbalance, undervoltage conditions, VFD (Variable Frequency Drive) issues, motor overload.  
8.3 **How to Fix**:  
 8.3.1 Check and correct power quality (voltage and phase).  
 8.3.2 Test motor insulation and windings.  
 8.3.3 Adjust or replace faulty VFDs or motor starters.  
 8.3.4 Implement overload protection and reset trip limits.  
8.4 **Indicating Parameters / Symptoms**:  
 8.4.1 Motor current imbalance exceeds 10%.  
 8.4.2 Winding temperature rises above normal.  
 8.4.3 Overload protection frequently trips.  
8.5 **Field Measurement Tag / Instruments**:  
 8.5.1 Motor Current Transformer (CT).  
 8.5.2 Winding Temperature Sensors.  
 8.5.3 Power Analyzer.

**9. Control System / PLC Faults**

9.1 **Priority**: Medium  
9.2 **Probable Reasons**: Incorrect setpoints, failed or drifting sensors, or communication faults between devices.  
9.3 **How to Fix**:  
 9.3.1 Review PLC logic and configuration.  
 9.3.2 Recalibrate or replace faulty sensors.  
 9.3.3 Fix communication protocol errors (Modbus, BACnet, etc.).  
 9.3.4 Provide adequate operator training.  
9.4 **Indicating Parameters / Symptoms**:  
 9.4.1 Frequent compressor cycling logged.  
 9.4.2 Unexplained or random trips.  
 9.4.3 Incorrect or unexpected control setpoints.  
9.5 **Field Measurement Tag / Instruments**:  
 9.5.1 PLC Event Logs.  
 9.5.2 Operator HMI (Human-Machine Interface).  
 9.5.3 Alarm and Trip History.

**10. Faulty or Drifted Sensors**

10.1 **Priority**: Medium  
10.2 **Probable Reasons**: Sensor drift over time, electrical wiring faults, or improper sensor installation.  
10.3 **How to Fix**:  
 10.3.1 Calibrate or replace suspect sensors.  
 10.3.2 Inspect and repair sensor wiring and grounding.  
 10.3.3 Reinstall sensors in proper locations per OEM guidance.  
10.4 **Indicating Parameters / Symptoms**:  
 10.4.1 Sudden jumps or erratic values in readings.  
 10.4.2 Mismatch between fixed and handheld sensor readings.  
 10.4.3 No parameter response during load changes.  
10.5 **Field Measurement Tag / Instruments**:  
 10.5.1 Temperature and Pressure Sensors.  
 10.5.2 Handheld Reference Gauge.

**11. Expansion Valve Malfunction**

11.1 **Priority**: High (Liquid Slugging Risk)  
11.2 **Probable Reasons**: Sticking thermal expansion valve (TXV), actuator malfunction, or blockage from filter drier.  
11.3 **How to Fix**:  
 11.3.1 Clean or replace TXV and actuator.  
 11.3.2 Check actuator calibration.  
 11.3.3 Replace or clean filter drier if blocked.  
11.4 **Indicating Parameters / Symptoms**:  
 11.4.1 Erratic superheat readings.  
 11.4.2 Suction pressure oscillations.  
 11.4.3 Unstable evaporator ΔT.  
11.5 **Field Measurement Tag / Instruments**:  
 11.5.1 Expansion Valve Position Sensor.  
 11.5.2 Suction Pressure and Temperature Sensors.

**12. Filter Drier / Strainer Blockages**

12.1 **Priority**: Medium  
12.2 **Probable Reasons**: Debris, corrosion particles, or oil degradation byproducts blocking filters or strainers.  
12.3 **How to Fix**:  
 12.3.1 Replace clogged filter driers.  
 12.3.2 Clean strainers regularly.  
 12.3.3 Flush system if severe contamination is present.  
12.4 **Indicating Parameters / Symptoms**:  
 12.4.1 High pressure drop (ΔP) across filter.  
 12.4.2 Low suction pressure.  
 12.4.3 Frosting observed at sight glass.  
12.5 **Field Measurement Tag / Instruments**:  
 12.5.1 Filter ΔP Sensor.  
 12.5.2 Suction Pressure Gauge.  
 12.5.3 Sight Glass.

**13. Non-Condensables / Air in Circuit**

13.1 **Priority**: High (Efficiency Loss)  
13.2 **Probable Reasons**: Incomplete evacuation during servicing or air ingress during maintenance.  
13.3 **How to Fix**:  
 13.3.1 Perform proper deep vacuum evacuation.  
 13.3.2 Recharge system with clean refrigerant.  
 13.3.3 Conduct pressure testing to detect air ingress points.  
13.4 **Indicating Parameters / Symptoms**:  
 13.4.1 High condensing pressure even when CW temperature is low.  
 13.4.2 Elevated condenser approach temperature.  
13.5 **Field Measurement Tag / Instruments**:  
 13.5.1 Condenser Pressure Gauge.  
 13.5.2 Cooling Water (CW) Temperature Sensors.

**14. Chiller Short-Cycling**

14.1 **Priority**: Medium  
14.2 **Probable Reasons**: Deadband set too narrow, oversized chiller, or improper sequencing logic.  
14.3 **How to Fix**:  
 14.3.1 Adjust control deadbands.  
 14.3.2 Implement anti-short-cycle timers.  
 14.3.3 Correct staging logic for chillers.  
14.4 **Indicating Parameters / Symptoms**:  
 14.4.1 Starts per hour exceed normal limits.  
 14.4.2 Short run-times observed in logs.  
 14.4.3 Increase in average power consumption per ton (kW/ton).  
14.5 **Field Measurement Tag / Instruments**:  
 14.5.1 Control System Logs.  
 14.5.2 Power Meter.  
 14.5.3 Compressor Start Counter.

### 15. Evaporator Freezing

15.1 **Priority**: High (Tube Rupture Risk)  
15.2 **Probable Reasons**:  
 15.2.1 Low chilled water flow due to pump or valve issues.  
 15.2.2 Chiller setpoint too low for current load.  
 15.2.3 Expansion valve malfunction causing overfeeding.  
15.3 **How to Fix**:  
 15.3.1 Ensure adequate chilled water flow is maintained.  
 15.3.2 Adjust chiller temperature setpoint to prevent freezing.  
 15.3.3 Install and test freeze protection devices (freeze-stat).  
 15.3.4 Check and repair expansion valve operation.  
15.4 **Indicating Parameters / Symptoms**:  
 15.4.1 Leaving water temperature drops below 2 °C.  
 15.4.2 Flow alarms triggered (low or no flow).  
 15.4.3 Visible icing on evaporator tubes or external piping.  
15.5 **Field Measurement Tag / Instruments**:  
 15.5.1 Evaporator Temperature Sensors.  
 15.5.2 Flow Switch or Flow Meter.  
 15.5.3 Freeze Stat.

### 16. Water Chemistry Induced Corrosion

16.1 **Priority**: High (Leak Risk)  
16.2 **Probable Reasons**:  
 16.2.1 High chloride concentration, low or acidic pH.  
 16.2.2 Oxygen ingress into closed loop.  
 16.2.3 Galvanic corrosion between dissimilar metals.  
16.3 **How to Fix**:  
 16.3.1 Maintain neutral pH and use corrosion inhibitors.  
 16.3.2 Prevent oxygen ingress by sealing leaks and using de-aerators.  
 16.3.3 Electrically isolate dissimilar metals (e.g., using dielectric unions).  
16.4 **Indicating Parameters / Symptoms**:  
 16.4.1 Unexpected tube or pipe leaks.  
 16.4.2 Elevated iron (Fe) or copper (Cu) levels in water test.  
 16.4.3 Increased corrosion coupon loss rates.  
16.5 **Field Measurement Tag / Instruments**:  
 16.5.1 Water Chemistry Test Kit (pH, chlorides, conductivity).  
 16.5.2 Corrosion Coupons or Probes.

### 17. Biofouling in Cooling Tower

17.1 **Priority**: High (Performance + Health Risk)  
17.2 **Probable Reasons**:  
 17.2.1 Inadequate biocide dosing program.  
 17.2.2 Stagnant water in basin or low flow.  
 17.2.3 Organic debris and airborne contaminants.  
17.3 **How to Fix**:  
 17.3.1 Implement regular and effective biocide treatment.  
 17.3.2 Periodically clean tower basins and distribution decks.  
 17.3.3 Maintain and inspect drift eliminators and filters.  
17.4 **Indicating Parameters / Symptoms**:  
 17.4.1 Lower ΔT across condenser water loop.  
 17.4.2 Visible slime or algae growth in basin and tower internals.  
 17.4.3 High microbial counts in water samples.  
17.5 **Field Measurement Tag / Instruments**:  
 17.5.1 Physical Inspection of Cooling Tower Basin.  
 17.5.2 Bacteria Test Kit (e.g., dip slides or ATP meters).

### 18. Pump Cavitation

18.1 **Priority**: Medium  
18.2 **Probable Reasons**:  
 18.2.1 Inadequate Net Positive Suction Head (NPSH) available.  
 18.2.2 Air entrainment into the suction line.  
 18.2.3 Blocked suction strainers or piping.  
18.3 **How to Fix**:  
 18.3.1 Reconfigure piping to reduce suction head loss.  
 18.3.2 Install air separators to remove entrained gases.  
 18.3.3 Clean suction strainers and remove obstructions.  
 18.3.4 Ensure pumps are properly selected for the application.  
18.4 **Indicating Parameters / Symptoms**:  
 18.4.1 Loud, gravel-like noise from pump.  
 18.4.2 Fluctuating suction pressure.  
 18.4.3 Increased vibration levels.  
18.5 **Field Measurement Tag / Instruments**:  
 18.5.1 Pump Suction and Discharge Pressure Gauges.  
 18.5.2 Vibration Sensor.

### 19. Oil / Refrigerant Migration on Shutdown

19.1 **Priority**: Medium  
19.2 **Probable Reasons**:  
 19.2.1 Refrigerant condensing in the compressor crankcase.  
 19.2.2 Poor oil return from the system during operation.  
 19.2.3 Absence of crankcase heaters or failed heater.  
19.3 **How to Fix**:  
 19.3.1 Install and verify operation of crankcase heaters.  
 19.3.2 Utilize hot gas bypass or pump-down cycles during shutdown.  
 19.3.3 Inspect oil return piping and traps.  
19.4 **Indicating Parameters / Symptoms**:  
 19.4.1 High inrush current during compressor start (hard start).  
 19.4.2 Low oil level observed at restart.  
 19.4.3 Abnormal crankcase pressure during standby.  
19.5 **Field Measurement Tag / Instruments**:  
 19.5.1 Crankcase Heater Status Indicator.  
 19.5.2 Oil Sight Glass.  
 19.5.3 Motor Current Meter.

### 20. Environmental Compliance Issues

20.1 **Priority**: High (Legal + Environmental Impact)  
20.2 **Probable Reasons**:  
 20.2.1 Undetected or unreported refrigerant leaks.  
 20.2.2 Incomplete or incorrect refrigerant logbooks.  
 20.2.3 Use of uncertified maintenance practices.  
20.3 **How to Fix**:  
 20.3.1 Install fixed or portable refrigerant leak detectors.  
 20.3.2 Maintain detailed logs per environmental regulations.  
 20.3.3 Ensure only certified personnel perform service.  
20.4 **Indicating Parameters / Symptoms**:  
 20.4.1 Leak detector alarms or notifications.  
 20.4.2 Cumulative refrigerant losses recorded in logs.  
 20.4.3 Failed pressure test or poor vacuum hold.  
20.5 **Field Measurement Tag / Instruments**:  
 20.5.1 Leak Detection System or Handheld Detector.  
 20.5.2 Refrigerant Log Book (manual or digital).  
 20.5.3 Pressure Test Kit or Vacuum Gauge.