# HVAC System Operations & Maintenance Manual

## 1. Introduction

### 1.1 Purpose

This manual provides comprehensive guidance for the operation, maintenance, and troubleshooting of the HVAC system installed at [Facility Name]. It serves as the primary reference for facility engineers, technicians, and operators.

### 1.2 System Description

Building Type: Commercial Office Building Total Area: 50,000 sq ft Zones: 4 primary zones (North, South, East, West) Operating Hours: 6:00 AM - 8:00 PM (Mon-Fri)

## 2. Equipment Specifications

### 2.1 Air Handling Units (AHUs)

* Manufacturer: Carrier
* Model: 39M
* Quantity: 4 units
* Capacity: 20,000 CFM each
* Motor: 25 HP, 460V, 3-phase
* Filter Types:
	+ Pre-filter: MERV 8
	+ Final filter: MERV 13
* Design Parameters:
	+ Supply Air Temp: 55°F ± 2°F
	+ Return Air Temp: 75°F ± 2°F
	+ Static Pressure: 2.5“ WC

### 2.2 Chillers

* Manufacturer: Trane
* Model: CVHF
* Type: Water-cooled centrifugal
* Capacity: 500 tons
* Refrigerant: R-134a
* Operating Parameters:
	+ Chilled Water Supply: 44°F
	+ Chilled Water Return: 54°F
	+ Condenser Water Supply: 85°F
	+ Condenser Water Return: 95°F
	+ Minimum Flow: 600 GPM
	+ Maximum Flow: 1200 GPM

### 2.3 Cooling Towers

* Manufacturer: Baltimore Aircoil
* Model: Series 3000
* Type: Induced draft counterflow
* Capacity: 600 tons
* Fan Motor: 30 HP
* Design Conditions:
	+ Wet Bulb: 78°F
	+ Range: 10°F
	+ Approach: 7°F

### 2.4 Boilers

* Manufacturer: Cleaver-Brooks
* Model: CFC-E
* Type: Fire-tube condensing
* Input: 4,000 MBH
* Output: 3,800 MBH
* Efficiency: 95%
* Fuel: Natural Gas
* Operating Parameters:
	+ Supply Temperature: 180°F
	+ Return Temperature: 160°F
	+ Operating Pressure: 30 PSI

## 3. Safety Procedures

### 3.1 Required Personal Protective Equipment (PPE)

* Safety glasses (ANSI Z87.1)
* Steel-toed boots (ASTM F2413-18)
* Hard hat (Type I, Class E)
* Hearing protection (NRR 25+)
* Chemical-resistant gloves (when handling water treatment chemicals)
* Respirator (when handling refrigerants)

### 3.2 Lockout/Tagout Procedures

1. Notify affected personnel
2. Shut down equipment
3. Isolate energy sources:
	* Electrical disconnects
	* Mechanical valves
	* Pneumatic systems
4. Apply locks and tags
5. Verify zero energy state
6. Complete lockout log

### 3.3 Confined Space Entry

Requirements for entering confined spaces (cooling towers, tanks):

* Entry permit
* Gas monitor calibration
* Ventilation equipment
* Safety harness and lifeline
* Attendant present
* Emergency rescue plan

## 4. Operating Procedures

### 4.1 Daily Start-up Sequence

1. System Check (5:00 AM)
	* Verify BMS operation
	* Check equipment status
	* Review alarms
2. Cooling Tower Start (5:15 AM)
	* Open isolation valves
	* Start condenser water pumps
	* Verify water flow
	* Enable fan operation
3. Chiller Operation (5:30 AM)
	* Verify oil temperature
	* Check refrigerant levels
	* Enable chiller controls
	* Monitor approach temperatures
4. Air Handler Start (5:45 AM)
	* Open outdoor air dampers
	* Start supply/return fans
	* Enable temperature controls
	* Verify proper pressurization

### 4.2 Normal Operation Monitoring

Hourly Checks:

* Supply air temperature: 55°F ± 2°F
* Return air temperature: 75°F ± 2°F
* Chilled water supply: 44°F ± 1°F
* Condenser water return: 95°F maximum
* Zone temperatures: 72°F ± 2°F
* Static pressure: 2.5“ WC ± 0.2“

### 4.3 Shutdown Procedure

1. Reduce cooling load
2. Disable AHUs sequentially
3. Shut down chillers per manufacturer protocol
4. Continue condenser water flow for 5 minutes
5. Shut down cooling tower fans
6. Close isolation valves
7. Document readings

## 5. Maintenance Procedures

### 5.1 Daily Tasks

* Log operating parameters
* Check equipment for unusual noise/vibration
* Inspect for leaks
* Monitor differential pressures
* Record energy consumption
* Check zone temperatures
* Verify proper drainage

### 5.2 Weekly Tasks

Cooling Tower:

* Clean strainers
* Check water chemistry
* Inspect fill material
* Verify fan operation
* Test water treatment system

Chillers:

* Check oil level/pressure
* Record operating temperatures
* Inspect for refrigerant leaks
* Clean local control panels
* Verify safety controls

AHUs:

* Check belt tension
* Inspect filter condition
* Clean drain pans
* Verify damper operation
* Test safety controls

### 5.3 Monthly Tasks

* Lubricate all bearings
* Replace air filters
* Clean cooling tower fill
* Test water quality
* Calibrate sensors
* Check electrical connections
* Test emergency systems
* Clean strainers
* Inspect insulation
* Check valve operation

### 5.4 Quarterly Tasks

* Clean cooling tower
* Test refrigerant levels
* Analyze oil samples
* Clean heat exchangers
* Test safety controls
* Calibrate BMS sensors
* Check VFD operation
* Service pump seals
* Inspect ductwork
* Clean coils

### 5.5 Annual Tasks

* Clean condenser tubes
* Clean evaporator tubes
* Replace oil filters
* Test relief valves
* Major electrical inspection
* Thermographic scanning
* Vibration analysis
* Cooling tower overhaul
* Boiler inspection
* Air balance verification

## 6. Troubleshooting Guide

### 6.1 Chiller Issues

#### High Condenser Pressure

Symptoms:

* High head pressure
* High approach temperature
* Reduced capacity

Possible Causes:

1. Dirty condenser tubes
2. Non-condensables in system
3. Cooling tower malfunction
4. Excessive refrigerant charge

Solutions:

1. Clean condenser tubes
2. Purge non-condensables
3. Check cooling tower operation
4. Verify refrigerant charge

#### Low Suction Pressure

Symptoms:

* Low evaporator temperature
* Reduced cooling capacity
* Possible freezing

Possible Causes:

1. Low refrigerant charge
2. Dirty evaporator
3. Low water flow
4. Failed expansion valve

Solutions:

1. Check refrigerant charge
2. Clean evaporator tubes
3. Verify pump operation
4. Inspect/replace expansion valve

### 6.2 AHU Issues

#### Insufficient Cooling

Symptoms:

* High space temperature
* High supply air temperature
* Low ΔT across coil

Possible Causes:

1. Low chilled water flow
2. Air in system
3. Dirty cooling coil
4. Control valve failure

Solutions:

1. Check pump operation
2. Vent air from system
3. Clean cooling coil
4. Repair/replace valve

#### Fan Vibration

Symptoms:

* Excessive noise
* Visible movement
* High vibration readings

Possible Causes:

1. Unbalanced fan
2. Worn bearings
3. Loose mounting
4. Belt issues

Solutions:

1. Balance fan assembly
2. Replace bearings
3. Tighten mounting
4. Replace/align belts

## 7. Emergency Procedures

### 7.1 Refrigerant Leak

Immediate Actions:

1. Evacuate area
2. Ventilate space
3. Don PPE
4. Shut down system
5. Isolate leak
6. Contact service provider

Recovery Steps:

1. Assess leak severity
2. Repair leak
3. Pressure test system
4. Recharge refrigerant
5. Test operation
6. Document incident

### 7.2 Water Leak

Immediate Actions:

1. Identify source
2. Shut off water supply
3. Power down equipment
4. Contain spread
5. Remove standing water
6. Document damage

Recovery Steps:

1. Repair leak
2. Dry affected areas
3. Test systems
4. Restore operation
5. Monitor for issues
6. Update procedures

### 7.3 Power Failure

Immediate Actions:

1. Check backup power
2. Secure equipment
3. Close outside air dampers
4. Monitor temperatures
5. Notify occupants
6. Contact utility

Recovery Steps:

1. Verify power quality
2. Reset equipment
3. Sequential start-up
4. Check operation
5. Document event
6. Review procedures

## 8. Documentation & Records

### 8.1 Required Logs

Daily Operating Log:

* Equipment run times
* Temperature readings
* Pressure readings
* Energy consumption
* Alarm conditions
* Operator notes

Maintenance Log:

* Completed tasks
* Parts replaced
* Contractor visits
* Test results
* Calibration data
* Repair history

### 8.2 Equipment History

For each major component:

* Installation date
* Warranty information
* Maintenance history
* Repair records
* Modification details
* Performance data

### 8.3 Compliance Records

* Refrigerant usage
* Water treatment
* Safety inspections
* Training records
* Permits/certifications
* Environmental reports

## 9. Essential Contacts

### 9.1 Emergency Contacts

* Fire Department: [Number]
* Police: [Number]
* Ambulance: [Number]
* Poison Control: [Number]
* Building Security: [Number]

### 9.2 Service Providers

* HVAC Contractor: [Company Name, Number]
* Controls Contractor: [Company Name, Number]
* Water Treatment: [Company Name, Number]
* Electrical Contractor: [Company Name, Number]
* Equipment Manufacturer: [Company Name, Number]

### 9.3 Utility Contacts

* Electric Utility: [Company Name, Number]
* Gas Utility: [Company Name, Number]
* Water Utility: [Company Name, Number]

## 10. Appendices

### 10.1 Technical Specifications

* Equipment submittal data
* Performance curves
* Control sequences
* Design drawings
* Test reports

### 10.2 Forms and Checklists

* Daily inspection form
* Maintenance checklist
* Safety inspection form
* Lockout/tagout permits
* Incident reports

### 10.3 Reference Documents

* Original equipment manuals
* Control system manual
* As-built drawings
* Warranty documents
* Training materials

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