offices, places of assembly, restaurants, and buildings for retail and wholesale businesses.

commercial HVAC: any non-residential or non-process or manufacturing-related HVAC application, including but not limited to, applications for governmental and educational facilities, healthcare and hospitality facilities, institutional buildings, offices, places of assembly, restaurants, and retail and wholesale businesses.

commercial process: a process used primarily to produce, process or hold material goods or works, such as cold food storage, painting, equipment assembly or repair, clothing assembly or cleaning, etc. It is used in manufacturing, assembly, repair, conditioned storage, and treatment systems.

inspection frequency: the time period or interval in which occurrences of a task or observations of a condition are to be made. The period of inspection frequency may be based on timed intervals (i.e., weekly, monthly, quarterly, or annually), on hours of usage ("run time"), or system condition ("condition based maintenance" determined from physical inspection or controls-based system alarms).

inspection or maintenance task: a well-defined unit of work that can be described by a sequence of instructions. Typical examples of such tasks include cleaning, calibration, visual inspection or observation, measurement, and lubrication.

maintenance program: a maintenance concept or approach that defines how maintenance will be performed for a specific facility in terms of time and resource allocation. It documents the maintenance objectives, establishes the criteria for evaluation, and commits the maintenance department to basic goals of performance, such as prompt response to mechanical failure and maintenance requirements.

performance: a measure of the success of an HVAC system in achieving thermal comfort, energy efficiency, and indoor air quality.

performance objective: the metrics for evaluating performance. They include written statements of performance, descriptions of normal operating characteristics, and measurable and observable indicators that are the basis for evaluating or inspecting elements of a system.

verification: confirmation by examination or commissioning that a specified requirement has been fulfilled. Typically verification requires independent reviewing, inspecting, examining, measuring, testing, checking, witnessing, monitoring, or otherwise establishing and documenting that products, processes, services, and documents conform to specified requirements.

4. IMPLEMENTATION

4.1 Responsible Party. The building owner shall be responsible for meeting the requirements of this standard. The owner may designate other parties that shall be authorized and contractually obligated to fulfill the owner's responsibility.

4.2 Maintenance Program. Each HVAC system shall have a *maintenance program* that, at a minimum, preserves the condition of the HVAC system and its elements in a manner that enables the system to provide the intended thermal comfort and energy efficiency and helps to achieve the intended indoor air quality required for the building.

At a minimum, the *maintenance program* shall contain an inventory of equipment and systems to be inspected and maintained and a maintenance plan describing the goals, objectives, and execution of the HVAC systems *maintenance program*.

4.2.1 Inventory of Items to be Inspected and Maintained. Components of HVAC systems that impact the building's *performance* shall be inventoried. This detailed list shall be used to establish unacceptable system condition indicators, *inspection frequencies* and *maintenance tasks*.

4.2.2 Maintenance Plan Development. For any given facility, the maintenance plan shall be written and developed specifically to meet the size, design, scope and complexity of the system(s) serving that facility.

The plan shall describe each required task, identify the party responsible for performing the task, specify the authorizing party, document its completion, and subsequently monitor the results.

The plan shall include all of the following information:

4.2.2.a Performance Objectives. *Performance objectives* shall incorporate thermal comfort, energy efficiency, and indoor air quality metrics. *Performance objectives* shall be based on basis of design and operational criteria specific to a particular system. The source of the *performance objectives* shall be documented; Appendix A lists some of the possible sources that can be used to establish *performance objectives*.

4.2.2.b Condition Indicators. Indicators of unacceptable system and equipment conditions shall be established. These indicators are measurements or observations of conditions that could lead to failure or *performance* degradation. See Appendix B for examples of unacceptable system condition indicators.

4.2.2.c Inspection and Maintenance Tasks. *Inspection and maintenance tasks* for inventoried equipment and systems shall be established. *Inspection* shall include the condition assessment of systems and/or their components by observation and/or measurement of operating parameters and may include data provided by sensors or a *building management system (BMS)*. *Maintenance tasks* shall include adjustment, service, or replacement of inventoried equipment and systems. See Section 5 for tables of required *inspection* and *maintenance tasks* by equipment type.

4.2.2.d Inspection and Maintenance Task Frequencies. Frequency of *inspection* and *maintenance tasks* for inventoried equipment and systems shall be established. If unacceptable condition indicators or unacceptable *performance* is found during two successive *inspections*, the owner, or owner's designated representative, shall investigate and analyze possible causes. At a minimum, the following possible causes shall be investigated.

- Poor field practices— review inspection documentation and/or technician execution to ensure *maintenance tasks* are performed correctly.
- Insufficient time budgeted for tasks—review time budgeted to the technician to assure that reasonable time has been given to perform the tasks.

- Component repairs noted/pending/not made—inspect documentation to determine that repair or component replacement has been undertaken.
- Design issues—determine whether underlying design issues are causing successive failures
- Obsolete equipment or components—determine whether the equipment or component has been in service beyond its useful life
- Conditions outside of the HVAC system causing failure—investigate whether water leaks, vandalism, a problem in the building envelope or some other external factor is causing the problem.

Based on the analysis, the *inspection frequency* or the *maintenance task* shall be modified to resolve the deficiency.

If acceptable condition indicators or acceptable *performance* is found during three successive inspections, then the *inspection frequency* for that task may be reduced from the existing frequency and/or the level of maintenance performed in the maintenance task may be reduced. The reduced frequency and/or maintenance shall be based on the specific findings and shall be documented.

Frequency may also be adjusted for climate related or operational reasons. Examples would include:

- A cooling tower shutdown during the winter—Inspection and maintenance may be suspended during the shutdown period.
- A new chiller is installed and the old chiller is retained as a backup—Inspection and maintenance of the backup unit may be adjusted to reflect fewer operating hours.

Each adjusted frequency shall be documented, including the reason for the adjustment.

4.2.2.e Documentation. A minimum inspection and maintenance documentation package shall consist of the following items:

a. Listings of HVAC systems and system components with associated performance criteria pertinent to the facility,
b. *Inspection* and *Maintenance Tasks* and the method of tracking (automated or manual), and
c. Sufficient record detail and *verification* (written or electronic) to demonstrate implementation of the maintenance plan.

The inspection and maintenance document directory shall provide easy access and be well organized and clearly identified. Emergency information shall be immediately available and shall include emergency staff and/or agency notification procedures.

4.3 Maintenance Plan Authorization and Execution. *Inspection* and *maintenance tasks* shall be performed on an established frequency or upon a documented observance of unacceptable condition. Whether authorized by written or verbal instructions, execution of the task shall be documented and archived for future reference.

4.4 Revision of the Maintenance Program

The *maintenance program* shall be reviewed and revision considered in any of the following situations:

1. Modifications to the building that impact HVAC *performance objectives* have occurred,
2. The building function or its use has changed in a way that impacts HVAC *performance objectives*,
3. HVAC component or HVAC system changes have occurred,
4. One or more systems are found to be incapable of achieving their *performance objectives*, and/or
5. Upon documented recommendation from the maintenance provider.

5. REQUIRED INSPECTION AND MAINTENANCE TASKS

This section lists the required minimum *inspection* and *maintenance tasks* for any facility to which this standard applies. The *maintenance program* for the facility shall include at a minimum all of the listed *inspection* and *maintenance tasks* that apply to the HVAC systems and related equipment in the facility. The types of equipment and systems for which tasks are listed are as follows.

Table Number	Equipment/System
5-1	Air Distribution Systems
5-2	Air Handlers
5-3	Chillers—Absorption
5-4	Chillers—Air Cooled
5-5	Chillers—Water Cooled
5-6	Boilers
5-7	Condensing Units
5-8	Control Systems
5-9	Cooling Tower and Evaporative Cooled Devices
5-10	Dehumidification and Humidification Devices
5-11	Engines, Micro-Turbines
5-12	Free-Standing Heating or Cooling Coils
5-13	Free-Standing Fans (e.g., exhaust, transfer, return)
5-14	Fan Coils, Hot Water & Steam Unit Heaters
5-15	Furnaces, Unit Heaters
5-16	Indoor Section Duct-Free Splits
5-17	PTAC (Package Terminal Air Conditioners)
5-18	PTHP (Package Terminal Heat Pumps)
5-19	Pumps
5-20	Rooftop Units
5-21	Steam Distribution Systems
5-22	Terminal and Control Boxes (e.g., VAV, fan powered, bypass)
5-23	HVAC Water Distribution Systems
5-24	Water Source Heat Pumps

To determine the required *inspection* and *maintenance tasks* for each subsystem or piece of equipment in your building, use the following procedure.

1. Referring to the HVAC equipment and systems inventory prepared as required in Section 4.2.1 of this standard, prepare a listing of the different equipment or subsystem types that exist in the building.
2. Using this list, identify from the following 24 tables (Tables 5-1 through 5-24) those that apply to the HVAC systems and equipment in the building.

   If the HVAC system for your facility contains subsystems or equipment that is not found in the tables in this section, use inspection and maintenance items from

tables for similar subsystems or equipment or create a new list of appropriate items.

3. At a minimum, the *maintenance plan* for the building shall include each of the *inspection* and *maintenance tasks* from all of the applicable tables.
4. The *maintenance program* may include other *inspection* and *maintenance tasks* to preserve the ability of the subsystem or equipment to achieve acceptable thermal comfort, energy efficiency, and indoor air quality.
5. This standard shall not supersede equipment manufacturer's instructions and guidelines that may require more frequent or increased tasks.

Note: In cases where manufacturers require more frequent tasks (or more tasks) than the following tables show, this standard does not require its users to perform the additional maintenance to comply with the standard.

TABLE 5-1 Air Distribution Systems

Inspection/Maintenance Task	Frequency[a]
Check control system and devices for evidence of improper operation. Repair, adjust or replace components to ensure proper operation.	Semi-annually
Visually inspect grilles, registers and diffusers for dirt accumulation. Clean as needed to remove dirt build up	Semi-annually
Lubricate field serviceable bearings.	Annually
Check for proper damper operation. Repair, replace or adjust as needed.	Annually
Visually inspect areas of moisture accumulation for biological growth. If present, clean or disinfect as needed.	Annually
Visually inspect exposed ductwork for insulation and vapor barrier integrity. Correct as needed.	Annually
Visually inspect internally lined ductwork until the first turn or up to 20 feet into the supply plenum from air handler for visible biological contamination and, if necessary, take corrective action.	Annually

Note a: Refer to Section 4.2.2.d for procedure to modify frequency.

TABLE 5-2 Air Handlers

Inspection/Maintenance Task	Frequency[a]
Check for particulate accumulation on filters. Clean or replace if accumulation results in pressure drop or airflow outside of established operating limits.	Monthly
Check air filter and housing integrity. Correct as needed.	Monthly
Check UV Lamp. Clean or replace as needed to ensure proper operation.	Quarterly
Check control system and devices for evidence of improper operation. Repair, adjust or replace components to ensure proper operation.	Semi-annually
Check P-trap. Prime as needed to ensure proper operation.	Semi-annually
Check fan belt tension. Check for belt wear and proper alignment. Replace if necessary to ensure proper operation.	Semi-annually
Check variable frequency drive for proper operation. Correct as needed.	Semi-annually
Check for proper operation of cooling or heating coil. Clean, restore or replace as required.	Semi-annually
Check control box for dirt, debris and/or loose terminations. Clean and tighten as needed.	Annually
Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
Check fan blades. Clean, repair or replace as needed to ensure proper operation.	Annually
Check refrigerant system pressures and/or temperatures. If outside of recommended levels, find cause, repair and adjust refrigerant to achieve optimal operating levels.	Annually
Check for fouling, corrosion or degradation. Clean or repair as needed.	Annually
Check drive alignment, wear, seating and operation. Repair or replace as needed.	Annually
Check integrity of all panels on equipment. Replace fasteners as needed to ensure proper integrity and fit/finish of equipment.	Annually
Lubricate field serviceable bearings.	Annually
Check drain pan, drain line and coil for biological growth. Clean as needed.	Annually
Check coil fins for evidence of build-up or fouling. Restore if possible. Replace coil if necessary to return to proper functioning.	Annually
Inspect for evidence of moisture carryover beyond the drain pan from cooling coils. Make corrections or repairs as necessary.	Annually
Check for proper damper operation. Repair, replace or adjust as needed.	Annually
Visually inspect areas of moisture accumulation for biological growth. If present, clean or disinfect as needed.	Annually
Check condensate pump. Clean or replace as needed.	Annually
Visual inspect exposed ductwork and external piping for insulation and vapor barrier for integrity. Correct as needed.	Annually
Visually inspect internally lined ductwork until the first turn or up to 20 ft into the supply plenum from air handler for integrity, and if soiled or degraded, correct.	Annually

Note a: Refer to Section 4.2.2.d for procedure to modify frequency.

TABLE 5-3 Chillers—Absorption

Inspection/Maintenance Task	Frequency[a]
Check for the presence of noncondensibles. Take necessary steps to eliminate noncondensibles in system.	Weekly
Visually inspect fuel filter. Clean, repair or replace as needed to ensure proper operation.	Monthly
Perform chemical testing of system water. Treat as needed to ensure proper water chemistry.	Monthly (open systems)/ Quarterly (closed systems)
Check fuel pump for proper operation. Repair or replace as needed to ensure proper operation.	Quarterly
Inspect gearbox for excessive wear. Repair or replace as needed.	Quarterly
Check steam system traps, pumps and controls. Clean or replace as needed to ensure proper operation.	Semi-annually
Check control system and devices for evidence of improper operation. Repair, adjust or replace components to ensure proper operation.	Semi-annually
Check variable frequency drive for proper operation. Correct as needed.	Semi-annually
Check control box for dirt, debris and/or loose terminations. Clean and tighten as needed.	Annually
Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
Check for fouling, corrosion or degradation. Clean or repair as needed.	Annually
Check drive alignment, wear, seating and operation. Repair and replace as needed.	Annually
Check for evidence of build-up or fouling on heat exchange surfaces. Clean as needed to ensure proper operation.	Annually
Check for proper fluid flow. Clean, adjust and repair as needed to restore proper flow.	Annually
Check inhibitor and internal fluid chemistry. Correct inhibitor and internal fluid chemistry if outside of established operating ranges.	Annually

Note a: Refer to Section 4.2.2.d for procedure to modify frequency.

TABLE 5-4 Chillers—Air-Cooled

Inspection/Maintenance Task	Frequency[a]
Perform chemical testing of system water. Treat as needed to ensure proper water chemistry.	Monthly (open systems)/ Quarterly (closed systems)
Inspect gearbox for excessive wear. Repair or replace as needed.	Quarterly
Check control system and devices for evidence of improper operation. Repair, adjust or replace components to ensure proper operation.	Semi-annually
Check fan belt tension. Check for belt wear and proper alignment. Replace if necessary to ensure proper operation.	Semi-annually
Check variable frequency drive for proper operation. Correct as needed.	Semi-annually
Check control box for dirt, debris and/or loose terminations. Clean and tighten as needed.	Annually
Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
Check fan blades. Clean, repair or replace as needed to ensure proper operation.	Annually
Check refrigerant system pressures and/or temperatures. If outside of recommended levels, find cause, repair and adjust refrigerant to achieve optimal operating levels.	Annually
Check for fouling, corrosion or degradation. Clean or repair as needed.	Annually
Check drive alignment, wear, seating and operation. Repair and replace as needed.	Annually
Lubricate field serviceable bearings.	Annually
Check for evidence of build-up or fouling on heat exchange surfaces. Clean as needed to ensure proper operation.	Annually
Check for proper fluid flow. Clean, adjust and repair as needed to restore proper flow.	Annually
Inspect air-cooled condenser surfaces. Repair or clean as needed.	Annually
Check low ambient head pressure control sequence for proper operation. Repair or replace components or modify software/algorithm to ensure proper operation.	Annually
Check compressor oil level and or pressure on refrigerant systems having oil level and or pressure measurement means. Repair, replace or adjust as needed to ensure proper control	Annually

Note a: Refer to Section 4.2.2.d for procedure to modify frequency.