APPENDIX 4A. CHARACTERISTICS OF MEDIUM OFFICE REFERENCE BUILDING MODEL AND MODULAR CLASSROOM MODEL

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4A.1 INTRODUCTION

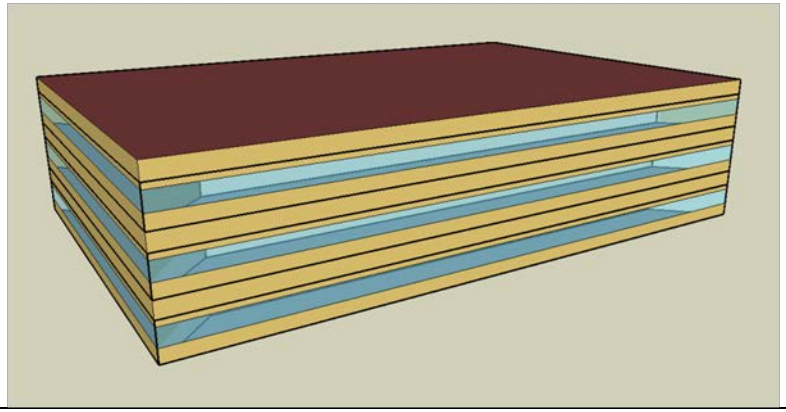
The analysis of baseline energy consumption for both water-cooled air conditioners and evaporatively cooled air conditioners discussed in chapter 4 were based on simulation data for DOE's medium office reference building model. This appendix provides key characteristics of the DOE medium office reference building model which formed the basis of this data. Further details and background may be found in the documentation and through review of the input files available at <http://www1.eere.energy.gov/buildings/commercial_initiative/new_construction.html>.

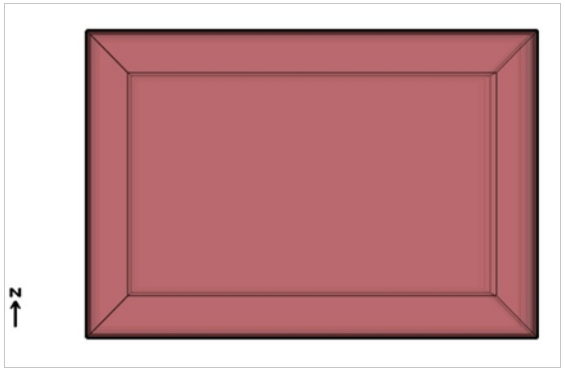
4A.2 MEDIUM OFFICE REFERENCE BUILDING MODEL DESCRIPTION

Table 4A.2.2 provides a high level description of the DOE medium office reference building model.

Table 4A.2.1. Description of DOE Reference Medium Office Building Model

	Item	Description		
Program				
	Vintage	**NEW CONSTRUCTION**		
	Location (Representing 8 Climate Zones)	Zone 1A: Miami (very hot, humid) Zone 2A: Houston (hot, humid) Zone 2B: Phoenix (hot, dry) Zone 3A: Memphis (warm, humid) Zone 3B: El Paso (warm, dry) Zone 3C: San Francisco (warm,marine)	Zone 4A: Baltimore (mild, humid) Zone 4B: Albuquerque (mild, dry) Zone 4C: Salem (mild, marine) Zone 5A: Chicago (cold, humid) Zone 5B: Boise (cold, dry)	Zone 6A: Burlington (cold, humid) Zone 6B: Helena (cold, dry) Zone 7: Duluth (very cold) Zone 8: Fairbanks (subarctic)
	Available fuel types	gas, electricity		
	Building Type (Principal Building Function)	**OFFICE**		
	Building Prototype	**Medium Office**		
Form				
	Total Floor Area (sq feet)	53,600 (163.8 ft x 109.2 ft)		

	Item	Description
	Building shape	
	Aspect Ratio	1.5
	Number of Floors	3
	Window Fraction (Window-to-Wall Ratio)	33%
	Window Locations	even distribution among all four sides
	Shading Geometry	none
	Azimuth	non-directional

	Item	Description	
	Thermal Zoning	Perimeter zone depth: 15 ft. Each floor has four perimeter zones and one core zone.Percentages of floor area: Perimeter 40%, Core 60%	
	Floor to floor height (feet)	13	
	Floor to ceiling height (feet)	9 (4 ft above-ceiling plenum)	
Architecture			
	Exterior walls		
	Construction	Steel-Frame Walls	
	U-factor (Btu / h * ft^2 * °F) and/or R-value (h * ft^2 * °F / Btu)	ASHRAE 90.1-1997 Requirements Nonresidential; Walls, Above-Grade, Steel-Framed	
	Roof		
	Construction	Built-up Roof: Roof membrane+Roof insulation+metal decking	
	U-factor (Btu / h * ft^2 * °F) and/or R-value (h * ft^2 * °F / Btu)	ASHRAE 90.1 Requirements Nonresidential; Roofs, Insulation entirely above deck	
	Window		

	Item	Description
	U-factor (Btu / h * ft^2 * °F)	ASHRAE 90.1 Requirements Nonresidential; Vertical Glazing, 31.1-40%, U_fixed
	SHGC (all)	
	Operable area	0
	Foundation	
	Foundation Type	Slab-on-grade floors (unheated)
	Construction	8" concrete slab poured directly on to the earth
	Thermal properties for ground level floor U-factor (Btu / h * ft2 * °F) and/or R-value (h * ft2 * °F / Btu)	ASHRAE 90.1 Requirements Nonresidential; Slab-on-Grade Floors, unheated
	Infiltration	
	Infiltration	Peak: 0.2016 cfm/sf of above grade exterior wall surface area (when fans turn off) Off Peak: 25% of peak infiltration rate (when fans turn on)
HVAC		
	System Type	
	Heating type	Gas furnace inside the packaged air conditioning unit
	Cooling type	Packaged air conditioning unit
	Distribution and terminal units	VAV terminal box with damper and electric reheating coil Zone control type: minimum supply air at 30% of the zone design peak supply air.
	HVAC Sizing	
	Air Conditioning	autosized to design day
	Heating	autosized to design day
	HVAC Control	
	Thermostat Setpoint	75°F Cooling/70°F Heating
	Thermostat Setback	80°F Cooling/60°F Heating
	Economizers	Various by climate location and cooling capacity Control type: differential dry bulb

	Item	Description
	Ventilation	ASHRAE Ventilation Standard 62.1-1999 0.10 cfm/sf.
	Supply Fan	
	Fan schedules	**See under HVAC Operation Schedules, Below**
	Supply Fan Total Efficiency (%)	60% to 62% depending on the fan motor size
	Supply Fan Pressure Drop	Varies depending on the Equipment Type
Internal Loads & Schedules		
	Lighting	
	Average power density (W/ft^2)	ASHRAE 90.1-2004 Lighting Power Densities Using the Building Area Method
	Schedule	See under **Schedules, Below**
	Daylighting Controls	ASHRAE 90.1 Requirements
	Occupancy Sensors	ASHRAE 90.1 Requirements
	Plug load	
	Average power density (W/ft^2)	0.75
	Schedule	See under **Schedules, Below**
	Occupancy	
	Average people	268 Total (5 persons/1000 sf)
	Schedule	See under **Schedules, Below**
Misc.		
	Elevator	
	Quantity	2
	Motor type	hydraulic
	Peak Motor Power (W/elevator)	16,055

	Item	Description
	Heat Gain to Building	Interior
	Peak Fan/lights Power (W/elevator)	161.9
	Exterior Lighting	
	Peak Power (W)	2,740
	Schedule	See under **Schedules, Below**

Table 4A.2.2. Key Schedules for DOE Reference Medium Office Building Model

Schedule	Type	Through	Day of Week	1 am	2 am	3 am	4 am	5 am	6 am	7 am	8 am	9 am	10 am	11 am	Noon
Internal Loads Schedules															
BLDG_LIGHT_SCH	Fraction	Through 12/31	WD, SummerDesign	0.05	0.05	0.05	0.05	0.05	0.1	0.1	0.3	0.9	0.9	0.9	0.9
			Sat, WinterDesign	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.1	0.3	0.3	0.3	0.3
			Sun, Hol, Other	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
BLDG_EQUIP_SCH	Fraction	Through 12/31	WD, SummerDesign	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.9	0.9	0.9	0.9
			Sat, WinterDesign	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5
			Sun, Hol, Other	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
BLDG_OCC_SCH	Fraction	Through 12/31	WD	0	0	0	0	0	0	0.1	0.2	0.95	0.95	0.95	0.95
			SummerDesign	0	0	0	0	0	0	1	1	1	1	1	1
			Sat, WinterDesign	0	0	0	0	0	0	0.1	0.1	0.3	0.3	0.3	0.3
			Sun, Hol, Other	0	0	0	0	0	0	0.05	0.05	0.05	0.05	0.05	0.05
HVAC Schedules															
HVACOperationSchd	on/off	Through 12/31	WD, SummerDesign	0	0	0	0	0	0	1	1	1	1	1	1
(Fan Schedule)			Sat, WinterDesign	0	0	0	0	0	0	1	1	1	1	1	1
			Sun, Hol, Other	0	0	0	0	0	0	0	0	0	0	0	0

Schedule	**Type**	**Through**	**Day of Week**	**1 pm**	**2 pm**	**3 pm**	**4 pm**	**5 pm**	**6 pm**	**7 pm**	**8 pm**	**9 pm**	**10 pm**	**11 pm**	**12 pm**
Internal Loads Schedules															
BLDG_LIGHT_SCH	Fraction	Through 12/31	WD, SummerDesign	0.8	0.9	0.9	0.9	0.9	0.5	0.3	0.3	0.2	0.2	0.1	0.05
			Sat, WinterDesign	0.15	0.15	0.15	0.15	0.15	0.05	0.05	0.05	0.05	0.05	0.05	0.05
			Sun, Hol, Other	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
BLDG_EQUIP_SCH	Fraction	Through 12/31	WD, SummerDesign	0.8	0.9	0.9	0.9	0.9	0.5	0.4	0.4	0.4	0.4	0.4	0.4
			Sat, WinterDesign	0.35	0.35	0.35	0.35	0.35	0.3	0.3	0.3	0.3	0.3	0.3	0.3
			Sun, Hol, Other	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
BLDG_OCC_SCH	Fraction	Through 12/31	WD	0.5	0.95	0.95	0.95	0.95	0.3	0.1	0.1	0.1	0.1	0.05	0.05
			SummerDesign	1	1	1	1	1	1	1	1	1	1	0.05	0.05
			Sat, WinterDesign	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0	0	0	0	0
			Sun, Hol, Other	0.05	0.05	0.05	0.05	0.05	0.05	0	0	0	0	0	0
HVAC Schedules															
HVACOperationSchd	on/off	Through 12/31	WD, SummerDesign	1	1	1	1	1	1	1	1	1	1	0	0
(Fan Schedule)			Sat, WinterDesign	1	1	1	1	1	1	0	0	0	0	0	0
			Sun, Hol, Other	0	0	0	0	0	0	0	0	0	0	0	0