Existing Mechanical System Description

Design Requirements & Intent

As the owner, the Baylor College of Medicine dictated the criteria for designing the mechanical systems of the Margaret M. Alkek Building for Biomedical Research. Within the design narrative put forth by BCM it states that the mechanical designer;

"…will implement the most appropriate and cost effective schemes for various materials, methods of distribution, etc. and make recommendations to the Design Team for the most advantageous system components on the basis of first cost vs. operating cost, reliability, safety and easy of maintenance."

BCM also put forth a list of characteristics that they deemed desirable in their HVAC system components. The list includes; a modular approach, energy responsiveness, flexibility for future changes, durability; ease of maintenance, reliability, and redundancy of critical components. BCM's design narrative goes on to stress that the layout of mechanical equipment should encourage routine preventative maintenance by providing easy access. Due to the location of the tower being on campus, BCM would like the building to utilize the campus chilled water loop as well as the TECO steam loop that also exists on the Texas Medical Center (which BCM is a part of). The overriding theme of the design narrative is that the system has a low first cost and is easy to maintain.

BCM's design narrative is extensive and sets many of the design conditions required for the mechanical systems in the research tower. BCM specifies the outdoor air design conditions for both winter and summer, which can be seen below in Figure 2. Also BCM puts forth requirements for internal heating loads, ventilation, pressurization and filtration for the various types of rooms in the building which can be reviewed in Figures 3 and 4.

Outside Conditions

1.	Summer:	97°F db/80°F wb
2.	Winter:	20°F
3.	Air Cooled Condensers:	115°F db

Figure 2

Space Type	Minimum O.A. Ventilation Rate	Summer Design		Winter Design		Pressurization	Minimum Supply Air Filtration	Remarks
		Max. Temperature (F)	Max. Relative Humidity (%rh)	Min. Temperature (F)	Min. Relative Humidity (%rh)			
Public Spaces and Office Areas								
Offices	20 cfm / person	74	55%	72	30%	Note 1	90%	-
Office Support	20 cfm / person	74	155%	72	30%	-	90%	-
Common Areas / Lobbies	20 cfm / person	74	55%	72	30%	Note 1	90%	-
Conference Rooms	20 cfm / person	74	55%	72	30%	-	90%	-
Conference Center	20 cfm / person	74	55%	72	30%	-	90%	-
Coffee / Break	20 cfm / person	74	55%	72	30%	-	90%	-
Laboratory Spaces								
Lab Workstation	100% / 6 ach	74	55%	72	30%	(-)	90%	-
Open Lab	100% / 6 ach	74	55%	72	30%	(--)	90%	-
Lab Support	100% / 6 ach	74	55%	72	30%	(---)	90%	-
Tissue Culture	100% / 6 ach	74	55%	72	30%	(+)	90%	-
Microscopy	100% / 6 ach	74	55%	72	30%	(+)	90%	-
Equipment Room	100% / 6 ach	74	55%	72	30%	(---)	90%	-
Glasswash	100% / 6 ach	74	65%	72	30%	(---)	90%	-
Glasswash Equipment	100% / 6 ach	85	65%	72	30%	(---)	90%	-
Darkroom	100% / 6 ach	74	55%	72	30%	(---)	90%	-
Cold Room	0.5 cfm / sq.ft.	-	-	-	-	None	90%	Note 2
Equipment Corridor	100% / 6 ach	78	55%	72	30%	(-)	90%	Note 5
Animal Facility Spaces								
Animal Holding Rooms	100% / 15 ach	Note 4	55%	Note 3	30%	Note 4	HEPA	Note 6

Space Type	Minimum O.A. Ventilation Rate	Summer Design		Winter Design		Pressurization	Minimum Supply Air Filtration	Remarks
		Max. Temperature (F)	Max. Relative Humidity (%rh)	Min. Temperature (F)	Min. Relative Humidity (%rh)			
Animal Procedure	100% / 15 ach	Note 4	55%	Note 3	30%	Note 4	HEPA	Note 6
Animal Hold Corridor	100% / 10 ach	74	55%	72	30%	Note 4	HEPA	Note 6
Animal Bedding / Feed	100% / 10 ach	74	55%	72	30%	(-)	HEPA	-
Dirty Cagewash	100% / 15 ach	78	65%	72	30%	(--)	HEPA	-
Clean Cagewash	100% / 15 ach	78	65%	72	30%	(+)	HEPA	-
Sterile Cagewash	100% / 15 ach	78	65%	72	30%	(++)	HEPA	-
Animal Corridor	100% / 10 ach	78	55%	72	30%	(+)	HEPA	-
Animal Gown	100% / 10 ach	78	55%	72	30%	(++)	HEPA	-
Specialty Spaces								
Specialty Lab	100% / 6 ach	74	55%	72	30%	TBD	90%	-
Miscellaneous Spaces								
Mech. / Elec. Rooms	Recirculation	85	60%	65	-	None	20%	-
Tel/Data Rooms	-	75	55%	60	30%	None	20%	-
Elevator Machine Rooms	-	78	60%	65	20%	None	20%	-
Receiving/Storage	100% Exhaust	78	-	65	-	None	20%	-
General Storage	-	78	-	72	-	None	20%	-
Hazardous Storage	100% Exhaust	78	-	72	-	(-)	20%	-
Waste Storage	100% Exhaust	78	-	72	-	(-)	20%	-
Toilet / Locker Rooms	100% Exhaust	78	-	72	-	(-)	80%	-
Housekeeping Closets	100% Exhaust	78	-	72	-	(-)	-	-

Note 1: Space pressurization is positive relative to adjacent labs and otherwise neutral.
Note 2: Environmental room temperature control is by Division 11.
Note 3: Animal holding and procedure spaces will have temperatures adjustable between 68°F and 80°F.
Note 4: Animal holding and procedure space pressurization will be adjustable from positive to negative.
Note 5: Equipment space will be provided with minimum air and house fed chilled water fan coil units to offset the equipment sensible heat load.
Note 6: Animal Room exhaust will include dander filter.

Figure 3

Space Type	People Load	Lighting Load	Equipment Load	Remarks
Public Spaces and Office Areas				
Offices	100 gsf/person	1.5 W/gsf	4.0 W/gsf	-
Office Support	250 gsf/person	1.5 W/gsf	4.0 W/gsf	-
Common Areas / Lobbies	250 gsf/person	1.5 W/gsf	0.5 W/gsf	-
Conference Rooms	25 gsf/person	1.5 W/gsf	2.0 W/gsf	-
Conference Center	25 gsf/person	1.5 W/gsf	0.5 W/gsf	-
Coffee / Break	25 gsf/person	1.5 W/gsf	0.5 W/gsf	-
Laboratory Spaces				
Lab Workstation	100 gsf/person	1.5 W/gsf	8 W/gsf	-
Open Lab	100 gsf/person	1.5 W/gsf	8 W/gsf	-
Lab Support	100 gsf/person	1.5 W/gsf	16 W/gsf	-
Tissue Culture	100 gsf/person	1.5 W/gsf	16 W/gsf	-
Microscopy	100 gsf/person	1.5 W/gsf	16 W/gsf	-
Equipment Room	100 gsf/person	1.5 W/gsf	16 W/gsf	-
Glasswash	200 gsf/person	1.5 W/gsf	Note 2	-
Glasswash Equipment	-	1.5 W/gsf	Note 2	-
Darkroom	100 gsf/person	1.5 W/gsf	8 W/gsf	-
Cold Room	-	-	-	-
Equipment Space	100 gsf/person	1.5 W/gsf	40W/gsf	-
Animal Facility Spaces				
Animal Holding Rooms	Note 1	1.5 W/gsf	Note 2	-
Animal Procedure	Note 1	1.5 W/gsf	Note 2	-
Animal Hold Corridor	200 gsf/person	1.5 W/gsf	-	-
Animal Bedding / Feed	200 gsf/person	1.5 W/gsf	Note 2	-
Dirty Cagewash	200 gsf/person	1.5 W/gsf	Note 2	-
Clean Cagewash	200 gsf/person	1.5 W/gsf	Note 2	-
Sterile Cagewash	200 gsf/person	1.5 W/gsf	Note 2	-
Animal Corridor	200 gsf/person	1.5 W/gsf	0.5 W/gsf	-
Animal Gown	100 gsf/person	1.5 W/gsf	0.5 W/gsf	-
Specialty Spaces				
Specialty Lab	100 gsf/person	1.5 W/gsf	8 W/gsf	
Miscellaneous Spaces				
Mech. / Elec. Rooms	-	-	-	Note 3
Tel/Data Rooms	-	1.5 W/gsf	Note 5	-
Elevator Machine Rooms	-	1.5 W/gsf	Note 2	-
Receiving/Storage	200 gsf/person	1.5 W/gsf	1.5 W/gsf	-
General Storage	200 gsf/person	1.5 W/gsf	1.5 W/gsf	-

Space Type	People Load	Lighting Load	Equipment Load	Remarks
Hazardous Storage	-	-	-	Note 4
Waste Storage	-	-	-	Note 4
Toilet / Locker Rooms	-	-	-	Note 4
Housekeeping Closets	-	-	-	Note 4

Figure 4

The building utilizes the campus chilled water loop for all chilled water production through a plate and frame heat exchanger. For domestic hot water and heating hot water the campus steam loop is utilized. Cost analyses were done for chilled water production as well as steam production for the Baylor College of Medicine campus. The electricity rate for BCM is $0.0515/kWh and the natural gas rate is $7.15/MMBTU. After the analysis was carried out it was found that steam production cost $0.0831/1000lbs of steam and chilled water production cost $0.0028/ton-hour. However, these prices did not factor into the decision to use the campus loops. BCM wants all their buildings on these loops for simplicity and that was the overriding factor.

Overview

Construction of the new research tower required BCM to replace one of the existing 800 ton chillers in the North Campus chiller plant with a 1300 ton centrifugal chiller to accommodate the extra load from the new research tower. The tower has access to the campus chilled water loop, as well as a high pressure steam loop. The campus chilled water is pumped into a plate and frame heat exchanger which is responsible for the process chilled water in the tower. The steam loop runs into 3 shell & tube clean steam generators which produce the steam needed in the building for process and humidification. The steam runs through the building in low pressure (15 psig) and medium pressure (80 psig) loops. A portion of the low pressure steam is sent to two shell & tube heat exchangers which generate the hot water for the building which feeds heating coils in the air handling units as well as all reheat coils.

There are 12 air handlers in total that supply the tower. Of the 12 air handlers 10 are located in the level 3 mechanical space and the other 2 are located on the roof. On the roof there is a 15,000 cfm and 10,000 cfm air handler which serves to pressurize the north and south stairwells, respectively. 4 25,000 cfm air handlers service the vivarium spaces, office and lab spaces on levels 1 and 2. There are 2 10,000 cfm air handlers that serve the level 3 mechanical space. The final 4 air handlers are 50,000 cfm and serve the main lab and office spaces on floors 4-8. Fan coil units are used in the emergency electrical rooms, elevator equipment room and in the eastern corridors on levels 4-8.

Levels 1 & 2 contain all of the animal research facilities and vivarium space and are served by the same 100% air system. A majority of the spaces on level 2 are variable volume however some of the vivarium and research spaces are constant volume. All the spaces on level 2 are exhausted through fume hoods or ductwork both of which are connected to exhaust fans located on the roof. Level 1 contains the lobby of the research tower. This lobby space and the attached corridor are variable volume spaces and are the only spaces on level 1 in which the air is returned instead of exhausted. However those spaces are supplied by and returned to an air system that is separate from the one that serves levels 1 and 2. Some of the vivarium spaces and animal research spaces on level 1 are constant volume, but most are variable volume however all spaces are exhausted through the same exhaust to level 2. The animal facility cagewash on level 1 is variable volume and is exhausted through exhaust diffusers as well as exhaust hoods. There is office space on level 1 which is variable volume however the air in this space is also exhausted and not returned. There are many vestibules which separate the “dirty” and “sterile” sides of level 1 which is divided by the cagewash. The “dirty” side is the office side and also where dirty cages are brought into the cagewash to be cleaned and the sterile side is the opposite side of the building where the sterile cages are removed from the cage wash.

Level 3 has only a few spaces to consider. In the northeastern corner of the building there is some storage space, corridor, glass wash and equipment service area that needs to be considers for heating and cooling. These spaces are all constant volume and exhausted. The rest of the space on level 3 is the mechanical area containing a

majority of the air handlers. There are louvers along the north side of the building that allow for outdoor air to come in and feed the air handlers.

On levels 4-8 the research laboratories are variable volume, as are the office spaces on the opposite side of the floors. However not all spaces on levels 4-8 are variable volume there are a some laboratory support spaces that are constant volume, typically the presence of a fume hood will indicate constant volume. The air within the laboratory and laboratory support spaces is exhausted through exhaust fans located on the roof via exhaust risers or through fume hoods that also exhaust through the roof. The laboratory and office spaces on levels 4-8 are separated by a pressurized corridor/interaction space. Air in the office side and separating corridor/interaction space is returned.

Existing Mechanical System Operation

This section of the report will describe the operation of the four main systems throughout the building. These systems are the steam, chilled water, heating hot water and air systems within the building. Each section will describe the system and reference and accompanying schematic of the system.

Building Steam System

The Margaret M. Alkek Building for Biomedical Research has an extensive steam system. Baylor College of Medicine's campus is located at the Texas Medical Center which produces its own steam via the Texas Medical Center Central Heating and Cooling Services Cooperative Association (TECO). The research tower utilizes this campus steam loop for many different uses.

The campus steam loop conditions are 398°F and 225 psig. The building draws in 26,000 lb/hr of steam at peak load. The amount of demand depends on the following; humidification in the air handlers, the amount of process of steam required, domestic hot water and heating hot water needs. The high pressure steam is brought into the building and then goes through a series of pressure reducing valves which creates medium pressure steam (80 psig) and low pressure steam (15 psig) loops.