

HVAC Characteristics

Information on the characteristics of the heating, ventilation, and air conditioning (HVAC) system(s) in the entire BASE building including types of ventilation, equipment configurations, and operation and maintenance issues was acquired by examining the building plans, conducting a building walk-through, and speaking with the building owner, manager, and/or operator. This information was collected using standard forms available in the appendices of the protocol (see [protocol](#)) during the building preliminary visit, and verified by the field team during the study week.

Test Space HVAC Inspections

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BASE Buildings Test Space HVAC Inspections: Mechanical Room General Condition

Mechanical Room General Condition	Number of Test Space Air Handlers ¹
Good	47
Fair	60
Poor	19
Total Number of Test Space Air Handlers	126
<u>Notes:</u> ¹ Data represent statistics for 126 test space air handling units indicating a response for mechanical room general condition.	

Variable Descriptions:

Mechanical Room General Condition describes the general condition of the mechanical room associated with a test space air handling unit. Mechanical room grading was only reported when the given air handling unit was situated in a mechanical room. The following grading system was used:

Good - Clean with no sign of water leakage.

Fair - Dusty and/or some evidence of water on floor.

Poor - Very dirty and/or standing water on floor.

BASE Buildings Test Space HVAC Inspections: Mechanical Room Other Uses

	Number of Test Space Air Handlers ¹	
	Mechanical Room Part of Return Air System	Mechanical Room Used for Storage
Other Uses of Mechanical Room	53	56
<u>Notes:</u> ¹ Data represent statistics for 126 study space air handling units located in mechanical rooms.		

Variable Descriptions:

Mechanical Room Part of Return Air System specifies whether the mechanical room housing the test space air handling unit was part of the return air system.

Mechanical Room Used for Storage specifies whether the mechanical room housing the test space air handling unit was used for general storage of materials.

BASE Buildings Test Space HVAC Inspections: System Fans and Airflow Directions

	Number of Test Space Air Handlers				
	Supply Fan Operating ¹	Correct Supply Fan Airflow Direction ²	Return Fan Operating ³	Correct Return Fan Airflow Direction ⁴	Correct Outdoor Air Intake Airflow Direction ⁵
Number of Test Space Air Handlers	136	135	45	42	130
Yes	134	134	42	42	129

Notes:
¹Data represent statistics for 136 study space air handling units. Five air handling units indicated no response for this variable.
²Data represent statistics for 135 study space air handling units. Six air handling units indicated no response for this variable.
³Data represent statistics for 45 study space air handling units equipped with return fans. 96 units did not have return fans.
⁴Data represent statistics for 42 study space air handling units. Three air handling units indicated no response for this variable.
⁵Data represent statistics for 130 study space air handling units. Eleven air handling units indicated no response for this variable.

Variable Descriptions:

Supply Fan Operating specifies whether the test space air handling unit supply fan was operating at the time of inspection.
Correct Supply Fan Airflow Direction specifies whether air flow delivered by the test space air handling unit supply fan discharged in the correct direction at the time of inspection.
Return Fan Operating specifies whether the test space air handling unit return fan was operating at the time of inspection.
Correct Return Airflow Direction specifies whether air flow through the test space air handling unit return fan was in the correct direction at the time of inspection.
Correct Outdoor Air Intake Airflow Direction specifies whether air flow through the test space air handling unit outdoor air intake was in the correct direction at the time of inspection.

BASE Buildings Test Space HVAC Inspections: Outdoor Air Intake Location

Outdoor Air Intake Location	Number of Test Space Air Handlers ¹
Ground Level	18
Rooftop	89
Wall	25
Total Number of Test Space Air Handlers	132

Notes:
¹Data represent statistics for 132 study space air handling units. Nine air handling units indicated no response for this variable.

Variable Descriptions:

Outdoor Air Intake Location describes the location of the outdoor air intake serving the test space air handling unit. The following locations apply:

Ground level is at or just above the level of the ground outside the building.

Rooftop is located on the roof of the building.

Wall is located on the vertical walls of the building.

BASE Buildings Test Space HVAC Inspections: Pollutant Sources Within 250 Feet From Outdoor Air Intake

Pollutant Sources Within 250 Feet From Outdoor Air Intake	Number of Test Space Air Handlers ¹
Standing Water	37
Sanitary Vents	74
Loading Dock	38
Vehicle Traffic	67
Exhaust Vents	97
Cooling Tower	64
Parking Garage	18
Trash Dumpster	27
Total Number of Test Space Air Handlers	141
Notes:	
¹ Column adds up to greater than the total number of test space air handlers because several test spaces reported more than one pollutant source within 250 feet from outdoor air intake.	

Variable Descriptions:

Pollutant Sources Within 250 Feet From Outdoor Air Intake provided a description of pollutant sources in the vicinity of the test space air handling unit outdoor air intake. The following sources were noted:

Standing Water (refers to puddles of water that are not appropriately draining)

Sanitary Vents (openings that relieve air from the buildings sanitary drain system)

Loading Dock

Vehicle Traffic

Exhaust Vents (openings or powered vents that relieve air from the building)

Cooling Towers (integral to many building cooling systems and are used to reject heat from the building cooling system)

Parking Garage

Trash Dumpster

BASE Buildings Test Space HVAC Inspections: Condition of Air Handling Unit (AHU) Components and Ductwork

Equipment Condition	Number of Test Space Air Handlers											
	AHU Housing - General ¹	AHU Housing - Sound Liner ²	Intake ³	Dampers ⁴	Coils ⁵	Drain Pans ⁶	Fan Belts ⁷	Ductwork - General ⁸	Ductwork - Seam Leakage ⁹	Duct Liners ¹⁰	Terminal Units- General ¹¹	Terminal Units- Dampers ¹²
Good	74	54	74	87	65	37	84	72	67	55	59	47
Fair	53	55	52	34	49	53	37	56	56	37	21	16
Poor	8	9	11	10	15	36	2	1	7	5	2	1
Total Number of Test Space Air Handlers	135	118	137	131	129	126	123	129	130	97	82	64

Notes:

¹Data represent statistics for 135 study space air handling units. Six air handling units indicated no response for this variable.

²Data represent statistics for 118 study space air handling units. Twenty-three air handling units indicated no response for this variable.

³Data represent statistics for 137 study space air handling units. Four air handling units indicated no response for this variable.

⁴Data represent statistics for 131 study space air handling units. Ten air handling units indicated no response for this variable.

⁵Data represent statistics for 129 study space air handling units. Twelve air handling units indicated no response for this variable.

⁶Data represent statistics for 126 study space air handling units. Fifteen air handling units indicated no response for this variable.

⁷Data represent statistics for 123 study space air handling units. Eighteen air handling units indicated no response for this variable.

⁸Data represent statistics for 129 study space air handling units. Twelve air handling units indicated no response for this variable.

⁹Data represent statistics for 130 study space air handling units. Eleven air handling units indicated no response for this variable.

¹⁰Data represent statistics for 97 study space air handling units. Forty-four air handling units indicated no response for this variable.

¹¹Data represent statistics for 82 study space air handling system with terminal units indicating a response for general condition.

¹²Data represent statistics for 64 study space air handling system terminal units indicating a response for damper condition.

Variable Descriptions:

Air Handler Housing - General Condition refers to the general condition of the test space air handling unit housing based on the following grading system:

- Good - Clean with metal panels securely in place
- Fair - Dusty and/or some gaps at seams
- Poor - Very dirty and/or many gaps at seams and/or metal panels loose

Air Handler Housing - Sound Liner refers to the general condition of the test space air handling unit sound liner based on the following grading system:

- Good - Clean, dry, and securely in place
- Fair - Moist in places and/or loose in some spots
- Poor - Very dirty and/or moist and falling from panels at many locations

Air Handler Components - Intake refers to the general condition of the test space air handling unit outdoor air intake based on the following grading system:

- Good - Clean insect screen, no debris inside plenum, linkages in good condition, and minimum dampers open
- Fair - Insect screen needs cleaning and/or some debris inside plenum and/or linkages need maintenance
- Poor - Insect screen partially blocked and/or much debris inside plenum and/or linkages broken or in very bad condition and/or minimum dampers closed

Air Handler Components - Dampers refers to the general condition of the test space air handling unit dampers based on the following grading system:

- Good - Linkages in good condition, dampers in correct positions, closed dampers fully closed and not excessively leaky, and properly positioned
- Fair - Linkages need maintenance and/or small deviations from correct positions and/or closed dampers leaking
- Poor - Linkages broken or in very bad condition and/or dampers not in correct positions

Air Handler Components - Coils refers to the general condition of the test space air handling unit coils based on the following grading system:

- Good - Coils clean
- Fair - Coils somewhat dirty
- Poor - Coils very dirty

Air Handler Components - Drain Pans refers to the general condition of the test space air handling unit condensate drain pans based on the following grading system:

- Good - Drain pans clean and draining well
- Fair - Some residue in pans but still draining
- Poor - Drain pans very dirty and/or poor drainage from pans

Variable Descriptions: (continued)

Air Handler Components - Fan Belts refers to the general condition of the test space air handling unit fan belts based on the following grading system:

- Good - Belts in good condition
- Fair - Belts somewhat worn and/or will need replacement soon
- Poor - Belts fraying or broken and/or need immediate replacement

Air Distribution Ductwork - General Condition refers to the general condition of the test space air handling unit distribution ductwork based on the following grading system:

- Good - Clean and dry, securely in place, and well labeled
- Fair - Some dust and moisture and/or some ducts not securely in place
- Poor - Very dirty and/or significant moisture and/or some ducts poorly secured

Air Distribution Ductwork - Leakage at Seams describes the general condition of the test space air handling unit distribution ductwork in terms of duct seam leakage based on the following grading system:

- Good - No or minimal leakage
- Fair - Small leaks at only some locations
- Poor - Large leaks at many locations

Air Distribution Ductwork - Liners refers to the general condition of the test space air handling unit distribution ductwork liners based on the following grading system:

- Good - Clean, dry, and securely in place
- Fair - Moist in places and/or loose in some spots
- Poor - Very dirty and/or moist and/or very loose at many locations

Terminal Units - General Condition refers to the general condition of the test space air handling unit distribution ductwork terminal units based on the following grading system:

- Good - Components clean and in good physical condition
- Fair - Components somewhat dirty and/or some deterioration evident
- Poor - Components very dirty and/or some components seriously deteriorated

Terminal Units - Dampers refers to the general condition of the test space air handling unit terminal unit dampers based on the following grading system:

- Good - Dampers clean and linkages in good condition
- Fair - Dampers somewhat dirty and/or some deterioration of linkages evident
- Poor - Dampers very dirty and/or linkages seriously deteriorated and/or dampers unable to modulate

BASE Buildings Test Space HVAC Inspections: Particulate Filtration Systems

Condition of Particulate Filtration Systems	Number of Test Space Handlers					
	Filtration Systems - General Condition ¹	Accessibility ¹	Filter Fit Into Frames ¹	Filter Condition ¹	Evenness of Filter Loading ¹	Resistance Indicator Provided ²
Good	76	121	104	72	112	
Fair	48	13	25	50	22	
Poor	12	2	7	14	2	
Yes (for Resistance Indicator)						68
Total Number of Test Space Air Handlers	136	136	136	136	136	134

Notes:
¹Data represent statistics for 136 study space air handling units. Five air handling units indicated no response for this variable.
²Data represent statistics for 134 study space air handling units. Seven air handling units indicated no response for this variable.

Variable Descriptions:

Particulate Filtration Systems - General Condition refers to the general condition of the test space air handling unit filtration systems (filters and filter rack frames) based on the following grading system:

- Good - Filters and frames in good physical condition and securely in position
- Fair - Filters somewhat old and/or some filters not securely in place
- Poor - Filters very old and/or deteriorating and/or some filters out of position and/or frames in very bad shape and/or no filters present

Particulate Filtration System - Accessibility refers to the accessibility of the test space air handling unit filtration systems based on the following grading system:

- Good - Adequate access to filter, adequate space for inspecting and changing filters
- Fair - Marginal access and/or very limited space for inspecting and changing filters
- Poor - No access doors and/or no means of changing filters

Particulate Filtration System - Filter Fit Into Frames refers to how well the filters fit into the filter frames based on the following grading system:

- Good - Filters fit very well into frames with minimal leakage around filters
- Fair - Filters fit marginally well into frames and/or some bypass around filters
- Poor - Filters fit poorly into frames and/or large amounts of bypass around filters

Particulate Filtration System - Filter Condition refers to the condition of the test space air handling unit filters based on the following grading system:

- Good - Filters in very good physical condition and either recently changed or no need to change anytime soon
- Fair - Filters somewhat old and/or will need to be changed soon
- Poor - Filters very dirty and/or need to be changed immediately

Particulate Filtration System - Evenness of Loading refers to the loading condition of the test space air handling unit filters based on the following grading system:

- Good - Filter loading very even across the face
- Fair - Some unevenness in loading
- Poor - Filter loading very uneven and/or some areas heavily loaded while others are like new

BASE Buildings Test Space HVAC Inspections: Humidifiers

Condition of Humidifiers	Number of Test Space Air Handlers	
	Humidifiers - General Condition ¹	Humidifier Drain Pan Condition ²
Good	7	7
Fair	5	5
Poor	2	3
Total Number of Test Space Air Handlers	14	15

Notes:

¹Data represent statistics for 14 study space air handling unit humidification systems indicating a response for general humidification system condition. Three test space air handlers with humidification systems indicated no response for this variable.

²Data represent statistics for 15 study space air handling unit humidification systems indicating a response for drain pan condition. Two test space air handlers with humidification systems indicated no response for this variable.

Variable Descriptions:

Humidifiers - General Condition refers to the general condition of the humidifiers installed in the test space air handling units based on the following grading system:

- Good - Components clean and in good physical condition with no corrosion
- Fair - Components somewhat dirty and/or some corrosion and/or some water leakage
- Poor - Components very dirty and/or heavy corrosion and/or large water leaks and/or some components not held securely in position

Humidifier Drain Pan Condition refers to the general condition of the drain pans installed in the test space air handling units based on the following grading system:

- Good - Drain pans clean and draining well
- Fair - Some residue in pans, but still draining
- Poor - Drain pans very dirty and/or poor drainage from pans

BASE Buildings Test Space HVAC Inspections: HVAC Control Systems

Condition of HVAC Control Systems	Number of Test Space Air Handlers	
	Control System - General Condition ¹	Control System - Sensor Condition ²
Good	97	91
Fair	31	34
Poor	5	3
Total Number of Test Space Air Handlers	133	128

Notes:
¹Data represent statistics for 133 study space air handling unit control systems. Eight air handling units indicated no response for this variable.
²Data represent statistics for 128 study space air handling unit control systems. Thirteen air handling units indicated no response for this variable.

Variable Descriptions:

Control System - General Condition refers to the general condition of the test space air handling unit control system based on the following grading system:

- Good - Components clean and in good physical condition
- Fair - Components somewhat dirty and/or some electrical and/or pneumatic connections loose
- Poor - Components very dirty and/or some electrical and/or pneumatic connections off

Control System Sensor Condition refers to the general condition of the test space air handling unit sensors based on the following grading system:

- Good - Sensors clean and securely in place
- Fair - Sensors somewhat dirty and/or some sensor connections loose
- Poor - Sensors very dirty and/or some sensors out of position

BASE Buildings Test Space HVAC Inspections: Cooling Towers

Condition of Cooling Towers ¹	Number of Test Space Air Handlers		
	Cooling Tower - General Condition	Cooling Tower - Surface Condition	Cooling Tower - Water Condition
Good	35	33	37
Fair	39	33	29
Poor	8	13	3
Total Number of Test Space Air Handlers Reporting	82	79	69

Notes:

¹The structure of the database required cooling tower inspection information to be reported for each air handling unit serving the test space. Therefore, study spaces served by more than one air handling unit may have duplicate tower inspection information when the chilled water system is serviced by a single cooling tower.

Variable Descriptions:

Cooling Towers - General Condition refers to the general condition of the cooling towers based on the following grading system:

- Good - Components clean and in good physical condition
- Fair - Components somewhat dirty and/or some deterioration evident
- Poor - Components very dirty and/or some components seriously deteriorated

Cooling Towers - Surface Condition refers to the condition of the cooling tower surfaces based on the following grading system:

- Good - Surfaces clean and in good physical condition
- Fair - Surfaces somewhat dirty and/or some deterioration evident
- Poor - Surfaces very dirty and/or heavy scaling and/or serious deterioration evident

Cooling Towers - Water Condition refers to the condition of the cooling tower water based on the following grading system:

- Good - Water very clear
- Fair - Water somewhat dirty
- Poor - Water very dirty